Optical Micrometers

- TM-3000 Series
- LS-9000 Series
- LS-7000 Series
Make the Ultimate Upgrade to an LED.

**Laser type**

Typical micrometer

- Low durability due to deterioration of moving parts
- Instability in measurements due to temperature fluctuation

**LED type**

LS-7000 Series

- No moving parts with LED-based optical system
- Longterm stability achieved with higher speed and accuracy
Evolution to 2D

2D Optical Micrometer  P. 6

TM-3000 Series

- Measures areas rather than points for increased stability
- 2D In-line measurement

Improved 1D Capabilities

High-speed Optical Micrometer  P. 18

LS-9000 Series

- High-speed sampling surpassing conventional models
- Active tilt-correction allows for accurate measurement on mis-aligned parts.
Application Examples TM Series

- Measuring targets on an index table
- Measuring targets transferred by a robot
- Measuring the outer diameter of a large target
- Measuring the shaft run-out of a rough-surfaced target
- Measuring targets moving on a conveyor
- Measuring the inner diameter of a target on a glass table
Application Examples LS Series

- Measuring the outer diameter of multiple wires simultaneously
- Measuring sheet width and position
- Measuring a roller gap by deflecting the optical axis with a mirror
- Measuring the outer diameter of a glass tube
- Measuring the outer diameter in two axes in a harsh environment
- Measuring the outer diameter of ultra-thin wires
2D Optical Micrometer

TM-3000 Series

Take measurements in-line from a 2D image
Accurately measure anywhere in the wide field of view

**TM-3000 Series**

<table>
<thead>
<tr>
<th>2D measurement</th>
<th>High-accuracy measurement</th>
<th>In-line measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multiple points</strong> can be measured simultaneously</td>
<td><strong>±0.15 μm 0.000006&quot;</strong> repeatability</td>
<td><strong>5.5 ms max.</strong> high-speed measurement</td>
</tr>
</tbody>
</table>

Area measurement has enabled measurement at multiple points without the need to move targets. Moreover, the system can recognize the orientation of the target and correct it automatically to ensure accurate measurement.

**Conventional problems**

<table>
<thead>
<tr>
<th>Measuring at multiple points is time-consuming.</th>
<th>Accuracy cannot be guaranteed.</th>
<th>Measurement takes too long.</th>
</tr>
</thead>
<tbody>
<tr>
<td>To measure multiple points with a conventional 1D micrometer, you would have to mount multiple sensor heads or move the target.</td>
<td>When a camera is used for measurement, the accuracy cannot be guaranteed due to illumination setting conditions or lens distortion, making high-accuracy measurements impossible.</td>
<td>Using an optical comparator can be very time consuming because measurement cannot be performed in-line, requiring parts to be removed and tested one by one.</td>
</tr>
</tbody>
</table>

**Measurement principle**

The green LED light is distributed from the transmitter as parallel light, and the silhouette of the target interrupting the light is captured by the CMOS in the receiver. Then the edges between the bright and dark sides are detected from the silhouette and used to measure outer diameter or other dimensions. This method utilizes a unique advantage of thrubeam devices, that they are unaffected by lighting or target surface conditions, to achieve high-accuracy measurements.
Various outer diameter measurements possible with 2D detection

Since the TM-3000 Series measures outer diameter based on a 2D image, it can ascertain information on the target inclination. Based on this information, it can measure outer diameters while correcting for the inclination automatically. You can obtain measured values by just specifying an area around the target section on the captured image. Unlike conventional micrometers, the measurement can be completed without the troublesome process of changing the target position or preparing a moving mechanism.

Effects of inclination can be corrected during measurement when calculating from 2D data. Both height difference and outer diameter can be measured with one sampling, allowing In-line measurement.

The size of a measurement area is customizable. Calculating the average of the diameters within the area minimizes the error caused by surface roughness during measurement. Simply selecting measurement points from the captured image allows measurement. The measurement of the deviation at multiple points can be perfectly synchronized and conducted at once, resulting in significant reduction of cycle time.

Measurement is conducted at once using the entire image, and the maximum diameter can be determined from the result. Since the maximum value can be specified from the entire image, measurement is not affected by errors resulting from the use of a jig.
Diverse measurement modes enabled by 2D detection

**Step**
- Measuring the depth of pulley V-grooves
- Measures the height difference between detected edges.

**Width**
- Measuring the width of ampoules
- Measures the maximum, minimum or average width between detected edges.

**Angle**
- Measuring the tip angle of injection needles
- Measures the angle between two detected straight lines.

**Distance**
- Measuring the distance between a drill and a target
- Measures the distance to or position of a detected edge.

**Radius**
- Measuring the radius of O-rings
- Measures the radius of a specified arc.

**Pitch**
- Measuring the pitch of connector terminals
- Measures the pitch of specified points.
Technologies to achieve high accuracy

Less affected by misalignment of a target

Using a large focal ratio allows a large depth of field (wide measuring range between the transmitter and receiver). The telecentric optical systems used in both the transmitter and receiver capture sharp edges, allowing accurate measurement without being affected by misalignment of the target.

Minimizing the influence of ambient light/temperature

The incorporated double telecentric optical system receives parallel light and maintains the parallelism to form an image on the light receiving element. Since it only receives parallel light based on its principle, it is less affected by ambient light*1. The structure is also designed to minimize the influence of temperature changes on measurements by suppressing the change in size of the formed image even when the light receiving element changes its position due to thermal expansion*2.

*1 A parallel light is received.

*2 The light is made to be parallel to form an image.
No adjustment necessary to ensure accuracy

A low distortion lens is used, which produces minimal distortion in captured images, even near the edges. Moreover, the original algorithm processing allows measurement without the need to carefully position the target. Conventional illumination and the position adjustment of targets are no longer necessary.

Calibration certificate for guaranteed accuracy

Unlike camera systems, calibration certificates including traceability, are available for all sensor heads.

Distortion appears near the edges.
Minimal distortion in the entire field of view.

Calibration certificate
Inspection report
Traceability system diagram
Technologies to achieve high-speed measurement

**Instantaneous measurement of 16 points – sub-pixel processing & dedicated processor**

High speed and high precision are achieved through pinpoint extraction and sub-pixel processing of only the contour selected for the measurement. A new processor dedicated for high-speed 2D processing has been developed. Moreover, the system uses a high-speed calculation CPU and two image processing DSPs. Using a total of four processors for parallel processing enables a maximum processing capacity of 1800 targets/minute.

![Image of measurement system](image)

**High intensity green LED – Acquire images of moving targets without blurring**

The use of a high intensity LED has reduced the light receiving period to accumulate light on the CMOS, resulting in measurement using unblurred images even of moving targets. The LED offers four advantages: even brightness distribution, EMF resistance, eye safety, and high intensity.

