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KEYENCE

96M0334

Instruction Manual

Ultra High Accuracy Laser Displacement Meter

LC-2400 Series



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Safety Precautions

This manual describes how to install the LC-2400 Series as well as its operating procedures and precautions. Please read this manual carefully to get the best from your LC-2400 Series.

Symbols

The following symbols alert you to important messages. Be sure to read these messages carefully.

⚠ WARNING Failure to follow instructions may lead to injury. (electric shock, burn, etc.)

⚠ CAUTION Failure to follow instructions may lead to product damage.

Note Provides additional information on proper operation.

General Precautions

- At startup and during operation, be sure to monitor the functions and performance of the LC-2400 series.
- We recommend that you take substantial safety measures to avoid any damage in the event a problem occurs.
- Do not open or modify the LC-2400 series or use it in any way other than described in the specifications.
- When the LC-2400 series is used in combination with other instruments, functions and performance may be degraded, depending on operating conditions and the surrounding environment.
- Do not use the LC-2400 series for the purpose of protecting the human body.

⚠ CAUTION **Turn the power OFF when connecting or disconnecting the sensor head connector, power supply cables, or any of the optional boards. Otherwise, the laser diode or other electronic components may become degraded or damaged.**

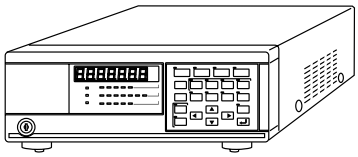
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Contents of the Package

The LC-2400 series includes the following items. Check that none of the items are missing or damaged.

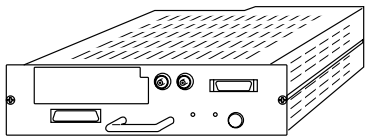
- Display unit model:
  LC-D1A/LC-D1W (Qty: 1)

If the control unit was ordered separately, the display unit is not included.



- Control unit model:
  LC-C1A / LC-C1W/LC-C2(1)

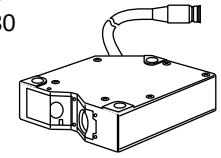
If the display unit was ordered, the control unit is incorporated in the display unit.



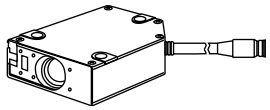
- Sensor head[1.]

Check that the requested sensor head is included in the contents.

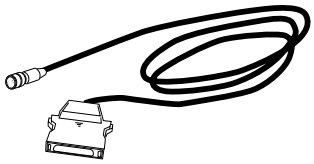
model: LC-2420
LC-2430



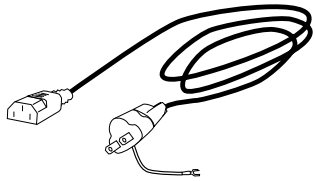
model: LC-2440
LC-2450



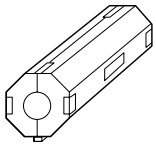
- 3-m connecting cable (1) [1., 2.]



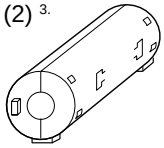
- 2-m power cable (1)



- Ferrite core
  ESD-SR-25 (TOKIN) for RS-232C cable (2) [3.]



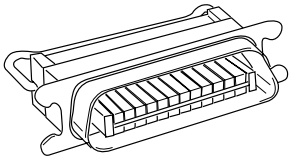
- Ferrite core
  ZCAT3035-1330 (TDK) for CONTROL I/O cable (2) [3.]



- Power supply key (2)

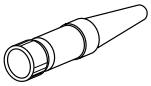


- 24-pin control I/O connector (1)

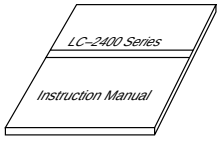


- 4-pin laser remote grounding plug (1)

Inserting this plug into the LASER REMOTE connector on the rear panel enables laser emission. (See page 15.)



- Instruction manual (1)



1. Depends on quantity ordered
2. 5-m or 10-m cable is also available.
   (To use a 5-m or 10-m cable with the LC-2400 series that has been calibrated for a 3-m cable the unit must be recalibrated by KEYENCE. We also offer the LC-2400 series configured for 5-m and 10-m cables.)
3. Included with the LC-2400W series.

Note

- The 5-m or 10-m cable is not available for the LC-2400W series.
- The LC-C1W cannot be used seperately from the display unit.

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WARRANTIES AND DISCLAIMERS

Sea page 113.

Conventions

The following symbols are used in this manual:



Failure to follow instructions may lead to injury. (electric shock, burn, etc.)



Cautions against procedures which may result in malfunctions or measurement errors as well as hazardous operating conditions. Be sure to read this information carefully.



Turn to this page for more detailed information on a given subject.



Read here for more details or for reference information on a given subject. This information can be read as required.



LC-2400 operation keys.

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How to Use This Instruction Manual

This instruction manual is composed of 9 chapters. An introduction to each chapter is given below:
Users who are using the LC-2400 series for the first time are encouraged to read through the entire instruction manual.

Chapter Guide

1. LASER SAFETY PRECAUTIONS
This chapter describes the safety precautions for dealing with the laser in the LC-2400 series.

2. SYSTEM CONFIGURATION
This chapter introduces the LC-2400 series measurement system. A "Quick Reference Table" is also included to help you quickly locate the information and procedures that you require.

3. PART NAMES AND FUNCTIONS
This chapter identifies parts used in the LC-2400 series.

4. OPERATING INSTRUCTIONS
This chapter explains in detail how to operate the LC controller. Please read and follow the instructions in this chapter carefully before operating the LC.

5. CONNECTIONS
This chapter explains the procedures for installing a sensor and connecting it to the LC controller.

6. SETTING UP
This chapter explains how to set the parameters quickly and easily for obtaining accurate measurements with the LC-2400 series. Read how to set the parameters in this chapter after checking the system setup against the table given in Chapter 2-4 "Quick Reference Table".

7. MEASUREMENT PROCEDURE
This chapter explains measurement procedures using various targets.

8. EXTERNAL I/O FUNCTIONS
This chapter explains how to communicate with external I/O devices such as a personal computer.

9. APPENDIX
The appendix includes a troubleshooting guide, a glossary, and a description of the expansion I/Os.

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CHAPTER 1

LASER SAFETY PRECAUTIONS

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1-1 Classification

The LC-2400 series employs a visible semiconductor laser as its light source classified as follows:

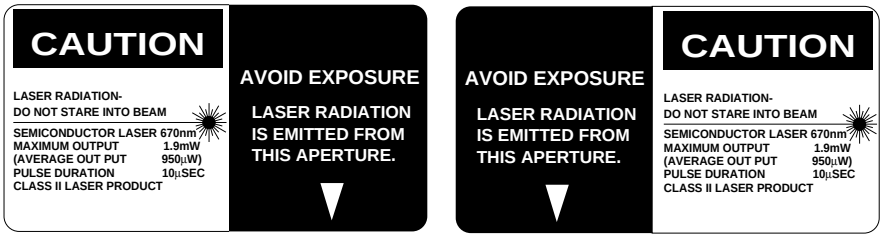
Model		LC-2420	LC-2430	LC-2440	LC-2450
Class	FDA	Class II			
	IEC 825-1 11.1993	Class 2			
	DIN EN 60825-1 07.1994	Klasse 2			

1-2 Warning Labels

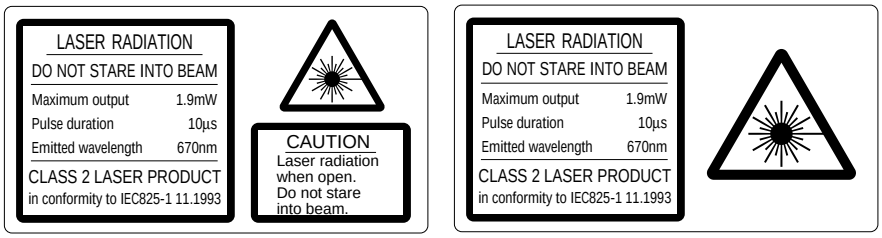
Warning Labels

1) Warning labels

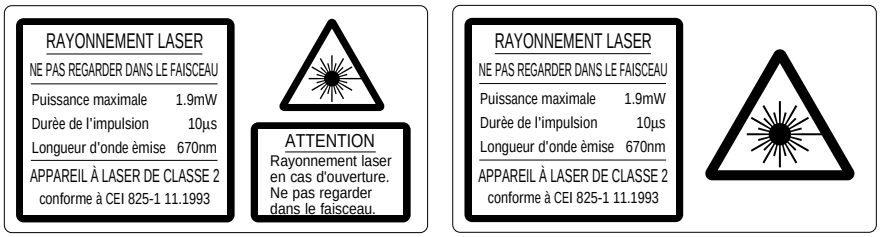
FDA Class II



IEC Class 2



IEC (French) Classe 2



DIN
Klasse 2



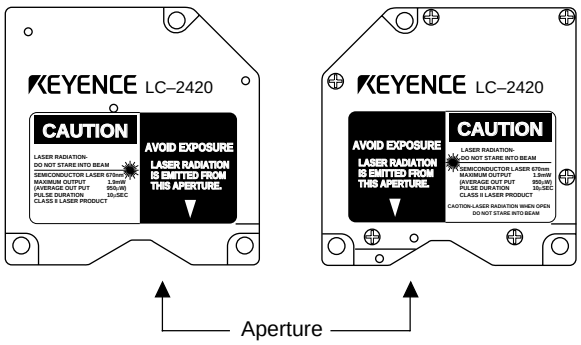
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1-3 Label Location

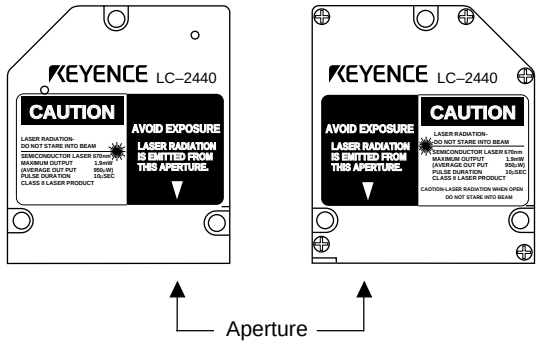
FDA Warning labels are attached to the sensor head as shown below. The IEC/DIN Warning labels are packaged with the LC-2400 Series. Affix the Warning labels on the sensor head as shown below.

FDA

• LC–2420/2430

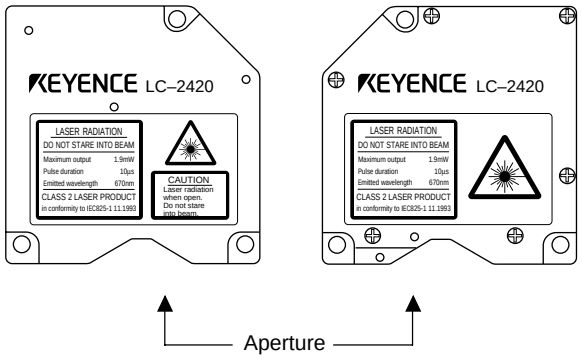


• LC–2440/2450

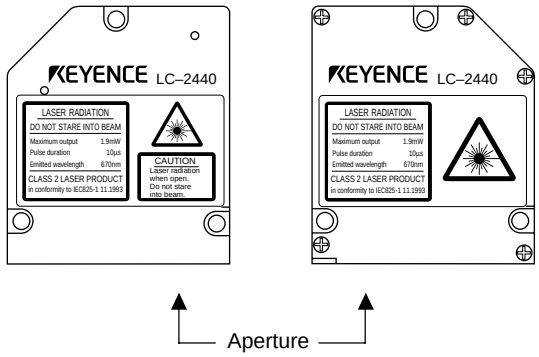


IEC/DIN

• LC–2420/2430



• LC–2440/2450



1-4 Safety Consideration

⚠ CAUTION

Use of controls or adjustments, or the performance of procedures other than those specified herein, may result in hazardous radiation exposure.

The laser beam is not harmful to the skin. There is, therefore, no danger in exposing arms or hands to the beam. The only possible health hazard is in exposing the eyes to the laser beam. Damage to the eyes can occur if the operator stares directly into the beam.

⚠ WARNING

Follow the safety precautions below to ensure operator safety:

- **Operate the LC-2400 series only according to the procedures described in this instruction manual.**
  Otherwise, injury may occur due to expose to the laser beam.

- **Do not disassemble the sensor head.**
  Laser emission from the LC-2400 series is not automatically stopped if the sensor head is disassembled. If you disassemble the sensor head for inspection or repair, you may be exposed to the laser beam. If the LC-2400 series malfunctions, contact KEYENCE immediately.

- **Do not look directly at the laser beam.**
  Looking directly at the laser beam may result in serious eye injury.

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- **Protective enclosure**
  We recommend that you install a protective enclosure around the sensor head to prevent any person from getting near the sensor head during operation.

- **Protective goggles**
  We recommend that you wear protective goggles when using the LC-2400 series.

Note The intense light from this laser can be harmful to the eyes during prolonged viewing. Normal reflex blinking is usually enough to prevent any eye damage. However, it is best to wear laser protective glasses whenever working around a sensor head.

1-5 Safety Features Provided with the LC-2400 Series

The LC-2400 series comes with the following safety features:

■ Laser ON alarm LED

Both the sensor head and the controller panel have a visible LED that lights when laser is ready to be and is being emitted.

Note LEDs can be checked to see if they are lit even when you are wearing laser protective glasses.

Reference: Laser ON alarm LED (p.12, 14, 16)

■ Delay of laser beam emission

To prevent an operator from being exposed to the laser beam, the laser beam is emitted three seconds after the laser ON alarm LED lights.

■ Laser emission remote control input connector

The laser emission control connector is located on the rear panel of the control unit. The laser can be turned on or off by a remote control signal through this connector.

Reference: Laser Remote Grounding Connector (p.15)

■ Key-operated power switch

The controller power switch can be locked using the attached key.
When the LC-2400 controller is OFF, the key can be removed.

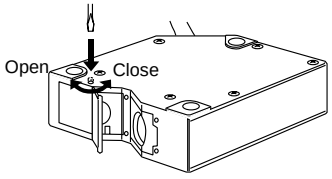
■ Laser beam shield

The sensor head transmitter comes with a laser beam shield.

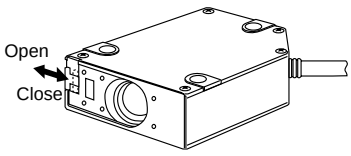
Precautions for parameter setup and measurements

If there is a danger of an operator looking into the laser beam when working in front of the sensor head, close the laser beam shield as shown below before starting operations.
Close or open the laser beam shield as shown below:

• Regular-reflective sensor head (LC-2420/LC-2430)



• Diffuse-reflective sensor head (LC-2440/LC-2450)



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CHAPTER 2

SYSTEM CONFIGURATION

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2-2 Expansion System Configuration 7
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2-4 Quick Reference Table 9

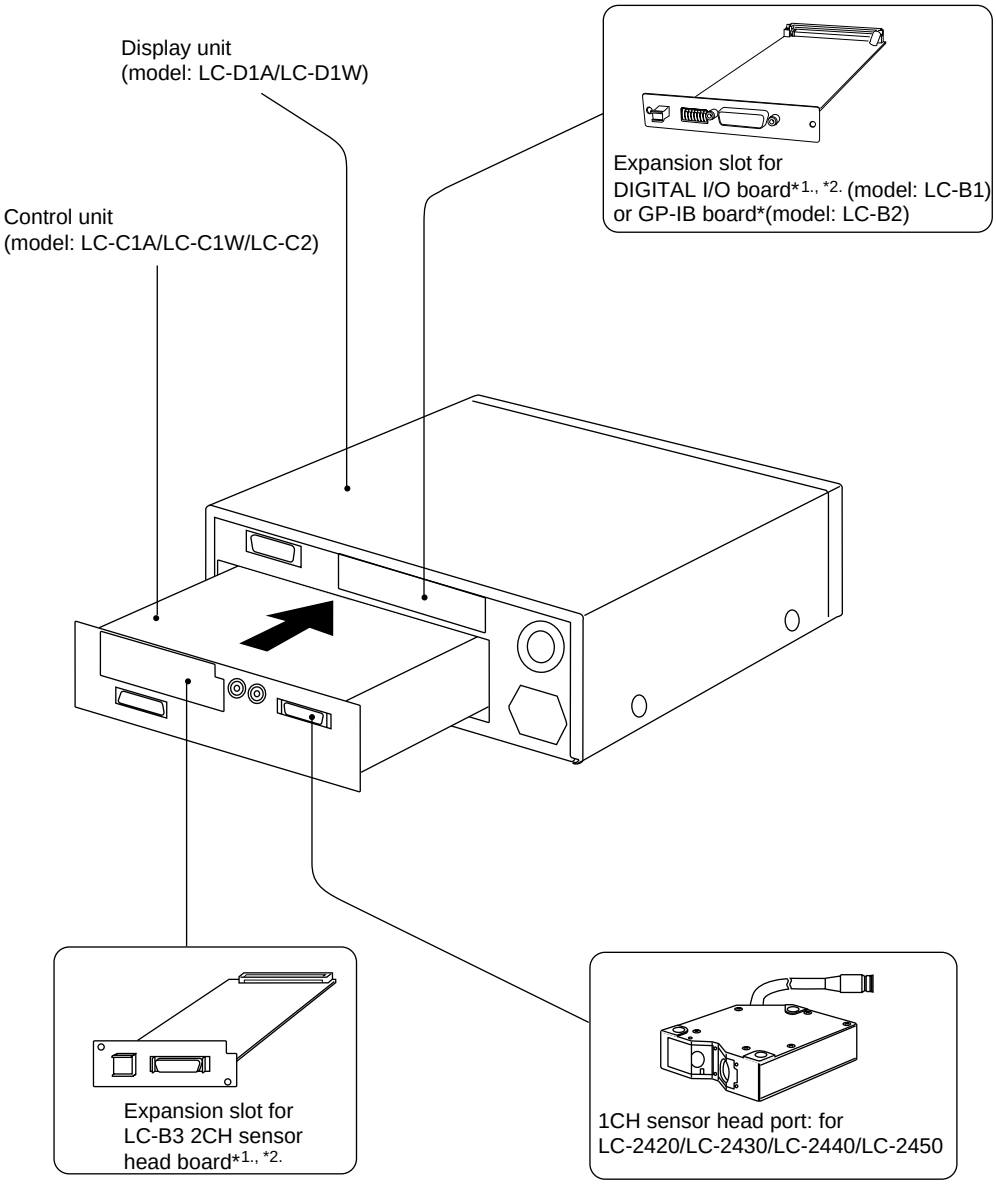
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The LC-2400 series is equipped with I/O ports for connecting to external equipment and a slot for installing an optional expansion board. By connecting personal computers or other devices to the LC-2400 series, measurement data obtained with the LC-2400 series can be used for various applications.

2-1 Basic System Configuration

The LC controller consists of a display unit and control unit. If required, the control unit can be used separately from the display unit. There are also two expansion slots; one for the optional LC-B3 board which, when installed, allows the use of a second sensor head and a second slot for either a DIGITAL I/O board or GP-IB board.

However, the LC-2400W series does not incorporate these expansion slots.

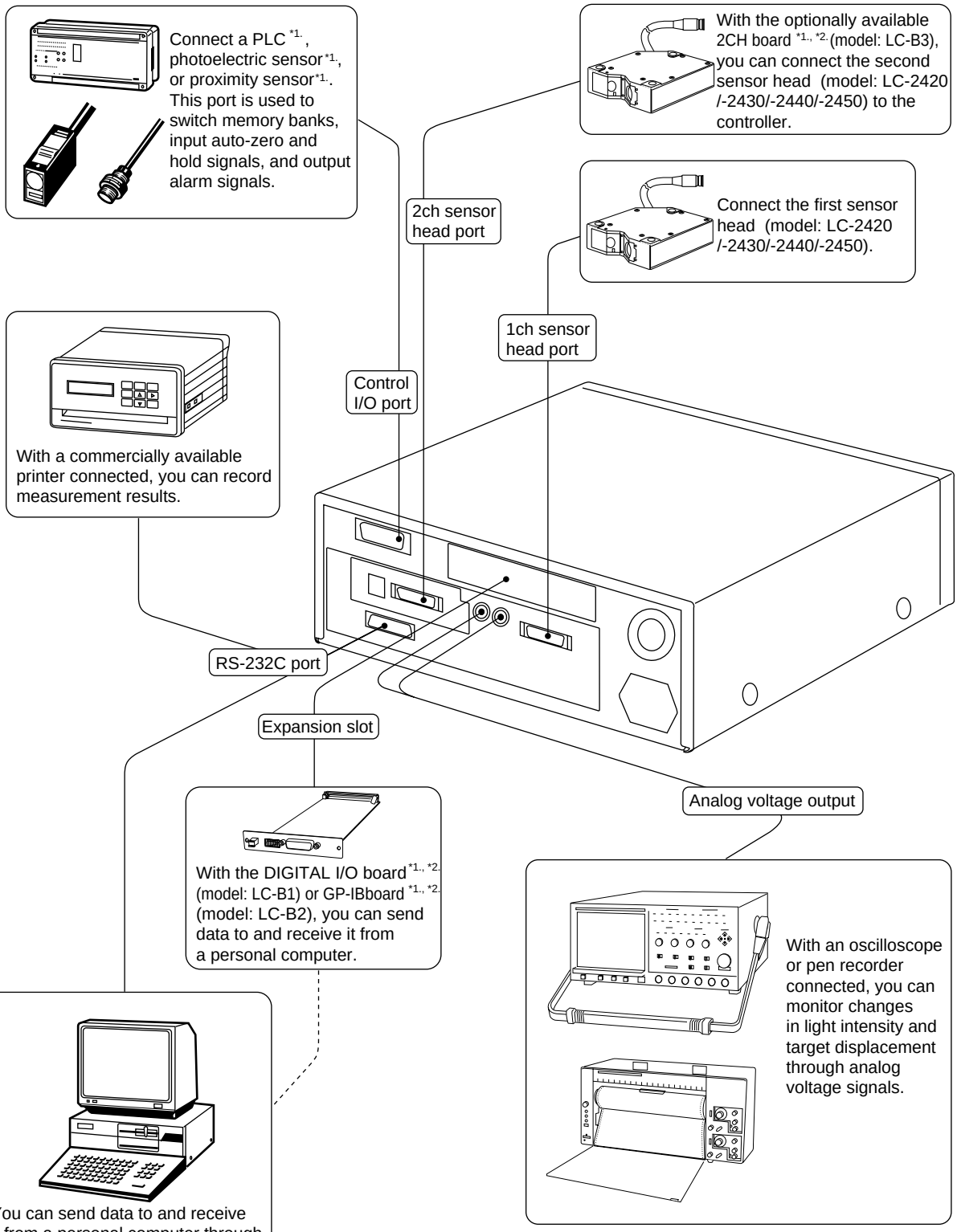


*1. Optionally available from KEYENCE
*2. Cannot be used with the LC-2400W series.

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2-2 Expansion System Configuration

For flexible expansion, a variety of external equipment can be connected to the LC-2400 series, as shown below.



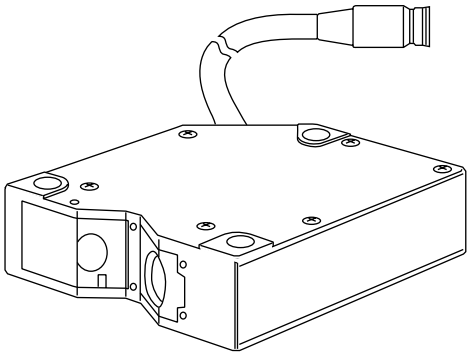
*1. Optionally available from KEYENCE
*2. Cannot be used with the LC-2400W series.

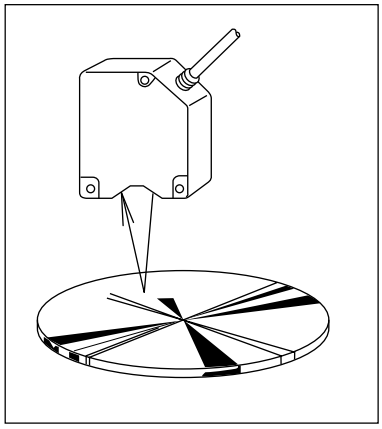
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2-3 Sensor Head Types and Functions

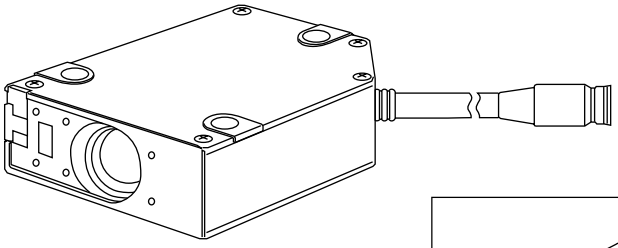
The LC-2400 Series gives you a choice of 4 sensor head models.

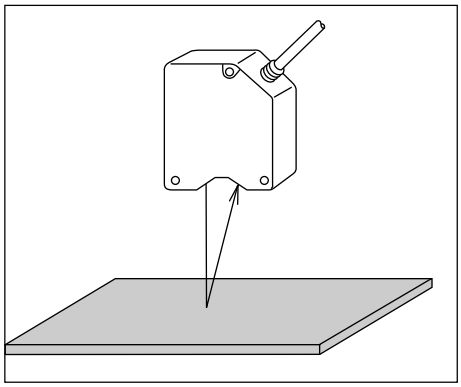
LC-2420/LC-2430: Regular-reflective sensor heads
Regular-reflective sensor heads are used to measure targets having a highly reflective or mirror-like surface.





LC-2440/LC-2450: Diffuse-reflective sensor heads
Diffuse-reflective sensor heads are used to measure targets having a low-reflective or opaque surface.





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2-4 Quick Reference Table

Sensor setup, cable connections, and various parameters must be set before starting measurement. However, some of the parameters are not necessary, depending on system configuration and the type of measurements being done. The following table shows the procedures to follow, in sequential order, before starting measurement. Find the items pertaining to your setup in the table to determine which sections of the manual are required reading.

