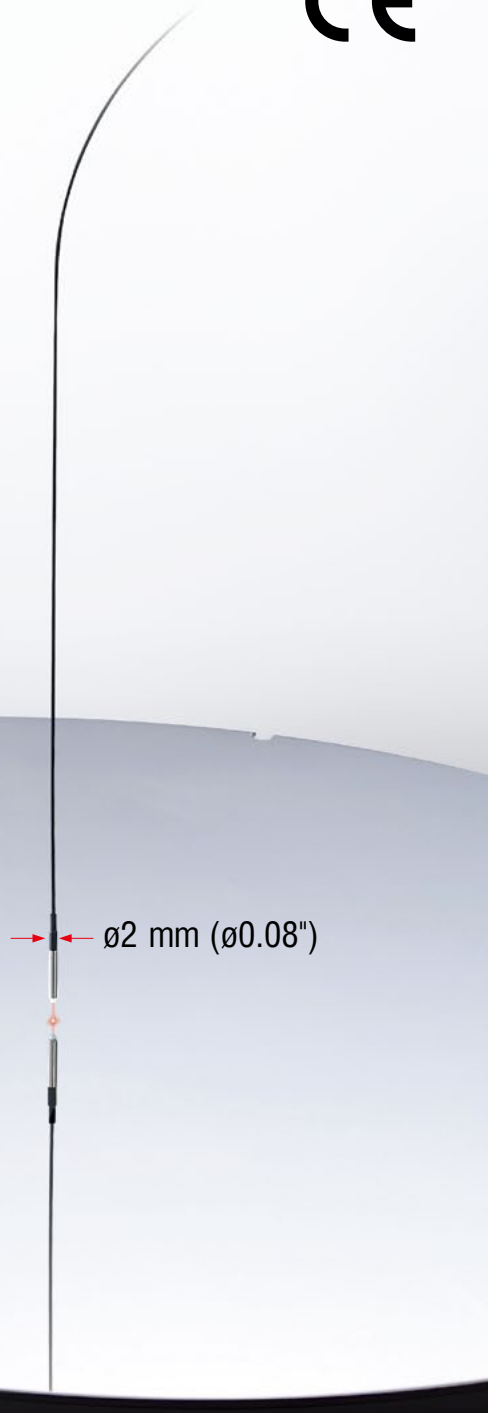
KEYENCE

Micro-Head Spectral-Interference Laser Displacement Meter

SI-F1000 Series

CE

World's first ø2 mm (ø0.08") micro-head

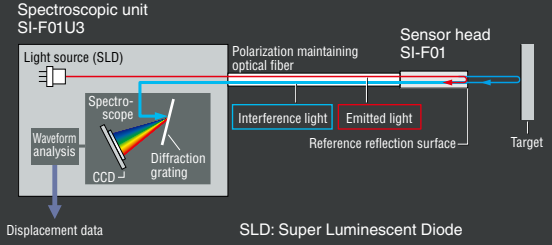


Ultra High-accuracy Reliable Measurement

A new type of laser displacement meter for even greater accuracy. KEYENCE technology defies expectations.

Introducing the world's first micro-head, with the highest measurement accuracy in its class and a level of performance that was previously thought impossible. Several advanced technologies combine for a new type of laser displacement meter.

Principle of measurement



SLD

Part of the broad wavelength light emitted from the SLD is reflected by the head's reference surface, while the part that passes the reference surface is mirror-reflected on the target and returns into the head.

Interference light

The two reflected light beams interfere with each other. The intensity of the interference light with a specific wavelength is determined according to the distance between the reference surface and the target. The relative maximum interference is reached when the determined distance is an integral multiple of the wavelength.

Spectroscopic assay

Splitting the interference light into different wavelengths with the spectroscope produces an optical intensity distribution for a specific wavelength. The distance to the target is obtained by carrying out waveform analysis on the distribution.

Spectroscopic unit

Controller
SI-F1003V

Thickness measurement type
SI-F80

Long-distance type
SI-F10

Micro-head type
SI-F01

Micro-head type spectral interference laser displacement meter

SI-F1000 Series

Ultra High-resolution

RESOLUTION:

0.25 µm (0.000010")

World's Smallest

MICRO-HEAD SIZE:

ø2 mm (ø0.08")

First in the Industry

MEASUREMENT PRINCIPLE:

Spectral interference method

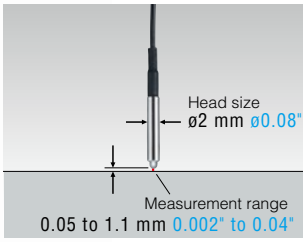
Head variations capable of expanding measurement applications

Micro-Head Type

HEAD SIZE	HEAT RESISTANCE	RESOLUTION
ø2 mm / ø0.08"	IP67 85°C/185°F	0.25µm/0.000010"

Best suited for measurements requiring ultra high-accuracy, restricted mounting space, and high temperatures.

SI-F01



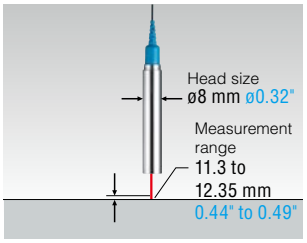
MAJOR TECHNICAL DATA	
Measurement range	0.05 to 1.1 mm 0.002" to 0.04"
Resolution	0.25 µm 0.000010"
Linearity	±0.3 µm ±0.000012"
Head size	ø2 mm ø0.08"

Long Distance Type

DISTANCE	RESOLUTION
11.3 mm / 0.44"	0.25µm/0.000010"

Long-distance measurement with high accuracy.