![Image of LED](image)
TM-3000 Series

Sensor head lineup

2D measurement of small diameter targets

![Small diameter type](image1.png)

<table>
<thead>
<tr>
<th>Model</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-006</td>
<td>ø6 mm 0.24&quot;</td>
<td>0.04 mm 0.0016&quot;</td>
<td>±0.06 μm</td>
<td>±0.5 μm ±0.00002&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard model for 2D measurement achieving good field of view and accuracy

![Standard type](image2.png)

<table>
<thead>
<tr>
<th>Model</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-040</td>
<td>ø40 mm 1.57&quot;</td>
<td>0.3 mm 0.01&quot;</td>
<td>±0.15 μm</td>
<td>±0.2 μm ±0.00008&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2D measurement of large diameter targets up to 65 mm 2.56"

![Large diameter type](image3.png)

<table>
<thead>
<tr>
<th>Model</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM-065</td>
<td>ø65 mm 2.56&quot;</td>
<td>0.5 mm 0.02&quot;</td>
<td>±0.2 μm</td>
<td>±3 μm ±0.0001&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OPERATING SYSTEM ENVIRONMENT

CPU
Pentium III 1GHz min. (recommended 1.7 GHz min.)

Support OS
Windows 10 *4
Windows 7 (SP1 or later) *5
Windows Vista (SP2 or later) *3
Windows XP (SP3 or later) *4

Memory capacity
512 MB min. (1 GB min. recommended)

Resolution of display
XGA (1024 x 768 pixels) min, 256 colors min.

Free disk space
1 GB min.

Interface
As described above, all those mounted, USB2.0/1.1 *6, Ethernet *4

*For your OS, use environments above that recommended.
*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.
### Heads

<table>
<thead>
<tr>
<th>Model</th>
<th>TM-006</th>
<th>TM-040</th>
<th>TM-065</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>ø6 mm ø0.24&quot;</td>
<td>ø40 mm ø1.57&quot;</td>
<td>ø65 mm ø2.56&quot;</td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.04 mm 0.001&quot;</td>
<td>0.3 mm 0.01&quot;</td>
<td>0.5 mm 0.02&quot;</td>
</tr>
<tr>
<td>Transmitter/receiver distance</td>
<td>60 mm 2.36&quot;</td>
<td>180 mm 7.09&quot;</td>
<td>270 mm 10.63&quot;</td>
</tr>
<tr>
<td>Light source</td>
<td>GaN Green LED</td>
<td>InGaN Green LED</td>
<td></td>
</tr>
</tbody>
</table>

- **Repeatability**: ±0.06 µm/±0.000006"/±0.02 µm/±0.000008"/±12 µm/±0.00017".
- **Environmental resistance**: IP64.
- **Ambient temperature**: 0 to 50°C (20 to 122°F).
- **Relative humidity**: 35 to 85% (No condensation).

### Controller

<table>
<thead>
<tr>
<th>Model</th>
<th>TM-3001</th>
<th>TM-3001P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor head compatibility</td>
<td>Compatible</td>
<td></td>
</tr>
<tr>
<td>Number of connectable sensors</td>
<td>2 units max.</td>
<td></td>
</tr>
</tbody>
</table>

- **Display**: Non-voltage input, 4 inputs Voltage input
- **Error output**: Voltage input
- **Process output**: Voltage input
- **Trigger input enable output**: Voltage input
- **Binary output**: OUT1 to OUT16 measured data output (21 bits)
- **Non-voltage input**: 3-level judgment output: OUT1 to OUT16, total judgment output
- **PNP open-collector output**: 3-level judgment output: OUT1 to OUT16, total judgment output
- **NPN open-collector output**: 3-level judgment output: OUT1 to OUT16, total judgment output
- **NPN open-collector output (N.C.)**: 3-level judgment output: OUT1 to OUT16, total judgment output
- **PNP open-collector output (N.C.)**: 3-level judgment output: OUT1 to OUT16, total judgment output
- **Memory card**: SD card CA-SD4G (4 GB), CA-SD1G (1 GB) support
- **RS-232C interface**: Measured data output and control input/output (Maximum baud rate: 115200 bps, selectable)
- **USB interface**: In conformity with USB Revision 2.0 Hi-SPEED (USB 1.1 Full-Speed compatible)
- **Ethernet interface**: 100BASE-T/100BASE-TX/10BASE-T
- **Memory card**: SD card CA-SD4G (4 GB), CA-SD1G (1 GB) support
- **Major functions**: Position correction function, OUT name change function, select measurement mode (outer diameter, height, step height, position, width, distance, intersection distance, angle, radius, roundness, coordinates, area, search, ring test, pitch) functions, OUT function between operators, auxiliary measurements (straight edge, circular edge, the edge bounding line, center line, intersection, straight line between two points, any line, any point) functions, scaling function, average function, measurement function, measurement value alarm setting function, tolerance setting function, auto-zero function, storage (data/image) function, memory card storage function, program memory function, trigger mode change function, mutual interference prevention function, adjustable measuring range function, detection threshold value change function, mask function, attitude correction function, display language switching function, support software setting function, trigger interval-measurement time display function, others
- **Ratings**: Power supply voltage 24 VDC ±10%, Ripple: 10% (P to P) or less
- **Current consumption**: 1 head connected 480 mA max. / 2 heads connected 550 mA max.
- **Ambient temperature**: 0 to 50°C (32 to 122°F)
- **Relative humidity**: 35 to 85% (No condensation)
- **Material**: Polycarbonate
- **Weight**: Approx. 1120 g

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*1 Value of ±2 when measuring the width of KEYENCE standard object (glass calibration scale) in the center of the measurement area, an average 16 times, average 1.3 mm 0.0005" line.
*2 Value of ±2 when measuring the width of KEYENCE standard object (glass calibration scale) in the center of the measurement area, an average 16 times, average 0.01" line.
*3 Value of ±2 when measuring the width of KEYENCE standard object (glass calibration scale) in the center of the measurement area, an average 16 times, average 0.01" line.
*4 Error when measuring width of KEYENCE standard object (glass calibration scale) in a measurement area of 20 mm 0.79" × ø40 mm ø1.57".
*5 Error when measuring width of KEYENCE standard object (glass calibration scale) in a measurement area of 20 mm 0.79" × ø40 mm ø1.57".
*6 Error when measuring width of KEYENCE standard object (glass calibration scale) in a measurement area of 20 mm 0.79" × ø40 mm ø1.57".
*7 When measurement area is minimum, others are initial settings.
*8 Apart from connector component.
High-speed Optical Micrometer
LS-9000 Series

Making conventionally impossible measurements possible
Innovative measurement method for optimal performance

With the LS-9000 Series

**Fastest in its class**

**16,000 Hz sampling rate**

Fitted with a high-speed exposure CMOS and high-intensity Green-LED to produce a 16,000 Hz sampling rate, far surpassing previous systems. Improves production line processing time and reduces variation in measurement results.

**World's first**

**Active Tilt and Vibration Correction**

The high-speed exposure CMOS clearly recognizes measurement targets that suddenly move due to target vibration and corrects measurement errors. The “Monitor CMOS” determines the alignment of the target to enable accurate measurement of tilted targets.