Type of measurement							
Trial measurement							
Measuring height							
Measuring eccentricity							
Measuring thickness							
Measuring difference in height							
Section No.		**Page No.**					
5-1	Connecting Controller to Sensor Head	p.22	R	R	R	R	R
5-2	Connecting Power Supply Cable	p.22	R	R	R	R	R
5-3	Grounding Controller	p.23	R	R	R	R	R
5-4	Installing LC-B3 Board (2CH Sensor Head Board)	p.24	R	R			
5-5	Installing GP-IB or DIGITAL I/O Board	p.24					
5-6	Adjusting Sensor Head Position	p.25	R	R	R	R	R
6-1	Basic Operation of Controller	p.28	R	R	R	R	
6-2	Selecting Measurement Mode	p.30	R	R	R	R	R
6-3	Calibrating Sensitivity (Gain Selection)	p.30	R	R	R	R	
6-4	Selecting the Display/Output Mode	p.31	R	R			
6-5	Correcting Measurement Error (Calibration)	p.32	R	R	R	R	
6-6	Offset Values	p.35	O	O	O	O	
6-7	Reducing Variation in Measurement Data (Setting Number of Averaging Measurements)	p.36	R	R	R	R	
6-8	Reducing the Effect of Target Surface Irregularities (Setting Low-pass Filter Value)	p.36	O	O	O	O	
6-9	Setting Range for Light Intensity (INT. LIMIT)	p.37	O	O	O	O	
6-10	Setting Upper/Lower Limits for Measurements (Setting Tolerance)	p.39	O	O	O	O	
6-12	Storing and Loading Settings (Programming)	p.41	R	R	R	R	
7-1	Measuring with One Sensor Head	p.44			R	R	
7-2	Measuring with Two Sensor Heads	p.45	R	R			

R: Required reading
O: Optional reading

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CHAPTER 3

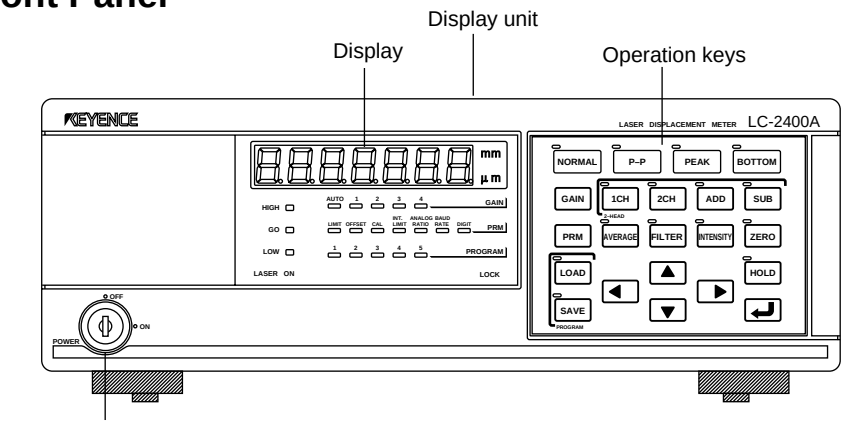
PART NAMES AND FUNCTIONS

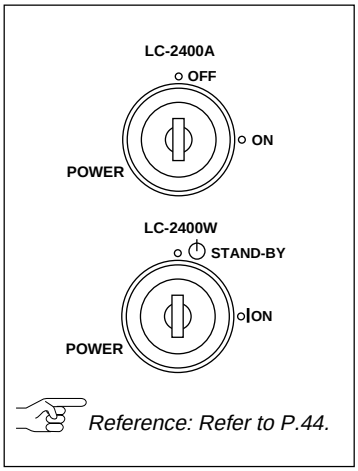
3-1 Controller 12
3-2 Sensor Head 16

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3-1 Controller

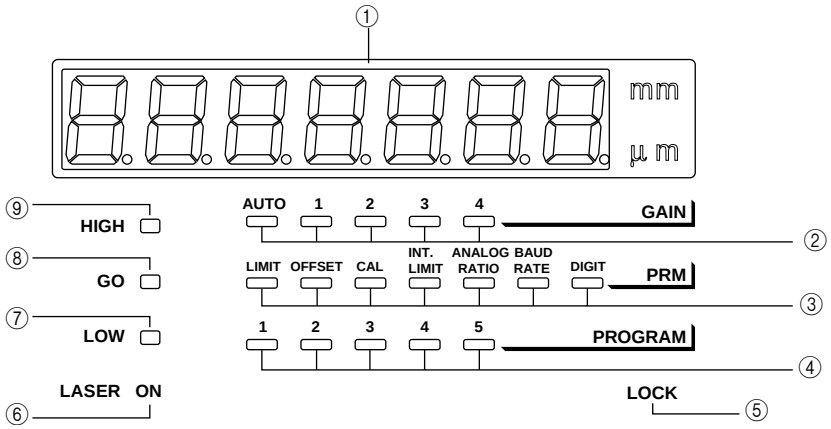
Front Panel





Reference: Refer to P.44.

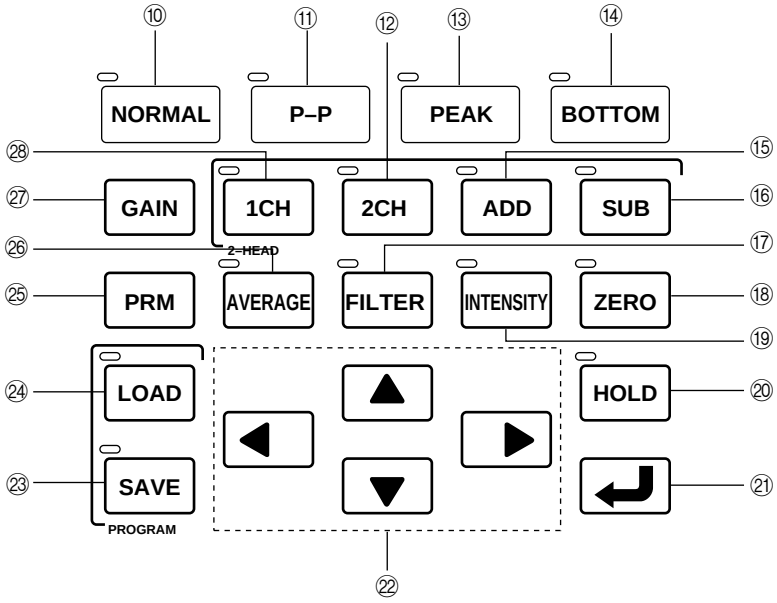
Display



No.	Name	Function	Ref. page
①	Display panel	Displays measured values, preset values and error messages.	p.82
②	GAIN LEDs	Indicates the receiver sensitivity. One of the four LEDs corresponding to the current sensitivity will be lit. When the receiver sensitivity is set to AUTO, one of the four LEDs and the AUTO LED will be lit.	p.30
③	PARAMETER LEDs	Lights when setting parameters such as upper/lower tolerance limits, offset, calibration, intensity limit, analog ratio, baud rate and display digit. The LED corresponding to the parameter currently being changed lights.	p.28
④	PROGRAM LEDs	The LED corresponding to the selected program number will be lit. The LEDs blink during program selection.	p.41
⑤	PANEL LOCK LED	Lights when the operation keys are disabled.	p.55
⑥	Laser ON alarm LED	Lights when the laser beam is ready to be and is being emitted from the sensor head.	p.4., 26
⑦	LOW LED	Lights when a measured value falls below the preset lower limit in each measurement mode.	p.39
⑧	GO LED	Lights when a measured value is within the preset tolerance range of that measurement mode.	p.39
⑨	HIGH LED	Lights when a measured value exceeds the preset upper limit of that measurement mode.	p.39

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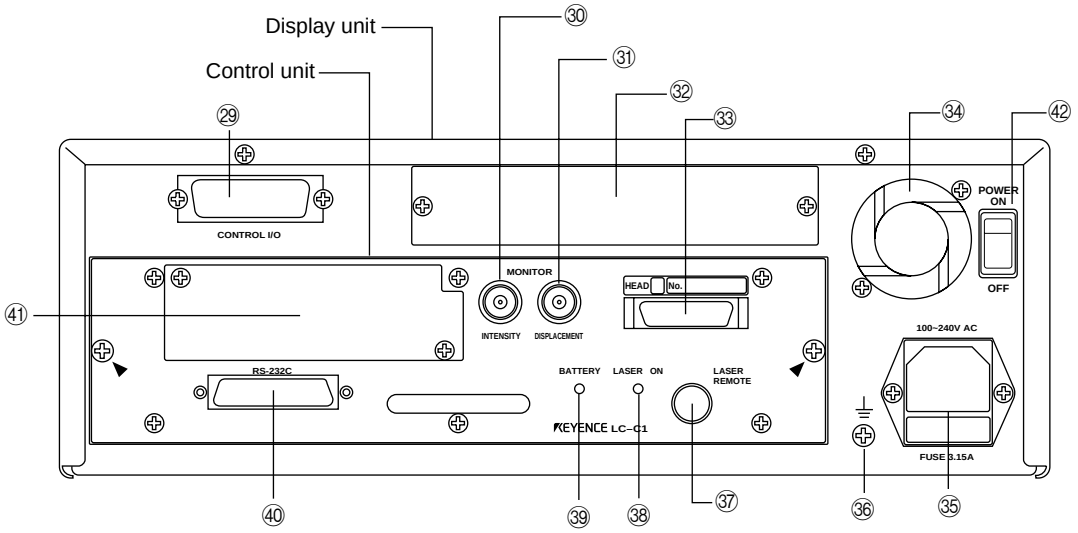
Operation Keys



No.	Name	Function	Ref. page
⑩	NORMAL key	Press this key to measure targets in the NORMAL mode.	p.30
⑪	P-P key	Press this key to measure targets in the Peak-to-Peak mode.	p.30
⑫	2CH key	Press this key to measure targets with the second sensor head (2CH slot) when two sensor heads are connected.	p.31, 45
⑬	PEAK key	Press this key to measure target in the PEAK mode.	p.30
⑭	BOTTOM key	Press this key to measure target in the BOTTOM mode.	p.30
⑮	ADD key	Press this key to measure thickness using two sensor heads.	p.31, 46
⑯	SUB key	Press this key to measure height deviation using two sensor heads.	p.31, 47
⑰	FILTER key	Press this key to set a (Low-pass) FILTER value.	p.36
⑱	ZERO key	Press this key to reset a measured value to "0".	p.29
⑲	INTENSITY key	Press this key to display received laser beam intensity.	p.29
⑳	HOLD key	Press this key to hold a measured value.	p.29
㉑	ENTER key.	Press this key to enter the value you set.	p.28
㉒	Numeral change keys	Press this key to change values. Press ◀ or ▶ to shift digits and press ▲ or ▼ to increase or decrease values as well as change signs.	p.28
㉓	SAVE key	Press this key to save a measured value.	p.41
㉔	LOAD key	Press this key to load stored parameter settings.	p.41
㉕	PRM key	Press this key to change parameter settings.	p.28
㉖	AVERAGE key	Press this key to set the number of averaging measure-ments.	p.36
㉗	GAIN key	Press this key to change receiver sensitivity.	p.30
㉘	1CH key	Press this key to use the first sensor head (1CH port) when two sensor heads are connected.	p.31,44

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Rear Panel



No.	Name	Function	Ref. page
㉙	CONTROL I/O port	Inputs signals (program, hold on/off, auto-zero on/off, etc.) from and outputs signals to external equipment.	p.71
㉚	INTENSITY output connector	Outputs the laser beam intensity measured with the LC in analog voltage.	p.74
㉛	DISPLACEMENT output connector	Outputs the measured displacement value as an analog voltage.	p.73
㉜	Expansion I/O slot	Install GP-IB board* or digital I/O board* in this slot.	p.24, 95
㉝	1CH sensor head connector	Connect the 1CH sensor head to this connector.	p.22
㉞	Ventilating fan	Radiates heat from the controller.	p.16
㉟	Power supply connector	Connect the power supply cable to this connector.	p.22
㊱	F.G. terminal	Ground the controller through this terminal.	p.23
㊲	LASER REMOTE connector	The LASER REMOTE connector is used to control laser emission by an external input signal. When this connector is not used, be sure to connect the attached laser remote grounding plug to this connector.	p.11
㊳	Laser ON alarm LED	Lights when a laser beam is ready to be and is being emitted from the sensor head.	p.18, 26
㊴	BATTERY LED	Lights when the internal backup battery is exhausted.	p.15
㊵	RS-232C I/O port	Connect a personal computer or other device to this port to externally control the LC.	p.50
㊶	LC-B3 board slot	Install the optional LC-B3 board in this slot. The LC-B3 cannot be used with the LC-2400W series.	p.24
b	Power switch	Use this switch to turn the main power supply on or off. (LC-2400W only)	

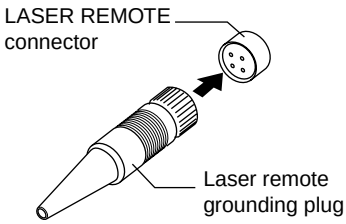
* Optionally available

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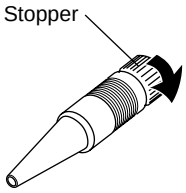
Laser Remote Grounding Plug

Follow the instructions below to insert this plug into the LASER REMOTE connector.

1. Check the connector's orientation before insertion.

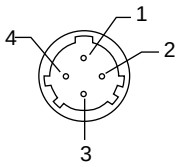


2. Turn the stopper clockwise to lock it in place.

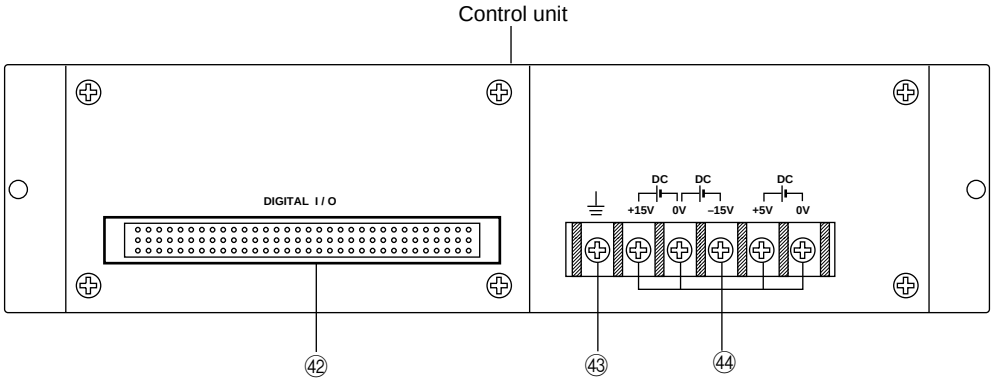


Note

Laser emission is enabled when pins 1 and 2 of the connector are shorted.



Control Unit Face

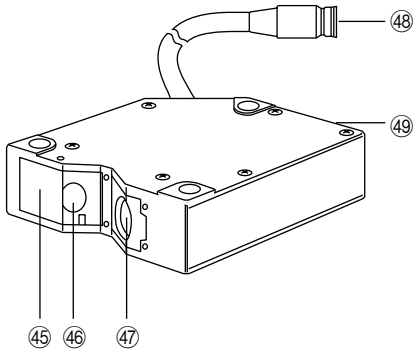


No.	Name	Function	Ref. page
㊷	96-pin DIGITAL I/O port	The control unit is connected to the display unit via this connector. Digital signals are output through this connector when the control unit is used separately from the display unit.	p.74
㊸	Earth ground terminal	Ground the control unit through this terminal when using the control unit separately from the display unit.	p.23
㊹	Power supply terminals	Connect the power supply cable to these terminals when using the control unit separately from the display unit.	p.23

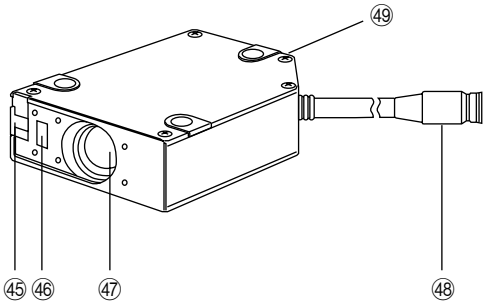
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3-2 Sensor Head

LC-2420/2430 (Regular-reflective)



LC-2440/2450 (Diffuse-reflective)



No.	Name	Function	Ref. page
㊺	Laser beam shield	The laser beam shield is used to cover the laser beam transmitter. When operators are working near the sensor head, if there is a risk of looking directly at the laser beam, be sure to cover the transmitter with the shield.	p.4
㊻	Transmitter	Emits laser beams.	p.18
㊼	Receiver	Receives the reflected laser beam.	p.18
㊽	Cable connector	Connects the sensor head cable to the controller.	p.22
㊾	Laser ON alarm LED	Lights when a laser beam is ready to be and is being emitted from the sensor head.	p.4, 26

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CHAPTER 4

OPERATING INSTRUCTIONS

4-1 Instructions for Using Controller and Sensor Head 18

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Before operating the LC-2400 series, read the following instructions carefully. If you encounter any problems, please contact us.

4-1 Instructions for Using Controller and Sensor Head

After Receiving the LC-2400 Series

- After receiving the LC, check the contents to see if any items were damaged during transportation.
- Check that all the items were included.

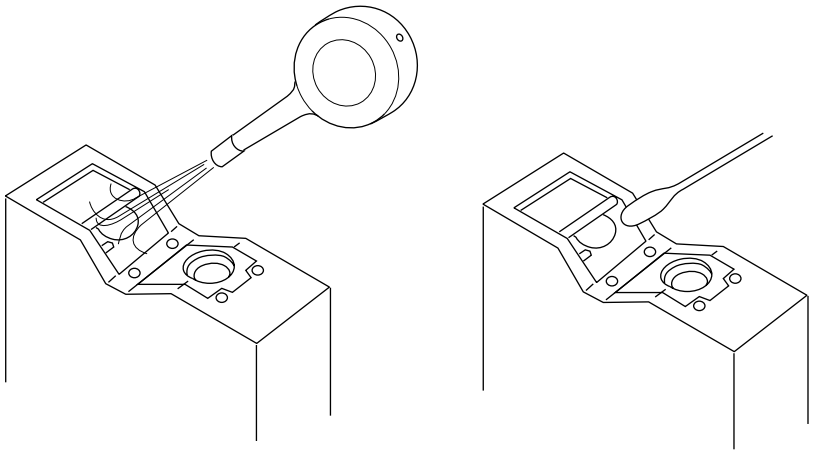
Reference: Contents of the Package (p.ii)

- Before using the LC, be sure to read this instruction manual for details on the correct use of this product.

Daily Maintenance Instructions

- Do not try to disassemble the LC or use a disassembled unit. Do not disassemble the sensor head in particular, since all of the sensor head parts have been factory-calibrated.
- Please handle the controller and sensor head with care. The precision optical components in the sensor head are especially susceptible to shock.
- The receiver and transmitter lenses are the critical components for accurate measurement. Any flaw or dust on the lenses may result in measurement errors. If dust has accumulated on the transmitter and receiver lenses, clean the lens surface by following the procedures given below.

1. Blow the dust off the receiver and transmitter lenses using a manual blower.
2. If dust persists, wipe the lens surface gently using a cotton swab dipped in alcohol.



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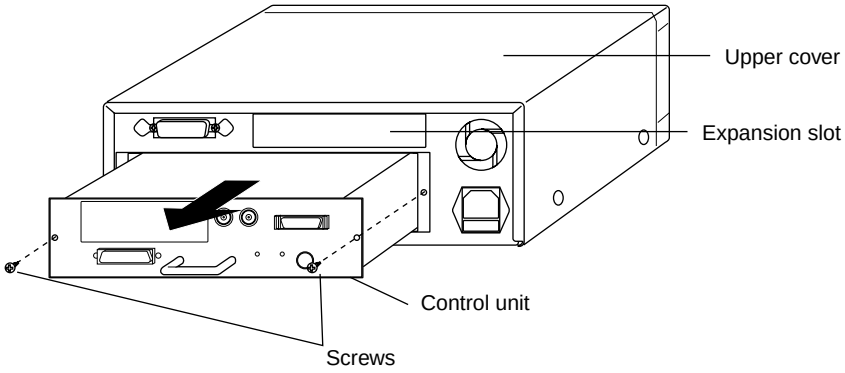
Replacing Battery

The LC controller has an internal backup battery for storing parameter settings. The expected battery life is 1 to 2.5 years. When the battery is exhausted, the BATTERY LED lights. When this LED is lit, replace the battery by following the procedure given below.

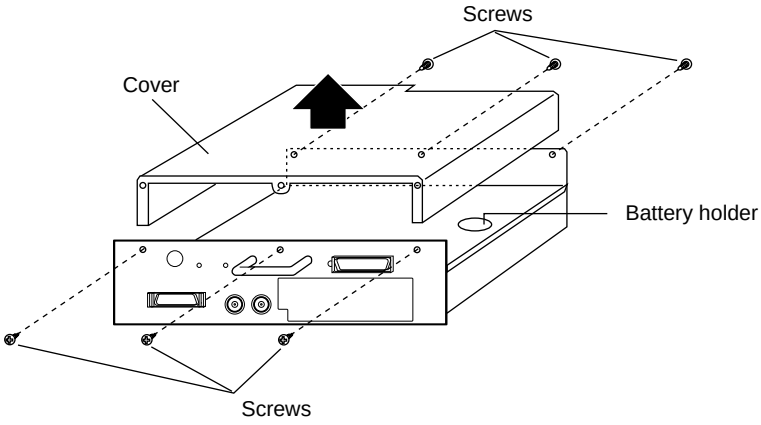
⚠ WARNING Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer's instructions.

⚠ CAUTION **Turn the power OFF and unplug the power cable from the wall outlet.**

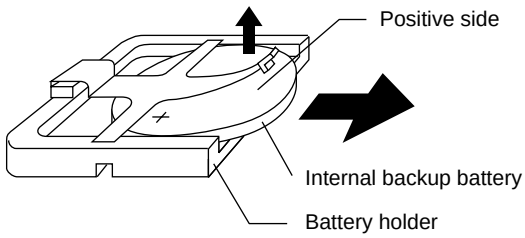
1. Remove the two screws from the back of the display unit and remove the control unit.



2. Turn the control unit upside down, remove the six cover screws from the cover and then remove the cover.
   Locate the battery holder in the control unit.



3. Remove the battery from the battery holder.



4. Install the new battery in the battery holder with the positive side facing up. When installing a new battery, be sure that the polarity of the battery is correct.

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5. Put the cover back on the control unit and secure it with the six cover screws.

6. Reinsert the control unit into the display unit with the top of the control unit facing up, and secure the control unit with the two retaining screws.

Instructions for Sensor Setup

CAUTION

Turn the power OFF when connecting or disconnecting the sensor head connector, power supply cables, or any of the optional boards. Otherwise, the laser diode or other electronic components may become degraded or damaged.

- Place the LC in a location that meets the following requirements:
  Temperature: 0 to 40°C
  Humidity: 35 to 85% RH (No condensation)
  Placing the LC in a location that does not meet these requirements may cause the controller and sensor head to malfunction.

  Do not operate the LC in a location where extreme temperature variations are expected.

- Do not operate the LC where volatile flammable objects or corrosive gases are present.

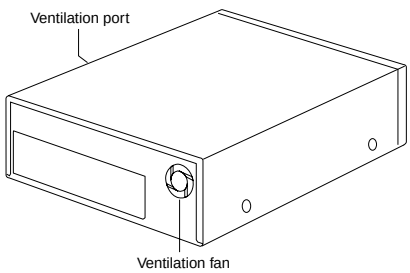
- Do not expose the LC to extremely high humidity or water splashes.

- When using the control unit separately from the display unit, be sure to provide a protective cover for the control unit during operation.

- To prevent noise, keep the connection cables separate from the power cables. If this is not possible, shield or ground the connection cables.

- Insulate the sensor head if noise is transferred through the sensor head.

- Do not block the ventilation port or the ventilation fan of the controller. If they are blocked, the controller may overheat, resulting in a malfunction. Note also that a ventilation fan is not provided with the control unit. When using the control unit separately from the display unit, make sure that the room is sufficiently ventilated.



Hints on Correct Use

- Keep the ambient temperature at a constant level during measurement.

- If the sensor head is operating in a location where there is thick fog or hot air, measurement errors may result.

- Be sure to leave the power on for at least 60 minutes before starting measurements.

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CHAPTER 5

CONNECTIONS

5-1 Connecting Controller to Sensor Head 22
5-2 Connecting Power Supply Cable 22
5-3 Grounding Controller 23
5-4 Installing LC-B3 Board (2CH Sensor Head Board) 24
5-5 Installing GP-IB or DIGITAL I/O Board 24
5-6 Adjusting Sensor Head Position 25

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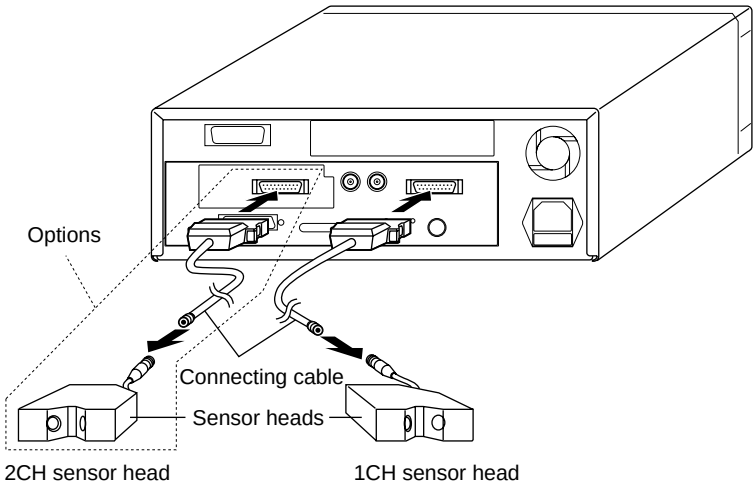
5-1 Connecting Controller to Sensor Head

The 2CH sensor head cannot be used with the LC-2400W series.

CAUTION

Turn the power OFF when connecting or disconnecting the sensor head connector, power supply cables, or any of the optional boards. Otherwise, the laser diode or other electronic components may become degraded or damaged.

Connect the controller to the sensor head using the supplied connecting cable. At this time, make sure that the control unit and sensor head have the same serial number.



If you purchase the LC-B3 and sensor head later, you can connect them to the controller without adjustment because the sensor head and the LC-B3 have been factory-calibrated as a pair.

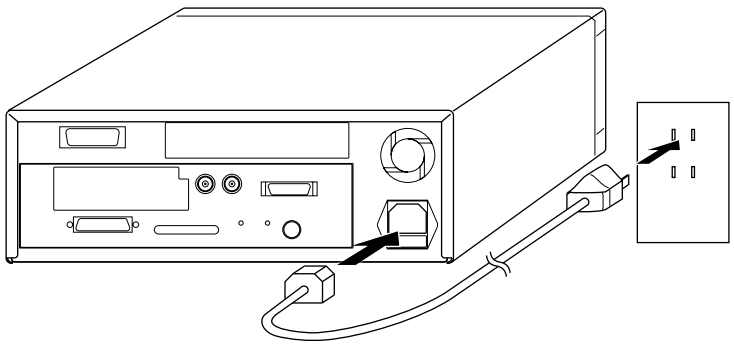
5-2 Connecting Power Supply Cable

Connecting the Power Supply Cable When Using the Display Unit

CAUTION

Turn OFF the LC controller before starting the following procedure.
Plug the power supply cable into the power supply socket located on the rear of the display unit, and then into a wall outlet.

Power must be 100 to 240 VAC (50/60 Hz).



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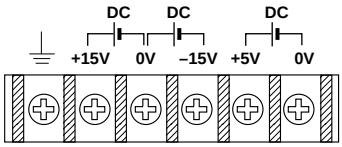
Connecting the Power Supply Unit to a Separate Control Unit

Cannot be used with the LC-2400W series.

CAUTION

Turn OFF the power supply unit before starting the following procedure.

Connect the power supply unit to the power supply terminals located on the front of the control unit.



Note that the control unit uses the following types of power:

- ±15 VDC (±3%), 0.5A
- ±5 VDC (±5%), 3A, ripple (p-p): 100 mV max.

CAUTION

Be sure to supply ±15 VDC and +5 VDC at the same time. Supplying only +5 VDC may cause a malfunction.

5-3 Grounding Controller

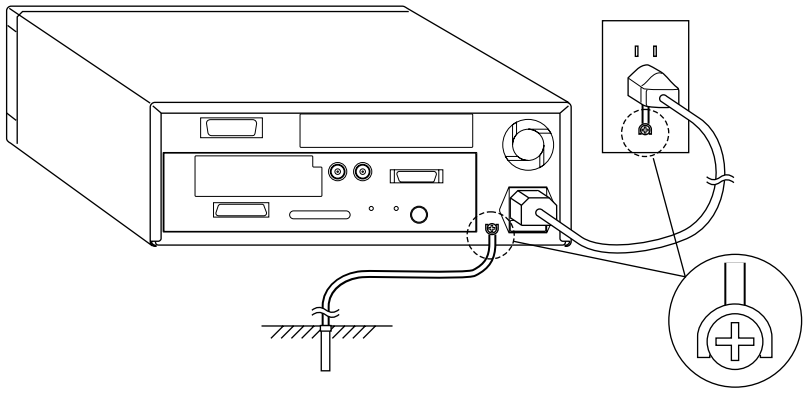
The controller can be grounded either by connecting the earth ground terminal located on the rear of the display unit to a grounding electrode or by connecting the ground wire of the power supply cable to the ground screw of a wall outlet. To prevent any risk of malfunction, ground the LC both ways as shown below.

CAUTION

Be sure to ground the controller separately from other devices.

Grounding the Controller When Using the Display Unit

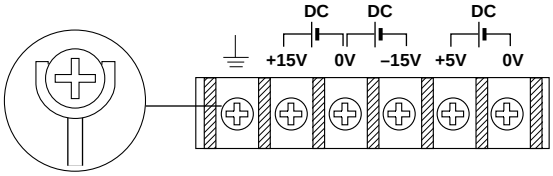
Earth-ground the controller through the earth ground terminal located on the rear of the display unit with the ground wire of the power supply cable.



Grounding the Control Unit

Cannot be used with the LC-2400W series.

Earth-ground the control unit through the earth ground terminal located on the front of this unit.



