16,000 Hz sampling rate

A new high precision micrometer system that automatically corrects for target misalignment and vibration
Compare against existing technology

The performance needed for 100% in-line measurement
KEYENCE’s proprietary 3-CMOS x Green-LED measurement system

**LS-9000 3-CMOS x Green-LED system**

Principle: Green-LED light is emitted as a uniform collimated beam. The CMOS detects the position of the edge between light and dark edges of the received light and calculates measured values.

- **Monitor CMOS**: The Monitor CMOS tracks workplace inclination to automatically correct for tilt errors.
- **Target Position CMOS**: The CMOS measures the position between the transmitter and receiver.
- **High-speed exposure CMOS**: Proprietary designed measurement CMOS features an integrated amplifier to maximize performance and speed.
- **High-intensity Green-LED**: High-intensity Green LED lasts longer than traditional LED light sources while providing high intensity and evenly-distributed lighting.

**Conventional Technology**

Laser scan micrometer system

Principle: A semiconductor laser is fired at a rotating polygon mirror and scans through the measurement range. Measured values are calculated by measuring how long the laser is obstructed by the target.
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 outstripping previous systems. Improves production line cycle times and ensures more stable measurement.

1,200 Hz sampling

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

Target alignment and vibration cause errors

Could not 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 was required due to the wear-related deterioration of moving parts.

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 measured values.

No moving parts

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.

With the LS-9000 Series

13.3 times faster than conventional systems
Fastest in its class

Problems with conventional systems

Speed

Stability

Durability

16,000 Hz sampling rate

Active Tilt and Vibration Correction

No moving parts

* LS-5000 Series

NEW

High-speed, Optical Micrometer: the LS-9000 Series

Standard model
LS-9030 (M)

Small diameter model
LS-9006 (M)

Display and settings panel
LS-D1000

Controller
LS-9501 (P)
Enhanced speed and accuracy

3-CMOS System
Three separate CMOS sensors provide advanced inspection capabilities

Even vibrating targets are 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.

Measuring the outer diameter of a high-speed wire

16,000 Hz sampling
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 1,000 m/min. can be measured at a pitch of around 1 mm. Even parts that vibrate at high speeds can be measured stably.

Error in relation to vibrating workpieces
On an average of once, ø1 mm pin gauges were vibrated and measured.

- LS-9006
- Conventional laser scanning system
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.

**Alignment adjustment**

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 measurements.

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.

**Transmitter/receiver direction and position measurement**

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.
Enhanced durability and reliability

High durability design

Constructed with no moving parts, a design that 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>

High-intensity Green-LED x high-efficiency condenser unit

Our proprietary wear-free construction

As a high intensity Green LED is used 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.

---

**Extreme resistance to shock and temperature drift**

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

---

**IP67 construction x air purge unit**

Best in class environmental resistance design

The system enclosure maintains an IP67 rated ingress 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.

---

**Die-cast housing x optical unit protection design**

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 (15 g/6 ms) for shock resistance.
Easy setup and analysis via a computer.

Computer software solves those "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

With the LS-9000 the setting support software LS-Navigator 2 is a standard feature

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
- Multifunction measurement display
  Support software features 12 independent display tools that let you customize your display. View any and all 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 that make previously unobtainable measurements easy

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

<table>
<thead>
<tr>
<th>Smallest detectable object</th>
<th>Standard mode</th>
<th>Ultra-thin mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mm type</td>
<td>40 μm</td>
<td>10 μm</td>
</tr>
<tr>
<td>30 mm type</td>
<td>300 μm</td>
<td>80 μm</td>
</tr>
</tbody>
</table>

- **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, position, gaps, etc. to meet your needs.

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

- **Transparent object/ two-level edge detection threshold value setting**
  Using two-level threshold settings, it is possible to simultaneously measure two targets of differing transparency.

- **Multi-point calibration**
  Up to 8 points can be adjusted and scaled. Multiple targets of differing diameters can be measured more precisely.
A wide variety of interfaces to ensure easy integration

Controller LS-9501 (P)
A variety of I/O to suit on-site needs is a standard feature.

### Controller line-up

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPN output type</td>
<td>LS-9501</td>
</tr>
<tr>
<td>PNP output type</td>
<td>LS-9501P</td>
</tr>
</tbody>
</table>

Setting and support software LS-H2

USB cable OP-66844 (LS-H2 accessory)

HMI / Display

Display panel LS-D1000
Measured values, judgment values and positions can be seen at a glance on the display panel. A maximum of 4 heads can be connected.