**Low maintenance**

**No moving parts**

Thanks to KEYENCE’s proprietary optic design, there are no moving parts. The use of an LED light source means no errors due to external sources. This combination of no moving parts with a LED light source means it can be used on-site for extended periods of time without requiring regular maintenance.

Problems with conventional systems

**1,200 Hz sampling**

Motor speed must be increased to raise the sampling rate. However, it was hard to achieve both durability and stability, so sampling speed could not be dramatically increased.

**Target alignment and vibration cause errors**

Conventional systems cannot recognize tilting of the target due to only having one source of measurement data. Vibration in the target could also cause errors in the scan that lead to incorrect values.

**Moving parts deteriorate**

Regular calibration of the polygon mirror and laser are required due to the wear-related deterioration of moving parts.

Measurement principle

The green LED light is distributed as uniform, parallel light and applied to the target. The edges between the bright and dark areas on the CMOS are detected and calculated to obtain a measured value such as an outer diameter.
By integrating the peripheral circuits of the measurement CMOS into one chip, the S/N ratio has been dramatically improved and high-speed sampling achieved. For example, targets that move at 1000 m/3280.8’/min. can be measured at a pitch of around 1 mm/0.04”. Even parts that vibrate at high speeds can be measured stably.

High-speed exposure is used so that a precise inspection of the target can be performed even if the target is vibrating, making accurate measurement possible.

### Error in relation to vibrating workpieces

- 1 mm 0.04” pin gauges were vibrated and measured by the number of average 1.
- LS-9006
- Conventional laser scanning system

### Measuring the outer diameter of a high-speed wire

Even vibrating targets can be accurately measured.
Even misaligned parts are measured stably

The target monitor CMOS recognizes the orientation of the part and adjusts the measured value so there are no measurement errors due to inclination.

Two axis target position indicator

The LS-9000 can use the target positioning CMOS receiver to determine the location of the measurement target in two axes. This makes installation and part position feedback simple, even with a single axis system.

Alignment adjustment*1

Recognizes the misalignment of a workpiece from the image taken by the monitor CMOS. Inclination error is removed automatically and does not affect the measurement result. The captured image can also be checked with computer software so even novices will have no problem taking accurate measurements.

Transmitter/receiver direction and position measurement*2

With the additional data obtained from the target positioning CMOS, the LS-9000 can determine the position of the target in both the X and Y axes.

*1 Functions of the LS-9006M and LS-9030M heads only.

*2 Functions of the LS-9006 (M) and LS-9030 (M) heads only.
Enhanced durability and reliability

High durability design
Constructed with no moving parts, this design offers enhanced service life.

Huge reduction of maintenance time
With no motor to introduce wear and a long lifespan LED, minimal maintenance is required.

<table>
<thead>
<tr>
<th></th>
<th>LS-9000 Series</th>
<th>Existing systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor durability</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Light source durability</td>
<td>✓</td>
<td>×</td>
</tr>
</tbody>
</table>

Our proprietary wear-free construction
By using a high intensity green LED to generate the measurement beam, laser degradation typical with traditional systems is completely avoided. In addition, as the entire beam is generated with no moving parts, there is no motor or mirror system to wear out or replace.
Stable measurements in harsh environments

The effects of water, dust, and oil mist on the measurement value are eliminated.

**IP67 construction + air purge unit**

Best in class environmental resistance design

The system enclosure maintains an IP67 rated protection for all internal components. In addition, the LS-9000 series heads come standard with a built in air purge mechanism* to further enhance the system’s resistance to environmental influence.

**Extreme resistance to shock and temperature drift**

Revolutionary design eliminates the influence of shock and temperature fluctuations on the measurement value.

**Measurement error in an oil mist environment**

With an averaging frequency of 512 times, measured when ø1.0 mm 0.04" pin gauges were moved in the direction of the measurement range.

<table>
<thead>
<tr>
<th>Measurement position (µm inch)</th>
<th>LS-9000</th>
<th>Conventional Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>-500</td>
<td>-3.00E-5</td>
<td>-2.00E-5</td>
</tr>
<tr>
<td>-400</td>
<td>-2.00E-5</td>
<td>-1.00E-5</td>
</tr>
<tr>
<td>-300</td>
<td>-1.00E-5</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>-200</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>-100</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>0</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>100</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>200</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>300</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
<tr>
<td>400</td>
<td>0.00E-0</td>
<td>0.00E-0</td>
</tr>
</tbody>
</table>

* Results reproduced in an in-house simulation of measurement in an oil mist environment.

**Outer diameter measurement error due to temperature fluctuations**

ø10 mm 0.39" pin gauges were measured an average of 512 times.

Measurement model: LS-9000

<table>
<thead>
<tr>
<th>Elapsed time (min.)</th>
<th>Error (µm inch)</th>
<th>Temperature (°C °F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
<tr>
<td>5</td>
<td>0.00E-0</td>
<td>22.17 ± 0.498</td>
</tr>
<tr>
<td>10</td>
<td>0.00E-0</td>
<td>22.74 ± 0.495</td>
</tr>
<tr>
<td>15</td>
<td>0.00E-0</td>
<td>24.31 ± 0.503</td>
</tr>
<tr>
<td>20</td>
<td>0.00E-0</td>
<td>25.88 ± 0.502</td>
</tr>
<tr>
<td>25</td>
<td>0.00E-0</td>
<td>27.45 ± 0.501</td>
</tr>
<tr>
<td>30</td>
<td>0.00E-0</td>
<td>27.77 ± 0.501</td>
</tr>
<tr>
<td>35</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
<tr>
<td>40</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
<tr>
<td>45</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
<tr>
<td>50</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
<tr>
<td>55</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
<tr>
<td>60</td>
<td>0.00E-0</td>
<td>24.71 ± 0.504</td>
</tr>
</tbody>
</table>

**Die-cast housing + designed for optical unit protection**

**Hardened housing protects internal construction**

The outer die-cast body has been mechanically isolated from the internal optical unit so that the outer body absorbs shocks and temperature variations, protecting the internal optics. Meets the IEC 68-2-29 standard (15G/6 ms) for shock resistance.

Image of the receiver’s internal construction

* The air purge unit is sold as an optional accessory only for the LS-9120M head.
Software simplifies setup and analysis

Computer software solves conventional difficulties in setting and measuring

Conventional measurement system
- Setting each device separately is time-consuming
- Original settings are easily lost
- Controller setup is complicated and hard to understand
- Difficult to verify measurement setup
- Needs a separate recorder to save data

The LS-Navigator2 setup and diagnostics software simplifies and streamlines setup. (OPTIONAL)

Easy setting and backup

Easy visual setting
Measurement details can be selected from a picture, so settings are simple, even for a novice. Setting details are stored on the computer as backup files.

Customize your display

Multi-function measurement display
Support software features 12 independent display tools that let you customize your display. View any and all of the information you need on a single screen to maximize efficiency.