SI-F10



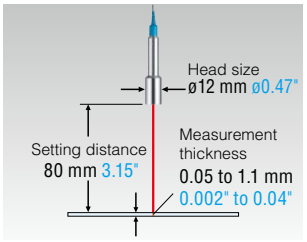
MAJOR TECHNICAL DATA	
Measurement range	11.3 to 12.35 mm 0.44" to 0.49"
Resolution	0.25 µm 0.000010"
Linearity	±0.3 µm ±0.000012"
Head size	ø8 mm ø0.32"

Thickness (Gap) Measurement Type

DISTANCE	RESOLUTION
80 mm / 3.15"	0.25µm/0.000010"

High accuracy achieved by targeting thickness measurement.

SI-F80



MAJOR TECHNICAL DATA	
Setting distance	80 to 81.1 mm 3.15" to 3.19"
Measurable thickness	0.05 to 1.1 mm 0.002" to 0.04"
Resolution	0.25 µm 0.000010"
Linearity	±0.3 µm ±0.000012"
Head size	ø12 mm ø0.47"

No heat generation and no noise

Advantages of the optical fiber head structure

The measurement head consists of only optical fibers and lenses, with no electronic parts.

Small size, light weight, and heat resistant

These features greatly reduce the constraints on selecting an installation area. A micro-head of this type can be used with a wider range of measurement applications because it can be installed in places where conventional units cannot.

No heat generation

An exothermic body is one of the error-causing factors in high-accuracy measurement. The optical fiber head structure produces no heat generation in the head section.

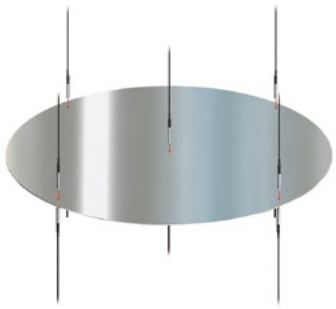
Not influenced by electromagnetic noise

The measurement head contains no electrical circuits. Because of this, it is not influenced by electromagnetic noise, which is difficult to isolate and remove.

APPLICATION

Measuring wafer thickness

The micro-head can be used to measure the thickness and warpage of high-precision objects such as silicon wafers.



ADVANTAGE

Ultra high-resolution
Resolution of 0.25 µm 0.000010"

Multifunctional controller
The arithmetic operation circuit instantly converts the measurement data to a thickness.

No heat generation
There are no electrical components in the head that generate heat.

Measuring the behavior of rollers in a copy machine

The micro-head can be used to measure the behavior of each component inside precision machines.

ADVANTAGE

ø2 mm (ø0.08") micro-head
No special location is needed for installation.

Heat resistant to 85°C (185°F)
Measurement is possible even beside an exothermic body.

5-kHz high-speed sampling
Even high-speed targets can be measured securely.

Positioning high-accuracy stages

The micro-head can be used to detect the location at which a stage stops, allowing the difference from the reference value to be fed back to the related equipment.

ADVANTAGE

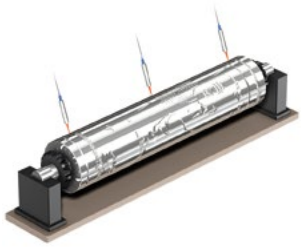
Setting distance of 10 mm (0.39") or longer
There is no danger of collision.

Up to six-axis simultaneous measurement
Multi-axis control is achieved with no time errors

ø8 mm (ø0.47") small head
No special location is needed for installation.

Measuring roller run out with high accuracy

The micro-head can be used to measure the run out in rollers, which demand precise measurement, such as in the case of coating rollers.



ADVANTAGE

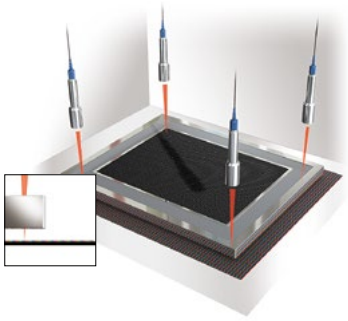
No damage to workpiece
Non-contact measurement prevents damage to workpieces.

Direct indication of amount of run out
The amount of run out is instantly calculated and displayed by the controller.

5-kHz high-speed sampling
The high-speed rotation of target objects can be followed.

Measuring exposure mask gaps

The micro-head can be used to measure the gap between an exposure mask and glass substrate.



ADVANTAGE

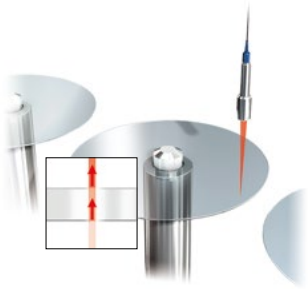
Setting distance of 80 mm (3.15")
The micro-head can be installed even when the mask is thick.

ø12mm (ø0.47") small head
No special location is required for installation.

No heat generation
There are no electrical components in the head to generate heat.

Measuring the thickness of glass discs

The micro-head can be used to measure the thickness of optically transparent targets.



