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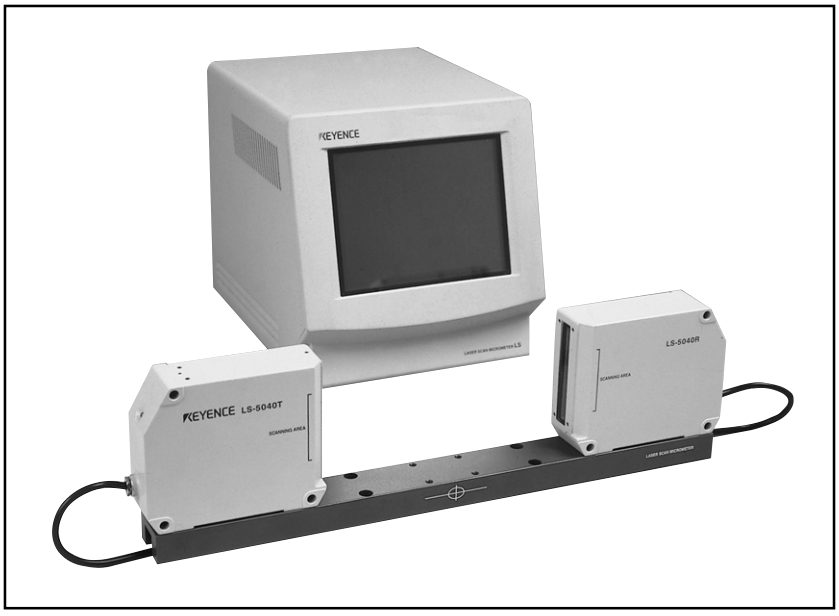
KEYENCE

96M12426

Instruction Manual

High-speed Laser Scan Micrometer

LS-5000 Series



Safety Precautions

This instruction manual describes the operation and function of the LS-5000 series. Read this manual carefully to ensure safe use and maximum performance from your LS-5000 series.
The LS-5000 series uses a semiconductor laser as the light source. Before using the product, see “Laser Safety Precautions” on page 1 to learn the safe and correct method of using the LS-5000 series.

Symbols

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

⚠ WARNING Failure to follow instruction 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 LS-5000 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 LS-5000 series or use it in any way other than described in the specifications.
- When the LS-5000 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 LS-5000 series for the purpose of protecting the human body.

⚠ CAUTION This is a class A (EN55011: EMI standard) product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Checking the Contents of the Package

The LS-5000 series includes the following items. Be sure to check that no item is missing or damaged.

■ **LS-5501 Package**

- Built-in display type controller: 1
- Instruction manual: 1
- AC power cables: 2 [1.]

■ **LS-5001 Package**

- Separate type controller: 1
- Instruction manual: 1
- Communication cable (OP-26401 + OP-96368): 1
- LS-VIEWER Software (3.5-inch FD, Instruction manual): 1

■ **LS-5041/5121 Package**

- Scanning head (Transmitter, receiver and mounting base): 1 [2.]
- Mounting brackets: 4
- ROM board: 1 [2.]

1. Two types of AC power cables are provided with the built-in display model LS-5501. One is for 125 VAC and the other is for 250 VAC. Select either according to your local power supply type.
2. The serial nos. of both units should be identical.

Warranty

See page 125.

Notice

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Contents

Chapter 1 Laser Safety Precautions

1.1 Classification 2
1.2 Warning Labels 2
1.3 Label Location 3
1.4 Safety Consideration 3
1.5 Safety Features Provided with the LS-5000 Series 4
1.6 Preparation for Operation 6

Chapter 2 Before Using the LS-5000 Series

2.1 System Configuration and Connections 8
2.1.1 System Configuration 8
2.1.2 Connection Procedure 9
2.2 Names and Functions of Indicators and Switches 12
2.3 Part Names 13

Chapter 3 Quick Start Reference

3.1 Quick Start Reference 16
3.1.1 Procedure for Starting Measurement 16

Chapter 4 Installation

4.1 Mounting the Scanning Head 18
4.2 Mounting the Controller 19

Chapter 5 Outline of Measurements

5.1 Area/Segment/Edge 22
5.2 Normal mode 22
5.2.1 DIA mode 23
5.2.2 T.EDGE (TOP EDGE) mode/B.EDGE (BOTTOM EDGE) mode 23
5.2.3 SEG (m,n) mode 23
5.3 Pitch mode 24

Chapter 6 Normal mode

6.1 Normal Mode Screens 24
6.2 Initial Screen 27
6.3 Setting Measuring Mode 28
6.4 Setting Functions 29
① [HOLD] Hold Function 30
② [ZERO] Auto-zero Function 31
③ [SCREEN] Screen Selection Function 32
④ Limit Setup 35
⑤ [CALIB] Calibration Setup 36
⑥ [PROGRAM] Program Selection Function 38
⑦ Area Setup 39
⑧ Calculation Setup 41
⑨ Average 44
⑩ Measuring Mode 46
⑪ Digit Suppression Function 54
⑫ Offset Function 55
⑬ Analog Output Function 57
⑭ I/O Slot Setup 59
⑮ Inspection 60
⑯ One-scan Mode 62
⑰ Program Selection Method Setup 64
⑱ Display Unit 65
⑲ Area Check Function 66
⑳ Initialize 67
㉑ Mode Change 68

Chapter 7 Pitch Mode

7.1 Pitch Mode Screens 70
7.2 Initial Screen 71
7.3 Setting Measurement 72
7.4 Setting Functions 72
① Screen Selection Function 73
② Limit Setup 75
③ Program Selection Function 76
④ Setting Number of Pitches 77
⑤ Average 79
⑥ Digit Suppressing Function 80
⑦ Measuring Mode 81
⑧ Masking 84
⑨ Mode Change 85

Chapter 8 RS-232C I/O

8.1 RS-232C Communication Protocol 88
8.2 Remote Control Function 90
8.3 Command List 97

Chapter 9 Expansion I/O Board

9.1 Control I/O Board 100
9.1.1 Part Names and Pin Assignment 100
9.1.2 I/O Terminal Operations 101
9.1.3 Specifications 102

Chapter 10 Display System Setup

10.1 Display System Setup 104
10.1.1 Adjusting Backlight Intensity 104
10.1.2 Reversing Display 105
10.1.3 Adjusting Contrast 106
10.1.4 Setting Backlight OFF Time 107
10.1.5 Adjusting Buzzer Volume 108
10.1.6 Numeric Keys 109
10.2 Display Hardware Check Function 110
10.3 Replacing Protective Sheet 111
10.4 Display Panel-lock Function 112

Appendices

Appendix A Specifications 114
Appendix B Initial Setting 116
Appendix C Troubleshooting Guide 118
Appendix D Error Messages 120
Appendix E Minimum Input Time and Output Response Time 121
Appendix F Dimensions 122

WARRANTIES AND DISLAIMERS 125

Chapter 1

Laser Safety Precautions

1.1 Classification 2

1.2 Warning Labels 2

1.3 Label Location 3

1.4 Safety Consideration 3

1.5 Safety Features Provided with the LS-5000 Series 4

1.6 Preparation for Operation 6

1.1 Classification

		LS-5041	LS-5121
Laser Class	FDA (CDRH) Part 1040.10	Class II Laser Product	
	IEC60825-1	Class 2 Laser Product	

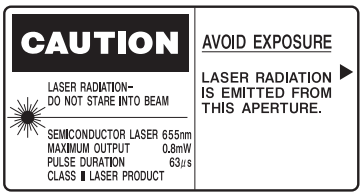
1

1.2 Warning Labels

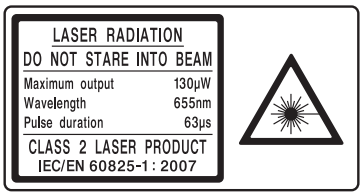
■ **LS-5041**

Warning label/Aperture label

FDA Class II



IEC Class 2



IEC (French) Classe 2



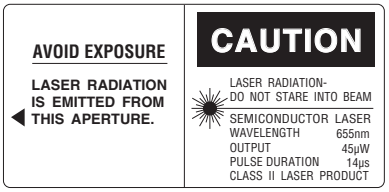
DIN Klasse 2



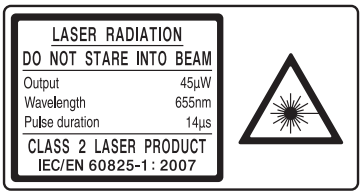
■ **LS-5121**

Warning label/Aperture label

FDA Class II



IEC Class 2



IEC (French) Classe 2

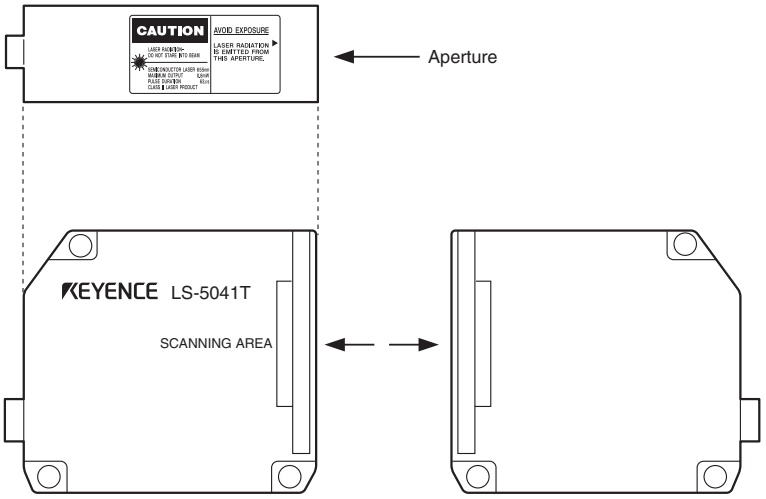


DIN Klasse 2

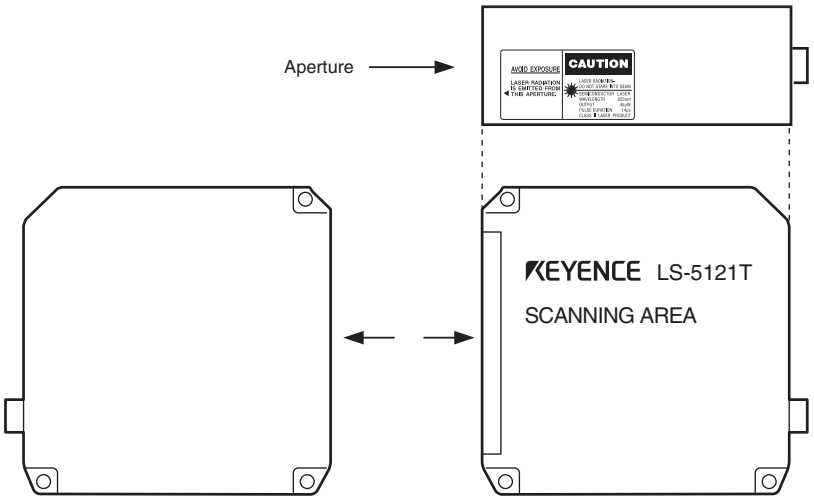


1.3 Label Location

■ **LS-5041**



■ **LS-5121**



The IEC/DIN Warning labels are packed with the scanning head. Stick the Warning labels on the scanning head or the vicinity where the scanning head is mounted in order to be easily seen by the operators.

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 LS-5041 employ a visible semiconductor laser for its light source. The beam is not harmful to the skin. The possible health hazard is in exposing the eyes to the laser beam. Damage to the eyes occur if the operator stares directly into the beam.

⚠ WARNING

Follow the safety precautions below to ensure operator safety:

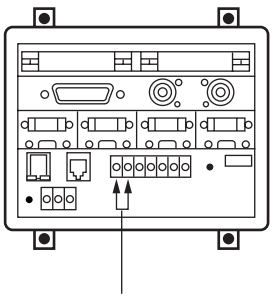
- **Operate the LS-5000 series only according to the procedures described in this instruction manual.**
  Otherwise, injury may occur due to exposure to the laser beam.
- **Do not disassemble the scanning head.**
  Laser emission from the LS-5000 series is not automatically stopped if the scanning head is disassembled. If you disassemble the scanning head for inspection or repair, you may be exposed to the laser beam. If the LS-5000 series malfunctions, contact KEYENCE immediately.
- **Do not look directly into the laser beam.**
  Looking directly into the laser beam may result in serious eye injury.
- **Protective enclosure**
  We recommend that you install a protective enclosure around the scanning head to prevent any person from getting near the scanning head during operation.
- **Protective goggles**
  We recommend that you wear protective goggles when using the LS-5000 series.
- You must stop all laser emissions before cleaning the laser aperture. Otherwise, you may be exposed to the laser beam.
- Be aware of the optical axis of the laser beam.
  If you may be exposed to a specularly-reflected or diffused laser beam, provide an enclosure with reflectivity and thermal characteristics adequate to interrupt the laser beam.
  Install the LS-5041 so that the optical axis of the laser beam will not be at the same height as your eyes when operating the LS-5000 series.

1.5 Safety Features Provided with the LS-5000 Series

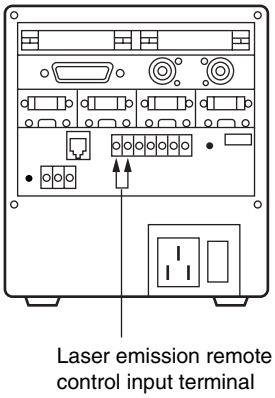
The LS-5000 series comes with the following safety features:

- **Laser emission remote control terminals**

Rear of the LS-5001



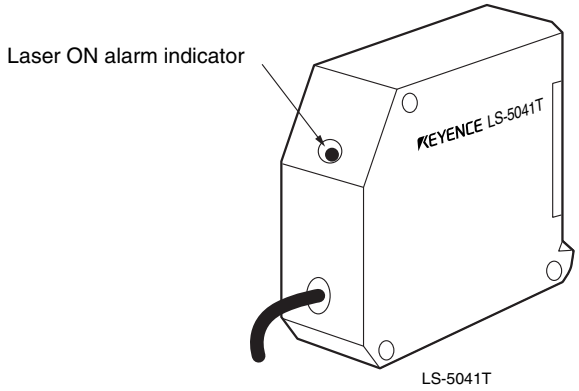
Rear of the LS-5501



- **LASER ON alarm indicator**

The scanning head has an LED which indicates that the laser beam is currently being emitted or is about to start.

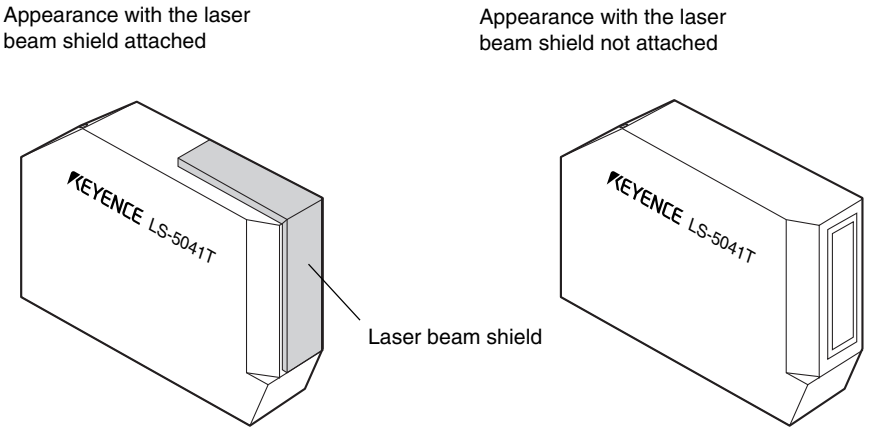
Even when you are wearing safety goggles, you can check whether the indicator is lit or not.



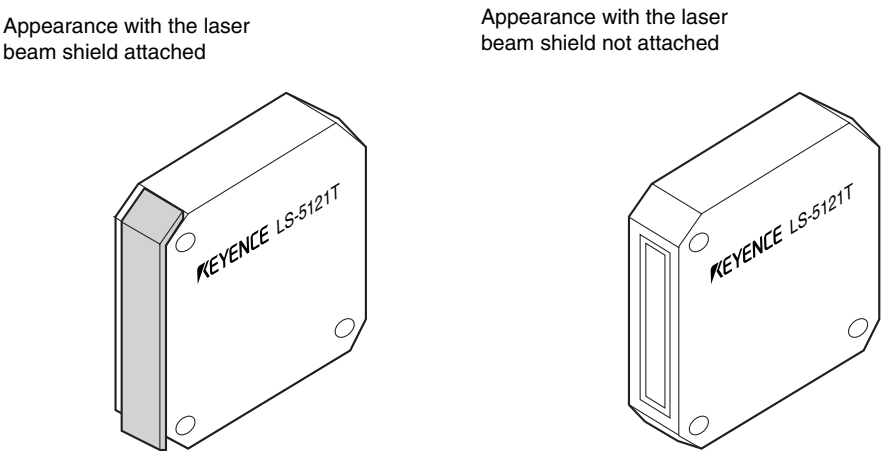
- **Laser beam shield**

The LS-5000 series includes a laser beam shield which is to be attached to the scanning head's transmitter. Attach this shield when your eyes may be exposed to the laser beam, for example during operation at the front of the scanning head.

■ **LS-5041**



■ **LS-5121**



* FDA safety standards do not require a laser beam shield to be provided with Class II laser products. However, the shield should be used if necessary.

1.6 Preparation for Operation

CAUTION

■ **Suppressing noise interference**
Be sure to isolate the connection cable from high-voltage or power lines. If the connection cable is placed in the same conduit as these lines, the LS-5000 series may malfunction due to noise interference.

■ **Cooling fan**
Do not block the cooling fan at the bottom of the LS-5501. If the cooling fan is blocked, the LS-5501 may overheat and malfunction.

■ **Operating environments**
- Use the controller at an ambient temperature of 0°C to 45°C (32 to 113°F), No freezing.
- Fluctuations in the ambient temperature cause measurement errors; therefore, the ambient temperature should be kept constant. If the temperature changes by 10°C (18°F), the LS-5000 series will take approximately 60 minutes until the temperature distribution in the unit becomes even.
- Do not allow any substance which may refract the laser beam, such as water and oil, to adhere to the scanning head.

* Blow dust off the protective glass using clean air. Wipe off any remaining dust using a soft cloth moistened with alcohol.

Note 1: Measurement conditions
When the target oscillates, the measured value may fluctuate. The measurement accuracy can be improved when the number of averaging measurements is set higher.

Note 2: Target
When the target shape or luster varies, a measurement error may occur. In this case, place a standard target in the measuring area and perform the calibration using the [CALIB] key.

Chapter 2

Before Using the LS-5000 Series

2.1 System Configuration and Connections 8

2.1.1 System Configuration 8
2.1.2 Connection Procedure 9

2.2 Names and Functions of Indicators and Switches 12

2.3 Part Names 13

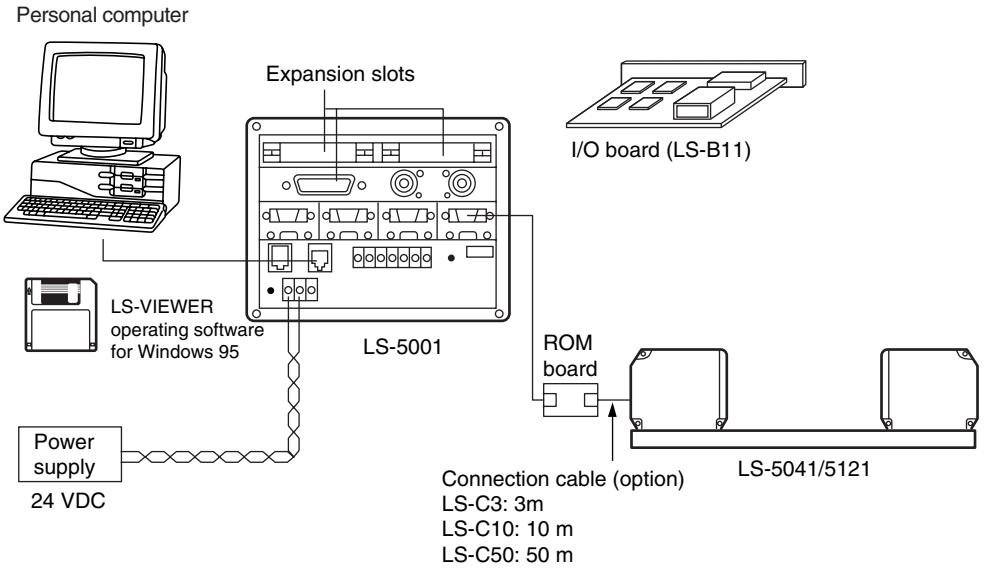
2.1 System Configuration and Connections

The LS-5000 series includes the display unit, controller and scanning head. This section describes the system configuration and connections of the LS-5000 series.

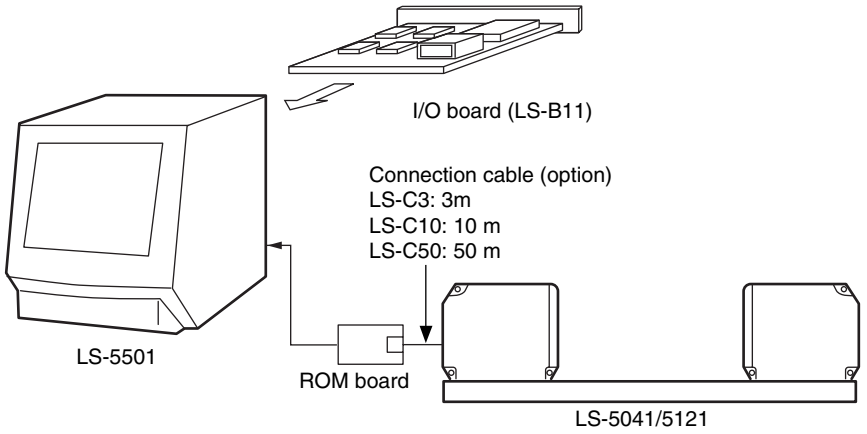
2.1.1 System Configuration

The LS-5000 series includes the display unit, controller and scanning head. The controller can be used separately.
The LS-5000 series also offers I/Oboard, as well as a control unit which incorporates the display unit and controller in a single body.

- **Separate display type**



- **Built-in display type**



Note: The scanning head and ROM board are calibrated as a pair. Be sure to combine the units that have the same serial number.

2.1.2 Connection Procedure

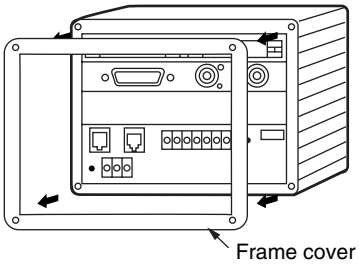
Connecting the Scanning Head

⚠ CAUTION Be sure to turn the power off before connecting the scanning head.

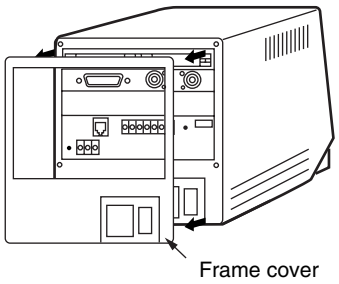
■ **Connection of ROM Board**

1. Remove the frame cover.

LS-5001

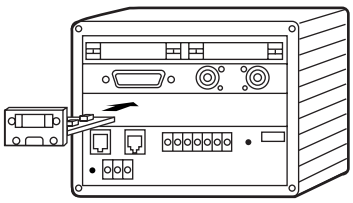


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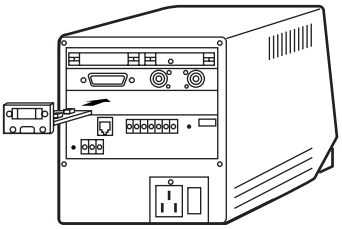


2. Insert the ROM board.

LS-5001



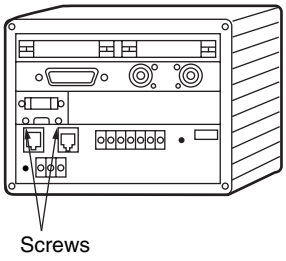
LS-5501



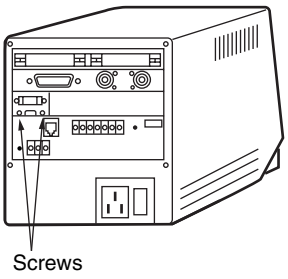
Note: Insert the ROM board into HEAD 1 first.

3. Tighten the screws.

LS-5001

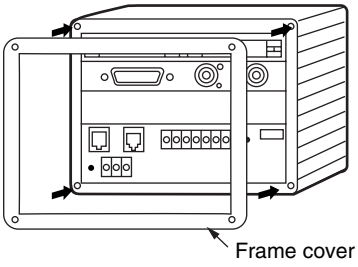


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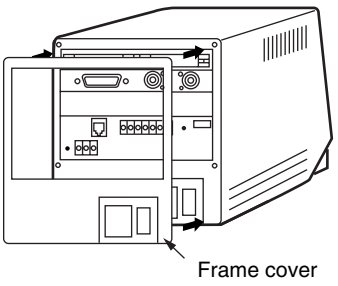


4. Re-attach the frame cover.

LS-5001



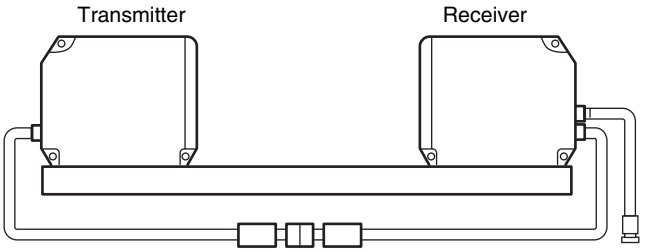
LS-5501



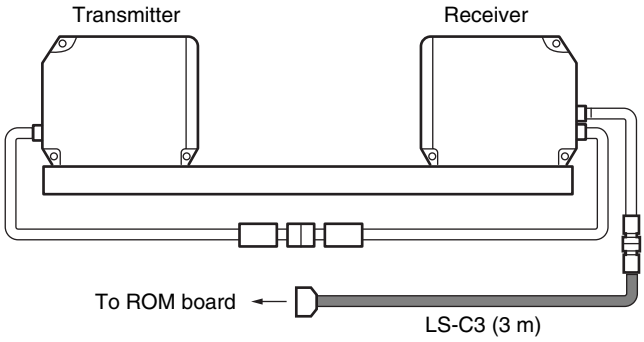
■ **Connecting Transmitter and Receiver**

1. Connect the cable between the transmitter and receiver.
   Use the extension cable if necessary.

   Extension cable between transmitter and receiver: OP-26540 (3 m)
   OP-26816 (10 m)



2. Connect the cable between the transmitter and receiver to the scanning head and ROM board. (This cable is optional.)



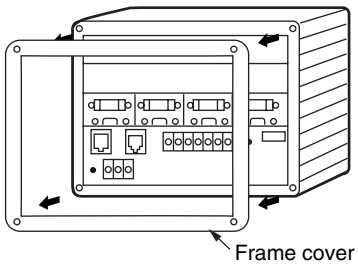
Connection cable	
LS-C3	3 m
LS-C10	10 m
LS-C50	50 m

Connecting I/O Board

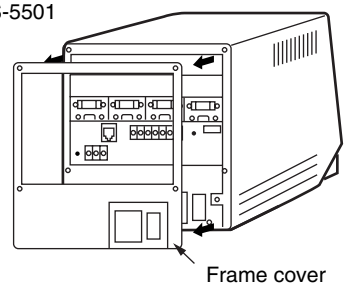
CAUTION Be sure to turn the power off before connecting the I/O board.

1. Remove the frame cover.

LS-5001



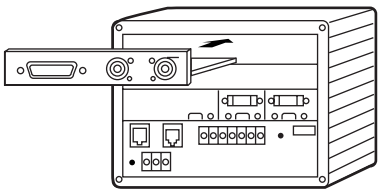
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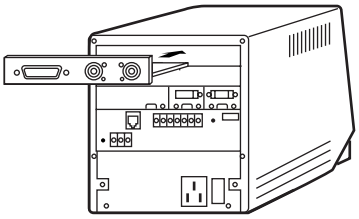
2. Insert the I/O board.

Note: Use the slot 1 first. When the slot 1 is used, use the slot 2.

LS-5001

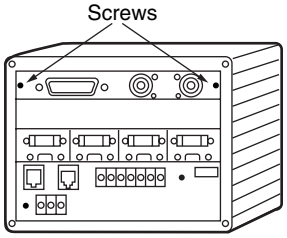


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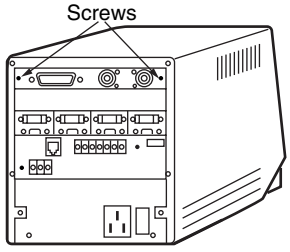


3. Tighten the screws.

LS-5001

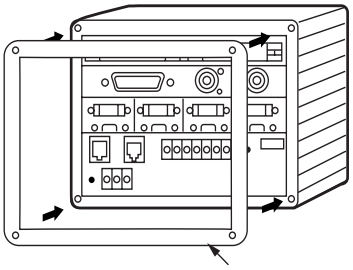


LS-5501

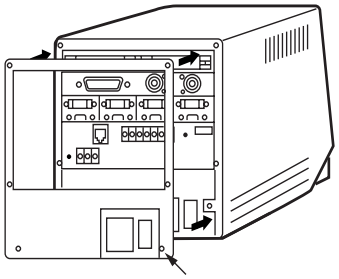


4. Re-attach the frame cover.

LS-5001



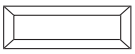
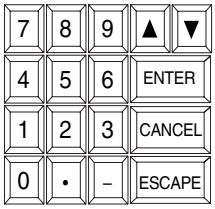
LS-5501



2.2 Names and Functions of Indicators and Switches

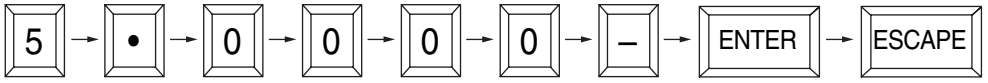
This section describes the names and functions of the indicators and switches.

■ Names and Functions of Indicators and Switches

Display	Name	Description
	Menu button	Used to move to each function's setup screen.
	Setup/Select button	Used to set values or select settings.
	Select button	Used to select settings or programs.
	Screen Select button	When you press the [Screen Select] button, you will move to the screen indicated on the button. In the example on the left, you will move to the DISPLAY DATA screen.
	Numeric keys	Used to set values. [ENTER] key: Used to accept the setting. [ESCAPE] key: Used to exit from the numeric keys screen. [CANCEL] key: Used to reset the preset value to zero. Sign key: Used to change the sign. [▲] [▼] keys: Used to move between setting items.

■ Input Procedure Using Numeric Keys

Example: Enter "-5.0000".

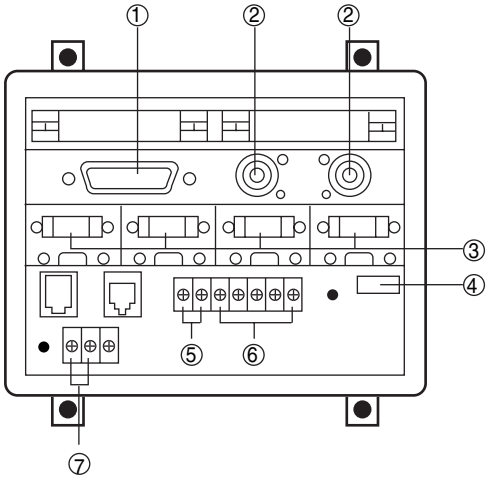


2.3 Part Names

This section describes the part names of each model.

