Mitutoyo

Laser Scan Micrometer <Controller>

LSM-CU-A

User's Manual

- Instructions for use -

Read this document thoroughly before operating the product. After reading, retain it close at hand for future reference.
This English language version of the document contains the original instructions.

MiCAT
Mitutoyo Intelligent Computer Aided Technology
the standard in world metrology software
SENSOR

● For the reading order of the related User's Manuals, see "■ Positioning of this document, document map" on page 4.

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■ Product names and model numbers covered in this document

Product name	Model number
Laser Scan Micrometer <Controller>	LSM-CU-A

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- Read this document thoroughly before operating the product. In particular, be sure to fully understand "Safety Precautions" on page 8 and "Precautions for Use" on page 10.
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About This Document

■ Positioning of this document, document map

This describes the positioning of this document and its relationship with other installments.

Laser Scan Micrometer <Controller> User's Manual (This document)	Describes use of LSMPAK to set up and operate the controller of the Laser Scan Micrometer.
Laser Scan Micrometer <Sensor> User's Manual	Describes the sensor of the Laser Scan Micrometer, including how to connect it to the controller and its specifications.
IF Module <EtherNet/IP> (Optional accessory) User's Manual	Describes the IF module for EtherNet/IP (optional accessory) to be attached to the controller of the Laser Scan Micrometer, including its attachment to the controller and specifications.
IF Module <PROFINET> (Optional accessory) User's Manual	Describes the PROFINET IF module (optional accessory) that is mounted on the controller of the Laser Scan Micrometer, including its attachment to the controller and specifications.
IF Module <EtherCAT> (Optional accessory) User's Manual	Describes the IF module for EtherCAT (optional accessory) that is mounted on the controller of the Laser Scan Micrometer, including its attachment to the controller and specifications.
IF Module <CC-Link IE TSN> (Optional accessory) User's Manual	Describes the IF module for CC-Link IE TSN (optional accessory) that is mounted on the controller of the Laser Scan Micrometer, including its attachment to the controller and specifications.

■ Intended readers and purpose of this document

● Intended readers

This document is intended for operators and administrators of the Laser Scan Micrometer.

The readers are assumed to have been familiar with basic operations on a PC and Windows.

They are also assumed to be able to understand individual instructions by reading the described drawings.

● Purpose

The purpose of this document is to help you to understand the functional overview of the product, the functions of each part, the non-contact type sensor using a laser beam, operation procedures, and maintenance details.

Conventions Used in This Document

■ Safety reminder conventions warning against potential hazards

DANGER	Indicates a hazard with a high level of risk which, if not avoided, **will result in death or serious injury**.
WARNING	Indicates a hazard with a medium level of risk which, if not avoided, **could result in death or serious injury**.
CAUTION	Indicates a hazard with a low level of risk which, if not avoided, **could result in minor or moderate injury**.
NOTICE	Indicates a situation which, if not avoided, **may result in property damage**.
	**Electricity** Alerts the user to a specific hazardous situation that means "Caution, risk of electric shock".
	**Optical radiation** Alerts the user to a specific hazardous situation that means "Caution, risk of high-intensity light".

■ Conventions indicating prohibited and mandatory actions

	Indicates concrete information about prohibited actions.
	Indicates concrete information about mandatory actions.
	Indicates that grounding needs to be implemented.

■ Conventions indicating referential information or reference location

IMPORTANT	Indicates information that must be known when using the product.
Tips	Indicates further information and details relevant for the operating methods and procedures that are explained in that section.
	Indicates reference location if there is information that should be referred to in this document or an extraneous User's Manual. Example: For details about XX, see "■ What to do if a dialog box appears at startup" on page C-4 in "PART B Preparation".

■ Other conventions

( ): Round brackets	Represent a paraphrase of an immediately preceding phrase or a supplementary explanation.
" ": Double quotation marks	Represent a highlighted phrase. They also indicate an index where information to be referenced is described.
[ ]: Square brackets	Represent a menu name on the screen, screen name, dialog name, button, display item, tab name, or key on the keyboard. They also indicate an item to be purposely entered or selected by the customer.
1, **2**, **3**… **1**, **2**, **3**…	Indicates the order and the contents of tasks. (**1** : indicates main tasks, **1**: indicates detailed tasks)
»	Indicates the action resulted from some operation(s).

■ Example of conventions use

2.1.4 I/O Device Connection (if Required)

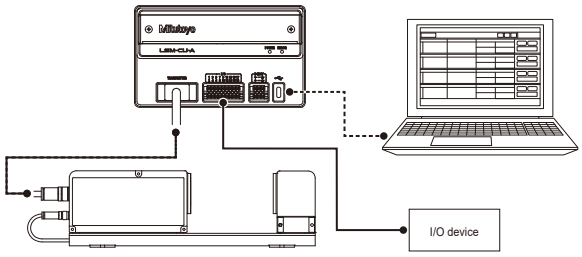
Connect this product to an I/O device using the I/O terminal block.

⚠CAUTION

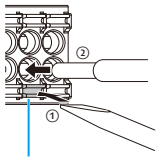
Check that the power to both this product and the I/O device is off, and then connect this product to the I/O device.
Working with this product and I/O equipment while they are energized may result in electric shock.

Tips

- The user is responsible for supplying an I/O cable.
- For details on I/O connectors, see "3.1.1 Terminal Block Connector Specifications" on page D-23 in "PART D Interfaces".



1 Press a flathead screwdriver against the flathead screwdriver slot on the terminal block socket.



Slot for flathead screwdriver

Indicates safety information.

Indicates supplementary information.

Indicates reference to some other document or section.

Indicates an operating procedure to be performed or its outline.

Safety Precautions

Read these "Safety Precautions" thoroughly before operating the product to use it properly.
These safety precautions include such information as to prevent injury to the operator and other persons, damage to property and product defects. Be sure to observe these precautions carefully.

■ Precautions for this product

⚠ DANGER

To prevent electric shocks, strictly observe the following.
Failure to observe these precautions could result in electric shocks or burns, or in some cases death.

- When mounting external devices or optional accessories, turn off the power to the device.
- Ensure that the product is properly grounded.
- Halt the system in case of a malfunction.

- Do not disassemble this product or remove its cover.
  There is a risk of electric shock or burns, and in some cases, death or serious injury. In addition, there is a risk of accidents due to intrusion of material such as metal powder.
- Do not touch the connection terminals with your hands or objects in order to prevent electric shocks due to connection faults.

NOTICE

Securely connect the connectors of the connecting cables for noise isolation.

Tips

Even if an error is displayed while measuring, it does not necessarily indicate a malfunction.
See 📖 "PART F Troubleshooting" on page F-i to check the cause and solution.

■ Precautions for the sensor used with this product

⚠CAUTION

The sensor that is connected to this product uses a visible-light laser beam. Handling this product or sensor in a manner not described in this manual or the 📖 "Laser Scan Micrometer <Sensor> User's Manual" may result in dangerous light exposure.
This product is a "Class 1 laser product" under IEC standard "IEC 60825-1", the safety standard for laser equipment.

- Under no circumstances should you ever remove the laser beam class indicator label attached to the sensor body. Display labels are required warn of the need for caution.

- Do not look into the laser beam-emitting port. Absolutely do not look into the laser beam-emitting port even when no light is being emitted.
- Do not look directly at the laser beam with optical equipment (things which converge light such as magnifying glasses, etc.). In addition, do not allow the light reflected from the flat surfaces to enter into your eyes, when measuring flat surfaces such as mirror surface. Even if the beam hits your skin, it will not particularly be a problem.

Tips

Even if the beam hits your skin, it will not particularly be a problem.

Precautions for Use

■ Use and handling of the product

● Use this product only by connecting to measuring instruments which supports this product.

Do not use this product for measuring instruments which does not support this product.
For measuring instruments supported by this product, see 📖 "2.1 Launching LSMPAK" on page C-3 in "PART C Operation".

● This product is for industrial usage.

Do not use this product for purposes other than for industrial usage.

● This product is a precision instrument.

- Do not subject the product to drastic shocks such as dropping it, or exert excessive force upon it.
- Do not disassemble or modify the product.

If the product is used beyond the conditions indicated in the specifications (📖 "1 Specifications" on page G-1 in "PART G Appendix"), be aware that the functions and performance cannot be guaranteed.

■ Environment for placement

This product is a precision electronic instrument and is designed for indoor use. To obtain the highest accuracy, take into account the following conditions when installing the product. Mitutoyo assumes no responsibility for accidents or failures that result from disregarding the following items.

Use the product in the following places.

- Where there is minimal dust and grit
  Dust or grit in the usage area will adversely affect the mechanical and electronic components inside the product.
- Where there are minimal vibrations
  If the product is going to be used in places where there are lots of vibrations, problems will be generated in the precision components being used, which will cause measuring performance to be impaired.
  If use in a place with vibrations is inevitable, take measures to reduce vibrations, such as laying an anti-vibration rubber mat under the product.
- Where the ambient temperature is from 0 °C through 50 °C
- Where the humidity is from 20 % RH through 85 % RH (without condensation)
- Where the altitude is 2000 m or lower
  If the product is used in places where the altitude exceeds 2000 m, it will cause measuring performance to be impaired.

Do not use or store the product in the following places where the temperature and humidity drastically fluctuate, because the product's functions and measurement results will be adversely affected and it will cause malfunction.

- Where exposed to direct sunlight
  If installing this product in a place exposed to direct sunlight, such as near a window, is inevitable, take measures to shade the product from the sun, such as using a curtain.
- Where extremely hot or cold
- Where there are risks of getting wet

Tips

This product does not conform to the International Protection standard (IP standard). Sensors (LSM-02-A and LSM-30-A) are IP67 rated.

■ Warming-up

IMPORTANT

To achieve measurements with a consistent accuracy, allow the product to warm up for about 30 minutes to an hour after you turn on the power to the product.

■ Maintenance

For the maintenance of this product, see 📖 "2 Cleaning" on page E-3 in "PART E Inspection and Maintenance".

Electromagnetic Compatibility (EMC)

This product complies with the EMC Directive and the UK Electromagnetic Compatibility Regulations; however, if this receives electromagnetic interference that exceeds these requirements, it will be out of warranty and require appropriate measures.

This product is an industrial product, and is not intended to be used in residential environment. If this product is used in residential environment, this product may cause electromagnetic interference with other instruments. In such a case, it is required to take appropriate measures for preventing such electromagnetic interference.

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If you intend re-export of the product from a country other than Japan, re-sale of the product in a country other than Japan, or re-providing of the technology (including Programs), you shall observe the regulations of your country.

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Disposal of Products outside the European Countries

Please follow the official instruction in each community and country.

Disposal of Old Electrical & Electronic Equipment (Applicable in the European Countries with Separate Collection Systems)

This symbol on the product or on its packaging is based on WEEE Directive (Directive on Waste Electrical and Electronic Equipment), and this symbol indicates that this product shall not be treated as household waste.

To reduce the environmental impact and minimize the volume of landfills, please cooperate in reuse and recycle.

For how to dispose of the product, please contact the agent where you purchased the product or a Mitutoyo sales office.

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This product meets China RoHS requirements. See the table below.

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部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
本体	○	○	○	○	○	○
电气设备部分	×	○	○	○	○	○
配件	○	○	○	○	○	○

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- Failure or damage owing to use in combination with hardware or software other than those designated or permitted by Mitutoyo
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https://github.com/PrismLibrary/Prism

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PART A
Overview

This part describes the features of the Laser Scan Micrometer (LSM), its measurement principle, system configuration, names, and the functions of its controller and sensor, and gives an overview of its configuration software (LSMPAK) and help functions.

1 Introduction

The Laser Scan Micrometer (hereinafter, LSM) consists of a sensor, which is a detector, and a controller (this product). In this manual, the set consisting of the sensor and controller (including the IF module if used) are referred to as the "LSM".

Installing "LSMPAK", which is used exclusively for the LSM, on a PC allows device information and measurement conditions to easily be set and measurement results to be monitored on the PC.

This chapter describes the features, measurement principles, etc. of the LSM.

1.1 Features

The LSM is a high-precision, non-contact measuring device capable of measuring length by a high-speed scanning laser beam.

The LSM allows you to easily and accurately measure workpieces that are difficult to measure with conventional instruments; for example:

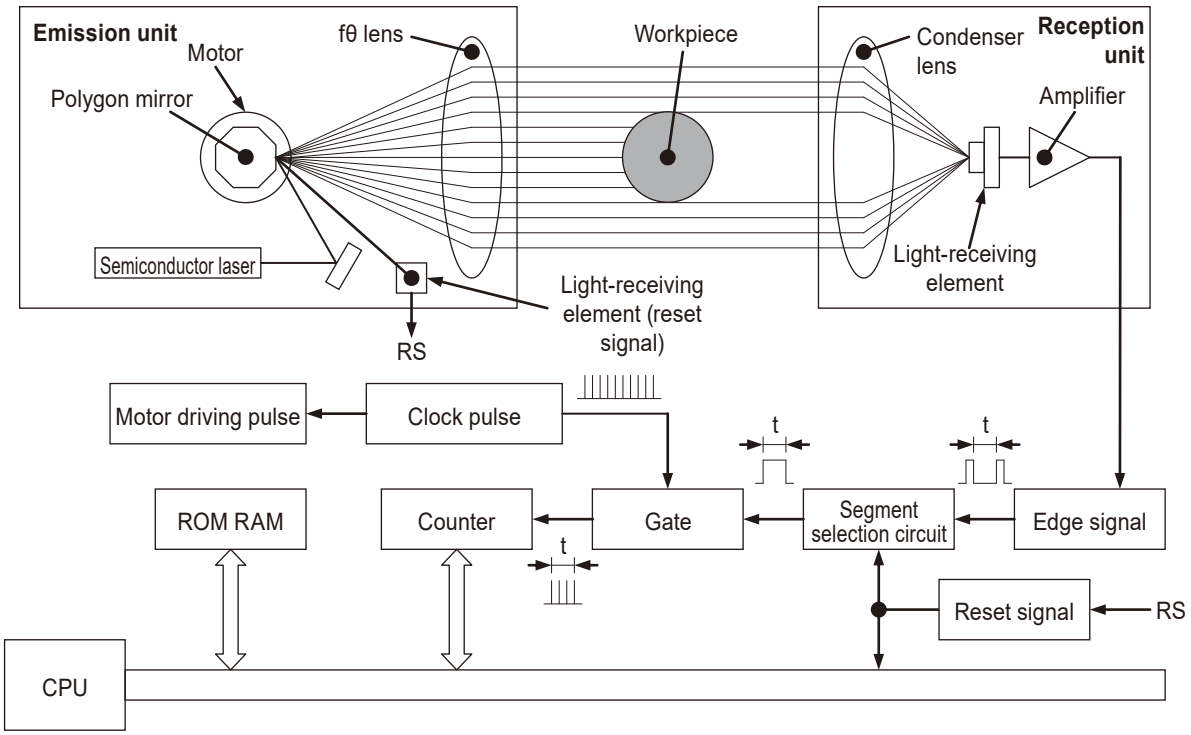
- Workpieces with a hot surface
- Workpieces that should be kept free of damage, deformation, and defacement due to contact
- Soft workpieces for which measuring force is a concern

In addition to dimensional measurement, the following functions are available.

- By using an I/F module (optional), Ethernet communication or industrial network communication can be performed by connecting a PC, PLC, and this product with a LAN cable.
- Scanning signals can be observed with an oscilloscope.
- The position of the workpiece is clearly displayed on LSMPAK.
- Segment measurement or edge measurement can be selected according to your application.
- Statistical calculations can be performed.
- Calculations (average, maximum, minimum, and range) can be performed on sampled measurement values.
- Calculation of measured values (sum, average, standard deviation, difference, range, film thickness) can be performed on multiple LSMs.
- Abnormal values in measurement data can be excluded.
- Communication with external devices is possible using USB or I/O analog interface.

1.2 Measurement Principles

The LSM displays dimensions by measuring the duration in which the ultra-fine parallel laser beam is obstructed by the workpiece to make a shadow.



As indicated in the figure above, the laser beam emitted from the semiconductor laser is reflected by the polygon mirror that rotates at high speed in synchronization with the clock pulse, and is parallelized and focused to minimum diameter at the measuring position by the collimator lens (fθ lens). The laser beam, as a parallel light source, scans the workpiece at high speed, and is converged to the light-receiving element by the condenser lens.

The light-receiving element induces an output voltage according to the light-dark change caused by the laser beam being obstructed by the workpiece. The pulses generated by changes in voltage during the time the laser beam is blocked by the measurement workpiece are counted, processed by the CPU, and output to external devices as dimensions.

This measurement principle enables measurement not only of the workpiece (dark parts) but also clearances between workpieces (light areas). The part to be measured is switched by specifying a segment (a light-dark number).

2 Example of the LSM System Configuration

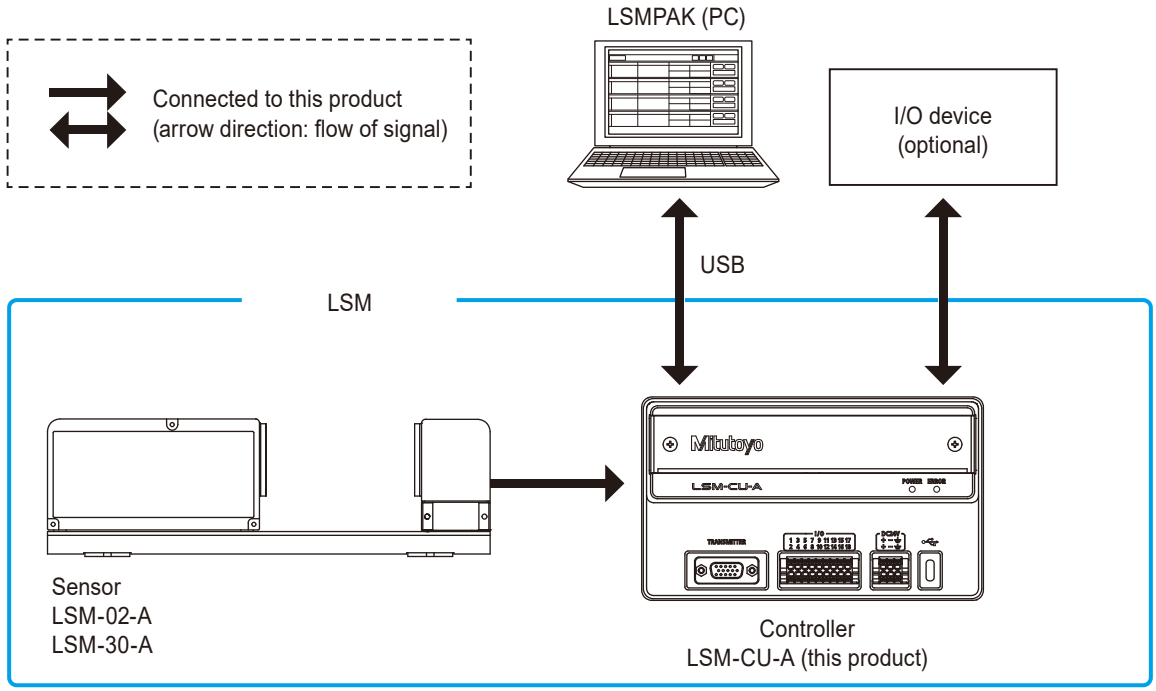
This chapter describes configuration of measurement systems that use LSMs.
For communication, this product is connected to a PC or I/O device with a USB cable.
By connecting an IF module (optional) to this product, Ethernet communication or industrial network communication can also be performed.

■ When using USB communication

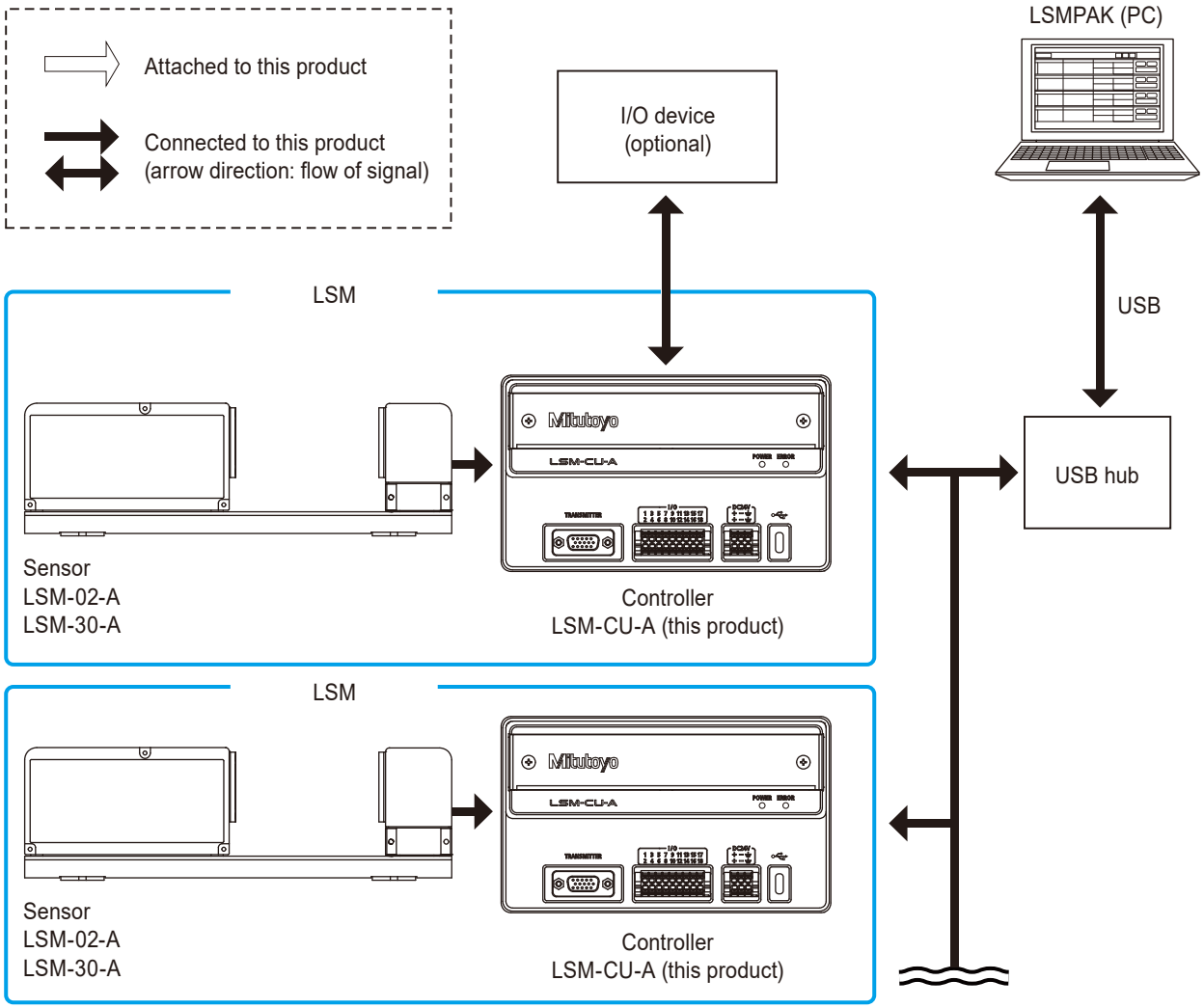
Devices required for system configuration

Device name	Description
Controller	LSM-CU-A (this product)
Sensor	LSM-02-A (0.005 mm–2 mm) or LSM-30-A (0.3 mm–30 mm) can be connected to this product. 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
PC	LSMPAK can be used to make LSM settings and check measurements (up to eight sets). Connect to this product with a USB Type-C cable. When using two or more sets of LSMs, use a USB hub. 📖 "2.1 USB Specifications" on page D-3 in "PART D Interfaces"
I/O device (optional)	Enables output of GO/NG judgments and analog output of measured values. 📖 "■ Analog signal connection specifications" on page D-26 in "PART D Interfaces"

● When using one set of LSM



● When using two or more sets of LSMs



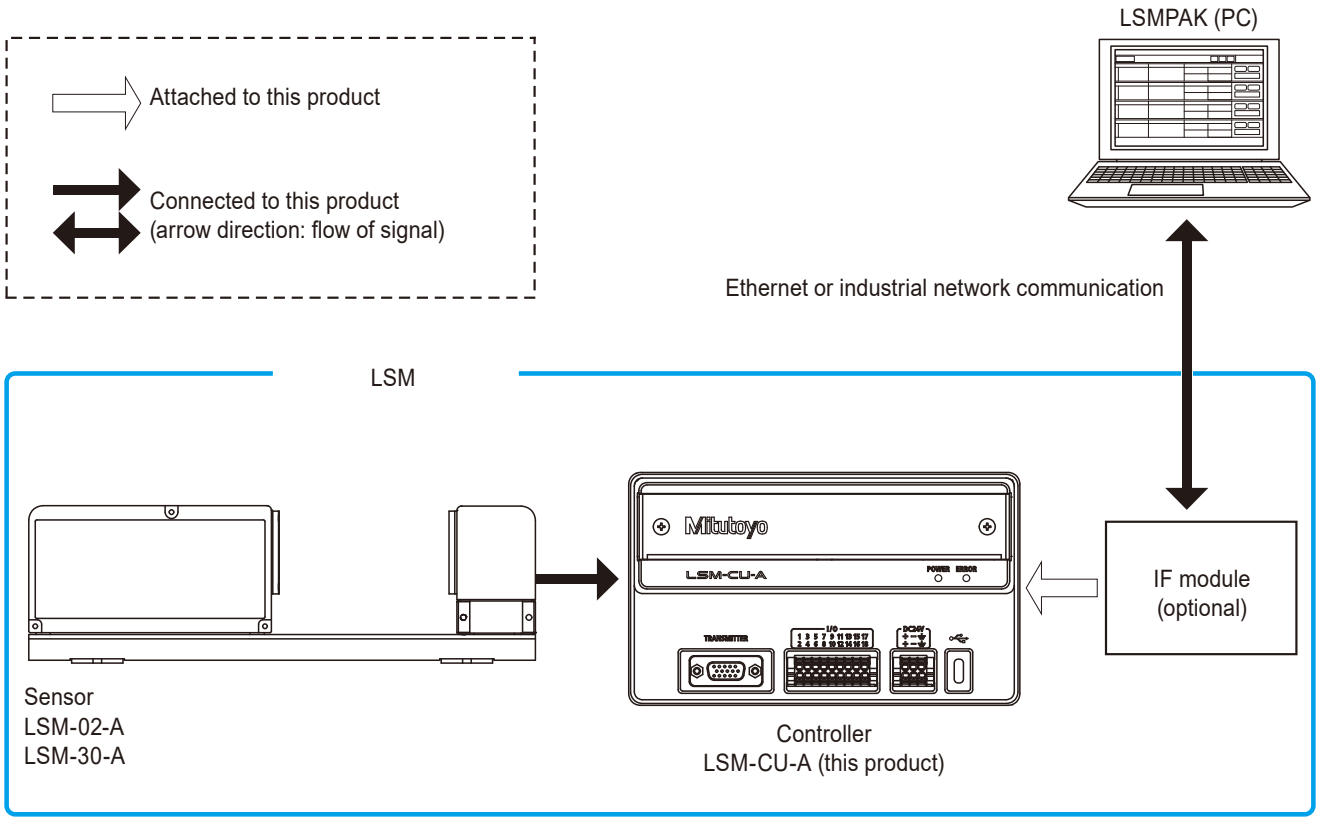
■ When using Ethernet communication or industrial network communication

Devices required for system configuration

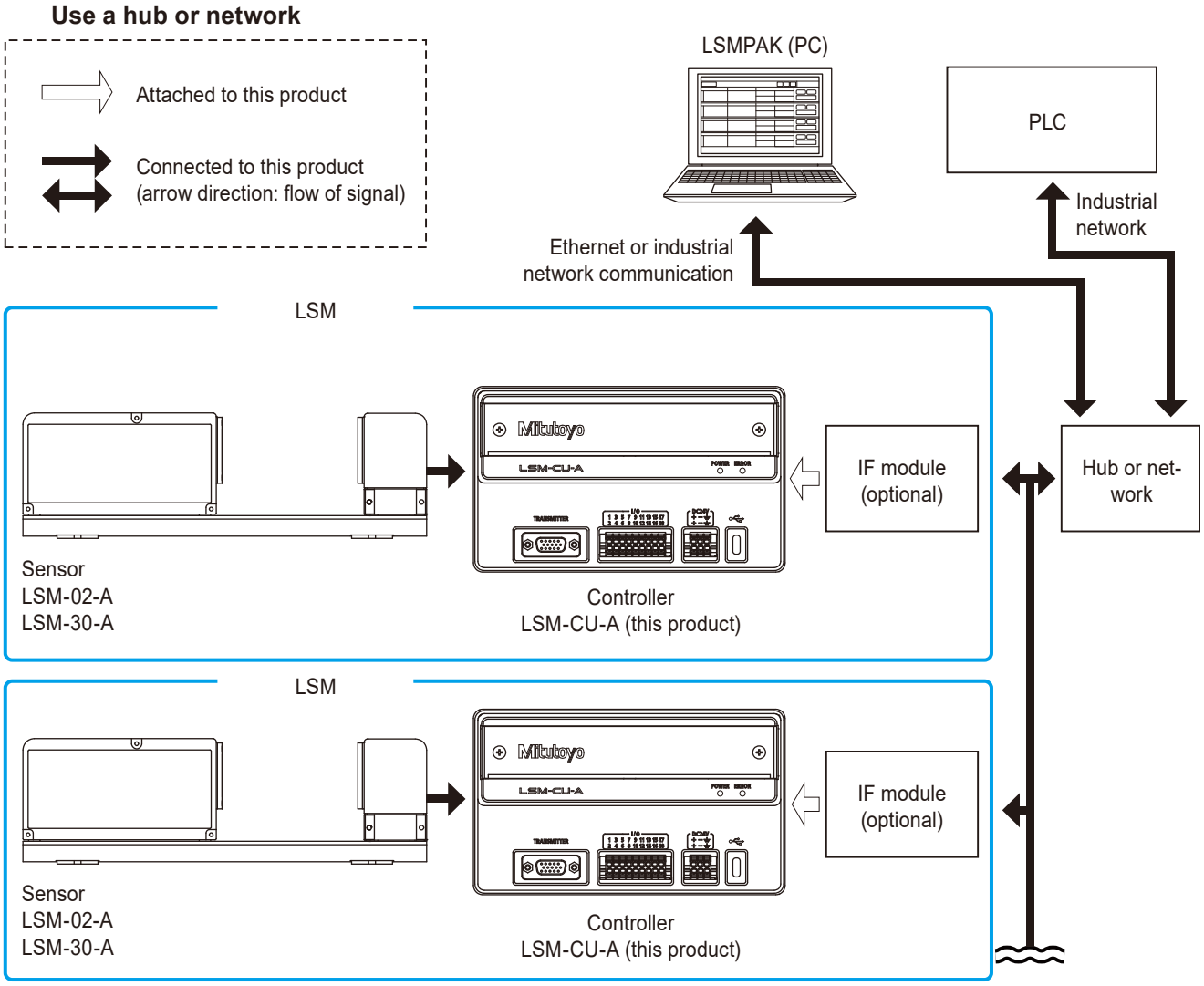
Device name	Description
Controller	LSM-CU-A (this product)
Sensor	LSM-02-A (0.005 mm–2 mm) or LSM-30-A (0.3 mm–30 mm) can be connected to this product. Two types of sensors can be used together. 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
PC	LSMPAK can be used to make LSM settings and check measurements (up to eight sets). Use an STP cable of Cat.5e or higher for connection to this product. When using two or more sets of LSMs, connect them via a hub or network, or dai-sy-chain them.
I/O device (optional)	Enables output of GO/NG judgments and analog output of measured values. 📖 "■ Analog signal connection specifications" on page D-26 in "PART D Inter-faces"

Device name	Description
IF module (optional)	IF modules (optional) are available for EtherNet/IP, PROFINET, EtherCAT and CC-Link IE TSN. Connection to another controller is possible using a LAN cable. "IF Module <EtherNet/IP> User's Manual" (separate document) "IF Module <PROFINET> User's Manual" (separate document) "IF Module <EtherCAT> User's Manual" (separate document) "IF Module <CC-Link IE TSN> User's Manual" (separate document) **IMPORTANT** When using the IF module <EtherCAT>, connect the LSM and LSMPAK via USB. Ethernet connection cannot be used.
PLC (optional)	A PLC can be used to switch parameter sets, collect data, etc.

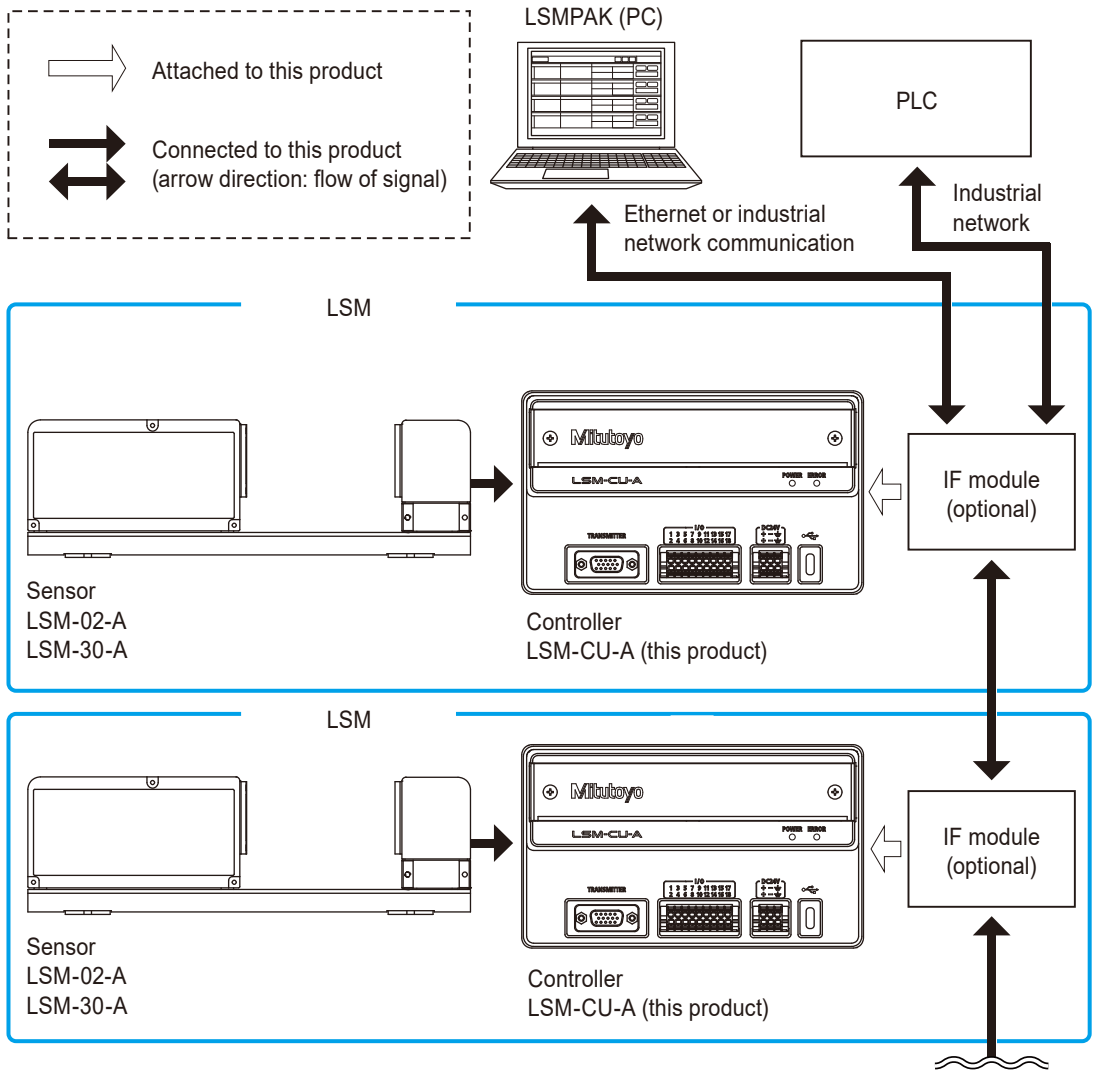
● When using one set of LSM



● When using two or more sets of LSMs



Daisy-chain LSMs with each other



IMPORTANT

When using the LSMPAK with an Ethernet connection, do not make any configuration changes that involve rebooting the equipment while multiple controllers are daisy-chained together. The timing of the reboots may cause the chain to break and cause unexpected behavior.

■ Storage location of settings

Depending on content, settings made with LSMPAK are stored either in the controller or a PC. No settings in particular are stored in the sensor.

IMPORTANT

Calculation conditions and environmental settings are not stored in the controller. If you change the connected PC or PLC, re-set the calculation conditions and environmental settings.

Settings stored in the controller

- Common settings (one set)
- Parameter sets (20 sets)
- Unit settings
- Memorize light amount
- Calibration
- Preset/Offset

Tips

[Calibration] and [Preset/Offset] information is stored in the controller, so keep this in mind when replacing the sensor. After replacing the sensor, re-calibrate and re-set the preset and offset.

Settings stored in PC

- Environmental settings (language, communication method, number of decimal places, and security function)
  See 📖 "3.2 [Environmental setting] Screen" on page C-19 in "PART C Operation".

  Tips

  Unit settings are not saved in LSMPAK. They are saved in the controller.

- Complete set of controller settings*1
- Calculation conditions*1
  See 📖 "4.2 Operational Calibration" on page C-92 in "PART C Operation".
- Measurement history*2

*1 Saved as a file on the PC by LSMPAK's [Save setting file] button. For details, see 📖 "3.3.9 Saving and Loading Settings Files" on page C-69 in "PART C Operation".

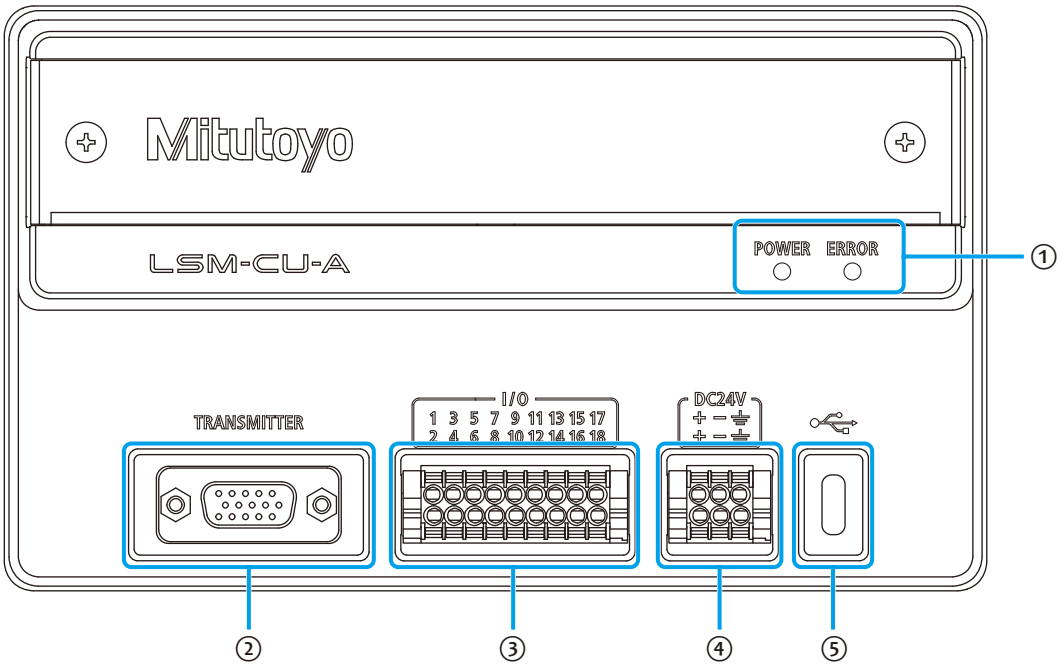
*2 The data is saved as a file on the PC by LSMPAK's [Save measurement data] button. For details, see 📖 "5.4.1 Confirming Measured Values" on page C-108 in "PART C Operation".

3 Part Names and Functions

This chapter describes the name and function of each part of this product.

3.1 Controller

■ Front view



No.	Name	Function
①	LEDs (indicator lamps)	Indicate the status of the LSM. For details, see 📖 "1 Display Check" on page E-1 in the "PART E Inspection and Maintenance" section.
②	Signal cable connector	Connect the sensor signal cable.

<table>
<tr><th>No.</th><th>Name</th><th>Function</th></tr>
<tr><td>③</td><td>I/O terminal block</td><td>A terminal block with I/O and analog outputs.

NOTICE

• Turn off the external power supply before you connect the I/O terminals.
• When wiring, be sure to touch the terminal wires to the metal part of the controller to discharge any static electricity. If you touch the terminal wires to the I/O terminals in the terminal block while your body holds a static electric charge, the internal circuitry could be damaged by an electric discharge.

Do not touch the I/O terminals in the terminal block during operation. Otherwise, an operation error may result.

Tips
• The I/O terminal block socket is included with the controller. Insert the I/O terminal block socket into the I/O terminals before use.
• Pin numbers are printed above the holes for the I/O terminal block. Use them when wiring.</td></tr>
<tr><td>④</td><td>Power supply terminal block</td><td>For connecting the power supply terminals.

⚠CAUTION

• Turn off the external power supply before you connect the I/O terminals.
• When wiring, be sure to touch the terminal wires to the metal part of the controller to discharge any static electricity. If you touch the terminal wires to the I/O terminals in the terminal block while your body holds a static electric charge, the internal circuitry could be damaged by an electric discharge.

Do not touch the I/O terminals in the terminal block during operation. Otherwise, an operation error may result.

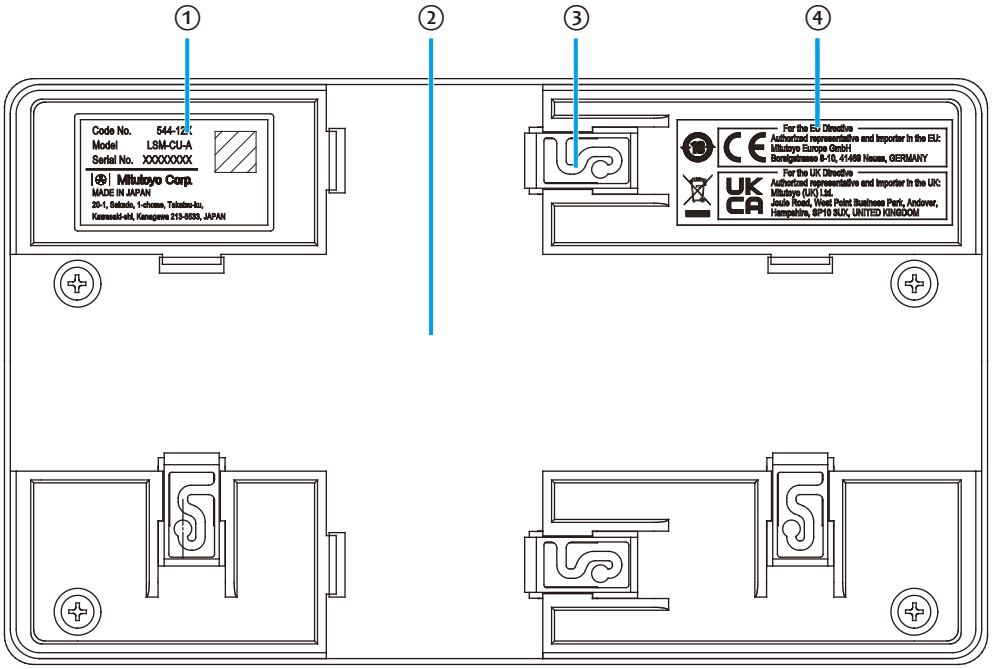
Connect the grounding terminals to the two holes on the right edge of the power supply terminal block.
This helps reduce noise.
📖 "2.1.5 Connection of Power Supply Terminal Wires and Power Supply" on page B-9

Tips
The power supply terminal block socket is included with the controller. Insert the power supply terminal block socket into the power supply terminals before use.</td></tr>
<tr><td>⑤</td><td>USB connector</td><td>For connecting a USB cable (type C).</td></tr>
</table>

Tips

For details on each connector, see 📖 "PART D Interfaces" on page D-i.

■ Rear view



No.	Name	Function
①	Nameplate	Labeled with the code number, serial number, etc.
②	Mounting groove for DIN rail	For mounting a DIN rail. "2 Setup" on page B-3
③	Slide tab for DIN rail	Secures the DIN rail mounted to this product.
④	Regulatory label	Contains information regarding regulations.

MEMO

4 LSMPAK Overview

IMPORTANT

When using LSMPAK to acquire measurements, it cannot be used in conjunction with other tools (such as customer-provided monitoring tools, I/O devices, and PLCs).

LSMPAK is an application that runs on a PC running the Windows operating system.

Used to set measurement conditions, collect measurement values, and manage equipment information in LSMs.

For details on how to install LSMPAK, see 📖 "2.3.1 Installing LSMPAK" on page B-15 in "PART B Preparation".

LSMPAK has a home screen and a detail screen.

The home screen displays a measurement list and various menus.

The detail screen displays the following tabs.

- Setting information
- Measurement history
- Work position
- Memorize light amount
- Calibration
- Preset/Offset

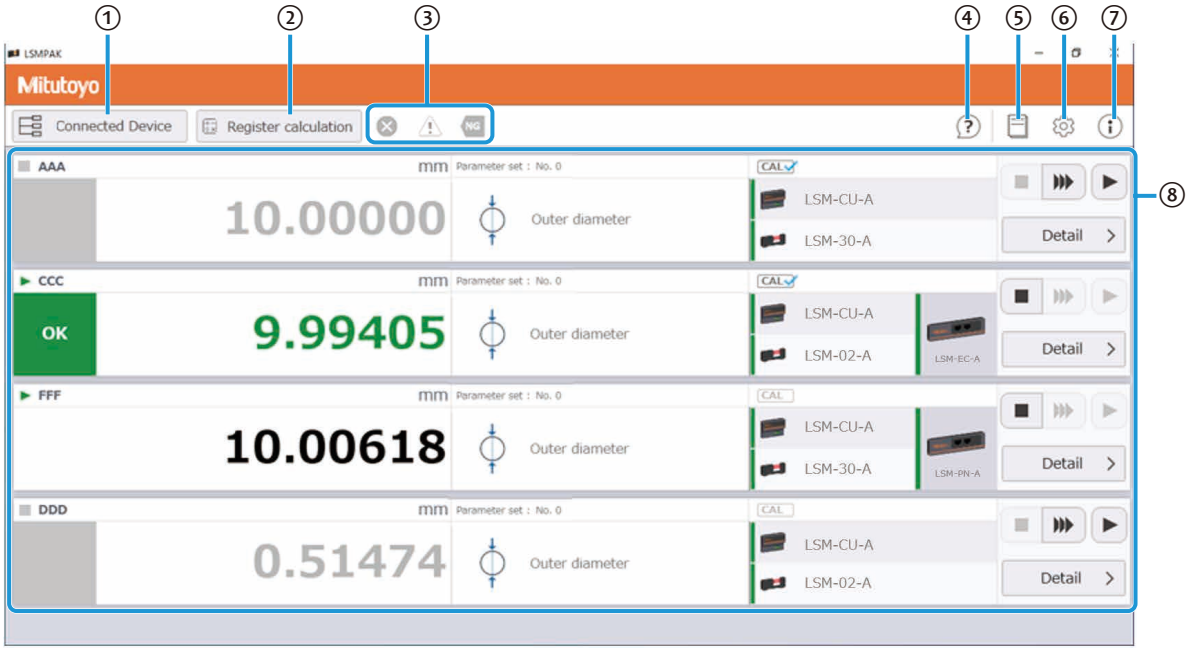
For details on measurement settings, see 📖 "3 Settings" on page C-9 in "PART C Operation".

Tips

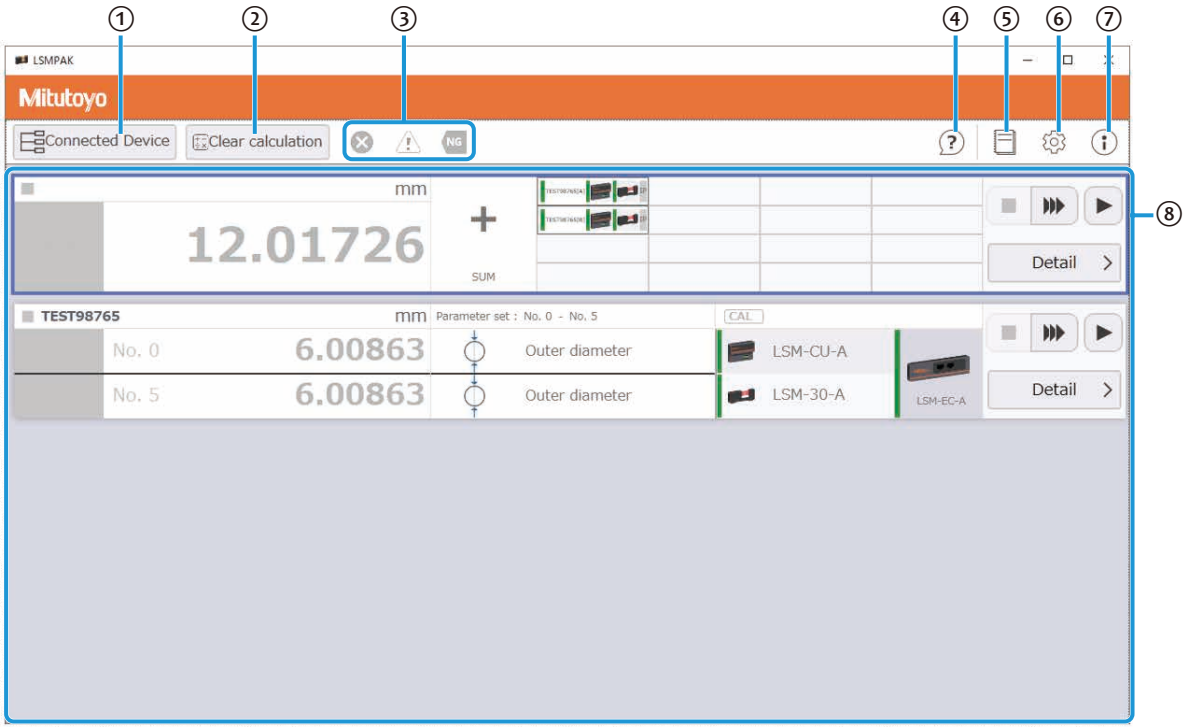
- LSMPAK requires a display with a resolution of 1280 x 768 or higher. On displays with a resolution of less than 1280 × 768, some areas may not be displayed or the layout may be broken.
- LSMPAK does not allow the keyboard to be used to start or stop measurements or to select items.

4.1 Home Screen

Home screen (measurement list screen)



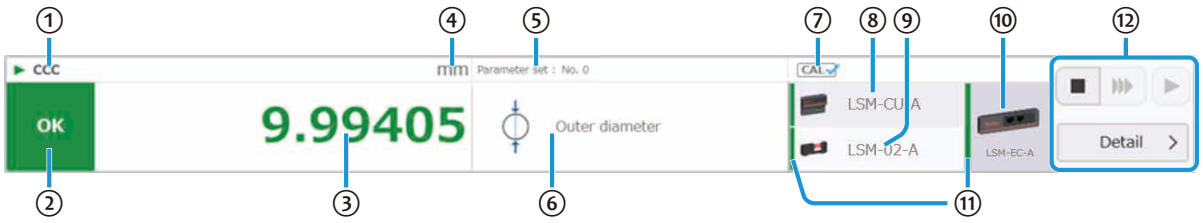
Home screen (measurement list screen) when making calculation settings



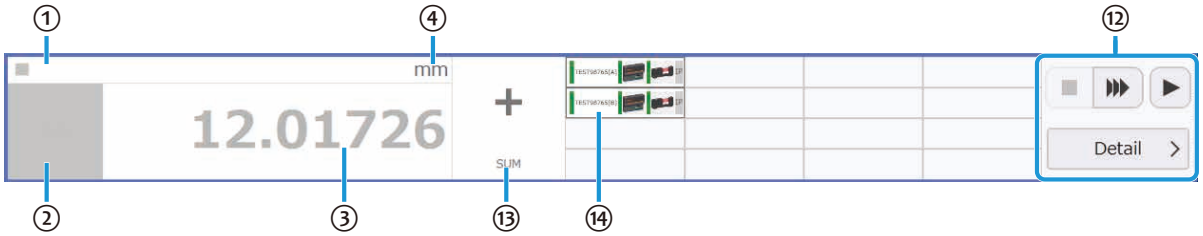
No.	Name	Description
①	[Connected Device] button	Displays a list of controllers, sensors, and IF modules (optional) connected to the PC. 📖 "2.3 Confirming Device Information" on page C-8 in "PART C Operation"
②	[Register calculation] / [Clear calculation] buttons	[Register calculation] button is for calculations of multiple LSM measurements. The [Clear calculation] button appears during calculation registration. **IMPORTANT** • Be sure to use the same sensor model when performing arithmetic operations. • Calculation settings are saved in the PC. Please note that data is not saved in the controller, so be careful when changing PCs. 📖 "■ Storage location of settings" on page A-8 **Tips** For details on the arithmetic operations screen, see 📖 "3.5.1 Register Calculation" on page C-76 in "PART C Operation".
③	Status display area  (Error)  (Warning)  (NG measured)	Displays the corresponding symbol lights and the number of cases when an error, warning or NG measurement occurs. 📖 "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting".
④	Help mode toggle button	Turns the help mode display on or off. 📖 "4.3 Help Function" on page A-29
⑤	Manual display button	Displays this User's Manual in PDF format.
⑥	Environmental setting display button	Displays the Environmental setting screen. Set language and security function. 📖 "3.2 [Environmental setting] Screen" on page C-19 in "PART C Operation"
⑦	LSMPAK information button	Displays LSMPAK version information.
⑧	Measurement list	Displays a list of measurement information. For details on displayed measurement information, see 📖 "● Contents displayed in the measurement information" on page A-16

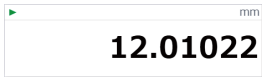
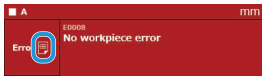
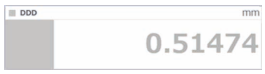
● Contents displayed in the measurement information

For individual measurements



If calculation is set

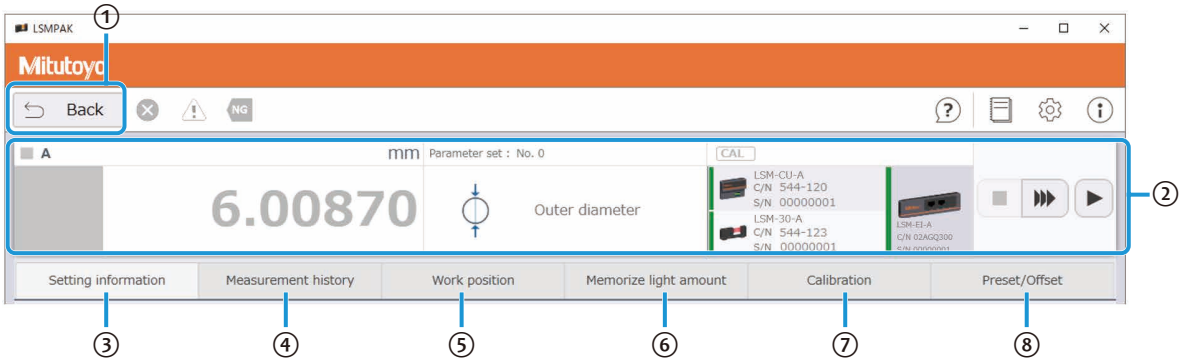


No.	Description
①	Displays a name (label) to identify each item of measurement information.
②	Displays GO/NG judgment results. The background color changes according to the measurement status.  If the GO/NG judgment results in GO, it is displayed in green.  If the GO/NG judgment results in NG (fail), it is displayed in red. The gage indicates whether the measured value is +NG (NG above the upper limit) or -NG (NG below the lower limit). Gage  If GO/NG judgment is not used, it is displayed in black.  If there is an error, it is displayed in red, and the error number and error name are shown. Click the icon to display the PDF instruction manual (this manual).  When the unit is in the measurement-ready state for measurement, it is displayed in gray.
③	Displays measured values.
④	Displays the unit.
⑤	Displays the parameter set number.
⑥	Displays measurement items (outer diameter, runout, gap, etc.).
⑦	Displays the calibration status. Calibration completed: CAL Calibration not completed: CAL
⑧	Displays the model name of the controller.
⑨	Displays the model name of the sensor.

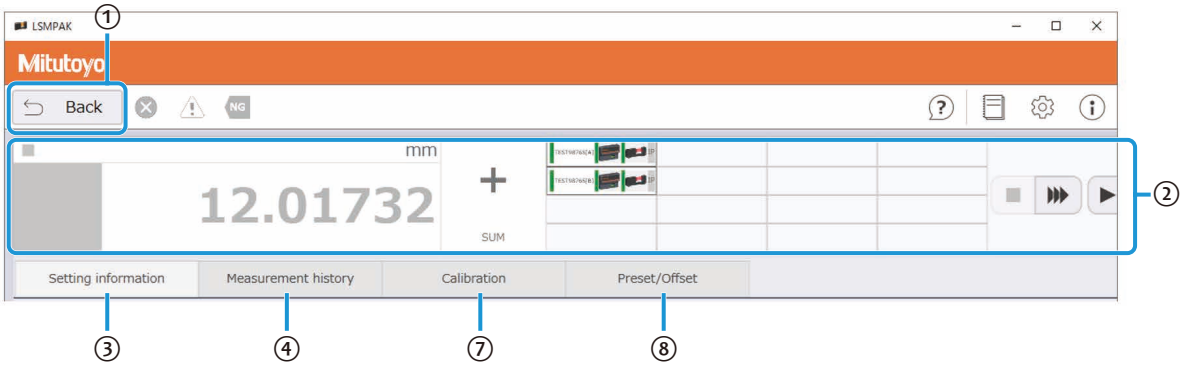
No.	Description
⑩	If the controller is equipped with an IF module (optional), also displays the model name of the IF module.
⑪	Displays the status of each device. Green: The LSM is operating normally. Red: • An error occurred in the LSM. 📖 "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting" • LSM device settings are incomplete. 📖 "2.3 Confirming Device Information" on page C-8 in "PART C Operation"
⑫	Displays the control buttons. ■ : Stops measurement. This button is grayed out except during measurement. ▶ : Performs measurement just once. The button is grayed out during measurement. 📖 "5.3.1 Single Run Measurement" on page C-105 in "PART C Operation" ⏩ : Performs measurement continuously. The button is grayed out during measurement. 📖 "5.3.2 Continuous Run Measurement" on page C-107 in "PART C Operation" Detail > : Displays the detail screen. Here you can check/edit settings, check measurement history, adjust workpiece position, record light amount, execute calibration and make preset/offset settings. 📖 "4.2 Detail Screen" on page A-18
⑬	Displays the calculation method.
⑭	Displays measurement information used for calculation.

4.2 Detail Screen

Click [Detail] in the measurement information of the home screen to display the detail screen. The detail screen displays LSM settings used for the selected measurement information and other details.