ADVANTAGE

Ultra high-resolution
Resolution of 0.25 µm 0.000010"

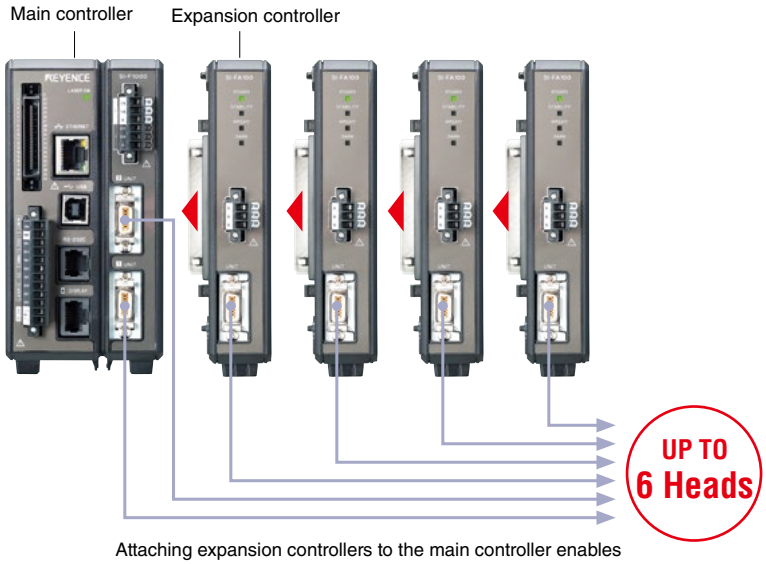
5-kHz high-speed sampling
The thickness of rapidly rotating targets can be measured.

Up to six-axis simultaneous measurement
Multi-axis control is achieved with no time errors.

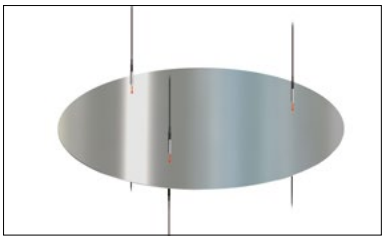
Intelligent controller offering convenience and ease of use

Simultaneous control of up to six heads

By connecting expansion controllers to the main controller, up to six heads can be used simultaneously for measurement.



Attaching expansion controllers to the main controller enables up to six heads to be connected.



All-head simultaneous measurement

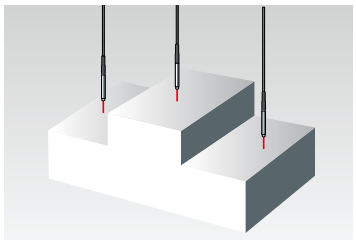
Multiple heads are synchronized to achieve simultaneous measurement. These can be used to make simultaneous measurements at multiple points on a moving object and high-accuracy measurements for an object placed between sensor heads.

Multi-calculation

Measurement values from multiple heads can be instantly calculated. Simple settings enable the controller to perform complex calculations.

Measuring a step height relative to a reference point

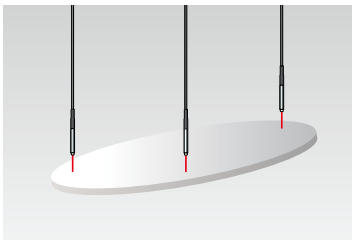
The difference in height between each measurement point and the reference point is obtained.



Measurement value 1 = A - B,
Measurement value 2 = A - C,
Measurement value 3 = A - D, ...

Measuring relative differences

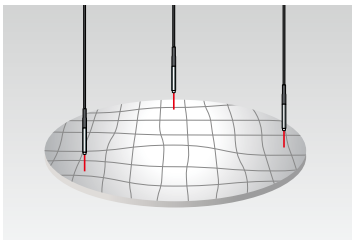
Differences in relative distances between specific sensor heads and a target are measured.



Measurement value 1 = A - B,
Measurement value 2 = B - C,
Measurement value 3 = A - C, ...

Measurement of flatness

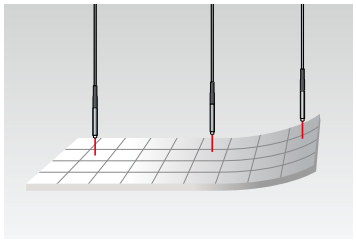
The difference between the maximum and minimum of all the measured values is obtained.



Measurement value 1 =
MAX (A, B, C, ...) - MIN (A, B, C, ...) ...

Measuring warpage

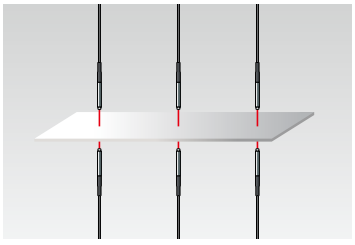
The warpage at specified measurement points is obtained.



Measurement value 1 = B - (A + C)/2 ...

Measuring the thicknesses of multiple points

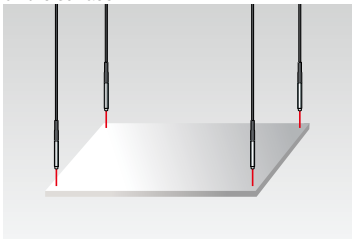
Pairs of heads are used to measure the thicknesses at multiple points.



Measurement value 1 = X - (A + B),
Measurement value 2 = Y - (C + D),
Measurement value 3 = Z - (E + F), ...

Measuring the average height

The average height of the surface is obtained for specified measurement points on the surface.



Measurement value 1 = Ave (A, B, C, ...), ...

Wide array of interfaces

The controller is equipped with six different I/O interfaces that make it possible for the controller to communicate with almost any peripheral device.

USB	Binary output	Ethernet
RS-232C	Analog	Discrete I/O

Separate display/setting panel

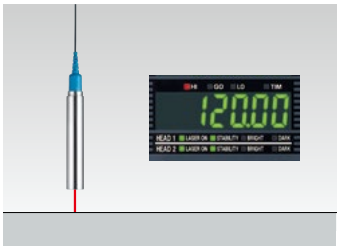
Controller design that stresses usability has resulted in a separate display. The display/setting panel may be separated depending on the controller installation. The display section can thus be installed away from the control unit and the controller section can be mounted on a DIN rail in the control panel. When used on a table top, the controller and display section can be combined into a single unit.

