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96M0335

Instruction Manual

Laser Scan Micrometer

LS-3100(W) Series



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SAFETY PRECAUTIONS

This manual describes how to install the LS-3100(W) Series as well as its operating procedures and precautions. Please read this manual carefully to get the best from your LS-3100(W) Series.

Symbols

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

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

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

Note — Provides additional information on proper operation.

General Pecautions

- At startup and during operation, be sure to monitor the functions and performance of the LS-3100(W) 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-3100(W) series or use it in any way other than described in the specifications.
- When the LS-3100(W) 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-3100(W) 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.

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Unpacking

Check that the following items are included in your LS system package.

- Controller 1
- Scanning head ..... 1[1.]
- Laser beam cover (attached to scanning head) ..... 1[1.]
- Connection cable ..... 3[1.]
- Power cable 1
- Power switch key 2
- Instruction manual 1
- Laser beam axis alignment tool ..... 1[1, 2.]

1. Or number purchased.
2. LS-3033, 3060 only. (Not provided with LS-3033 SO)

WARRANTIES AND DISCLAIMERS

See page 97.

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CHAPTER 1

LASER SAFETY PRECAUTIONS

1-1. Classification

		LS-3034	LS-3033 SO(8073)	LS-3032	LS-3033	LS-3036	LS-3060
Class	FDA	Class I				Class II	
	IEC 825-1 11.1993	Class 1					
	DIN EN 60825-1 07.1994	Klasse 1					

1-2. Warning Labels

1) Warning label

FDA Class II



IEC Class 1



IEC (French) Classe 1

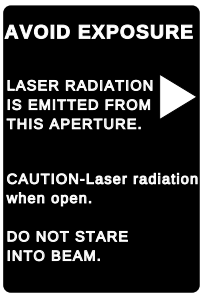


DIN Klasse 1



2) Aperture label

FDA Class II

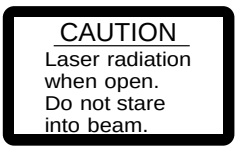


3) Label for non-interlocked protective housing

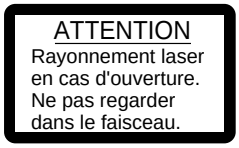
FDA Class II



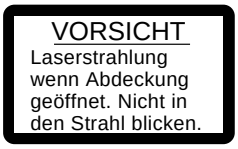
IEC Class 1



IEC (French) Classe 1



DIN Klasse 1

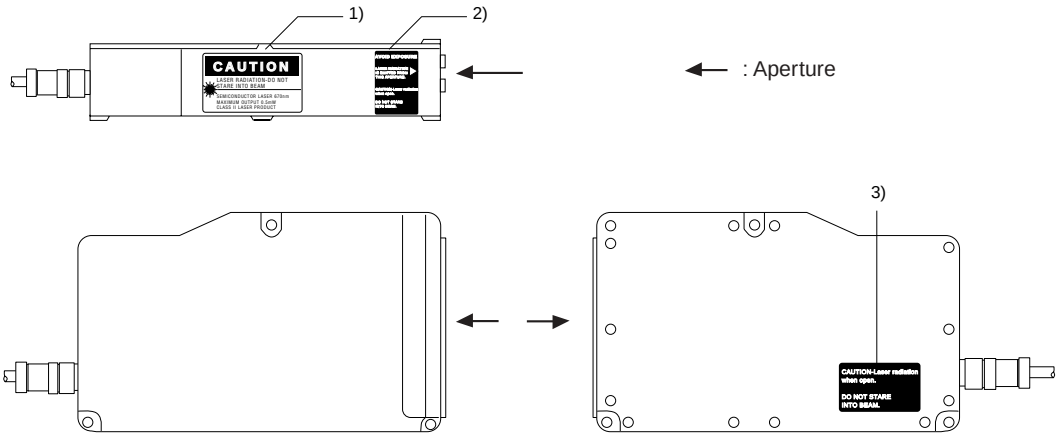


* The FDA Warning labels are affixed to the scanning head. (See 1-3. Label location.)