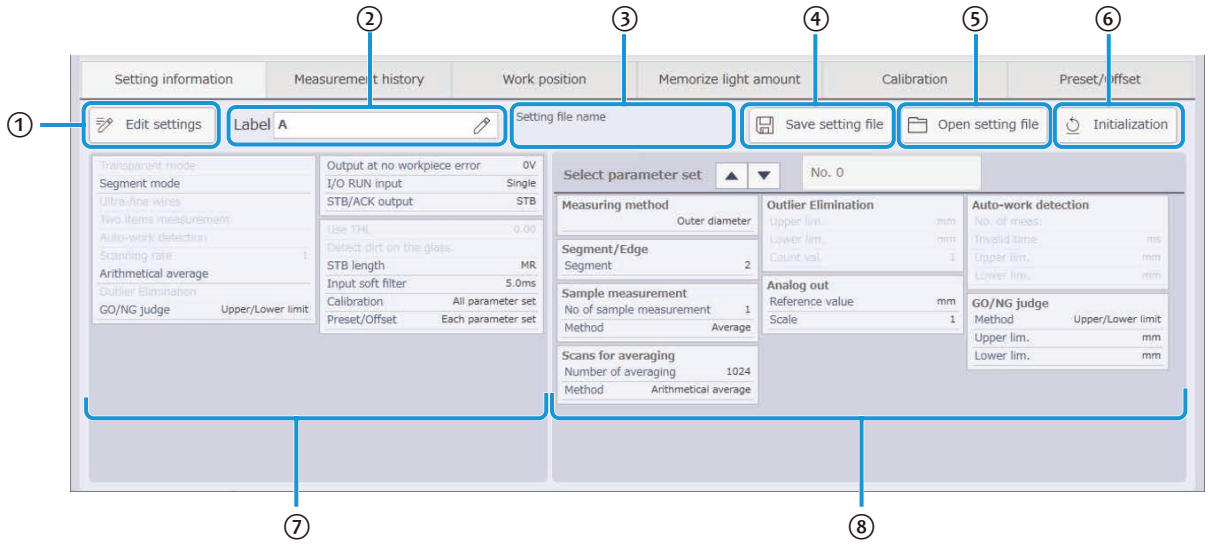
Detail screen when making calculation settings



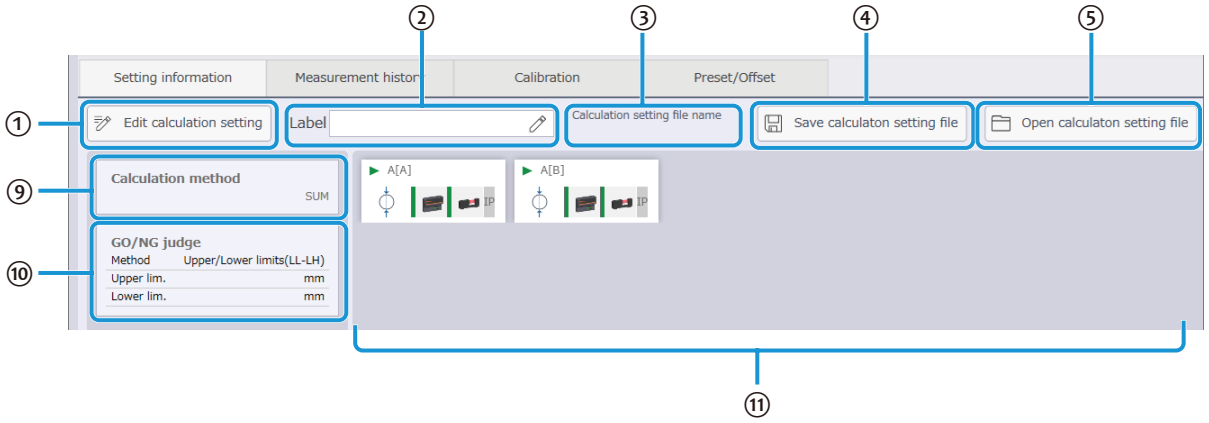
No.	Name	Description
①	[Back] button	Returns to the home screen.
②	Measurement information	Displays contents of the selected measurement information. Content and functions displayed are the same as in the home screen. However, the code number and serial number of the controller, sensor, and IF module are displayed only on the detail screen. For details on displayed measurement information, see "● Contents displayed in the measurement information" on page A-16.
③	[Setting information] tab	Displays device and settings information. "4.2.1 [Setting information] Tab" on page A-20
④	[Measurement history] tab	Displays the measurement history. "4.2.2 [Measurement history] Tab" on page A-22
⑤	[Work position] tab	Displays the workpiece position and the scan signal. "4.2.3 [Work position] Tab" on page A-25
⑥	[Memorize light amount] tab	Records the light intensity. "4.2.4 [Memorize light amount] Tab" on page A-26

No.	Name	Description
⑦	[Calibration] tab	Executes calibration. "4.2.5 [Calibration] Tab" on page A-27
⑧	[Preset/Offset] tab	Sets the preset and offset. "4.2.6 [Preset/Offset] Tab" on page A-28

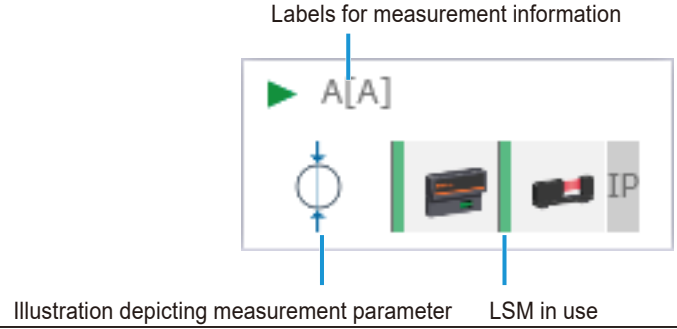
4.2.1 [Setting information] Tab



[Setting information] tab screen during calculation setting



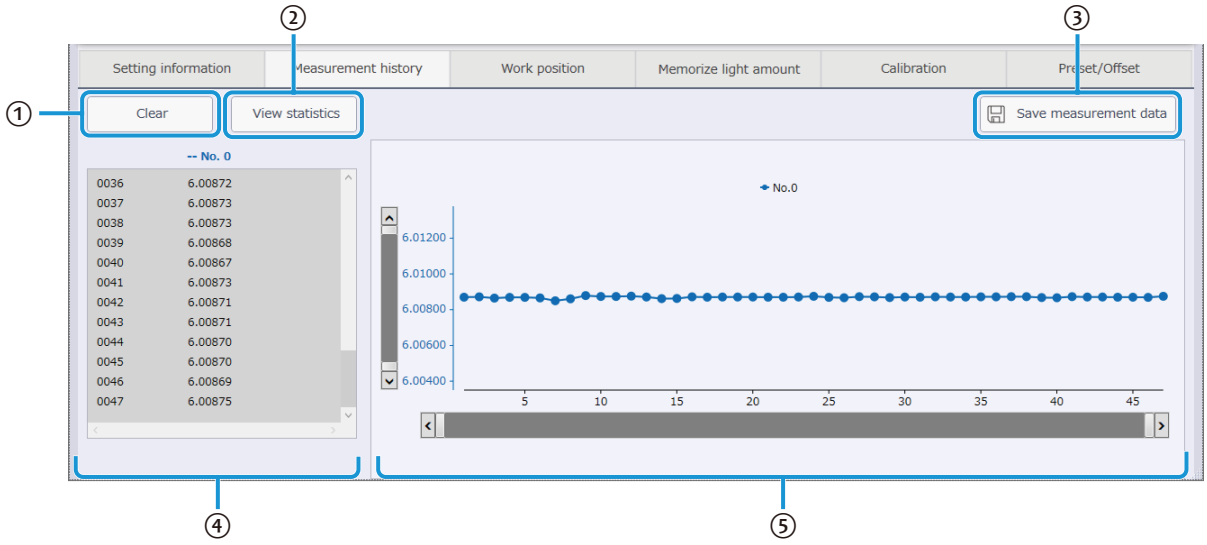
No.	Name	Description
①	[Edit settings] button [Edit calculation setting] button when making calculation settings	Displays the edit settings screen. See 📖 "3 Settings" on page C-9 in "PART C Operation". **Tips** • The button is disabled during measurement. • If the security function is enabled in the environmental settings, a prompt for password entry appears when this button is pressed.
②	Label	A name to identify measurement information You can change the name as desired. Specify using up to 13 single-byte alphabetic characters (uppercase only), numbers, and _ (underscore). Clicking ✎ displays a screen for editing the label.
③	Setting file name [Calculation file name] when making calculation settings	Displays the setting file name set in the measurement information.

No.	Name	Description
④	[Save setting file] button [Save calculation file] button when making calculation settings	
⑤	[Open setting file] button [Open calculation file] button when making calculation settings	Loads a previously saved setting file into the controller. For details on settings that can be read, see 📖 "3.3.9 Saving and Loading Settings Files" on page C-69 in "PART C Operation". **Tips** If the security function is enabled in the environmental settings, a prompt for password entry appears when this button is pressed.
⑥	[Initialization] button	Initializes setting information (common settings and parameter settings). **IMPORTANT** After initialization, setting information is returned to the initial factory values. 📖 "3.3.10 Initialization of Settings" on page C-71 in "PART C Operation" **Tips** If the security function is enabled in the environmental settings, a prompt for password entry appears when this button is pressed.
⑦	Common settings information	Displays information regarding current common settings. Unused functions are grayed out.
⑧	Information about parameter settings	Displays information about current parameter settings. Unused functions are grayed out.
⑨	Calculation method	Displays the calculation method (sum, average, standard deviation, difference, range, or film thickness).
⑩	GO/NG judgment conditions	Displays the GO/NG judgment method (condition).
⑪	Measurement information details	Displays details the measurement information used during calculation. 

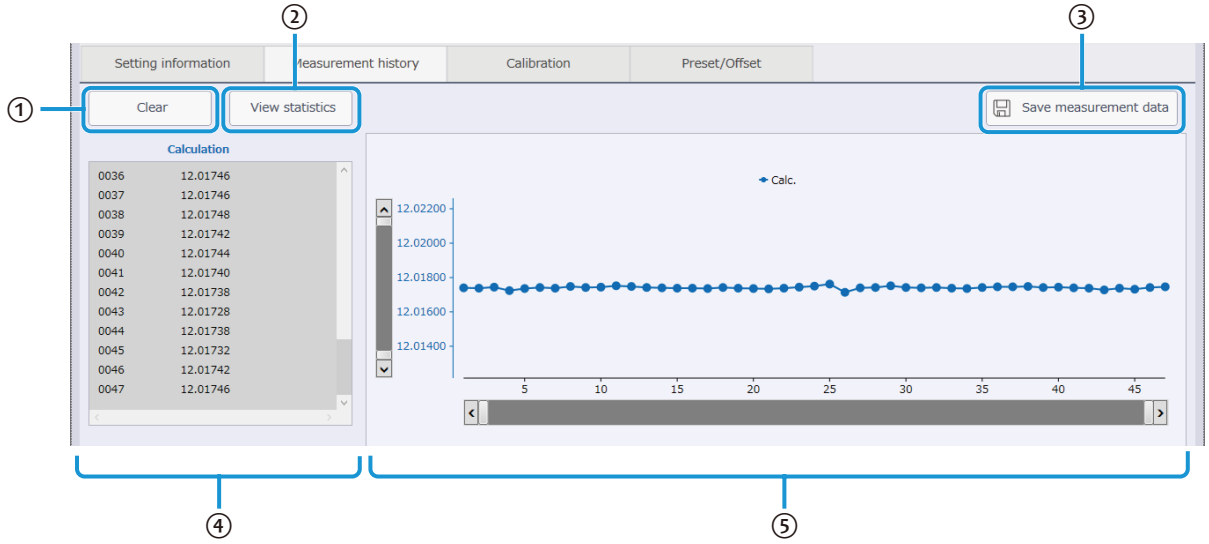
Tips

For details on calculation, see 📖 "3.5.1 Register Calculation" on page C-76 in "PART C Operation".

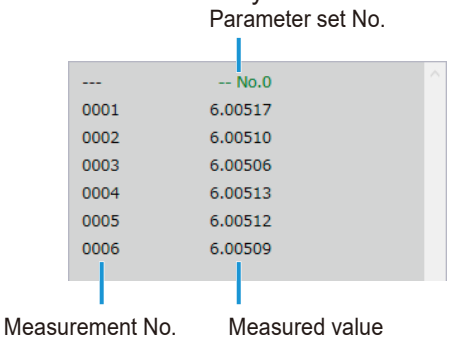
4.2.2 [Measurement history] Tab

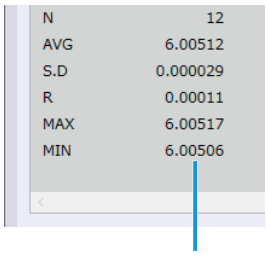


[Measurement history] tab screen during calculation setting



No.	Name	Description
①	[Clear] button	Clears measurements and statistical values. When making calculation settings, the measurement history of the LSM registered in the calculation is also cleared.
②	[View statistics] button	Displays statistics. "5.4.2 Confirming Statistics" on page C-109 in "PART C Operation"
③	[Save measurement data] button	Saves measurement data as a CSV file.

No.	Name	Description
④	[Measurement history]	Lists measurement data history.  Displays the latest data. New data is added from the bottom, oldest data disappears first when the number of data items exceeds 15. Also note that data is lost when LSMPAK is closed. • Measurement No.: Up to 100,000 points. • Parameter set No.: Indicates the parameter set used as a number from No.00 through No.19. • Measured value: With millimeters, up to 5 decimal places are displayed; with inches, up to 6 decimal places are displayed. With two items measurement, parameter set numbers and measured values are displayed in two columns. For details on two items measurement, see "■ Two items measurement" on page C-31 in "PART C Operation". If GO/NG judgment is set, measurements that exceed the limit values are displayed in red as NG.

No.	Name	Description
		 Statistical values Click the [View statistics] button to display statistics. The contents are displayed as follows. • N: Number of sample measurement • AVG: Average • S.D: Standard deviation • R: Range • MAX: Maximum value • MIN: Minimum value Displays statistics to 5 decimal places for millimeters and to 6 decimal places for inches. With two items measurement, statistical values are displayed in two columns. For details on two items measurement, see "■ Two items measurement" on page C-31 in "PART C Operation".
⑤	Measurement history (graph)	Displays the measurement data history as a line graph. Also displays thresholds if a GO/NG judgment method is set.

4.2.3 [Work position] Tab

This tab displays the position of the workpiece relative to the sensor. By moving the workpiece while viewing the screen, the workpiece can be placed in the optimal position for measurement.

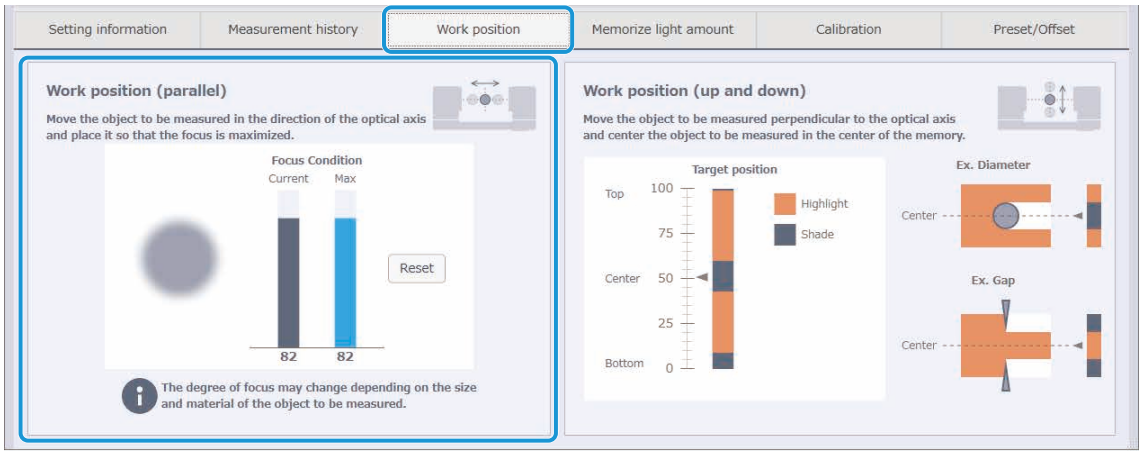
The position along the optical axis is displayed in the [Work position (parallel)] area.

The position in the scanning direction is displayed in the [Work position (up and down)] area.

- [Work position (parallel)]

The degree of focus blur and the scale indicate where the workpiece is located along the optical axis relative to the LSM's measurement range.

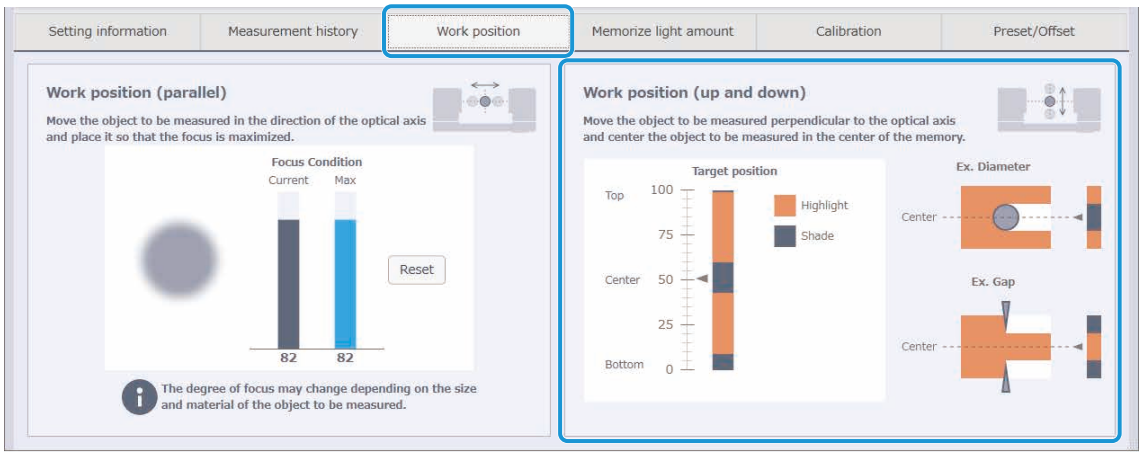
For details on how to adjust the workpiece position, see "5.1 Setting the Workpiece" on page C-95 in "PART C Operation".



- [Work position (up and down)]

The scale shows where the workpiece is located in the scan direction relative to the LSM measurement range.

For details on how to adjust the workpiece position, see "5.1 Setting the Workpiece" on page C-95 in "PART C Operation".

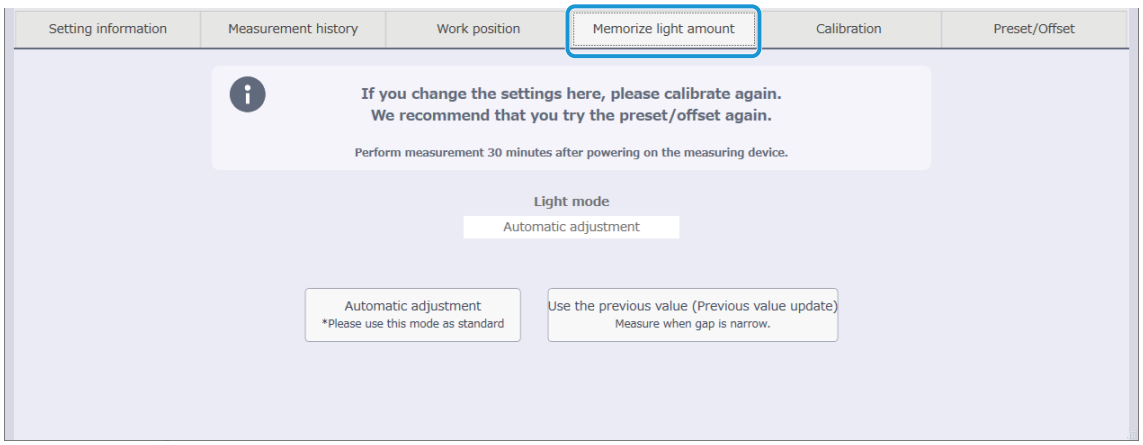


4.2.4 [Memorize light amount] Tab

This tab sets the light amount memorize mode.

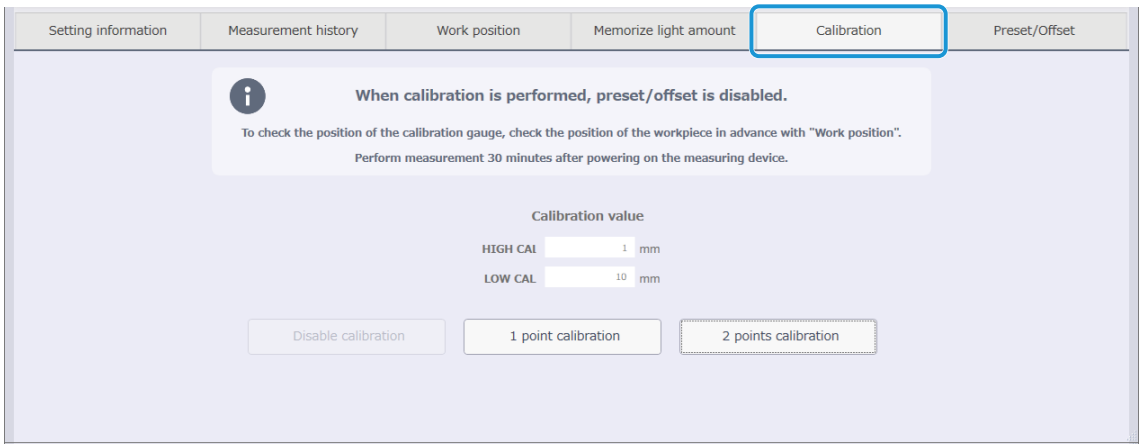
After setting the light amount memorize mode, we recommend recalibrating and remaking the preset/offset values.

For details, see 📖 "3.4 Memorize Light Amount" on page C-73 in "PART C Operation".

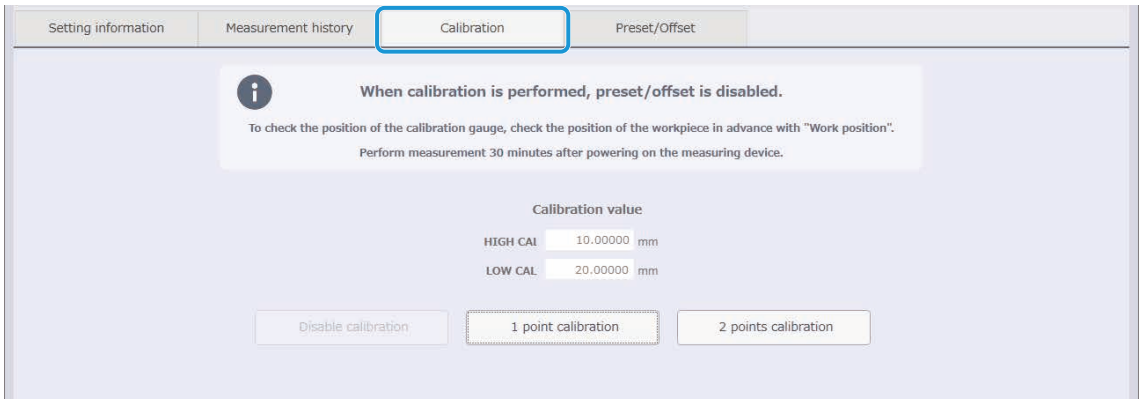


4.2.5 [Calibration] Tab

This tab is used to execute calibration.
After executing calibration, the preset and offset are cleared.
For details, see "3 Settings" on page C-9 in "PART C Operation".

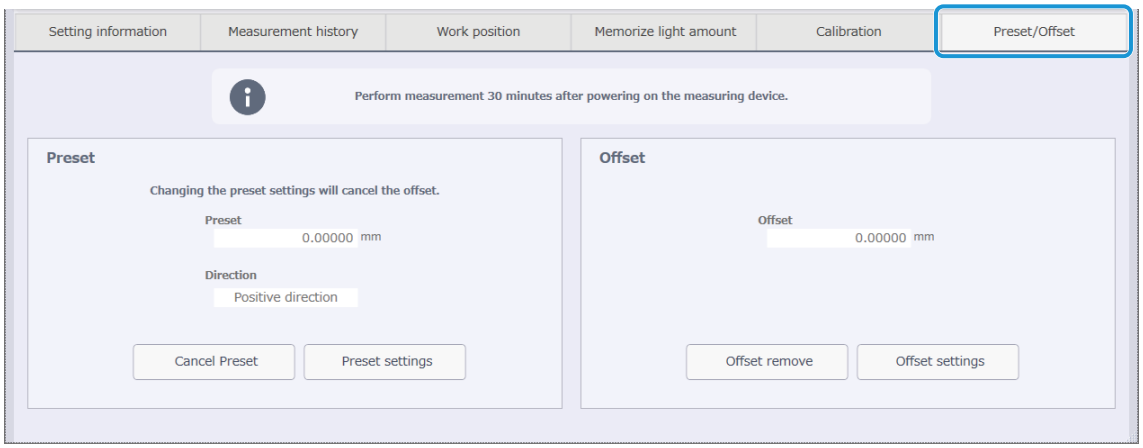


[Calibration] tab screen during calculation setting

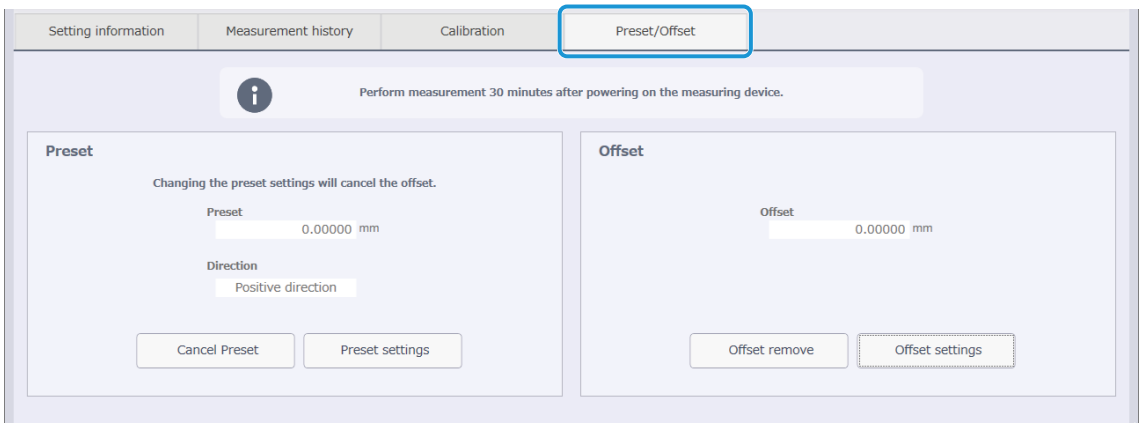


4.2.6 [Preset/Offset] Tab

This tab sets the preset and offset.
Offset is cleared when the preset setting is changed.
For details, see "5.2 Setting the Preset and Offset" on page C-97 in "PART C Operation".



[Preset/Offset] tab screen during calculation setting



4.3 Help Function

Clicking the help mode toggle button on each screen switches the screen to help mode.

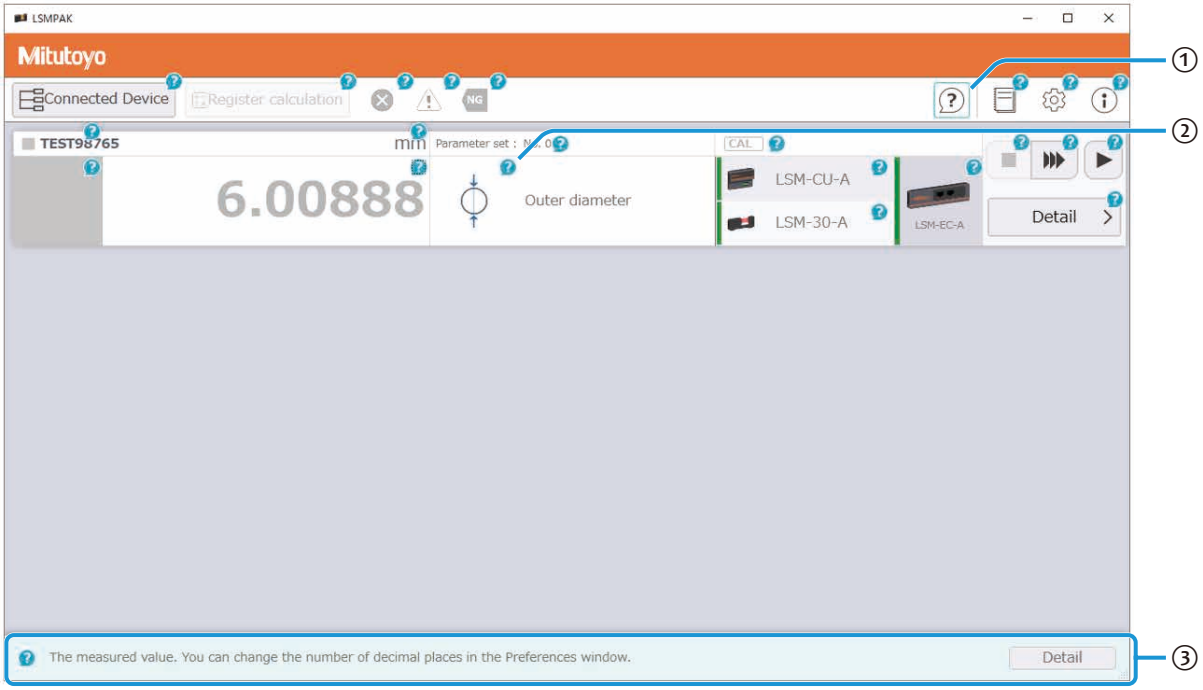
Clicking the guidance display button for an item displays the guidance in the guidance display area at the bottom of the screen.

Tips

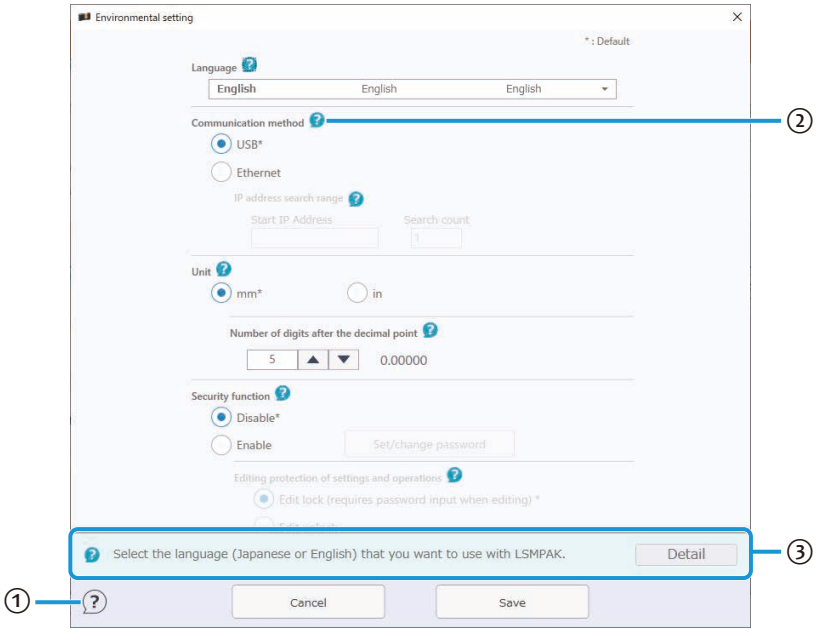
You cannot switch to help mode during the following operations.

- While light amount is being recorded
- During calibration
- While making preset/offset settings

Example of help mode display (Home screen)



Example of help mode display ([Environmental setting] screen)



No.	Name	Description
①	Help mode toggle button	Turns the help mode display on or off.
②	Guidance display button	This is the question-mark button displayed beside a term or setting item. Clicking this button displays a simple description in the guidance display area. **Tips** The guidance display button is displayed when help mode is on.
③	Guidance display area	Displays a brief explanation of terms and settings. Pressing the guidance display button displays a simple description in the guidance display area. If a detailed description is required, click Detail. The corresponding section from the "Laser Scan Micrometer <Controller> User's Manual" PDF is displayed. **Tips** The guidance display area is displayed when help mode is on.

PART B
Preparation

This part first describes the product items to be checked in preparation for measurement. Next, it describes how to connect this product with other devices (sensors, optional accessories, interface devices, etc.) and how to check the operation.

No. 99MBC150A

1 Unpacking and Checking

After removing the product from its packaging, check for missing parts and damage.

This product has been thoroughly inspected prior to shipment. The mechanical, optical, and electrical systems are guaranteed to operate properly.

First, remove the product from its packaging and check the following.

- Make sure that the product and accessories are all present
- No damage was sustained by these devices during transit.

If you have any questions, contact the agent where you purchased the product or a Mitutoyo sales office.

■ This product and attachments

Part No.	Name	Quantity
02AGQ210	LSM-CU-A controller (this product)	1
D800-396	I/O terminal block socket	1
D827-827	Power supply terminal block socket	1
02AGQ068	Grounding wire (4 m)	1
99MBC151B	Quick Start Manual	1
02NGA070	CD (containing the following files) • LSMPAK Installer • User's Manual (PDF) (this document)	1
WA140	General product warranty (large)	1

MEMO

2 Setup

⚠CAUTION 

First, check that the power to this product is off. If power is being supplied, shut off the power supply. Working with this product while it is energized may result in electric shock.

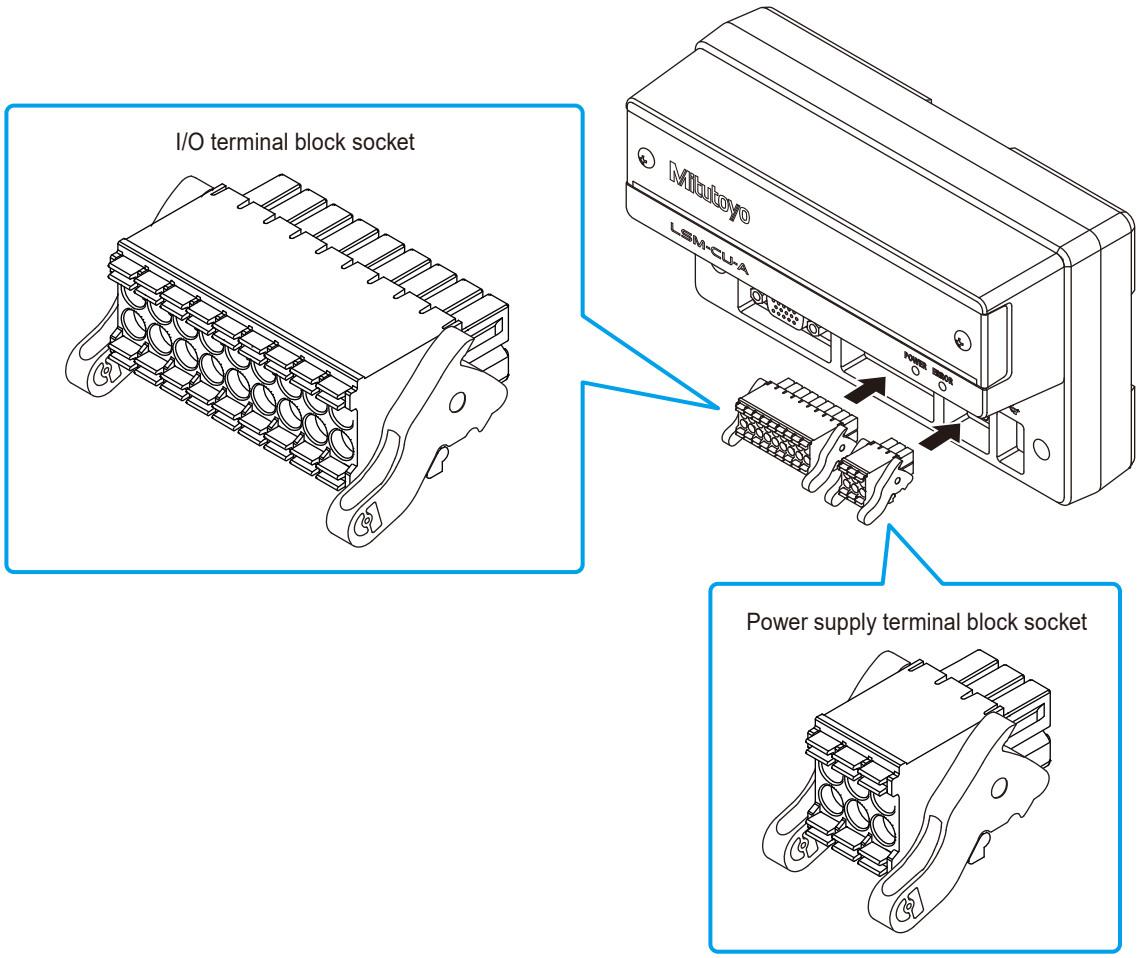
2.1 Wiring and Connection

2.1.1 Socket Installation

Insert the I/O terminal block socket and the power supply terminal block socket into the I/O terminal and power supply terminal of this product.

Refer to the following figure and insert the sockets straight into the product in the correct orientation.

When the socket is fully inserted, the lever on the socket will rise.



2.1.2 Sensor Connection

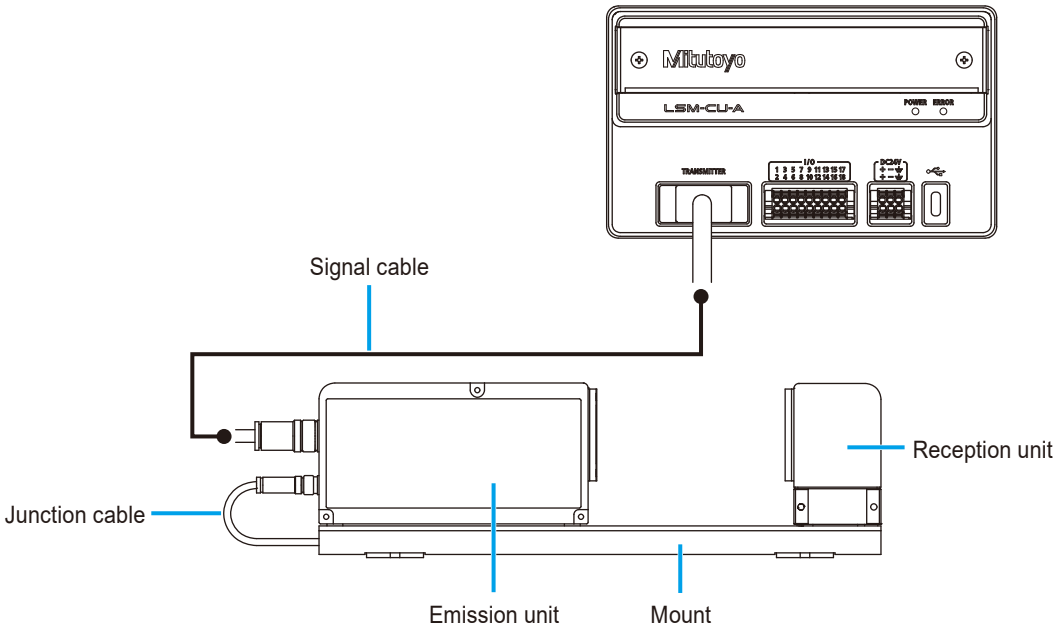
See the table below for sensors that can be connected to this product.

Sensor	Signal cable	Junction cable
LSM-02-A (integrated body)	✓	N/A
LSM-30-A (separable body)	✓	✓

For the names of the sensor parts, see "2.1 Launching LSMPAK" on page C-3 in "PART C Operation". For details about the sensors, see "Laser Scan Micrometer <Sensor> User's Manual" (separate document).

NOTICE

- After connecting the junction cable, connect the wires to the power supply terminal block to supply power.
  If you connect the junction cable after supplying power, the sensor may become damaged.
- Sensors models other than those listed above cannot be connected to this product.



1 Connect the junction cable of the sensor (LSM-30-A) to the lower connector (5-pin) on the rear panel of the emission unit.

2 Connect the round connector (12-pin) of the signal cable to the upper connector (12-pin) on the rear panel of the sensor emission unit.

3 Connect the signal cable's rectangular connector (15-pin) to the [TRANSMITTER] connector on the front of the controller and tighten the screws on the left and right sides.

2.1.3 PC Connection

Connect this product to a PC using a USB cable (type C).

⚠CAUTION

Check that the power to both this product and the PC is off, and then connect this product to the PC.
Working with this product and a PC while they are energized may result in electric shock.

IMPORTANT

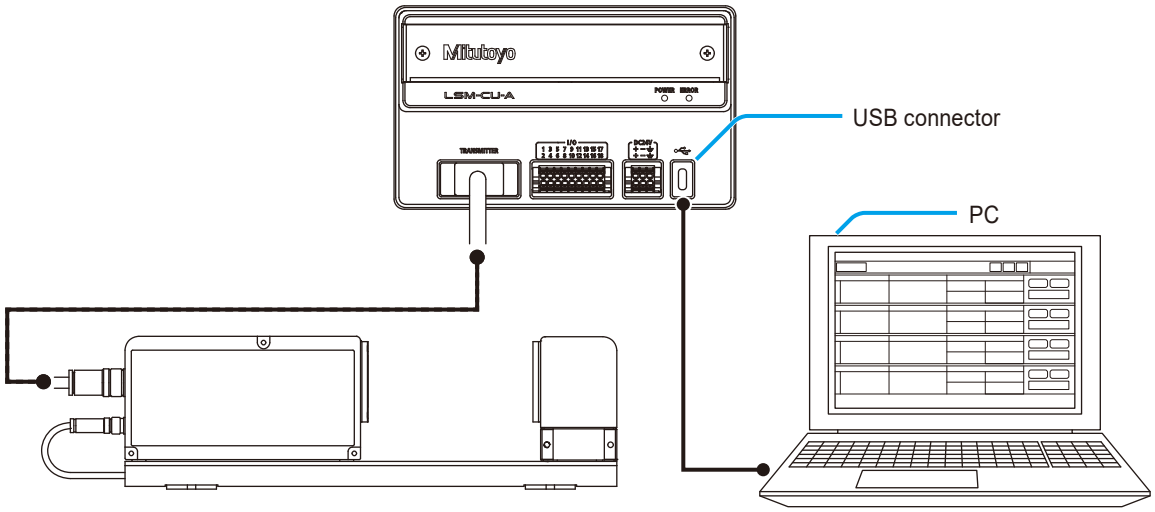
Even when operating LSM via Ethernet communication or industrial network communication using the IF module (optional), connection to the product must first be made via USB in order to set its IP address and communication method.

- For details on IP address setting, see "■ How to check the [Connected Device] screen" on page C-8 in "PART C Operation".
- For details on communication method settings, see "■ Communication method" on page C-20 in "PART C Operation".

Tips

The user is responsible for supplying a USB cable (type C).

Connection example: this product (one unit) + sensor (one unit) + PC (one unit)



■ When using two or more sets of LSMs

Use a USB type C cable and USB hub to connect each LSM to the PC.

2.1.4 I/O Device Connection (if Required)

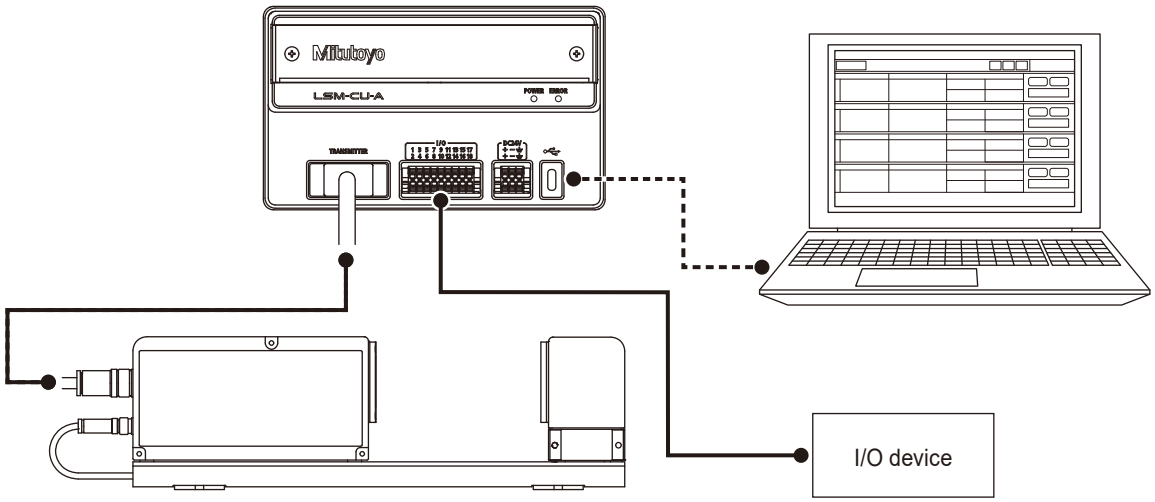
Connect this product to an I/O device using the I/O terminal block.

⚠CAUTION

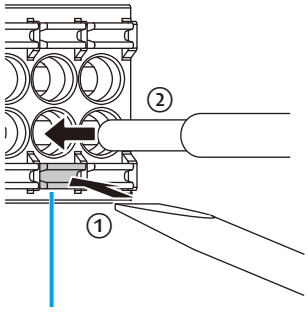
Check that the power to both this product and the I/O device is off, and then connect this product to the I/O device.
Working with this product and I/O equipment while they are energized may result in electric shock.

Tips

- The user is responsible for supplying an I/O cable.
- For details on I/O connectors, see "3.1.1 Terminal Block Connector Specifications" on page D-23 in "PART D Interfaces".



1 Press a flathead screwdriver against the flathead screwdriver slot on the terminal block socket.



Slot for flathead screwdriver

2 **Exerting pressure on the flathead screwdriver slot with the flathead screwdriver, insert the cable into the terminal hole.**

IMPORTANT

Push the terminal unit in until it hits the back.

3 **Remove the flathead screwdriver.**

Tips

It is also possible to attach the terminals to the terminal block after removing it from the controller, and then to reattach the terminal block to the controller after attaching the terminal wires.

In this case, place the terminal block on a flat desk and insert the terminal wires into the terminal holes in accordance with steps 1 through 3.

4 **Pull inserted terminal wires lightly by hand to confirm that they do not come out.**

Tips

If you want to reinsert terminal wires, check that the power to this product is off, and then do the following.

Press a flathead screwdriver against the flathead screwdriver slot and pull out the terminal wires. Then, insert the terminal wires into the terminal holes in the manner described in steps 1 through 3.

The flathead screwdriver slots are outward from the terminal holes (at the top for the upper row, at the bottom for the lower row).

2.1.5 Connection of Power Supply Terminal Wires and Power Supply

After you have finished connecting this product to a sensor, PC, and I/O device, connect the power supply terminal wires and grounding wires to the power supply terminal block.

⚠CAUTION

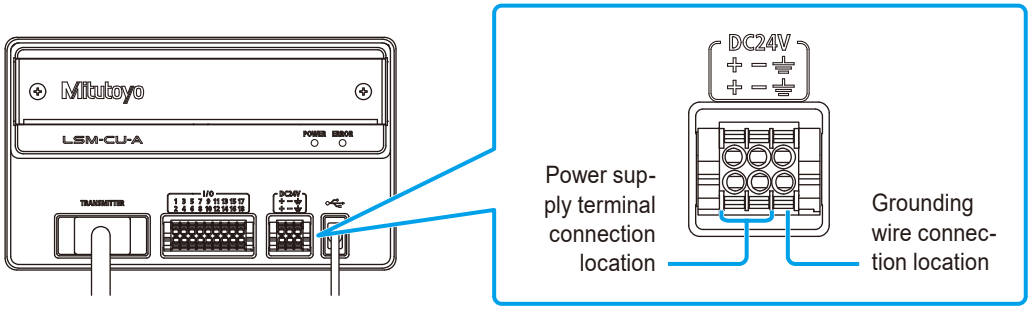
Before making connection to the power supply terminals, make sure that the terminals are not energized.
Touching the power terminals while the system is energized may result in electric shock or burns.

NOTICE

When wiring, be sure to touch the terminal wires to the metal part of the controller to discharge any static electricity. If you touch the terminal wires to the terminal block while your body holds a static electric charge, the internal circuitry could be damaged by an electric discharge.

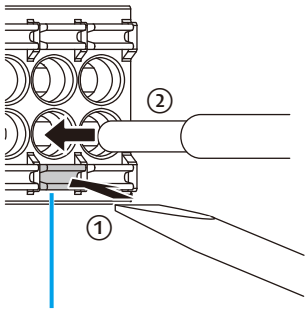
Connect the grounding terminals to the two holes on the right edge of the power supply terminal block.
This helps reduce noise.

For details about where to connect the power supply terminal wires and grounding wires, see the following figure.



Connection specifications for power terminal block	
Item	**Specification**
Power voltage	DC+24 V±10 %
Current consumption	3.0 A or more
Wire diameter	AWG14-30
Stripped line length	7 mm
Power cable length	Length that accounts for voltage attenuation * The power supply requirements pertain at the point of terminal block input.

1 **Press a flathead screwdriver against the flathead screwdriver slot.**



Slot for flathead screwdriver

2 **Insert the terminal wire into the terminal hole while pressing with the flathead screwdriver.**

IMPORTANT

Push the terminal unit in until it hits the back.

3 **Remove the flathead screwdriver.**

Tips

It is also possible to attach the terminals to the terminal block after removing it from the controller, and then to reattach the terminal block to the controller after attaching the terminal wires.

In this case, place the terminal block on a flat desk and insert the terminal wires into the terminal holes in accordance with steps **1** through **3**.

4 **Pull inserted terminal wires lightly by hand to confirm that they do not come out.**

Tips

If you want to reinsert the power supply terminal wires or grounding wires, check that the power to this product is off, and then do the following.

Press a flathead screwdriver against the flathead screwdriver slot and pull out the terminal wires. Then, insert the terminal wires into the terminal holes in the manner described in steps **1** through **3**.

The flathead screwdriver slots are outward from the terminal holes (at the top for the upper row, at the bottom for the lower row).

5 **Supply power to the LSM.**

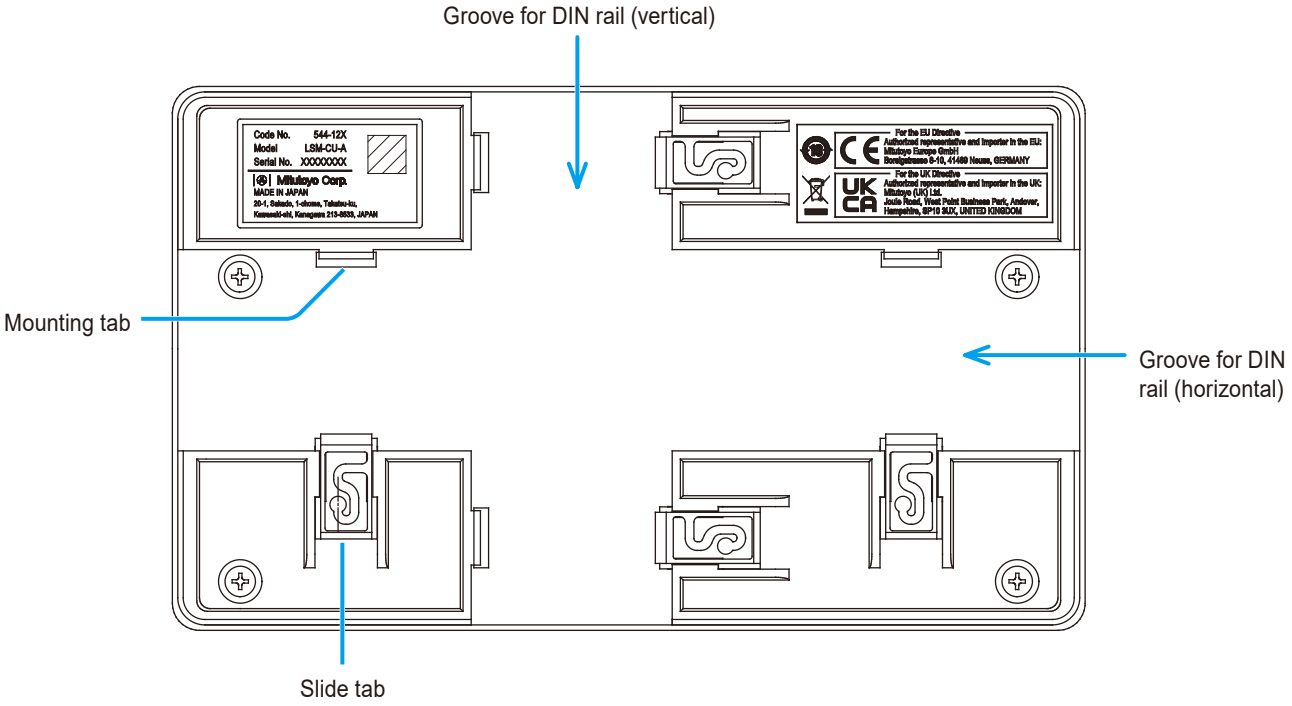
2.2 Communication Method

■ Installation using a DIN rail

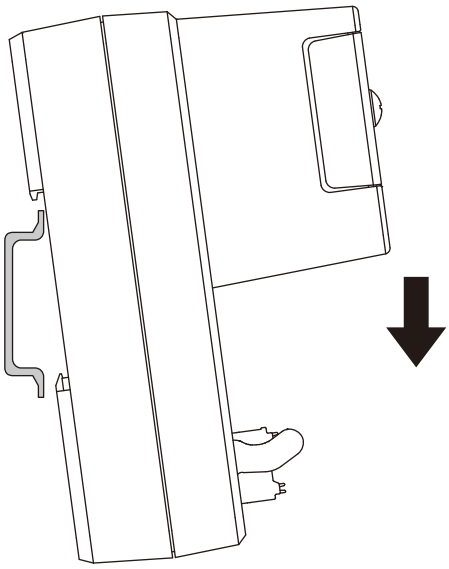
There are horizontal and vertical grooves for a DIN rail on the rear of this product.

If you will be arranging controllers vertically, use the vertical grooves. If you will be arranging controllers horizontally, use the horizontal grooves.

The following explanation describes the procedure for attaching a DIN rail to the horizontal DIN groove.

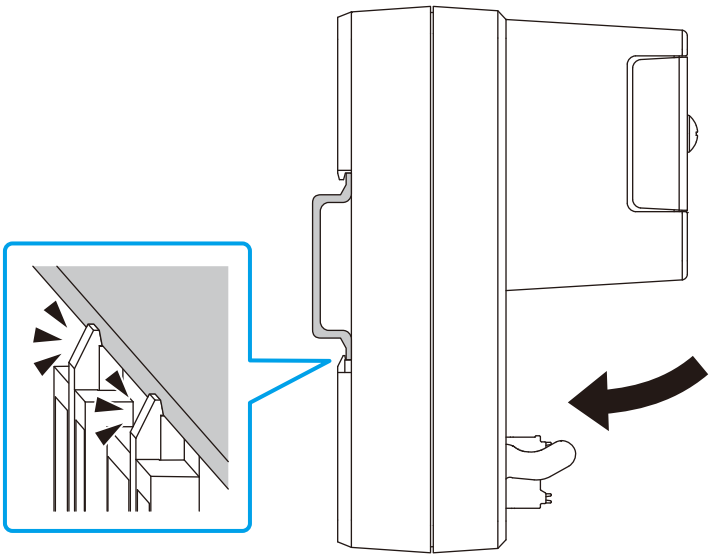


1 **Hook the two mounting tabs of this product onto the upper edge of the DIN rail.**



2 **Place the lower edge of the DIN rail against the tapered part on the inner part of the two slide tabs, and then press this product against the DIN rail until you hear a click.**

» This product is secured to the DIN rail.

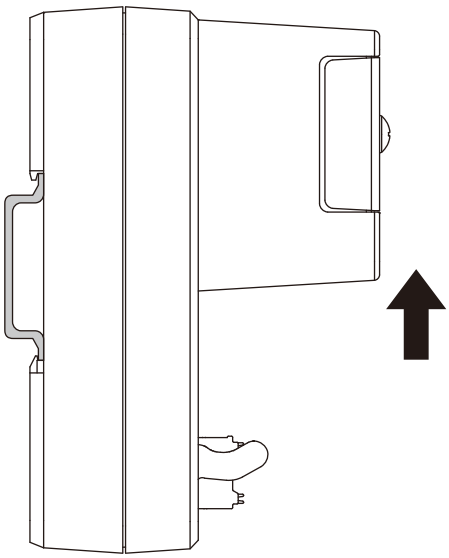


■ Removal from a DIN rail

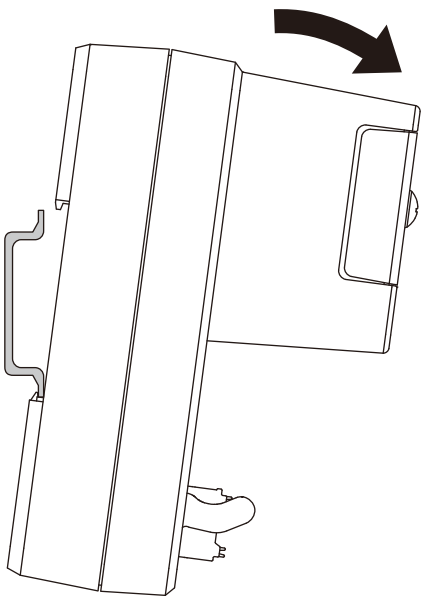
1 **Hold this product with both hands.**

2 **Press this product upward.**

» The slide tabs (two locations) are pressed in.
» The mounting tabs (two locations) disengage from the DIN rail.



3 **Remove this product from the DIN rail.**



■ Replacing the slide tabs

Slide tabs (four pieces) are attached to this product when it is shipped.

Two slided tabs are required in order to mount this product on a DIN rail. Keep the two remaining slide tabs for use as spares.

If a slide tab breaks, replace it according to the following procedure.

1 Remove the slide tab.

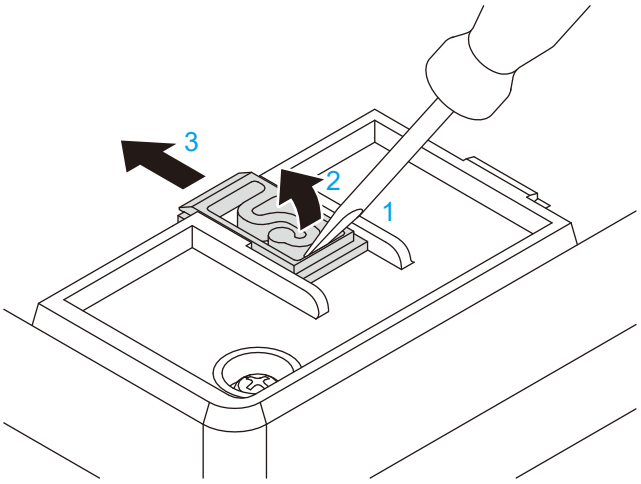
1 Insert a flathead screwdriver into the bottom of the S-shaped part of the slide tab (the side not connected to the outer frame).

2 Lightly lift the S-shaped part of the slide piece with the flathead screwdriver.

» The pin attached to the bottom of the S-shaped part disengages from its hole.

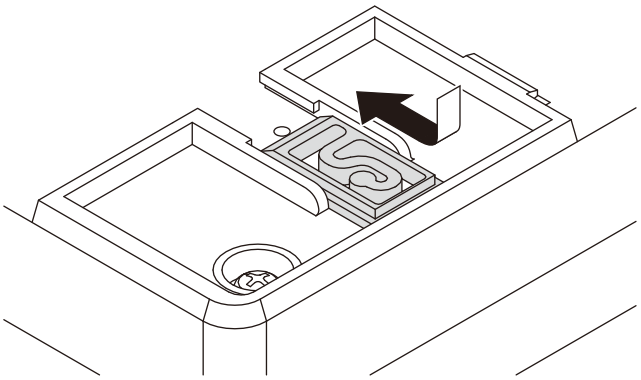
3 With the pin disengaged, slide the S-shaped part using the flathead screwdriver.

» The slide tab comes off.



2 Attach the new slide tab.

1 Insert the upper side of the S-shaped part of the slide tab (the side connected to the outer frame) into the rails on the controller.



» The pin on the S-shaped part engages with its hole and the slide tab is attached.

2.3 LSMPAK Setup

2.3.1 Installing LSMPAK

LSMPAK manages and controls the LSM settings, monitoring of measured values, displaying of the GO/NG judgment result, error information, etc.

Operating environment

- Windows 10 Home 64 bit
- Windows 10 Pro 64 bit

The LSMPAK installer is provided on a CD and is included with this product.

Tips

The LSMPAK installer can also be downloaded from our website (https://www.mitutoyo.co.jp/downloads/software-drivers/).

1 **Sign on to Windows with an account that has administrative privileges.**

2 **Insert the provided CD into your PC.**

3 **Double-click "setup.exe" on the CD.**

» The LSMPAK installer launches.

