



An inspection certificate is supplied as standard.  
Refer to page X for details.

## Linear Scales AT402E SERIES 539 — General-purpose Type

- Ideal for machine tools for heavy cutting as well as linear motors.
- Has multi-point elastic fixing for excellent vibration resistance (200m/s<sup>2</sup>), shock resistance (400m/s<sup>2</sup>), and temperature characteristics.
- The Absolute Interval Code allows for a simplified, low-cost ABS system.

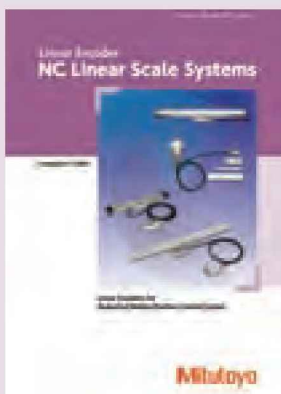


### SPECIFICATIONS

Model	AT402E
Effective range	140 to 3040mm (24 models)
Accuracy (20°C)	Effective range: 140 to 540mm: ±2µm Effective range: 640 to 940mm: ±3µm Effective range: 1040 to 3040mm: ±3µm/m
Output signal	Signal: 1Vp-p differential sinusoidal signal Differential reference point pulse: <b>Absolute Interval Code</b> compatible
Maximum response speed	120m/min (With sinusoidal signal amplitude of -3dB)
Signal output pitch	20µm
Protection Level	IP53
Operating temperature	0 to 45°C
Cable configuration	Type A: 3m flying lead cable Type B: 3m cable with European CNC connectors Type C: 3m cable with FANUC connectors

AT402E		Effective range L <sub>0</sub> (mm)	Signal cable length (m)
Order No.	Model		
539-371-□□	AT402E-140	140 (5.6")	3
539-373-□□	AT402E-240	240 (9.6")	
539-374-□□	AT402E-340	340 (13.6")	
539-375-□□	AT402E-440	440 (17.6")	
539-376-□□	AT402E-540	540 (21.6")	
539-377-□□	AT402E-640	640 (25.6")	
539-378-□□	AT402E-740	740 (29.6")	
539-379-□□	AT402E-840	840 (33.6")	
539-380-□□	AT402E-940	940 (37.6")	
539-381-□□	AT402E-1040	1040 (41.6")	
539-382-□□	AT402E-1140	1140 (45.6")	
539-383-□□	AT402E-1240	1240 (49.6")	
539-384-□□	AT402E-1340	1340 (53.6")	
539-385-□□	AT402E-1440	1440 (57.6")	
539-386-□□	AT402E-1540	1540 (61.6")	
539-387-□□	AT402E-1640	1640 (65.6")	
539-388-□□	AT402E-1740	1740 (69.6")	
539-389-□□	AT402E-1840	1840 (73.6")	
539-390-□□	AT402E-2040	2040 (81.6")	
539-391-□□	AT402E-2240	2240 (89.6")	
539-392-□□	AT402E-2440	2440 (97.6")	
539-393-□□	AT402E-2640	2640 (105.6")	
539-394-□□	AT402E-2840	2840 (113.6")	
539-395-□□	AT402E-3040	3040 (121.6")	

\* The indication of "□□" in the code numbers will be **01** for Type A, **02** for Type B, and **03** for Type C.



Refer to the NC Linear Scale Systems  
(Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales AT203 SERIES 539 — Standard Type



### SPECIFICATIONS

Model	AT203
Effective range	100 to 6000mm (42 models)
Accuracy (20°C)	Effective range: 100 to 1500mm (3+3L <sub>o</sub> /1000)μm Effective range: 1600 to 3000mm (5+5L <sub>o</sub> /1000)μm Effective range: 3250 to 6000mm (5+8L <sub>o</sub> /1000)μm
Output signal	Two 90° phase-shifted square wave signals
Maximum response speed	120m/min (50m/min when the effective range is 3250 to 6000mm)
Resolution	0.1/0.5/1μm (Switchable by the DIP switches)
Scale reference point	Output in 50mm pitch
Protection Level	IP53
Operating temperature	0°C to 45°C

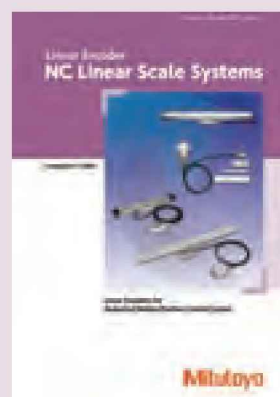
\* The indication accuracy does not include quantizing error. L<sub>o</sub>: Effective range (mm)

AT203		Effective range L <sub>o</sub> (mm)	Signal cable length (m)
Order No.	Model		
539-411-30	AT203-100	100 (4")	5
539-412-30	AT203-150	150 (6")	
539-413-30	AT203-200	200 (8")	
539-414-30	AT203-250	250 (10")	
539-415-30	AT203-300	300 (12")	
539-416-30	AT203-350	350 (14")	
539-417-30	AT203-400	400 (16")	
539-418-30	AT203-450	450 (18")	
539-419-30	AT203-500	500 (20")	
539-421-30	AT203-600	600 (24")	
539-423-30	AT203-700	700 (28")	
539-424-30	AT203-750	750 (30")	
539-425-30	AT203-800	800 (32")	
539-426-30	AT203-900	900 (36")	
539-427-30	AT203-1000	1000 (40")	
539-428-30	AT203-1100	1100 (44")	
539-429-30	AT203-1200	1200 (48")	
539-430-30	AT203-1300	1300 (52")	
539-431-30	AT203-1400	1400 (56")	
539-432-30	AT203-1500	1500 (60")	
539-433-30	AT203-1600	1600 (64")	
539-434-30	AT203-1700	1700 (68")	
539-435-30	AT203-1800	1800 (72")	
539-436-30	AT203-2000	2000 (80")	
539-437-30	AT203-2200	2200 (88")	
539-438-30	AT203-2400	2400 (96")	
539-439-30	AT203-2500	2500 (100")	
539-440-30	AT203-2600	2600 (104")	
539-441-30	AT203-2800	2800 (112")	
539-442-30	AT203-3000	3000 (120")	
539-443-30	AT203-3250	3250 (130")	
539-444-30	AT203-3500	3500 (140")	
539-445-30	AT203-3750	3750 (150")	
539-446-30	AT203-4000	4000 (160")	
539-447-30	AT203-4250	4250 (170")	
539-448-30	AT203-4500	4500 (180")	
539-449-30	AT203-4750	4750 (190")	
539-450-30	AT203-5000	5000 (200")	
539-451-30	AT203-5250	5250 (210")	
539-452-30	AT203-5500	5500 (220")	
539-453-30	AT203-5750	5750 (230")	
539-454-30	AT203-6000	6000 (240")	



An inspection certificate is supplied as standard. Refer to page X for details.

- The travel length of the linear scale is output with 2-phase square wave signals, which can be used as a feedback signal for NC machine tools.
- The pulse signal unit (PSU) is no longer needed, and the **AT203** can be directly connected to the NC machine tool.



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.



An inspection certificate is supplied as standard. Refer to page X for details.

- Slim, sealed type incremental linear scales suitable for feedback systems in NC machine tools.
- Direct connection with NC machine tools is possible.

## Linear Scales AT216-T SERIES 539 — Slim Sealed Type



### SPECIFICATIONS

Model	AT216-T
Effective range	100 to 1500mm (20 models)
Resolution	5 $\mu$ m
Accuracy (20°C)	(5+5L <sub>o</sub> /1000) $\mu$ m
Output signal	Two 90° phase-shifted sinusoidal signals
Maximum response speed	48m/min
Signal output pitch	20 $\mu$ m
Scale reference point	Output in 50mm pitch
Protection Level	IP53
Operating temperature	0 to 45°C

\* The indication accuracy does not include quantizing error. L<sub>o</sub>: Effective range (mm)

AT216-T		Effective range L <sub>o</sub> (mm)	Signal cable length (m)
Order No.	Model		
529-431-3	AT216-100T	100 (4")	5
529-432-3	AT216-150T	150 (6")	
529-433-3	AT216-200T	200 (8")	
529-434-3	AT216-250T	250 (10")	
529-435-3	AT216-300T	300 (12")	
529-436-3	AT216-350T	350 (14")	
529-437-3	AT216-400T	400 (16")	
529-438-3	AT216-450T	450 (18")	
529-439-3	AT216-500T	500 (20")	
529-441-3	AT216-600T	600 (24")	
529-443-3	AT216-700T	700 (28")	
529-444-3	AT216-750T	750 (30")	
529-445-3	AT216-800T	800 (32")	
529-446-3	AT216-900T	900 (36")	
529-447-3	AT216-1000T	1000 (40")	
529-448-3	AT216-1100T	1100 (44")	
529-449-3	AT216-1200T	1200 (48")	
529-450-3	AT216-1300T	1300 (52")	
529-451-3	AT216-1400T	1400 (56")	
529-452-3	AT216-1500T	1500 (60")	

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales AT217-TL / AT217-TL-B SERIES 539 — Slim Sealed Type



An inspection certificate is supplied as standard. Refer to page X for details.

- 0.5µm resolution is now available in addition to 1.0µm.
- Improved current consumption due to 3.3V operation.

### SPECIFICATIONS

Model	AT217-TL/AT217-TL-B
Effective range	100 to 1500mm (20 models)
Resolution	1µm
Accuracy (20°C)	(5+5Lo/1000)µm
Output signal	Two 90° phase-shifted sinusoidal signals
Maximum response speed	50m/min
Signal output pitch	20µm
Scale reference point	Output in 50mm pitch
Protection Level	IP53
Operating temperature	0 to 45°C

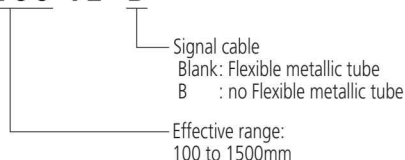
\* The indication accuracy does not include quantizing error. Lo: Effective range (mm)

AT217-TL		Effective range Lo (mm)	Signal cable length (m)
Order No.	Model		
529-461-5	AT217-100TL	100 (4")	5
529-462-5	AT217-150TL	150 (6")	
529-463-5	AT217-200TL	200 (8")	
529-464-5	AT217-250TL	250 (10")	
529-465-5	AT217-300TL	300 (12")	
529-466-5	AT217-350TL	350 (14")	
529-467-5	AT217-400TL	400 (16")	
529-468-5	AT217-450TL	450 (18")	
529-469-5	AT217-500TL	500 (20")	
529-471-5	AT217-600TL	600 (24")	
529-473-5	AT217-700TL	700 (28")	
529-474-5	AT217-750TL	750 (30")	
529-475-5	AT217-800TL	800 (32")	
529-476-5	AT217-900TL	900 (36")	
529-477-5	AT217-1000TL	1000 (40")	
529-478-5	AT217-1100TL	1100 (44")	
529-479-5	AT217-1200TL	1200 (48")	
529-480-5	AT217-1300TL	1300 (52")	
529-481-5	AT217-1400TL	1400 (56")	
529-482-5	AT217-1500TL	1500 (60")	

AT217-TL-B		Effective range Lo (mm)	Signal cable length (m)
Order No.	Model		
529-461-7	AT217-100TL-B	100 (4")	5
529-462-7	AT217-150TL-B	150 (6")	
529-463-7	AT217-200TL-B	200 (8")	
529-464-7	AT217-250TL-B	250 (10")	
529-465-7	AT217-300TL-B	300 (12")	
529-466-7	AT217-350TL-B	350 (14")	
529-467-7	AT217-400TL-B	400 (16")	
529-468-7	AT217-450TL-B	450 (18")	
529-469-7	AT217-500TL-B	500 (20")	
529-471-7	AT217-600TL-B	600 (24")	
529-473-7	AT217-700TL-B	700 (28")	
529-474-7	AT217-750TL-B	750 (30")	
529-475-7	AT217-800TL-B	800 (32")	
529-476-7	AT217-900TL-B	900 (36")	
529-477-7	AT217-1000TL-B	1000 (40")	
529-478-7	AT217-1100TL-B	1100 (44")	
529-479-7	AT217-1200TL-B	1200 (48")	
529-480-7	AT217-1300TL-B	1300 (52")	
529-481-7	AT217-1400TL-B	1400 (56")	
529-482-7	AT217-1500TL-B	1500 (60")	

### Meaning of Model No.

AT217 - 0100 TL - B





An inspection certificate is supplied as standard. Refer to page X for details.

- This is a slim, sealed, 2-phase, square wave scale that can be directly connected to a control unit.
- Scale alarm display LED allows for easy maintenance.
- A wide range of specifications to best suit your application.
- Suitable for the control of semiconductor manufacturing systems and NC machine tools.

## Linear Scales AT211-A(Multipoint mounting) AT211-B(Double-end mounting) SERIES 539 — Slim and high speed Type

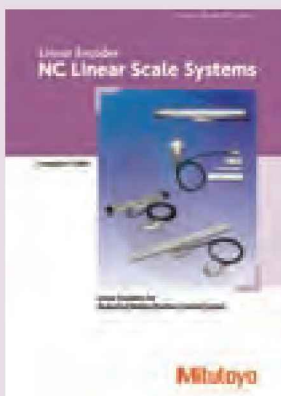
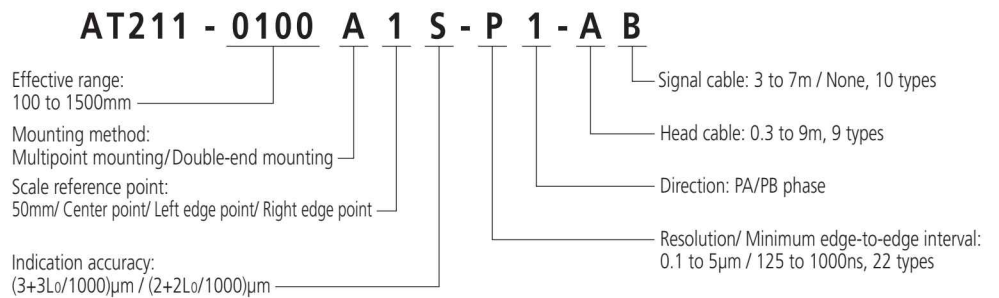


### Common specification

Model	AT211
Effective range*	100 to 1500mm (20 models)
Accuracy (20°C)*	(3+3L <sub>0</sub> /1000)μm L <sub>0</sub> : effective range (mm) (2+2L <sub>0</sub> /1000)μm (L <sub>0</sub> ≤500mm)
Output signal	Two 90° phase-shifted square wave signals
Maximum response speed*	5.4 to 120m/min (varies depending on the resolution or minimum edge interval)
Resolution*	0.1/ 0.2/ 0.5/ 1.0/ 2.5/ 5.0μm
Scale reference point*	50mm/ Center point/ Left edge point/ Right edge point
Protection Level	IP53
Operating temperature	0 to 45°C

\* Desired specification is selectable.

### Meaning of Model No.



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales ABS AT300 SERIES 539 — Standard Type



**ABSOLUTE™** (Refer to page X for details.)



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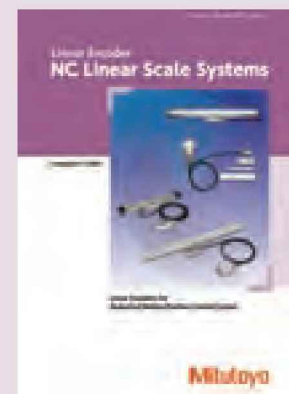
- ABSOLUTE linear encoder incorporates both our unique electrostatic capacity and photoelectric technology.
  - \*Refer to page H-30 "Quick Guide to Precision Measuring Instruments" for details of the principle of the absolute linear scale.
- Drastically reduced power consumption since there are no backup batteries.
- Easy operation because no recalibration is required at startup or after a power failure.
- Suitable for position feedback in machinery requiring high-accuracy, high-speed control.
- Improved environmental resistance against mechanical vibration and noise.

## SPECIFICATIONS

Model	ABS AT353	ABS AT343	ABS AT343A	ABS AT303	ABS AT303A
Applicable system	FANUC Ltd. NC Control unit	Mitsubishi Electric Corporation MITSUBISHI CNC series	Mitsubishi Electric Corporation MR-J3	Amplifiers supporting Mitutoyo ENSIS interface	
Resolution	0.05μm				
Maximum response speed	120m/min				
Effective range	100 to 3000mm				
Accuracy (20°C)*	(3+3L <sub>o</sub> /1000)μm, (5+5L <sub>o</sub> /1000)μm when the effective range is 1600mm or more				

\* The indication accuracy does not include quantizing error. L<sub>o</sub>: Effective range (mm)

\* A wide variety of special orders are available.



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.



An inspection certificate is supplied as standard. Refer to page X for details.

- Slim shape is suitable for space-saving designs.
- The high rigidity **ABS AT500-S** series has vibration resistance, shock resistance and temperature control, the **ABS AT500-H** series offers excellent temperature control and high accuracy.
- Scale alarm display LED allows for easy maintenance.
- Supports the interfaces of various manufacturers allowing a variety of system configurations.

## Linear Scales ABS AT500 SERIES 539 — Slim Type



### SPECIFICATIONS

Model	High rigidity type		High accuracy type	
	ABS AT500-SC	ABS AT500-HC	ABS AT500-HL/HR	
Resolution	0.005 $\mu$ m*/0.05 $\mu$ m (0.01 $\mu$ m for AT524 and 0.001 $\mu$ m for AT527)			
Maximum response speed	150m/min (72m/min for the H series whose resolution is 0.005 $\mu$ m)			
Effective range	100 to 2200mm	100 to 1000mm	100 to 350mm	
Accuracy (20°C)*2	(3+3L $\alpha$ /1000) $\mu$ m		(2+2L $\alpha$ /1000) $\mu$ m	
Reference point of expansion influenced by the temperature fluctuation	Center of the effective measuring length		Edge of the effective measuring length HL: "+" side of the absolute value HR: "-" side of the absolute value	

\*1: The exact value is 0.0048828125 $\mu$ m since the 20 $\mu$ m signal is divided by 4096.

\*2: The indication accuracy does not include quantizing error. L $\alpha$ : Effective range (mm)

### Meaning of Model No.

ABS AT5□□□ - □□□ - □□

Resolution/Applicable system

Effective range

Model	Resolution	Applicable system
ABS AT553	0.05 $\mu$ m	FANUC Ltd.
ABS AT555	0.005 $\mu$ m	NC Control unit
ABS AT543	0.05 $\mu$ m	Mitsubishi Electric Corporation
ABS AT545	0.005 $\mu$ m	MITSUBISHI CNC series
ABS AT543A	0.05 $\mu$ m	Mitsubishi Electric Corporation
ABS AT545A	0.005 $\mu$ m	MELSERVO series
ABS AT573A	0.05 $\mu$ m	Panasonic Corporation, Motor Business Unit MINAS series*1
ABS AT503	0.05 $\mu$ m	Amplifiers supporting Mitutoyo ENSIS interface*1
ABS AT503A		
ABS AT505	0.005 $\mu$ m	(Nikki Denso Co., Ltd., Servoland corporation, PMAC Japan Co., Ltd.)
ABS AT505A		
ABS AT524	0.01 $\mu$ m	Siemens AG
ABS AT527	0.001 $\mu$ m	SINAMICS/SINUMERIK series (supporting DRIVE-CLiQ)

Reference point of expansion on the scale unit influenced by temperature fluctuation\*

C: Center of the effective range

L: "+" side of the absolute value

R: "-" side of the absolute value

\* "L" or "R" is marked only for the high accuracy type.

Type of the scale unit

S: High rigidity type

H: High accuracy type

Note: "Reference point of expansion"

The scale unit expands or contracts influenced by the temperature fluctuation.

The mechanical reference point of expansion is defined as the reference point.

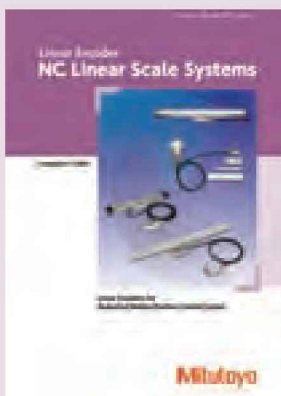
\*ABS AT5□□□

Transmission method

Nothing: Full duplex communication

A: Half-duplex communication

\*1: Please contact each manufacturer for details.



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales ABS AT715 SERIES 539 — Slim Type



### SPECIFICATIONS

Model	ABS AT715	
Detection method	Electromagnetic induction	
Minimum resolution	0.001mm to 0.01mm (Changeable by parameter on the KA-200/KLD-200 counter)	
Effective range	100 to 3000mm	
Accuracy (20°C)	±5µm (Lo: 100 to 500mm), ±7µm (Lo: 600 to 1800mm), ±10µm (Lo: 2000 to 3000mm) Lo: Effective range (mm)	
Maximum response speed	50m/min	
Protection level	IP67	
Sliding force	5N or less	
Signal cable	Standard Accessories Refer to the dimension table shown below for the length.	
Extension cable (optional)	Length	Order No.
	2m	09AAB674A
	5m	09AAB674B
	7m	09AAB674C
Connectable counter	KA-200 Counter / KLD-200 Counter	

AT715		Effective range Lo (mm)	Signal cable length (m)
Order No.	Model		
539-801	ABS AT715-100	100 (4")	3.5
539-802	ABS AT715-150	150 (6")	
539-803	ABS AT715-200	200 (8")	
539-804	ABS AT715-250	250 (10")	
539-805	ABS AT715-300	300 (12")	
539-806	ABS AT715-350	350 (14")	
539-807	ABS AT715-400	400 (16")	
539-808	ABS AT715-450	450 (18")	
539-809	ABS AT715-500	500 (20")	
539-811	ABS AT715-600	600 (24")	
539-813	ABS AT715-700	700 (28")	
539-814	ABS AT715-750	750 (30")	
539-815	ABS AT715-800	800 (32")	
539-816	ABS AT715-900	900 (36")	
539-817	ABS AT715-1000	1000 (40")	
539-818	ABS AT715-1100	1100 (44")	
539-819	ABS AT715-1200	1200 (48")	
539-820	ABS AT715-1300	1300 (52")	
539-821	ABS AT715-1400	1400 (56")	
539-822	ABS AT715-1500	1500 (60")	
539-823	ABS AT715-1600	1600 (64")	
539-824	ABS AT715-1700	1700 (68")	
539-825	ABS AT715-1800	1800 (72")	
539-860	ABS AT715-2000	2000 (80")	
539-861	ABS AT715-2200	2200 (88")	
539-862	ABS AT715-2400	2400 (96")	
539-863	ABS AT715-2500	2500 (100")	
539-864	ABS AT715-2600	2600 (104")	
539-865	ABS AT715-2800	2800 (112")	
539-866	ABS AT715-3000	3000 (120")	
			5
			7*1

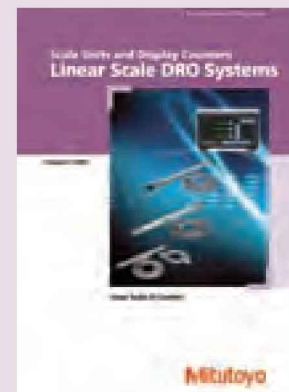
\*1: Combination of a 5m signal cable and a 2m extension cable

ABSOLUTE™ (Refer to page X for details.)



An inspection certificate is supplied as standard. Refer to page X for details.

- Electromagnetic induction principle means scales are unaffected by contamination
- Absolute scales have eliminated the need for origin restoration, also drastically reduces power consumption.



Refer to the Linear Scale DRO Systems (Catalog No. E13000) for more details.



- The KA-200 Counter has a lathe function, as well as standard functions (parameter selection).
- Compact, light and multifunctional.
- Sub-display enables easy setting.
- The RS-232C interface enables connection to a PC or printer.
- Text data can be output using the USB interface (optional).

#### Optional Accessories

- Code out unit: **No.06AET993**
- Extension cable: **No.06ACF941**
- Foot switch for USB: **No.937179T**

## KA-200 Counter SERIES 174 — Standard Type



174-185  
KA-213

#### SPECIFICATIONS

Order No.	174-183 <input type="checkbox"/>	174-185 <input type="checkbox"/>
Model	KA-212	KA-213
Number of axes to be displayed	2 axes	3 axes
Resolution	When <b>AT100</b> is connected: 0.05 - 0.0001mm When <b>AT715</b> is connected: 0.01 - 0.001mm	
Display/digit	Main display: 9 digits including sign Sub display: 8 digits	
Power supply voltage	100V-240V AC, 50/60Hz	
Power consumption	20-25VA	
Operating temperature/humidity range	0 to 45°C / 20 to 80% (Operational environment) -10 to 60°C / 20 to 80% (Storage environment)	
Dimensions	300(W)×70(D)×167(H)mm	
Mass	1.25kg	1.3kg

: 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.

- Counter designed to signal when a linear scale displacement value and a preset limit value coincide.
- Two types of limit settings are available: 2-step (**KLD-212**) and 4-step (**KLD-214**).

#### Optional Accessories

- External zero-set box (1 axis): **No.936551**
- External load box (1 axis, for the RS-232C output): **No.937326**

## KLD-200 Counter SERIES 174 — Special Purpose Type with Limit Signal Output



174-147  
KLD-214

#### SPECIFICATIONS

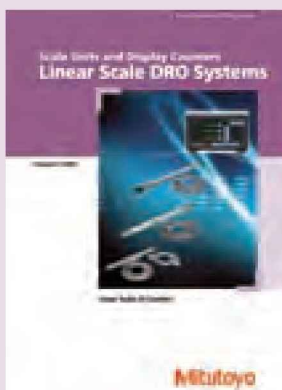
Order No.	174-146 <input type="checkbox"/>	174-147 <input type="checkbox"/>
Model	KLD-212	KLD-214
Number of axes to be displayed	1 axis	
Number of limit values to be set	2	4
Resolution	(Changeable according to the parameter) When <b>AT100</b> series is connected: 0.05 to 0.0001mm When <b>AT715</b> is connected: 0.01 to 0.001mm	
Output	RS-232C (provided as standard)	
Display	7-segment LCD/ 7 digit*1	
Power supply voltage	100V-240V AC, 50/60Hz	
Power consumption	25 VA	
Operating temperature/ humidity range	0 to 45°C / 20 to 80%	
Dimensions	332(W)×163(D)×204(H)mm	
Mass	3.0kg	3.1kg

\*1: Count range when the minimum reading is 0.001mm: 99999.999 to -9999.999

Count range when the minimum reading is 0.005mm: 99999.995 to -9999.995

: 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.



Refer to the Linear Scale DRO Systems (Catalog No.E13000) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear scale counter

### FUNCTIONS

Function	Type	High performance  KA-200 Counter	Limit signal output  KLD-200 Counter
	Zero-setting	 ZERO	●
Preset	 P.SET	●	●
Resolution setting	 0.0005 / 0.1	●	●
Measurement direction setting	 ← →	●	●
mm/inch conversion	 mm / E	●	●
Diameter display	 DIA	●	●
Scale reference point setting <sup>-1</sup>	 ▽ SET	●	●
1/2 calculation	 1/2	●	●
Coordinate system switching	 N	●	—
Bolt-hole circle machining	 ● <sup>-2</sup>	● <sup>-2</sup>	—
Pitch machining	 ●	●	—
Zero approach machining (INC mode)	 ●	●	—
Addition of 2-scale data	 Z1+Z2	● <sup>-3</sup>	—
Linearity error compensation	 ●	●	●
Pitch error compensation	 ● <sup>-1</sup>	● <sup>-1</sup>	—
Smoothing	 1234	●	●
Memory backup	 ●	●	●
Expansion/contraction coefficient setting	 —	—	●
Lower digit blanking out	 123	●	●
External zero-setting	 ZERO SET INPUT	▲ <sup>-4</sup>	●
RS-232C interface unit	 RS-232C OUTPUT	▲ <sup>-4</sup>	●
USB output	 USB	▲ <sup>-5</sup>	—
Limit signal output	 LIMIT OUTPUT	—	●
Error message	 Error	●	●

●: Standard function, ▲: Optional function, —: Not available

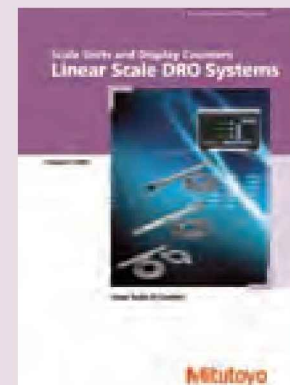
-1: Only available when connecting with AT100 series.

-2: Not available in single-axis use

-3: Only available for 3-axis model

-4: Code out unit (06AET993) is required.

-5: Text can be output by interface unit and foot switch



Refer to the Linear Scale DRO Systems (Catalog No.E13000) for more details.



An inspection certificate is supplied as standard. Refer to page X for details.

- Outputs two-phase sinusoidal wave signal, two-phase pulse signal, and 1Vp-p at 4μm pitch.
- High accuracy type, 0.5μm class (effective range up to 300mm)
- Has a thinner detector head (thickness 11.5mm).
- The maximum effective measurement range of 3000mm enables use on large machines.
- 4 different types available for each signal output specification.
- LED display function for indicating signal errors.
- Along with the output specifications of 2-phase sinusoidal wave and 2-phase square wave, the output specification of 1Vp-p wave is also available.

## Linear Scales ST36 SERIES 579 — High Accuracy Type

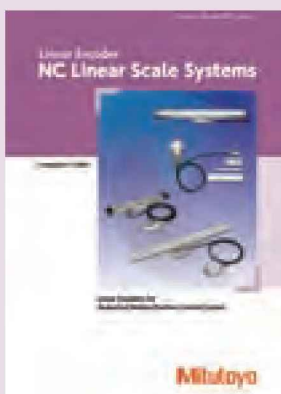


### SPECIFICATIONS

Model	ST36
Detection method	Reflective photoelectric linear encoder
Output signal	<b>ST36A:</b> 2-phase sinusoidal signals <b>ST36B:</b> 2-phase square wave signals, Alarm reset input <b>ST36C:</b> 2-phase square wave signals, 2-phase sinusoidal signals <b>ST36D:</b> 1Vp-p differential sinusoidal signals
Main scale grating pitch	8μm
Signal output pitch	4μm
Effective range	10 to 3000mm
Accuracy (20°C)*1	±0.5μm, ±1μm, ±2μm/m
Maximum response speed*2	1200mm/s
Scale reference point	Center point (10 to 80mm) 50mm pitch (100 to 3000mm)
Power supply voltage	DC5V ±5%
Operating temperature/ humidity range	0 to 40°C/ 20 to 80% (no condensation)
Storage temperature/ humidity range	-20 to 60°C/ 20 to 80% (no condensation)
Head cable length	1m (high-flex connecting cable)

*1:	Effective range	Accuracy
	300mm or less	±0.5μm
	500mm or less	±1μm
	1000mm or less	±2μm
	3000mm or less	±2μm/m

\*2: Maximum response speed when the sinusoidal signals are output



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales ST24 SERIES 579 — Standard Type



An inspection certificate is supplied as standard. Refer to page X for details.

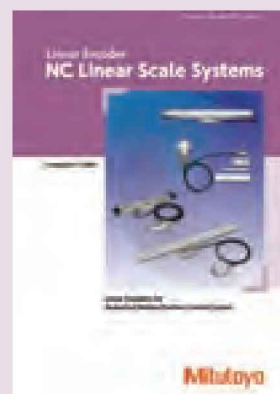
- Outputs 2-phase square and sinusoidal wave signals at 10 $\mu$ m pitch.
- Has a thinner detector head (thickness 11mm).
- The maximum effective measurement range of 3000mm enables use on large machines.
- 2 different types available for each signal output specification
- LED display function for indicating signal errors.

## SPECIFICATIONS

Model	ST24
Detection method	Reflective photoelectric linear encoder
Output signal	<b>ST24B:</b> 2-phase square wave signals, Alarm reset input <b>ST24C:</b> 2-phase square wave signals, 2-phase sinusoidal signals
Main scale grating pitch	20 $\mu$ m
Signal output pitch	10 $\mu$ m
Effective range	10 to 3000mm
Accuracy (20°C)*1	$\pm 1\mu$ m, $\pm 2\mu$ m, $\pm 3\mu$ m/m
Maximum response speed*2	1200mm/s
Scale reference point	Center point (10 to 80mm) 50mm pitch (100 to 3000mm)
Power supply voltage	DC5V $\pm 5\%$
Operating temperature/ humidity range	0 to 40°C/ 20 to 80% (no condensation)
Storage temperature/ humidity range	-20 to 60°C/ 20 to 80% (no condensation)
Head cable length	1m (high-flex connecting cable)

*1:	Effective range	Accuracy
	300mm or less	$\pm 1\mu$ m
	500mm or less	$\pm 2\mu$ m
	1000mm or less	$\pm 3\mu$ m
	3000mm or less	$\pm 3\mu$ m/m

\*2: Maximum response speed when the sinusoidal signals are output



Refer to the NC Linear Scale Systems (Catalog No. E13005) for more details.



An inspection certificate is supplied as standard.  
Refer to page X for details.

- The maximum response speed is 5000mm/s. (When resolution is 1μm and the minimum edge interval is 125ns)
- Ultra-compact detector control unit allows use in applications where space-saving design is important.
- The maximum effective measurement length of 3000mm enables use on large machines.
- Simultaneous output of 2-phase square wave signals (maximum resolution: 0.2μm) and 2-phase sinusoidal wave signals (main signal: 40μm) is available.
- LED display function for indicating signal errors.
- Equipped with scale reference point output.

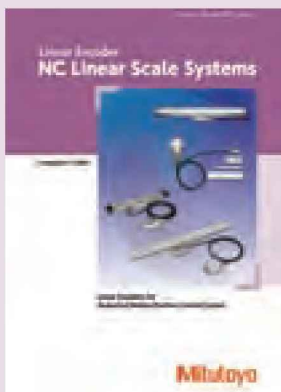
## Linear Scales ST422 SERIES 579 — Compact Type



### SPECIFICATIONS

Model	ST422
Detection method	Reflective photoelectric linear encoder
Output signal	2-phase sinusoidal signals, 2-phase square wave signals
Main scale grating pitch	40μm
Signal output pitch	40μm
Effective range	10 to 3000mm
Accuracy (20°C)*1	±1μm, ±2μm, ±3μm/m
Resolution	0.2μm/ 0.5μm/ 1μm/ 5μm (Selectable with internal switch)
Scale reference point	Center point (10 to 75mm)/ 50mm pitch (100mm or more)
Maximum response speed	5000mm/s (varies depending on the setting)
Minimum edge-to-edge interval	125ns/ 250ns/ 500ns/ 1μs (selectable with internal switch)
Operating temperature/ humidity range	0 to 40°C, RH 20 to 80% (no condensation)
Storage temperature/ humidity range	-20 to 60°C, RH 20 to 80% (no condensation)
Head cable length	1m

*1:	Effective range	Accuracy
	300mm or less	±1μm
	500mm or less	±2μm
	1000mm or less	±3μm
	3000mm or less	±3μm/m

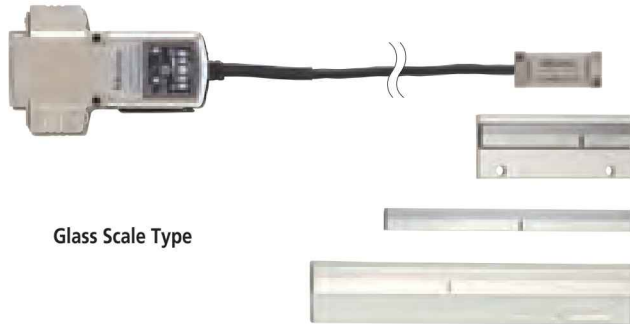


Refer to the NC Linear Scale Systems  
(Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales ST46-EZA SERIES 579 — Compact Type



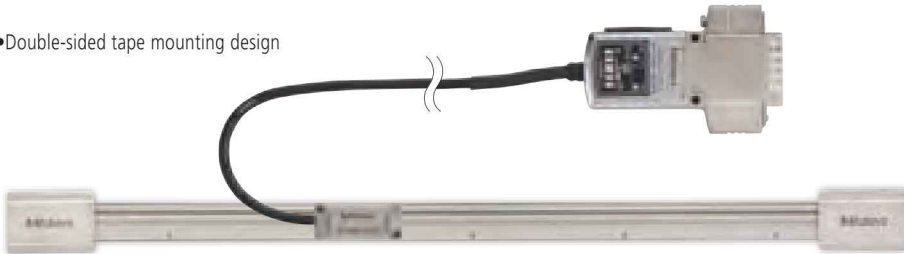
Glass Scale Type

### Metal Tape Scale Type

- Double-end mounting design



- Double-sided tape mounting design

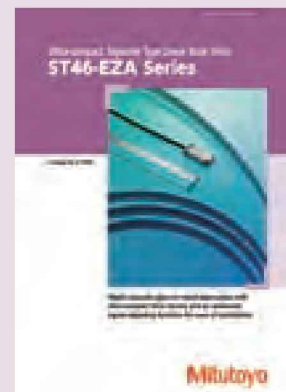


An inspection certificate is supplied as standard. Refer to page X for details.

- Includes an automatic adjusting function for the signal (EZA function) at the push of a button.
- Detector head mounting and signal adjustment possible without oscilloscope or PC.
- A setup indicator for checking signal strength is included.
- I/F circuit integrated in connector shell reduces volume to 60% compared to conventional interface.
- Self-diagnosis function with USB connectivity facilitates signal strength checking and parameter setup.
- Glass and metal tape scales are available.
- The thickness of the detector head is only 7.5 mm. The metal tape scale type has a mounting surface area of 12.5 by 9.325 mm, allowing use in applications where a space-saving design is important.

## SPECIFICATIONS

Model	ST46-EZA	
Detection method	Reflective photoelectric linear encoder	
Scale type	Glass	Metal tape
Main scale grating pitch	20μm	
Output signal	Type B: 2-phase square wave signals, reference point pulse, external reset input. Type C: 2-phase square wave signals, reference point pulse, 2-phase sinusoidal signals.	
Effective range	10 to 3000mm	
Accuracy (20°C)	Effective range 10 to 300mm: ±1μm Effective range 350 to 500mm: ±2μm Effective range 600 to 1000mm: ±3μm Effective range 1100 to 3000mm: ±3μm/m	Effective range 10 to 1000mm: ±5μm Effective range 1100 to 3000mm: ±5μm/m (The above accuracy applies to individual scales. For double-end mounting designs, perform point-to-point correction after ensuring the metal tape is tensioned correctly.)
Maximum response speed	2.6m/s (With sinusoidal signal amplitude of -3dB)	
Scale reference point	50mm pitch, 10 to 80mm: Center point	
Power supply voltage	5VDC±5%	
Operating temperature/ humidity range	0 to 40°C, RH 20 to 80% (no condensation)	
Storage temperature/ humidity range	-20 to 60°C, RH 20 to 80% (no condensation)	



Refer to the ST46-EZA Series (Catalog No.E13008) for more details.



An inspection certificate is supplied as standard. Refer to page X for details.

- Absolute measurement with exposed scales
- Non-contact detection is optimal for high speed and high acceleration devices such as linear motors.
- Electromagnetic induction principle means scales are unaffected by water and oil contamination
- The detector head is approximately 1/3 the previous model size: 50mm (W) × 28mm (D) × 11mm (H)
- Cable outlets can be in four directions, with mounting holes on the top and sides
- Accuracy (5+5L/1000)μm, glass scale: (3+3L/1000)μm (previous models: (8+5L/1000)μm)  
L: Effective range (mm)
- Compatible with servo amplifiers from a range of companies (high-speed serial interfaces)

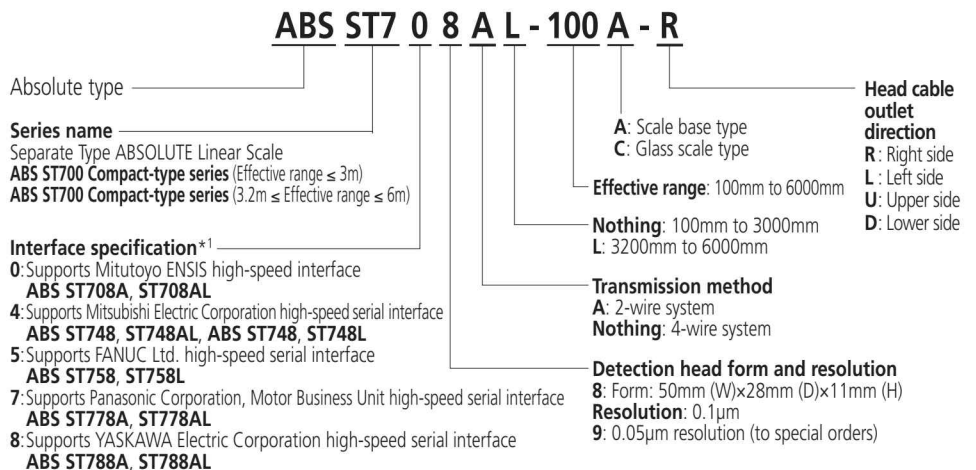
## Linear Scales ABS ST700 SERIES 579 — General-purpose Type



### SPECIFICATIONS

Model	ABS ST700	
	Scale base type	Glass scale type
Resolution	0.1μm (0.05μm to special order)	
Detection method	Electromagnetic induction ABS linear encoder	
Max. effective range	6000mm	1100mm
Accuracy (20°C)	5+(5L/1000)μm L: Effective range (mm)	3+(3L/1000)μm L: Effective range (mm)
Maximum response speed	5m/s	
Linear expansion coefficient	(12.0±1.5)×10 <sup>-6</sup> /K (When the material of the mounting components is steel or equivalent)	
Power supply voltage	5V±10% (at the detection head) (Ripple + spike noise component should be less than 100mV.)	
Operating temperature/ humidity range	0 to 50°C, RH 20 to 80%	
Storage temperature/ humidity range	-20 to 70°C, RH 20 to 80%	

### Meaning of Model No.

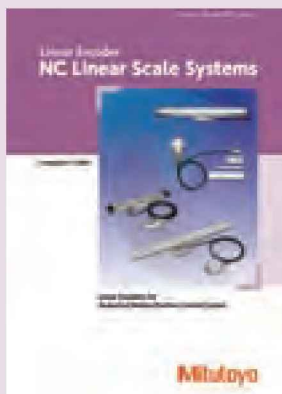


### Available Interfaces\*1

FANUC Ltd. FS-i Series, Power Mate i Series
Mitsubishi Electric Corporation, MELSERVO MR-J4/MR-J3 Series
Mitsubishi Electric Corporation, CNC Series, MDS-D/MDS-DH Series
YASKAWA Electric Corporation, Σ-V, Σ-III Series
Panasonic Corporation, Motor Business Unit MINAS-A5, A5L, A5N, A5NL, MINAS-A4, A4P, A4N, A4NL Series
Mitutoyo ENSIS*2
Nikki Denso Co., Ltd. VCI/VC/VPS series
Servoland Corporation SVF Series
PMAC Japan Co. Ltd. UMAC-Turbo PMAC2

\*1 Be sure to contact each manufacturer for details of the applicable systems (availability of connection).

\*2 ENSIS is a registered trademark of Mitutoyo Corporation.



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## Linear Scales ABS ST1300 SERIES 579

### Double-end screw-mounting version



### Double-sided tape mounting version



## SPECIFICATIONS

Model	ABS ST1300	
Scale type	Double-end mounting	Double-sided tape mounting
Max. effective length	500 to 12000mm	10 to 3000mm
Resolution	0.001 μm/0.01 μm (switched at shipment)	
Detection method	Optical reflection type linear encoder	
Indication accuracy (20°C)	±5 μm (1m or less), ±5 μm/m (1.1m or more)	
Maximum response speed	8m/s or less	
Expansion coefficient	10×10 <sup>-6</sup> /K	
Power supply	5VDC ±10%	
Maximum current consumption	270mA (250mA for Panasonic Corporation)	
Cable length	1m (standard)	
Maximum cable length	29m (including the head cable length)	
Usable temperature/humidity range	0 to 50 °C / RH 20 to 80% (no condensation) Mounted to steel: 0 to 50 °C / RH 20 to 80% (no condensation) Mounted to another material: 10 to 40 °C / RH 20 to 80% (no condensation)	
Storage temperature/humidity range	-20 to 70 °C/RH 20 to 80% (no condensation)	

\*For details on specification, mounting procedure, and adjustments, refer to the corresponding catalog and operation manual.

## Meaning of Model No.

### ABS ST13 4 1 A - 1200 D

Absolute type

Series name

Separate Type ABSOLUTE Linear Scale

Interface specification\*1

0: Supports Mitutoyo ENSIS high-speed interface

ABS ST130□A

4: Supports Mitsubishi Electric Corporation high-speed serial interface

ABS ST134□A

5: Supports FANUC Ltd. high-speed serial interface

ABS ST135□

7: Supports Panasonic Corporation, Motor Business Unit high-speed serial interface

ABS ST137□A

8: Supports YASKAWA Electric Corporation high-speed serial interface

ABS ST138□A

Scale mount

D: Double-end mounting

E: Double-sided tape mounting

Effective range: 10mm to 12000mm

Transmission method

A: When 0, 4, 7, or 8 is selected in the interface specification listed on the left

Nothing: When 5 is selected in the interface specification listed on the left

Resolution

1: Resolution 0.01 μm

2: Resolution 0.001 μm

## Available Interfaces\*1

FANUC Ltd., upcoming product

Mitsubishi Electric Corporation, MELSERVO MR-J4 Series

YASKAWA Electric Corporation, Σ-VII Series

Panasonic Corporation, Motor Business Unit MINAS-A5 Series

Mitutoyo ENSIS\*2, upcoming product

\*1 Be sure to contact each manufacturer for details of the applicable systems (availability of connection).

\*2 ENSIS is a registered trademark of Mitutoyo Corporation.

ABSOLUTE™



An inspection certificate is supplied as standard. Refer to page X for details.

- Effective length: 12 m, Maximum response speed: 8m/s, Resolution: 1nm
- Various interfaces are supported.
- A new detection method has improved robustness in regards to contamination resistance and gap tolerance (in-house testing result).
- There is a choice of mounting method: double-sided tape or double-end screw.
- Signal check program enables integrity check and maintenance.



- The **PSU-200** splits the sinusoidal signal output by Mitutoyo linear scales into a minimum of four and a maximum of 200 divisions, and converts the signal to a square wave signal so that NC feedback systems, measurement control devices, etc., can be used with linear scales in order to achieve highly accurate positioning.

## Pulse signal interface unit PSU-200 SERIES 539



### SPECIFICATIONS

Order No.	<b>539-005</b>
Model	<b>PSU-200</b>
Number of axes	1 axis
Input	Input connector DA-15S-N (JAE) or equivalent Input signal: 2-phase sinusoidal and the reference voltage, Reference point, Scale alarm
Output	Output connector: MR-20RMA (HONDA TSUSHIN KOGYO CO., LTD.) Output signal: 2-phase square wave signals (PA, PB), reference point (PZ), Alarm, Alarm reset, Photo-coupler
Number of splits	4, 8, 10, 20, 40, 80, 100, 200 (Selectable with the switch)
Function	Setting the number of slits, setting the minimum edge interval, and maximum response speed. Detection of broken wires or short circuits and abnormalities (alarm), detection of signal errors (alarm). Power supply voltage low alarm (warning light only), switching between high-impedance mode and alarm signal output mode. Reference position detection light, hysteresis width settings (directly linked to No. of divisions), external alarm reset input (photocoupler), switching directions
Power supply voltage	5VDC $\pm$ 5%
Current consumption	200mA
Storage temperature range	-20°C to 70°C
Operating temperature range	0°C to 40°C
Dimensions	160(W) $\times$ 100(D) $\times$ 28(H)mm
Mass	Approx. 620g

- **PSU251** series is a serial signal interface unit for incremental linear scales.
- The interface outputs serial data equivalent to 400 divisions from the signal (sinusoidal).
- The PSU-251 can be connected to Mitsubishi Electric Corporation's MR-J4/ MR-J3 series servo amplifier.
- The PSU-252 can be connected to Panasonic Corporation, Motor business unit's MINAS series servo amplifier.
- Since this unit is connected to incremental linear scales, the reference point should be passed through to determine the absolute position.