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5-4 Installing LC-B3 Board (2CH Sensor Head Board)

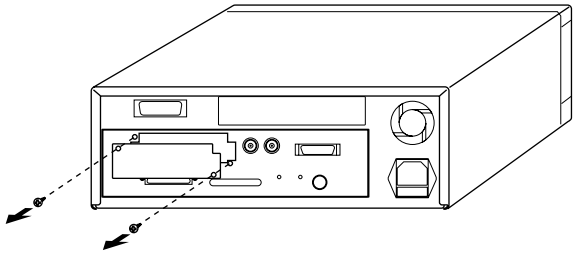
Cannot be used with the LC-2400W series.

To use two sensor heads with the LC controller, the LC-B3 board must be inserted into the LC-B3 board slot located at the rear of the control unit. (The LC-B3 board is optional. Contact KEYENCE for details.)

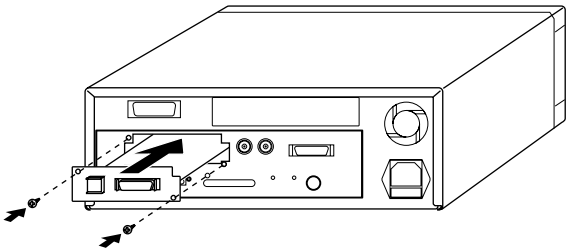
CAUTION

Turn OFF the LC and unplug the power cable from the wall outlet before starting the following procedure.

1. Remove the two screws securing the LC-B3 board slot cover on the rear of the control unit.



2. Align the LC-B3 board with the grooves of the LC-B3 board slot, insert the LC-B3 board all the way into the slot, and secure the board using the two screws removed in step (1).



4-5 Installing GP-IB or Digital I/O Board (Options)

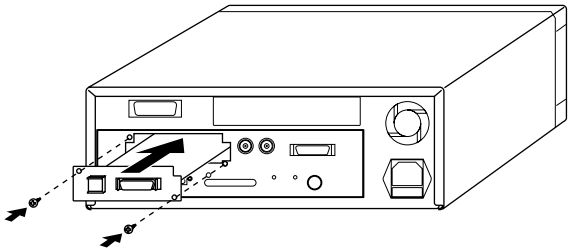
Cannot be used with the LC-2400W series.

CAUTION

Turn OFF the controller and unplug the power cable from the wall outlet.

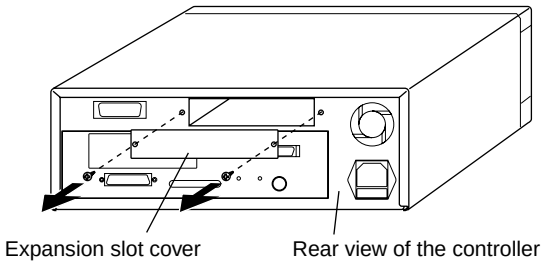
Insert the GP-IB or Digital I/O Board into the expansion slot on the display unit as shown in the following figure. (See chapter 9.)

1. Remove the two screws securing the expansion slot cover at the rear of the display unit.



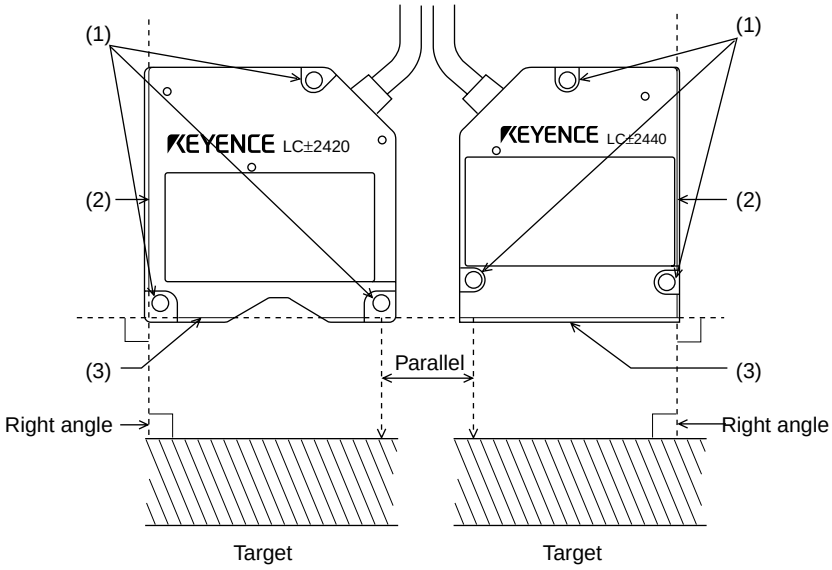
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2. Align the board with the grooves of the expansion slot, insert the GP-IB or DIGITAL I/O board all the way into the slot, and secure the board using the two screws removed in step (1).

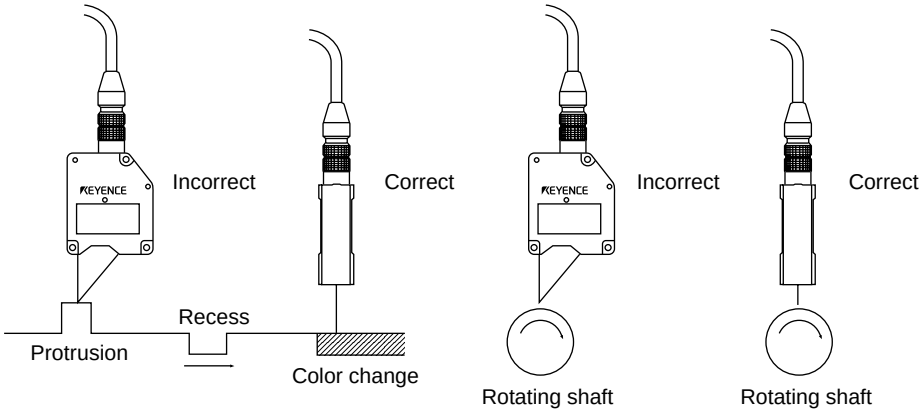


5-6 Adjusting Sensor Head Position

1. Align the sensor head using the following three positions as alignment points:
   (1) The three mounting holes on each side of the sensor head
   (2) The sides of the sensor head
   (3) The front (laser-emitting surface) of the sensor head



When there is a significant change in target color, material, or height, measurement errors may result depending on the orientation of the sensor head. Proper orientation is shown below.

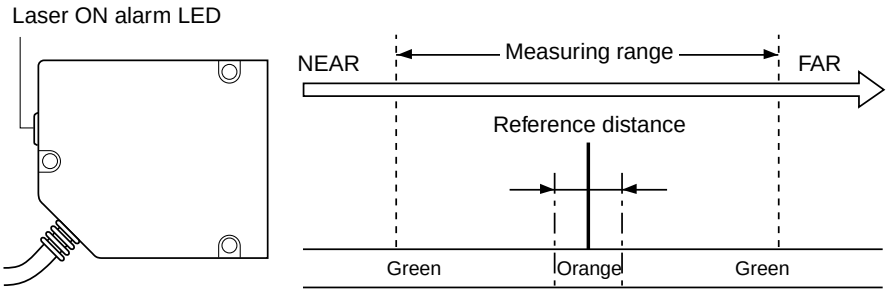


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2. Turn on the LC controller and adjust the sensor head position so that the laser ON alarm LED located on the sensor head lights orange. The sensor head is at the "reference distance" from the target when the above LED lights orange.

Checking for Reference Distance

When the distance between the target and sensor head is within the reference distance range, the laser ON alarm LED lights orange. The sensor head can be easily positioned even when the control unit is used without the display unit.



Sensor head	Range the LED lights orange
LC-2420	±0.02 mm
LC-2430	±0.05 mm
LC-2440	±0.3 mm
LC-2450	±0.8 mm

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CHAPTER 6

SETTING UP

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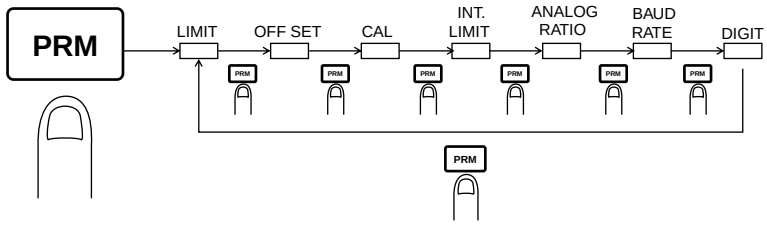
6-1 Basic Operation of Controller

This section describes the basic operation procedures of the controller.

Selecting a Parameter (PRM key)

1. Press the PRM key.
   One of the PARAMETER LEDs lights, and the current value for the parameter appears on the display panel. The LC is now in the setting mode.

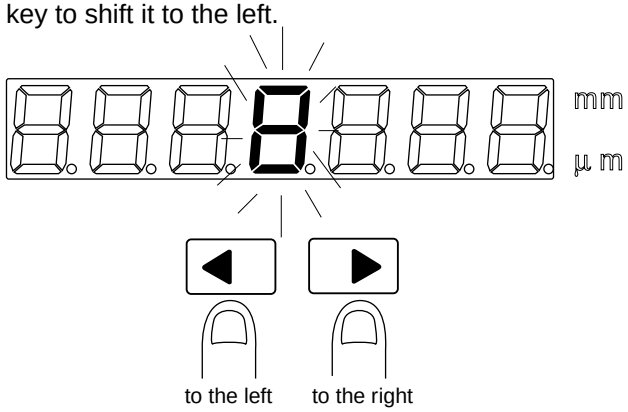
2. Press the PRM key repeatedly.
   The PARAMETER LEDs go on and off one after another as shown below. The illuminated LED means that the corresponding parameter is selected.



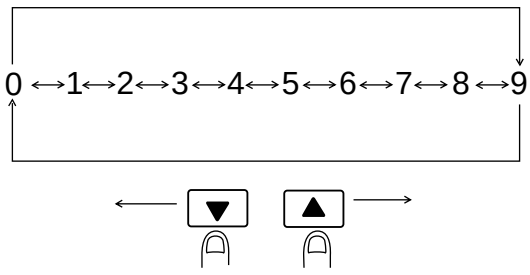
Entering Numerical Values (▲, ▼, ◀, and ▶ keys)

1. Select the desired parameter. The LC is ready to accept a numerical value.

2. Select a digit.
   Press the ▶ key. The selected digit starts flashing.
   Press the ▶ key to shift the selection to the right, and press the ◀ key to shift it to the left.



3. Change the digit.
   Press the ▲ or ▼ key while the digit is flashing. Press the ▲ key to increase the value. Press the ▼ key to decrease it.



4. Confirm the setting.
   Press the ↵ key to confirm the new setting.

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Displaying Light Intensity (INTENSITY key)

A function is available to display the intensity of reflected light from the target. The light intensity is displayed and output within a range of 1 to 50000. If possible, the target should have a light intensity of 00050 or greater for accurate displacement measurement.

1. Position a target for measurement.

2. Press the INTENSITY key.
   The LED above the INTENSITY key lights, and the light intensity appears on the display panel.

Note An analog voltage equivalent to the light intensity is always output.

3. Press the INTENSITY key again.
   The LED above the INTENSITY key goes off, and the system will return to the measuring mode.

Automatic Zero Function (ZERO key)

This function sets the current measurement and displayed values to +0.0000 mm in the NORMAL, BOTTOM, or PEAK mode. After the function is executed, the LC will display and output displacement relative to the new reference (zero) point.

1. Execute the automatic zero function.
   Press the ZERO key.
   The LED above the ZERO key lights and the displayed value turns to +0.0000 mm. Now the display will show the displacement relative to the new reference point.



2. Cancel the automatic zero setting function.
   Press the ZERO key again.
   The display restores the value before the automatic zero function was executed.

Note
- This function can be operated even when the ADD or SUB key is used.
- The automatic zero function can also be operated via the CONTROL I/O port.

Hold Function (HOLD key)

The hold function is used to retain and output the last measured value. This function enables reading and recording of a specific analog value at a given moment.

1 Press the HOLD key.
   The LED above the HOLD key lights and the last measured value is displayed as well as output.

2 Press the HOLD key again.
   The hold function is deactivated and the LC-2400 series returns to the measurement mode.

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Note The HOLD function can also be operated via the CONTROL I/O port.

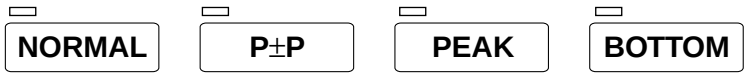
> Activating or deactivating the hold function in the P-P, PEAK, or BOTTOM mode will cause the LC to return to the measurement mode and reset the measurements.

6-2 Selecting Measurement Mode

Four measurement modes are available. Measurements from each mode can be displayed as well as output to external equipment.

Measurement mode	Function
NORMAL	Measures displacement from reference point
P-P (Peak-to-Peak)	Measures displacement between maximum and minimum values
PEAK	Measures maximum value from reference point
BOTTOM	Measures minimum value from reference point

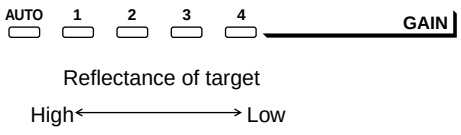
Factory setting: NORMAL
Press the mode selector key (NORMAL , P–P , PEAK , or BOTTOM key). The LED of the selected mode lights, confirming that the controller is now in that measurement mode. Note that the measurements in any of the P-P, PEAK, or BOTTOM mode can be reset by pressing the same mode selector key again.



Note The measurements can also be reset by pressing HOLD twice.

6-3 Calibrating Sensitivity (Gain Selection)

Light sensitivity of the sensor head can be adjusted through gain selection. The LC calculates a measurement based on the intensity of reflected light from the target. Because the light intensity varies with the reflectance of the target surface, the sensitivity of the sensor head must be optimized accordingly. The system offers four levels of sensitivity, which can be identified by the GAIN LEDs on the display unit. The correlation between the GAIN LEDs and light sensitivity of the sensor head is as shown below.

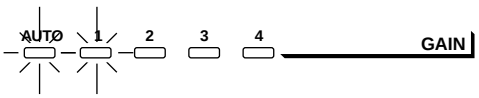


Factory setting: AUTO

Reference: Displaying Light Intensity (P. 29)

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1 Press the GAIN key. The AUTO LED and one of the four GAIN LEDs will light. When measurements are performed with these two LEDs on, the sensitivity will change automatically according to the light intensity received.



2 Press the GAIN key again to select the lit LED.

Note For a target whose reflectance varies greatly, the AUTO function can be selected. However, the measurement may show some variation when sensitivity is changed.

6-4 Selecting Display/Output Mode

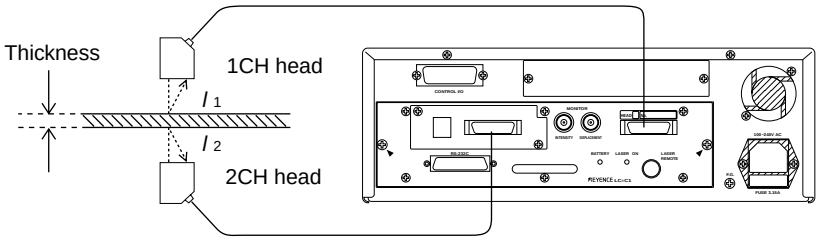
The 2CH mode cannot be used with the LC-2400W series.

Any of the following modes can be selected when two sensor heads are used during measurements.

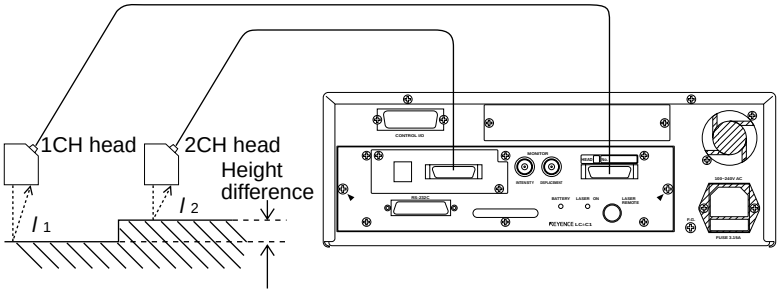
Mode	Function
1 CH	Displays/outputs the 1CH measurement.
2 CH	Displays/outputs the 2CH measurement.
ADD	Adds the 1CH and 2CH measurements and displays/outputs the negative of this result. $-(l_1 + l_2)$
SUB	Subtracts the 2CH measurement from the 1CH measurement. $(l_1 - l_2)$

Factory setting: 1CH

• Measurement example in the ADD mode



• Measurement example in the SUB mode



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- Only one of the four modes can be selected at a time.
- None of these modes can be selected when only one sensor head is used.
- In the ADD or SUB mode the 1CH intensity is displayed/output.

To enter any of the above modes, press the desired key (1CH , 2CH , ADD , or SUB key) and the LED above the key pressed will light.

6-5 Correcting Measurement Error (Calibration)

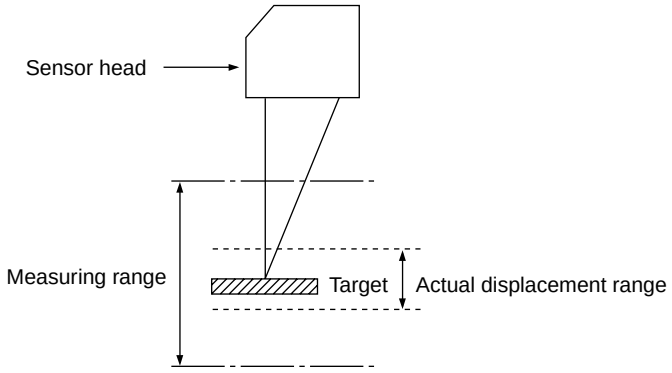
Calibrating the LC corrects the difference between the actual displacement and that measured by the LC. Always calibrate the LC after having moved the sensor head or having changed over the target types.
There are two ways to calibrate the LC; calibration with a target (target positioning), and calibration without a target (entering a numerical value). Calibrate the LC using one of these methods. If frequent product changeover occurs, it is useful to record the calibration value for each product after calibration. The LC can then be re-calibrated simply by entering the calibration value recorded.

Factory settings: LC-2420: 200.00 µm LC-2430: 500.00 µm
LC-2440: 3.0000 mm LC-2450: 8.0000 mm

Calibration by Target Position

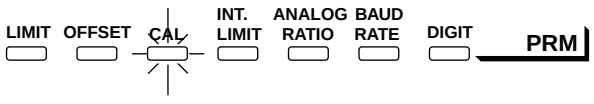
The LC is calibrated based on measurements of the target position.

1 Position the target within the measuring range.



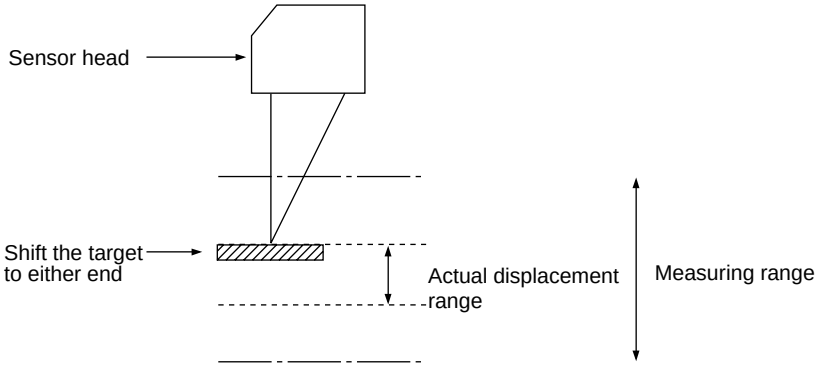
2 Press the NORMAL key. The LED above the key will light.

3 Press the PRM key repeatedly until the CAL LED lights. The LED lights and the LC continues to measure.



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4 Shift the target to either end of the actual displacement range (closest or farthest from the sensor head).

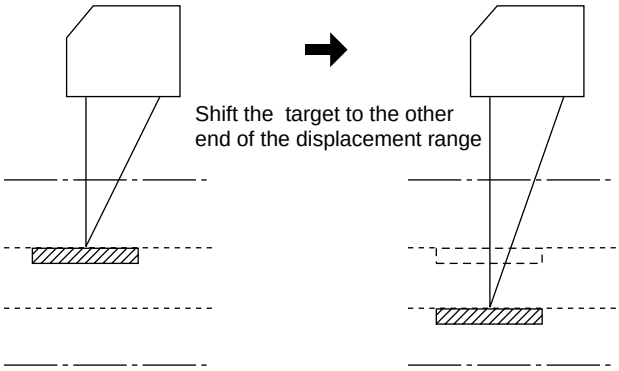


- Be careful not to position the target outside of the measuring range.
- Instead of the target, the sensor head may be shifted during calibration.

5. Press the ZERO key.
The displayed value changes to zero.

6. Shift the target to the other end of the displacement range. Again, the sensor head may be shifted instead of the target.

Shift the target to the other end of the displacement range.



Be careful not to position the target outside of the measuring range.

7 Press the ↵ key.
The digits on the display start flashing and the LC switches to the calibration mode.

Note During calibration, pressing the PRM key, then the ↵ key will cancel calibration. When the calibration mode is canceled, the LC will return to the measurement mode.

8 Change the value on the display panel to the actual distance the target was moved.

Reference: Entering Numerical Values (P.28)

9 Press the ↵ key.
Calibration is complete. The LC returns to the measuring mode.

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- Calibrate the LC by shifting the target only within the measuring range.
- If the calibration measurement is unacceptable, the error message "C-Err" (Calibration Error) appears on the display when the ↵ key is pressed. If this occurs, repeat the calibration.

The calibration range is as follows:

$$0.9 \leq \frac{\text{Value to be entered in step 8}}{\text{Measurement obtained with factory settings}} \leq 1.1$$

Calibration by Entering a Numerical Value

The LC can be calibrated simply by entering previously recorded calibration values.
Check and record the calibration values by following the procedures shown below. The LC can then be calibrated simply by entering this value.

Checking Calibration Value

Check the calibration value obtained from the calibration procedure using a target.

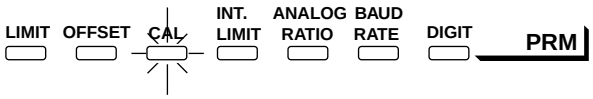
1. Calibrate the LC using a target.

Reference: Calibration by Target Position (P.32)

2. To interrupt the laser beam, close the laser beam shield or insert a light-shielding object at the closest possible position to the sensor head, between the sensor head and target.
   The message "dRr" appears on the display panel.

When interrupting the laser beam, be careful not to touch the glass window of the sensor head.

3. Press the PRM key repeatedly until the CAL LED lights.



4. Press the ↵ key.
   The LC is ready to accept a new calibration value, and the calibration value appears on the display. Record the value.

5. Press the ↵ key again.
   The LC returns to the measuring mode.

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Entering Calibration Value

Enter the calibration value by following the procedures shown below.

1. Follow the same procedures used for checking the calibration value.

2. Change the displayed value to the recorded calibration value.

Reference: Entering Numerical Values (P.28)

Note Press the PRM key first, then the ↵ key as many times as required to return to the measuring mode. The entered value and calibration mode are canceled.

3 Press the ↵ key.
Calibration is complete. The LC returns to the measuring mode.

Note To calibrate the LC through the RS-232C interface, enter the following calibration coefficient:

$$\text{Calibration coefficient} = \frac{\text{Desired preset value}}{\text{Factory setting value}}$$

6-6 Offset Values

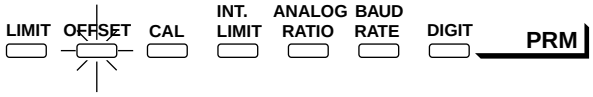
Offset values are added to or subtracted from a measurement before displaying or outputting it. Offset values are used for displaying or outputting the target height or thickness as an absolute value. This function is also used to tune the LC to the input requirements of the equipment that is connected to it.
The maximum and minimum offset values available depend on the sensor head as shown below.

Sensor head	Offset value range	Max. output range
LC-2420	+199.99 µm	±327.66 µm
LC-2430	+499.98 µm	±655.32 µm
LC-2440	+2.9998 mm	±6.5532 mm
LC-2450	+7.9995 mm	±16.3830 mm

Factory setting: 0

> If a displayed value with a offset becomes beyond the maximum output range is specified, "**- - - - -**" will appear.

1. Press the PRM key repeatedly until the OFFSET LED lights.
The current offset value appears on the display panel and the LC is ready to accept a new offset value.



2. Enter an offset value.

Note To cancel entry of the offset value, press the PRM key first, then the ↵ key as many times as required to return to the measuring mode. The entered value and offset mode are canceled.

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3. Press the [↵] key.
   The offset value is stored, and the LC will returns the measurement mode.

6-7 Reducing Variation in Measurement Data (Setting Number of Averaging Measurements)

The LC has a function for creating an average measurement value from a series of measurements. The more variation occurring in measurements, the higher the number of measurements should be taken in order to attain a stable, average measurement. The number of measurements can be selected from 18 different settings ranging from 1 to 131072.

> This averaging function and the filtering function explained in Section 6-8 cannot be used at the same time.

Factory setting: 2048

Reference: Number of averaging measurements vs. response frequency (P.83)
Averaging method (P.91)

1. Press the [AVERAGE] key.
   The LED above the [AVERAGE] key lights, and the current number of averaging measurements appears on the display panel.

2. Press the [▲] or [▼] key to change the value. Every time the key is pressed, the number of measurements increases or decreases to twice or half the original value (1, 2, 4, 8, 16, 32, 64, 128 ..... 131072).

Note To cancel entry of the number of measurements, press [AVERAGE] key. This mode is canceled and the LC returns to the measuring mode.

3. Press the [↵] key.
   The number of measurements chosen is set, and the LC returns to the measuring mode. The LED above the [AVERAGE] key remains lit during measurements.

6-8 Reducing Effect of Target Surface Irregularities (Setting Low-pass Filter Value)

A low-pass filter is used to attenuate measurements at frequencies higher than the preset limit. The preset frequency is referred to as the cutoff frequency.
This is useful for targets with treated surfaces (e.g. hairline finish). When measuring these targets, the sensor detects surface irregularities (picks up noise), preventing accurate measurement. By setting a filter value, the LC can more accurately measure the displacement of the target without distortion from the texture of the target surface.

Factory setting: FILTER OFF, cutoff frequency: 100

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- A digital low-pass filter is used.
- The filtering function cannot be used when using the control unit independently.
- This function and the averaging function explained in the previous section cannot be used at the same time.

1. Press the FILTER key.
   The LED above the key flashes and the current cutoff frequency appears on the display.

2. Set the cutoff frequency
   The cutoff frequency can be set between 0100 and 4999 Hz.

Note If this frequency is set below 0100, the error message "F-Err" appears.

Note To cancel entry of the cutoff frequency, press the FILTER key. The setting is canceled, and the LC returns to the measuring mode.

3. Press the ↵ key.
   The new cutoff frequency is set, and the LC returns to the measuring mode. The LED above the FILTER key remains lit during measurements.

6-9 Setting Range for Light Intensity (INT. LIMIT)

The range for light intensity can be set. The upper/lower limits are referred to as the "HIGH-INTENSITY LIMIT" and "LOW-INTENSITY LIMIT", respectively. Also, the measurement of displacement just before the light intensity exceeds the HIGH-INTENSITY LIMIT or falls below the LOW-INTENSITY LIMIT can be retained. The duration to retain the measurement is referred to as a "level-cut time". This can eliminate inaccurate measurements resulting from sudden changes in the light intensity or presence of dents or grooves on the target surface.

Factory settings:
LOW-INTENSITY LIMIT: 50 (selectable between 00000 and 49998)
HIGH-INTENSITY LIMIT: 49750 (selectable between 00000 and 49998)
Level-cut time: 0000.0 ms (selectable between 0000.0 and 2999.9 ms or 9999.9 [infinity])

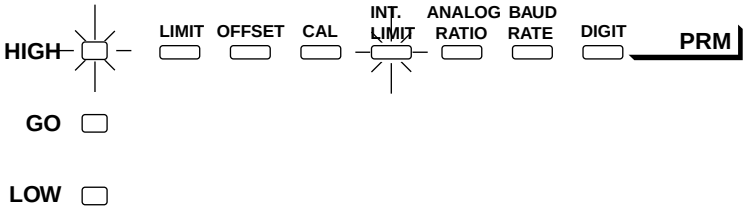
- A level-cut time must be set each for the LOW-INTENSITY LIMIT and HIGH-INTENSITY LIMIT.
- The HIGH-INTENSITY LIMIT must be greater than the LOW-INTENSITY LIMIT.