* The IEC/DIN Warning labels are packed with the LS-3100 Series. 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.

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1-3. Label Location



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-3036 and 3060 employ a visible semiconductor laser of 670 nm in wavelength for its light source. The maximum power consumed to generate the laser is 2 mW, which is reduced to 0.5 mW or less when the laser beam is emitted. The laser beam is not harmful to the skin. There is, therefore, no danger in exposing arms or hands to the beam. The only possible health hazard is in exposing the eyes to the laser beam. Damage to the eyes can occur if the operator stares directly into the beam.
Do not look directly at the laser beam.

WARNING

Follow the safety precautions below to ensure operator safety:

- **Operate the LS-3100(W) 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 sensor head.**
  Laser emission from the LS-3100(W) series is not automatically stopped if the sensor head is disassembled. If you disassemble the sensor head for inspection or repair, you may be exposed to the laser beam. If the LS-3100(W) series malfunctions, contact KEYENCE immediately.

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

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

- **Protective goggles**
  We recommend that you wear protective goggles when using the LS-3100(W) series.

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1-5 Safety Features Provided with the LS-3100(W) Series

The LS-3100(W) series comes with the following safety features:

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

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

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

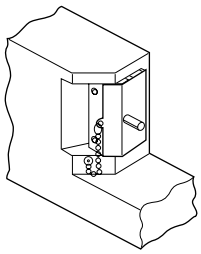
■ **Laser emission remote control input connector**
The laser emission control connector is located on the rear panel of the control unit. The laser can be turned on or off by a remote control signal through this connector.

■ **Key-operated power switch**
The controller power switch can be locked using the attached key. When the LS-3100(W) controller is OFF, the key can be removed.

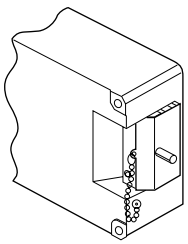
■ **Laser beam shield**
The sensor head transmitter comes with a laser beam shield.

Cover is closed.

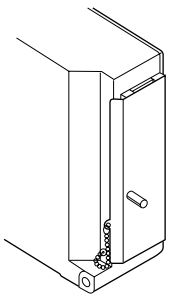
LS-3032/3034/3036



LS-3033/3033SO(8073)

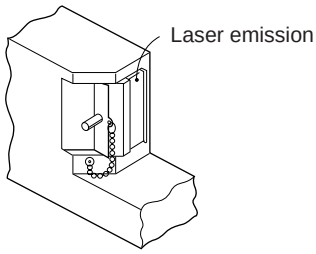


LS-3060

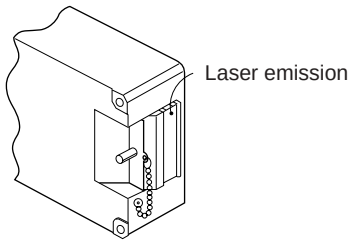


Cover is open.

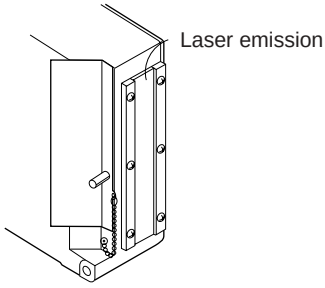
LS-3032/3034/3036



LS-3033/3033SO(8073)



LS-3060



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1-6. Preparation for Operation