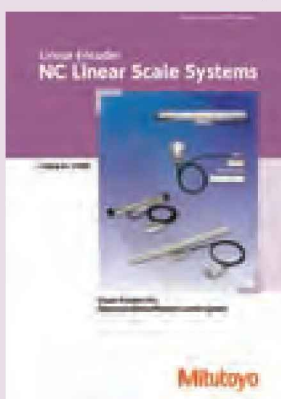
## Serial signal interface unit PSU-200 SERIES 539



### SPECIFICATIONS

Order No.	<b>539-006</b>	<b>539-007</b>
Model	<b>PSU-251</b>	<b>PSU-252</b>
Number of axes	1 axis	1 axis
Input	2-phase sinusoidal signals and standard voltage, reference signal, scale alarm signal. Maximum input frequency: 500kHz	
Output	Mitsubishi Electric Corporation MR-J4/MR-J3 series High-speed serial data*	Panasonic Corporation Motor Business Unit MINAS-A5, A5L, A5N, A5NL Series* MINAS-A4, A4P, A4N, A4NL Series*
Number of splits	400 splits	
Function	Alarm detection: Broken wires, short circuits in the scale and abnormalities. Alarm output: Status data is output through serial communication and the PWR light blinks. Also, the PWR light turns on.	
Power supply voltage	Power supply from the servo amplifier: 5VDC $\pm$ 5% External power supply: 5VDC $\pm$ 5% Power supply is selected with the shorting link for the terminal block used to supply external power. To choose a servo amplifier or external power supply, please refer to the servo amplifier power specifications (in particular, the maximum supplied current) and the power supply specifications of the scale that is used.	
Current consumption	150mA (not including the scale)	
Operating temperature range	0°C to 40°C	
Storage temperature range	-20°C to 70°C	
Dimension	110(W) $\times$ 60(D) $\times$ 27.5(H)	
Mass	Approx. 315g	

\*Please contact each manufacturer for details of the applicable systems.



Refer to the NC Linear Scale Systems (Catalog No.E13005) for more details.

# Linear Scales

Designed to capture positional coordinates from slides on machine tools and precision instruments including semiconductor production equipment

## 2D Image Correlation Encoder SERIES 549



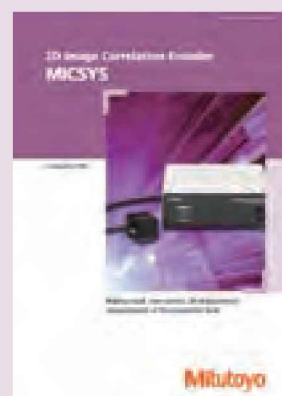
### SPECIFICATIONS

Order No.	549-701
Model	MICSYS-SA1
Detection method	Laser speckle image correlation
Effective range	$\pm 100\mu\text{m}$ (2D)
Resolution	1nm
Accuracy (20°C)	$\pm 100\text{nm}$
Data update frequency	20Hz



An inspection certificate is supplied as standard. Refer to page X for details.

- Applies the image correlation of a speckle pattern.
- Simultaneous, non-contact measurement of X-Y position.
- Nano-resolution measurement.
- Suitable for applications such as stage position repeatability.
- Capable of measuring slight deformations and flex of parts.



Refer to the MICSYS (Catalog No.E13001) for more details.



### Tests for Evaluating Linear Scales

#### 1. Testing within the service temperature range

Confirms that there is no performance abnormality of a unit within the service temperature range and that data output is according to the standard.

#### 2. Temperature cycle (dynamic characteristics) test

Confirms that there is no performance abnormality of a unit during temperature cycling while operating and that data output is according to the standard.

#### 3. Vibration test (Sweep test)

Confirms that there is no performance abnormality of a unit while subject to vibrations of a frequency ranging from 30Hz to 300Hz with a maximum acceleration of  $29.42\text{m/s}^2$ .

#### 4. Vibration test (Acceleration test)

Confirms that there is no performance abnormality of a unit subject to vibrations at a specific, non-resonant frequency. (Approx.  $98.07\text{m/s}^2$ )

#### 5. Noise test

The noise test conforms to EMC Directive EN61326-1+A1:1998.

#### 6. Package drop test

This test conforms to JIS Z 0200 (Heavy duty material drop test)

### Glossary

#### ■ Absolute system

A measurement mode in which every point measurement is made relative to a fixed origin point.

#### ■ Incremental system

A measurement mode in which every point measurement is made relative to a certain stored reference point.

#### ■ Origin offset

A function that enables the origin point of a coordinate system to be translated to another point offset from the fixed origin point. For this function to work, a system needs a permanently stored origin point.

#### ■ Restoring the origin point

A function that stops each axis of a machine accurately in position specific to the machine while slowing it with the aid of integrated limit switches.

#### ■ Sequence control

A type of control that sequentially performs control steps according to a prescribed order.

#### ■ Numerical control

A way of controlling the movements of a machine by encoded commands created and implemented with the aid of a computer (CNC). A sequence of commands typically forms a 'part program' that instructs a machine to perform a complete operation on a workpiece.

#### ■ Binary output

Refers to output of data in binary form (ones and zeros) that represent numbers as integer powers of 2.

#### ■ RS-232C

An interface standard that uses an asynchronous method of serial transmission of data over an unbalanced transmission line for data exchange between transmitters located relatively close to each other. It is a means of communication mainly used for connecting a personal computer with peripherals.

#### ■ Line driver output

This output features fast operating speeds of several tens to several hundreds of nanoseconds and a relatively long transmission distance of several hundreds of meters. A differential-voltmeter line driver (RS422A compatible) is used as an I/F to the NC controller in the linear scale system.

#### ■ BCD

A notation of expressing the numerals 0 through 9 for each digit of a decimal number by means of four-bit binary sequence. Data transmission is one-way output by means of TTL or open collector.

#### ■ RS-422

An interface standard that uses serial transmission of bits in differential form over a balanced transmission line. RS-422 is superior in its data transmission characteristics and in its capability of operating with only a single power supply of +5V.

#### ■ Accuracy

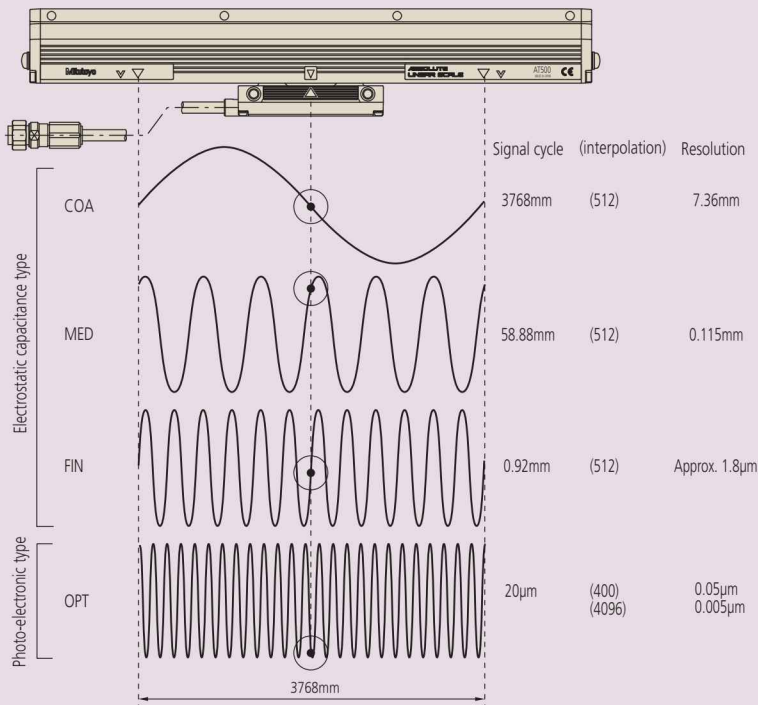
The accuracy specification of a scale is given in terms of the maximum error to be expected between the indicated and true positions at any point, within the range of that scale, at a temperature of  $20^{\circ}\text{C}$ .

Since there is no international standard defined for scale units, each manufacturer has a specific way of specifying accuracy. The accuracy specifications given in our catalog have been determined using laser interferometry.

#### ■ Narrow range accuracy

Scale gratings on a scale unit normally adopt  $20\mu\text{m}$  pitch though it varies according to the kind of scale. The narrow range accuracy refers to the accuracy determined by measuring one pitch of each grating at the limit of resolution ( $1\mu\text{m}$  for example).

## ■ Principle of the Absolute Linear Scale (Example: ABS AT300, 500-S/H)

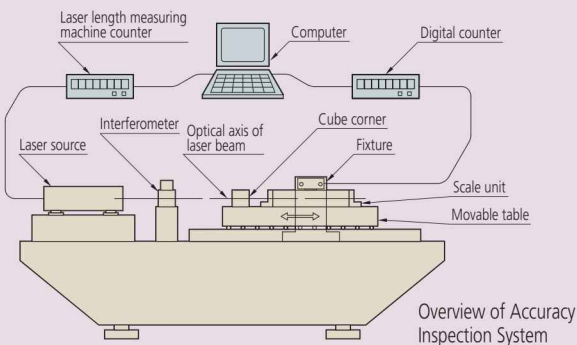


Upon supply of power to a linear scale, position readings from three capacitance-type sub-scales (COarse, MEDium and FINE) and one from a photoelectric sub-scale (OPTical) are taken. These sub-scales use such a combination of pitches, and are so positioned relative to each other, that the readings at any one position form a unique set and allow a microprocessor to calculate the position of the read head on the scale to a resolution of 0.05µm (0.005µm).

## ■ Specifying Linear Scale Accuracy

### Positional Indication accuracy

The accuracy of a linear scale is determined by comparing the positional value indicated by the linear scale with the corresponding value from a laser length measuring machine at regular intervals using the accuracy inspection system as shown in the figure below. As the temperature of the inspection environment is 20°C, the accuracy of the scale applies only in an environment at this temperature. Other inspection temperatures may be used to comply with internal standards.



The accuracy of the scale at each point is defined in terms of an error value that is calculated using the following formula:

$$\text{Error} = \text{Value indicated by laser inspection system} - \text{Corresponding value indicated by the linear scale}$$

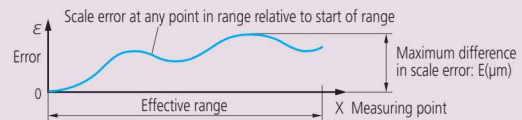
A graph in which the error at each point in the effective positioning range is plotted is called an accuracy diagram.

There are two methods used to specify the accuracy of a scale, unbalanced or balanced, described below.

### (1) Unbalanced accuracy specification - maximum minus minimum error

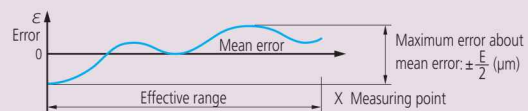
This method simply specifies the maximum error minus the minimum error from the accuracy graph, as shown below. It is of the form:  $E = (\alpha + \beta L)\mu\text{m}$ . L is the effective range (mm), and  $\alpha$  and  $\beta$  are factors specified for each model.

For example, if a particular type of scale has an accuracy specification of  $(3 + \frac{3L}{1000})\mu\text{m}$  and an effective range of 1000mm, E is 6µm.



### (2) Balanced accuracy specification - plus and minus about the mean error

This method specifies the maximum error relative to the mean error from the accuracy graph. It is of the form:  $e = \pm \frac{E}{2} (\mu\text{m})$ . This is mainly used in separate-type (retrofit) scale unit specifications.

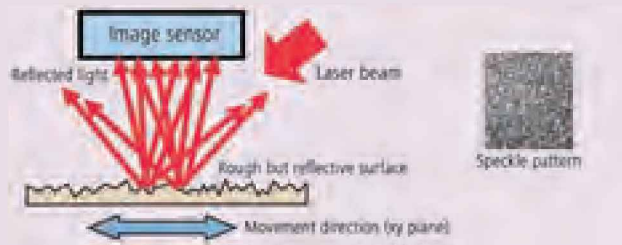


A linear scale detects displacement based on graduations of constant pitch. Two-phase sinusoidal signals with the same pitch as the graduations are obtained by detecting the graduations. Interpolating these signals in the electrical circuit makes it possible to read a value smaller than the graduations by generating pulse signals that correspond to the desired resolution. For example, if the graduation pitch is 20µm, interpolated values can generate a resolution of 1µm. The accuracy of this processing is not error-free and is called interpolation accuracy. The linear scale's overall positional accuracy specification depends both on the pitch error of the graduations and interpolation accuracy.

## ■ Image correlation and the MICSYS two-dimensional encoder

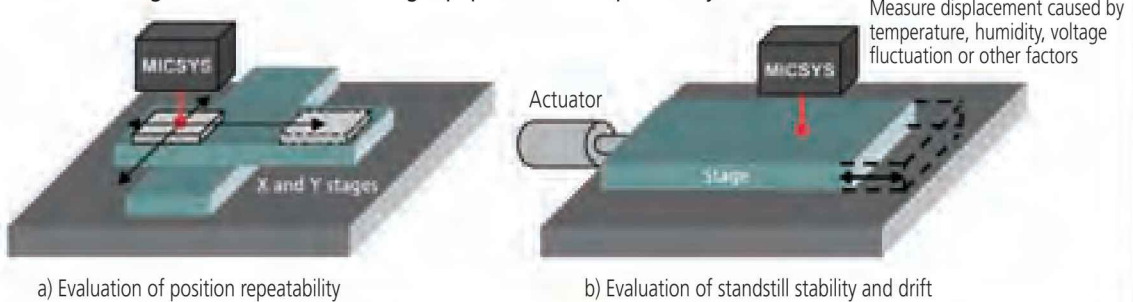
### Principle of measurement

When an optically rough surface is irradiated with a laser beam, reflected coherent light scattering from the surface creates visible interference in the form of a speckle pattern. As the object moves in the XY plane, the speckle pattern also moves in response. Displacement of the object can be calculated by comparing, through image correlation, the speckle images obtained before and after movement, and this is the principle used in the highly accurate MICSYS measuring system.

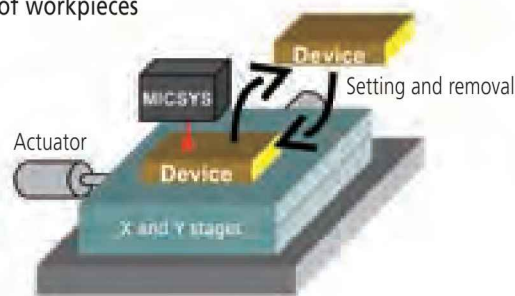


### Applications

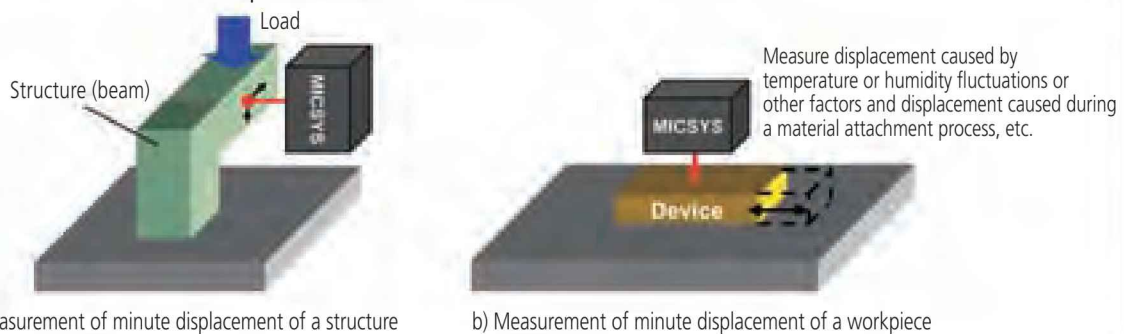
#### 1. Evaluation of stages used in manufacturing equipment and inspection systems



#### 2. Highly accurate positioning of workpieces



#### 3. Measurement of minute displacement



# New Products



## Measuring Microscopes/ Universal Measuring Microscopes

MF Series/MF-U Series

Refer to pages J-11, 13 for details.



## Motor-Driven Z-axis Measuring Microscopes

MF Series/MF-U Series

Refer to pages J-12, 14 for details.



## Motor-Driven Measuring Microscopes

MF Series/MF-U Series

Refer to pages J-12, 14 for details.



## Toolmakers' Microscopes

TM Series

Refer to pages J-16 for details.



## Microscope Units

WIDE VMU Series

Refer to pages J-22 for details.





## Profile Projectors

Profile Projectors



## Microscopes

Measuring Microscopes



Video Microscope Unit



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# Profile Projectors

For efficient measurement, inspection and observation of very small workpieces

## PJ-A3000 series SERIES 302 — Profile Projectors

- Each model has a digital counter and digital readout protractor screen to facilitate dimensional and angular measurement.
- High operability due to the layout of the built-in counter at an easily readable position.
- Large handwheel enables easy height adjustment of the stage for setting the best surface illumination conditions.
- Combination use with the optional 2-D Data Processor QM-Data200 facilitates a variety of dimensional measurement methods.

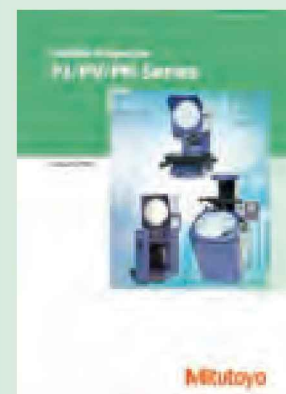


PJ-A3010F-200

## SPECIFICATIONS

Model No.	PJ-A3005D-50	PJ-A3010F-100	PJ-A3005F-150	PJ-A3010F-200
Order No.	302-704*	302-703*	302-702*	302-701*
Projected image	Inverted-reversed			
Protractor screen	Effective diameter	ø315mm (12.4")		
	Screen material	Fine-ground glass		
	Screen rotation	±360° (±370° for display)		
	Angle display	Digital counter (LED) (ABS/INC mode switching, Zero Set)		
	Resolution	1' or 0.01° (switchable)		
	Mechanism	Fine feed and clamp		
Projection lens	Cross-hairs	90° (solid lines)		
	Magnification	10X (standard accessory), 20X, 50X, 100X 10X, 20X (equipped with an external half-mirror for coaxial surface illumination)		
Magnification accuracy	Lens mount	Bayonet mount		
	Transmitted illumination	Less than ±0.1% of nominal magnification		
Illumination	Surface illumination	Less than ±0.15% of nominal magnification		
	Transmitted illumination	Halogen bulb (24V, 150W, 500hours) (No.512305) Telecentric system, Heat-absorbing filter, Built-in cooling fan 2-step (High/Low) brightness switch, Combination use with a color filter available		
Resolution for X/Y counter	Surface illumination	Halogen bulb (24V, 150W, 500hours) (No.512305) Beam concentration and adjustment available, Heat-absorbing filter, Built-in cooling fan		
	Resolution for X/Y counter	0.001mm/0.00005"	0.001mm/0.0001"	
Measuring unit	Digital micrometer head	Digital scale		
Measuring range (XxY)	50x50mm	100x100mm	150x50mm	200x100mm

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



Refer to the Measuring Projector (Catalog No.E14005) for more details.



## PJ-H30 series SERIES 303 — Profile Projectors

- ø306mm screen makes erect-unreversed images more visible.
- Newly developed transmitted-illumination optical system improves the illumination intensity for all types of projection lenses by 60% on average, compared to easy XY and angle readings.
- High-level visibility of digital display for all models allows easy XY and angle readings.
- Uses a 3-lens turret type bayonet mount with parfocal characteristics.
- Uses an elevating shaft mechanism.
- Quick-release control inside the XY handle can switch the stage feeding between the fine and coarse traverse.
- All models have a high-precision workstage with linear scales.
- All stage sizes achieve the high measuring accuracy of  $(3+0.02L)\mu\text{m}$  for the X-and Y-axis directions.
- Models with the high-precision edge detector (OPTOEYE) are also available.
- Measuring range (300×170mm) is the widest in its class.



PJ-H30D3017B

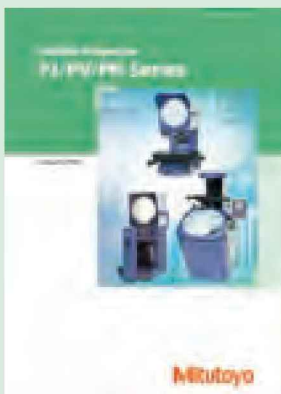
### SPECIFICATIONS

Protractor screen	Model No.	<b>PJ-H30A1010B</b>	<b>PJ-H30A2010B</b>	<b>PJ-H30A2017B</b>	<b>PJ-H30A3017B</b>
	Order No.	<b>303-712-1*<sup>1</sup></b>	<b>303-713-1*<sup>1</sup></b>	<b>303-714-1*<sup>1</sup></b>	<b>303-715-1*<sup>1</sup></b>
Protractor screen, OPTOEYE (built-in), Electromotive focusing	Model No.	<b>PJ-H30D1010B</b>	<b>PJ-H30D2010B</b>	<b>PJ-H30D2017B</b>	<b>PJ-H30D3017B</b>
	Order No.	<b>303-732-1*<sup>1</sup></b>	<b>303-733-1*<sup>1</sup></b>	<b>303-734-1*<sup>1</sup></b>	<b>303-735-1*<sup>1</sup></b>
Projected image		Erect			
Protractor screen	Effective diameter	ø 306mm (12")			
	Screen material	Fine-ground glass			
	Screen rotation	±360° (±370° for display)			
	Angle display	Digital counter (LED) (ABS/INC mode switching, Zero Set)			
	Resolution	1' or 0.01° (switchable)			
	Mechanism	Fine feed and clamp			
Projection lens	Cross-hairs	90° (solid lines)			
	Magnification	10X (standard accessory), 5X, 20X, 50X, 100X All lens have the same focus. Half-mirror for the coaxial surface illumination are built-in and movable.			
	Lens mount	Bayonet mount, 3-lens mount turret type			
Magnification accuracy	Transmitted illumination	Less than ±0.1% of nominal magnification			
	Surface illumination	Less than ±0.15% of nominal magnification			
Illumination	Transmitted illumination	Halogen bulb (24V, 150W, 50hours) ( <b>No.515530</b> ) Variable Illumination angle (Coaxial surface/Oblique reflected, Beam concentration and adjustment), Built-in heat-absorbing filter, Built-in cooling fan, Stepless brightness adjustment, Soft lighting (inrush current reduction)			
	Surface illumination	Halogen bulb (24V, 150W, 50hours) ( <b>No.515530</b> ) Zoom Telecentric system, Heat absorbing filter, Built-in cooling fan, Stepless brightness adjustment, Soft lighting (inrush current reduction), Bulb sliding mechanism			
Resolution for X/Y counter* <sup>2</sup>		0.001mm/0.001"			
Measuring unit		High-accuracy digital scale			
Measuring range (X×Y)		100×100mm	200×100mm	200×170mm	300×170mm
Measuring accuracy* <sup>3</sup>		$(3+0.02L)\mu\text{m}$ L: Measured length (mm)			

\*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: 0.5μm or 0.1μm resolution is also available. Please contact Mitutoyo Techno Service Business Division.

\*3: Measuring method complies with JIS B7184.



Refer to the Measuring Projector (Catalog No.E14005) for more details.

# Profile Projectors

For efficient measurement, inspection and observation of very small workpieces

## PV-5110

### SERIES 304 — Profile Projectors

- Floor-standing model uses overhead illumination.
- Conveniently positioned screen (height: 960mm, inclination angle: 32° from the horizontal) allows measurement and observation with ease.
- Digital display of protractor screen and LED illumination display of screen index line are both easy to read.
- When using a 5X projection lens, a 100mm field of view is available without moving the workpiece.



PV-5110

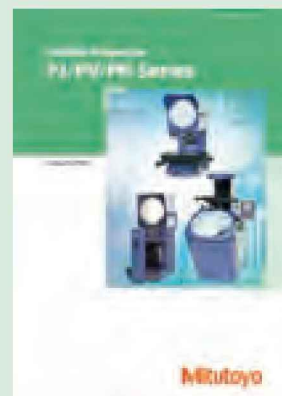
## SPECIFICATIONS

Model No.	<b>PV-5110</b>	
Order No.	<b>304-919*1</b>	
Projected image	Inverted-reversed	
Protractor screen	Effective diameter	ø508mm (20")
	Screen material	Fine-ground glass
	Screen rotation	±360° (±370° for display)
	Angle display	Digital counter (LED) (ABS/INC mode switching, Zero Set)
	Resolution	1' or 0.01° (switchable)
	Mechanism	Fine feed and clamp
	Cross-hairs	90° (solid lines)
Projection lens	Zero-base index	(Equipped with the built-in backlight)
	Magnification	10X (standard accessory), 5X, 20X, 50X, 100X
	Lens mount	Quick insertion type
Magnification accuracy	Transmitted illumination	Less than ±0.1% of nominal magnification
	Surface illumination	Less than ±0.15% of nominal magnification
Illumination	Transmitted illumination	Halogen bulb (24V, 150W, 500hours) ( <b>No.512305</b> ) Telecentric system, Heat-absorbing filter, Built-in cooling fan 2-step (High/Low) brightness switch, Combination use with a color filter available
	Surface illumination	Halogen bulb (24V, 150W, 500hours) ( <b>No.512305</b> ) Heat-absorbing filter, Beam concentration and adjustment available, Double-lighting oblique surface illumination unit (5X, 10X, 20X), Built-in cooling fan, 2-step (High/Low) brightness switch
Resolution for X/Y counter *2	—	
Measuring unit	Digital scale	
Measuring range (X×Y)	200×100mm (164×68mm*3)	

\*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: X and Y counters are not built into the **PV-5110** main unit. If a counter display is required, it is recommended that a **QM-Data200** or **KA-212** is purchased separately.

\*3: When using 5X lens under transmitted illumination the view will be partially obscured.



Refer to the Measuring Projector (Catalog No.E14005) for more details.

## PH-3515F, PH-A14 SERIES 172 — Profile Projector

- Bench-top model uses a horizontal optical system.
- Maximum loading of workstage (45kg) allows the measurement of heavy workpieces.
- Wide measuring range 254mm (X) × 152mm (Y) allows measurement of large workpieces. (**PH-3515F**)
- Digital display of protractor screen angle enables easy angular measurement. (**PH-3515F**)
- Combination use with the optional 2-D data processor **QM-Data200** facilitates a variety of dimensional measurement methods
- Provides transmitted illumination for inspecting workpiece contour, and oblique incident illumination for the observation of workpiece surfaces.



PH-3515F



PH-A14

### SPECIFICATIONS

Model No.	PH-3515F	PH-A14
Order No.	172-868*1	172-810*2
Projected image	Erect-reversed	Invert-reversed
Effective diameter	ø353mm (13.9")	ø356mm (14")
Screen material	Fine-ground glass	
Screen rotation	±360°(±370°for display)	
Protractor screen	Angle display	Vernier
Resolution	1' or 0.01° (switchable)	2' (graduation)
Mechanism	Fine feed and clamp	
Cross-hairs	90°(solid lines)	
Projection lens	Magnification	10X (standard accessory), 5X(PH-3515F only), 20X, 50X, 100X
Lens mount	Screw mount	
Magnification accuracy	Transmitted illumination	Less than ±0.1% of nominal magnification
Surface illumination	Less than ±0.15% of nominal magnification	
Illumination*3	Transmitted illumination	Halogen bulb (24V, 150W, 500hours) ( <b>No.515530</b> ) Telecentric system, Heat-absorbing filter, Built-in cooling fan 2-step (High/Low) brightness switch, Combination use with a color filter available
Surface illumination	Parabolic halogen bulb (24V, 200W, 500hours) ( <b>No.12BAA637</b> ) Beam concentration and adjustment available, Heat-absorbing filter, Built-in cooling fan	
Resolution for X/Y counter*4	—	
Measuring unit	Digital scale	
Measuring range (X×Y)	254×152mm	200×100mm

\*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.

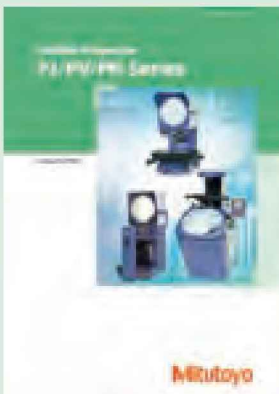
\*2: To denote your AC power cable add the following suffixes to the order No.: -10A for UL/CSA, -20D for CEE, -20DC for CCC, -20E for BS, -20K for KC.

\*3: For the PH-A14, a light source (24V 150W), which is common to the Transmitted illumination and Surface illumination, is used. It is not possible to regulate brightness.

\*4: XY counter is not built in the main unit of **PH-3515F** and **PH-A14**.

If the counter display is required, it is recommended to purchase **QM-Data200** or a counter (**KA-212**) separately.

Note1: Depending on the angle of illumination, measurement results may be smaller than actual values.



Refer to the Measuring Projector  
(Catalog No.E14005) for more details.

# Profile Projectors

For efficient measurement, inspection and observation of very small workpieces

## Accessories for Profile Projectors SERIES 172 — Profile Projector

### Standard Scales

- Used for checking magnification accuracy.

### SPECIFICATIONS

Metric			
Graduation	Range	Order No.	Accuracy (20°C)*
0.1mm	50mm	172-116	(3+5L/1000)μm
0.1mm	80mm	172-330	(3+5L/1000)μm

\* L = Measured length (mm)

Inch			
Graduation	Range	Order No.	Accuracy (20°C)*
.01"	2"	172-117	.00013"

172-116



### Reading Scales

- Specially designed for inspecting the magnified image of a standard scale on the projection screen.

### SPECIFICATIONS

Metric			
Graduation	Range	Order No.	Accuracy (20°C)*
0.5mm	200mm	172-118	(15+15L/1000L)μm
0.5mm	300mm	172-161	(15+15L/1000L)μm
0.5mm	600mm	172-329	(15+15L/1000L)μm

\* L = Measured length (mm)

Inch			
Graduation	Range	Order No.	Accuracy (20°C)*
.02"	8"	172-119	.00071"
.02"	2"	172-162	.00077"

172-161

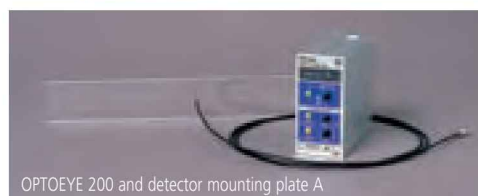


172-118

## OPTOEYE (Projected image position detecting device)



PJ-A3000 with OPTOEYE 200



OPTOEYE 200 and detector mounting plate A

- An edge detecting device for improving the measuring efficiency and reliability of a profile projector by removing the need to position the cross hairs on an edge manually. This has the effect of eliminating the operator variability factor from data entry and shortening the measurement time.
- The detector uses an optical fiber that can be easily fixed on the screen with chart clips.
- The device is provided with an error detection function that works if the screen light intensity changes.
- This device can be retrofitted onto the QM-Data200 and does not need an AC adapter since power is supplied from the QM-Data200 through the connecting cable.
- The X and Y-axis linear scales on the projector main unit are directly connected to the QM-Data200 during use of the Optoeeye system.
- This system can be used in combination with the QM-Data200 but is only available for the PJ-H30A. (PJ-H30D does not need this system because it has a built-in Optoeeye sensor.)

## Built-in OPTOEYE (only PJ-H30D)



PJ-H30D	Detecting sensor: Built in center of screen, non-directional
	Illumination*, Minimum detectable circle: ø2mm (projected image size), Minimum line width: 1mm (projected image size), Repeatability: $\sigma = 1\mu\text{m}^{**}$

\*Mitutoyo's condition  
\*\*Mitutoyo test condition

Order No.	332-151
Model	OPT-200
Illumination	Contour/surface*
Detecting directivity	Non direction
Minimum detectable circle	ø2mm
Minimum detectable line width	1mm
Maximum response speed	1000mm/s
Illumination range (Bright)	30 - 1500ℓ X
Bright-Dark field difference	20 ℓ X or higher
Repeatability (contour illumination)	$\sigma = 1\mu\text{m}^*$

\* Mitutoyo's condition

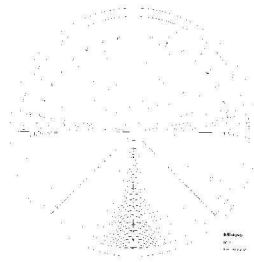
Configuration of standard accessories	
Electronic unit	
Detector: Optical fiber	
Connecting cable: For connecting electrical component main unit and QM-Data200	
Fixture for QM-Data200: For fixing the electrical component (No.12BAG139) main unit to QM-Data200	

Note) Detector mounting plate is an optional accessory.

## Overlay Chart Set

- Makes inspection of projected images an easy process.
- Twelve different patterns are available in the set.
- Designed for use with profile projectors whose screen diameter is 300mm or larger.

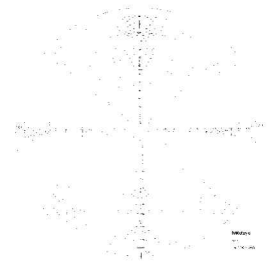
Overlay chart set (12 sheets)  
Order No.: 12AAM027



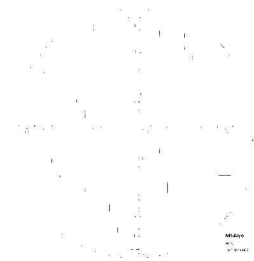
**12AAM587**  
Protractor (1°-grad. radial index) and radius (1mm-radius increment concentric semicircles)



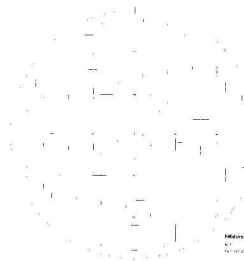
**12AAM588**  
Radius (0.1cm-reading scales and 5mm-radius increment concentric circles)



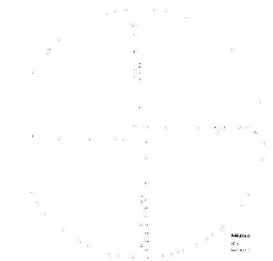
**12AAM589**  
Radius (1X, 10X, 20X, 50X)



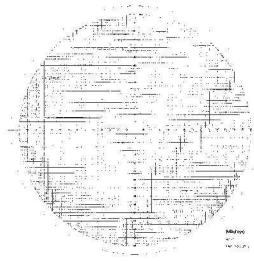
**12AAM590**  
1mm-reading scales (20X, 50X)



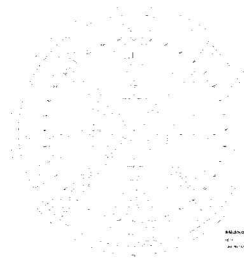
**12AAM591**  
10x10mm sections



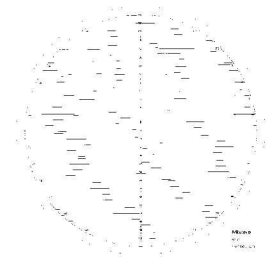
**12AAM592**  
0.5mm-reading scales



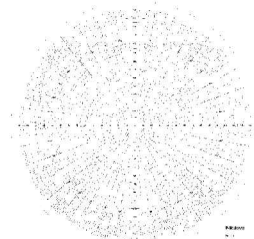
**12AAM593**  
1x1mm sections



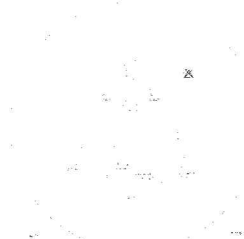
**12AAM594**  
Protractor (1°-grad. diametral index)



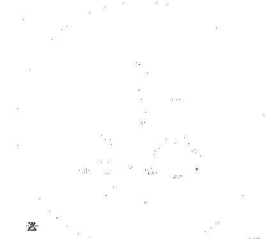
**12AAM595**  
1mm-reading vertical scale



**12AAM596**  
Protractor (1°-grad. diametral index) and radius (1mm-radius increment concentric circles)



**12AAM597**  
Metric, Unified, and Whitworth screw threads (20X)



**12AAM598**  
Metric screw thread (100X) and 20° and 14.5° gear teeth (20X)

## Workpiece Fixtures for Profile Projectors and Measuring Microscopes

### Rotary Tables



176-106

172-198

176-305

176-306

### SPECIFICATIONS

Order No.	176-106	172-198	176-305	176-306
Effective glass dia.	60mm	96mm	182mm	238mm
Angular resolution	6°	2°	—	—
Fine feed	—	Available	Available	Available
Mass	1.7kg	2.4kg	5.5kg	6.5kg

### Holder with Clamp



176-107

### SPECIFICATIONS

Order No.	176-107
Max. workpiece height	35mm
Mass	0.4kg

### Swivel Center Supports



176-105

172-197

### SPECIFICATIONS

Order No.	176-105	172-197
Max. workpiece dia.	70mm (45mm)*	80mm(65mm)*
Max. workpiece length	140mm	140mm
Swivel range	±10°	±10°
Mass	2.4kg	2.5kg

\* When swiveled 10°

### Center Support



172-142

172-143

### SPECIFICATIONS

Order No.	172-142	172-143
Max. workpiece height	120mm (240mm)*	60mm
Mass	3.3kg	2.2kg

\* When using a center support riser (172-143)

### V-Block with Clamp



172-234

172-378

### SPECIFICATIONS

Order No.	172-234	172-378
Max. workpiece dia.	50mm	25mm
Central height from a mounting surface	38 - 48mm	38 - 48mm
Mass	1.24kg	0.8kg

### Rotary Vise



172-144

### SPECIFICATIONS

Order No.	172-144
Rotation range	360°
Distance between mounting surface and top surface	76mm
Angle graduations	5°
Mass	2.8kg

### Vertical Holder



172-132

### SPECIFICATIONS

Order No.	172-132
Mass	1.3kg

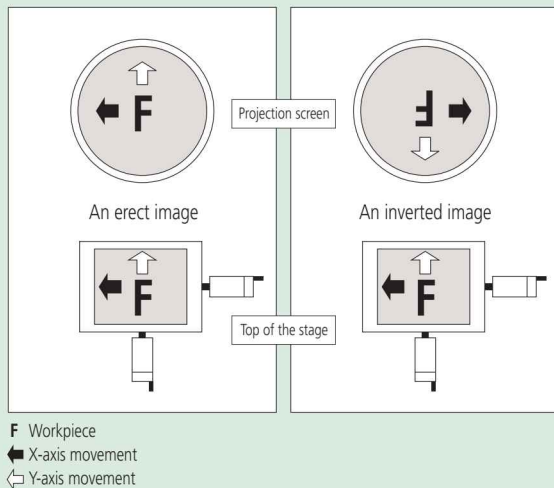
# Quick Guide to Precision Measuring Instruments



## Profile Projectors

### Erect Image and Inverted Image

An image of an object projected onto a screen is erect if it is orientated the same way as the object on the stage. If the image is reversed top to bottom, left to right and by movement with respect to the object on the stage (as shown in the figure below) it is referred to as an inverted image (also known as a reversed).



### Magnification Accuracy

The magnification accuracy of a projector when using a certain lens is established by projecting an image of a reference object and comparing the size of the image of this object, as measured on the screen, with the expected size (calculated from the lens magnification, as marked) to produce a percentage magnification accuracy figure, as illustrated below. The reference object is often in the form of a small, graduated glass scale called a 'stage micrometer' or 'standard scale', and the projected image of this is measured with a larger glass scale known as a 'reading scale'.

(Note that magnification accuracy is not the same as measuring accuracy.)

$$\Delta M(\%) = \frac{L - \ell M}{\ell M} \times 100$$

- $\Delta M(\%)$ : Magnification accuracy expressed as a percentage of the nominal lens magnification
- $L$ : Length of the projected image of the reference object measured on the screen
- $\ell$ : Length of the reference object
- $M$ : Magnification of the projection lens

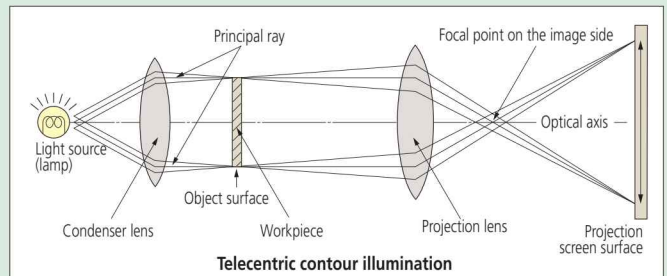
### Type of Illumination

- **Contour illumination:** An illumination method to observe a workpiece by transmitted light and is used mainly for measuring the magnified contour image of a workpiece.
- **Coaxial surface illumination:** An illumination method whereby a workpiece is illuminated by light transmitted coaxially to the lens for the observation/measurement of the surface. (A half-mirror or a projection lens with a built-in half-mirror is needed.)
- **Oblique surface illumination:** A method of illumination by obliquely illuminating the workpiece surface. This method provides an image of enhanced contrast, allowing it to be observed three-dimensionally and clearly. However, note that an error is apt to occur in dimensional measurement with this method of illumination. (An oblique mirror is needed. Models in the PJ-H30 series are supplied with an oblique mirror.)

### Telecentric Optical System

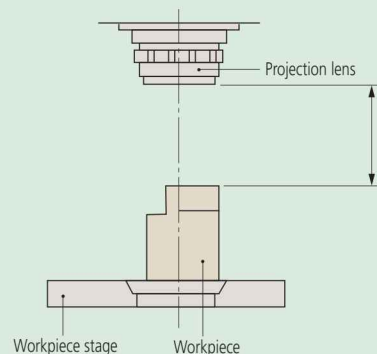
An optical system based on the principle that the primary ray is aligned parallel to the optical axis by placing a lens stop on the focal point on the image side. Its functional feature is that the image will not vary in size even though the image blurs as the object is shifted along the optical axis.

For measuring projectors and measuring microscopes, an identical effect is obtained by placing a lamp filament at the focal point of a condenser lens instead of a lens stop so that the object is illuminated with parallel beams. (See the figure below.)



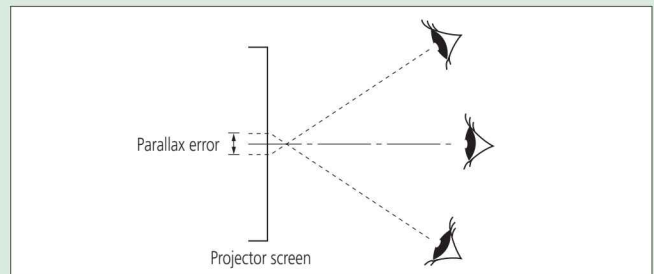
### Working distance

Refers to the distance from the face of the projection lens to the surface of a workpiece in focus. It is represented by  $L$  in the diagram below.



### Parallax error

This is the displacement of an object against a fixed background caused by a change in the observer's position and a finite separation of the object and background planes.



### Field of view diameter

The maximum diameter of the workpiece that can be projected using a particular lens.

$$\text{Field of view diameter (mm)} = \frac{\text{Screen diameter of profile projector}}{\text{Magnification of projection lens used}}$$

Example: If a 5X magnification lens is used for a projector with a screen of  $\varnothing 500\text{mm}$ :

$$\text{Field of view diameter is given by } \frac{500\text{mm}}{5} = 100\text{mm}$$

# Microscopes

Microscope lineups that systemize observation, measurement and processing

## MF series

### SERIES 176 — Measuring Microscopes

- Observation with a clear and flareless erect image along with a wide field of view.
- Measuring accuracy is the highest in its class (and conforms to JIS B 7153).
- ML series, high-NA objectives that are specially designed for the MF series (long working distance type).
- Illumination unit (reflected/transmitted) can be selected from a high-intensity LED or halogen bulb.
- Variable aperture diaphragm (reflected/transmitted) allows observation measurement while suppressing light diffraction.
- Variety of standardized stages in sizes up to 400×200mm.
- Quick-release mechanism useful for moving the stage quickly when measuring workpieces that are large in size or quantity.
- Coarse/fine feed handles are as standard on both sides allowing precise focus and observation measurement regardless of handedness.
- High-magnification eyepiece observation up to 2000X.
- Standard measuring microscope that has a wide variety of optional accessories including a Vision Unit and various digital CCD cameras.



**MF-B2017D**

• The binocular tube (eyepiece) and illumination unit are optional accessories.



Refer to the MF /MF-U series (Catalog No.E14003) for more details.

## SPECIFICATIONS

Without Z-axis scale	Model No.	MF-A1010D	MF-A2010D	MF-A2017D	MF-A3017D	MF-A4020D
	Order No.	176-861* <sup>1</sup>	176-862* <sup>1</sup>	176-863* <sup>1</sup>	176-864* <sup>1</sup>	176-865* <sup>1</sup>
With Z-axis scale	Model No.	MF-B1010D	MF-B2010D	MF-B2017D	MF-B3017D	MF-B4020D
	Order No.	176-866* <sup>1</sup>	176-867* <sup>1</sup>	176-868* <sup>1</sup>	176-869* <sup>1</sup>	176-870* <sup>1</sup>
Observation image		BF (Bright field)/Erect image				
Eyepiece (optional) Adjustable diopter		10X (eyepiece field number: 24), 15X, 20X Note: Monocular - one 10X eyepiece provided as standard; Binocular - two 10X eyepieces provided as standard				
Objective (optional)		ML objective 3X (provided as standard), 1X, 5X, 10X, 20X, 50X, 100X				
Illumination unit (One of the two options must be selected.)	LED illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, White LED light source, stepless light intensity control, With cooling fan Reflected illumination: Koehler illumination, Variable aperture diaphragm mechanism, White LED light source, stepless light intensity control Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector				
	Halogen illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, Halogen bulb (12V, 50W), stepless light intensity control, With cooling fan Reflected illumination: Koehler illumination, Variable aperture diaphragm mechanism, Halogen bulb (12V, 50W), stepless light intensity control, With cooling fan Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector				
Stage	Measurement range	100×100mm	200×100mm	200×170mm	300×170mm	400×200mm
	Quick-release mechanism	Provided as standard for the X and Y axes				
	Zero-set button	Provided as standard for the X and Y axes (and for the Z axis only for the MF-B type)				
Z axis	Max. workpiece height	150mm	220mm			
	Feed mechanism	Coaxial coarse and fine feed, handles on both sides (coarse: 30mm/rotation, fine: 0.2mm/rotation)				
Measuring accuracy* <sup>2</sup> (X and Y axes, when not loaded)		(2.2+0.02L)μm L: measuring length(mm)				
Digital display	Minimum reading	1/0.5/0.1μm .0001"/.00005"/.00001" switchable				
	Display axes	X and Y (or X, Y, and Z only for the MF-B type)				
	Functions	Zero-setting, direction switching, RS232C output, USB output (specific to QSPAK)				

\*1: The following suffixes are added to the order No. to specify the User Manual's language: -10 for English; -11 for Simplified Chinese; No suffix for Japanese.