Automatically record data

High-capacity data storage
With a storage capacity of 400,000 points, it is easy to record output data without external units. This data can then easily be exported to Excel.
New measurement functions make previously unobtainable measurements easy

**Ultra-thin outer diameter and ultra-thin gap measurement**

Specialized ultra-fine diameter / gap tool now allows measurement of previously undetectable gaps and diameters.

<table>
<thead>
<tr>
<th>Smallest detectable object</th>
<th>Standard mode</th>
<th>Ultra-thin mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mm 0.24&quot; type</td>
<td>40 μm 0.00157&quot;</td>
<td>10 μm 0.00039&quot;</td>
</tr>
<tr>
<td>30 mm 1.18&quot; type</td>
<td>300 μm 0.01181&quot;</td>
<td>80 μm 0.00315&quot;</td>
</tr>
</tbody>
</table>

* Functions of the LS-9006 (M) and LS-9030 (M) heads only.

**Irregular surface cancellation**

Irregular surface cancellation allows for proper outer diameter inspection of parts with complex profiles such as key slots or D-cuts.

**16-channel simultaneous measurement**

With up to 16 simultaneous outputs, it is possible to measure any combination of diameters, positions, gaps, etc. to meet your needs.

**Difference function**

Detecting only abrupt changes allows detection of irregularities on the target surface.

**Terminal operation monitoring**

Ability to monitor live terminal I/O status with manual test data output greatly simplifies setup and troubleshooting.

**Multi-point calibration**

Up to 8 points can be adjusted and scaled allowing multiple targets with differing diameters to be measured more precisely.
Various communication interfaces

Field Network for easy communication

Various control options possible via PLC

High-speed digital communication

Feedback control through various communication methods

Simultaneous output from 4 BCD channels

Expansion units
- Head expansion unit LS-HA100
- EtherNet/IP™ unit CB-EP100
- PROFIBUS unit CB-PN100
- BCD output unit CB-BD100

HMI / Display
- Display panel stand
- Overlay switch

Cables
- Head extension cable CB-B10E (5 m 16.4')
- Transmitter-receiver cable CB-B20E (10 m 32.8')
- Display panel cable OP-87602 (2 m 6.6')
- OP-87603 (5 m 16.4')
- OP-87604 (10 m 32.8')
- OP-87605 (20 m 65.6')
- Display panel stand OP-87611
- Display and settings panel LS-D1000

Options
- Head expansion unit
- EtherNet/IP™ unit
- PROFIBUS unit
- BCD output unit
- Replacement air purge unit
- Replacement glass
- Target positioning jig
- 40 m 131.2’ extension connection unit
- Display panel protection sheet (Set of 5 sheets)
- Display panel stay

Head cable CB-810 (10 m 32.8')

Required
- Controller LS-9501(P)
- Controller line-up
  - NPN output type: LS-9501
  - PNP output type: LS-9501P

When connected with a display and settings panel
- Display panel cable OP-87602 (2 m 6.6')
- OP-87603 (5 m 16.4')
- OP-87604 (10 m 32.8')
- OP-87605 (20 m 65.6'

When connected with a PC
- USB cable OP-96844
- Ethernet cable OP-66843 (3 m 9.8')

Measured values, judgment values and positions can be seen at a glance on the display panel. A maximum of 4 displays can be connected.

Measured values, judgment values and positions can be seen at a glance on the display panel. A maximum of 4 displays can be connected.
**LS-9000 Series**

**Sensor head lineup**

More accurate measurement for small-diameter targets

Standard type offers both high speed and high precision

Measures large-diameter workpieces of up to 120 mm 4.72" in size

Uses two axes to perform highly accurate measurements of small-diameter workpieces

Achieves high-speed and high-accuracy with two axes

<table>
<thead>
<tr>
<th>Small diameter type</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-9000M (with monitor camera)</td>
<td>0.01 to 6 mm 0.0004&quot; to 0.24&quot;</td>
<td>0.01 mm 0.0004&quot;</td>
<td>±0.03 μm</td>
<td>±0.5 μm ±0.00002&quot;</td>
</tr>
<tr>
<td>LS-9006 (without monitor camera)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard type</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-9000M (with monitor camera)</td>
<td>0.08 to 30 mm 0.003&quot; to 1.18&quot;</td>
<td>0.08 mm 0.003&quot;</td>
<td>±0.1 μm ±0.000004&quot;</td>
<td>±2 μm ±0.00008&quot;</td>
</tr>
<tr>
<td>LS-9030 (without monitor camera)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Large diameter model</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-9000M (without monitor camera)</td>
<td>0.04 to 6 mm 0.002&quot; to 0.24&quot;</td>
<td>0.04 mm 0.002&quot;</td>
<td>±0.03 μm</td>
<td>±0.5 μm ±0.00002&quot;</td>
</tr>
<tr>
<td>Lahore</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- LS-9006M (with monitor camera)
- LS-9006 (without monitor camera)
- LS-9030M (with monitor camera)
- LS-9030 (without monitor camera)
- LS-9120M (with monitor camera)
- LS-9006D (without monitor camera)
- LS-9030D (without monitor camera)

More accurate measurement for small-diameter targets

Standard type offers both high speed and high precision

Measures large-diameter workpieces of up to 120 mm 4.72" in size

Uses two axes to perform highly accurate measurements of small-diameter workpieces

Achieves high-speed and high-accuracy with two axes

<table>
<thead>
<tr>
<th>Small diameter type</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-9000M (with monitor camera)</td>
<td>0.01 to 6 mm 0.0004&quot; to 0.24&quot;</td>
<td>0.01 mm 0.0004&quot;</td>
<td>±0.03 μm</td>
<td>±0.5 μm ±0.00002&quot;</td>
</tr>
<tr>
<td>LS-9006 (without monitor camera)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard type</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-9000M (with monitor camera)</td>
<td>0.08 to 30 mm 0.003&quot; to 1.18&quot;</td>
<td>0.08 mm 0.003&quot;</td>
<td>±0.1 μm ±0.000004&quot;</td>
<td>±2 μm ±0.00008&quot;</td>
</tr>
<tr>
<td>LS-9030 (without monitor camera)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Large diameter model</th>
<th>Measuring range</th>
<th>Smallest detectable object</th>
<th>Repeatability</th>
<th>Measurement accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-9000M (without monitor camera)</td>
<td>0.04 to 6 mm 0.002&quot; to 0.24&quot;</td>
<td>0.04 mm 0.002&quot;</td>
<td>±0.03 μm</td>
<td>±0.5 μm ±0.00002&quot;</td>
</tr>
<tr>
<td>Lahore</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- LS-9006M (with monitor camera)
- LS-9006 (without monitor camera)
- LS-9030M (with monitor camera)
- LS-9030 (without monitor camera)
- LS-9120M (with monitor camera)
- LS-9006D (without monitor camera)
- LS-9030D (without monitor camera)
### Specifications