4 **Follow the on-screen instructions to install LSMPAK.**

IMPORTANT

If the [User Account Control] dialog box appears, click [Yes].

5 **Disable sleep mode and power saving mode in the PC settings.**

IMPORTANT

If the PC enters sleep mode or power saving mode, communication with the LSM is interrupted, and LSMPAK will be forced to terminate with a system error. Forced termination will result in loss of measurement history data.

MEMO

PART C
Operation

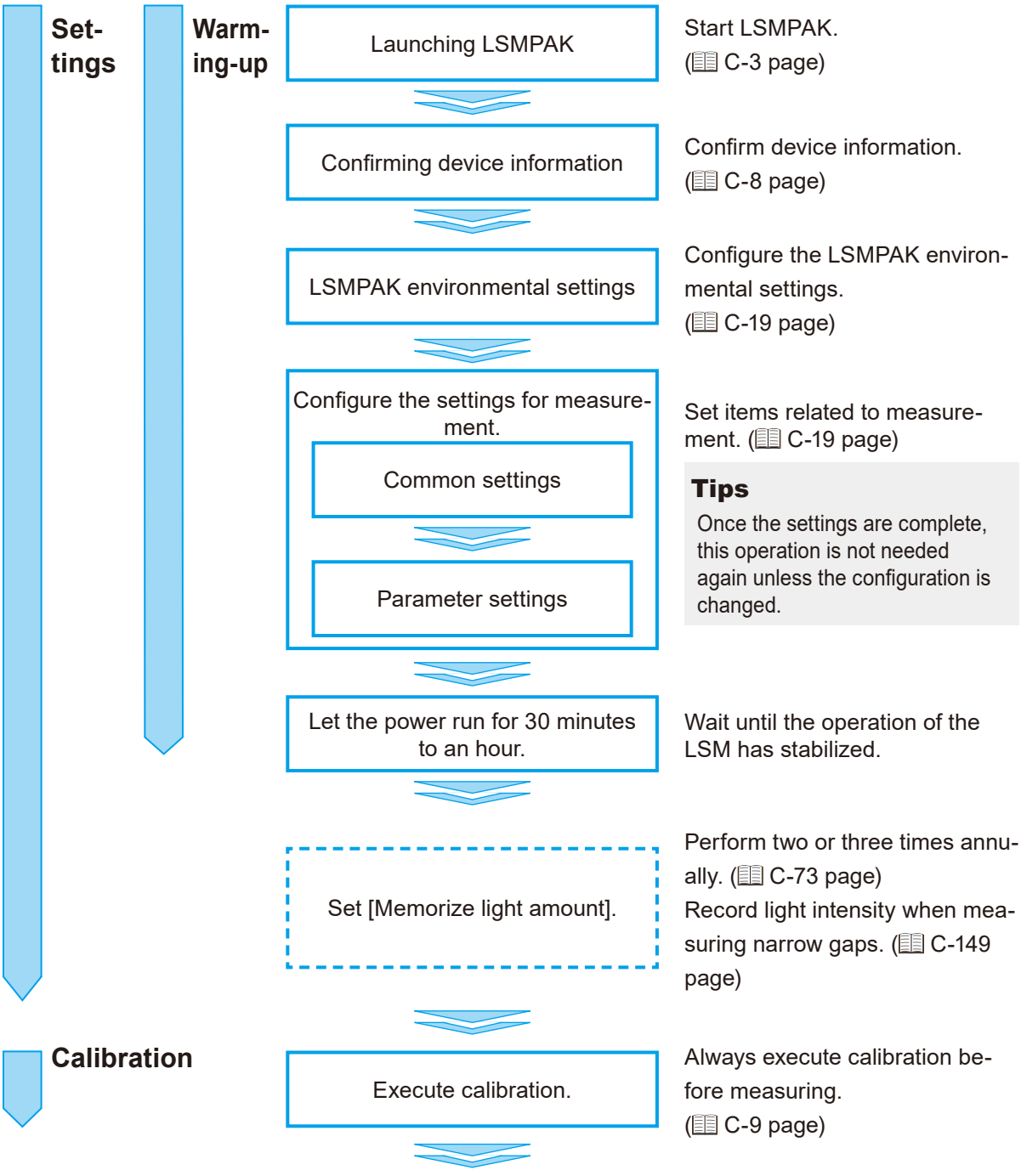
This part describes the operations for configuring the various functions, from the basic operation flow to methods for obtaining more accurate measurements.

There are some restrictions on the combination of measurement functions. Confirm the content before using this product.

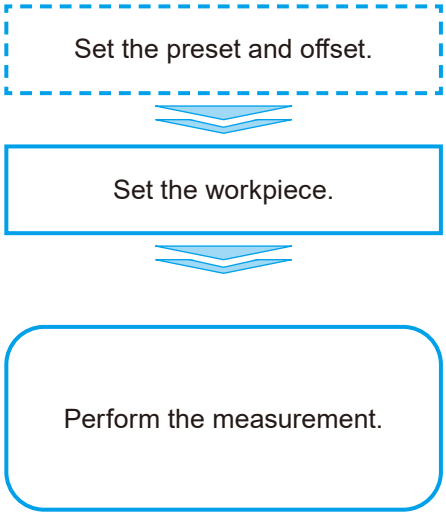
For details about the restrictions, see "● Exclusivity of items in the [Common setting 1] screen" on page C-26.

No. 99MBC150A

1 Measurement Flow



Measurement



Set the preset and offset.
(📖 C-97 page)

Set a workpiece.
(📖 C-95 page)

For examples of settings for various measurements, see the following descriptions.

- Basic measurements (📖 C-113 page)
- Advanced measurement (📖 C-126 page)

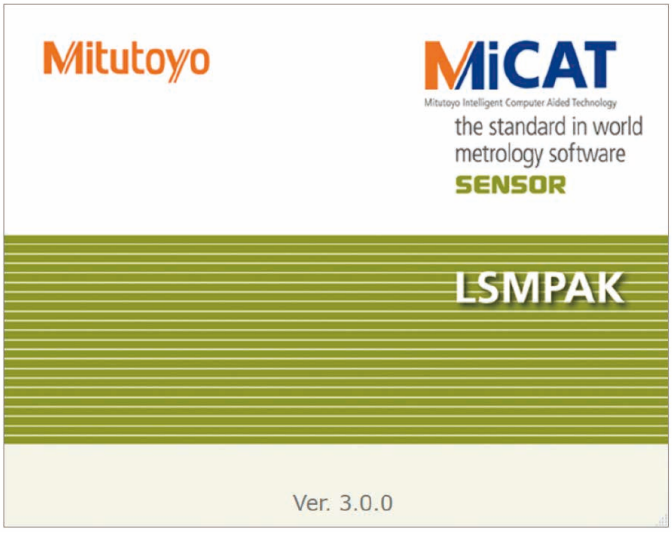
2 Start-Up

2.1 Launching LSMPAK

1 **Check that the LSM and external devices are connected to the PC and have power supplied.**

2 **Turn on the PC.**

3 **Double-click the LSMPAK icon**  **on the desktop.**



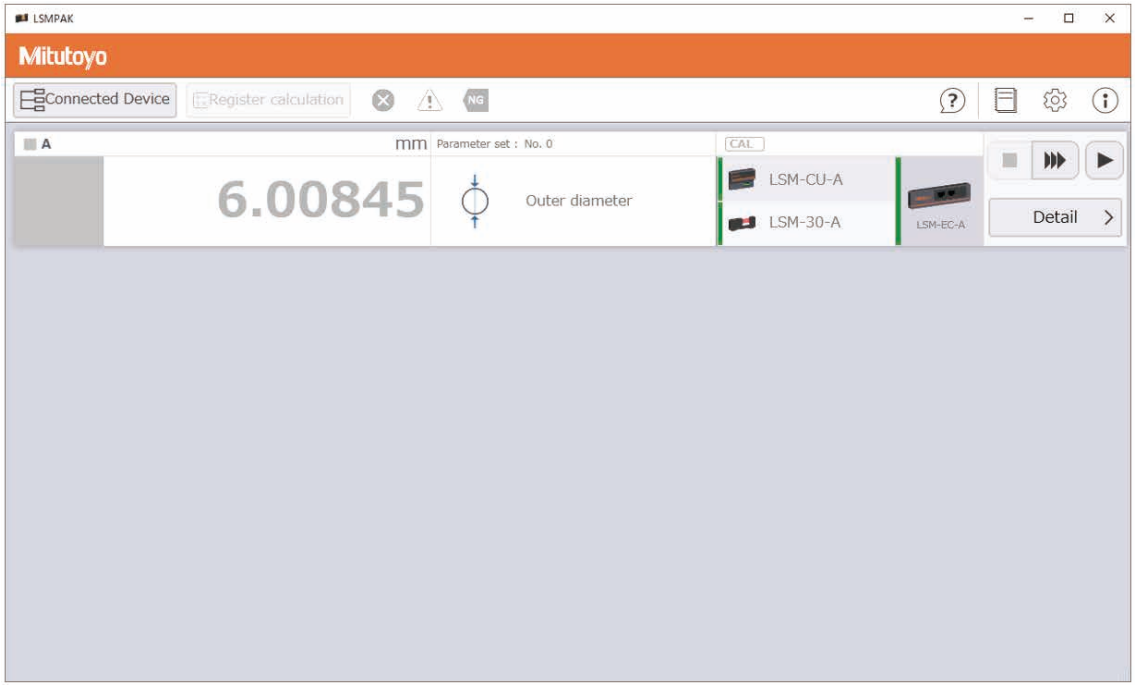
» Information on connected LSMs is displayed on the LSMPAK home screen.

IMPORTANT

- When activating LSMPAK, make sure that the LSM is in measurement standby mode (the controller's POWER LED is lit green).
  If you activate LSMPAK when the controller's POWER LED is blinking green (during startup or measurement), not only will measurement stop, but the LSMPAK may be damaged and not start. If the LSMPAK is damaged, reinstall the LSMPAK.
- Make sure that LSMPAK is not running while connecting cables or making connections. If a cable is connected or disconnected while LSMPAK is running, LSMPAK will report a system error and will be forcibly terminated. Forced termination will result in loss of measurement history data.
- When using LSMPAK via Remote Desktop, do not disconnect or reconnect Remote Desktop while LSMPAK is in use. Disconnecting or reconnecting Remote Desktop while using LSMPAK may force LSMPAK to terminate with a system error. Forced termination will result in loss of measurement history data.

Tips

- Depending on PC specifications and the number of LSMs connected, it may take a few dozen seconds for LSMPAK to start. Please wait without exiting LSMPAK.
- If the PC and LSM are connected via Ethernet, the LSM may not be recognized immediately after installation of LSMPAK. For what to do if the LSM is not recognized, see "• If communication with the LSM fails" on page C-6.



Tips

The application is shipped with initial values set for the measurement settings (common settings and parameter settings).

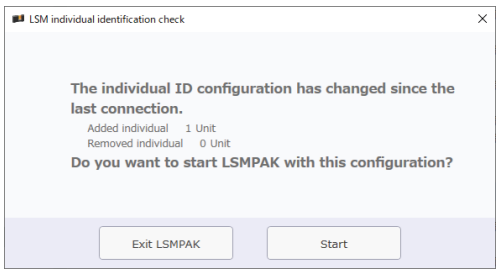
■ What to do if a dialog box appears at startup

● Verifying the LSM configuration

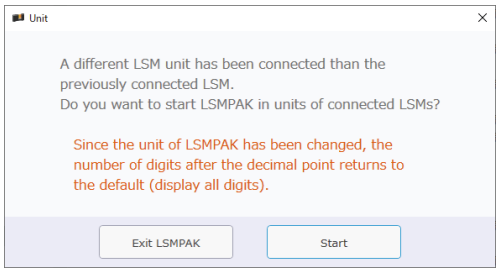
When LSMPAK is launched, a dialog appears if the LSM configuration has changed since the last time connection was made or if there is a mixture of LSMs with different unit settings.

After reviewing the contents and changing settings as necessary, click [Start].

If LSM configuration has changed since last connection



If an LSM is connected that has a different unit setting than the last time connection was made.

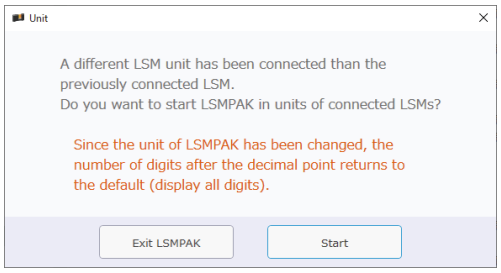


Clicking [Start] launches LSMPAK with the unit setting of the connected LSM.

If units of measure are mixed

One of the following [Unit] screens will appear.

- When LSMs with millimeter and inch settings are mixed and millimeter-only type LSMs are included



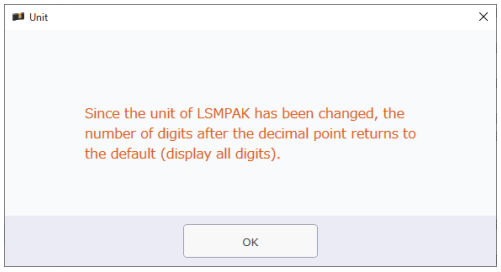
Clicking [Start] launches LSMPAK with the unit set to mm.

In addition, the measurement unit changes to mm for all connected LSMs, and those LSMs whose unit has been changed are restarted.

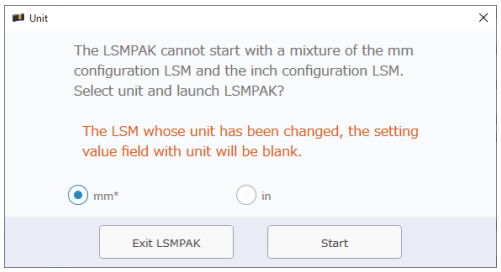
IMPORTANT

When using the LSMPAK with an Ethernet connection, do not make any configuration changes that involve rebooting the equipment while multiple controllers are daisy-chained together. The timing of the reboots may cause the chain to break and cause unexpected behavio.

If LSMPAK measurement units have changed since the last connection, the following screen will appear; click [OK].



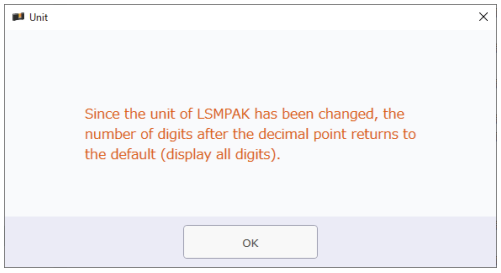
- When LSMs with millimeters and inch settings are mixed and all LSMs are of mm/in type



Select mm or in and click [Start] to launch LSMPAK with the unit set to the selected unit.

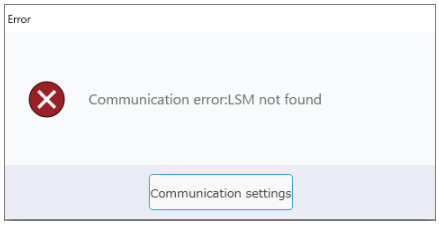
This also changes the unit setting all connected LSMs, and LSMs whose units have been changed are restarted.

If LSMPAK measurement units have changed since the last connection, the following screen will appear; click [OK].



● If communication with the LSM fails

When LSMPAK is started, the following error dialog appears if communication between the PC and the LSM fails.



Check the LSM communication settings under [Communication settings].

For details on communication method settings, see "■ Communication method" on page C-20.

1 Click [Communication settings].

» The environmental settings screen is displayed.

2 Select [USB] or [Ethernet] in [Communication method] according to the usage situation.

3 If [Ethernet] is selected, set the IP address range.

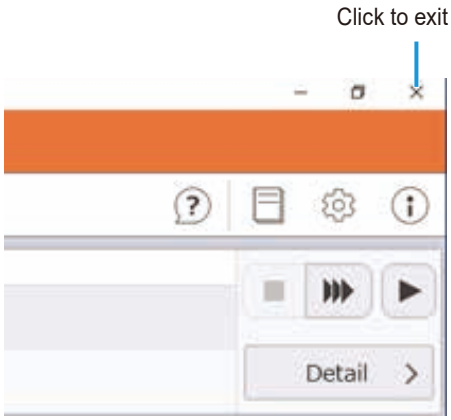
4 Click [Save].

2.2 Exiting LSMPAK

IMPORTANT

Upon exiting LSMPAK, data in the measurement history is deleted. If you do not want to the data to be deleted, save the measurement data before exiting.

For details on saving measurement data, see "5.4.3 Storage of Measured Values" on page C-110.

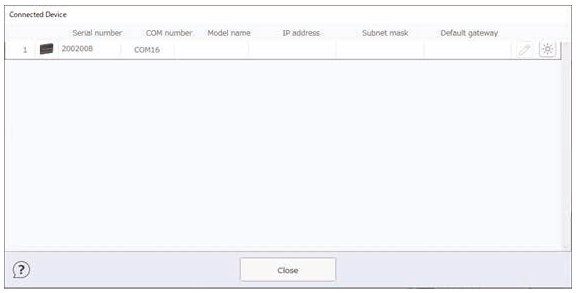


2.3 Confirming Device Information

Information on LSMs connected to the PC can be viewed on the [Connected Device] screen.

■ How to check the [Connected Device] screen

Click [Connected Device] on the home screen to display the [Connected Device] screen.
Serial numbers, COM numbers, and model names can be verified in the [Connected Device] screen.



Tips

The optional IF modules allow LSMs and LSMPAK to be connected via Ethernet. For specific instructions, see the individual IF module manuals.

"IF Module <EtherNet/IP> User's Manual" (separate document)

"IF Module <PROFINET> User's Manual" (separate document)

"IF Module <EtherCAT> User's Manual" (separate document)

"IF Module <CC-Link IE TSN> User's Manual" (separate document)

IMPORTANT

When using the IF module <EtherCAT>, connect the LSM and LSMPAK via USB. Ethernet connection cannot be used.

■ Procedure for checking LSMs connected to the PC

Clicking on the [Connected Device] screen causes the [POWER] LED of the corresponding controller to blink.

If you have multiple LSMs connected to your PC, this feature is useful for locating the LSM you want to work with.

3 Settings

Set the necessary items for measurement.
Follow the LSMPAK wizard and enter the settings.

Tips

When using multiple LSMs, set the calculation method on the calculation screen.
For details, see "3.5.1 Register Calculation" on page C-76.

3.1 Settings List

■ [Environmental setting] screen

The [Environmental setting] screen allows you to set the items listed in the table below.
For details, see "3.2 [Environmental setting] Screen" on page C-19.

Item	Setting value	Description
Language	N/A	Select the language to be used by LSMPAK. Languages available are Japanese and English.
Communication method	• USB (initial value) • Ethernet	Either USB (USB virtual COM communication) or Ethernet can be selected as the method of communication with the LSM or PLC. **Tips** When an IF module (optional) is attached to the controller, Ethernet can be used.
IP address search range	• Start IP address • Search count	You can search for connected LSMs by specifying the [Start IP Address] and [Search count]. LSMs found are displayed on the Home screen and the [Connected Device] screen.
Unit	• mm (initial value) • in	Select the desired unit of measure. When this setting is changed, the change is applied to all connected controllers. If an mm-only type controller is connected, the "in" option is not displayed.
Number of digits after the decimal point	N/A	Set the desired number of decimal places. If the unit is millimeters, you can set from 1 through 5 decimal places (up to 0.00001); if the unit is inches, you can set from 1 through 6 decimal places (up to 0.000001).

Item	Setting value	Description
Security function	• Disable (initial value) • Enable	Set the security function to enabled or disabled. When the security function is enabled, LSM-PAK measurement settings, calculation settings, etc. can be password-protected.
Setting and changing password	N/A	Set/change the password. Up to 20 characters can be set using half-width alphanumeric characters and symbols.
Editing protection of settings and operations	N/A	Lock/unlock editing of settings and arithmetic operations.

■ [Common setting 1] screen

In the [Common setting 1] screen, items in the table below can be set.

For details on each item, see "3.3.1 [Common setting 1] Screen" on page C-26.

Tips

- The [Common setting 1] screen includes combinations of settings that cannot be used at the same time. For details, see "● Exclusivity of items in the [Common setting 1] screen" on page C-26.
- The settings made here change the measurement conditions of the parameter set.

Item	Setting value	Description
Transparent mode	N/A	Enable this setting when measuring workpieces with transparent bodies.
Detection method	• Segment mode (initial value) • Edge mode	Select the area to be measured by the laser.
Ultra-fine wire mode	N/A	Enable this setting when measuring workpieces with ultra-fine wires. **IMPORTANT** • Ultra-fine wires are measured using the LSM-02-A sensor. This setting cannot be set in LSM-30-A. • When measuring ultra-fine and transparent material (such as glass fibers), the minute influence of transmitted light may affect measured values. Prepare a master gage of the same nominal diameter and transmittance as that of the workpiece to be measured and compare measurement results.
Two items measurement	N/A	Enable this setting when measuring two measurement items at simultaneously (e.g., average OD and run-out). Disable this setting when there is only one measurement item.
Auto-work detection	• Disable (initial value) • Diameter detection **Scanning rate** 16 or 1 • Position detection	Select [Diameter detection] or [Position detection] when automatically detecting the workpiece. When [Diameter detection] is selected, select 16 or 1 as the scanning rate.
Scans for averaging (method)	• Arithmetical average (initial value) • Moving average	Select the method to be used averaging.
Outlier Elimination	• Disable (initial value) • USE1 • USE2	Select [USE1] or [USE2] to exclude abnormal values from the measurement data.
GO/NG judgment method	• Upper/ Lower limit (initial value) • Multi-limits • Target value and tolerance	Select the method to be used judging GO/NG.

■ [Common setting 2] screen

In the [Common setting 2] screen, items in the table below can be set.

For details on each item, see "3.3.2 [Common setting 2] Screen" on page C-44.

Item	Setting value	Description
Output at no workpiece error	• 0V (initial value) • 5V • -5V	Set the "E0008" analog output voltage (no workpiece error) when external devices are connected to this product.
I/O RUN input	• Single (initial value) • Continuous run measurement with a specified period • Continuous run measurement	Select the type of control (measurement execution method) to be performed by "RUN_IN_N" (pin 17) of the I/O connector.
STB/ACK output	• STB (initial value) • ACK	Select the I/O connector output signal.

■ [Common setting 3] screen

In the [Common setting 3] screen, items in the table below can be set.

For details on each item, see "3.3.3 [Common setting 3] Screen" on page C-46.

Item	Setting value	Description
Extension function THL settings	• Disable (initial value) • Enable 0.00–5.00 (specifiable in 0.01 increments)	Sets whether the edge detection level (THL: signal level at which workpieces are detected) is to be used. **IMPORTANT** Changes in THL significantly impact measurement accuracy.
Detect dirt on the glass	• Disable (initial value) • Enable	When enabled, the system detects dirt on the protective glass. **IMPORTANT** When this function is enabled, the protective glass is checked for dirt at LSM startup. Detection is not possible if there is contamination with dirt, etc. during measurement. To check for contamination, remove the measurement workpiece and afterward restart the LSM.
Set the STB length	• MR (automatic) (initial value) • 0.1 ms • 0.3 ms • 2.0 ms • 5.0 ms • 10.0 ms • 20.0 ms • 50.0 ms • 100.0 ms	Specify the STB length when using the I/O analog interface of this product to connect with an external device (communication destination).
Set the input software filter	• 5.0 ms (initial value) • 20.0 ms • 2.0 ms	Specify the filter length of input signals.
Setting the application range of calibration, preset/offset		
Calibration	• Separated for each parameter set pair • Unified all the parameter set (initial value)	Set the applicable range for Calibration and Preset/Offset. **Tips** Cannot be set to a combination of [Separated for each parameter set pair.] for [Calibration] and [Unified all the parameter set.] for [Preset/Offset].
Preset/Offset	• Separated for each parameter set (initial value) • Unified all the parameter set	

■ [Measurement condition 1] screen

The display and settings of the [Measurement condition 1] screen will change according to settings made in the common settings.

For details, see 📖 "3.3.5 [Measurement condition 1] Screen" on page C-54.

● Pattern 1

When [Segment mode] is selected for the detection method in the [Common setting 1] screen, the parameters shown in the table below will be displayed.

Tips

- When an item other than [Other] is selected, [Segment], [No of sample measurement], and [Method] (calculation items) are selected automatically.
- When [Transparent mode] is enabled in the [Common setting 1] screen, [Gap (SEG1)] and [Gap (SEG3)] are not displayed in the [Measurement condition 1] screen.
- If the segment number, number of samples, and calculation items set in [Other] are the same as items that are pre-defined for settings such as [Outer diameter (segment 2)] and [Runout (SEG 1)], the relevant items are automatically changed accordingly when the display is switched.
  For example, if the following are set in [Other], [Outer diameter (SEG 2)] is set because it is the same condition as for [Outer diameter (SEG 2)].
  - [Segment]: 2
  - [No of sample measurement]: 1
  - [Method]: Average
- If [No of sample measurement] is changed when [Two items measurement] is enabled, the [No of sample measurement] setting for the paired parameter set will automatically be set to the same value.

Item	Setting value	Description
Outer diameter (SEG 2) (initial value)	Segment: 2 No of sample measurement: 1 Method: Average (Cannot be changed)	Specify segment 2 to set the outer diameter measurement.
Runout (SEG1)	Segment: 1 No of sample measurement: If other than 1, the value remains the same as before selection. If 1, changed to 0. Method: Range (Cannot be changed)	Specify segment 1 to set run-out measurement.
Runout (SEG3)	Segment: 3 No of sample measurement: If other than 1, the value remains the same as before selection. If 1, changed to 0. Method: Range (Cannot be changed)	Specify segment 3 to set run-out measurement.

Item	Setting value	Description
Average OD	Segment: 2 No of sample measurement: If other than 1, the value remains the same as before selection. If 1, changed to 0. Method: Average (Cannot be changed)	Set average measurement of outer diameter.
Roundness	Segment: 2 No of sample measurement: If other than 1, the value remains the same as before selection. If 1, changed to 0. Method: Range (Cannot be changed)	Sets roundness measurement.
Cylindricity	Segment: 2 No of sample measurement: If other than 1, the value remains the same as before selection. If 1, changed to 0. Method: Range (Cannot be changed)	Set cylindricity measurement.
Gap (SEG1)	Segment: 1 No of sample measurement: 1 Method: Average (Cannot be changed)	Specify segment 1 to set gap measurement.
Gap (SEG3)	Segment: 3 No of sample measurement: 1 Method: Average (Cannot be changed)	Specify segment 3 to set gap measurement.
Other	N/A	Set the segment(s), number of sample measurement, and calculation items as desired.
Segment	1–7 (initial value: 2)	Specify a segment or segments. When [Other] is selected, this item is enabled. Multiple segments can be specified simultaneously.

Item	Setting value	Description
Sample measurement		
No of sample measurement	0–999 (initial value: 1)	Set the number of sample measurement. When number of sample measurement is 0: Zero-run measurement When number of sample measurement is 1: Normal measurement When number of sample measurement is from 2 through 999: Sample measurement.
Method	• Average (initial value) • Maximum • Minimum • Range	Specify the calculation item for sample measurement. This can be selected when the number of sample measurement is from 2 through 999. It cannot be selected when the number of sample measurement is 1.

● Pattern 2

The parameters shown in the table below are displayed when [Edge Mode] is selected for the detection method in the [Common setting 1] screen.

Setting item	Setting value	Description
Edge, manual	N/A	Set an arbitrary edge.
Edge mode		
Start edge	1–254 (initial value: 2)	Specify which edge to begin measurement from.
End edge	2–255 (initial value: 3)	Specify which edge to end measurement with.
Sample measurement	Same as pattern 1.	

■ [Measurement condition 2] screen

The display and settings of the [Measurement condition 2] screen will change according to settings made in the common settings.

For details, see "3.3.6 [Measurement condition 2] Screen" on page C-59.

Item	Setting value	Description
Number of averaging (measurement interval)		
Number of averaging (measurement interval)	1–2048 (initial value: 1024)	Specify the number of averaging.
Outlier Elimination*1		
Upper lim.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the upper limit for normal values.
Lower lim.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the lower limit for normal values.
Count val.	1–100 (initial value: 1)	Set the allowed number of measured values outside the normal range (abnormal values). When the number of abnormal values reaches the number set, an outlier detection warning is displayed. **Tips** For details on the outlier detection warning, see "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting".
GO/NG judge*2		
Upper/Lower limit		
Upper lim.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the upper limit for GO/NG judgment.
Lower lim.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the lower limit for GO/NG judgment.
Multi-limits		
Ranges	3–7	Set the number of rows for GO/NG judgment.
Thresholds (L1 to L6)	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the range values for each region.
Target value		
Target value	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the target value for GO/NG judgment.
Upper tol.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the upper tolerance of the target value.
Lower tol.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the lower tolerance of the target value.

Item	Setting value	Description
Analog out*2		
Reference value	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Set the reference value used when the difference between the reference value and the measured value and the reference value is output to an external device via the I/O analog interface.
Scale	1–5 (initial value: 1)	Specify the reference value for scale values (gain).
Auto-work detection*2		
No. of meas. (scanning rate)	1–999 (initial value: blank)	When enabling automatic detection, specify the scanning rate to perform to check whether a workpiece has entered the measurement area.
Invalid time (ms)	1–9999 (initial value: blank)	Specify the length of time from when a workpiece is detected to the start of measurement (invalid time).
Upper lim.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the upper limit for detection.
Lower lim.	Sign + two digits of integer part + five digits of decimal part (initial value: blank)	Specify the lower limit for detection.

*1 If both the upper and lower limits are blank, this function is disabled.

*2 If all input fields are blank, this function is disabled.

3.2 [Environmental setting] Screen

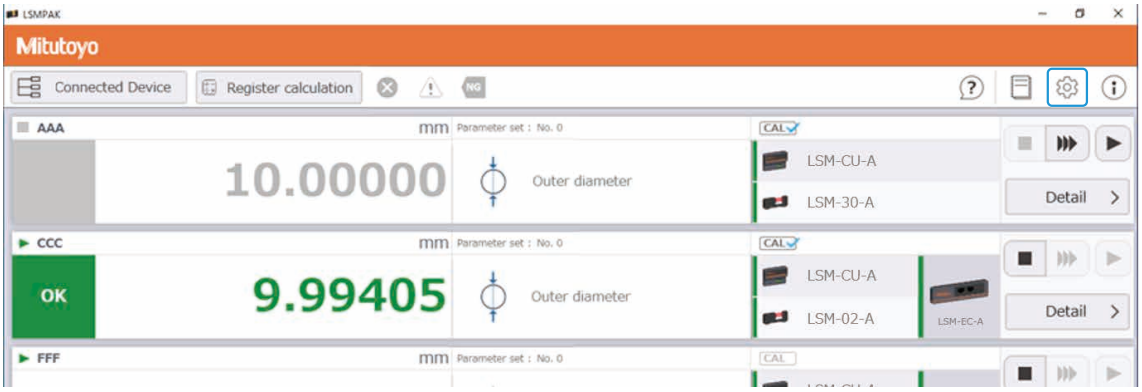
Items below are set in the [Environmental setting] screen.

- Language
- Communication method
- Unit
- Number of digits after the decimal point
- Security function

IMPORTANT

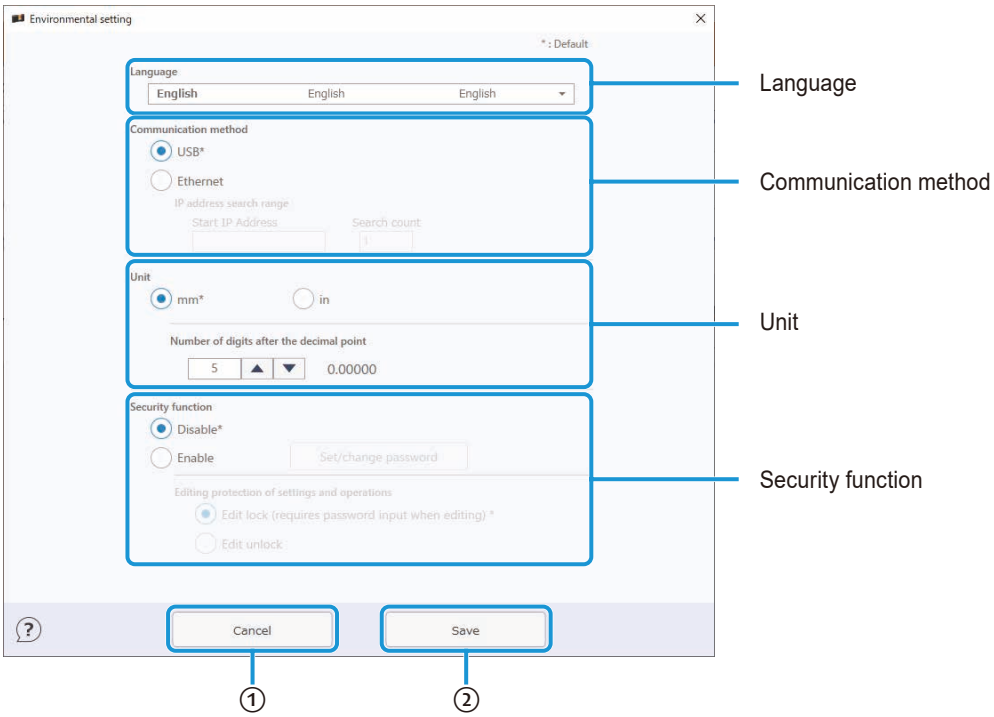
If the power is turned off in the middle of setup, the contents of the settings will not be saved.
We recommend that you write your settings down.

1 **Click [Environmental setting] ( ) in LSMPAK.**



» The [Environmental setting] screen is displayed.

2 Set items in the environmental settings.



No.	Description
①	Cancels editing and closes the [Environmental setting] screen.
②	Saves the settings to LSMPAK.

■ Language

Select the language to be used by LSMPAK.

Select a language from the drop-down list.

Languages available are Japanese and English.

■ Communication method

Either USB or Ethernet can be selected as the communication method.

Tips

To edit the IP address, subnet mask, etc. on the [Connected Device] screen, connect the PC and LSM via USB and select [USB].

● When [USB] is selected

Communication with the LSM is via USB.

Tips

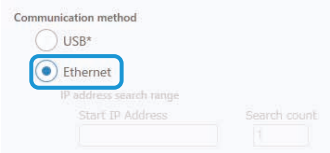
- To edit IP addresses, etc., select [USB].
- If you will be using Ethernet, first do device setup via USB.

● When [Ethernet] is selected

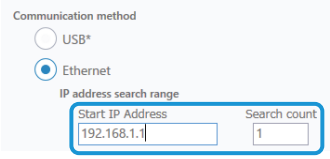
Communication with the LSM is via Ethernet.
Communicating LSMs are detected using the [IP address search range].

Tips
For communication via Ethernet, device settings must first be made via USB.

1 **Select [Ethernet] in [Communication method].**



2 **Enter a range of IP addresses for connected controllers in the [Start IP Address] and [Search count] fields.**



3 **Click [Save].**

» A dialog box is displayed prompting for LSMPAK to be restarted.

■ Unit

You can select the unit of measure for LSMs.

IMPORTANT
Changing the unit will cause the controller to restart. Please note that measurement data is be cleared upon restarting.

Tips
- This item appears only if all connected controllers are the "mm/in" type. It does not appear if a mm-only type controller is included.
- When the unit of measure is changed, the change is applied to all connected controllers.

● Number of digits after the decimal point

Sets the number of decimal places for values measured.

If the unit is millimeters, you can set from 1 through 5 decimal places (up to 0.00001); if the unit is inches, you can set from 1 through 6 decimal places (up to 0.000001).

Click [▼] or [▲] to set the desired number of digits.

Tips

The number of decimal places setting only applies to display of measured and idle values in measurement and calculation lists.

The number of digits displayed in locations where numeric values are input or displayed for setting information, measurement history, calibration, preset, and offset are fixed as indicated below.

- With mm: 5 decimal places
- With in: 6 decimal places

■ Security function

You can either enable or disable the security function.

To enable the security function, set a password.

The security function is mainly used to enable/disable editing of items configured in LSMPAK.

Item	Description
Enable	• You can set or change the password. You can also set a blank password. • You can select edit lock or edit unlock for [Editing protection of settings and operations].
Disable	[Editing protection of settings and operations] is not available.

Tips

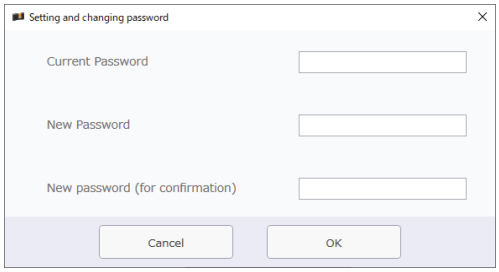
- The password is set to blank at the factory.
- If you forget the password, you can clear it by reinstalling LSMPAK.

● Setting and changing password

You can set a password.

Up to 20 characters can be set using half-width alphanumeric characters and symbols. (Both upper and lower case alphanumeric characters may be used.)

Enter the current and new passwords in the password fields and click OK to set the password. An error message appears if the information entered is missing or incomplete.



If the security function is enabled, you will be asked to enter a password when configuring the following settings.

Screen	Item	
Connected Device	[Edit device information]	
Measurement list	[Register calculation]	
Detail screen		
	[Setting information] tab	[Edit settings], [Open setting file], [Initialization]
	[Memorize light amount] tab	[Automatic adjustment], [Memorize light amount]
	[Calibration] tab	[Disable calibration], [1 point calibration], [2 points calibration]
	[Preset/Offset] tab	[Cancel Preset], [Preset settings], [Offset remove], [Offset settings]
Environmental setting	[Unit] (mm/in type only), [Security function] > [Disable], [Editing protection of settings and operations] > [Edit unlock]	

Tips

- The password is set to blank at the factory.
- If you forget the password, you can clear it by reinstalling LSMPAK.

● Editing protection of settings and operations

You can restrict who can edit LSMPAK settings.

Item	Description
Edit lock (requires password input when editing)	• Disables editing of measurement settings (common settings and parameter settings), calculation settings, etc. Settings are viewable. • If you set edit lock, you will be prompted to enter a password when editing a setting.
Edit unlock	Allows editing and viewing of measurement settings, calculation settings, etc.

Tips

- Password entry is required when changing from [Edit lock (password required for editing)] to [Edit unlock].
- Even when [Edit unlock] is selected, LSMPAK automatically switches to [Edit lock (password required for editing)] after restarting.
- The factory setting is [Edit lock (requires password input when editing)].

3.3 Measurement Settings

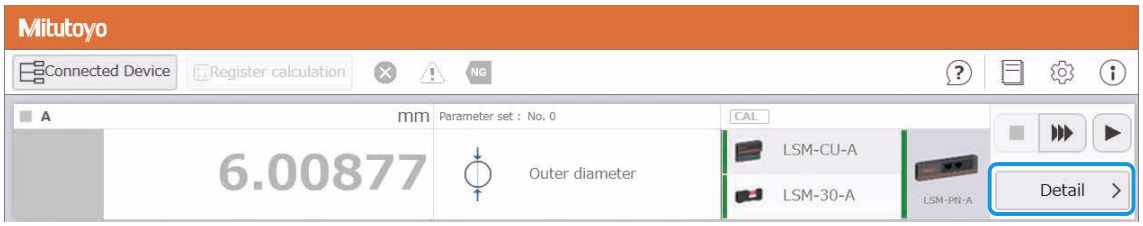
After the environmental settings have been configured, configure the measurement settings.

Edit any of the measurement settings. (These includes initial values, so edit them to suit your application.)

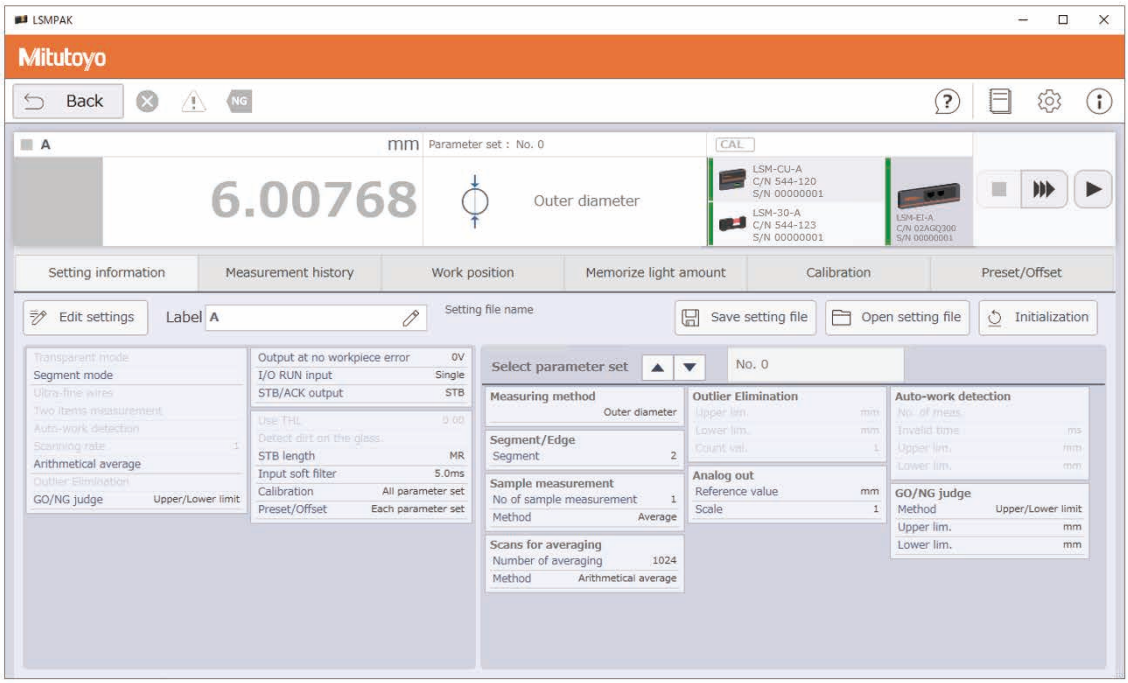
IMPORTANT

If the power is turned off in the middle of setup, the contents of the settings will not be saved.
We recommend that you write your settings down.

1 Click [Detail] in the measurement information.



» The detail screen is displayed.



Tips

If an error occurs on a connected device as shown in the figure below (where a red line appear to the left of the device name), it indicates that device settings have not been completed on the LSM.

Complete the device settings before making any measurement settings.

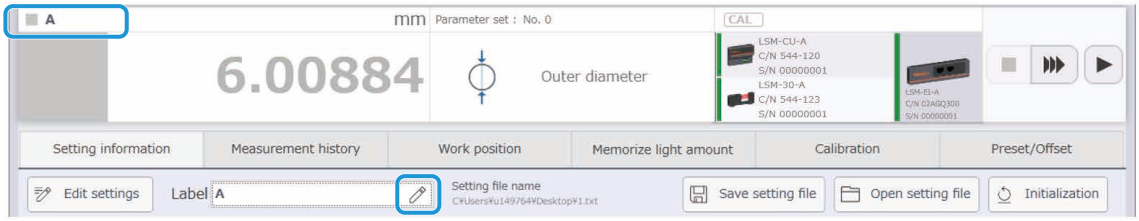
For details about the device settings, see "6.2 Advanced Measurement" on page C-126 in "PART B Preparation".

2 Editing label names (optional)

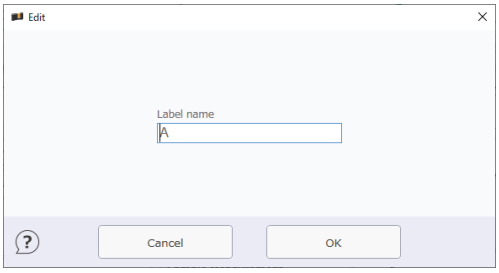
IMPORTANT

When using with multiple LSMs connected, assign a different label to each LSM. If the same label is set for multiple LSMs, registration of calculations may not be performed correctly.

1 Click in the [Label] input field.



» The label editing screen is displayed.



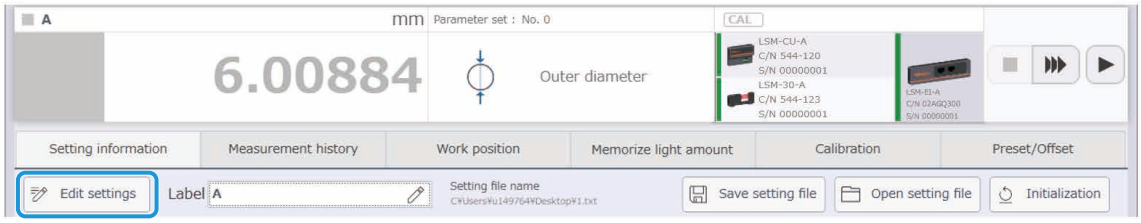
2 Enter the label.

3 Click [OK].

Tips

Labels can include up to 13 half-width alphanumeric characters (uppercase only) and underscore characters.

3 Click [Edit settings].



» The [Common setting 1] screen is displayed. ("3.3.1 [Common setting 1] Screen" on page C-26)

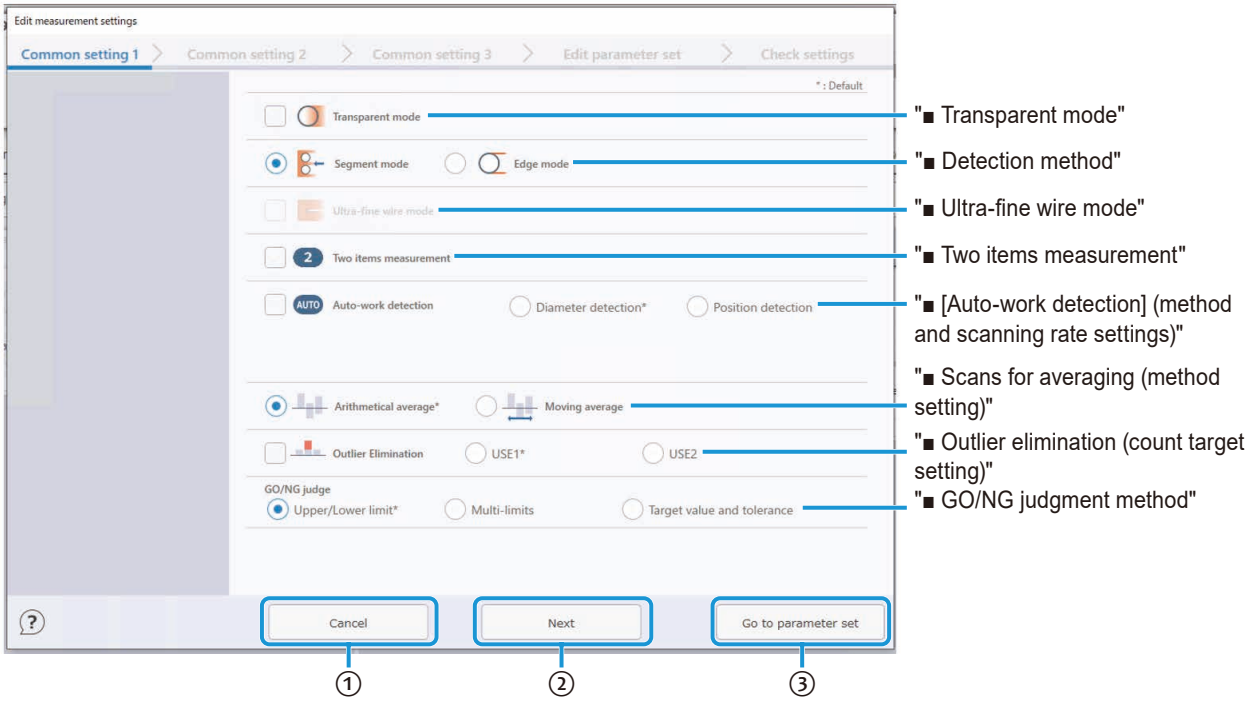
Tips

If the security function is enabled in the [Environmental setting] screen, a password entry dialog is displayed. In this case, the [Common setting 1] screen is displayed after password authentication.

4 Proceed to follow the wizard from "3.3.1 [Common setting 1] Screen" to "3.3.7 [Check settings] Screen".

3.3.1 [Common setting 1] Screen

The [Common setting 1] screen is used to set items related to the workpiece and measurement location.
The settings made here change the measurement conditions of the parameter set.



No.	Description
①	Returns display to the detail screen.
②	Continues to the [Common setting 2] screen.
③	Continues to the [Edit parameter set] screen.

● Exclusivity of items in the [Common setting 1] screen

The [Common setting 1] screen includes combinations of settings that cannot be used at the same time.

	Trans-parent mode	Edge Mode	Ultra-fine wire mode	Two items measure-ment	Au-to-Work Detec-tion	Moving average	Outlier Elimina-tion
Transparent mode		—	✓	✓	✓	✓	✓
Edge Mode	—		—	—	✓	✓	✓
Ultra-fine wire mode	✓	—		—	—	✓	✓
Two items measure-ment	✓	—	—		—	—	—
Auto-Work Detection	✓	✓	—	—		—	✓
Moving average	✓	✓	✓	—	—		✓
Outlier Elimination	✓	✓	✓	—	✓	✓	

✓: Available combination
—: Unavailable combination

■ Transparent mode

To measure transparent workpieces such as glass tubes, optical fibers, and films, enable [Transparent mode] in the common settings.

Since a workpiece made of transparent material allows a portion of light to pass through, the way a segment (the dark laser irradiation shadow of the workpiece and the bright laser-irradiated portion) is generated differs from that for an opaque workpiece, such as steel material, as shown in the figure below.

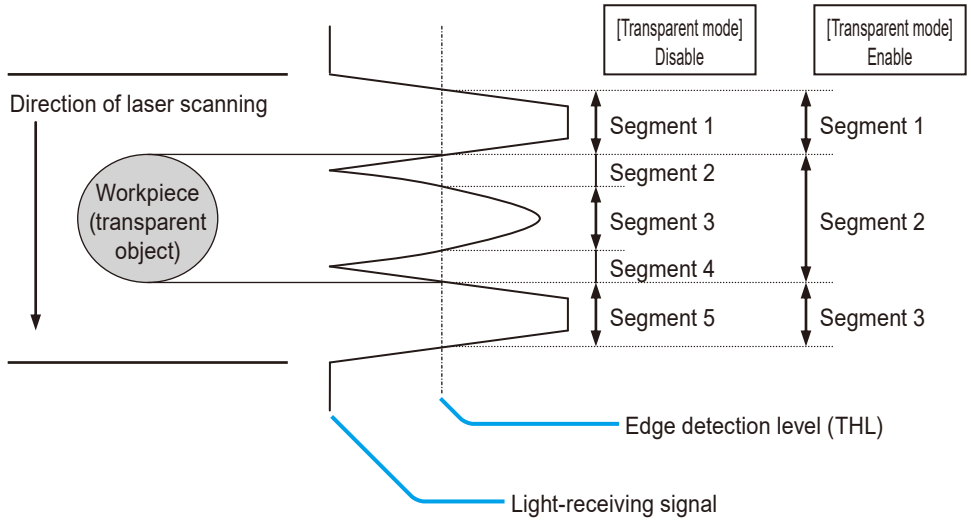
In such case, the segment can be corrected by enabling [Transparent mode] to ensure accurate measurements.

Measurement example

"■ Measuring the outer diameter of transparent round bars" on page C-126

Tips

When [Transparent mode] is enabled, [Edge Mode] cannot be selected for detection method. Also, [Segment] can only be set from 1 through 3. If it is set to 4 or higher, it is automatically changed to 2.



IMPORTANT

When measuring ultra-fine and transparent material (such as glass fibers), the minute influence of transmitted light may affect measured values. Prepare a master gage of the same nominal diameter and transmittance as that of the workpiece to be measured and compare measurement results.

■ Detection method

The detection method can be either "segment" or "edge".

"Segments" are areas that are demarcated as light and dark parts of the workpiece that result from laser scanning.

"Edges" are the boundaries between highlights and shadows of the workpiece that result from laser scanning.

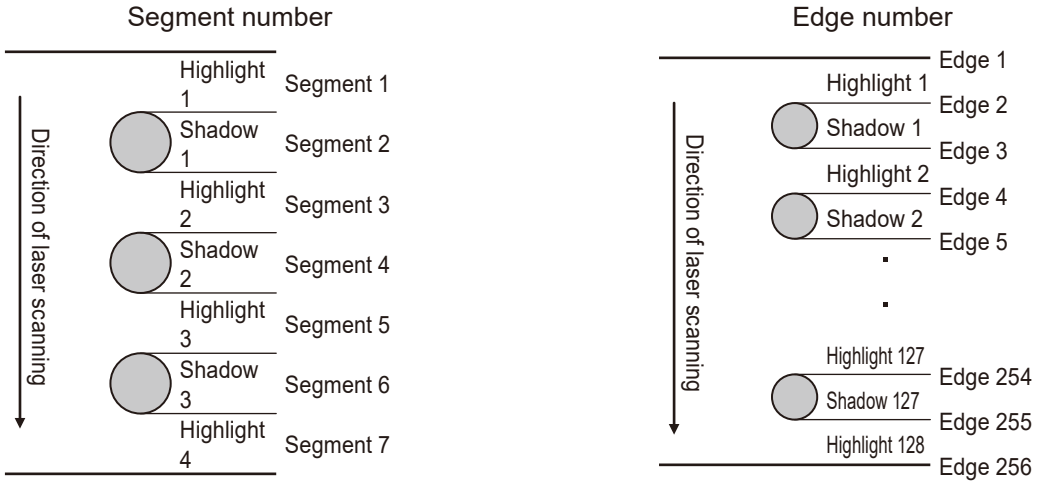
Segments and edges are each numbered and managed as shown in the figure below.

Specifying a segment number is referred to as "segment mode", and specifying an edge number is referred to as "edge mode".

Select [Segment mode] or [Edge mode] according to your application.

Tips

- When [Transparent mode] or [Ultra-fine wire mode] is enabled, [Edge Mode] cannot be selected.
- [Edge Mode] and [Two items measurement] cannot be used at the same time.



● Segment mode

With segment mode, up to 4 highlights and 3 shadows can be measured.

Segment numbers are specified from 1 through 7.

Items to be set for each parameter set

Segment number

"■ Segment mode" on page C-56

Measurement example

Basic measurements

"6.1.1 Outer Diameter Measurements" on page C-113, "6.1.2 Gap Measurement" on page C-115, "6.1.3 Run-Out Measurement" on page C-116, "6.1.4 Thickness Measurement" on page C-118

Advanced measurement

"6.2.4 Ultra-Fine Wire Measurements" on page C-132

● Edge mode

With edge mode, up to 128 highlights and 127 shadows can be measured.

Edges are specified as numbers from 1 through 256.

Since a workpiece consisting of a transparent object cannot be measured by edge mode, it is measured by segment mode.

Items to be set for each parameter set

- Start edge number
- End edge number

For details, see "■ Edge mode" on page C-56.

Measurement example

"6.1.1 Outer Diameter Measurements" on page C-113

■ Ultra-fine wire mode

When measuring ultra-fine wires with diameters smaller than ø0.05, enable [Ultra-fine wire mode].

Since ultra-fine wires are thinner than the laser beam diameter at the focal point, the laser beam is not completely blocked (occulted) and a clear edge signal is not obtained.

This LSM can measure workpieces that are thinner than the laser beam diameter by varying the edge detection level (THL) according to the size of the workpiece using a special algorithm based on slight variations in the obtained light-receiving signal.

Ultra-fine wire measurement is available by connecting LSM-02-A. Ultra-fine wire measurement is not available with LSM-30-A.

When the LSM-02-A is connected, the measuring range (range of guaranteed accuracy) changes as follows, depending on the ultra-fine wire measurement settings:

- When [Ultra-fine wire mode] is enabled: 0.005 mm–2 mm
- When [Ultra-fine wire mode] is disabled: 0.05 mm–2 mm

Measurement example

"6.2.4 Ultra-Fine Wire Measurements" on page C-132

Restrictions

When [Ultra-fine wire mode] is enabled, restrictions apply to the following items.

Item	Restrictions
Measurement interval	When using ultra-fine wire measurement, THL is adjusted at the start of measurement, so the first measurement time is about 0.02 seconds longer than the set measurement interval. • Single run measurement: measurement interval + approx. 0.02 sec. • Continuous run measurement: measurement interval + approx. 0.02 seconds for the first measurement, and normal measurement interval for the second and subsequent measurements
Number of averaging	Set to 16–2048 times. Values from 1 through 8 cannot be set (normally 1 through 2048 times).
Measurement position	• Only [Segment mode] can be used as the detection method. • If multiple segments are set within one parameter set, the measuring range starts from 0.1 mm. • When measuring a workpiece of 0.1 mm or less, only use one segment.
Other	• [Two items measurement] and [Auto-Work Detection] cannot be set. In addition, only [Segment mode] can be used as the detection method. • For a fine gap measurement, the laser beam intensity is insufficient for stable measurement. Be sure to memorize the light intensity with no jigs or workpieces. "6.2.12 Measurement of Narrow Gaps" on page C-149 • When measuring ultra-fine and transparent material (such as glass fibers), the minute influence of transmitted light may affect measured values. Prepare a master gage of the same nominal diameter and transmittance as that of the workpiece to be measured and compare measurement results.

■ Two items measurement

One LSM measures two (2) measurement items simultaneously.

Parameter sets are set for each measurement item.

To perform two items measurement, enable [Two items measurement].

If not enabled, [One item measurement] is set.

Measurement example

"6.2.9 Two Items Measurement of Outer Diameter and Run-Out of Rubber Roll (Sample Measurement)" on page C-142

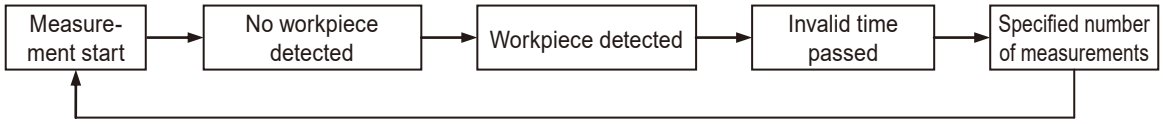
Tips

- The following items cannot be used together with [Two items measurement].
  - [Edge Mode]
  - [Ultra-fine wire mode]
  - [Auto-work detection]
  - [Moving average]
- If [Two items measurement] is set, two parameter sets are paired. The paired parameter set combinations are as follows.
  - 0 and 5
  - 1 and 6
  - 2 and 7
  - 3 and 8
  - 4 and 9
  - 10 and 15
  - 11 and 16
  - 12 and 17
  - 13 and 18
  - 14 and 19
- When [Two items measurement] is enabled, [Number of averaging] and [No of sample measurement] of paired parameter sets are automatically set to the same valued.
  For example, if you change [No of sample measurement] in parameter set 0 from 1 to 2, the number of samples in paired parameter set 5 will also be automatically changed to 2.

■ [Auto-work detection] (method and scanning rate settings)

[Auto-work detection] is a function that allows an LSM to automatically detect and measure a workpiece when it comes within the set detection range (between the lower and upper detection limits).

It automatically detects workpieces entering the measuring position from outside the set detection range (outside the lower and upper detection limits) and repeats the specified number of measurements.



To automatically detect workpieces, enable [Auto-work detection].

After enabling, set the detection method and scanning rate.

Item	Description	Setting value	Remarks
Detection method	Select the detection method. 📖 "● Diameter detection" on page C-33, 📖 "● Position detection method" on page C-34	Diameter detection Position detection	Initial value: Diameter detection
Detection speed	Select the detection speed (scanning rate). **Tips** • To detect a precise workpiece, it is recommended that you select [16 times]. • If the position detection method is selected, you can only select [1 time].	1 time 16 times	Initial value: 16 times

Items to be set for each parameter set

- No. of meas.
- Invalid time
- Upper limit of detection range
- Lower limit of detection range

For details, see 📖 "■ Auto-work detection (set individually)" on page C-65.