\*2: Measuring method complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination	Standard: Halogen bulb (12V, 50W) (No.513667) Bulb life: 1,100 hours
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## MF series (Motor-Driven Z-axis/Motor-Driven) SERIES 176 — Measuring Microscopes



**MF-J2017D**

• The binocular tube (eyepiece) and illumination unit are optional accessories.



**MF-G2017D**

• The binocular tube (eyepiece) and illumination unit are optional accessories.

- Motor-driven Z-axis model of the MF series and Motor-driven X-, Y-, and Z-axes model of the MF series.
- Using the optional Vision Unit enables the image AF function.
- Illumination unit (reflected/transmitted) can be selected from a high-intensity LED or halogen bulb (required).
- Variable aperture diaphragm (reflected/transmitted) allows observation measurement while suppressing light diffraction.
- A wide variety of optional accessories including various digital CCD cameras are offered.
- ML series, high-NA objectives that are specially designed for the MF series. (long working distance type)
- High-magnification observation up to 2000X.

### Specifications for Motor-Driven Z-axis MF Series

Model No.	<b>MF-J2017D</b>		<b>MF-J3017D</b>	<b>MF-J4020D</b>
Order No.	<b>176-891*1</b>		<b>176-892*1</b>	<b>176-893*1</b>
Observation image	BF (Bright field)/Erect image			
Eyepiece (optional) Adjustable diopter	10X (eyepiece field number: 24), 15X, 20X Note: Monocular - one 10X eyepiece provided as standard; Binocular - two 10X eyepieces provided as standard			
Objective (optional)	ML objective 3X (provided as standard), 1X, 5X, 10X, 20X, 50X, 100X			
Illumination unit (One of the two options must be selected.)	LED	Transmitted: Telecentric, built-in aperture diaphragm, white LED light source, stepless brightness adjustment, equipped with cooling fan Reflected: Kohler illumination with adjustable aperture diaphragm, white LED light source, stepless brightness adjustment Control unit: Power switch (main switch), AC power supply input connector (100 to 240V)		
	Halogen	Transmitted: Telecentric, built-in aperture diaphragm, 12V/50W halogen lamp, stepless brightness adjustment, with cooling fan Reflected: Kohler illumination with adjustable aperture diaphragm, 12V50W halogen lamp, stepless brightness adjustment with cooling fan Control unit: Power switch (main switch), AC power supply input connector (100 to 240V)		
Vision AF*2	Yes			
Stage	Measurement range	200x170mm	300x170mm	400x200mm
	Quick release mechanism	Fitted to X and Y axes		
Z axis	Zero set switch	Fitted to X and Y axes		
	Max. workpiece height	220mm		
Measuring accuracy*3 (X and Y axes, when not loaded)	Feed mechanism	Motordrive (Maximum measuring speed: 20mm/s)		
	Minimum reading	(2.2 + 0.02L)μm L: measuring length (mm)		
Digital display	Minimum reading	1/0.5/0.1μm .0001"/.00005"/.00001" switchable		
	Display axes	X, Y and Z axes		
Functions	Zero-setting, direction switching			

\*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: Vision Unit and an image AF cable are separately required.

\*3: Measuring method complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination	Standard: Halogen bulb (12V, 50W) (No.513667) Bulb life: 1,100 hours
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### Specifications for Motor-Driven MF Series

Model No.	<b>MF-G2017D</b>		<b>MF-G3017D</b>	<b>MF-G4020D</b>
Order No.	<b>176-781*1</b>		<b>176-782*1</b>	<b>176-783*1</b>
Observation image	BF (Bright field)/Erect image			
Eyepiece (optional) Adjustable diopter	10X (eyepiece field number: 24), 15X, 20X Note: Monocular - one 10X eyepiece provided as standard; Binocular - two 10X eyepieces provided as standard			
Objective (optional)	ML objective 3X (provided as standard), 1X, 5X, 10X, 20X, 50X, 100X			
Illumination unit (One of the two options must be selected.)	LED	Transmitted: Telecentric, built-in aperture diaphragm, white LED light source, stepless brightness adjustment, equipped with cooling fan Reflected: Kohler illumination with adjustable aperture diaphragm, white LED light source, stepless brightness adjustment Control unit: Power switch (main switch), AC power supply input connector (100 to 240V)		
	Halogen	Transmitted: Telecentric, built-in aperture diaphragm, 12V/50W halogen lamp, stepless brightness adjustment, with cooling fan Reflected: Kohler illumination with adjustable aperture diaphragm, 12V50W halogen lamp, stepless brightness adjustment with cooling fan Control unit: Power switch (main switch), AC power supply input connector (100 to 240V)		
Vision AF*2	Yes			
Stage	Measurement range	200x170mm	300x170mm	400x200mm
	Feed mechanism	Motordrive (Maximum measuring speed: 40mm/s)		
Z axis	Max. workpiece height	220mm		
	Feed mechanism	Motordrive (Maximum measuring speed: 20mm/s)		
Measuring accuracy*3 (X and Y axes, when not loaded)	Minimum reading	(2.2 + 0.02L)μm, L: measuring length (mm)		
	Minimum reading	1/0.5/0.1μm .0001"/.00005"/.00001" switchable		
Digital display	Display axes	X, Y and Z axes		
	Functions	Zero-setting, direction switching		

\*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: Vision Unit and an image AF cable are separately required.

\*3: Measuring method complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination	Standard: Halogen bulb (12V, 50W) (No.513667) Bulb life: 1,100 hours
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# Microscopes

Microscope lineups that systemize observation, measurement and processing

## MF-U series

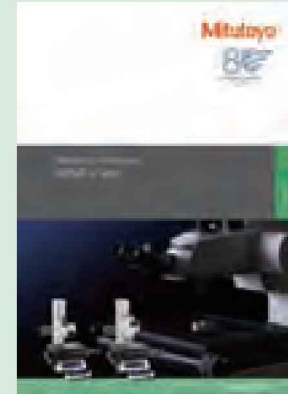
### SERIES 176 — Universal Measuring Microscopes

- Observation with a clear and flareless erect image and a wide field of view.
- Measuring accuracy is the highest in its class (and conforms to JIS B 7153).
- Proven high-NA objectives from the FS optical system (long working distance type).
- Integration of metallurgical and measurement microscope functions provide high-resolution observation and a high-accuracy measurement solutions.
- Illumination unit (reflected/transmitted) can be selected from a high-intensity LED or halogen bulb (required).
- Variable aperture diaphragm (reflected/transmitted) allows observation measurement while suppressing light diffraction.
- Variety of standardized stages in sizes up to 400×200mm.
- Quick-release mechanism useful for moving the stage quickly.
- Coarse/fine feed handles are standard on both sides allowing precise focus and observation measurement regardless of handedness.
- High-magnification observation up to 4000X.



**MF-UB2017D**

• The turret, objectives and illumination unit are optional accessories.



Refer to the MF /MF-U series (Catalog No.E14003) for more details.

## SPECIFICATIONS

	Without Z-axis scale	Model No.	MF-UA1010D	MF-UA2010D	MF-UA2017D	MF-UA3017D	MF-UA4020D
BF (bright-field)	Order No.		176-871*1	176-872*1	176-873*1	176-874*1	176-875*1
	With Z-axis scale	Model No.	MF-UB1010D	MF-UB2010D	MF-UB2017D	MF-UB3017D	MF-UB4020D
	Order No.		176-876*1	176-877*1	176-878*1	176-879*1	176-880*1
BD (bright-field/dark-field)	Without Z-axis scale	Model No.	MF-UC1010D	MF-UC2010D	MF-UC2017D	MF-UC3017D	MF-UC4020D
	Order No.		176-881*1	176-882*1	176-883*1	176-884*1	176-885*1
	With Z-axis scale	Model No.	MF-UD1010D	MF-UD2010D	MF-UD2017D	MF-UD3017D	MF-UD4020D
Order No.		176-886*1	176-887*1	176-888*1	176-889*1	176-890*1	
Observation image	BF (Bright field), DF (Dark field) (MF-UC and MF-UD models only), Polarization, Differential Interference Contrast (DIC) / Erect image						
Eyepiece (optional)	Adjustable diopter	10X (eyepiece field number: 24, two eyepieces provided as standard), 15X, 20X					
Turret (required)	Bright-field (BF)	Adjustable manual turret or adjustable power turret (Select one.)					
	Bright-field/dark-field (BD)	Manual turret or power turret (Select one.)					
Objective (optional)	Bright-field (BF)	M Plan Apo, M Plan Apo SL, G Plan Apo series					
	Bright-field/dark-field (BD)	BD Plan Apo, BD Plan Apo SL series					
Illumination unit (One of the two options must be selected.)	LED illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, White LED light source, stepless light intensity control, With cooling fan Reflected illumination: Koehler illumination, Variable aperture diaphragm mechanism, White LED light source, stepless light intensity control Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector					
	Halogen illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, Halogen bulb (12V, 50W), stepless light intensity control, With cooling fan Reflected: BF/BD Kohler illumination with adjustable aperture diaphragm, 12V/100W or 12V/15W halogen lamp (selectable), external fiber illumination, stepless brightness adjustment Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector					
Stage	Measuring range	100×100mm	200×100mm	200×170mm	300×170mm	400×200mm	
	Quick-release mechanism	Provided as standard for the X and Y axes					
	Zero-set button	Provided as standard for the X and Y axes (and for the Z axis only for the MF-UB and -UD types)					
Z axis	Max. workpiece height	150mm	220mm				
	Feed mechanism	Coaxial coarse and fine feed, handles on both sides (coarse: 10mm/rotation, fine: 0.1mm/rotation)					
Measuring accuracy *2 (X and Y axes, when not loaded)		(2.2+0.02L)μm L: measuring length(mm)					
	Minimum reading	1/0.5/0.1μm .0001"/.00005"/.00001" switchable					
Digital display	Display axes	X and Y (or X, Y, and Z only for the MF-UB and -UD types)					
	Functions	Zero-setting, direction switching, RS232C output, USB output (specific to QSPAK)					

\*1: The following suffixes are added to the order No. to specify the User Manual's language: -10 for English; -11 for Simplified Chinese; No suffix for Japanese.

\*2: Measuring method complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination	Standard: Halogen bulb (12V, 50W) (No.513667)
	Bulb life: 1,100 hours
For replacement for reflected illumination (from separate light source) *3	Standard: Halogen bulb (12V, 100W) (No.517181)
	High-intensity bulb (12V, 100W) (No.12BAD602)

\*3: At the time of purchase, a standard bulb and a high-intensity bulb are provided. (Only for the Reflected illumination models.)

## MF-U series (Motor-Driven Z-axis/Motor-Driven) SERIES 176 — Universal Measuring Microscopes



**MF-UJ2017D**

• The turret, objectives and illumination unit are optional accessories.

**MF-UE2017D**

• The turret, objectives and illumination unit are optional accessories.

- Motor-driven Z-axis model of the MF-U series and Motor-driven X-, Y-, and Z-axes model of the MF-U series.
- Using the optional Vision Unit enables the image AF function.
- Illumination unit (reflected/transmitted) can be selected from a high-intensity LED or halogen bulb (required).
- Variable aperture diaphragm (reflected/ transmitted) allows observation measurement while suppressing light diffraction.
- A wide variety of optional accessories including various digital CCD cameras are offered.
- Proven high-NA objectives from the FS optical system (long working distance type).
- Integration of metallurgical and measurement microscope functions provides high-resolution observation and a high-accuracy measurement solution.
- High-magnification observation up to 4000X.
- MF-UE/UF is capable of performing Laser AF. The standard Laser AF function is equipped with the tracking function which keeps a focus even when the stage is moving.

### Specifications for Motor-Driven Z-axis MF-U Series

BF (brightfield)	Model No.	MF-UJ2017D	MF-UJ3017D	MF-UJ4020D
	Order No.	176-894*1	176-895*1	176-896*1
BD (brightfield/darkfield)	Model No.	MF-UK2017D	MF-UK3017D	MF-UK4020D
	Order No.	176-897*1	176-898*1	176-899*1
Observation image		BF (Bright field), DF (Dark field) (MF-UK models only), Polarization, Differential Interference Contrast (DIC) / Erect image		
Eyepiece (optional)	Adjustable diopter	10X (eyepiece field number: 24, two eyepieces provided as standard), 15X, 20X		
Turret (required)	Bright-field (BF)	Adjustable manual turret or adjustable power turret (Select one.)		
	Bright-field/dark-field (BD)	Manual turret or power turret (Select one.)		
Objective (optional)	Bright-field (BF)	M Plan Apo, M Plan Apo SL, G Plan Apo series		
	Bright-field/dark-field (BD)	BD Plan Apo, BD Plan Apo SL series		
Illumination unit (One of the two options must be selected.)	LED	Transmitted: Telecentric, built-in aperture diaphragm, white LED light source, stepless brightness adjustment, equipped with cooling fan Reflected: Kohler illumination with adjustable aperture diaphragm, white LED light source, stepless brightness adjustment, equipped with cooling fan Control unit: Power switch (main switch), AC power supply input connector (100 to 240V)		
	Halogen	Transmitted: Telecentric, built-in aperture diaphragm, 12V/50W halogen lamp, stepless brightness adjustment, with cooling fan Reflected: BF/BD Kohler illumination with adjustable aperture diaphragm, 12V100W or 12V15W halogen lamp (selectable), external fiber illumination, stepless brightness adjustment Control unit: Power switch (main switch), AC power supply input connector (100 to 240 V)		
Vision AF *2		Yes		
Laser auto focus (LAF)		—	—	—
Stage	Measuring range	200x170mm	300x170mm	400x200mm
	Quick release mechanism	Fitted to X and Y axes		
	Zero set switch	Fitted to X and Y axes		
Z axis	Max. workpiece height	220mm		
	Feed mechanism	Motor drive (measuring speed: max. 20mm/s)		
Measuring accuracy*3 (X and Y axes, when not loaded)		(2.2 + 0.02L)µm L: measuring length (mm)		
	Minimum reading	1/0.5/0.1µm .0001"/.00005"/.00001" switchable		
Digital display	Display axes	X, Y and Z		
	Functions	Zero-setting, direction switching		

### Specifications for Motor-Driven MF-U Series

BF (brightfield)	Model No.	Motorized			Motorized LAF		
		MF-UG2017D	MF-UG3017D	MF-UG4020D	MF-UE2017D	MF-UE3017D	MF-UE4020D
	Order No.	176-784*1	176-785*1	176-786*1	176-790*1	176-791*1	176-792*1
BD (brightfield/darkfield)	Model No.	MF-UH2017D	MF-UH3017D	MF-UH4020D	MF-UF2017D	MF-UF3017D	MF-UF4020D
	Order No.	176-787*1	176-788*1	176-789*1	176-793*1	176-794*1	176-795*1
Observation image		BF (Bright field), DF (Dark field) (MF-UH and MF-UF models only), Polarization, Differential Interference Contrast (DIC) / Erect image					
Eyepiece (optional)	Adjustable diopter	10X (eyepiece field number: 24, two eyepieces provided as standard), 15X, 20X					
Turret (required)	Bright-field (BF)	Adjustable manual turret or adjustable power turret (Select one.)			Manual turret with BF sensor, adjustable power turret*1		
	Bright-field/dark-field (BD)	Manual turret or power turret (Select one.)			Manual turret with BD sensor, power turret*1		
Objective (optional)	Bright-field (BF)	M Plan Apo, M Plan Apo SL, G Plan Apo series					
	Bright-field/dark-field (BD)	BD Plan Apo, BD Plan Apo SL series					
Illumination unit (One of the two options must be selected.)	LED	Transmitted: Telecentric, built-in aperture diaphragm, white LED light source, stepless brightness adjustment, equipped with cooling fan Reflected: Kohler illumination with adjustable aperture diaphragm, white LED light source, stepless brightness adjustment, equipped with cooling fan Control unit: Power switch (main switch), AC power supply input connector (100 to 240V)					
	Halogen	Transmitted: Telecentric, built-in aperture diaphragm, 12V/50W halogen lamp, stepless brightness adjustment, with cooling fan Reflected: BF/BD Kohler illumination with adjustable aperture diaphragm, 12V100W or 12V15W halogen lamp (selectable), external fiber illumination, stepless brightness adjustment Control unit: Power switch (main switch), AC power supply input connector (100 to 240 V)					
Vision AF *2		Yes					
Laser auto focus (LAF)		—	—	—	✓	✓	✓
Stage	Measuring range	200x170mm	300x170mm	400x200mm	200x170mm	300x170mm	400x200mm
	Feed mechanism	Motordrive (Maximum measuring speed: 40mm/s)					
Z axis	Max. workpiece height	220mm					
	Feed mechanism	Motordrive (Maximum measuring speed: 20mm/s)					
Measuring accuracy*3 (X and Y axes, when not loaded)		(2.2 + 0.02L)µm L: measuring length (mm)					
	Minimum reading	1/0.5/0.1µm .0001"/.00005"/.00001" switchable					
Digital display	Display axes	X, Y and Z					
	Functions	Zero-setting, direction switching					

\*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: Vision Unit and an image AF cable are separately required.

\*3: Measuring method complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination	Standard: Halogen bulb (12V, 50W) (No.513667) Bulb life: 1,100 hours	For replacement for reflected illumination (from separate light source)*4	Standard: Halogen bulb (12V, 100W) (No.517181) High-intensity bulb (12V, 100W) (No.12BAD602)
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\*4: At the time of purchase, a standard bulb and a high-intensity bulb are provided. (Only for the Reflected illumination models.)

# Microscopes

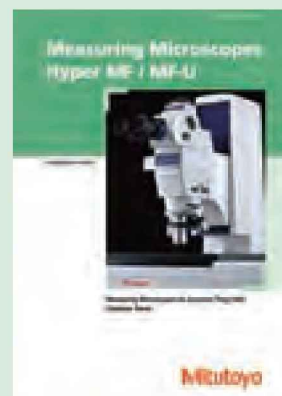
Microscope lineups that systemize observation, measurement and processing

## Hyper MF/MF-U SERIES 176 — High-Accuracy Measuring Microscopes

- Ultimate automated world's highest accuracy Measuring Microscope (Minimum display Resolution 0.01 μm).
- The front-operation design of the main unit is based on the concept of UD (universal design).
- Three-axis motorized front operation joystick control, which makes a refreshing change from conventional microscope operation, allows fine positioning even during fast movement.
- User selection of a conventional microscope optical tube or one equipped with built-in laser AF has improved measurement throughput due to the diversified observation methods available.
- Large workstage with stroke of 250×150mm provides enough margin for the measurement of larger workpieces.
- Utilizes ultra-high-precision glass scales with low thermal expansion and a detector head with high resolution.
- The best-selling data processing unit, QM-Data200, and the Vision Unit can be integrated to provide an effective and stable measurement environment.
- A wafer holder (available for wafers of less than 8") and high rigidity center supports meet the needs for high precision measurement.
- Motorized turret models are equipped with a retracting function that works when the objective lens is changed.



**Hyper MF-U**  
•An optical tube, turret, and objective lens are optional.



Refer to the Hyper MF/MF-U  
(Catalog No.E14012) for more details.

### SPECIFICATIONS

Model No.	HyperMF-B2515B	HyperMF-UB2515B	HyperMF-UD2515B	HyperMF-UE2515B	HyperMF-UF2515B
Order No.	176-430*1	176-431*1	176-432*1	176-433*1	176-434*1
Optical tube	Finite correction optical system		Infinity-correction optical system BF (Bright field)	Infinity-correction optical system BD (Bright / Dark field)	Infinity-correction optical system BF (Bright field) with the LAF function
Standard reticle (Built-in)	90° broken-cross line (line width 5 μm)				
Pupil distance adjustment	Siedentopf type Adjustment range: 51 to 76mm				
Optical path switching ratio	Observation/TVphotomicrography = 50/50				
Vertical tilt angle	25°	Tilting			
TV port	Provided as standard				
Observation image	Erect image				
Eyepiece Magnification	10X, 15X, 20X				
Objective lens (optional)	Selectable from the monocular unit (equipped with an eyepiece) or binocular tube (equipped with two eyepieces)		Equipped with two 10X eyepieces		
ML series objective lens	1X, 3X, 5X, 10X, 20X, 50X, 100X		—		
BF (Bright field)	—		M Plan Apo, M plan Apo SL, G plan Apo		
BD (Bright / Dark field)	—		BD Plan Apo, BD Plan Apo SL		
Turret (optional) BF (Bright field)	—		(Equipped with a four-hole manual sensor / motorized five-hole sensor*2)		
BD (Bright / Dark field)	—		(Equipped with a four-hole manual sensor / motorized four-hole sensor*3)		
Focusing section	Maximum height of workpiece 150mm				
Measuring accuracy	(1.5+0.01L) μm L: Measuring length (mm)				
Drive method	Motorized control with the use of a joystick				
Illumination unit	Transmitted illumination device Telecentric system, Built-in aperture diaphragm, Halogen bulb (12V, 50W), 100-step light intensity control, Fiber optics cable cold light illumination				
Reflected illumination unit	Koehler illumination, Variable aperture diaphragm mechanism, Halogen bulb (12V, 100W), 100-step light intensity control, Fiber optics cable cold light illumination				
Workstage	Measuring range (X×Y) 250×150mm				
Measuring accuracy*4 (When no load is put on the X- or Y-axis)	(0.9+0.003L) μm L: Measuring length (mm)				
Dimensions of the top plane	460×350mm				
Usable dimensions of the stage glass	300×200mm				
Swiveling angle	±3°				
Maximum loading mass	30kg				
Drive method	Motorized control with the use of a joystick				
Detector	High precision digital scale (Patented)				
Digital display	Resolution 0.01 μm				
Axes to be displayed	X, Y, Z				
Data processing unit	QM-Data200 or Vision Unit				
Operation section	Joystick lock Available				
Fine pitch	Available				
Data output	Available				
Digital display reset	Available				
Illumination light intensity control:	Available				
LAF (just focus)	—	—	—	Available	
LAF (tracking focus)	—	—	—	Available	
Turret remote control	—				
	—		Available (when installing a motorized turret)		

\*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 and \*3 are the factory-installed options.

\*4: Measurement accuracy complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination Standard: Halogen bulb (12V, 50W) (No.02APA527)

For replacement for reflected illumination (from separate light source) Standard: Halogen bulb (12V, 100W) (No.517181) High-intensity bulb (12V, 100W) (No.12BAD602)

### Angle Index (Standard Accessory)



## TM series SERIES 176 — Toolmakers' Microscopes

- Compact universal toolmakers' microscope that can be installed on any site.
- Newly designed LED illuminators provide enhanced observation for higher accuracy and resolution.
- Optional LED circular illuminator available for applications requiring all-round lighting.
- Achieves a maximum measuring height of 115mm despite the compact size.
- Installation of digimatic micrometer heads (MHD-50MB, option) facilitates makes measurement easy and precise.
- A vernier scale (Angle Index) built into the eyepiece mount enables accurate angular measurements.
- Overall magnification is 30X using the standard accessory lenses but can be changed to lie within the 20-200X range by using optional objectives and/or eyepieces.



TM-505B



TM-1005B

\* micrometer heads is option.

### SPECIFICATIONS

Model No.	TM-505B	TM-1005B	
Order No.	176-818* <sup>1</sup>	176-819* <sup>1</sup>	
Optical tube	Monocular type (Vertical tilt angle: 60°)		
Observation image	Erect		
Eyepiece protractor	Resolution (graduation) : 1°, Rotation angle: 360°, Resolution (angle): 6', Adjustable zero point		
Eyepiece	Standard accessory: 15X (field number: 13), Options: 10X, 20X		
Objective lens	Standard accessory: 2X, Options: 5X, 10X		
Microscope head	Maximum height of workpiece	115mm	
	Focusing method	Manual (Coarse feed)	
Illumination unit	Transmitted illumination	Stepless brightness adjustment, White LED light source, With green filter	
	Surface illumination	Oblique single-source type, Stepless brightness adjustment, White LED light source	
Cross-travel stage	Measuring range	50x50mm	100x50mm (An optional 50mm gauge block is required to cover full range. A CERA block is recommended.)
	Table size	152x152mm	240x152mm
	Usable area of the stage glass	96x96mm	154x96mm
	Maximum stage glass loading	5kg	
Linear measurement method	Micrometer head* <sup>2</sup>		
Resolution	Depends on the micrometer head specifications* <sup>2</sup> (for MHD-50MB (164-163): 0.001mm)		
Micrometer head travel range	for MHD-50MB (164-163): 50mm		
Power supply	100 to 240VAC 50/60Hz Maximum power consumption: 4.2W		
Main unit mass	14kg	15kg	

Note: The main unit with digimatic micrometer head (MHD-2"MB) is provided in the TM-500 series. To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA.

**TM-A505B (176-820A)**

**TM-A1005B (176-821A)**

Other specifications are the same as the other TM-500 Series.

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

\*2: Micrometer heads are optional for **TM-505B** and **TM-1005B**.



Refer to the TM Series  
(Catalog No.E14013) for more details.

# Microscopes

Microscope lineups that systemize observation, measurement and processing

## Accessory for Measuring Microscope

### Focus Pilot

- By installing this system on the camera mount of an MF series measuring microscope and projecting the focusing chart onto the workpiece surface, the focal point can be detected with high-accuracy and high-repeatability.
- The brightness of the chart can be adjusted.
- A wide view field observation on the monitor is made possible with the use of a CCD camera (C-mount adapter is included).

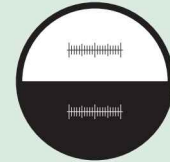
- Four types of chart patterns are available. The pattern should be selected in accordance with the type of workpiece surface texture.



Concentric circle

Slit

### Stage Micrometer



### SPECIFICATIONS

Model No.	FP-05		FP-05U	
Order No.	375-057*	375-058*	375-067*	375-068*
Applicable microscopes	MF D models		MF-U D models	
Light source	Green LED	Red LED	Green LED	Red LED
Magnification	0.5X, Accuracy: 0.1%**			
Camera adapter	C-mount (provided)			
Applicable CCD camera	Up to 2/3-type			
Mass	1.8kg		1.8kg	

\* Order No. depends on the destination

\*\* Within 2/3 area from the center of view field

Note) Combination of MF-U D and FP-05U are optional at factory default.



### SPECIFICATIONS

Order No.	375-056
Range	1mm
Graduations	0.01mm
Accuracy (at 20°C)	(1+L)μm, L = Measuring length (mm)
Dimensions (WxD)	76 x 26mm
Mass	16g

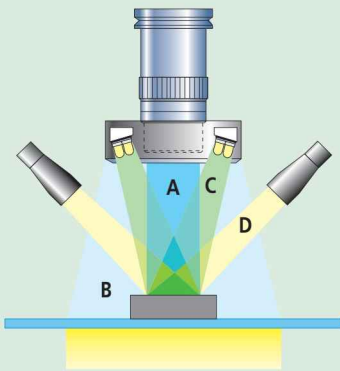
### Manual and Power Turrets



### SPECIFICATIONS

Order No.	176-211	176-412	378-018	176-410	176-212*	378-016*	378-216*
Supported observation	For bright-field and dark-field (BD)	For bright-field and dark-field with sensor (BD)	For bright-field (BF)	For bright-field with sensor (BF)	For bright-field and dark-field (BD)	For bright-field (BF)	For bright-field (BF)
Number of ways	4	4	4	4	4	4	5
Centering and parfocal mechanism	—		Standard fixed: 1 position Centering and parfocal: 3 positions		—	Standard fixed: 1 position Centering and parfocal: 3 positions	Standard fixed: 1 position Centering and parfocal: 4 positions
Driving method	Manual				Electric		
Power supply	—				100 to 240V AC		
External dimensions (mm)	—	ø120 x 48.2(H)	ø110 x 50.7(H)	ø120 x 50.6(H)	Turret: 164(W)x65(H)x137(D)		
					Console box: 108(W)x72(H)x193(D)		
					Cable length: 3m		
Applicable model	Required for MF-U D						

\* Order No. depends on the destination



**A: Reflected and transmitted illumination**



PCB



HDD suspension



IC circuit

**B: Fiber-optic Ring Light**



Flexible PCB



PCB



Electric parts

**C: LED Ring Light**



HDD suspension



PCB



Black resin molded parts

**D: Dual swan-neck light pipe**



IC package



Garnet



PCB

## Dual swan-neck light pipe



### SPECIFICATIONS

Order No.	176-343*
Applicable microscopes	MF, MF-U models
Length of fiber cable	700mm
Light source	Halogen bulb (12V, 100W) (517181: halogen bulb)
Dimensions (W x D x H)	Light unit: 235 x 76 x 120mm

\*Order No. depends on the destination

## Fiber-optic Ring Light



### SPECIFICATIONS

Order No.	176-366*
Applicable microscopes	MF models (ML objective 10X or lower model)
Length of fiber cable	1000mm
Light source	Halogen bulb (12V, 100W) (517181: halogen bulb)
Dimensions (W x D x H)	Light unit: 235 x 76 x 120mm

\*Order No. depends on the destination

## LED Ring Light



### SPECIFICATIONS

Order No.	176-367-2* 176-371* (Specific to Sliding Nosepiece)
Applicable microscopes	MF models (ML objective 10X or lower)
Light source	White LED
Dimensions (W x D x H)	75 x 150 x 90mm (only the control unit)
Length of LED cable	1500mm

\*Order No. depends on the destination

## LED Ring Light (for FS Objectives)



### SPECIFICATIONS

Order No.	Please contact us.
Applicable microscopes	MF-U models (FS objective M plan Pro 10X or lower)
Light source	Supplied from microscope (surface illumination)
Dimensions (W x D x H)	75 x 150 x 90mm (only the control unit)
Length of LED cable	1000mm

\*Order No. depends on the destination

# Microscopes

Microscope lineups that systemize observation, measurement and processing

## QM-Data200

### SERIES 264 — 2-D Data Processing Unit

- 2-D Data Processor designed to perform arithmetic processing of XY coordinate data acquired from projectors and measuring microscopes, for local display or output to a printer.
- Informative color graphic displays on the large LCD screen make for easy measurement operations.
- One-key operation for combined measurements (circle-circle distance, etc.).
- The AI measurement function (automatic identification of measuring item) eliminates switching between the measurement command keys.
- Equipped with a measurement procedure teaching function and measuring position navigation in Repeat mode.
- The user menu function allows the user to register measurement commands or part programs to create custom menus.
- Tolerance zone testing of data processing results and various statistical processing routines for each item are available.
- Measurement result output to "MS-Excel"\* in spreadsheet (CSV) format.  
\* Microsoft Excel is a registered trademark of Microsoft Corporation.
- Part programs and calculation results can be saved on a USB-compatible memory device.
- Two models are available: a stand-alone type with tilt system, and a flexible arm type that can be mounted on a Profile Projector.



QM-Data200  
(stand type)

## SPECIFICATIONS

Model No.	QM-Data200		
Order No.	Standard type 264-155*1	Flexible arm type 264-156*1	Standard type 264-159*1
Applicable models (Conventional models)*2	PJ-A3000 series PJ-H30 series PV-5110 PH-3515F PH-A14 MF series MF-U series	PJ-A3000 series PJ-H30 series PV-5110 PH-3515F PH-A14	HyperMF/MF-U
Unit of measurement	Length: mm    Angle: Switchable between decimal degree and sexagesimal notation		
Resolution	0.1μm		0.01μm
Program function	Creating, performing, and editing of the measurement procedures		
Statistical processing	Number of data, maximum value, minimum value, mean value, standard deviation, range, histogram Statistics classified by each measurement function (Statistics classified by each command)		
Display unit	Color graphic LCD (equipped with a backlight)		
ABS point	—		Available (Automatic movement)
LAF (Laser AF)	—		Available
Edge sensor position correction	Available (Profile Projectors with OPTOEYE)		—
Input/output	XYZ: Data input from linear scales (Maximum number of axes: 3) RS-232C 1: Connection to an external PC RS-232C 2: Connection to a measuring unit counter OPTOEYE: Connection to an OPTOEYE edge signal (OPTOEYE 200) FS: For the connection to the foot switch PRINTER: For the connection to an external printer USB-MEMORY: For the connection to a USB memory		
Measurement result file output	RS-232C output (CSV format, MUX-10 format)		
Display language	16 languages (Japanese, English, German, French, Italian, Spanish, Portuguese, Cheskey, Chinese (simplified/traditional), Korean, Turkish, Swedish, Polish, Dutch, Hungarian)		
Power supply	100 - 240V AC		
Maximum power consumption	17W (excluding optional accessories)		
External dimensions (W×H×D)	260×242×310mm (including the stand section)	318×153×275mm (when the arm is horizontal)	260×242×310mm (including the stand section)
Mass	Approx. 2.9kg	Approx. 2.8kg	Approx. 2.9kg
Standard Accessories	AC adapter, Power cable, Quick Operation Guide		

\*1: To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA, D for CEE, E for BS, K for KC,C and No suffix are required for PSE, and 00 for power cord other than A, D, E, K, C, No suffix.

\*2: Please contact Mitutoyo office with respect to the models that are applicable to the models other than mentioned above.

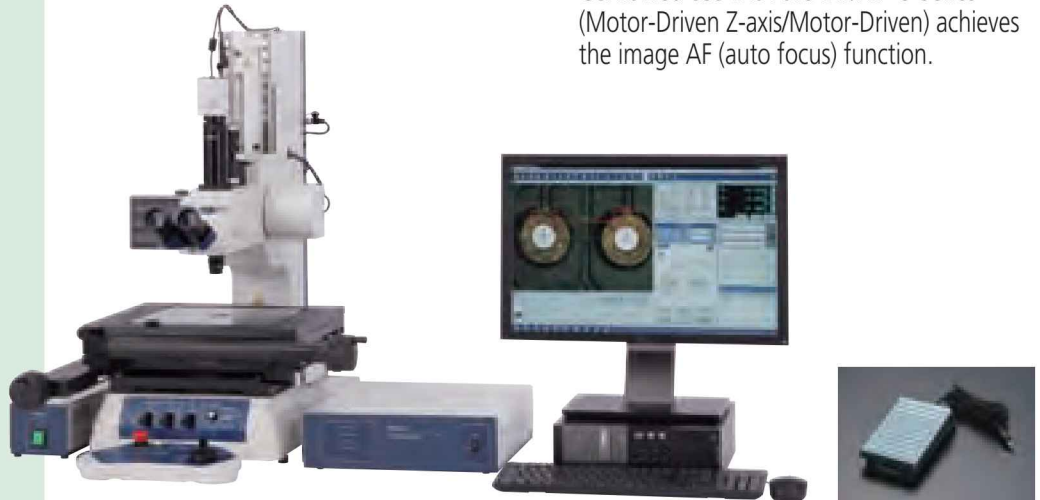


Refer to the QM-Data200 and Vision Unit  
(Catalog No.E14008) for more details.



## Vision Unit SERIES 359 — Vision System Retrofit for Microscopes

- Installation of this unit can upgrade your measuring microscope to a vision measuring machine.
- The measurement tools and various macro icons allow measurement in one easy step.
- The graphics and measurement navigation functions facilitate operation.
- The image saving function and the data output function to the spreadsheet software are standard.
- Combined use with the MF/MF-U Series (Motor-Driven Z-axis/Motor-Driven) achieves the image AF (auto focus) function.



MF-J2017D plus Vision Unit

Foot switch  
12AAJ088

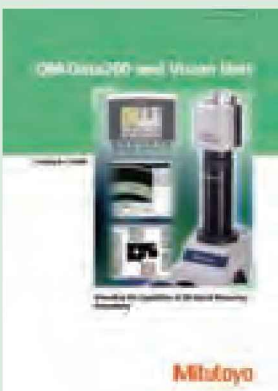
### SPECIFICATIONS

	Vision Unit
Magnification of the optical system	When installed on the microscope 0.5X (using the 0.5X TV adapter)
Image detection	High-sensitivity 1/2" color CMOS camera 3 million pixels
Resolution	0.1 $\mu$ m
Measuring accuracy for each axis (Measurement environment: 20°C)	Depends on the accuracy specification of the Mitutoyo measuring microscope to which the unit is fitted.
Accuracy (Measurement environment: 20°C)	Depends on the accuracy of Mitutoyo measuring microscopes. For reference: When using an ML series 3X objective lens (In an inspection using a sample workpiece based on the Mitutoyo standards) Measurement accuracy in the screen: Less than $\pm 2.5\mu$ m Repetitive accuracy in the screen ( $\pm 2\sigma$ ): Less than $\pm 1\mu$ m
Software (option)	QSPAK Vision Unit Edition

Note: QSPAK and a data processor are required separately.

### Applicable Models

- Mitutoyo **MF series, MF-U series** (Connection to the **MF-H series** is not available.)  
**Hyper MF series, Hyper MF-U series**



Refer to the QM-Data200 and Vision Unit  
(Catalog No.E14008) for more details.

# Microscopes

Microscope lineups that systemize observation, measurement and processing

## VMU series SERIES 378 — Video Microscope Unit

- Compact and lightweight microscope unit dedicated observation by camera. Suitable for inspecting metal surfaces, semiconductors, liquid crystal substrates, resin, etc.
- A versatile microscope head typically used as an OEM product suitable for fitting to specialist machines, such as those designed for inspection and repair of semiconductor wafers using YAG (near-infrared, visible, near-ultraviolet, or ultraviolet) laser\*.
  - \*The performance and safety of the laser-equipped system products is not guaranteed. Applications: cutting, trimming, correcting, marking of semiconductor circuits / clearing & processing of thin films (insulation films), repairing (correcting failure) of liquid crystal color filters. Also suited for use as the optical observation section for a prober analyzing semiconductor failures.
- For VMU-LB and VMU-LB, the rigidity and general performance of the microscope main unit have been enhanced compared with previous models.
- Applications\*: internal observation of silicon systems, spectral characteristics analysis using infrared, etc.
  - \* An infrared source and infrared camera are necessary.
- Telecentric system equipped with an aperture diaphragm is standard on the surface illumination optical system. Best suited to process images for which the uniform illumination is required. Available for the dimensional measurement, form inspection, positioning, etc.
- Design and manufacture are available to meet your demands such as double camera mounting, double (low/high) magnification.



## SPECIFICATIONS

Model No.	VMU-V	VMU-H	VMU-LB	VMU-L4B
Order No.	378-505	378-506	378-513	378-514
Camera mounting direction	Vertical	Horizontal	Vertical	
Observation	Bright field/Erect image	Bright field/Inverted image	Bright field/Erect image	
Optical tube	TV adapter	Equipped with a C-mount	Equipped with a C-mount (Equipped with a green filter switching mechanism)	
	Image forming (tube) lens	Built-in 1X (visible/near-infrared calibration) zoom	Built-in 1X (near-infrared/visible/near-ultraviolet calibration) zoom	Built-in 1X (visible/ultraviolet) zoom
	Available for lasers	—	YAG laser source (Basic, Second/Third harmonic) mountable	YAG laser source (Second/Third/Fourth harmonic) mountable
For observation	<b>M Plan Apo series, M Plan Apo HR series, M Plan Apo SL series, G Plan Apo series</b>			
Objective lens (required option) For laser processing	—		<b>M/LCD Plan Apo NIR series M/LCD Plan Apo NUV series</b> Note: Selected depending on the wavelength of the laser source	<b>M/LCD Plan Apo NIR series M/LCD Plan Apo NUV series M Plan UV series</b> Note: Selected depending on the wavelength of the laser source
Applicable camera(s)	2/3 type or less cameras (C-mount type)			
Reflected illumination optical system	Telecentric system equipped with an aperture diaphragm			
Illumination unit (optional)	Fiber optics cable illumination unit (12V, 100W) (No.378-700*)/(15V, 150W) (No.176-316*)			
Main unit weight	650g	750g	1270g	1300g

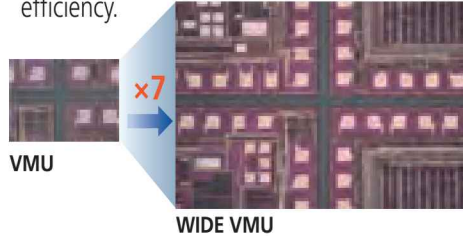
Note1: Besides the models shown above, products equipped with a compact Koehler illumination system intended for general observation are also available.

Note2: The **M Plan Apo 1X** objective lens is used with the polarization unit (No.378-710).

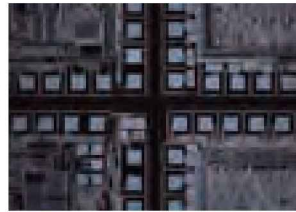
\* Order numbers differ depending on the power supply cord.

## WIDE VMU series SERIES 378 — Wide-field Video Microscope Unit

- Incorporates a wide-field image sensor (APS-C format or smaller size) providing seven times greater viewing area than the VMU Series for greatly enhanced inspection efficiency.

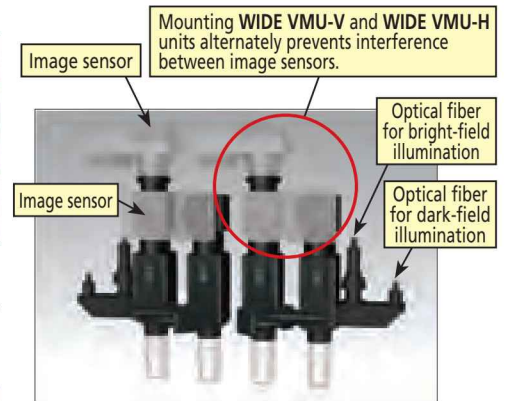


- In addition to normal bright-field observation, this series supports dark-field observation for scratch inspection, etc., and polarized light observation for increased contrast when viewing certain specimens.



WIDE VMU dark-field

- Bulk inspections covering a wide area can be performed with multiple units in a high-density configuration.



WIDE VMU-V



WIDE VMU-H



WIDE VMU-BDV



WIDE VMU-BDH

## SPECIFICATIONS

	For Bright-field Observation		For Bright-/Dark-field Observation	
	WIDE VMU-V 378-515	WIDE VMU-H 378-516	WIDE VMU-BDV 378-517	WIDE VMU-BDH 378-518
Model				
Order No.				
Camera mounting orientation	Vertical	Horizontal	Vertical	Horizontal
Observation	Bright field/Erect image	Bright field/Inverted image	Bright field and Dark field/Erect image	Bright field and Dark field/Inverted image
Optical tube	Optical system	Magnification: 1X Visible light		
	Camera Mount	F-Mount, C-Mount (with aligning and parfocal adjustment mechanism)		
	Imaging forming (tube) lens	Built-in 1X tube lens (Correcting wavelength range: 436 - 656nm)		
	Image field	ø30		
Polarized unit*	Mountable			
Objective lens (required option)	M Plan Apo, M Plan Apo HR, M Plan Apo SL, G Plan Apo		BD Plan Apo, BD Plan Apo HR, BD Plan Apo SL	
Applicable camera	APS-C format or smaller size			
Reflected illumination optical system	Telecentric illumination, Bright-field illumination optical tube (Single-port fiber-optic illumination)		Telecentric illumination, Bright/Dark-field illumination optical tube (Dual-port fiber-optic illumination) Bright/Dark-field switching with light source on-off	
Illumination unit (optional)	Fiber-optic illumination unit (12V, 100W) (No. 378-700)/(12V, 150W) (No. 176-316)			
Main unit mass	1800g	1950g	2000g	2150g

\*Polarized observation by Bright-field illumination

# Microscopes

Microscope lineups that systemize observation, measurement and processing

## FS-70 series

### SERIES 378 — Microscope Unit for Semiconductor Inspection

- Compact microscope unit equipped with an eyepiece observation section. Suitable for inspecting metal surfaces, semiconductors, liquid crystal substrates, resin, etc.
- A versatile microscope head typically used as an OEM product suitable for fitting to specialist machines, such as those designed for inspection and repair of semiconductor wafers using YAG (near-infrared, visible, near-ultraviolet, or ultraviolet) lasers\*.
- \* The performance and safety of the laser-equipped system products is not guaranteed. Applications: cutting, trimming, correcting, marking of semiconductor circuits / clearing & processing of thin films (insulation films), repairing (correcting failure) of liquid crystal color filters. Also suited for use as the optical observation section for a probe analyzing semiconductor failures.
- Usable in infrared optical systems\*. Applications: internal observation of silicon systems; spectral characteristics analysis using infrared. \* An infrared source and infrared camera are necessary.
- Models supporting BF (Bright field), DF (Dark field), Polarization, and Differential Interference Contrast (DIC) are available.
- Koehler illumination equipped with an aperture diaphragm is provided as standard on the surface illumination optical system.
- The inwardly slanting turret and ultra-long working distance objective lens maintains the high operability under the microscope. Koehler illumination is equipped with the aperture diaphragm as standard on the surface illumination optical system.



\*A parfocal manual turret, eyepiece and objective lens are optional.

## SPECIFICATIONS

Model No.	FS70	FS70-TH	FS70Z	FS70Z-TH	FS70L	FS70L-TH	FS70L4	FS70L4-TH
Order No.	378-184-1	378-184-3	378-185-1	378-185-3	378-186-1	378-186-3	378-187-1	378-187-3
Short base model No.	FS70-S	FS70-THS	FS70Z-S	FS70Z-THS	FS70L-S	FS70L-THS	FS70L4-S	FS70L4-THS
Order No.	378-184-2	378-184-4	378-185-2	378-185-4	378-186-2	378-186-4	378-187-2	378-187-4
Focus adjustment	50mm travel range with concentric coarse (3.8mm/rev) and fine (0.1mm/rev) focusing wheels (right / left)							
Image	Erect image							
Optical tube type	Siedentopf, adjustable interpupillary distance range: 51 - 76mm							
Field number	24mm							
Tilt angle	—	0° - 20°	—	0° - 20°	—	0° - 20°	—	0° - 20°
Optical pass ratio	Fixed type (Eyepiece/TV = 50/50)	Switchable type (Eyepiece/Tube = 100/0: 0/100)	Fixed type (Eyepiece/TV = 50/50)	Switchable type (Eyepiece/Tube = 100/0: 0/100)				
Protective filter	—				Built-in laser beam filter			
Tube lens	1X		1X - 2X zoom		1X			
Applicable laser	—				1064/532/355nm		532/266nm	
Camera mount	C-mount (using optional adapter B*1)				Use a laser with TV port.		C-mount receptacle (with green filter switch)	
Illumination system, optional	Reflective illumination for bright field (Koehler illumination, with aperture diaphragm) 12V 100W fiber-optics, stepless adjustment, light guide length: 1.5m							
Objective, optional (for observation)	M Plan Apo, M Plan Apo SL, G Plan Apo							
Objective, optional (for laser-cutting)	—				M/LCD Plan NIR, M/LCD Plan NUV		M Plan UV	
Loading*2	14.5kg	13.6kg	14.1kg	13.2kg	14.2kg	13.5kg	13.9kg	13.1kg
Mass (main unit)	6.1kg	7.1kg	6.6kg	7.5kg	6.4kg	7.2kg	6.7kg	7.5kg

\*1: Installation is optional.