#### Head (Small-diameter model/Standard model/Large-diameter model)

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-9006M (with monitor camera)</th>
<th>LS-9006 (without monitor camera)</th>
<th>LS-9030M (with monitor camera)</th>
<th>LS-9030 (without monitor camera)</th>
<th>LS-9120M (without monitor camera)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement range</strong></td>
<td>0.04 mm (0.001”) to 6.6 mm (0.26”)</td>
<td>0.01 mm (0.0004”) to 0.4 mm (0.01”)</td>
<td>0.3 mm (0.001”) to 30 mm (1.18”)</td>
<td>0.5 mm (0.002”) to 1.18 mm (0.045”)</td>
<td>8.8 mm (0.35”) to 45 mm (1.77”)</td>
</tr>
<tr>
<td><strong>Smallest detectable object</strong></td>
<td>0.04 mm (0.001”)</td>
<td>0.01 mm (0.0004”)</td>
<td>0.3 mm (0.001”)</td>
<td>0.5 mm (0.002”)</td>
<td>8.8 mm (0.35”)</td>
</tr>
<tr>
<td>Transmitter/receiver distance</td>
<td>60 ±5 mm ±0.2”</td>
<td>160 ±40 mm ±0.3”</td>
<td>400 ±100 mm ±0.5”</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>±0.03 μm <strong>1</strong></td>
<td>±0.1 μm ±0.00004” <strong>2</strong></td>
<td>±0.3 μm ±0.00012” <strong>2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measurement accuracy</strong></td>
<td>±0.5 μm ±0.00002” <strong>3</strong></td>
<td>±2 μm ±0.00008” <strong>4</strong></td>
<td>±8 μm ±0.00031” <strong>6</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **1** Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area using outer diameter mode.
- **2** Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area using outer diameter mode.
- **3** Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area.
- **4** Margin of error when measuring a ø40 mm ø1.57” rod in the center of the measurement area using outer diameter mode.
- **5** Margin of error when measuring a ø1.0 mm ø0.04” rod in the center of the measurement area.
- **6** Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area.
- **7** The sampling cycle is changed by the number of OUT set, and by the use of the mutual interference prevention function.
- **8** The value of ±2 when the position of a rod ø10 mm ø0.39” is measured at the center of the measuring area while the number of averaging measurements is set to 128.

#### Head (2-axis small-diameter model/2-axis standard model)

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-9006D</th>
<th>LS-9030D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement range</strong></td>
<td>0.04 mm to ø6.6 mm</td>
<td>0.01 mm to ø6.6 mm</td>
</tr>
<tr>
<td><strong>Smallest detectable object</strong></td>
<td>0.04 mm ±0.001”</td>
<td>0.3 mm ±0.001”</td>
</tr>
<tr>
<td>Transmitter/receiver distance</td>
<td>16000 samples/sec.</td>
<td>16000 samples/sec.</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>±0.03 μm <strong>1</strong></td>
<td>±1 μm ±0.00004” <strong>2</strong></td>
</tr>
<tr>
<td><strong>Measurement accuracy</strong></td>
<td>±0.5 μm ±0.00002” <strong>3</strong></td>
<td>±2 μm ±0.00008” <strong>4</strong></td>
</tr>
</tbody>
</table>

**Notes:**
- **1** Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area using outer diameter mode.
- **2** Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area using outer diameter mode.
- **3** Margin of error when measuring a ø40 mm ø1.57” rod in the center of the measurement area using outer diameter mode.
- **4** Margin of error when measuring a ø1.0 mm ø0.04” rod in the center of the measurement area using outer diameter mode.
- **5** Margin of error when measuring a ø40 mm ø1.57” rod in the center of the measurement area using outer diameter mode.
- **6** Margin of error when measuring a ø1.0 mm ø0.04” rod in the center of the measurement area using outer diameter mode.

#### Controller

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-9501</th>
<th>LS-9501P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of connectable sensor heads</strong></td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>Minimum display unit: 0.01 μm</td>
<td>Dynamic range: ±19999.99 µm to ±1999.9 mm ±0.005” to ±0.093”</td>
</tr>
<tr>
<td><strong>Input terminal</strong></td>
<td>Synchronous, 1, 2 input</td>
<td>Non-voltage input</td>
</tr>
<tr>
<td><strong>Output terminal</strong></td>
<td>Voltage input</td>
<td>Voltage input</td>
</tr>
<tr>
<td><strong>Universal output</strong></td>
<td>NPN/PNP open-collector output, voltage output (5 V / 24 V), line-driver output</td>
<td></td>
</tr>
<tr>
<td><strong>Status 1, 2, output</strong></td>
<td>Non-voltage output + 4 inputs</td>
<td>Voltage input + 4 inputs</td>
</tr>
<tr>
<td><strong>Output interface</strong></td>
<td>Analog voltage output: ±10 V ±2 outputs, output impedance 100 Ω</td>
<td></td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td>4 to 20 mA × 2 outputs, compatible load max. 350 Ω</td>
<td></td>
</tr>
<tr>
<td><strong>Environment resistance</strong></td>
<td>Ambient temperature: 0 to +45°C ±113°F</td>
<td></td>
</tr>
<tr>
<td><strong>Relative humidity</strong></td>
<td>20 to 85% RH (no condensation)</td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>Approx. 4.9 kg</td>
<td></td>
</tr>
</tbody>
</table>

#### Head expansion unit

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-HA100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of connectable sensor heads</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Head compatibility</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>LED display</strong></td>
<td>POWER ON indicator, status indicator</td>
</tr>
<tr>
<td><strong>Analog output</strong></td>
<td>4 to 20 mA ±2 outputs, compatible load max. 350 Ω</td>
</tr>
<tr>
<td><strong>Power source</strong></td>
<td>Supplied from the controller</td>
</tr>
<tr>
<td><strong>Environment resistance</strong></td>
<td>Ambient temperature: 0 to +45°C ±113°F</td>
</tr>
<tr>
<td><strong>Relative humidity</strong></td>
<td>20 to 85% RH (no condensation)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>Approx. 600 g</td>
</tr>
</tbody>
</table>

*1 Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area using outer diameter mode.
*2 Margin of error when measuring a ø10 mm ø0.39” rod in the center of the measurement area using outer diameter mode.