Measurement example

📖 "6.2.10 Outer Diameter Measurement of Shaft Processed with a Centerless Grinder (Auto-Work Detection Function)" on page C-145

Tips

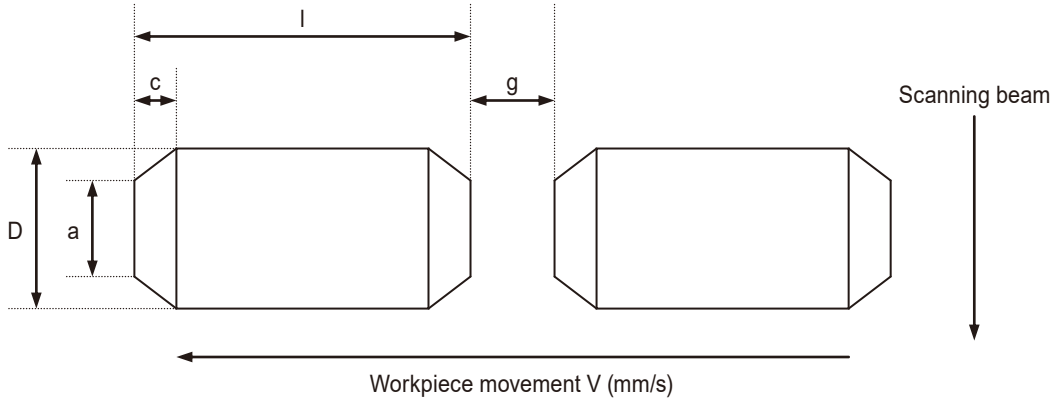
The following items cannot be used at together with [Auto-work detection].

- [Ultra-fine wire mode]
- [Two items measurement]
- [Moving average]

● Diameter detection

When the workpiece enters the laser scanning plane perpendicularly, it is automatically detected and measured.

- To detect a workpiece, the measured value after calibration and preset correction is used.
- Starting from a state with no workpiece, after a workpiece with a surface that falls within the set detection range (between the upper and lower detection limits) is detected and the invalid time elapses, measurement is repeated the specified number of times. After the specified number of measurements, the final measurement result is latched and displayed. Once measurement is started, the upper and lower detection limits will no longer be checked.
- Either [1 (time)] or [16 (times)] can be selected as the speed for workpiece detection. Use [16 (times)] if connecting bars are used between workpieces as feeding convenience to set appropriate intervals between workpieces, and the difference in the outer diameter between the workpieces and the bars is insufficient or if the feed rate is low.
- An example configuration of workpieces is shown in the diagram below.

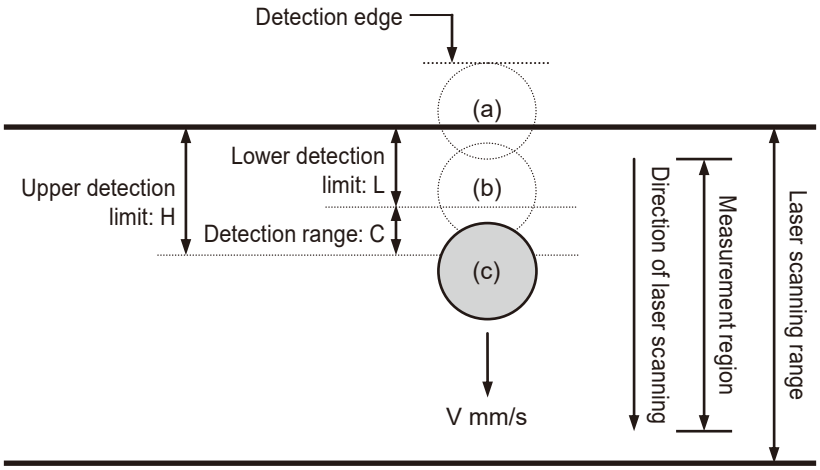


Item	Setting value	Remarks
Detection speed (scanning rate)	16 times	One time may be enough for detection. Use 16 times if precise detection is required, such as for small chamfers.
Upper detection limit	H > Upper measuring range limit, or 1.1 × D	Specifying either only the upper limit or only the lower limit is enough for detection.
Lower detection limit	L < (D + a) / 2	
Invalid time	T > (c / V) ms	
No. of Meas.	N < (l - 2 × c) × 0.8 (Safety factor) / Measurement interval / V	Normally one time is used.

● Position detection method

When the workpiece enters the laser scanning plane horizontally from the scanning direction, it is automatically detected and measured.

- The scan speed (scanning rate) for workpiece detection is fixed at 1 time. 16 times cannot be specified (it is ignored even if specified).
- The preset correction is not applied to the upper and lower detection limits.
- Starting from a state with no workpiece, after the edge of a workpiece that falls within the set detection range (between the upper and lower detection limits) is detected and the invalid time elapses, measurement is repeated the specified number of times. However, once measurement is started, the upper and lower detection limits will no longer be checked.
- An example configuration is described in the diagram below.
  Workpiece positions (a) and (b) are judged as no workpiece, and (c) is judged as that a workpiece is present.

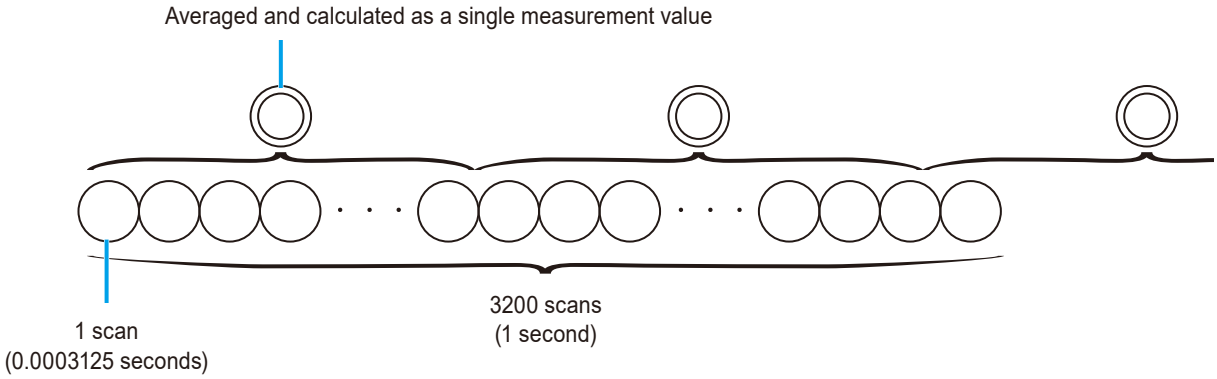


Item	Setting value	Remarks
Detection speed (scanning rate)	1 time	You can only select 1 time.
Upper detection limit	H < (Laser scanning range + Measurement region) / 2 - D	Specifying either only the upper limit or only the lower limit is enough for detection.
Lower detection limit	L > (Laser scanning range - Measurement region) / 2 - D	
Invalid time	T = 0	
No. of Meas.	N = 1	For position detection, 1 time.

■ Scans for averaging (method setting)

The LSM uses a laser to scan the workpiece 3,200 times per second and then averages these scans to obtain measurement data. Stable measurement data can be obtained by setting the number of averaging to a large number (collecting a large number of samples and calculating representative values), although it takes more time to measure.

You can select either [Simple average] or [Moving average] as the method for averaging measurement data.



Items to be set for each parameter set

Number of averaging

"■ Number of averaging (measurement interval)" on page C-60

Measurement example

"6.2.3 Measuring Fast-Moving Wires" on page C-131

Tips

[Moving average] cannot be used together with the following items.

- [Two items measurement]
- [Auto-work detection]

● Arithmetical average

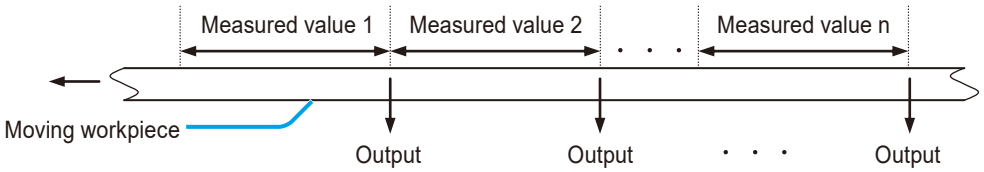
When the number of sample measurement is 1

When measuring the outside diameter of a moving workpiece using arithmetic averaging, measurement values are output in the area divided according to the set number of averaging (the area of measurement values 1, 2, ...n for each part of the workpiece).

For example, when the number of averaging is set to 1024, measurement results are obtained at intervals of 0.32 seconds.

Calculation formula

Measurement interval (seconds) = number of scans x time for one scan
0.32 = 1024 x 0.0003125



When the number of sample measurement is 2

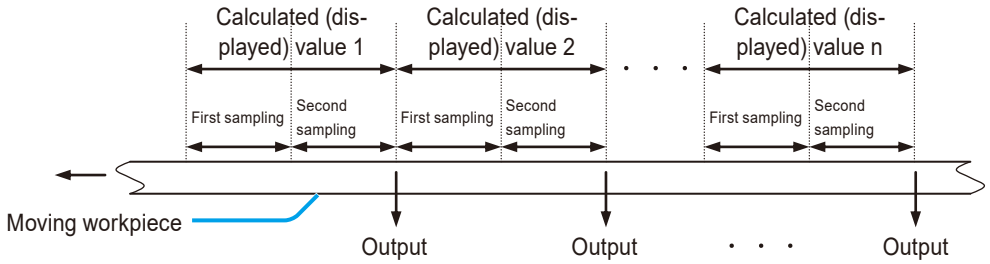
When the number of sample measurement is set to 2 for arithmetical averaging, the first sampling and the second sampling are calculated, and calculated values (displayed values) 1, 2, and 3.....n are calculated for each part. The time required to obtain one calculated value (displayed value) is determined by the set number of averaging.

For example, when the number of averaging is set to 1024 and the number of sample measurement is set to 2, calculated values (displayed values) are obtained at intervals of 0.64 seconds.

Calculation formula

Measurement interval (seconds) = (number of scans x time for one scan) x number of sample measurement

0.64=(1024×0.0003125) x 2



For the relationship of measurement interval (measurement time) between the number of averaging and the arithmetical average, see "■ Number of averaging (measurement interval)" on page C-60.

IMPORTANT

Setting the number of averaging to a higher number improves repeatability.
If there is enough time available for measurement, set the number of averaging to a higher number.

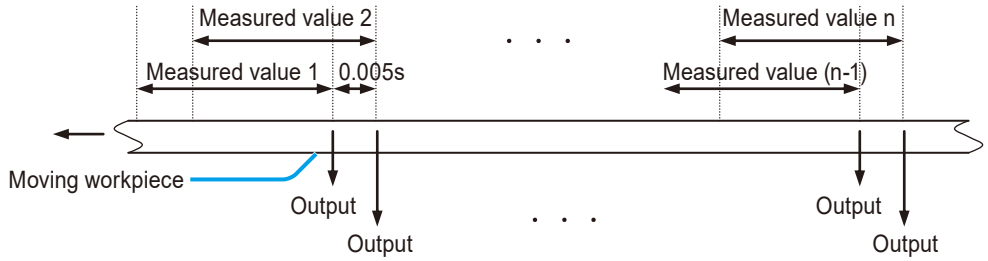
● Moving average

When the number of sample measurement is 1

Even if the set number of averaging is the same as for arithmetic averaging, moving averages can be calculated in parallel (moving averages in which the range to be averaged is shifted 16 times each) for each further subdivided part of measurement 1, 2, ...n. With the arithmetical average, because the measured value is updated for each scan for averaging, the required time is determined by the number of averaging. With the moving average, the measurement interval (measurement time) is shortened because averaging is performed with the above method. This allows measurement results with a small amount of change to be obtained for workpieces whose outer diameter changes, enabling quick detection of trends in outer diameter change in the workpiece.

For example, if the number of averaging is 1024, initial measurement value 1 takes 0.32 seconds (time required when the number of averaging is 1024), but results for measurement value 2 and on are obtained at intervals of 0.005 seconds (time for a number of averaging of 16).

This makes moving averages suitable for observing minute variations in measured values (such as wire drawing machines for electrical lines and feedback control of extruding machines).

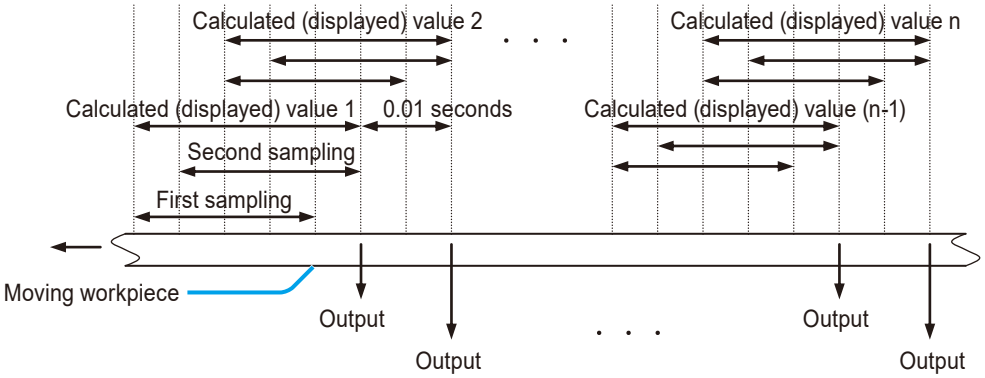


When the number of sample measurement is 2

When the number of sample measurement is set to 2 for moving average, calculated (displayed) value 1 is calculated when the first sampling and the second sampling both become available. For calculated (displayed) value 2 and on, the interval at which the measurement result is calculated changes according to the set number of sample measurement.

For example, if the number of averaging is set to 1024 and the number of sample measurement is set to 2, calculated (displayed) value 1 requires 0.32 seconds (time for the set number of averaging of 1024) + 0.005 seconds (time for the set number of averaging of 16), or 0.325 seconds. If the number of samples is set to 3, an additional 0.005 seconds (for a set number of averaging of 16) is added.

Calculated (displayed) values 2 and on take 0.005 seconds (for a set number of averaging of 16) x the number of sample measurement. In other words, calculated (displayed) values 2 and on are obtained at intervals of 0.01 seconds (0.005 x 2) when the number of sample measurement is 2, and at intervals of 0.015 seconds (0.005 x 3) when the number of sample measurement is 3.



For the relationship of measurement interval (measurement time) between the number of averaging and the moving average, see "■ Number of averaging (measurement interval)" on page C-60.

IMPORTANT

- For moving averages, the number of averaging can only be set to 32 or more.
- Setting the number of averaging to a higher number improves repeatability.
  If there is enough time available for measurement, set the number of averaging to a higher number.

■ Outlier elimination (count target setting)

[Outlier Elimination] is a function for determining whether a measured value is a normal value or an abnormal value. By setting upper and lower limits for normal values, measurement values outside the range can be excluded as abnormal values. If value is determined to be abnormal, its data will not be displayed or output.

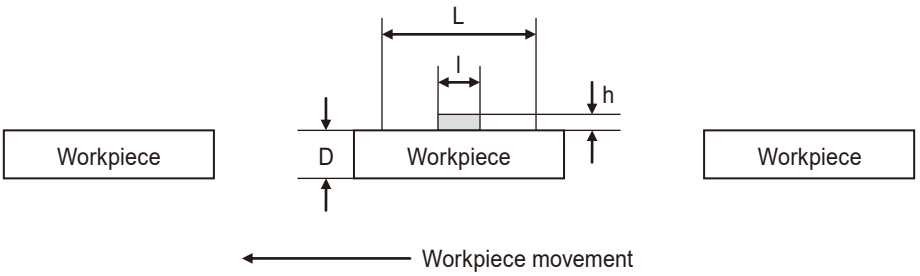
Judgment	Judgment conditions
Abnormal values (exclusion target)	Measured value < Lower limit value
Normal value	Lower limit value ≤ Measured value ≤ Upper limit value
Abnormal values (exclusion target)	Upper limit value < Measured value

Applications suited to [Outlier Elimination]

Control of grindstone feed for centerless grinders, etc.

If the grindstone of a centerless grinder is controlled based on the measured data from the LSM, a large measurement error could occur due to foreign matter, such as from coolant, adhered to the workpiece.

As shown in the figure, if foreign matter (with a height of h) adheres to the workpiece (diameter D) within the averaging region L, an abnormal outer diameter in the region of l is created, the displayed measured value will be (D + lh / L). As a result, control of the grinder is temporarily influenced by the error.



You can use this function to exclude clearly abnormal measured values generated due to the foreign matter that adheres to the grindstone, allowing proper control of feeding of the grindstone.

Items to be set for each parameter set

- Upper lim.
- Lower lim.
- Count val.

For details, see "■ Outlier elimination" on page C-62.

● USE1

Measurement is performed until the measured values within the upper and lower limits reach the value set in [No of sample measurement] (C-57 page) on the [Measurement condition 1] screen, and only measured values within the range are calculated and displayed as measurement results.

● USE2

The number of measurements set in [No of sample measurement] (C-57 page) on the [Measurement condition 1] screen is performed, and only measured values that are within the upper and lower limits are calculated and displayed as measurement results. However, in the case of a single measurement, measurement continues until a measurement value within the upper and lower limits is obtained.

Tips

When the number of measured values outside the upper and lower limits (abnormal values) reaches the number set in [Count val.], an outlier detection warning is displayed.

For details on the outlier detection warning, see "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting".

■ GO/NG judgment method

Select the method of GO/NG judgment of the measurement results.

There are three methods of determining GO/NG judgment: [Upper/Lower limit], [Multi-limits], and [Target value and tolerance]. (The initial value is [Upper/Lower limit].)

For details on each of the GO/NG judgment methods, see "● Upper/Lower limit" on page C-40, "● Multi-limits" on page C-41, "● Target value and tolerance" on page C-43.

Items to be set for each parameter set

- When [Upper/Lower limit] is selected: Upper and lower limits
- When [Multi-limits] is selected: Values from L1 through L6
- When [Target value and tolerance] is selected: Target value, upper tolerance, lower tolerance

For details, see "■ GO/NG judgment" on page C-63.

Measurement example

"6.2.2 Outer Diameter Measurement of Precision-Machined Product" on page C-130

IMPORTANT

In case of continuous measurement with a short measurement interval, the GO/NG judgment result (GO/NG) may be displayed only momentarily or may be thinned out or hidden. To be sure about the GO/NG result for each measurement, check the measurement history.

● Upper/Lower limit

Perform GO/NG judgment for measurement results by specifying an upper limit and a lower limit.

The GO/NG judgment results are displayed as GO (pass), +NG (fail - exceeded the upper limit) and -NG (fail - exceeded the lower limit).

GO/NG judgment display

When an upper limit and lower limit are specified, the GO/NG judgment is displayed in LSMPAK as shown below.

GO/NG judg-ment	GO/NG judgment conditions	Example of LSMPAK display
-NG	Measured value < Lower limit value	
OK	Lower limit value ≤ Measured value ≤ Upper limit value	
+NG	Upper limit value < Measured value	

● Multi-limits

Two to six thresholds are set and three to seven ranges (ranges) are used to determine GO/NG judgment.

The GO/NG judgment is displayed in LSMPAK as shown below.

When thresholds L1–L6 are set

GO/NG judgment	Range	GO/NG judgment conditions	Example of LSMPAK display
-NG	R1	Measured value < L1	
OK	R2	L1 ≤ Measured value < L2	
	R3	L2 ≤ Measured value < L3	
	R4	L3 ≤ Measured value ≤ L4	
	R5	L4 < Measured value ≤ L5	
	R6	L5 < Measured value ≤ L6	
+NG	R7	L6 < Measured value	

When thresholds L1–L5 are set

GO/NG judgment	Range	GO/NG judgment conditions	Example of LSMPAK display
-NG	R1	Measured value < L1	
OK	R2	L1 ≤ Measured value < L2	
	R3	L2 ≤ Measured value < L3	
	R4	L3 ≤ Measured value ≤ L4	
	R5	L4 < Measured value ≤ L5	
+NG	R6	L5 < Measured value	

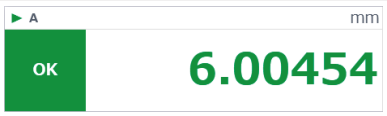
When thresholds L1–L4 are set

GO/NG judgment	Range	GO/NG judgment conditions	Example of LSMPAK display
-NG	R1	Measured value < L1	
OK	R2	L1 ≤ Measured value < L2	
	R3	L2 ≤ Measured value ≤ L3	
	R4	L3 < Measured value ≤ L4	
+NG	R5	L4 < Measured value	

When thresholds L1–L3 are set

GO/NG judgment	Range	GO/NG judgment conditions	Example of LSMPAK display
-NG	R1	Measured value < L1	
OK	R2	L1 ≤ Measured value < L2	
	R3	L2 ≤ Measured value ≤ L3	
+NG	R4	L3 < Measured value	

When thresholds L1–L2 are set

GO/NG judgment	Range	GO/NG judgment conditions	Example of LSMPAK display
-NG	R1	Measured value < L1	
OK	R2	L1 ≤ Measured value ≤ L2	
+NG	R3	L2 < Measured value	

● Target value and tolerance

Perform GO/NG judgment for measurement results by specifying a target value and tolerance.

The GO/NG judgment results are displayed as GO (pass), +NG (fail - exceeded the upper limit) and -NG (fail - exceeded the lower limit).

GO/NG judgment display

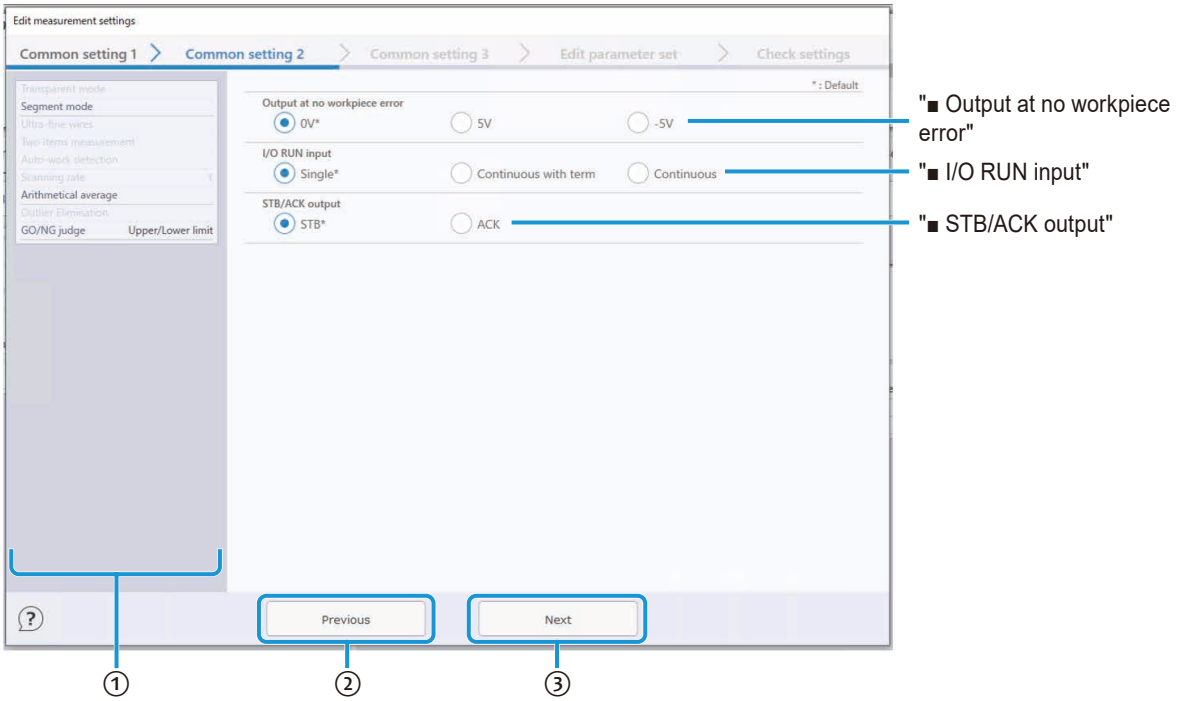
When a target value and tolerance are specified, the GO/NG judgment is displayed in LSMPAK as shown below.

GO/NG judgment	GO/NG judgment conditions	Example of LSMPAK display
-NG	Measured value < (Target value + Lower tolerance)	
OK	(Target value + Lower tolerance) ≤ Measured value ≤ (Target value + Upper tolerance)	
+NG	(Target value + Upper tolerance) < Measured value	

3.3.2 [Common setting 2] Screen

The [Common setting 2] screen sets items related to output of measurement data.

The measurement conditions of the parameter set change according to contents of the common settings.



No.	Description
①	Displays the settings for [Common setting 1].
②	Returns to the [Common setting 1] screen.
③	Continues to the [Common setting 3] screen.

■ Output at no workpiece error

Used when this product is connected to an external device.

Select the analog output voltage for error "E0008" (no workpiece error).

Select from 0V, 5V, or -5V. (The initial value is 0V.)

■ I/O RUN input

Select the type of control (measurement execution method) to be performed by "RUN_IN_N" (pin 17) of the I/O connector.

Select from [Single], [Continuous with term], or [Continuous]. (The initial value is [Single-run].)

Tips

The setting of this item does not affect the following controls.

- LSMPAK
- Command (USB virtual COM communication, general-purpose Ethernet TCP communication)
- PROFINET
- EtherNet/IP
- EtherCAT

■ STB/ACK output

Select the I/O connector output signal.

Select from [STB] (strobe) and [ACK] (acknowledgement signal). (The initial value is [STB].)

For details on signals, see "3.2.4 Timing Charts" on page D-35 in "PART D Interfaces".

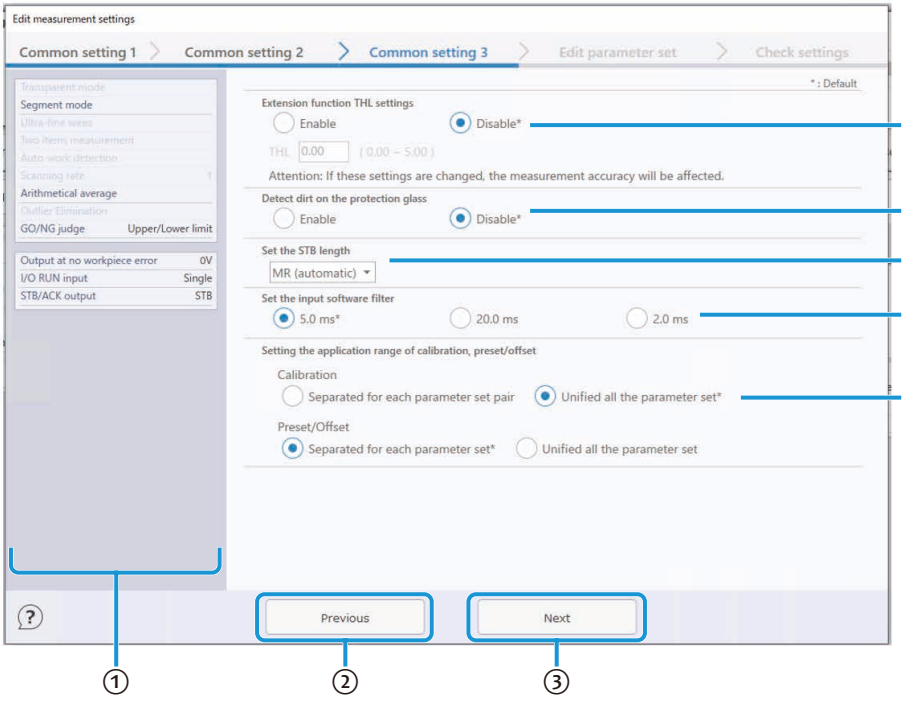
Tips

The setting of this item does not affect the following controls.

- LSMPAK
- Command (USB virtual COM communication, general-purpose Ethernet TCP communication)
- PROFINET
- EtherNet/IP
- EtherCAT

3.3.3 [Common setting 3] Screen

The [Common setting 3] screen is used to set items related to extended functions.



"■ Extension function THL settings"

"■ Detect dirt on the protection glass"

"■ Set the STB length"

"■ Set the input software filter"

"■ Setting the application range of calibration, preset/offset"

No.	Description
①	Displays the settings for [Common setting 1], and [Common setting 2].
②	Returns to the [Common setting 2] screen.
③	Continues to the [Edit parameter set] screen.

■ Extension function THL settings

The edge detection level (THL) is the signal level at which the workpiece is detected.

When measuring the width of a transparent film or sheet, the workpiece may be difficult to detect.

In such cases, set this item to [Enable] and change THL to an appropriate value (the initial setting is [Disable]).

Item	Description	Setting value	Remarks
Enable	THL is used.	0 V–5.00 V (In 0.01 V increments) (Initial value: 0.00 V)	
Disable	THL is not used.	N/A	Initial value

IMPORTANT

- Changing THL will affect measurement accuracy.
  Change carefully when required.
- If THL is changed, measurement accuracy may be reduced because the measurement value can easily vary depending on the condition of the end face edge. After changing THL, be sure to execute calibration.

Tips

The measurement error may be reduced by making the end face shape of the calibration master the same as that of the workpiece.

THL configuration is explained using the example below. The following example pertains to measurement of a transparent object.

1 Configure the settings for measurement.

Make settings according to intended use.

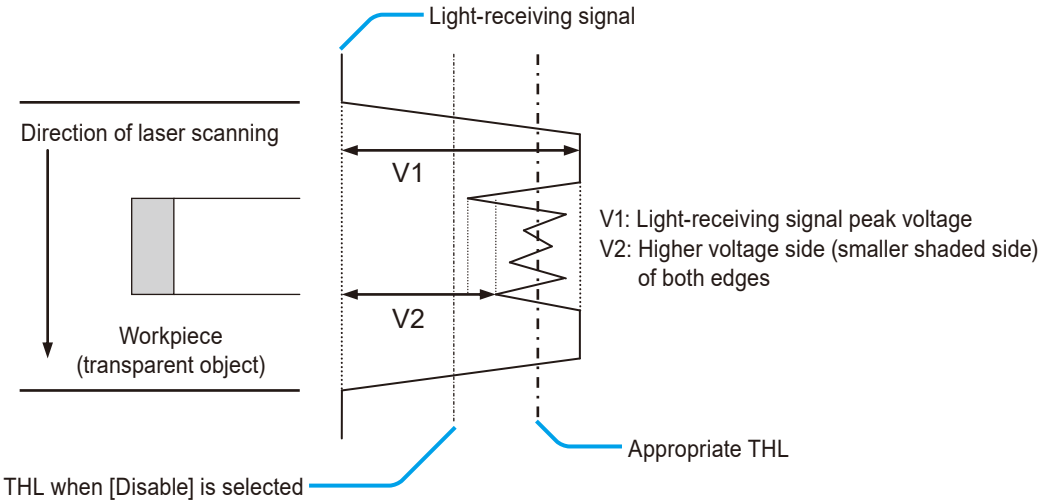
For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Set a reference workpiece, connect an oscilloscope to this product, and observe the received light signal.

For details on how to observe the light-receiving signal, see "3.1 I/O Specifications" on page D-23 in "PART D Interfaces".

3 When you obtain a light-receiving signal as illustrated below, apply V1 and V2 values read from the light-receiving signal to the following formula to calculate the appropriate THL.

Calculation formula: "Appropriate THL" = (V1+V2)/2 [V]



4 Enter the value calculated in step 3 in the THL setting field.

■ Detect dirt on the protection glass

When [Detect dirt on the protection glass] is enabled, LSMPAK displays "E0007" (dirt detection error) if the protective glass of the sensor is dirty when the LSM is started.

IMPORTANT

When this function is enabled, the protective glass is checked for dirt at LSM startup. Detection is not possible if there is contamination with dirt, etc. during measurement. To check for contamination, remove the measurement workpiece and afterward restart the LSM.

Item	Description	Remarks
Enable	Contamination of the protective glass is detected.	
Disable	Contamination of the protective glass is not detected.	Initial value

■ Set the STB length

Set the STB length when connecting this product to an external device (communication destination) using the I/O analog interface.

Select any setting value from the drop-down list.

Setting value	Remarks
MR (automatic)	Initial value
0.1 ms	
0.3 ms	
2.0 ms	
5.0 ms	
10.0 ms	
20.0 ms	
50.0 ms	
100.0 ms	

■ Set the input software filter

When connecting this product to an external device (communication destination) using the I/O analog interface, select the filter length for the input signal.

Setting value	Remarks
5.0 ms	Initial value
20.0 ms	
2.0 ms	

■ Setting the application range of calibration, preset/offset

Set the applicable range for Calibration, Preset, and Offset.

Item		Description	Remarks
Calibration	Separated for each parameter set pair	Set calibration for each parameter set pair.	
	Unified all the parameter set	Make the same calibration settings for all parameter sets.	Initial value
Preset/Offset	Separated for each parameter set	Set the preset and offset for each parameter set.	Initial value
	Unified all the parameter set	Set the same presets and offsets for all parameter sets.	

Tips

Cannot be set to a combination of [Separated for each parameter set pair.] for [Calibration] and [Unified all the parameter set.] for [Preset/Offset].

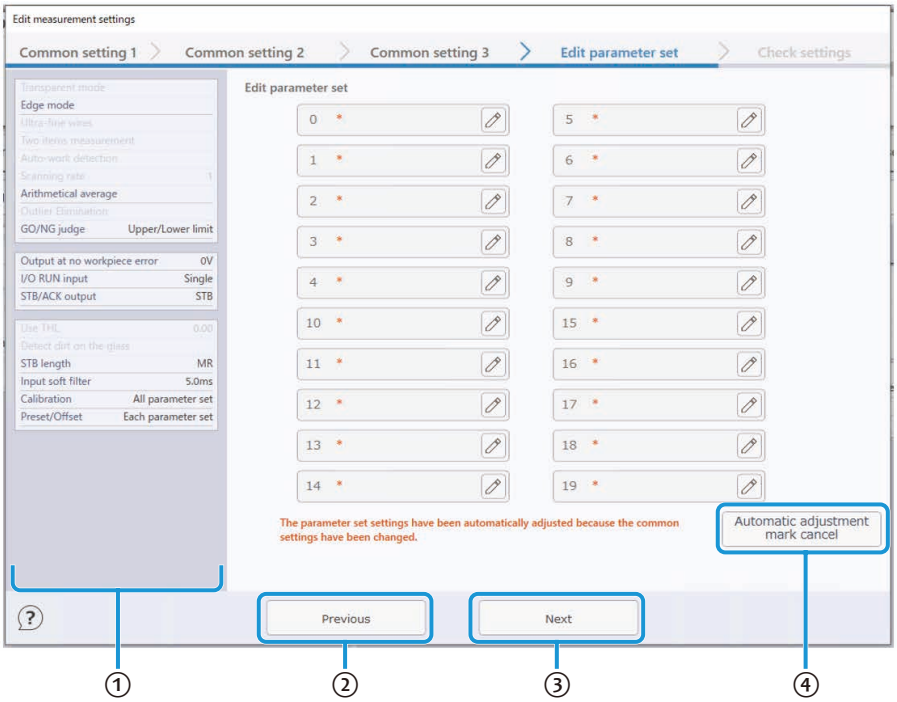
3.3.4 [Edit parameter set] Screen

Edit the parameter set to be used for the measurement.

The measurement conditions of the parameter set change according to contents of the common settings.

Tips

- Parameters are set to default values at the factory. For details on initial values, see "■ [Measurement condition 1] screen" on page C-14.
- A total of 20 parameter sets can be registered.



No.	Description
①	Displays the settings for [Common setting 1], [Common setting 2] and [Common setting 3].
②	Returns to the [Common setting 3] screen.
③	Continues to the [Check settings] screen.
④	If the common settings are changed, the associated settings for each parameter set are adjusted automatically. Adjusted parameter sets are indicated by a * mark. Check the contents of the adjusted parameter set and click this button to clear the * mark.

Tips

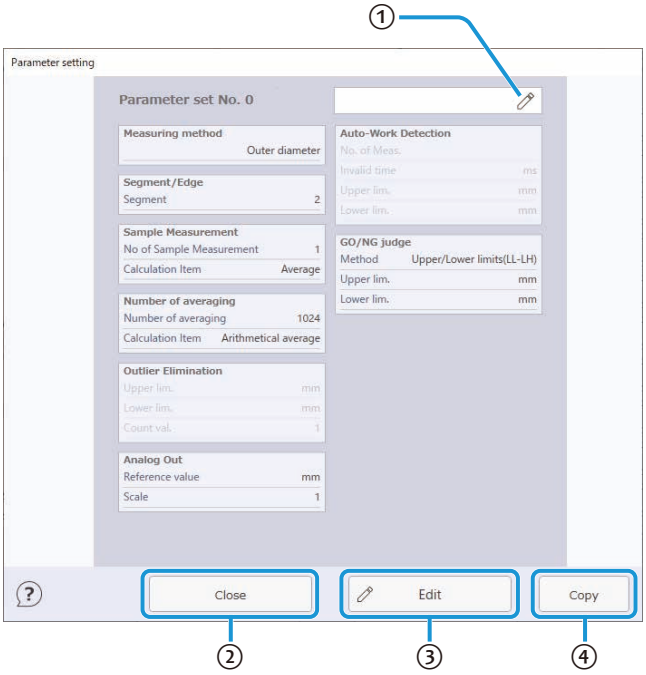
If [Two items measurement] is set, two parameter sets are selected.

The paired parameter set combinations are as follows.

– 0 and 5
– 1 and 6
– 2 and 7
– 3 and 8
– 4 and 9
– 10 and 15
– 11 and 16
– 12 and 17
– 13 and 18
– 14 and 19

1 **Click  to the right of the parameter set number.**

» The [Parameter setting] screen is displayed.



No.	Description
①	Edits the parameter set label. Labels can include up to 13 half-width alphanumeric characters (uppercase only) and underscore characters.
②	Closes the [Parameter setting] screen and returns to the [Edit parameter set] screen.
③	Displays the [Measurement condition 1] screen.
④	Copies the contents of the displayed parameter set to any parameter set.

2 **Click [Edit].**

» The [Edit parameter set] screen (Measurement condition 1) is displayed.

Tips

- For details on the [Measurement condition 1] screen, see "3.3.5 [Measurement condition 1] Screen" on page C-54.
- To stop editing the parameter set, click [Close]. The display returns to the [Edit parameter set] screen.

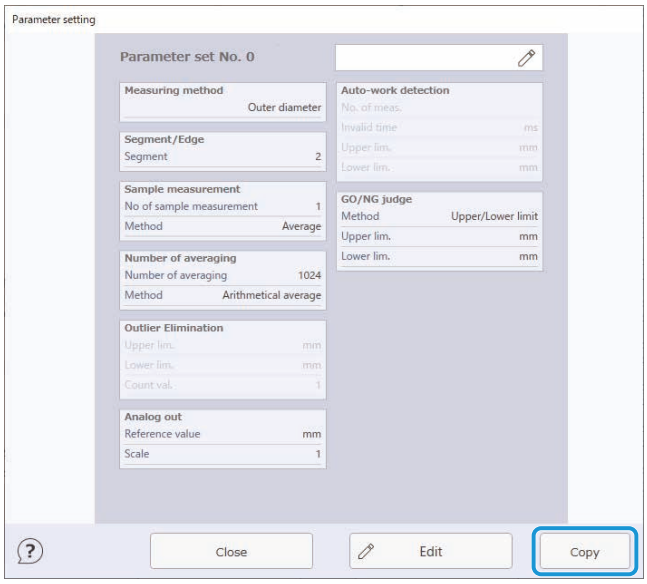
■ Duplicating parameter sets

Parameter sets can be duplicated and registered as new parameter sets.

1 **In the [Edit parameter set] screen, click to the right of the parameter set number you want to duplicate.**

» The [Parameter setting] screen is displayed.

2 **Click [Copy].**

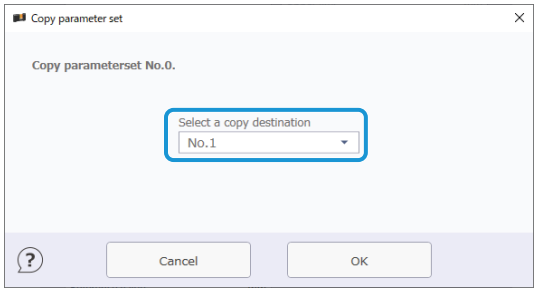


» The [Copy parameter set] screen is displayed.

Tips

Click [Cancel] if you want to stop parameter set duplication. The display returns to the [Parameter setting] screen.

3 **Select the parameter set number to be duplicated from the [Select a copy destination] drop-down list.**



4 **Click [OK].**

» Parameters are replicated to the selected destination parameter set.

3.3.5 [Measurement condition 1] Screen

Sets measurement items (such as outer diameter and runout), segment/edge specification, number of sample measurement and calculation method.

The measurement conditions of the parameter set change according to contents of the common settings.

For details on items displayed, see "■ [Measurement condition 1] screen" on page C-14.

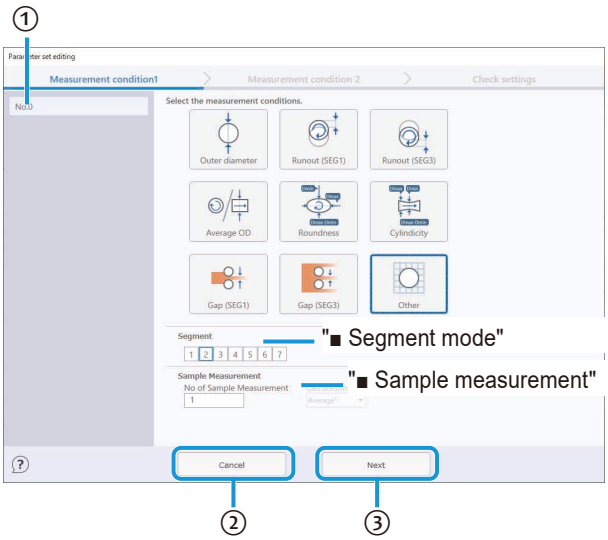
Tips

When two items measurement is enabled, changing the setting of one of the paired parameter sets will also change the setting of the other parameter set accordingly. The paired parameter set combinations are as follows.

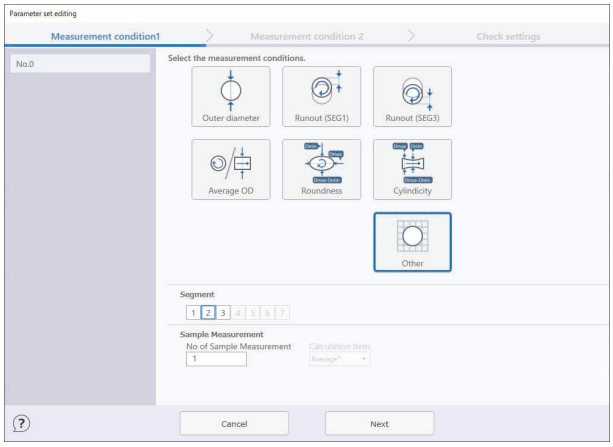
– 0 and 5
– 1 and 6
– 2 and 7
– 3 and 8
– 4 and 9
– 10 and 15
– 11 and 16
– 12 and 17
– 13 and 18
– 14 and 19

● Pattern 1

When [Segment mode] is selected for the detection method on the [Common setting 1] screen.



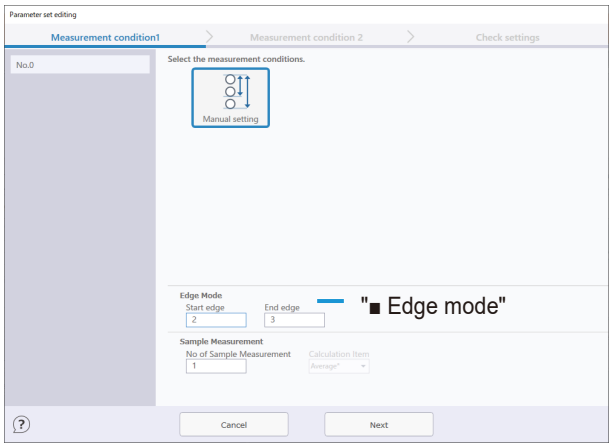
When [Transparent mode] is enabled on the [Common setting 1] screen.



No.	Description
①	Displays the parameter set number and label.
②	Returns to the [Parameter setting] screen.
③	Continues to the [Measurement condition 2] screen.

● Pattern 2

When [Edge Mode] is selected for the detection method on the [Common setting 1] screen.



■ Segment mode

Segment numbers can be specified when [Segment mode] is selected for the detection method in the [Common setting 1] screen and the "Other" icon is selected in the [Measurement condition 1] screen.

Specify the segment number according to intended purpose.

For more information on segment mode, see "■ Detection method" on page C-28.

Item	Description	Remarks
Segment number	Click segments to specify them for measurement. Segments 1 through 7 can be specified (up to 3 when [Transparent mode] is enabled). Multiple segments can also be specified. **Tips** • If you want to cancel a selection, click a selected item again. • If multiple segments are specified, the total measured values for all specified segments will be displayed. For example, if segments 1 and 2 are specified, the sum of measured values for segment 1 and segment 2 will be displayed.	Initial value: 2

■ Edge mode

Edge numbers can be specified when [Edge Mode] is selected for the detection method in the [Common setting 1] screen.

Specify the segment number according to the intended purpose.

For more information on edge mode, see "■ Detection method" on page C-28.

Item	Description	Remarks
Start edge number	Enter the edge number to begin measurement from. Enter a number that is smaller than the end edge's.	You can specify contiguous or non-contiguous numbers as the start and end edge numbers, but you cannot specify the same number.
End edge number	Enter the edge number to end measurement with. Enter a number that is larger than the start edge's.	

■ Sample measurement

Sets the [No of sample measurement] and [Method] (calculation item).

Measurement example

"6.2.9 Two Items Measurement of Outer Diameter and Run-Out of Rubber Roll (Sample Measurement)" on page C-142

Item	Description	Remarks
No of sample measurement	Enter the number of sample measurement (0–999).	Initial value: 1
Method	This can be selected when the [No of sample measurement] setting is 0 or from 2 through 999. If 1 is set, no selection is possible. Select one of the following calculation items from the drop-down list. • Average • Maximum • Minimum • Range	Initial value: Average

Buttons available for measurement and their actions differ depending on the [No of sample measurement] setting.

Tips

When [Two items measurement] is enabled, [Number of averaging] and [No of sample measurement] of paired parameter sets are automatically set to the same values.

No of sample measurement	[Single run measurement] button (▶)	[Continuous] button (⏭)
0	Measurement continues until ■ is clicked. Measurement values obtained between the start and end of the measurement are calculated using the calculation item set in [Method] and displayed as a single measurement value.	Not available
1	One measurement is taken and the measured value is displayed.	Single run measurement is repeated until you click the ■ button, and the measured value is displayed for each measurement.
2–999	The number of measurements set in [No of sample measurement] is performed. Measurement values obtained between the start and end of the measurement are calculated using the calculation item set in [Method] and displayed as a single measurement value.	Measurement is repeated until ■ is clicked. Each set of measurements shown at left is calculated using the calculation item set in [Method] and displayed as a single measurement value.

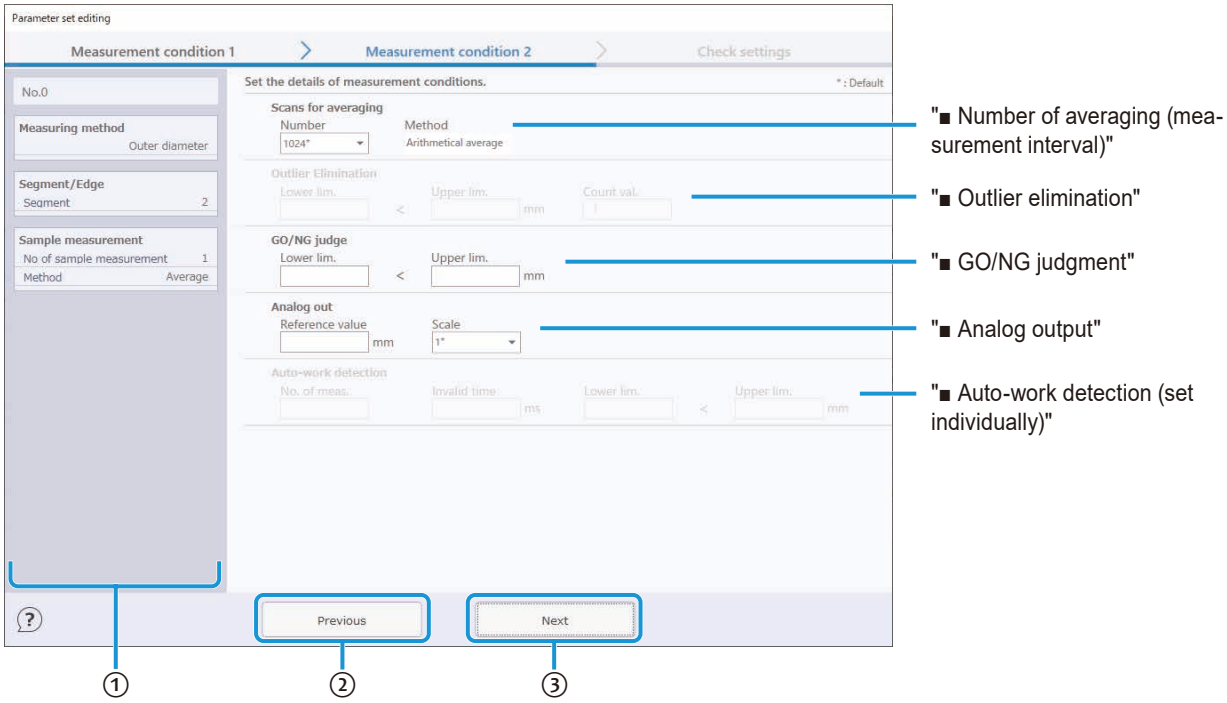
Tips

- The larger the number of sample measurement, the longer each measurement takes and the longer the refresh interval of the measurement screen becomes. This should not be mistaken for frozen operation.
- For details on single run measurement, see "5.3.1 Single Run Measurement" on page C-105.
- For details on continuous run measurement, see "5.3.2 Continuous Run Measurement" on page C-107.

3.3.6 [Measurement condition 2] Screen

Sets the details of measurement conditions.

The measurement conditions of the parameter set change according to contents of the common settings.



"■ Number of averaging (measurement interval)"

"■ Outlier elimination"

"■ GO/NG judgment"

"■ Analog output"

"■ Auto-work detection (set individually)"

No.	Description
①	Displays the parameter set name and [Measurement condition 1] settings.
②	Returns to the [Measurement condition 1] screen.
③	Continues to the [Check settings] screen.

■ Number of averaging (measurement interval)

Sets the number of averaging (measurement interval) for the averaging method set in the [Common setting 1] screen.

By specifying the number of averaging and the averaging method for the measured values, you can configure the measurement interval.

Setting a larger value for the number of averaging improves repeatability and stabilizes the measured value. If measurement time permits, specify as large a value as possible for the number of averaging.

Item	Description	Remarks
Number of averaging	Select from the drop-down list.	
	Number of averaging for [Arithmetical average]: 1–2048*. *When ultra-fine wire measurement is specified: 16–2048	Initial value: 1024
	Number of averaging for [Moving average]: 32–2048	Initial value: 1024

IMPORTANT

- The [Number of averaging] should be set to 16 or more.
- When the [Number of averaging] is set to 8 or less, an output buffer overflow may occur depending on the specifications of your PC and usage conditions*. For details on output buffer overflow errors, see "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting".

  * Conditions such as the number of LSMs connected, calculation registration settings, communication status, and whether other applications are in use.
- Some [Number of averaging] settings require a high-speed communication environment. Use of a PC with higher specifications or an IF module and PLC may be required.

Tips

When [Two items measurement] is enabled, the [Number of averaging] of the paired parameter sets is automatically set to the same value. For details, see "■ Scans for averaging (method setting)" on page C-35.

● Relationship between the number of averaging and measurement interval (measurement time)

With [Arithmetical average]

Number of averaging	Measurement interval for [Arithmetical average] (seconds)
1	0.0003125
2	0.000625
4	0.00125
8	0.0025
16	0.005
32	0.01
64	0.02
128	0.04
256	0.08
512	0.16
1024	0.32
2048	0.64

Tips

The above measurement intervals apply when the number of sample measurement is 1.

If the number of sample measurement is n, the actual measurement interval is the number indicated above multiplied by n.

For details, see "■ Sample measurement" on page C-57.

With [Moving average]

Number of averaging	Measurement interval (seconds) with [Moving average]	
	1st data	2nd data on
1	—	—
2	—	—
4	—	—
8	—	—
16	—	—
32	0.01	0.005
64	0.02	0.005
128	0.04	0.005
256	0.08	0.005
512	0.16	0.005
1024	0.32	0.005
2048	0.64	0.005

Tips

The above measurement intervals apply when the number of sample measurement is 1.

If the number of sample measurement is n, measurement intervals will be as follows.

1st data: time for the set number of averaging + 0.005 × (n-1)

2nd data on: 0.005 x n

For details on number of sample measurement, see "■ Sample measurement" on page C-57.

■ Outlier elimination

When [Outlier Elimination] is enabled in the [Common setting 1] screen, set the upper and lower limits of normal values in the [Measurement condition 2] screen.

Once upper and lower limits have been set, the measured value is determined for each measurement interval as follows.

Item	Description
Upper lim.	Enter the upper limit of normal values. If a measured value is greater than the upper limit, it is excluded as an abnormal value. Enter a number with the sign (plus or minus) and a maximum of seven digits.
Lower lim.	Enter the lower limit of normal values. If the measured value is less than the lower limit, it is excluded as an abnormal value. Enter a number with the sign (plus or minus) and a maximum of seven digits.
Count val.	When the number of abnormal values reaches the number set, an outlier detection warning is displayed. **Tips** The number of measurements that are counted depends on settings made in the common settings. For details, see "■ Outlier elimination (count target setting)" on page C-39. For details on the outlier detection warning, see "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting".

IMPORTANT

This function is disabled if both [Upper lim.] and [Lower lim.] are left blank.

■ GO/NG judgment

Enter the tolerances for the judgment method set in the [Common setting 1] screen in the [Measurement condition 2] screen.

The relationship between the judgment method and tolerances is shown below.

Judgement method	Setting item	Description
Upper/Lower limit	Upper lim.	Enter a number with the sign (plus or minus) and a maximum of seven digits.
	Lower lim.	Enter a number with the sign (plus or minus) and a maximum of seven digits.
Multi-limits	Ranges: 3 to 6 L1 to L6	Enter a number with the sign (plus or minus) and a maximum of seven digits.
Target value and tolerance	Target value	Enter a number with the sign (plus or minus) and a maximum of seven digits.
	Upper tol.	Enter a number with the sign (plus or minus) and a maximum of seven digits.
	Lower tol.	Enter a number with the sign (plus or minus) and a maximum of seven digits.

IMPORTANT

- If all input fields are blank, this function is disabled.
- An error dialog box is displayed if any of the entries are incomplete.

For details on the GO/NG judgment method, see 📖 "■ GO/NG judgment method" on page C-40.

■ Analog output

You can observe the difference between the measured value and the reference value using analog output.

Specify the reference value and the scale value (gain).

Item	Description	Remarks
Reference value	Enter the reference value. You can enter a number with the sign (plus or minus) and a maximum of seven digits.	Initial value: blank
Scale	Select the multiplier for displaying analog output values from the drop-down list. See the table below for multipliers and gain when each option (1 to 5) is selected.	Initial value: 1

Analog voltage values are output according to the following formula.

Analog output voltage = (measured value - analog output reference value) x gain

See the following table for analog voltage outputs.

[Scale] setting value (multiplier)	Gain (output voltage/displayed value)	Display range (maximum output voltage/maximum displayed value)
1 (1 times)	0.625 mV/0.01 µm	±5 V/±80 µm
2 (10 times)	0.625 mV/0.1 µm	±5 V/±800 µm
3 (100 times)	0.625 mV/1 µm	±5 V/±8 mm
4 (1000 times)	0.625 mV/10 µm	±5 V/±80 mm
5 (10000 times)	0.625 mV/100 µm	±5 V/±800 mm

■ Auto-work detection (set individually)

When [Auto-work detection] is enabled in the [Common setting 1] screen, set the number of measurements, invalid time, and upper and lower limits in the [Measurement condition 2] screen.

Enter setting values according to your purpose.

For details on the detection method and scanning rate for [Auto-work detection], see "■ [Auto-work detection] (method and scanning rate settings)" on page C-32.

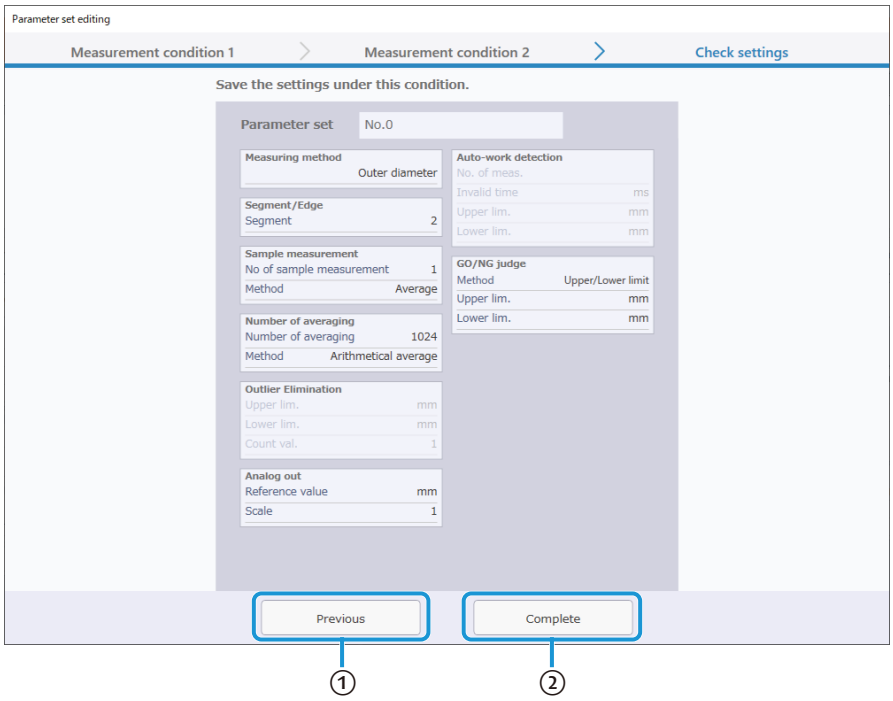
Item	Description	Setting value	Remarks
No. of Meas.	Enter the number of measurements.	0–999	Initial value: 0
Invalid time (ms)	Enter the length of time from when a workpiece is detected to the start of measurement (invalid time). Invalid time is the length of time where locations not included in the scan, such as the chamfered portion, are scanned.	0–9999	Initial value: 0
Upper lim.	Specify the detection upper limit. Enter a number with the sign (plus or minus) and a maximum of seven digits.	N/A	Initial value: 0
Lower lim.	Specify the detection lower limit. Enter a number with the sign (plus or minus) and a maximum of seven digits.	N/A	Initial value: 0

IMPORTANT

- If all input fields are blank, this function is disabled.
- An error dialog box is displayed if any of the entries are incomplete.

3.3.7 [Check settings] Screen

Confirms your settings in the [Check settings] screen and saves the measurement settings for the parameter set.



No.	Description
①	Returns to the [Measurement condition 2] screen.
②	Completes the settings and returns to the [Edit parameter set] screen.

1 Check the settings and if there are no problems, click [Complete].

» The [Edit parameter set] screen is displayed.

Tips

To edit the settings, click [Previous].

2 Click [Next] on the [Edit parameter set] screen.

» The [Check settings] screen for editing measurement settings is displayed.

3 Click [Complete] on the [Check settings] screen of measurement settings editing.

» The [Check settings] message screen is displayed.

Tips

In this screen, you can check the contents of common settings and parameter sets and select a parameter set.
For details on selecting parameter sets, see "3.3.8 Selecting Parameter Sets" on page C-68.

4 **Confirm the parameter set No. on the [Check settings] message screen, and if there are no problems, click [Yes].**

» The [Measurement settings have been saved] message screen is displayed.

Tips

If you want to change the parameter set No., click [No].