When used on a table top
The one-piece display/controller setup saves installation space.

When attached to a control unit
The display can be attached to the front panel and the controller section can be mounted on a DIN rail in the panel.

Displaying the amount of light

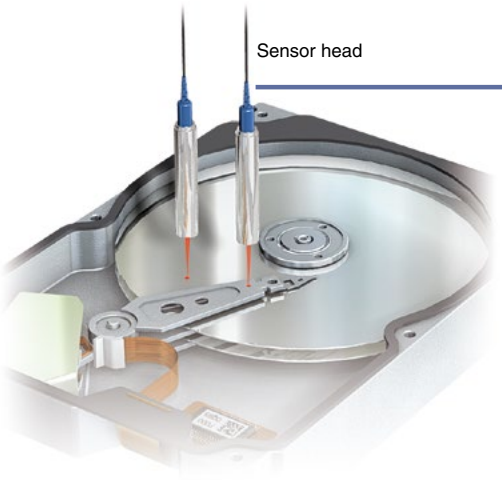
The amount of light received by a sensor head can be displayed in 256 levels. Checking the amount of received light helps confirm the measurement stability for individual target objects and reduces the labor-hours needed for angle adjustment during installation.



When the sensor is installed perpendicular to the target:
A large amount of reflected light returns into the sensor.

When the sensor is installed at an angle to the target:
A sufficient amount of reflected light may not be returned to the sensor.

“SI-Navigator 3”, PC software dedicated to ease of use and data collection



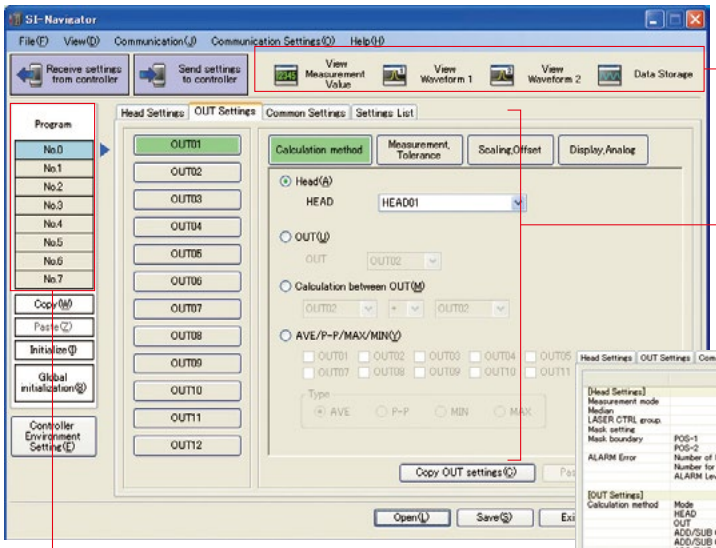
Operating environment required to use SI-H13 (SI-Navigator 3)

Item	Minimum system requirements
CPU	Pentium III, 1 GHz or higher (1.7 GHz or higher is recommended)
OS	Windows 10*1 Windows 7 (SP1 or later)*2 Windows Vista (SP2 or later)*3 Windows XP (SP3 or later)*4
Memory capacity	256 MB or higher (1 GB or more is recommended)
Display resolution	1024 × 768 pixels, 24-bit full color or higher
Free hard disk space	1 GB or larger
Interface	One of the following interfaces is required. - USB: Revision 2.0, high-speed (full speed in USB1.1 compatible mode)*5 - LAN: 100BASE-TX or 10BASE-T*6 - RS-232C (serial port)

The other system requirements must meet those recommended for your OS.
*1 Home, Pro, and Enterprise editions are supported.
*2 Home Premium, Professional, and Ultimate editions are supported.
*3 Ultimate, Business, Home Premium, and Home Basic editions are supported.
*4 Professional and Home editions are supported.
*5 Connection through a USB hub is not included in the guarantee.
*6 Connection to LAN and connection via a router is not included in the guarantee.

Simple configuration

Simply position the cursor to a desired setting menu and make a selection. With many pull-down lists and icons available for selection, anyone can easily configure.

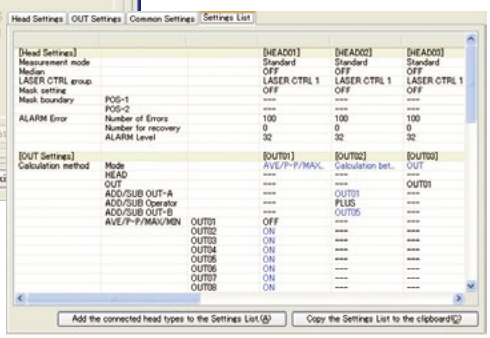


ICON SELECTION

The user can quickly access setting menus that are frequently used, such as the measurement value display, received light waveform display, and data storage menus.

OUT SETTING

Twelve different output channels are supported. There are setting menus offering considerable flexibility, such as tolerance, scaling, and calculation between OUTs.



LIST OF SETTINGS

The list lets the user view all of the settings together.

PROGRAM SWITCHING

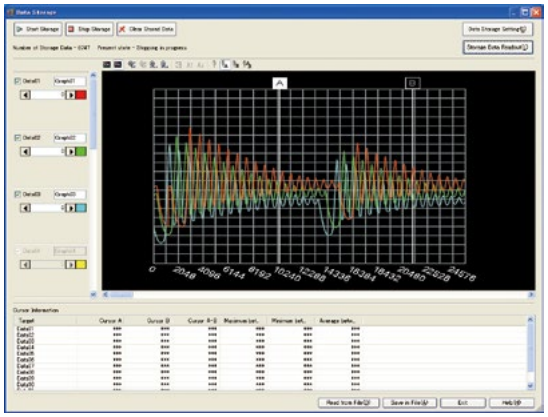
Eight programs can be toggled between for even greater flexibility. Settings can be easily copied between programs and initialized.