---

**Notes:**
- **1** Add the current consumption values for all units when connecting the display settings panel and expansion units.
### Display and settings panel

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-D1000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Display interface</strong></td>
<td></td>
</tr>
<tr>
<td>Measured value display</td>
<td>Measured value display: 2 colors, 8 digits. 16 segments  OUT number display: Monochrome, 2 digits, 7 segments  Tolerance judgment display: HH, HI, GO, LO, LL, Monochrome  Control status display: TIM, ZERO indicator. Monochrome</td>
</tr>
<tr>
<td>Program number display</td>
<td>Monochrome, 2 digits, 7 segments</td>
</tr>
<tr>
<td>Position monitor display</td>
<td>1D display; 2 colors, 32 levels  2D display; Monochrome, 7 x 7 matrix display</td>
</tr>
<tr>
<td>Display update cycle</td>
<td>1 min. or less.</td>
</tr>
</tbody>
</table>

| Operation interface | Numerical keypad, function key, lock key, timing input key, zero input key, reset input key, escape key, arrow keys (4) |

| Display and settings panel connection port | 2 |

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Supplied from the controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current consumption</td>
<td>0.19 A max.</td>
</tr>
</tbody>
</table>

| Environmental resistance | Ambient temperature: 0 to +50°C (32 to 122°F)  Relative humidity: 20 to 85% RH (no condensation) |

| Enclosure rating | IPES (When panel attached, front surface only) |

| Weight | Approx. 400 g |

### EtherNet/IP™ unit

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-EP100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compatible network</strong></td>
<td>EtherNet/IP™ and displacement sensor-specific protocols (socket communication)</td>
</tr>
</tbody>
</table>

| **Compliant standards** | IEEE 802.3 (10BASE-T), IEEE 802.3u (100BASE-TX), IEEE 802.3 (10BASE-T), IEEE 802.3u (100BASE-TX) |

| **Transmission speed** | 10 Mbps (10BASE-T), 100 Mbps (100BASE-TX) |

| **Transmission media** | STP or Category 3 or higher UTP (10BASE-T), STP or Category 5 or higher UTP (100BASE-TX) |

| **Maximum cable length** | 100 m (328 ft) (Distance between the unit and Ethernet switch) |

| **Maximum number of connectable hubs*1** | 4 hubs (10BASE-T), 2 hubs (100BASE-TX) |

| **Supported functions** | Cyclic communication (implicit messaging), Message communication (Explicit messaging), Compatible with UCMC and Class 3 |

| **Number of connections** | 64 |

| **EtherNet/IP™** | NPI 0.5 ms to 10000 ms (in 0.5 ms) |

| **Tolerable communication bandwidth for cyclic communication** | 6000 pps |

| **Message communication** | UCMC, Class 3 |

| Conformance test | Compatible with Version A8 |

| Power supply voltage | 24 VDC ±10%, including ripple (P-P) (supplied from the controller unit of the laser scanner) |

| Current consumption | 0.12 A max. |

| Environmental resistance | Ambient temperature: 0 to +50°C (32 to 122°F)  Relative humidity: 20 to 85% RH (no condensation) |

| Weight | Approx. 470 g |

*1 The number of connectable hubs is not limited when using a switching hub.

### BCD output unit

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-BD100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LED display</strong></td>
<td>POWER-ON LED</td>
</tr>
</tbody>
</table>

| **Output terminal** | BCD output*1  NPN open-collector output × 4 ports  STP or Category 5 or higher UTP (100BASE-TX) |

| **Input terminal** | OUT selection input  Non-voltage input × 4 inputs |

| **Power source** | Supplied from the controller |
| **Rating** | 0.16 A max. |

| **Environmental resistance** | Ambient temperature: 0 to +50°C (32 to 122°F)  Relative humidity: 20 to 85% RH (no condensation) |

| **Weight** | 800 g |

*1 Up to 1 unit can be connected to the controller.  NPN open-collector output rating: 30 mA max. (30 V max.), residual voltage of 0.5 V max.  Non-voltage input rating: ON voltage of 1 V max., OFF current of 0.6 mA max.  Selectable from BCD output (29 bits, signed), binary output (25 bits, negative numbers are represented by the two’s complement), and judgment output.

### PROFIBUS unit

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-PH100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compatible network</strong></td>
<td>PROFIBUS 10 communication</td>
</tr>
</tbody>
</table>

| **Ethernet** | |
| **Compliant standards** | IEEE 802.3 (10BASE-T), IEEE 802.3u (100BASE-TX) |

| **Transmission speed** | 100 Mbps, full duplex (100BASE-TX) |

| **Transmission media** | STP or Category 3 or higher UTP (10BASE-T), STP or Category 5 or higher UTP (100BASE-TX) |

| **Maximum cable length** | 100 m (328 ft) |

| **Supported functions** | Data I/O communication  Record data communication |

| **Number of connectable PROFIBUS 10 controllers*1** | 1 |

| **Update time** | 2 ms to 2048 ms |

| **SDOML** | Version 2.25 |

| **Conformance class** | Conformance Class A compliant |

| **Conformance version** | Based on Version 2.2.4 |

| **Applicable protocol** | LLDP, DCP |

| **Power supply voltage** | 24 VDC ±10%, including ripple (P-P) (supplied from the controller unit of the laser scanner) |

| **Current consumption** | 0.12 A max. |

| **Weight** | Approx. 470 g |

*1 Although this unit conforms to IEEE 802.3u and can establish 100 Mbps full duplex communication using AutoNegotiation function, it does not have AutoCrossOver and AutoPolarity functions that are normally required for the PROFIBUS 10 standard. Select a straight or cross cable according to the Ethernet port of the device to be connected.

### Specification of Display and settings panel

<table>
<thead>
<tr>
<th>Documentation</th>
<th>Display and settings panel connection port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>LS-D1000</td>
</tr>
<tr>
<td><strong>Display interface</strong></td>
<td></td>
</tr>
<tr>
<td>Measured value display</td>
<td>Measured value display: 2 colors, 8 digits. 16 segments  OUT number display: Monochrome, 2 digits, 7 segments  Tolerance judgment display: HH, HI, GO, LO, LL, Monochrome  Control status display: TIM, ZERO indicator. Monochrome</td>
</tr>
<tr>
<td>Program number display</td>
<td>Monochrome, 2 digits, 7 segments</td>
</tr>
<tr>
<td>Position monitor display</td>
<td>1D display; 2 colors, 32 levels  2D display; Monochrome, 7 x 7 matrix display</td>
</tr>
<tr>
<td>Display update cycle</td>
<td>1 min. or less.</td>
</tr>
</tbody>
</table>

| Operation interface | Numerical keypad, function key, lock key, timing input key, zero input key, reset input key, escape key, arrow keys (4) |

| Display and settings panel connection port | 2 |

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Supplied from the controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current consumption</td>
<td>0.19 A max.</td>
</tr>
</tbody>
</table>

| Environmental resistance | Ambient temperature: 0 to +50°C (32 to 122°F)  Relative humidity: 20 to 85% RH (no condensation) |

| Enclosure rating | IPES (When panel attached, front surface only) |

| Weight | Approx. 400 g |

### Interface

| Interface | USB 2.0 Hi-SPEED supported (USB 1.1 Full-Speed compatible)*5 |

### PROFINET unit

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-PN100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compatible network</strong></td>
<td>PROFIBUS 10 communication</td>
</tr>
</tbody>
</table>

| **Ethernet** | |
| **Compliant standards** | IEEE 802.3 (10BASE-T), IEEE 802.3u (100BASE-TX) |

| **Transmission speed** | 100 Mbps, full duplex (100BASE-TX) |

| **Transmission media** | STP or Category 3 or higher UTP (10BASE-T), STP or Category 5 or higher UTP (100BASE-TX) |