LS-5001 (Separate display type)

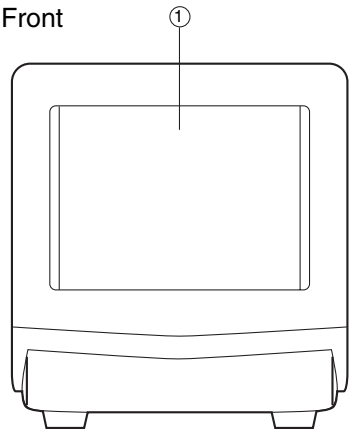
Front



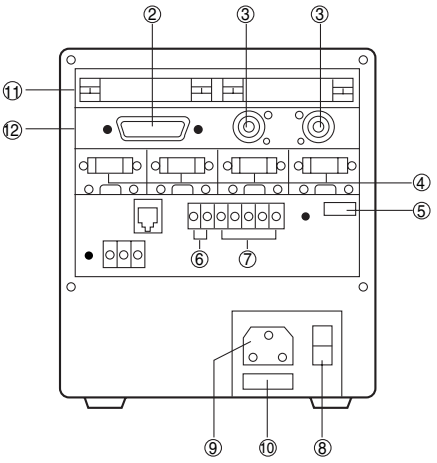
① I/O connector (LS-B11)
② Analog output BNC connector (LS-B11)
③ Scanning head connecting port
④ DIP switch
⑤ Laser emission control input terminal
⑥ Program selection input terminal
⑦ Power supply terminal (24 VDC)

LS-5501 (Built-in display type)

Front

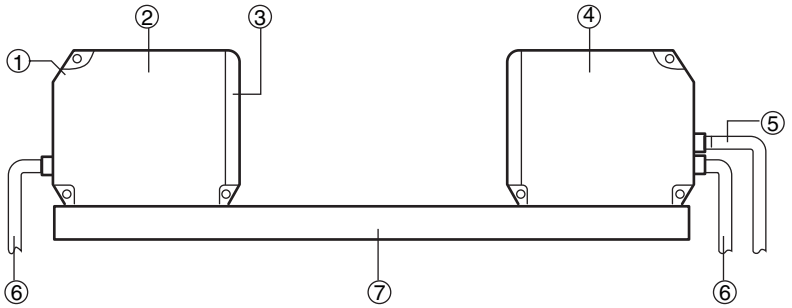


Rear



① Measured value display and function setup/operating unit
② I/O connector (LS-B11)
③ Analog output BNC connector (LS-B11)
④ Scanning head connecting port
⑤ DIP switch
⑥ Laser emission control input terminal
⑦ Program selection input terminal
⑧ Power supply switch
⑨ Power supply input
⑩ Fuse holder (250 V, 3.15 A)
⑪ Expansion slot 1 for I/O board
⑫ Expansion slot 2 for I/O board

LS-5041/5121 (Scanning head)



① Laser ON alarm indicator
② Transmitter (T)
③ Laser emission aperture
④ Receiver (R)
⑤ Connecting cable between scanning head and controller
⑥ Connecting cable between transmitter and receiver
⑦ Scanning head mounting frame

Chapter 3

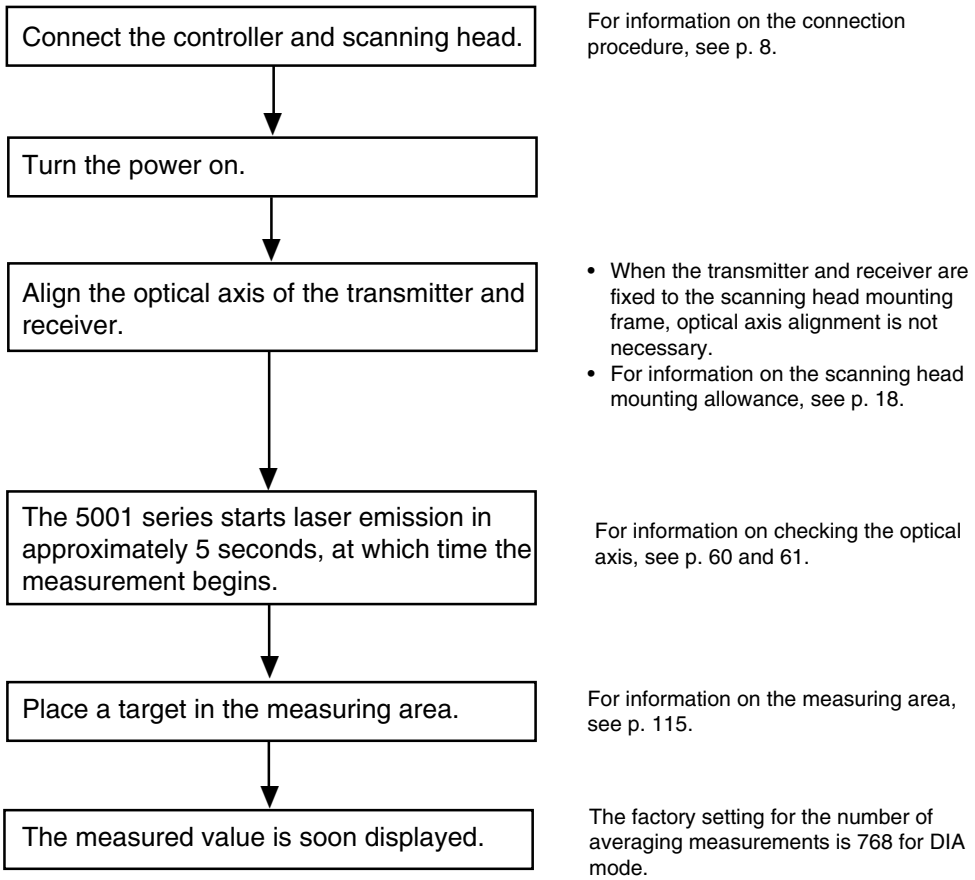
Quick Start Reference

3.1 Quick Start Reference 16
3.1.1 Procedure for Starting Measurement 16

3.1 Quick Start Reference

This section describes the procedures for starting measurement for trial operation.

3.1.1 Procedure for Starting Measurement



Before changing the measuring mode or the number of averaging measurements, read this instruction manual thoroughly for the correct settings.
For setting items, see the table of contents.

The following is reference page numbers for typical operations.

• Changing the DIA mode to EDGE mode p.39, 40
• Changing the number of averaging measurements p.44, 45
• Changing the measuring mode ..... p.46 to 51
• Simultaneous measurement p.32
• (X + Y)/2 measurement using two scanning heads p.41, 42

Chapter 4

Installation

4.1 Mounting the Scanning Head 18

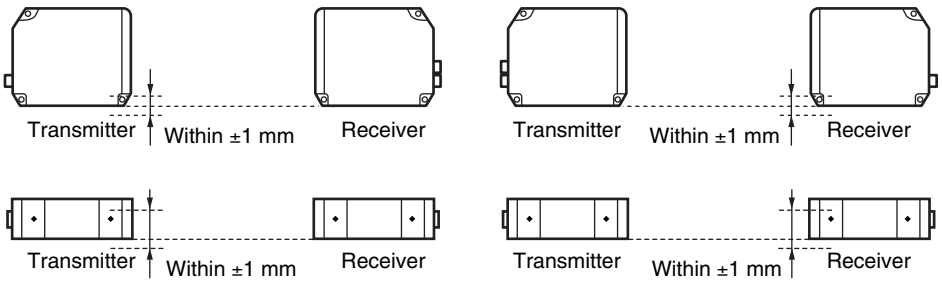
4.2 Mounting the Controller 19

4.1 Mounting the Scanning Head

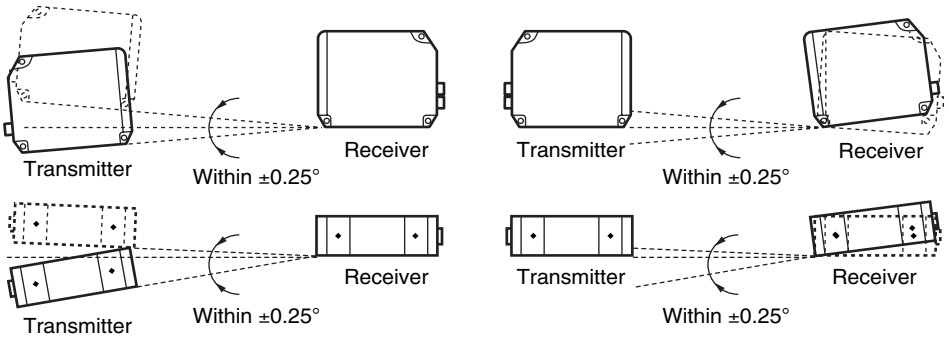
The LS-5000 series comes with the transmitter and receiver fixed to the scanning head mounting frame. To use the LS-5000 series with the transmitter and receiver removed from the mounting frame, mount the scanning head so that the following specifications are met. This will eliminate measurement errors caused by optical axis misalignment.

Allowance for Mounting the Scanning Head

■ Horizontal deviation of transmitter and receiver positions



■ Inclination of transmitter and receiver



* Values in parentheses are for the LS-5121.

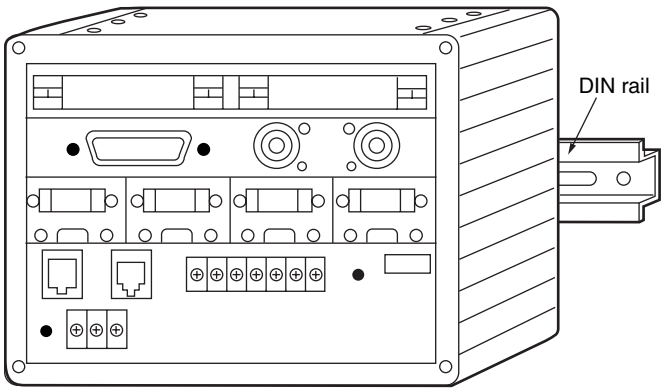
Note: For information on the optical axis checking function, see “Head Inspection” on p. 60.

4.2 Mounting the Controller

This section describes how to mount the controller (LS-5001).

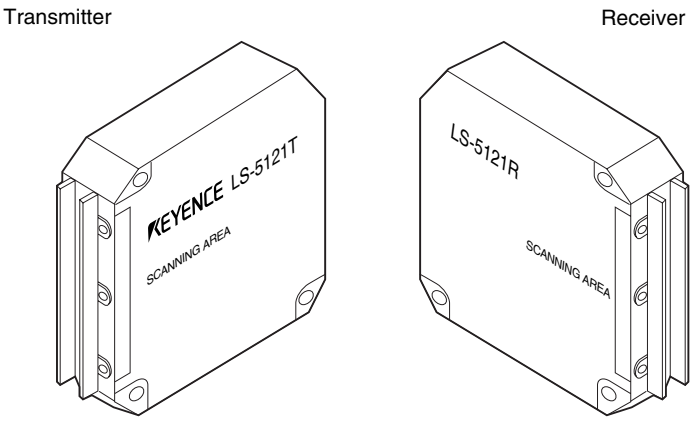
Mounting the LS-5001

The LS-5001 can be mounted to a DIN rail.
Hook the upper claw first, and then press the controller against the DIN rail until it clicks.



Mounting the Scanning Head Front Protection Cover (For LS-5121)

Application example of front protection cover



The LS-5121 transmitter and receiver come with a protection cover for the scanning head.
Mount the cover as shown in order to prevent the front glass of the scanning head from being scratched or broken.

Chapter 5

Outline of Measurements

5.1 Area/Segment/Edge 22

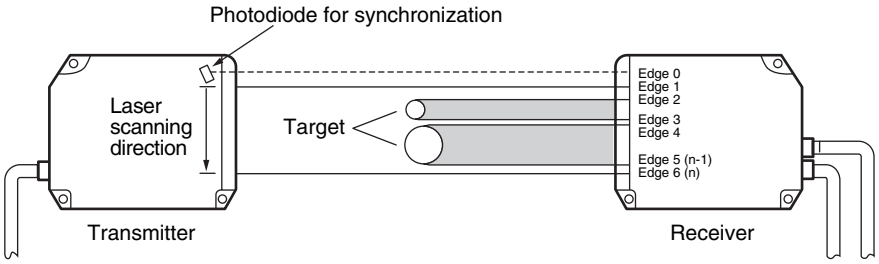
5.2 Normal Mode 22

5.2.1 DIA Mode 23
5.2.2 T.EDGE (TOP EDGE) Mode / B.EDGE (BOTTOM EDGE) Mode 23
5.2.3 SEG (m,n) Mode 23

5.3 Pitch Mode 24

5.1 Area/Segment/Edge

When a target is placed in the measuring area, there are areas where the laser beam is received (laser beam enters the receiver), and where the laser beam is interrupted by the target (shadow of the target is projected on the receiver). The border between the light and dark areas is called “EDGE”. Each section divided by the edge is called a “SEGMENT”. The measurement "AREA" is determined by two edges and includes all "SEGMENTS" between these two edges.

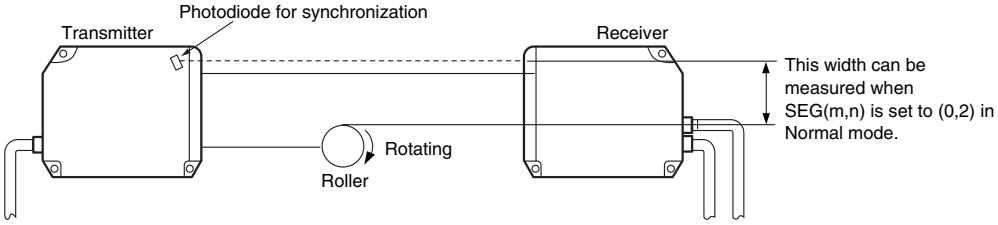


* The edge number is counted in the laser scanning direction starting at T.EDGE (top edge).

Note: EDGE 0

The position of the photodiode for synchronization is called “EDGE 0”.
EDGE 0 can be used as a reference point during roller oscillation measurement or sheet edge control. (No reference edge is required.)

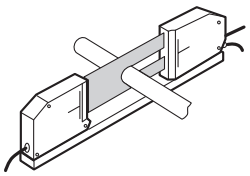
Example: Roller oscillation measurement



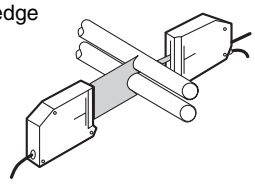
5.2 Normal Mode ➪ *For the setting procedure, see p. 39.*

The LS-5000 series has two measuring modes; NORMAL and PITCH. NORMAL mode provides four types of measurement3: “DIA”, “T.EDGE (Top Edge)”, “B.EDGE (Bottom Edge)” and “SEG(m,n)”.
The function of each mode is described below. Select the mode that suits your measurement condition.

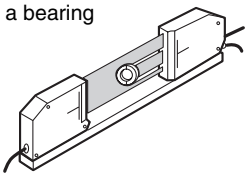
DIA mode
Measurement of outer diameter of rod or electric wire



T.EDGE/B.EDGE modes
Measurement of gap between rollers or position of target edge



SEG(m,n) mode
Setting the measurement position to measure inner diameter using a bearing

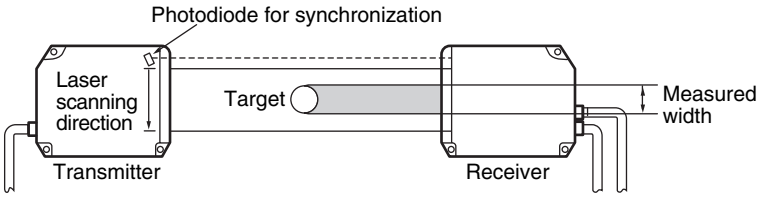


5.2.1 DIA Mode

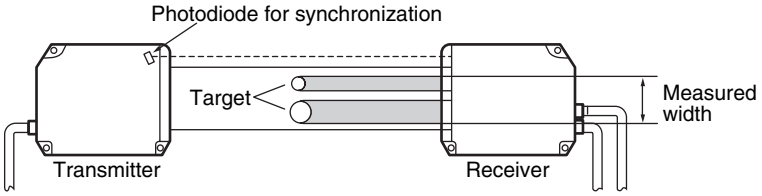
Example: Outer diameter measurement using a rod or transparent object

The width between the lower edge of the first light segment and the top edge of the last light segment is measured.

- **When one target is measured**



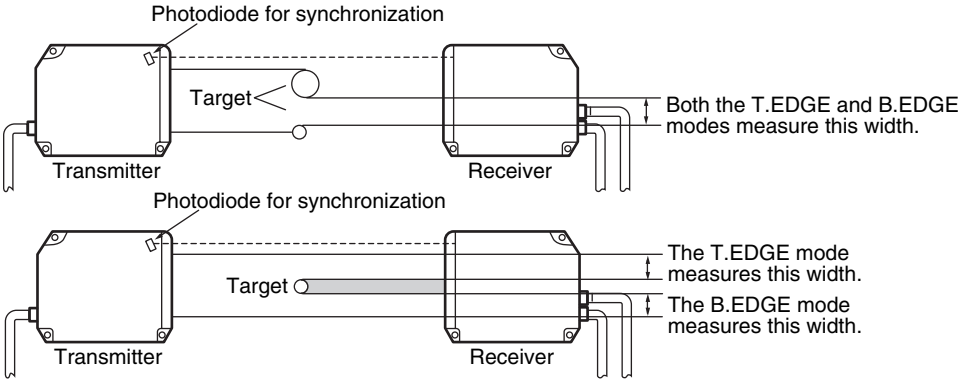
- **When several targets are measured**



5.2.2 T.EDGE (TOP EDGE) Mode / B.EDGE (BOTTOM EDGE) Mode

Example: Measurement of a gap between rollers

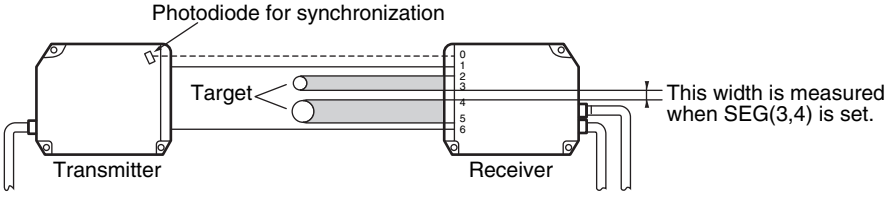
T.EDGE: Measures the width of the first light segment.
B.EDGE: Measures the width of the last light segment.



5.2.3 SEG (m,n) Mode

Example: Inner diameter measurement using a bearing

When two edges are specified, the width between these edges is measured.



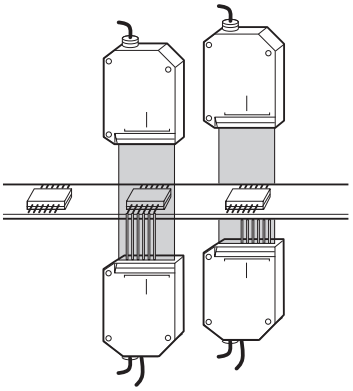
* (m,n) indicates any number between 0 and 254. “m” should be smaller than “n”.

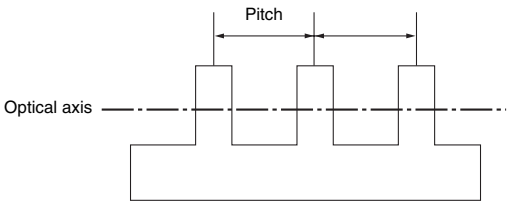
Note: DIA mode

Since DIA mode is basically intended for outer diameter measurement of a rod, transparent tube or other round surface, the measurement error due to the round surface is calibrated.
To perform outer diameter measurement of a round target, select DIA mode.

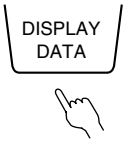
5.3 Pitch Mode ➪ *For the setting procedure, see p. 72.*

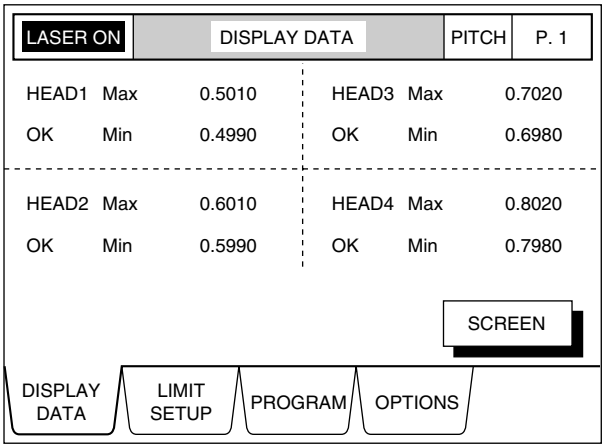
Pitch mode enables pitch measurement using connector pins or IC leads.





This mode measures each center-to-center pitch, and displays the maximum and minimum values.





Note 1: When Pitch mode is selected, only one measurement can be performed with one scanning head.

Note 2: When Pitch mode is selected, the comparator output is activated as shown below:
HI3 = Alarm output
HI2 = Disabled
HI1 = Output when the measured value exceeds the upper/lower limit.
GO = Output when the measured value is within the upper/lower limit.
LO1: Disabled
LO2: Disabled
LO3: Disabled

The analog output and RS-232C output are activated as shown below.
Analog output: Held at +10V.
RS-232C output: Output according to the command. ➪ *See p. 97.*

Chapter 6

Normal Mode

6.1 Normal Mode Screens 26

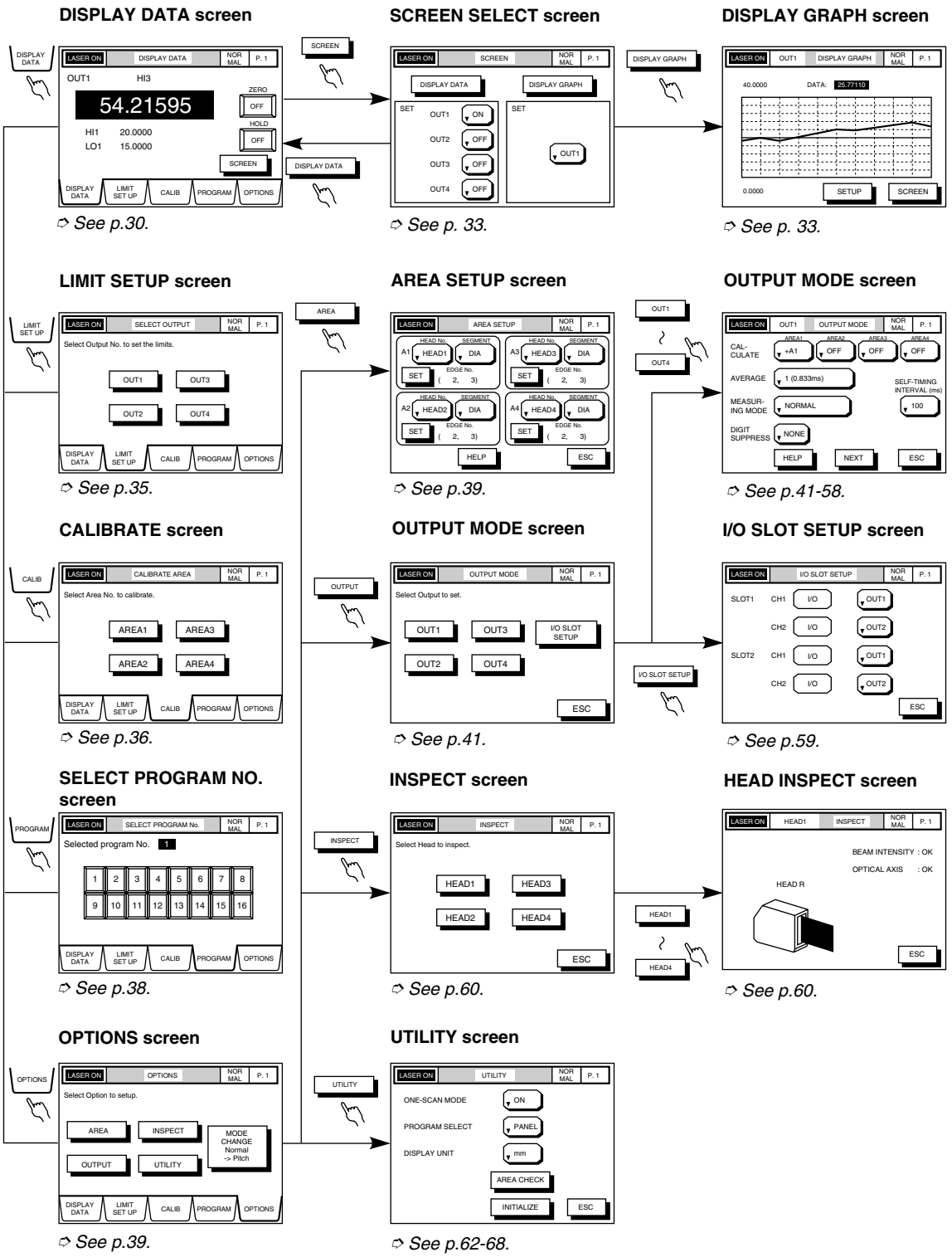
6.2 Initial Screen 27

6.3 Setting Measuring Mode 28

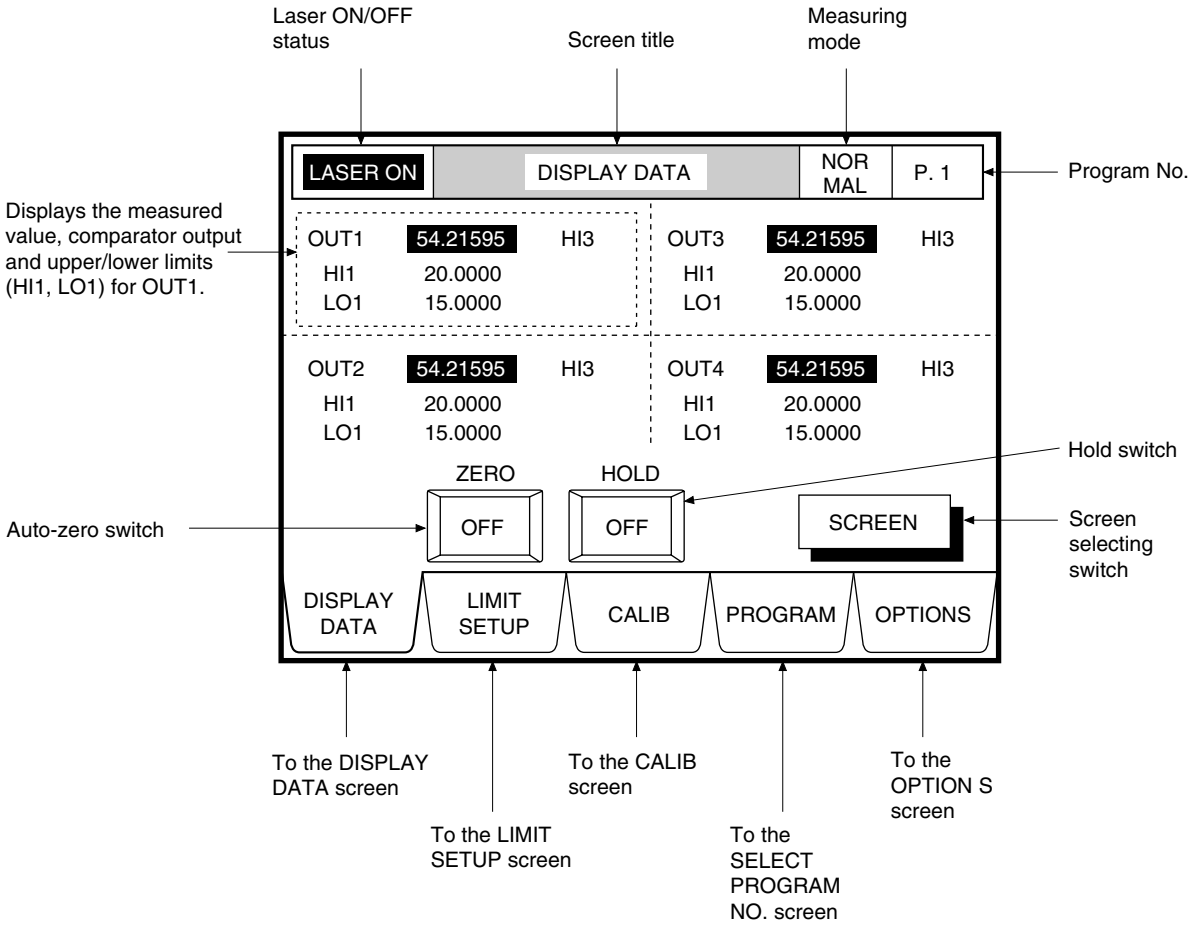
6.4 Setting Functions 29

① [HOLD] Hold Function 30
② [ZERO] Auto-zero Function 31
③ [SCREEN] Screen Selection Function 32
④ Limit Setup 35
⑤ [CALIB] Calibration Setup 36
⑥ [PROGRAM] Program Selection Function 38
⑦ Area Setup 39
⑧ Calculation Setup 41
⑨ Average 44
⑩ Measuring Mode 46
⑪ Digit Suppression Function 54
⑫ Offset Function 55
⑬ Analog Output Function 57
⑭ I/O Slot Setup 59
⑮ Inspection 60
⑯ One-scan Mode 62
⑰ Program Selection Method Setup 64
⑱ Display Unit 65
⑲ Area Check Function 66
⑳ Initialize 67
㉑ Mode Change 68

6.1 Normal Mode Screens



6.2 Initial Screen

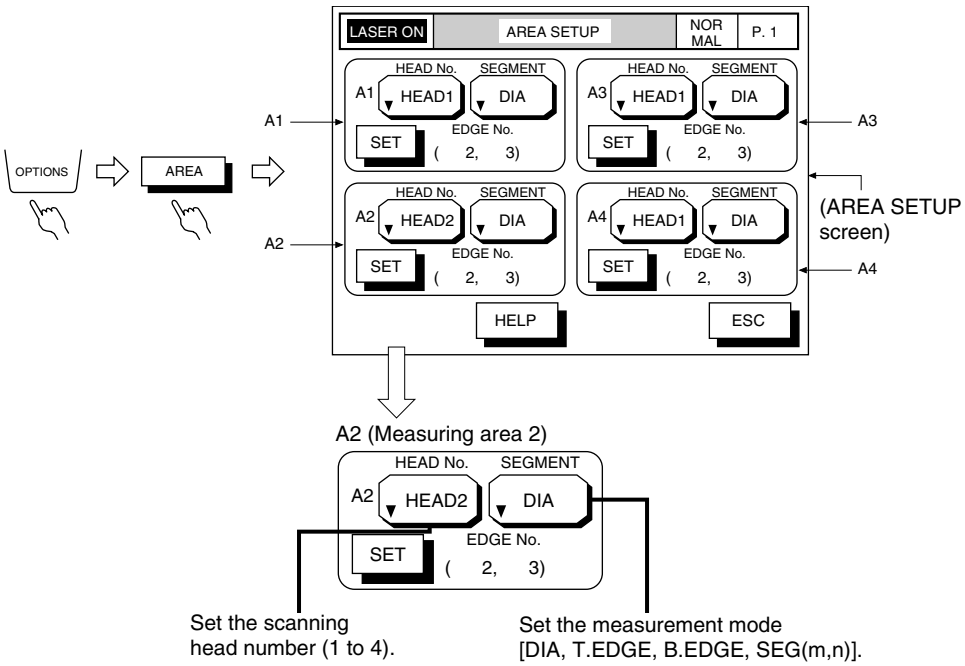


6.3 Setting Measuring Mode

Setting Scanning Head and Measurement

1. Setting Measuring Area

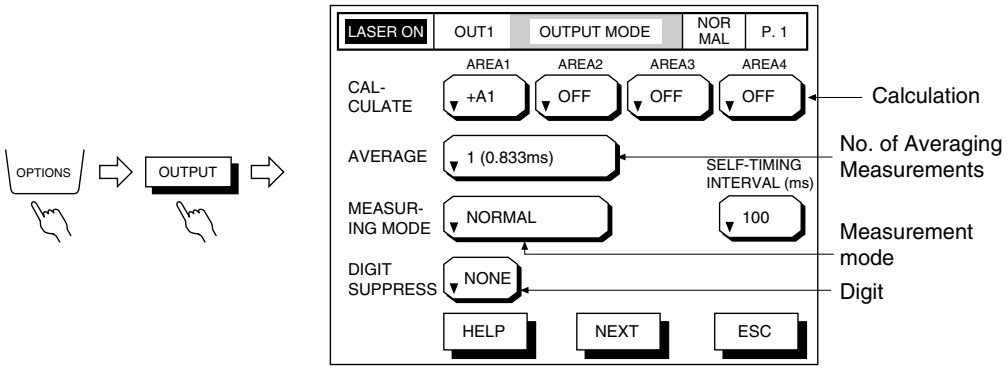
The LS-5000 series can simultaneously perform four measurements and outputs with one scanning head, and different measurements and outputs with four scanning heads. *(⇨ See note.)*
The place for which the measurement condition is set is called the “measuring area” (A1 to A4), where the scanning head number and measuring mode can be set.



Note: The LS-5002 and 5502 can only control a single scanning head.

2. Setting Output Mode

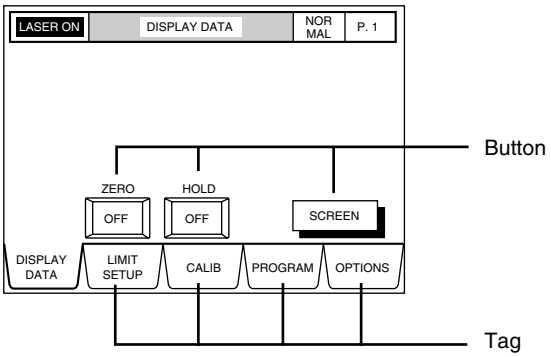
The LS-5000 series can accept measurement data from multiple scanning heads and perform calculations on the data for displaying and outputting the comparator result.
Using the preset measuring area (A1 to A4), you can set various calculation and measuring modes, as well as the number of averaging measurements as shown below.