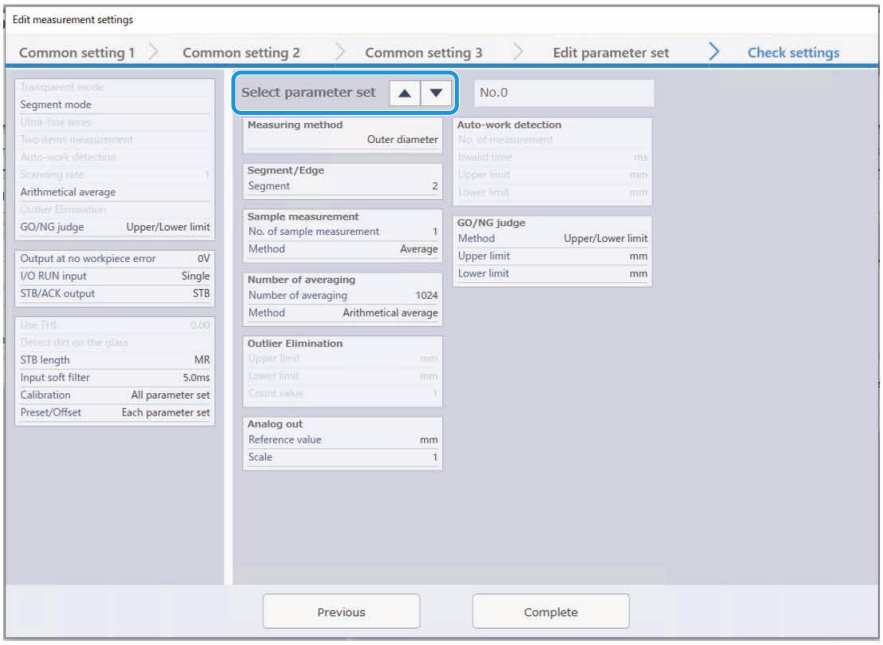
5 **Click [OK].**

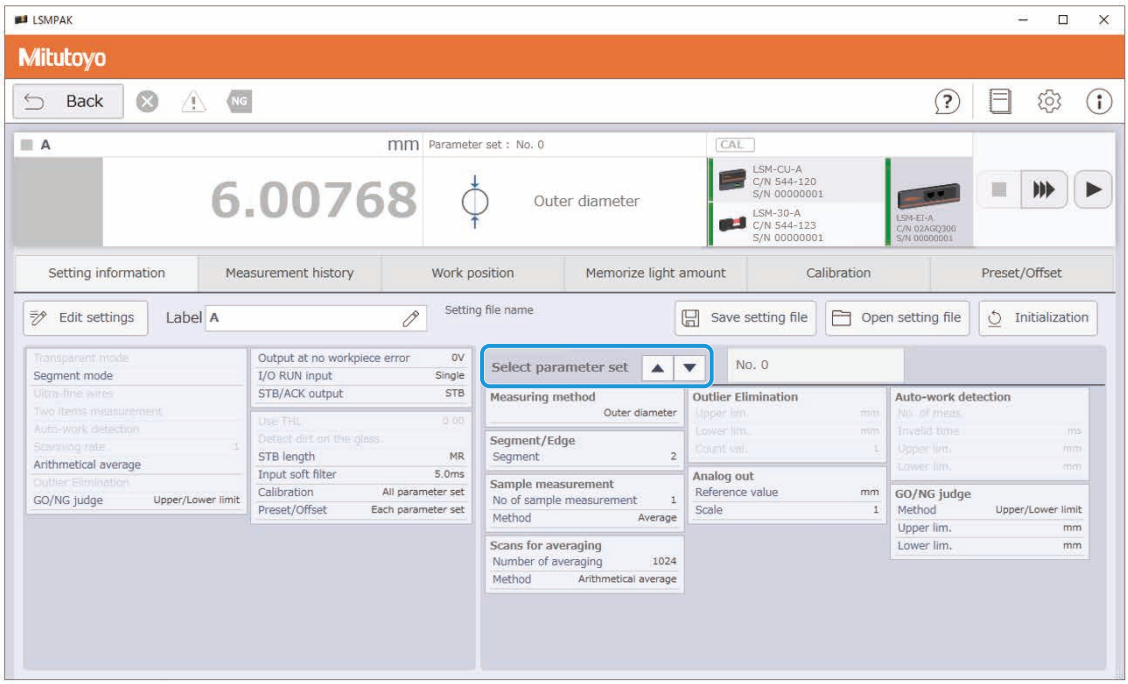
» The [Setting information] tab of the advanced setting screen is displayed.

3.3.8 Selecting Parameter Sets

You can select the parameter set to be used on the [Check settings] screen of measurement settings editing and on the [Setting information] tab of the detail screen.

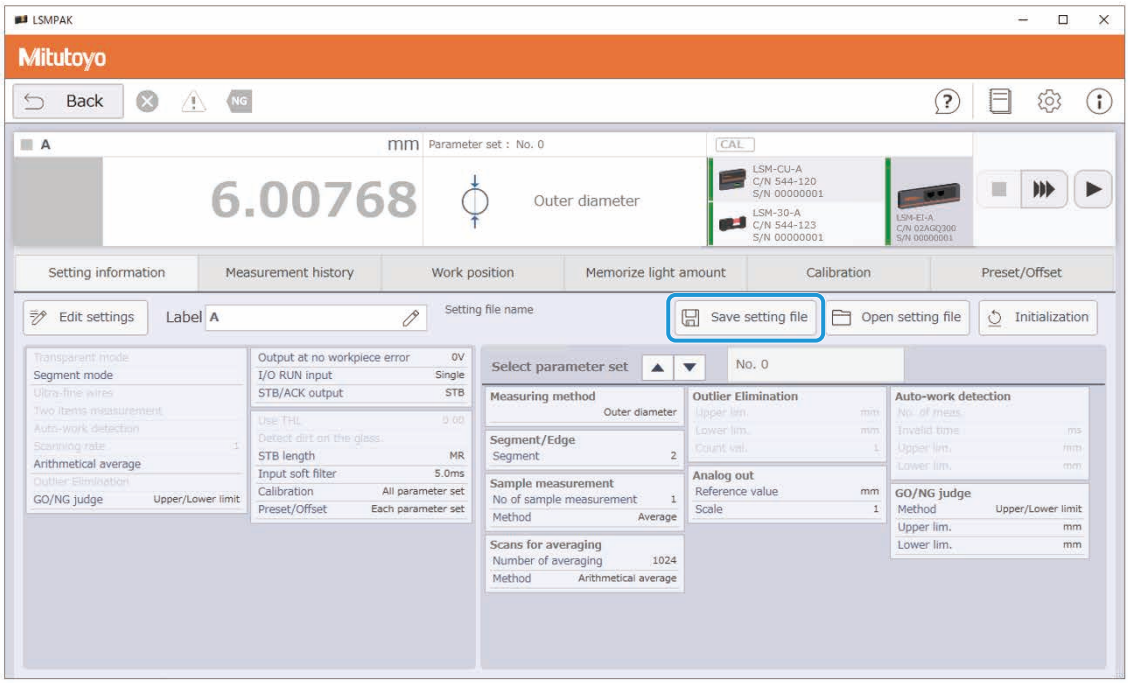
Click [▼] or [▲] to switch parameter sets.





3.3.9 Saving and Loading Settings Files

■ Saving settings files



Click [Save setting file], specify the location where the file is to be saved, then name the file and save it.
Only controller-specific information can be saved.
Specifically, this includes the following.

- All common settings
- All parameter sets

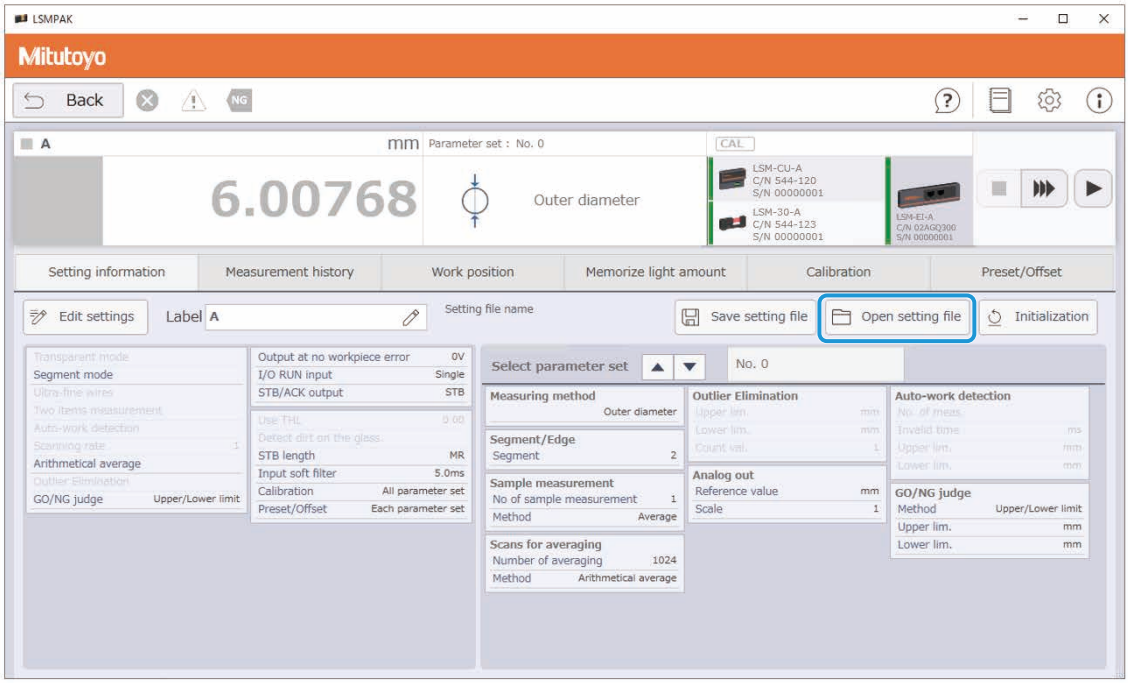
Tips

The [Unit], [Memorize light amount], [Calibration], [Preset], and [Offset] are stored in the controller itself.

IMPORTANT

Environmental setting are not saved in a system settings file.

■ Loading settings files



Click [Open setting file], specify the file, and click [Open].
The settings file is reflected in LSMPAK.

3.3.10 Initialization of Settings

This section describes the procedure for initializing settings (common settings, parameter sets, etc.).
Initialization returns the following items to their default values (factory settings).

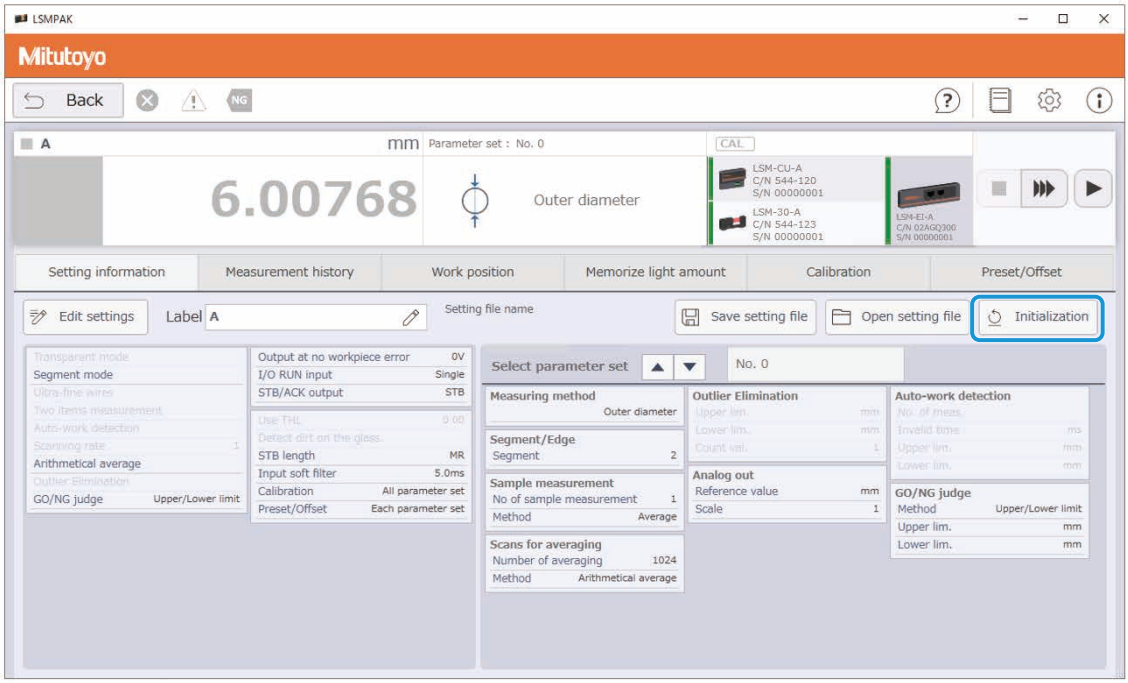
- Common settings
- Parameter set
- Memorize light amount
- Calibration
- Preset, Offset

It is recommended that you save any needed settings before initialization.

For information about how to save settings files, see "3.3.9 Saving and Loading Settings Files" on page C-69.

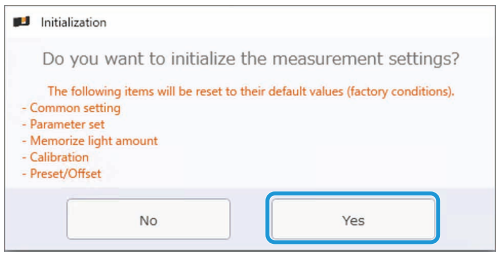
1 Click the [Setting information] tab on the LSMPAK detail screen.

2 Click [Initialization].



» The [Initialization] screen is displayed.

3 Click [Yes].



» The controller is restarted and each item is returned to its default value (factory setting).

Tips

Initializing and restarting the controller takes several minutes.
Please wait without exiting LSMPAK.

3.4 Memorize Light Amount

After completing measurement settings, set the sensor's light amount memorize mode.

Ordinarily, set the light amount memorize mode to [Automatic adjustment].

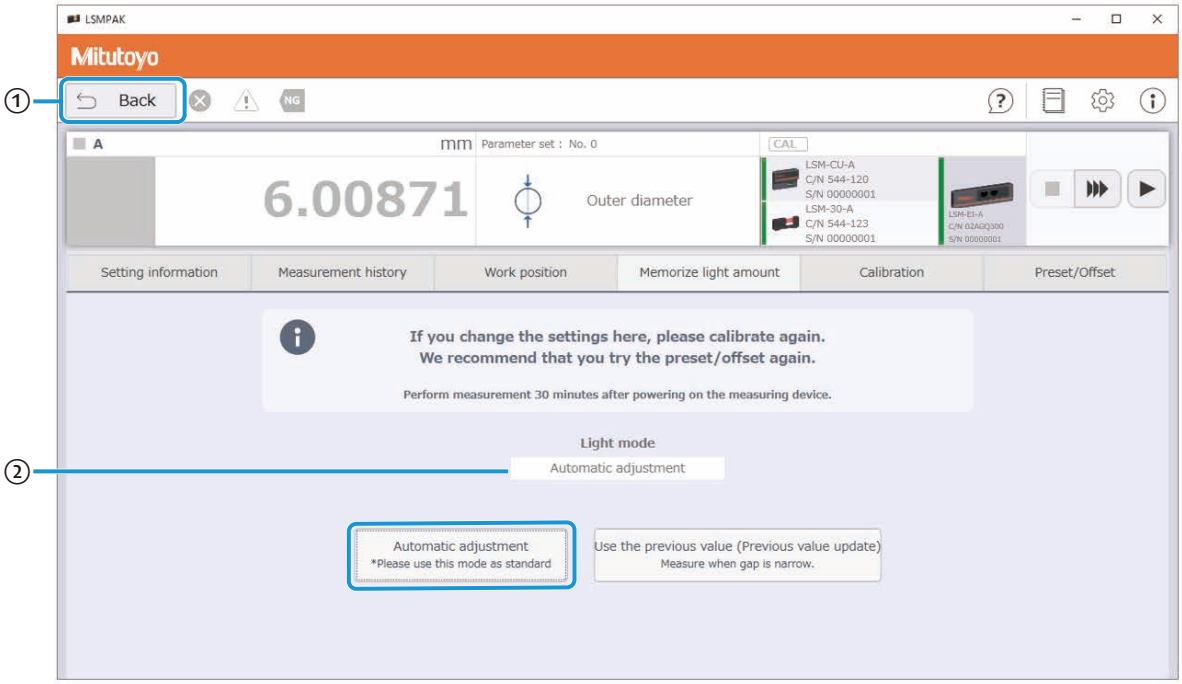
If the light amount of the transiting laser beam is low during measurement (e.g., during measurement of narrow gaps), set the light amount memorize mode to [Use the previous value (Previous value update)].

See below for details on the setting procedure.

- "3.4.1 Automatic Adjustment Mode" on page C-73
- "3.4.2 [Use the previous value (Previous value update)] Mode" on page C-74

3.4.1 Automatic Adjustment Mode

1 Click the [Memorize light amount] tab on the LSMPAK detail screen.



No.	Description
①	Returns to the home screen.
②	Displays the current settings.

2 Click [Automatic adjustment].

» A message screen is displayed and the light amount memorize mode is set to [Automatic adjustment].

3 Click [OK] on the message screen.

» The display returns to the detail screen.

3.4.2 [Use the previous value (Previous value update)] Mode

If the light amount of the transiting laser beam is low during measurement (e.g., during measurement of narrow gaps), set the light amount memorize mode to [Use the previous value (Previous value update)] and memorize the amount of light.

For more information on measuring narrow gaps, see "6.2.12 Measurement of Narrow Gaps" on page C-149.

IMPORTANT

To prevent sensor degradation over time from affecting light intensity, you should memorize light intensity two or three times a year.

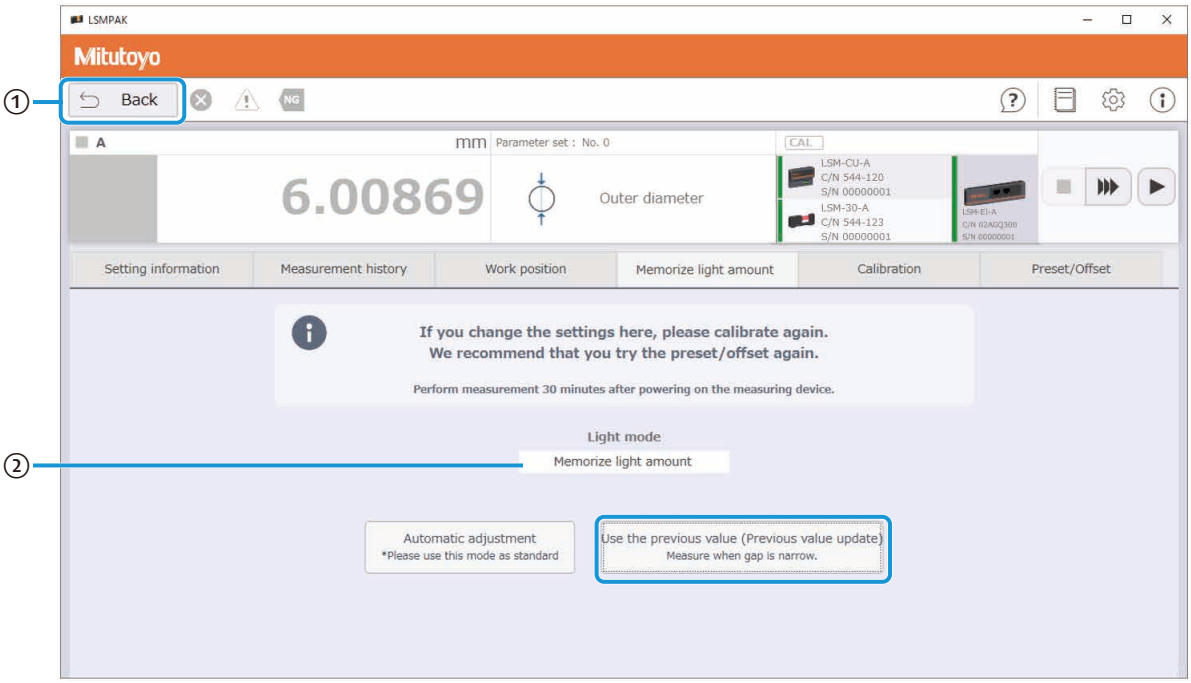
If measured values fluctuate greatly due to temperature changes, memorize the light intensity as needed.

1 **Remove obstacles that block the laser beam.**

IMPORTANT

Before memorizing the light intensity, remove obstacles that block the laser beam, such as the workpiece or workpiece support jig.

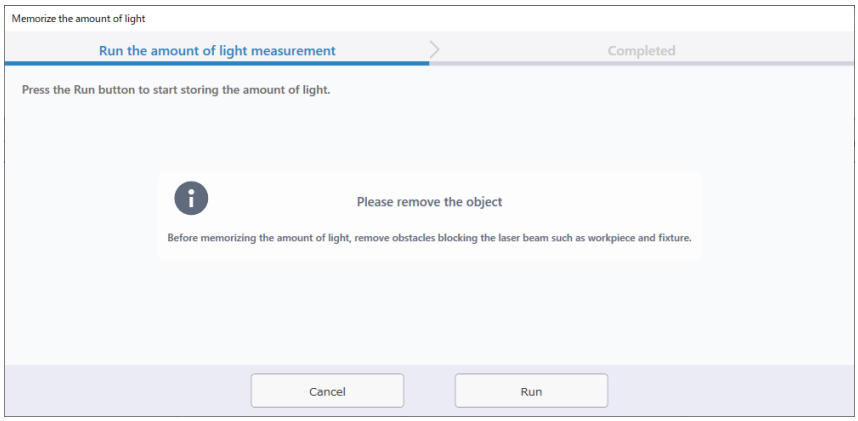
2 **Click the [Memorize light amount] tab on the LSMPAK detail screen.**



No.	Description
①	Returns to the home screen.
②	Displays the current settings.

3 Click [Use the previous value (Previous value update)].

» The [Run the amount of light measurement] screen is displayed.

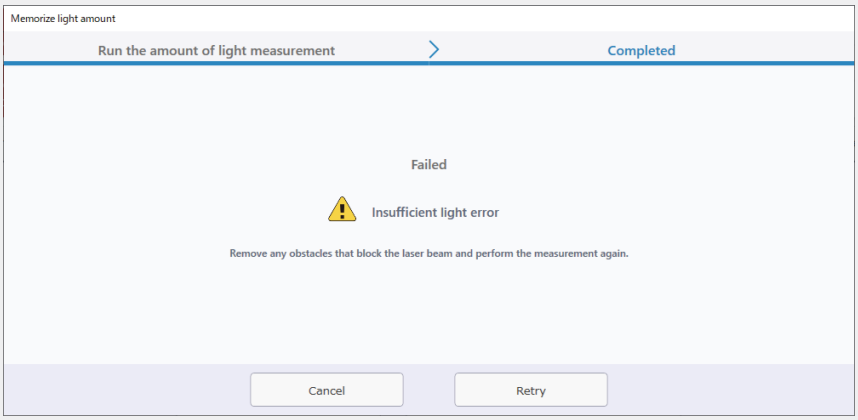


4 Click [Run].

» On the [Completed] screen, [Succeeded] is displayed (if light amount is successfully memorized).

Tips

If light intensity is insufficient, [Failed] is displayed.
When this message is displayed, click [Retry] and perform steps 2 through 4 again.
To interrupt the light amount memorize mode setting, click [Cancel].



5 Click [Close].

» Light intensity is memorized.
» The display returns to the detail screen.

3.5 Calculation

3.5.1 Register Calculation

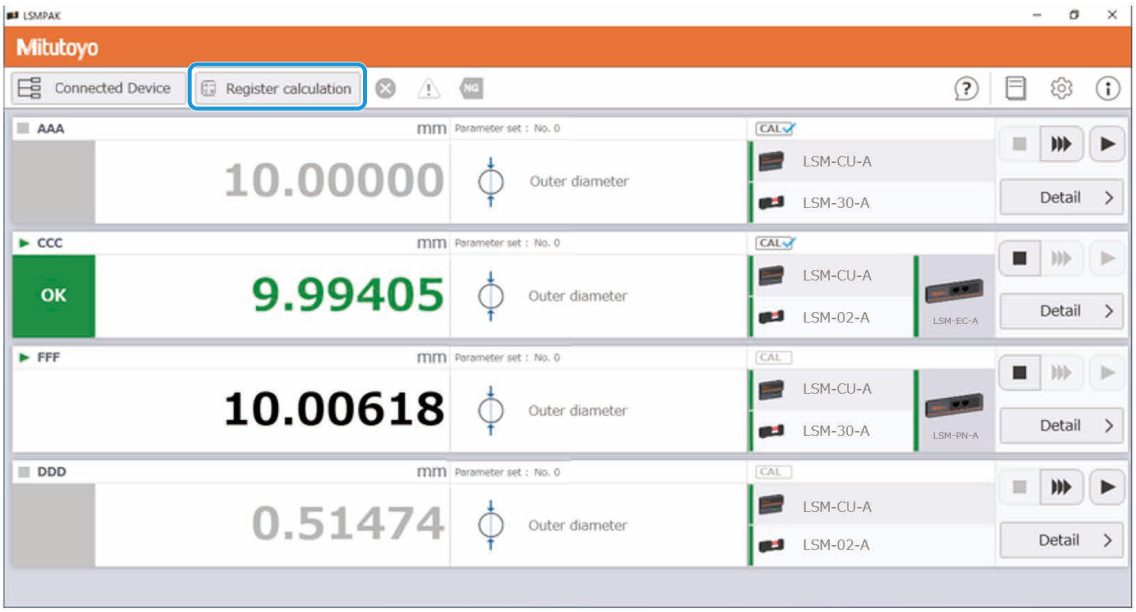
Calculation items (calculation method, target workpiece, and GO/NG judgment conditions) can be set to calculate measurement values for measurements using multiple sensors.

Since up to eight sets of LSMs can be connected to LSMPAK, the average or standard deviation of up to 16 measured values can be calculated when performing two items measurement.

IMPORTANT

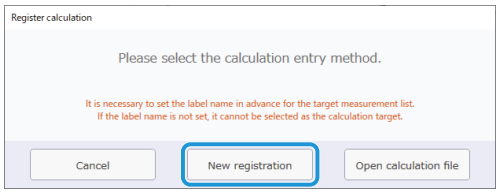
- Calculation is a limited feature when using LSMPAK. It is not available for other tools (customer-provided monitor cables, I/O equipment, PLCs, etc.).
- Only one type of operation can be selected.
- When performing arithmetic operations, be sure to use the same sensor model.
- To register as a target calculation, set a label for each LSM in advance.
- Each LSM should be assigned a different label, regardless of whether it is involved in calculations. If multiple LSMs have the same label assigned, they may not be properly registered for calculation.
  For details on how to set labels, see "3.3 Measurement Settings" on page C-24.
- Calculation is performed based on the label information of the calculation target. If, for example, the registered calculation conditions and the controller label differ due to replacement of the controller or a change to the calculation target label name after the calculation is registered, the calculation cannot be performed. If the controller has been replaced or the calculation target label has been changed, please re-register the calculation.
- The number of averaging and number of sample measurement for each LSM which is a calculation target should all be aligned to the same setting.
- Operations involving measurements with zero samples cannot be performed. For details on the number of sample measurement, see "■ Sample measurement" on page C-57.

1 Click [Register calculation] on the home screen.

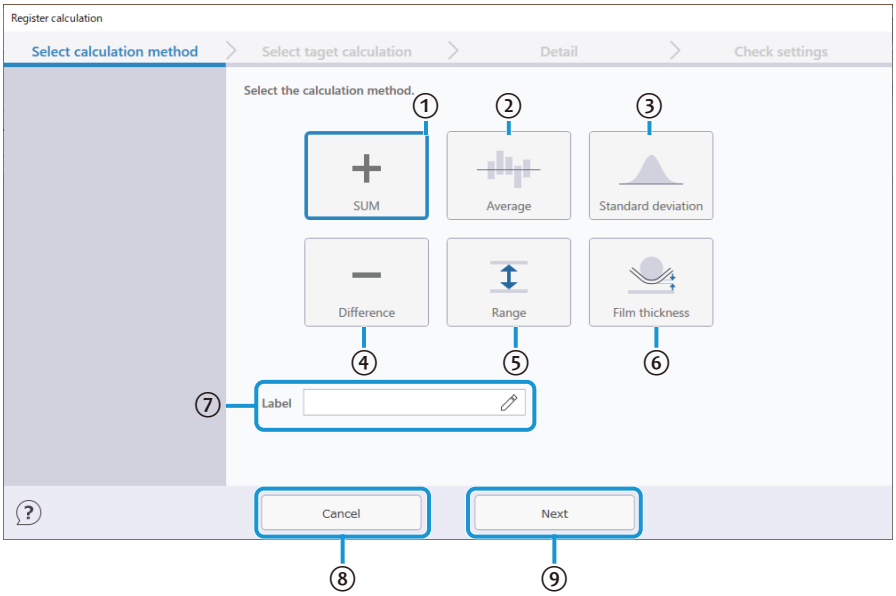


» The [Register calculation] dialog is displayed.

2 Click [New registration].



» [Select calculation method] screen for calculation registration is displayed.



No.	Description	Calculation formula
①	Sums up the measurements of multiple LSMs.	X1+X2+…
②	Calculates the average of multiple LSM measurements.	Avg(X1,X2,…)
③	Calculates the standard deviation of multiple LSM measurements.	SD(X1,X2,…)
④	Calculates the difference between the measurements of two LSMs.	X-Y
⑤	Calculates the upper and lower limit ranges of measured values for multiple LSMs.	Rng(X1,X2,…)
⑥	Calculates film thickness from the measurements of two LSMs.	(X-Y)/2
⑦	Edits the operation label for calculation.	
⑧	Cancels the calculation settings and returns to the Home screen.	
⑨	Continues to the target measurement selection screen.	

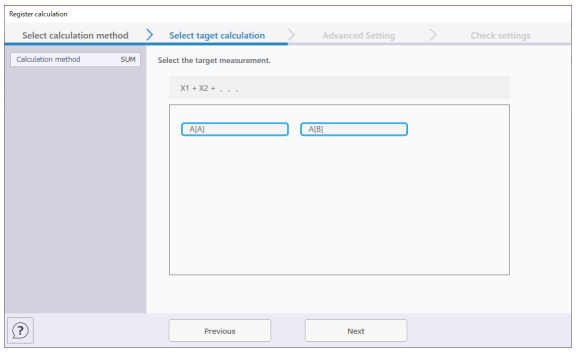
Tips

- When [Two items measurement] is enabled, up to two items per LSM can be selected for calculation. When [Two items measurement] is disabled, only one item per LSM can be selected for calculation.
- [Standard deviation] regards arguments as samples and returns an estimate of the standard deviation of the population based on the samples.

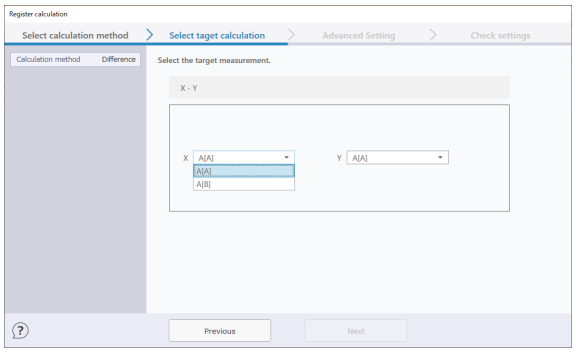
3 Select the desired calculation method and click [Next].

» The [Select target calculation] screen is displayed.

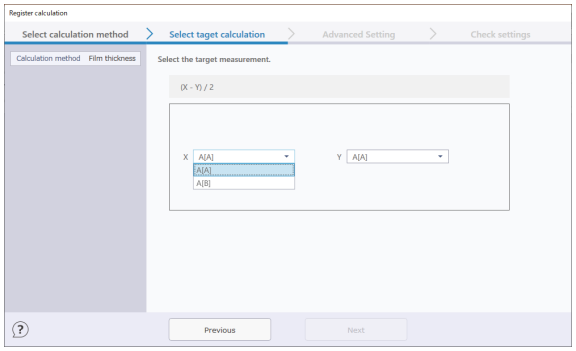
When sum, average, standard deviation, or range is selected



When difference is selected



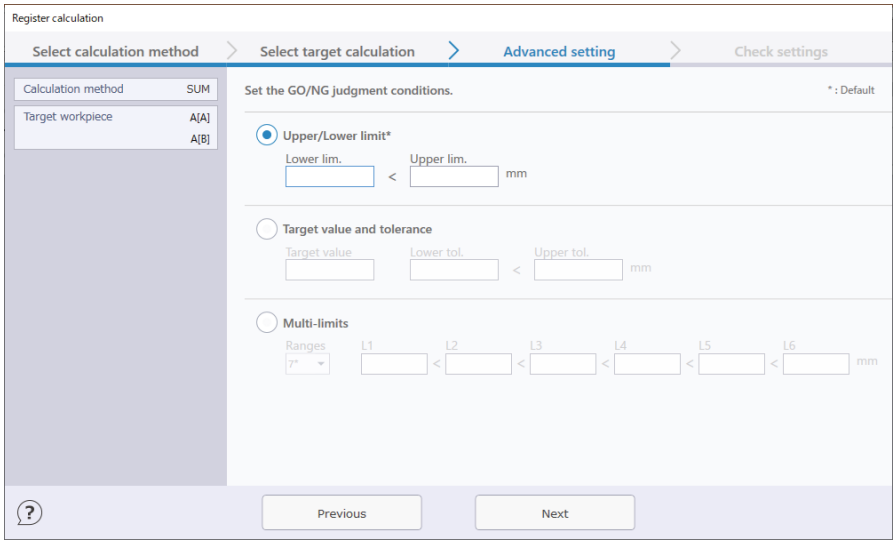
When film thickness is selected



4 Select two or more measurement information items to be used in the calculation.

5 Click [Next].

» The [Advanced setting] screen is displayed.

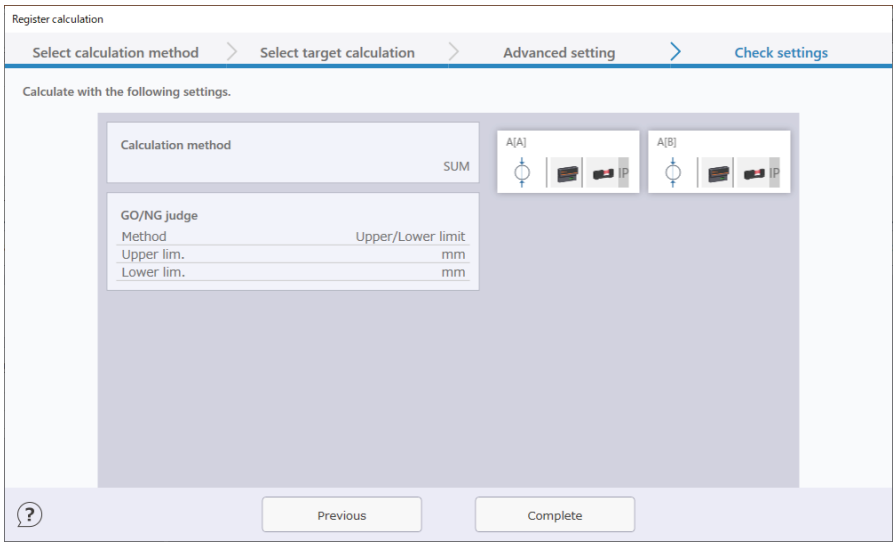


6 Set the GO/NG judgment conditions.

For details, see "■ GO/NG judgment method" on page C-40 and "■ GO/NG judgment" on page C-63.

7 Click [Next].

» The [Check settings] screen is displayed.

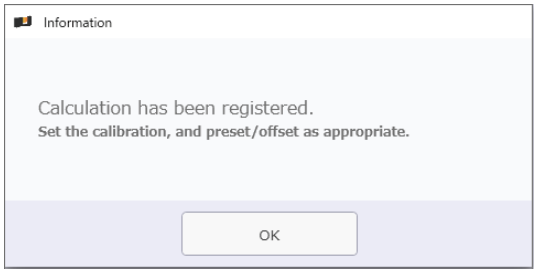


Tips

Click [Previous] to modify the calculation settings.

8 Confirm the settings and click [Complete].

» The following message screen is displayed.

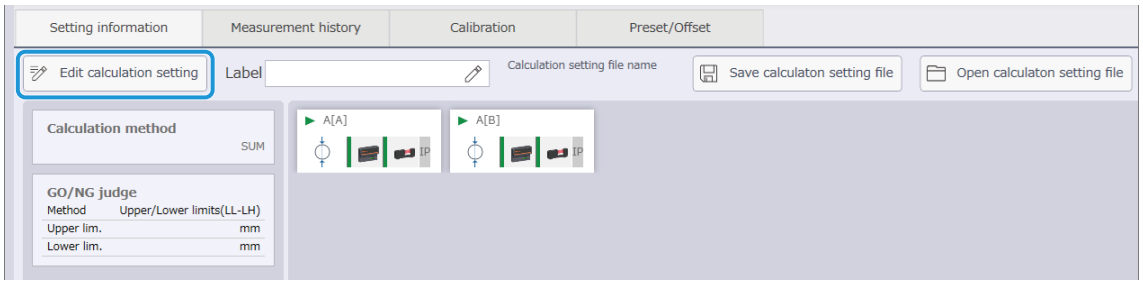


9 Click [OK].

» The LSM for which arithmetic operations have been set appears at the top of the measurement list.

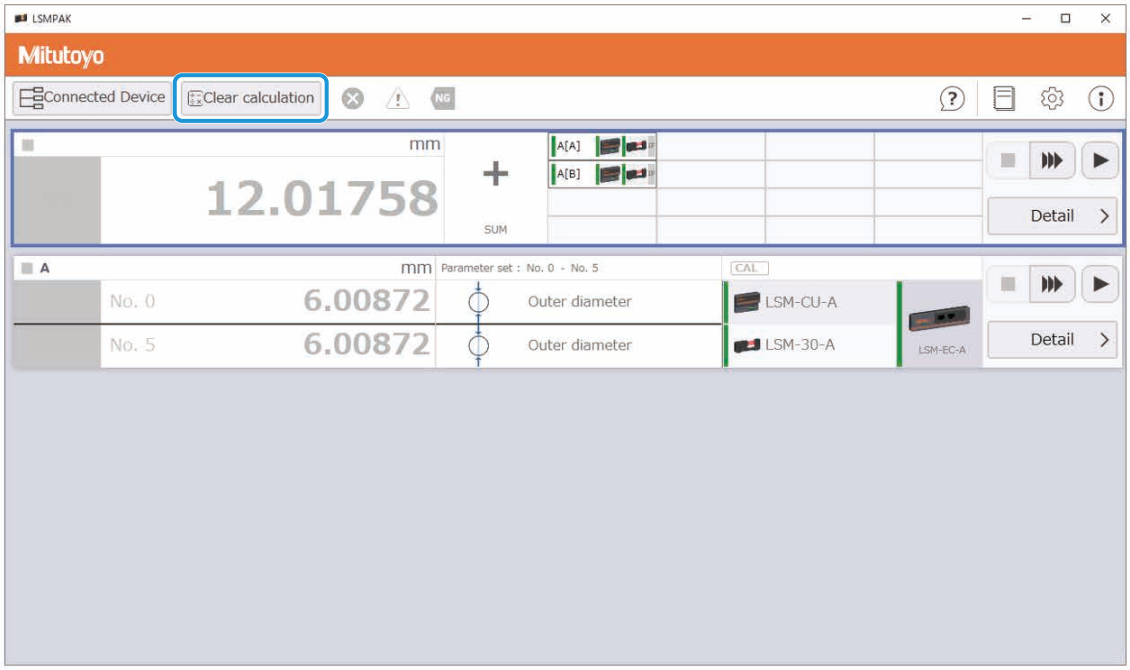
3.5.2 Editing Calculation Settings

To edit a registered calculation, click [Edit calculation setting] on the detail screen. The [Select calculation method] screen is displayed.



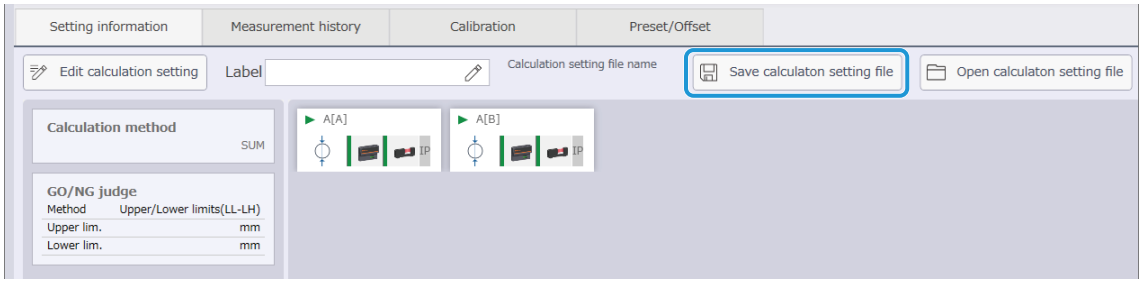
3.5.3 Clear Calculation

To clear arithmetic operation settings, click [Clear calculation] in the upper left corner of the home screen.



3.5.4 Save and Load Calculation Setting Files

■ Save calculation setting files



Click [Save calculation file], specify the location where the file is to be saved, then name the file and save it.

Only controller-specific information can be saved.

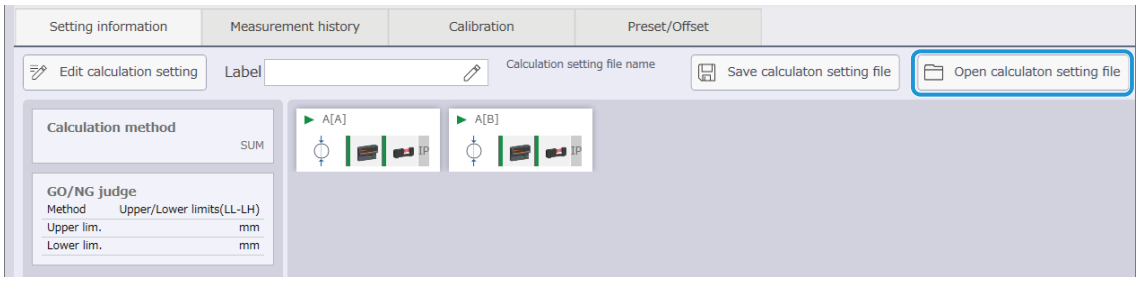
Specifically, this includes the following.

- All arithmetic operation settings
- Calibration
- Preset/Offset

IMPORTANT

Environmental setting are not saved in a system settings file.

■ Load calculation settings files



Click [Open calculation file], specify the file, and click [Open].

The settings file is reflected in LSMPAK.

IMPORTANT

Loading of the calculation file is performed based on the label information of the calculation target. If, for example, the controller has been replaced and the saved calculation conditions and controller labels are different, the calculation file cannot be read. For details on setting labels, see "3.3 Measurement Settings" on page C-24.

4 Calibration

After completing the settings, perform calibration of the LSM (sensor) before measuring.

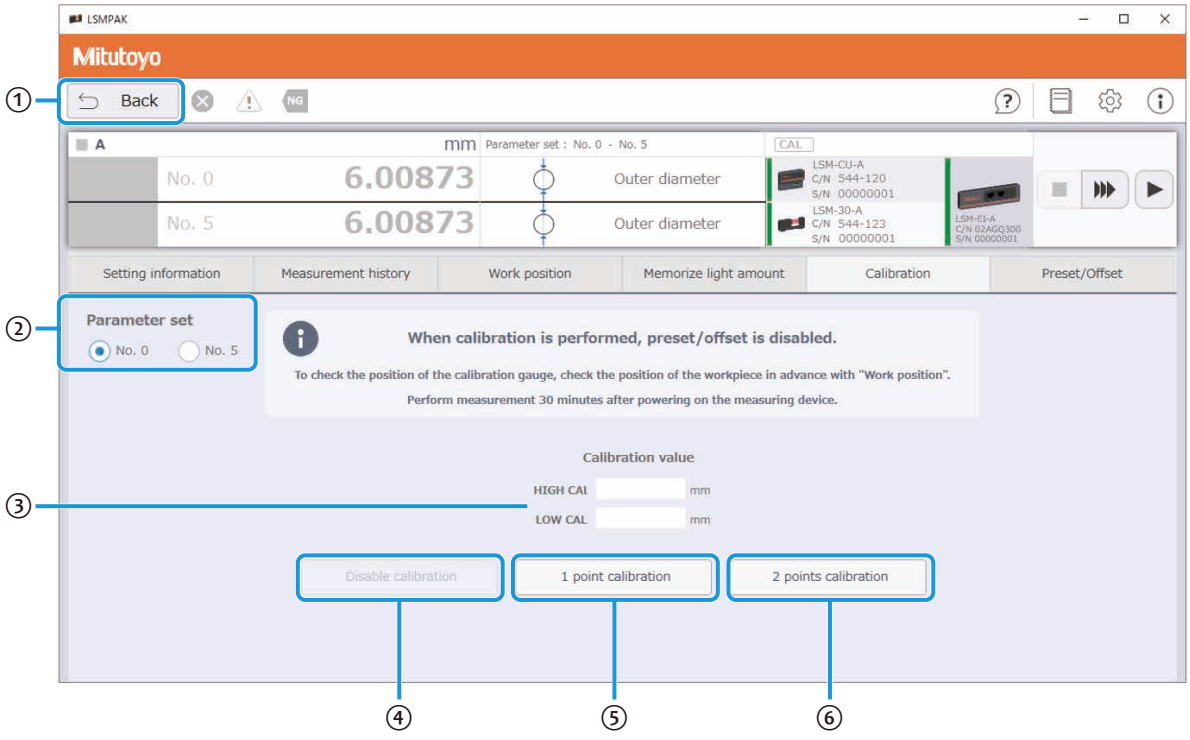
Sometimes a measurement error occurs due to the influence of the shape/material/surface state of a workpiece, installation situations, etc. To reduce such errors and perform measurements with higher accuracy, be sure to calibrate before measuring.

About calibration gages

Calibration requires a calibration gage or workpiece.
You can use calibration gages made by Mitutoyo.

IMPORTANT

- The type of calibration gage to use will differ according to sensor model.
  For details about calibration gages, see "Laser Scan Micrometer <Sensor> User's Manual" (separate document).
- If the customer prepares gages or workpieces for calibration, the dimensional ratio of the gages used for calibration (large to small) should be 1.2 times or greater. Calibration using gages or workpieces with similar diameters may not provide sufficient measurement accuracy.
- Executing calibration clears the preset and offset settings.
- Selecting a calibration gage or workpiece that is made of the same or similar material as that measured workpieces enables measurements with higher accuracy. If a gage of different material is used, an error may occur due to the difference in surface roughness or material.



No.	Description
①	Cancels calibration setting and returns to the home screen.
②	Select the parameter set to be used. (Appears only when two items measurement is enabled.)
③	Displays currently set calibration values.
④	Cancels calibration.
⑤	Performs 1 point calibration (HIGH CAL).
⑥	Performs 2 points calibration (HIGH CAL and LOW CAL).

Tips

1 point calibration should be used if, for example, there is only one type of workpiece to be measured.

Use 2 points calibration when there are many types of workpieces to be measured and you want to ensure linearity over a wide area.

4.1 Standard Calibration

Make sure that measurement settings are complete before proceeding to calibration.

IMPORTANT

- Execute calibration after the measurement settings are configured.
- After executing calibration, the preset and offset are cleared. Set the preset and offset values after completing calibration.

For outer diameter measurements, check that the following settings are made.

Segment mode		Edge mode	
Segment	2 (optional)	Manual measurement or automatic measurement (diameter)	
		Start edge	2
		End edge	3

Tips

- For details on segment and edge mode, see "3.3.5 [Measurement condition 1] Screen" on page C-54.
- There is no restriction on segment mode for calibration. If a gap or displacement needs to be precisely measured, a thickness gage can be used for calibration. However, when measuring an outer diameter or a gap, there may be a slight difference.

1 **Let the LSM run for 30 minutes to 1 hour (warm-up operation).**

Tips

If warm-up operation has been completed, proceed to step **2**.

2 **Clean calibration gages and workpieces with alcohol or thinner to remove any deposits of oil or dust.**

IMPORTANT

The calibration gage or workpiece is critical to the measurement accuracy of the LSM. After use, apply rust prevention oil to prevent rusting during storage.

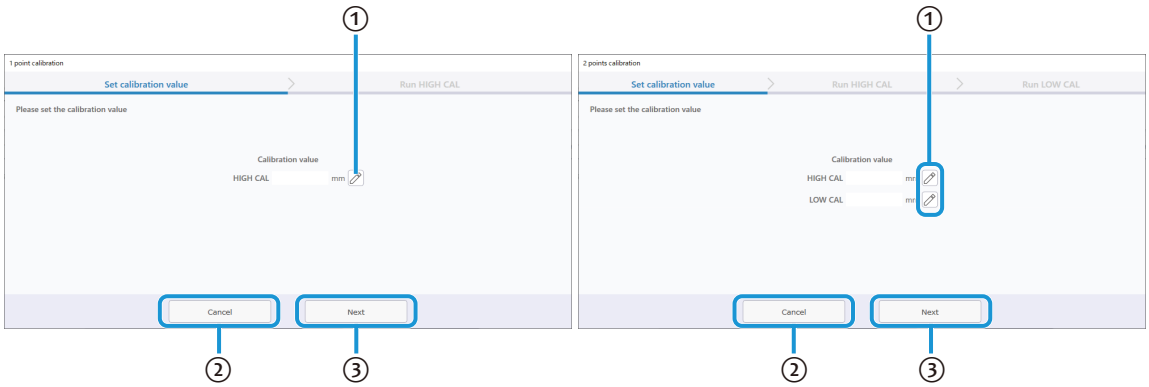
3 **Set the calibration gage or workpiece.**

Tips

- It is convenient to adjust positioning of the gage or workpiece while checking the workpiece position display on the LSMPAK.
  For information about how to read the workpiece position display and how to adjust the measured workpiece position, see "5.1 Setting the Workpiece" on page C-95.
- For 2 points calibration, execute calibration in the order of HIGH CAL gage (large diameter) → LOW CAL gage (small diameter).

4 Click [1 point calibration] or [2 points calibration].

» The [Set calibration value] screen is displayed.



No.	Description
①	Displays the edit calibration value screen.
②	Returns display to the detail screen.
③	Continues to the [Run HIGH CAL] screen.

5 Check the calibration value.

Tips

If you don't need to change the calibration value, proceed to step 7.

6 Edit calibration values.

1 Click  on the right side of the calibration value.

» The [Edit] screen is displayed.

2 Enter new calibration values.

Tips

To stop editing calibration values, click [Cancel].

3 Click [OK].

» The display returns to the [Calibration value] screen.

Tips

For 2 points calibration, edit the LOW CAL calibration value using in the same procedure as when editing the HIGH CAL calibration value.

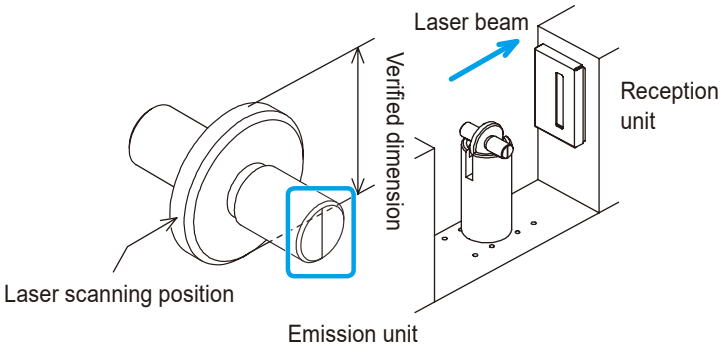
7 Click [Next].

» The [Run HIGH CAL] screen is displayed.

8 Set the HIGH CAL gage (large diameter).

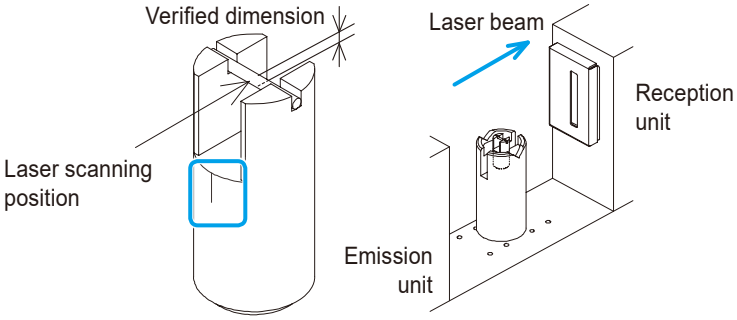
Stepped type

Set the gage on the gage stand so that the "|" mark is vertical.

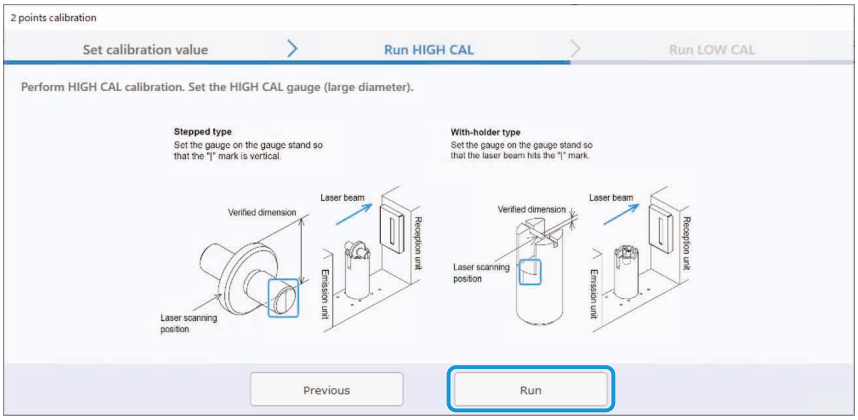


With-holder type

Set the gage on the gage stand so that the laser beam hits the "|" mark.



9 Click [Run] on the [Run HIGH CAL] screen (to perform HIGH CAL calibration).



» HIGH CAL calibration is performed.

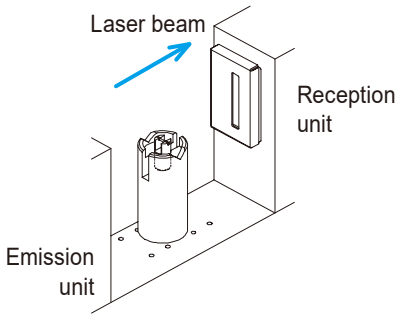
» The [Run LOW CAL] screen is displayed.

Tips

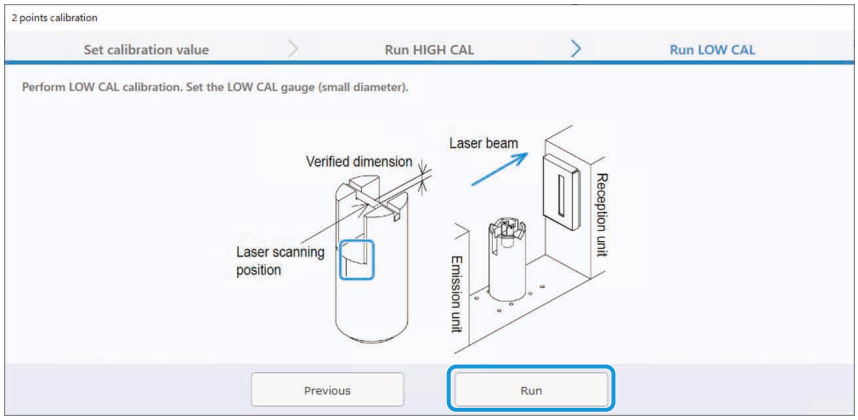
- In the case of 1 point calibration, the calibration completion message screen is displayed. Click [OK] on the message screen to return to the detail screen.
- To repeat measurement, click [Run again].

10 Set the LOW CAL gage (small diameter).

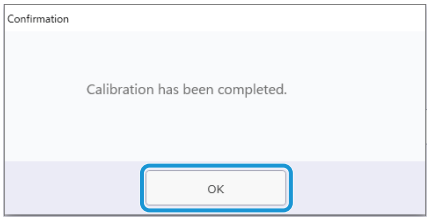
- As with the HIGH CAL gage, set the gage stand so that the center of the verified range is measured.
- A LOW CAL gage smaller than 2 mm should be set in the mounting hole of the gage stand.



11 Click [Run] on the [Run LOW CAL] screen (to perform LOW CAL calibration).



» LOW CAL calibration is performed.
» The calibration completion message screen is displayed.



12 Click [OK] on the message screen.

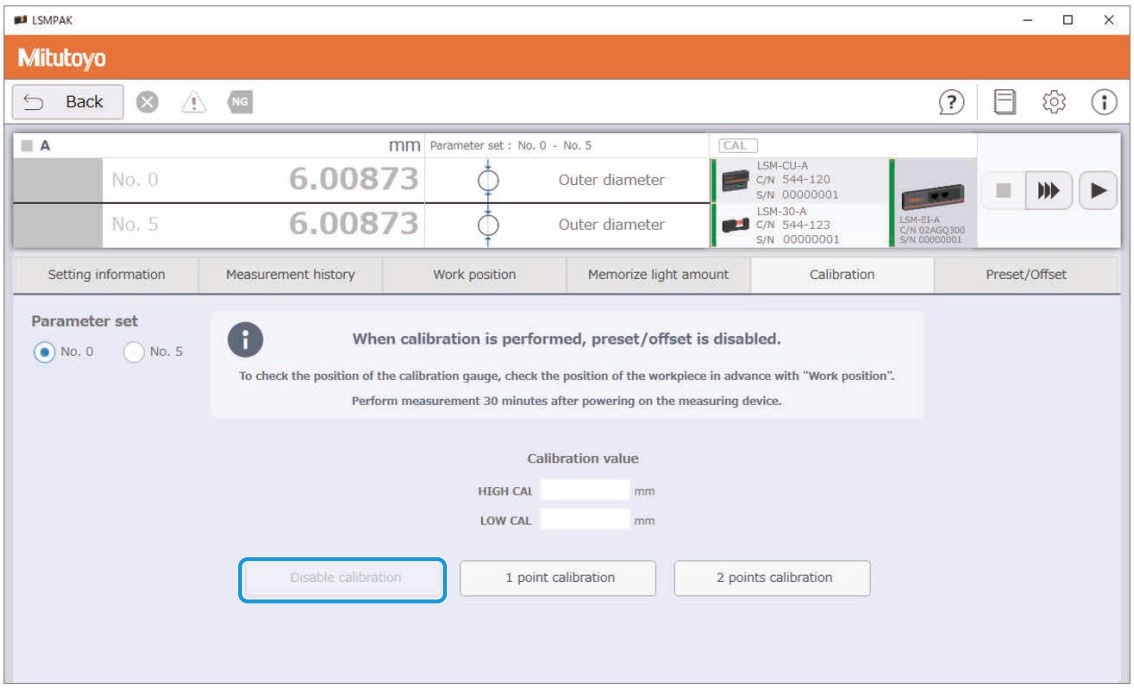
» Calibration is set.
» Calibration values in the [Calibration] tab of the detail screen are updated.
» CAL in the measurement information changes to CAL.

■ Canceling calibration

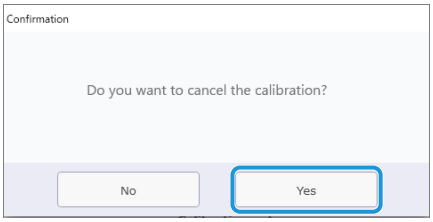
The currently set calibration is canceled by the following procedure.

1 **Click the [Calibration] tab on the detail screen.**

2 **Click [Disable calibration].**



» The following message screen is displayed.

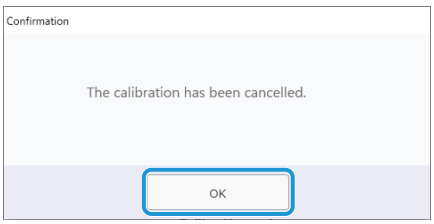


Tips

Click [No] if you decide not to cancel calibration.
The display returns to the detail screen.

3 **Click [Yes].**

» The following message screen is displayed.



4 **Click [OK].**

» The display returns to the detail screen.