\*2: Loading on optical tube excluding weight of objective lenses and eyepieces

Bulb replacement	Standard: Halogen bulb (12V, 100W) (No.517181)
	For the fiber optics cable illumination unit (12V, 100W) (No.378-700)

### Reticles (optional)

- 516848: Cross-hair
- 516576: Broken cross hair (90° and 60°)
- 516578: Concentric circle  
(Diametric increment: 1.2mm)
- 516577: 20mm scale  
(Minimum reading: 0.1mm) with cross hair
- 516849: 10mm scale (Minimum reading: 0.1mm)
- 516850: 5mm scale (Minimum reading: 0.05mm)
- 516851: 10x10mm section  
(Minimum section: 1x1mm)

## Eyepieces SERIES 378

- The field of view is extra wide.
- Optional reticles are available.



### SPECIFICATIONS

Order No. (2pcs. set)	Magnification	Field number	Mass	Individual order No.
378-866	10X	24	150g	378-866-5
378-857	15X	16	40g	378-857-5
378-858	20X	12	55g	378-858-5

## FS series objective lens SERIES 378 — Ultra-long working distance objective lens

- **M/BD Plan Apo** (M Plan Apochromat Brightfield and Darkfield) series features the image evenness in the entire view field needed to achieve high color reproducibility.
- The following objective lenses support a wide range of wavelength including near infrared, visible, and ultraviolet lasers. Specialty LCD laser objectives are available: **M/LCD Plan NIR (-HR) series** (Near-infrared calibration lenses for laser processing featuring ultra-long

- working distances), **M/LCD Plan NUV series** (Near-ultraviolet lenses), **M Plan UV series** (Ultraviolet lenses), and **G Plan Apo series** (Cover Glass corrected lenses that allow focusing through a window as in vacuum and high temperature applications).
- Uses environment-friendly glass (including no lead or arsenic) for the lens material (of the specified models).

BF (Bright field) for observation/measurement



BD (Bright / Dark field) for observation/measurement



For near-infrared calibration (NIR series)



For near-ultraviolet calibration (NUV series)



For the ultraviolet calibration (UV series)



# Microscopes

Microscope lineups that systemize observation, measurement and processing

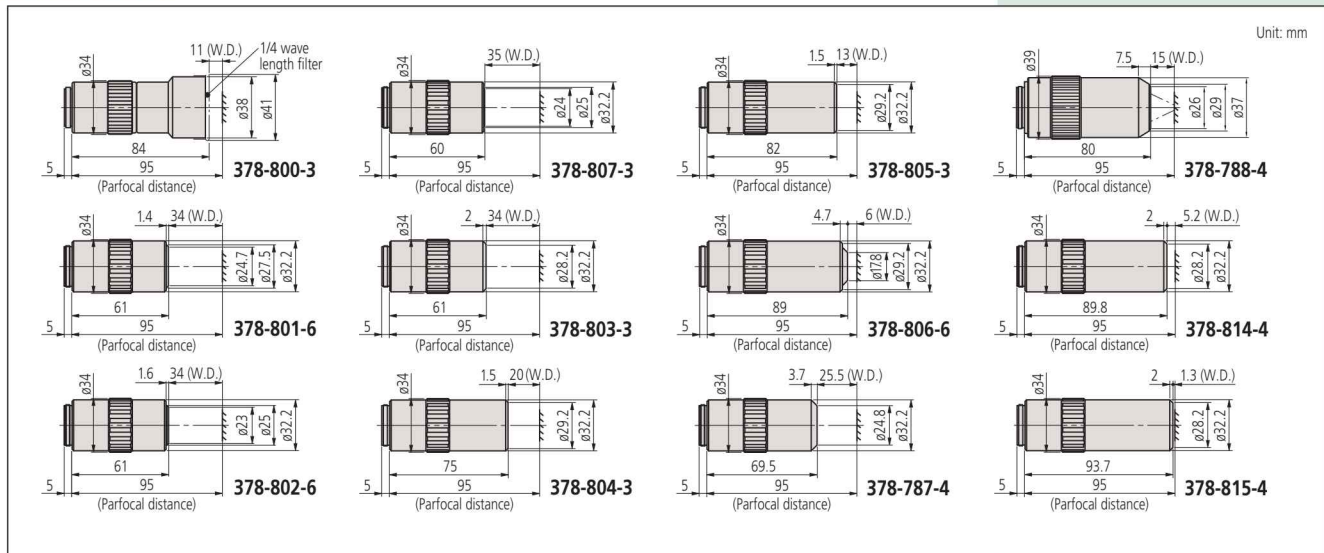
## M Plan Apo/M Plan Apo HR for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
<b>M Plan Apo</b>									
378-800-3	1X	0.025	11.0mm	200mm	11.0 $\mu$ m	440 $\mu$ m	$\phi$ 24mm	4.8x6.4mm	300g
378-801-6	2X	0.055	34.0mm	100mm	5.0 $\mu$ m	91 $\mu$ m	$\phi$ 12mm	2.4x3.2mm	220g
378-802-6	5X	0.14	34.0mm	40mm	2.0 $\mu$ m	14.0 $\mu$ m	$\phi$ 4.8mm	0.96x1.28mm	230g
378-807-3	7.5X	0.21	35.0mm	26.67mm	1.3 $\mu$ m	6.2 $\mu$ m	$\phi$ 3.6mm	0.64x0.85mm	240g
378-803-3	10X	0.28	34.0mm	20mm	1.0 $\mu$ m	3.5 $\mu$ m	$\phi$ 2.4mm	0.48x0.64mm	240g
378-804-3	20X	0.42	20.0mm	10mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 1.2mm	0.24x0.32mm	270g
378-805-3	50X	0.55	13.0mm	4mm	0.5 $\mu$ m	0.9 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	290g
378-806-3	100X	0.70	6.0mm	2mm	0.4 $\mu$ m	0.6 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	320g
<b>M Plan Apo HR</b>									
378-787-4	5X	0.21	25.5mm	40mm	1.3 $\mu$ m	6.2 $\mu$ m	$\phi$ 4.8mm	0.96x1.28mm	285g
378-788-4	10X	0.42	15mm	20mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 2.4mm	0.48x0.64mm	460g
378-814-4	50X	0.75	5.2mm	4mm	0.4 $\mu$ m	0.49 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	400g
378-815-4	100X	0.90	1.3mm	2mm	0.3 $\mu$ m	0.34 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	410g

Note: Polarizing unit is required when using 1X objective.



## DIMENSIONS

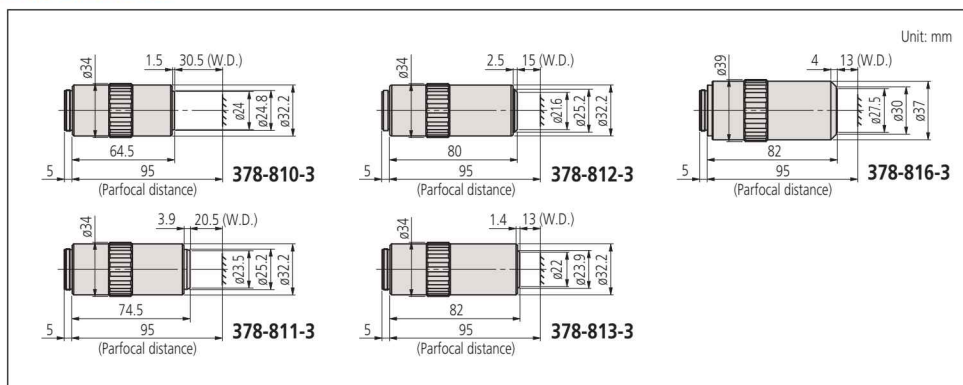


## M Plan Apo SL for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-810-3	20X	0.28	30.5mm	10mm	1.0 $\mu$ m	3.5 $\mu$ m	$\phi$ 1.2mm	0.24x0.32mm	240g
378-811-3	50X	0.42	20.5mm	4mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	280g
378-812-3	80X	0.50	15.0mm	2.5mm	0.6 $\mu$ m	1.1 $\mu$ m	$\phi$ 0.3mm	0.06x0.08mm	280g
378-813-3	100X	0.55	13.0mm	2mm	0.5 $\mu$ m	0.9 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	290g
378-816-3	200X	0.62	13.0mm	1mm	0.4 $\mu$ m	0.7 $\mu$ m	$\phi$ 0.12mm	0.025x0.03mm	490g

Note: These objectives offer extra-long working distance.

## DIMENSIONS



Mag.: Magnification  
 NA: Numerical aperture  
 W.D.: Working distance  
 f: Focal distance  
 R: Resolving power  
 D.F.: Focal depth  
 View field 1: Field of view when using  $\phi$ 24mm eyepiece  
 View field 2: Field of view when using 1/2" CCD camera

## Glass Thickness (t = 3.5mm) Corrected G Plan Apo for Bright-field Observation

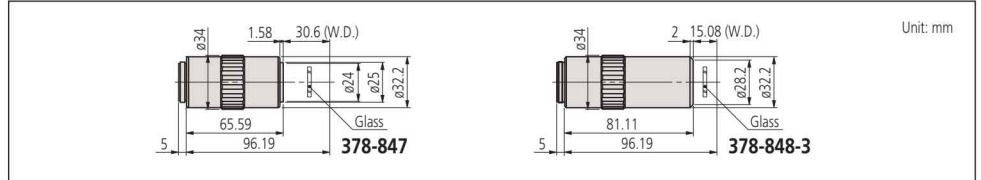


Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-847	20X	0.28	29.42mm*	10mm	1.0μm	3.5μm	ø1.2mm	0.24x0.32mm	270g
378-848-3	50X	0.50	13.89mm*	4mm	0.6μm	1.1μm	ø0.48mm	0.10x0.13mm	320g

Note: The G Plan Apo Series are designed for observing a workpiece through glass (thickness = 3.5mm).

\* In air

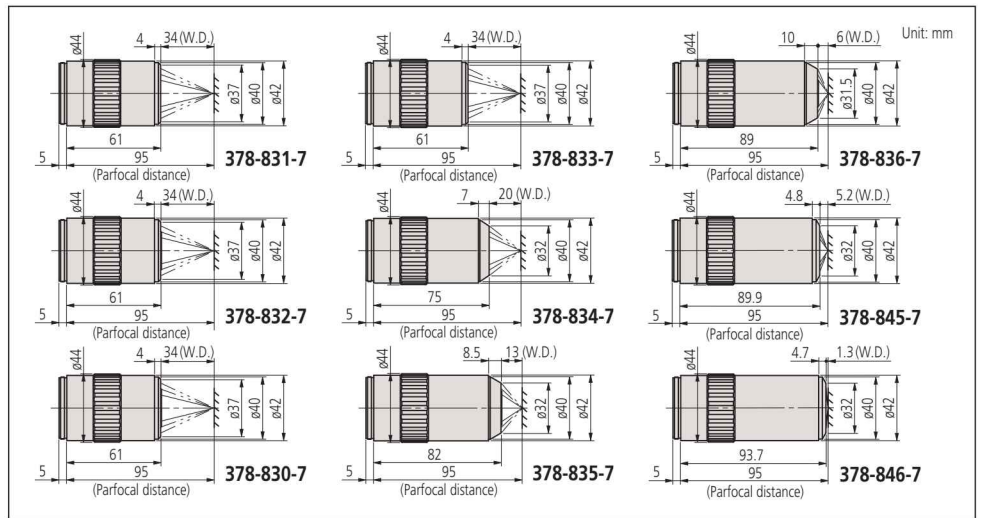
### DIMENSIONS



## BD Plan Apo/BD Plan Apo HR for Bright/Dark-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
<b>BD Plan Apo</b>									
378-831-7	2X	0.055	34.0mm	100mm	5.0μm	91μm	ø12mm	2.4x3.2mm	340g
378-832-7	5X	0.14	34.0mm	40mm	2.0μm	14.0μm	ø4.8mm	0.96x1.28mm	350g
378-830-7	7.5X	0.21	34.0mm	26.67mm	1.3μm	6.2μm	ø3.6mm	0.64x0.85mm	350g
378-833-7	10X	0.28	34.0mm	20mm	1.0μm	3.5μm	ø2.4mm	0.48x0.64mm	350g
378-834-7	20X	0.42	20.0mm	10mm	0.7μm	1.6μm	ø1.2mm	0.24x0.32mm	400g
378-835-7	50X	0.55	13.0mm	4mm	0.5μm	0.9μm	ø0.48mm	0.10x0.13mm	440g
378-836-7	100X	0.70	6.0mm	2mm	0.4μm	0.6μm	ø0.24mm	0.05x0.06mm	460g
<b>BD Plan Apo HR</b>									
378-845-7	50X	0.75	5.2mm	4mm	0.4μm	0.49μm	ø0.48mm	0.10x0.13mm	530g
378-846-7	100X	0.90	1.3mm	2mm	0.3μm	0.34μm	ø0.24mm	0.05x0.06mm	545g

### DIMENSIONS

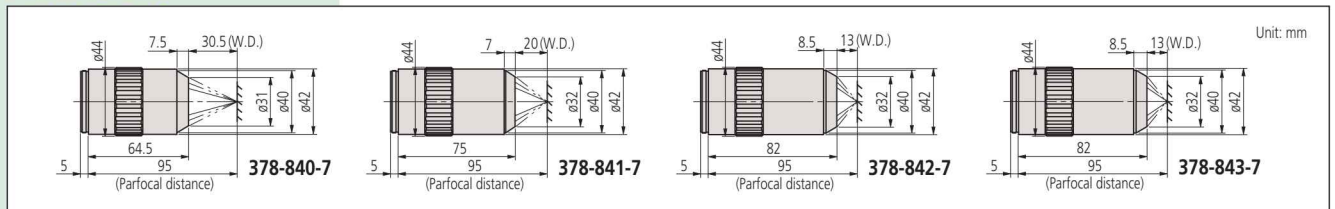


## BD Plan Apo SL for Bright/Dark-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-840-7	20X	0.28	30.5mm	10mm	1.0μm	3.5μm	ø1.2mm	0.24x0.32mm	350g
378-841-7	50X	0.42	20.0mm	4mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	410g
378-842-7	80X	0.50	13.0mm	2.5mm	0.6μm	1.1μm	ø0.3mm	0.06x0.08mm	430g
378-843-7	100X	0.55	13.0mm	2mm	0.5μm	0.9μm	ø0.24mm	0.05x0.06mm	440g

Note: These objectives offer extra-long working distance.

### DIMENSIONS



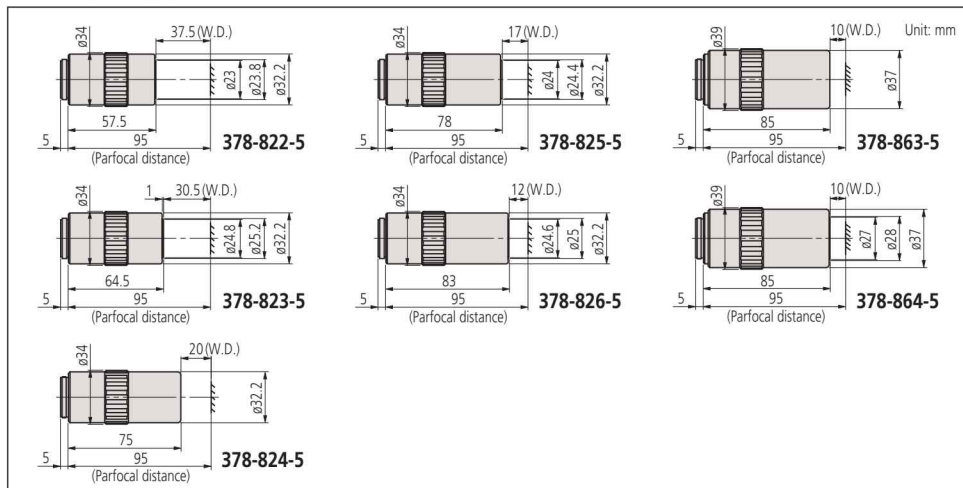
# Microscopes

Microscope lineups that systemize observation, measurement and processing

## Near-infrared Radiation Corrected M Plan Apo NIR/M Plan Apo NIR HR for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
<b>M Plan Apo NIR</b>									
378-822-5	5X	0.14	37.5mm	40mm	2.0 $\mu$ m	14.0 $\mu$ m	$\phi$ 4.8mm	0.96x1.28mm	220g
378-823-5	10X	0.26	30.5mm	20mm	1.1 $\mu$ m	4.1 $\mu$ m	$\phi$ 2.4mm	0.48x0.64mm	250g
378-824-5	20X	0.40	20.0mm	10mm	0.7 $\mu$ m	1.7 $\mu$ m	$\phi$ 1.2mm	0.24x0.32mm	300g
378-825-5	50X	0.42	17.0mm	4mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	315g
378-826-5	100X	0.50	12.0mm	2mm	0.6 $\mu$ m	1.1 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	335g
<b>M Plan Apo NIR HR</b>									
378-863-5	50X	0.65	10mm	4mm	0.4 $\mu$ m	0.7 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	450g
378-864-5	100X	0.70	10mm	2mm	0.4 $\mu$ m	0.6 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	450g

### DIMENSIONS



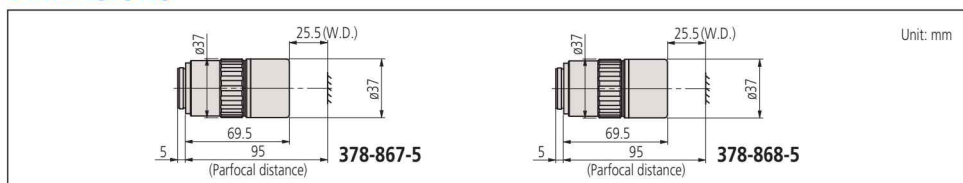
Note:

These objectives are designed so that a workpiece's image can be focused within the focal depth even when the wavelength used is changed anywhere from the visible range ( $\lambda = 480\text{nm}$ ) up to near-infrared range ( $\lambda = 1800\text{nm}$ ). Therefore the M Plan NIR Series are suitable for laser repair. However, when the wavelength used exceeds 1100nm, the focusing position may slightly deviate from that in the visible range due to changes in glass dispersion and refractive index.

## Near-infrared Radiation Corrected M Plan Apo NIR B for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-867-5	20X	0.40	25.5mm	10mm	0.7 $\mu$ m	1.7 $\mu$ m	$\phi$ 1.2mm	0.24x0.32mm	350g
378-868-5	50X	0.42	25.5mm	4mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	375g

### DIMENSIONS

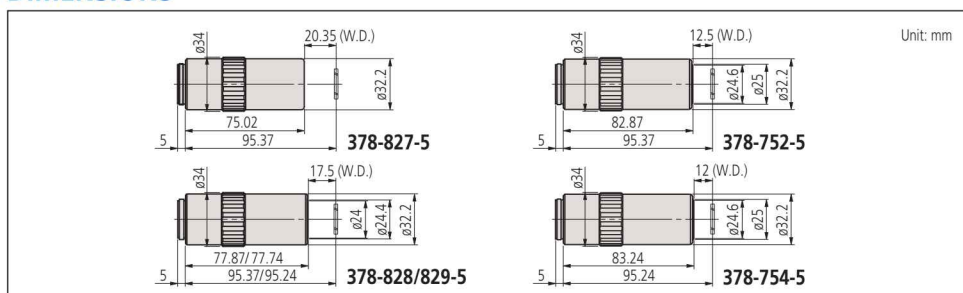


## Near-Infrared Radiation and LCD Glass Thickness ( $t = 1.1\text{mm}$ or $0.7\text{mm}$ ) Corrected LCD Plan Apo NIR for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-827-5	20X	0.40	19.98mm*	10mm	0.7 $\mu$ m	1.7 $\mu$ m	$\phi$ 1.2mm	0.24x0.32mm	305g
378-828-5	50X	0.42	17.13mm*	3.9mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	320g
378-829-5	50X	0.42	17.26mm*	3.9mm	0.7 $\mu$ m	1.6 $\mu$ m	$\phi$ 0.48mm	0.10x0.13mm	320g
378-752-5	100X	0.50	12.13mm*	2mm	0.6 $\mu$ m	1.1 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	335g
378-754-5	100X	0.50	11.76mm*	2mm	0.6 $\mu$ m	1.1 $\mu$ m	$\phi$ 0.24mm	0.05x0.06mm	335g

\*In air

### DIMENSIONS



Note:

These near-infrared ( $\lambda = 1800\text{nm}$ ) corrected objectives are designed for observing a workpiece through LCD glass (thickness = 1.1mm (378-827-5, 378-828-5, 378-752-5) or 0.7mm (378-829-5, 378-754-5)) and for laser repair.

Mag.: Magnification  
 NA: Numerical aperture  
 W.D.: Working distance  
 f: Focal distance  
 R: Resolving power  
 D.F.: Focal depth  
 View field 1: Field of view when using  $\phi$ 24mm eyepiece  
 View field 2: Field of view when using 1/2" CCD camera



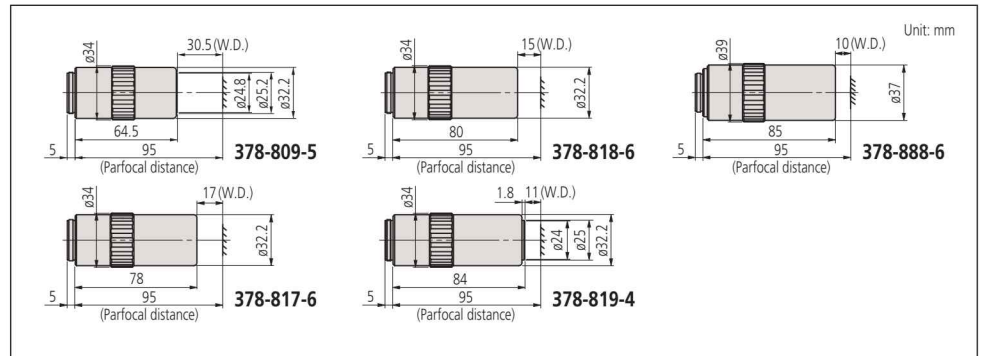


Note:  
These objectives are designed so that a workpiece's image can be focused within the focal depth even when the wavelength used is changed anywhere from the visible range ( $\lambda = 620\text{nm}$ ) to the near-ultraviolet range ( $\lambda = 355\text{nm}$ ). Therefore the M Plan NUV Series are suitable for laser repair using a high frequency laser beam.

## Near-ultraviolet Radiation Corrected M Plan Apo NUV/M Plan Apo NUV HR for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
<b>M Plan Apo NUV</b>									
378-809-5	10X	0.28	30.5mm	20mm	1 $\mu\text{m}$	3.5 $\mu\text{m}$	$\phi 2.4\text{mm}$	0.48x0.64mm	255g
378-817-6	20X	0.40	17.0mm	10mm	0.7 $\mu\text{m}$	1.7 $\mu\text{m}$	$\phi 1.2\text{mm}$	0.24x0.32mm	340g
378-818-6	50X	0.42	15.0mm	4mm	0.7 $\mu\text{m}$	1.6 $\mu\text{m}$	$\phi 0.48\text{mm}$	0.10x0.13mm	350g
378-819-4	100X	0.50	11.0mm	2mm	0.6 $\mu\text{m}$	1.1 $\mu\text{m}$	$\phi 0.24\text{mm}$	0.05x0.06mm	380g
<b>M Plan Apo NUV HR</b>									
378-888-6	50X	0.65	10.00mm	4mm	0.42 $\mu\text{m}$	0.65 $\mu\text{m}$	$\phi 0.48\text{mm}$	0.10x0.13mm	500g

### DIMENSIONS



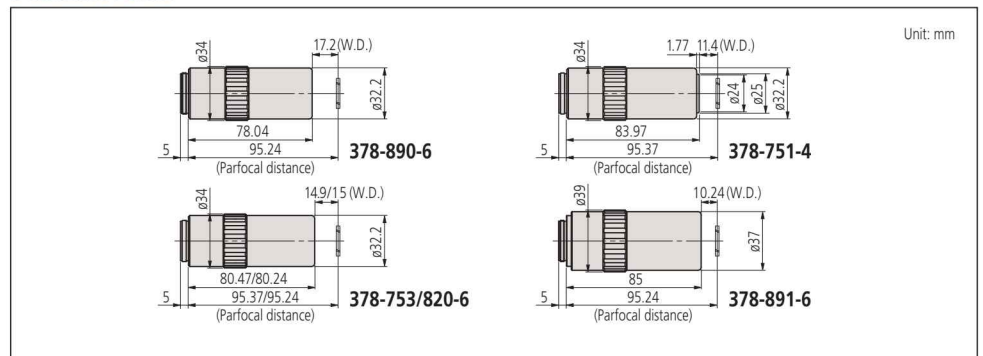
Note:  
These Near-ultraviolet( $\lambda=355\text{nm}$ ) corrected objectives are designed for observing a workpiece through LCD glass (thickness = 1.1mm (378-753-6, 378-751-4) or 0.7mm (378-890-6, 378-820-4, 378-891-6)) and for laser repair.

## Near-ultraviolet Radiation and LCD Glass Thickness ( $t = 1.1\text{mm}$ or $0.7\text{mm}$ ) Corrected LCD Plan Apo NUV/LCD Plan Apo NUV HR for Bright-field Observation

Order No.	Mag.	NA	W.D.	f	R	D.F.	View field 1	View field 2	Mass
<b>LCD Plan Apo NUV</b>									
378-890-6	20X	0.40	16.96mm*	10mm	0.7 $\mu\text{m}$	1.7 $\mu\text{m}$	$\phi 1.2\text{mm}$	0.24x0.32mm	340g
378-753-6	50X	0.42	14.53mm	4mm	0.7 $\mu\text{m}$	1.6 $\mu\text{m}$	$\phi 0.48\text{mm}$	0.10x0.13mm	350g
378-820-6	50X	0.42	14.76mm*	4mm	0.7 $\mu\text{m}$	1.6 $\mu\text{m}$	$\phi 0.48\text{mm}$	0.10x0.13mm	350g
378-751-4	100X	0.50	11.03mm	2mm	0.6 $\mu\text{m}$	1.1 $\mu\text{m}$	$\phi 0.24\text{mm}$	0.05x0.06mm	380g
<b>LCD Plan Apo NUV HR</b>									
378-891-6	50X	0.65	9.76mm	4mm	0.4 $\mu\text{m}$	0.7 $\mu\text{m}$	$\phi 0.48\text{mm}$	0.10x0.13mm	500g

\* In air

### DIMENSIONS



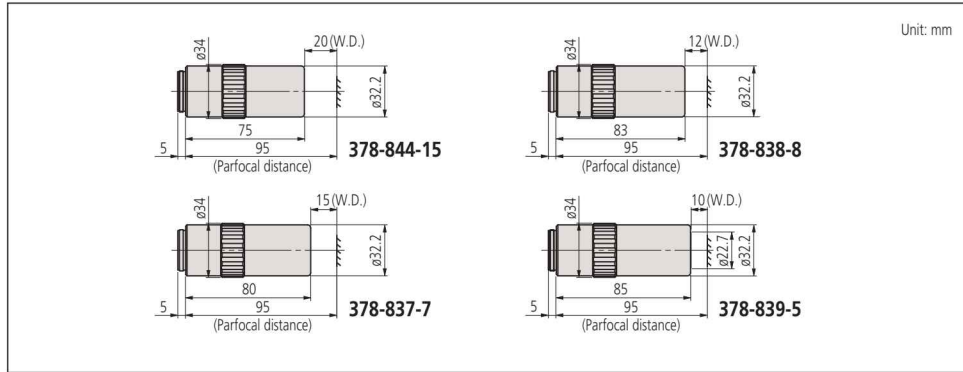
# Microscopes

Microscope lineups that systemize observation, measurement and processing

## Ultraviolet Radiation Corrected M Plan UV for Bright-field Observation

Order No.	Mag.	NA	W.D.	f <sub>266</sub>	f <sub>550</sub>	R	D.F.	View field 1	View field 2	Mass
<b>378-844-15</b>	10X	0.25	20.0mm	20mm	20.3mm	1.1μm	4.4μm	ø2.4mm	0.48x0.64mm	310g
<b>378-837-7</b>	20X	0.36	15.0mm	10mm	10.4mm	0.8μm	2.1μm	ø1.2mm	0.24x0.32mm	330g
<b>378-838-8</b>	50X	0.41	12.0mm	4mm	4.5mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	400g
<b>378-839-5</b>	80X	0.55	10.0mm	2.5mm	2.9mm	0.5μm	0.9μm	ø0.3mm	0.06x0.08mm	380g

### DIMENSIONS

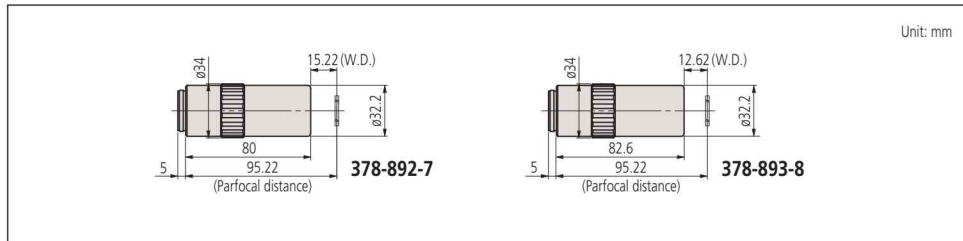


Note:  
These ultraviolet corrected objectives are designed so that a workpiece's image can be focused within the focal depth even when the wavelength used is changed anywhere from the visible range (λ = 550nm) to the ultraviolet range (λ = 266nm). Therefore the M Plan UV Series are suitable for laser repair using a high frequency laser beam.

## Ultraviolet Radiation and LCD Glass Thickness (t=0.7mm) Corrected LCD Plan UV for Bright-field Observation

Order No.	Mag.	NA	W.D.	f <sub>266</sub>	f <sub>550</sub>	R	D.F.	View field 1	View field 2	Mass
<b>378-892-7</b>	20X	0.36	15.0mm	10mm	10.4mm	0.8μm	2.1μm	ø1.2mm	0.24x0.32mm	330g
<b>378-893-8</b>	50X	0.41	12.4mm	4mm	4.5mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	400g

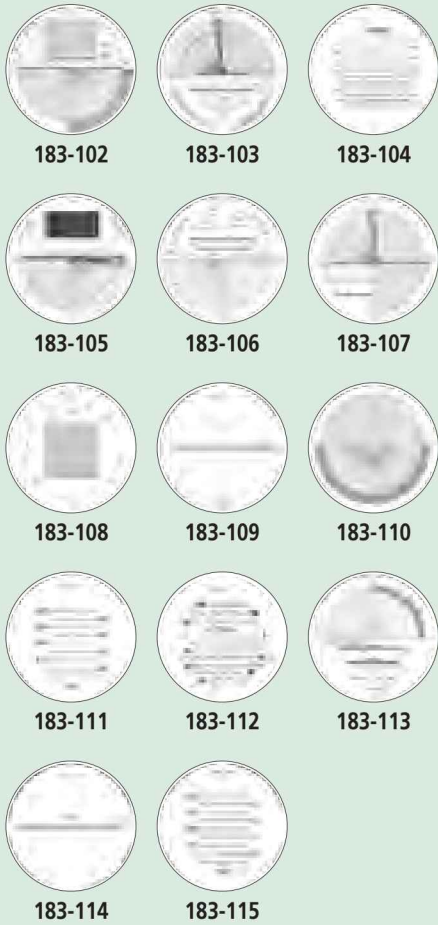
### DIMENSIONS



Note:  
These ultraviolet corrected objectives are designed for observing a workpiece through LCD glass (thickness = 0.7mm) and for laser repair.

Mag.: Magnification  
 NA: Numerical aperture  
 W.D.: Working distance  
 f: Focal distance  
 R: Resolving power  
 D.F.: Focal depth  
 View field 1: Field of view when using ø24mm eyepiece  
 View field 2: Field of view when using 1/2" CCD camera

### Optional Reticles for pocket comparators



## Pocket Magnifiers SERIES 183

- Suitable for inspecting metal surfaces.

### SPECIFICATIONS

Magnification	Order No.	Remarks
25X	183-201	Pen type
	183-202	With stand
50X	183-203	With stand

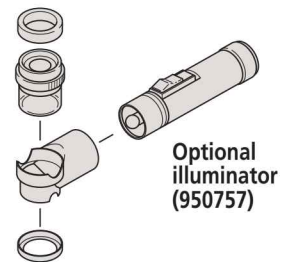


## Pocket Comparators SERIES 183

- By replacing optional reticles, dimensional, angle, and other types of measurement can be performed.
- An optional illuminator (950757) is available.

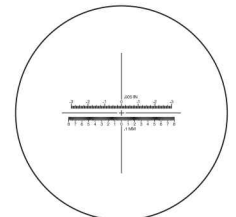
### SPECIFICATIONS

Magnification	Order No.	Remarks
8X	183-101	Optional reticles available
10X	183-131	Optional reticles available



## Zoom loupe SERIES 183

- Allows the user 8X - 16X zoom observation.
- Magnification indicator is provided for 8X, 10X, 12X, 14X, and 16X observation.
- Metric and inch scales are provided for measuring.
- Comes with a carrying case.



### SPECIFICATIONS

Magnification	Order No.	Remarks
8X	183-304	With reticles (Scale graduation: 0.1mm, .005")

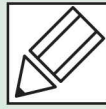
## Clear Loupe SERIES 183



### SPECIFICATIONS

Magnification	Order No.	Remarks
7X	183-301	Drawtube removable
10X	183-302	Drawtube removable
15X	183-303	Drawtube removable

# Quick Guide to Precision Measuring Instruments



## Microscopes

### Numerical Aperture (NA)

The NA figure is important because it indicates the resolving power of an objective lens. The larger the NA value the finer the detail that can be seen. A lens with a larger NA also collects more light and will normally provide a brighter image with a narrower depth of focus than one with a smaller NA value.

$$NA = n \cdot \sin\theta$$

The formula above shows that NA depends on  $n$ , the refractive index of the medium that exists between the front of an objective and the specimen (for air,  $n=1.0$ ), and angle  $\theta$ , which is the half-angle of the maximum cone of light that can enter the lens.

### Resolving Power (R)

The minimum detectable distance between two image points, representing the limit of resolution. Resolving power (R) is determined by numerical aperture (NA) and wavelength ( $\lambda$ ) of the illumination.

$$R = \frac{\lambda}{2 \cdot NA} \text{ (}\mu\text{m)}$$

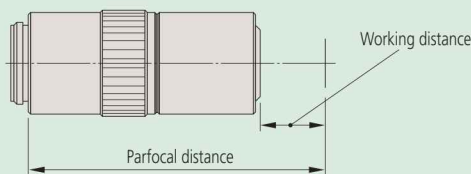
$\lambda = 0.55\mu\text{m}$  is often used as the reference wavelength

### Working Distance (W.D.)

The distance between the front end of a microscope objective and the surface of the workpiece at which the sharpest focusing is obtained.

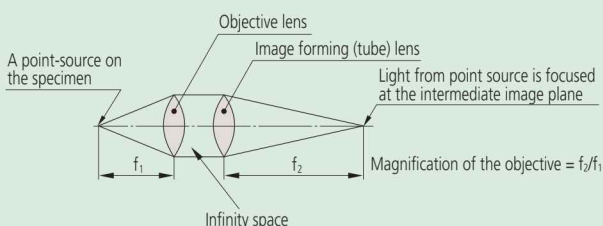
### Parfocal Distance

The distance between the mounting position of a microscope objective and the surface of the workpiece at which the sharpest focusing is obtained. Objective lenses mounted together in the same turret should have the same parfocal distance so that when another objective is brought into use the amount of refocussing needed is minimal.



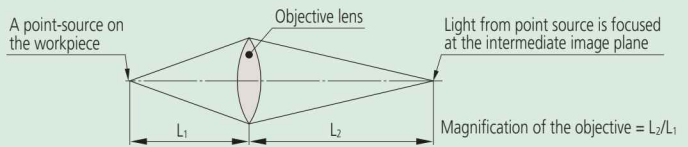
### Infinity Optical System

An optical system where the objective forms its image at infinity and a tube lens is placed within the body tube between the objective and the eyepiece to produce the intermediate image. After passing through the objective the light effectively travels parallel to the optical axis to the tube lens through what is termed the 'infinity space' within which auxiliary components can be placed, such as differential interference contrast (DIC) prisms, polarizers, etc., with minimal effect on focus and aberration corrections.



### Finite Optical System

An optical system that uses an objective to form the intermediate image at a finite position. Light from the workpiece passing through the objective is directed toward the intermediate image plane (located at the front focal plane of the eyepiece) and converges in that plane.



### Focal Length (f)

unit: mm

The distance from the principal point to the focal point of a lens: if  $f_1$  represents the focal length of an objective and  $f_2$  represents the focal length of an image forming (tube) lens then magnification is determined by the ratio between the two. (In the case of the infinity-correction optical system.)

$$\text{Objective magnification} = \frac{\text{Focal length of the image-forming (tube) lens}}{\text{Focal length of the objective}}$$

$$\text{Example: } 1X = \frac{200}{200} \quad \text{Example: } 10X = \frac{200}{20}$$

### Focal Point

Light rays traveling parallel to the optical axis of a converging lens system and passing through that system will converge (or focus) to a point on the axis known as the rear focal point, or image focal point.

### Depth of Focus (DOF)

unit: mm

Also known as 'depth of field', this is the distance (measured in the direction of the optical axis) between the two planes which define the limits of acceptable image sharpness when the microscope is focused on an object. As the numerical aperture (NA) increases, the depth of focus becomes shallower, as shown by the expression below:

$$DOF = \frac{\lambda}{2 \cdot (NA)^2} \quad \lambda = 0.55\mu\text{m} \text{ is often used as the reference wavelength}$$

Example: For an **M Plan Apo 100X** lens (NA = 0.7)

The depth of focus of this objective is

$$\frac{0.55\mu\text{m}}{2 \times 0.7^2} = 0.6\mu\text{m}$$

### Bright-field Illumination and Dark-field Illumination

In brightfield illumination a full cone of light is focused by the objective on the specimen surface. This is the normal mode of viewing with an optical microscope. With darkfield illumination, the inner area of the light cone is blocked so that the surface is only illuminated by light from an oblique angle. Darkfield illumination is good for detecting surface scratches and contamination.

### Apochromat and Achromat Objectives

An apochromat objective is a lens corrected for chromatic aberration (color blur) in three colors (red, blue, yellow).

An achromat objective is a lens corrected for chromatic aberration in two colors (red, blue).

## ■ Magnification

The ratio of the size of a magnified object image created by an optical system to that of the object. Magnification commonly refers to lateral magnification although it can mean lateral, vertical, or angular magnification.

## ■ Principal Ray

A ray considered to be emitted from an object point off the optical axis and passing through the center of an aperture diaphragm in a lens system.

## ■ Aperture Diaphragm

An adjustable circular aperture which controls the amount of light passing through a lens system. It is also referred to as an aperture stop and its size affects image brightness and depth of focus.

## ■ Field Stop

A stop which controls the field of view in an optical instrument.

## ■ Telecentric System

An optical system where the light rays are parallel to the optical axis in object and/or image space. This means that magnification is nearly constant over a range of working distances, therefore almost eliminating perspective error.

## ■ Erect Image

An image in which the orientations of left, right, top, bottom and moving directions are the same as those of a workpiece on the workstage.

## ■ Field number (FN), real field of view, and monitor display magnification

unit: mm

The observation range of the sample surface is determined by the diameter of the eyepiece's field stop. The value of this diameter in millimeters is called the field number (FN). In contrast, the real field of view is the range on the workpiece surface when actually magnified and observed with the objective lens.

The real field of view can be calculated with the following formula:

### (1) The range of the workpiece that can be observed with the microscope (diameter)

$$\text{Real field of view} = \frac{\text{FN of eyepiece}}{\text{Objective lens magnification}}$$

Example: The real field of view of a 1X lens is  $24 = \frac{24}{1}$   
The real field of view of a 10X lens is  $2.4 = \frac{24}{10}$

### (2) Monitor observation range

$$\text{Monitor observation range} = \frac{\text{The size of the camera image sensor (diagonal length)}}{\text{Objective lens magnification}}$$

#### • Size of image sensor

Format	Diagonal length	Length	Height
1/3"	6.0	4.8	3.6
1/2"	8.0	6.4	4.8
2/3"	11.0	8.8	6.6

### (3) Monitor display magnification

$$\text{Monitor display magnification} =$$

$$\text{Objective lens magnification} \times \frac{\text{Display diagonal length on the monitor}}{\text{Diagonal length of camera image sensor}}$$

# New Products



## **CNC Vision Measuring System**

### **QV Active**

Refer to page K-5 for details.



## **Non-contact 3D Measuring System**

### **Hyper QV WLI**

Refer to page K-11 for details.



## **2D Color Vision Measuring System**

### **QUICK IMAGE Series**

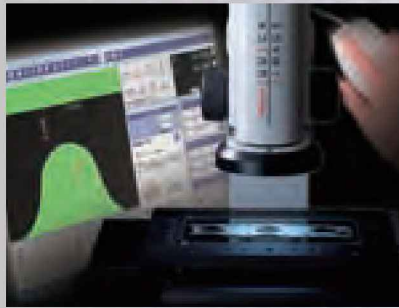
Refer to page K-17 for details.

# Vision Measuring Systems

## Quick Vision/QUICK SCOPE



## QUICK IMAGE



## UMAP Vision System



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### Quick Vision series

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# Vision Measuring Systems

Vision measuring systems for multipurpose use

## QV Apex SERIES 363 — Standard CNC Vision Measuring System

## Hyper QV SERIES 363 — High-accuracy CNC Vision Measuring System

- The Quick Vision series of CNC vision measuring machines are equipped with CCD cameras eliminating the need for visual alignment with a measuring microscope or projector. Automatic measuring can be easily achieved for electronic components, press molded products, resin molded products, etc.
- The Quick Vision PRO features LEDs for all light sources. This provides enhanced edge detectability, low power consumption and a long service life.
- A programmable power turret with high magnification reproducibility is used in the observation system, enabling automatically switchable magnification during measurement. (PRO/PRO3)
- All models feature surface, edge, and pattern autofocus systems offering measurement flexibility for a variety of applications. A laser autofocus system can be added as a factory-installed option.
- A model equipped with the tracking focus function is also available.
- The PRO type version of this model supports ISO10360-7:2011 guaranteed accuracy (specifications on request).



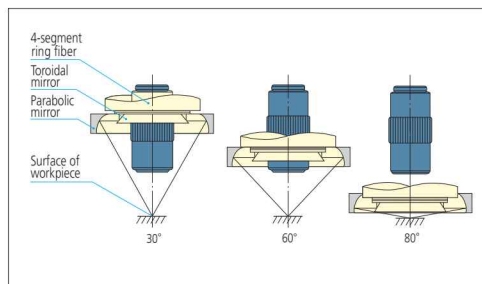
QV Apex302



Hyper QV 404

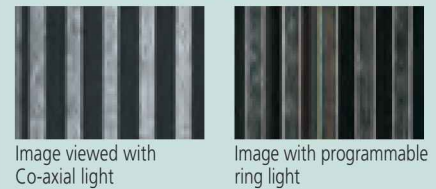
### Programmable ring light

Fine control of obliquity and direction provides illumination optimal for measurement. Obliquity can be arbitrarily set in the range from 30° to 80°. This type of illumination is effective for enhancing the edge of inclined surfaces or very small steps. Illumination can be controlled independently in every direction, back and forth, right and left. Measurement with edge enhancement is possible by forming a shadow by lighting from only one direction.



The programmable ring light shows the effect of a finely stepped section and the enhanced contrast of an inclined plane.

### Measurement example of IC package terminal bottom width



### Tracking Auto Focus (TAF)

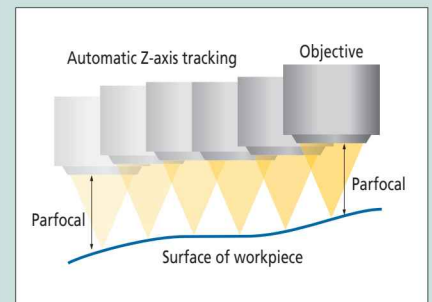
The TAF feature focuses continuously, adjusting to changes in the height of the object being measured. Automatic tracking of surface waves and warpage (in the Z-axis height direction) improves measurement throughput. The feature also cuts out the hassle of focusing during manual measurement, reducing the work burden for measuring system operators. In addition, Laser Auto Focus (LAF) function allows height measurement.

Note: Continuous measurement of displacement is not performed.

Laser source	Semiconductor laser (peak wavelength: 690nm)				
Laser safety	Class 2 (JIS C6802:2011, EN/IEC 60825-1:2007)				
Auto focus system	Objective coaxial autofocusing (knife-edge method)				
Applicable objectives	QV-HR1X	QV-SL1X	QV-HR2.5X	QV-SL2.5X	QV-5X
Tracking range *	6.3mm (±3.15mm)	6.3mm (±3.15mm)	1mm (±0.5mm)	1mm (±0.5mm)	0.25mm (±0.125mm)

\* When using Tracking Auto Focus, be sure to set upper and lower limits in the software to prevent the objective colliding with the workpiece.

The tracking range depends on the surface texture and reflectance of a workpiece.





## SPECIFICATIONS

Model	QV Apex 302				QV Apex 404				QV Apex 606			
	PRO		PRO3		PRO		PRO3		PRO		PRO3	
Optical system	—											
Tracking Auto Focus device	●											
Order No.	363-170	363-174	363-171	363-175	363-180	363-184	363-181	363-185	363-190	363-194	363-191	363-195
Measuring range (XxYxZ)	300x200x200mm				400x400x250mm				600x650x250mm			
Resolution of scale / Scale type	0.1µm/Linear Encoder											
Observation Unit*1	PPT1X-2X-6X											
Imaging Device	B&W CCD		3CCD Color		B&W CCD		3CCD Color		B&W CCD		3CCD Color	
Illumination Unit*2	Co-axial Light				White LED				White LED			
	Transmitted light				White LED				White LED			
	PRL				White LED				White LED			
Accuracy*3	E1x, E1y				(1.5+3L/1000)µm				(1.5+3L/1000)µm			
	E1z				(1.5+4L/1000)µm				(1.5+4L/1000)µm			
	E2xy				(2+4L/1000)µm				(2+4L/1000)µm			
Operating Temperature range	Ambient temperature				20±1°C				20±1°C			
	Temperature variation				2°C / 8H				2°C / 8H			
Stage glass size	399x271mm				493x551mm				697x758mm			
Maximum stage loading*4	20kg				40kg				50kg			
Main unit external dimensions	859x951x1609mm				1027x1407x1778mm				1309x1985x1794mm			
Main unit mass (including the sub-base)	360kg				579kg				1450kg			

\*1: The specific combination of 1X, 2X and 4X or 1X, 2X, 4X and 6X is available by custom order.

\*2: The color LED lighting or halogen lighting specification is available by custom order.

\*3: Determined by Mitutoyo's inspection method. L is the measured length (mm).

The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*4: An excessively biased or concentrated load is excluded.

\* The Laser Auto Focus (LAF) specification is available by custom order.