6.4 Setting Functions

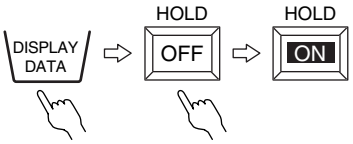
Names and functions

Tag/Button		Function	Description	Reference page
DISPLAY DATA	HOLD	Hold	A measured value can be held or reset.	30
	ZERO	Auto-zero	A measured value can be instantaneously reset to “0.000”.	31
	SCREEN	Screen Selection	The DISPLAY DATA screen or DISPLAY GRAPH screen can be selected.	32 to 34
LIMIT SETUP		Limit Setup	7 level tolerance limits can be set for each output.	35
CALIB		Calibration Setup	Minute measurement fluctuations caused by a change in the target surface condition or target inclination can be corrected.	36
PROGRAM		Program Selection	Measurement data is stored and called as programs.	38
OPTIONS	AREA	Area Setup	DIA, T.EDGE, B.EDGE or SEG(m,n) can be selected.	39
	OUTPUT	Calculation Setup	Calculation can be performed with each measuring area (A1 to A4).	41
		Average	Measurement results can be averaged.	44
		M. Mode	Nine measuring modes are provided.	46 to 53
		Offset	Any value can be added to or subtracted from the displayed value.	55
		Digit	Sets the number of digits after the decimal point.	54
		Analog Output	An analog voltage (within ±10 V) proportional to the displayed value can be output.	57
		I/O Slot Setup	Expansion I/O boards can be set.	59
	INSPECT	Inspect	The scanning head conditions (optical axis, intensity) can be checked.	60
	UTILITY	One-Scan Function	Data obtained with only one surface of the 12-surface polygon mirror becomes effective.	62
		Program Selection	The program selection method (front panel or rear terminals) can be selected.	64
		Display Unit	The display units can be selected (“mm” or “inch”).	65
		Area Check	The number of edges in the measuring area can be checked.	66
		Initialize	All settings are reset to the initial values.	67
		Mode Change	Normal mode or Pitch mode can be selected.	68



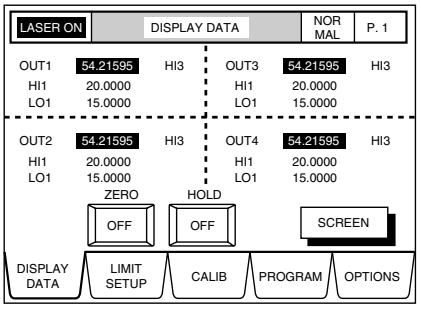
① [HOLD] Hold Function

The hold function allows the displayed value and output value to be held or reset regardless of the measuring mode.

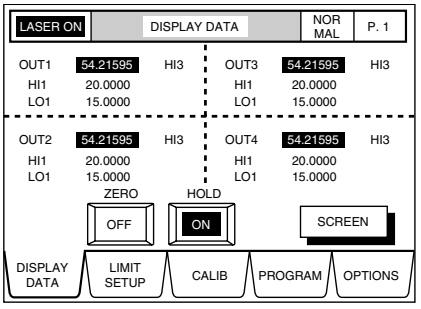


■ Setting Procedure

1. Select the DISPLAY DATA screen.
   Press the [DISPLAY DATA] button. The screen shown below is displayed.



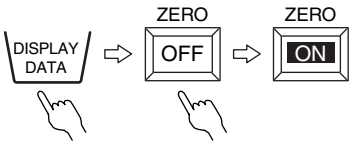
2. Set the hold function.
   Press the [HOLD OFF] button. [HOLD OFF] is changed to [HOLD ON].



Note: The hold function cannot be set separately for each output from this screen. To set this function separately for each output, send the hold signal from the control I/O board (Option). (Short-circuit the Tim input terminal and the GND terminal.)

② [ZERO] Auto-zero Function

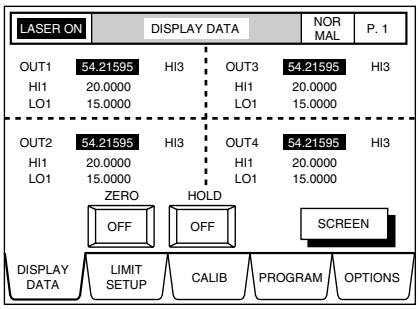
The auto-zero function can instantaneously reset the displayed value to “0.0000”.



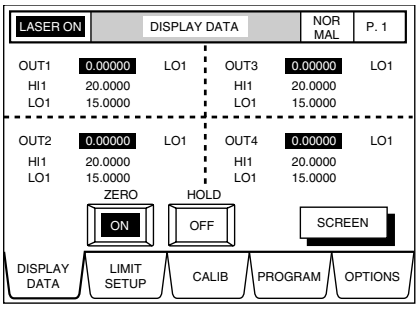
This function simplifies zero-point adjustment when targets are changed over.

■ Setting Procedure

1. Select the DISPLAY DATA screen.
   Press the [DISPLAY DATA] button. The screen below is displayed.



2. Set the auto-zero function.
   Press the [ZERO OFF] button. [ZERO OFF] is changed to [ZERO ON].



The following two methods will also activate the auto-zero input.

- Short-circuit the auto-zero input terminal and the GND terminal of the control I/O board (Option).
  The auto-zero function can be set separately for each output.

- Send a command through the RS-232C board from external equipment such as a computer.
  You can reset the auto-zero function by sending the command. ☞ *See p. 93.*

Note 1: The auto-zero function cannot be reset with the control I/O input.

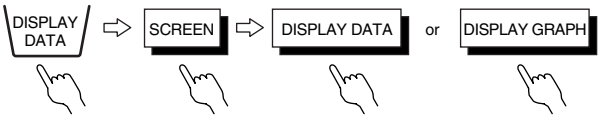
Note 2: When the displayed value is “- - - - -”, the auto-zero function cannot be activated.

Note 3: When the auto-zero function is activated from the front panel, all outputs are simultaneously reset to “0.0000”.

---

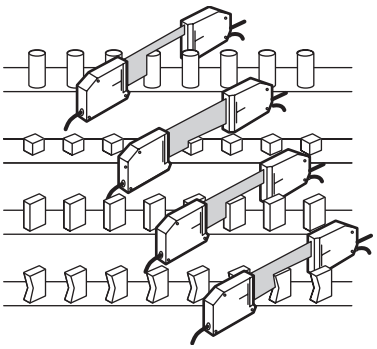
③ [SCREEN] Screen Selection Function

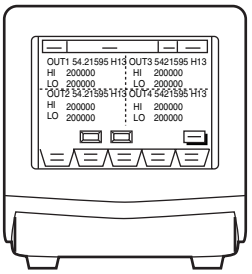
The screen selection function allows you to select the DISPLAY DATA screen (1 to 4 data displays) or the DISPLAY GRAPH screen.



<DISPLAY DATA>

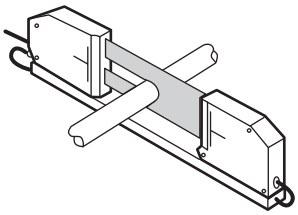
Example 1: When several scanning heads are used

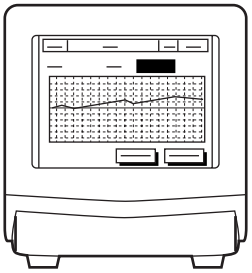




<DISPLAY GRAPH>

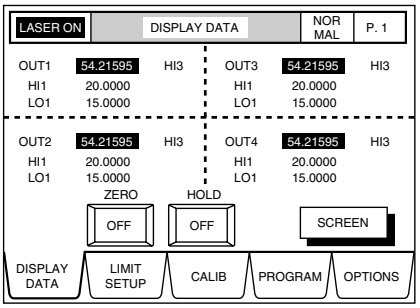
Example 2: Measurement of wire's outer diameter





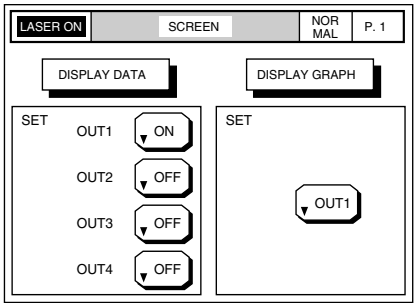
■ **Setting Procedure <DISPLAY DATA>**

1. Select the DISPLAY DATA screen.
   Press the [DISPLAY DATA] button. The screen shown below is displayed.



2. Select the SCREEN SELECT screen.
   Press the [SCREEN] button.

3. Set the output to be displayed. (☞ *For setting outputs, see p.41.*)
   Turn ON the output to be displayed.
   If an output is not to be displayed, press the [ON] button once to turn it OFF.

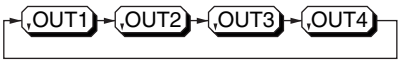


4. Return to the DISPLAY DATA screen.
   Press the [DISPLAY DATA] button to return to the DISPLAY DATA screen.

■ **Setting Procedure <DISPLAY GRAPH>**

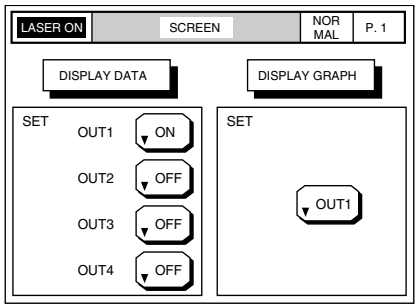
1. Perform steps 1 and 2 described on the previous page to go to the SCREEN SELECT screen shown below.

2. Select “DISPLAY GRAPH”.
   Select the output to be graphically displayed.

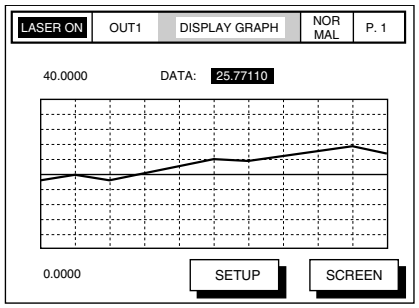


   OUT1 to OUT4 are switched in the above order.

   Press the [DISPLAY GRAPH] button.

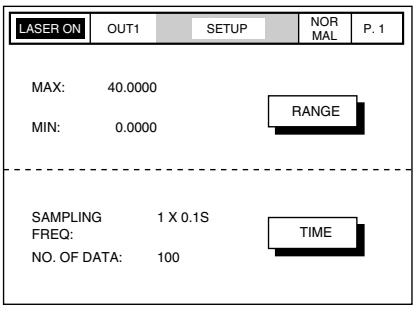


3. Perform “GRAPH SETUP”.
   Press the [SETUP] button.

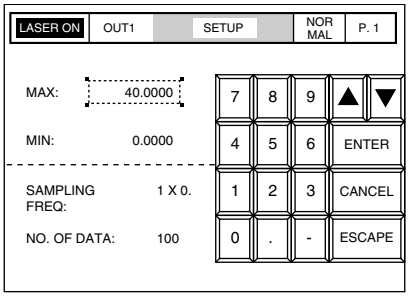


6

4. Set the range of GRAPH display.
   Perform “RANGE SETUP”. Press the [RANGE] button.

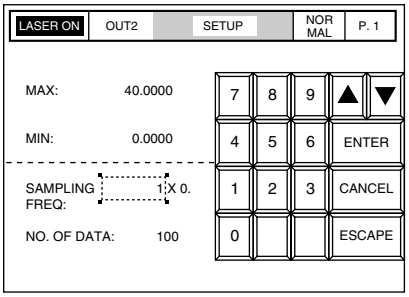


   Select the item from MAX or MIN using the [▲] [▼] arrow keys.
   Enter a value using the numeric keys and press [ENTER].



   Press [ESCAPE] to complete the entry.
   Press [CANCEL] to cancel the entry. The value returns to the previous value.

5. Perform “TIME SETUP”.
   Press the [TIME] button. Select the item from SAMPLING FREQ or NO. OF DATA using the [▲] [▼] arrow keys. Enter a value using the numeric keys and press [ENTER].



   Press [ESCAPE] to complete the entry.
   Press [CANCEL] to cancel the entry. The value returns to the previous value.

Note 1: Range Setup

The maximum and minimum range setup values are as follows:

Max.: 999.9999 (9.99999)
Min.: -99.9999 (-0.99999)

* Values in ( ) are the maximum and minimum values displayed in inches.

When the displayed value exceeds the above range, “OVER” is displayed and the entered value cannot be accepted.

Note 2: Time Setup

The maximum and minimum values for the sampling frequency and the number of displayed data are as follows:

Sampling frequency

Max.: 30000 x 0.1 s (3000 s) Min.: 1 (0.1 s)

Number of displayed data

Max.: 600 Min.: 2

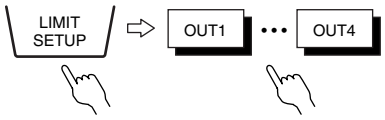
When the sampling frequency or the number of displayed data exceeds the above range, “OVER” is displayed and the entered value cannot be accepted.

Note 3: The above maximum and minimum values are independent of tolerance limits.

---

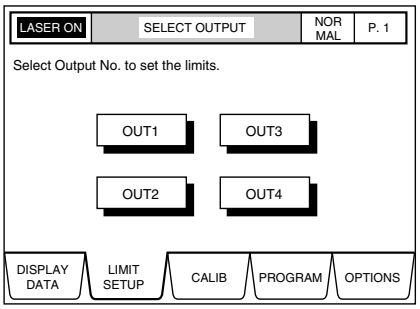
④ Limit Setup

7-level-tolerance-limits can be set separately for four outputs. (➪ *See p.41 for setting output.*)

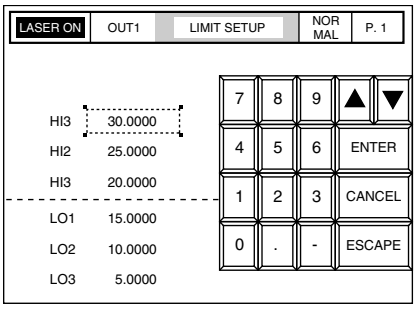


■ Setting Procedure

1. Select the LIMIT SETUP screen.
   Press the [LIMIT SETUP] button. The screen shown below is displayed.



2. Set tolerance limits.
   Press the button corresponding to the output for which you wish to set tolerance limits.



   Select a desired tolerance limit using the [▲]/[▼] arrow keys.

   Enter a value using the numeric keys, and press [ENTER].

   Press [ESCAPE] to complete the entry.
   Press [CANCEL] to cancel the entry. The value returns to the previous value.

Note 1: When a measured value exceeds the tolerance range, the measured value is displayed in reverse. The differentiation result corresponding to the tolerance limits is output from the display unit and the control I/O (option) board.

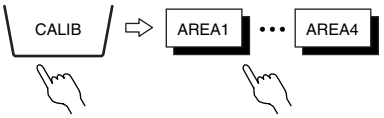
Note 2: Tolerance limits must conform to the following condition:
HI3 > HI2 > HI1 > LO3 > LO2 > LO1
Otherwise, the tolerance value cannot be entered. (The “ERR” message appears on the display and the entered value cannot be accepted.)

Note 3: The maximum and minimum tolerance limit values are as follows:
Max.: 999.9999 (9.99999)
Min.: -99.9999 (-0.99999)
* Values in ( ) are the maximum and minimum values displayed in inches.

---

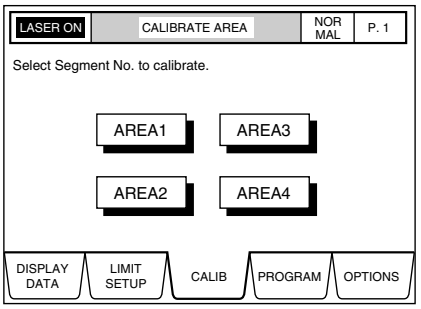
⑤ [CALIB] Calibration Setup

Minute measurement fluctuations caused by a change in the target surface condition or target inclination can be corrected with each AREA. (☞ *See p.39 for setting AREA.*)

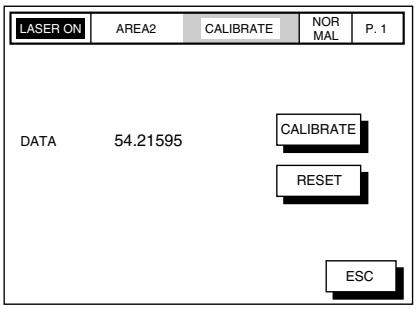


■ Setting Procedure

1. Select the CALIBRATE AREA screen.
   Press the [CALIB] button. The screen shown below is displayed.

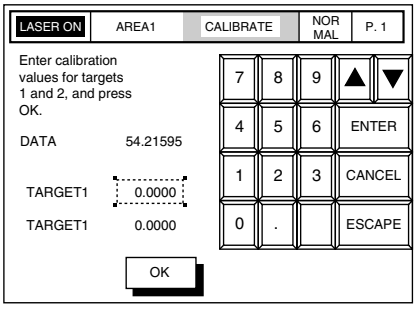


2. Press the button corresponding to the area for which you wish to perform calibration.



   Press the [RESET] button to reset the calibration. The calibration value is reset to the factory setting.

   Press the [CALIBRATE] button to go to the CALIBRATE screen.



3. Insert sample workpiece 1 to check the measured value.
   Enter the value of sample workpiece 1 using the numeric keys, and accept the value by pressing the [ENTER] button.

4. Insert sample workpiece 2 to check the measured value.

   Enter the value of sample workpiece 2 using the numeric keys, and accept the value by pressing the [ENTER] button.

   When you press the [OK] button, the calibration is performed and a message regarding the calibration result is displayed.

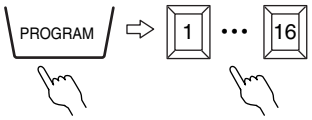
Input Conditions Workpiece 1 < Workpiece 2 0.5 ≤ Span ≤ 2

   If the above conditions are not satisfied, the “Calibration Error” message is displayed.

   When the above conditions are satisfied, the “Calibration OK” message is displayed.

⑥ [PROGRAM] Program Selection Function

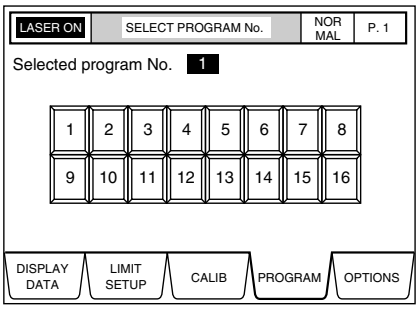
The LS-5000 series can store all measurement conditions as a program. Up to 16 programs can be stored and loaded easily.



■ Setting Procedure

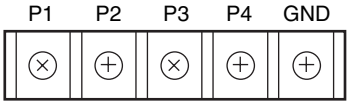
1. Select the SELECT PROGRAM NO. screen.
   Press the [PROGRAM] button.

2. Select a program number.
   Press the button corresponding to the program number to be loaded.



Note 1: When the program selection method is set to the rear terminals, the program number cannot be switched on the front panel. *See p. 63.*

Note 2: To switch a program number using the rear terminals, change the combination of the following four terminals and GND terminal.



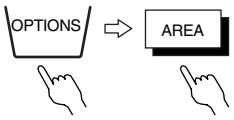
	Terminal No.			
Program No.	**P1**	**P2**	**P3**	**P4**
1	OFF	OFF	OFF	OFF
2	ON	OFF	OFF	OFF
3	OFF	ON	OFF	OFF
4	ON	ON	OFF	OFF
5	OFF	OFF	ON	OFF
6	ON	OFF	ON	OFF
7	OFF	ON	ON	OFF
8	ON	ON	ON	OFF
9	OFF	OFF	OFF	ON
10	ON	OFF	OFF	ON
11	OFF	ON	OFF	ON
12	ON	ON	OFF	ON
13	OFF	OFF	ON	ON
14	ON	OFF	ON	ON
15	OFF	ON	ON	ON
16	ON	ON	ON	ON

ON: This terminal and the GND terminal are short-circuited.
OFF: This terminal is open.

Note 3: The system setup for the display unit (*see p. 104*) cannot be stored by the program function.

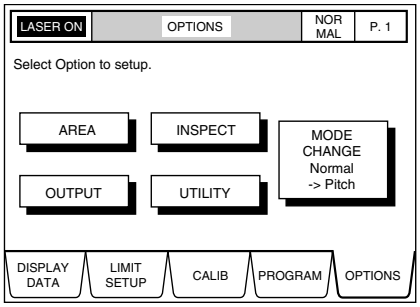
⑦ Area Setup

The scanning head (Head 1 to Head 4) and measuring mode (DIA, T.EDGE, B.EDGE, SEG(m,n))can be selected for a measuring area. Up to 4 areas can be set at the same time. (⇨ *see p. 22 for Area*.)

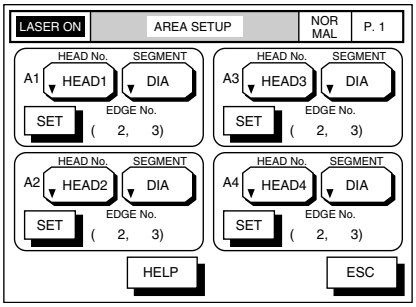


■ Setting Procedure

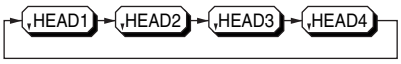
1. Select the OPTIONS screen.
   Press the [OPTIONS] button.



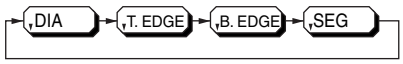
2. Select the AREA SETUP screen.
   Press the [AREA] button.



3. Set the scanning head number.
   When you press the [HEAD No.] button, the scanning head number is switched in the following order.



4. Set the segment.
   When you press the [SEGMENT] button, the segment is switched in the following order.



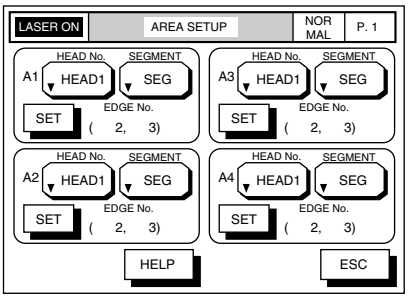
Note 1: The edge number setting is effective only when “SEG” is selected as the SEGMENT.

Note 2: When either of DIA, T.EDGE, or B.EDGE is selected for a scanning head, SEG cannot be selected for the same head. Also, when SEG is selected, DIA, T.EDGE, and B.EDGE cannot be selected for the same head.

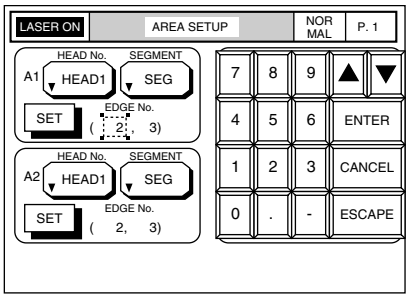
Note 3: When only one scanning head is connected, the head number remains “HEAD 1” even if the head number button is pressed.

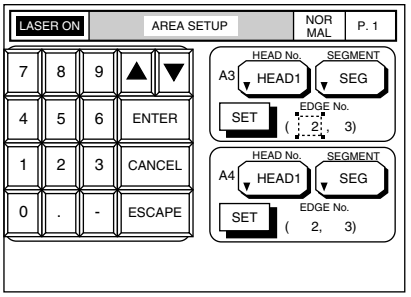
■ **Procedure for Setting Edge Number (Only when SEG is selected.)**

1. Select the AREA SETUP screen.
   Perform steps 1 and 2 described on the previous page to go to the screen shown below.



2. Set the EDGE number.
   Press the [SET] button corresponding to the area for which you wish to set the edge number.





You can enter a value in the space indicated by the dotted line ⬚.

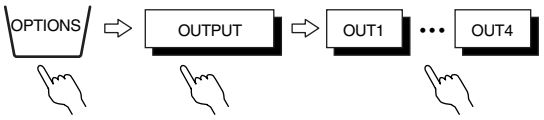
Enter a value using the numeric keys, and press [ENTER] key.
Press [ESCAPE] to complete the entry.
Press [CANCEL] to cancel the entry. The value returns to the previous value.

Note 1: The edge number (m,n) must conform to the condition: m < n.
When “m” is larger than “n”, the “ERR” message is displayed and the entered value cannot be accepted.

Note 2: When you press the [HELP] button, descriptions about the measuring mode (DIA, T.EDGE/B.EDGE and SEG) are displayed on the screen.

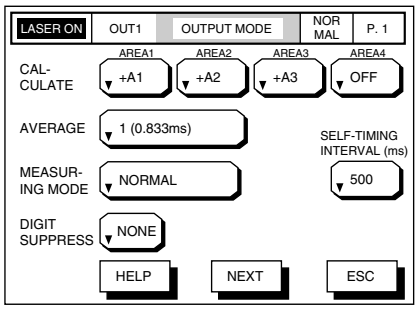
⑧ Calculation Setup

The following calculation modes can be set for the area (A1 to A4) specified on the AREA SETUP screen. Addition and subtraction using data of several areas can be set.



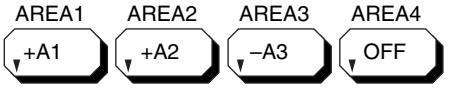
■ Calculation for each area

OFF : The measured value is not used for calculation.
+A# : The measured value is output without changes.
+A#/2 : The measured value is multiplied by “1/2”.
+A#/3 : The measured value is multiplied by “1/3”.
:
–A#/4 : The measured value is multiplied by “-1/4”.
* A# indicates either of A1 to A4.



Calculation using data of several areas

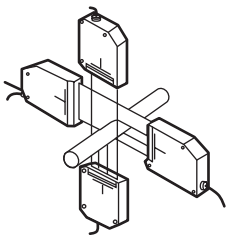
Calculation setup



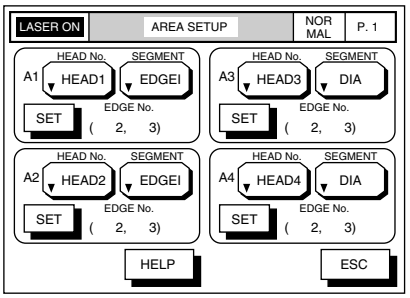
When the calculation modes are set as shown above, the calculation result of “+A1+(+A2)+(-A3)” is output.

[Example 1]

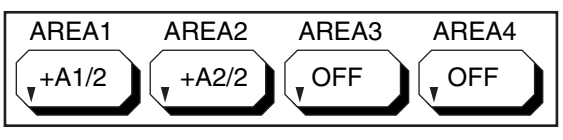
When two scanning heads are installed along two axes, the average value of the wire’s outer diameter is output.



[AREA SETUP]



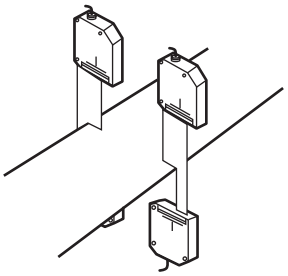
Setting Status



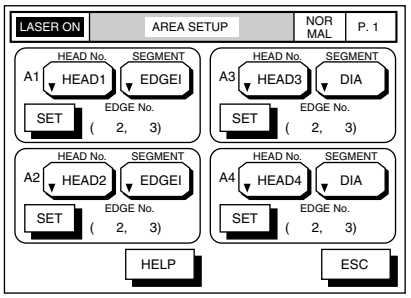
1/2 of the outer diameters measured with HEAD 1 and HEAD 2 are added.

[Example 2]

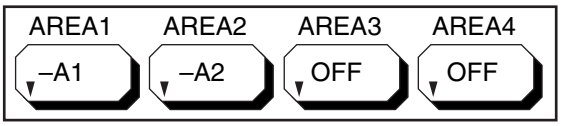
Two scanning heads are used to measure a sheet width.



[AREA SETUP]



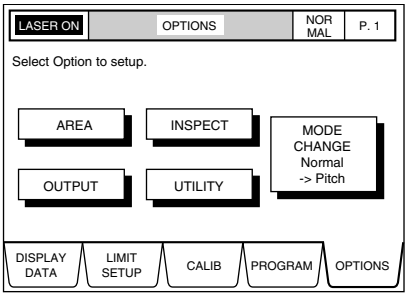
Setting Status



⇨ The measured values of HEAD 1 and HEAD 2 are both multiplied by "-1", and the resulting values are added.

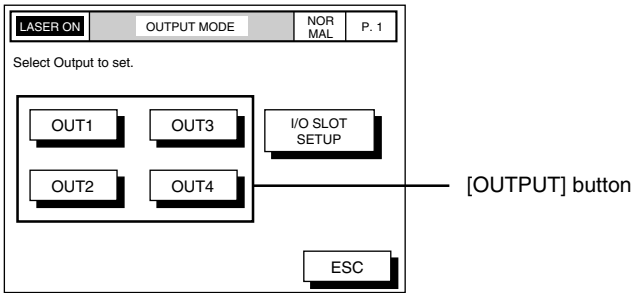
■ Setting Procedure

1. Select the OUTPUT MODE screen.
   Press the [OPTIONS] button. The screen shown below is displayed.

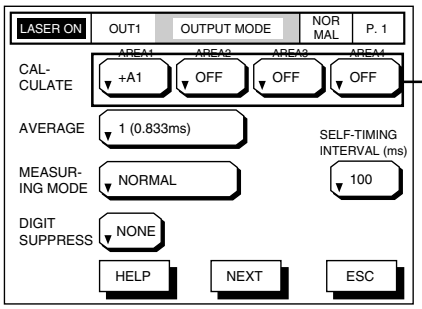


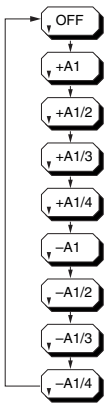
2. Select the output number to be set.
   Press the [OUTPUT] button.

   Press the button corresponding to the output number for which calculation setup is to be performed.



3. Set the calculation modes.
   Every time you press the [CALCULATE] button, the setting changes as shown below. (For AREA 1)

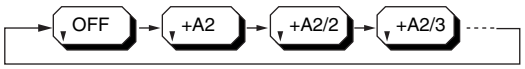




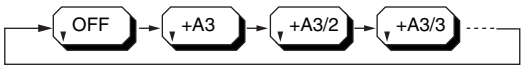
OFF: Calculation is set to OFF.
+A1: The measured value is output without changes.
+A1/2: The measured value is multiplied by “1/2”.
+A1/3: The measured value is multiplied by “1/3”.
+A1/4: The measured value is multiplied by “1/4”.
–A1: The measured value is multiplied by “–1”.
–A1/2: The measured value is multiplied by –1/2”.
–A1/3: The measured value is multiplied by “–1/3”.
–A1/4: The measured value is multiplied by “–1/4”.

Note:

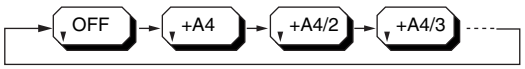
For AREA 2



For AREA 3



For AREA 4

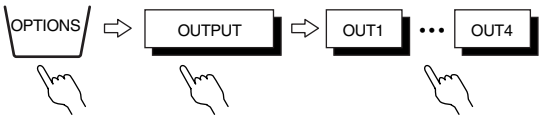


⑨ Average

The number of averaging measurements can be set based on the application as follows.

- Increase the number of averaging measurements:
  To average fluctuations in measured values to obtain stable data

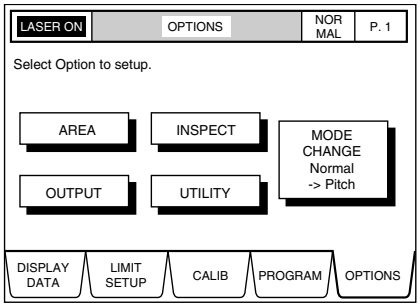
- Reduce the number of averaging measurements:
  To increase high speed differentiation speed



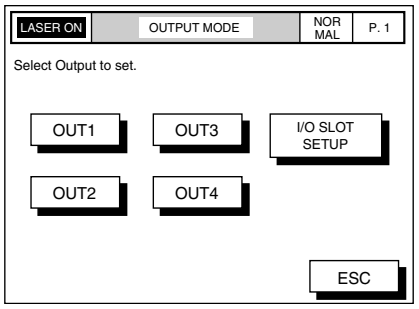
■ Setting Procedure

1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

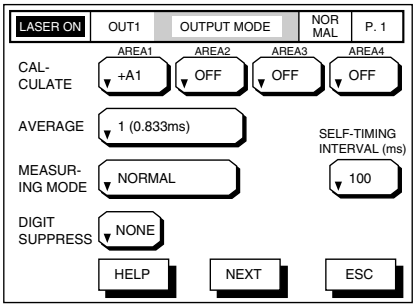
2. Select the OUTPUT MODE screen.
   Press the [OUTPUT] button.



3. Set the number of averaging measurements.
   Press the button corresponding to the output number for which the number of averaging measurements is to be set.



Press the [AVERAGE] button and set a number of averaging measurements.



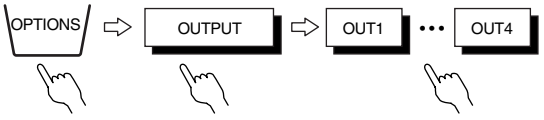
[Relationship between number of averaging measurements and averaging time]

No. of averaging measurements	Averaging time	No. of averaging measurements	Averaging time
1	0.833 ms	96	80 ms
2	1.67 ms	192	160 ms
4	3.33 ms	384	320 ms
8	6.67 ms	768	640 ms
12	10 ms	1538	1.28 s
24	20 ms	3072	2.56 s
48	40	6144	5.12 s

Note: The averaging time is not the same as output response time.
➪ *For output response time, see p. 121.*

⑩ Measuring mode

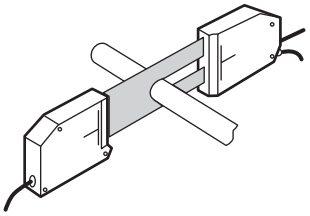
The LS-5000 series provides the following nine measuring modes.