Data Storage

The controller can hold up to 1.2 million points of measurement data, which can then be sent to a PC connected to the controller via the USB interface. Settings can be arbitrarily changed for sampling rates, the number of measurement points, and data collection via external signals.

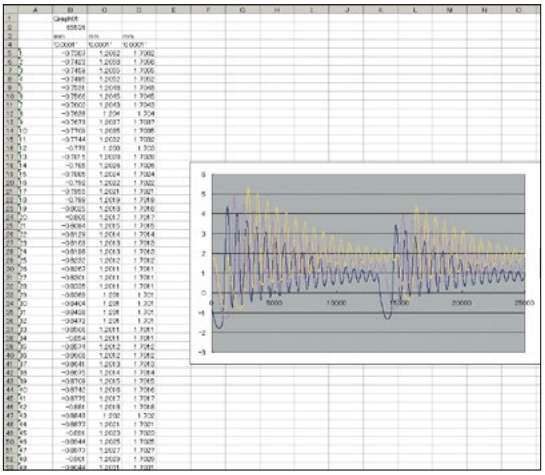
ANALYSIS WITH SI-NAVIGATOR

SI-Navigator can display waveforms. It lets the user zoom waveforms in/out, as well as overlay them on one another. It also makes it possible to read values simply by positioning a cursor.



ANALYSIS WITH EXCEL

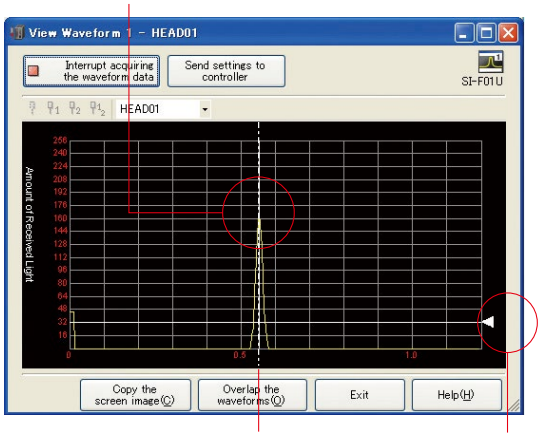
Data collected with SI-Navigator can be saved in CSV format, so it can be read in Excel.



Displaying received light waveforms

The amount of received light can be displayed as a waveform. This serves as a rough indication of the measurement stability. This is very useful when making measurements on workpieces with low reflectance and for checking whether the amount of received light is small because of a tilted measurement head or target.

How the light is being received is displayed as a waveform. The amplitude of the waveform indicates the intensity of received light.

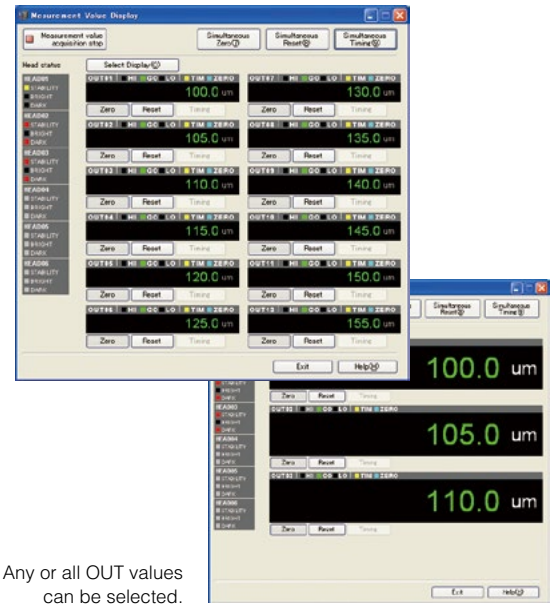


The horizontal position of the waveform peak indicates both the distance to and/or the thickness of the workpiece.

The detection level can be changed arbitrarily with the received light waveform.

Displaying measurement values

Values displayed on the controller can be checked on the PC. Up to 12 OUT values can be displayed simultaneously. This function is useful when many channels are connected or when there are many calculation settings.



Any or all OUT values can be selected.