\* Append "S" to the end of code number to order a QV machine compatible with ISO10360-7:2011 Accuracy Assurance. (PRO machine only)

## Specifications\*1

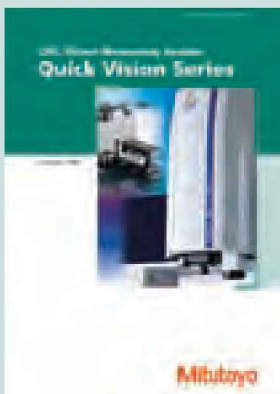
Model	Hyper QV 302		Hyper QV 404		Hyper QV 606	
	PRO					
Optical system	—					
Tracking Auto Focus device	●					
Order No.	363-173	363-177	363-183	363-187	363-193	363-197
Resolution of scale / Scale type	0.02µm/Linear Encoder					
Imaging Device	B&W CCD					
Accuracy*2	E1x, E1y		(0.8+2L/1000)µm		(0.8+2L/1000)µm	
	E1z		(1.5+2L/1000)µm		(1.5+2L/1000)µm	
	E2xy		(1.4+3L/1000)µm		(1.4+3L/1000)µm	
Maximum stage loading*3	15kg		30kg		40kg	

\*1 Specifications other than the table are the same as the QV Apex specifications.

\*2 Determined by Mitutoyo's inspection method. L is the measured length (mm).

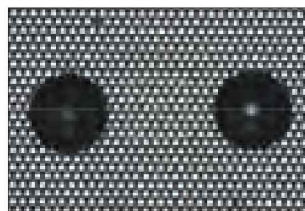
The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*3 An excessively biased or concentrated load is excluded.



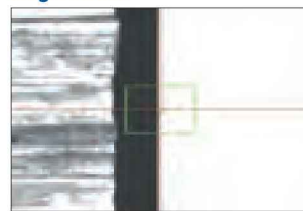
Refer to the QUICK VISION (Catalog No.E14007) for more details.

### Pattern Focus



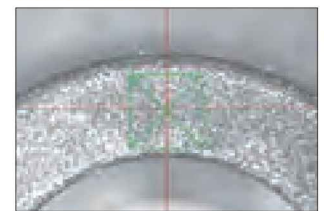
The pattern focus reticle (included on QV Apex model) allows a projected focused image on low contrast transparent objects and mirrored surfaces to pattern. Useful for measuring the height of various surface types.

### Edge Focus



Robust edge detection methods for multiple lighting techniques are available with edge focus.

### Surface Focus



Surface focus can be selected for each unique material type and texture. A singular Z measurement point is extracted in this example.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## QV Active SERIES 363 — CNC Vision Measuring System

- These space-saving new entry models meet various needs with advanced functionality and easy operation.
- Two sizes, 250×200mm and 400×400mm are available to cover a wide range of workpiece types.
- Newly designed objective lenses achieve a maximum zoom ratio of 14x, which covers the range from wide-view measurement at low magnification to micro-measurement under high magnification.
- Usability has been improved by adopting a high-resolution color camera. The images bear comparison with observation devices such as a microscope.
- A model is also available equipped with a touch probe that can be used for measuring three-dimensional objects that cannot be measured with a purely vision-based measuring system.



QV-L202Z1L-D

## SPECIFICATIONS

Order No.	363-109	364-109	363-110	364-110
Model No.	QV-L202Z1L-D	QVT1-L202Z1L-D	QV-L404Z1L-D	QVT1-L404Z1L-D
Measuring range (X×Y×Z)	250×200×150 (250×200×118: when Z-objective 1X is used)		400×400×200 (400×400×168: when Z-objective 1X is used)	
Resolution	0.1μm			
Scale unit	Linear encoder			
Observation unit	Yes			
Color CMOS camera	Yes			
Illumination Unit	Co-axial Light	White LED		
	Transmitted Light	White LED		
	PRL	4-quadrant fixed white LED		
Accuracy*1	E <sub>1x</sub> , E <sub>1y</sub>	(2+3L/1000)μm		
	E <sub>1z</sub>	(3+5L/1000)μm		
	E <sub>2</sub>	(2.5+4L/1000)μm		
	Accuracy guaranteed with optics specified	Z-objective 1.5X and 3.5X Zoom ratio		
Touch-probe measuring accuracy*1	E <sub>1x</sub> , E <sub>1y</sub> , E <sub>1z</sub>	(2.4+3L/1000)μm	—	(2.4+3L/1000)μm
Accuracy guaranteed temperature range	20±1°C	18~23°C	20±1°C	18~23°C
Size of stage glass	311×269mm		466×480mm	
Maximum stage loading *2	10kg		20kg	
Dimensions (W×D×H)	570×767×845mm		776×1303×1004mm	
Mass (including machine stand)	155kg		324kg	
Temperature compensation function	—	Manual	—	Manual

\*1 Inspected to a Mitutoyo standard. L = Measured length (mm)

\*2: Does not apply for unbalanced or concentrated loads.

## ULTRA QV404 SERIES 363 — Ultra-High Accuracy CNC Vision Measuring System

- ULTRA QV404 PRO is an ultra-high accuracy CNC vision measuring system that offers the world's highest level of measurement accuracy,  $E_{1XY}: (0.25+L/1000)\mu\text{m}$ .
- This machine uses air bearings specially developed for use in high-accuracy 3D measuring machines on the X-, Y-, and Z-axes to provide a guide system with minimum straightness errors.
- Optimal design is achieved by using FEM (Finite Element Method) analysis to provide high rigidity of the main unit.
- An optical linear encoder featuring a resolution of  $0.01\mu\text{m}$  has been adopted for the all-important length measurement system.  
In order to minimize error caused by temperature fluctuations, the linear encoder scale is made of a special crystallized glass whose expansion coefficient is almost zero.
- This model supports ISO10360-7:2011 guaranteed accuracy (specifications on request).



ULTRA QV404

### SPECIFICATIONS

Model		ULTRA QV 404	
Optical system		PRO	
Tracking Auto Focus device		—	●
Order No.		363-518	363-519
Measuring range (XxYxZ)		400x400x200mm	
Resolution of scale / Scale type		0.01 $\mu\text{m}$ / Linear Encoder	
Observation Unit*1		PPT1X-2X-6X	
Imaging Device		B&W CCD	
Illumination Unit	Co-axial Light	Halogen	
	Transmitted Light	Halogen	
	PRL	Halogen	
Accuracy*2	$E_{1X}, E_{1Y}$	$(0.25+L/1000)\mu\text{m}$	
	$E_{1Z}$ (50mm stroke)*3	$(1+2L/1000)\mu\text{m}$	
	$E_{1Z}$ (Full stroke)	$(1.5+2L/1000)\mu\text{m}$	
	$E_{2XY}$	$(0.5+2L/1000)\mu\text{m}$	
On-screen repeatability		$3\sigma = 0.2\mu\text{m}$	
Auto focus repeatability		$\sigma = 0.4\mu\text{m}$	
Operating Temperature range	Ambient temperature	19 ~ 23°C	
	Temperature variation	0.5°C / 1H and 1°C / 24H	
Stage glass size		493x551mm	
Maximum stage loading*4		40kg	
Main unit external dimensions		1172x1735x1910mm	
Main unit mass (including the sub-base)		2150kg	
Operating air pressure		0.4 MPa*5	
Required air flow rate		300L/min(ANR)*6	
Temperature compensation function		Automatic	

\*1: The specific combination of 1X, 2X and 4X or 1X, 2X, 4X and 6X is available by custom order.

\*2: Determined by Mitutoyo's inspection method. L is the measured length (mm).

The optical condition for accuracy assurance is to be QV-5X + Middle magnification of the tube lens.

\*3: Verified at shipment from factory.

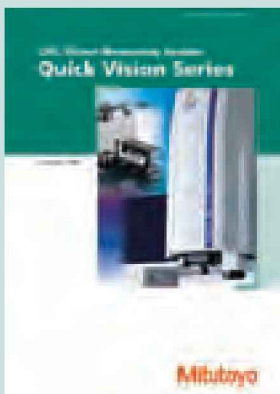
\*4: An excessively biased or concentrated load is excluded.

\*5: Air supply pressure to be in range 0.5 - 0.9MPa.

\*6: Indicates the flow rate under normal conditions.

\* The Laser Auto Focus (LAF) specification is available by custom order.

\* Append "S" to the end of code number to order a QV machine compatible with ISO10360-7:2011 Accuracy Assurance.



Refer to the QUICK VISION  
(Catalog No.E14007) for more details.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## QV ACCEL

### SERIES 363 — Large-Sized CNC Vision Measuring System

- QV ACCEL is a system that focuses on measurement efficiency, with the moving-bridge design eliminating the need for a moving stage. This allows a more simplified design of workpiece fixturing, especially for light and thin workpieces, resulting in a significant reduction in the time required for fixture fabrication and inspection.
- The QV ACCEL enables inspection capabilities to keep pace with the introduction of increasingly dense and downsized IC packages, as well as being suitable for inspecting large PCBs, metal masks and display panels.
- All models feature surface, edge, and pattern autofocus systems offering measurement flexibility for a variety of applications. A laser auto focus option (factory-installed only) that enables high-speed height measurement is available.



## SPECIFICATIONS

Model	QV ACCEL 808		QV ACCEL 1010		QV ACCEL 1212		QV ACCEL 1517	
Optical system	PRO	PRO3	PRO	PRO3	PRO	PRO3	PRO	PRO3
Standard Machine	363-315	363-316	363-335	363-336	363-355	363-356	363-375	363-376
Tracking Auto Focus device	363-321	363-322	363-341	363-342	363-361	363-362	363-381	363-382
Measuring range (X×Y×Z)	800×800×150mm		1000×1000×150mm		1250×1250×100mm		1500×1750×100mm	
Resolution of scale / Scale type	0.1μm/Linear Encoder							
Observation Unit *1	PPT1X-2X-6X							
Imaging Device	B&W CCD	Color CCD	B&W CCD	Color CCD	B&W CCD	Color CCD	B&W CCD	Color CCD
Illumination Unit *2	Co-axial Light				White LED			
	Transmitted Light				White LED			
	PRL				White LED			
Accuracy *3	E <sub>1x</sub> , E <sub>1y</sub>		(1.5+3L/1000)μm				(2.2+3L/1000)μm	
	E <sub>1z</sub>		(1.5+4L/1000)μm				(2.5+5L/1000)μm	
	E <sub>2xy</sub>		(2.5+4L/1000)μm				(3.5+4L/1000)μm	
Repeatability *3	Short dimension	XY axis			3σ=0.2μm			
	Long dimension		3σ=0.7μm				3σ=1.5μm	
Operating Temperature range	Ambient temperature				20±1°C			
	Temperature variation				2°C / 8H			
Stage glass size	883×958mm		1186×1186mm		1440×1440mm		1714×1968mm	
Maximum stage loading *4	10kg		30kg		30kg		30kg	
Main unit external dimensions	1475×1860×1578mm		1912×2141×1603mm		2166×2370×1554mm		2440×2898×1554mm	
Main unit mass (not including the sub-base)	2050kg		2950kg		3600kg		4500kg	

\*1: The specific combination of 1X, 2X and 4X or 1X, 2X, 4X and 6X is available by custom order.

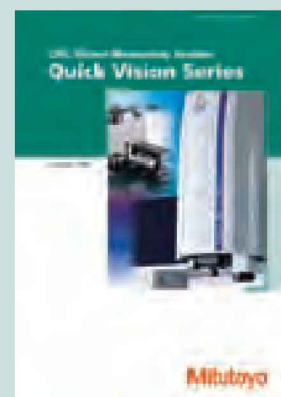
\*2: The color LED lighting or halogen lighting specification is available by custom order.

\*3: Determined by Mitutoyo's inspection method. L is the measured length (mm).

The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Low magnification of the tube lens.

\*4: An excessively biased or concentrated load is excluded.

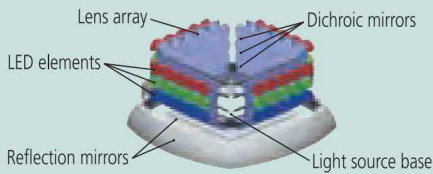
\* The Laser Auto Focus (LAF) specification is available by custom order.



Refer to the QUICK VISION  
(Catalog No.E14007) for more details.

## Non-stop Vision Measurement

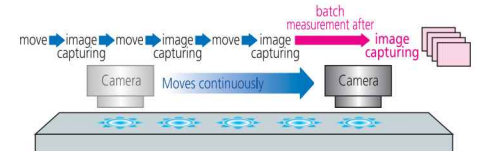
The development of a high-intensity LED flash illuminator has made non-stop vision measurement possible. At the precise moment the stage reaches a measurement point the illuminator creates an extremely short, high-intensity flash that effectively freezes all motion. The illuminator turns on and off so fast that no image blur occurs and the image is captured in full and accurate detail. This innovative design takes full advantage of high-density, high-intensity LED arrays aided by collimating lenses and dichroic mirrors to produce ultra-bright, directional and efficient illumination.



## QV STREAM PLUS SERIES 363 — Non-stop CNC Vision Measuring System

- Various models provide a choice of measuring range to suit the size of workpiece handled.
- Introducing a novel method to capture images without stopping the stage offers overwhelming throughput improvement. With a conventional vision measuring system, operations are repeated in a move → stop → measurement → move sequence, but this

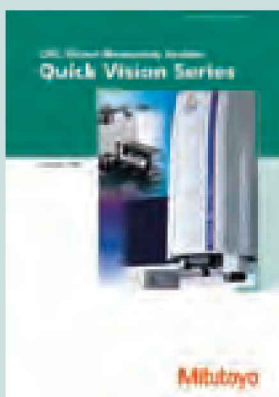
repetition has always limited throughput improvement. In contrast, QV STREAM PLUS has achieved shortening of measurement time by introducing nonstop vision measuring (stream mode) that eliminates non-productive time caused by the conventional acceleration, deceleration, and stop cycle.



QV STREAM PLUS 606

## SPECIFICATIONS

Model	QV STREAM PLUS 302		QV STREAM PLUS 404		QV STREAM PLUS 606	
Optical system	PRO					
Tracking Auto Focus device	●		●		●	
Order No.	363-172	363-176	363-182	363-186	363-192	363-196
Measuring range (XxYxZ)	300x200x200mm		400x400x250mm		600x650x250mm	
Resolution of scale / Scale type	0.1μm/Linear Encoder					
Observation Unit*1	PPT1X-2X-6X					
Imaging Device	B&W CCD					
Illumination Unit*2	Co-axial Light*3		Color LED			
	Transmitted Light		Blue LED			
	PRL*3		Color LED			
Accuracy*4	E1X, E1Y		(1.5+3L/1000)μm			
	E1Z		(1.5+4L/1000)μm			
	E2XY		(2+4L/1000)μm			
Operating Temperature range	Ambient temperature		20±1°C			
	Temperature variation		2°C/8H			
Stage glass size	399x271mm		493x551mm		697x758mm	
Maximum stage loading*5	20kg		40kg		50kg	
Main unit external dimensions	859x951x1609mm		1027x1407x1778mm		1309x1985x1794mm	
Main unit mass (including the sub-base)	360kg		579kg		1450kg	



Refer to the QUICK VISION (Catalog No.E14007) for more details.

- \*1: The specific combination of 1X, 2X and 4X or 1X, 2X, 4X and 6X is available by custom order.  
 \*2: Only one of the illumination functions (reflected, transmitted, and PRL illumination) can be set in STREAM mode. The 4-way PRL illumination can be set to the entire lighting (4-direction lighting) or single-direction lighting.  
 \*3: Enable to use cyan only while using STREAM mode.  
 \*4: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.  
 \*5: An excessively biased or concentrated load is excluded  
 \* The Laser Auto Focus (LAF) specification is available by custom order.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## QV HYBRID TYPE1, TYPE4 SERIES 365 — CNC Vision Measuring System equipped with Non-contact displacement sensor

- The Quick Vision Hybrid is an advanced machine offering vision measurement and high-speed scanning with a CCD camera and non-contact displacement sensor in parallel.
- This model (excluding QV ACCEL and QV STREAM PLUS type) supports ISO10360-7: 2011 guaranteed accuracy (specifications on request).



QVH4 606

### Features: HYBRID TYPE1

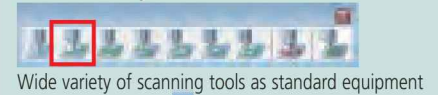
- The focusing point method minimizes the difference in the measuring face reflectance and achieves high measurement reproducibility.
- Capable of measuring detailed shapes in high resolution.

### Features: HYBRID TYPE4

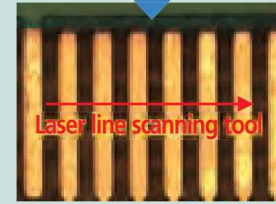
- Enables detection of high inclination angles for both mirror and diffused Surfaces.
- The automatic lighting adjustment function allows for high accuracy measurements.
- Surface roughness or thickness measurement of thin and transparent objects such as film.

### Application

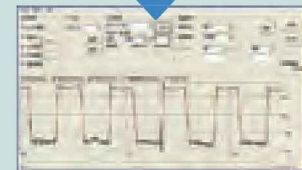
2D form analysis



Wide variety of scanning tools as standard equipment



Measurement example) PCB



Check with viewer function



Form assessment software, FORMTRACEPAK-AP

## SPECIFICATIONS

### QV Apex HYBRID TYPE1

Model	QVH1 Apex 302		QVH1 Apex 404		QVH1 Apex 606	
	PRO	PRO3	PRO	PRO3	PRO	PRO3
Optical system	365-170		365-180		365-190	
Order No.	365-171		365-181		365-191	
Measuring range by vision probe (X×Y×Z)	300×200×200mm		400×400×250mm		600×650×250mm	
Measuring range by displacement sensor (X×Y×Z)	180×200×200mm		280×400×250mm		480×650×250mm	
Resolution of scale / Scale type	0.1μm / Linear Encoder					
Observation Unit *1	PPT1X-2X-6X					
Imaging Device	B&W CCD	3 CCD Color	B&W CCD	3 CCD Color	B&W CCD	3 CCD Color
Illumination unit *2	Co-axial Light		White LED			
	Transmitted Light		White LED			
	PRL		White LED			
Measuring Accuracy *3 (Vision)	E <sub>1x</sub> , E <sub>1y</sub>		(1.5+3L/1000)μm			
	E <sub>z</sub>		(1.5+4L/1000)μm			
	E <sub>2xy</sub>		(2+4L/1000)μm			
Displacement sensor Measuring Accuracy *3	E <sub>z</sub>		(1.5+4L/1000)μm			
	Detecting range of probe itself		±0.5mm			
Displacement sensor	Vertical resolving power		10nm			
	Spot diameter		About ø2μm			
	Working distance (including the collision sensor)		5mm			
Operating Temperature range	Ambient temperature		20±1°C			
	Temperature variation		2°C / 8H			
Stage glass size	399×271mm		493×551mm		697×758mm	
Maximum stage loading *4	20kg		40kg		50kg	
Main unit external dimensions	859×951×1609mm		1027×1407×1778mm		1309×1985×1794mm	
Main unit mass (including the sub-base)	370kg		589kg		1460kg	

\*1: The specific combination of 1X, 2X and 4X or 1X, 2X, 4X and 6X is available by custom order.

\*2: The color LED lighting or halogen lighting specification is available by custom order.

\*3: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*4: An excessively biased or concentrated load is excluded.

\* Append "S" to the end of code number to order a QV machine compatible with ISO10360-7:2011 Accuracy Assurance. (PRO machine only)

### Hyper QV HYBRID TYPE 1

Model	Hyper QVH1 302		Hyper QVH1 404		Hyper QVH1 606	
	PRO	PRO	PRO	PRO	PRO	PRO
Optical system	365-173		365-183		365-193	
Order No.	365-173		365-183		365-193	
Resolution of scale / Scale type	0.02μm / Linear Encoder					
Measuring Accuracy *1 (Vision)	E <sub>1x</sub> , E <sub>1y</sub>		(0.8+2L/1000)μm			
	E <sub>z</sub>		(1.5+2L/1000)μm			
	E <sub>2xy</sub>		(1.4+3L/1000)μm			
Displacement sensor Measuring Accuracy *1	E <sub>z</sub>		(1.5+2L/1000)μm			
	Ambient temperature		18 ~ 23°C			
Operating Temperature range	Temperature variation		0.5°C / 1H and 1°C / 24H			
	Temperature Compensation function		Automatic			
Maximum stage loading *2	15kg		30kg		40kg	

\*1: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*2: An excessively biased or concentrated load is excluded. Other specifications are the same as those of the QVH1 Apex. For details, refer to above table.

## QV STREAM PLUS HYBRID TYPE1

Model		QVH1 STREAM 302	QVH1 STREAM 404	QVH1 STREAM 606
Optical system		PRO	PRO	PRO
Order No.		365-172	365-182	365-192
Imaging Device			B&W CCD	
Illumination unit	Co-axial Light		Color LED	
	Transmitted Light		Blue LED	
	PRL		Color LED	
Measuring Accuracy*1 (Vision)	E1X,E1Y		(1.5+3L/1000)µm	
	E1Z		(1.5+4L/1000)µm	
	E2XY		(2+4L/1000)µm	
Displacement sensor Measuring Accuracy*1	E1Z		(1.5+4L/1000)µm	
Operating Temperature range	Ambient temperature		20±1°C	
	Temperature variation		2°C / 8H	

\*1: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens. Other specifications are the same as those of the QVH1 Apex. For details, refer to above table.

## QV ACCEL HYBRID TYPE1

Model		QVH1 ACCEL 808	QVH1 ACCEL 1010	QVH1 ACCEL 1212	QVH1 ACCEL 1517
Optical system		PRO	PRO	PRO	PRO
Order No.		365-315	365-316	365-335	365-375
Measuring range by vision probe (XxYxZ)		800x800x150mm	1000x1000x150mm	1250x1250x100mm	1500x1750x100mm
Measuring range by displacement sensor (XxYxZ)		680x800x150mm	880x1000x150mm	1130x1250x100mm	1380x1750x100mm
Measuring Accuracy*1 (Vision)	E1X,E1Y	(1.5+3L/1000)µm			(2.2+3L/1000)µm
	E1Z	(1.5+4L/1000)µm			(2.5+5L/1000)µm
	E2XY	(2.5+4L/1000)µm			(3.5+4L/1000)µm
Displacement sensor Measuring Accuracy*1	E1Z	(2.5+4L/1000)µm			(3.5+5L/1000)µm
	Detecting range of probe itself			±0.5mm	
Displacement sensor	Vertical resolving power			10nm	
	Spot diameter			About ø2µm	
	Working distance (including the collision sensor)			5mm	
	Ambient temperature			20±1°C	
Operating Temperature range	Temperature variation			2°C / 8H	

\*1: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Low magnification of the tube lens. Other specifications are the same as those of the QV ACCEL. For details, refer to page K-7.

## QV Apex HYBRID TYPE 4

Model		QVH4 Apex 302	QVH4 Apex 404	QVH4 Apex 606
Optical system		PRO	PRO	PRO
Order No.		365-413	365-433	365-453
Measuring range by vision probe (XxYxZ)		300x200x200mm	400x400x250mm	600x650x250mm
Measuring range by displacement sensor (XxYxZ)		176x200x200mm	276x400x250mm	476x650x250mm
Resolution of scale / Scale type			0.1µm / Linear Encoder	
Observation Unit*1			PPT1X-2X-6X	
Imaging Device		B&W CCD	B&W CCD	B&W CCD
Illumination unit*2	Co-axial Light		White LED	
	Transmitted Light		White LED	
	PRL		White LED	
Measuring Accuracy*3 (Vision)	E1X,E1Y		(1.5+3L/1000)µm	
	E1Z		(1.5+4L/1000)µm	
	E2XY		(2+4L/1000)µm	
Displacement sensor Accuracy	E1Z		(1.5+4L/1000)µm	
	Detecting range of probe itself		±0.6mm	
Displacement sensor	Vertical resolving power		25nm	
	Spot diameter		About ø4µm	
	Working distance (including the collision sensor)		21.0mm	
	Ambient temperature		20±1°C	
Operating Temperature range	Temperature variation		2°C / 8H	
	Stage glass size	399x271mm	493x551mm	697x758mm
Maximum stage loading*4	20kg	40kg	50kg	
Main unit external dimensions	859x951x1609mm	1027x1407x1778mm	1309x1985x1794mm	
Main unit mass (including the sub-base)	370kg	589kg	1460kg	

\*1: The specific combination of 1X, 2X and 4X or 1X, 2X, 4X and 6X is available by custom order.

\*2: The color LED lighting or halogen lighting specification is available by custom order.

\*3: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*4: An excessively biased or concentrated load is excluded.

\* Append "S" to the end of code number to order a QV machine compatible with ISO10360-7:2011 Accuracy Assurance. (PRO machine only)

## Hyper QV HYBRID TYPE4

Model		Hyper QVH4 302	Hyper QVH4 404	Hyper QVH4 606
Optical system		PRO	PRO	PRO
Order No.		365-416	365-436	365-456
Resolution of scale / Scale type			0.02µm / Linear Encoder	
Measuring Accuracy*1 (Vision)	E1X,E1Y		(0.8+2L/1000)µm	
	E1Z		(1.5+2L/1000)µm	
	E2XY		(1.4+3L/1000)µm	
Displacement sensor Accuracy	E1Z		(1.5+2L/1000)µm	
Operating Temperature range	Ambient temperature		18 ~ 23°C	
	Temperature variation		0.5°C / 1H and 1°C / 24H	
Temperature compensation function			Automatic	
Maximum stage loading*2		15kg	30kg	40kg

\*1: Determined by Mitutoyo's inspection method. L is the measured length (mm). The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*2: An excessively biased or concentrated load is excluded. Other specifications are the same as those of the QVH4 Apex. For details, refer to the table above.

## Main Unit Specifications

Model name	Grade	PRO	PRO3
QVH Apex/ACCEL		○	○
Hyper QVH/QVH STREAM		○	—

Refer to the table in the lower part of page K-4 for the details of grade.

**CLASS 1 LASER PRODUCT**

### Safety Precautions for Laser Beam

These systems use a low-power invisible laser beam (780nm) which corresponds to Class 1 (invisible light) of JIS C 6802 "Safety Standard of Laser Radiation Products". The class 1 laser warning label as shown above is attached to the main unit.

## Form assessment software

### FORMTRACEPAK-AP

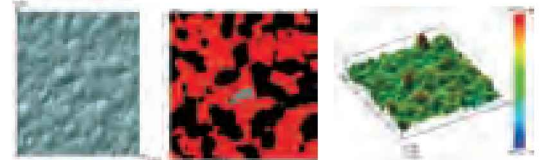
The 2D micro form is analyzable from the contour data obtained via the non-contact displacement sensor, PFF, and WLI.



Micro form analysis screen

### FORMTRACEPAK-PRO

A wide variety of surface textures are analyzable including 3D displays such as filling between contour lines and shading.



Shading

Example of cut surface analysis

Wire frame

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## Hyper QV WLI SERIES 363 — Non-contact 3D measuring system

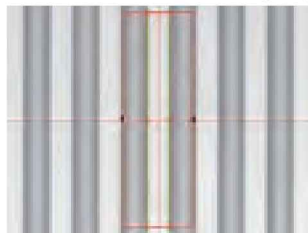
- QV WLI alone can measure coordinates and dimensions and assess micro-3D forms without contact.
- This machine is a high accuracy, dual-head vision measuring system equipped with a white light interferometer.
- The white light interferometer uses high aspect ratio to accurately measure shapes.
- The standard vision measuring function can continuously perform coordinate, dimension and 3D shape measuring without interruption.
- The large work stage accurately handles large-sized work pieces such as a PCB.



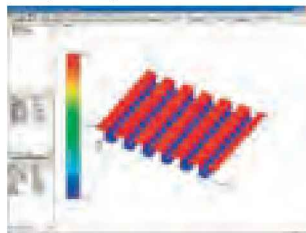
Hyper QV WLI 606

### Application example

#### Si mold line and 10/10 $\mu$ m pitch spacing



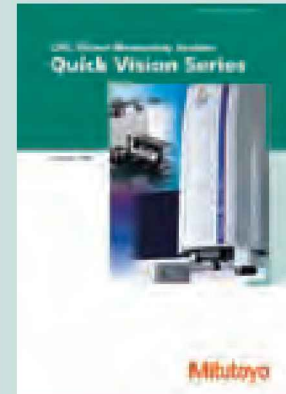
2D measurement using vision head



3D form analysis (arbitrary angle display)



Section measurement



Refer to the QUICK VISION  
(Catalog No.E14007) for more details.

## SPECIFICATIONS

		Hyper QV WLI 302	Hyper QV WLI 404	Hyper QV WLI 606
Measuring range (X×Y×Z)	Vision measuring area	300×200×190 mm	400×400×240mm	600×650×220mm
	WLI measuring area*1	215×200×190 mm	315×400×240mm	515×650×220mm
<b>WLI optical head unit</b>				
View field (H×V)		5X lens: approx. 0.64×0.48mm / 10X lens: approx. 0.32×0.24mm / 25X lens: approx. 0.13×0.10mm		
Repeatability		2 $\sigma$ ≤ 0.08 $\mu$ m		
Z-axis scanning range*2		170 $\mu$ m		
<b>Vision optical head unit</b>				
Magnification change system		PPT1X-2X-6X		
Image detection method		B&W CCD camera		
Illumination	Co-axial Light	White LED		
	Transmitted Light	White LED		
	Programmable ring Light	White LED		
Measuring accuracy	E <sub>1X</sub> , E <sub>1Y</sub>	(0.8+2L/1000) $\mu$ m		
	E <sub>1Z</sub>	(1.5+2L/1000) $\mu$ m		
	E <sub>2XY</sub>	(1.4+3L/1000) $\mu$ m		
<b>Main unit</b>				
Resolution		0.01 $\mu$ m		
Max. stage loading		15kg	25kg	35kg
Guidance system		Direct acting type hard bearing		
Dimensions (W×D×H)		859×950×1606 mm	1027×1407×1781 mm	1309×1985×1792 mm
Mass (vibration isolator stand included)		Approx. 490kg	Approx. 1160kg	Approx. 2275kg

\*1: Movable range of WLI optical head.

\*2: In case of standard mode. Applicable to max. 200 $\mu$ m by modifying scan pitch.

\*3: Determined by Mitutoyo's inspection method. L is measured length (mm).

The optical condition for accuracy assurance is to be (QV-HR2.5X or QV-SL2.5X) + Middle magnification of the tube lens.

\*4: An excessively biased or concentrated load is excluded.

\* Append "S" to the end of code number to order a QV machine compatible with ISO10360-7:2011 Accuracy Assurance.

\* Hyper QV WLI is not compatible with the Easy Editor function of QVPAK.



## QV TP SERIES 364 — CNC Vision Measuring System equipped with a Touch Trigger Probe

### Non-contact and contact measurement with one machine

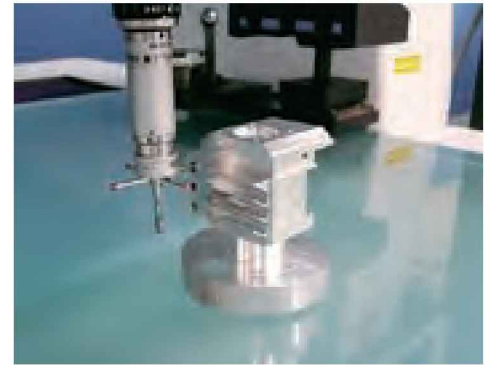
QV touch probe unit enables both vision measurement and touch probe measurement.

### 3D workpiece measurement

Measures three-dimensional workpieces such as molded products resin molded products, machined products, and more.

### Module change rack available

Easily change between vision and touch probe measurement with a module change rack.



### Specifications with touch probe options mounted

		QV TP Apex302 Hyper QV TP302	QV TP Apex404 Hyper QVz TP404	QV TP Apex606 Hyper QV TP606
Measuring range*1 (X×Y×Z)	Vision	300×200×200mm	400×400×250mm	600×650×250mm
	Common to Touch Trigger Probe	234×200×200mm	334×400×250mm	534×650×250mm
Measuring accuracy*2 (Touch probe)	E1x, E1y, E1z	QV TP Apex: (1.8+3L/1000)μm Hyper QV TP: (1.7+3L/1000)μm		

		QV TP ACCEL 808	QV TP ACCEL 1010	QV TP ACCEL 1212	QV TP ACCEL 1517
Measuring range*1 (X×Y×Z)	Vision	800×800×150mm	1000×1000×150mm	1250×1250×100mm	1500×1750×100mm
	Common to Touch Trigger Probe	734×800×150mm	934×1000×150mm	1184×1250×100mm	1434×1750×100mm
Measuring accuracy*2 (Touch probe)	E1x, E1y, E1z	(1.8+3L/1000)μm	(3+4L/1000)μm	(6+7L/1000)μm	

\*1: When a module change rack, a master ball, and a calibration ring are mounted, the measurement ranges are smaller than those in the table. Other specifications are the same as those of QV Apex, Hyper QV, and QV ACCEL.

Please contact our sales office for more details.

\*2: Inspected by Mitutoyo standard. L = length between two arbitrary points (mm)

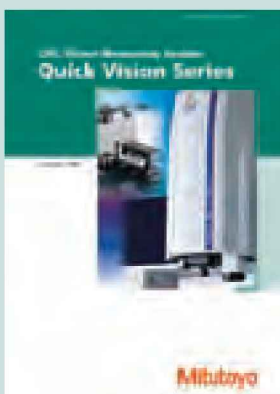
**CLASS 1 LASER PRODUCT**

### Safety precautions regarding laser autofocus system (factory-installed option)

This product uses a low-power visible laser (690nm) for measurement. The laser is a CLASS 1 EN/IEC60825-1 (2007) device. A warning and explanation label, as shown above, is attached to the product as appropriate.

### Safety precautions regarding QV HYBRID TYPE1.

This product uses a low-power visible laser (780nm) for measurement. The laser is a CLASS 1 EN/IEC60825-1 (2007) device. A warning and explanation label, as shown above, is attached to the product as is appropriate.



Refer to the QUICK VISION  
(Catalog No.E14007) for more details.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## Options

### Objective lenses



A wide choice of objectives enables magnification of the optical system to be specified over the range of 0.5 to 25X to provide the best match to the application. The longer working distance type is also available.

Objective lens		QV-SL0.5×	QV-HR1×	QV-SL1×	QV-HR2.5×	QV-SL2.5×	QV-5×	QV-HR10×	QV-10×	QV-25×
Order No.		02AKT199	02AKT250	02ALA150	02AKT300	02ALA170	02ALA420	02AKT650	02ALG010	02ALG020
Optical magnification		0.5×	1×		2.5×		5×	10×		25×
Working distance		30.5mm	40.6mm	52.5mm	40.6mm	60mm	33.5mm	20mm	30.5mm	13mm
1/2" White/Black CCD	Turret 1×	12.54×9.4	6.27×4.7		2.49×1.88		1.25×0.94	0.62×0.47		0.25×0.18
Camera imaging FOV [(H) mm × (V) mm]	Turret 2×	6.27×4.7	3.13×2.35		1.24×0.93		0.62×0.47	0.31×0.23		0.10×0.07
	Turret 6×	2.09×1.56	1.04×0.78		0.41×0.31		0.20×0.15	0.10×0.07		0.04×0.03
1/3" CCD Color	Turret 1×	9.4×7.04	4.7×3.52		1.87×1.41		0.93×0.7	0.46×0.34		0.18×0.14
Camera imaging FOV [(H) mm × (V) mm]	Turret 2×	4.7×3.52	2.35×1.76		0.09×0.7		0.47×0.35	0.23×0.17		0.09×0.07
	Turret 6×	1.56×1.17	0.78×0.59		0.31×0.24		0.16×0.12	0.08×0.06		0.03×0.02

## QV-INDEX



From the viewpoint of measurement expansion and streamlining, measurement of the workpiece not only on the front but also the sides and back can be performed with just one setup.

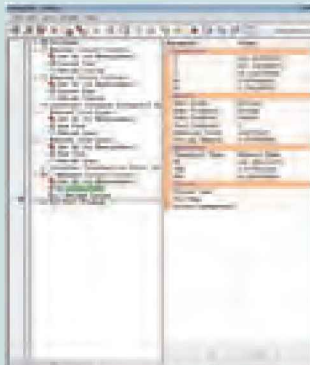
Items	Specifications
Workpiece diameter	ø140mm (max.)
Workpiece mass	2kg (max.)
Resolution	0.1°
Positioning accuracy	±0.5°
Rotational speed	10rpm

## Calibration glass chart & Compensation glass chart

These glass charts are used to compensate for the pixel size of the CAMERA chip, autofocus accuracy and the optical axis offset at each magnification of the Programmable Power Turret (PPT).



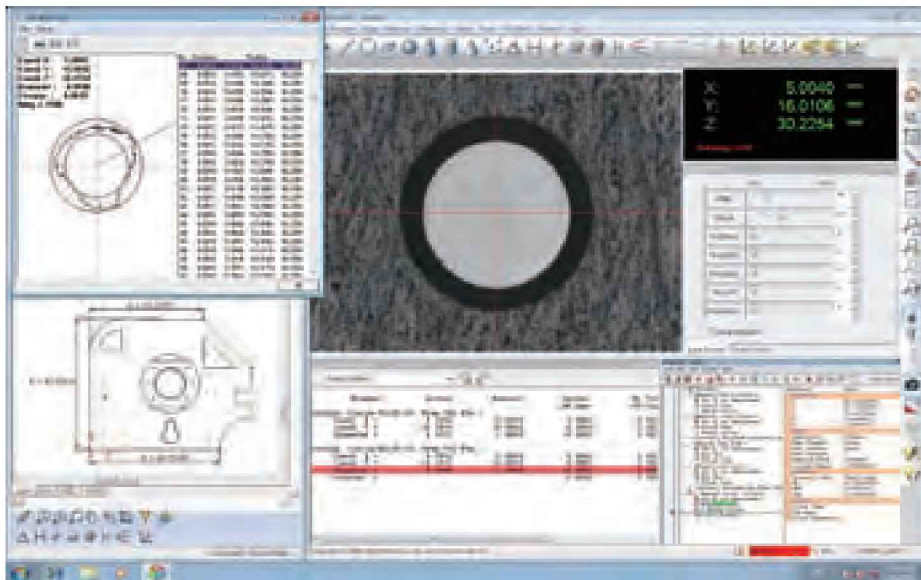
## Features of QVPAK (QV EasyEditor)



"QV EasyEditor" is equipped as standard, and enables simple editing of part programs. This is the most powerful software that can be created by combining QV EasyEditor, which does not require specialized knowledge, and QV Basic Editor, which provides the full functions that satisfy software developers. This software enables users to simply correct errors occurring during program execution as well as to edit, insert, and delete part programs with ease, which reduces errors caused by variations of workpieces and man-hours for program revision associated with design change.

## Data Processing Software for QUICK VISION QVPAK

- The X, Y, and Z position data is detected from the measurement data gathered by the Quick Vision system and the arithmetic processing of coordinates and dimensions is performed immediately.



### Application software (Options)

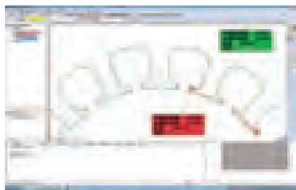
#### • QV PartManager

The QV PartManager is an execution program management software for multiple workpieces arranged on the measuring stage.

#### Form assessment/analysis software

##### • FORMTRACEPAK-AP

Verification of designed value and form analysis are performed on the basis of the contour data obtained via the QV auto trace tool, non-contact displacement sensor, PFF, and WLI.



##### • FORMTRACEPAK-PRO

This software performs 3D form analysis from the data obtained via the non-contact displacement sensor of the QV Hybrid series.



##### • QV3DPAK

This software generates 3D forms from the PFF (Point Form Focus) or WLI (White Light Interferometer) data.



#### Measurement support software

##### • QV3DCAD-OnLine

This software creates QVPAK measurement procedure programs with use of 3D CAD data. This allows users to reduce program creation man-hour and shorten lead times.



##### • QV-CAD I/F

This software displays CAD data in the graphic window to improve measurement operability.

#### Off-line teaching software

##### • EASYPAG PRO

This software creates QVPAK measurement procedure programs using 2D CAD data. This allows users to reduce program creation man-hours and shorten lead times.

#### Test chart software/Statistical processing software

##### • MeasureReportQV

This software creates an inspection report from the QV measurement results.

##### • MeasurLink

This software allows for statistical arithmetic processing of measurement results.

#### External control software

##### • QVEio

This is a client application software that can externally control QVPAK or provide the operating status of QVPAK by connecting a PLC or remote software on an external PC. This software can be used for connecting an automatic transfer robot to a signal tower.



Refer to the QUICK VISION (Catalog No.E14007) for more details.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## QS SERIES 359 — CNC Vision Measuring System



QS250Z

- This is a CNC vision measuring machine equipped with a color CCD camera.
- Ring fiber illumination along with transmitted illumination and coaxial reflected illumination is provided as standard to reproduce color images more clearly.
- A control box provides convenient access to frequently used functions including illumination, data input and zoom.
- This machine is equipped with a zoom lens (the zoom lens fitted offers 8-positions/7-steps and a 7:1 magnification ratio).
- This machine is equipped with the autofocus function, and is a Z-axis measurement accuracy guaranteed type.

### SPECIFICATIONS

Model No.	QS250Z	
Drive method	X-, Y-, Z-axis: CNC	
Optical magnification	Zoom 0.5X to 3.5X (8-positions/7-steps)	
Total magnification *1	26X to 180X (8 steps)	
Measuring range (X×Y×Z)	200×250×100mm	
Resolution	0.1μm	
Scales	Linear encoder	
Image detection method	Color CCD camera	
Illumination	Co-axial Light, Transmitted Light, Ring Light	
Measuring accuracy *2	E <sub>1x</sub> , E <sub>1y</sub>	(2.5+6L/1000)μm
	E <sub>1z</sub>	(5+6L/1000)μm
Size of stage glass	269×311mm	
Max. stage loading*3	10kg	
Dimensions (W×D×H)	465×815×663mm	
Mass	Approx. 76kg	

\*1: This is an approximate indication for the default window display on a 22" LCD monitor.

\*2: Specification applicable to 20°C, zoom magnification 2.5X.

\*3: Except for workpieces that cause an unbalanced or concentrated load.

## QS-L/AFB SERIES 359 — Manual Vision Measuring System

- This is a manual vision measuring machine equipped with a color CCD camera.
- All models are equipped with coaxial reflected illumination, transmitted illumination, and ring fiber illumination as standard.
- This machine is equipped with a zoom lens (the zoom lens fitted offers 8 steps and a 7:1 magnification ratio).
- This machine is equipped with the autofocus function, and is a Z-axis measurement accuracy guaranteed type.



QS-L3017Z/AFB

### SPECIFICATIONS

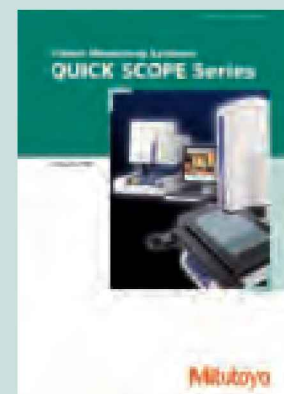
Model No.	QS-L2010Z/AFB	QS-L3017Z/AFB	QS-L4020Z/AFB
Drive method	Autofocus equipped, X-, Y-axis: manual, Z-axis: motor-operated		
Optical magnification	Zoom 0.5X to 3.5X (8 steps)		
Total magnification *1	26X to 180X (8 steps)		
Measuring range (X×Y×Z)	200×100×150mm	300×170×150mm	400×200×150mm
Resolution	0.1μm		
Scales	Linear encoder		
Image detection method	Color CCD camera		
Illumination	Co-axial Light, Transmitted Light, Ring Light		
Indication accuracy *2	X-axis, Y-axis	(2.5+20L/1000)μm	
	Z-axis	(5.0+6L/1000)μm	
Max. stage loading *3	10kg	20kg	15kg
Dimensions*4 (W×D×H)	624×705×722mm	682×852×837mm	757×867×837mm
Mass	Approx. 66kg	Approx. 134kg	Approx. 140kg

\*1: This is an approximate indication for the default window display on a 22" LCD monitor.

\*2: Specification applicable to 20°C, zoom magnification 2.5X.

\*3: Except for workpieces that cause an unbalanced or concentrated load.

\*4: These dimensions increase by up to 1 stroke length for the X- and Z-axis directions and up to half stroke length for the Y-axis direction.



Refer to the QUICK SCOPE (Catalog No.E14004) for more details.

## QS-LZB SERIES 359 — Manual Vision Measuring System

- This is a manual vision measuring machine equipped with a color CMOS camera.
- All models are equipped with coaxial reflected illumination, transmitted illumination, and ring fiber illumination as standard.
- This machine is equipped with a zoom lens (the zoom lens fitted offers 8 steps and a 7:1 magnification ratio).
- Simple and convenient push-button operation of frequently used functions such as illumination, data input and zoom is provided by the control box.



QS-L2010ZB

### SPECIFICATIONS

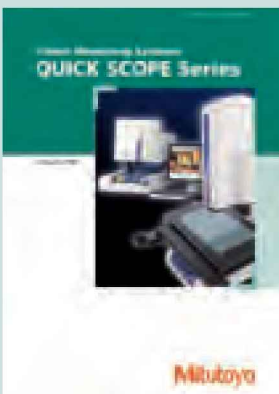
Model No.	QS-L2010ZB	QS-L3017ZB	QS-L4020ZB
Drive method	X-, Y-, Z-axis: Manual		
Optical magnification	Zoom 0.75X to 5.25X (8 steps)		
Total magnification *1	29X to 202X (8 steps)		
Measuring range (X×Y×Z)	200×100×150mm	300×170×150mm	400×200×150mm
Resolution	0.1μm		
Scales	Linear encoder		
Image detection method	Color CMOS camera		
Illumination	Co-axial Light, Transmitted Light, Ring Light		
Indication accuracy *2	X-axis, Y-axis	(2.5+20L/1000)μm	
	Z-axis	(5.0+40L/1000)μm	
Max. stage loading *3	10kg	20kg	15kg
Dimensions *4 (W×D×H)	624×769×722mm	682×916×837mm	757×930×837mm
Mass	Approx. 72kg	Approx. 140kg	Approx. 146kg

\*1: The total magnification is an indication when 22-inch LCD monitor is used and displayed in the default window.

\*2: Specification applicable to 20°C, zoom magnification 3X.

\*3: Except for workpieces that cause an unbalanced or concentrated load.

\*4: These dimensions increase by up to 1 stroke length for the X- and Z-axis directions and up to half stroke length for the Y-axis direction.



Refer to the QUICK SCOPE  
(Catalog No.E14004) for more details.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## QI SERIES 361 — Non-contact 2D Vision Measuring System

- A series of 2D vision measuring machines that offers high-efficiency measurement with a double telecentric optical system. QI-A models offer wide field of view (32x24mm). QI-B series (12.8x9.6mm) can offer easy dimensional measurement of micro-workpieces and workpieces with uneven surfaces.
- This series is equipped with a megapixel color camera. Even with low magnification, high repeatability can be obtained.
- Long focal depth and wide field of view. Easily change between long focal depth and switch to high resolution modes for increased accuracy.
- Several sizes of XY stage types are available including a large 400x200mm stage for large or multiple identical workpiece measurement.
- With the XY quick-release handles, the stage can be moved rapidly but with fine feed always available. This saves time when measuring between distant points and so dramatically improves productivity.



QI-A2010C



Refer to the QUICK IMAGE (Catalog No.E14009) for more details.