Display panel stand OP-87610

Stand switch OP-87611

Expansion units

Head expansion unit LS-HA100
Used when 3 or 4 heads are being used.

Head cable Maximum extension 40 m

Max. of 4 heads can be connected
When an LS-HA100 head expansion unit is connected, a maximum of 4 heads can be connected.

Encoder input

Head expansion unit connector

Head connectors

Display and settings panel connector

Power supply terminal block

RS-232C

USB

Analog

Ethernet

Input terminal block

Output terminal block

Encoder input

Maximum extension

40 m

10
Standard type offers both high speed and high precision

### Standard model
- **LS-9030M** (with monitor camera)
- **LS-9030** (without monitor camera)

<table>
<thead>
<tr>
<th>Feature</th>
<th>LS-9030M</th>
<th>LS-9030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>0.08 to 30 mm</td>
<td>0.08 to 6 mm</td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.08 mm</td>
<td>0.01 mm</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±2 μm</td>
<td>±0.5 μm</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.1 μm</td>
<td>±0.03 μm</td>
</tr>
</tbody>
</table>

### Precise measurement of small diameter workpieces

### Small-diameter model
- **LS-9006M** (with monitor camera)
- **LS-9006** (without monitor camera)

<table>
<thead>
<tr>
<th>Feature</th>
<th>LS-9006M</th>
<th>LS-9006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>0.01 to 6 mm</td>
<td>0.01 to 30 mm</td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.01 mm</td>
<td>0.08 mm</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±0.5 μm</td>
<td>±2 μm</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.03 μm</td>
<td>±0.1 μm</td>
</tr>
</tbody>
</table>

---

**Air purge unit**

(Standard feature)

The LS-9000 Series heads come standard with a built-in air purge mechanism, which prevents dirt adhesion to the sensor head front face.

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**Cables**

- **Head cable**
  - CB-B3 (3 m)
  - CB-B10 (10 m)
- **Head extension cable**
  - CB-B10E (10 m)
  - CB-B20E (20 m)
- **Transmitter-receiver cable**
  - OP-87602 (2 m)
  - OP-87603 (5 m)
  - OP-87604 (10 m)
  - OP-87605 (20 m)
- **Display panel cable**
  - OP-87686 (1 m)
  - OP-87687 (3 m)
- **RS-232C cable**
  - OP-96368 (2.5 m)
- **D-sub-9 pin connector**
  - OP-26401
- **Ethernet cable**
  - OP-66843
- **Extension I/O cable**
  - (3 m)
  - For the BCD output unit
  - OP-51657

**Options**

- **24 VDC power supply**
  - CA-U3
- **40 m extension connection unit**
  - CB-BR01
  - OP-87697 (For the LS-9030)
  - OP-87698 (For the LS-9006)
- **Replacement air purge unit**
  - OP-87695 (For the LS-9030)
  - OP-87696 (For the LS-9006)
- **Replacement glass**
  - OP-87699 (For the LS-9006 transmitter head)
  - OP-87700 (For the LS-9006 receiver head)
- **Display panel protection sheet**
  - (Set of 5 sheets)
  - OP-87729
**Specifications**

### Head

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-9006M</th>
<th>LS-9006</th>
<th>LS-9003M</th>
<th>LS-9030</th>
</tr>
</thead>
<tbody>
<tr>
<td>(with monitor camera)</td>
<td>(without monitor camera)</td>
<td>(with monitor camera)</td>
<td>(without monitor camera)</td>
<td></td>
</tr>
<tr>
<td>Measurement range</td>
<td>0.04 mm (0.01 mm) to 6 mm</td>
<td>0.3 mm (0.06 mm) to 30 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smallest detectable object</td>
<td>0.04 mm (0.01 mm)</td>
<td>0.3 mm (0.06 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmitter/receiver distance</td>
<td>60 ±2 mm</td>
<td>160 ±40 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.03 μm (^{1})</td>
<td>±0.1 μm (^{2})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>±0.5 μm (^{3})</td>
<td>±2 μm (^{4})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling cycle (^{5})</td>
<td>16,000 samples/sec.</td>
<td>4,000 samples/sec.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Light source**

- InGaL green LED

**Monitor camera**

- Provided
- Not provided

**Enclosure rating**

- IP67 (including connector)