Specifications

Sensor head

Type			Micro-head type	Long distance type	Thickness measurement type
Model	Sensor head		SI-F01	SI-F10	SI-F80
	Spectrum unit		SI-F01U3	SI-F10U3	SI-F80U3
Measurement range			0.05 to 1.1 mm 0.002" to 0.04" *1	11.3 to 12.35 mm 0.04" to 0.49" *1	0.05 to 1.1 mm 0.002" to 0.04" *2 (Possible detection distance : 80 to 81.1 mm 3.15" to 3.19")
Light source			Infrared SLD Central wavelength 820 nm Output 0.6 mW, Class 1 Laser product (IEC60825-1, FDA (CDRH) Part 1040.10 *8)		
Beam spot diameter*3			ø20 µm ø0.001"	ø40 µm ø0.002"	ø20 µm ø0.001"
Linearity			±0.3 µm ±0.000012" *4	±0.3 µm ±0.000012" *4	±0.3 µm ±0.000012" *5
Resolution			0.25 µm 0.000010" *6	0.25 µm 0.000010" *6	0.25 µm 0.000010" *7
Sampling cycle			200 µs		
Light source for guide			Red semiconductor laser Wavelength 650 nm Output 0.1 mW, Class 1 Laser product (IEC60825-1, FDA (CDRH) Part 1040.10 *8)		
LED display			Target near center of measurement range: green lights. Target within measurement range: orange lights. Target outside measurement range: Flashes orange.		
Temperature fluctuation	Spectrum unit		0.01% of F.S./°C		
Environment resistance	Enclosure rating	Sensor head	IP67	IP64	IP64
	Ambient light		Incandescent lamp or fluorescent lamp: 10000 lux max.		
	Ambient temperature	Sensor head	0 to +85°C 32°F to 185°F	0 to +40°C 32°F to 104°F	0 to +50°C 32°F to 122°F
		Spectrum unit	0 to +35°C 32°F to 95°F		
	Relative humidity	Sensor head	35 to 85%RH (No condensation)		
		Spectrum unit	35 to 80%RH (No condensation)		
	Vibration	Sensor head	10 to 55 Hz, 1.5 mm 0.06" double amplitude in X, Y, and Z directions, 2 hours respectively		
		Spectrum unit	10 to 55 Hz, 0.5 mm 0.02" double amplitude in X, Y, and Z directions, 2 hours respectively		
Material	Sensor head		SUS		
	Spectrum unit		Polycarbonate		
Weight	Sensor head (including cable)		Approx. 24 g	Approx. 38 g	Approx. 39 g
	Spectrum unit		Approx. 1 kg		

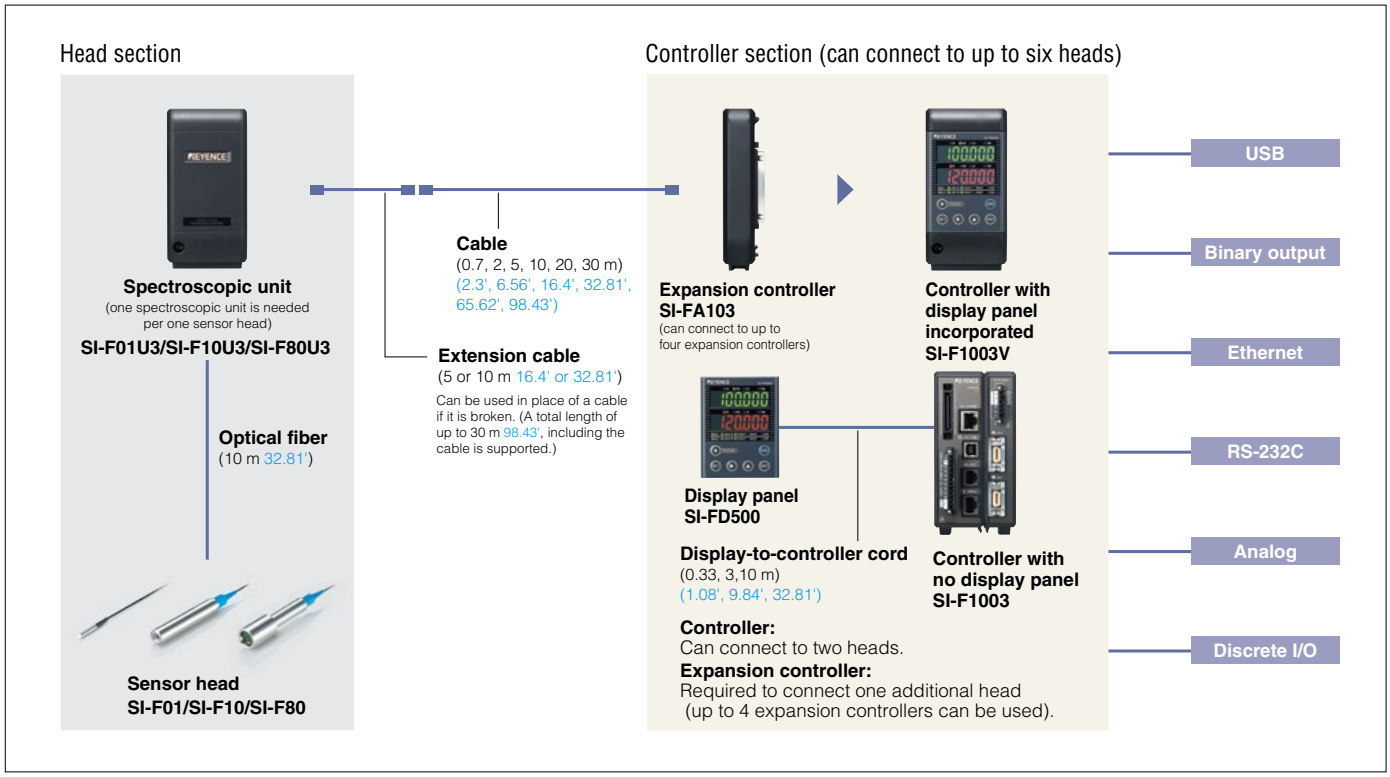
*1 Indicates distance from the front of the sensor head. For long distance type sensor heads there is an individual difference of up to ±0.2 mm ±0.01".
*2 The thickness measurement type sensor head displays the measurement range for the distance between plates of glass. Ensure that the measurement target is within the possible detection distance range.
*3 Indicates the minimum beam spot diameter within the measurement range.
*4 This value is obtained when the measurement target is a glass plate with the number of averaging measurements set to 256.
*5 This value is obtained by measuring the gap between two glass plates with the number of averaging measurements set to 256.
*6 This value is obtained by measuring a glass plate surface located at the center of the measurement range with the number of averaging measurements set to 4,096.
*7 This value is obtained by measuring a 0.3 mm 0.01" thick glass target within the possible detection distance with the number of averaging measurements set to 4,096.
*8 The laser classification for FDA is based on IEC60825-1 in accordance with the requirements of Laser Notice No. 50.