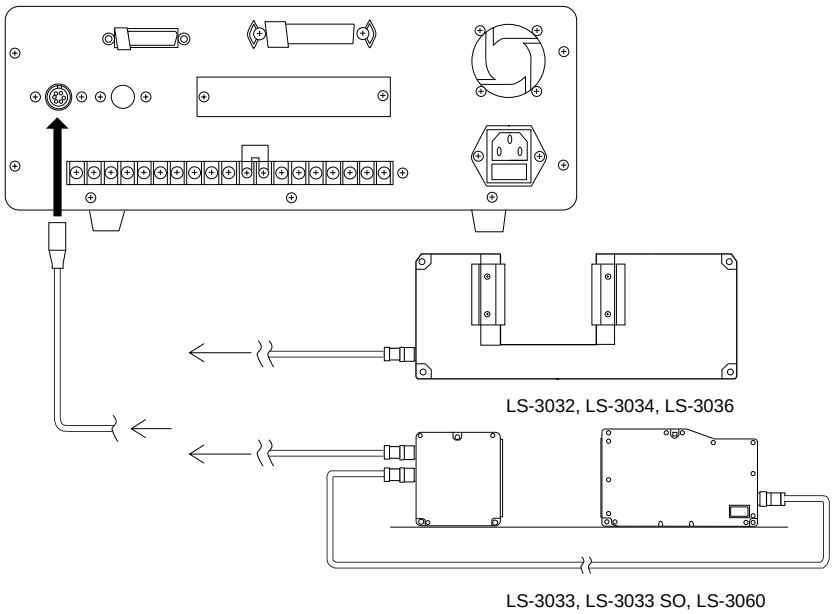
CAUTION

- Do not mount the scanning head to the place where a certain level of electrical noise is applied or transferred. Isolate the scanning head if electrical noise may be occured. Otherwise, laser diode may deteriorate or become damaged.
- Although the LS controller has been thoroughly inspected before shipment, we kindly request that you check it upon purchase for any damage. Contact the nearest KEYENCE distributor if your LS controller is damaged in any way.
- Precision components are incorporated in the scanning head, therefore be sure not to subject it to shocks.
- The scanning head has been precision set before shipment. Always keep the casing closed to maintain the head's setting.
- The LS controller can operate normally at 0 to 45°C (32 to 113°F) [0 to 40°C (32 to 104°F) for LS-3036/3060] with no freezing and 35 to 85%RH without condensation. Operation outside these ranges may result in malfunction.

CAUTION

Do not connect or disconnect any cables while the power is ON. Otherwise, the laser diode may deteriorate and/or may be damaged.

1. Connect the controller to the scanning head and the transmitter and receiver using the supplied cables.



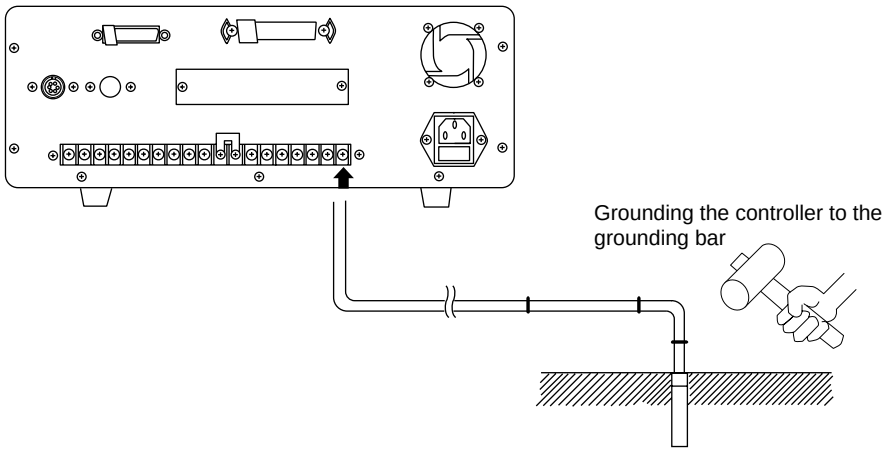
LS-3032, LS-3034, LS-3036

LS-3033, LS-3033 SO, LS-3060

Note The LS-3101(W) can be used with LS-3032, 3033, 3036 and 3060.