Mode	Description
Normal	The measured value and comparator output are displayed/ output at any time.
Peak hold	The maximum value during a specified period is measured.
Bottom hold	The minimum value during a specified period is measured.
Difference hold	The difference between the maximum and minimum values during a specified period is measured.
Auto peak hold	The maximum measured value is retained.
Auto bottom hold	The minimum measured value is retained.
Auto difference hold	The difference between the maximum and minimum values is retained.
Sample hold	The instantaneous value at a specified time is measured.
Self-timing	Automatic measurement without using external synchronous input. Only with DIA or SEG (m, n).

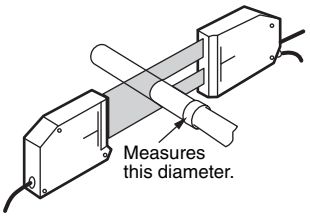
[Applications of each mode]

• Normal mode



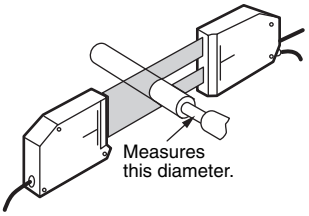
Used for normal continuous measurement.

• Peak hold
• Auto peak hold



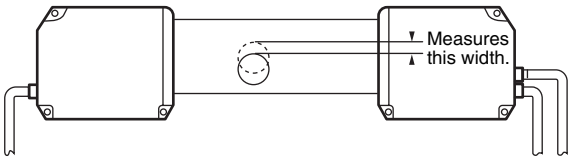
Used to measure the maximum value of the target.

• Bottom hold
• Auto bottom hold



Used to measure the minimum value of the target.

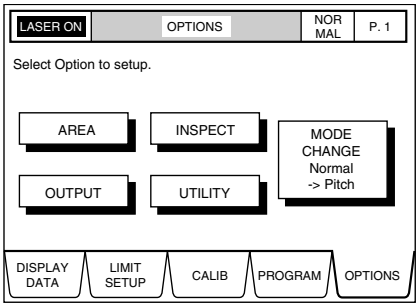
• Difference hold
• Auto difference hold



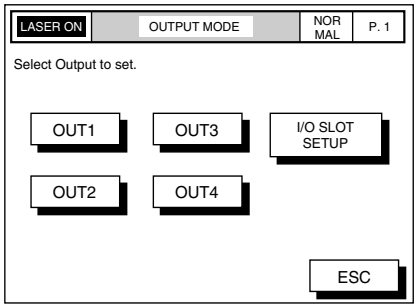
■ Setting Procedure

1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

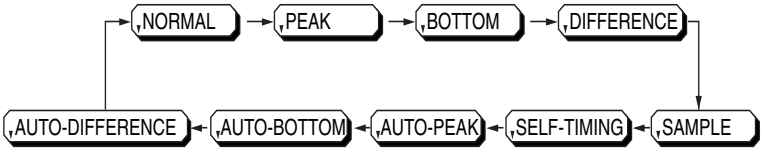
2. Select the OUTPUT MODE screen.
   Press the [OUTPUT] button.



   Press the button corresponding to the output number for which the measuring mode is to be set.



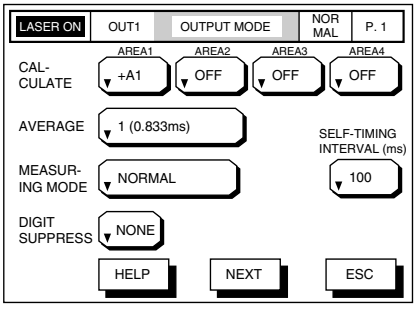
3. Set the measuring mode.
   Press the [MEASURING MODE] button to set the measuring mode.



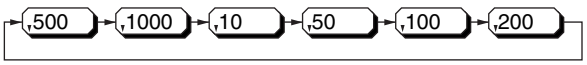
   Every time the [MEASURING MODE] button is pressed, the indication changes in the above order.

[When the self-timing mode is selected] [Only with DIA or SEG (m, n)]

4. Set the self-timing interval.
   Press the [SELF-TIMING INTERVAL] button to set the self-timing interval.



   Every time the [SELF-TIMING INTERVAL] button is pressed, the setting changes in the following order.



Note 1: The self-timing setting is effective only when self-timing mode is selected.

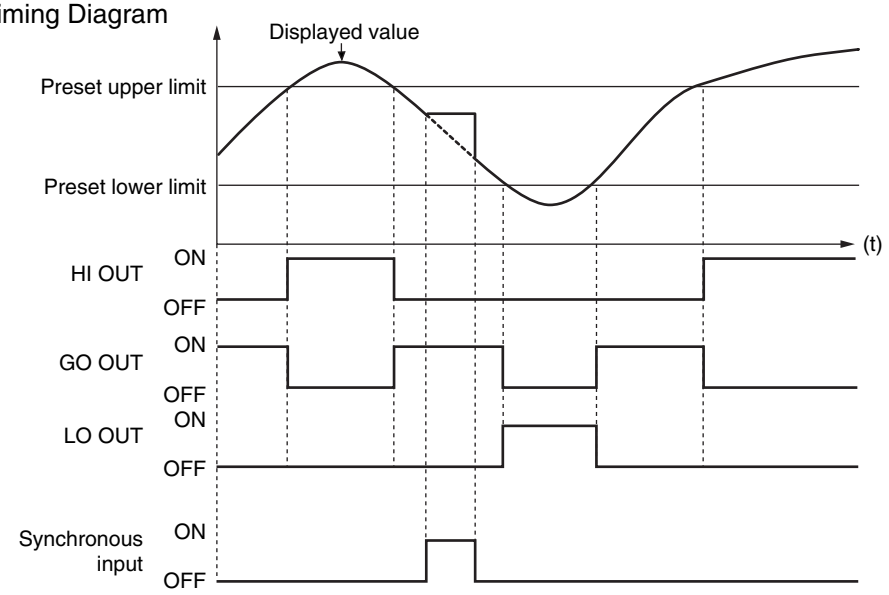
Note 2: The self-timing interval should be set longer than the averaging time.

Note 3: Self-timing mode is enabled only when DIA or SEG(m,n) is selected. (When T.EDGE or B.EDGE is selected, self-timing mode is disabled.)

● **Normal mode**

The measurement value/comparator output can be displayed/output at any time.

Timing Diagram



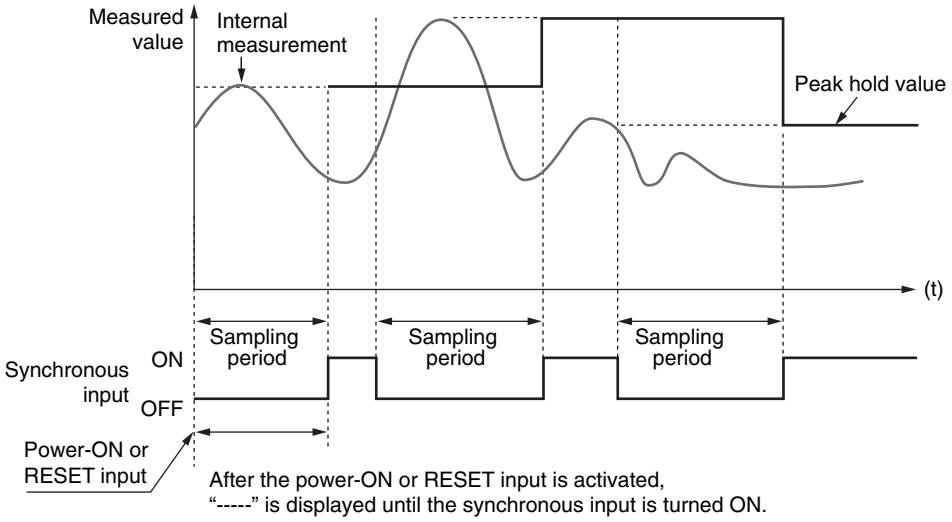
* When the synchronous input is ON, the displayed value/comparator output is retained.

● **Peak hold mode**

The maximum value during a specified period can be measured.

The sampling period is the duration between the falling edge and the next rising edge of the synchronous input.

Timing Diagram



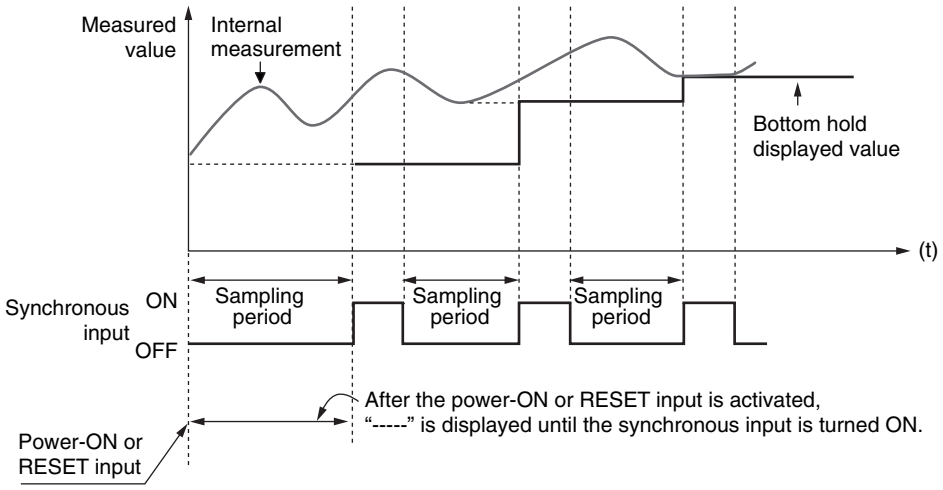
Note: When the reset input terminal and the GND terminal are short-circuited, the retained value is reset and measurement starts again.

● **Bottom hold mode**

The minimum value during a specified period can be measured.

The sampling period is the duration between the falling edge and the next rising edge of the synchronous input.

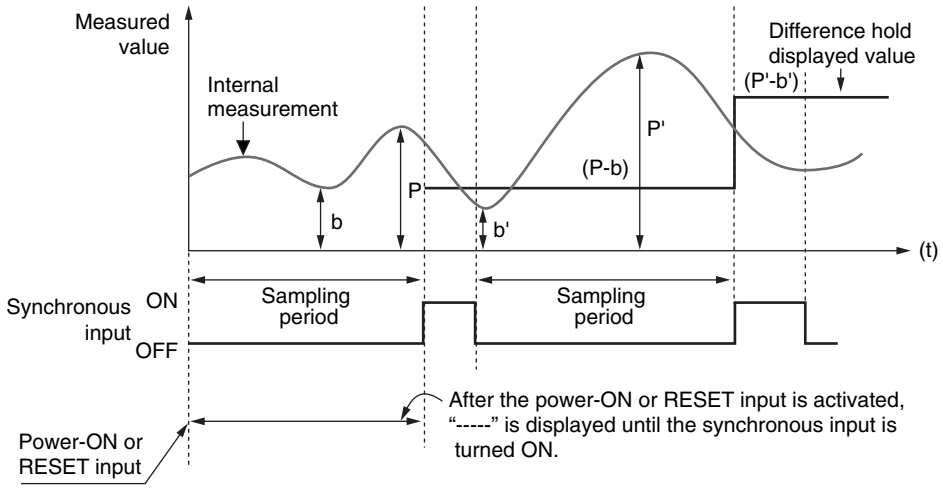
Timing Diagram



● **Difference mode**

The difference between the maximum and minimum values during a specified period can be measured.

Timing Diagram

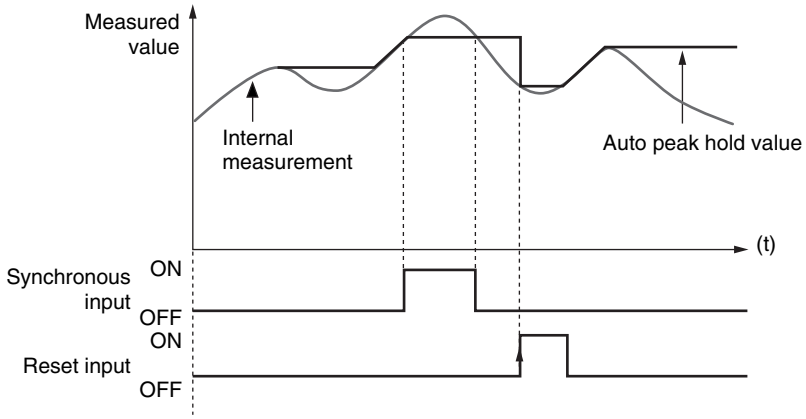


Note: When the reset input terminal and the GND terminal are short-circuited, the retained value is reset to the present value and measurement starts again.

● **Auto peak hold mode**

The maximum value after measurement starts can be measured.

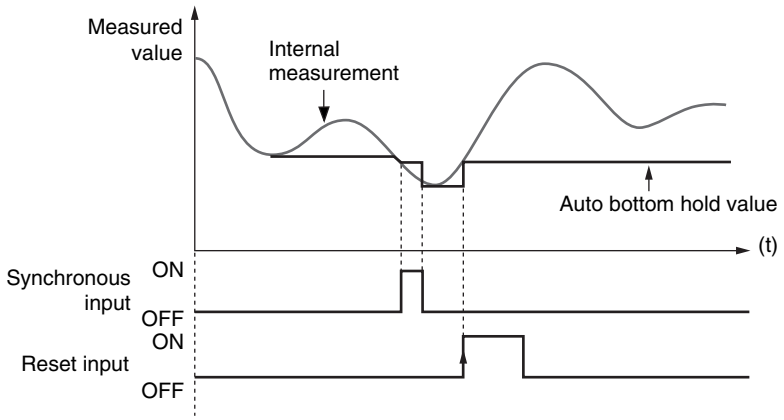
Timing Diagram



● **Auto bottom hold mode**

The minimum value after measurement starts can be measured.

Timing Diagram

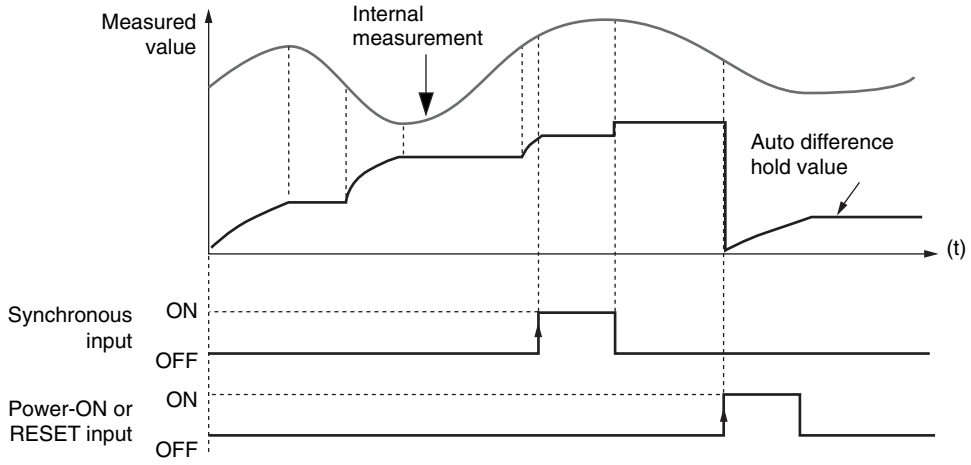


Note: When the reset input terminal and the GND terminal are short-circuited, the retained value is reset to the present value and measurement starts again.

● **Auto difference hold mode**

The difference between the maximum and minimum values after measurement starts can be measured.

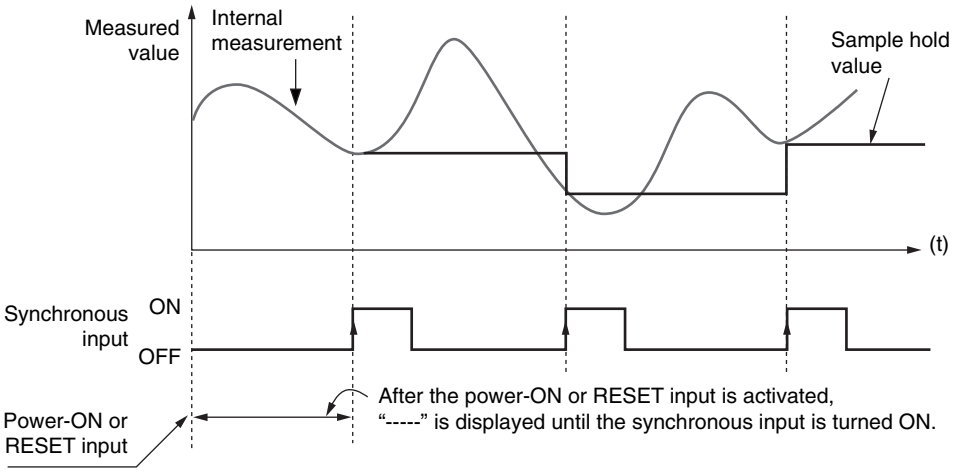
Timing Diagram



● **Sample hold mode**

The instantaneous value at a specified time can be measured.

Timing Diagram

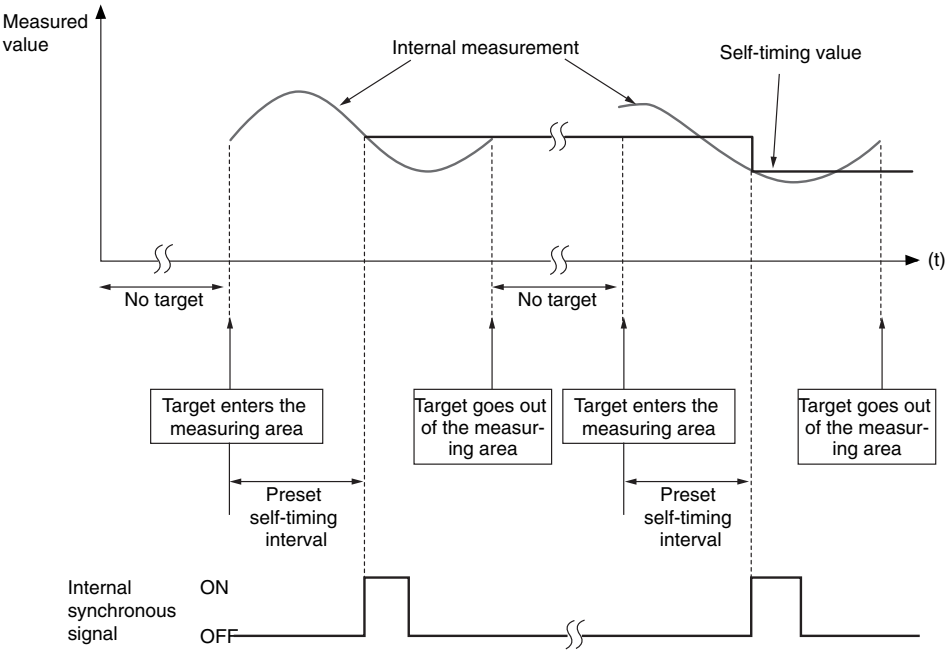


Note: When the reset input terminal and the GND terminal are short-circuited, the retained value is reset to the present value and measurement starts again.

● Self-timing mode

Measurement is automatically performed according to the internal synchronous signal.

Timing Diagram



After the power-ON or RESET input is activated,
"-----" is displayed until the internal synchronous signal is turned ON.

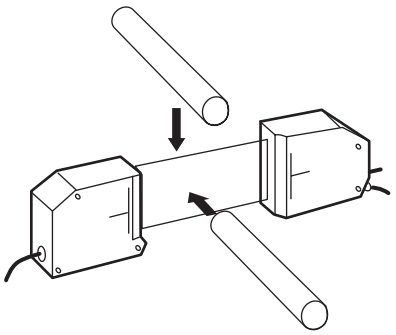
Note 1: When the self-timing hold mode is used, the external synchronous input is ignored.

Note 2: When the reset input terminal and the GND terminal are short-circuited, the retained value is reset and measurement starts again.

■ Target recognition method in self-timing mode

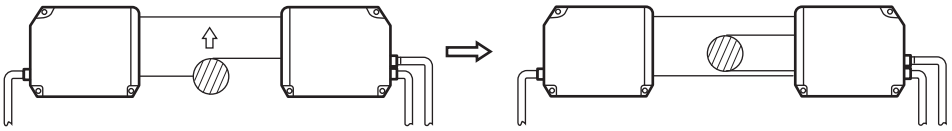
The LS-5000 series' self-timing mode takes a specified duration to start sample-holding after the LS-5001 has recognized that a target has been placed in the measuring area. (The target recognition method varies depending on the SEGMENT.)

The LS-5001 can measure a target regardless of the direction it enters the measuring area from.



Target recognition method by measuring mode

- DIA mode: A target is recognized when the number of edges in the measuring area is two or more.

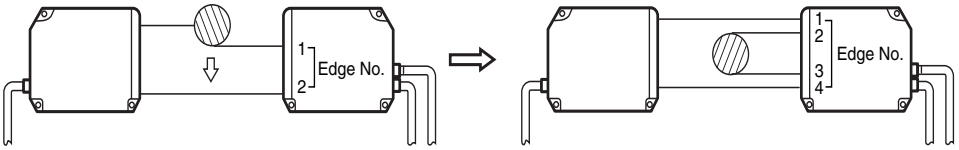


The target has not yet been recognized.

The LS-5001 recognizes that a target has been placed in the measuring area when the number of edges in the measuring area is two or more.

- SEG (m, n) mode: A target is recognized when a specified number of edges is generated in the measuring area.

When SEG(2,3) is set:

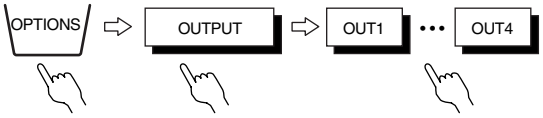


The target has not yet been recognized because the specified number of edges (Edge No.) is not present in the measuring area.

The target has been recognized when the specified number of edges is generated in the measuring area.

⑪ Digit Suppression Function

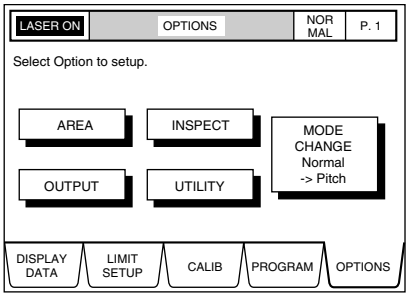
The digits after the decimal point can be suppressed as required.



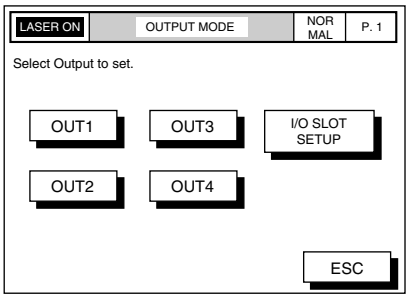
■ Setting Procedure

1. Select the OPTIONS screen. Press the [OPTIONS] button.

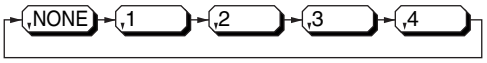
2. Select the OUTPUT MODE screen. Press the [OUTPUT] button.

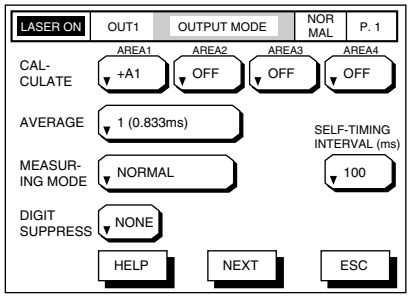


3. Change the number of digits.
   Press the button corresponding to the output number for which the number of digits is to be changed.



Every time you press the [DIGIT SUPPRESS] button, the display changes in the following order. The value indicates the number of digit to be suppressed.





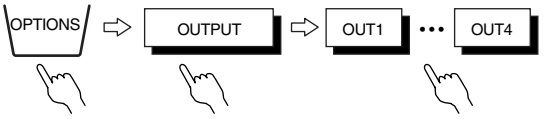
Note: The relationship between each switch setting and the number of displayed digits is as follows:

Example

- ,NONE ⇨ (Displays 5 digits after the decimal point: 10.00000 mm/1.000000 inch)
- ,1 ⇨ (Displays 4 digits after the decimal point: 10.0000 mm/1.00000 inch)
- ,2 ⇨ (Displays 3 digits after the decimal point: 10.000 mm/1.0000 inch)
- ,3 ⇨ (Displays 2 digits after the decimal point: 10.00 mm/1.000 inch)
- ,4 ⇨ (Displays 1 digit after the decimal point: 10.0 mm/1.00 inch)

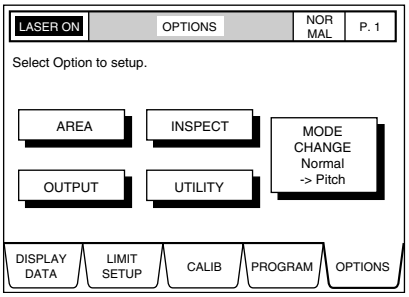
⑫ Offset Function

The desired value can be added to or subtracted from the displayed value.

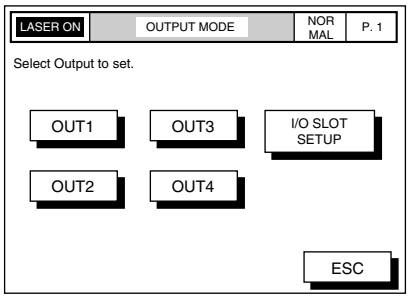


■ Setting Procedure

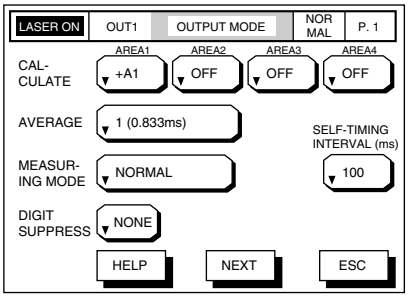
1. Select the OPTIONS screen. Press the [OPTIONS] button.
2. Select the OUTPUT MODE screen. Press the [OUTPUT] button.



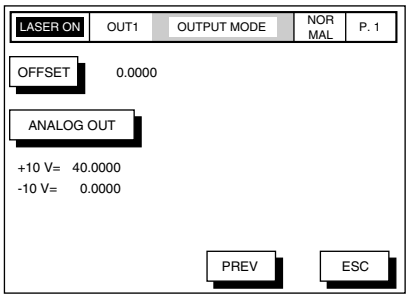
3. Press the button corresponding to the output number for which the offset function is to be set.



4. Press the [NEXT] button.

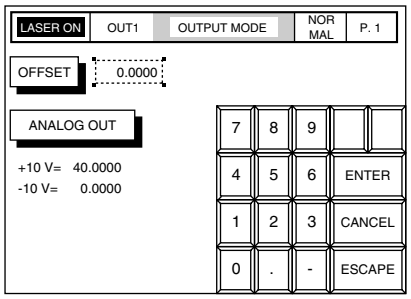


5. Set the offset function. Press the [OFFSET] button.



6

6. Enter an offset value using the numeric keys, and press [ENTER].



Press [ESCAPE] to complete the entry.
Press [CANCEL] to cancel the entry.
The value returns to the previous value.

Note: The maximum and minimum offset values are as follows:

Max.: 999.9999 (9.99999)
Min.: -99.9999 (-0.99999)
Values in ( ) are in inches.

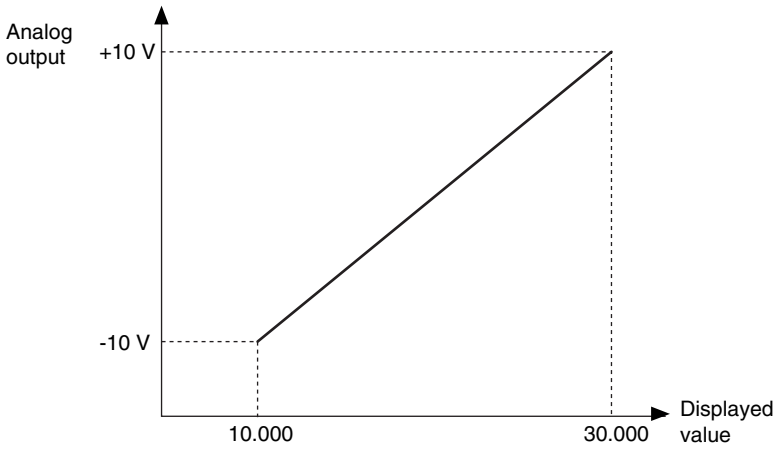
⑬ Analog Output Function

An analog voltage proportional to the displayed value can be output using an optional I/O board in the range of ±10 V.
The analog output scaling range is between -99.9999 and 999.9999 in “mm” (-0.99999 and -99.9999 in “inch”), and the ripple is 5 mV.

● Scaling

The analog output is scaled to set the changing rate (inclination) of the analog output relative to the displayed value. Enter a value to be displayed, relative to +10 V and -10 V respectively.

When the analog output is set to “+10 V = 30.000” and “-10 V = 10.000”, the relation between analog output and displayed value is as follows:



Note: Resolution

The resolution of the LS-5000 series’ analog output is 5 mV. The resolution in displayed value varies depending on the scaling.

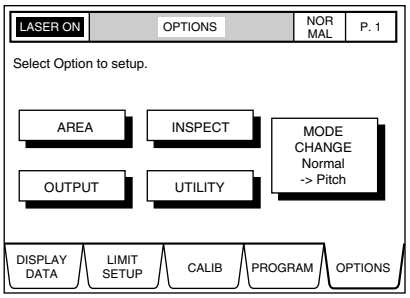
Example 1
When the analog output is set to “+10 V = 10.000” and “-10 V = -10.000”:
20 (V) : 0.005 (V) = 20 (mm) : x (mm) x = 0.005 mm

Example 2
When the analog output is set to “+10 V = 40.000” and “-10 V = 0.0000”:
20 (V) : 0.005 (V) = 40 (mm) : x (mm) x = 0.010 mm

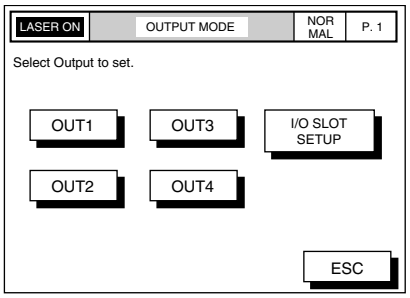
■ Setting Procedure

1. Select the OPTIONS screen. Press the [OPTIONS] button.

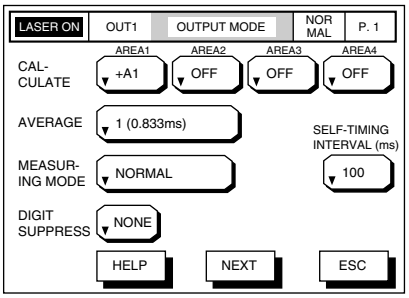
2. Select the OUTPUT MODE screen. Press the [OUTPUT] button.



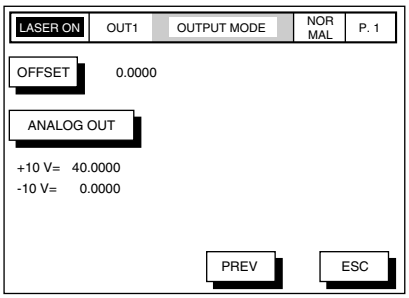
3. Set the analog output function.
   Press the button corresponding to the output for which the analog output function is to be set.



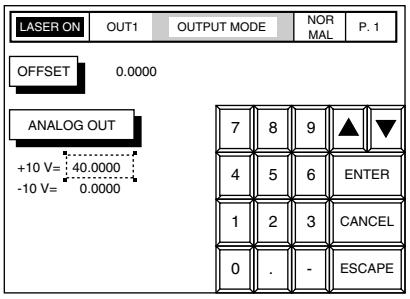
4. Press the [NEXT] button.



5. Press the [ANALOG OUTPUT] button.



   Using the numeric keys, enter an analog output value in the location indicated by the dotted line.

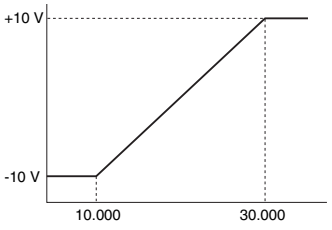


Press [ESCAPE] to complete the entry.
Press [CANCEL] to cancel the entry.
The value returns to the previous value.

Note 1: When "-----" is displayed, the analog output is retained at +10 V.

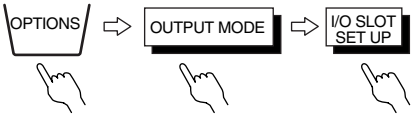
Note 2: When the displayed value exceeds the preset scaling range, the analog output is retained at +10 V. (When the displayed value falls below the scaling range, the analog output is retained at -10 V.)