4.2 Operational Calibration

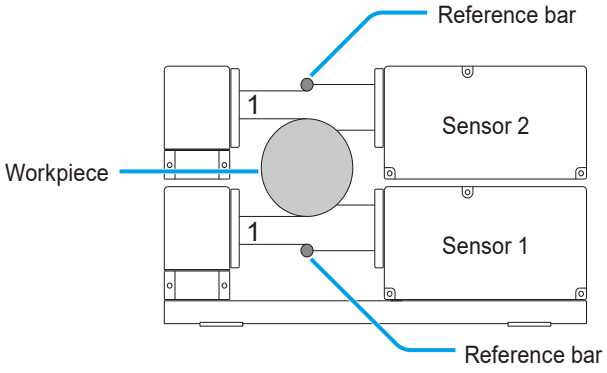
After registering arithmetic operations, it is recommended that operational calibration be performed before starting sum or other arithmetic operations.

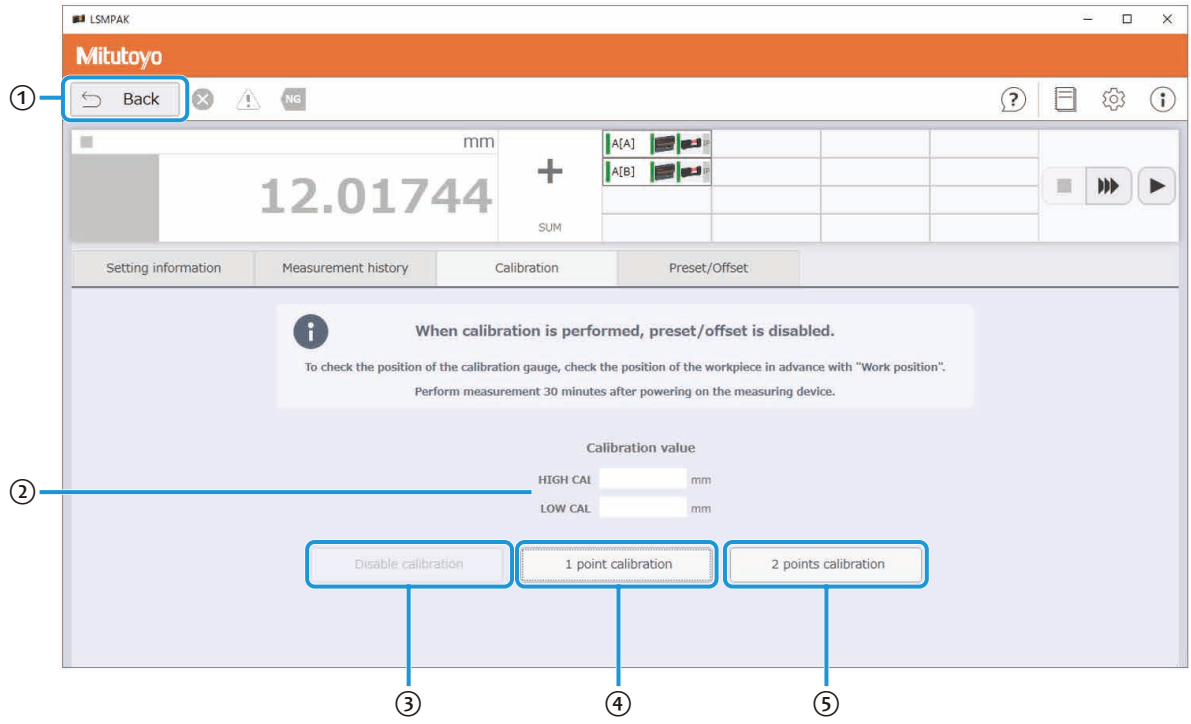
For details, see "6.1.5 Measurement (arithmetic calculation) with Multiple Combined LSMs" on page C-120.

In particular, when measuring a large-diameter workpiece with two sensors stacked above and below each other as shown in the figure below, execute individual calibration and operational calibration for the effect of reflected light.

For information on the effect of reflected light, see "■ The effect of reflected light" on page C-94.

In the figure below, sensor 1 and sensor 2 are combined to measure a workpiece. Reference bars (edges) are placed above and below the workpiece to improve measurement reproducibility.





No.	Description
①	Cancels calibration setting and returns to the home screen.
②	Displays currently set calibration values.
③	Cancels calibration.
④	Performs 1 point calibration (HIGH CAL).
⑤	Performs 2 points calibration (HIGH CAL and LOW CAL).

The calibration procedure is the same as for the LSM by itself.

For details, see 📖 "4.1 Standard Calibration" on page C-87.

IMPORTANT

- When measuring a large-diameter workpiece with two sensors stacked vertically, be sure to perform "2 points calibration" when performing calculation calibration. Calibration cannot be performed properly with "1 point calibration".
- Operational calibration using measurements with zero samples is not possible. For details on the number of sample measurement, see 📖 "■ Sample measurement" on page C-57.

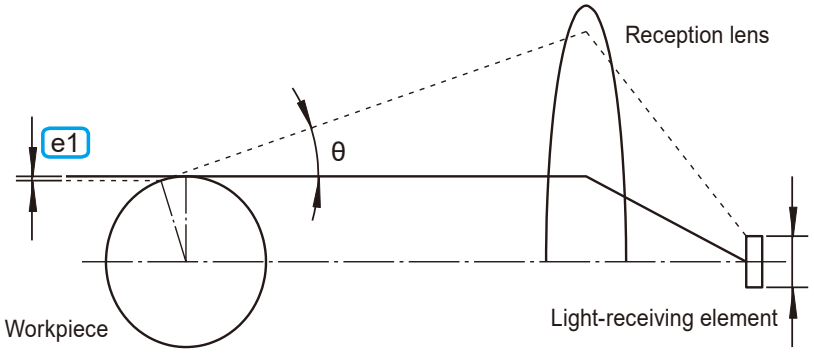
■ The effect of reflected light

When measuring a large-diameter workpiece with two sensors stacked vertically, light reflected by the large-diameter workpiece affects the measurement.

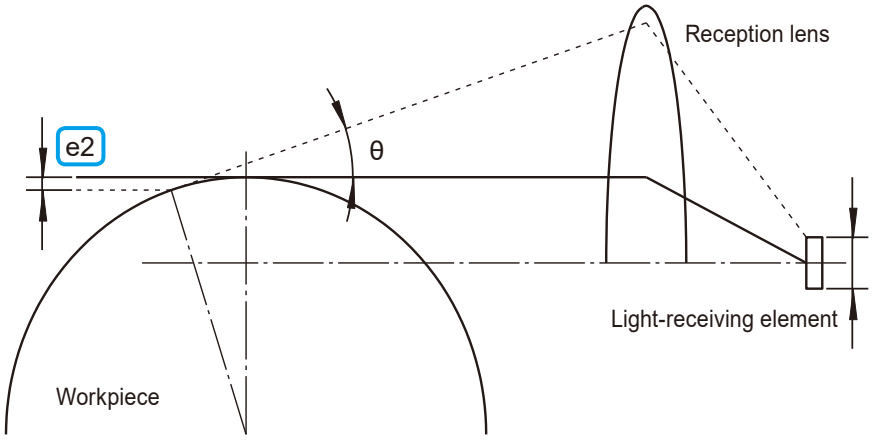
Reflected light reduces measurement accuracy compared to individual sensor measurements.

The degree to which reflected light influences measurement (e1 and e2 in the figure below) is not only proportional to the diameter of the workpiece to be measured, but also depends on the reflectivity of its surface.

Therefore, when measuring a large-diameter workpiece with two sensors stacked vertically, it is recommended that operational calibration be performed in addition to normal calibration.



Workpieces with small diameters



Workpieces with large diameters

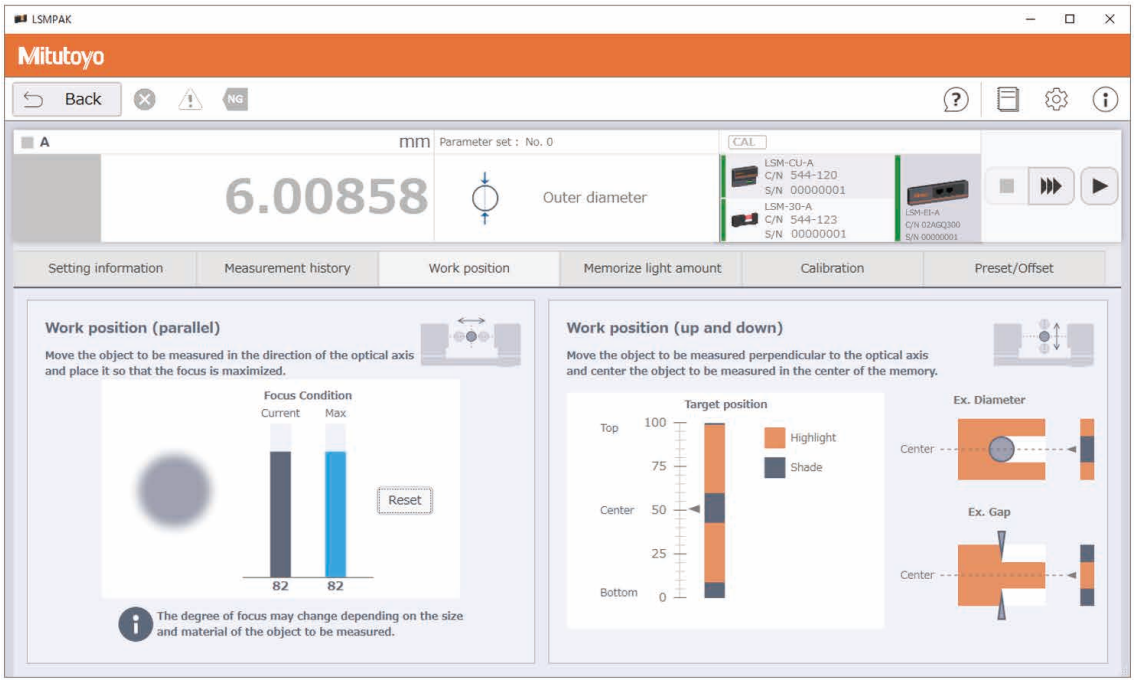
5 Measurements

5.1 Setting the Workpiece

After calibration is complete, set the workpiece on the sensor.

Adjust the position of the workpiece to be measured while watching the workpiece position display on LSMPAK.

For details on the workpiece position display, see "● [Work position (parallel)]" on page A-25 "PART A Overview".

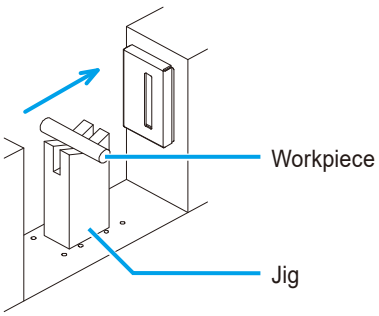


■ Adjust workpiece positioning

1 Click [Reset].

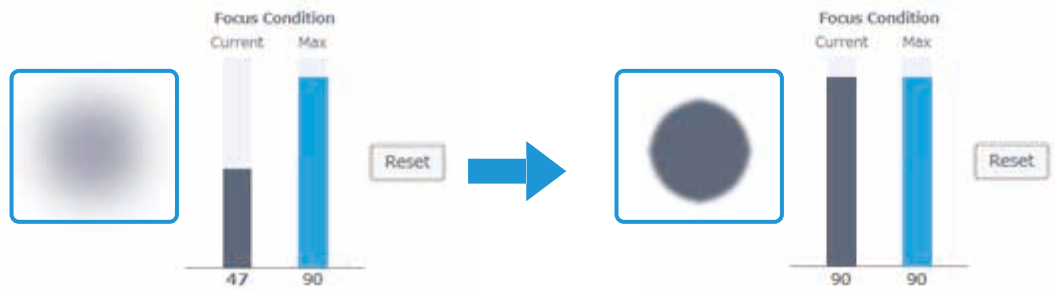
» [Focus Condition] (the degree of focus) is reset.

2 Set the workpiece between the sensor's emission unit and reception unit.



3 Adjust horizontal positioning of the workpiece.

1. Move the workpiece parallel to the optical axis while checking the laser spot and focus condition graph in the [Work position (parallel)] area.
2. Set the workpiece for optimum focus.

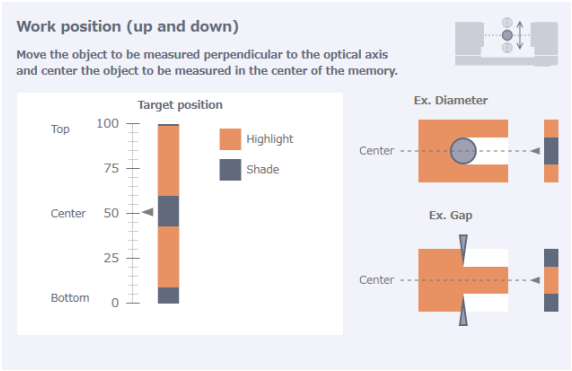


4 Adjust positioning of the workpiece in the scanning direction.

1. Move the workpiece in the scanning direction (longitudinal direction of the light-emitting window) while checking the gage in the [Work position (up and down)] area and the shadowed area indicating the workpiece to be measured.
2. Set the workpiece to align the center of the shadowed area with the Center (50) position of the gage.

Tips

When measuring a gap, set the workpiece so that the center of the measurement area is aligned with Center (50).



IMPORTANT

- Although measurements are possible outside the measurement area as long as they are within the laser scanning range, they will not fulfill the accuracy specifications of the LSM measurement unit.
- In particular, note that the LSM-02-A has a narrow measurement area.
- If a thin workpiece is placed outside the measurement area, "Err-0" (no workpiece error) may appear on the data display. In such cases, adjust the position of the workpiece so that values are displayed.

5.2 Setting the Preset and Offset

Set the preset and offset values after completing calibration.
Settings can be made or canceled from the [Preset/Offset] tab of the detail screen.
For arithmetic operations, use the [Preset/Offset] tab on the detail screen of the operation to set or cancel the setting.

The procedure for setting up and canceling is the same.

5.2.1 Preset

By using the preset function, you can display the dimensional difference between the workpiece and the reference gage/master gage or measure a workpiece that is larger than the measuring range.

Preset

The setting of the dimensional value of a reference gage or master gage is called a preset.

This is applied to measurement of the absolute dimensions of the workpiece to be measured.
The preset value can also be set to zero to measure the difference (deviation) from a reference or master gage.

IMPORTANT

Presets that include measurements with zero samples cannot be made. For details on the number of sample measurement, see "■ Sample measurement" on page C-57.

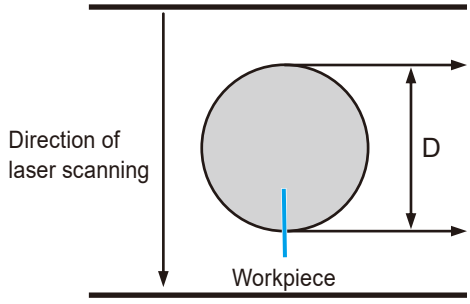
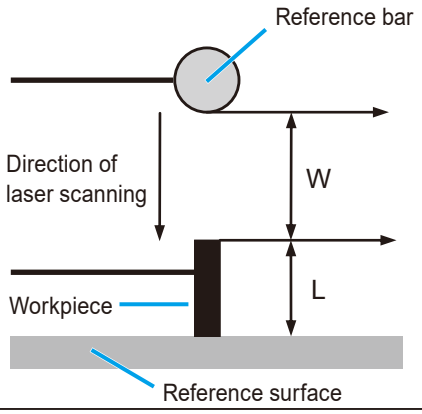
Tips

Setting a preset value resets the offset information.

Direction

When setting the preset, specify the direction in which measured values increase and decrease.

Depending on the type of a workpiece, decide whether it will be the positive direction or the negative direction.

Positive direction is specified	Negative direction is specified
Measurement example The shaded portion D of the workpiece is being measured. Measurement example: "6.2.5 High-Precision Outer Diameter Measurement of Round Bar (Preset Function)" on page C-134  	**Measurement example** The light portion W (gap) of the workpiece is being measured to determine the dimension L of the workpiece. Measurement example: "6.2.6 Plate-Shaped Width Measurement (Preset Function)" on page C-136 

■ Setting preset

Specify [Preset value] and [Direction].

Item	Description	Remarks
Preset value	Enter a number with the sign (plus or minus) and a maximum of seven digits.	Initial value: 0
Direction	Specify the direction in which measured values increase or decrease. • Positive direction • Negative direction	Initial value: positive direction

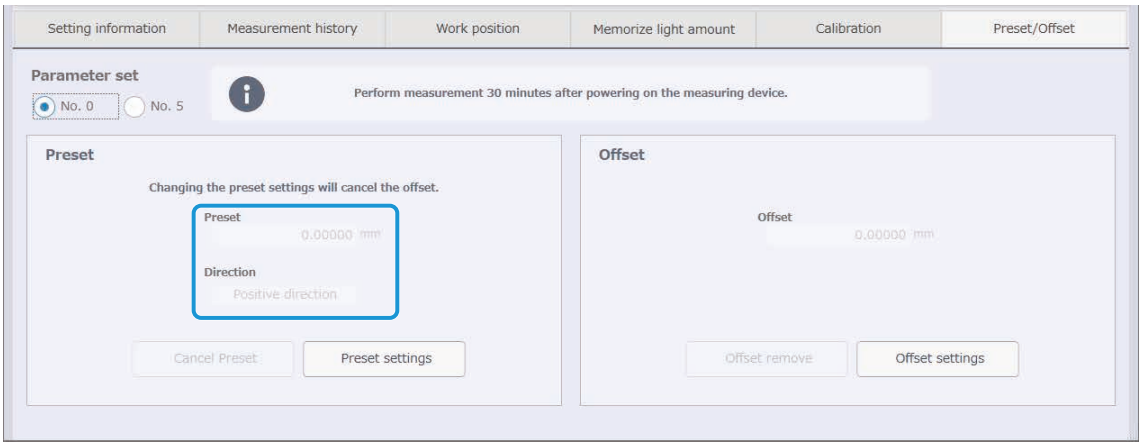
1 Set the reference gage/master gage.

2 Measure the reference gage/master gage.

3 Specify the preset value and the direction.

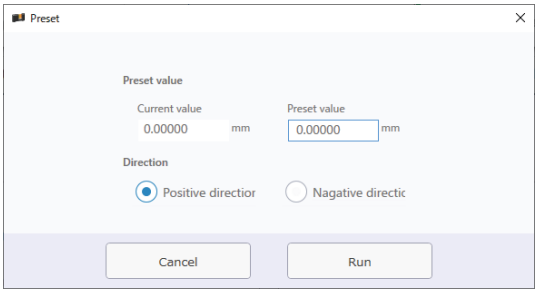
1 Click the [Preset/Offset] tab on the detail screen.

» The currently set preset value and direction are displayed.



2 Click [Preset settings].

» The [Preset] screen is displayed.



Tips

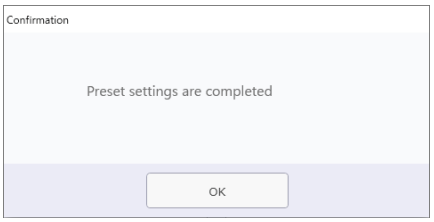
If you do not want to change the preset value or direction, click [Cancel]. The display returns to the detail screen.

3 Enter the preset value in the preset value field.

4 Select the Direction.

5 Click [Run].

» A message screen is displayed.



» The preset value and direction are set.

6 Click [OK].

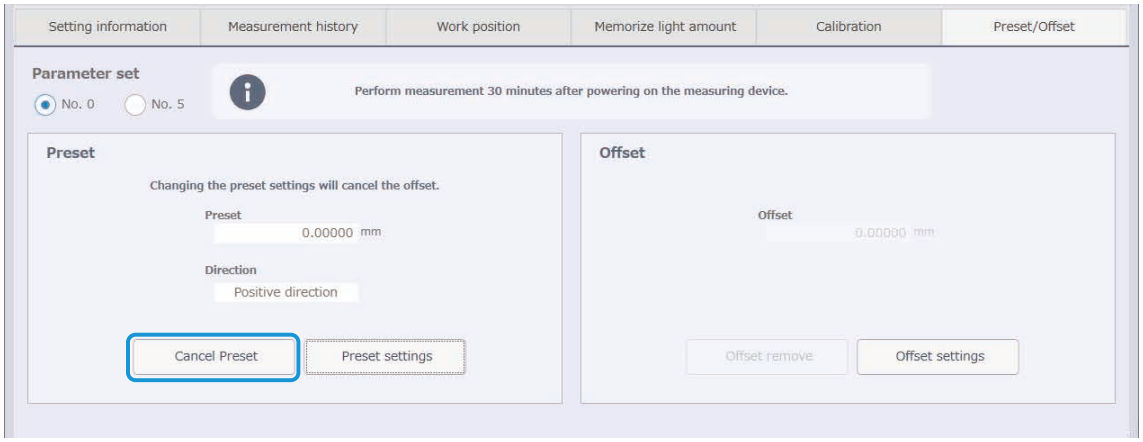
» The display returns to the detail screen.

■ Canceling the preset

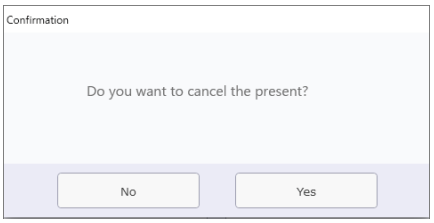
The currently set preset is canceled by the following procedure.

1 **Click the [Preset/Offset] tab on the detail screen.**

2 **Click [Cancel Preset].**



» A message screen is displayed.



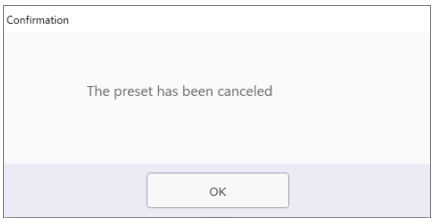
Tips

Click [No] if you decide not to cancel the preset.
The display returns to the detail screen.

3 **Click [Yes].**

» Preset is canceled.

» A message screen is displayed.



4 **Click [OK].**

» The display returns to the detail screen.

5.2.2 Offset

If you configure the offset, the total correction value becomes "Preset value" + "±Offset value". Setting a positive (+) or negative (-) offset value makes the measured value larger or smaller, respectively.

Tips

- When configuring the offset, you do not need a reference gage or master gage. (This is because reference gages and master gages are not measured.)
- If preset or zero-set is configured again, the offset is canceled.
- If you configure the offset without setting a preset value, the total correction value becomes "Measured value (displayed value)" + "±Offset value".

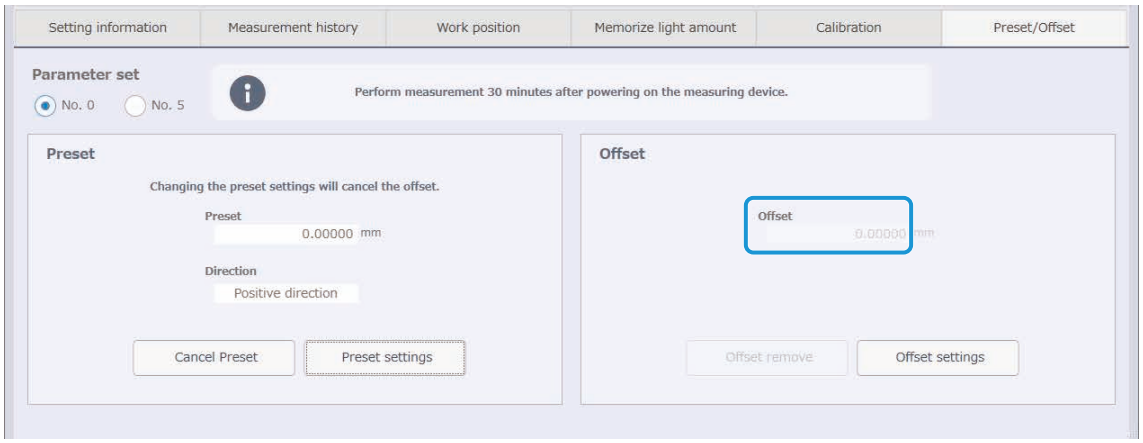
■ Setting the offset

Specify the offset value.

Item	Description	Remarks
Offset value	Enter a number with the sign (plus or minus) and a maximum of seven digits.	Initial value: No offset is specified

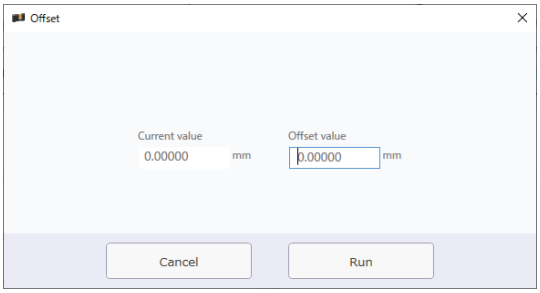
1 Click the [Preset/Offset] tab on the detail screen.

» The currently set offset value is displayed.



2 Click [Offset settings].

» The [Offset] screen is displayed.



Tips

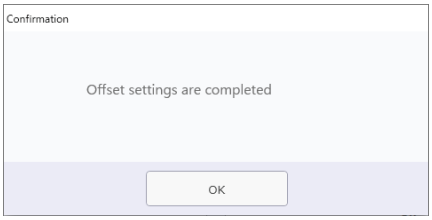
If you do not want to change the offset value, click [Cancel]. The display returns to the detail screen.

3 **Enter the offset value in the offset value field.**

4 **Click [Run].**

» The offset value is set.

» A message screen is displayed.



5 **Click [OK].**

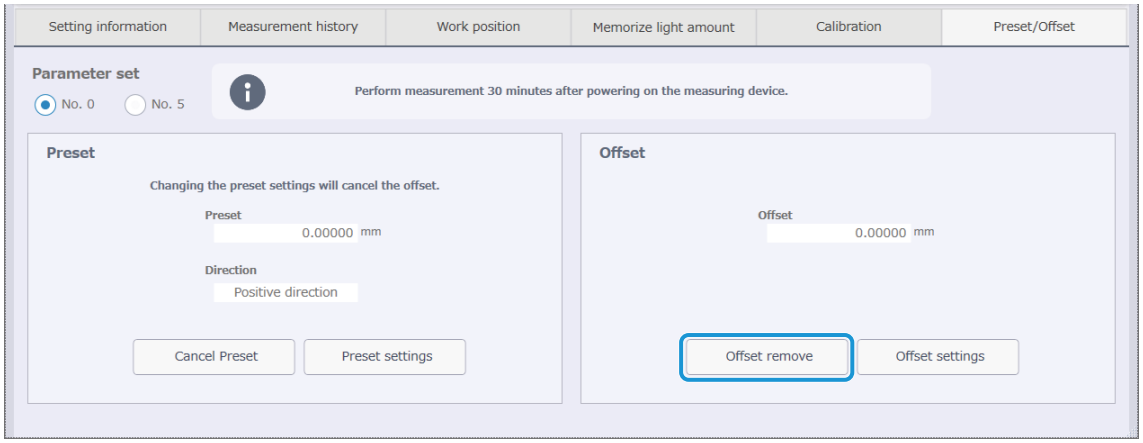
» The display returns to the detail screen.

■ Canceling the offset

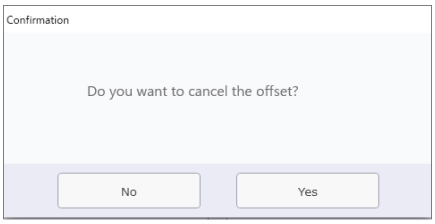
The currently set offset is canceled by the following procedure.

1 **Click the [Preset/Offset] tab on the detail screen.**

2 **Click [Offset remove].**



» A message screen is displayed.



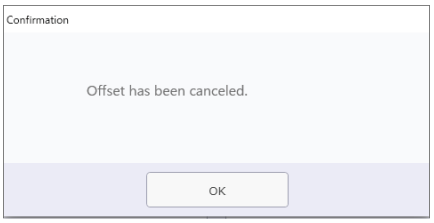
Tips

Click [No] if you decide not to cancel the offset. The display returns to the detail screen.

3 **Click [Yes].**

» Offset is canceled.

» A message screen is displayed.



4 **Click [OK].**

» The display returns to the detail screen.

5.3 Measurement Execution Method (Measurement Mode)

This section describes how measurements are performed (measurement modes) by the LSM.

IMPORTANT

When using LSMPAK to acquire measurements, it cannot be used in conjunction with other tools (such as customer-provided monitoring tools, I/O devices, and PLCs). Please keep this in mind when performing measurements with LSMPAK.

Tips

To perform measurements by means other than LSMPAK, see "1 Interface Overview" on page D-1 in "PART D Interfaces".

5.3.1 Single Run Measurement

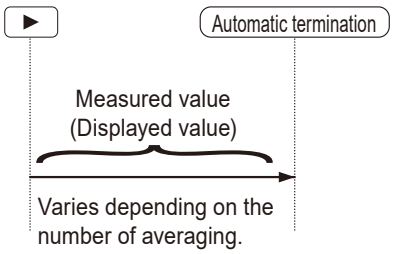
■ When [No of sample measurement] is 1

This is the measurement performed when [No of sample measurement] is set to 1 in the sample measurement settings.

Measurement is performed according to the set contents of the parameter set.

Only one measurement value is output.

Measurement start	Click ▶.
Measurement end	Automatic termination



■ When [No of sample measurement] is from 2 through 999

This is the measurement performed when [No of sample measurement] is set to 2 to 999 in the sample measurement settings.

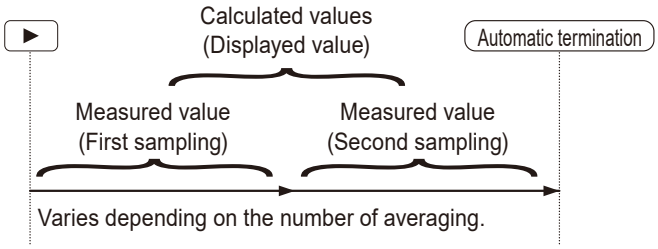
Measurement (sampling) is performed for the set number of sample measurement and set calculation items are executed.

Only one measurement value is output.

For details, see "■ Sample measurement" on page C-57.

Measurement start	Click ▶.
Measurement end	Automatic termination

When the number of sample measurement is 2



■ When [No of sample measurement] is 0

This is the measurement performed when [No of sample measurement] is set to 0 in the sample measurement settings. This is also referred to as "zero run measurement".

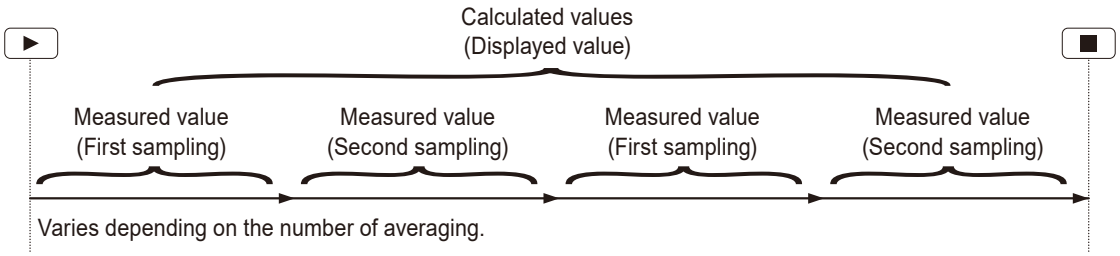
Measurement is performed from the starting measurement operation to the ending measurement operation and the set calculation items are executed.

Only one measurement value is output.

This is useful when measuring cylindricity or run-out of rotating rolls, or when you want to extend measurement time.

For details, see "■ Sample measurement" on page C-57.

Measurement start	Click ▶.
Measurement end	Click ■. **Tips** After 65535 measurements have been performed, measurement is automatically terminated.



5.3.2 Continuous Run Measurement

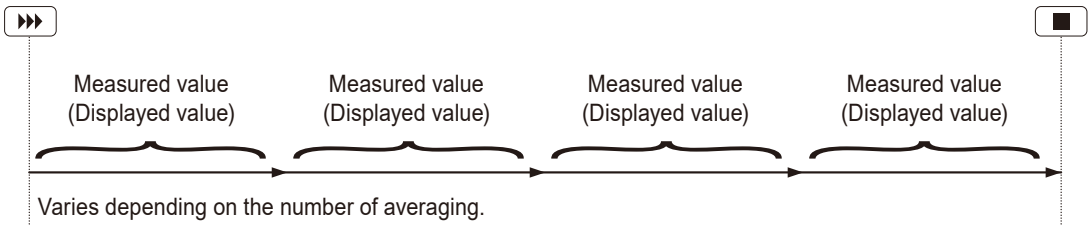
■ When [No of sample measurement] is 1

This is the measurement performed when [No of sample measurement] is set to 1 in the sample measurement settings.

Measurement is repeated continuously according to the set contents of the parameter set.

Multiple measurement values are output.

Measurement start	Click ⏭.
Measurement end	Click ■.



■ When [No of sample measurement] is from 2 through 999

This is the measurement performed when [No of sample measurement] is set to 2 to 999 in the sample measurement settings.

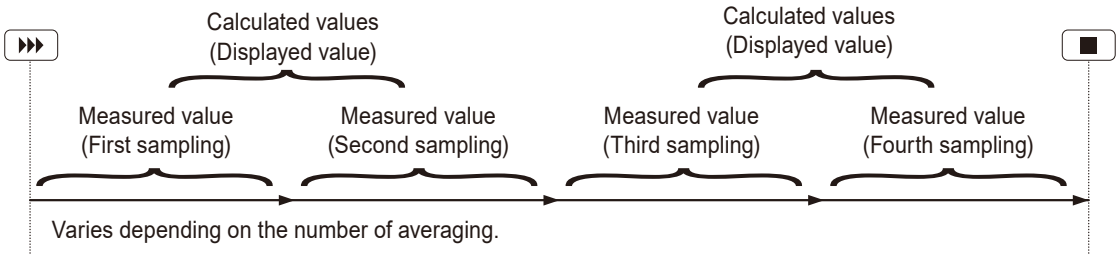
Measurement (sampling) is performed for the set number of sample measurement and set calculation items are executed.

Multiple measurement values are output.

For details, see 📖 "■ Sample measurement" on page C-57.

Measurement start	Click ⏭.
Measurement end	Click ■.

When number of sample measurement is 2



5.4 Confirming Measurements and Statistics

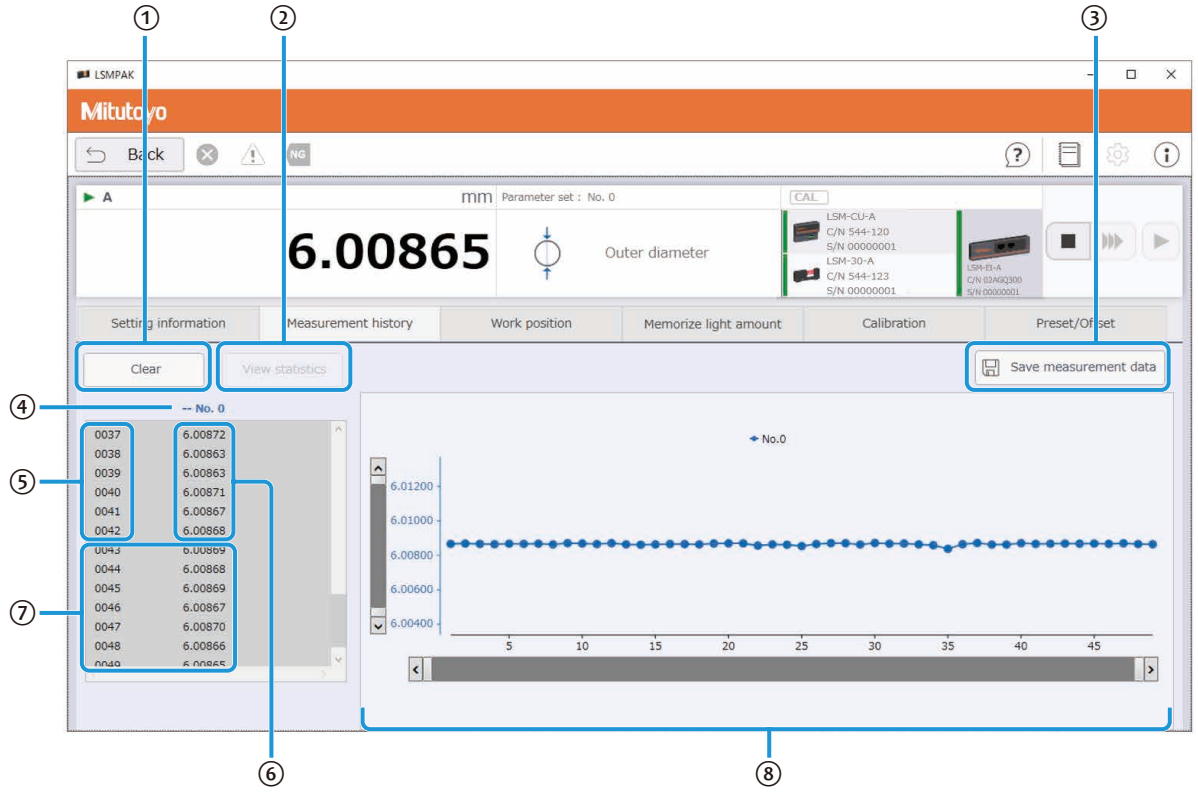
5.4.1 Confirming Measured Values

Select the [Measurement history] tab on the detail screen to check measured values.

Tips

The number of points that can be measured using LSMPAK is up to 100,000.

Measured values should be saved or cleared periodically, as an error is displayed if the number of points exceeds 100,000.



No.	Description
①	Clears the measurement history and statistical values.
②	Statistics are displayed in the list at the bottom.
③	Saves measurement data.
④	Parameter set No.
⑤	Measurement No.
⑥	Measured value
⑦	Statistical values
⑧	Measured values are displayed as a line graph. The vertical and horizontal axis scales are adjustable. However, defaults are restored if you move between tabs or re-measure.

5.4.2 Confirming Statistics

Statistics are displayed for measurement results such as single and continuous measurements.

To check statistics by means other than LSMPAK, see "1 Interface Overview" on page D-1 in "PART D Interfaces".

The following items are displayed as statistical values.

- Number (N)
- Average (AVG)
- Standard deviation (S.D.)
- Range (R): maximum value - minimum value
- Maximum value (MAX)
- Minimum value (MIN)

■ Displaying statistics

1 Click the [Measurement history] tab on the LSMPAK detail screen.

2 Click [View statistics].

» Statistical values are displayed.

Tips

If [View statistics] does not appear, [Statistical Processing] may be disabled in the parameter settings of the [Measurement condition 2] screen. When [Enable] is selected, [View statistics] appears on the [Measurement history] tab.

5.4.3 Storage of Measured Values

Measurement data can be saved.

1 Click [Save measurement data].

» A screen is displayed for selecting a location for data storage.

2 Follow the screen directions to save the measurement data.

» Measurement data is stored.

Tips

Measurement data is saved in CSV format. If GO/NG judgment is set, GO/NG judgment results will be included. Saved CSV files can be opened using Excel or other software. For details, see the manual of the software used.

■ CSV file format

This section describes the CSV file format used by LSMPAK to save measurement data.

● Text

Character types: Half-width alphabetic characters (upper and lowercase), numerals, and half-width symbols

Encoding: UTF8

● Format

Example

"---","No.7","Judge"
"1","1.12345","-NG"
"2","2.12345","OK"
"3","3.12345","+NG"

- Header row and data rows

  The first row is the header row (column heading) and the second and following rows are data rows.

- Field delimiters

  Delimiter characters are used to separate fields.

Tips

The symbols used for field delimiters and decimal points follow the settings of the Windows PC on which LSMPAK is installed.

- Japanese and English: Commas (,) as delimiters, periods (.) for decimal points
- German: Semicolons (;) as delimiters, commas (,) for decimal points

- Field values

  Field values are enclosed in double quotation marks (").

Tips

There are no spaces between delimiters and double quotation marks.

● Composition of measurement data columns for individual LSMs

Example

"---","No.2","Judge","Range","No.7","Judge","Range"

"1","1.12345","-NG","R1","7.12345","+NG","R7"

From left to right: Sequence number, measured value of item A, GO/NG judgment of item A, range of item A, measured value of item B, GO/NG judgment of item B, range of item B.

Tips

- In the case of one-item measurement, the columns related to item B (measured value, GO/NG, and range) are omitted.
  Example

  "---","No.2","Judge","Range"

  "1","1.12345","-NG","R1"
- If the GO/NG judgment method is not multi-limit selection, the range column is omitted (the GO/NG column is not omitted).
  Example

  "---","No.2","Judge"

  "1","1.12345","-NG"

● Column composition of measured data at the time of calculation

Example

"---","Calc","Judge","Range","LSM1[A]","LSM2[B]"

"1","3.24690","+NG","R7","1.12345","2.12345"

From left to right: Sequence number, calculated, GO/NG judgment of calculated value, range of calculated value, operation target 1, operation target 2, ... (all subsequent operation targets follow).

Tips

No GO/NG judgment or range is added to the operation target.

● If there is blank data

If no GO/NG judgment threshold is set, the GO/NG column of each data row will contain a half-width space.

If multi-limit GO/NG judgment without thresholds is selected, the GO/NG and range columns of each data line will contain half-width spaces.

Example

"---","No.7","Judge","Range"

"1","1.12345"," "," "

● Typical content and formatting of individual columns

	Sequence number
Header row	"---"
Data row	"1", "2", "3", ……, "100000"

Measured value	
Header row	"No.0", "No.1", ……, "No.19" Parameter set number.
Data row	Numeric value such as 12.12345. The symbol used for decimal points follow the settings of Windows. The number of digits after the decimal point is 5 when the unit is "mm" and 6 when the unit is "in".

Operational target	
Header row	Operational target name such as "LSM1[B]". The description format is "(LSM label) [(item)]". The "item" portion is determined as follows. • With one-item measurement: A • Upper item of 2-item measurement: A • Lower item of 2-item measurement: B
Data row	Numeric value such as 12.12345. The symbol used for decimal points follow the settings of Windows. The number of digits after the decimal point is 5 when the unit is "mm" and 6 when the unit is "in".

Calculated values	
Header row	"Calc"
Data row	Numeric value such as 12.12345. The symbol used for decimal points follow the settings of Windows. The number of digits after the decimal point is 5 when the unit is "mm" and 6 when the unit is "in".

GO/NG judgment (upper and lower limits, target value and tolerance)	
Header row	"Judge"
Data row	"-NG", "OK", "+NG", " " (half-width space*) * If no upper/lower limits, etc. are set.

GO/NG judgment (multi-limit selection)	
Header row	"Range"
Data row	"R1", "R2", "R3", "R4", "R5", "R6", "R7", " " (half-width space*) * When the threshold for multi-limit selection is not set and the range is not defined.

6 Measure Procedure

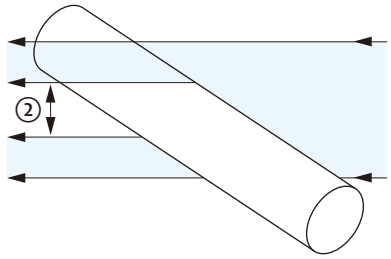
6.1 Basic Measurements

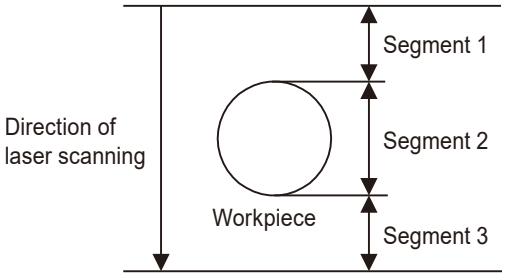
The measuring method varies by measurement position of the workpiece or the measurement item.
This section provides an overview of the basic measurements: outer diameter, gap, run-out, and thickness.

6.1.1 Outer Diameter Measurements

Measure the outer diameter of a wire or round bar with the following procedure.
Depending on the dimensional calculation, ellipticity and simple cylindricity can also be measured.

Workpiece example





1 Configure the settings for measurement.

On the [Measurement condition 1] screen, select [Outer diameter].
The following settings are made automatically.

- Segment: 2
- No of sample measurement: 1

Common settings and parameters other than those listed above should be set according to the intended purpose.

Tips

- Segment mode can also be changed to edge mode in the common settings. If you change to edge mode, set the edge number in the parameter settings.
- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

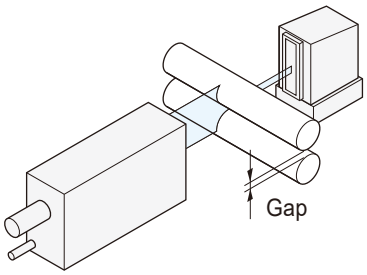
If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

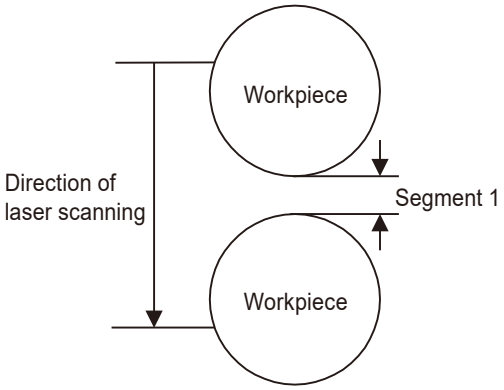
4 Check the measurement result.

6.1.2 Gap Measurement

Measure the gap between two rolls with the following procedure.

Workpiece example





1 Configure the settings for measurement.

Select [Gap (SEG1)] in [Measurement condition 1] of the parameter settings.

The following settings are made automatically.

- Segment: 1
- No of sample measurement: 1
- Method: Average

Common settings and parameters other than those listed above should be set according to the intended purpose.

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

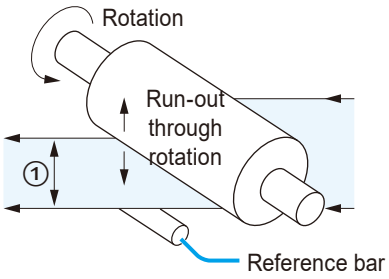
4 Check the measurement result.

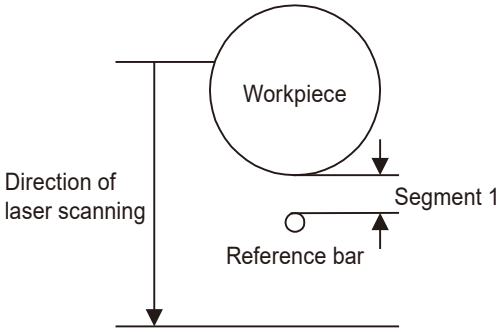
6.1.3 Run-Out Measurement

The run-out of a rotating workpiece is measured using the reference bar placed above or below the workpiece to obtain the change in the gap between the reference bar and the workpiece as the run-out.

The measured value is calculated with a calculation of the dimensional difference.
The run-out measurement can also be applied to roundness measurement.

Workpiece example





1 Configure the settings for measurement for checking the measurement results.

Select [Runout (SEG1)] in [Measurement condition 1] of the parameter settings.

The following settings are made automatically.

- Segment: 1
- No of sample measurement: Other than 1
- Method: Range

To change the number of sample measurement, select [Other] and set [No of sample measurement].
See below for how to calculate the number of sample measurement.

* Example: When the workpiece rotation speed is 3 seconds per rotation, and the measurement interval is 0.08 seconds (number of averaging: 256)
  3 seconds ÷ 0.08 seconds = 38

Common settings and parameters other than those listed above should be set according to the intended purpose.

Tips

For details about the settings for measurement, see 📖 "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see 📖 "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

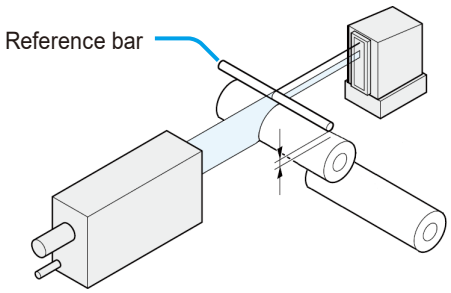
If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

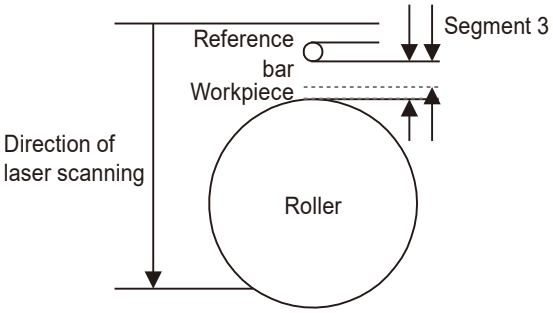
4 Check the measurement result.

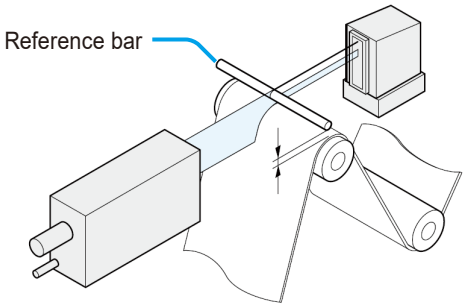
6.1.4 Thickness Measurement

Measure the thickness of a film or sheet with the following procedure.

Workpiece example







1 Configure the settings for measurement.

Select [Gap (SEG3)] in the [Measurement condition 1] of the parameter settings.

The following settings are made automatically.

- Segment: 3
- No of sample measurement: 1
- Method: Average

Common settings and parameters other than those listed above should be set according to the intended purpose.

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Preset with no workpiece (reference bar only)

Preset the gap between the reference bar and the roller with no workpiece set.

4 Input the preset and direction values.

Here, enter 0.0 for the preset value and + for the direction value.

Tips

For details on presets, see "5.2.1 Preset" on page C-97.

5 Perform the measurement.

Measure the gap between the reference bar and the roller.

1 Set the workpiece.

2 ▶ or click ⏩.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

6 Check the measurement result.

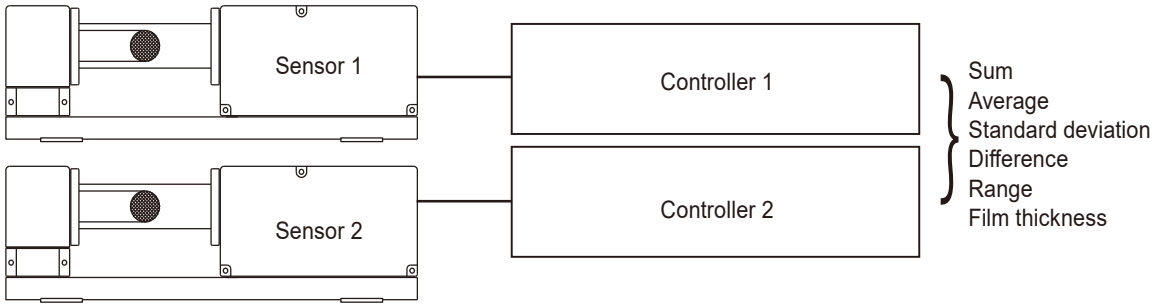
6.1.5 Measurement (arithmetic calculation) with Multiple Combined LSMs

By combining several LSMs, the following measurements can be made.

- Parallel measurement: Simultaneously measure different parts of the workpiece.
- Orthogonal measurement: The outline of the wire is measured simultaneously from the X and Y directions.
- Large diameter measurement: Measure workpieces with large diameters that cannot be measured with a single sensor.

IMPORTANT

When performing calculations, be sure to use the same model of sensor. For details on LSM positioning, see the "Laser Scan Micrometer <Sensor> User's Manual".

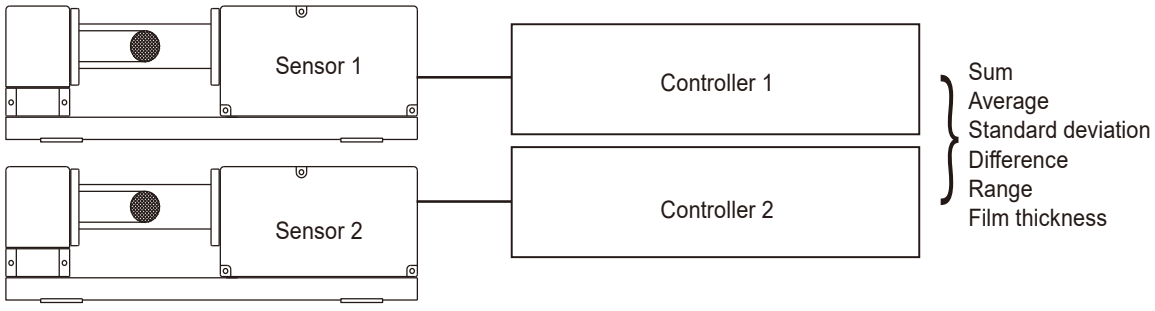


■ Parallel measurements

Multiple sensors are placed side by side to measure different parts of the same workpiece.

Registration of arithmetic operations enables calculation of the average, standard deviation, difference, etc.

Example of sensor arrangement



Measurement example: simultaneous two-position measurement of the outer diameter of a precision shaft

1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Setting item	Setting value	
Segment mode	Sensor 1	Segments 1 to 7 (segments 1 to 3 for transparent object measurements)
	Sensor 2	

Setting item	Setting value	
Edge Mode	Sensor 1	Edges 1 to 255
	Sensor 2	

Tips

- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.
- For details on arithmetic operations, see "3.5.1 Register Calculation" on page C-76.

2 Execute calibration for each LSM.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

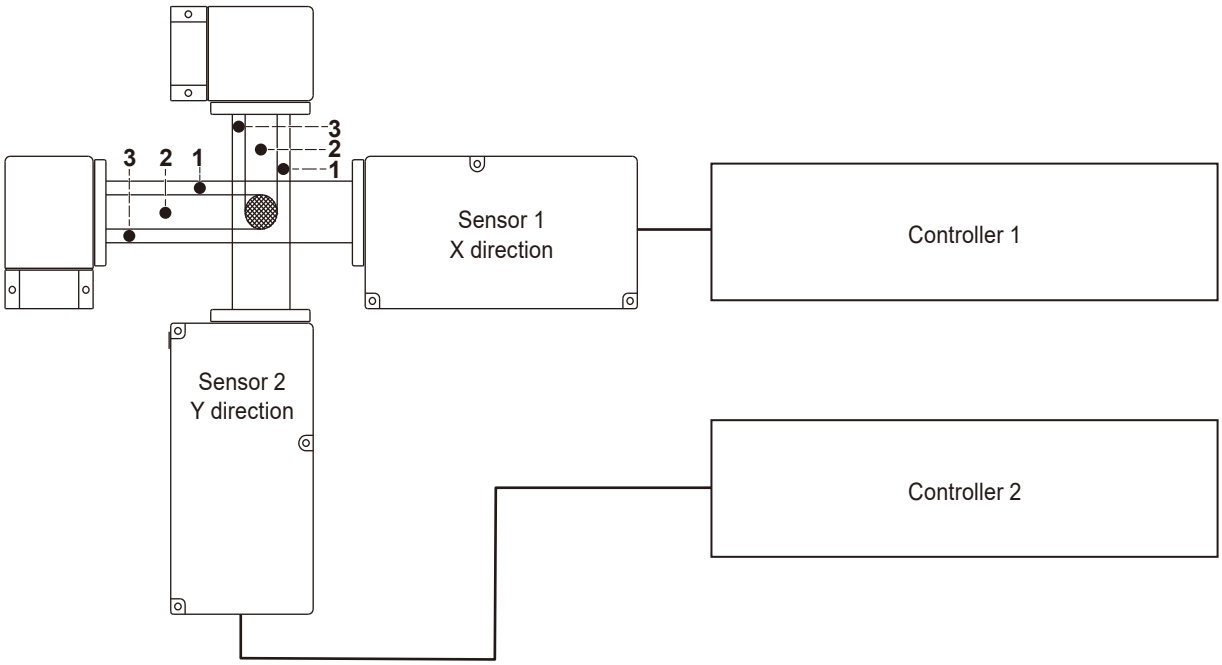
If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

4 Check the measurement result.

■ Orthogonal measurement

Two sensors are placed orthogonally to measure the same workpiece.
Registering calculations enables allows calculation of averages, differences, etc.

Example of sensor arrangement



Measurement example: simultaneous XY measurement of the outer diameter of a wire

1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Setting item	Setting value	
Segment mode	Sensor 1	Outer diameter (segment 2)
	Sensor 2	
Edge Mode	Sensor 1	Start edge: 2
	Sensor 2	End edge: 3

Tips

- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.
- For details on arithmetic operations, see "3.5.1 Register Calculation" on page C-76.

2 Execute calibration for each LSM.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Set the calculation method.

The calculation method can be selected from sum, average, and difference.
For details, see "3.5.1 Register Calculation" on page C-76.

4 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

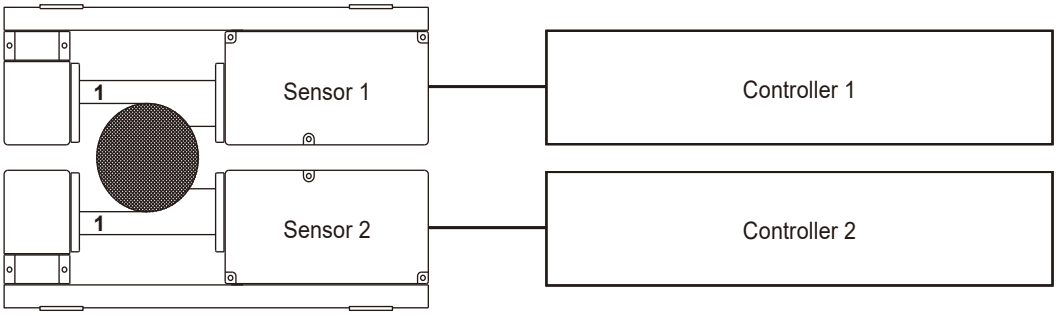
5 Check the measurement result.

■ Large diameter measurement

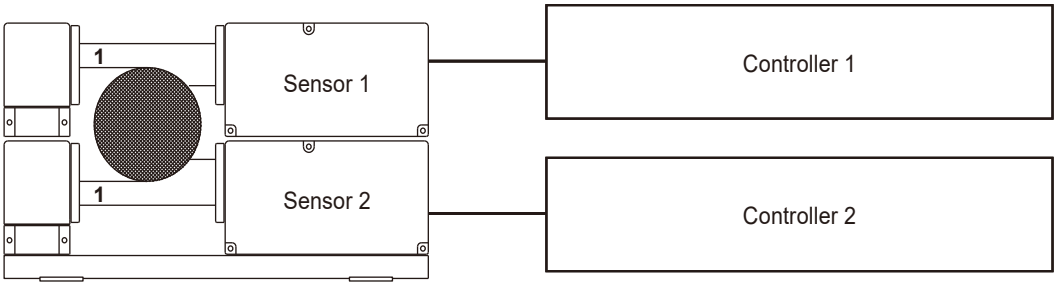
Multiple sensors can be placed face to face or in close contact to measure workpieces with large diameters that cannot be measured with a single sensor.

Registration of arithmetic operations enables calculation of the average and standard deviation.

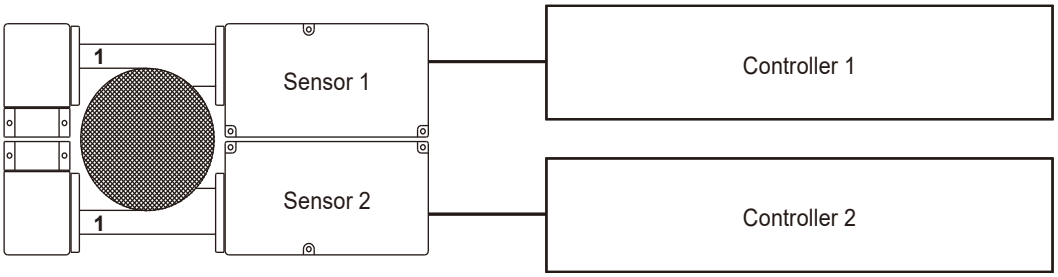
Example of sensors arranged on opposite sides



Example of stacked sensor arrangement



Example of aligning the bottoms of the sensors with each other



Measurement example: Outer diameter measurement of a large-diameter round bar

For details on measurement, see "6.2.7 Outer Diameter Measurement of Large-Diameter Round Bar (Preset Function)" on page C-138.