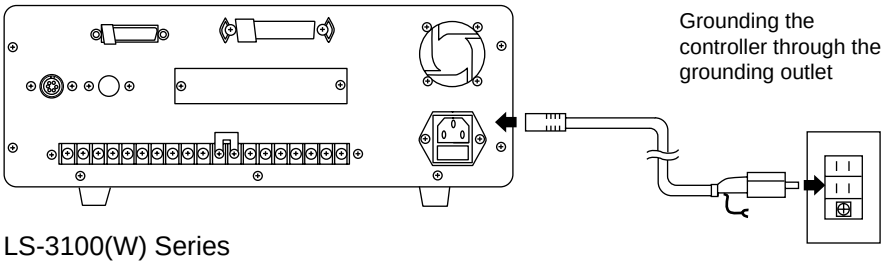
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2. Ground the controller. (Except for models followed with “W”.)

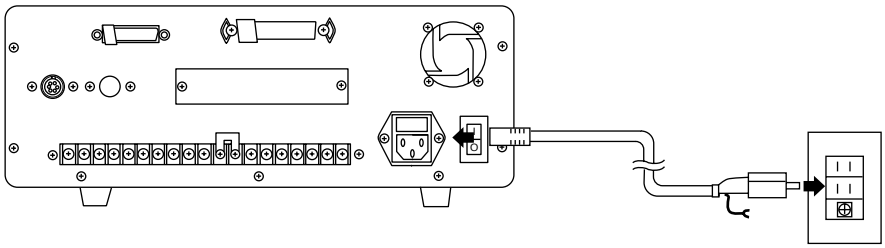


3. Check first that the power switch of the controller is OFF, then connect it to the outlet using the supplied power cable.

Controller (rear view)
LS-3100 Series

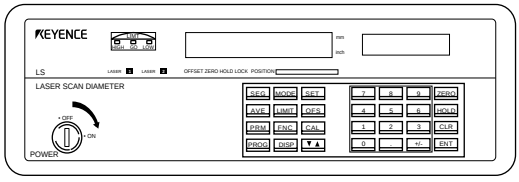


LS-3100(W) Series

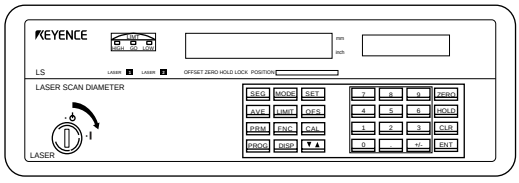


4. Check that laser can be safely emitted, then turn the power switch ON. Allow the controller to warm-up for approximately 30 minutes after the laser emission indicator LED has lit.
With the LS-3100(W) series, first turn on the POWER switch (at the rear), and then turn on the LASER switch (on the front panel).

Controller (front view)
LS-3100 Series



LS-3100(W) Series



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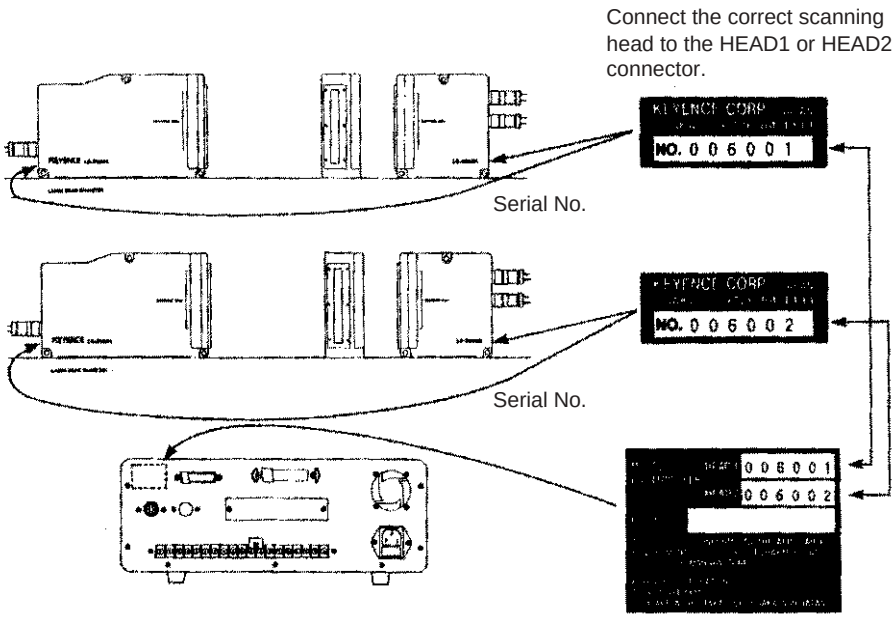
1-7. Connecting 2 Scanning Heads