Controller

Designation			Main Controller	Expansion controller*1
Model	Single unit type		SI-F1003V	SI-FA103
	Separate type*2		SI-F1003/SI-FD500	
No. of connectable spectrum units			2	1
Display	Minimum display unit		0.001 µm	N/A
	Display range		±999.999 µm to ±9999.99 mm, ±0.04" to ±0.4" (7 settings selectable)	
	Display cycle		10 times/sec.	
Terminal block	Laser remote interlock input		Non-voltage input	N/A
	TIMING1 input		Non-voltage input 2	
	RESET1 input		Non-voltage input	
	Auto-zero1 input			
	Laser control input			
	Analog voltage output		±10 V × 2 outputs, Output impedance: 100 Ω	±10 V × 1 output, Output impedance: 100 Ω
	Analog current output		4 to 20 mA × 2 outputs, Maximum load resistance: 350 Ω	4 to 20 mA × 1 output, Maximum load resistance: 350 Ω
	Alarm output		NPN open-collector output (N.C.)	N/A
	General comparator output		NPN open-collector output	
Expansion connector	TIMING input		Non-voltage input 2	N/A
	RESET input		Non-voltage input	
	Auto-zero input			
	Program switch input		Non-voltage input × 3 inputs	
	Alarm output		NPN open-collector output (N.C.)	
	Comparator/ binary output	Binary output	Measured value data output (21 bits) OUT selectable NPN open-collector output	
		Strobe output	NPN open-collector output	
		Binary selection output	NPN open-collector output	
		Binary selection input	Non-voltage input	
RS-232C interface			Measured data output and control input/output (Baud rate selectable to 115,200 bps max.)	N/A
USB interface			USB 2.0 high speed compliant (USB 1.1 Full-SPEED compatible)	
Ethernet interface			100Base-TX/10Base-T	
Major functions			**12 Out simultaneous measurement** calculation, average, filter, scaling measurement, measured value alarm, tolerance setting, auto-zero, data storage, light monitor, 8-program memory, interferometer mode, mask, connection of setting support software, etc.	
Power supply	Power supply voltage		24 VDC ±10% Ripple 10% (P-P) max.	Supplied from the main controller
	Maximum current consumption		One head connected: 0.6 A or less. Six heads connected: 1.5 A or less.	
Environment resistance	Ambient temperature*3		0 to +50°C 32°F to 122°F	
	Relative humidity		35 to 85%RH (No condensation)	
	Vibration*4		10 to 55 Hz, 0.5 mm 0.02" double amplitude in X, Y, and Z directions, 2 hours respectively	
Weight			Approx. 600 g	Approx. 300 g

*1 Up to four expansion controllers can be connected to the main controller.
*2 The SI-F1003 can be used independently. The measured value display and setting change can be done with the display panel (SI-FD500) and setup support software (SI-H13).
*3 When two or more expansion controllers are connected, the ambient temperature is 0 to 40°C 32°F to 104°F.
*4 When two or more expansion controllers are connected, the vibration resistance is "10 to 55 Hz, 0.3 mm 0.01" double amplitude in X, Y, and Z directions, 2 hours respectively".
• NPN open-collector output rating: 50 mA max. (40 V max.), Residual voltage: 0.5 V max.
• Non-voltage input rating: ON voltage: 1 V max., OFF current: 0.6 mA max.
• Part of the input/output circuit of the SI-F1000 Series is internally common. Be careful that no potential difference is generated between the internally common terminals due to the potential difference between the cables/external devices. For details, refer to "Precautions on wiring".

System configuration



Components

Sensor head

Micro-head type
SI-F01

Long distance type
SI-F10

Thickness measurement type
SI-F80

Spectrum unit
SI-F01U3/
SI-F10U3/
SI-F80U3

(One spectroscopic unit is needed for each sensor head.)

Optional unit

Head mounting jig (For SI-F01)
OP-84480

Controller

Single unit type
SI-F1003V

Separate type
SI-F1003

Expansion controller
SI-FA103

Back surface

Spectrum unit spacer
OP-84474

(Supplied together with the spectroscopic unit)

Display

Display panel
SI-FD500

Cable

Controller-to-sensor head unit connecting cable
CB-A07/CB-A2/CB-A5/
CB-A10/CB-A20/CB-A30

Controller-to-spectrum unit extension cable
CB-A5E/CB-A10E

Display-to-controller cord
0.33 m 1.08': OP-84428
3 m 9.84': OP-51655
10 m 32.81': OP-51656

Software

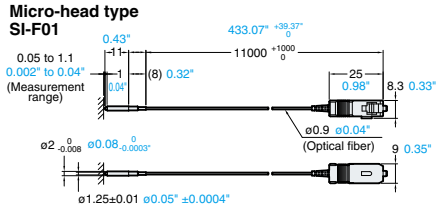
Dedicated PC software "SI-Navigator 3"
SI-H13