[Example]
When the analog output is set to "+10 V = 30.000" and "-10 V = 10.000":
When the displayed value is 30 or more, the analog output is retained at +10 V.
When the displayed value is 10 or less, the analog output is retained at -10 V.



⑭ I/O Slot Setup

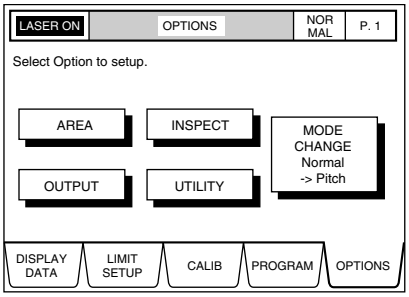
The expansion I/O board can be set. ☞ *See p. 100.*



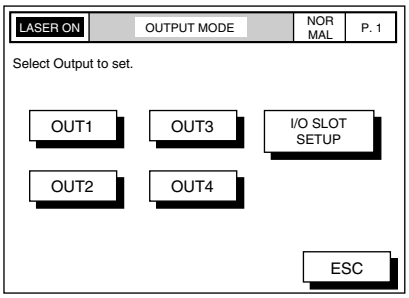
■ Setting Procedure

1. Select the OPTIONS screen. Press the [OPTIONS] button.

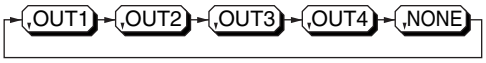
2. Select the OUTPUT MODE screen. Press the [OUTPUT] button.

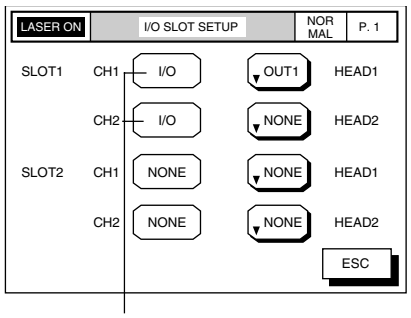


3. Press the [I/O SLOT SETUP] button.



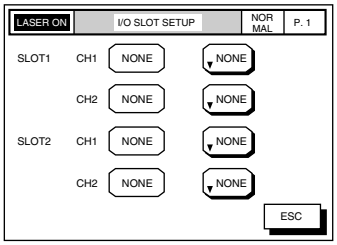
4. Set the output number.
   Every time you press the button, the display changes in the following order.





The I/O board mounted in the expansion slot is shown.

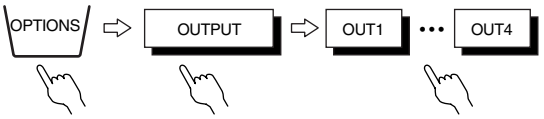
Note 1: When there is no I/O board mounted in the expansion slot, the display is as shown on the right.



Note 2: When an I/O board is mounted in the expansion slot, the same output number cannot be set for different channels.

⑮ Inspection

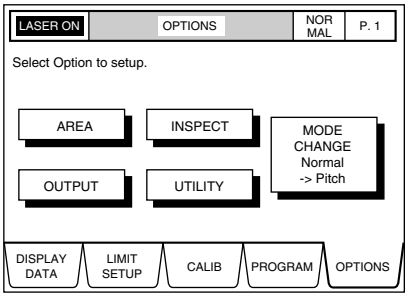
The scanning head can be checked for conditions such as dust on the front surface, laser condition, and optical axis alignment.



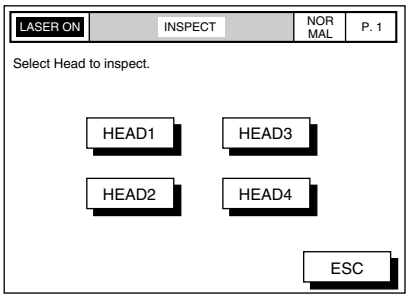
■ Setting Procedure

1. Select the OPTIONS screen. Press the [OPTIONS] button.

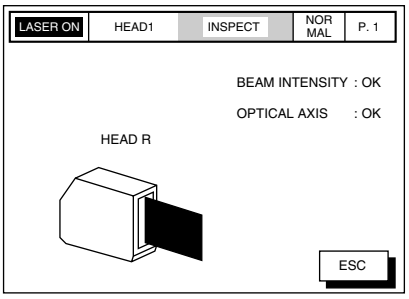
2. Select the INSPECT screen. Press the [INSPECT] button.



3. Check the condition of the scanning head.
   Press the button corresponding to the scanning head to be inspected.



   When the condition of the scanning head is normal, the display is as shown below.



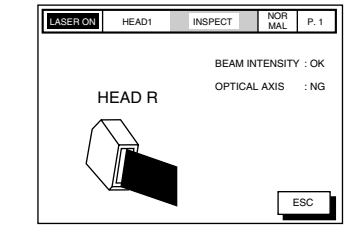
Note 1: During the scanning head inspection, measurement is interrupted. (The comparator output and analog output are the same as when "-----" is displayed.)

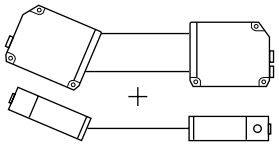
Comparator output: All outputs are OFF.
Analog output: Retained at +10 V.

Note 2: When any problem occurs with the laser diode, the message "LASER" is displayed on the screen.

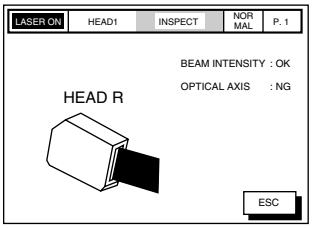
● Optical axis misalignment indications

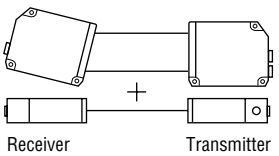
Optical axis misalignment is indicated when the receiver is tilted relative to the optical axis.



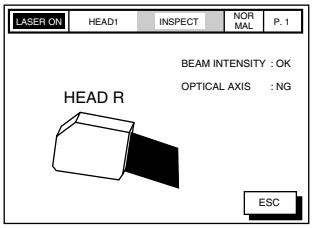


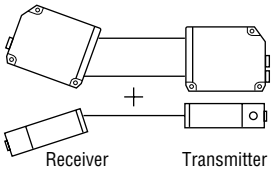
The receiver is tilted to the upper right (viewed from the transmitter).



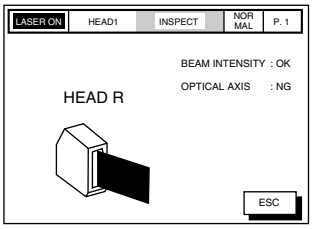


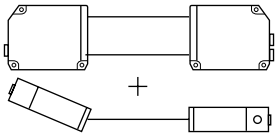
The receiver is tilted upward.





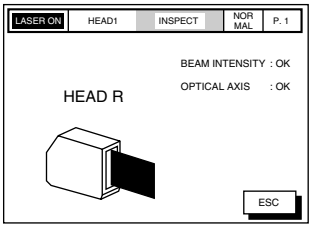
The receiver is tilted to the upper left (viewed from the transmitter).

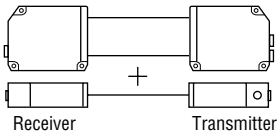




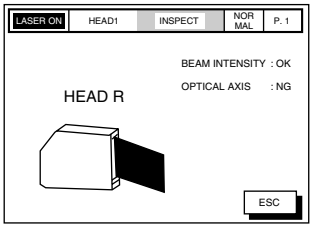
The transmitter is tilted to the right (viewed from the transmitter).

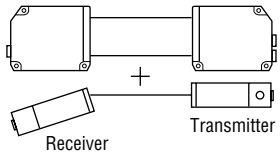
Normal Alignment



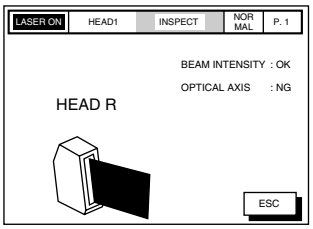


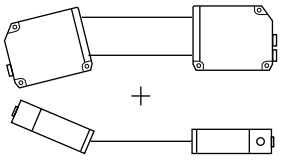
The optical axis is aligned.



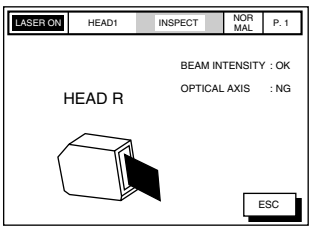


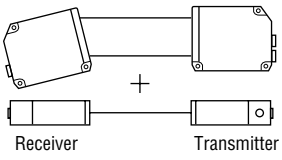
The receiver is tilted to the left (viewed from the transmitter).



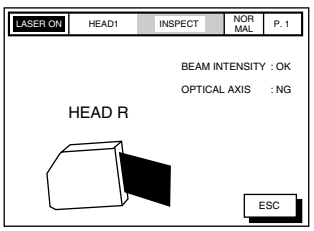


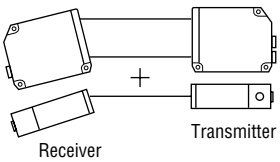
The receiver is tilted to the lower right (viewed from the transmitter).



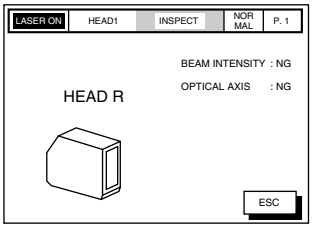


The receiver is tilted downward.

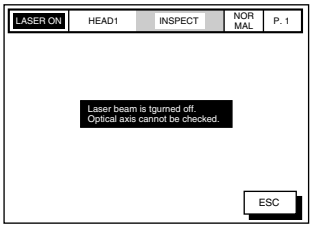




The receiver is tilted to the lower left (viewed from the transmitter).



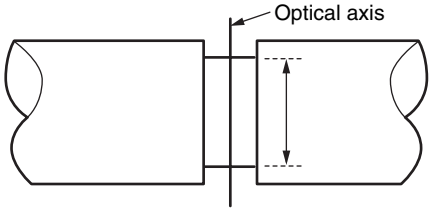
No optical axis enters the receiver.



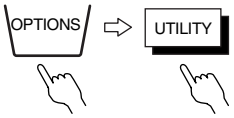
Laser beam is not emitted.

⑯ One-scan Mode

Data on only one of the 12 surfaces of the polygon mirror becomes effective. (This mode negates slight changes in the optical axis caused by the polygon mirror surface runout.) This is effective for measuring a narrow gap as shown below.

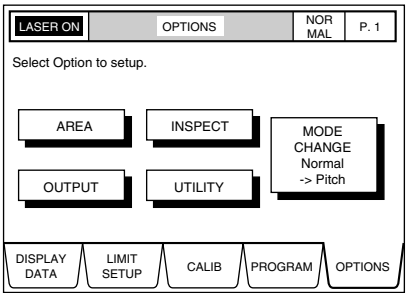


■ Setting Procedure



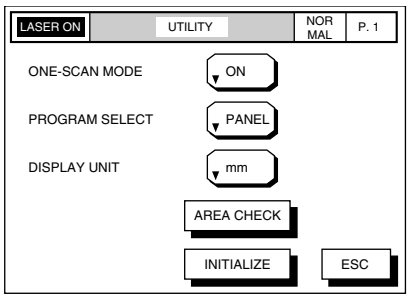
1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

2. Select the UTILITY screen.
   Press the [UTILITY] button.

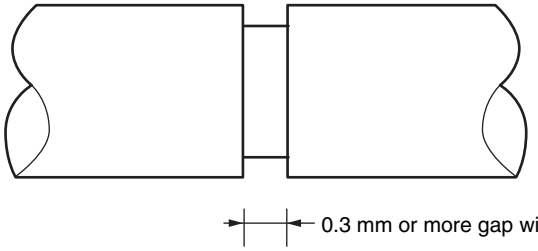


3. Set the one-scan mode.
   Press the [ONE-SCAN MODE] button to turn it ON.

   Every time you press this button, the display toggles between ON and OFF.



Note: The laser beam spot diameter is 0.2 mm at a distance of 80 mm from the transmitter. For gap measurement, however, a gap width of 0.3 mm or more is required.



When the one-scan mode is used, the averaging time[1] is longer than in normal measuring mode.

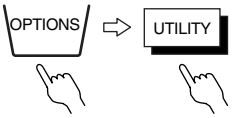
No. of averaging measurements and averaging time when one-scan mode is ON/OFF

OFF	ON	Averaging time
1	1	10 ms
2	1	10 ms
4	1	10 ms
8	1	10 ms
12	1	10 ms
24	2	20 ms
48	4	40 ms
96	8	80 ms
192	16	160 ms
384	32	320 ms
768	64	640 ms
1536	128	1280 ms
3072	256	2460 ms
6144	512	5120 ms

1. The averaging time is not the same as mean output response time. For the output response time, see p. 121.

⑰ Program Selection Method Setup

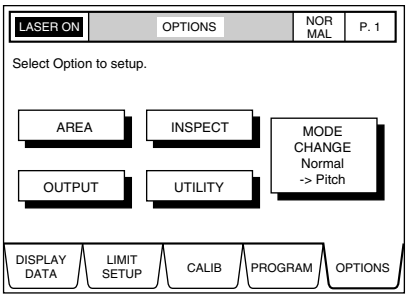
The program selection method can be set to the front panel or the rear terminals.



■ Setting Procedure

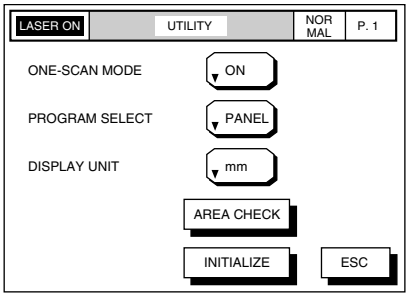
1. Select the OPTIONS screen. Press the [OPTIONS] button.

2. Select the UTILITY screen. Press the [UTILITY] button.



3. Set the program selection method.
   Press the [PROGRAM SELECT] button to select [PANEL] or [EXT].

   Every time you press the button, the display toggles between [PANEL] and [EXT].



Note 1: When the program selection method is set to [PANEL], program selection can be performed using the front panel and the RS-232C input.

Note 2: When the program selection method is set to [EXT], program selection can be performed using the terminal input only.

	Program selection	
	Panel	**Terminal**
Front panel	Enabled	Disabled
Terminal input	Disabled	Enabled
RS-232C input	Enabled	Disabled

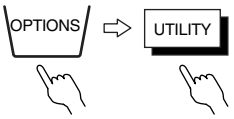
Note 3: When the panel lock function is used, program selection is performed as shown below.

	Program selection	
	Panel	**Terminal**
Front panel	Disabled	Disabled
Terminal input	Disabled	Enabled
RS-232C input	Enabled	Disabled

☞ *For information on the panel lock function, see p. 112.*

⑱ Display Unit

The measured value can be displayed in millimeters or inches.

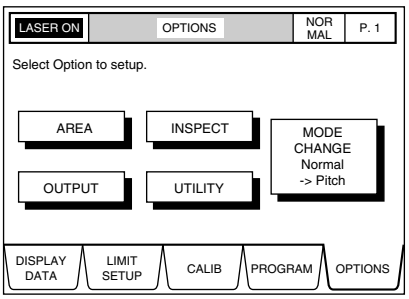


Note: When the display units setting is changed, the preset values (tolerance limits, etc.) of the selected program number are reset to the initial settings.

■ Setting Procedure

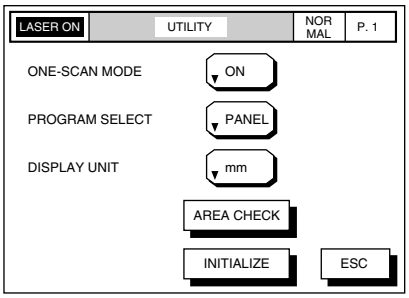
1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

2. Select the UTILITY screen.
   Press the [UTILITY] button.



3. Set the display unit.
   Press the [DISPLAY UNIT] button to select [mm] or [inch].

   Every time you press the button, the display toggles between [mm] and [inch].



⑲ Area Check Function

When the number of edges changes during measurement, the area check function displays the "----" error message. It also cancels the measured value by detecting the difference from the preset total number of edges.

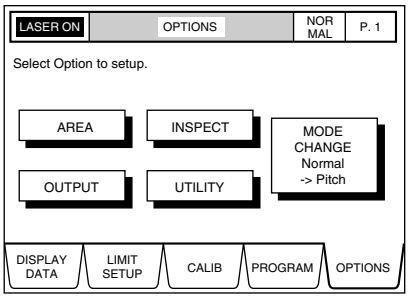
■ Effective Application

When dust or oil adheres to the scanning head or no target is placed in the measuring area, the area check function prevents an abnormal measured value from being displayed or output.

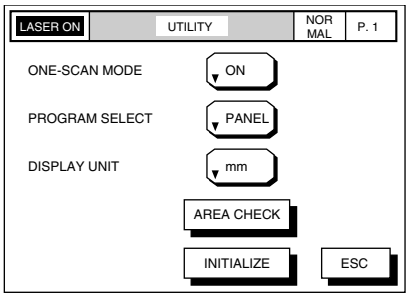
■ Setting Procedure

1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

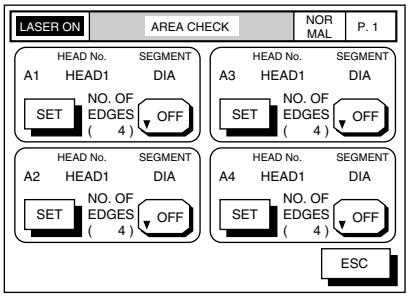
2. Select the UTILITY screen.
   Press the [UTILITY] button.



3. Press the [AREA CHECK] button.



4. Set the number of edges.
   Press the [SET] button.



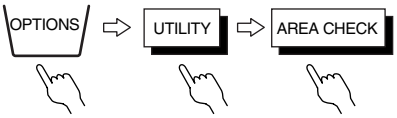
Enter a value using the numeric keys.

Press the [OFF] button to turn it ON.

Every time you press the button, the display toggles between [ON] and [OFF].

⑳ Initialize

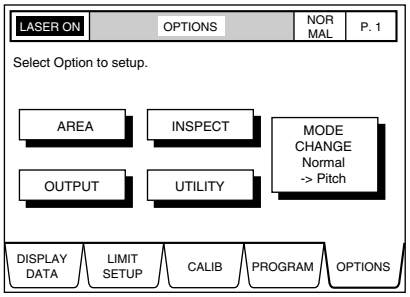
This function resets all settings to the initial values. ☞ *See p. 116 and 117.*



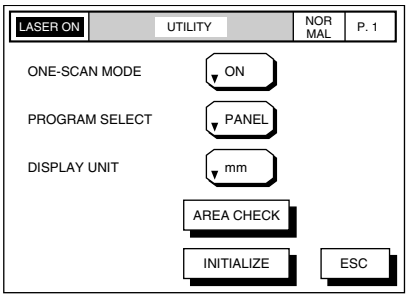
■ Setting Procedure

1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

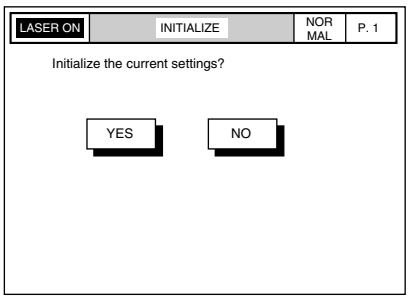
2. Select the UTILITY screen.
   Press the [UTILITY] button.



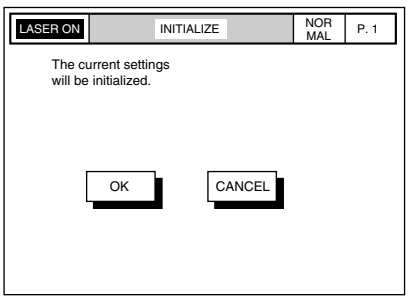
3. Perform initialization.
   Press the [INITIALIZE] button.



4. Press the [YES] button.

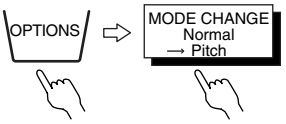


5. Press the [OK] button.



㉑ Mode Change

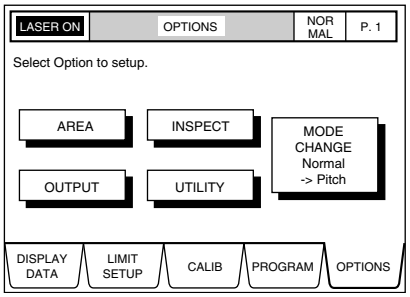
The measuring mode can be changed from Normal mode to Pitch mode.



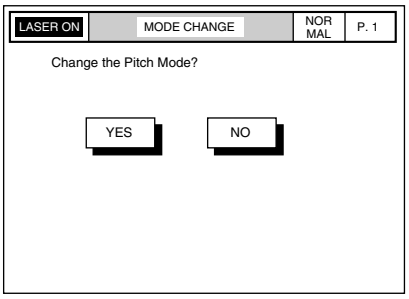
■ Setting Procedure

1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

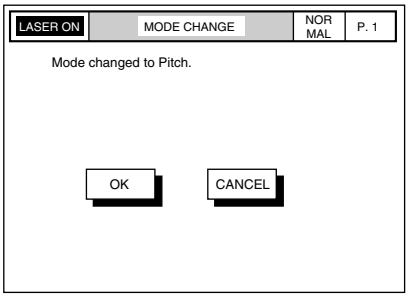
2. Change the measuring mode.
   Press the [CHANGE MODE Normal -> Pitch] button.



3. Press the [YES] button.



   Press the [OK] button.



Chapter 7

Pitch Mode

This section describes functions and settings procedures for Pitch mode.

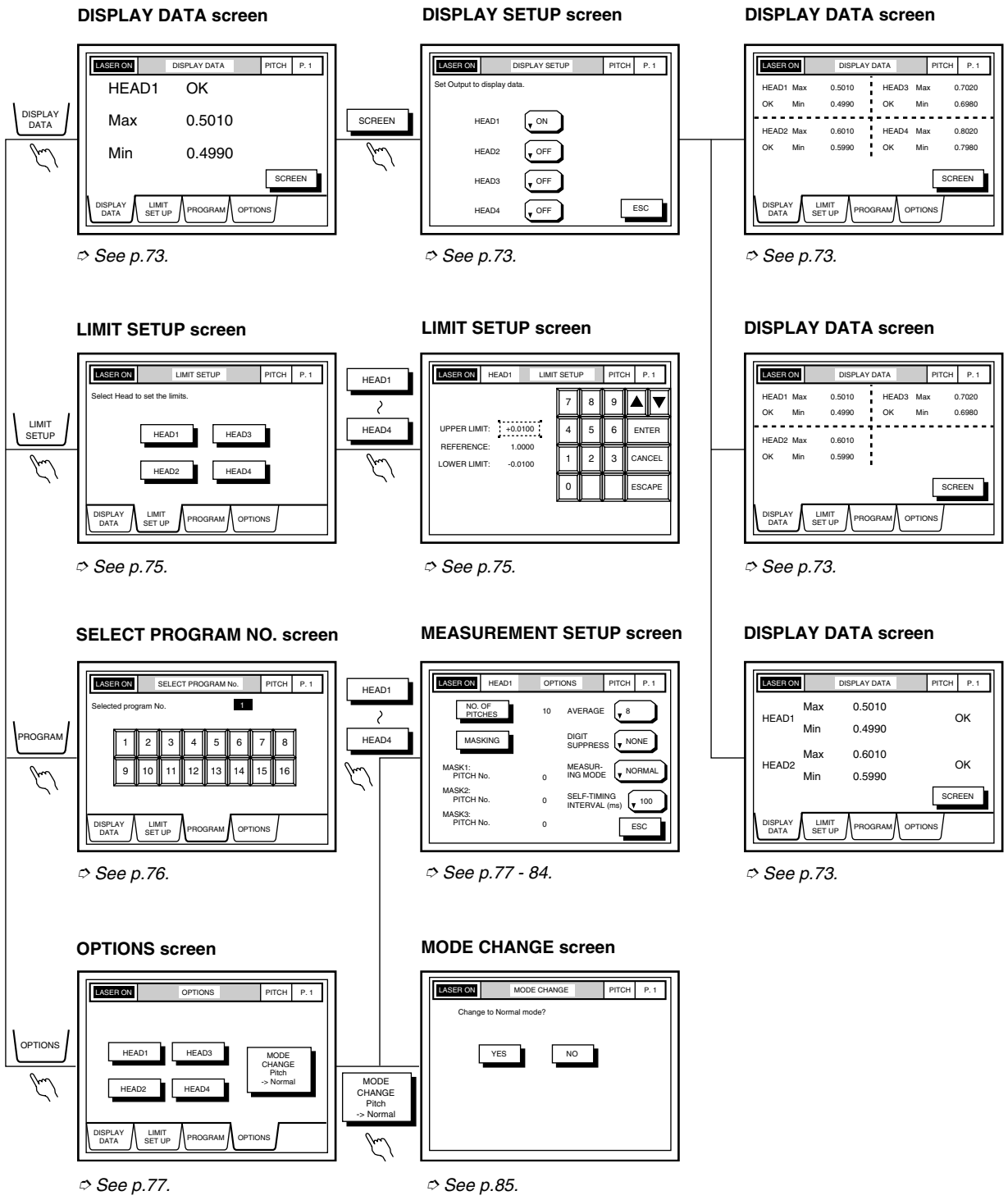
7.1 Pitch Mode Screens 70

7.2 Initial Screen 71

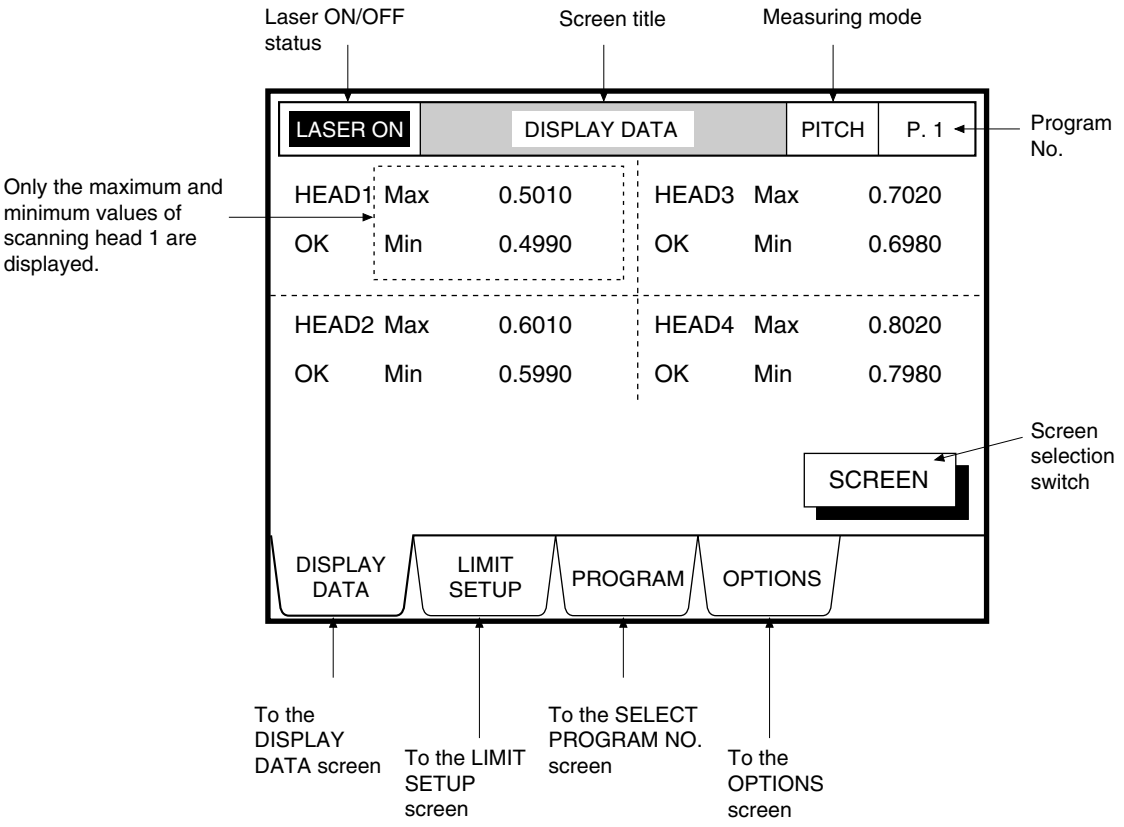
7.3 Setting Measurement 72

7.4 Setting Functions 73

7.1 Pitch Mode Screens



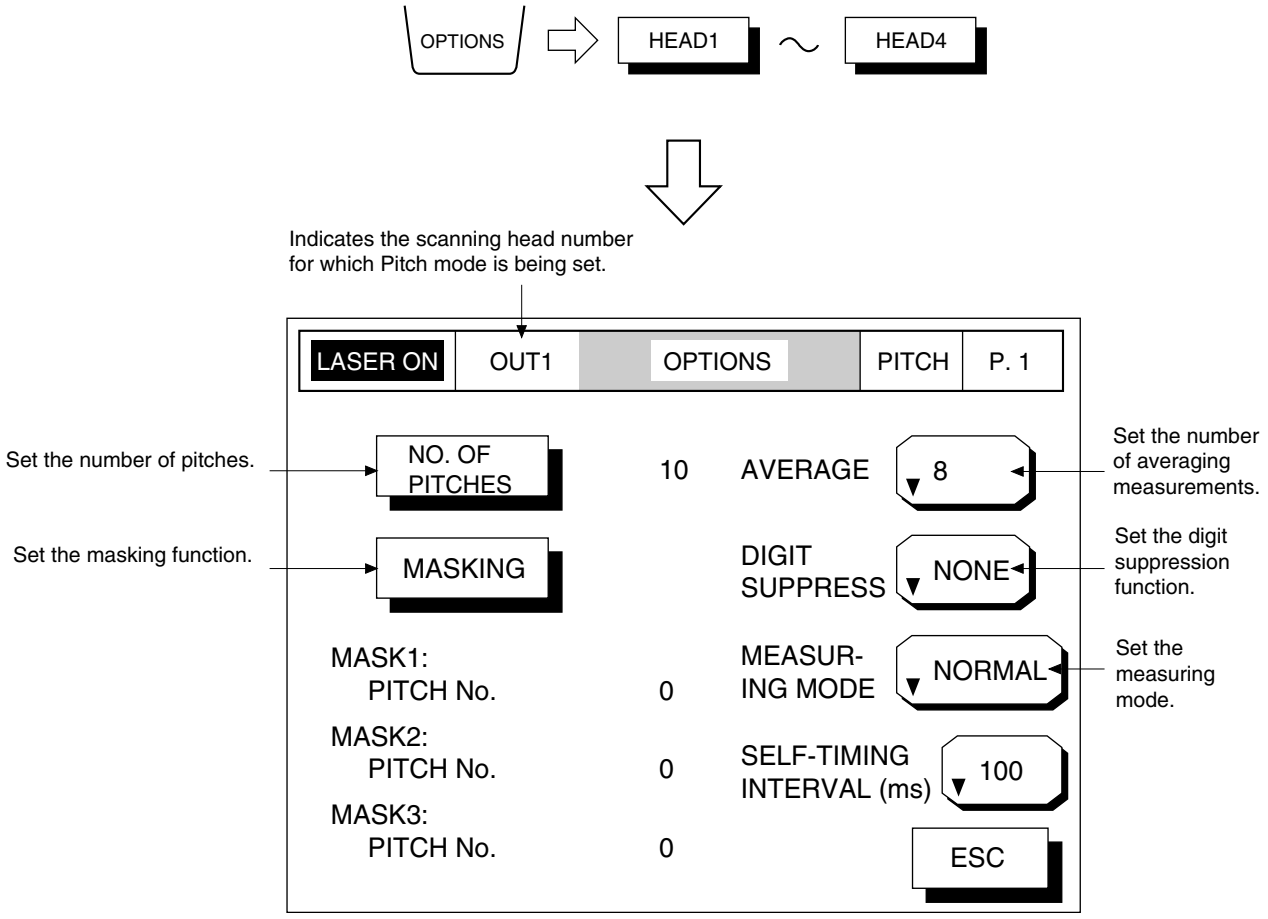
7.2 Initial Screen



7.3 Setting Measurement

When Pitch mode is selected, only one measurement can be performed with one scanning head, unlike in Normal mode. Therefore, Pitch mode setup must be performed for each scanning head.