**Weight**

- Transmitter: Approx. 130 g
- Receiver: Approx. 330 g
- Base: Approx. 180 g

### Controller

<table>
<thead>
<tr>
<th>Model</th>
<th>LS-9501</th>
<th>LS-9501P</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of connectable sensor heads</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Head compatibility</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Display**

- Encoder input
  - NPN open-collector output, voltage output (5 V / 12 V / 24 V), line-driver output all supported
- LED display
  - POWER ON indicator, ERROR indicator

**Input terminal block**

- Synchronous 1, 2 input
- Auto-zero 1, 2 input
- Reset 1, 2 input
- Storage trigger input
- Storage enable input
- Storage data clear input
- Statistics 1, 2 input
- Statistics clear 1, 2 input
- Program selection input
  - Non-voltage input x 4 inputs
  - Voltage input x 4 inputs

**Output terminal**

- Analog voltage output
  - ±10 V ±2 outputs, output impedance100 Ω
- Analog current output
  - 4 to 20 mA x 2 outputs, compatible load max. 350 Ω
- Universal output
  - NPN open-collector output x 10 outputs
  - Measured value and tolerance judgment output, status output allocatable
- Status 1, 2 output
- Total judgment output
- Memory FULL output
- Strobe 1, 2 output
- Error output
  - NPN open-collector output (N.C.)
  - PNP open-collector output (N.C.)

**Ethernet interface**

- 1000BASE-T/100BASE-TX

**USB interface**

- USB 2.0 Hi-SPEED supported (USB 1.1 Full-SPEED compatible)

**RS-232C interface**

- Measured value output, control I/O, setting change, baud rate can be selected up to 115,200 bps

**Display and settings panel interface**

- RS-232C (Max. four heads connectable)

**Rating**

- Power supply voltage
  - 24 VDC ±10%, including ripple (P-P)
- Current consumption \(^{1}\):
  - When LS-HA100 not used: 1.0 A max.
  - When 1 head connected: 1.3 A max.
  - When 2 heads connected: 1.6 A max.
- Ambient temperature
  - When LS-HA100 not used: 0 to +50°C
  - When LS-HA100 in use: 0 to +45°C
- Relative humidity
  - 20 to 85% RH (no condensation)

**Weight**

- Approx. 1,500 g

---

1. ±2
2. ±2
3. ±2
4. ±2
5. ±2
6. ±2
7. ±2
8. ±2
9. ±2
10. ±2
11. ±2
12. ±2
13. ±2
14. ±2
15. ±2
16. ±2
17. ±2
18. ±2
19. ±2
20. ±2
21. ±2
22. ±2
23. ±2
24. ±2
25. ±2
26. ±2
27. ±2
28. ±2
**OS environment for using the LS-H2 (LS-Navigator 2) Setting Support Software**

<table>
<thead>
<tr>
<th>Item</th>
<th>Required environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>- Windows 7(^1) () - Windows Vista(^2) () - Windows XP (SP or later)(^3)</td>
</tr>
<tr>
<td>Supported languages</td>
<td>Japanese, English, German, Simplified Chinese, Traditional Chinese</td>
</tr>
<tr>
<td>CPU</td>
<td>Core 2 Duo 2 GHz or more</td>
</tr>
<tr>
<td>Memory capacity</td>
<td>2 GB or more</td>
</tr>
<tr>
<td>2 cache memory</td>
<td>12 MB or more</td>
</tr>
<tr>
<td>Free space in hard disk</td>
<td>10 GB or more</td>
</tr>
<tr>
<td>Display</td>
<td>XGA (1024 × 768 pixels) or more, 256 colors or more</td>
</tr>
<tr>
<td>Interface</td>
<td>USB 2.0 Hi-SPEED supported (USB 1.1 Full-SPEED compatible)(^4)</td>
</tr>
</tbody>
</table>

*1 Selectable from BCD output (29 bits, signed), binary output (25 bits, negative numbers are represented by the two's complement), and judgment output.

**BCCD output unit**

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-BD100</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED display</td>
<td>POWER-ON LED</td>
</tr>
<tr>
<td>Output terminal</td>
<td>BCD output (^1) () NPN open-collector output x 4 ports</td>
</tr>
<tr>
<td></td>
<td>NPN open-collector output x 4 ports</td>
</tr>
<tr>
<td></td>
<td>Non-voltage input x 4 inputs</td>
</tr>
<tr>
<td></td>
<td>Supplied from the controller</td>
</tr>
<tr>
<td></td>
<td>Ambient temperature</td>
</tr>
<tr>
<td></td>
<td>Relative humidity</td>
</tr>
<tr>
<td></td>
<td>0 to +50°C</td>
</tr>
<tr>
<td></td>
<td>20 to 85% RH (no condensation)</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 400 g</td>
</tr>
</tbody>
</table>

* 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 BCCD output (29 bits, signed), binary output (25 bits, negative numbers are represented by the two’s complement), and judgment output.