| **Maximum cable length** | 100 m (328 ft) |

| **Supported functions** | Data I/O communication  Record data communication |

| **Number of connectable PROFIBUS 10 controllers*1** | 1 |

| **Update time** | 2 ms to 2048 ms |

| **SDOML** | Version 2.25 |

| **Conformance class** | Conformance Class A compliant |

| **Conformance version** | Based on Version 2.2.4 |

| **Applicable protocol** | LLDP, DCP |

| **Power supply voltage** | 24 VDC ±10%, including ripple (P-P) (supplied from the controller unit of the laser scanner) |

| **Current consumption** | 0.12 A max. |

| **Environmental resistance** | Ambient temperature: 0 to +50°C (32 to 122°F)  Relative humidity: 20 to 85% RH (no condensation) |

| **Weight** | Approx. 470 g |

*1 Although this unit conforms to IEEE 802.3u and can establish 100 Mbps full duplex communication using AutoNegotiation function, it does not have AutoCrossOver and AutoPolarity functions that are normally required for the PROFIBUS 10 standard. Select a straight or cross cable according to the Ethernet port of the device to be connected.
Advanced Optical Micrometer

**LS-7000 Series**

**Sensor head lineup**

High-accuracy measurement of small-diameter targets

<table>
<thead>
<tr>
<th>Small diameter type</th>
<th>LS-7010M (with monitoring function)</th>
<th>LS-7010 (without monitoring function)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>0.04 to 6 mm 0.0016&quot; to 0.24&quot;</td>
<td>0.04 mm 0.0016&quot;</td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.04 mm 0.0016&quot;</td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.06 μm 0.000006&quot;</td>
<td>±0.000006&quot;</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±0.5 μm 0.00002&quot;</td>
<td>±0.00002&quot;</td>
</tr>
</tbody>
</table>

Basic model with high accuracy and long life

<table>
<thead>
<tr>
<th>Standard type</th>
<th>LS-7030M (with monitoring function)</th>
<th>LS-7030 (without monitoring function)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>0.3 to 30 mm 0.01&quot; to 1.18&quot;</td>
<td></td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.3 mm 0.01&quot;</td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.15 μm ±0.000006&quot;</td>
<td></td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±0.5 μm ±0.00002&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Wide measuring range with high accuracy

<table>
<thead>
<tr>
<th>Large diameter type</th>
<th>LS-7070M (with monitoring function)</th>
<th>LS-7070 (without monitoring function)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range</td>
<td>0.5 to 85 mm 0.02&quot; to 2.56&quot;</td>
<td></td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.5 mm 0.02&quot;</td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.2 μm ±0.000008&quot;</td>
<td></td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±3 μm ±0.00012&quot;</td>
<td></td>
</tr>
</tbody>
</table>
Structure without moving parts achieves high durability & long service life

With the LS-7000 Series

<table>
<thead>
<tr>
<th>Low maintenance</th>
<th>First in the world</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No moving parts</strong></td>
<td><strong>Target Monitor</strong></td>
</tr>
</tbody>
</table>

Thanks to KEYENCE’s proprietary optic design there are no moving parts. The use of a LED light source means no errors due to external sources. This combination of no moving parts with a LED light source means it can be used on-site for extended periods without requiring regular maintenance.

**Target Monitor**

The CMOS monitor camera built into the measuring head captures the image of a target, which is displayed on the LCD monitor. Since the measurement condition is visible, target positioning and checking measurement conditions become easier.

**Problems with conventional systems**

**Moving parts deteriorate**

Regular calibration of the polygon mirror and laser was required due to the wear-related deterioration of moving parts.

**Difficult position alignment**

When the target is small or has a complicated shape, it is difficult to check the position of the measurement point, so position alignment took some time.

**Measurement principle**

The green LED light is distributed as a uniform, parallel light and is applied to a target. The edge between the bright and dark area on the CCD is detected and converted to a measured value, such as an outer diameter.

**Principle diagram of laser-scanning method**

A measured value such as an outer diameter is determined by measuring the difference in the timing between bright and dark areas created by the scanning laser beam.

**Target viewer function**

The CMOS monitor camera built into the measuring head captures the image of a target. The measurement condition is visible on the LCD monitor, which can be used for target positioning and measurement condition checking. The measurement area of the current measurement mode is indicated in real time.
### Specifications

#### Measuring head (Small-diameter type/Standard type/Large-diameter type)

<table>
<thead>
<tr>
<th>Type</th>
<th>Small-diameter</th>
<th>Standard</th>
<th>Large-diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>with monitor camera</td>
<td>without monitor camera</td>
<td>with monitor camera</td>
</tr>
<tr>
<td>LS-7010M</td>
<td>LS-7010</td>
<td>LS-7030M</td>
<td>LS-7070M</td>
</tr>
<tr>
<td>Measuring range</td>
<td>0.04 to 6 mm (±0.02)</td>
<td>0.3 to 30 mm (±0.15)</td>
<td>0.5 to 65 mm (±0.25)</td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.04 mm (±0.005)</td>
<td>0.2 mm (±0.01)</td>
<td>0.5 mm (±0.025)</td>
</tr>
<tr>
<td>Transmitter/receiver distance</td>
<td>60 to 500 mm (±5%)</td>
<td>160 to 200 mm (±1%)</td>
<td>250 ± 50 mm (±1%)</td>
</tr>
<tr>
<td>Light source</td>
<td>Sath green LED</td>
<td>Sath green LED</td>
<td>Sath green LED</td>
</tr>
<tr>
<td>CCD scanning range</td>
<td>Approx. 1 mm (±0.002)</td>
<td>Approx. 3 mm (±0.01)</td>
<td>Approx. 5 mm (±0.02)</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±0.5 μm (±0.002)</td>
<td>±3 μm (±0.005)</td>
<td>±0.2 μm (±0.004)</td>
</tr>
<tr>
<td>No. of samples</td>
<td>2400 samples/sec</td>
<td>2400 samples/sec</td>
<td>2400 samples/sec</td>
</tr>
<tr>
<td>Monitor camera</td>
<td>Provided</td>
<td>Not provided</td>
<td>Provided</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to +50°C (No condensation)</td>
<td>0 to +50°C (No condensation)</td>
<td>0 to +50°C (No condensation)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>35 to 85% (No condensation)</td>
<td>35 to 85% (No condensation)</td>
<td>35 to 85% (No condensation)</td>
</tr>
<tr>
<td>Weight</td>
<td>Transmitter: Approx. 140 g</td>
<td>Receiver: Approx. 200 g</td>
<td>Base: Approx. 200 g</td>
</tr>
<tr>
<td>Measurement data output and control I/O, printer (Baud rate can be selected up to 115200 bps.)</td>
<td>NPN open-collector output (±V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistical processing input</td>
<td>Selectable from focus, area check, and differential</td>
<td>NPN open-collector output × 4 outputs</td>
<td></td>
</tr>
<tr>
<td>Analog output</td>
<td>±10 V ± 5% ± 5%</td>
<td>NPN open-collector output (±V)</td>
<td></td>
</tr>
<tr>
<td>Alarm output</td>
<td>NPN open-collector output (±V)</td>
<td>NPN open-collector output (±V)</td>
<td></td>
</tr>
</tbody>
</table>

*1 The error when a moving rod 1 mm (0.04") in diameter is measured within the measuring area of 2 x 4 mm (0.08" x 0.16").
*2 The error when a moving rod 10 mm (0.39") in diameter is measured within the measuring area of 15 x 20 mm (0.59" x 0.79").
*3 The error when a moving rod 20 mm (0.79") in diameter is measured within the measuring area of 20 x 40 mm (0.79" x 1.57").
*4 The value of ±2σ when the outer diameter of a rod 1 mm (0.04") in diameter is measured in the center of the measuring area while the number of averaging measurements is set to 512.