■ **Setting Procedure**

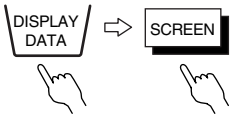


7.4 Setting Functions

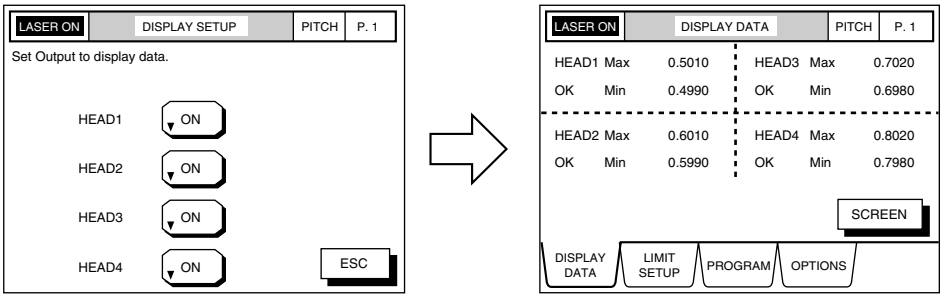
Switch		Function	Description	Reference page
DATA DISPLAY		**Screen Selection**	Measurement results are displayed.	72, 73
LIMIT SETUP		**Limit Setup**	Upper and lower limits can be set relative to the reference value for each output.	75
PROGRAM SELECT		**Program Selection**	Measurement conditions can be stored and retrieved as programs.	76
OPTIONS	**For each scanning head**	**No. of Pitches**	Set the number of pitches according to the target.	77
		Average	Measurement results can be averaged.	79
		Digit suppression	The number of digits after the decimal point can be set.	80
		M. Mode	Three measuring modes are provided.	81-83
		Masking	Set the pitch number for the measurement to be canceled.	84
		Mode Change	Normal mode or Pitch mode can be selected.	85

① Screen Selection Function

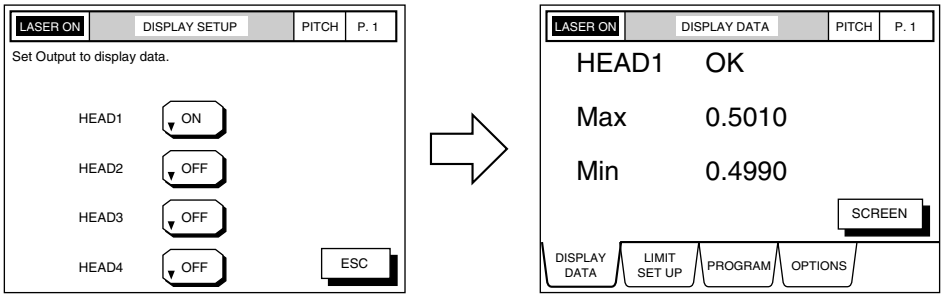
Using the screen selection function, set the measured value display screen (OUT1 to OUT4).



[Example 1: Four measurement results are displayed.]



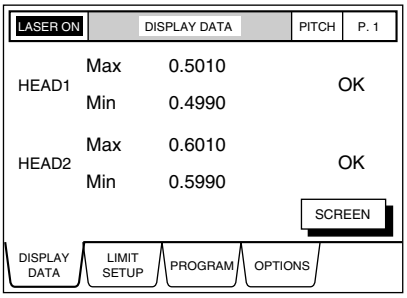
[Example 2: One measurement result is displayed.]



■ Setting Procedure

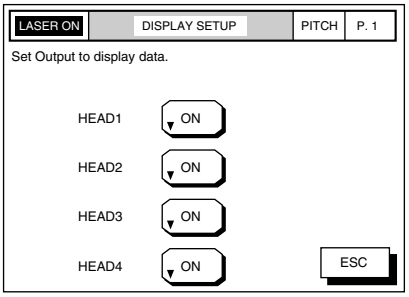
1. Select the DISPLAY DATA screen.
   Press the [DISPLAY DATA] button.

   Press the [SCREEN] button.

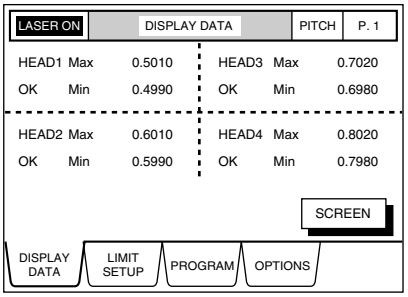


2. Select the data display screen.
   Press the button corresponding to the output to be displayed to turn it ON.

   Press the [ESC] button.

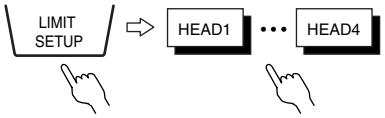


3. The screen has been changed.



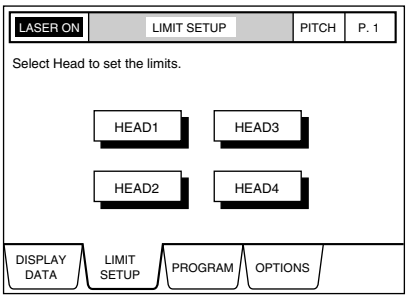
② Limit Setup

The reference value, upper limit, and lower limit can be set separately for each of the four scanning heads.



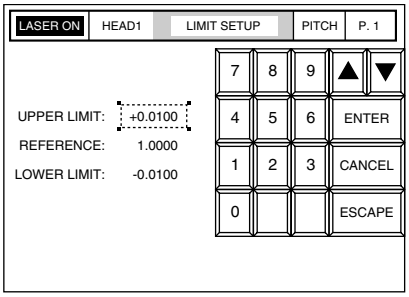
■ Setting Procedure

1. Select the LIMIT SETUP screen.
   Press the [LIMIT SETUP] button.



2. Set tolerance limits.
   Press the button corresponding to the output for which tolerance limits are to be set.

   Set tolerance limits using the numeric keys, and press [ENTER].
   Press [ESCAPE] to complete the entry.
   Press [CANCEL] to cancel the entry. The value returns to the previous value.



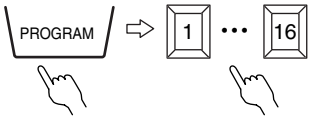
Note: When the measured value exceeds the tolerance range, the value is displayed in reverse. The differentiation result relative to the tolerance limits is output from the display unit and the control I/O board (optional).

When the measured value exceeds the upper limit or falls below the lower limit, the HI1 output is turned on.

In PITCH mode, the Upper-Lower Limit indicates the difference from the Reference value. If a measured value of more than 1.1000 mm is to be checked and the Reference value is set to 1.000 mm, the Upper Limit should be +0.1000. If 0.9000 mm is to be checked, the Lower Limit should be -0.1000 mm.

③ Program Selection Function

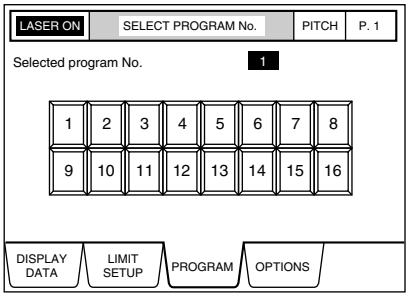
The LS-5000 series can store all the measurement conditions as a program. Up to 16 programs can be stored and loaded easily.



■ Setting Procedure

1. Select the SELECT PROGRAM NO. Screen.
   Press the [PROGRAM] button.

2. Select a program number.
   Press the button corresponding to the desired program number.

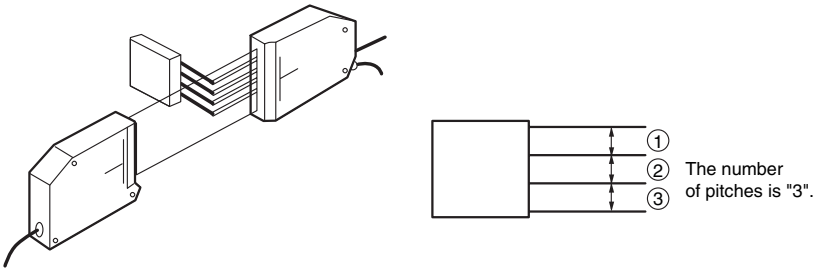


Note: When the program selection method is set to the rear terminals, the program number cannot be changed using the front panel. *See p. 64.*

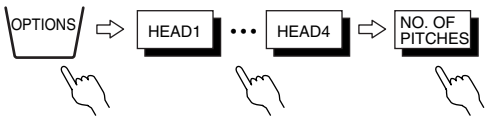
④ Setting Number of Pitches

The number of pitches can be set up to 100, depending on the target.

Example: IC lead pitch measurement

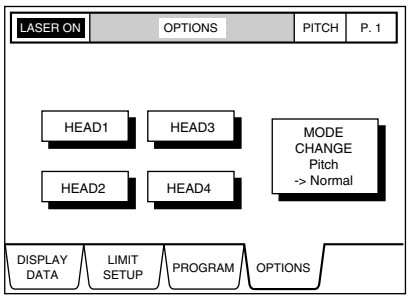


■ **Setting Procedure**

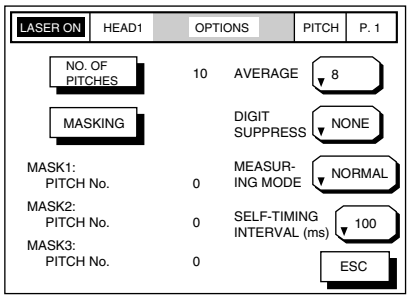


1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

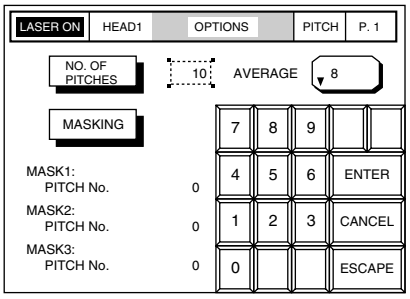
2. Set the number of pitches.
   Press the button corresponding to the output for which the number of pitches is to be set.



3. Press the [NO. OF PITCHES] button.

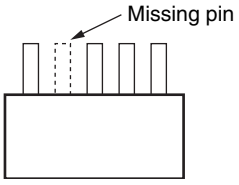


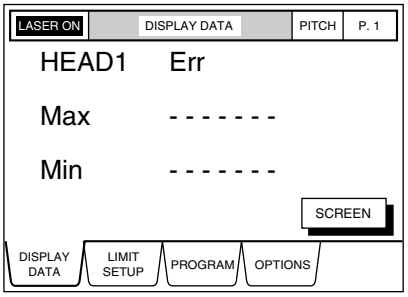
4. Enter a value using the numeric keys, and press [ENTER].
   Press [ESCAPE] to complete the entry.
   Press [CANCEL] to cancel the entry. The value returns to the previous value.



Note 1: Up to 100 pitches can be set.

Note 2: When the number of pitches for a target is different from the preset number of pitches, “-----” is displayed and "Err" appears. (When the error message is displayed, the HI3 output of the control I/O board (optional) is turned ON.)



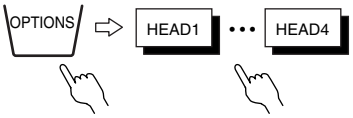


⑤ Average

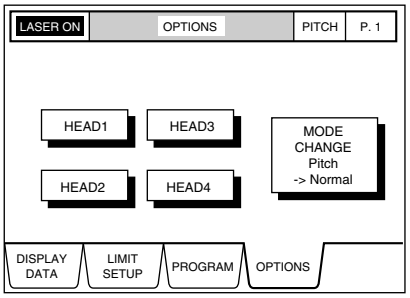
The number of averaging measurements can be set, according to the application, as follows:

- Increase the number of averaging measurements to average fluctuations in measured values to obtain stable data.
- Reduce the number of averaging measurements to increase differentiation speed.

■ Setting Procedure

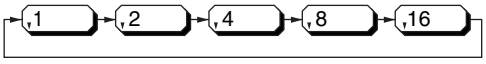


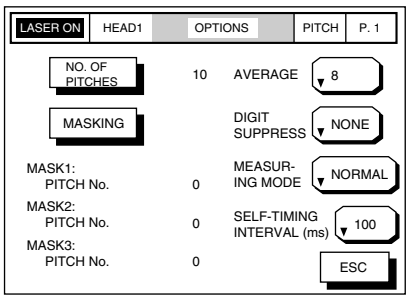
1. Select the OPTIONS screen. Press the [OPTIONS] button.
2. Set the number of averaging measurements.
   Press the button corresponding to head number for which the number of averaging measurements is to be set.



Press this button and set the number of averaging measurements.

Every time you press this button, the display changes in the following order.





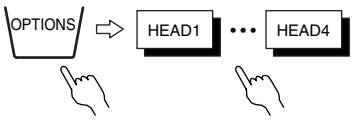
[Relationship between No. of averaging measurements and averaging time]

No. of averaging measurements	Averaging time
1	10 ms
2	20 ms
4	40 ms
8	80 ms
16	160 ms

Note: The averaging time is not the same as mean output response time. For information on output response time, see p. 121.

⑥ Digit Suppression Function

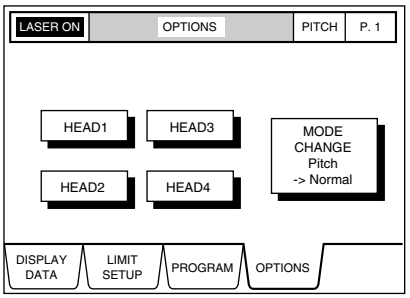
The number of digits after the decimal point can be suppressed as desired.



■ Setting Procedure

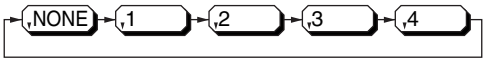
1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

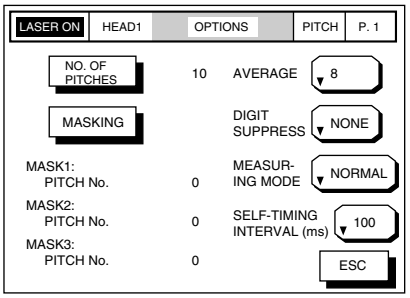
2. Set the number of digits.
   Press the button corresponding to the scanning heads for which the number of digits is to be set.



Press this button to select the number of digits.

Every time you press this button, the display changes in the following order.





Note: The relationship between each switch setting and the displayed digits is as follows:

Example

- ,NONE ⇨ (Displays 5 digits after the decimal point: 10.00000 mm/1.000000 inch)
- ,1 ⇨ (Displays 4 digits after the decimal point: 10.0000 mm/1.00000 inch)
- ,2 ⇨ (Displays 3 digits after the decimal point: 10.000 mm/1.0000 inch)
- ,3 ⇨ (Displays 2 digits after the decimal point: 10.00 mm/1.000 inch)
- ,4 ⇨ (Displays 1 digit after the decimal point: 10.0 mm/1.00 inch)

⑦ Measuring Mode

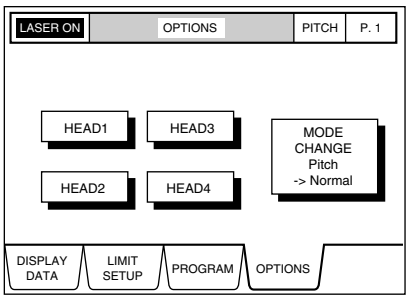
The LS-5000 series provides the following three measuring modes.

Mode	Description
Normal	The measured value and differentiation results are displayed/output at any time.
Sample hold	The instantaneous value at a specified time is measured.
Self-timing	Automatic measurement without using external synchronous input.

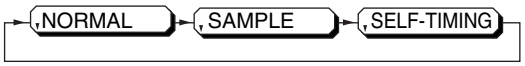
■ Setting Procedure

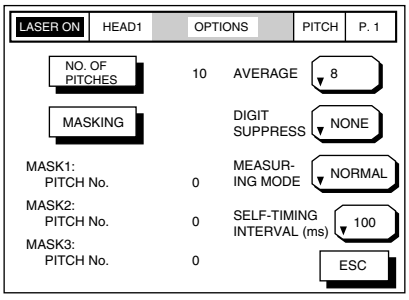
1. Select the OPTIONS screen. Press the [OPTIONS] button.

2. Set the measuring mode.
   Press the button corresponding to the head for which the measuring mode is to be set.



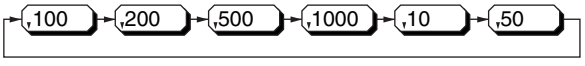
   Press this button to select the measuring mode.
   Every time you press this button, the display changes in the following order.

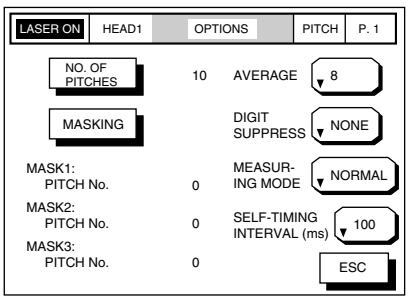




[When self-timing mode is selected]

3. Set the self-timing interval.
   Every time you press this button, the display changes in the following order.



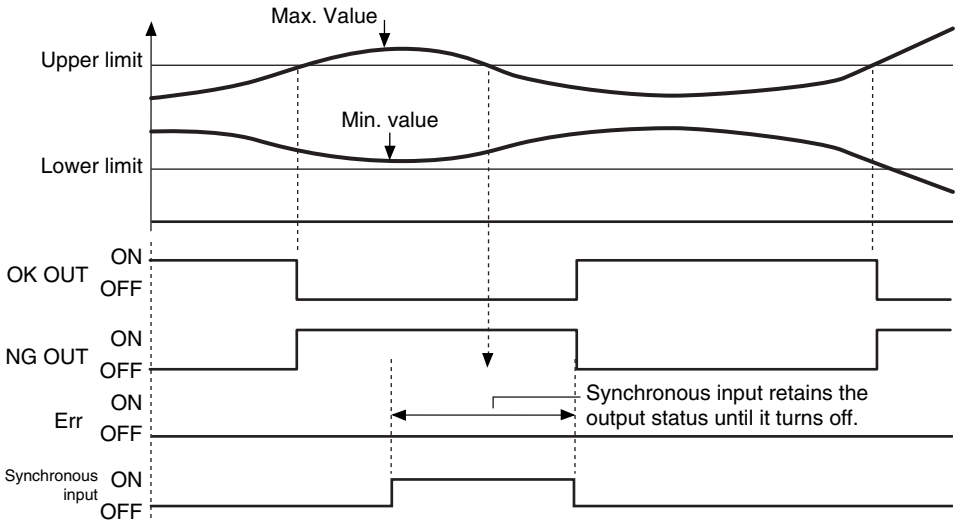


Note: The self-timing interval can be set only when self-timing mode is selected.

● **Normal mode**

The maximum and minimum values of the measured pitch and the differentiation result can be displayed/output at any time.

Timing Diagram

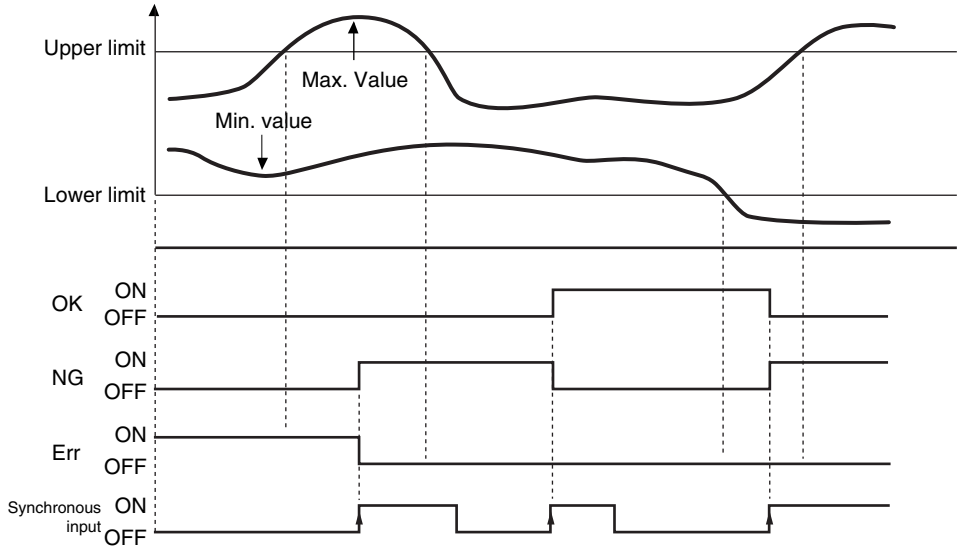


- The output when the synchronous input is turned ON is retained.
- When the reset input is turned ON while the synchronous input is ON, "—" is displayed and the Err output is turned ON.

● **Sample hold mode**

The instantaneous value at a specified time can be measured.

Timing Diagram

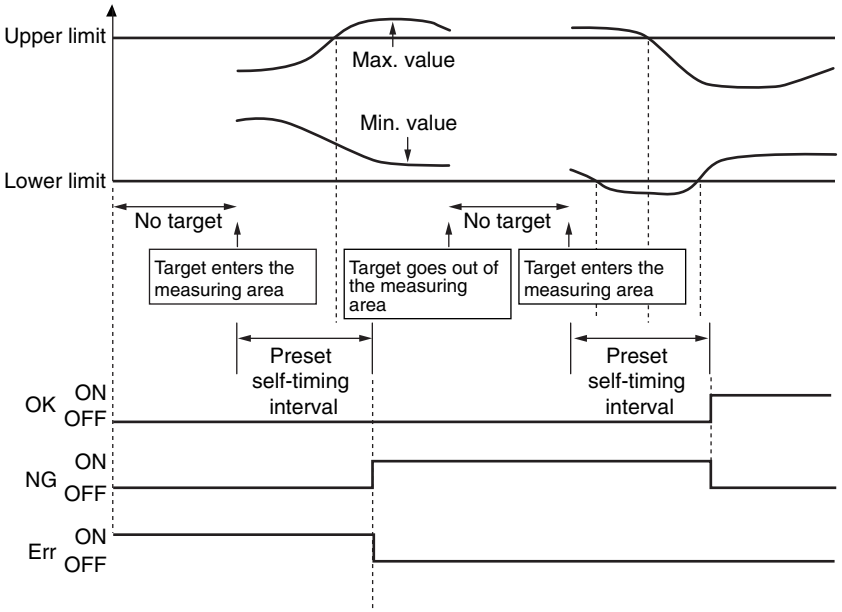


- The value when the synchronous input is turned ON is retained.
- When the reset input is turned ON, "—" is displayed and the Err output is turned ON.

● **Self-timing hold mode**

Measurement can be automatically performed according to the internal synchronous signal.

Timing Diagram

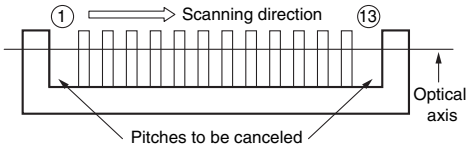


- When the self-timing period has passed after a target is placed in the measuring area, the measured value is retained.
- The previous value is retained until the self-timing period has passed after the next target is placed in the measuring area.
- If the number of pitches of an actual target is different from the preset number of pitches, self-timing mode is not activated even when the target is placed in the measuring area.

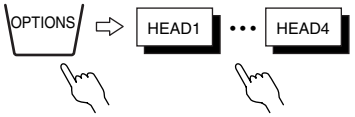
⑧ Masking

Up to three pitches can be excluded from measurement, based on the application, as shown below.

If pitch (1) and pitch (13) are included in the measurement of connector lead pitches as shown on the right, the maximum value becomes larger than the actual value. The masking function is useful to cancel these unnecessary part in such a case.

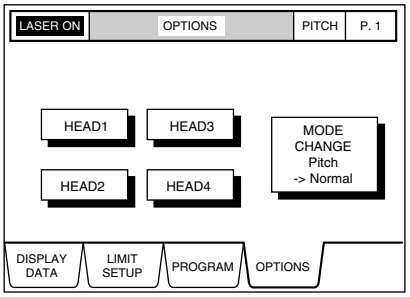


■ Setting Procedure

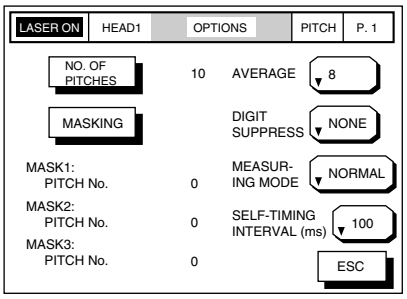


1. Select the OPTIONS screen. Press the [OPTIONS] button.

2. Set the masking function.
   Press the button corresponding to the output for which the masking function is to be set.

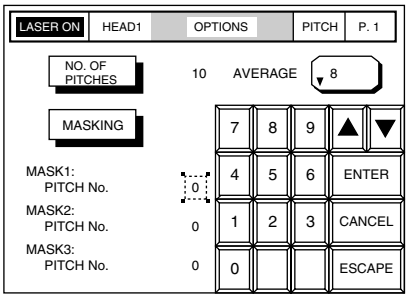


3. Press the [MASKING] button.



In this example, set the No. of Pitches to 13.

   Enter the pitch number to be canceled using the numeric keys, and press [ENTER]. Press [ESCAPE] to complete the entry. Press [CANCEL] to cancel the entry. The value returns to the previous value.



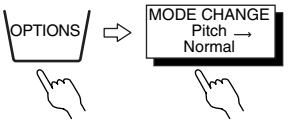
In this example, set MASK1 to 1 and MASK2 to 13.

Note 1: Pitch number is counted from Pitch 1 in the scanning direction (from the top of the scanning head to the bottom).

Note 2: When the total number of pitches changes (i.e. due to lead breakage), the control I/O board's HI3 output is turned ON which indicates an "Error with No. of Pitches". (Except for the self-timing mode)

⑨ Mode Change

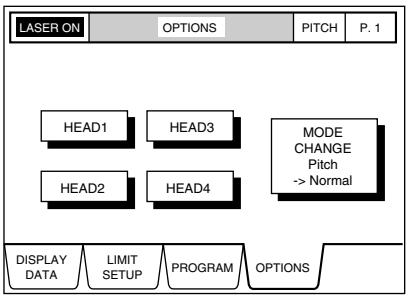
The measuring mode can be changed from Pitch mode to Normal mode.



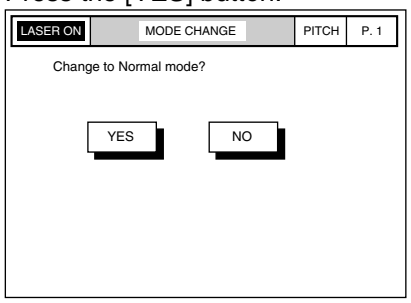
■ Setting Procedure

1. Select the OPTIONS screen.
   Press the [OPTIONS] button.

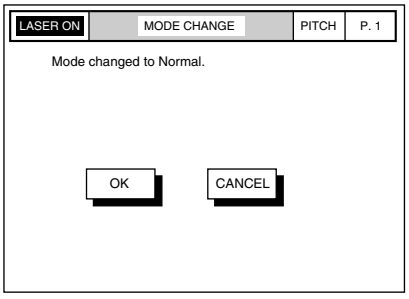
2. Change the measuring mode from Pitch mode to Normal mode.
   Press the [MODE CHANGE Pitch → Normal] button.



3. Press the [YES] button.



4. Press the [OK] button.



Chapter 8

RS-232C I/O

8.1 RS-232C Communication Protocol 88

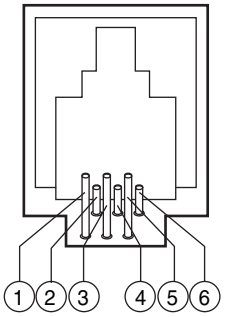
8.2 Remote Control Function 90

8.3 Command List 97

8.1 RS-232C Communication Protocol

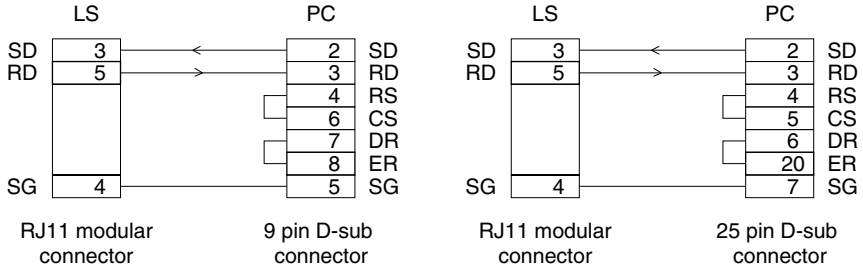
Using the RS-232C interface, the LS-5000 series can communicate with a personal computer. Data transmission and setting changes can be remotely controlled.

■ Pin Assignment



Pin No.	Signal code	Description	Direction of signal
1	—	No connection	—
2	—	No connection	—
3	SD (TXD)	Inputs data from external equipment	Input
4	SG (GND)	Signal ground	—
5	RD (RXD)	Outputs measured value data	Output
6	—	No connection	—

Example of Connections



Do not connect terminals (1), (2) and (6).

■ Communication Protocol

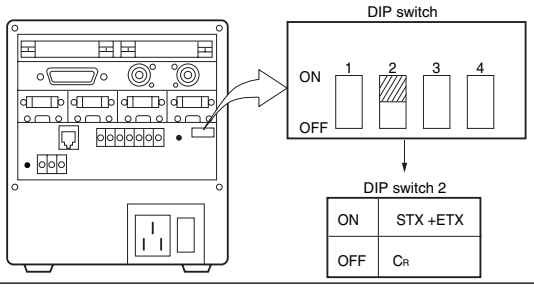
Conforming to EIA RS-232C

These settings can be changed by adjusting DIP switch 2.

DIP switch 2 setting	OFF	ON
Duplex	Full	
Synchronization	Start-stop	
Data format	ASCII	
Data length	8	
Stop bit length	1	
Parity check	None	Even
Baud rate	9600	
Delimiter	CR	STX + ETX
Applicable external equipment	Personal computer, KV-300 with KV-L2 (Non procedure mode)	KV series (KV mode)

When DIP switch 2 is set to ON and “STX + ETX” is selected, OUT1’s measured value is output continuously.

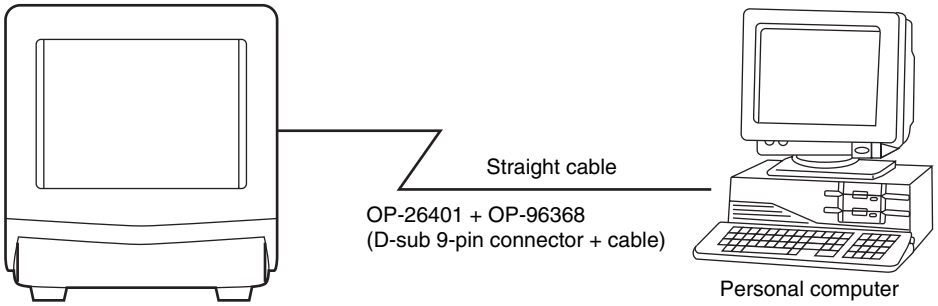
■ Setting Delimiter



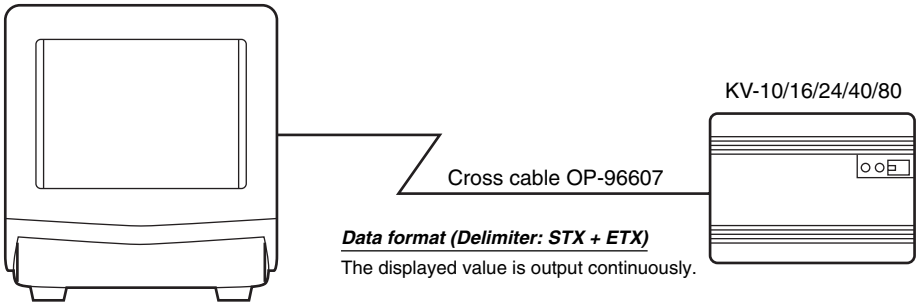
■ Examples of Connections

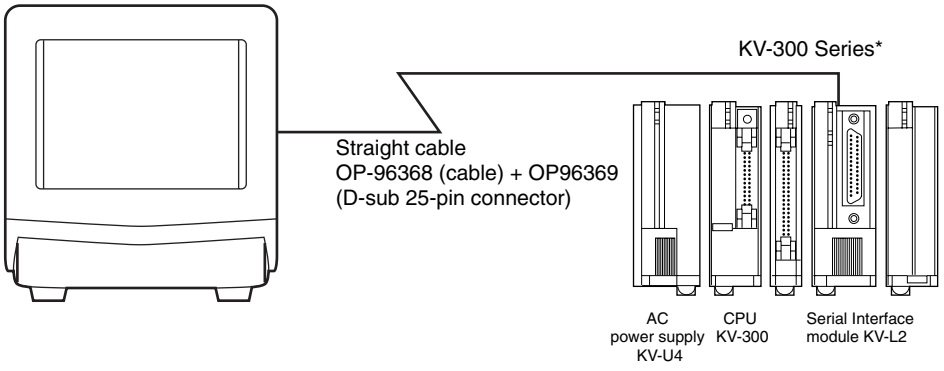
• Connection with a personal computer

Delimiter: CR



• Connection with the KV series





* KV-300 series is not available in European area.

8.2 Remote Control Function

You can control the LS-5000 series remotely by sending an ASCII command from external equipment, such as a personal computer.

Character codes corresponding to the ASCII command can be used for remote control.

Measured Value Output

RS-232C command list I

Function	command received[1.]	Description
Output of measured value	[M] [#] [CR] 4DH#0DH	Send a measured value once.
	[N] [#] [CR] 4EH#0DH	Send a measured value continuously.
	[O] [CR] 4FH 0DH	Stop continuous transmission of meas ured value.