**PROFINET unit**

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-PN100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible network</td>
<td>PROFINET IO communication</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Compliant standards</td>
</tr>
<tr>
<td></td>
<td>IEEE 802.3u(^5)</td>
</tr>
<tr>
<td></td>
<td>IEEE 802.3 (10BASE-T), IEEE 802.3u (100BASE-TX)</td>
</tr>
<tr>
<td>Transmission speed</td>
<td>100 Mbps, full duplex (100BASE-TX)</td>
</tr>
<tr>
<td>Transmission media</td>
<td>STP or Category 5e or higher UTP</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m</td>
</tr>
<tr>
<td>Supported functions</td>
<td>Data I/O communication</td>
</tr>
<tr>
<td>Number of connectable PROFINET IO controllers</td>
<td>1</td>
</tr>
<tr>
<td>Update time</td>
<td>2 ms to 2048 ms</td>
</tr>
<tr>
<td>GSML</td>
<td>Version 2.2.1</td>
</tr>
<tr>
<td>Conformance class</td>
<td>Conformance Class A compliant</td>
</tr>
<tr>
<td>Conformance test version</td>
<td>Based on Version 2.2.4</td>
</tr>
<tr>
<td>Applicable protocol</td>
<td>LLCNP, DLP</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>24 V ±10% () (supplied from the controller unit of the laser scanner)</td>
</tr>
<tr>
<td>Current consumption</td>
<td>0.12 A max.</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 470 g</td>
</tr>
</tbody>
</table>

* 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 PROFINET IO standard. Select a straight or cross cable according to the Ethernet port of the device to be connected.

**EtherNet/IP unit**

<table>
<thead>
<tr>
<th>Model</th>
<th>CB-EP100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible network</td>
<td>EtherNet/IP and displacement sensor-specific protocols (socket communication)</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Compliant standards</td>
</tr>
<tr>
<td></td>
<td>IEEE 802.3 (10BASE-T), IEEE 802.3u (100BASE-TX)</td>
</tr>
<tr>
<td></td>
<td>10 Mbps (10BASE-T), 100 Mbps (100BASE-TX)</td>
</tr>
<tr>
<td>Transmission speed</td>
<td>STP or Category 3 or higher UTP</td>
</tr>
<tr>
<td>Transmission media</td>
<td>STP or Category 6 or higher UTP (100BASE-TX)</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m (Distance between the unit and Ethernet switch)</td>
</tr>
<tr>
<td>Maximum number of connectable hubs (^1)</td>
<td>4 hubs (10BASE-T), 2 hubs (10BASE-TX)</td>
</tr>
<tr>
<td>Supported functions</td>
<td>Cyclic communication (Implicit messaging), Message communication (Explicit messaging), Compatible with UCMN and Class 3</td>
</tr>
<tr>
<td>Number of connections</td>
<td>64</td>
</tr>
<tr>
<td>EPH</td>
<td>0.5 ms to 10000 ms (in 0.5 ms)</td>
</tr>
<tr>
<td>Message communication</td>
<td>UCMN, Class 3</td>
</tr>
<tr>
<td>Conformance test</td>
<td>Compatible with Version A9</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>24 VDC ±10%, including ripple (P-P) () (supplied from the controller unit of the laser scanner)</td>
</tr>
<tr>
<td>Current consumption</td>
<td>0.12 A max.</td>
</tr>
<tr>
<td>Environmental resistance</td>
<td>Ambient temperature</td>
</tr>
<tr>
<td></td>
<td>0 to +50°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>20 to 85% RH (no condensation)</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 470 g</td>
</tr>
</tbody>
</table>

* The number of connectable hubs is not limited when using a switching hub.
Simultaneous measurement of outer diameters and steps at multiple points

High-speed 2D measurement sensor **TM-3000 Series**

### Applications

- **Measuring the runout of a bulb at multiple points**
- **Measuring the largest and smallest diameters of an ampule**
- **Measuring the outer diameters and steps of an injector**
- **Measuring the outer diameter of a drill bit at multiple points**