#### Controller

<table>
<thead>
<tr>
<th>Type</th>
<th>High performance</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>LS-7001</td>
<td>LS-7001</td>
</tr>
<tr>
<td>No. of connectable measuring heads</td>
<td>2 (fully compatible for all head types)</td>
<td>2 (fully compatible for all head types except monitor (M) models)</td>
</tr>
<tr>
<td>Measurement display</td>
<td>TFT 5.5-inch LCD display</td>
<td>Main display: 7-segment red LED (Character height: 20.3 mm (0.80&quot;)</td>
</tr>
<tr>
<td>Minimum display unit</td>
<td>0.01 to 100 μm (±0.005%) (7-level selectable)</td>
<td>Linked to minimum display unit setting, mm/μm selectable</td>
</tr>
<tr>
<td>Measurement position monitor</td>
<td>Monitor image (When the measuring head with the monitor function is connected)</td>
<td>7-level display with a red LED</td>
</tr>
<tr>
<td>Tolerance check output display</td>
<td>5-level LED indicator</td>
<td>Green LED (GO), Red LED (± 2.0 mm, LG)</td>
</tr>
<tr>
<td>Alarm output</td>
<td>NPN open-collector output (±V)</td>
<td>NPN open-collector output (±V)</td>
</tr>
<tr>
<td>Comparator ready output</td>
<td>NPN open-collector output for OUT1</td>
<td>NPN open-collector output for OUT2</td>
</tr>
<tr>
<td>Stroke output</td>
<td>Non-voltage input for OUT1</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Synchronous input</td>
<td>Non-voltage input for OUT1</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Auto-zero input</td>
<td>Non-voltage input for OUT1</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Statistical processing input</td>
<td>Non-voltage input + 4 inputs</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Analog output</td>
<td>±10 V ± 5% ± 5%</td>
<td>±10 V ± 5% ± 5%</td>
</tr>
<tr>
<td>5-level comparator output</td>
<td>NPN open-collector output (±V)</td>
<td>NPN open-collector output (±V)</td>
</tr>
<tr>
<td>Comparator ready output</td>
<td>NPN open-collector output (±V)</td>
<td>NPN open-collector output (±V)</td>
</tr>
<tr>
<td>Stroke output</td>
<td>Non-voltage input for OUT1</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Synchronous input</td>
<td>Non-voltage input for OUT1</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Auto-zero input</td>
<td>Non-voltage input for OUT2</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>Statistical processing input</td>
<td>Non-voltage input for OUT2</td>
<td>Non-voltage input for OUT2</td>
</tr>
<tr>
<td>RS-232C interface</td>
<td>Measurement data output and control I/O, printer (Baud rate can be selected up to 115200 bps.)</td>
<td>Measurement data output and control I/O, printer (Baud rate can be selected up to 115200 bps.)</td>
</tr>
<tr>
<td>Video output</td>
<td>Conforming to the NTSC system (PIN connector)</td>
<td>Conforming to the NTSC system (PIN connector)</td>
</tr>
<tr>
<td>Rating**</td>
<td>Power supply voltage</td>
<td>Current consumption</td>
</tr>
<tr>
<td></td>
<td>24 VDC ±10%</td>
<td>1.2 A max</td>
</tr>
<tr>
<td>Environmental resistance</td>
<td>Enclosure rating</td>
<td>Weight</td>
</tr>
<tr>
<td></td>
<td>IP64</td>
<td>Approx. 1,010 g</td>
</tr>
</tbody>
</table>

*1 Either SUB mode or BCD mode can be selected.
*2 The value of ±2σ when the outer diameter of a rod 1 mm (0.04") in diameter is measured in the center of the measuring area while the number of averaging measurements is set to 512.
*3 The rating of the NPN open-collector inside the terminal block is 100 mA max, 400 V max. The terminal voltage of 0.5 V max is the rating of the NPN open-collector inside the controller (100 to 30 mA max, 30 V max), residual voltage of 0.5 V max. The rating of non-voltage input is: OH voltage of 1 V max, OH current of 0.6 mA max.
*4 The value of ±2σ when the outer diameter of a rod 10 mm (0.39") in diameter is measured at the center of the measuring area while the number of averaging measurements is set to 512.
*5 The value of ±2σ when the outer diameter of a rod 10 mm (0.39") in diameter is measured at the center of the measuring area while the number of averaging measurements is set to 512.
*6 The value of ±2σ when the outer diameter of a rod 20 mm (0.79") in diameter is measured at the center of the measuring area while the number of averaging measurements is set to 512.
*7 1200 samples/sec, when the mutual interference prevention function is used.
*8 4000 samples/sec, when the mutual interference prevention function is used.
*9 The connector section is excluded.
**Dimensions**

**LS-7000 Series**

### Measuring head

**LS-7101/LS-7101M**

- Measuring head-controller cable
  - **Model** | **Cable length**
  - LS-C3A | 3 m 9.8"
  - LS-C18A | 10 m 32.8"
  - LS-C38A | 20 m 64.8"

**LS-7070/LS-7070M**

- Measuring head-camera cable
  - **Model** | **Cable length**
  - LS-C3AM | 3 m 9.8"
  - LS-C18AM | 10 m 32.8"
  - LS-C38AM | 20 m 64.8"

- Measuring head-transmitter-receiver cable
  - **Model** | **Cable length**
  - OP-42182 | 1 m 3.9"
  - OP-42183 | 3 m 9.8"

### Controller

**High-performance controller LS-7601**

**Standard controller LS-7001**

**Panel cutout**

### Measuring area

- **Effective display area:** 0.05 to 0.16"

### Performances

**Controller**

- Panel thickness: 1.2 to 4.0"
- Measurement position: ±0.008" ±0.01"
- Measurement area: 40 ±0.2"

**Measuring head**

- Dimensions: 2.76" 0.83" 0.35"
- Dimensions: 0.59" 0.59"

**Cable length: 500 19.69"**

**Camera cable**

- Model: 3 m 9.8"
- Model: 10 m 32.8"
- Model: 20 m 64.8"

**Transmitter-receiver cable**

- Model: 1 m 3.9"
- Model: 3 m 9.8"

**Unit:** mm inch