1. Measure the light intensity of the irregular portion of the surface and record the value.

Reference: Displaying Light Intensity (P.29)

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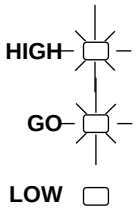
2. Press the PRM key repeatedly until the INT. LIMIT LED lights.
The HIGH LED lights and the LC switches to the entry mode. Also, the current HIGH-INTENSITY LIMIT appears on the display panel.



3. Change the displayed value to the desired HIGH-INTENSITY LIMIT.

Note To use the current HIGH-INTENSITY LIMIT, press the ↵ key. The setting remains unchanged, and the LC will proceed to the setting of the HIGH-INTENSITY LIMIT (Step 5).

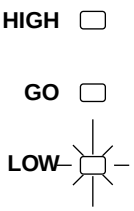
4. Press the ↵ key.
Simultaneously, the HIGH and GO LEDs light and the LC is ready for setting the INTENSITY LIMIT TIME. The current INTENSITY LIMIT TIME appears on the display panel.



5. Change the displayed value to the desired INTENSITY LIMIT TIME.

Note To use the current INTENSITY LIMIT TIME, press the ↵ key. The setting remains unchanged, and the LC will proceed to the setting of the LOW-INTENSITY LIMIT (Step 7).

6. Press the ↵ key.
The new INTENSITY LIMIT TIME is set and the HIGH and GO LEDs go off. Simultaneously, the LOW LED lights and the LC is ready to accept a new LOW-INTENSITY LIMIT. The display indicates the current LOW-INTENSITY LIMIT.

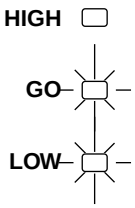


7. Change the displayed value to the desired LOW-INTENSITY LIMIT.

Note To use the current LOW-INTENSITY LIMIT, press the ↵ key. The setting remains unchanged, and the LC will proceed to setting of the level-cut time for LOW-INTENSITY LIMIT (Step 9).

8. Press the ↵ key.
The new LOW-INTENSITY LIMIT is set. Simultaneously, the LOW and GO LEDs light and the system is switched to the setting mode. The display indicates the current INTENSITY LIMIT TIME.

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9. Change the displayed value to the desired INTENSITY LIMIT TIME.

Note To use the current INTENSITY LIMIT TIME, press the ↵ key. The setting remains unchanged, and the LC will return to the measuring mode.

10. Press the ↵ key.
The new INTENSITY LIMIT TIME is set, the LOW and GO LEDs go off, and the LC will return to the measuring mode.

Note To cancel the entry of light intensity parameters, press the PRM key first, then the ↵ key as many times as required to return to the measuring mode. The entered value will also be canceled.

The light intensity parameters are set only after the LOW-INTENSITY LIMIT TIME has been entered and the ↵ key pressed. If you stop before entering all the parameters, the parameters entered will be canceled.

6-10 Setting Upper/Lower Limits for Measurements (Setting Tolerance)

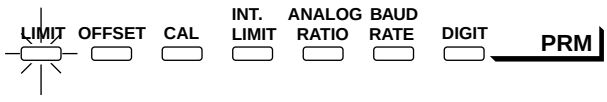
The LC can set upper/lower limits for measurements in each measurement mode. Measurements outside the preset range is indicated by the display or output signal. The upper/lower limits range differs, depending on the sensor head as shown below. Numbers in parentheses are factory settings.

LC-2420: +299.99 µm (±200.00 µm)
LC-2430: +599.98 µm (±500.00 µm)
LC-2440: +5.9998 mm (±3.0000 mm)
LC-2450: +15.9995 mm (±8.0000 mm)

Note Upper and lower measurement limits can be set for each measurement mode.

1. Choose the measurement mode and press the ↵ key.

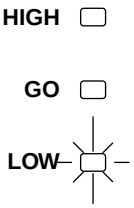
2. Press the PRM key. The LIMIT LED lights.
The HIGH LED lights and the LC is ready to accept a new upper limit. The display indicates the current upper limit.



3. Change the displayed value to the desired upper limit.

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4 .Press the ↵ key.
The new upper limit is set. The LOW LED lights and the LC is ready to accept a new lower limit. The display now indicates the current lower limit.



5. Change the displayed value to the desired lower limit.

6. Press the ↵ key.
The new lower limit is set, and the LC returns to the measuring mode.

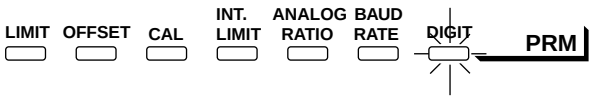
> The upper/lower limits are set only after the ↵ key has been pressed. If you stop before entering the lower limit, the new upper limit will be canceled.

6-11 Setting Number of Displayed Digits

Follow the procedure below to set the number of displayed digits.

Factory setting: All digits

1. Press the PRM key repeatedly until the DIGIT LED lights.
The display starts flashing.



2. Press the ◀ or ▶ key to set the number of displayed digits.
Every time the key is pressed, the number of digits on the display increases or decreases by one, thus activating or deactivating the last four digits. Press the ▶ key to increase the number of displayed digits; press the ◀ key to decrease it.

> If you choose not to display integer digits, "0" will be displayed in these digits.

3. Press the ↵ key.
Measurements will be displayed as specified.

Note To cancel entry of the number of displayed digits, press the PRM key first, then the ↵ key as many times as required to return to the measuring mode.

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6-12 Storing and Loading Settings (Programming)

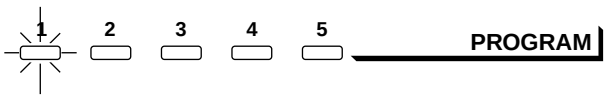
A set of parameters, including an offset value and upper and lower measurement limits, can be stored as a program. Up to five different programs can be stored. By storing programs prepared for each target, the need for setting individual parameters is eliminated. This is useful when frequent product changeover is required.

Factory setting: See the factory setting of each parameter.

Storing Settings (SAVE)

1. Set the parameters required for measurement, then switch the LC to the measuring mode.

2. Press the [SAVE] key. The LED above the key starts flashing and one of the five PROGRAM LEDs lights.



3. Press the [◀] or [▶] key to select a program number.

Note

- To cancel the saving of a program, press the [SAVE] key.
- When overwriting a previously saved program (corresponding PROGRAM indicator is lit) be sure that this program does not contain settings that should be retained.

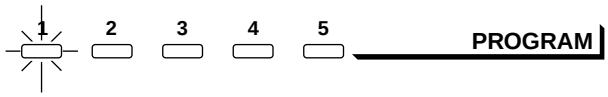
4. Press the [↵] key.
   The message "rEAdY" appears on the display panel.
   Press the [↵] key again to store the parameter settings. The LC is ready to measure using these settings.

5. Press the [↵] key.

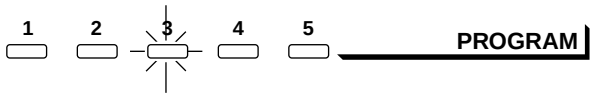
Loading Stored Settings (LOAD)

Follow the steps below to load the stored program.

1. Press the [LOAD] key. The LED above the key starts flashing and one of the five PROGRAM LEDs lights.



2. Press the [◀] or [▶] key to select a program number.

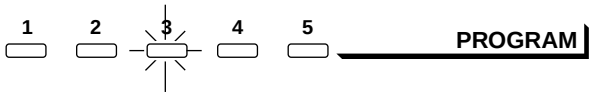


Note

To cancel the loading of a program, press the [LOAD] key. The selected program will be canceled and the LC will return to the measurement mode.

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3. Press the ↵ key.
   The setting is loaded, and the LC switches to the measurement mode. The LED above the LOAD key goes off, but the selected PROGRAM LED remains lit. At this time, if any parameter is changed the LED will go off.



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CHAPTER 7

MEASUREMENT PROCEDURE

7-1 Measuring with One Sensor Head 44
7-2 Measuring with Two Sensor Heads 45

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The versatile LC-2400 Series can measure height or eccentricity as well as displacement. With an optional board installed, the LC can measure thickness or height deviation using two sensor heads. Stored parameters can be quickly called up by using the LOAD function.

Note

- The LC requires 60 min. to warm up. Turn on the controller and wait at least 60 min. before starting measurements.
- If you find displayed values or output measurements incorrect, check the sensor head position as well as parameters.

Reference: Storing and Loading Settings (Programming) (P.41)
Error Message List (P.82)

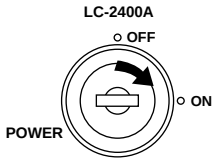
7-1 Measuring with One Sensor Head

Measuring Target Height

Measure the target height with respect to the reference surface by following the procedures shown below.

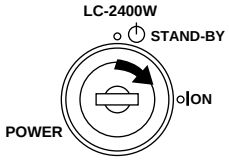
[LC-2400A]

1. Turn the key-operated power switch to the ON position to turn on the LC controller.
2. Position the sensor head. Keep in mind the measuring range and angle of the sensor heads.



[LC-2400W]

1. To start the LC controller, turn on the power switch at the rear of the controller and then turn the key-operated switch to the ON position .
2. Position the sensor head. Keep in mind the measuring range and angle of the sensor heads.



Reference: Adjusting Sensor Head Position (P.25)

Note

When two sensor heads are connected, select either one by pressing the 1CH or 2CH key. The LED above the key lights.

3. Press the NORMAL key to switch the LC to the NORMAL measuring mode.
4. Calibrate the LC.

Reference: Correcting Measurement Error (Calibration) (P. 32)

5. Set the number of averaging measurements.

Reference: Reducing Variation in Measurement Data (Setting Number of Averaging Measurements) (P.36)

6. Measure the reference surface of the target.
7. Press the ZERO key.
   The displayed value and output are set to zero. Now the displayed value and output indicate the deviation in height from the reference value.

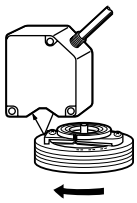
Note

To determine the target shape, move the sensor head or target in parallel with respect to the other.

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Measuring Runout and Eccentricity

Measure the runout and eccentricity of a revolving target by following the procedures shown below.



1. Position the sensor head. Be careful about the measuring range and angle of the sensor head.

Reference: Adjusting Sensor Head Position (P.25)

2. Turn the key-operated power switch to turn the system on.



3. Calibrate the LC.

Reference: Correcting Measurement Error (Calibration) (P.32)

4. Set the number of averaging measurements.

Reference: Reducing Variation in Measurement Data (Setting Number of Averaging Measurements) (P.36)

5. Press the P–P key to switch the LC to the NORMAL mode.
   Now the displayed value and output indicate the runout and eccentricity (max. and min. values).

6. To measure again, press the P–P key to reset the measurement.

7-2 Measuring with Two Sensor Heads

The LC-2400W series does not support this feature.

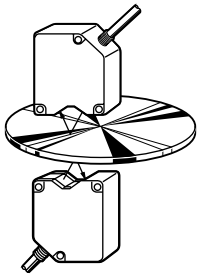
By installing the optional LC-B3 board, the LC-2400 can measure a target using two sensor heads. With two sensor heads used, thickness or height deviation can be measured by adding together the measurements from the two sensor heads or by subtracting one measurement from the other. Even while two sensor heads are connected, the LC can still be used for measurements that requires only one sensor head.

Note Be sure to use sensor heads of the same model when measuring in the ADD or SUB mode.

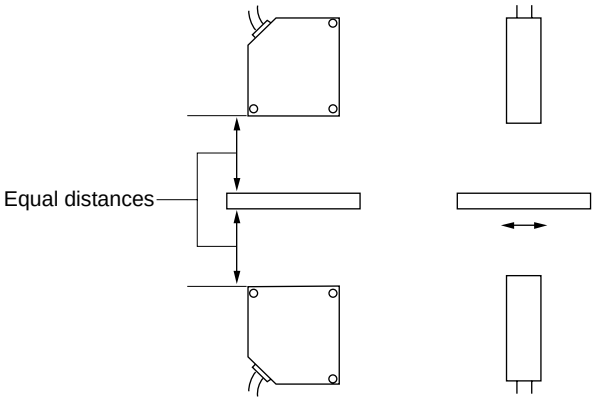
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Measuring Thickness (ADD)

Measure the thickness of a target by following the procedures shown below.

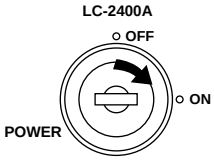


1. Position the sensor heads and the reference target. Keep in mind the measuring range and angle of the sensor heads.



Reference: Adjusting Sensor Head Position (P.25)

2. Turn the key-operated power switch to turn on the LC.



3. Press the 1CH key. The LED above the key lights.

4. Calibrate the 1CH sensor head.

Reference: Correcting Measurement Error (Calibration) (P.32)

5. Press the 2CH key. The LED above the key lights.

6. Calibrate the 2CH sensor head.

7. Press the ADD key. The LED above the key lights.

8. Set the number of averaging measurements as in Step 4.

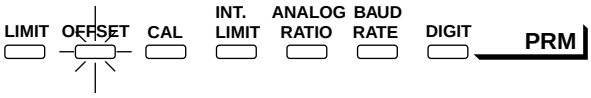
Reference: Reducing Variation in Measurement Data (Setting Number of Averaging Measurements) (P.36)

9. Press the NORMAL key. The LED above the key lights.
   The LC is now in the NORMAL mode.

10. Press the ZERO key.
    The displayed value and output are set to zero. Now the displayed value and output indicate the deviation in thickness from the reference value. Skip this step and follow the steps described below to display and output the thickness.

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11. Change the current offset value to the thickness of the target.
When entry of the offset value is complete, the display will show the reference thickness.



The following shows the maximum displayable thicknesses using the LC sensor heads:

Sensor head	Max. value
LC-2420	+327.66 µm
LC-2430	+655.32 µm
LC-2440	+6.5532 mm
LC-2450	+16.3830 mm

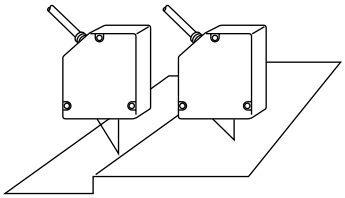
If the measurement that contains the offset value exceeds the display range, the LC holds the measurement at the maximum value.

Reference: Offset Values (P.35)

12. Start measurement.
Thickness of the target is displayed and output. If the automatic zero setting function was executed in Step 10, deviation from the reference value will be displayed and output.

Measuring Height Deviation (SUB)

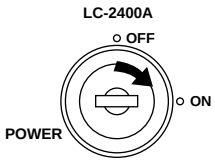
Measure height deviation by following the procedures shown below.



1. Position the sensor heads and the target. Be careful about the measuring range and the angle of the sensor heads.

Reference: Adjusting Sensor Head Position (P.25)

2. Turn the key-operated power switch to turn the system on.



3. Press the 1CH key. The LED above the key lights

4. Calibrate the 1CH sensor head.

Reference: Correcting Measurement Error (Calibration) (P.32)

5. Press the 2CH key. The LED above the key lights.

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6. Calibrate the 2CH sensor head.

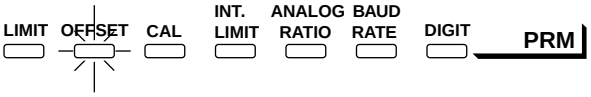
7. Press the SUB key. The LED above the key lights.

8. Set the number of averaging measurements.
Reference: Reducing Variation in Measurement Data (Setting Number of Averaging Measurements) (P.36)

9. Press the NORMAL key. The LED above the key lights.
The LC is now in the NORMAL mode.

10. Press the ZERO key.
The displayed value and output are set to zero. Now the displayed value and output indicate the deviation in thickness from the reference value. Skip this step and follow the steps described below to display and output the thickness.

11. Change the current offset value to the height deviation of the reference target.
When entry of the offset value is complete, the display will show the reference height deviation.



The following shows the range of height deviation values that can be displayed using the LC sensor heads:

Sensor head	Range
LC-2420	+327.66 µm to -327.67 µm
LC-2430	+655.32 µm to -655.34 µm
LC-2440	+6.5532 mm to -6.5534 mm
LC-2450	+16.3830 mm to -16.3835 mm

If the measurement that contains the offset value exceeds the display range, the LC holds the measurement at the corresponding value.

12. Start measurement.
The target height difference is displayed and output as an absolute value. When you start measurements, after pressing the auto-zero key as shown in step 10, the deviation in height difference from the reference value is displayed and output.

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CHAPTER 8

EXTERNAL INPUT/OUTPUT

8-1 RS-232C Interface 50

8-2 Control I/O (Standard Equipment on Display Unit) 71

8-3 Monitor Output (Standard Equipment) 73

8-4 Digital I/O (Standard Equipment on Control Unit) 74

For information on the optional GP-IB (LC-B1) or DIGITAL I/O (LC-B2) boards, please refer to Chapter 9, section 9-9.

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The LC-2400 series is equipped with an RS-232C serial interface, control I/O port (when the display unit is used), monitor output, and a digital I/O board. Using these I/O connections, the LC can transmit measurement data and alarm signals to external equipment and receive parameter settings from external equipment.

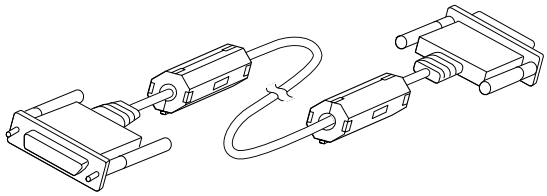
8-1 RS-232C Interface (Standard Equipment)

The LC-2400 series can communicate with a computer using the RS-232C interface. It can transmit measurement data to the computer and receive control signals from the computer. When the control unit is used separately, the parameters of each function can be set by the computer.

⚠ CAUTION

The ferrite cores are packaged with the LC-2400W series. When using the RS-232C or the CONTROL I/O connecting cable, attach the appropriate ferrite cores at both ends of the cable. Otherwise, noise interference may occur.

When using the RS-232C cable



Specifications

This serial interface conforms to EIA (Electronic Industries Association) RS-232C specifications.

Communication Parameters

Duplex	Full
Synchronization	Start-stop
Data format	ASCII
Data bit length	7/8 bit*
Stop bit length	1/2 bit*
Parity check	Even/odd/none*
Baud rate	75/150/300/600/1200/2400/4800/9600/19200 bps*

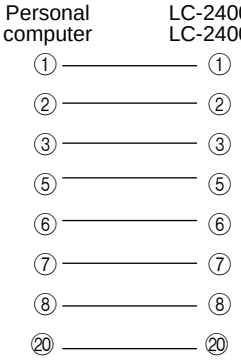
* Parameters are selectable.

Connecting Cable

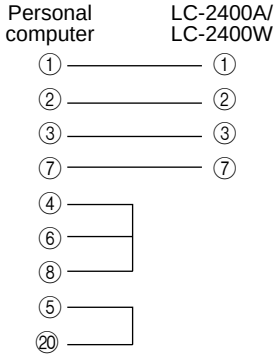
Use a standard serial cable for connection to a computer.
For alternative connection configurations, see the following.

When using a personal computer:

[Example 1]

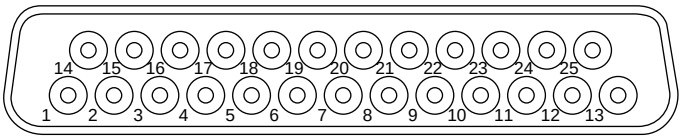


[Example 2]



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Pin Assignment



Pin No.	RS-232C signals	Description of signals	Input/output
1	Shield	Shield (common to signal ground)	———
2	SD (TXD)	Receives data from external equipment.	Input
3	RD (RXD)	Transmits measurement data to external equipment.	Output
5	CS (CTS)	ON (High) when the power is turned on	Output
6	DR (DSR)	ON (High) when the power is turned on	Output
7	SG (GND)	Signal ground	———
8	CD (DCD)	ON (High) when the power is turned on	Output
20	ER (DTR)	Enables transmission of measurement data to external equipment when the signal is ON (High).	Input

Note

Pin 20 is connected to the power supply through a pull-up resistor inside the LC controller. Even if this terminal is not connected to external equipment, measurement data can be output.

Setting Communication Parameters

Initial settings

Baud rate:	1200 bps
Data bit length:	8 bits
Parity check:	None
Stop bit length:	1 bit

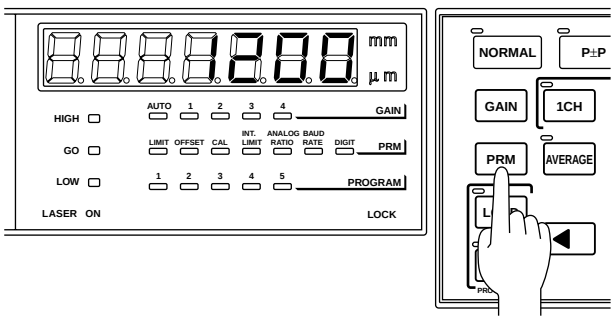
Note

Be sure that the communication parameters of the LC are the same as those of the external device.

Setting Communication Parameters When Using the Control Unit Together with the Display Unit

When the control unit is installed in the display unit, communication parameters can be set using the display unit keys.

1. Press the PRM key until the BAUD RATE indicator lights.
   The current baud rate is displayed on the display panel.

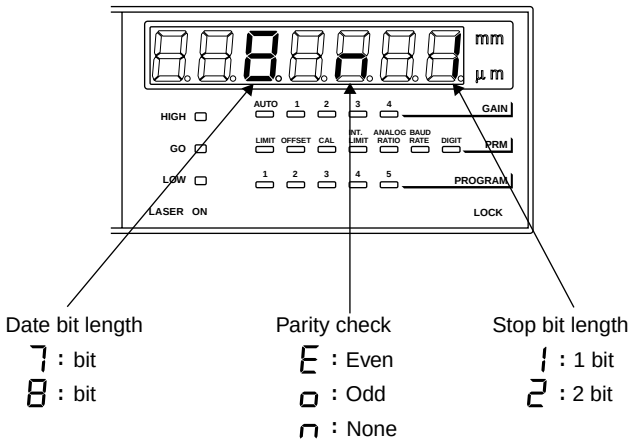


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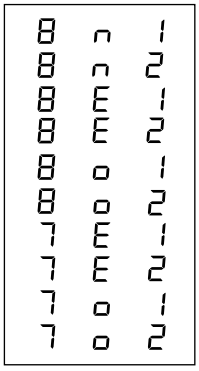
2. Press the ▲ or ▼ key to select the desired baud rate.
   The following baud rates can be selected.

   75/150/300/600/1200/2400/4800/9600/19200

3. Press the ↵ key.
   The remaining parameters are displayed on the display panel.



4. Press the ▲ or ▼ key to select the desired parameter.
   The following data formats can be selected.



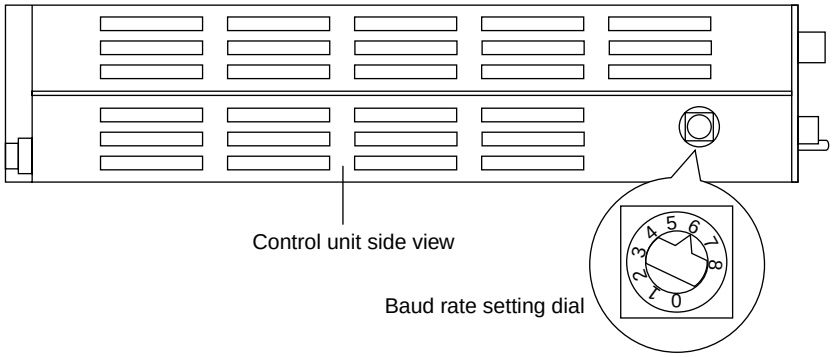
Note To cancel entry of communication parameters, press the PRM key and then press the ↵ key several times until the LC returns to the measurement mode. Any changes are ignored, and the LC is in the measurement mode.

5. Press the ↵ key.
   Once the communication parameters are entered, the LC will return to the measurement mode.

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Setting Communication Parameters with the Separate Control Unit

When the control unit is used separately, adjust the baud rate using the baud rate dial, located on the side of the control unit.



Dial numbers and baud rates correspond as shown below:

Dial number	0	1	2	3	4	5	6	7	8	9
Baud rate	75	150	300	600	1200	2400	4800	9600	19200	19200

Note

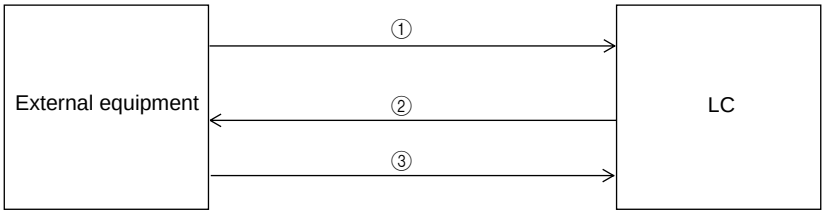
- When the control unit is used separately, parameters other than baud rate are fixed at the following values:
  Data bit length: 8 bits, Parity check: None,
  Stop bit length: 1 bit
- When the baud rate is changed using the display unit keys after installing the control unit in the display unit, the baud rate set with the baud rate dial is ignored.

Changing and Verifying Parameter Settings using External Equipment

By transmitting the proper character or ASCII code from an external device to the LC, the LC parameter settings can be changed or verified.

Procedure for Changing and Verifying Parameter Settings

Follow the procedure below to change or verify parameter settings.



1. Transmit the proper character or ASCII code from the external device to the LC.
2. When the character is received by the LC, the message "PASS CR" is sent to the external device. The parameter is changed to the setting corresponding to the character.

Note

When a character for setting measurement output or information output is received, the LC does not output the "PASS CR" message.

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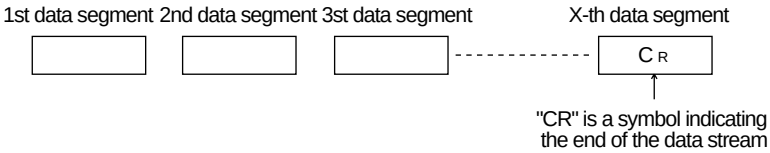
3. Send the desired value from the external device to the LC.

Note

When the required setting procedure is completed in step (2), step (3) is not necessary.

Response Data Format

The data output from the LC to external equipment is called "response data". Response data for verifying parameter settings is output in the following format:



Changing Gain, Measurement Mode and Number of Averaging Measurements

To change or set gain, measurement mode and number of averaging measurements, select the proper character or ASCII code from the following table and send it from the external device to the LC.

Function	Desired setting	Transmission code	
		Character	ASCII code
Changing gain	AUTO	SP	20H
	GAIN1	!	21H
	GAIN2	”	22H
	GAIN3	#	23H
	GAIN4	$	24H
Changing measurement mode	NORMAL	%	25H
	P-P	&	26H
	PEAK	’	27H
	BOTTOM	(	28H
Changing number of averaging measurements	1	)	29H
	2	*	2AH
	4	+	2BH
	8	,	2CH
	16	——	2DH
	32	.	2EH
	64	/	2FH
	128	0	30H
	256	1	31H
	512	2	32H
	1024	3	33H
	2048	4	34H
	4096	5	35H
	8192	6	36H
	16384	7	37H
	32768	8	38H
	65536	9	39H
	131072	:	3AH

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Setting the AUTO-ZERO/ HOLD/FILTER/PANEL LOCK Functions

To set each function, select the proper character or ASCII code from the following table and send it from the external device to the LC.

Function	Desired setting	Transmission code	
		Character	ASCII code
AUTO-ZERO ON/OFF	AUTO-ZERO ON	;	3BH
	AUTO-ZERO OFF	<	3CH
HOLD ON/OFF	HOLD ON	=	3DH
	HOLD OFF	>	3EH
PANEL LOCK ON/OFF	PANEL LOCK ON	?	3FH
	PANEL LOCK OFF	@	40H
FILTER ON/OFF	FILTER ON	A	41H
	FILTER OFF	B	42H

Note The PANEL LOCK function is used to disable any input from the display unit keys. The LOCK indicator is lit when the PANEL LOCK function is ON.