1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Setting item	Setting value	
Segment mode	Sensor 1	Gap (segment 1)
	Sensor 2	
Edge Mode	Sensor 1	Start edge: 1
	Sensor 2	End edge: 2

Tips

- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.
- For details on arithmetic operations, see "3.5.1 Register Calculation" on page C-76.
- When measuring a workpiece with a large diameter, the calculation method must be set to [SUM] in registration of the arithmetic operation.

2 Perform calibration for each LSM.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Set the calculation method.

Select sum as the calculation method.
For details, see "3.5.1 Register Calculation" on page C-76.

4 Perform operational calibration (2 points calibration)

For details on operational calibration, see "4.2 Operational Calibration" on page C-92.

IMPORTANT

When measuring a large-diameter workpiece with two sensors stacked vertically, be sure to perform "2 points calibration" when performing calculation calibration. Calibration cannot be performed properly with "1 point calibration".

5 Perform calculation presets.

For details on calculation presets, see "■ Setting preset" on page C-99.

6 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

7 **Check the measurement result.**

6.2 Advanced Measurement

When measuring a unique workpiece, the settings need to be changed to match the characteristics of the workpiece. This section describes measurements of specific items, such as transparent objects, precision-machined products, fast-moving or ultra-fine wire, multiple-pin IC lead pitch, round bars, plate-shaped width, large-diameter round bars, film sheets, rubber rolls, shafts processed with a centerless grinder, and stepped round bars.

6.2.1 Transparent Object Measurement

■ Measuring the outer diameter of transparent round bars

This section describes the setting items and procedures for measuring the outer diameter of a transparent round bar.

1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value
Common setting 1	Transparent mode
Parameters (Measurement condition 1)	Outer diameter (segment 2)

Tips

- The edge mode cannot be set.
- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values are displayed on the home screen or detail screen of LSMPAK.

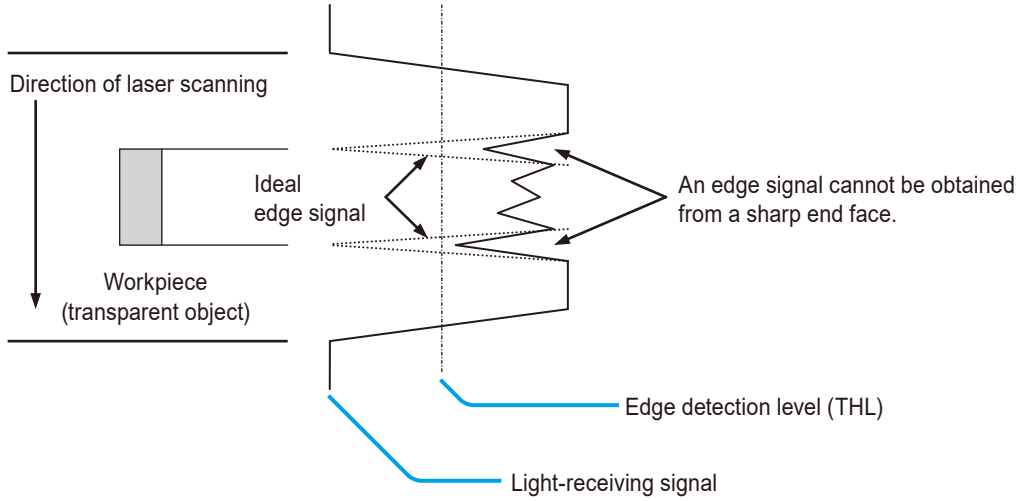
Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

4 Check the measurement result.

■ Width measurement of transparent, plate-shaped workpiece

A transparent, non-chamfered, plate-shaped (sheet-like) workpiece may not be measured because it does not yield a sharp end-face edge signal (shadow) at its end face, producing an insufficient edge detection level (THL) for converting the light-receiving signal to a digital signal and resulting in judgment of E0008 (no workpiece error).



If the measurement cannot be performed, try measure 1 or 2 below.

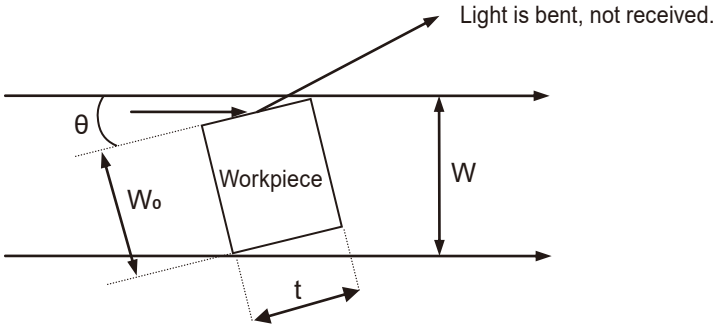
If the workpiece is not detected even after executing measures 1 and 2, changing the THL setting may enable detection of the workpiece.

For details, see "■ Extension function THL settings" on page C-46.

● Measure 1: Tilt the workpiece.

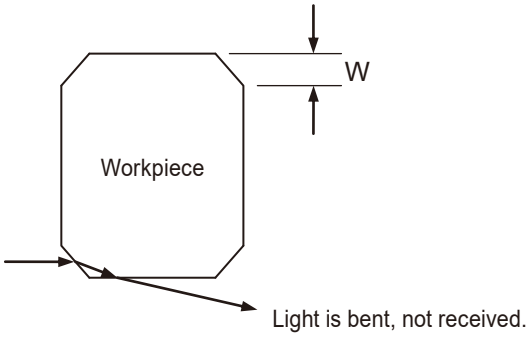
Tilting the workpiece may make the end-face edge signal acuter.

The tilt may cause an error, and the measured value becomes W = W_0 (workpiece dimensions) x cos θ + t x sin θ.



● Measure 2: Increase the chamfering amount on the workpiece.

Increasing the chamfering amount on the workpiece may make the end-face edge signal acuter.



Tips

- Regarding the chamfering amount above (W), we recommend a larger value than listed below for each sensor model.

Sensor model	Chamfering amount (W)
LSM-02-A	0.1 mm
LSM-30-A	0.2 mm

- The appropriate chamfering amount may vary depending on the workpiece material.

Measurement example: width measurement of transparent, plate-shaped workpiece

1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value
Common setting 1	Transparent mode
Parameters (Measurement condition 1)	Outer diameter (segment 2)

Tips

- The edge mode cannot be set.
- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

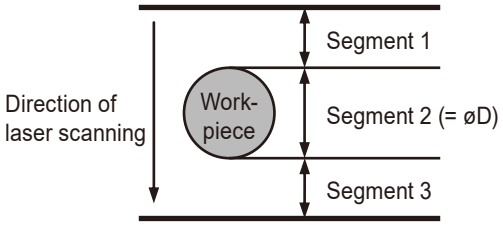
4 Check the measurement result.

6.2.2 Outer Diameter Measurement of Precision-Machined Product

For the outer diameter of a precision-machined product like precision shafts and pin gages, the single measurement can be performed for the GO/NG judgment of øD of the workpiece.

Workpiece example

øD = ø10±0.05 mm



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Parameters (Measurement condition 1)	Outer diameter (segment 2)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging*	512 times or more
		Averaging method	Arithmetical average
	GO/NG judge	Upper lim.	10.05 mm
		Lower lim.	9.95 mm

* If a higher accuracy is required, select the greatest possible number of averaging. Usually, the greater the number of averaging, the better the repeatability is.

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values and GO/NG judgment results are displayed on the home screen or detail screen of LSMPAK.

4 Check the measurement result.

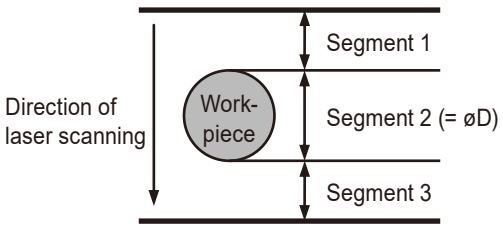
6.2.3 Measuring Fast-Moving Wires

With a laser beam scanning 3,200 times per second, the LSM can measure a vibrating fast-moving workpiece at high accuracy.

In the wire drawing or coating process that controls the outer diameter, the outer diameter can be measured at all times, and the measurement result can undergo the GO/NG judgment and be output in analog.

Workpiece example

øD = 0.05±0.001 mm



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 1	Scans for averaging		Moving average*
	GO/NG judgment method		Target value and tolerance
Parameters (Measurement condition 1)	Outer diameter (segment 2)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	12 times or more
	GO/NG judge	Target value	0.05 mm
		Upper tolerance value	0.001 mm
		Lower tolerance value	-0.001 mm

* To avoid abrupt feedback, we recommend that you set the averaging method to [Moving average].

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1. Set the workpiece.
2. ▶ or click ⏭.

» Measuring will start.

» The measurement values and GO/NG judgment results are displayed on the home screen or detail screen of LSMPAK.

4 Check the measurement result.

6.2.4 Ultra-Fine Wire Measurements

This section describes the setting items and procedures for measuring the outer diameter of magnet wire.

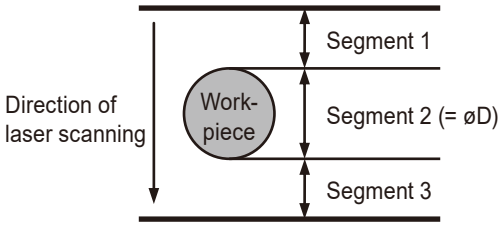
IMPORTANT

- For measurements of 0.3 mm or less, and especially 0.005 mm or less, use the LSM-02-A sensor. LSM-30-A cannot be used for ultra-fine wire measurement.
- Ensure that the light in the laser scanning range is not blocked by multiple workpieces or jigs.

For ultra-fine wire measurement, the THL is optimized depending on the workpiece size. A thin workpiece (less than ø0.05 mm) may not be detected if there are several light-shielded portions by the workpieces or jigs in the laser scanning range.

Workpiece example

øD = 0.05±0.001 mm



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 1	Enable [Ultra-fine wire mode].		
Parameters (Measurement condition 1)	Outer diameter (segment 2)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging*	512 times or more
		Averaging method	Arithmetical average
	GO/NG judge	Upper lim.	0.006 mm
		Lower lim.	0.004 mm

* If a higher accuracy is required, select the greatest possible number for averaging. Usually, the greater the number of averaging, the better the repeatability is.

Tips

- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.
- Enabling the ultra-fine wire measurement limits the functions and measuring methods. For details, see "■ Ultra-fine wire mode" on page C-29.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips
If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

4 Check the measurement result.

6.2.5 High-Precision Outer Diameter Measurement of Round Bar (Preset Function)

When measuring the outer diameter of a round bar, the preset function allows you to perform high-precision measurements.

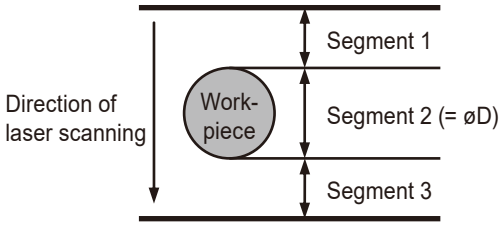
Tips

- The preset function sets an arbitrary value in advance for the measured value of the reference gage.
- The direction (positive/negative direction) in which the measured value is increased or decreased depends on the type of the workpiece.

Workpiece example

øD = ø20.0000±0.0015 mm

* Set the direction to [0 (positive)].



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 1	GO/NG judgment method		Upper/Lower limit
Parameters (Measurement condition 1)	Outer diameter (segment 2)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	512 times or more
	GO/NG judge	Upper lim.	20.0015 mm
		Lower lim.	19.9985 mm

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Check the measured value before the preset value is set.

4 Input the preset and direction values.

For this example, enter 20.0 for the preset value* and select plus (+) for the direction.

* Enter the nominal dimension of the reference gage. When using the calibration gage, enter the verified dimension.

» The displayed value changes to 20.0.

Tips

- Setting the reference gage preset value to 0.0 will allow the difference between the reference gage and the workpiece to be obtained.
- For details on presets, see "5.2.1 Preset" on page C-97.

5 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏩.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

6 Check the measurement result.

6.2.6 Plate-Shaped Width Measurement (Preset Function)

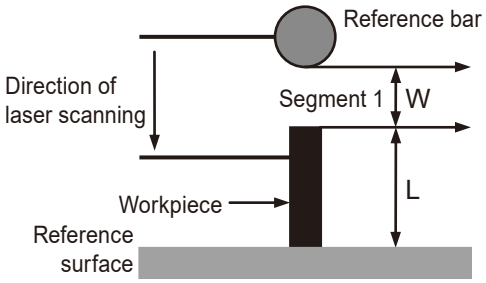
When measuring the width of a plate shape, the preset function allows you to perform high-precision measurements.

This is used for measuring a workpiece that exceeds the measuring range.

Workpiece example

L = 50.0±0.01 mm

* Select negative (–) for the direction value.



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 1	GO/NG judgment method		Upper/Lower limit
Parameters (Measurement condition 1)	Gap (segment 1)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	512 times or more
	GO/NG judge	Upper lim.	50.01 mm
		Lower lim.	49.99 mm

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Check the measured value before the preset value is set.

In this example, the measured value of the gap with segment 1 is displayed.

4 Input the preset and direction values.

For this example, input 50.0 for the preset value and 1 (negative) for the direction value.

* Enter the nominal dimension of the reference gage.

» The displayed value changes to 50.0.

Tips

Set the direction value to 1 (negative) for gap measurements.

5 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

6 Check the measurement result.

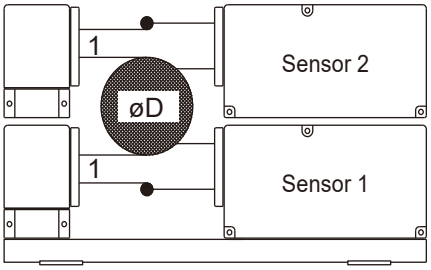
6.2.7 Outer Diameter Measurement of Large-Diameter Round Bar (Preset Function)

Use two sensors to measure the outer diameter of a large-diameter workpiece that is difficult to measure with only one sensor. When measuring, set the calculation presets.

For details on the calculation presets, see "5.2 Setting the Preset and Offset" on page C-97.

Workpiece example

øD = 150.0±0.05 mm



1 Configure the settings for measurement.

Set the Sensor 1 and 2 as follows.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 2	GO/NG judgment method		Upper/Lower limit
Parameter (measurement condition 1)	Gap(segment 1)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	512 times or more

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration for each LSM.

For details, see "2.1 Launching LSMPAK" on page C-3.

3 Click [Calculation], set [SUM] as the calculation method and select the LSM.

Measurement settings	Setting value		
Calculation method	Addition		
Detailed settings	Upper and lower limit	Upper limit	150.05 mm
		Lower limit	149.95 mm

Tips

For details on the arithmetic operations screen, see "3.5.1 Register Calculation" on page C-76.

4 Perform operational calibration (2 points calibration)

For details on operational calibration, see "4.2 Operational Calibration" on page C-92.

IMPORTANT

When measuring a large-diameter workpiece with two sensors stacked vertically, be sure to perform "2 points calibration" when performing calculation calibration. Calibration cannot be performed properly with "1 point calibration".

5 Set the calculation preset and offset.

For this example, enter 150.0 for the preset value* and select plus (+) for the direction.

* Enter the nominal dimension of the reference gage.

IMPORTANT

If operational calibration and individual calibration for the sensors are canceled, the operational preset and offset are also canceled.

6 Perform the measurement.

1. Set the workpiece.
2. ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

7 Check the measurement result.

6.2.8 Thickness Measurement of Film Sheet (Preset Function)

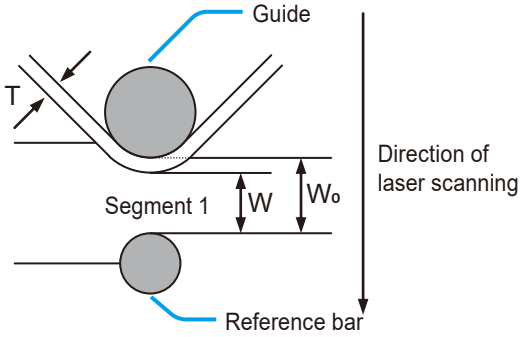
When measuring the film sheet thickness, use the preset function to get high-precision results.
Remove the film from the guide that is the reference gage and measure segment 1 (W_0).
Next, set the film that is the workpiece and measure segment 1 (W).
The film thickness (T) is T = (W_0 - W).

Tips

If W_0 = 0.0 mm is replaced by zero and the direction is set to "1 (minus), then the calculation becomes T = {W_0 - (- W)} = 0.0 - (-W) = W, and the thickness is displayed as the display value.

Workpiece example

Film
Thickness: T = 0.1±0.005 mm



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 1	GO/NG judgment method		Upper/Lower limit
Parameters (Measurement condition 1)	Gap (segment 1)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	128 times or more
	GO/NG judge	Upper lim.	0.105 mm
		Lower lim.	0.095 mm

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Remove the workpiece (film).

4 Input the preset and direction values.

For this example, enter 0.0 for the preset value and select negative (-) for the direction.

» The displayed value changes to 0 (zero).

5 Mount the workpiece (film).

Tips

When the film is set, the film thickness is displayed, but the GO/NG judgment is not performed at this time.

6 Perform the measurement.

1 Set the workpiece.

2 ▶ or click ⏭.

» Measuring will start.

» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

7 Check the measurement result.

6.2.9 Two Items Measurement of Outer Diameter and Run-Out of Rubber Roll (Sample Measurement)

When measuring the outer diameter and run-out of a rubber roll at the same time, use sample measurement to get high-precision results.

In this example, a roller is rotated to measure its roundness to obtain the run-out width and outer diameter.

The run-out T is obtained by measuring the gap with segment 1, and the outer diameter øD with segment 2 is measured while the roller is rotating. The run-out width is calculated using the sample measurement range (maximum - minimum).

Tips

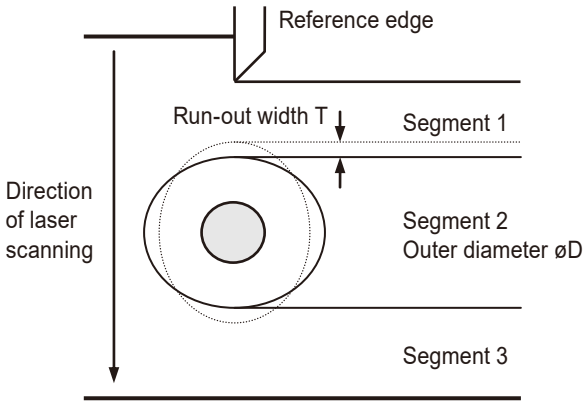
This example uses the reference edge for stable gap measurement. The reference bar can also be used.

Workpiece example

Rubber roll

Diameter: øD = 25.0±0.05 mm

Number of rotations: 50 rpm



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value	
Common setting 1	Two items measurement	
	GO/NG judgment method	Upper/Lower limit

Measurement settings	Setting value			
			Measurement item A*1	Measurement item B*1
Parameters (Measurement condition 1)	Segment		1	2
	Sample measurement	No of sample measurement	60*2	(60)*2
		Method	Range	Average
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	64 times*2	(64 times)*2
	GO/NG judge	Upper lim.	0.03 mm	25.05 mm
		Lower lim.	0.0 mm	24.95 mm

*1 The parameter set should be selected from the following 10 combinations of patterns.
0 and 5, 1 and 6, 2 and 7, 3 and 8, 4 and 9, 10 and 15, 11 and 16, 12 and 17, 13 and 18, 14 and 19

*2 The workpiece (roller) must be measured while rotating. Set the number of sample measurement and the number of averaging according to the workpiece revolution speed.
A larger number of averaging will make the repeatability more stable. To perform high-precision measurement, set the greatest possible number of averaging.
For details about the relationship among the number of workpiece revolutions, the number of sample measurement, and the number of averaging, see "● Relationship among the number of workpiece revolutions, the number of sample measurement, and the number of averaging" on page C-144.

Tips

- In either measurement item A or B, if the number of sample measurement or the number of averaging is changed, the other parameter set will automatically be changed to the same setting.
- For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Check that the run-out width of segment 1 and the outer diameter of segment 2 are displayed.

4 Perform the measurement.

1 Set the workpiece.
2 ▶ or click ⏭.
» Measuring will start.
» The measurement values are displayed on the home screen or detail screen of LSMPAK.

Tips

If a GO/NG judgment has been set, the result of the GO/NG judgment will also be displayed.

5 Check the measurement result.

● Relationship among the number of workpiece revolutions, the number of sample measurement, and the number of averaging

The following table shows the relationship between the number of workpiece revolutions and the number of averaging when 60 pieces of data are obtained while the workpiece rotates one full turn (60 samples every 6°). Refer to this as a rough guide.

Number of averaging	Number of workpiece revolutions	Time required for each revolution
32	100 rpm	Approximately 0.6 seconds
64	50 rpm	Approximately 1.2 seconds
128	25 rpm	Approximately 2.4 seconds
256	12.5 rpm	Approximately 4.8 seconds
512	6 rpm	Approximately 9.6 seconds
1024	3 rpm	Approximately 19.2 seconds
2048	1.5 rpm	Approximately 38.4 seconds

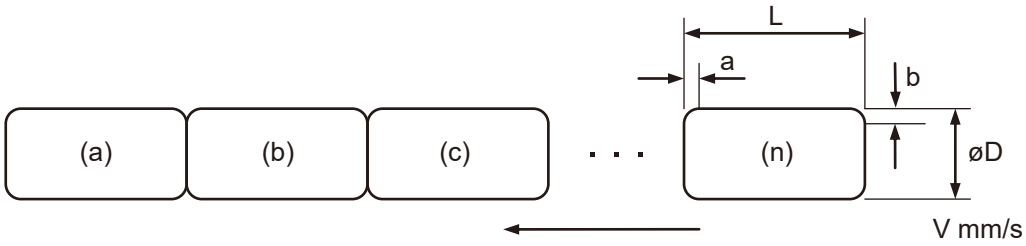
6.2.10 Outer Diameter Measurement of Shaft Processed with a Centerless Grinder (Auto-Work Detection Function)

Using the [Auto-work detection] function, perform automatic continuous run measurement of the outer diameter (øD mm) of precision shafts on the conveyor line and perform GO/NG judgment of the measurement results.

For details on the [Auto-work detection] function, see "■ Auto-work detection (set individually)" on page C-65.

Workpiece example

Shaft
Outer diameter: øD = ø5.0±0.0015 mm
Length: L = 12 mm
Chamfer: a = 0.5 mm / b = 0.5 mm
Moving speed: V = 50 mm/s



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value		
Common setting 1	Auto-work detection		Diameter detection
	GO/NG judgment method		Upper/Lower limit
	Auto-work detection	Scanning rate	16
Parameters (Measurement condition 1)	Outer diameter (segment 2)		
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	512 times*1
	GO/NG judge	Upper lim.	5.001,5 mm
		Lower lim.	4.998,5 mm
	Auto-work detection	No. of meas.	1 time
		Invalid time	20 ms*2
		Upper lim.	5.1 mm
		Lower lim.	4.9 mm

*1Use the following formula and set as large a value as possible.
Measurement interval < (L - 2a) / V

*2Invalid time > a / V

IMPORTANT

The LSM may be unable to recognize the gaps between workpieces with a small chamfer that are in close contact with each other. If this is the case, use connection rods to ensure sufficient space between workpieces. Also, allow a margin in the invalid time and the upper and lower detection limits.

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Check that there are no workpieces in the measuring region.

4 Perform the measurement.

1. Set the workpiece.
2. Click ⏭.

» Awaiting workpiece status.
» The diameter detection starts when the workpiece (a) enters the measuring region.
» If the average diameter value from 16 scans is within the setting value, the system judges that a workpiece is present.
» After the Invalid time elapses, the outer diameter measurement starts for the workpiece (a).
» The measurement values and GO/NG judgment results of workpiece (a) are displayed on the home screen or detail screen of LSMPAK.
» Measurement starts for workpiece (b) in the same way as the workpiece (a).
» The measurement values and the GO/NG judgment results of workpiece (b) are displayed on the home screen or detail screen of LSMPAK.
» Workpieces are measured sequentially as they enter the measuring region.
» The measurement values and the GO/NG judgment results of workpiece (c) are displayed on the home screen or detail screen of LSMPAK.

5 Click ■.

» The measurement value and the GO/NG judgment results of the last measurement workpiece are displayed on the home screen or advanced setting screen of LSMPAK.
» Measurement ends.

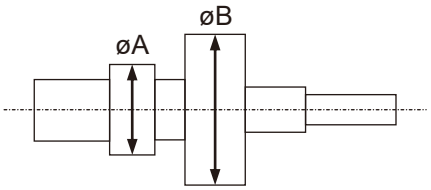
6 Check the measurement result.

6.2.11 Measurements of Stepped Round Bars

In this example, ten stepped round bars (right diagram) are measured and statistically processed.

Workpiece example

Stepped round bar
Minor outer diameter: øA = ø6±0.01 mm
Major outer diameter: øB = ø10 h 7 mm



1 Configure the settings for measurement.

Except for settings listed below, set other settings according to the intended purpose.

Measurement settings	Setting value	
Common setting 1	GO/NG judgment method	Upper/Lower limit

Measurement settings	Setting value			
			Parameter set 0 (small outer diameter)	Parameter set 1 (large outer diameter)
Parameters (Measurement condition 1)	Outer diameter (segment 2)			
Parameters (Measurement condition 2)	Number of averaging	Number of averaging	1024 times	1024 times
	GO/NG judge	Upper lim.	6.01 mm	10.0 mm
		Lower lim.	5.99 mm	9.985 mm

Tips

For details about the settings for measurement, see "3.3 Measurement Settings" on page C-24.

2 Execute calibration.

For details on calibration, see "4.1 Standard Calibration" on page C-87.

3 Click the [Measurement history] tab on the detail screen.

4 Perform the measurement.

1. Set øA (the small diameter) of the workpiece.
2. Select parameter set 0 and click ▶.

» The measurement values and GO/NG judgment results are displayed on the home screen or detail screen of LSMPAK.

3. Set øB (the large diameter) of the workpiece.
4. Select parameter set 1 and click ▶.

» The measurement values and GO/NG judgment results are displayed on the home screen or detail screen of LSMPAK.

5. Change the workpiece and repeat the measurement in the same manner.

Tips

For details about parameter sets, see "3.3.8 Selecting Parameter Sets" on page C-68.

5 **Click [View statistics] on the [Measurement history] tab.**

Tips

For details on statistics display, see "■ Displaying statistics" on page C-109.

6 **Check the measurement results and the statistical values.**

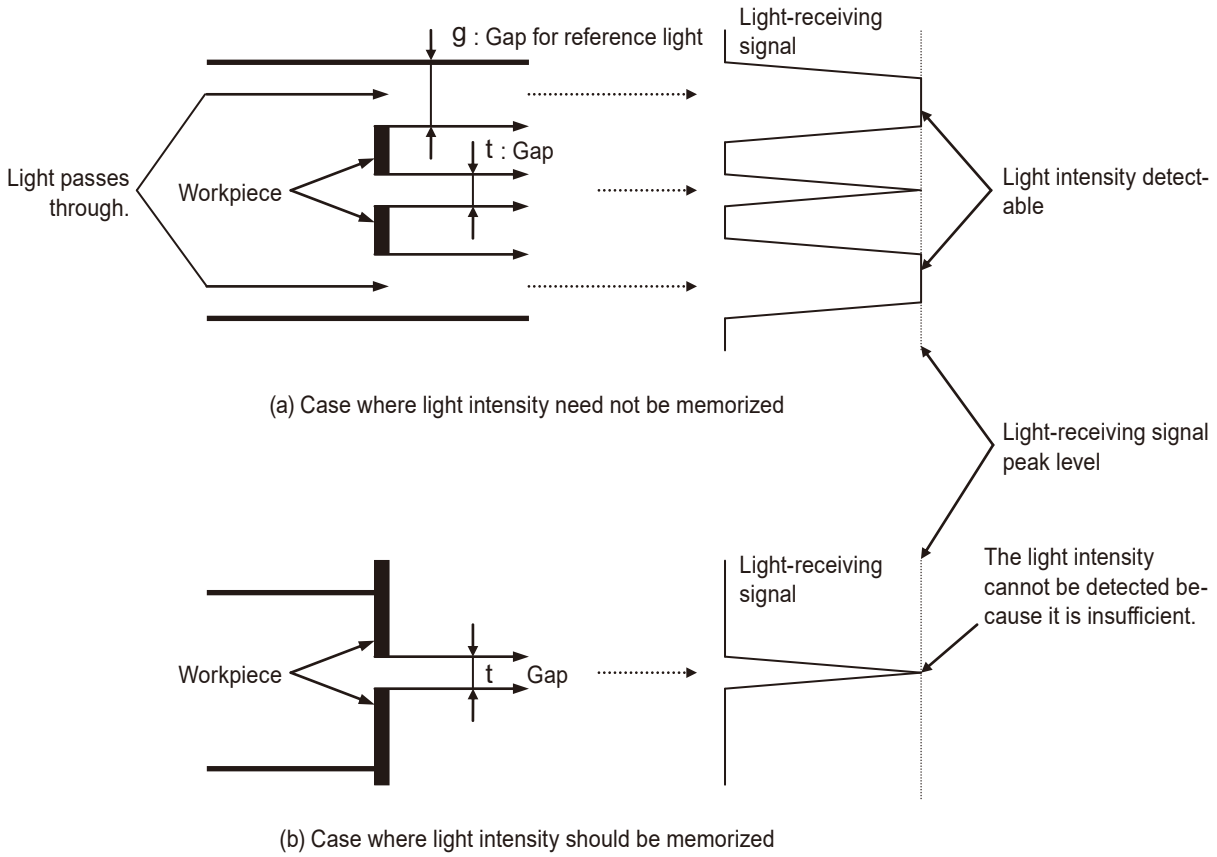
6.2.12 Measurement of Narrow Gaps

Measurement of a gap narrower than one that is measured with normal gap measurement may be unstable due to an insufficient laser beam light intensity passing through the gap (light-receiving signal peak level-holding time).

For example, in the case of "(a) Case where light intensity need not be memorized" below, even if the gap width t between workpieces is narrow, the laser beam passes through the gap width g above and below the workpiece to obtain sufficient light intensity, but in "(b) Case where light intensity should be memorized" if the gap width t is narrow, the light intensity will be insufficient to accurately detect the peak level and measurement error will be large.

If this is the case, high-precision measurement can be achieved by memorizing the light intensity when there is no obstacle

shielding the laser beam (e.g., workpieces, jigs).



Normally, the LSM is detecting the light intensity all the time to automatically follow the change in light intensity.

Memorize the light amount if the gap width g or t is less than the gap width shown in the table below.

Model name	Gap width g or t
LSM-02-A	0.2 mm or more
LSM-30-A	1 mm or more

MEMO

PART D
Interfaces

This part describes the interfaces for input/output.

No. 99MBC150A

1 Interface Overview

The interfaces indicated in the table below are included on this product.

Interface	External device to connect	Function
USB connector	PC	This is the interface for command communication.
I/O connector	Control units such as a switch or PLC	This interface is used to control the product from an external device.
IF module connector	IF module	Interface for connecting an IF module. Used for communication with external devices such as PLCs via an IF module.

Tips

When using industrial interfaces such as EtherNet/IP, PROFINET, EtherCAT, etc., attach the optional IF module to this product.

See below for details.

- 📖 "IF Module <EtherNet/IP> User's Manual" (separate document)
- 📖 "IF Module <PROFINET> User's Manual" (separate document)
- 📖 "IF Module <EtherCAT> User's Manual" (separate document)
- 📖 "IF Module <CC-Link IE TSN> User's Manual" (separate document)

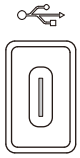
MEMO

2 USB

2.1 USB Specifications

This product is provided with a USB interface for communication with a PC or other external device.
The interface uses a Type-C USB connector. Use a compatible cable.
This product functions as a USB device.

2.1.1 USB Connector Specifications



Specification	USB2.0 compliant High-speed/full-speed support
Connector type	Type-C

Connector pinouts

Pin no.	Signal name	Function	Pin no.	Signal name	Function
A1	GND	Ground	B12	GND	Ground
A2	–		B11	–	
A3	–		B10	–	
A4	V_{BUS}	Bus power	B9	V_{BUS}	Bus power
A5	CC1	Configuration channel	B8	–	
A6	Dp1	D+ signal	B7	Dn2	D- signal
A7	Dn1	D- signal	B6	Dp2	D+ signal
A8	–		B5	CC2	Configuration channel
A9	V_{BUS}	Bus power	B4	V_{BUS}	Bus power
A10	–		B3	–	
A11	–		B2	–	
A12	GND	Ground	B1	GND	Ground

2.2 USB Description of Operation

This product is recognized by the USB host as a virtual COM port.
This product can be controlled by sending and receiving commands via serial communication from the COM port.

2.2.1 USB Command List

These communication commands are used to control LSM-CU-A.

● Command format

The command format is as follows.

<command>,<ID>,<data>,<delimiter>

The contents of each element are as follows.

Command

The length of a command is variable.

The initial letters of the send commands have the following meanings.

P: Execution

S: Setting

G: Acquisition

The response consists of the first letter of the outgoing command converted to a number.

The first character response has the following meanings.

0: No error

1: Post-execution error

2: Command data is abnormal (data content is incorrect)

3: Unable to execute

4: Undefined command received

5: Functional limitation error

Tips

- When using two items measurement, two parameter sets are paired. The paired parameter set combinations are as follows.
  - 0 and 5
  - 1 and 6
  - 2 and 7
  - 3 and 8
  - 4 and 9
  - 10 and 15
  - 11 and 16
  - 12 and 17
  - 13 and 18
  - 14 and 19

ID

Fixed to 1000.

Data

Data length is variable.

If the data contains multiple items, they are separated by commas (,) as follows.

< Ident 1>,< Ident 2>,.....< data>

Tips

- Applicable items must be separated with commas (,) even if they are not present.
- Responses in binary format are not delimited with commas (,).

Delimiter

CR and LF are fixed at "0x0D" and "0x0A", respectively.

● List of commands

Item	Send commands	Response	Remarks
Single run measurement execution	PMEAS,1000,R	P<parameter set number>,<GO/NG judgment result>,<measured value>	• The output timing of measurement results can be set with SCOND,1000,PRC and SCOND,1000,PRT. • If GO/NG judgment is enabled, the GO/NG results are output.
Execute continuous measurement	PMEAS,1000,CR		
Measurement end	PMEAS,1000,STOP	0MEAS,1000,STOP	Ends measurement processing. Upon command input, measurement is ended following output of measurement results.
Execute LSM cancellation	PMEAS,1000,CL	0MEAS,1000,CL	Assorted cancellations. Cancels measurement. Measurement in progress at the time the command is entered is discarded.
Acquire FW version of LSM-CU-A.	GCF,1000	0CF,1000,*	* <model name>,<version>,<release date>,<release time>
Set and apply high calibration value	PCAL,1000,H,*	0CAL,1000,H,*	* High calibration value (mm or in)
Acquire high calibration value setting	GCAL,1000,H	0CAL,1000,H,*	
Set and apply low calibration value	PCAL,1000,L,*	0CAL,1000,L,*	* High calibration value (mm or in)
Acquire high calibration value setting	GCAL,1000,L	0CAL,1000,L,*	
Clear calibration	PCAL,1000,C	0CAL,1000,C	
Set calibration application range	SCAL,1000,R,*	0CAL,1000,R,*	* 1: Apply individually to each pair in the current parameter set 2: Apply to pairs in all parameter sets
Acquire calibration application range	GCAL,1000,R	0CAL,1000,R,*	

Item	Send commands	Response	Remarks
Configure parameter set	SCOND,1000,P,*	0COND,1000,P,*	* 0–19
Acquire parameter set	GCOND,1000,P	0COND,1000,P,*	
Set parameter set name	SCOND,1000,P_NAME,*	0COND,1000,P_NAME,*	* Parameter set name
Acquire parameter set name	GCOND,1000,P_NAME	0COND,1000,P_NAME,*	
Set controller name	SCOND,1000,S_NAME,*	0COND,1000,S_NAME,*	* Controller name
Acquire controller name	GCOND,1000,S_NAME	0COND,1000,S_NAME,*	
Set number of sample measurement	SCOND,1000,SMPN,*	0COND,1000,SMPN,*	* 0: Set zero-run measurement 1–999 (number of sample measurement)
Acquire number of sample measurement	GCOND,1000,SMPN	0COND,1000,SMPN,*	
Set calculation items for measurement.	SCOND,1000,SMPA,*	0COND,1000,SMPA,*	* 1: Maximum value 2: Minimum value 3: Range 4: Average
Acquire calculation item for measurement.	GCOND,1000,SMPA	0COND,1000,SMPA,*	
Set averaging method	SCOND,1000,AVEA,*	0COND,1000,AVEA,*	* 0: Arithmetical average 1: Moving average
Acquire averaging method	GCOND,1000,AVEA	0COND,1000,AVEA,*	
Set number of averaging	SCOND,1000,AVEN,*	0COND,1000,AVEN,*	* 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048
Acquire number of averaging	GCOND,1000,AVEN	0COND,1000,AVEN,*	
Batch save common setting items	PCOND,1000,STR	0COND,1000,STR	Batch save common setting items to EEPROM. If the power is turned off without saving the settings, settings revert to their former values the next time the power is turned on.
Set two items measurement	SCOND,1000,SUBMEAS,*	0COND,1000,SUBMEAS,*	* 0: Disabled 1: Enabled
Acquire setting of two items measurement	GCOND,1000,SUBMEAS	0COND,1000,SUBMEAS	

Item	Send commands	Response	Remarks
Set data output timer	SCOND,1000,PRT,*	0COND,1000,PRT,*	When data output conditions are met, measured values and GO/NG judgment results are output to USB after the set time. * 0: Disabled 1–999: Valid (specified in seconds)
Acquire setting of data output timer	GCOND,1000,PRT	0COND,1000,PRT,*	
Setting data output conditions	SCOND,1000,PRC,*	0COND,1000,PRC,*	Measurement values and GO/NG judgment results are output to USB according to the set conditions. Output timing can be delayed according to the data output timer setting. * 0: Disabled 1: Output each time measurement ends 2: Output only when judgment is NG 3: Output only when judgment is OK
Acquire data output conditions	GCOND,1000,PRC	0COND,1000,PRC,*	
Acquire workpiece position	GCOND,1000,WORK_POS	0COND,1000,WORK_POS,*	Displayed in hexadecimal
Acquire focus detection position	GCOND,1000,OPT_POS	0COND,1000,OPT_POS,*	
Set automatic workpiece detection	SAUT,1000,T,*	0AUT,1000,T,*	* 0: Disabled D: Diameter method P: Position method
Acquire setting of auto-work detection	GAUT,1000,T	0AUT,1000,T,*	
Set number of measurements for automatic workpiece detection	SAUT,1000,N,*	0AUT,1000,N,*	* 1–999
Acquire number of measurements for automatic workpiece detection	GAUT,1000,N	0AUT,1000,N,*	

Item	Send commands	Response	Remarks
Set invalid time for automatic workpiece detection	SAUT,1000,D,*	0AUT,1000,D,*	Specify the interval from when a workpiece is automatically detected to the start of measurement (the measurement invalid time). * 0–9999 (in milliseconds)
Acquire automatic workpiece detection invalid time	GAUT,1000,D	0AUT,1000,D,*	
Set lower detection limit for automatic workpiece detection	SAUT,1000,L,*	0AUT,1000,L,*	* Lower limit (mm or in)
Acquire lower detection limit for automatic workpiece detection setting	GAUT,1000,L	0AUT,1000,L,*	
Set upper detection limit for automatic workpiece detection	SAUT,1000,H,*	0AUT,1000,H,*	* Upper limit (mm or in)
Acquire upper detection limit for automatic workpiece detection setting	GAUT,1000,H	0AUT,1000,H,*	
Set "S send" for automatic workpiece detection	SAUT,1000,S,*	0AUT,1000,S,*	During auto-work detection, "S" is sent at the start of measurement. Always set to disabled at start-up. * 0: Disabled 1: Enabled
Acquire "S send" for automatic workpiece detection	GAUT,1000,S	0AUT,1000,S,*	
Set "E send" for automatic workpiece detection	SAUT,1000,E,*	0AUT,1000,E,*	During auto-work detection, "E" is sent at the end of measurement. Always set to disabled at start-up. * 0: Disabled 1: Enabled
Acquire "E send" for automatic workpiece detection	GAUT,1000,E	0AUT,1000,E,*	

Item	Send commands	Response	Remarks
Set scanning rate for automatic workpiece detection	SAUT,1000,C,*	0AUT,1000,C,*	Set when using the "diameter detection" in "auto-work detection" (number of averaging during auto-work detection). * 1, 16 (times)
Acquire scanning rate for automatic workpiece detection	GAUT,1000,C	0AUT,1000,C,*	
Set outlier elimination	SABO,1000,T,*	0ABO,1000,T,*	* 0: Disabled 1: USE1 2: USE2
Acquire setting of outlier elimination	GABO,1000,T	0ABO,1000,T,*	
Set lower value of outlier elimination	SABO,1000,L,*	0ABO,1000,L,*	* Lower limit (mm or in)
Acquire lower value of outlier elimination	GABO,1000,L	0ABO,1000,L,*	
Set upper value of outlier elimination	SABO,1000,H,*	0ABO,1000,H,*	* Upper limit (mm or in)
Acquire upper value of outlier elimination	GABO,1000,H	0ABO,1000,H,*	
Set count for outlier elimination	SABO,1000,N,*	0ABO,1000,N,*	A warning is displayed if the number of samples excluded as outliers exceeds [Count val.]. * Count value
Acquire count for outlier elimination	GABO,1000,N	0ABO,1000,N,*	
Set detection method	SEDG,1000,T,*	0EDG,1000,T,*	* 0: Normal measurement as segment mode method 1: Transparent object measurement as segment mode method 2: Ultra-fine wire measurement as segment mode method 3: Transparent object & ultra-fine wire as segment mode method N: Edge mode method
Acquire detection method	GEDG,1000,T	0EDG,1000,T,*	

Item	Send commands	Response	Remarks
Set arbitrary THL value	SEDG,1000,THL_E,*	0EDG,1000,THL_E,*	* 0: Disabled 1: Enabled
Acquire arbitrary of THL value setting	GEDG,1000,THL_E	0EDG,1000,THL_E,*	
Set THL value	SEDG,1000,THL,*	0EDG,1000,THL,*	* Set as a hexadecimal number
Acquire THL value	GEDG,1000,THL	0EDG,1000,THL,*	
Set segment mode location	SEDG,1000,S,*	0EDG,1000,S,*	* Segment number
Set edge mode location	SEDG,1000,E,*,*	0EDG,1000,E,*,*	*,* <starting edge number> <ending edge number>
Function setting: Acquire Segment/Edge (measurement location) setting	GEDG,1000,P	0EDG,1000,P,* 0EDG,1000,P,*,*	* Segment number *,* <starting edge number> <ending edge number>
Obtains judgment result indicating whether the connected sensor supports ultra-fine wire measurement.	GEDG,1000,CAPFIN	0EDG,1000,CAPFIN,*	* 0: Ultra-find wire measurement not supported (LSM-30-A is connected) 1: Ultra-fine wire measurement supported (LSM-02-A is connected)
Set I/O RUN input	SEXIO,1000,RUN_T,*	0EXIO,1000,RUN_T,*	* 0: Single run measurement 1: Continuous run measurement with a specified period 2: Continuous run measurement
Acquire I/O RUN input setting	GEXIO,1000,RUN_T	0EXIO,1000,RUN_T,*	
Set STB/ACK output selection	SEXIO,1000,ACK_T,*	0EXIO,1000,ACK_T,*	* 0: STB 1: ACK
Acquire STB/ACK output selection setting	GEXIO,1000,ACK_T	0EXIO,1000,ACK_T,*	

Item	Send commands	Response	Remarks
Set the STB length	SEXIO,1000,STB_T,*	0EXIO,1000,STB_T,*	* 0: Auto 1: 0.1 ms 2: 0.3 ms 3: 2.0 ms 4: 5.0 ms 5: 10.0 ms 6: 20.0 ms 7: 50.0 ms 8: 100.0 ms
Acquire STB length setting	GEXIO,1000,STB_T,*	0EXIO,1000,STB_T,*	
Set the input software filter	SEXIO,1000,IN_FILTER,*	0EXIO,1000,IN_FILTER,*	Input signal filter setting for I/O. Signals less than the setting are discarded (filtered). * 2: 2.0 ms 5: 5.0 ms 20: 20.0 ms
Acquire setting of input software filter	GEXIO,1000,IN_FILTER	0EXIO,1000,IN_FILTER,*	
Set the output voltage at the time of no workpiece error	SEXIO,1000,AN_OUTE,*	0EXIO,1000,AN_OUTE,*	* 0: 0 V 1: 5 V 2: -5 V
Acquire the output voltage setting at the time of no workpiece error	GEXIO,1000,AN_OUTE	0EXIO,1000,AN_OUTE,*	
Set analog output scale	SEXIO,1000,AN_OUTS,*	0EXIO,1000,AN_OUTS,*	* 1: 1X 2: 10X 3: 100X 4: 1000X 5: 10000X
Acquire analog output scale	GEXIO,1000,AN_OUTS	0EXIO,1000,AN_OUTS,*	
Set analog output reference value	SEXIO,1000,AN_OUTR,*	0EXIO,1000,AN_OUTR,*	* Reference value (mm or in)
Acquire analog output reference value	GEXIO,1000,AN_OUTR	0EXIO,1000,AN_OUTR,*	
GO/NG judgment	SJDG,1000,E,*	0JDG,1000,E,*	* 0: Disabled 1: Enabled
Acquire setting of GO/NG judgment	GJDG,1000,E	0JDG,1000,E,*	
Set type of GO/NG judgment	SJDG,1000,T,*	0JDG,1000,T,*	* 0: LL, LH (upper/lower limit value) 1: L1–L6 (multi-limits) 2: Target value and upper/lower tolerance
Acquire GO/NG judgment type	GJDG,1000,T	0JDG,1000,T,*	

Item	Send commands	Response	Remarks
Set lower limit value for GO/NG judgment	SJDG,1000,L,*	0JDG,1000,L,*	* Lower limit (mm or in)
Acquire lower limit value for GO/NG judgment	GJDG,1000,L	0JDG,1000,L,*	
Set upper limit for GO/NG judgment.	SJDG,1000,H,*	0JDG,1000,H,*	* Upper limit (mm or in)
Acquire upper limit value for GO/NG judgment	GJDG,1000,H	0JDG,1000,H,*	
Set target value for GO/NG judgment.	SJDG,1000,t,*	0JDG,1000,t,*	* Target value (mm or in)
Acquire target value for GO/NG judgment	GJDG,1000,t	0JDG,1000,t,*	
Set lower limit value for GO/NG judgment	SJDG,1000,l,* (lower case L)	0JDG,1000,l,*	* Lower tolerance (mm or in)
Acquire lower tolerance for GO/NG judgment	GJDG,1000,l (lower case L)	0JDG,1000,l,*	
Set upper tolerance for GO/NG judgment	SJDG,1000,h,*	0JDG,1000,h,*	* Upper tolerance (mm or in)
Acquire upper tolerance for GO/NG judgment	GJDG,1000,h	0JDG,1000,h,*	
Batch set multi-limit GO/NG judgment	SJDG,1000,nn,*,*,*……	0JDG,1000,nn,*,*,*……	* <number of multi-limit judgment rows>,L1 (mm or in)>,<L2 (mm or in)>…… Number of multi-limit judgment rows: 3–7
Acquire multi-limit GO/NG judgment	GJDG,1000,nn	0JDG,1000,nn,*,*,*……	
Execute [Memorize light amount]	PLIGHT,1000,P	0LIGHT,1000,P	

Item	Send commands	Response	Remarks
Set [Memorize light amount]	SLIGHT,1000,E,*	0LIGHT,1000,E,*	* 0: Disabled 1: Enabled
Acquire setting [Memorize light amount]	GLIGHT,1000,E	0LIGHT,1000,E,*	
Apply/cancel preset	PPST,1000,T,*	0PST,1000,T,*	* 0: Cancel 1: Start application
Setting preset	SPST,1000,*,*	0PST,1000,*,*	*,* <preset direction>,<preset value (mm or in)> • Preset direction P: Positive direction M: Negative direction
Acquire preset	GPST,1000	0PST,1000,*,*,*	*,*,* <preset direction>,<status>,<preset value> • Status 0: Canceling 1: Applying
Set preset application range	SPST,1000,R,*	0PST,1000,R,*	* 1: Apply to current parameter set 2: Apply to all parameter sets
Acquire preset application range	GPST,1000,R	0PST,1000,R,*	
Apply/cancel offset	POST,1000,T,*	0OST,1000,T,*	* 0: Cancel 1: Start application
Setting the offset	SOST,1000,V,*	0OST,1000,V,*	* Offset value (mm or in)
Acquire offset	GOST,1000,V	0OST,1000,V,*,*	*,* <status>,<offset value> • Status 0: Canceling 1: Applying
Acquire current position and status (in ASCII format)	GSTS,1000,A	0STS,1000,A,*,*,*,*,*	*,*,*,*,* <parameter set number>,<measured value>,<status>,<error status>,<number of averaging> **Tips** For details about the status and error status, see "● About Status and Error Status" on page D-17.

Item	Send commands	Response	Remarks
Acquire current position and status (in binary format)	GSTS,1000,B	0STS,1000,B,*****	***** <parameter set number (4 bytes)><measured value (4 bytes)><status (4 bytes)><error status (4 bytes)><number of averaging (4 bytes)>
Clear error status	PSTS,1000,C	0STS,1000,C	
Acquire statistical processing results	GSTAT,1000,A	0STAT,1000,A	P,①,N,②,A,③,X,④,N,⑤,R,⑥,S,⑦ ①: Parameter set number (integer) ②: Number of data (integer) ③: Average (real number) ④: Maximum value (real number) ⑤: Minimum value (real number) ⑥: Width (real number) ⑦: Standard deviation (real number) **IMPORTANT** During [Two items measurement], only the statistical processing result of the currently selected parameter set number can be obtained.
Run/stop statistical processing	PSTAT,1000,E,*	0STAT,1000,E,*	* 0: Stop 1: Run
Acquire setting of statistical processing	GSTAT,1000,E	0STAT,1000,E,*	

Item	Send commands	Response	Remarks
Clear statistical processing results	PSTAT,1000,C,*	0STAT,1000,C,*	Clears measurement results accumulated for statistical processing (clears statistical processing memory). * 0: Clear accumulated measurement results only for the parameter set being displayed. 1: Clear accumulated measurement results for both the parameter set being displayed and the paired parameter set.
Unit settings	SSYS,1000,UNIT,*	0SYS,1000,UNIT,*	* M: mm I (upper case "i"): in Valid only with mm/in-type LSM controllers **Tips** If the unit is changed, turn the power off and then on again.
Acquire set unit	GSYS,1000,UNIT	0SYS,1000,UNIT,*	
Initialize arithmetic unit EEPROM	PSYS,1000,INIEEP	0SYS,1000,INIEEP	Initialize settings.

● About Status and Error Status

The status and error statuses that can be acquired by the GSTS,1000,A USB command are as follows: Convert the decimal number output in ASCII data format to 8 hex digits and then refer to the table below.

(Example: 256 → 0x00000100)

For details about error number displayed by LSMPAK, see 📖 "1 Error Messages and Solutions" on page F-1 in "PART F Troubleshooting".

Status

Value	Status
0x00000000	Ready
0x00000001	Measuring
0x00000002	Simultaneous measurement
0x00000020	Workpiece detected (automatic workpiece detection)
0x00000100	Preset state
0x00000200	Offset state
0x00000400	Calibrating

Error status

Value	Status	Error number displayed by LSMPAK
0x00000001	Outlier elimination	—
0x00000002	Outlier elimination (all)	—
0x00000010	Hardware error	H0007
0x00000020	Statistics buffer overflow error	—
0x00000040	Calibration error	E0001
0x00000080	Outlier detection warning	W0001
0x00000100	No workpiece error	E0008
0x00000200	Output buffer overflow error	E0002
0x00000800	Hardware error	H0005
0x00001000	Edge not found error	E0005
0x00002000	Edge error	E0004
0x00010000	Hardware error	H0003
0x00020000	Hardware error	H0004
0x00040000	Hardware error	H0002
0x00080000	Insufficient light error	E0006
0x00100000	Hardware error	H0006
0x00200000	Hardware error	H0001
0x00800000	Dirt detection error	E0007
0x01000000	Power supply error	P0001

2.2.2 Example of USB Command Usage

Some examples of command usage with USB connection are explained below.

For more information on how to use the commands in addition to the examples in this section, contact your local Mitutoyo sales and service representative.

■ Measurement operation

● Pre-measurement settings

Set the number of sample measurement, calculation items, averaging method, and number of averaging before starting measurement.

For settings, see the following.

- "3 Settings" on page C-9 in "PART C Operation"
- "2.2.1 USB Command List" on page D-4

Setting item	USB command	Settings
Set number of averaging	SCOND,1000,AVEN,*	* 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048 (number of averaging)
Check the number of averaging	GCOND,1000,AVEN	
Set number of sample measurement	SCOND,1000,SMPN,*	* 0–999 (number of sample measurement)
Check the number of sample measurement	GCOND,1000,SMPN	
Set the calculation items	SCOND,1000,SMPA,*	* 1: Maximum value 2: Minimum value 3: Range 4: Average
Check the calculation items	GCOND,1000,SMPA	

● USB data output

Output data (measurement values and GO/NG results) in accordance with the output conditions. This command is only supported with USB output.

This function outputs data from USB after measurement when measured values meets the output conditions and the set time for timer output setting has elapsed.

Setting item	USB command	Settings
Set output conditions for USB data output	SCOND,1000,PRC,*	* 0: Disabled 1: Output each time measurement ends 2: Output only when judgment is NG 3: Output only when judgment is OK
Check output conditions for USB data output	GCOND,1000,PRC	
Set timer output for USB data output	SCOND,1000,PRT,*	* 0: Disabled 1–999: Valid (specified in seconds)
Check timer output for USB data output	GCOND,1000,PRT	

● Measurement operation using USB

Measuring method	Settings	Operation (command)		
	Number of samples*	Measurement start	End measurement (measurement in progress at the time of input is valid)	Cancel measurement (measurement in progress at the time the command is entered is discarded)
Single run measurement	0	PMEAS,1000,R	PMEAS,1000,STOP Or when 65535 samples acquired	PMEAS,1000,CL
	1–999		Measure once then end automatically (acquire set number of sample measurement)	
Continuous run measurement	1–999	PMEAS,1000,CR	PMEAS,1000,STOP	

* Measurement values are calculated from acquired samples based on calculation item settings. When the number of sample measurement is 1, no calculation is possible, so the acquired sample value is output as the measured value. For details, see "■ Sample measurement" on page C-57 in "PART C Operation".

Tips

- The number of measurement results output depends on the measuring method. The number of sample measurement does not affect the number of measurement results.
- With single measurement, one measurement result is output.
- With continuous measurement, the number of measurement results output is the same as the number of measurements performed consecutively from start of measurement to end of measurement.

■ I/O settings

Make the following settings in advance when operating from external devices that uses I/O and when inputting to/outputting from external devices.

Settings that are used frequently are excerpted below.

For settings, see the following.

- See 📖 "3 Settings" on page C-9 in "PART C Operation".
- 📖"2.2.1 USB Command List" on page D-4

Setting item	USB command	Settings
Set RUN pin	SEXIO,1000,RUN_T,*	* 0: Single run measurement 1: Continuous run measurement with a specified period 2: Continuous run measurement
Check RUN pin setting	GEXIO,1000,RUN_T	
Select STB/ACK	SEXIO,1000,ACK_T,*	* 0: STB 1: ACK
Check STB/ACK selection	GEXIO,1000,ACK_T	
Select STB length	SEXIO,1000,STB_T,*	* 0: Auto 1: 0.1 ms 2: 0.3 ms 3: 2.0 ms 4: 5.0 ms 5: 10.0 ms 6: 20.0 ms 7: 50.0 ms 8: 100.0 ms
Check STB length selection	GEXIO,1000,STB_T	
Input signal filter	SEXIO,1000,IN_FIL-TER,*	* 2: 2.0 ms 5: 5.0 ms 20: 20.0 ms
Check input signal filter	GEXIO,1000,IN_FILTER	

■ Analog output settings

With analog output from I/O, the following settings can be configured by USB commands.

Setting item	USB command	Settings
Set analog output reference value	SEXIO,1000,AN_OUTR,*	* Reference value (mm)
Check analog output refer-ence value	GEXIO,1000,AN_OUTR	
Set analog output scale	SEXIO,1000,AN_OUTS,*	* 1: 1X 2: 10X 3: 100X 4: 1000X 5: 10000X
Check analog output scale setting	GEXIO,1000,AN_OUTS	
Set the output voltage at the time of no workpiece error	SEXIO,1000,AN_OUTE,*	* 0: 0 V 1: 5 V 2: -5 V
Check the output voltage at the time of no workpiece error	GEXIO,1000,AN_OUTE	

■ Save settings

Save all settings included in common settings to EEPROM in the LSM-CU-A at once.
If settings are not saved, they are not retained and are reset when the power is turned off.

Operation	USB command	Settings
Batch save common settings	PCOND,1000,STR	N/A

MEMO

3 I/O

The I/O interface can be used to for the following purposes.
For details, see "3.2 I/O Operation Description" on page D-28.

- Operation (external signal input)
  - Start/end/cancel measurement
  - Make preset setting
  - Clear error
- Confirmation of measurement results
  - GO/NG judgment output
  - Output of measured value analog voltage
- Status verification
  - Error output
  - STB/ACK output
  - SCAN signal output
  - SYNC output (synchronous signal)

3.1 I/O Specifications

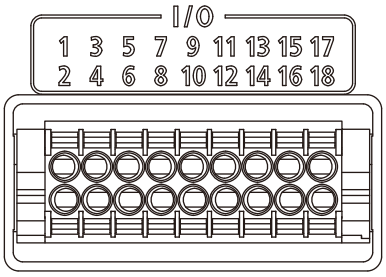
3.1.1 Terminal Block Connector Specifications

The I/O connector is on a separate terminal blocks.
Use the provided terminal block socket for wiring.

Terminal block socket specifications

Number of terminals	18 terminals
Terminal pitch	3.5 mm
Supported wire type	AWG24-16 (cross-sectional area 0.2-1.5 mm^2)
Strip length	10 mm

3.1.2 Connection Specifications



Terminal number	Signal type*1	Signal name*2	Signal direction*3	Function
1	–	5-24V DC	I	Power supply for IO interface +5 V to +24 V
2	–	GND	–	Ground
3	A	ANOUT	O	Analog voltage output (from -5 V through +5 V)
4	–	AGND	–	Analog ground for ANOUT pin
5	A	SCAN	O	Scan waveform output (from 0 V through +5 V)
6	–	SCAN_GND	–	Analog ground for SCAN pin
7	–	N.C.	–	Unconnected
8	–	N.C.	–	Unconnected
9	D	$\overline{\text{LT3}}$	O	GO/NG judgment output 3 (LT3): -NG (The measured value exceeds the limit on the minus side. NG judgment.)
10	D	$\overline{\text{STB}}$, $\overline{\text{ACK}}$ (Selectable)	O	$\overline{\text{STB}}$: Low pulse output when the GO/NG judgment output ($\overline{\text{LT1}}$, $\overline{\text{LT2}}$, $\overline{\text{LT3}}$) is updated. $\overline{\text{ACK}}$: Low during measurement, High when measurement ends.
11	D	$\overline{\text{LT1}}$	O	GO/NG judgment output 1 (LT1): +NG (The measured value exceeds the limit on the positive side. NG judgment.)
12	D	$\overline{\text{LT2}}$	O	GO/NG judgment output 2 (LT2): OK (The measured value is within limits.) GO judgment.)
13	D	$\overline{\text{PRST}}$	I	Preset operation
14	–	GND	–	Ground
15	D	$\overline{\text{ERR}}$	O	Low level signal is output when an error occurs.
16	D	$\overline{\text{CLER}}$	I	During ready state: Low input executes the error status clearing process. During measurement: Low input executes measurement cancellation process (measurement at the time of input is discarded).
17	D	$\overline{\text{RUN}}$	I	During ready state: Low input starts measurement in accordance with settings. During measurement: Depending on the [I/O RUN input] setting, execute end measurement processing on input (measurements are valid to the point of input).