Dimensions

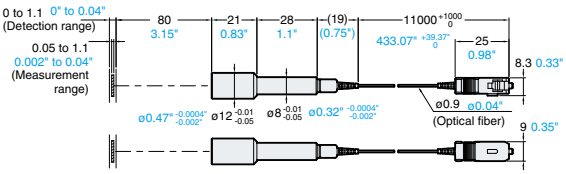
Unit: mm inch

Sensor head

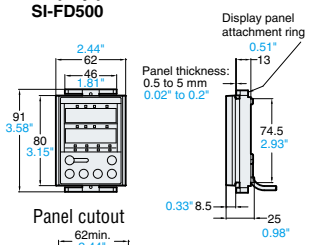
Micro-head type
SI-F01



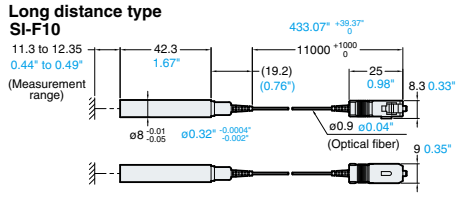
Thickness measurement type
SI-F80



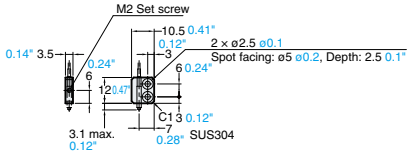
Display panel
SI-FD500



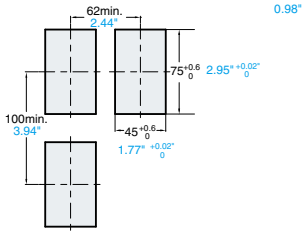
Long distance type
SI-F10



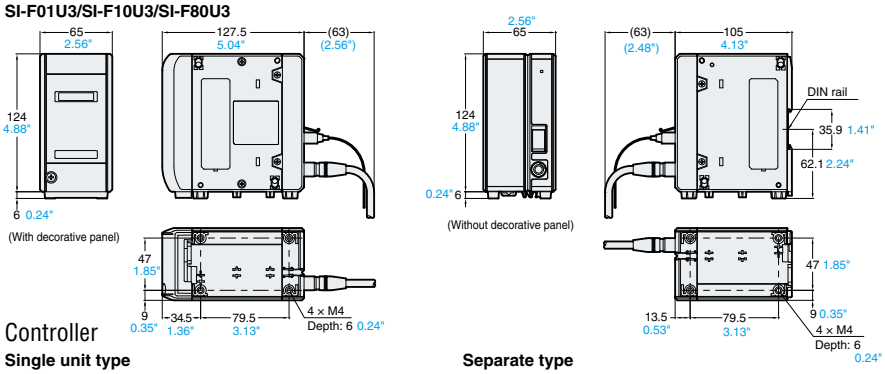
Head mounting jig (For SI-F01)
OP-84480



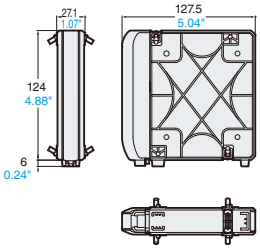
Panel cutout



Spectrum unit
SI-F01U3/SI-F10U3/SI-F80U3

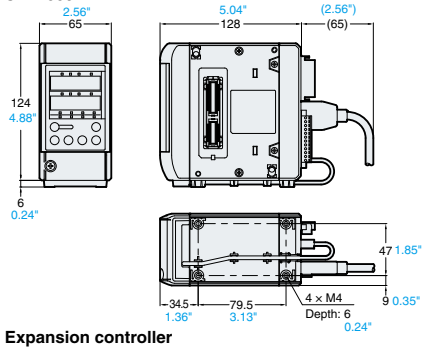


Spectrum unit spacer
OP-84474

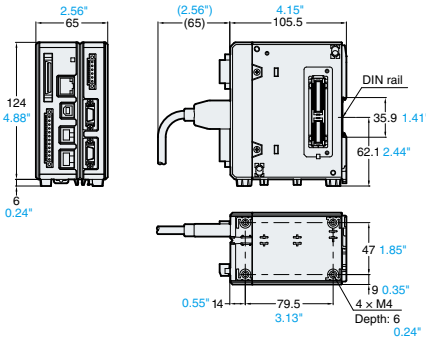


Controller

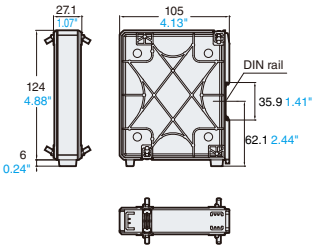
Single unit type
SI-F1003V



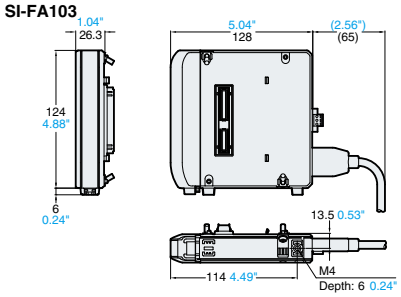
Separate type
SI-F1003

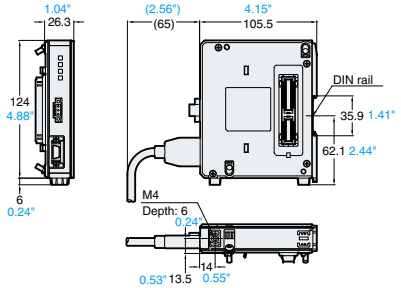


Spectrum unit spacer
OP-84474



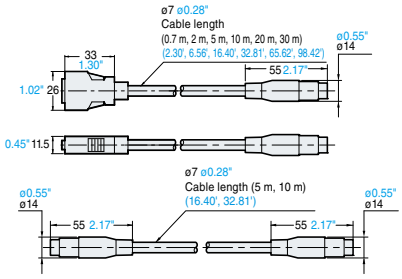
Expansion controller
SI-FA103





Additional accessories

Controller-to-sensor head unit connecting cable
CB-A07/CB-A2/CB-A5/CB-A10/
CB-A20/CB-A30



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