Setting Upper/Lower Limits, Parameters, and Filter

To set upper/lower limits, parameters and filter, select the proper character or ASCII code from the following table and send it from an external device to the LC.

Function	Desired setting	Transmission code	
		Character	ASCII code
Upper/lower limits	NORMAL mode upper limit	C	43H
	NORMAL mode lower limit	D	44H
	P-P mode upper limit	E	45H
	P-P mode lower limit	F	46H
	PEAK mode upper limit	G	47H
	PEAK mode lower limit	H	48H
	BOTTOM mode upper limit	I	49H
	BOTTOM mode lower limit	J	4AH
Parameters	OFFSET	e	65H
	Calibration	f	66H
	HIGH-INTENSITY LIMIT	g	67H
	HIGH-INTENSITY LIMIT TIME	h	68H
	LOW-INTENSITY LIMIT	i	69H
	LOW-INTENSITY LIMIT TIME	j	6AH
	Analog ratio	k	6BH
	DIGIT SUPPRESS	l	6CH
FILTER	FILTER preset value	m	6DH

The procedure for setting the upper/lower limits, parameters, and filter is as follows:

1. Select the desired sensor head (1CH/2CH) or function (ADD/SUB).

2. After receiving the "PASS CR" message from the LC, send the required character or ASCII code to the LC.

3. Send the desired value to the LC.

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The upper/lower limits, parameters, and filter values must be in the following ranges. The upper/lower limits and OFFSET value are output with a "+" or "-" sign.

Item		Sensor head	Setting range
Upper/lower limits		LC-2420	- 299.99 to + 299.99 µm
		LC-2430	- 599.98 to + 599.98 µm
		LC-2440	- 5.9998 to + 5.9998 mm
		LC-2450	- 15.9995 to + 15.9995 mm
Param-eters	OFFSET	LC-2420	- 199.99 to + 199.99 µm
		LC-2430	- 499.98 to + 499.98 µm
		LC-2440	- 2.9998 to + 2.9998 mm
		LC-2450	- 7.9995 to + 7.9995 mm
	Calibration	All models	0.9000 to 1.1000 (See P.35.)
	HIGH-INTENSITY LIMIT	All models	00000 to 49998
	LOW-INTENSITY LIMIT		
	HIGH-INTENSITY LIMIT TIME	All models	0000.0 to 2999.9 ms 9999.9 (Infinity)
	LOW-INTENSITY LIMIT TIME		
	ANALOG RATIO	All models	0 to 5 (See P.73)
	DIGIT SUPPRESS	All models	0 to 4 digits
Filter		All models	0100 to 4999 Hz

Note

- When the upper/lower limits, parameters, and filter values exceed the above ranges, the error message "ERROR C_R" is returned.
- When the ADD or SUB function is selected, calibration, INT. LIMIT and gain cannot be set.
- Be sure to set HIGH-INTENSITY LIMIT higher than LOW-INTENSITY LIMIT.
- The filter function can be set only when the display unit is used.

Measurement Data Output Method

The LC outputs displacement and intensity measurement values using the following four methods. To output these measurement values, select the desired character or ASCII code in the following table and transmit it from an external device to the LC.

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Output method	Code transmitted to the LC	
	Character	ASCII code
Single output of displacement measurement value	M	4DH
Single output of displacement and intensity measurement values	N	4EH
Continuous output of displacement measurement value	O	4FH
Continuous output of displacement and intensity measurement values	P	50H
Quit continuous output	Q	51H

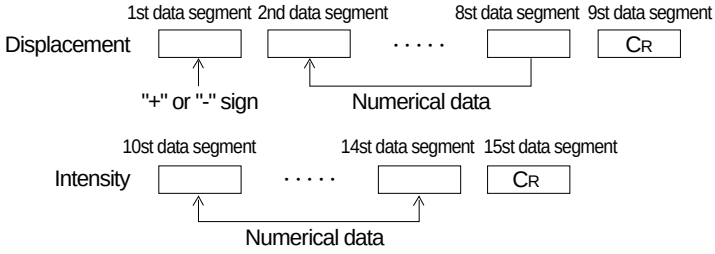
Send character "Q" or ASCII code "51H" when in continuous output mode. Even if character "Q" ("51H") is received while in single output mode, the LC ignores this codes.

■ Single output of displacement and intensity measurement values

[External equipment to the LC]
Character: N
ASCII code: 4EH

[Output data]

[The LC to external equipment]



Example:
When a displacement of + 2.0000 mm is measured using the diffuse-reflective sensor head (LC-2440/LC-2450), the LC outputs the displacement and intensity measurement values sequentially in the following format:

Displacement	+	SPACE	2	.	0	0	0	0	CR
	sign	10^1 digit	10^0 digit	Decimal point	10^{-1} digit	10^{-2} digit	10^{-3} digit	10^{-4} digit	
Intensity	1	2	0	0	0	CR			

■ Single output of displacement measurement value

[External equipment to the LC]
Character: M
ASCII code: 4DH

Example:
When a displacement of - 20.02 µm is measured using the regular-reflective sensor head (LC-2420/LC-2430), the LC outputs the displacement measurement value once in the following format:

±	SPACE	SPACE	2	0	.	0	2	CR

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Note a [SPACE] is output for any digit having no data.

■ **Continuous output of displacement and intensity measurement values or continuous output of displacement measurement values**
When the displacement and intensity continuous output method or the displacement continuous output method is selected, the above measurement values are output at a predetermined time interval.

■ **Measurement error**
When a measurement error occurs, the LC outputs the following values:

(When using the LC-2420 or LC-2430 sensor head)

+	9	9	9	9	.	9	9	CR

(When using the LC-2440 or LC-2450 sensor head)

+	9	9	.	9	9	9	9	CR

Measurement output values are changed depending on the specified number of averaging measurements.

Verifying Parameter Settings and Output Conditions

Current parameter settings and output conditions can be verified by transmitting an character or ASCII code to the LC. The LC outputs the current parameter settings and output conditions corresponding to the specified ASCII code (character).

Parameter setting/output mode	Code transmitted to the LC	
	Character	ASCII code
Alarm output mode	R	52H
Preset gain	S	53H
Preset measurement mode	T	54H
NORMAL mode upper/lower limits	U	55H
P-P mode upper/lower limits	V	56H
PEAK mode upper/lower limits	W	57H
BOTTOM mode upper/lower limits	X	58H
Preset number of averaging measurements	Y	59H
OFFSET preset value	Z	5AH
CALIBRATION preset value	[	5BH
INT. LIMIT preset value	¥	5CH
Preset analog ratio	]	5DH
DIGIT SUPPRESS preset value	^	5EH
AUTO-ZERO ON/OFF	–	5FH
HOLD ON/OFF	'	60H
FILTER ON/OFF	a	61H
FILTER preset value	b	62H
Preset program number	c	63H
Preset function	d	64H

■ **Alarm output mode**
[External equipment to the LC]
Character: R
ASCII code: 52H

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[The LC to external equipment]

1st data segment	2nd data segment	3rd data segment	4th data segment	5th data segment	6th data segment	7th data segment	8th data segment	9th data segment
H	L	+	±	B	D	E	G	CR
HIGH	LOW	+AREA OVER	-AREA OVER	BRIGHT	DARK	ERROR	GO	

Note When the response data includes no alarm output, the LC feeds back the character " * " or the ASCII code "2AH".

Example: "HIGH" and "+ AREA OVER" alarm output

H	*	+	*	*	*	*	*	CR

■ **Verifying the preset gain**
[External equipment to the LC]
Character: S
ASCII code: 53H

[The LC to external equipment]

1st data segment	2nd data segment	3rd data segment
		CR

Preset data

Example:
- When the gain is set to GAIN 1 in the AUTO gain selector mode:

N	R	CR

- When the gain is set to GAIN 1:

G	1	CR

Note When the gain is set to GAIN 2, GAIN 3 or GAIN 4, the 2nd data segment is changed to "2", "3" or "4".

■ **Verifying the preset measurement mode**
[External equipment to the LC]
Character: T
ASCII code: 54H

[The LC to external equipment]

1st data segment	2nd data segment	3rd data segment
		CR

Preset data

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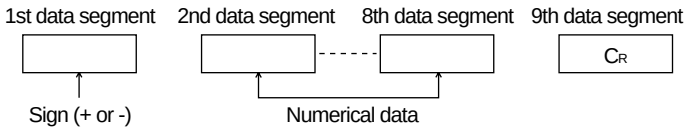
Example: When the measurement mode is set to NORMAL:

N	R	CR

Note When the measurement mode is set to P-P, PEAK or BOTTOM, the first and 2nd data segment are changed to "PP", "PK" or "BT".

■ **Verifying the preset upper/lower limits**
[External equipment to the LC]
Character: U to X
ASCII code: 54H to 58H

[The LC to external equipment]



Note a [SPACE] is output for any digit having no data. Be sure to verify the preset measurement mode before verifying the upper/lower limit settings.

Example:
When the upper limit is set to + 2.5000 mm and the lower limit is set to - 0.1500 mm in the NORMAL measurement mode using the diffuse-reflective sensor head:

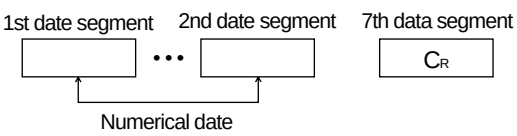
+	SPACE	2	.	5	0	0	0	CR
±	SPACE	0	.	1	5	0	0	CR

Example:
When the upper limit is set to + 20.02 µm and the lower limit is set to - 0.21 µm in the NORMAL measurement mode using the regular-reflective sensor head:

+	SPACE	SPACE	2	0	.	0	2	CR
±	SPACE	SPACE	SPACE	0	.	2	1	CR

■ **Verifying the preset number of averaging measurements**
[External equipment to the LC]
Character: Y
ASCII code: 59H

[The LC to external equipment]



Note The number of digits for the above response data varies depending on the specified number of averaging measurements.

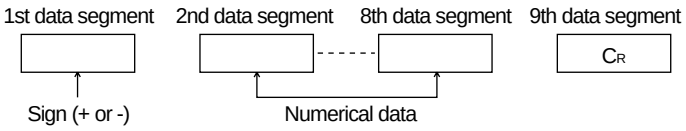
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Example: When the number of averaging measurements is set to 128:

1	2	8	CR

■ **Verifying the OFFSET preset value**
[External equipment to the LC]
Character: Z
ASCII code: 5AH

[The LC to external equipment]



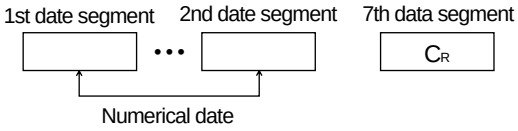
Example:
When the OFFSET value is set to - 1.567 mm:

±	SPACE	1	.	5	6	7	0	CR

Note The OFFSET value is output in the same format as measurement values.

■ **Verifying the CALIBRATION preset value**
[External equipment to the LC]
Character: [
ASCII code: 5BH

[The LC to external equipment]



Note When the calibration setting is verified, the LC outputs a calibration coefficient.

Calibration coefficient (P.35)

Example:
When the calibration coefficient is set to 0.9876:

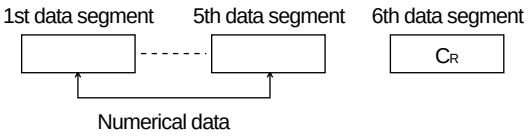
0	.	9	8	7	6	CR

■ **Verifying the INT. LIMIT preset values**
[External equipment to the LC]
Character: "
ASCII code: 5CH

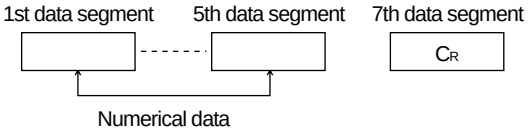
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[The LC to external equipment]

HIGH-INTENSITY LIMIT (H.I.L.) / LOW-INTENSITY LIMIT (L.I.L.)



HIGH-INTENSITY LIMIT (H.I.L.T.) / LOW-INTENSITY LIMIT TIME (L.I.L.T.)



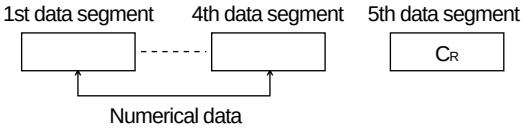
Note The INT. LIMIT preset values are output sequentially in the order of HIGH-INTENSITY LIMIT (H.I.L.), HIGH-INTENSITY LIMIT TIME (H.I.L.T.), LOW-INTENSITY LIMIT (L.I.L.) and LOW-INTENSITY LIMIT TIME (L.I.L.T.).

Example:
When the INT. LIMIT values are set to the following values:
H.I.L. = 10000 H.I.L.T. = 0000.0 ms
L.I.L. = 00050 L.I.L.T. = 9999.9 ms

1	0	0	0	0	CR	
0	0	0	0	.	0	CR
0	0	0	5	0	CR	
9	9	9	9	.	9	CR

■ Verifying the preset analog ratio
[External equipment to the LC]
Character:]
ASCII code: 5DH

[The LC to external equipment]



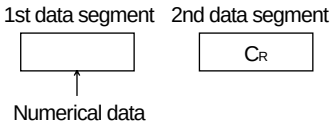
Example:
When the analog ratio is set to 100 µm/V:

1	0	0	CR

■ Verifying the DIGIT SUPPRESS preset value
[External equipment to the LC]
Character: ^
ASCII code: 5EH

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[The LC to external equipment]

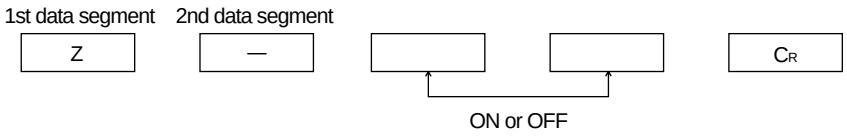


Example:
When the DIGIT SUPPRESS value is set to "1-digit":

1	CR

■ **Verifying the AUTO-ZERO ON/OFF status**
[External equipment to the LC]
Character: —
ASCII code: 5FH

[The LC to external equipment]



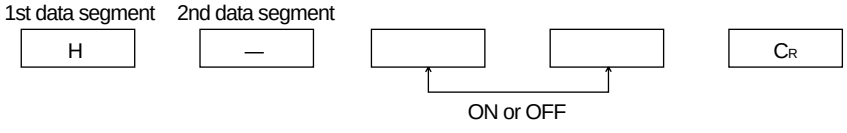
Example:
When the AUTO-ZERO function is ON:

Z	±	O	N	CR

Note When the AUTO-ZERO function is OFF, the LC outputs the message "Z-OFF".

■ **Verifying the HOLD ON/OFF status**
[External equipment to the LC]
Character: '
ASCII code: 60H

[The LC to external equipment]



Example:
When the HOLD function is OFF:

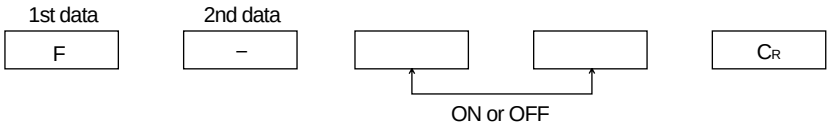
H	±	O	F	F	CR

Note When the HOLD function is ON, the LC outputs the message "H-ON".

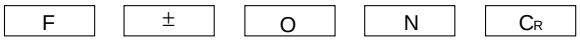
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■ **Verifying the FILTER ON/OFF status**
[External equipment to the LC]
Character: a
ASCII code: 61H

[The LC to external equipment]



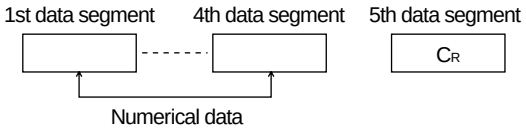
Example:
When the FILTER function is ON:



Note When the FILTER function is OFF, the LC outputs the message "F-OFF".

■ **Verifying the preset CUTOFF frequency**
[External equipment to the LC]
Character: b
ASCII code: 62H

[The LC to external equipment]



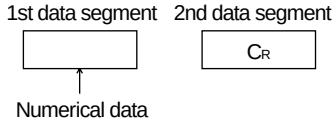
Note Be sure to verify the FILTER status before verifying the preset CUTOFF frequency.

Example:
When the CUTOFF frequency is set to 100 Hz:



■ **Verifying the preset program number**
[External equipment to the LC]
Character: c
ASCII code: 63H

[The LC to external equipment]



Example:
When no program is running:



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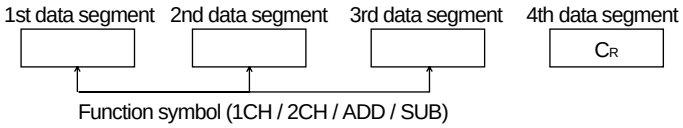
Note When Program No. 1, 2, 3, 4 or 5 is running, the 1st data segment is changed to 1, 2, 3, 4 or 5.

Example:
When Program No. 1 is running:

1	CR

■ **Verifying the preset function**
[External equipment to the LC]
Character: d
ASCII code: 64H

[The LC to external equipment]



Example:
When the function is set to 1CH:

1	C	H	CR

Note When the function is set to 2CH, ADD or SUB, the LC outputs the message "2CH", "ADD" or "SUB".

Setting Programs

The parameter settings can be saved and loaded by sending signals from external equipment to the LC. When the following character or ASCII code is transmitted from an external device (e.g. a computer) to the LC, the parameter settings can be saved and loaded. The LC can store up to 5 parameter setting programs. The program numbers correspond to the PROGRAM indicator numbers provided on the display panel.
For initial settings of each program, see page 90.

Function	Code transmitted to the LC	
	Character	ASCII code
Program No. 1 SAVE	n	6EH
Program No. 2 SAVE	o	6FH
Program No. 3 SAVE	P	70H
Program No. 4 SAVE	q	71H
Program No. 5 SAVE	r	72H
Program No. 1 LOAD	s	73H
Program No. 2 LOAD	t	74H
Program No. 3 LOAD	u	75H
Program No. 4 LOAD	v	76H
Program No. 5 LOAD	w	77H

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■ **Saving parameter settings (SAVE)**

When the desired character or ASCII codes are transmitted from an external device (e.g. a computer) to the LC, the LC outputs the message "PASS CR" to the external device and saves the parameter settings in the backup program area. The following is an example of the procedure for saving parameter settings.

Saving parameter settings in Program No. 1

1. Set the parameters required for measurement. The LC will be in the measurement mode.

2. To save the parameter settings in Program No. 1, send the character "n" from an external device to the LC.

3. The LC sends back the message "PASS CR", and the current measurement conditions are saved in Program No. 1.

■ **Loading parameter settings (LOAD)**

When the desired character or ASCII code is transmitted from an external device (e.g. a computer) to the LC, the LC outputs the "PASS CR" message to the external device and loads the program stored in the backup program area, according to the specified character or ASCII code.

Loading the parameter settings stored in Program No. 1

1. Send character "s" from an external device to the LC.

2. The "PASS CR" message is output from the LC, and Program No. 1 is loaded. The current parameter settings are changed to the parameter settings stored in Program No. 1.



If a program is specified which has no stored settings, the parameter settings revert to the factory settings.

Changing the Function (When using two sensor heads)

The following four functions (sensor heads or measurement modes) can be selected. To change each function, select the desired character or ASCII code in the following table, and send it from external equipment to the LC. If the specified character or ASCII code is not properly received, the LC will output an "ERROR CR" message and will not perform the specified operation.

Function	Code transmitted to the LC	
	Character	ASCII code
CH1	x	78H
CH2	y	79H
ADD	z	7AH
SUB	{	7BH



These functions cannot be changed without the LC-B3 board.

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RS-232C Code List

Function	Code transmitted to the LC		Setting item
	Character	ASCII code	
Changing gain	SP	20H	AUTO
	!	21H	GAIN1
	"	22H	GAIN2
	#	23H	GAIN3
	$	24H	GAIN4
Changing measurement mode	%	25H	NORMAL
	&	26H	P-P
	’	27H	PEAK
	(	28H	BOTTOM
Changing number of averaging measure-ments	)	29H	AVE1
	*	2AH	AVE2
	+	2BH	AVE4
	,	2CH	AVE8
	—	2DH	AVE16
	.	2EH	AVE32
	/	2FH	AVE64
	0	30H	AVE128
	1	31H	AVE256
	2	32H	AVE512
	3	33H	AVE1024
	4	34H	AVE2048
	5	35H	AVE4096
	6	36H	AVE8192
	7	37H	AVE16384
	8	38H	AVE32768
	9	39H	AVE65536
	:	3AH	AVE131072
	;	3BH	AUTO-ZERO ON
	<	3CH	AUTO-ZERO OFF
	=	3DH	HOLD ON
	>	3EH	HOLD OFF
	?	3FH	PANEL LOCK ON
	@	40H	PANEL LOCK OFF
	A	41H	FILTER ON
	B	42H	FILTER OFF
Setting upper/lower limits	C	43H	NORMAL mode upper limit
	D	44H	NORMAL mode lower limit
	E	45H	P-P mode upper limit
	F	46H	P-P mode lower limit
	G	47H	PEAK mode upper limit
	H	48H	PEAK mode lower limit
	I	49H	BOTTOM mode upper limit
	J	4AH	BOTTOM mode lower limit

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Function	Code transmitted to the LC		Setting item
	Character	ASCII code	
Measurement data output	M	4DH	Single output of displacement measurement value
	N	4EH	Single output of displacement and intensity measurement values
	O	4FH	Continuous output of displacement measurement values
	P	50H	Continuous output of displacement and intensity measurement values
	Q	51H	Quit continuous output
Information output	R	52H	Alarm output mode
	S	53H	Preset gain
	T	54H	Preset measurement mode
	U	55H	NORMAL mode upper/lower limits
	V	56H	P-P mode upper/lower limits
	W	57H	PEAK mode upper/lower limits
	X	58H	BOTTOM mode upper/lower limits
	Y	59H	Preset number of averaging measurements
	Z	5AH	OFFSET preset value
	[	5BH	CALIBRATION preset value
	¥	5CH	INT. LIMIT preset value
	]	5DH	Preset analog ratio
	^	5EH	DIGIT SUPPRESS preset value
	—	5FH	AUTO-ZERO ON/OFF
	'	60H	HOLD ON/OFF
	a	61H	FILTER ON/OFF
	b	62H	FILTER preset value
	c	63H	Preset program number
	d	64H	Preset function
Parameter settings	e	65H	OFFSET
	f	66H	Calibration
	g	67H	HIGH-INTENSITY LIMIT
	h	68H	HIGH-INTENSITY LIMIT TIME
	i	69H	LOW-INTENSITY LIMIT
	j	6AH	LOW-INTENSITY LIMIT TIME
	k	6BH	Analog ratio
	l	6CH	DIGIT SUPPRESS
FILTER preset value	m	6DH	Preset CUTOFF frequency
Program (SAVE)	n	6EH	Program No. 1 SAVE
	o	6FH	Program No. 2 SAVE
	p	70H	Program No. 3 SAVE
	q	71H	Program No. 4 SAVE
	r	72H	Program No. 5 SAVE

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Function	Code transmitted to the LC		Setting item
	Character	ASCII code	
Program (Load)	s	73H	Program No. 1 LOAD
	t	74H	Program No. 2 LOAD
	u	75H	Program No. 3 LOAD
	v	76H	Program No. 4 LOAD
	w	77H	Program No. 5 LOAD
Preset function	x	78H	Setting 1CH
	y	79H	Setting 2CH
	z	7AH	Setting ADD
	{	7BH	Setting SUB

Sample Program

Program 1

In the following program, the LC outputs measurement values to a personal computer when "M" is entered on the computer keyboard.

```
100    OPEN  “COM1:4800,N,8,1,RS,CS,DS,CD” FOR RANDOM AS #1
110    ON COM(1)GOSUB 170
120    COM(1)ON
130    A$=INKEY$
140    IF A$<>“M” THEN 130
150    PRINT #1,A$;
160    GOTO 130
170    N=LOC(#1)
180    IF N=0 THEN RETURN
190    B$=INPUT$(N,#1)
200    IF RIGHT$(B$,1)=CHR$(13) THEN PRINT B$ ELSE PRINT B$;
210    RETURN
```


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Program 2

In the following program, the LC sequentially outputs 100 measurement values to a computer. The computer display shows the maximum, minimum and average values of the output data when "S" is entered through the computer key board.

```
100   DIM A$(100)
110   PRINT “START or END ? (PUSH [S] or [E] Key)”
120   PRINT
130   A$=INPUT$(1)
140   IF A$“E” OR A$=“e” THEN END
150   IF A$<>“S” AND A$<>“S” THEN 130
160   OPEN “COM1:4800,N,8,1,RS,CS,DS,CD” FOR RANDOM AS #1
170   PRINT #1,“0”;
180   FOR I=1 TO 100
190   INOUT #1,A$(I)
200   NEXT I
210   PRINT #1,“Q”;
220   FOR I=1 TO 500  :NEXT I
230   IF FOR(1)=0 THEN INPUT #1,DAMMY$  :GOTO 230
240   CLOSE    #1
250   MAX=-1000  :MIN=1000  :SUM=0
260   FOR I=1 TO 100
270   A=VAL(A$(I))
280   IF A>MAX THEN MAX=A
290   IF A<MIN THEN MIX=A
300   SUM=SUM+A
310   NEXT I
320   AVE=SUM/100
330   PRINT USING “MAX =###.#### mm”;MAX
340   PRINT USING “MiX =###.#### mm”;MIN
350   PRINT USING “AVE =###.#### mm”;AVE
360   PRINT
370   GOTO 110
```

Displays prompt for starting or stopping measurement.

Instruction to start continuous data output

Data input

Instruction to stop continuous data output

Discards the data entered after the continuous data output has stopped.

Performs arithmetic operations to obtain the maximum, minimum and average values.

Displays the maximum, minimum and average values.

Note Be sure that the baud rate of the LC is identical to that of the computer.

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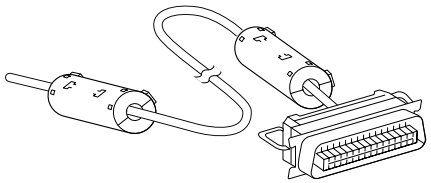
8-2 Control I/O (Standard Equipment on Display Unit)

The operation of the LC-2400 series can be controlled by sending signals from an external device (e.g. a computer) to the LC. By shorting the desired control input pin and the GND pin, preset functions, program numbers and the HOLD/AUTO-ZERO ON/OFF status can be changed. Also, the LC outputs various alarm signals for indicating abnormal measurement conditions (e.g. INTENSITY alarm signal).

⚠ CAUTION

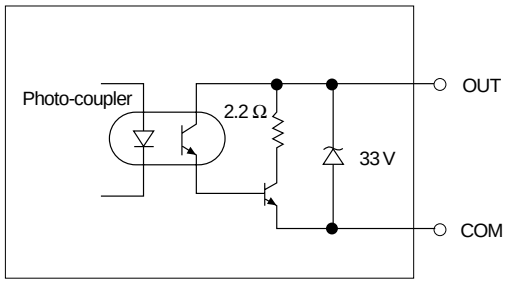
The ferrite cores are packaged with the LC-2400W series. When using the RS-232C or the CONTROL I/O connecting cable, attach the appropriate ferrite cores at both ends of the cable. Otherwise, noise interference may occur.