1. Upper line: Character code, Lower line: ASCII code (Hex)

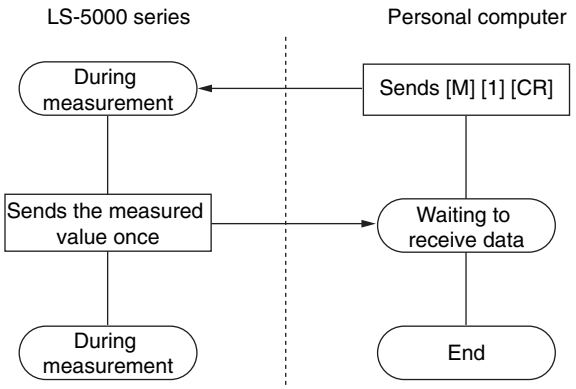
Note 1: "#" is a character code between 0 and 4, or the ASCII code corresponding to the character code.

0: Outputs data from all output numbers.
1 to 4: Outputs data from the specified output number (OUT1 to OUT4).

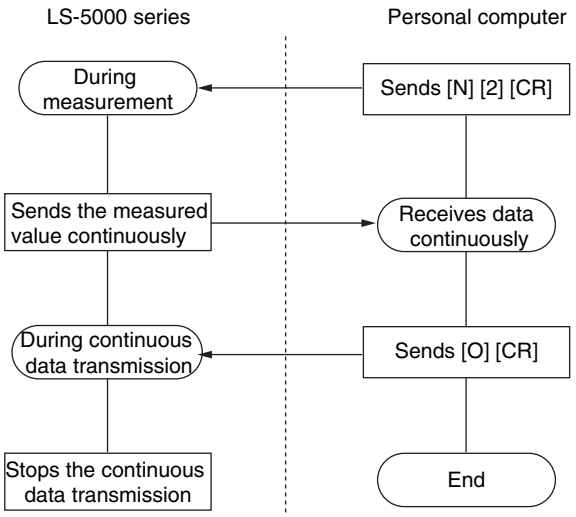
Note 2: When the ASCII (character) command given in command list I is received, the measured value is sent either once or continuously.

■ Operating Procedure

Example: Send the measured value from OUT No. 1 once.



Example: Send the measured value from OUT No. 2 continuously.



Note 1: When the LS-5000 series receives the “N” (continuous output) command in either peak hold, bottom hold, difference hold, sample hold or self-timing mode, the LS-5000 series sends the measured value once every time the synchronous input is turned on (the measured value is confirmed).

Note 2: When the LS-5000 series receives the “N” (continuous output) command in either normal, auto peak, auto bottom or auto difference hold mode, the LS-5000 series continuously sends the measured value.

■ Data format

- **Received Command: [M] [1] [CR]**

- **Transmitted data**

In Normal mode

First data	Second data	Third data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
1	2	3	.	4	5	6	7	0	CR

(Displayed value: 123.45670)

–	SP	0	.	9	8	7	6	5	CR

(Displayed value:-0.98765)

In Pitch mode

First data	Second data	Third data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
SP	SP	1	.	2	3	4	5	6	,

11th data	12th data	13th data	14th data	15th data	16th data	17th data	18th data	19th data	20th data
SP	SP	0	.	9	8	7	6	5	CR

(Displayed value: Max: 1.23450, Min.: 0.98765)

- **Received Command: [M] [0] [CR]**

- **Transmitted data**

In Normal mode

First data	Second data	Third data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
1	2	3	.	4	5	6	7	0	,
11th data	12th data	13th data	14th data	15th data	16th data	17th data	18th data	19th data	20th data
–	SP	0	.	9	8	7	6	5	,
21th data	22th data	23th data	24th data	25th data	26th data	27th data	28th data	29th data	30th data
SP	SP	1	.	2	3	4	5	5	,
31th data	32th data	33th data	34th data	35th data	36th data	37th data	38th data	39th data	40th data
–	9	8	.	7	6	5	4	0	CR

(Displayed value: OUT1: 123.45670, OUT2: -0.98765, OUT3: 1.23455, OUT4: -98.76540)

In Pitch mode

First data	Second data	Third data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
SP	SP	1	.	2	3	4	0	0	,
11th data	12th data	13th data	14th data	15th data	16th data	17th data	18th data	19th data	20th data
SP	SP	1	.	2	3	0	0	0	,
21th data	22th data	23th data	24th data	25th data	26th data	27th data	28th data	29th data	30th data
SP	1	0	.	5	6	7	8	5	,
31th data	32th data	33th data	34th data	35th data	36th data	37th data	38th data	39th data	40th data
SP	1	0	.	5	5	7	8	5	,
41th data	42th data	43th data	44th data	45th data	46th data	47th data	48th data	49th data	50th data
SP	SP	2	.	3	4	5	6	0	,
51th data	52th data	53th data	54th data	55th data	56th data	57th data	58th data	59th data	60th data
SP	SP	2	.	4	5	6	7	0	,
61th data	62th data	63th data	64th data	65th data	66th data	67th data	68th data	69th data	70th data
SP	SP	0	.	3	4	5	6	0	,
71th data	72th data	73th data	74th data	75th data	76th data	77th data	78th data	79th data	80th data
SP	SP	0	.	2	3	4	5	5	CR

(Displayed value: OUT1 Max.: 1.23400, Min.: 1.23000, OUT2 Max.: 10.56785, Min.: 10.55785, OUT3 Max.: 2.34560, Min.: 2.45670, OUT4 Max.: 0.34560, Min. 0.23455)

Transmitted data for each display is as follows:

Example

Display status	Normal mode	Pitch mode
OUT1	123.45670	Max.: 999.99995
		Min.: -99.99995
OUT2	-99.99995	Max.: - - -.- - - - -
		Min.: - - -.- - - - -
OUT3	- - -.- - - - -	Max.: - - -.- - - - - (No setting)
		Min.: - - -.- - - - - (No setting)
OUT4	999.99995	Max.: 0.00005
		Min.: -0.00005
Received command	**Transmitted data**	
[M] [1] [CR]	123.45670	999.99995 -99.99995
[M] [0] [CR]	123.45670 (OUT1) -99.99995 (OUT2) - - -.- - - - - (OUT3) 999.9995 (OUT4)	999.99995 (OUT1 Max.) -99.99995 (OUT1 Min.) - - -.- - - - - (OUT2 Max.) - - -.- - - - - (OUT2 Min.) - - -.- - - - - (OUT3 Max.) - - -.- - - - - (OUT3 Min.) 0.00005 (OUT4 Max.) -0.00005 (OUT4 Min.)

Control Command 1

Command list II

Function	Command received[1.]	Description
Timing	[T] [#] [CR] 54H#0DH	Turns ON the synchronous input
	[U] [#] [CR] 55H#0DH	Turns OFF the synchronous input
Reset	[Q] [#] [CR] 51H#0DH	Reset input
Auto-zero	[V] [#] [CR] 56H#0DH	Auto-zero input
	[W] [#] [CR] 57H#0DH	Resets the auto-zero input

1. Upper line: Character code, Lower line: ASCII code

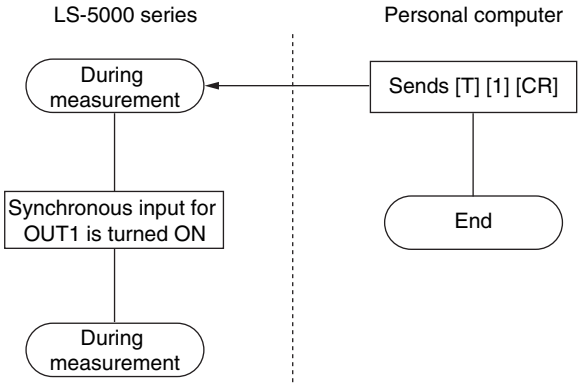
Note 1: "#" is a character code between 0 and 4, or the ASCII code corresponding to the character code.

0: Outputs data from all output numbers.
1 to 4: Outputs data from the specified output number (OUT1 to OUT4).

Note 2: When the LS-5000 series receives the ASCII (character) code given in code list II, it performs the specified operation.

■ Operating Procedure

Example: Turn ON the synchronous input.



Note 1: The operating procedure for functions other than "synchronous input: ON" is similar to the above.

Note 2: The timing, reset and auto-zero terminal input, and the RS-232C command input can be simultaneously used.

Control Command 2

Command list III

Function	Command received[1]	Description
Program No. Selection	__ __ __[P] [#] [#] [CR]__ __ __ 50H##0DH	Program number is changed

1. Upper line: Character code, Lower line: ASCII code

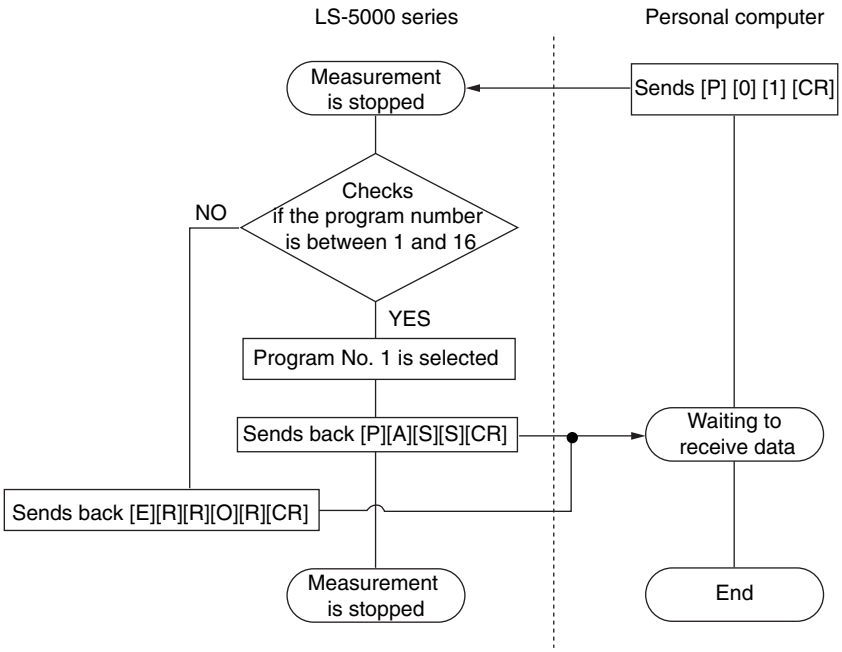
Note 1: # is a character code between 1 and 16, or the ASCII code corresponding to the character code.

1 to 16: The program number can be changed to a number between 1 and 16.

Note 2: When the LS-5000 series receives the ASCII (character) code given in code list III, it performs the specified operation.

■ **Operating Procedure**

Example: Change the program number.



Reading Preset Data (Batch)

This function is used to store the LS-5000 series' settings. (The preset data is sent as binary code.) Use the "Writing Preset Data (Batch)" command ([S][W][CR]) when reloading the settings on the LS-5000 series .

- **Received command**

S	R	CR

- **Transmitted data**

<When operation is normal>

S 53H	R 52H	No. of data 01H CCH	Data 1	Data 2	• • • • •	Data n	Check-sum	CR

Checksum range

* No. of data: 460 (bytes)

<When an error occurs>

E	R	R	O	R	CR

8

Writing Preset Data (Batch)

This function is used to write stored data to the LS-5000 series.

- **Received command**

S 53H	W 52H	No. of data 01H CCH	Data 1	Data 2	• • • • •	Data n	Check-sum	CR

Checksum range

* No. of data: 460 (bytes)

- **Transmitted data**

<When command is accepted normally>

P	A	S	S	CR

<When an error occurs>

E	R	R	O	R	CR

* Checksum content is not open. Be sure to save all the preset data when reading from the LS-5000 series.

8.3 Command List

This section lists all commands and describes each code.

Function	Command received[1]	Description
Output of measured value	[M][#][CR] (#:0 to 4) 4DH#0DH	Send a measured value once.
	[N][#][CR] (#:0 to 4) 4EH#0DH	Send a measured value continuously.
	[O][CR] 4FH 0DH	Stop continuous transmission of meas ured value.
Timing	[T][#][CR] (#:0 to 4) 54H#0DH	Turns ON the synchronous input.
	[U][#][CR] (#:0 to 4) 55H#0DH	Turns OFF the synchronous input.
Reset	[Q][#][CR] (#:0 to 4) 51H#0DH	Reset input.
Auto-zero	[V][#][CR] (#:0 to 4) 56H#0DH	Auto-zero input.
	[W][#][CR] (#:0 to 4) 57H#0DH	Resets the auto-zero input.
Program No. Selection	[P][#][#][CR] (##:01 to 16) 50H##0DH	Program number is changed.
Reading preset data	[S][R][CR] 53H 52H 0DH	Read preset data.
Writing preset data	[S][W] ... [CR] 53H 57H ...0DH	Write preset data.

1. Upper line: Character code, Lower line: ASCII code

Note: When the LS-5000 series receives a command other than those listed above, it sends back the “ERRORCR” message ([E][R][R][O][R][CR]).

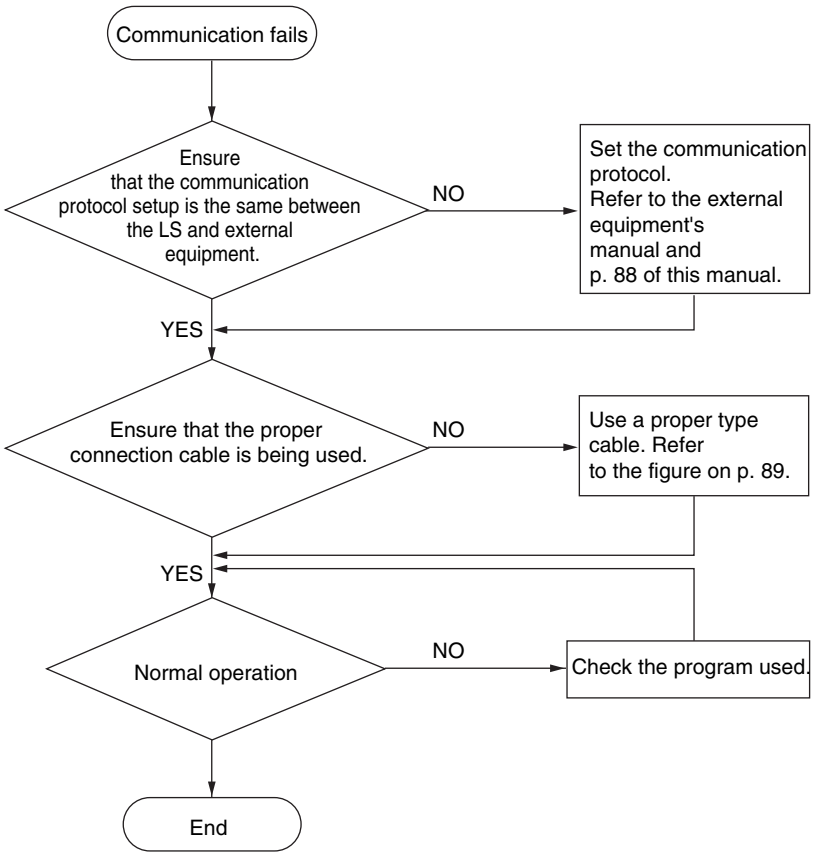
Sample Program (BASIC)

The following program can controll the LS using your computer's keyboard.

```
100       OPEN"COM1:9600,N,8,1"FOR RANDOM AS #1
110       ON COM(1) GOSUB 180
120       COM(1) ON
130       A$=INKEY$
140       IF A$<>""THEN 150 ELSE 130
150       PRINT #1,A$;
160       PRINT A$
170       GOTO 130
180       N=LOC(1)
190       IF N=0 THEN RETURN
200       B$=B$+INPUT$ (N, #1)
210       IF RIGHT$(B$, 1)<>CHR$(13)THEN RETURN
220       PRINT CHR$(13):PRINT"RD=>";B$:B$=""
230       A$=INKEY$
240       IF A$<>""THEN PRINT #1,A$;
250       RETURN
```

- To use this program, set the communication protocol of the LS-5000 series and your personal computer to the "DIP switch 2: OFF" settings. *See p. 88*.

Troubleshooting for communication errors using the RS-232C.



Chapter 9

Expansion I/O Board

9.1 Control I/O Board 100

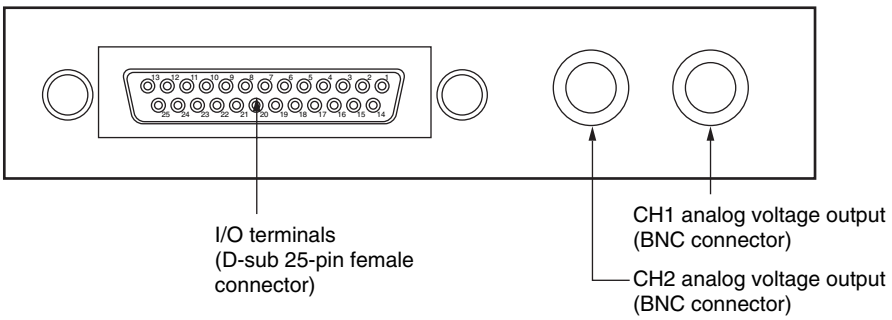
9.1.1 Part Names and Pin Assignment 100
9.1.2 I/O Terminal Operations 101
9.1.3 Specifications 102

9.1 Control I/O Board (Model: LS-B11)

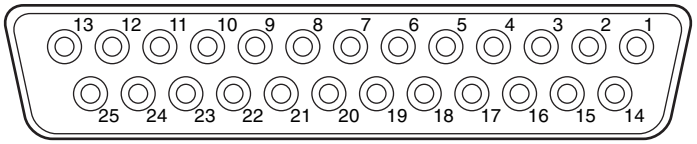
This control I/O board is used for comparator output and synchronous input. 2-channel analog voltage outputs are provided.

9.1.1 Part Names and Pin Assignment

LS-B11



I/O Board Pin Assignment



Pin No.	Signal name	Description
1	CH1 HI3	CH1 comparator output
2	CH1 HI2	CH1 comparator output
3	CH1 HI1	CH1 comparator output
4	CH1 GO	CH1 comparator output
5	CH1 LO1	CH1 comparator output
6	CH1 LO2	CH1 comparator output
7	CH1 LO3	CH1 comparator output
8	CH2 HI3	CH2 comparator output
9	CH2 HI2	CH2 comparator output
10	CH2 HI1	CH2 comparator output
11	CH2 GO	CH2 comparator output
12	CH2 LO1	CH2 comparator output
13	CH2 LO2	CH2 comparator output
14	CH2 LO3	CH2 comparator output
15	CH1 S.T.	CH1 self-timing output
16	CH2 S.T.	CH2 self-timing output
17	GND	
18	GND	
19	CH1 TIM	CH1 timing input
20	CH2 TIM	CH2 timing input
21	CH1 RESET	CH1 reset input
22	CH2 RESET	CH2 reset input
23	CH2 ZERO	CH1 auto-zero input
24	CH2 ZERO	Ch2 auto-zero input
25	GND	

9.1.2 I/O Terminal Operations

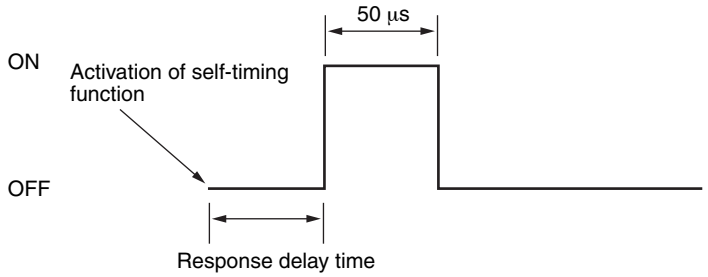
① 7-level comparator output (terminals 1 to 14)
The LS-5000 series performs comparator output (➪ *See p. 35*) for the output number specified during the I/O slot setup (➪ *See p. 59.*) procedure.

Note: When Pitch mode is selected, the comparator output is as follows:

HI3: Turns ON when the target's actual number of pitches is different from the preset number of pitches.
HI2: Unused
HI1: Turns ON when the measured value exceeds the preset upper/lower limits.
GO: Turns ON when the measured value is within the tolerance range.
LO1: Unused
LO2: Unused
LO3: Unused

---

② Self-timing output (terminals 15 and 16)
In self-timing mode, the output specified during the I/O slot setup procedure turns ON when the self-timing signal turns ON. The self-timing output is a one-shot signal, as shown below:
➪ *See p. 59 for I/O slot setup.*



③ Timing input (terminals 19 and 20)
When this terminal and the GND terminal are short-circuited, the LS-5000 series performs the measuring mode operation for the output number specified during the I/O slot setup procedure.
➪ *See p.46 for measuring mode and p.59 for I/O slot setup.*

④ Reset input (terminals 21 and 22)
When this terminal and the GND terminal are short-circuited, the LS-5000 series performs the measuring mode operation for the output number specified during the I/O slot setup procedure.
➪ *See p.46 for measuring mode and p.59 for I/O slot setup.*

⑤ Auto-zero input (terminals 23 and 22)
When this terminal and the GND terminal are short-circuited, the LS-5000 series instantaneously resets the measured value to "0.00000" for the output number specified during the I/O slot setup procedure.
➪ *See p.59 for I/O slot setup.*

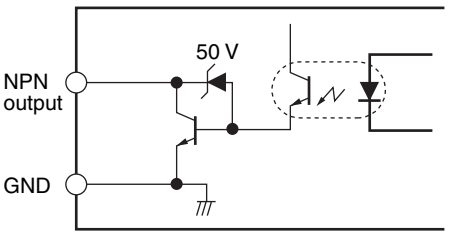
⑥ Analog output
The LS-5000 series performs analog output in the range of ±10 V for the output number specified during the I/O slot setup procedure.
➪ *See p.57 for analog output and p.59 for I/O slot setup.*

9.1.3 Specifications

Input/Output

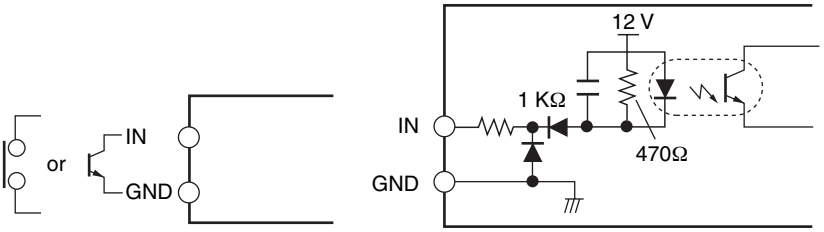
■ **Output**

- NPN open-collector output
- Max. applicable voltage: 40 V
- Max. sink current: 100 mA



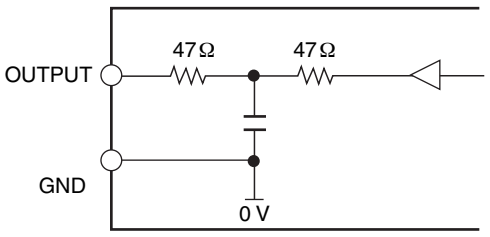
■ **Input**

- Non-voltage contact (relay) input or open-collector input.
- Use the (17), (18) or (25) ground terminal.
- These ground terminals are connected internally.



Analog Voltage Output

- Output voltage: ±10 V
- Impedance: 100



Chapter 10

Display System Setup

10.1 Display System Setup 104

10.1.1 Adjusting Backlight Intensity 104
10.1.2 Reversing Display 105
10.1.3 Adjusting Contrast 106
10.1.4 Setting Backlight OFF Time 107
10.1.5 Adjusting Buzzer Volume 108
10.1.6 Numeric Keys 109

10.2 Display Hardware Check Function 110

10.3 Replacing Protective Sheet 111

10.4 Display Panel-lock Function 112

Note: If you use the separate controller model LS-5001 without a display, you do not have to perform the Display System setup.

10.1 Display System Setup

This section describes how to adjust the display backlight intensity, contrast, reversing, backlight OFF time, and buzzer volume.

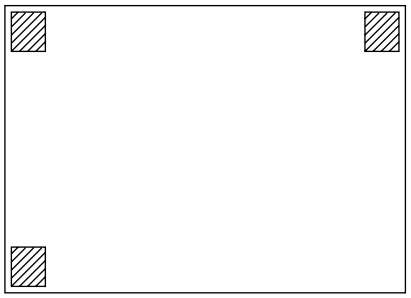
Note: The system setup menu will automatically return to operation mode after completing the setup. However, follow the prompt if "Turn on the power again" appears.

10.1.1 Adjusting Backlight Intensity

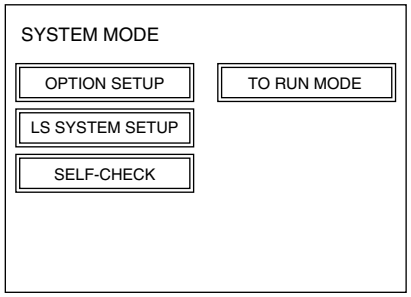
The backlight intensity can be adjusted in increments of two intensity levels.

■ **Setting Procedure**

1. Select the SYSTEM MODE screen.
   Press the touch switches at three corners of the screen simultaneously.

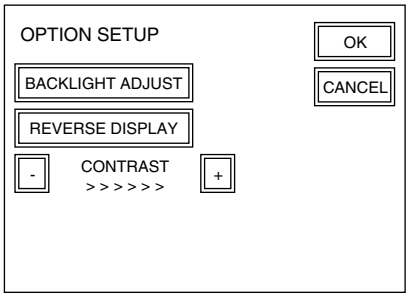


2. Select the OPTION SETUP screen.
   Press the [OPTION SETUP] button.



3. Adjust the backlight intensity.
   Every time you press the [BACKLIGHT ADJUST] button, the light intensity increments by two intensity levels.

   Press the [OK] button.

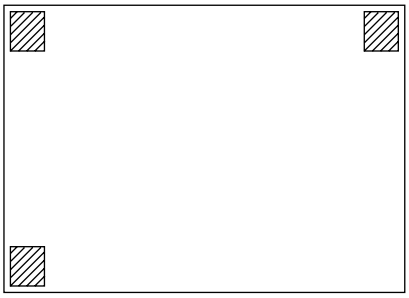


10.1.2 Reversing Display

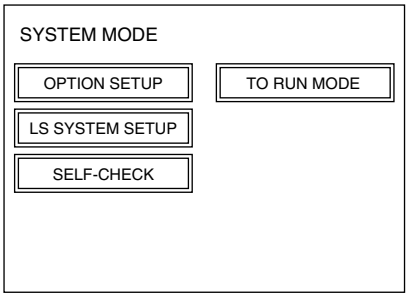
The display screen can be reversed.

■ **Setting Procedure**

1. Select the SYSTEM MODE screen.
   Press the touch switches at three corners of the screen simultaneously.

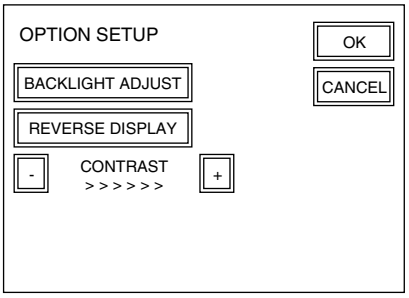


2. Select the OPTION SETUP screen.
   Press the [OPTION SETUP] button.



3. Reverse the display.
   Every time you press the [REVERSE DISPLAY] button, the display screen reverses.

   Press the [OK] button.

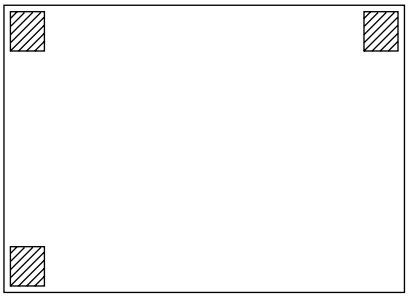


10.1.3 Adjusting Contrast

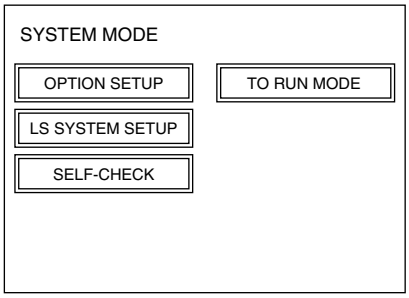
The contrast of the display screen can be adjusted.

■ **Setting Procedure**

1. Select the SYSTEM MODE screen.
   Press the touch switches at three corners of the screen simultaneously.



2. Select the OPTION SETUP screen.
   Press the [OPTION SETUP] button.

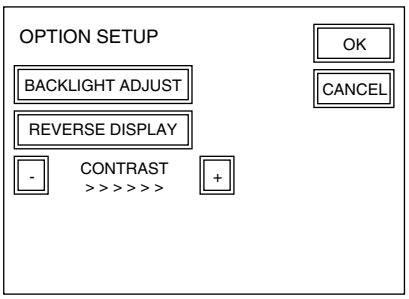


3. Adjust the contrast.
   Every time you press the [-] or [+] button, the contrast changes.

   [+] button: Reduces the contrast.
   [-] button: Increases the contrast.

   Contrast level: The number of > signs increases or decreases according to the current contrast level.
   When the number of > signs increases, this indicates the contrast is reduced.

   Press the [OK] button.



10.1.4 Setting Backlight OFF Time

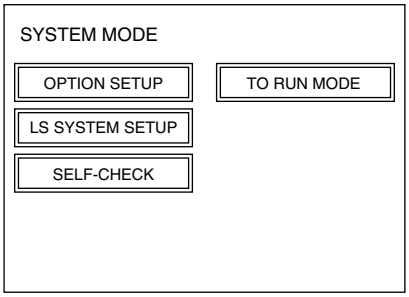
This function is used to turn OFF the backlight when the display has not been touched for a specified amount of time.

■ **Setting Procedure**

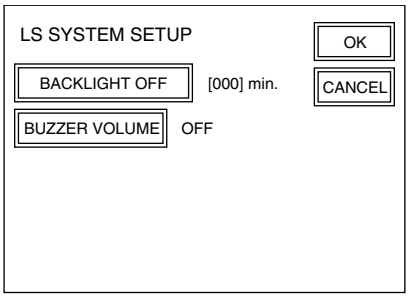
1. Select the SYSTEM MODE screen.
   Press the touch switches at three corners of the screen simultaneously.



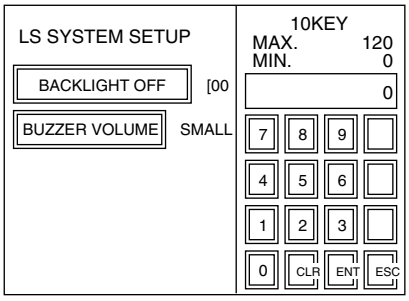
2. Select the LS SYSTEM SETUP screen.
   Press the [LS SYSTEM SETUP] button.



3. Set the backlight OFF time.
   Press the [BACKLIGHT OFF] button.



Using the numeric keys, enter the amount of time after which the backlight will be turned OFF if the screen has not been touched.
☞ *See p.109 for entry procedure.*

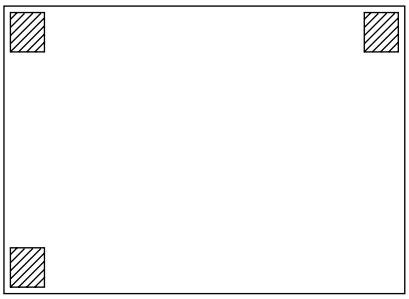


10.1.5 Adjusting Buzzer Volume

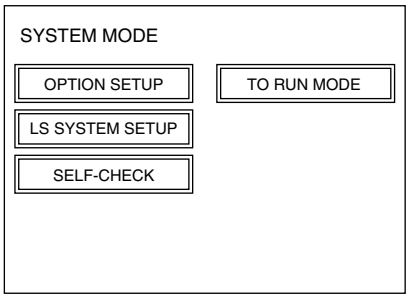
The buzzer sound heard with each key press can be adjusted in four levels (large, middle, small, none).

■ **Setting Procedure**

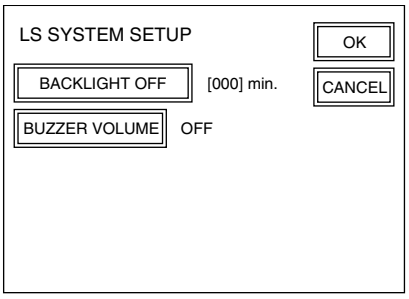
1. Select the SYSTEM MODE screen.
   Press the touch switches at three corners of the screen simultaneously.