*1 D: Digital signals, A: Analog signals
*2 The bar above the signal name indicates that the signal is active Low.
*3 I: Input, O: Output

Terminal number	Signal type*1	Signal name*2	Signal direction*3	Function
18	D	$\overline{\text{SYNC}}$	O	SYNC signal output: Low pulse is output when measurement starts. Duration of $\overline{\text{SYNC}}$ signal output is the same as duration of $\overline{\text{RUN}}$ signal input.

*1 D: Digital signals, A: Analog signals
*2 The bar above the signal name indicates that the signal is active Low.
*3 I: Input, O: Output

Tips

In two items measurement, the GO/NG judgment results of the two parameter sets are ORed for output as $\overline{\text{LT[3:1]}}$.
$\overline{\text{LT}}$(3:1) = (1,0,1) only when both items are GO.

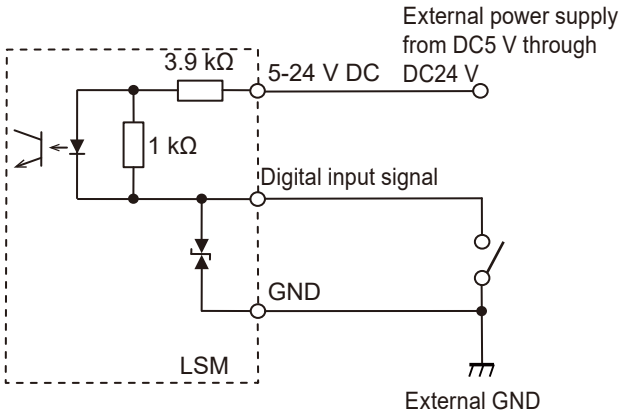
■ Digital signal connection specifications

Digital input/output can output GO/NG judgment results.
It can also control operation of this product, such as starting, stopping, or canceling measurement.

IMPORTANT

- I/O GND is connected to the GND inside the LSM and to FG (the casing). Ensure that it has a voltage level of 0 V.
- Use shielded wires for wiring, and connect the shields to FG. This can prevent malfunction due to electrical noise and reduce electromagnetic interference caused by this product.
- For a relay or other inductive loads, implement protective measures such as a reverse voltage prevention diode.
- A regular control relay or lamp cannot be connected. Use small capacity SSRs (7 mA or less) and LED lamps.

● Digital input circuit

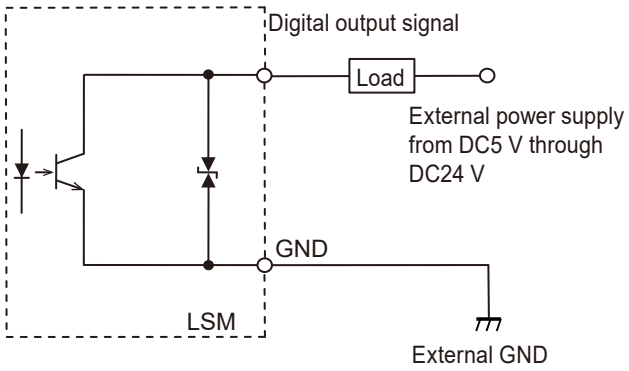


Digital input specifications

Input format	Photocoupler isolated input (current sink) negative logic*1
Input resistance	Limiting resistance 3.9 kΩ (0.25 W)
External power supply	From +5 V through +24 V

*1 Low level: Valid signal
High level: No signal

● Digital output circuit



Digital output specifications

Output format	Photocoupler isolated output (current sink) negative logic*1
External power supply	From +5 V through +24 V
Output current	Sink current 7 mA

*1 Low level: Valid signal
High level: No signal

■ Analog signal connection specifications

Analog output allows output of measured values as a voltage of ±5 V.
It can also output scan waveforms input from the sensor.

NOTICE

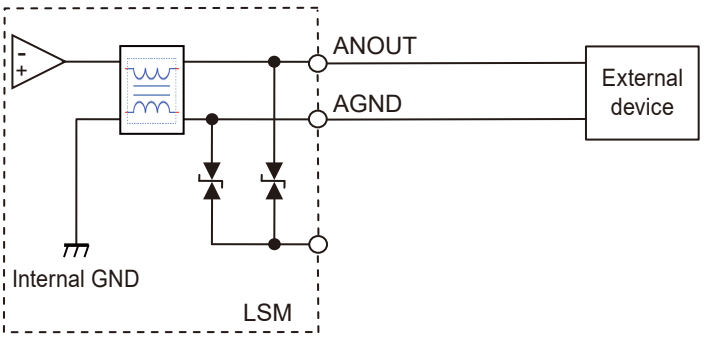
Be careful of electrostatic charges. If a high-voltage electrostatic charge is applied to a signal terminal, it could cause a failure. Turn off the external power supply before performing wiring.

IMPORTANT

0 V is connected to FG (casing) inside the LSM, and must be at a potential of 0 V.

● Analog output

Outputs measured values with a voltage of ±5 V.
For details on analog output settings, see "■ Analog output" on page C-64 and beyond in "PART C Operation".

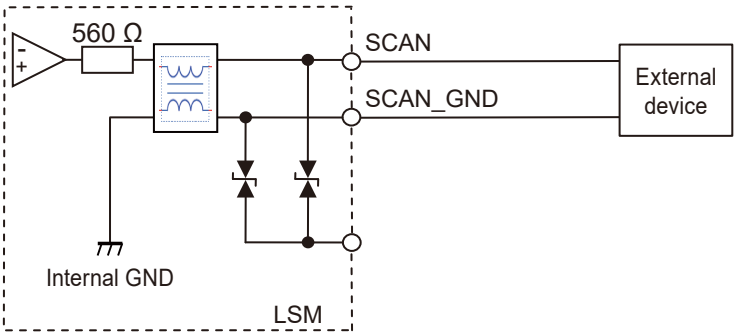


● Scan waveform output

The scan waveform input from the sensor at is output as 0 V to +5 V.

For details on how to use, see "3.2.6 Scan Waveform Output" on page D-43.

SCAN_GND is the reference.



3.2 I/O Operation Description

This section describes the functions of I/O.

3.2.1 List of I/O Functions

Tips

- Connect an external power supply for IO (from +5 V through +24 V) to terminal 1.
- Connect IO GND to terminals 2, 4, 6, and 14.

■ Device operation

Function	Signal name	Terminal number	Signal type*1	Signal direction*2	Function details
Preset execution	$\overline{\text{PRST}}$	13	D	I	Used to control the preset from an external device. Low input set the preset to the previously set [Preset value]. Performing preset resets the offset information (Offset remove). **Tips** For details on the preset and offset, see 📖 "5.2 Setting the Preset and Offset" on page C-97 in "PART C Operation".
Start measurement/ end measurement	$\overline{\text{RUN}}$	17	D	I	• In ready state Used to start measurement from an external device. Low input starts measurement in accordance with settings. • During measurement Used to end measurement from an external device. Depending on the [I/O RUN input] setting, execute end measurement processing on input (measurements are valid to the point of input). **Tips** • The measurement that starts when the $\overline{\text{RUN}}$ signal is input can be selected from [Single-run] (initial value), [Continuous], and [Continuous with term] in [Common setting 2] of LSMPAK's [I/O RUN input] (📖 "■ I/O RUN input" on page C-45) or USB communication command (📖"2.1.1 USB Connector Specifications" on page D-3). • For details on measuring methods, see 📖 "■ Sample measurement" on page C-57 and "6.2.4 Ultra-Fine Wire Measurements" on page C-132 in "PART C Operation".

Function	Signal name	Terminal number	Signal type*1	Signal direction*2	Function details
Clear error/ cancel measurement	$\overline{\text{CLER}}$	16	D	I	• In ready state Used to clear the error status from an external device. The error status clearing process is executed on Low input. • During measurement Used to cancel measurement from an external device. Low input executes the measurement cancellation process (measurement at the time of input is discarded).

*1 D: Digital signals, A: Analog signals

*2 I: Input, O: Output

■ Confirmation of measurement results

Function	Signal name	Terminal number	Signal type*1	Signal direction*2	Function details
Analog output	ANOUT	3	A	O	The difference between the measured value and the reference value for analog output is output to an external device at a set voltage. The analog voltage output is from -5 V through +5 V. **Tips** For details, see 📖 "■ Analog output" on page C-64 in "PART C Operation".
GO/NG judgment output*3	$\overline{\text{LT1}}$	11	D	O	GO/NG judgment output ($\overline{\text{LT1}}$): +NG (The measured value exceeds the limit on the positive side. NG judgment.)
	$\overline{\text{LT2}}$	12	D	O	GO/NG judgment output ($\overline{\text{LT2}}$): OK (The measured value is within limits.) GO judgment.)
	$\overline{\text{LT3}}$	9	D	O	GO/NG judgment output ($\overline{\text{LT3}}$): -NG (The measured value exceeds the limit on the minus side. NG judgment.)

*1 D: Digital signals, A: Analog signals

*2 I: Input, O: Output

*3 For details, see 📖 "■ GO/NG judgment method" on page C-40 and "■ GO/NG judgment" on page C-63 in "PART C Operation".

■ Status verification

Function	Signal name	Terminal number	Signal type*1	Signal direction*2	Function details
Scan waveform output	$\overline{\text{SCAN}}$	5	A	O	Used to output the scan waveform input to this product from the sensor to an external device. The scan waveform voltage is from 0 V through +5 V. **Tips** For details, see 📖 "● Scan waveform output" on page D-27.
Error output	$\overline{\text{ERR}}$	15	D	O	Used when you want an external device to detect that an error has occurred. Outputs a Low level signal when an error occurs. **Tips** For details, see 📖 "■ Digital signal connection specifications" on page D-25.
STB output/ ACK output	$\overline{\text{STB}}$ or $\overline{\text{ACK}}$	10	D	O	Used when connecting this product to an external device. The measurement status can be checked. Since this terminal is used for dual functions, select either STB or ACK for use. $\overline{\text{STB}}$: Low pulse output when the GO/NG judgment output ($\overline{\text{LT1}}$, $\overline{\text{LT2}}$, $\overline{\text{LT3}}$) is updated. $\overline{\text{ACK}}$: Low during measurement, High when measurement ends. **Tips** • For details about signals, see 📖 "3.2.4 Timing Charts" on page D-35. • For details on STB/ACK, see 📖 "■ STB/ACK output" on page C-45 and "■ Set the STB length" on page C-48 in "PART C Operation".

Function	Signal name	Terminal number	Signal type*1	Signal direction*2	Function details
Sync signal output	$\overline{\text{SYNC}}$	18	D	O	A Low pulse is output at the start of measurement. The duration of $\overline{\text{SYNC}}$ signal output is the same as the duration of $\overline{\text{RUN}}$ signal input. The signal can be used to synchronize measurements, as when combining multiple controllers. Synchronous measurement can be achieved by connecting to the $\overline{\text{RUN}}$ terminal of the controller to be synchronized. **Tips** • This is a dedicated signal for synchronizing with other controllers. Connection to other devices is not possible. • For details on measurements combining multiple controllers, see "4.2 Operational Calibration" on page C-92, "5.2 Setting the Preset and Offset" on page C-97 and "6.1.5 Measurement (arithmetic calculation) with Multiple Combined LSMs" on page C-120 in "PART C Operation".

*1 D: Digital signals, A: Analog signals

*2 I: Input, O: Output

3.2.2 GO/NG Judgment Output

Pin name	GO/NG judgment	Judgment conditions	
$\overline{LT1}$	+NG	The measured value is greater than the upper limit.	Upper limit value < Measured value
$\overline{LT2}$	OK	The measured value is greater than the lower limit and less than the upper limit.	Lower limit value ≤ Measured value ≤ Upper limit value
$\overline{LT3}$	-NG	The measured value is lower than the lower limit.	Measured value < Lower limit value

Tips

When a no-workpiece error occurs, measurement stops and GO/NG judgment is turned off (LT1–LT3 all go High).

3.2.3 Measurement Operation

I/O can be used to start, stop or cancel measurement. Specific operations are as follows.

Tips

Change the settings according to the measuring method you wish to execute. Settings can be changed by LSMPAK or USB commands.

Measuring method	Settings		Timing Charts	Operating procedure		
	No of sample measurement*	RUN pin setting for I/O		Measurement start	End measurement (measurement at time of input is valid.)	Cancel measurement (measurement in progress at the time the command is entered is discarded)
Single run measurement	0	Single run measurement	"● Zero run measurement (continuous measurement, single run measurement)" on page D-36	$\overline{\text{RUN}}$ pulse	$\overline{\text{RUN}}$ pulse or 65535 samples acquired	$\overline{\text{CLER}}$ signal
		Continuous run measurement				
		Continuous run measurement with a specified period	"● Zero run measurement (continuous run measurement with a specified period, single run measurement)" on page D-36	$\overline{\text{RUN}}$ falling edge	$\overline{\text{RUN}}$ rising edge or 65535 samples acquired	
	1–999	Single run measurement	"● Single run measurement" on page D-35	$\overline{\text{RUN}}$ pulse	Measure once then end automatically (acquire set number of sample measurement)	
Continuous run measurement	1–999	Continuous run measurement	"● Continuous run measurement" on page D-38	$\overline{\text{RUN}}$ pulse	$\overline{\text{RUN}}$ pulse	$\overline{\text{CLER}}$ signal
		Continuous run measurement with a specified period	"● Continuous run measurement with a specified period" on page D-37	$\overline{\text{RUN}}$ falling edge	$\overline{\text{RUN}}$ rising edge	

* Measured values are calculated from acquired samples based on the calculation item settings (average, maximum, minimum, and range). For details on how to set arbitrary calculation items and number of sample measurement from LSMPAK, see "3.3.5 [Measurement condition 1] Screen" on page

C-54 in "PART C Operation".
When the number of sample measurement is 1, no calculation is possible, so the acquired sample value is output as the measured value.

Tips

For details on each measuring method, see "3.2.4 Timing Charts" on page D-35.

3.2.4 Timing Charts

Tips

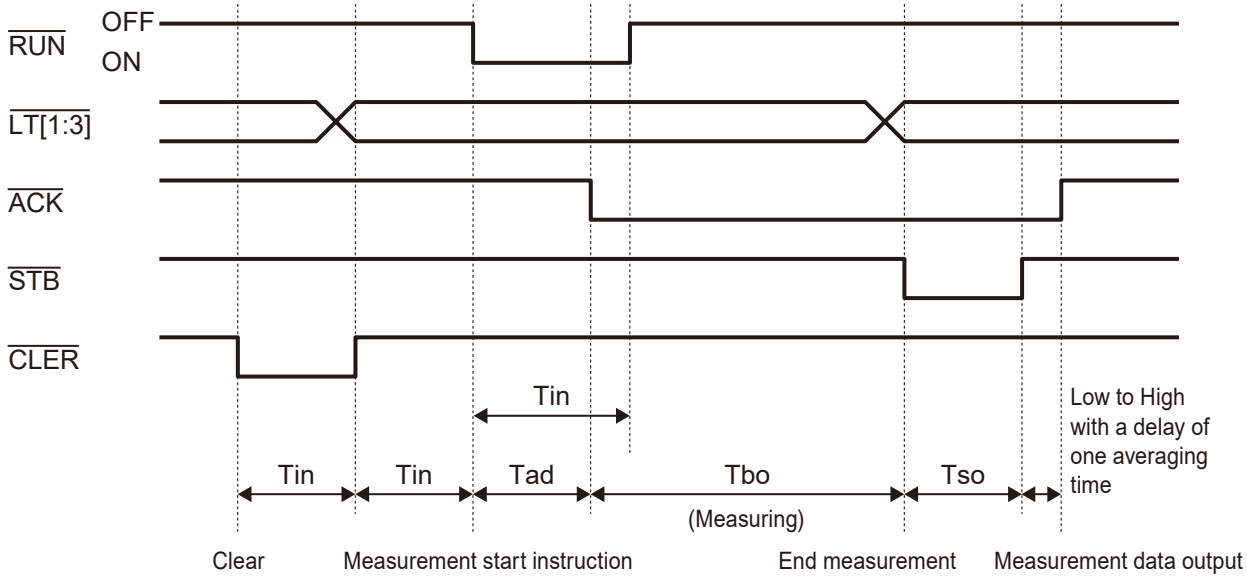
$\overline{STB}$ and $\overline{ACK}$ are dual-function pins, so select either function for use. The selection can be changed by LSM-PAK or USB command.

For details, see 📖 "■ STB/ACK output" on page C-45 and "■ I/O settings" on page D-20 in "PART C Operation".

● Single run measurement

Measurement is started by $\overline{RUN}$ signal pulse input.

Measurement starts when $\overline{RUN}$ changes from High to Low. The measurement is automatically terminated after one measurement.

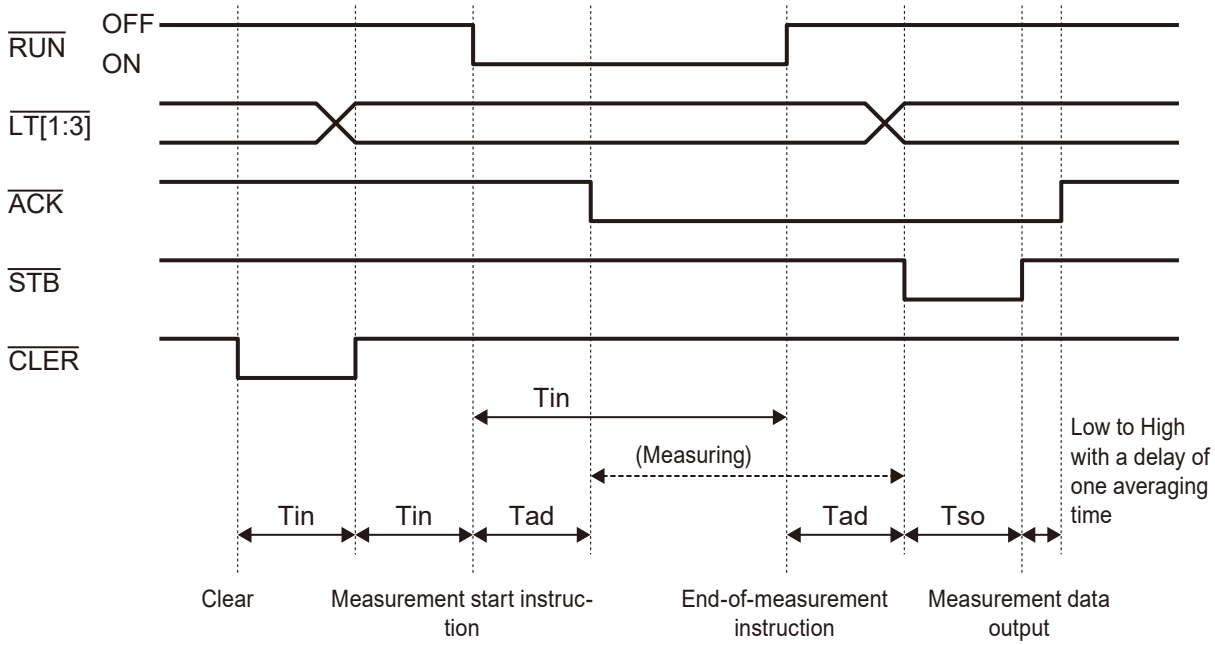


● Zero run measurement (continuous run measurement with a specified period, single run measurement)

The start and end of measurement are given by the pulse width of $\overline{\text{RUN}}$.

Measurement starts when $\overline{\text{RUN}}$ changes from High to Low. Measurement continues as long as $\overline{\text{RUN}}$ is Low, and sample acquisition continues during measurement.

Measurement ends when $\overline{\text{RUN}}$ changes from Low to High. Measurement is automatically terminated when 65535 samples are acquired.

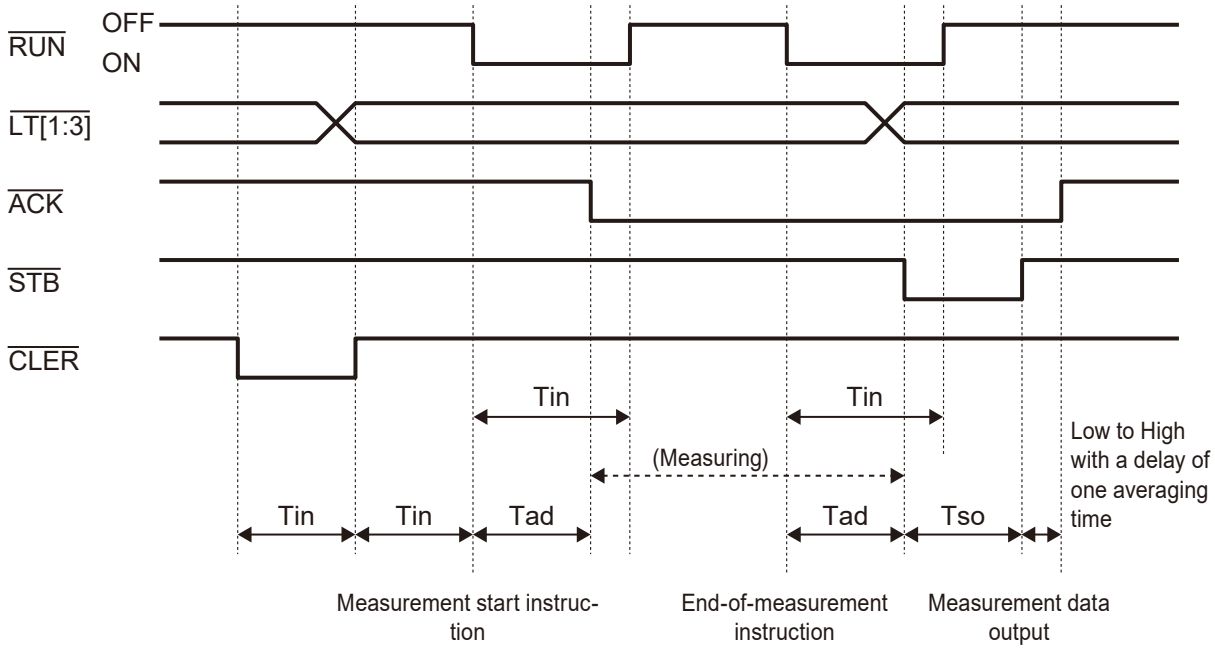


● Zero run measurement (continuous measurement, single run measurement)

Measurement start and end are given by one-shot pulses of the $\overline{\text{RUN}}$ signal.

Measurement starts when $\overline{\text{RUN}}$ changes from High to Low. Measurement is terminated when $\overline{\text{RUN}}$ changes from High to Low again.

Other operation is the same as in "● Zero run measurement (continuous measurement, single run measurement)" on page D-36.

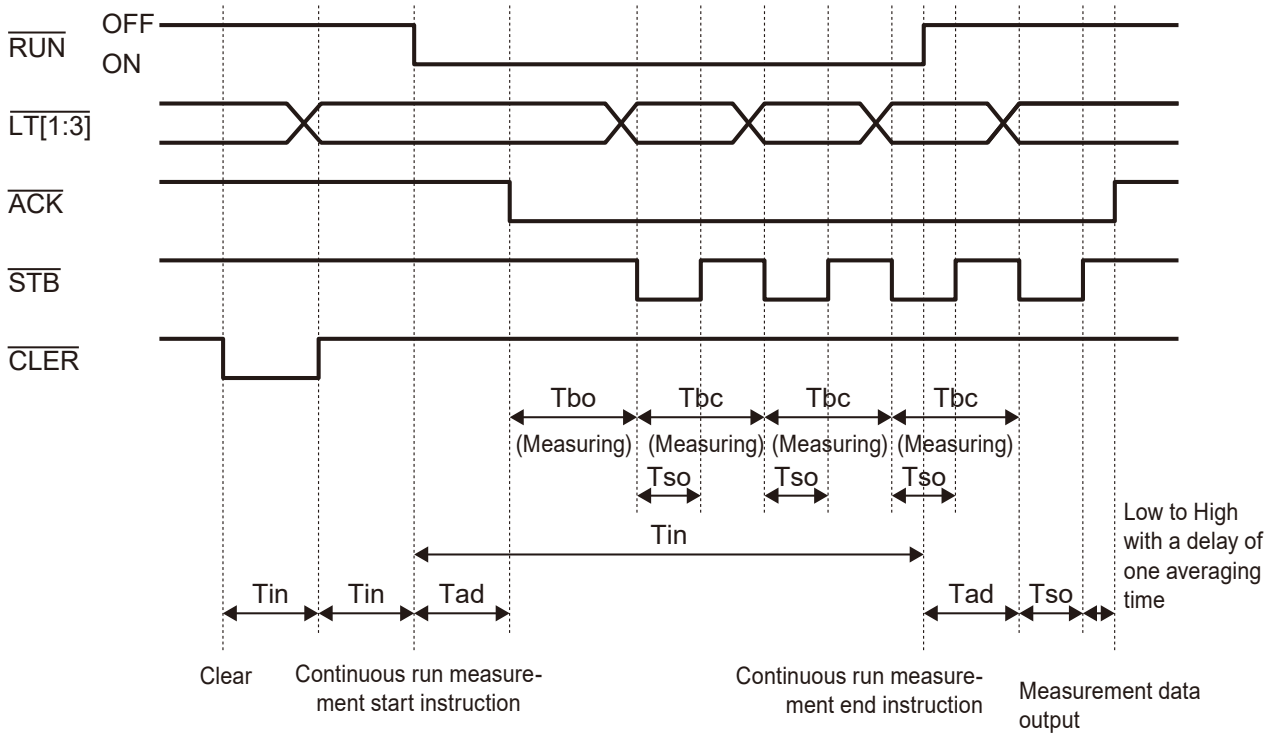


● Continuous run measurement with a specified period

The start and end of continuous measurement are given by the pulse width of $\overline{RUN}$.

Continuous run measurement starts when $\overline{RUN}$ changes from High to Low. Measurement is repeated while $\overline{RUN}$ is Low. Measurement results are output for each measurement.

Continuous run measurement ends when $\overline{RUN}$ changes from Low to High.

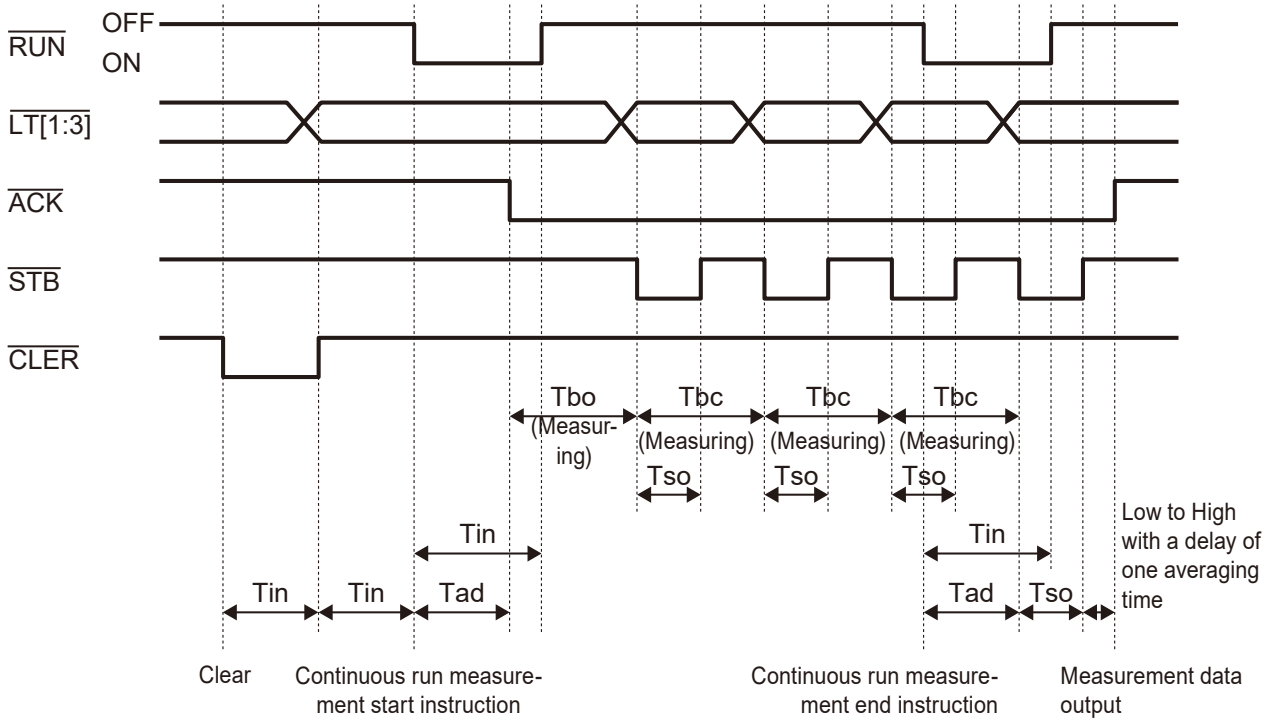


● Continuous run measurement

The start and end of continuous measurement are given by one-shot pulses of the $\overline{RUN}$ signal.

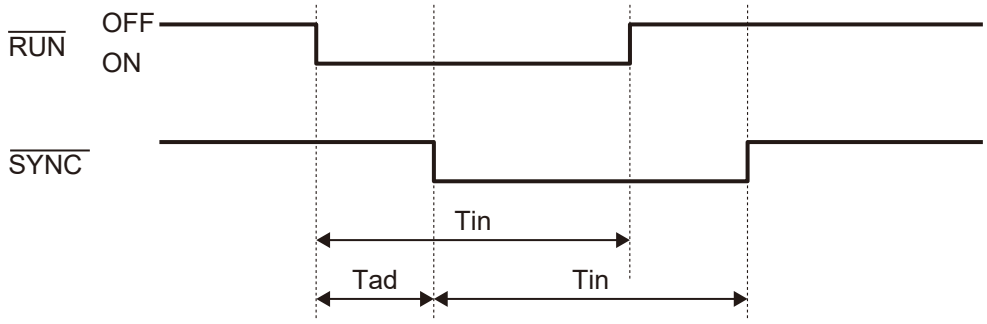
Continuous run measurement starts when $\overline{RUN}$ changes from High to Low. Continuous run measurement is terminated when $\overline{RUN}$ changes from High to Low again. Measurement is repeated from the start of continuous measurement to the end.

Other operation is the same as in "● Continuous run measurement with a specified period" on page D-37.



■ $\overline{\text{SYNC}}$ signal output timing

$\overline{\text{RUN}}$ signal input time (Tin) becomes $\overline{\text{SYNC}}$ signal output time (Tin) as it is, and the $\overline{\text{SYNC}}$ signal is output.



Tips

- The $\overline{\text{SYNC}}$ signal is used to synchronize measurement combining multiple controllers. Synchronous measurement can be achieved by inputing the $\overline{\text{SYNC}}$ signal to the $\overline{\text{RUN}}$ pin of other controllers.
- The $\overline{\text{SYNC}}$ signal is output as a Low pulse when the controller starts measurement.
- The $\overline{\text{SYNC}}$ signal is a dedicated signal for synchronization with other controllers. Connection to other devices is not possible.
- An input signal filter (filter length Tif: 5 ms by default) acts on the input signal to prevent malfunction.
- The input signal response will have delay (Tad) of about 1 to 2 times the filter length (Tif).
- The filter length (Tif) can be set to 2 ms, 5 ms, or 20 ms.
- In case of input signal instability due to electrical noise, etc., increase the filter length.

■ Timing chart time parameters

Parameter		MIN	TYP	MAX	Remarks
Tin	Signal input time	(Tif x 2 + 3 ms)	−	−	Tin > (Tif x 2 + 3 ms) > Tad The above relationships must be fulfilled.
Tad	Input signal response time	−	−	Tif x 2 + 3 ms	
Ter	Time allowed for simultaneous input	−	−	Tif / 2	−
Tif	Input signal filter length	2 ms	−	20 ms	Initial value: 5 ms
Tso	STB length	0.1 ms	AUTO (initial value)	100 ms	With arithmetical average: 📖 "■ Measurement interval and recommended STB length" on page D-42 Moving average time: 2 ms
MRN	Number of averaging	With arithmetical average: 1 Moving average: 32	−	2048	Number of scans used for "averaging" (Set as powers of 2)
Tmr	Measurement interval	With arithmetical average: (MRN × 1000/3200) [ms] ±20% With moving average: Time required for the first average is the same as given by the above formula. Subsequent averages are at 5 ms intervals.			Interval between "averaging" runs
N	Number of samples	0 (no pre-specified number of sample measurement = zero run measurement)	−	999	Number of samples (values obtained by "averaging") used to calculate one measurement result (calculation set in [Method]).
Tbo	Single run measurement time	−	−	Tmr x N + 3 ms	In case of zero run measurement, it is single measurements (N=1–65535) that continue to acquire samples until the measurement termination operation is performed.
Tbc	Continuous run measurement time	−	−	Tmr x N + 1 ms	

Tips

- When output operations involving printers and USB, delay may be greater than the values in the table.
- There are two averaging methods for measurement data: arithmetical average and moving average.
  With arithmetical averages, the measurement interval (Tmr) varies with the number of averaging (MRN). The STB length (Tso) changes accordingly.
  With moving averages, the measurement interval (Tmr) is fixed at 5 ms and the STB length (Tso) is fixed at 2 ms, regardless of the number of averaging (MRN). For details, see 📖 "● Moving average" on page C-37and 📖 "■ Measurement interval and recommended STB length" on page D-42 in "PART C Operation".

■ Measurement interval and recommended STB length

The $\overline{\text{STB}}$ signal is output as a pulse when the judgment outputs ($\overline{\text{LT1}}$–$\overline{\text{LT3}}$) are updated. This indicates that valid measurement data has been output.

The $\overline{\text{STB}}$ length indicates the validity time (Tso) of the STB signal.

When using measurement with arithmetical average, the measurement interval varies depending on the number of averaging. The recommended STB length for each measurement interval is as follows.

Tips

- If [Set the STB length] is set to the default setting of [MR (automatic)], Tso is automatically set to the recommended STB length indicated in the table below.
- Tmr in the table below indicates the averaging interval. The result of averaging is called the sample.
- When [No of sample measurement] is set to 1, the measurement interval = Tmr because there is no [Method].
- When [No of sample measurement] is set to other than 1, the measurement interval = Tmr x [No of sample measurement].

Recommended STB length for arithmetical average

Number of averaging: MRN	Measurement interval: Tmr	STB length: Tso
2048	640 ms±20 %	20 ms±20 %
1024	320 ms±20 %	
512	160 ms±20 %	
256	80 ms±20 %	
128	40 ms±20 %	2 ms±20 %
64	20 ms±20 %	
32	10 ms±20 %	
16	5 ms±20 %	
8	2.5 ms±20 %	0.3 ms±50 %
4	1.2 ms±30 %	
2	0.6 ms±30 %	
1	0.3 ms±30 %	0.1 ms±50%

STB length for moving averages

Number of averaging: MRN	Measurement interval: Tmr	STB length: Tso
Any value (32-2048)*	5 ms±20 %	2 ms±20 %

* When the averaging method is set to moving average, the measurement interval and STB length for the second and subsequent samples remain 5 ms and 2 ms, respectively, even if the number of averaging is changed.
  After measurement starts, the first sample (the first to be averaged) is performed at the same timing as with arithmetic averaging.

Tips

- Depending on load conditions of the connected circuit, the error magnitude may be larger than the values indicated in the table.
- Tso can be changed in [Set the STB length] of [Common setting 3] (MR, from 0.1 ms through 100.0 ms). For details, see "■ Set the STB length" on page C-48 in "PART C Operation".

3.2.5 Analog Output

The difference between the measured value and the analog output reference value is output as a voltage.

The magnitude of the output voltage can be adjusted by setting the scale (sensitivity adjustment).

See below for details on the adjustment method.

- Setup using LSMPAK: 📖 "■ Analog output" on page C-64 in "PART C Operation".
- Setup by USB commands: 📖 "■ Analog output settings" on page D-20
- External Device Connections: 📖 "● Analog output" on page D-26

[Scale] setting value (multiplier)	Gain (output voltage/displayed value)	Display range (Maximum output voltage/Maximum displayed value)
1 (1 times)	0.625 mV/0.01 µm	±5 V/±80 µm
2 (10 times)	0.625 mV/0.1 µm	±5 V/±800 µm
3 (100 times)	0.625 mV/1 µm	±5 V/±8 mm
4 (1000 times)	0.625 mV/10 µm	±5 V/±80 mm
5 (10000 times)	0.625 mV/100 µm	±5 V/±800 mm

Analog output voltage = (measured value - analog output reference value) x gain

3.2.6 Scan Waveform Output

The controller outputs the scan waveform input from the sensor (from 0 V through +5 V).

Can be used to check the optical axis (optical axis alignment and position adjustment) of separate-type sensors.

For details on connection specifications, see 📖 "● Scan waveform output" on page D-27.

For usage examples, see 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document).

MEMO

4 IF Module

When using an industrial interface, attach the optional IF module to this product.

See below for details.

- 📖 "IF Module <EtherNet/IP> User's Manual" (separate document)
- 📖 "IF Module <PROFINET> User's Manual" (separate document)
- 📖 "IF Module <EtherCAT> User's Manual" (separate document)
- 📖 "IF Module <CC-Link IE TSN> User's Manual" (separate document)

MEMO

PART E
Inspection and Maintenance

This part describes product inspection and maintenance methods.

No. 99MBC150A

1 Display Check

This chapter describes the LED display of this product.

Status	Controller LED indications
Operating	[POWER] LED: Flashing green [ERROR] LED: Lit in red
Normal (ready for measurement)	[POWER] LED: Lit in green [ERROR] LED: Off
Measuring	[POWER] LED: Flashing green [ERROR] LED: Off
Error	[POWER] LED: Off [ERROR] LED: List in red Rapidly flashing red (power supply error)
No workpiece error (When there is no workpiece)	[POWER] LED: Lit in green [ERROR] LED: Slowly flashing red
Warning	[POWER] LED: Lit [ERROR] LED: Slowly flashing red

Tips

For details about error messages, see "1 Error Messages and Solutions" on page F-1 and beyond in "PART F Troubleshooting".

MEMO

2 Cleaning

⚠CAUTION

Turn off the power supply before cleaning.

If you perform cleaning while the power is still on, the cleaning agent, water, etc. could get inside of this product and cause an electric shock.

1 **Check that the power supply is shut off.**

2 **Wipe the product with a soft, dry cloth.**

NOTICE

Do not use a wet cloth, benzine, thinner, etc.
These could cause deformation or discoloration.

Tips

If the product is extremely dirty, wipe the dirt off using a cloth soaked in diluted neutral detergent and wrung well, and then finally wipe the unit with a soft dry cloth.

MEMO

PART F
Troubleshooting

This part describes the details of error messages and their solutions and also how to handle problems when they occur.

No. 99MBC150A

1 Error Messages and Solutions

This chapter describes possible causes and remedies for error and warning messages displayed by LSMPAK.

Error message

Error number	Possible cause	Solution	LED status	
			POWER	ERROR
Hardware error				
H0001	Processing stops for a certain period of time. There is a failure somewhere on the main board.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
H0002	FPGA will not start.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
H0003	Main board EEPROM cannot be read/written. The main board of the controller has failed.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
H0004	Sensor board EEPROM cannot be read. The LD*1 driver board of the sensor has failed.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
H0005	Sensor failure (inadequate light emission from LD*1 or motor drive failure)	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
H0006	Unexpected current flow in LD*1. The LD*1 driver board of the sensor has failed.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
H0007	The value from FPGA became abnormally large. The FPGA is operating abnormally and outputting abnormal counter values.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
	The sum of the preset and offset is three digits.	Clear the preset and offset.		
Power supply error				
P0001	Normal power supply (24 V) is not being supplied. Customer operating environment is unstable. The power supply voltage is low. Surges or other adverse events affecting power supply.	Reevaluate the environment of use. (Eliminate noise, etc.) If turning the power off and on does not resolve the problem, check the power supply voltage for any abnormality such as low voltage or noise.	Off	Flashing red (rapid)

*1 LD: Laser diode

Error number	Possible cause	Solution	LED status	
			POWER	ERROR
Calibration error				
E0001	The wrong measurement position (segment/edge) is specified.	Check the settings for the measurement position (segment/edge).	Off	Lit in red
	A value significantly different from the dimension of the reference gage was entered.	Re-set them with the same values as the gage verification values. If the problem persists, contact the agent where you purchased the product or a Mitutoyo sales office.		
	The HIGH CAL setup value is too close to LOW CAL.	Re-set using reference gages with a dimensional ratio of at least 1.2 times.		
Output buffer overflow				
E0002	The output buffer for measurement data acquisition overflowed.	Check the number of averaging, the number of sample measurement, etc. Also, use a higher spec PC if necessary. "3.3.5 [Measurement condition 1] Screen" on page C-54 "3.3.6 [Measurement condition 2] Screen" on page C-59	Off	Lit in red
Edge error				
E0004	An odd number of edges was detected.	Contact the agent where you purchased the product or a Mitutoyo sales office.	Off	Lit in red
Edge not found error				
E0005	Scan waveform not obtained or edge not detected.	Check that the laser is not blocked.	Off	Lit in red
	The sum of the preset and offset is three digits.	Clear the preset and offset.		
Insufficient light error				
E0006	The light amount is insufficient and the light amount memory function cannot be used.	Execute [Memorize light amount] under conditions where light intensity is sufficient. "3.4 Memorize Light Amount" on page C-73 in "PART C Operation"	Off	Lit in red
Dirt detection error				
E0007	The protection glass is dirty. The protective glass is stained or scratched (if the dirt detection function is enabled).	Clean or replace the protective glass. "Laser Scan Micrometer <Sensor> User's Manual" (separate document)	Off	Lit in red

*1 LD: Laser diode

Error number	Possible cause	Solution	LED status	
			POWER	ERROR
No workpiece error				
E0008	There is no workpiece corresponding to the specified measurement point (segment/edge).	Check that the workpiece is correctly set. Check that segment and edge mode are correctly set. 📖 "3.3.5 [Measurement condition 1] Screen" on page C-54	On	Flashing red (slow)
Measurement number over error				
E0009	The number of measurements that can be stored by LSMPAK (up to 100,000) has been exceeded.	Save data stored in LSMPAK and clear the measurement history.	No effect	

*1 LD: Laser diode

Warning message

Error number	Possible cause	Solution	LED status	
			POWER	ERROR
Outlier detection warning				
W0001	The measured value exceeded the upper and lower limits of the outlier elimination function, and the number of such values reached the count.	Check the dimensions of the workpiece and set a workpiece of the correct dimensions. Also, check the upper and lower limit settings for outlier elimination. 📖 "■ Outlier elimination (count target setting)" on page C-39 📖 "■ Outlier elimination" on page C-62	On	Flashing red (slow)
Calculation error				
C0001	Cannot find the label (operation target) when registering a calculation. (Example: When the label of an operation target has been changed and can no longer be recognized as an operation target.)	Check the label of each LSM and re-select the operation target. If calculation is not required, clear the calculation setting. See 📖 "3.3 Measurement Settings" on page C-24 to check the label, 📖 "3.5.2 Editing Calculation Settings" on page C-81 to select the operation target, and 📖 "3.5.3 Clear Calculation" on page C-82 for clearing calculations.	No effect	

Error number		Possible cause	Solution	LED status	
				POWER	ERROR
	C0002	An error occurred in the operation target, making calculation impossible. (Example: An arithmetic operation was registered with two LSMs, but an error occurred in one of the LSMs, preventing the operation from being completed.)	Check for errors on the LSM which is the operation target and clear them. 📖 "1 Error Messages and Solutions" on page F-1	No effect	
Statistics count overwarning					
	—	The number of data points for statistical calculation results exceeded 100,000.	Save data resulting from statistical calculations on a regular basis, and ensure that the number of data points does not exceed 100,000.	Off	Lit in red

■ About dialogs that appear when LSMPAK is started

When LSMPAK is launched, a dialog box appears if the LSM configuration has changed since the last connection, if there is a mixture of LSMs with different unit settings, or if a communication error occurs.

For details on dealing with such situations, see 📖 "■ What to do if a dialog box appears at startup" on page C-4 in "PART C Operation".

2 Troubleshooting and Solutions

This chapter describes issues that may occur with this product and how to solve them.

Issue	Possible cause	Solution
From setup to startup		
The product does not start even when power is supplied. (The [POWER] and [ERROR] LEDs do not light up.)	Setup was not correctly performed.	Check the setup procedure. "2 Setup" on page B-3 in "PART B Preparation"
	The power supply terminals are not fully connected.	Cut the power, and ensure that the power supply terminals are correctly connected.
	The supply-side power source is off.	Check the supply-side power source.
	The voltage on the power-supply side is low.	Check the voltage on the power-supply side (+24 VDC ±10%, 3.0 A or more).
	The power cable is defective or disconnected.	Replace the power cable.
	The signal cable is defective.	Cut the power, disconnect the signal cable, and supply power again. If the [POWER] LED on this product lights up green, the product is operating normally. Replace the signal cable.
	The sensor has failed.	Cut the power, disconnect the sensor, and supply power again. If the [POWER] LED on this product lights up green, the product is operating normally. In this case, the sensor is likely faulty. Contact the agent where you purchased the product or a Mitutoyo sales office.
	This product (the controller) has failed.	Contact the agent where you purchased the product or a Mitutoyo sales office.
The sensor makes an abnormal noise.	The scanner motor has failed.	Contact the agent where you purchased the product or a Mitutoyo sales office.

Issue	Possible cause	Solution
Regarding screen displays and errors		
Error messages are displayed.	—	"1 Error Messages and Solutions" on page F-1
About calibration		
The calibration values are not reflected.	The calibration was performed incorrectly.	Correctly perform calibration. See "4 Calibration" on page C-85 in "PART C Operation".
	The calibration gage is not set correctly.	Set the calibration gage correctly.
Reliability of measured values		
There are errors in the measured values.	Calibration was not performed correctly.	Correctly perform calibration. See "4 Calibration" on page C-85 in "PART C Operation".
	The dimensional difference of the calibration master is too small.	
	Foreign materials are attached to the workpiece.	Remove the foreign materials attached to the workpiece.
	The protective glass of the sensor is stained or scratched.	Clean or replace the protective glass. "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
	The calibration values of the sample workpiece used as a master are incorrect.	Check the calibration values of the sample workpiece used as a master.
	The optical axes are out of alignment between the emission and reception units.	Align the optical axes. "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
Measured values vary. Measured values are unstable.	The system was not sufficiently warmed up.	Warm up the unit for 30 minutes to 1 hour.
	The number of averaging is insufficient.	Increase the number of averaging.
	The protective glass of the sensor is stained or scratched.	Clean or replace the protective glass. "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
	Foreign materials are attached to the workpiece.	Remove the foreign materials attached to the workpiece.
	The measuring unit is in the direct path of air from an air conditioner or sunlight.	Do not expose this product directly to blowing air or sunlight.
	The measuring environment is poor (vibrations, air temperature changes, blowing air, etc.).	Measure in an environment without vibrations, air temperature changes, blowing air, etc.
	The output of the laser diode is reduced.	Check the status of the [ERROR] LED. If the LED is blinking red, the sensor may be faulty. Contact the agent where you purchased the product or a Mitutoyo sales office.

Issue	Possible cause	Solution
The potential abnormal value is shown.	Calibration was not performed correctly.	Correctly perform calibration. See 📖 "4 Calibration" on page C-85 in "PART C Operation".
	The protective glass of the sensor is stained or scratched.	Clean or replace the protective glass. 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
	Foreign materials are attached to the workpiece.	Remove the foreign materials attached to the workpiece.
When the same workpiece is measured by multiple LSMs, differences in measurement values occur.	Calibration was not performed correctly.	Correctly perform calibration. See 📖 "4 Calibration" on page C-85 in "PART C Operation".
	The dimensional difference of the calibration master is too small.	
	Foreign materials are attached to the workpiece.	Remove the foreign materials attached to the workpiece.
	The protective glass of the sensor is stained or scratched.	Clean or replace the protective glass. 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
	The calibration values of the sample workpiece used as a master are incorrect.	Check the calibration values of the sample workpiece used as a master.
	The optical axes are out of alignment between the emission and reception units.	Align the optical axes. 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document)
Others		
Measured values vary. Measured values are unstable.	The installation place is poor.	Install this product in a location where it will be subject to minimal vibration.
If the emission and reception units are separated from the mount, how is the optical axis aligned?	—	For details about the optical axis alignment, see 📖 "Laser Scan Micrometer <Sensor> User's Manual" (separate document).
Is the system compatible with older models?	—	There is no compatibility with old models. Use this product with a sensor from the same series.
Operation of this product is unstable. • Correct measurement values cannot be obtained. • The [ERROR] LED lights. • USB communication errors occur. • This product restarts.	This product is receiving electromagnetic interference that exceeds the requirements of the EMC Directive and the UK Electromagnetic Compatibility Regulations.	Eliminate the electromagnetic interference. This product resumes normal operation after the electromagnetic interference is eliminated.

Issue	Possible cause	Solution
Operation of other devices is unstable. This product is causing loss of specified functionality of other devices.	This product is being used in other than the intended operating environment. This product generates electromagnetic emissions in an industrial environment. This product is not intended for use outside of an industrial environment, and its use in residential areas or other environments may cause electromagnetic interference with other devices.	Implement countermeasures to prevent electromagnetic interference with other devices.

PART G
Appendix

This part includes the specifications of this product and the index.

No. 99MBC150A

1 Specifications

1.1 Specifications

Item	Specifications		
Code No.	544-120 (mm type), 544-121 (mm/in switchable type)		
Model number	LSM-CU-A		
Measuring functions*1	Segment mode	1–7 (1–3 for Transparent mode)	
	Edge Mode	1–255	
	Averaging method	Arithmetical average	1–2048 times
		Moving average	32–2048 times
	Transparent mode, Ultra-fine wire mode (LSM-02-A only), Two items measurement, Auto-work detection, Outlier Elimination, GO/NG judge (Upper/Lower limit, Multi-limits, Target value and tolerance), Detect dirt on the glass, Sample measurement, Analog out, Parameter setting (measurement conditions): 20, Work position, Calibration, Preset, Offset, Statistical calculation, Calculation of two or more sets, Sensor model identification, Display unit switching (544-121 only)		
Standard interface*2	Indicators	[POWER] LED (green), [ERROR] LED (red)	
	Signal cable connector	Mini D-Sub (15-pin)	
	USB connector	Type-C	
	I/O connector	Separate terminal blocks (18 poles)	
	Power connector	Separate terminal blocks (6 poles)	
Rated power supply	+24 VDC±10 %, 3.0 A or more		
Protective structure (dust-proofing and waterproofing)	This product does not conform to the IP standard*3.		
Operating environment	Temperature	From 0 °C through 50 °C	
	Humidity	From 20 %RH through 85 %RH (no condensation)	
	Altitude	2000 m or lower	
Storage environment	Temperature	From -10 °C through 60 °C	
	Humidity	From 20 %RH through 85 %RH (no condensation)	
Weight	About 550 g		

Item	Specifications
CE marking/UKCA marking	EMC Directive/Electromagnetic Compatibility Regulations: EN IEC 61326-1 Immunity test requirements: Clause 6.2 Table2 Emission limit: ClassA RoHS Directive/The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations: EN IEC 63000

*1 There are some restrictions on the combination of measurement functions.
For details, see 📖 "● Exclusivity of items in the [Common setting 1] screen" on page C-26 and beyond in "PART C Operation".

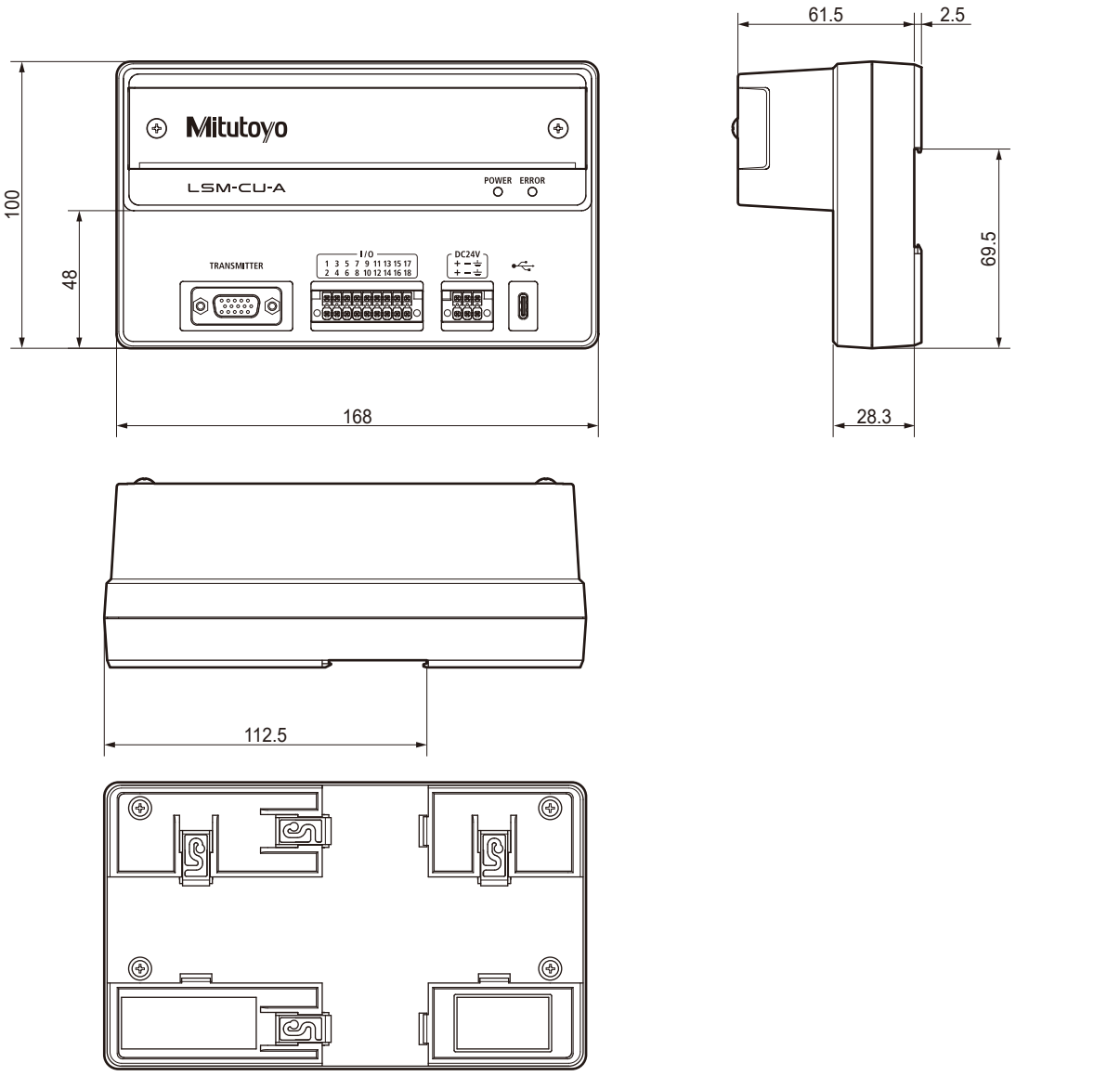
*2 For details on optional interfaces, see 📖 "About This Document" on page 4.

*3 Sensors (LSM-02-A and LSM-30-A) are IP67 rated.

1.2 External Dimensions Drawing

■ Main unit dimensions

Unit: mm



■ DIN rail and connector installation dimensional drawing

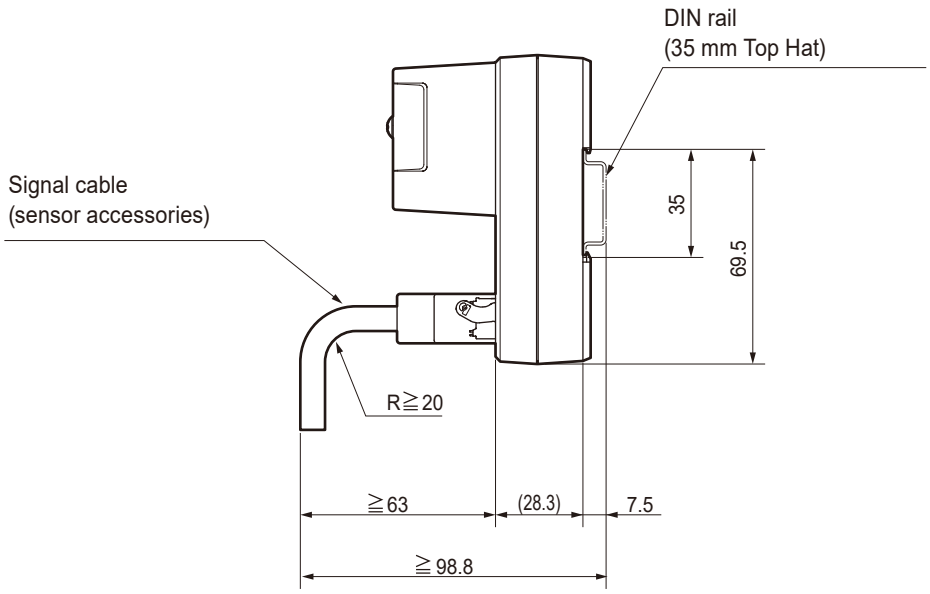
IMPORTANT

Signal cables may break if bent over a small radius.

Allow in installation space with minimum dimensions as indicated in the figure below.

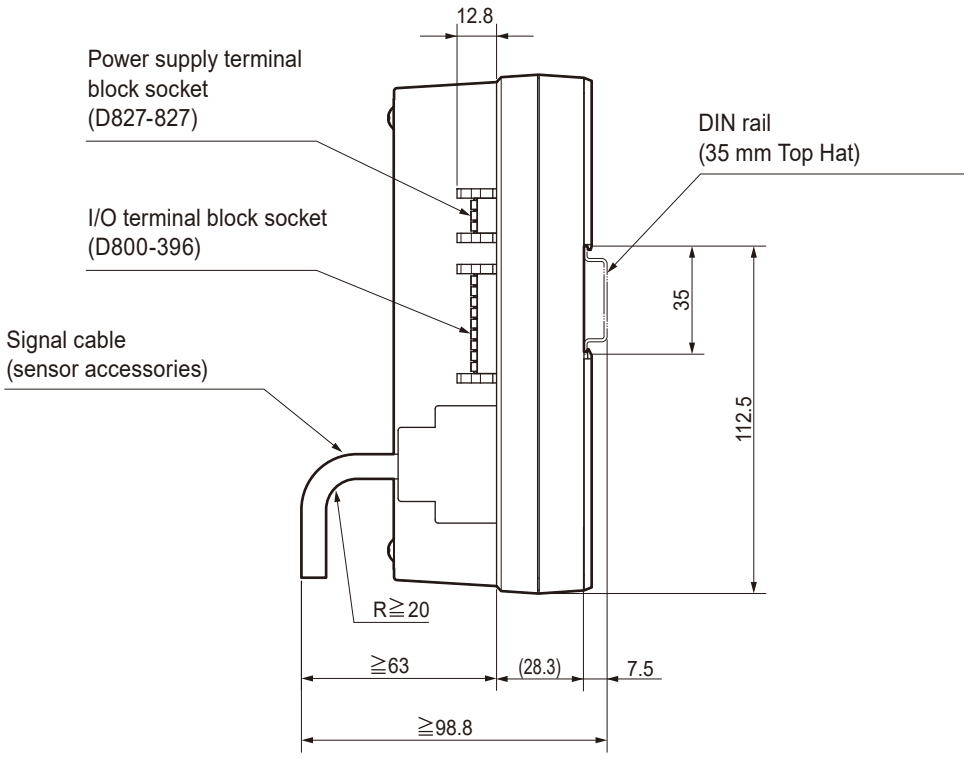
● When using a DIN rail groove (horizontal)

Unit: mm



● When using a DIN rail groove (vertical)

Unit: mm



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*As of June 2023

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