When using the CONTROL I/O cable

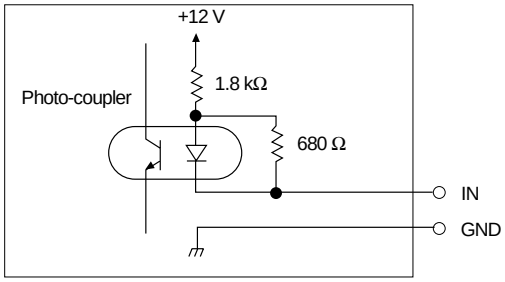


Specifications

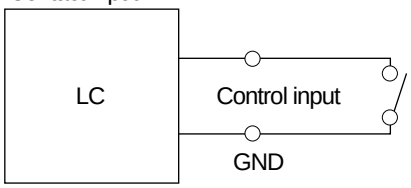
Output
Open-collector
Maximum applied voltage: 30 V
Maximum sink current: 100 mA



Input
Non-voltage input

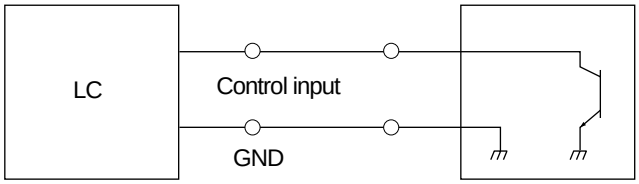


• Contact input



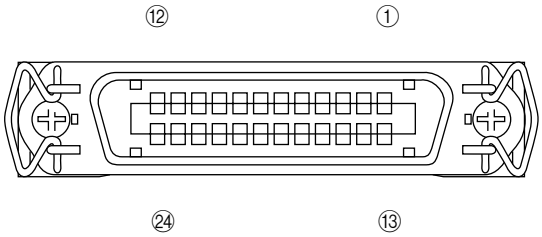
• Open-collector input

• Open-collector



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Pin Names and Functions



Pin No.	Input/output	Signal name	Description
1	Output	INTENSITY alarm output	OFF in the DARK and BRIGHT modes
2	–	COM	
3	Output	AREA OVER output (NEAR)	ON when a target is out of the measuring range (NEAR)
4	–	COM	
5	Output	AREA OVER output (FAR)	ON when a target is out of the measuring range (FAR)
6	Output	GO output	ON when a measurement value is within the upper/lower limits.
7	–	COM	
8	Output	Upper limit (HIGH) output	ON when a measurement value exceeds the upper limit.
9	–	COM	
10	Output	Lower limit (LOW) output	ON when a measurement value falls below the lower limit.
11	Input	FUNCTION 1CH input*	When pin 11 and the GND pin are short-circuited, the function is changed to 1CH.
12	Input	FUNCTION 2CH input*	When pin 12 and the GND pin are short-circuited, the function is changed to 2CH.
13	Input	AUTO-ZERO input	When pin 13 and the GND pin are short-circuited, the AUTO-ZERO input turns ON.
14	–	GND	
15	Input	AUTO-ZERO reset input	When pin 15 and the GND pin are short-circuited, the AUTO-ZERO input is reset.
16	Input	HOLD input	When pin 17 and the GND pin are short-circuited, the HOLD input turns ON.
17	–	GND	
18	Input	Program 1	When pin 18 and the GND pin are short-circuited, program No. 1 is loaded.
19	Input	Program 2	When pin 19 and the GND pin are short-circuited, program No. 2 is loaded.
20	Input	Program 3	When pin 20 and the GND pin are short-circuited, program No. 3 is loaded.
21	Input	Program 4	When pin 21 and the GND pin are short-circuited, program No. 4 is loaded.
22	Input	Program 5	When pin 22 and the GND pin are short-circuited, program No. 5 is loaded.
23	–	GND	
24	–	GND	

1CH/2CH input is enabled only when the LC-B3 board is installed.

Note If a program is specified when no data is stored, the measurement mode is changed to the initial parameter settings.

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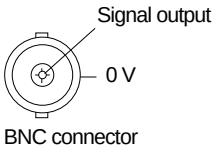
8-3 Monitor Output (Standard Equipment)

The LC-2400 series outputs an analog voltage, proportional to the target displacement, through the DISPLACEMENT connector and an analog voltage, proportional to the intensity, through the INTENSITY connector.

Analog Displacement Output

The LC outputs an analog voltage proportional to the target displacement.

Output range: - 10 to + 10 V
Output impedance: 0 Ω
Current capacity: 10 mA



Note

- When the analog output voltage exceeds the specified output range, the output voltage is retained to + 10 V or - 10 V.
- When an error message is displayed, the output voltage is retained to + 10 V.

Setting Output Range (Analog Ratio)

6 steps of output range can be selected for analog displacement output.

The output range setting procedure is as follows:

1. Press the PRM key to turn ON the ANALOG RATIO indicator. The current output range is displayed.
2. Press the ▲ or ▼ key to select the desired output range. The relationship between the registered numbers and the output range for each sensor head is as follows:

(Unit: µm/V)

Model / Registered number	LC-2420	LC-2430	LC-2440	LC-2450
0	2.5	5	50	100
1	5	10	100	200
2	10	25	250	500
3	25	50	500	1000
4	50	100	1000	2000
5	100	200	2000	4000

Note

To change the analog ratio using the RS-232C interface, transmit the registered number corresponding to the desired output range from an external device to the LC.

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Note

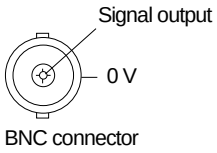
To interrupt entry of the analog ratio, press the PRM key, and then press the ↵ key several times until the LC returns to the measurement mode. Any new parameter settings are ignored, and the LC returns to the measurement mode.

3. Press the ↵ key.
   The specified analog ratio is entered, and the LC returns to the measurement mode.

Intensity Monitor Output

The LC outputs an analog voltage proportional to the intensity.

Output range: 0 to + 5 V
Output impedance: 0 Ω
Current capacity: 10 mA



Note

- The intensity monitor output range is 10000/V for all sensor head models
- When an error message is displayed, the output voltage is retained to 0 V.

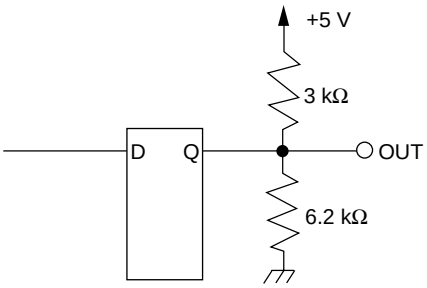
8-4 Digital I/O (Standard Equipment on Control Unit)

Cannot be used with the LC-2400W series.

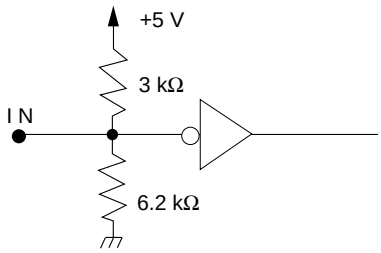
The digital I/O function can be used when the control unit is used separately. Displacement and intensity measurement values and alarm signals for indicating abnormal measurement conditions are output as digital signals.

Specifications

Output
TTL level (74LS652 or equivalent)



Input
TTL level (74LS19 or equivalent)



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Output Signal

Displacement data output
The displacement data output signal is a positive logic signal in the form of a 16-bit twos complement binary numbers representing displacement measurement values. When the number of averaging measurements is set to between 1 and 2048, the displacement data is output every 20 µs.

Sensor head	Displacement data output
LC-2420	1LSB = 0.01 µm
LC-2430	1LSB = 0.02 µm
LC-2440	1LSB = 0.2 µm
LC-2450	1LSB = 0.5 µm

Intensity data output
The intensity data output signal is a positive logic signal in the form of 16-bit twos complement binary numbers representing intensity.
For all sensor head models: 1LSB= 2

Strobe (STB)
The strobe signal is output to specify data output timing. It is a negative logic signal with a pulse duration of approx. 6 µs. The strobe signal goes LOW approx. 1.6 µs after the measurement data output signal is prepared.

Alarm output
The LC alarm signal output is LOW.

Alarm (OR logic)
All alarm outputs except for [GO] are ORed. The alarm signal goes LOW when at least one alarm signal is output.

Input Signal

External trigger enable input ($\overline{\text{ETE IN}}$)
When the external trigger enable input ($\overline{\text{ETE IN}}$) is LOW and the external trigger input (EXT TRIG IN) signal is received, the LC outputs measurement data at a specified frequency.

Input	Level	Output
$\overline{\text{ETE IN}}$	HI (The input is HIGH even if the input pin is open.)	When the number of averaging measurements is set to between 1 and 2048, measurement data is output every 20 µs.
	LOW	Measurement data is output only when the external trigger input (EXT TRIG IN) signal is received.

Note

When the number of averaging measurements is set to between 1 and 2048, measurement data is output every 20 µs.
When the number of averaging measurements is set to 4096 or more, measurement data is output at the following frequencies.

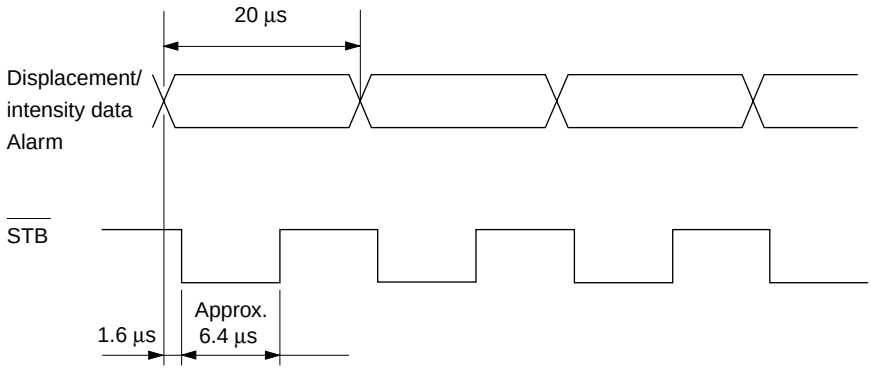
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Number of averaging measurements	Frequency
1 to 2048	20 µs (40 µs)
4096	40 µs (80 µs)
8192	80 µs (160 µs)
16384	160 µs (320 µs)
32768	320 µs (640 µs)
65536	640 µs (1280 µs)
131072	1280 µs (2560 µs)

Figures in ( ) apply when the ADD or SUB function is selected.

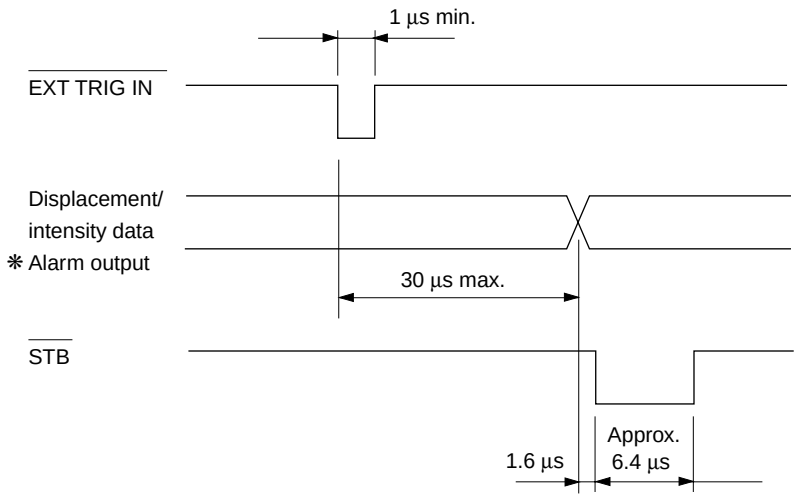
Timing chart

1. When the $\overline{\text{ETE IN}}$ signal is HIGH:



Note The strobe ($\overline{\text{STB}}$) signal is output at a frequency of 20 µs, regardless of the number of averaging measurements.

2. When the $\overline{\text{ETE IN}}$ signal is LOW:



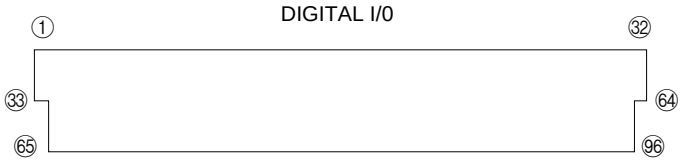
Note * When the $\overline{\text{ETE IN}}$ signal is LOW and the number of averaging measurements is set to between 1 and 2048, the alarm signal is output every 20 µs (40 µs), regardless of the $\overline{\text{EXT TRG IN}}$ signal level.

- Data in ( ) apply when the ADD or SUB function is selected.

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External trigger input (EXT TRIG IN)
When the ETE IN signal is LOW, measurement data is output a maximum of every 30 µs. After the EXT TRG IN signal goes LOW. The output data is retained until the EXT TRIG IN signal goes LOW again.

Pin Names and Functions



Pin No.	Signal name	Pin No.	Signal name	Pin No.	Signal name
1	Displacement data output DBIN1 (LSB)	32	Earth ground terminal	65	Alarm output (HIGH)
		33	Intensity data output IBIN1 (LSB)	66	Alarm output (LOW)
2	Displacement data output DBIN2	34	Intensity data output IBIN2	67	Alarm output (+ AREA OVER)
3	Displacement data output DBIN3	35	Intensity data output IBIN3	68	Alarm output (- AREA OVER)
4	Displacement data output DBIN4	36	Intensity data output IBIN4	69	Alarm output (BRIGHT)
5	Displacement data output DBIN5	37	Intensity data output IBIN5	70	Alarm output (DARK)
6	Displacement data output DBIN6	38	Intensity data output IBIN6	71	alarm output (ERROR)
7	Displacement data output DBIN7	39	Intensity data output IBIN7	72	Alarm output (GO)
8	Displacement data output DBIN8	40	Intensity data output IBIN8	73	Alarm (OR logic)
9	Displacement data output DBIN9	41	Intensity data output IBIN9	74	*
10	Displacement data output DBIN10	42	Intensity data output IBIN10	75	ETE IN (input)
11	Displacement data output DBIN11	43	Intensity data output IBIN11	76	*
12	Displacement data output DBIN12	44	Intensity data output IBIN12	77	EXT TRG IN (input)
13	Displacement data output DBIN13	45	Intensity data output IBIN13	78	STB (output)
14	Displacement data output DBIN14	46	Intensity data output IBIN14	79	*
15	Displacement data output DBIN15	47	Intensity data output IBIN15	80	*
16	Displacement data output DBIN16 (MSB)	48	Intensity data output IBIN16 (MSB)	81	*
		49	*	82	*
17	OPEN	50	*	83	*
18	0 V (for ±5 V)	51	*	84	*
19	OPEN	52	*	85	*
20	*	53	*	86	*
21	*	54	*	87	*
22	*	55	*	88	*
23	OPEN	56	*	89	+5 V
24	OPEN	57	+5 V	90	0 V (for +5 V)
25	+5 V	58	0 V (for +5V)	91	0 V (for +5 V)
26	+5 V	59	0 V (for +5 V)	92	+15 V
27	+15 V	60	+15 V	93	0 V (for ±15 V)
28	+15 V	61	0 V (for ±15 V)	94	0 V (for ±5 V)
29	0 V (for ±15 V)	62	-15 V	95	Earth ground terminal
30	-15 V	63	-15 V	96	Earth ground terminal
31	-15 V	64	Earth ground terminal		

* Through the reserve pins (pin Nos. 49 to 56, and 79 to 88), input signals from the display unit are received. When the control unit is used separately, the reserve pins must remain open (without connection to any device).

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CHAPTER 9

APPENDIX

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9-1 Trouble-Shooting Guide

If the LC series does not display a measurement value or displays an inaccurate measurement value, or if an error occurs during communication with external equipment, refer to the following list to identify the problem and reinstall or readjust the LC.
If the LC does not work properly after taking the appropriate actions, please contact KEYENCE.

Troubleshooting

Problem	Cause	Action	Reference page
Nothing is displayed on the display panel.	The key-operated power switch is turned OFF.	Turn ON the key-operated power switch.	p.12
	The power switch on the rear panel is turned OFF. (LC-2400W only)		p.14
	The power supply cable is disconnected.	Connect the power supply cable.	p.22
	The fuse is blown.	Replace the fuse.	–
"- - - -" is displayed on the display panel.	The power has just been switched on or a parameter setting has been just changed.	No problem	–
	Measurement error has occurred.	Refer to the "Error Message List" for appropriate actions.	p.82
Measurement value fluctuates.	The transmitter/receiver of the sensor head is not clean.	Wipe the dust off the transmitter/receiver.	p.18
	The preset gain is not correct.	Set the gain to a correct value.	p.30
	The preset number of averaging measurements is too small.	Set the number of averaging measurements to an appropriate value.	p.36
	The measurement point is not clean.	Wipe the dust off the measurement point.	–
	The sensor head orientation is not correct.	Make sure that the sensor head orientation is correct.	p.25
	The sensor head or target is tilted.	Check the sensor head and target setup positions.	p.25
Inaccurate measurement value is displayed.	The control unit and the sensor head have different serial numbers.	Use the control unit and sensor head having the same serial number.	p.22
	Calibration was improperly performed.	Re-calibrate.	p.32
	The sensor head or target is tilted.	Check the sensor head and target setup positions.	p.25
	The target is out of the measuring range.		
	The preset measurement mode is not correct.	Set the measurement mode properly according to the setting.	p.30

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Problem	Cause	Action	Reference page
	The measurement mode is set to INTENSITY.	Press the INTENSITY key to change the measurement mode to DISPLACEMENT.	p.29
	OFFSET value is entered.	Make sure that the OFFSET value is correct.	p.35
	The preset mode is not correct.	Be sure to choose the correct display/output mode.	p.31
	The transmitter/receiver of the sensor head are not clean.	Wipe the dust off the transmitter/ receiver.	p.18
	The measurement point is not clean.	Wipe the dust off the measure-ment point.	–
Analog output voltage exceeds 10 V.	An error message is displayed.	Referring to the "Error Message List", take the appropriate actions.	p.82
	The analog output voltage ex-ceeds the specified output range.	Make sure that the preset analog ratio is correct.	p.73
Analog output value is not correct.	The preset analog ratio is not correct.	Make sure the preset analog ratio is correct.	p.73
The LC cannot communi-cate with the external device connected to the RS-232C connector.	A null modem cable was used.	Use a standard serial cable.	p.50
	The preset baud rate is not correct.	Set the baud rate and data format to that of the external device.	p.51
	The preset data format is not correct.		
	The transmitted character or ASCII code is not correct.	Transmit the correct character or ASCII code.	p.67

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Error Message List

Display	Error message	Cause	Action	Reference page
- - - - -	Measurement error	The measurement value exceeds the specified output range.	Change the OFFSET value and the sensor head and target setup positions so that the measurement value does not exceed the specified output range.	p.25 p.35
dAr	Insufficient intensity	Intensity is insufficient or the laser beam shield is closed.	Make sure that the LOW-INTENSITY LIMIT and gain are set to correct values in relation to the intensity. Make sure that the laser beam shield is opened.	p.4 p.30 p.37
bri	Intensity too high	Intensity is too high.	Make sure that the HIGH-INTENSITY LIMIT and gain are set to correct values in relation to the intensity.	p.30 p.37
FAr	+ AREA OVER	The sensor-to-target distance is too long.	Check the sensor head and target setup position.	p.25
nEAr	- AREA OVER	The sensor-to-target distance is too short.		
C-Err	Calibration error	The output value exceeds the specified calibration range.	Re-calibrate.	p.32
F-Err	Filter setting error	The preset CUTOFF frequency is not correct.	Set the CUTOFF frequency to 0100 or more.	p.36
Err-1	Connection error	Pins 1 and 2 of the LASER REMOTE connector are not shorted. No sensor head is connected. The connecting cable is disconnected.	Reconnect the sensor head. Short the LASER REMOTE connector pins 1 and 2 by connecting the LASER REMOTE input connector to the LASER REMOTE connector. Check that the connecting cable is not disconnected.	p.15 p.22
Err-2	GP-IB error	The GP-IB board is not properly connected to the GP-IB connector.	Install the GP-IB board properly to the GP-IB connector.	p.24
BAUD RATE LED is flashing	Battery error	Memory back-up battery is exhausted.	Replace the battery.	p.19

Note "Far" and " Near" are displayed when the sensor-to-target distance exceeds the measuring range by at least 5%.

Example: When using the LC-2440:
"Far" is displayed when the sensor-to-target distance exceeds the measuring range by at least + 3.3 mm.

"Near" is displayed when the sensor-to-target distance exceeds the measuring range by at least - 3.3 mm.

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9-2 Hints on Highly Accurate Measurement

This section describes the measurement conditions for improving the LC-2400 series measurement accuracy.

Performance of the LC-2400 Series

The resolution given in the LC specifications was obtained under the following conditions:

- A regular-refective object (for LC-2420/LC-2430) or white diffuse-reflective object (for LC-2440/LC-2450) was used as the target. Sufficient intensity was received.
- The number of averaging measurements was set to 512.
- Each target was measured in static conditions.

As the number of averaging measurements and the intensity level were reduced, the resolution was reduced.
The resolution was also reduced when measuring a moving target with an uneven surface such as a metal-worked or hair-line finished target. For example, when measuring the surface runout of a hair-line finished rotating disk, the resolution is reduced. Linearity is also reduced under such conditions.

How to Improve the Measurement Accuracy

Under the following conditions, the LC enables highly accurate measurements using a target with an uneven surface such as a hair-line finished target.

- Increase the intensity.

Apply a white acrylic resin board or mirror-surfaced object to the measurement point to increase the intensity.

- Increase the laser beam diameter.

Place a target at the end of the measuring range to increase the laser beam diameter. When using the LC, for example, set the sensor-to-target distance to 28 mm or 32 mm. In this case, be sure to place the target within the measuring range.

- Increase the number of averaging measurements.

As the number of averaging measurements is increased, the response frequency is reduced. Be sure to set the number of averaging measurements to an appropriate value in relation to the target travel speed.

Number of averaging measurements vs. response frequency

$$\text{Response frequency (Hz)} = \frac{20000}{\text{Number of averaging measurements}}$$

* The response frequency is defined as the value when the analog output level is 3 dB lower than the stable level.

For other methods for improving the measurement accuracy, consult KEYENCE.

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9-3 Specifications

Model	**Controller**		**LC-2400A/LC-2400W/LC-2401**			
	Sensor head		**LC-2420**	**LC-2430**	**LC-2440**	**LC-2450**
Measuring range			±0.2 mm	±0.5 mm	±3 mm	±8 mm
Operating distance			10 mm	30 mm	30 mm	50 mm
Light source			Visible red semiconductor laser, Maximum output 1.9 mW, Pulse duration: 10 µs			
	Wavelength		670 nm			
	Class	**FDA**	Class II			
		IEC 825-1 11.1993	Class 2			
		DIN EN 60825-1 07.1994	Klasse 2			
Minimum spot diameter			20 x 12 µm	30 x 20 µm	35 x 20 µm	45 x 20 µm
Resolution [1.]	**LC-2400A/LC-2400W**		0.01 µm	0.02 µm	0.2 µm	0.5 µm
	LC-2401		0.32 µm		0.4 µm	0.5 µm
Linearity [2.]	**LC-2400A/LC-2400W**		±0.05% of F.S.			
	LC-2401		±0.1% of F.S.		±0.05% of F. S.	
Sampling frequency			50 kHz			
Response frequency			20 kHz (- 3 dB, Number of averaging measurements: 1)			
Response time			100 µs			
Number of averaging measurements			1 to131072 (18 selectable settings)			
OFFSET range			±199.99 µm	±499.98 µm	±2.9998 mm	±7.9995 mm
Gain adjustment			AUTO/MANUAL (4 settings)			
Analog output	**Displacement data output**		± 10 V, Output impedance: 0 Ω, 6 settings, Resolution: 5 mV			
	Intensity data output		0 to 5 V, Output impedance: 0 Ω			
Digital I/O	**96-pin connector** [3.]	**Displacement data output**	**LC-2400A/ LC-2400W**	TTL level, positive logic		
				1LSB=0.01 µm	1LSB=0.02 µm	1LSB=0.2 µm	1LSB=0.5 µm
			LC-2401	TTL level, positive logic		
				1LSB=0.32 µm		1LSB=0.4 µm	1LSB=0.5 µm
		Intensity data output		TTL level, positive logic, 1LSB = 2			
		Control input		TTL level, negative logic [Output timing]			
		Control output		TTL level, negative logic [Upper/lower limit, INTENSITY alarm, AREA OVER alarm]			
	50-pin connector [4.]	**Displacement data output**	**LC-2400A/ LC-2400W**	16-bit parallel NPN open-collector, negative logic			
				1LSB=0.01 µm	1LSB=0.02 µm	1LSB=0.2 µm	1LSB=0.5 µm
			LC-2401	Paralle NPN open-collector, negative logic			
				11 bits	12 bits	15 bits	16 bits
				1LSB=0.32 µm		1LSB=0.4 µm	1LSB=0.5 µm
		Intensity data output		16-bit parallel NPN open-collector, negative logic 1LSB=2			
		Control input		TTL level, negative logic [Output timing]			
Control I/O	**Control input**			Non-voltage input (contact, solid-state) [HOLD timing input, AUTO-ZERO ON/OFF input, Program selection input, 1CH/2CH selection input, LASER REMOTE input]			
	Control output			NPN open-collector, 100 mA (30 V) max. [Upper/lower limit output, Intensity alarm output,AREA OVER alarm output]			
Interface	**RS-232C**			Displacement/intensity data output and control input (baud rate: 75 to 19200 bps selectable)			
	GB-IB[5.]			Displacement/intensity data output and control input			
Measuring stability (±5°C (±9°F))[6.]				±0.2% of F.S.		±0.03% of F.S.	
Power supply voltage				100 to 240 VAC ±10%, 50/60 Hz (when using the control unit separately; ±15 VDC ±3%, 0.5 A, +5 V±5%, 3 A)			
Fuse				250 V ~ 3.15 A FAST High Breaking			
Power consumption				70 VA max.			
Ambient temperature				0 to 40°C (32 to 104°F), No freezing			
Relative humidity				35 to 85%, No condensation			
Noise				70 dB max.			
Weight	**Sensor head**			Approx. 500 g		Approx. 250 g	
	Controller			Approx. 6.8 kg (Approx. 2 kg, not including the display unit)			

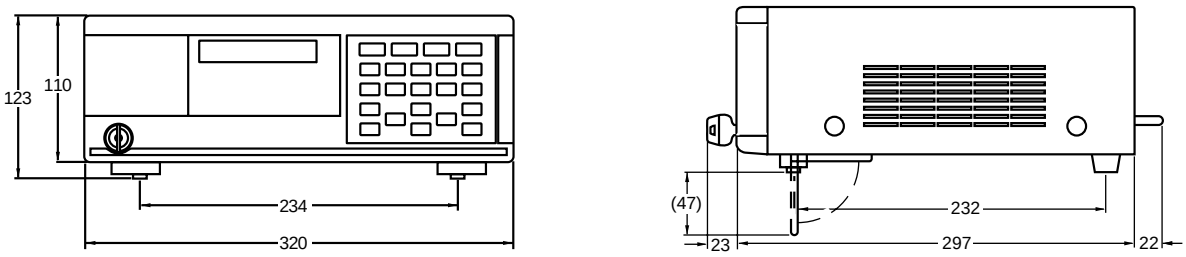
1, 2: When using a standard specular-reflective object (LC-2420/LC-2430) or white diffuse-reflective object (LC-2440/LC-2450) as a target and the number of averaging measurements is set to 512:
3: The 96-pin connector can be used only when the control unit is used separately. Cannot be used with the LC-2400W.
4, 5: Optionally available for LC-2400A only. Contact us for details.
6: The data was obtained when the standard target and the sensor head were fixed to a steel plate (LC-2420/LC-2430) or an aluminum plate (LC-2440/LC-2450). (20°C (68°F) as reference temperature)