2. Select the LS SYSTEM SETUP screen.
   Press the [LS SYSTEM SETUP] button.

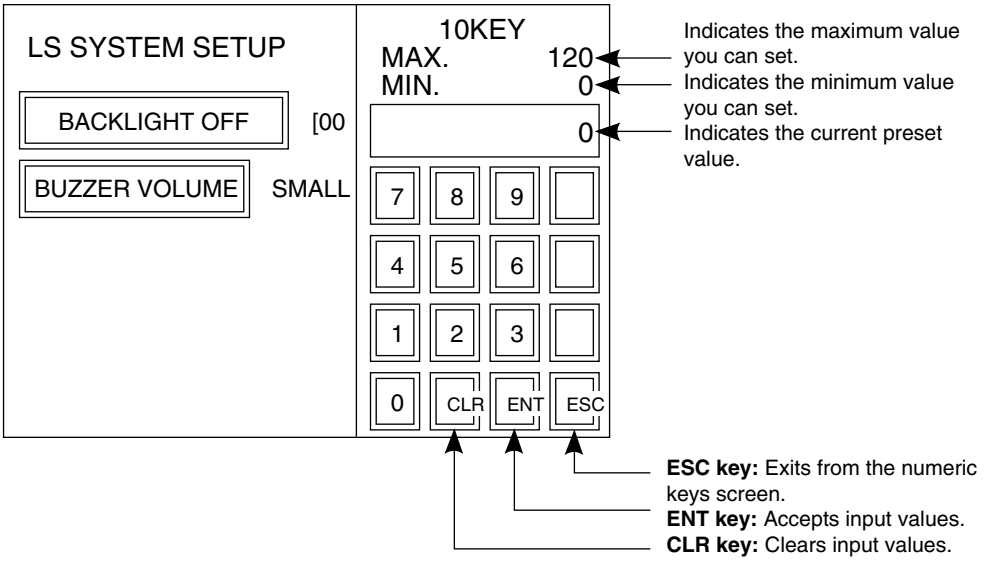


3. Adjust the buzzer volume.
   Every time you press the [BUZZER VOLUME] button, the buzzer volume changes between large, middle, small, and none. Press the [OK] button.



10.1.6 Numeric Keys

This section describes the numeric keys.



Procedure for entering values

1. Using the numeric keys, enter a value in the specified setting range.

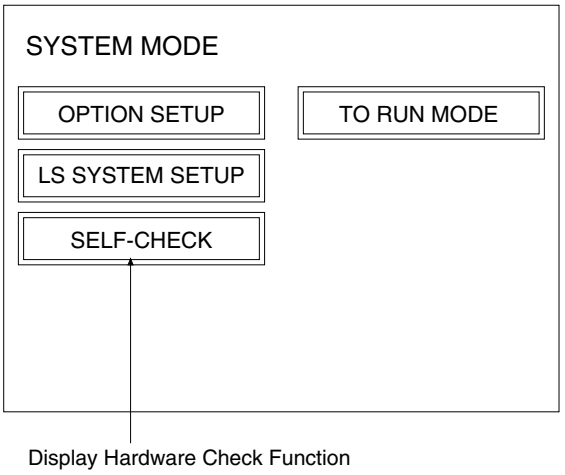
2. Press the [ENT] key to accept the input value and exit from the numeric key screen.

   Press the [CLR] key to clear the input value.

   Press the [ESC] key to exit from the numeric key screen without accepting the input value.

10.2 Display Hardware Check Function

This function is used for factory adjustment only. Do not touch the [SELF-CHECK] button.



Note: Accidentally touching this button will not affect the LS-5000 series' measurement or settings.

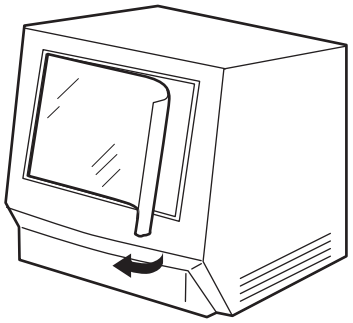
Press the [ESC] button or [END] button to return to operation.

10.3 Replacing Protective Sheet

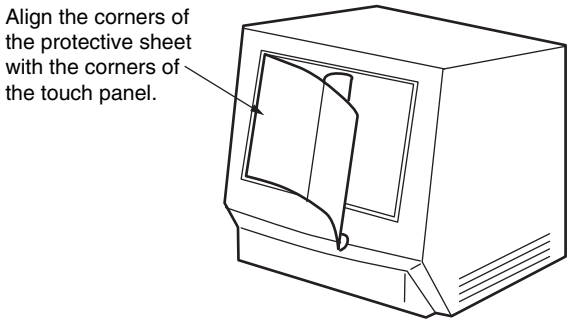
To replace the protective sheet, perform the following procedure.

■ **LS-5501**

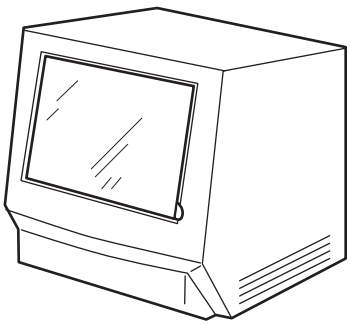
1. Remove the old protective sheet.



2. Peel the edge of the release film from the back of a new protective sheet, and align the corners of the protective sheet with the corners of the touch panel.



3. While slowly removing the release film, apply the protective sheet to the touch panel so that there is no air between the sheet and the panel.

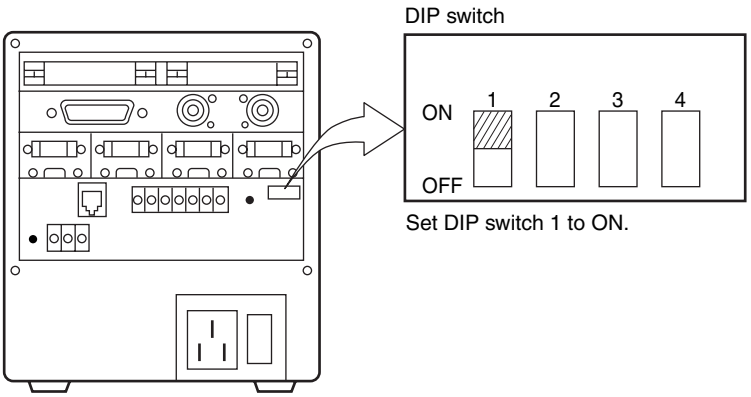


Protective sheet (for protection against flaws and reflection)
5 sheets/set: OP-23976

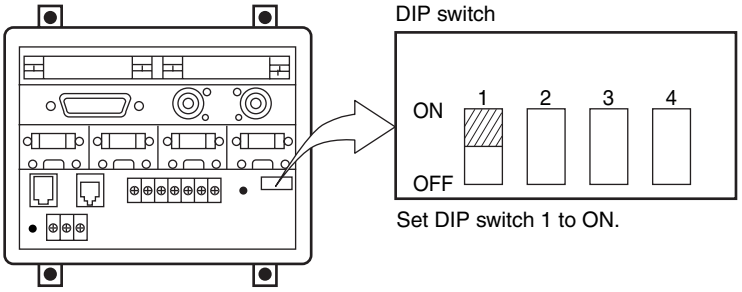
10.4 Display Panel-lock Function

This function disables key operations on the liquid crystal display panel, thus eliminating operating errors when the panel is accidentally touched.

■ **LS-5501**



■ **LS-5001**



Appendices

Appendix A Specifications 114

Appendix B Initial Setting 116

Appendix C Troubleshooting Guide 118

Appendix D Error Messages 120

Appendix E Minimum Input Time and Output Response Time 121

Appendix F Dimensions 122

Appendix A Specifications

Specifications

Controller

Type		Built-in Display type	Separate display type
Model		**LS-5501**	**LS-5001**
Display	**Measured value display**	Liquid crystal display, 320 x 240 dots, Backlit	—
	Min. Display units	0.05 μm	—
	Display range	-99.99995 to 999.99995	—
	Measuring range	mm/inch selectable	—
	Comparator output indicator	7-level, Liquid crystal display	—
	Laser ON alarm indicator	Liquid crystal display (Scanning head: Green LED)	—
Terminal block input	**Program select input Laser remote input**	Non-voltage input (contact / solid state)	
Interface	**RS-232C output**	Measurement data output and control input	
I/O board [1.]	**Timing input, Hold reset input, Auto-zero / Auto-zero reset input**	Non-voltage input (contact / solid state)	
	Analog output	±10 V output	
	7-level comparator output	NPN open-collector output 100 mA (40 V) max.	
Power supply voltage		85 to 264 VAC, 50/60 Hz	24 VDC ±10%, Ripple (P-P) 10% max.
Current consumption		8.5 A max.	1.4 A max.
Ambient temperature		0 to 45°C (32 to 113°F), No condensation	
Relative humidity		35 to 85%, No condensation	
Weight		Approx. 3.7 kg	Approx. 1.1 kg

1. The I/O board is available as an option.

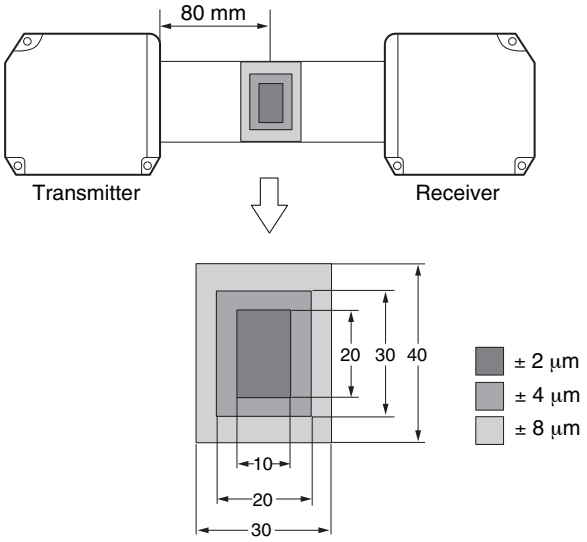
Scanning Head

Type			Standard	Wide range
Scanning head type			**Separate**	
Model			**LS-5041**	**LS-5121**
Measuring range			0.2 to 40 mm	0.8 to 120 mm
Smallest detectable object			0.2 mm	0.8 mm
T-to-R distance			160 ±40 mm	400 ± 100 mm, 1000 mm max.[1.]
Light source			Visible red semiconductor laser	
	Wavelength		655 nm	655 nm
	Output	**FDA (CDRH) Part 1040.10**	0.8 mW	45 μW
		IEC60825-1	130 μW	45 μW
	Pulse duration		63 μs	14 μs
	Laser Class	**FDA (CDRH) Part 1040.10**	Class II	
		IEC60825-1	Class 2	
Measuring accuracy			±2 μm max.[2.]	±8 μm max.[3.]
Repeatability			±0.3 μm max.[4.]	±1 μm max.[5.]
Laser scan rate			1200 scans/sec.	
Laser scan velocity			121 m/sec.	504 m/sec.
Laser scan range			Approx. 46 mm	Approx. 124 mm
Enclosure rating			IP64	IP65
Ambient temperature			0 to 50°C (32 to 112°F), No condensation	
Relative humidity			35 to 85%, No condensation	
Weight (including base)			Approx. 1.4 kg	Approx. 5.5 kg

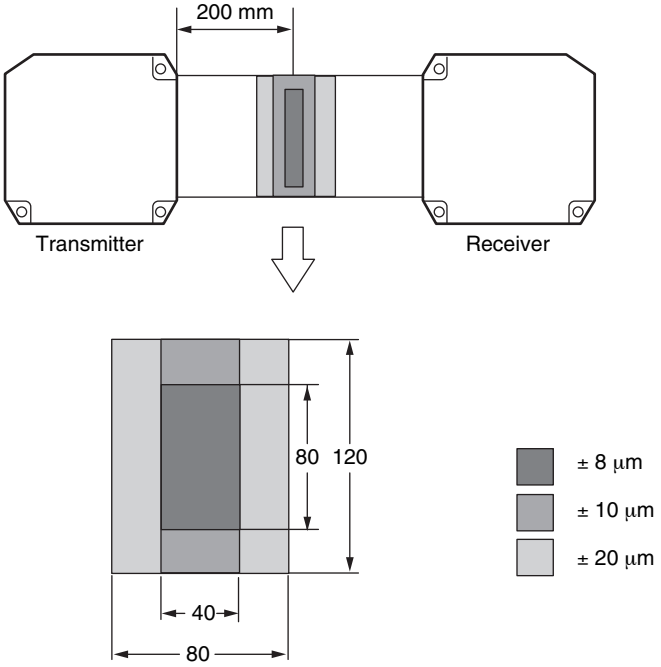
1. When the transmitter-to-receiver distance is set to 1,000 mm, the measurable area is limited to within 800 mm of the tramsmitter.
2. When a rod 10 mm in diameter is measured in a 10 x 20 mm measurement area, the center of which is 80 mm from the transmitter.
3. When a rod 40 mm in diameter is measured in a 40 x 80 mm measurement area, the center of which is 200 mm from the transmitter.
4. When an object is measured in a 10 x 20 mm measurement area, the center of which is 80 mm from the transmitter, with the number of averaging measurements set to 768.
5. When an object is measured in a 40 x 80 mm measurement area, the center of which is 200 mm from the transmitter, with the number of averaging measurements set to 768.

Measurement Range and Accuracy

■ **LS-5041**



■ **LS-5121**



Temperature Characteristics (Typical)

■ **LS-5041**

Unit: μm

Ambient temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)	50°C (122°F)
Temperature fluctuation	+1.4	+0.6	0	-0.6	-1.6	-2.7

When a 10 mm diameter rod with is measured in the middle of the measuring range. [Reference temperature: 20°C (68°F)]

■ **LS-5121**

Unit: μm

Ambient temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)	50°C (122°F)
Temperature fluctuation	+10.0	+5.0	0	-5.0	-10.0	-15.0

When a 40 mm diameter rod with is measured in the middle of the measuring range. [Reference temperature: 20°C (68°F)]

Appendix B Initial Settings

NORMAL Mode

Item				Initial setting
Display Data	**Display output**	**OUT1**		ON
		OUT2		OFF
		OUT3		OFF
		OUT4		OFF
Display Graph	**Display Graph**			OUT1
	Display output	**Upper Limit**		40 mm (1.57 inch)
		Lower Limit		0 mm (0 inch)
	Time	**Sampling Frequency**		1
		No. of Data		100
Limit Setup[1.]		**HI3**		90.0000 mm (4.00000 inch)
		HI2		80.0000 mm (3.00000 inch)
		HI1		40.0000 mm (1.57000 inch)
		LO1		0.0000 mm (0.00000 inch)
		LO2		-80.0000 mm (-0.80000 inch)
		LO3		-90.0000 mm (-0.90000 inch)
Program No.				1
Options	**Area Setup**[2.]	**Head No.**		1
		Area		DIA
	Output Mode[3.]	**Calculation**[4.]		Area 1 +A1 / Area 2 OFF / Area 3 OFF / Area 4 OFF
		No. of averaging measurements		768
		M. Mode		Normal
		Self-Timing Interval (ms)		100
		Digit Suppress		None
		Offset		0.0000 mm (0 inch)
		Analog Output	**+10 V**	40 mm (1.57 inch)
			-10 V	0 mm (0 inch)
Utility		**One-Scan Function**		OFF
		Program Select		Panel
		Display Unit		mm
		Area Setup	**No. of Edges**	4
			ON/OFF	OFF

1. Indicates initial settings for all differentiation outputs (OUT1 to OUT4).
2. Indicates initial settings for all areas (A1 to A4).
3. Initial settings for all outputs (OUT1 to OUT4) (except for “Calculation”).
4. Initial setting for OUT 1.
   Initial settings for OUT2 to OUT4 are as follows:

	Area 1	Area 2	Area 3	Area 4
OUT2	OFF	+A2	OFF	OFF
OUT3	OFF	OFF	+A3	OFF
OUT4	OFF	OFF	OFF	+A4

PITCH Mode

Item		Initial setting
Display Data	Display output	OUT1: ON
		OUT2: OFF
		OUT3: OFF
		OUT4: OFF
Limit Setup[1.]	Upper limit	0.01 mm (0.010000 inch)
	Reference value	1.0000 mm (0.100000 inch)
	Lower limit	0.01 mm (0.010000 inch)
Program No.		1
Options	No. of pitches	10
	Masking	Mask 1: Pitch No. 0
		Mask 2: Pitch No. 0
		Mask 3: Pitch No. 0
	No. of averaging measurements	8
	Digit supression	None
	M. Mode	Normal
	Self-Timing Interval (ms)	100

1. The same tolerance values have been set for all scanning heads.

Appendix C Troubleshooting Guide

If a condition occurs that could be due to equipment failure or malfunction, follow the inspection procedures given below.
If the LS-5000 series does not operate normally after this inspection, contact the nearest KEYENCE dealer or sales office.

Item	Problem	Inspection	Action	Ref. page
Measured value display	• Measured value is not displayed. • Nothing is displayed.	• Check power switch. • Turn power switch ON.	• Check connection with power supply. • Connect AC power cable. (LS-5501)	p.8, 13
	"- - - - -" is displayed.	• Check if target is correctly placed in measurement area. • Check if scanning area is entirely covered. • Check if AREA is correctly selected. • Check if scanning head is connected. • Check laser emitting/receiving windows for dust or dirt. • Check if laser ON alarm indicator is lit. • Check if power switch has just been turned ON. • Check if the measurement mode has just been changed. • Check number of averaging measurements. • Check condensation.	• Place target in measurement area correctly. • Select AREA correctly. • Turn power OFF. Connect scanning head, and turn power ON. • Remove dust or dirt from laser emitting/receiving window. • Short-circuit LASER REMOTE terminals. • Wait for approx. 10 seconds after turning power ON. • Wait for approx. 3 seconds after changing the measurement mode. • Depending on No. of averaging measurements, approx. 2.6 or less seconds is required to display measured value after target is placed in measuring area. • Change measurement environment.	p.115 p.39 p.13 p.60 p.4 p.13 p.44
	Measured value fluctuates.	• Check if target is correctly placed in measurement area. • Check if reference edge is set in measurement area. • Check laser emitting/receiving windows for dust or dirt. • Check target for dust or dirt. • Check for large variations in ambient temperature.	• Place target in measurement area correctly. • Set reference edge (when T.EDGE/B.EDGE mode is used). • Remove dust or dirt. • Keep ambient temperature constant.	p.115 p.60

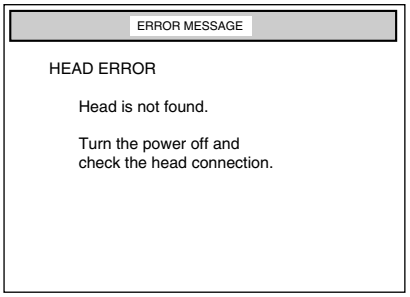
Item	Problem	Inspection	Action	Ref. page
Measured value display	Displayed value is incorrect.	• Check if scanning head's serial No. matches that of ROM board. • Check if calibration has been performed correctly. • Check if optical axis is properly aligned.	• Use scanning head with same serial number as ROM board. • Perform calibration correctly. • Make sure that optical axis is properly aligned in INSPECT mode. If optical axis is misaligned, adjust mounting conditions while referring to error message.	p.60
		• Check if target is tilted or incorrectly positioned.	• Place target correctly.	p.115
		• Check if target is correctly placed in measurement area. • Check if reference edge is set in measurement area. • Check target for dust or dirt.	• Place target in measurement area correctly. • Set reference edge (when T.EDGE/B.EDGE mode is used). • Remove dust or dirt.	p.115
Analog output (Option)	No output	Check if measured value is displayed.	Set controller and target correctly so that measured value is displayed.	p.8
	Output above +10 V or below -10 V.	Check if analog scaling is set correctly.	Make sure that analog scaling is set correctly.	p.57
Computer output	Computer data output is disabled.	• Check if connector pin connections are correct. • Check if computer has been turned ON before controller. • Check if program is correct.	• Connect connector pins correctly. • Turn ON computer first, and then turn ON controller. • When " " is sent from computer, controller outputs measured value.	

Appendix D Error Messages

The LS-5000 series displays the error messages “HEAD ERROR”, “ROM BOARD ERROR” and “BATTERY ERROR”.

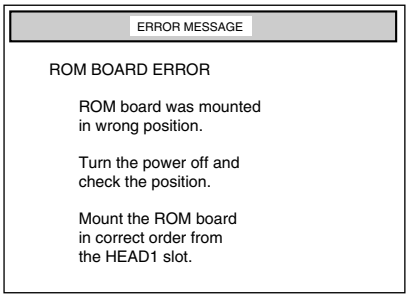
Head Error

- The scanning head is not properly connected, or an abnormal condition has occurred with the scanning head.
- Properly connect the scanning head for which the ROM board has been installed.



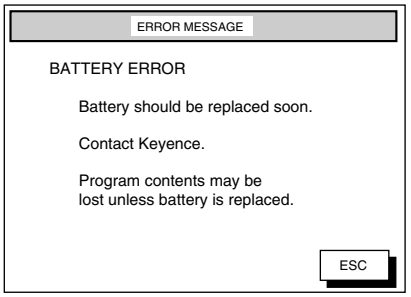
ROM Board Error

- The ROM boards have not been installed from the HEAD 1 slot.
- Install the ROM boards in the correct order (from the HEAD 1 slot).



Battery Error

The memory backup battery has been exhausted. Contact KEYENCE for a replacement.

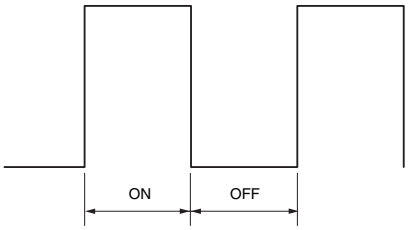


Appendix E Minimum Input Time and Output Response Time

This section describes the minimum input time and the output response time.

Minimum Input Time

For all control I/O board and terminal block inputs



ON : 2 ms min.
OFF : 2 ms min.

Output Response Time

① In Normal mode

When the one-scan function is OFF:

No. of averaging measurements	Response time (max.)
1	0.833 ms x 1 + 0.833 x 2
2	0.833 ms x 2 + 0.833 x 2
4	0.833 ms x 4 + 0.833 x 2
8	0.833 ms x 8 + 0.833 x 2
12	0.833 ms x12 + 0.833 x 2
24	0.833 ms x 24 + 0.833 x 2
48	0.833 ms x 48 + 0.833 x 2
96	0.833 ms x 96 + 0.833 x 2
192	0.833 ms x 192 + 0.833 x 2
384	0.833 ms x 384 + 0.833 x 2
768	0.833 ms x 768 + 0.833 x 2
1538	0.833 ms x 1538 + 0.833 x 2
3072	0.833 ms x 3072 + 0.833 x 2
6144	0.833 ms x 6144 + 0.833 x 2

When the one-scan function is ON:

No. of averaging measurements	Response time (max.)
1	10 ms x 1 + 0.833 x 2
2	10 ms x 2 + 0.833 x 2
4	10 ms x 4 + 0.833 x 2
8	10 ms x 8 + 0.833 x 2
12	10 ms x12 + 0.833 x 2
24	10 ms x 24 + 0.833 x 2
48	10 ms x 48 + 0.833 x 2
96	10 ms x 96 + 0.833 x 2
192	10 ms x 192 + 0.833 x 2
384	10 ms x 384 + 0.833 x 2
768	10 ms x 768 + 0.833 x 2
1538	10 ms x 1538 + 0.833 x 2
3072	10 ms x 3072 + 0.833 x 2
6144	10 ms x 6144 + 0.833 x 2

② In Pitch mode

No. of averaging measurements	Response time (max.)
1	10 ms x 1 + 0.833 x 2
2	10 ms x 2 + 0.833 x 2
4	10 ms x 4 + 0.833 x 2
8	10 ms x 8 + 0.833 x 2
12	10 ms x12 + 0.833 x 2
16	10 ms x 16 + 0.833 x 2

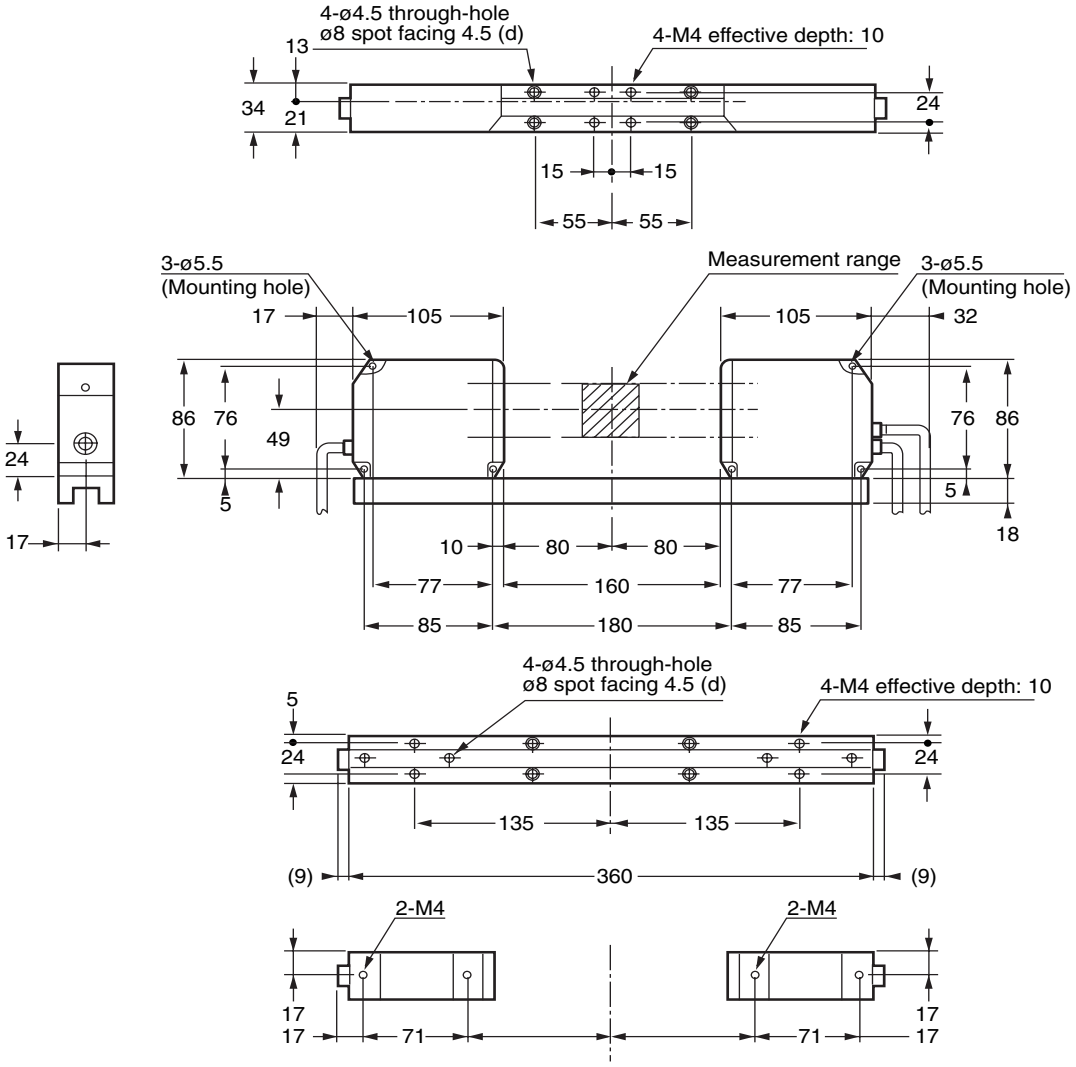
Note: In Pitch mode, the output response time changes depending on the number of scanning heads. To calculate the response time, refer to the following formula:

Output response time = Response time of HEAD 1 + Response time of HEAD 2 + Response time of HEAD 3 + Response time of HEAD 4

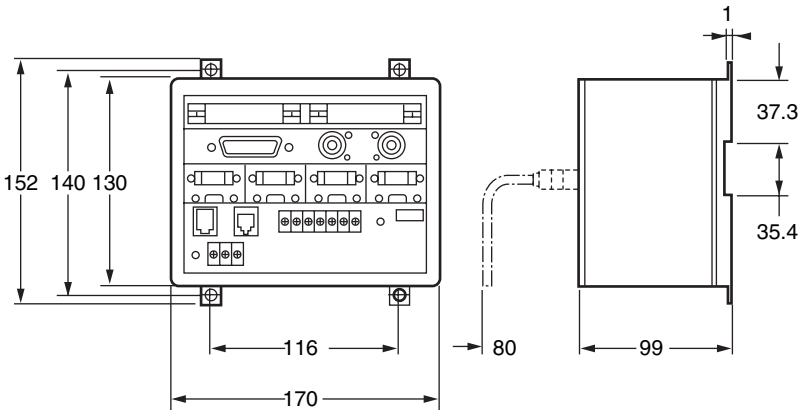
Appendix F Dimensions

This section lists the dimensions of each model.

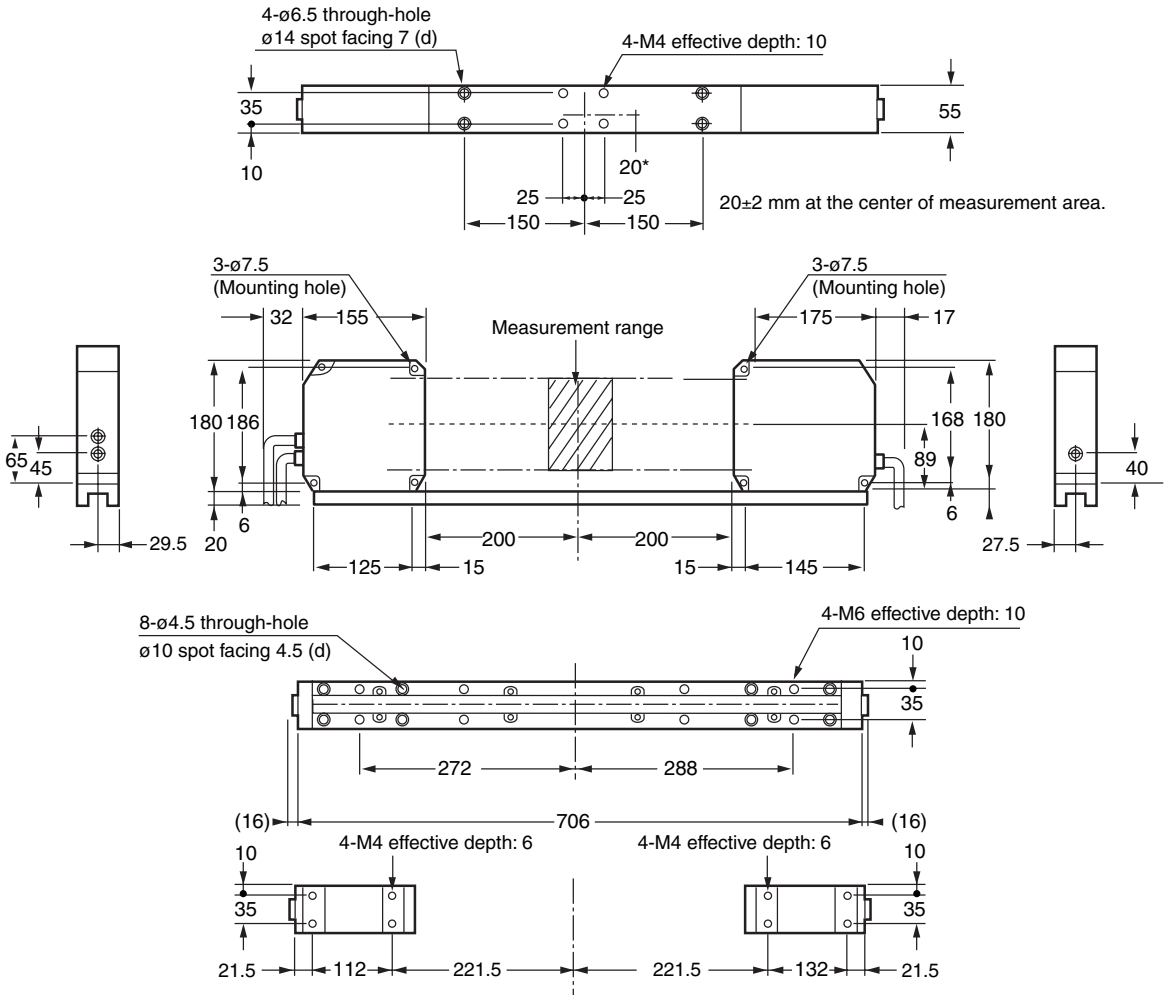
■ **LS-5041**



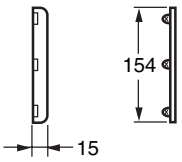
■ **LS-5001**



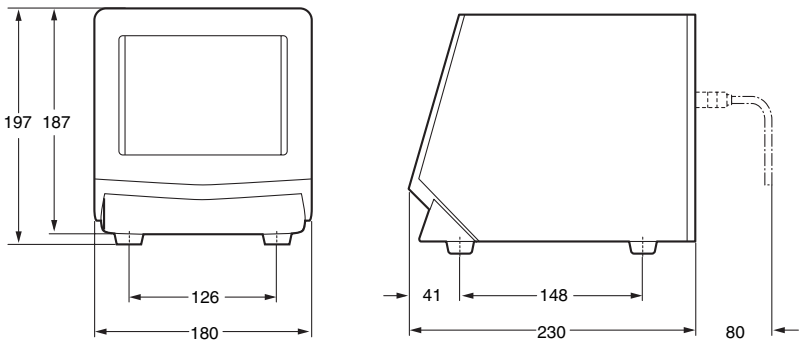
■ LS-5121



Scanning head front protection cover (Accessory for LS-5121)



■ LS-5501



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