### SPECIFICATIONS

#### QI-A series

Model No.	QI-A1010C	QI-A2010C	QI-A2017C	QI-A3017C	QI-A4020C
View field	32x24mm				
Measurement mode check	High resolution mode / Normal mode				
Measuring range (X×Y)	100×100mm	200×100mm	200×170mm	300×170mm	400×200mm
Travel range (Z-direction)	100mm				
Measuring accuracy	High resolution mode: ±2μm / Normal mode: ±4μm				
	High resolution mode: ±1μm / Normal mode: ±2μm				
Image capturing element	±(3.5+0.02L)μm L = arbitrary measurement length (mm)				
	3M pixel, 1/2", Color camera				
Optical system	Magnification (Telecentric Optical System)				
	0.2×				
Focal depth	Working distance				
	90mm				
High resolution mode: ±0.6mm / Normal mode: ±11mm					
Illumination	Co-axial Light: White LED, Transmitted Light: green LED Telecentric system, Ring Light: 4 white LED				
Size of stage glass	170×170mm	242×140mm	260×230mm	360×230mm	440×232mm
Max. stage loading depth*3	Approx. 10Kg		Approx. 20Kg		Approx. 15Kg
Mass	Approx. 70Kg	Approx. 74Kg	Approx. 140Kg	Approx. 148Kg	Approx. 154Kg

#### QI-B series

Model No.	QI-B1010C	QI-B2010C	QI-B2017C	QI-B3017C	QI-B4020C
View field	12.8x9.6mm				
Measurement mode check	High resolution mode / Normal mode				
Measuring range (X×Y)	100×100mm	200×100mm	200×170mm	300×170mm	400×200mm
Travel range (Z-direction)	100mm				
Measuring accuracy*1	High resolution mode: ±1.5μm / Normal mode: ±3μm				
	High resolution mode: ±0.7μm / Normal mode: ±1μm				
Image capturing element	±(3.5+0.02L)μm L = arbitrary measurement length (mm)				
	3M pixel, 1/2", Color camera				
Optical system	Magnification (Telecentric Optical System)				
	0.5×				
Repeatability within screen (±2σ)*2	Working distance				
	90mm				
High resolution mode: ±0.6mm / Normal mode: ±1.8mm					
Illumination	Co-axial Light: White LED, Transmitted Light: green LED Telecentric system, Ring Light: 4 white LED				
Size of stage glass	170×170mm	242×140mm	260×230mm	360×230mm	440×232mm
Max. stage loading depth*3	Approx. 10Kg		Approx. 20Kg		Approx. 15Kg
Mass	Approx. 70Kg	Approx. 74Kg	Approx. 140Kg	Approx. 148Kg	Approx. 154Kg

\*1: Inspected to Mitutoyo standards by focus point position.

\*2: The measuring accuracy is guaranteed to be accurate within the depth of focus.

\*3: Does not include extremely offset loads and concentrated loads.

## UMAP Vision System TYPE2 SERIES 364 — Micro Form Measuring System

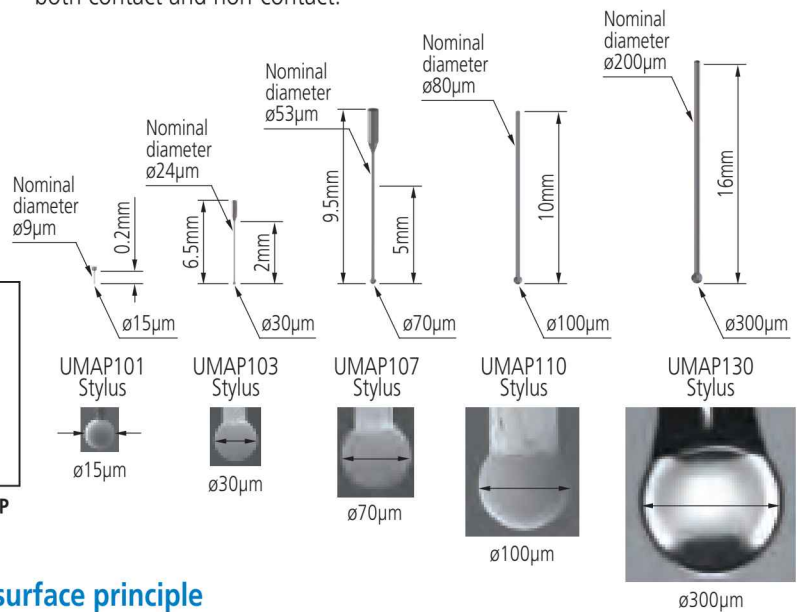


### • Ultrasonic micro probe, UMAP

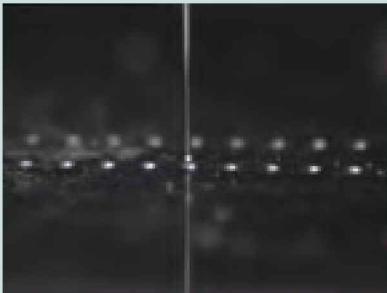
The ultrasonic micro probe (UMAP) has the ability to sense the amplitude variability in a micro area and the optional contact points (15 to 300 $\mu$ m diameter) offer a large range of high accuracy measurement meeting a wide variety of specifications.

### • Both high-accuracy sophisticated non-contact and contact measurement capabilities with one machine

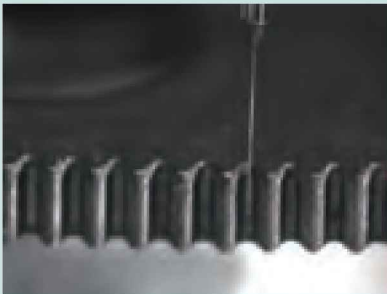
This unit includes the UMAP and the non-contact type vision head. Until now, it was difficult to measure micro areas, but it is now possible with both contact and non-contact.



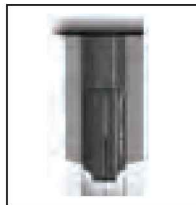
### Application example



Contour measurement of a  $\phi 0.125$  hole

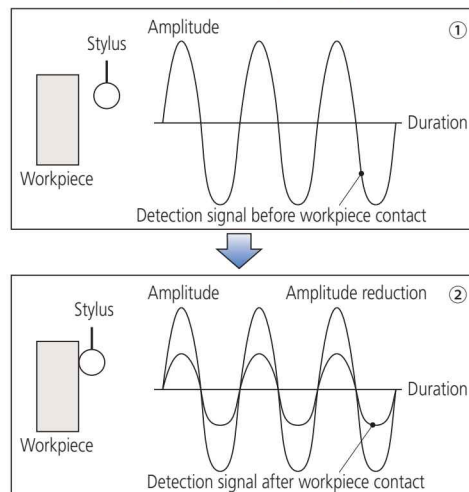


Measuring form of micro gear teeth



Micro probe, UMAP

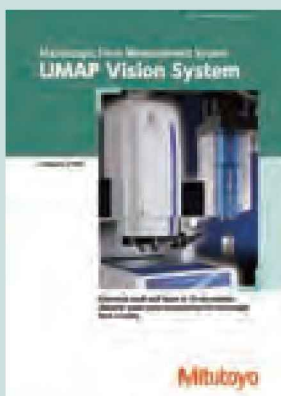
### Detection of surface principle



- ① In this drawing, the stylus is vibrating with a micro amplitude. When it does not come into contact with the workpiece as shown, the vibration state is maintained.
- ② As the stylus comes into contact with the workpiece surface the vibration amplitude decreases as the contact increases. When the decreasing amplitude falls below a certain level, a touch-trigger signal is generated.

### SPECIFICATIONS

		TYPE2	
		Hyper UMAP302	ULTRA UMAP404
Measuring range (common to vision and UMAP)	X-axis $\times$ Y-axis	185 $\times$ 200mm	285 $\times$ 400mm
	Z-axis	175mm: UMAP101/103 180mm: UMAP107/110 185mm: UMAP130	
Measuring accuracy (Vision)	$E_{1x}, E_{1y}$	(0.8+2L/1000) $\mu\text{m}$	(0.25+L/1000) $\mu\text{m}$
	$E_{1z}$	(1.5+2L/1000) $\mu\text{m}$	
Repeatability	UMAP 101/103/107	$\sigma = 0.1 \mu\text{m}$	$\sigma = 0.08 \mu\text{m}$
	UMAP 110/130	$\sigma = 0.15 \mu\text{m}$	$\sigma = 0.12 \mu\text{m}$



Refer to UMAP Vision System  
(Catalog No.E14000) for more details.

# Vision Measuring Systems

Vision measuring systems for multipurpose use

## Micro Form Measuring System M-NanoCoord

- M-NanoCoord is an ultra-high accuracy measuring system developed to target the field of micro measurement.
- The M-NanoCoord consists of the measuring stage of an XY-plane guiding structure, a vision head that observes and positions measuring points, and a highly sensitive measuring sensor for assessing micro forms. The M-NanoCoord is equipped with the same vision head (including illumination systems) as the Quick Vision series, so the M-NanoCoord can also be used as an ultra-high accuracy CNC vision measuring machine.
- Any one of the sensors shown in Figure 1 below is mountable to suit the application.

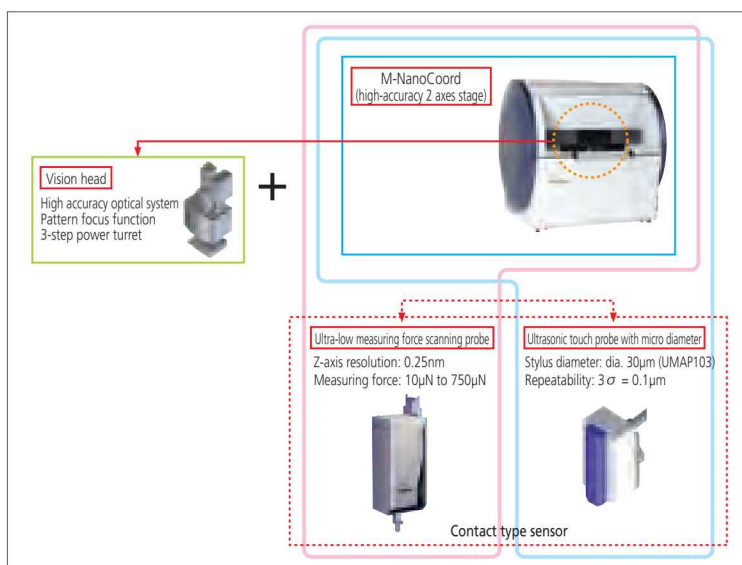


Figure 1: M-NanoCoord system block diagram



## SPECIFICATIONS

Items	Specifications					
Main unit	Structure	XY-plane guiding structure				
	Guide system	Hydrostatic air bearing				
	Measuring range (X×Y×Z)	200×200×100mm				
	Scales	Low expansion laser holoscale				
	Resolution	1nm				
	Accuracy	$E_1 = (0.2+L/1000)\mu\text{m}$				
Sensor section	Sensor to be selected	1	Ultrasonic micro probe UMAP	Stylus	UMAP101: $\phi 15\mu\text{m}$ , length 0.2mm UMAP103: $\phi 30\mu\text{m}$ , length 2mm UMAP107: $\phi 70\mu\text{m}$ , length 5mm UMAP110: $\phi 100\mu\text{m}$ , length 10mm UMAP130: $\phi 300\mu\text{m}$ , length 16mm	
				Repeatability	$\sigma = 0.1\mu\text{m}$	
	Common sensor	Vision head (power turret, programmable ring light illumination, megapixel camera)	2	Wide range nano probe LNP	Measuring range	20mm
					Resolution	0.25nm
					Indication accuracy	$(0.05+3.8H/20)\mu\text{m}$ H=height [mm]
					Measuring force	10 to 750 $\mu\text{N}$
				Traceable angle	Tracing measurement: max. 80° Touch measurement: max. 90° Note: Applies to a ruby ball stylus	
				Stylus	1) Diamond: tip radius 2 $\mu\text{m}$ 2) Ruby ball: $\phi 0.3\text{mm}$	



# Quick Guide to Precision Measuring Instruments



## Vision Measuring Machines

### ■ Vision Measurement

Vision measuring machines mainly provide the following processing capabilities.

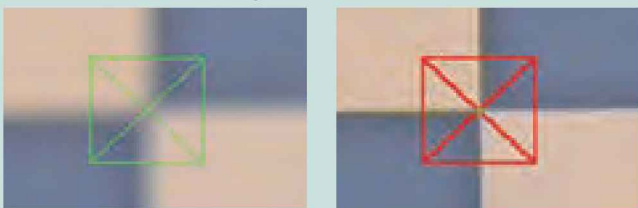
#### ■ Edge detection

Detecting/measuring edges in the XY plane



#### ■ Auto focusing

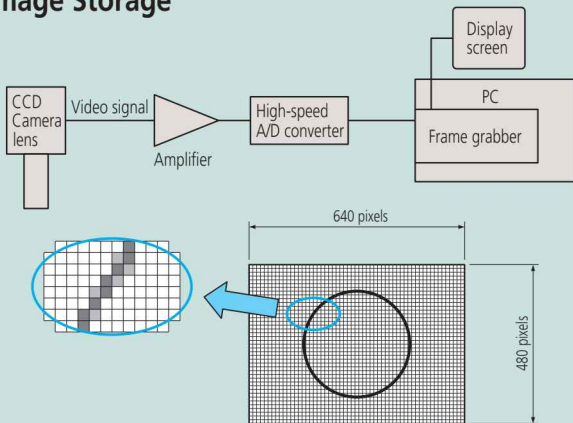
Focusing and Z measurement



#### ■ Pattern recognition

Alignment, positioning, and checking a feature

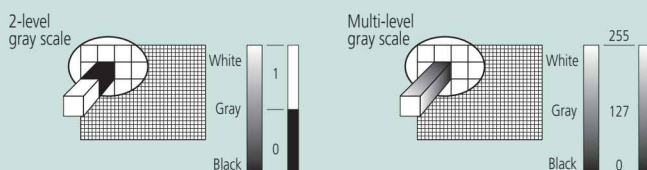
### ■ Image Storage



An image is comprised of a regular array of pixels. This is just like a picture on fine plotting paper with each square solid-filled differently.

### ■ Gray Scale

A PC stores an image after internally converting it to numeric values. A numeric value is assigned to each pixel of an image. Image quality varies depending on how many levels of gray scale are defined by the numeric values. The PC provides two types of gray scale: two-level and multi-level. The pixels in an image are usually displayed as 256-level gray scale.

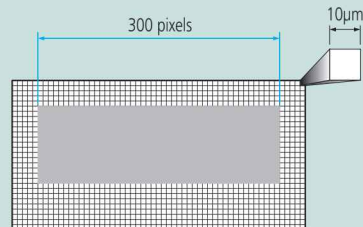


Pixels in an image brighter than a given level are displayed as white and all other pixels are displayed as black.

Each pixel is displayed as one of 256 levels between black and white. This allows high-fidelity images to be displayed.

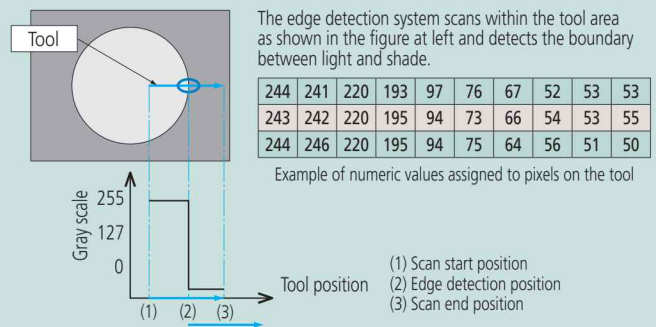
### ■ Dimensional Measurement

An image consists of pixels. If the number of pixels in a section to be measured is counted and is multiplied by the size of a pixel, then the section can be converted to a numeric value in length. For example, assume that the total number of pixels in the lateral size of a square workpiece is 300 pixels as shown in the figure below. If a pixel size is  $10\mu\text{m}$  under imaging magnification, the total length of the workpiece is given by  $10\mu\text{m} \times 300 \text{ pixels} = 3000\mu\text{m} = 3\text{mm}$ .

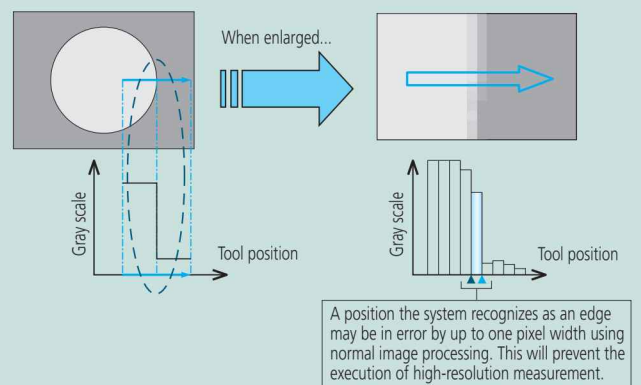


### ■ Edge Detection

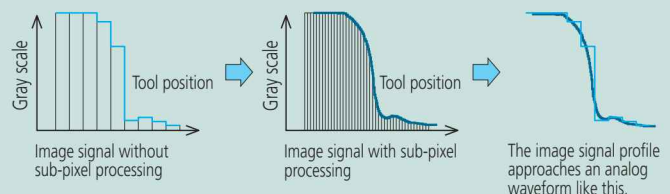
How to actually detect a workpiece edge in an image is described using the following monochrome picture as an example. Edge detection is performed within a given domain. A symbol which visually defines this domain is referred to as a tool. Multiple tools are provided to suit various workpiece geometries or measurement data.



### ■ High-resolution Measurement



To increase the accuracy in edge detection, sub-pixel image processing is used. An edge is detected by determining an interpolation curve from adjacent pixel data as shown below. As a result, it allows measurement with a resolution better than 1 pixel.



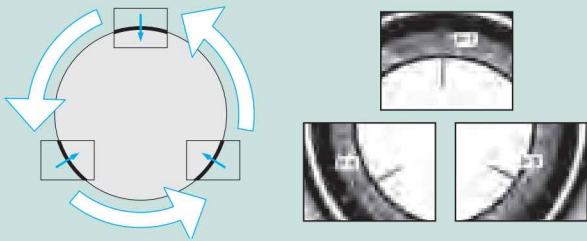
# Quick Guide to Precision Measuring Instruments



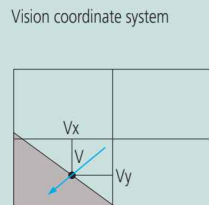
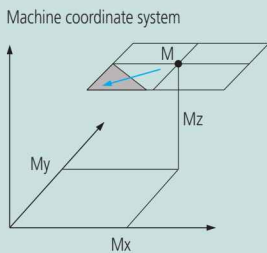
## Vision Measuring Machines

### Measurement along Multiple Portions of an Image

Large features that cannot be contained on one screen have to be measured by precisely controlling the position of the sensor and stage so as to locate each reference point within individual images. By this means the system can measure even a large circle, as shown below, by detecting the edge while moving the stage across various parts of the periphery.



### Composite Coordinates of a Point



Measuring machine stage position  
 $M = (M_x, M_y, M_z)$

Detected edge position (from the center of vision)  
 $V = (V_x, V_y)$

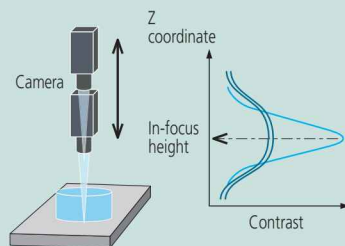
Actual coordinates are given by  $X = (M_x + V_x)$ ,  $Y = (M_y + V_y)$ , and  $Z = M_z$ , respectively.

Since measurement is performed while individual measured positions are stored, the system can measure dimensions that cannot be included in one screen, without problems.

### Principle of Auto Focusing

The system can perform XY-plane measurement, but cannot perform height measurement using only the camera image. The system is commonly provided with the Auto Focus (AF) mechanism for height measurement. The following explains the AF mechanism that uses a common image, although some systems may use an AF laser.

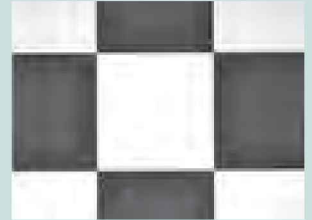
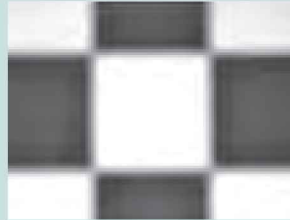
The AF system analyzes an image while moving the camera up and down in the Z axis. In the analysis of image contrast, an image in sharp focus will show a peak contrast and one out of focus will show a low contrast. Therefore, the height at which the image contrast peaks is the just-in-focus height.



### Variation in Contrast Depending on the Focus Condition

Edge contrast is low due to out-of-focus edges.

Edge contrast is high due to sharp, in-focus edges.



### Overview of ISO 10360-7

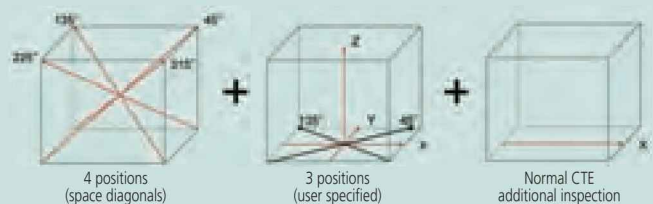
ISO10360-7 (Geometrical product specifications (GPS) -- Acceptance and reverification tests for coordinate measuring machines (CMM) -- Part 7: CMMs equipped with imaging probing systems) was published on June 1, 2011.

Some inspecting items are listed in ISO10360-7. The following summarizes the test method for determining length measurement error (E) and probing error (PF2D).

#### Length measurement error, E

Five test lengths in seven different directions within the measuring volume, each length measured three times, for a total of 105 measurements. Four directions are the space diagonals; remaining three positions are user specified; default locations are parallel to VMM axes.

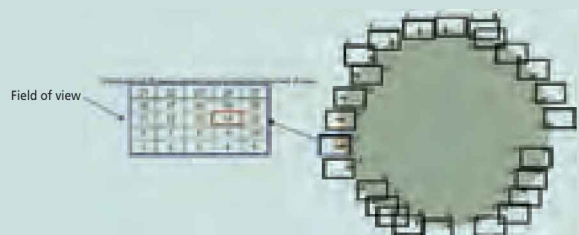
When CTE (coefficient of thermal expansion) of the test-length artifact is  $< 2 \times 10^{-6}/K$ , additional measurement of artifact with normal CTE ( $8$  to  $13 \times 10^{-6}/K$ ) is performed.



#### Probing error, PF2D

Measure 25 points distributed evenly around the test circle (14.4° pitch). Each of the 25 points shall be measured by using the specified 25 areas of the field of view.

Calculate probing error as the range of the 25 radial distances ( $R_{max} - R_{min}$ ) from the center of the least-square circle.





# New Products



## **Surftest (Surface Roughness Testers)**

**SV-3200**

Refer to page L-10 for details.



## **Contracer (Contour Measuring Instruments)**

**CV-2100**

Refer to page L-19 for details.



## **Formtracer (Surface Texture Measuring Instruments)**

**SV-C4500CNC**

Refer to page L-29 for details.



## Surftest



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#### Surftest Extreme (CNC Surface Roughness Testers)

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## Contracer



#### Contracer (Contour Measuring Instruments)

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#### Formtracer (Surface Texture Measuring Instruments)

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## Formtracer



#### Roundtest (Roundness/Cylindricity Measuring Systems)

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## Roundtest



# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

## Surftest SJ-210 SERIES 178 — On-site Surface Roughness Tester

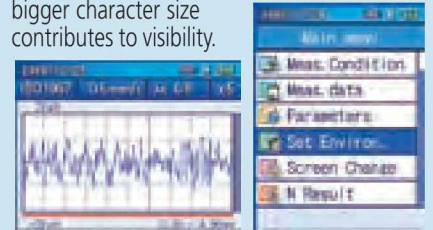


Model No.	Standard drive unit		Retractable drive unit		Transverse tracing drive unit		
	SJ-210 (0.75mN type)	SJ-210 (4mN type)	SJ-210 (0.75mN type)	SJ-210 (4mN type)	SJ-210 (0.75mN type)	SJ-210 (4mN type)	
Code No.	mm inch/mm	<b>178-560-01</b> <b>178-561-01</b>	<b>178-560-02</b> <b>178-561-02</b>	<b>178-562-01</b> <b>178-563-01</b>	<b>178-562-02</b> <b>178-563-02</b>	<b>178-564-01</b> <b>178-565-01</b>	
Measuring range	X axis	16.0 mm				5.6 mm	
Detector	Range	360 μm (-200 μm to +160 μm)					
	Range/Resolution	360 μm / 0.02 μm, 100 μm / 0.006 μm, 25 μm / 0.002 μm					
Measuring speed		When measuring: 0.25mm/s, 0.5mm/s, 0.75mm/s When returning: 1mm/s					
Measuring force/Stylus tip shape		Depends on the Code No.: 0.75mN/60°, 2μmR (when the Code No. ends with "-01") 4mN/90°, 5μmR (when the Code No. ends with "-02")					
Skid force		400mN or less					
Applicable standards		JIS1982/ JIS1994/ JIS2001/ ISO1997/ ANSI/ VDA					
Assessed profile		Primary profile, Roughness profile, DF profile, Roughness motif profile					
Parameter		Ra, Rc, Ry, Rz, Rq, Rt, Rmax*1, Rp, Rv, R3z, Rsk, Rku, Rc, Rpc, Rsm, Rz1max*2, S, HSC, RzJIS*3, Rppi, RAa, RAq, Rlr, Rmr, Rmr(c), Rδc, Rk, Rpk, Rvk, Mr1, Mr2, A1, A2, Vo, Rpm, tp, Htp*4, R, Rx, AR, Possible Customize					
Analysis graph		BAC and ADC curves					
Filter		Gaussian, 2CR75, PC75					
Cutoff value	$\lambda_c$	0.08, 0.25, 0.8, 2.5 mm					
	$\lambda_s^{*5}$	2.5, 8 μm					
Sampling length		0.08, 0.25, 0.8, 2.5 mm					
No. of sampling lengths		×1, ×2, ×3, ×4, ×5, ×6, ×7, ×8, ×9, ×10, arbitrary length (0.3 to 16.0mm: 0.01mm interval)		×1, ×2, ×3, ×4, ×5, ×6, ×7, ×8, ×9, ×10, arbitrary length (0.3 to 5.6mm: 0.01mm interval)			
Dimensions of LCD display area		36.7 × 48.9 mm					
Display language		Supports 16 languages (Japanese, English, German, French, Italian, Spanish, Portuguese, Dutch, Polish, Hungarian, Swedish, Czech, Simplified Chinese, Traditional Chinese, Korean, Turkish)					
Calculation result display		Vertical display: 1 row/3 rows/Trace Horizontal display: 1 column/4 columns/Trace (Right/Left switching display is available.)					
Print functions *6		Measurement condition / Calculation result / Calculation result per segment / Assessed profile / Material ratio curve / Profile height amplitude distribution curve / Environmental setting items					
External I/O functions	Customization	USB I/F, Digimatic output, printer output, RS-232C I/F, foot switch I/F					
	GO/NG judgment function*7	Desired parameters can be selected for calculation and display.					
	Storing measurement condition	Maximum value rule, 16% rule, mean value rule When the power is turned off					
Function	Storage	Built-in memory: Measurement condition (Up to 10) Memory card (optional): 500 measurement conditions, 10000 measured profiles, 500 display images, Text files (Measurement condition/Measurement data/Assessed profile/Profile height amplitude distribution curve)					
	Calibration	Auto-calibration with the entry of numerical value /Average calibration with multiple measurement (Max. 5 times) is available.					
Power saving function		Auto sleep (settable in the range of 10 to 600 sec.) *8					
Power supply		Built-in battery (rechargeable Ni-MH battery) / AC adapter Charging time of the built-in battery: about 4 hours (may vary due to ambient temperature) Endurance: about 1000 measurements (differs slightly due to use conditions/environment)					
External dimensions (W×D×H)	Calculation display unit	52.1 × 65.8 × 160 mm (sliding cover closed, detector not mounted)					
	Drive unit	115 × 23 × 26 mm (excluding the detector)					
Mass		Approx. 500 g (Calculation display unit, Drive unit, Standard detector)					
Standard Accessories		<b>12BAA303</b> Connecting cable*9		<b>12BAA303</b> Connecting cable*9			
		<b>178-601</b> Roughness specimen		<b>178-605</b> Roughness specimen			
	<b>12BAK699</b> Carrying case		<b>12AAE643</b> Point-contact adapter				
	<b>12BAK700</b> Calibration stage		<b>12AAE644</b> V-type adapter				
	Protective sheet for display		<b>12BAK699</b> Carrying case				
	AC adapter, Operation manual		<b>12BAK700</b> Calibration stage				
	One-sheet manual, Warranty card		Protective sheet for the display, AC adapter, Operation manual, One-sheet manual, Warranty card				

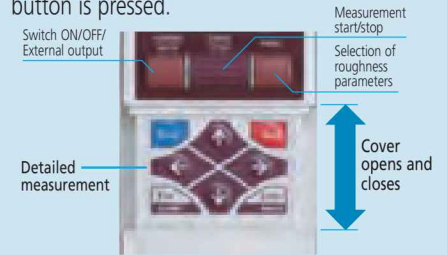
\*1: Calculation is available only when selecting the VDA, ANSI, or JIS 1982 standard.  
 \*2: Calculation is available only when selecting the ISO 1997 standard.  
 \*3: Calculation is available only when selecting the JIS 2001 standard.  
 \*4: Calculation is available only when selecting the ANSI standard.  
 \*5: Not available when selecting the JIS1982 standard.  
 \*6: Please procure the printer for SJ-210 (Code No.: **178-421**, Option) separately. Refer to page L-6 for details.  
 \*7: Only the mean value rule is available for the ANSI standard. Only the maximum value and the mean value rules are available for the VDA standard.  
 \*8: Not available when using the AC adapter. Auto sleep can be set to Off.  
 \*9: For the connection between the calculation display unit and drive unit.  
 To denote your AC line voltage add the following suffixes (e.g. **178-560-01A**).  
 A for 120V, C for 100V, D for 230V, E for 230V (for UK), DC for 220V (for China), K for 220V (for Korea)

### Compact type all-in-one surface roughness tester has evolved by meeting customer demands

- Color LCD can display not only calculation results and measurement conditions, but also surface roughness waveforms. In addition, bigger character size contributes to visibility.



- Supports a variety of roughness standards. Equipped with a variety of parameters and functions such as arbitrary length measurement. Facilitates the operation and settings using the buttons on the top and inside the openable cover of the main unit. Displays the result after a measurement when the measurement start button is pressed.



- Built-in rechargeable battery allows measurement without the power supply.
- Optional printer for SJ-210 allows the printing of calculation results and measured profiles.
- Outputs the alarm display when the accumulated measurement distance exceeds the threshold level that is set. (Useful for maintaining a stylus-tip replacement policy.)
- Three types of drive unit are available: Standard, Transverse tracing, and Retractable. Selectable depending on the workpiece.



Refer to the Surftest SJ-210 series (Catalog No.E4388) for more details.

## Advanced handheld tester that is easy to operate and meets a variety of needs

- Equipped with a large, touch-screen color graphic LCD to achieve intuitive operation and excellent ease of use.
- Features new measurement assistance and analysis functions to improve ease of operation while maintaining the operability of previous models.
- The detector can be oriented to any position according to the workpiece: a horizontal, inclined, overhead or perpendicular surface can be tested. Many optional accessories are available to support this feature. (Common between SJ-310/210)
- The optional memory card can save a large amount of measurement data. In addition, Trace 10 is a convenient function to save 10 sets of recent measurement data.
- The statistical processing and GO/NG judgment functions facilitates data management.
- High-speed thermal printer (whose printing speed is approx. 1.5 times that of conventional models) is provided as standard. Printing of measurement results (including judgment results) and assessed profiles are available as well as BAC and ADC profiles. Allows landscape mode printing to match the display on the LCD.



Profile display: One parameter measurement result and the measured profile

### Optional Accessories for SJ-310 Consumables

- Printer paper: Standard type (x5 packs): **No.270732**
- Printer paper: High-durability type (x5 packs): **No.12AAA876**
- Protective sheet for the touch panel (x10 sheets): **No.12AAN040**
- Memory card (4GB): **No.12AAL069**



Refer to the Surftest SJ-310 series (Catalog No.E15013) for more details.

## Surftest SJ-310 SERIES 178 — On-site Surface Roughness Tester



### SPECIFICATIONS

Model No.	Standard drive unit		Retractable drive unit		Transverse tracing drive unit		
	SJ-310 (0.75mN type)	SJ-310 (4mN type)	SJ-310 (0.75mN type)	SJ-310 (4mN type)	SJ-310 (0.75mN type)	SJ-310 (4mN type)	
Code No.	mm	mm	mm	mm	mm	mm	
	inch/mm	inch/mm	inch/mm	inch/mm	inch/mm	inch/mm	
Measuring range	X axis	16.0 mm				5.6 mm	
	Detector Range/Resolution	360 μm (-200 μm to +160 μm)					
Measuring speed	When measuring: 0.25mm/s, 0.5mm/s, 0.75mm/s				When returning: 1mm/s		
Measuring force/Stylus tip shape	Depends on the Code No.: 0.75mN/60°, 2μmR (when the Code No. ends with "-01") 4mN/90°, 5μmR (when the Code No. ends with "-02")						
Skid force	400mN or less						
Applicable standards	JIS1982/ JIS1994/ JIS2001/ ISO1997/ ANSI/ VDA						
Assessed profile	Primary profile, Roughness profile, DF profile, Roughness motif profile, Waviness motif profile						
Parameter	Ra, Rc, Ry, Rz, Rq, Rt, Rmax*1, Rp, Rv, R3z, Rsk, Rku, Rc, Rpc, Rsm, Rz1max*2, S, HSC, RzJIS*3, Rppi, RDa, RAq, Rlr, Rmr, Rmr(c), Rōc, Rk, Rpk, Rvk, Mr1, Mr2, A1, A2, Vo, λa, λq, Lo, Rpm, tp*4, Htp*4, R, Rx, AR, W, AW, Wx, Wte, Possible Customize						
Analysis graph	BAC and ADC curves						
Filter	Gaussian, 2CR75, PC75						
Cutoff value	λc	0.08, 0.25, 0.8, 2.5, 8mm					
	λs*5	2.5, 8 μm					
Sampling length	0.08, 0.25, 0.8, 2.5, 8mm						
No. of sampling lengths	×1, ×2, ×3, ×4, ×5, ×6, ×7, ×8, ×9, ×10, arbitrary length (0.3 to 16.0mm: 0.01mm interval)				×1, ×2, ×3, ×4, ×5, ×6, ×7, ×8, ×9, ×10, arbitrary length (0.3 to 5.6mm: 0.01mm interval)		
Dimensions of LCD display area	117.8 × 88.2 mm						
Display language	Supports 16 languages (Japanese, English, German, French, Italian, Spanish, Portuguese, Dutch, Polish, Hungarian, Swedish, Czech, Simplified Chinese, Traditional Chinese, Korean, Turkish)						
Calculation result display	1 row: Displays the calculation result of a parameter. 4 rows: Displays the calculation results of 4 parameters in 4 rows. Waveform: Displays the calculation result and assessed profile of a parameter in 2 rows. Trace: Displays the calculation results of the same parameter of the past 10 times.						
Print functions *1	Measurement condition / Calculation result / Judgment result / Calculation result per segment / Tolerance value / Assessed profile / Graphic curve / Material ratio curve / Profile height amplitude distribution curve / Environmental setting items						
External I/O functions	USB I/F, Digimatic output, RS-232C I/F, foot switch I/F						
Customization	Desired parameters can be selected for calculation and display.						
GO/NG judgment function*6	Maximum value rule, 16% rule, mean value rule, standard deviation (1σ, 2σ, 3σ)						
Storing measurement condition	When the power is turned off						
Storage	Built-in memory: Measurement condition (Up to 10) Memory card (optional): 500 measurement conditions, 10000 measured profiles, 500 display images, 10000 text files, 500 statistical data, 1 backup file of device setting data, 10 data of Trace 10						
Calibration	Auto-calibration with the entry of numerical value / Average calibration with multiple measurement (Max. 12 times) is available.						
Power saving function	Auto sleep (settable in the range of 30 to 600 sec.) *7						
Power supply	Built-in battery (rechargeable Ni-MH battery) / AC adapter Charging time of the built-in battery: about 4 hours (may vary due to ambient temperature) Endurance: about 1500 measurements (differs slightly due to use conditions/environment)						
External dimensions (W×D×H)	Calculation display unit		275 × 109 × 198mm				
Mass	Drive unit		115 × 23 × 26.7 mm (excluding the detector)				
Standard Accessories			Approx. 1.8 kg (Calculation display unit, Drive unit, Standard detector)				
	12AAM475	Connecting cable *8	12AAM475	Connecting cable *8	12AAM475	Connecting cable *8	
178-601	Roughness specimen (Ra3μm)	178-605	Roughness specimen (Ra1μm)	178-605	Roughness specimen (Ra1μm)		
357651	AC Adapter	357651	AC Adapter	357651	AC Adapter		
12AAA217	Nosepiece for flat surfaces	12AAE643	Point-contact adapter	12AAE643	Point-contact adapter		
12AAA218	Nosepiece for cylindrical surfaces	12AAE644	V-type adapter	12AAE644	V-type adapter		
12AAA216	Support feet set	12BAK700	Calibration stage	12BAK700	Calibration stage		
12BAK700	Calibration stage	12BAG834	Touch pen	12BAG834	Touch pen		
12BAG834	Touch pen	12BAL402	Protective sheet	12BAL402	Protective sheet		
12BAL402	Protective sheet	270732	Printer paper (5 packs)	270732	Printer paper (5 packs)		
270732	Printer paper (5 packs)	12BAL400	Carrying case	12BAL400	Carrying case		
12BAL400	Carrying case	Phillips screwdriver, Strap for the touch pen, Operation manual, One-sheet manual, Warranty card		Phillips screwdriver, Strap for the touch pen, Operation manual, One-sheet manual, Warranty card			

\*1: Calculation is available only when selecting the VDA, ANSI, or JIS 1982 standard.

\*2: Calculation is available only when selecting the ISO 1997 standard.

\*3: Calculation is available only when selecting the JIS 2001 standard.

\*4: Calculation is available only when selecting the ANSI standard.

\*5: Not available when selecting the JIS 1982 standard.

\*6: Only the mean value rule is available for the ANSI standard. 16% rule is not available when selecting the VDA standard.

\*7: Not available when using the AC adapter. Auto sleep can be set to OFF.

\*8: For the connection between the calculation display unit and drive unit

To denote your AC line voltage add the following suffixes (e.g. 178-570-01A).

A for 120V, C for 100V, D for 230V, E for 230V (for UK), DC for 220V (for China), K for 220V (for Korea)

# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

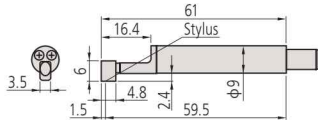
## Optional Accessories for Surftest SJ-210/310

### Detector

#### • Standard detectors

Code No.	Measuring force	Stylus profiles*	Remarks
178-296	0.75mN	2µmR/60°	Dedicated to the standard/retractable drive unit
178-390	4mN	5µmR/90°	
178-387	0.75mN	2µmR/60°	Dedicated to the transverse tracing drive unit
178-386	4mN	5µmR/90°	
178-391	4mN	10µmR/90°	Dedicated to the standard/retractable drive unit

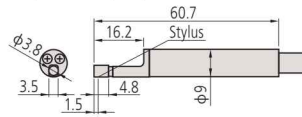
\*Tip radius / Tip angles



#### • Small hole detectors

Code No.	Measuring force	Stylus profiles*	Remarks
178-383	0.75mN	2µmR/60°	Minimum measurable hole diameter: ø4.5mm
178-392	4mN	5µmR/90°	

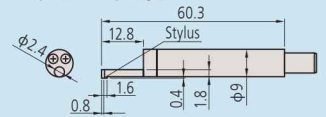
\*Tip radius / Tip angles



#### • Extra small hole detectors

Code No.	Measuring force	Stylus profiles*	Remarks
178-384	0.75mN	2µmR/60°	Minimum measurable hole diameter: ø2.8mm
178-393	4mN	5µmR/90°	

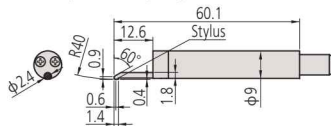
\*Tip radius / Tip angles



#### • Gear-tooth surface detectors

Code No.	Measuring force	Stylus profiles*
178-388	0.75mN	2µmR/60°
178-398	4mN	5µmR/60°

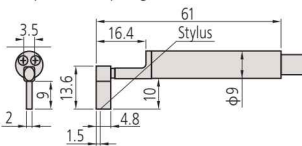
\*Tip radius / Tip angles



#### • Deep groove detectors

Code No.	Measuring force	Stylus profiles*	Remarks
178-385	0.75mN	2µmR/60°	Not available for the transverse tracing drive unit
178-394	4mN	5µmR/90°	

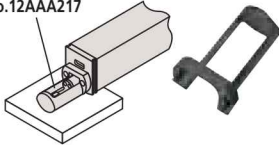
\*Tip radius / Tip angles



## Optional Accessories for Drive Units

#### • Nosepiece for flat surfaces

Nosepiece for flat surfaces  
No.12AAA217

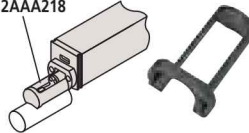


No.12AAA217

\*Standard accessory for the standard/retractable drive unit of the SJ-310 series  
\*Not available for the transverse tracing drive unit

#### • Nosepiece for cylindrical surfaces

Nosepiece for cylindrical surfaces  
No.12AAA218



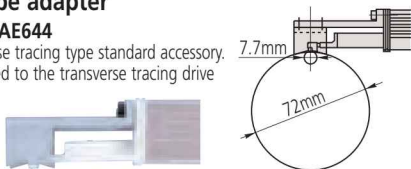
No.12AAA218

\*Standard accessory for the standard/retractable drive unit of the SJ-310 series  
\*Not available for the transverse tracing drive unit

#### • V-type adapter

No.12AAE644

\*Transverse tracing type standard accessory.  
\*Dedicated to the transverse tracing drive unit.



#### • Point-contact adapter

No.12AAE643

\*Transverse tracing type standard accessory.  
\*Dedicated to the transverse tracing drive unit.



#### • Extension rod (50mm) (Note: Only one rod can be used.)

No.12AAA210

\*Not available for the transverse tracing drive unit

\*Not applicable to upward measurement.



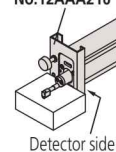
#### • Extension cable (1m) (Note: Only one rod can be used.)

No.12BAA303

\*For the connection between the calculation display unit and drive unit

#### • Support feet set

Support feet set  
No.12AAA216



No.12AAA216

\*Standard accessory for the standard/retractable drive unit of the SJ-310 series  
\*Not available for the transverse tracing drive unit  
\*Adjustment range is 28mm from bottom face.

#### • Adapter for flat surface

No.12AAA219

\*Not available for the transverse tracing drive unit



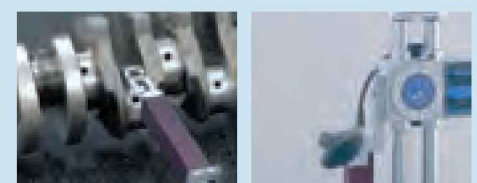
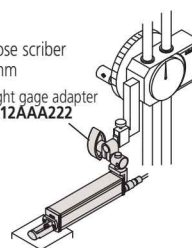
#### • Height gage adapter

Note: Dedicated to the height gage whose scriber mounting dimensions are 9 × 9 mm

No.12AAA222



Height gage adapter  
No.12AAA222





## Optional Accessories for Surftest SJ-210/310

### Setting attachments\*

Improves measurement efficiency by allowing the setup of multiple workpieces of the same type and the positioning of hard-to-access features of a workpiece.

\*Not available for the transverse tracing drive unit

#### • Attachment for the measurement of cylinder shaft direction

No.178-033

The V-width is adjustable to the cylinder diameter, facilitating axial measurement of a wide range of cylinder diameters.

- Applicable diameter:  $\varnothing 5$  to 150mm



#### • Attachment for interrupted surface measurement

No.178-034

Best suited for measurement of the flat surface of a workpiece that has partial indentations and steps and that is hard to set the drive unit. Combination use with the magnet type specimen holder (Option: No.12AAA910) further improves the ease of operation.



#### • Attachment for measuring inside bores and holes

No.178-035

Greatly facilitates measurement of internal wall surfaces of, for example, cylinder-block bores.

- Applicable diameter:  $\varnothing 75$  to 95mm
- Accessible depth: 30 to 135mm



### Printer for SJ-210

Assessed profiles and calculation results and curves can be printed out by connecting the SJ-210-dedicated printer, which is palm sized (W×D×H: 93×125×70mm) and can run on an internal battery.

- Power supply can be selected. (AC adapter or battery pack)
- Printable items: Measurement conditions, calculation results, assessed profile, bearing area curve (BAC), amplitude distribution curve (ADC), GO/NG judgment

#### • Printer for SJ-210

(Provided with the connecting cable and printer paper (×6 packs))

No.178-421

#### • Printer paper

Standard type (x5 packs): No.270732

High-durability type (x5 packs): No.12AAA876



### Digimatic mini-processor

It is possible to process Digimatic data output from the Surftest SJ series with the DP-1VR. This compact, hand-held device can provide printouts of measurement data and various statistical analyses results such as histograms, D-charts, and X bar R control charts.

#### • Digimatic mini-processor DP-1VR

No.264-504

#### • Digimatic connecting cable

• Connecting cable 1m: No.936937

• Connecting cable 2m: No.965014

Note: The symbol 'µm' is not printable, but measurement results can still be printed out without setting the measurement unit.



### Introduction of the specified communication program for Surftest SJ-210/310/410 series, 500, SV-2100

The communication function, one of the features of SJ-210/310/410/500 and the SV-2100 series, allows data transfer to spreadsheet software. The program can also create an inspection certificate using macros in Microsoft Excel.

\*Only for the dedicated control unit type

This program can be downloaded for free from the Mitutoyo website.  
<http://www.mitutoyo.co.jp>

#### System environments supporting the operation

• OS: Windows XP-SP3  
 Windows Vista  
 Windows 7  
 Windows 8

• Spreadsheet software: Microsoft Excel 2000  
 Microsoft Excel 2002  
 Microsoft Excel 2003

Microsoft Excel 2007  
 Microsoft Excel 2010  
 Microsoft Excel 2013

#### Optional USB cable is required.

- USB communication cable for SJ-210: No.12AAL068
- USB communication cable for SJ-310/410\*: No.12AAD510
- USB communication cable for SJ-500/SV-2100\*: No.12AAH490

\*Equivalent to Type AB for the communication between the device and host

### Input tool for measurement data input units

Using this tool, measurement data from the Surftest SJ series can be instantly imported into commercially-available spreadsheet software through a USB or PS-2 keyboard socket on a PC. Refer to the Catalog (No.4279) for more details.

#### • Input tool

• USB keyboard signal conversion model

IT-012U: No.264-012-10

USB-ITN-D (Direct type): No.06ADV380D

#### • Digimatic connecting cable

• Connecting cable 1m: No.936937

• Connecting cable 2m: No.965014

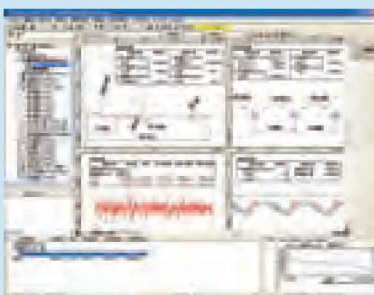


\* Refer to pages A-7 to A-9 for details of U-WAVE.