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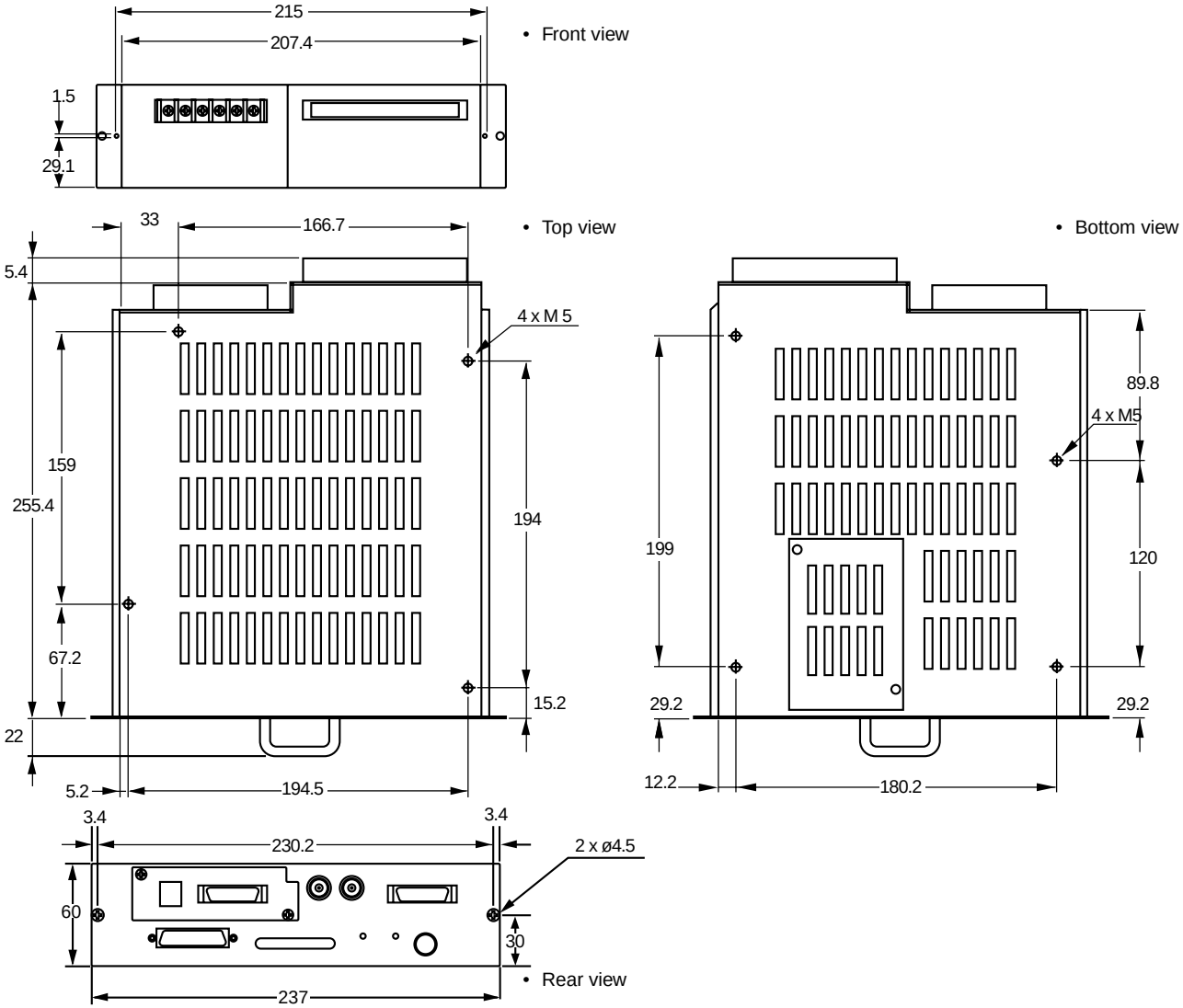
9-4 Dimensions

[Unit: mm]

Display Unit (LC-D1A/LC-D1W)



Control Unit (LC-C1A/LC-C1W/LC-C2)



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Sensor head

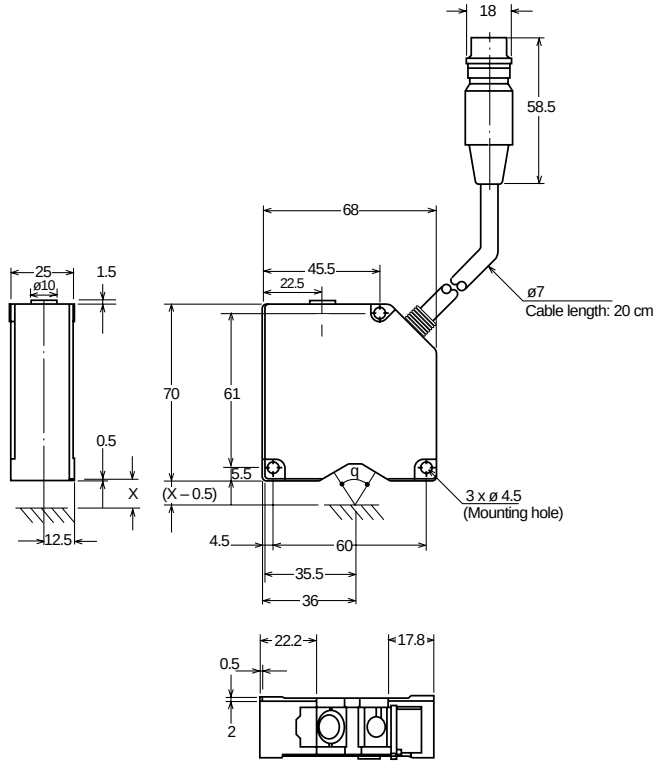
[Unit: mm]

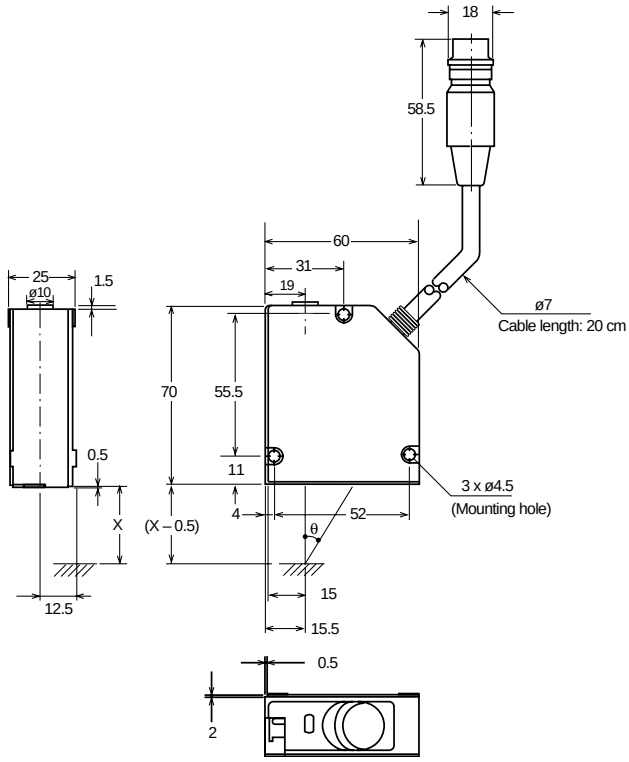
LC-2420/LC-2430 Regular-reflective

Model	LC-2420	LC-2430
Reference distance (X)	10.5	30.5
Angle formed by transmitted and received beams (θ)	63°	45°

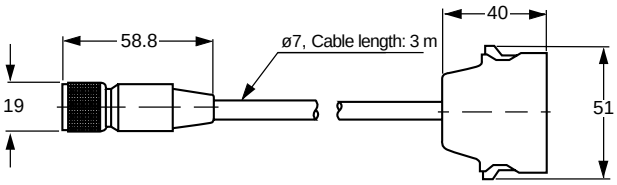
LC-2440/LC-2450 Diffuse-reflective

Model	LC-2440	LC-2450
Reference distance (X)	30.5	50.5
Angle formed by transmitted and received beams (θ)	30°	22°





Connecting Cable (Model: OP-21412)

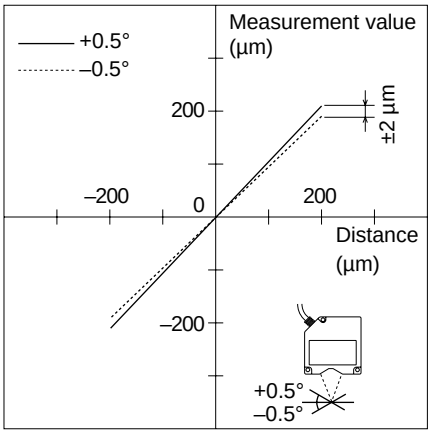


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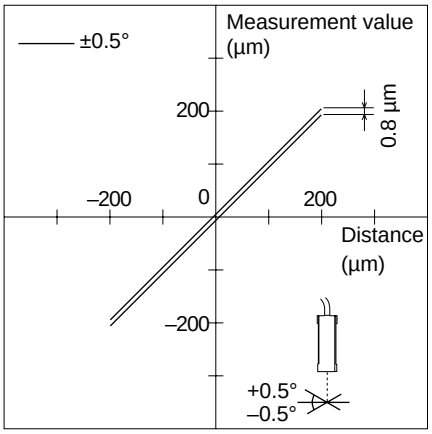
9-5 Characteristics

Measurement Error due to Target Inclination (Typical)

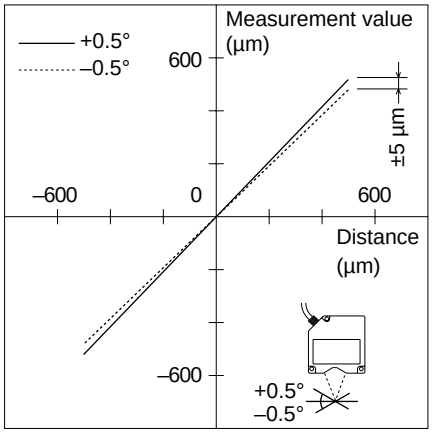
• LC-2420 (Longitudinal direction with respect to the target inclination)
(Target: Block gauge)



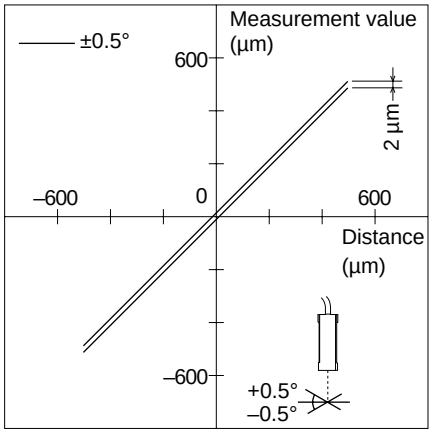
• LC-2420 (Traversal direction with respect to the target inclination)
(Target: Block gauge)



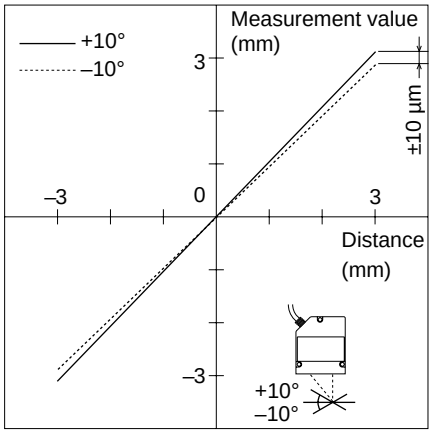
• LC-2430 (Longitudinal direction with respect to the target inclination)
(Target: Block gauge)



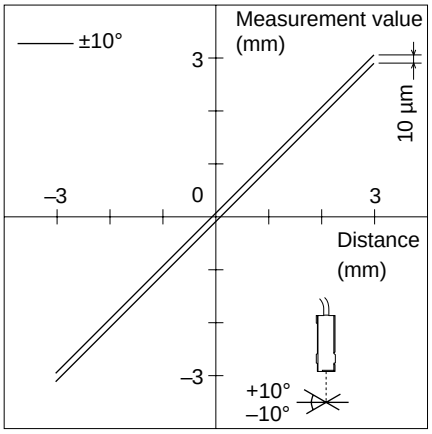
• LC-2430 (Traversal direction with respect to the target inclination)
(Target: Block gauge)



• LC-2440 (Longitudinal direction with respect to the target inclination)
(Target: Standard white diffuse-reflective object)

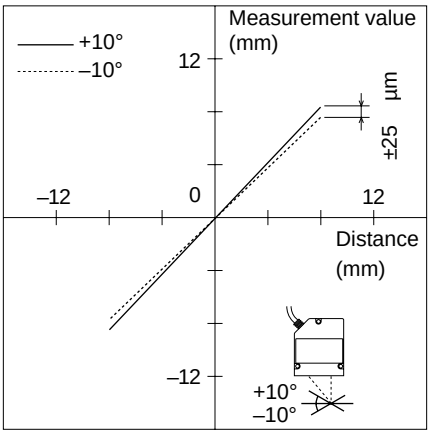


• LC-2440 (Traversal direction with respect to the target inclination)
(Target: Standard white diffuse-reflective object)

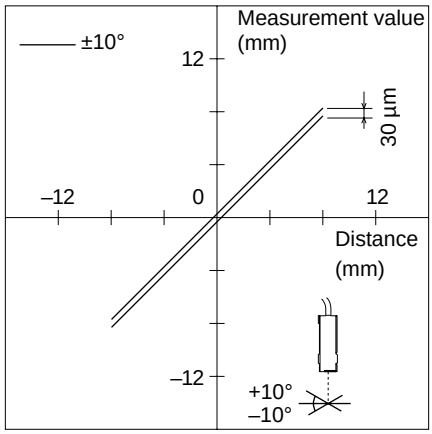


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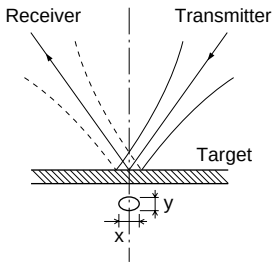
• LC-2450 (Longitudinal direction with respect to the target inclination)
(Target: Standard white diffuse-reflective object)



• LC-2450 (Traversal direction with respect to the target inclination)
(Target: Standard white diffuse-reflective object)

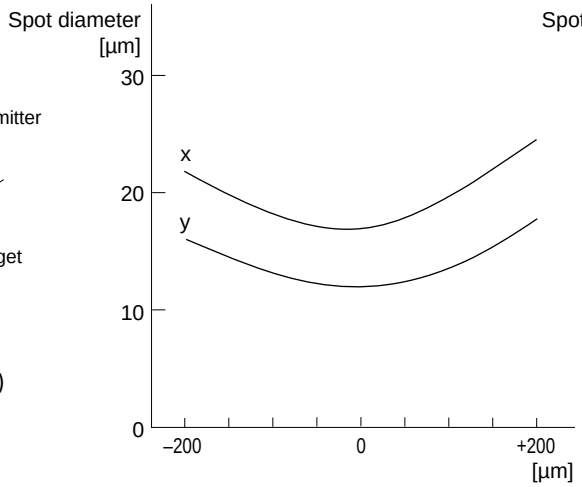


Distance vs. Spot Diameter (Typical)



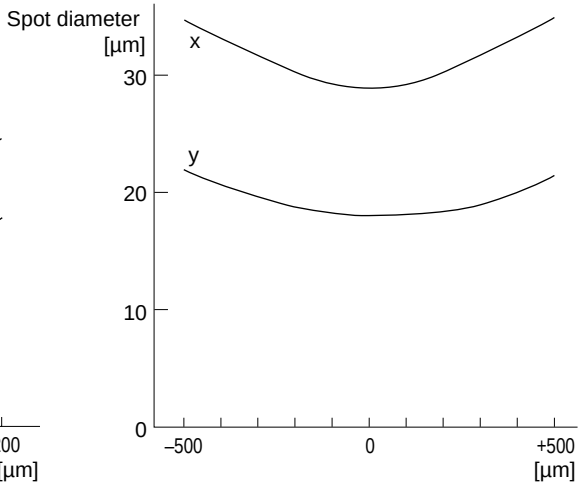
(Regular-reflective type)

• LC-2420

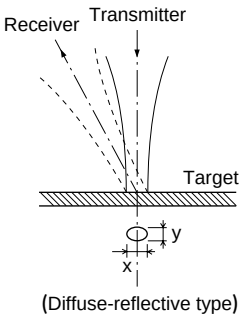


Distance from the center of the measuring range

• LC-2430

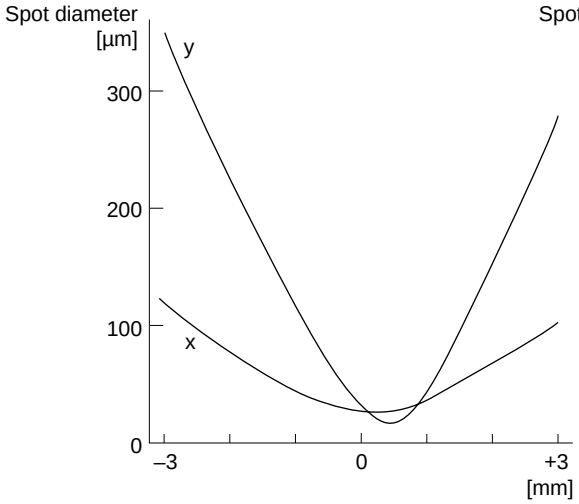


Distance from the center of the measuring range



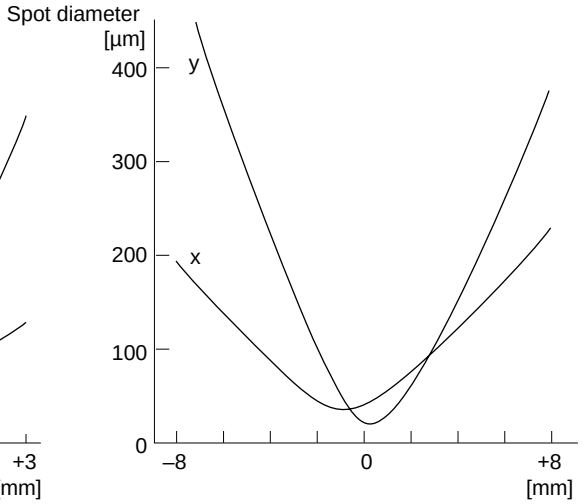
(Diffuse-reflective type)

• LC-2440



Distance from the center of the measuring range

• LC-2450



Distance from the center of the measuring range

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9-6 Initial Settings List

Sensor head	LC-2420	LC-2430	LC-2440	LC-2450
Offset	0			
Low-intensity limit	50			
High-intesity limit	49750			
Low-intensity limit time	0 ms			
High-intensity limit time	0 ms			
Gain	AUTO			
Number of averaging measurements	2048			
Measurement mode	NORMAL			
Auto-zero	OFF			
Filter	OFF			
Cutoff frequency	100 Hz			
Baud rate	1200 bps			
Data format	8 bits, Parity check: None, Stop bit length: 1 bit (Display panel: 8n1)			
Upper/lower limits in each mode	+200.00 µm -200.00 µm	+500.00 µm -500.00 µm	+3.0000 mm -3.0000 mm	+8.0000 mm -8.0000 mm
Calibration	200.00 µm	500.00 µm	3.0000 µm	8.0000 µm
Analog ratio	50 µm/V	100 µm/V	1000 µm/V	2000 µm/V
Digit suppress	Full			
Function	1CH			

Initializing the LC-2400 Series

Follow the procedure below to reset the LC to initial settings.

Note When you initialize your LC, all settings stored in programs will also be deleted.

[LC-2400A series]
- Turn the power OFF.
- Turn the power ON while pressing and holding the ↵ key.
- The LC will be initialized and reset to the above initial settings.

[LC-2400W series]
- Turn the power switch at the rear of the controller off.
- Turn the key-operated switch to the ON position while pressing and holding the ↵ key.
- The LC will reinitialize with the delfault settings shown above.

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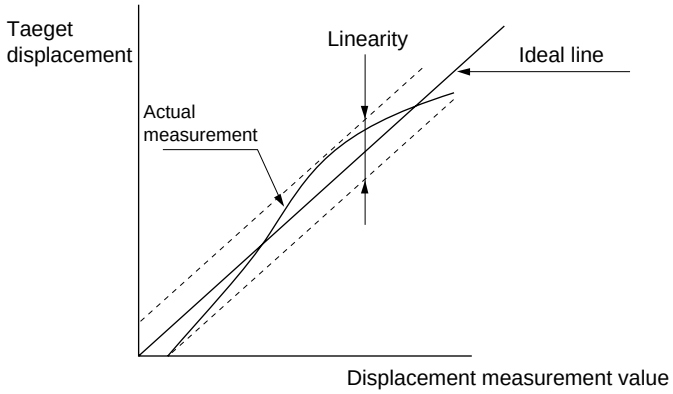
9-7 Glossary

Resolution

The LC series outputs a target displacement value by detecting the displacement of the laser beam reflected on the target surface. The S/N ratio of the electric signal generated by the beam displacement varies depending on the intensity of the received laser beam. The displacement output value fluctuates due to internal noise. The amount of the fluctuation is called resolution.

Linearity

Ideally, the displacement output from the LC would be identical to the target displacement, and the relationship between the output value and the target displacement would be represented by a straight line. Actual measurements, however, deviate slightly from the ideal line. The tolerance range in relation to the ideal line is called linearity.



Sampling Frequency

Sampling frequency is defined as the number of samples taken per second.

Response frequency

If a target rotates or oscillates above a certain frequency, the LC cannot detect the target displacement. Response frequency is defined as the frequency when the output level is 3 dB lower than (approx. 70% of) the stable level.

Response Time

Response time is defined as the time required for output voltage to reach ± 10% of the stable level when a target instantaneously moves between two points.

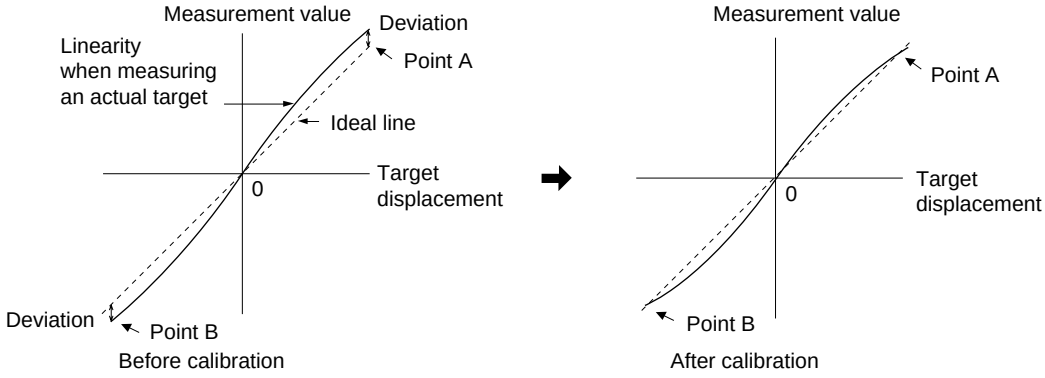
Operating Distance

Operating distance is defined as the distance between the front face of the sensor head and the middle of the measuring range.

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Calibration

Calibration is performed to compensate for the measurement deviation from the ideal line that is caused by the difference in target color, material and surface condition. For example, the LC may output 1.990 mm, although actual displacement is 2.000 mm. This deviation results from differences in the target surface, since the laser beam reflects differently depending on the target surface. This is a characteristic of sensors using the principle of laser beam reflection. By calibrating, the measurement deviation between two measurement points can be corrected. The amount of deviation between two measurement points varies depending on the linearity for each target.



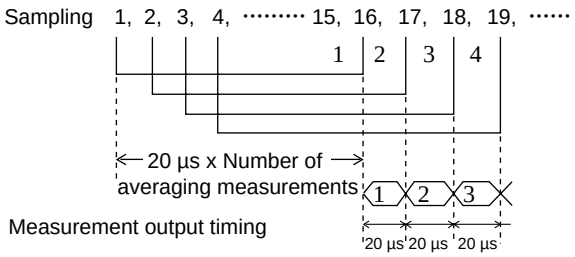
Number of Averaging Measurements

The LC samples 50000 pieces of data per second to output measurement values. By averaging the sample data, fluctuation of measurement values can be reduced. The averaging methods are as follows:

Number of averaging measurements	Averaging method
1 to 2048	Moving average of one sampling
4096 to 131072	Moving average of N samplings

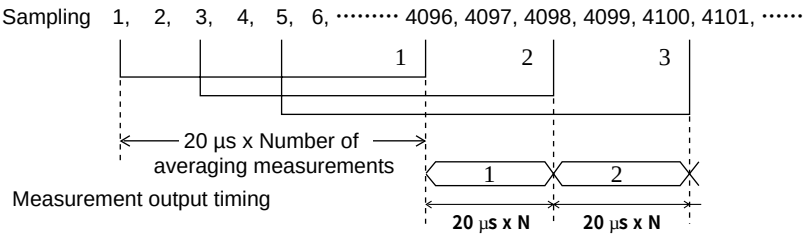
$$N = \frac{\text{Number of averaging measurements}}{2048}$$

Example:
Number of averaging measurements: 16 (Shifting one measurement before each new average)



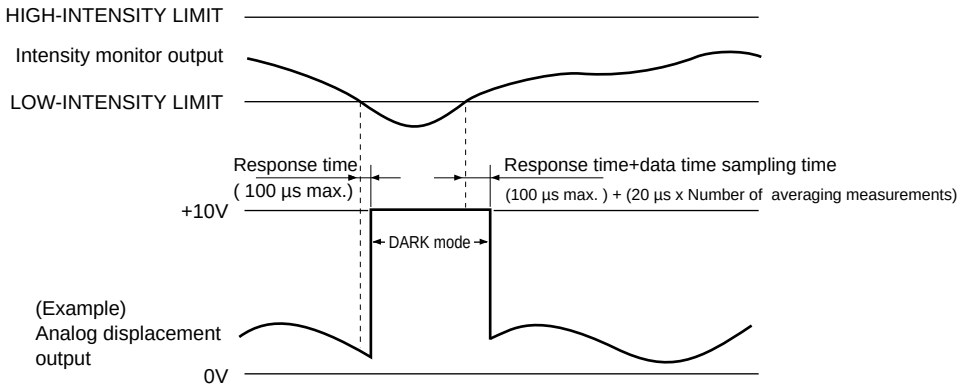
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Example:
Number of averaging measurements: 4096 (Shifting "N" measurements before each new average: N = $\frac{4096}{2048}$ = 2)



HIGH-INTENSITY LIMIT/LOW-INTENSITY LIMIT

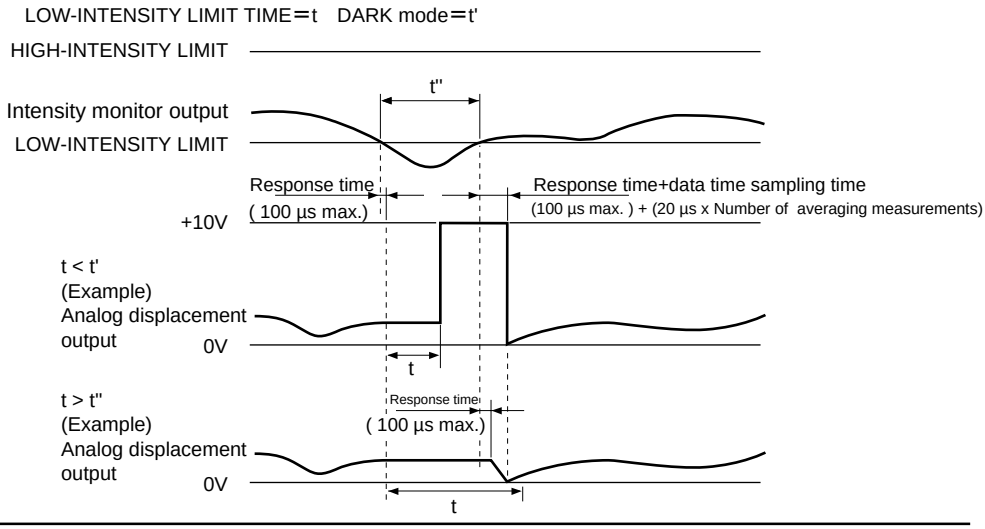
The LC is set to the DARK mode 100 µs max. after the intensity monitor output falls below the LOW-INTENSITY LIMIT. Then, the LC returns to the measurement mode 100 µs max. + (20 µs x Number of averaging measurements) after the intensity monitor output exceeds the LOW-INTENSITY LIMIT.



Note When the intensity monitor output exceeds the HIGH-INTENSITY LIMIT, measurement data is output at the same timing as above.

INTENSITY LIMIT TIME

The BRIGHT and DARK modes can be canceled for a specified time duration. This duration is called the INTENSITY LIMIT TIME. The INTENSITY LIMIT TIME can be set individually for the BRIGHT and Dark modes. Using the INTENSITY LIMIT TIME, a measurement value just before the BRIGHT or DARK mode is retained for a specified time duration.



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When the LOW-INTENSITY LIMIT TIME (t) is longer than the DARK mode time (t''), the LC returns to the measurement mode 100 μs max. after the intensity monitor output exceeds the LOW-INTENSITY LIMIT.

Note

As for the HIGH-INTENSITY LIMIT TIME, measurement data is output at the same timing as above.

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9-8 Expansion I/O (Optional)

The LC-B1 digital I/O board and the LC-B2 GP-IB board are expansion boards that can be installed in the LC-2400A series.
For installation instructions, refer to page 24 in this manual. Be sure to read the instructions carefully when installing the expansion units.