\* Refer to pages A-5 to A-6 for details of the input tool.

### Surface Roughness / Contour Analysis Software FORMTRACEPAK

Measurement data from the SJ-210/310/410 series can be imported into FORMTRACEPAK running on a desktop type surface roughness tester via an optional memory card to perform a more advanced analysis if required.



# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

## Surftest SJ-410 SERIES 178 — Compact Surface Roughness Tester



### SPECIFICATIONS

Model No.	SJ-411		SJ-412		
Code No./mm	mm	178-580-01	178-580-02	178-582-01	178-582-02
	inch/mm	178-581-01	178-581-02	178-583-01	178-583-02
Measuring range	X axis	25mm		50mm	
	Z axis (detector)	800µm, 80µm, 8µm Up to 2,400µm when using an optional stylus.			
Detector	Detection method	Differential inductance			
	Resolution	0.01µm (800µm range), 0.001µm (80µm range), 0.0001µm (8µm range)			
	Stylus tip shape (Angle/Radius)	60°/2µm	90°/5µm	60°/2µm	90°/5µm
	Measuring force	0.75mN	4mN	0.75mN	4mN
	Radius of skid curvature	40mm			
	Measuring methods	Skidless / Skidded (switchable)			
Drive unit (X axis)	Measuring speed	0.05, 0.1, 0.2, 0.5, 1.0mm/s			
	Drive speed	0.5, 1, 2, 5mm/s			
	Straightness	0.3µm / 25mm		0.5µm / 50mm	
Up/down inclination unit	Up/down movement	10mm			
	Inclination adjustment	±1.5°			
Applicable standards		JIS1982 / JIS1994 / JIS2001 / ISO1997 / ANSI / VDA			
Parameters		Ra, Rq, Rz, Ry, Rp, Rt, R3z, Rsk, Rku, Rc, RPC, RSm, Rmax*1, Rz1max*2, S, HSC, RzJIS*3, Rppi, RAa, RAq, Rlr, Rmr, Rmr(c), Rσc, Rk, Rok, Rvk, Mr1, Mr2, A1, A2, Vo, λa, λq, Lo, Rpm, tp*4, Htp*4, R, Rx, AR, W, AW, Wx, Wte, Possible Customize			
Assessed profile		Primary profile, Roughness profile, Waviness profile, DF profile, Roughness motif profile, Waviness motif profile			
Analysis graph		Material ratio curve, Profile height amplitude distribution curve			
Data compensation functions		Parabola, Hyperbolic, Ellipse, Circle, Conic, Tilt, No compensation			
Filter		2CR, PC75, Gaussian			
Cutoff value	$\frac{\lambda c}{\lambda s *5}$	0.08, 0.25, 0.8, 2.5, 8mm			
		2.5, 8, 25µm			
Sampling length		0.08, 0.25, 0.8, 2.5, 8, 25mm			
No. of sampling lengths		×1, ×2, ×3, ×4, ×5, ×6, ×7, ×8, ×9, ×10, ×11, ×12, ×13, ×14, ×15, ×16, ×17, ×18, ×19, ×20			
Arbitrary length		0.1 to 25mm		0.1 to 50mm	
Calculation display unit	Customization	Selection of display/evaluation roughness parameter			
	Simplified contour analysis function	Step, Step quantity, Area, Coordinate difference			
	DAT function	Helps to level workpiece prior to skidless measurement			
	Real sampling function	Inputs the displacement of the detector while stopping the drive unit			
	Statistical processing	Calculates the maximum value, minimum value, average value, standard deviation, pass rate and histogram for each parameter.			
	GO/NG judgment *6	Maximum value rule, 16% rule, mean value rule, standard deviation (1σ, 2σ, 3σ)			
	Storing measurement condition	Up to 10 (Calculation display unit)			
	Print function (Built-in thermal printer)	Measurement condition / Calculation result / Judgment result / Calculation result per segment / Tolerance value / Assessed profile / Graphic curve / Material ratio curve / Profile height amplitude distribution curve / Environmental setting items / Statistical result (Histogram)			
	Display language	Supports 16 languages (Japanese, English, German, French, Italian, Spanish, Portuguese, Dutch, Polish, Hungarian, Swedish, Czech, Simplified Chinese, Traditional Chinese, Korean, Turkish)			
	Storage	Built-in memory: Measurement condition (Up to 10) Memory card (Optional): 500 measurement conditions, 10000 measured profiles, 500 display images, 10000 text files, 500 statistical data, 1 backup file of device setting data, 10 data of Trace 10			
Power supply	External I/O functions	USB I/F, Digimatic output, RS-232C I/F, foot switch I/F			
	Battery	Built-in battery (rechargeable Ni-MH battery) / AC adapter Charging time of the built-in battery: about 4 hours (may vary due to ambient temperature) Endurance: about 1000 measurements (differs slightly due to use conditions/environment)			
External dimensions (W×D×H)	Maximum power consumption	50W			
	Calculation display unit	275×198×109mm			
	Up/down inclination unit	130.9×63×99mm			
Mass	Drive unit	128×35.8×46.6mm		154.5×35.8×46.6mm	
	Calculation display unit	1.7kg			
	Up/down inclination unit	0.4kg			
Standard Accessories	Drive unit	0.6kg		0.64kg	
		Detector*/Standard stylus*8 178-601 Roughness specimen (Ra3µm) 270732 Printer paper: Standard type (x5 packs) 12BAL402 Protective sheet for the LCD (x1 sheet) 12BAG834 Touch pen 12AAN041 Carrying case		AC adapter, Power cable, Flat-blade screwdriver, Phillips screwdriver, Hex wrench, Strap for the touch pen, Operation manual, One-sheet manual, Warranty card	

\*1: Calculation is available only when selecting the VDA, ANSI, or JIS 1982 standard.

\*2: Calculation is available only when selecting the ISO 1997 standard.

\*3: Calculation is available only when selecting the JIS 2001 standard.

\*4: Calculation is available only when selecting the ANSI standard.

\*5: Not available when selecting the JIS 1982 standard

\*6: Only the mean value rule is available for the ANSI standard. 16% rule is not available when selecting the VDA standard.

\*7: Depending on the Code No. of the SJ-410 series main unit, No.178-396 or No.178-397 is provided as standard.

\*8: Standard stylus (No.12AAC731 or No.12AAB403) supporting the provided detector is provided as standard

To denote your AC line voltage add the following suffixes (e.g. 178-580-01A).

A for 120V, C for 100V, D for 230V, E for 230V (for UK), DC for 220V (for China), K for 220V (for Korea)



An inspection certificate is supplied as standard. Refer to page X for details.

### Dramatic improvement on compact type surface roughness testers

- Equipped with the touch-screen large color graphic LCD to achieve both of the intuitive operation and high operability
- Skidded and skidless measurement are switchable to perform the optimum evaluation according to the measurement condition.
- A wide-range, high-resolution detector and a drive unit provide superior high-accuracy measurement in its class.
  - Detector  
Measuring range: 800µm  
Resolution: 0.0001µm (at 8µm range)
  - Drive unit  
Straightness/traverse length: 0.3µm/25mm (SJ-411)  
Straightness/traverse length: 0.5µm/50mm (SJ-412)
- Simplified contour analysis (Step, Step quantity, Area, Coordinate difference) is available using the point cloud data collected to evaluate the surface roughness. Allows the evaluation of detailed shapes that cannot be achieved by contour measuring instruments.

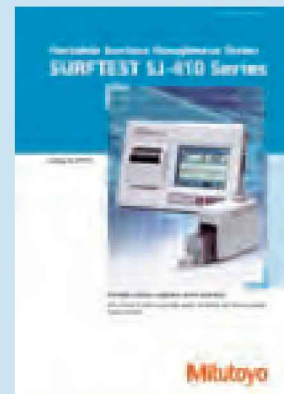


(Coordinate difference)

- Allows the evaluation of surface roughness in a circumferential direction using the skidless measurement and R-surface compensation functions.
- Conforms to the latest ISO standard and ANSI/VDA standard in addition to the JIS standard (2001/1994/1982).
- Achieves the performance of a desktop type surface roughness tester in combination with the simplified stand and associated optional accessories.

### Optional Accessories for SJ-410 Consumables

- Printer paper: Standard type (x5 packs): **No.270732**
- Printer paper: High-durability type (x5 packs): **No.12AAA876**
- Protective sheet for the touch panel (x10 sheets): **No.12AAN040**
- Memory card (2GB): **No.12AAL069**



Refer to the Surftest SJ-410 series (Catalog No.E15014) for more details.



An inspection certificate is supplied as standard.  
Refer to page X for details.

## High precision and high performance type surface roughness tester with a dedicated control unit, achieving user-friendly display and simple operation.

- Equipped with a 7.5-inch, color TFT LCD, large color icons and touch panel controls, the display unit is easy to read and simple to operate.
- A built-in joystick on the control unit allows quick and easy positioning. The manual adjustment knob allows fine positioning of a small stylus for measuring small holes.
- In addition to the roughness parameters compliant with ISO/JIS/ANSI/VDA surface roughness standard, contour analysis is also available.

## Surftest SJ-500/SV-2100 SERIES 178 — Dedicated Control Unit Type Surface Roughness Tester



- Consumables for SV-2100 series/SJ-500**
- Printer paper: Standard type (x5 packs): **No.270732**
  - Printer paper: High-durability type (x5 packs): **No.12AAA876**

### SPECIFICATIONS

Model No.	SJ-500	SV-2100M4	SV-2100S4	SV-2100H4	SV-2100W4	
Standard type	(Optional)	Manual stand		Motorized stand		
Measuring range	Z1 axis (detector) X axis		800μm, 80μm, 8μm		100mm	
Straightness		0.2μm/50mm*1			0.15μm/100mm	
Resolution	Z1 axis (detector) Z2 axis (column)		0.01μm (800μm), 0.001μm (80μm), 0.0001μm (8μm)		0.1μm	
Drive speed	X axis Z2 axis (column)	0 to 20mm/s or manual operation		0 to 40mm/s or manual operation	0 to 20mm/s or manual operation	
Measuring speed			0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0mm/s			
Up/down movement	Connector unit: 30mm	350mm	350mm		550mm	
Assessed profile		Primary profile, Roughness profile, Waviness profile, DF profile, Roughness motif profile, Waviness motif profile				
Parameter		Ra, Rc, Ry, Rz, Rq, Rt, Rmax, Rp, Rv, R3z, Sm, S, Pc, m(rc), δc, mr, tp, Htp, Lo, lr, Ppl, HSC, Δa, Δq, Ku, Sk, Rpk, Rvk, Rk, Mr1, Mr2, A1, A2, Vo, λa, λq, R, AR, Rx, W, AW, Wx, Wte				
Contour analysis		Step (AVE, MAX, MIN), Circle, Angle, Area, Coordinate value margin, inclination				
Analysis graph		Material ratio curve (BAC), Profile height amplitude distribution curve (ADC), Power spectrum chart				
Data compensation functions		Parabola compensation, Hyperbolic compensation, Ellipse compensation, Circle compensation, Conic compensation, Tilt compensation (General/Arbitrary)				
Filter		2CR75, PC75, GAUSS, Robust-Spline				
Cutoff value	λs λc λf		0.25, 0.8, 2.5, 8, 25, 80, 250μm, no filter 0.025, 0.08, 0.25, 0.8, 2.5, 8, 25, 80*2mm, no filter 0.08, 0.25, 0.8, 2.5, 8, 25, 80*2mm, no filter			
Sampling length		0.025, 0.08, 0.25, 0.8, 2.5, 8, 25, 80*2mm, no filter				
LCD Specification		Touch-screen 7.5" color TFT with backlight				
Built-in printer		High-speed thermal printer (Paper width: 58mm)				
Recording magnification	Vertical magnification Horizontal magnification		10X to 500,000X, Auto 0.5X to 10,000X, Auto			
Detector	Detection method Stylus & Measuring force		Differential inductance			
Power specification		0.75mN stylus tip (cone): Tip taper angle: 60°, Tip radius: 2μm 4mN stylus tip (cone): Tip taper angle: 90°, Tip radius: 5μm				
Power consumption		100 VA	70 VA		140 VA	
External dimensions (W×D×H)	Main unit Calculation display unit Motorized unit	425×94×160mm	716×450×863mm	766×482×966mm 330×270×94mm	766×482×1166mm 372×245×71.8mm	1166×482×1176mm
Mass	Main unit Calculation display unit Motorized unit	2.7kg	140kg	4.0kg	150kg	220kg

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.  
\*1: When using the optional simplified stand: 0.4μm/50mm, When using the optional manual column stand: 0.3μm/50mm  
\*2: Except for **SJ-500**  
Note: Stand for **SJ-500** is optional. Refer to page L-15 for details.

# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

## Surftest SJ-500P/SV-2100M4 Data Processing Unit (PC) Surface Roughness Testers

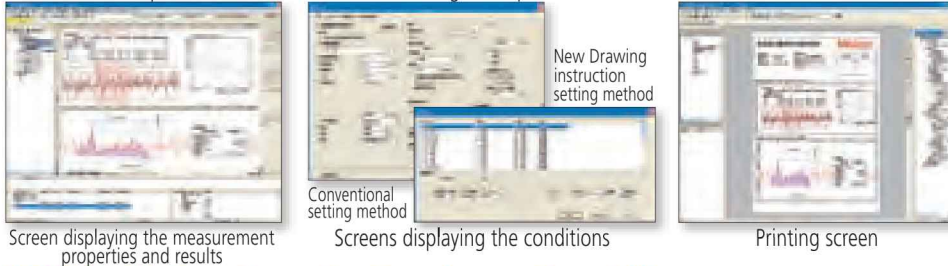


**SJ-500P**  
Software is selectable from FORMTRACEPAK or SURFPAK-EZ.

**SV-2100M4 (PC type)**

### FORMTRACEPAK: Best-selling Surface Roughness Analysis Program

Best-selling dedicated software for surface roughness measurement and analysis. Features a flexible printer format and creation of an original inspection certificate.



Screen displaying the measurement properties and results

Screens displaying the conditions

Printing screen

### SURFPAK-EZ: Easy Operation Focusing on Operability

Intuitive operation is available thanks to the user-friendly graphic display and button layout. Simplified contour analysis functions such as step, area, angle, and circle calculation are provided as standard.



Screen displaying the measurement properties and results

Screen for calibration and control (For SJ-500P)

Screen for the simplified contour analysis function

## SPECIFICATIONS

Type of data processing unit	PC type	
Model No.	SJ-500P	SV-2100M4*
Elevating shaft mechanism of stand	—*1	Manual operation only
Measuring X axis range	50mm	100mm
Z1 axis (detector)	800µm / 80µm / 8µm	
Z2-axis (column) moving range	—	350mm
Resolution X axis	0.05µm	
Z1 axis (detector)	0.01µm (800µm), 0.001µm (80µm), 0.0001µm (8µm)	
Z2 axis (column)	—	
Drive speed X axis	0 to 20mm/s or manual operation	
Z2 axis (column)	0 to 40mm/s or manual operation	
Measuring speed	0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0mm/s	
Straightness	0.2µm / 50mm*2	
X-axis operation	From PC/ with manual knob	
Measuring force/Stylus tip angle, Radius	Depends on the Code No.: 0.75mN/60°, 2µm (when the Code No. ends with "-01") 4mN/90°, 5µm (when the Code No. ends with "-02")	
Applicable standards	JIS1982/ JIS1994/ JIS2001/ ISO1997/ ANSI/ VDA	
Assessed profile	Primary profile, Roughness profile, Waviness profile, Filtered waviness profile, Rolling circle waviness profile, Rolling circle center line waviness profile, Envelope residual profile, DIN4776 profile, Roughness motif profile, Waviness motif profile	
Parameter	Pa, Pq, Psk, Pku, Pp, Pv, Pz, Pt, Pc, PSm, PAq, Pmr(c), Pmr, Pδc, Ra, Rq, Rsk, Rku, Rp, Rv, Rz, Rt, Rc, RSm, RAq, Rmr(c), Rmr, Rδc, Wa, Wq, Wsk, Wku, Wp, Wv, Wz, Wt, Wc, WSm, WΔq, Wmr(c), Wmr, Wδc, Rk, Rok, Rvk, Mr1, Mr2, A1, A2, Rx, AR, R, Wx, AW, W, Wte, Ry, RyDIN, RzDIN, R3y, R3z, S, HSC, Lo, If, Aa, Aa, Aq, Vo, Htp, NR, NCRX, CPM, SR, SAR, NW, SW, SAW	
Analysis graph	ADC, BAC, Power spectrum chart, Auto-correlation chart, Walsh power spectrum chart, Walsh auto-correlation chart, Slope distribution chart, Local peak distribution chart, Parameter distribution chart	
Data compensation functions	Tilt compensation (General/First half/Second half/Anchor/Arbitrary), R-surface compensation, Ellipse compensation, Parabola compensation, Hyperbolic compensation, Conic compensation, Polynomial compensation	
Contour analysis function	When using SURFPAK-EZ*3: Step, Circle, Angle, Area, Coordinate difference	
Filter	Gaussian, 2CR75, 2CR50, 2CRPC75, 2CRPC50, Robust-Spline	
Base size (W×D)	600×450mm	
Base material	Gabbro	
External dimensions (W×D×H)	Main unit: 425×94×160mm Display unit: —*4 Motorized unit: — PC I/F Unit: —	Main unit: 716×450×863mm Display unit: —*4 Motorized unit: — PC I/F Unit: —
Mass	Main unit: 2.7 kg Display unit: —*4 Motorized unit: — PC I/F Unit: —	Main unit: 140 kg Display unit: —*4 Motorized unit: — PC I/F Unit: —
	3.8 kg	

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

\*1: The simplified stand or manual column stand is available as optional accessory. (Refer to page L-15 for details.)

\*2: When using the simplified stand (optional): 0.4µm/50mm, When using the manual column stand (optional): 0.3µm/50mm

\*3: When using FORMTRACEPAK, please inquire separately.

\*4: Depends on the PC system

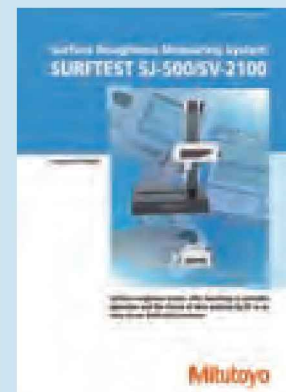


An inspection certificate is supplied as standard. Refer to page X for details.

Highly precise, high-performance surface roughness testers that use the advantages of sophisticated analysis software. The SJ-500P is a stand-alone instrument whereas the SV-2100M4 is a benchtop machine incorporating a precision column with manual drive.

- Simple setup for surface roughness measuring conditions.

A simple input function is used to calculate according to ISO/JIS roughness standard drawing instruction symbols. Complicated measuring condition settings can easily be entered by selecting a drawing instruction symbol from the surface roughness menu.



Refer to the Surftest SJ-500/SV-2100 (Catalog No. E15006) for more details.



An inspection certificate is supplied as standard. Refer to page X for details.

## Surftest SV-3200 SERIES 178 — Desktop Surface Roughness Tester

Equipped to measure a variety of parameters. A precision surface roughness tester supported by a wide range of optional accessories for a versatile benchtop surface-analysis solution.

- The analysis unit is equipped with the FORMTRACEPAK Surface Roughness / Contour analysis program.
- High-resolution type Z1-axis detector is provided as standard. The highest display resolution of the Z1 axis is 0.0001 $\mu$ m (when the measuring range is 8 $\mu$ m.)
- X-axis drive unit is equipped with a built-in high-precision glass scale to achieve the highly accurate positioning for the travel direction (X axis). SV-3200 series employs a ceramic guide for the drive unit to enhance resistance to abrasion for a long service life.
- The resolution of the X axis is 0.05 $\mu$ m.
- Detectors with standard or low measuring force, 4mN or 0.75mN, are selectable whether the instrument is equipped with the inclinable drive unit or not.
- The 700mm Z2-axis (column) range models are new to the lineup.



SV-3200

SV-3200L4 (with options)

### SPECIFICATIONS

Model No.	SV-3200S4	SV-3200H4	SV-3200W4	SV-3200L4	SV-3200S8	SV-3200H8	SV-3200W8	SV-3200L8	
Measuring range/Resolution	Z1 axis 800 $\mu$ m/0.01 $\mu$ m, 80 $\mu$ m/0.001 $\mu$ m, 8 $\mu$ m/0.0001 $\mu$ m								
	Travel range of the X axis 100mm				200mm				
	X-axis straightness (0.05+0.001L) $\mu$ m (L: Measuring length (mm))				(0.1+0.002L) $\mu$ m (L: Measuring length (mm))				
Drive unit	Measuring speed 0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20mm/s								
	Z2 axis (column)	300mm (motorized)*1	500mm (motorized)*1	700mm (motorized)*1	300mm (motorized)*1	500mm (motorized)*1	700mm (motorized)*1		
Assessed profile	Primary profile, Roughness profile, Waviness profile, Filtered waviness profile, Rolling circle waviness profile, Rolling circle center line waviness profile Envelope residual profile, DIN4776 profile, Roughness motif profile, Waviness motif profile								
Parameter	Pa, Pq, Psk, Pku, Pp, Pv, Pz, Pt, Pc, PSm, P $\Delta$ q, Pm (rc), Pmr, P $\delta$ c, Ra, Rq, Rsk, Rku, Rp, Rv, Rz, Rt, Rc, RSm, R $\Delta$ q, Rm (rc), Rmr, R $\delta$ c, Wa, Wq, Wsk, Wku, Wp, Wv, Wz, Wt, Wc, WSm, W $\Delta$ q, Wm (rc), Wmr, W $\delta$ c, Rk, Rpk, Rvk, Mr1, Mr2, A1, A2, Rx, AR, R, Wx, AW, W, Wte, Ry, RyDIN, RzDIN, R3y, R3z, S, HSC, Lo, Ir, $\Delta$ a, $\lambda$ a, $\lambda$ q, Vo, Htp, NR, NCRX, CPM, SR, SAR, NW, SW, SAW								
Analysis graph	ADC, BAC, Power spectrum chart, Auto-correlation chart, Walsh power spectrum chart, Walsh auto-correlation chart, Slope distribution chart, Local peak distribution chart, Parameter distribution chart								
Data compensation functions	Tilt compensation (General/First half/Second half/Anchor/Arbitrary), R-surface compensation, Ellipse compensation, Parabola compensation, Hyperbolic compensation, Conic compensation, Polynomial compensation								
Filter	Gaussian, 2CR75, 2C R50, 2CRPC75, 2CRPC50, Robust-Spline								
	$\lambda$ s	0.0008, 0.0025, 0.008, 0.025, 0.08, 0.25, 0.8mm							
	$\lambda$ c	0.025, 0.08, 0.25, 0.8, 2.5, 8, 25mm, arbitrary (0.025 to 50mm)							
Cutoff value	$\lambda$ f	0.08, 0.25, 0.8, 2.5, 8, 25, 80mm, arbitrary (0.025 to 50mm)							
	$\lambda$ h	0.025, 0.08, 0.25, 0.8, 2.5, 8mm, arbitrary (0.025 to 50mm)							
	$\lambda$ l	0.08, 0.25, 0.8, 2.5, 8, 25mm, arbitrary (0.025 to 50mm)							
Sampling length	0.025, 0.08, 0.25, 0.8, 2.5, 8, 25mm, arbitrary (0.025 to 50mm)								
Recording magnification	Vertical magnification	10X to 500,000X, Auto							
	Horizontal magnification	0.5X to 10,000X, Auto							
	Detection method	Differential inductance							
Detector	Stylus & Measuring force	0.75mN stylus tip (cone): Tip taper angle: 60°, Tip radius: 2 $\mu$ m 4mN stylus tip (cone): Tip taper angle: 90°, Tip radius: 5 $\mu$ m							
Power supply	Measuring main unit	100V 50/60Hz							
External dimensions (W×D×H)	Measuring main unit	756×482×996mm	756×482×1166mm	1156×482×1176mm	1156×492×1436mm	766×482×996mm	766×482×1166mm	1166×482×1176mm	1166×492×1436mm
Mass		140kg	150kg	220kg	270kg	140kg	150kg	220kg	270kg

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

\*1: Manual operation is also available.

# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

## Surftest Extreme SV-3000CNC/SV-M3000CNC SERIES 178 — CNC Surface Roughness Testers



**SV-3000CNC**  
(Inclinable drive unit + Y-axis table)



**SV-M3000CNC**  
(Surface Roughness Tester with movable Y-axis column unit.)  
(The photo represents a special specification model.)

### SV-3000CNC SPECIFICATIONS

X1-axis (drive unit)	Measuring range		200mm
	Resolution		0.05μm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200mm/s
		Joystick mode	0 to 60mm/s
	Measuring speed		0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0mm/s
Measuring direction		Backward	
Straightness		0.5μm/200mm	
Z2 axis (column)	Travel range	Z2 axis (column, type S)	300mm
		Z2 axis (column, type H)	500mm
	Resolution		0.05μm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200mm/s
		Joystick mode	0 to 60mm/s
Base size (width×depth)		750×600mm	
Base material		Gabbro	

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

### SV-M3000CNC SPECIFICATIONS

X1-axis (drive unit)	Measuring range		200mm
	Resolution		0.05μm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200mm/s
		Joystick mode	0 to 50mm/s
	Measuring speed		0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0mm/s
Straightness	When using a standard detector		0.5μm/200mm
	When using a long-type detector		0.7μm/200mm
	When using a rotary-type detector holder	Up/down direction	0.5μm/200mm
		Forward/backward direction	0.7μm/200mm
Z2 axis (column)	Measuring range		500mm
	Resolution		0.05μm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200mm/s
Joystick mode		0 to 50mm/s	
Y axis	Measuring range		800mm
	Resolution		0.05μm
	Scale type		Reflective-type linear encoder
	Drive speed	CNC mode	Max. 200mm/s
		Joystick mode	0 to 50mm/s
	Measuring speed		0.02 to 2mm/s
Straightness	When using a standard detector holder	Narrow range	0.5μm/50mm
		Wide range	2μm/800mm
	When using a long-type detector holder	Narrow range	0.7μm/50mm
		Wide range	3μm/800mm
	When using a rotary-type detector holder (up/down direction)	Narrow range	0.7μm/50mm
		Wide range	3μm/800mm
Base unit	Base size (width×depth)		600×1500mm
	Base material		Steel
	Maximum table loading		300kg



An inspection certificate is supplied as standard. Refer to page X for details.

- The X1-, Y and Z2 axes have a maximum drive speed of 200mm/s. This permits high-speed positioning that can potentially result in a large increase in the throughput of multiple-profile / multiple-workpiece measurement tasks.
- Capable of inclined plane measurement through 2 axis simultaneous control in X and Y.
  - \* Optional Y-axis table is required when using the **SV-3000CNC**.
- For models equipped with the  $\alpha$  axis, it is possible to perform continuous measurement over horizontal and inclined surfaces by power-tilting the drive unit.
- For models with the Y-axis table, it is possible to expand the measuring range for multiple workpieces, etc., through positioning in Y.
- Measuring force for the Z1-axis detector is selectable from 4mN or 0.75mN.
- All connecting cables are incorporated into the measuring instrument to eliminate the inconvenience for measurement.
- Since the Z1-axis detector incorporates an anti-collision safety device, the machine will automatically stop if the detector touches a workpiece or jig.
- Surftest Extreme **SV-3000CNC** (CNC Surface Roughness Tester with the movable Y-axis column unit) that handles measurement of large/heavy workpieces such as engine blocks, crankshafts, etc., is also available.
- Optional external control function (Ext I/O) through bidirectional communication (RS-232C) with the PLC (programmable logic controller) is available.



Refer to the CNC Form Measuring Instrument Series (Catalog No.E4284) for more details.



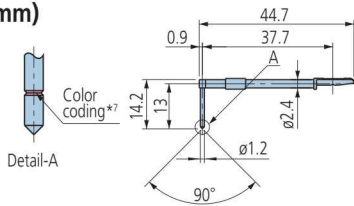
# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

## Styli

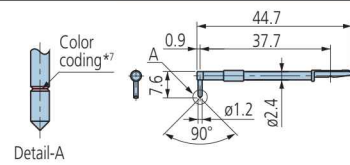
### For deep groove (10mm)

Parts No.:  
**12AAC735** (2μm)\*5  
**12AAB409** (5μm)  
**12AAB421** (10μm)  
 ( ) : Tip radius



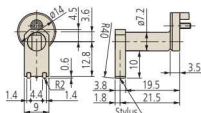
### For knife-edge\*8

Parts No.:  
**12AAC738** (2μm)\*5  
**12AAB411** (5μm)  
**12AAB423** (10μm)  
 ( ) : Tip radius



### Nosepiece\*9

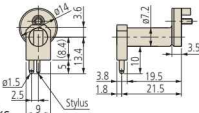
For deep groove 10  
 Parts No.: **12AAB349**



Remarks  
 Depth: 10 or less, Width: 9.5 or more

### For R-surface

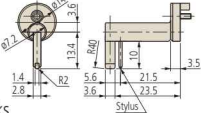
Parts No.: **12AAB351**



Remarks  
 Convex: R1.5 or more  
 Concave: R3 or more

### For narrow groove

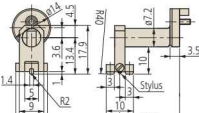
Parts No.: **12AAB350**



Remarks  
 Depth: 10 or less, Width: 3 or more

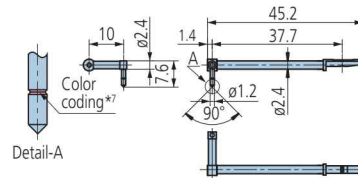
### For seesaw type

Parts No.: **12AAB352**



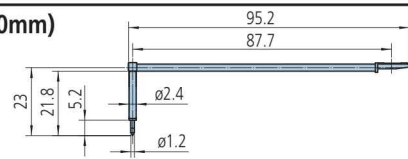
### For eccentric arm\*6

Parts No.:  
**12AAC739** (2μm)\*5  
**12AAB412** (5μm)  
**12AAB424** (10μm)  
 ( ) : Tip radius



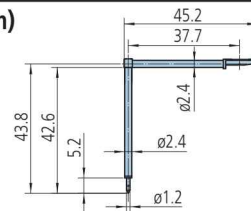
### For deep groove\*6 (20mm)

Parts No.:  
**12AAE893** (2μm)\*5  
**12AAE909** (5μm)  
 ( ) : Tip radius



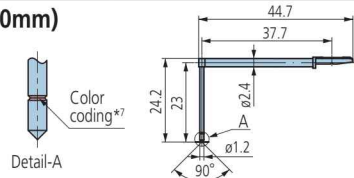
### For deep groove\*6 (40mm)

Parts No.:  
**12AAE895** (2μm)\*5  
**12AAE911** (5μm)  
 ( ) : Tip radius



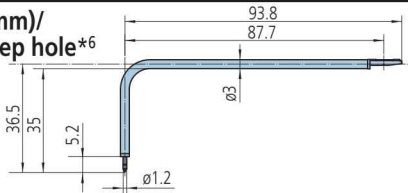
### For deep groove\*6 (20mm)

Parts No.:  
**12AAC736** (2μm)\*5  
**12AAB408** (5μm)  
**12AAB420** (10μm)  
 ( ) : Tip radius



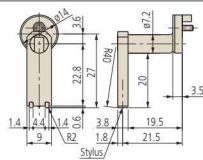
### For deep groove (30mm)/ Double-length for deep hole\*6

Parts No.:  
**12AAE894** (2μm)\*5  
**12AAE910** (5μm)  
 ( ) : Tip radius



### Nosepiece\*9

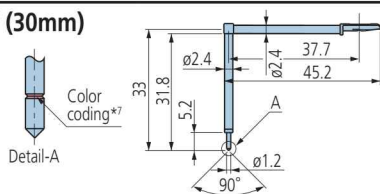
For deep groove 20  
 Parts No.: **12AAB348**



Remarks  
 Groove depth: 20 or less  
 Groove width: 9.5 or more

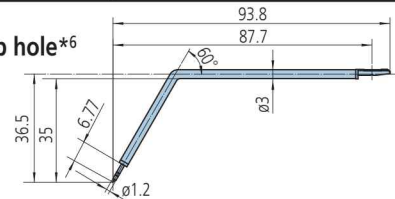
### For deep groove\*6 (30mm)

Parts No.:  
**12AAC737** (2μm)\*5  
**12AAB407** (5μm)  
**12AAB419** (10μm)  
 ( ) : Tip radius



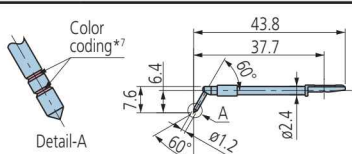
### For gear tooth/ Double-length for deep hole\*6

Parts No.:  
**12AAE896** (2μm)\*5  
**12AAE912** (5μm)\*5  
 ( ) : Tip radius



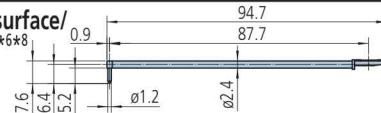
### For gear tooth

Parts No.:  
**12AAB339** (2μm)\*5  
**12AAB410** (5μm)\*5  
**12AAB422** (10μm)\*5  
 ( ) : Tip radius



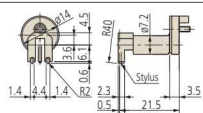
### For rolling circle waviness surface/ Double-length for deep hole\*6\*8

Parts No.:  
**12AAE886** (250μm)



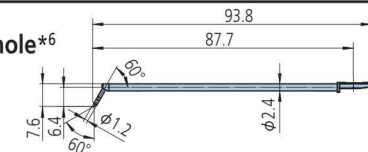
### Nosepiece\*9

for corner  
 Parts No.: **12AAB353**



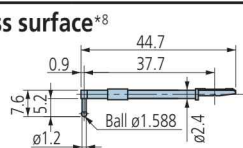
### For corner hole/ Double-length for deep hole\*6

Parts No.:  
**12AAM601** (2μm)\*5  
**12AAM603** (5μm)\*5  
 ( ) : Tip radius



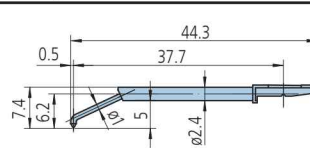
### For rolling circle waviness surface\*8

Parts No.:  
**12AAB338** (ø1.588)



### For bottom surface

Parts No.:  
**12AAE899** (2μm)\*5  
**12AAE915** (5μm)  
 ( ) : Tip radius



\*5: Tip angle 60°

\*6: For downward-facing measurement only  
 The measurement force of the detector is out of warranty

*7: Tip radius	2μm	5μm	10μm
Color coding	Black	No color	Yellow

\*8: For calibration, a step gage (No.178-611, option) is also required.

\*9: The skid measurement (attaching a nosepiece to the detector) is available only with the SJ-410 and SJ-500 series.



### 3-axes adjusting table

- For the high-accuracy surface roughness measurement of a cylindrical workpiece, it is necessary to set the workpiece axis parallel with the measurement axis and to adjust the leveling.

Code No.	<b>178-047</b>
Swivel adjusting angle	±2°
Inclination adjustment	±1.5°
Travel range of the Y axis	±12.5mm
Maximum loading	15kg
Measurement capacity	∅1 to ∅160mm (using two V-grooves)
External dimensions (W×D×H)	287×235×150mm
Mass	9kg

### SV-3200 series SV-C3200/4500 series

#### Auto-leveling table

- This table enables automatic alignment of the surface to be measured so that automatic measurement can be implemented.



Inclination adjustment	±2°
Maximum loading	7kg
Dimensions of table (W×D)	130×100mm
External dimensions (W×D×H)	140×105×57mm
Mass	3.5kg

#### 3D/Y-axis table No.178-096\*

- Combined with highly sophisticated analysis software (MCubeMap/FORMTRACEPAK-PRO), the 3D/Y-axis table offers the ability to perform advanced 3D surface roughness analysis.

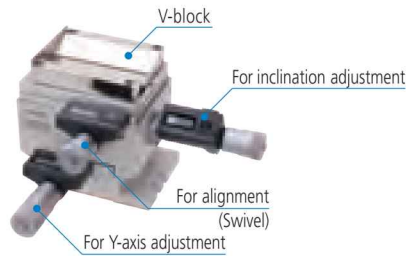


Travel range	100mm
Resolution	0.05 μm
Minimum positioning pitch	1 μm
Straightness accuracy	0.3 μm/100mm
Maximum drive speed	20mm/s
Maximum loading	15kg
Mass	31kg

\*The Y-axis table with this Order No. cannot be used with CNC form measuring instruments. Please order the Y-axis table for those instruments separately

## Optional Accessories for Surftest

- Using the three-axis adjustment table facilitates the adjustment of the alignment and leveling necessary just by following the guidance supplied by the machine. No experience or intuition is required.
- Available for the use with **SJ-410, SJ-500, SV-2100/3200, SV-C3200/4500.**



### Leveling table (For D.A.T.)

- Available for use with **SJ-410, SJ-500, SV-2100/3200, SV-C3200/4500.**

Inclination range	: ±1.5°
Tabletop size (W×D)	: 130×100mm
Maximum loading	: 15kg
Code No.	: <b>178-048</b>



### Measuring block for cylindrical workpieces (dedicated to SJ-410)

- Block to be directly mounted on a cylindrical workpiece for measurement.

Applicable diameter	: ∅15 to 60mm
Order No.	: <b>12AAB358</b>

#### Y-axis table No.178-097\*

- Enables efficient, automatic measurement of multiple aligned workpieces and multiple points on a single table surface.



Travel range	200mm
Resolution	0.05 μm
Positioning accuracy	±3 μm
Drive speed	3.5kg
Maximum loading	50kg
Mass	28kg

\*The Y-axis table with this Order No. cannot be used with CNC form measuring instruments. Please order the Y-axis table for those instruments separately

#### ∅1-axis table No.12AAD975

- This rotary table can index a workpiece to practically any required angle for making radial cross-sectional measurements on cylindrical-form workpieces.



Travel range	360°
Resolution	0.004°
Rotational speed	10%/sec (max.)
Table diameter	∅150mm
Maximum loading	12kg

#### ∅2-axis table No.178-078

- This rotary table can index a workpiece to practically any required angle for making axial cross-sectional measurements on cylindrical-form workpieces.



Travel range	360°
Resolution	0.0072°
Rotational speed	18%/sec (max.)
Table diameter	∅118mm
Maximum loading (loading moment)	4kg (343N·cm or less)

#### DAT unit No.178-040

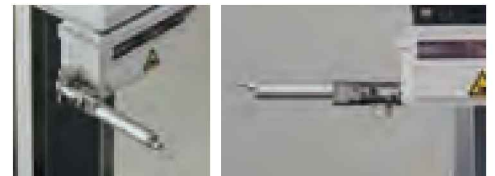
- The DAT unit tilts the X-axis unit, enabling easy alignment of the drive axis with the surface to be measured.



This DAT unit is for SV-3200 series.  
It cannot be used with SV-C3200/4500.

#### Detector holders

- Holders that can change the position by hand.



Holders	Measurement posture	Remarks
S-3000	—	Standard accessory
S-3000C	Crank	Optional accessory
S-3000CR	Crank/upward	Optional accessory
S-3000MR	Upward	Optional accessory, long type

# Surftest

Performs brilliantly in many situations such as in the quality control room, on the factory floor and on the production line.

## Optional Accessories for Surftest

### Manual column stand

(Optional accessory dedicated to SJ-500)

- Best suited for the use as a stationary type stand in an inspection room.

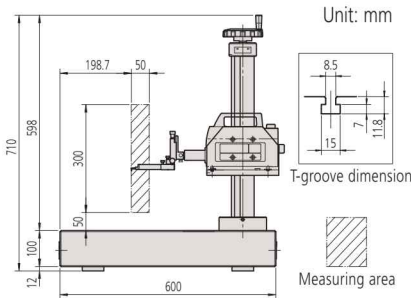
Up/down movement range: 300mm  
Dimensions (W×D×H): 600×450×710mm

Mass: 110kg  
Code No.: **No.178-085**

\* Excluding the measuring section



#### External Dimensions of SJ-500 + manual column stand



Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

### Simplified stand

(Optional accessory dedicated to SJ-500)

- Simplified stand that is easy to carry.

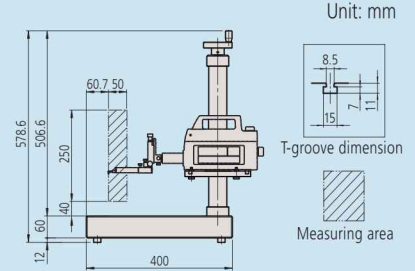
Up/down movement range: 250mm  
Dimensions (W×D×H): 400×250×578.6mm

Mass: 20kg  
Code No.: **178-089**

\* Excluding the measuring section



#### External Dimensions of SJ-500 + Simplified stand



Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

### Simplified stand

(Optional accessory dedicated to SJ-410)

- Setting is available according to the height of workpieces.

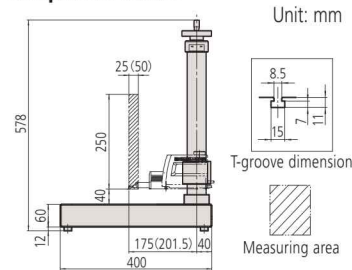
Range of vertical movement: 250mm  
Dimensions (W×D×H): 400×250×578mm

Mass: 20kg  
Code No.: **178-039**

\* Excluding the measuring section



#### External Dimensions of SJ-410 + Simplified stand



\* The value in parentheses indicates the dimensions with SJ-412 installed. AD

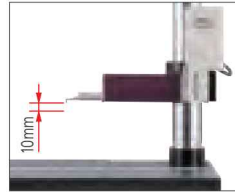
Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

### Optional accessories for the simplified stand dedicated to SJ-410

- Three types of optional accessories to be mounted on the simplified stand (**No.178-039**) are newly available. In addition, these three types can be flexibly combined.

#### Auto-set unit\*

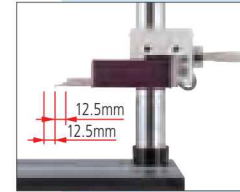
No.178-010



Enables the auto-set function that automatically performs the positioning of vertical direction (up/down, Z axis).

#### X-axis adjustment unit\*

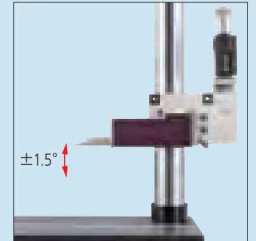
No.178-020



Enables fine adjustment of the right/left (X axis) direction.

#### Inclination adjustment unit\*

No.178-030



Allows the inclination adjustment. Supports the DAT function that allows leveling of a workpiece surface.

\*Not available for previous models of measuring unit (**SJ-401/402**).

- The optional accessories introduced here can be commonly used with almost any Surftest model. For some models, they are provided as standard.

## Optional Accessories for Surftest

### Cross-travel table

- Equipped with micrometer heads on the X and Y axes. Best suited for the alignment of axes since the inclination adjustment center and the rotation center are the same.



Code No.	Digimatic: <b>178-042-1</b>	Digimatic: <b>178-049</b>	Venier: <b>178-043-1</b>
Dimensions of table (W×D)	130×100mm		
Maximum table loading	15kg		
Inclination range	±1.5°	—	±1.5°
Rotation range	±3°	—	±3°
X- and Y-axes range	±12.5mm		
Resolution/Graduation	0.001mm		0.01mm
External dimensions (W×D×H)	262×233×83mm	262×233×55mm	220×189×83mm
Mass	6.3kg	5kg	6kg

### Roughness specimen for calibration

Indication: Ra = approx. 3µm  
Material: Chrome-plated nickel.

**No.178-601**

### Roughness specimen

For checking the stylus tip condition.  
Indication: Ra = approx. 3µm, 0.4µm (nominal)

**No.178-604**

### Step gage

Step nominal value: 2µm, 10µm

**No.178-611**

\*Not available for the use with Surftest **SJ-310/210**.



An inspection certificate is supplied as standard. Refer to page X for details.

### Monitor arm\*

**No.12AAK120**

\*Used with the vibration isolator (**No.12AAK110**, **No.178-119**)

### Side table\*

**No.12AAL019**

\*Used with the vibration isolator (**No.12AAK110**, **No.178-119**)

### Stand for vibration isolator

- Stand dedicated to the installation of the vibration isolator (**No.178-023**, **No.178-025**).

External dimensions (W×D×H): 640×470×660mm

Mass: 25kg

**No.178-024**



### Vibration isolator

(actively pumped air system)

**No.178-023** (for standard base)

**No.178-093** (for simplified stand)\*

\*For Simplified stand (No.178-039) for SJ-410 and Simplified stand (No.178-089) for SJ-500.



### Vibration isolator

(sealed air system)

**No.178-025** (for standard base)

**No.178-115** (for wide base)\*



### Vibration isolator

(stand integrated type, air system)

**No.12AAK110** (for standard base)

**No.178-119** (for wide base)

### Measurement Workbench

**No.12AAQ587** (for standard base)

**No.12AAQ583** (for wide base)

### Precision vise

**No.178-019**

- Can be mounted on the cross-travel table.



Fixing method	Two-slide jaw
Jaw opening	36mm
Jaw width	44mm
Jaw depth	16mm
Total height	38mm

### Leveling table



Code No.	<b>178-016</b>
Dimensions of table (W×D)	130×100mm
Inclination range	±1.5°
Maximum table loading	15kg
External dimensions (W×D×H)	130×100×40mm
Mass	3kg

### V-block with clamp

Can be mounted on the cross-travel table.

**No.998291**



Workpiece diameter (using both V-grooves)	ø1 to 7mm
	ø6 to 160mm

### V-block stage (A set of two)

Maximum supportable diameter: ø25mm

Mass: 700g

**No.181-902-10**



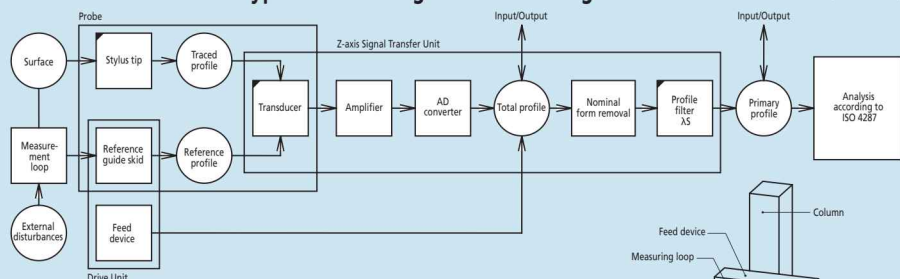
# Quick Guide to Precision Measuring Instruments



## Surftest (Surface Roughness Testers)

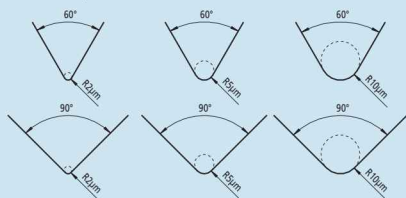
- ISO 1302:2002 Notation method of surface texture
- ISO 4287:1997 Geometrical Product Specifications (GPS) – Surface Texture: Profile method– Terms, definitions, and surface texture parameters
- ISO 4288:1996 Geometrical Product Specifications (GPS) – Surface Texture: Profile method– Rules and procedures for the assessment of surface texture
- ISO 3274:1996 Geometrical Product Specifications (GPS) – Surface Texture: Profile method– Nominal characteristics of contact (stylus) instruments

### Elements of Contact Type Surface Roughness Measuring Instruments



### Stylus Shape

A typical shape for a stylus end is conical with a spherical tip.  
 Tip radius:  $r_{tip} = 2 \mu\text{m}, 5 \mu\text{m}$  or  $10 \mu\text{m}$   
 Cone angle:  $60^\circ, 90^\circ$   
 In typical surface roughness testers, the taper angle of the stylus end is  $60^\circ$  unless otherwise specified.



### Static Measuring Force (ISO 80651)

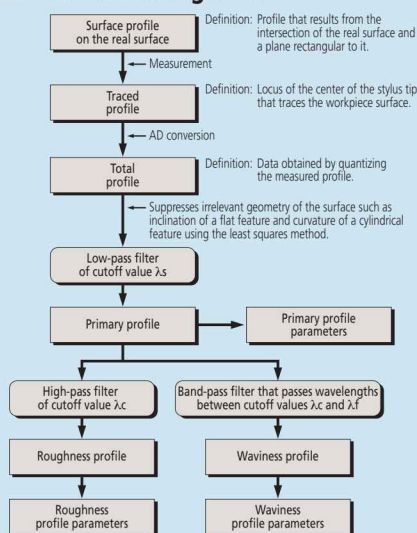
Nominal radius of curvature of stylus tip: $\mu\text{m}$	Static measuring force at the mean position of stylus: mN	Tolerance on static measuring force variations: mN/ $\mu\text{m}$
2	0.75	0.035
5	0.75 (4.0) Note 1	0.2
10		

Note 1: The maximum value of static measuring force at the average position of a stylus is to be 4.0mN for a special structured probe including a replaceable stylus.

### Metrological Characterization of Phase Correct Filters

A profile filter is a phase-correct filter without phase delay (cause of profile distortion dependent on wavelength). The weight function of a phase-correct filter shows a normal (Gaussian) distribution in which the amplitude transmission is 50% at the cutoff wavelength.

### Data Processing Flow



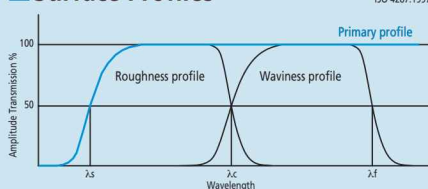
### Relationship between Cutoff Value and Stylus Tip Radius

The following table lists the relationship between the roughness profile cutoff value  $\lambda_c$ , stylus tip radius  $r_{tip}$ , and cutoff ratio  $\lambda_c/r_{tip}$ .

$\lambda_c$ mm	$\lambda_c$ $\mu\text{m}$	$\lambda_c/r_{tip}$	Maximum $r_{tip}$ $\mu\text{m}$	Maximum sampling length $\mu\text{m}$
0.08	2.5	30	2	0.5
0.25	2.5	100	2	0.5
0.8	2.5	300	2 Note 1	0.5
2.5	8	300	5 Note 2	1.5
8	25	300	10 Note 2	5

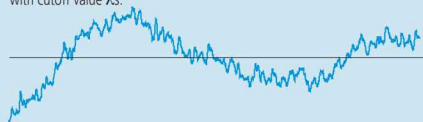
Note 1: For a surface with  $R_a > 0.5 \mu\text{m}$  or  $R_z > 3 \mu\text{m}$ , a significant error will not usually occur in a measurement even if  $r_{tip} = 5 \mu\text{m}$ .  
 Note 2: If a cutoff value  $\lambda_c$  is  $2.5 \mu\text{m}$  or  $5 \mu\text{m}$ , attenuation of the signal due to the mechanical filtering effect of a stylus with the recommended tip radius appears outside the roughness profile pass band. Therefore, a small error in stylus tip radius or shape does not affect parameter values calculated from measurements. If a specific cutoff ratio is required, the ratio must be defined.

### Surface Profiles



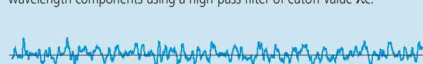
### Primary Profile

Profile obtained from the measured profile by applying a low-pass filter with cutoff value  $\lambda_s$ .



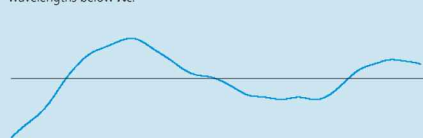
### Roughness Profile

Profile obtained from the primary profile by suppressing the longer wavelength components using a high-pass filter of cutoff value  $\lambda_c$ .



### Waviness Profile

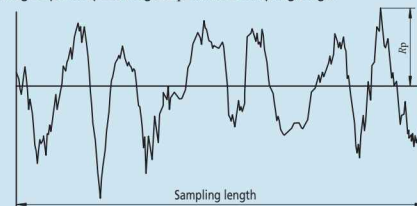
Profile obtained by applying a band-pass filter to the primary profile to remove the longer wavelengths above  $\lambda_f$  and the shorter wavelengths below  $\lambda_c$ .



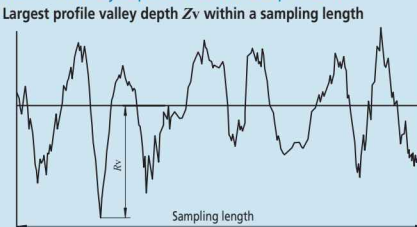
### Definition of Parameters

#### Amplitude Parameters (peak and valley)

Maximum peak height of the primary profile  $P_p$   
 Maximum peak height of the roughness profile  $R_p$   
 Maximum peak height of the waviness profile  $W_p$   
 Largest profile peak height  $Z_p$  within a sampling length

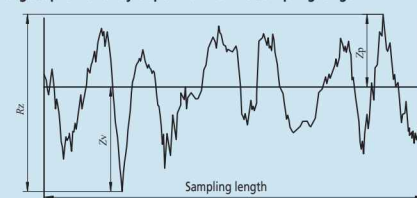


Maximum valley depth of the primary profile  $P_v$   
 Maximum valley depth of the roughness profile  $R_v$   
 Maximum valley depth of the waviness profile  $W_v$   
 Largest profile valley depth  $Z_v$  within a sampling length



Maximum height of the primary profile  $P_z$   
 Maximum height of the roughness profile  $R_z$   
 Maximum height of the waviness profile  $W_z$

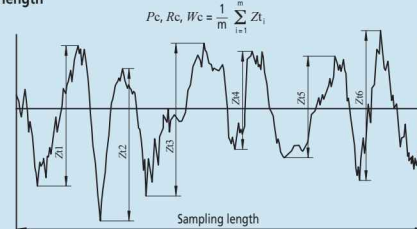
Sum of height of the largest profile peak height  $Z_p$  and the largest profile valley depth  $Z_v$  within a sampling length



In Old JIS and ISO 4287-1:1984,  $R_z$  was used to indicate the "ten point height of irregularities". Care must be taken because differences between results obtained according to the existing and old standards are not always negligibly small. (Be sure to check whether the drawing instructions conform to existing or old standards.)

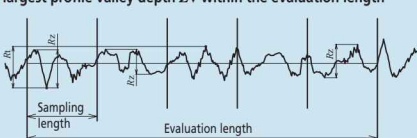
Mean height of the primary profile elements  $P_c$   
 Mean height of the roughness profile elements  $R_c$   
 Mean height of the waviness profile elements  $W_c$

Mean value of the profile element heights  $Z_t$  within a sampling length



Total height of the primary profile  $P_t$   
 Total height of the roughness profile  $R_t$   
 Total height of the waviness profile  $W_t$

Sum of the height of the largest profile peak height  $Z_p$  and the largest profile valley depth  $Z_v$  within the evaluation length



### Amplitude Parameters (average of ordinates)

Arithmetical mean deviation of the primary profile  $P_a$   
 Arithmetical mean deviation of the roughness profile  $R_a$   
 Arithmetical mean deviation of the waviness profile  $W_a$   
 Arithmetical mean of the absolute ordinate values  $Z(x)$  within a sampling length

$$P_a, R_a, W_a = \frac{1}{l} \int_0^l |Z(x)| dx$$

with  $l$  as  $l_p, l_r, \text{ or } l_w$  according to the case.

Root mean square deviation of the primary profile  $P_q$   
 Root mean square deviation of the roughness profile  $R_q$   
 Root mean square deviation of the waviness profile  $W_q$   
 Root mean square value of the ordinate values  $Z(x)$  within a sampling length

$$P_q, R_q, W_q = \sqrt{\frac{1}{l} \int_0^l Z^2(x) dx}$$

with  $l$  as  $l_p, l_r, \text{ or } l_w$  according to the case.

Skewness of the primary profile  $P_{sk}$   
 Skewness of the roughness profile  $R_{sk}$   
 Skewness of the waviness profile  $W_{sk}$

Quotient of the mean cube value of the ordinate values  $Z(x)$  and the cube of  $P_q, R_q, \text{ or } W_q$  respectively, within a sampling length

$$R_{sk} = \frac{1}{R_q^3} \left[ \frac{1}{l} \int_0^l Z^3(x) dx \right]$$

The above equation defines  $R_{sk}$ .  $P_{sk}$  and  $W_{sk}$  are defined in a similar manner.  $P_{sk}, R_{sk}, \text{ and } W_{sk}$  are measures of the asymmetry of the probability density function of the ordinate values.

Kurtosis of the primary profile  $P_{ku}$   
 Kurtosis of the roughness profile  $R_{ku}$   
 Kurtosis of the waviness profile  $W_{ku}$

Quotient of the mean quartic value of the ordinate values  $Z(x)$  and the fourth power of  $P_q, R_q, \text{ or } W_q$  respectively, within a sampling length

$$R_{ku} = \frac{1}{R_q^4} \left[ \frac{1}{l} \int_0^l Z^4(x) dx \right]$$

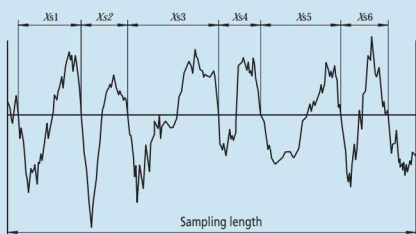
The above equation defines  $R_{ku}$ .  $P_{ku}$  and  $W_{ku}$  are defined in a similar manner.  $P_{ku}, R_{ku}, \text{ and } W_{ku}$  are measures of the sharpness of the probability density function of the ordinate values.

### Spacing Parameters

Mean width of the primary profile elements  $P_{Sm}$   
 Mean width of the roughness profile elements  $R_{Sm}$   
 Mean width of the waviness profile elements  $W_{Sm}$

Mean value of the profile element widths  $X_s$  within a sampling length

$$P_{Sm}, R_{Sm}, W_{Sm} = \frac{1}{m} \sum_{i=1}^m X_{si}$$



### Hybrid Parameters

Root mean square slope of the primary profile  $P_{Zq}$   
 Root mean square slope of the roughness profile  $R_{Zq}$   
 Root mean square slope of the waviness profile  $W_{Zq}$

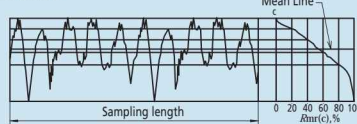
Root mean square value of the ordinate slopes  $dZ/dX$  within a sampling length



### Curves, Probability Density Function, and Related Parameters

Material ratio curve of the profile (Abbott-Firestone curve)

Curve representing the material ratio of the profile as a function of section level  $c$



Material ratio of the primary profile  $P_{mr}(c)$   
 Material ratio of the roughness profile  $R_{mr}(c)$   
 Material ratio of the waviness profile  $W_{mr}(c)$

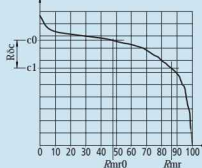
Ratio of the material length of the profile elements  $M(c)$  at a given level  $c$  to the evaluation length

$$P_{mr}(c), R_{mr}(c), W_{mr}(c) = \frac{M(c)}{ln}$$

Section height difference of the primary profile  $P_{\delta c}$   
 Section height difference of the roughness profile  $R_{\delta c}$   
 Section height difference of the waviness profile  $W_{\delta c}$

Vertical distance between two section levels of a given material ratio

$$R_{\delta c} = c(R_{mr1}) - c(R_{mr2}), R_{mr1} < R_{mr2}$$



Relative material ratio of the primary profile  $P_{mr}$   
 Relative material ratio of the roughness profile  $R_{mr}$   
 Relative material ratio of the waviness profile  $W_{mr}$

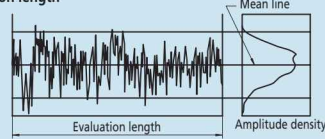
Material ratio determined at a profile section level  $R_{\delta c}$  (or  $P_{\delta c}$  or  $W_{\delta c}$ ), related to the reference section level  $c_0$

$$P_{mr}, R_{mr}, W_{mr} = P_{mr}(c_1), R_{mr}(c_1), W_{mr}(c_1)$$

where  $c_1 = c_0 - R_{\delta c} (R_{\delta c}, W_{\delta c})$   
 $c_0 = c(P_{mr0}, R_{mr0}, W_{mr0})$

Probability density function (profile height amplitude distribution curve)

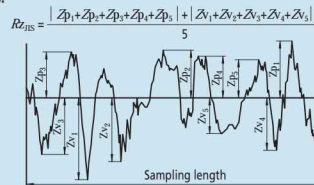
Sample probability density function of the ordinate  $Z(x)$  within the evaluation length



### JIS Specific Parameters

Ten-point height of irregularities,  $R_{Z10}$

Sum of the absolute mean height of the five highest profile peaks and the absolute mean depth of the five deepest profile valleys, measured from the mean line within the sampling length of a roughness profile. This profile is obtained from the primary profile using a phase-correct band-pass filter with cutoff values of  $l_c$  and  $l_s$ .



Symbol	Used profile
$R_{Z10S2}$	Surface profile as measured
$R_{Z10S4}$	Roughness profile derived from the primary profile using a phase-correct high-pass filter

Arithmetic mean deviation of the profile  $R_{a_{75}}$

Arithmetic mean of the absolute values of the profile deviations from the mean line within the sampling length of the roughness profile (75%). This profile is obtained from a measurement profile using an analog high-pass filter with an attenuation factor of 12db/octave and a cutoff value of  $\lambda_c$ .

$$R_{a_{75}} = \frac{1}{ln} \int_0^{ln} |Z(x)| dx$$

## Roughness sampling length for non-periodic profiles

ISO 4288: 1996 (JIS B 0633: 2001)

Table 1: Sampling lengths for aperiodic profile roughness parameters ( $R_a, R_q, R_{sk}, R_{ku}, R_{Zq}$ ), material ratio curve, probability density function, and related parameters

$R_a$ $\mu m$	Sampling length $l_r$ mm	Evaluation length $l_n$ mm
(0.006) < $R_a$ ≤ 0.02	0.08	0.4
0.02 < $R_a$ ≤ 0.1	0.25	1.25
0.1 < $R_a$ ≤ 2	0.8	4
2 < $R_a$ ≤ 10	2.5	12.5
10 < $R_a$ ≤ 80	8	40

Table 2: Sampling lengths for aperiodic profile roughness parameters ( $R_z, R_v, R_p, R_c, R_t$ )

$R_z$ $R_z$ max. $\mu m$	Sampling length $l_r$ mm	Evaluation length $l_n$ mm
(0.025) < $R_z, R_z$ max. ≤ 0.1	0.08	0.4
0.1 < $R_z, R_z$ max. ≤ 0.5	0.25	1.25
0.5 < $R_z, R_z$ max. ≤ 10	0.8	4
10 < $R_z, R_z$ max. ≤ 50	2.5	12.5
50 < $R_z, R_z$ max. ≤ 200	8	40

1)  $R_z$  is used for measurement of  $R_z, R_v, R_p, R_c, \text{ and } R_t$ .  
 2)  $R_z$  max. only used for measurement of  $R_z$  max.,  $R_v$  max.,  $R_p$  max., and  $R_t$  max.

Table 3: Sampling lengths for measurement of periodic roughness profile roughness parameters and periodic or aperiodic profile parameter  $R_{Sm}$

$R_{Sm}$ mm	Sampling length $l_r$ mm	Evaluation length $l_n$ mm
0.013 < $R_{Sm}$ ≤ 0.04	0.08	0.4
0.04 < $R_{Sm}$ ≤ 0.13	0.25	1.25
0.13 < $R_{Sm}$ ≤ 0.4	0.8	4
0.4 < $R_{Sm}$ ≤ 1.3	2.5	12.5
1.3 < $R_{Sm}$ ≤ 4	8	40

### Procedure for determining a sampling length if it is not specified

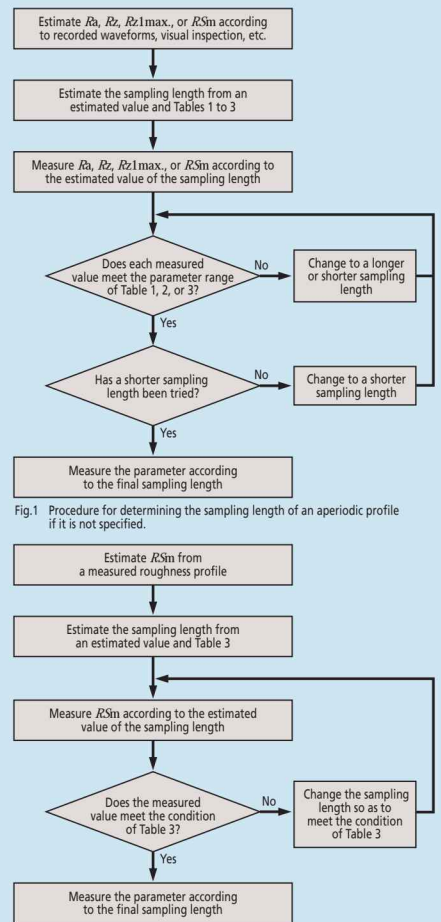


Fig.1 Procedure for determining the sampling length of an aperiodic profile if it is not specified.

# Contracer

High precision + high functionality + high operability = Contracer

## Contracer CV-2100 SERIES 218 — Contour Measuring Instruments



CV-2100M4



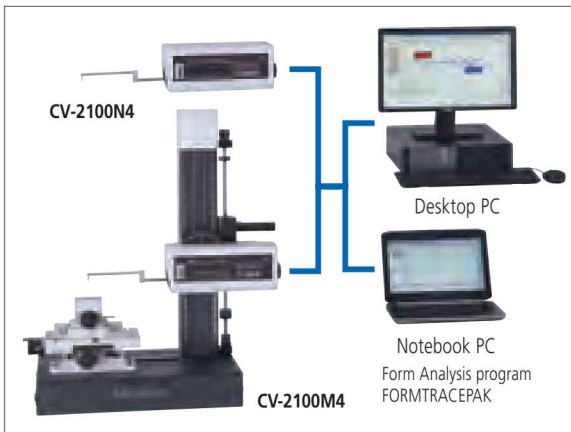
Centralized front control panel



Motor-driven jog shuttle



Quick-vertical-motion stand



### Optional accessories dedicated to the CV-2100N4

#### Column stand

- Allows the use of the CV-2100N4 in a fixed configuration.

Order No. **218-042**  
Inclination range:  $\pm 45^\circ$   
Up/down movement: 320mm  
Mass: 110kg

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.



An inspection certificate is supplied as standard. Refer to page X for details.

### Contour Measuring System enabling measurement that is fast, accurate, and easy.

- The operation flow is significantly shortened by arranging the controls for stylus position change, measurement start/stop and return on the front of the drive unit.
- Fine and coarse X-axis positioning can be performed easily by using the jog shuttle that covers the whole measuring range.
- The quick-vertical-motion stand allows operators to swiftly and easily move the drive unit to and from the measurement height without having to push or pull (only for CV-2100M4).
- The detector unit (Z1 axis) is equipped with a highly accurate arc scale. This scale directly tracks the arc locus of the stylus tip so that the most accurate compensation can be applied to the scale output, which leads to higher accuracy and resolution. Operators are free from bothersome operations such as measurement magnification switching and calibrating each magnification as required for analog instruments.

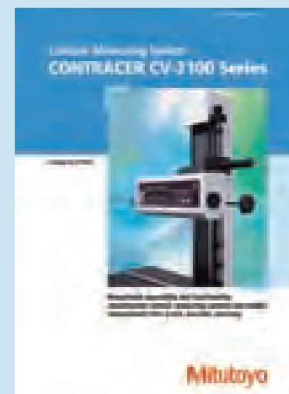


- A notebook or desktop PC can be used as the data processing unit for the CV-2100M4/N4.

## SPECIFICATIONS

Model No.		CV-2100M4	CV-2100N4
Measurement range	X-axis		100mm
	Z1-axis (detector unit)		50mm
Z2-axis (column) travel range		350mm	—
X-axis inclination angle		$\pm 45^\circ$	—
Resolution	X-axis		0.1 $\mu$ m
	Z1-axis		0.1 $\mu$ m
Drive method	X-axis		Motorized drive (0 - 20mm/s)
	Z1-axis (column)	Manual (quick-up-and-down motion, fine feed)	—
Measuring speed		0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0mm/s	
Linearity accuracy (X-axis horizontal orientation)		2.5 $\mu$ m/100mm	
Accuracy (20°C)	X-axis	$\pm(2.5+0.02L) \mu$ m L = Measurement Length (mm)	
	Z1-axis	$\pm(2.5+0.1H) \mu$ m H = Measurement height from horizontal position within $\pm 25$ mm	
Measurement direction		Forward / backward	
Measurement surface direction		Downward	
Measuring force		30 $\pm$ 10mN (3gf)	
Stylus traceable angle (Standard accessory stylus)		Ascent 77°, Descent 87° (Depends on the surface condition)	
External dimensions (WxDxH)		745x450x885mm	651x143x138.5mm
Mass		145.8 kg	5.8 kg

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.



Refer to the Contracer CV-2100 (Catalog No. E15020) for more details.

## Optional Accessories for Contracer For CV-2100 series

### List of Applicable Arms

Arm name	Arm No.	Order No.	Applicable stylus No.	H (mm)
Straight arm	AB-51	935111	SPH-51, 52, 53, 54, 55, 56, 57	6
	AB-61	935112	SPH-61, 62, 63, 64, 65, 66, 67	12
	AB-71*	935113	SPH-71, 72, 73, 74, 75, 76, 77, 79	20
	AB-81	935114	SPH-81, 82, 83, 84, 85, 86, 87	30
	AB-91	935115	SPH-91, 92, 93, 94, 95, 96, 97	42
Eccentric arm	AB-52	935116	SPH-51, 52, 53, 54, 55, 56, 57	6
	AB-62	935117	SPH-61, 62, 63, 64, 65, 66, 67	12
	AB-72	935118	SPH-71, 72, 73, 74, 75, 76, 77, 79	20
	AB-82	935119	SPH-81, 82, 83, 84, 85, 86, 87	30
Small hole arm	AB-11	935110	SP-11, 31	0.4
			SP-12, 32	1
			SP-13, 33	2.5

\* Standard Accessories

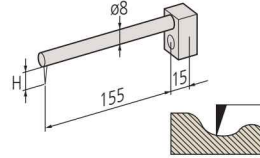
### List of Applicable Stylis

Stylus	Stylus No.	Order No.	Compatible Arm No.	H (mm)
One-sided cut stylus	SPH-51	354882	AB-51-52	6
	SPH-61	354883	AB-61-62	12
	SPH-71*	354884	AB-71-72	20
	SPH-81	354885	AB-81-82	30
	SPH-91	354886	AB-91-92	42
Intersecting cut stylus	SPH-52	354887	AB-51-52	6
	SPH-62	354888	AB-61-62	12
	SPH-72	354889	AB-71-72	20
	SPH-82	354890	AB-81-82	30
Cone stylus tip angle 20° (carbide-tipped)	SPH-92	354891	AB-91-92	42
	SPH-57	12AAE865	AB-51-52	6
	SPH-67	12AAE866	AB-61-62	12
	SPH-77	12AAE867	AB-71-72	20
Cone stylus tip angle 30° (Sapphire)	SPH-87	12AAE868	AB-81-82	30
	SPH-97	12AAE869	AB-91-92	42
	SPH-53	354892	AB-51-52	6
	SPH-63	354893	AB-61-62	12
Cone stylus tip angle 50° (Diamond)	SPH-73	354894	AB-71-72	20
	SPH-83	354895	AB-81-82	30
	SPH-93	354896	AB-91-92	42
Cone stylus tip angle 30° (carbide-tipped)	SPH-79	355129	AB-71-72	20
	SPH-56	12AAA566	AB-51-52	6
	SPH-66	12AAA567	AB-61-62	12
	SPH-76	12AAA568	AB-71-72	20
	SPH-86	12AAA569	AB-81-82	30
	SPH-96	12AAA570	AB-91-92	42
Knife-edge stylus	SPH-54	354897	AB-51-52	6
	SPH-64	354898	AB-61-62	12
	SPH-74	354899	AB-71-72	20
	SPH-84	354900	AB-81-82	30
Ball stylus	SPH-94	354901	AB-91-92	42
	SPH-55	354902	AB-51-52	6
	SPH-65	354903	AB-61-62	12
	SPH-75	354904	AB-71-72	20
	SPH-85	354905	AB-81-82	30
Small hole stylus (One-sided cut)	SPH-95	354906	AB-91-92	42
	SP-11	932693	AB-11	0.4
	SP-12	932694	AB-11	1
Small hole stylus (Cone)	SP-13	932695	AB-11	2.5
	SP-31	12AAE873	AB-11	0.4
	SP-32	12AAE874	AB-11	1
	SP-33	12AAE875	AB-11	2.5

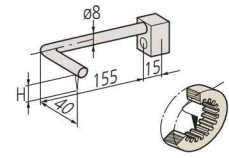
\*Standard Accessories

### Arms

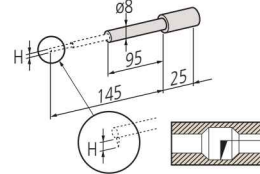
#### • Straight arm



#### • Eccentric arm

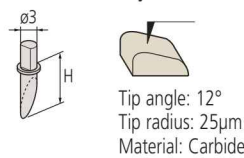


#### • Small hole arm

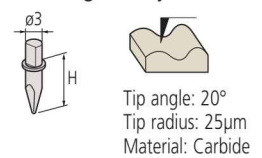


### Stylis

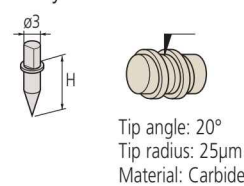
#### • One-sided cut stylus



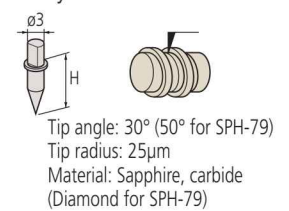
#### • Intersecting cut stylus



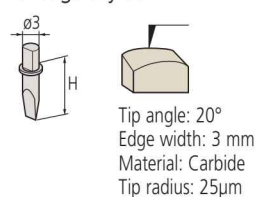
#### • Cone stylus



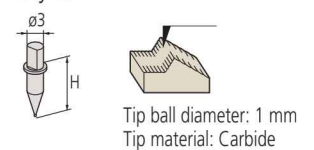
#### • Cone stylus



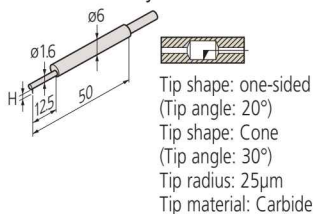
#### • Knife-edge stylus



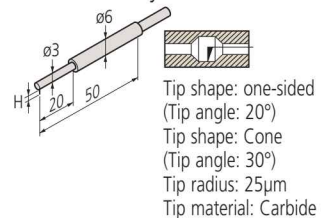
#### • Ball stylus



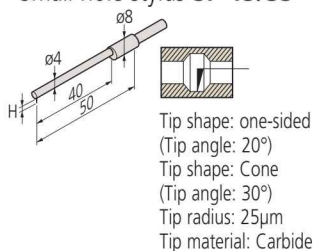
#### • Small hole stylus SP-11/31



#### • Small hole stylus SP-12/32



#### • Small hole stylus SP-13/33



# Contracer

High precision + high functionality + high operability = Contracer

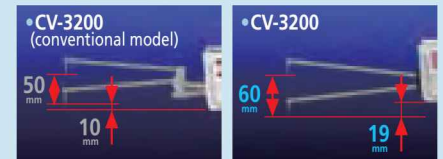
## Contracer CV-3200 SERIES 218 — Contour Measuring Instruments



An inspection certificate is supplied as standard. Refer to page X for details.

### Dramatically Improved High-Precision Contour Measuring Instruments.

- CV-3200 series are contour measuring instruments equipped with a high-precision arc scale and newly designed arm on the Z1 axis (detector). The high-precision arc scale can directly read the arc track of the stylus tip to achieve high accuracy and resolution. The new arm has extended the Z1-axis measuring range by 10 mm while reducing the chance of interference with workpieces compared to conventional models. The arm mount can be attached/detached with a single touch on the magnet joint for improved ease of operation.



Z1-axis measuring range has been extended by 10mm.

- The 700mm Z2-axis (column) range models are new to the lineup.



CV-3200S4

CV-3200L4 (with options)

## SPECIFICATIONS

Model No.		CV-3200S4	CV-3200H4	CV-3200W4	CV-3200L4	CV-3200S8	CV-3200H8	CV-3200W8	CV-3200L8
Measuring range	X axis	100mm				200mm			
	Z1 axis (detector)	60mm (±30mm from the horizontal)				200mm			
Z2-axis (column) moving range		300mm	500mm	700mm	300mm	500mm	700mm		
Z1 axis (Detector)	Scale type	Arc							
	Resolution	0.04µm							
	Stylus up/down	Arc motion							
	Measuring direction	Forward / backward							
	Face of stylus	Vertical direction (up/down, single measurement)							
	Measuring force	30mN (adjustment using weights)							
	Traceable angle	Ascent: 77°, descent: 83° (using the standard one-sided cut stylus*1 provided and depending on the surface roughness)							
Drive unit	Scale type	X axis	Separate type linear scale			ABS scale			
		Z2 axis (column)							
	Resolution	X axis	0.05 µm			1 µm			
		Z2 axis (column)							
	Drive speed	X axis	0 to 80mm/s or manual operation			0 to 30mm/s or manual operation			
		Z2 axis (column)							
Measuring speed	X axis	0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20mm/s							
Straightness*2	X axis	0.8µm/100mm				2µm/200mm			
Inclination range	X axis					±45°			
Accuracy (20°C)	X axis	±(0.8+0.01L)µm L = traverse length (mm) Wide range: 1.8µm/100mm Narrow range: 1.05µm/25mm				±(0.8+0.02L)µm L = traverse length (mm) Wide range: 4.8µm/200mm Narrow range: 1.3µm/25mm			
	Z1 axis (detector)	±(1.4+ 2H /100)µm H = probing height from the horizontal (mm)							
External dimensions (WxDxH)	Main unit*3	756x482x966mm	756x482x1166mm	1156x482x1176mm	1156x492x1436mm	766x482x966mm	766x482x1166mm	1166x482x1176mm	1166x492x1436mm
Mass	Main unit	140kg	150kg	220kg	270kg	140kg	150kg	220kg	270kg

\*1: SPH-71 (No.354884)

\*2: In X-axis horizontal position

\*3: Base material of the main unit is Gabbro.

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

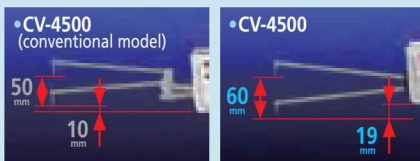




An inspection certificate is supplied as standard. Refer to page X for details.

## Dramatically Improved High-Precision Contour Measuring Instruments.

• CV-4500 series are contour measuring instruments equipped with a high-precision arc scale and newly designed arm on the Z1 axis (detector). The high-precision arc scale can directly read the arc track of the stylus tip to achieve high accuracy and resolution. The new arm has extended the Z1-axis measuring range by 10 mm while reducing the chance of interference with workpieces compared to conventional models. The arm mount can be attached/detached with a single touch on the magnet joint for improved ease of operation.

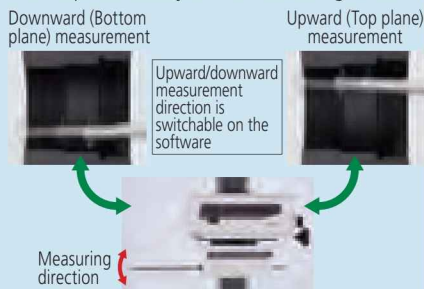


Z1-axis measuring range has been extended by 10mm.

• The following two features have been added exclusively for the **CV-4500** series.

(1) Continuous measurement in the vertical direction (up/down) is available in combination with a double-sided conical stylus. Up/down continuous measurement data facilitates the analysis of the effective diameter of screw threads, which has been difficult to measure in the past.

(2) The measuring force can be set in the **FORMTRACEPAK** software. Weight replacement and position adjustment are not required to adjust the measuring force.



• The 700mm Z2-axis (column) range models are new to the lineup.



Refer to the Contracer CV-3200/4500 series (Catalog No.E15010) for more details.

## Contracer CV-4500 SERIES 218 — Contour Measuring Instruments



CV-4500S4

### SPECIFICATIONS

Model No.	CV-4500S4	CV-4500H4	CV-4500W4	CV-4500L4	CV-4500S8	CV-4500H8	CV-4500W8	CV-4500L8	
Measuring range	X axis	100mm			200mm				
	Z1 axis (detector)	60mm (±30mm from the horizontal)							
Z2-axis (column) moving range	300mm	500mm	700mm	300mm	500mm	700mm			
Z1 axis (Detector)	Scale type	Arc							
	Resolution	0.02µm							
	Stylus up/down	Arc motion							
	Measuring direction	Forward / backward							
	Face of stylus	Vertical direction (up/down, available for continuous measurement)							
	Measuring force	10, 20, 30, 40, 50mN (switching on the software)							
Drive unit	Traceable angle	Ascent: 77°, descent: 83° (using the standard one-sided cut stylus*1 provided and depending on the surface roughness)							
	Scale type	X axis	Separate type linear scale						
		Z2 axis (column)	ABS scale						
	Resolution	X axis	0.05 µm						
Z2 axis (column)		1 µm							
Drive speed	X axis	0 to 80mm/s or manual operation							
	Z2 axis (column)	0 to 30mm/s or manual operation							
Measuring speed	X axis	0.02, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20mm/s							
	Straightness*2	X axis	0.8µm/100mm			2µm/200mm			
		Inclination range	X axis	±45°					
Accuracy (20°C)	X axis	±(0.8+0.01L)µm L = traverse length (mm) Wide range: 1.8µm/100mm Narrow range: 1.05µm/25mm			±(0.8+0.02L)µm L = traverse length (mm) Wide range: 4.8µm/200mm Narrow range: 1.3µm/25mm				
	Z1 axis (detector)	±(0.8+ 2H /100)µm H = probing height from the horizontal (mm)							
External dimensions (WxDxH)	Main unit*3	756x482x966mm	756x482x1166mm	1156x482x1176mm	1156x492x1436mm	766x482x966mm	766x482x1166mm	1166x482x1176mm	1156x492x1436mm
		Mass	140kg	150kg	220kg	270kg	140kg	150kg	220kg

\*1: SPH-71 (No.354884)

\*2: In X-axis horizontal position

\*3: Base material of the main unit is Gabbro.

Note: While the appearance of the natural stone measuring table varies according to the source, the high stability for which this material is known can always be relied upon.

# Contracer

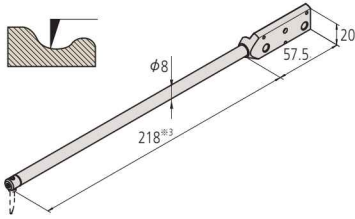
High precision + high functionality + high operability = Contracer

## Optional Accessories for Contracer

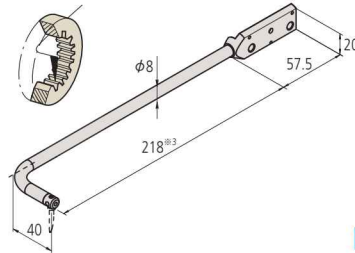
Arms for CV-3200/4500 series, SV-C3200/4500 series, and SV-C4500 CNC series

### Arms

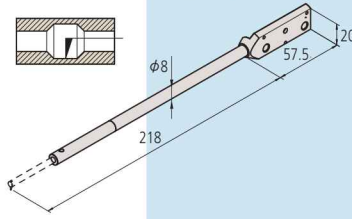
#### • Straight arm AB-31



#### • Eccentric arm AB-37



#### • Small hole arm AB-33

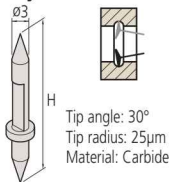


### List of Applicable Arms

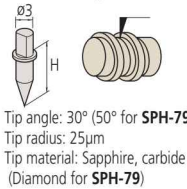
Stylus name	Model No.	Order No.	Applicable styli
Straight arm	AB-31	12AAM101*1	SPH-5*, 6*, 7*, 8*, 9* SPHW*2-56, 66, 76
Eccentric arm	AB-37	12AAQ762	SPH-5*, 6*, 7*, 8*, 9* SPHW*2-56, 66, 76
Small hole arm	AB-33	12AAM103	SPH-41, 42, 43

### Stylus

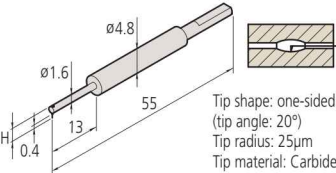
#### • Double-sided conical stylus



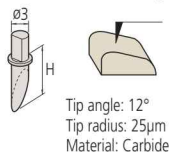
#### • Cone stylus



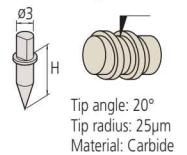
#### • Small hole stylus SPH-41



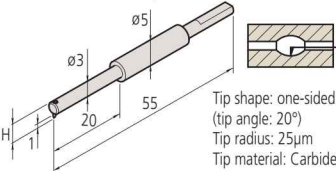
#### • One-sided cut stylus



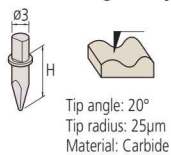
#### • Cone stylus



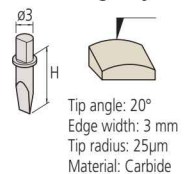
#### • Small hole stylus SPH-42



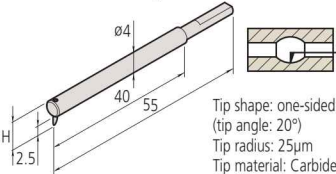
#### • Intersecting cut stylus



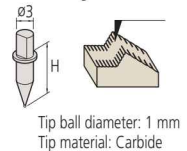
#### • Knife-edge stylus



#### • Small hole stylus SPH-43



#### • Ball stylus



### List of Applicable Styli

Stylus name	Model No.	Order No.	Compatible arm No.		H(mm)
			CV-3200/4500 SV-C3200/4500 SV-C4500CNC		
Double-sided conical stylus*2	SPHW-56	12AAM095*4	AB-31, 37		20
	SPHW-66	12AAM096			32
	SPHW-76	12AAM097			48
One-sided cut stylus	SPH-51	354882			6
	SPH-61	354883			12
	SPH-71	354884*5			20
	SPH-81	354885			30
	SPH-91	354886			42
Intersecting cut stylus	SPH-52	354887			6
	SPH-62	354888			12
	SPH-72	354889			20
	SPH-82	354890			30
	SPH-92	354891			42
Cone stylus tip angle 30° (Sapphire)	SPH-53	354892			6
	SPH-63	354893			12
	SPH-73	354894			20
	SPH-83	354895			30
	SPH-93	354896			42
	SPH-56	12AAA566			6
	SPH-66	12AAA567			12
Cone stylus tip angle 30° (carbide-tipped)	SPH-76	12AAA568*6			20
	SPH-86	12AAA569			30
	SPH-96	12AAA570			42
	SPH-57	12AAE865			6
Cone stylus tip angle 20° (carbide-tipped)	SPH-67	12AAE866			12
	SPH-77	12AAE867			20
	SPH-87	12AAE868			30
	SPH-97	12AAE869			42
Cone stylus tip angle 50° (Diamond)	SPH-79	355129			20
Knife-edge stylus	SPH-54	354897			6
	SPH-64	354898			12
	SPH-74	354899			20
	SPH-84	354900	30		
	SPH-94	354901	42		
Ball stylus	SPH-55	354902	6		
	SPH-65	354903	12		
	SPH-75	354904	20		
	SPH-85	354905	30		
	SPH-95	354906	42		
Small hole stylus	SPH-41	12AAM104	AB-33	2	
	SPH-42	12AAM105		4	
	SPH-43	12AAM106		6.5	

\*1: Standard accessory for the CV-3200/4500, SV-C3200/4500, and SV-C4500CNC series.

\*2: Dedicated stylus for the CV-4500, SV-C4500, and SV-C4500CNC series.

\*3: When one-sided cut stylus SPH-71 (standard accessory) is used.

\*4: Standard accessory for the CV-4500, SV-C4500, and SV-C4500CNC series.

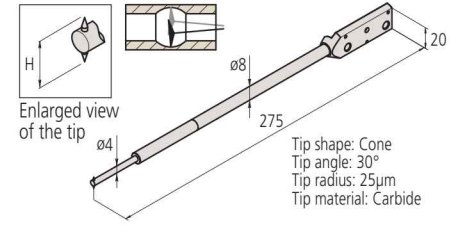
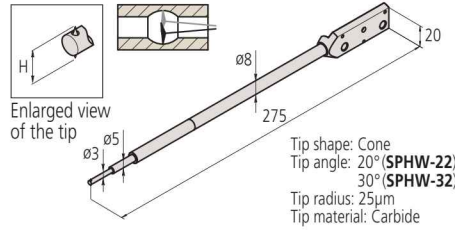
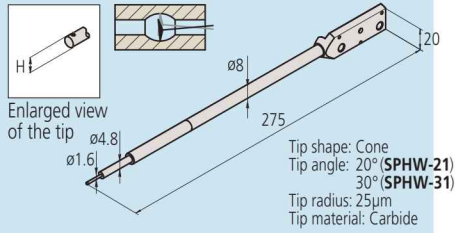
\*5: Standard accessory for the CV-3200/4500 and SV-C3200/4500 series.

\*6: Standard accessory for the SV-C4500CNC.

## Optional Accessories for Contracer

### Arm stylus (Arm/stylus integrated type) for CV-4500 series, SV-C4500 series, and SV-4500CNC series

- Double-sided small hole Arm stylus **SPHW-21/31**
- Double-sided small hole Arm stylus **SPHW-22/32**
- Double-sided small hole Arm stylus **SPHW-33**



Arm stylus name	Model No.	Order No.	H (mm)
Double-sided small hole arm stylus*1	SPHW-21	12AAT469	2.4
	SPHW-22	12AAT470	5
	SPHW-31	12AAM108	2.4
	SPHW-32	12AAM109	5
	SPHW-33	12AAM110	9

\*1: Arm stylus for the CV-4500, SV-C4500, and SV-C4500CNC series.

## Cross-travel table



No.218-001

Code No.	218-001
Dimensions of the table	280x180mm
Height of the table	100mm
Max. stage loading	30kg
Fixture mounting	T-groove and dovetail groove
Travel range	100mm (right/left) x50mm (forward/backward)
Resolution/Graduation	0.01mm thimble (with 1mm scales only in the right/left direction)
Swivel range	—

## Optional accessories that can be used with the cross-travel table.

### Workpiece fixture for rotary vise



Code No.	218-003
Fixing method	Two-slide jaw
Angle of rotation	360° (0°, 30°, 60°, 90° equipped with quick stop function)
Resolution	1°
Jaw opening	60mm
Jaw width	80mm
Jaw depth	35mm
Total height	110mm

### Swivel center support



Code No.	172-197
Inclination range	±10°
Resolution	1°
Max. length of workpiece	140mm
Max. diameter of workpiece	80mm (when the inclination angle is 0°) 65mm (when the inclination angle is 10°)

### Center support



Code No.	172-142
Max. length of the workpiece	120mm
Max. diameter of workpiece	120mm

### Rotary vise



Code No.	172-144
Rotation method	One-slide jaw
Angle of rotation	360°
Jaw opening	80mm (When the auxiliary block is inserted: 25mm)
Jaw width	40mm
Jaw depth	20mm
Total height	76mm

### V-block with clamp



Code No.	172-234	172-378
V-block length	60mm	41mm
Maximum height of workpiece	50mm	25mm

### Center support riser



Code No.	172-143
Total height	60mm

### Holder with clamp



Code No.	176-107
Maximum supportable height	35mm
T-groove	152mm
Mounting hole pitch	84mm, 120mm

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## Optional Accessories for Contracer

### For information on the three-axis adjustment table

(No.178-047)

For the high-accuracy surface roughness measurement of a cylindrical workpiece, it is necessary to set the workpiece line axis parallel with the measurement axis and to adjust the leveling. Using the three-axis adjustment table facilitates the adjustment of the alignment and leveling necessary just by following the guidance supplied by the machine. No experience or intuition is required.



### Cross-travel table

- Equipped with micrometer heads on the X and Y axes. Best suited for the alignment of axes since the inclination adjustment center and the rotation center are the same.



Code No.	Digimatic: 178-042-1	Digimatic: 178-049	venier: 178-043-1
Dimensions of table (WxD)	130x100mm		
Maximum table loading	15kg		
Inclination range	±1.5°	—	±1.5°
Rotation range	±3°	—	±3°
X- and Y-axes range	±12.5mm		
Resolution/Graduation	0.001mm		0.01mm
External dimensions (WxDxH)	262x233x83mm	262x233x55mm	220x189x83mm
Mass	6.3kg	5kg	6kg

### Leveling table



Code No.	178-016
Dimensions of table	130x100mm
Inclination range	±1.5°
Maximum table loading	15kg
External dimensions (WxDxH)	130x100x40mm
Mass	3kg

### Lubricant

- Apply in a thin layer regularly to the Z-column sliding surfaces of a motorized model. (Standard accessory for the motorized column type models)



Order No. 352637

### V-block with clamp

- Can be mounted on the cross-travel table.



No.998291

Workpiece diameter (using both V-grooves)	ø1 to 7mm
	ø6 to 160mm

### Centering chuck (knurled ring operated)

- Suitable for holding small parts with easy-to-operate knurled-ring clamping.



No.211-032

Holding capacity	OD with internal jaws ø1-ø36mm ID with internal jaws ø16-ø69mm OD with external jaws ø25-ø79mm
External dimensions (DxH)	ø118x41mm
Mass	1.2kg

### Precision vise

No.178-019

- Can be mounted on the cross-travel table.



Fixing method	Two-slide jaw
Jaw opening	36mm
Jaw width	44mm
Jaw depth	16mm
Total height	38mm

### V-block stage 2 (A set of two)

Maximum supportable diameter: 25mm  
Mass: 700g

No.181-902-10



### Micro chuck

- Used for clamping workpieces smaller than ø1 mm that the centering chuck cannot hold.



No.211-031

Holding capacity	OD ø0.2-ø1.5mm
External dimensions (DxH)	ø107x48.5mm
Mass	0.6kg