Hints on Correct Use

- When the LC is located in an area subject to noise interference from other devices, use a shielded cable to connect the LC with external equipment (e.g. computer). Be sure to turn OFF the LC before connecting it to an external device.
- First switch on the external equipment (e.g. computer), and then the LC. If this order is not followed, the LC may malfunction due to noise created when another device starts up.
- To use the GP-IB board, set the address and delimiter corresponding to the program being used or the device being connected.

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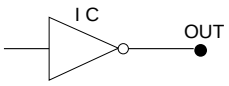
Digital I/O (50-pin)

Displacement and Intensity values are output as digital data.

Specifications

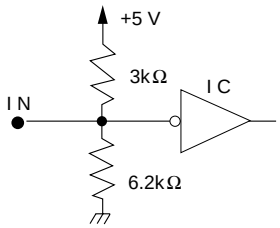
Output Specifications

- Open collector (TTL7406 or equivalent)
- Maximum applied voltage: 30 V
- Maximum sink current: 40 mA



Input Specifications

- TTL level, Negative logic
  (74LS19 or equivalent)



Output Signals

Displacement data output
The displacement data output signal is a negative logic signal in the form of a 16-bit two's complement binary number. When the output signal is LOW ("1"), the output transistor is ON.

Sensor head model	Displacement data output
LC-2420	1LSB=0.01 µm
LC-2430	1LSB=0.02 µm
LC-2440	1LSB=0.2 µm
LC-2450	1LSB=0.5 µm

Intensity data output
The intensity data output signal is a negative logic signal in the form of a 16-bit two's complement binary number.
All sensor head models: 1LSB = 2.

Strobe output ($\overline{\text{STROBE OUT}}$)
The strobe signal is output to specify data output timing. It is a negative logic signal with a pulse duration of approx. 6.4 µs. The strobe signal goes LOW approx. 1.6 µs after the measurement data output signal is prepared.

Note The MSB of the displacement data is "0" when a measurement error occurs or the LC is set to the DARK or BRIGHT mode. In other conditions, the MSB is "1".

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Input Signals

External trigger enable input (ETE IN)

When the external trigger enable input (ETE IN) is LOW and the external trigger input (EXT TRIG IN) signal is received, the LC outputs measurement data at a specified frequency.

Input	Level	Output
ETE IN	HIGH (The input level is HIGH even if the input terminal is open.)	When the number of averaging measurements is set to between 1 and 2048, measurement data is output every 20 µs.
	LOW	Measurement data is output only when the external trigger input (EXT TRIG IN) signal is received.

Note

When the number of averaging measurements is set to between 1 and 2048, measurement data is output every 20 µs.

When the number of averaging measurements is set to 4096 or more, measurement data is output at the frequencies shown at right.
Figures in ( ) apply when the ADD or SUB function is selected.

Number of averaging measurements	
1 to 2048	20 µs (40 µs)
4096	40 µs (80 µs)
8192	80 µs (160 µs)
16384	160 µs (320 µs)
32768	320 µs (640 µs)
65536	640 µs (1280 µs)
131072	1280 µs (2560 µs)

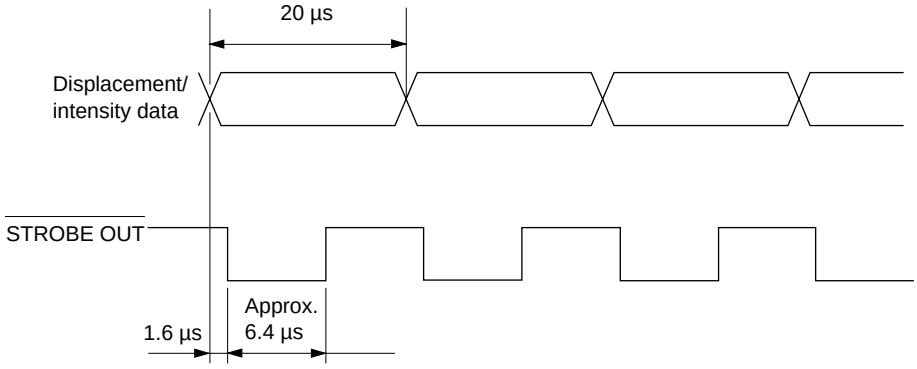
External trigger input (EXT TRIG IN)

When the ETE IN signal is LOW and the EXT TRIG IN signal is LOW, measurement data is output every 30 µs max. The output data is retained until the EXT TRIG IN signal goes LOW again.

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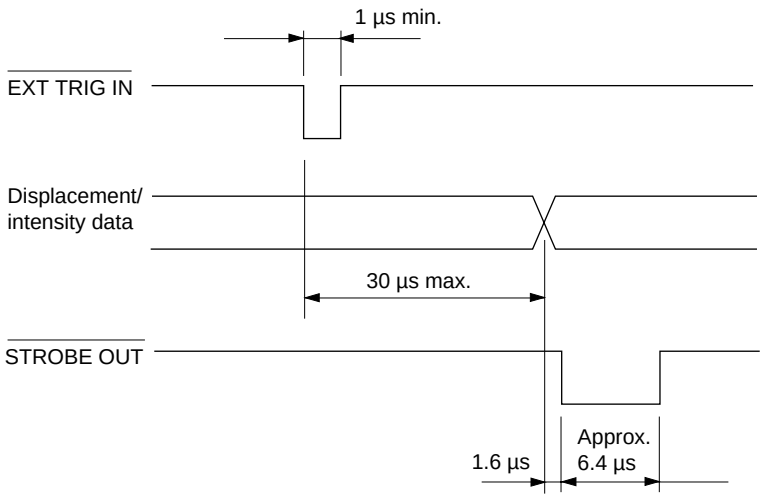
Timing chart

1. When the ETE IN signal is HIGH:



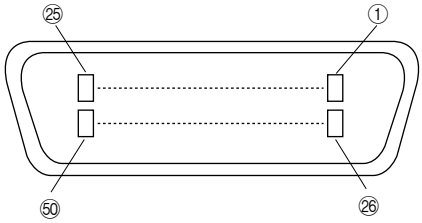
Note The STROBE OUT signal is output at a frequency of 20 µs, regardless of the number of averaging measurements.

2. When the ETE IN signal is LOW:



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Pin Names and Functions



Pin No.	Signal name	Pin No.	Signal name
1	Displacement data output $\overline{\text{DIBIN1}}$ (LSB)	26	Displacement data output $\overline{\text{DBIN2}}$
2	Displacement data output $\overline{\text{DIBIN3}}$	27	Displacement data output $\overline{\text{DBIN4}}$
3	Displacement data output $\overline{\text{DIBIN5}}$	28	Displacement data output $\overline{\text{DBIN6}}$
4	Displacement data output $\overline{\text{DIBIN7}}$	29	Displacement data output $\overline{\text{DBIN8}}$
5	Displacement data output $\overline{\text{DIBIN9}}$	30	Displacement data output $\overline{\text{DBIN10}}$
6	Displacement data output $\overline{\text{DIBIN11}}$	31	Displacement data output $\overline{\text{DBIN12}}$
7	Displacement data output $\overline{\text{DIBIN13}}$	32	Displacement data output $\overline{\text{DBIN14}}$
8	Displacement data output $\overline{\text{DIBIN15}}$	33	Displacement data output $\overline{\text{DBIN16}}$ (MSB)
9	GND	34	Strobe output $\overline{\text{STROBE OUT}}$
10	External trigger input $\overline{\text{EXT TRIG IN}}$	35	External trigger enable input $\overline{\text{ETE IN}}$
11	GND	36	GND
12	GND	37	GND
13	GND	38	Intensity data output $\overline{\text{IBIN1}}$ (LSB)
14	Intensity data output $\overline{\text{IBIN2}}$	39	Intensity data output $\overline{\text{IBIN3}}$
15	Intensity data output $\overline{\text{IBIN4}}$	40	Intensity data output $\overline{\text{IBIN5}}$
16	Intensity data output $\overline{\text{IBIN6}}$	41	Intensity data output $\overline{\text{IBIN7}}$
17	Intensity data output $\overline{\text{IBIN8}}$	42	Intensity data output $\overline{\text{IBIN9}}$
18	Intensity data output $\overline{\text{IBIN10}}$	43	Intensity data output $\overline{\text{IBIN11}}$
19	Intensity data output $\overline{\text{IBIN12}}$	44	Intensity data output $\overline{\text{IBIN13}}$
20	Intensity data output $\overline{\text{IBIN14}}$	45	Intensity data output $\overline{\text{IBIN15}}$
21	Intensity data output $\overline{\text{IBIN16}}$ (MSB)	46	GND
22	GND	47	GND
23	GND	48	GND
24	GND	49	GND
25	GND	50	GND

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GP-IB Interface

The GP-IB interface board provides a communication link between the LC and computers or other external equipment.

Specifications

Communication Specifications

The GP-IB interface conforms to IEEE (Institute of Electrical and Electronics Engineers) standard 488-1978.

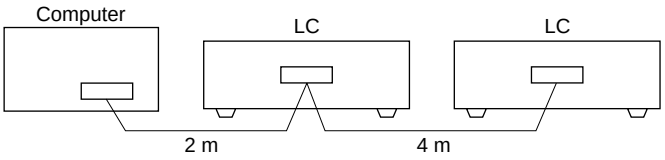
Transmission code	ASCII
Logic level	Logic 0 (High): +2.4 V min. Logic 1 (Low): +0.4 V max. (Bidirectional transceiver is used.)
Number of connectable devices	15 max. (including the controller)
Total cable length	20 m max.*
Cable length between two devices	4 m max.

* Variable depending on the number of devices.

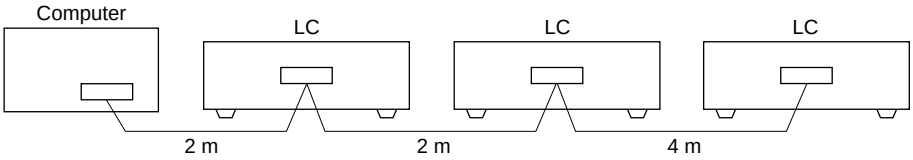
Connecting Cable

Use the GP-IB cable to connect equipment (e.g. computer) to the GP-IB interface board. Up to 15 devices can be interconnected.
The total cable length should be 20 m or less, provided that it does not exceed "the number of devices x 2 m".
The cable length between two devices should be 4 m max.

Example 1: When connecting three devices

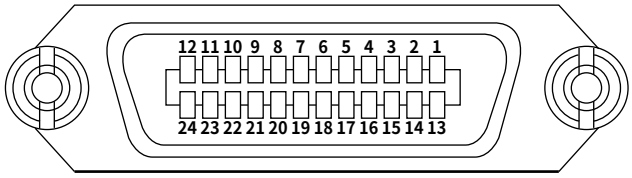


Example 2: When connecting four devices



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Pin Assignment



Pin No.	Signal name	Description
1	DIO1	Data bus
2	DIO2	Data bus
3	DIO3	Data bus
4	DIO4	Data bus
5	EOI	Indicates end of data transmission.
6	DAV	Indicates that the data is valid
7	NRFD	Indicates that the data cannot be received.
8	NDAC	Indicates that the data has not been received.
9	IFC	Initializes the interface.
10	SRQ	Allows each device to send a Request To Interrupt to the controller.
11	ATN	Determines whether the data is an interface message or a device message.
12	Shield	Shield
13	DIO5	Data bus
14	DIO6	Data bus
15	DIO7	Data bus
16	DIO8	Data bus
17	REN	Allows the controller to set the Remote or Local interface function for each device.
18	GND (DVA)	Ground for control bus
19	GND (NRFD)	Ground for control bus
20	GND (NDAC)	Ground for control bus
21	GND (IFC)	Ground for control bus
22	GND (SRQ)	Ground for control bus
23	GND (ATN)	Ground for control bus
24	Logic GND	Signal ground

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Interface Functions

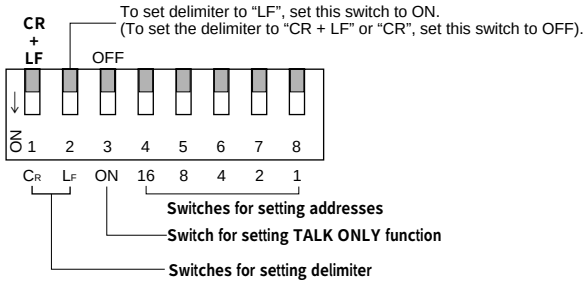
The LC has the following interface bus functions.

Code	Function
SH1	All transmit handshaking functions are included.
AH1	All receive handshaking functions are included.
T5	Basic Talker function Serial Polling function TALK ONLY function Resets the Talker function of the device specified as a Listener
L4	Basic Listener function Resets the Listener function of the device specified as a Talker
SR1	All Service-Request functions are included.
RL1	All Remote/Local functions are included.
PPO	No Parallel Polling function is included.
DC1	All Device-Clear functions are included.
DT1	All Device-Trigger functions are included.
CO	No controller function is included.
E2	3-state driver is included.

Initial Settings

Using the GP-IB interface, up to 15 devices, including the controller, can be interconnected. When connecting devices with the GP-IB cables, each device must be assigned an address. To set the address, use the address DIP switches. (See the figure below.)
Set the TALK ONLY mode and delimiter with the DIP switches, as required.

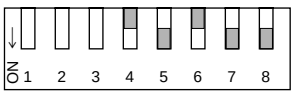
Note Be sure to turn off the LC, and then set the address and delimiter with the DIP switches located on the rear panel of the LC.



Setting Addresses

To set an address, use the 1st to 5th DIP switches from the right (4, 5, 6, 7, and 8 in the figure). You can set addresses from "0" to "30" with these switches.

Example: When setting the address to "11":



Note The address has been factory-set to "0".

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Setting the TALK ONLY Mode

Set the TALK ONLY mode DIP switch (the 3rd switch from the left) to ON. The LC will be set to TALK ONLY mode.

Note

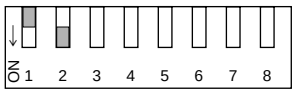
TALK ONLY mode has been factory-set to OFF.

Setting Delimiter

For data transmission, the following delimiter can be set with the DIP switches.

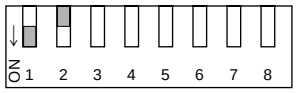
- Setting the delimiter to "LF":

Set the 1st DIP switch from the left to OFF and the 2nd DIP switch to ON.



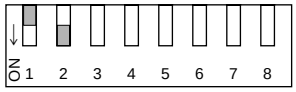
- Setting the delimiter to "CR":

Set the 1st DIP switch from the left to ON and the 2nd DIP switch to OFF.



- Setting the delimiter to "CR+LF":

Set the 1st and 2nd DIP switches from the left to OFF.



Note

- The delimiter has been factory-set to "CR+LF".
- An EOI (End of Identify) simplex signal can be output simultaneously when the delimiter is transmitted from the LC. To set the EOI signal, send the GP-IB program code from an external device (e.g. computer) to the LC. (See p.107.)

INTERFACE MESSAGES

Interface messages (commands) are sent from external equipment (e.g. controller) to the interface through a bus line.
The interface commands and the responses corresponding to the commands are as follows:

Note

Interface messages may also be sent from the talker. Delimiters, for example, are sent from a talker to control the interface.
On the other hand, device messages are sent to control devices connected to the interface, for example, the LC.
The messages that control the LC main unit are called device messages.

Clear Commands

Command	Response
IFC (Interface Clear)	Initializes the GP-IB interface of all the devices interconnected.
SDC (Selected Device Clear)	Initializes a specified device.
DCL (Device Clear)	Initializes all the devices interconnected.

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Trigger Command

Command	Response
GET (Group Execute Trigger)	Signal to start reading displacement data into the GP-IB buffer.

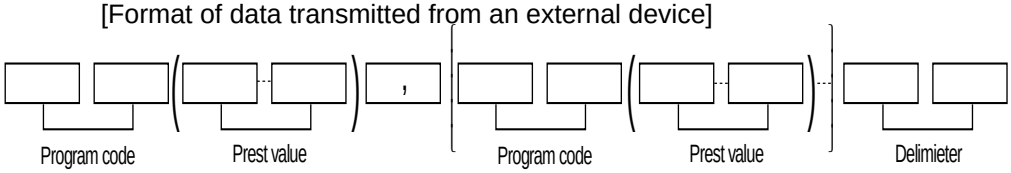
Setting Functions

By sending a program code from external equipment (e.g. computer) to the LC, you can remotely change the LC settings. When the program code and setting values are received, the LC sets each function according to the program code and setting values, and then returns to the measurement mode.

Note

- To set or change settings by sending program code from an external device, set the TALK ONLY mode of the device specified as a Talker to OFF (See p.104).
- Be sure to enter a comma (,) between program codes as a partition.
- Up to 200 characters (including the delimiter) can be simultaneously transmitted.

[Format of data transmitted from an external device]



( ): Required only when setting upper/lower limits and parameter values.
[ ]: Two or more program codes and preset values can be set.

[Preset value]
The data format and setting range of the preset values are the same as those of the RS-232C interface. See section 8-1, p. 55.

[Syntax error]
- When the LC receives an undefined program code, the received program code and the subsequent data are ignored.
- When the LC receives a preset value exceeding the specified setting range, the received data is ignored. When the number of digits under the decimal point exceeds the specified value, the received data is ignored.
- When the LC can receives the program code for the setting function, the program codes for measurement data/information output functions cannot be received.

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Changing Gain, Mode and Number of Averaging Measurements

By sending the following program code from an external device to the LC, you can change or set gain, mode and the number of averaging measurements.

Function	Description	Program code
Changing gain	AUTO	GA
	GAIN1	G1
	GAIN2	G2
	GAIN3	G3
	GAIN4	G4
Changing mode	NORMAL	MN
	P-P	MP
	PEAK	ME
	BOTTOM	MB
Changing number of averaging measurements	1	AO
	2	A1
	4	A2
	8	A3
	16	A4
	32	A5
	64	A6
	128	A7
	256	A8
	512	A9
	1024	AA
	2048	AB
	4096	AC
	8192	AD
	16384	AE
	32768	AF
	65536	AG
	131072	AH

Setting/Resetting AUTO-ZERO, Hold, Filter and Panel Lock Functions

By sending the following program codes from an external device to the LC, you can set or reset each function.

Function	Description	Program code
AUTO-ZERO ON/OFF	The AUTO-ZERO function is set.	ZS
	The AUTO-ZERO function is reset.	ZR
Hold ON/OFF	The hold function is set.	HS
	The hold function is reset.	HR
Panel lock ON/OFF	The panel lock function is set.	RS
	The panel lock function is reset.	RR
Filter ON/OFF	The filter function is set.	FS
	The filter function is reset.	FR

The panel lock function is used to disable input from any keys of the display unit. When the panel lock function is ON, the LOCK indicator lights.

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Setting GP-IB Communication Functions

By sending the following program codes from an external device to the LC, you can set the GP-IB communication functions.

Function	Description	Program code
GP-IB communication functions	Transmits EOI (End of Identify) simultaneously when the delimiter is transmitted.	ES
	Transmits EOI (End of Identify) only.	EO
	Resets EOI (End of Identify).	ER
	Enables SRQ (Service Request) transmission.	SS
	Disables SRQ (Service Request) transmission.	SR

Note The GP-IB communication functions have been factory-set to "ES" (to transmit EOI simultaneously) and "SR" (to disable SRQ transmission).

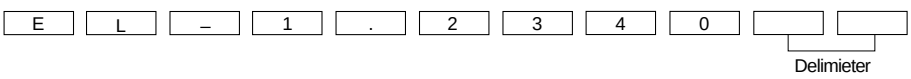
Setting Upper/Lower Limits, Parameters and Filter

By sending the following program codes from an external device to the LC, you can set the upper/lower limits, parameter and filter.

Function	Description	Program code
Setting upper/lower limits	NORMAL mode upper limit	NH
	NORMAL mode lower limit	NL
	P-P mode upper limit	PH
	P-P mode lower limit	PL
	PEAK mode upper limit	EH
	PEAK mode lower limit	EL
	BOTTOM mode upper limit	BH
	BOTTOM mode lower limit	BL
Setting parameters	Offset	OF
	Calibration	CL
	HIGH-INTENSITY LIMIT	BC
	HIGH-INTENSITY LIMIT TIME	BT
	LOW-INTENSITY LIMIT	DC
	LOW-INTENSITY LIMIT TIME	DT
	Analog ratio	AR
	Digit suppress	DS
Setting filter	Cutoff frequency	FP

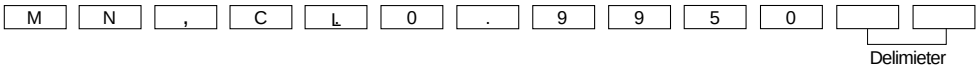
[Data format of preset vales]
The setting range of preset values is the same as that of the RS-232C. See section 8-1, p. 55.

[Example of preset values]
Example 1 : When setting the lower limit to "-1.234 mm" in the PEAK mode:



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Example 2: When changing the calibration coefficient from "1.0000" to "0.9950" in the NORMAL mode:



Setting Program

By sending the following program codes from an external device to the LC, you can set the program.

Function	Description	Program code
Setting program	Program No. 1 is saved.	S1
	Program No. 2 is saved.	S2
	Program No. 3 is saved.	S3
	Program No. 4 is saved.	S4
	Program No. 5 is saved.	S5
	Program No. 1 is saved.	L1
	Program No. 2 is loaded.	L2
	Program No. 3 is loaded.	L3
	Program No. 4 is loaded.	L4
	Program No. 5 is loaded.	L5

Setting Head Status (Function)

By sending the following program codes from an external device to the LC, you can set the Head Status function.

Function	Description	Program code
Setting function	1CH is specified.	H1
	2CH is specified.	H2
	ADD is specified.	HA
	SUB is specified.	HU

MEASUREMENT DATA OUTPUT FUNCTIONS

By sending the following program codes from an external device to the LC, you can change the displacement and intensity data output methods.

Function	Description	Program code
Measurement data output	Single output of displacement data	X0
	Single output of displacement and intensity data	X1
	Continuous output of displacement data	X2
	Continuous output of displacement and intensity data	X3
	Stop continuous output of measurement data	XS

Note The "XS" code is effective only when the LC is set to the continuous output modes.
This code is ignored even if it is received in other output modes.

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Format of Data Transmitted from an External Device

Send the program code in the following format.



Output Data

The output data format is the same as that of the RS-232C. See section 8-1, p. 56.
The output data includes the delimiter set with the DIP switches.

TALK ONLY Mode

When using the GP-IB interface board, you can set the LC to the TALK ONLY mode by setting the 3rd DIP switch from the left to ON (See p. 103). When the LC is set to the TALK ONLY mode, it is specified as a talker and continuously outputs displacement data.

Note

When the LC is set to the TALK ONLY mode, the setting function and the information output function does not work.

Information Output Functions

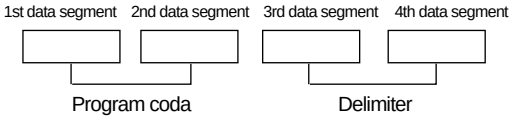
By sending the following program codes from an external device to the LC, the LC outputs parameter settings or preset values corresponding to the program code. Using the information output function, you can confirm the LC settings.

Function	Description	Program code
Information output	Alarm output status	Q?
	Preset gain	G?
	Preset mode	M?
	NORMAL mode upper/lower limits	N?
	P-P mode upper/lower limits	P?
	PEAK mode upper/lower limits	E?
	BOTTOM mode upper/lower limits	B?
	Preset number of averaging measurements	A?
	Offset setting	O?
	Calibration setting	C?
	INT. LIMIT setting	I?
	Analog ratio setting	R?
	Digit suppress setting	D?
	AUTO-ZERO ON/OFF status	Z?
	Hold ON/OFF status	H?
	Filter ON/OFF status	F?
	Filter setting	L?
	Program setting	J?
	Function setting	T?

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Format of Data Transmitted from an External Device

Send the program code in the following format.

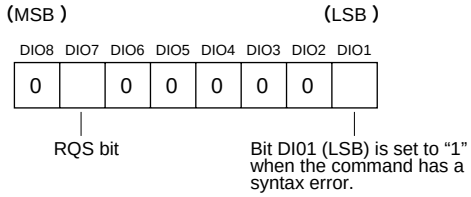


Output Data

The output data format is the same as that of the RS-232C. See section 8-1, p. 57.
The output data includes the delimiter set with the DIP switches.

Status Byte

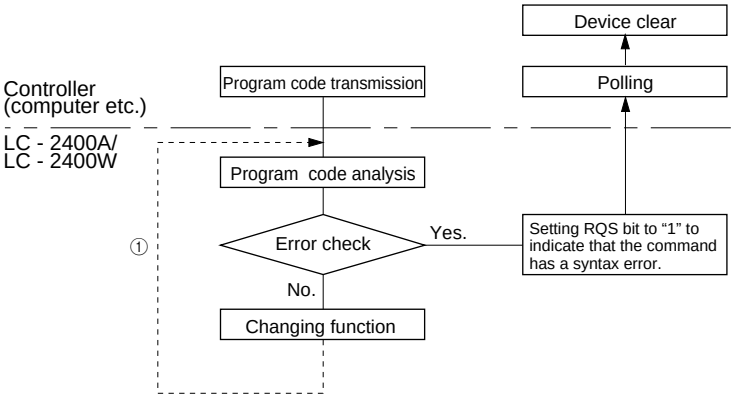
The LC transmits a status byte when the serial polling command from the controller is executed.
The status byte is represented as shown below.



Basic Sequence

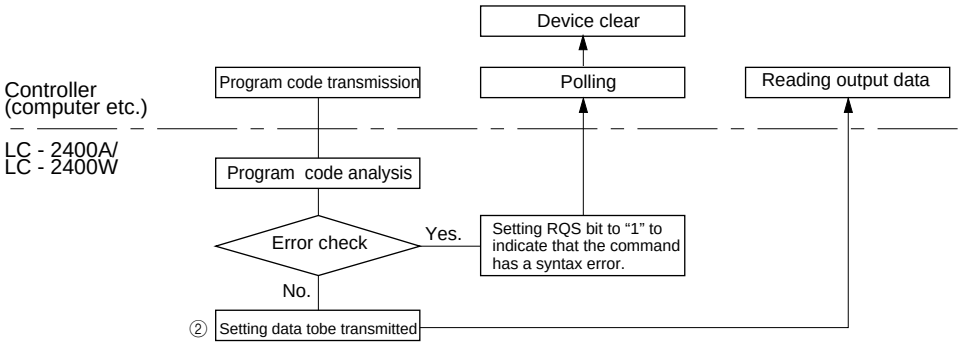
Changing and Setting Function (Setting Function)

When two or more program codes are transmitted from an external device, loop 1 is repeatedly executed until all program codes have been processed.



Reading Output Data (Measurement Data/Information Output Functions)

When the command for measurement data continuous output (program code "X3") is executed, loop 2 is repeatedly executed.



Note The above sequence does not apply when the LC is set to the TALK ONLY mode.

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Sample Program

Connecting the LC-2400 Series to a Personal Computer

Example:
After the number of averaging measurements is set to "2048" in the NORMAL mode, one measurement is displayed on the computer.

```
100   ISET IFC
110   ISET REN
120   CMD DELIM=0
130   WBYTE  &H3F, &H41, &H20, &H4;
140   PRINT @0; "MN, AB"
150   PRINT @0; "X0"
160   LINE INPUT @0; A$
170   PRINT A$; "mm"
180   IRESET REN
190   END
```

	Description
100	Interface clear
110	Remote enable
120	Sets the delimiter to "CR+LF".
130	&-H3F → "UNL" &-H41 → Sets the talker address for the controller (PC) to "1". &-H20 → Sets the listener address for the LC to "0". &-H4 → "SDC"
140	Transmits the program code to the LC. "MN": Sets the LC to the NORMAL mode. "AB": Sets the number of averaging measurements to "2048".
150	Allows the LC to output one measurement.
160	Allows the controller (computer) to receive one measurement from the LC.
170	Displays measurement data on the computer
180	Returns the interface to the Local function.
190	Terminates the program.

Note In the above program, the talker address for the controller (computer) is set to "1" and the listener address for the LC is set to "0". The delimiter is set to "CR+LF" and the TALK ONLY mode is set to OFF.

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