CAUTION

Do not connect or disconnect any cables while the power is ON. Otherwise, the laser diode may deteriorate and/or may be damaged.

Note the following for connecting 2 scanning heads to the controller:

- These heads have been factory-set for use either as the HEAD1 or HEAD2. Incorrect connection of the scanning heads will, therefore, result in malfunction. To prevent this, first check the serial No. of each scanning head, then check the serial No. of the HEAD1 and HEAD2 on the back of the controller for correct connection. Each of the scanning heads must be connected respectively to the HEAD1 or HEAD2 connector on the back of the controller.



Next, follow the steps (1) through (4) on P4. and 5.

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CHAPTER 2

TRIAL OPERATION

1. Connect the controller and scanning head(s). Make sure that the optical axis of the transmitter and receiver are aligned before turning the power ON. Aligning the optical axis is not necessary, however, when using the single-body type scanning head or when the transmitter and receiver are secured on the detachable frame.

2. Laser emission starts in approximately 5 seconds.

3. Make sure that the target is correctly positioned in the measurement area. The measured value will be displayed shortly.

4. The LS controller has been adjusted to the following factory-settings:

Ref.
- DIA: Outer diameter measuring mode. P.32
- 1024: Number of measurements for averaging P.21
- MOVE: Averaging method P.21

Therefore, the displayed value was measured in the above settings. Read this manual carefully to use the desired settings on your LS controller. To change each setting, see the table of contents for the corresponding page No. Some of the most frequently-used operations are given below with the reference page Nos.

Ref.
- Changing the measurement position of targets P.32
- Changing the number of measurements for averaging..... P.21
- Changing the measurement mode (NORMAL, P-P, PEAK, BOTTOM)P.40
- Measuring two values at a time P.32
- Using two scanning heads to measure (X+Y)/2..... P.32

⚠ CAUTION Do not connect or disconnect any cables while the power is ON. Otherwise, the laser diode may deteriorate and/or may be damaged.

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CHAPTER 3

QUICK SETUP PROCEDURES

The LS Series is a multi-function, versatile laser scan micrometer. This chapter describes the procedures for setting the LS-3100(W)/3101(W) by illustrating typical applications.

This chapter covers the procedures needed to make measurements after the memory is initialized (after "MEMORY INITIALIZED" is displayed).

Initializing Current Settings 8
How to Use This Chapter 9

Common Settings 9
- Setting the Number of Measurements for Averaging 9
- Tolerance Settings 10

Measurement Procedures 10
- Outer Diameter Measurements 10
- Gap Measurement 1 11
- Gap Measurement 2 11
- Measuring Roundness 12
- Measuring Eccentricity 12
- Measuring Target Displacement within the Measuring Range 13
- Measuring Edge Movement 13

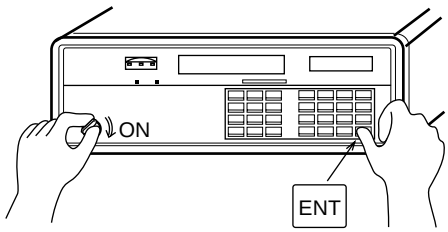
Using LS-3100D(W) Controller with 2 Scanning Heads 14

> Once a setup is completed, do not initialize the setting again unless you need to change them. (When initialized, all the current settings are cleared.)

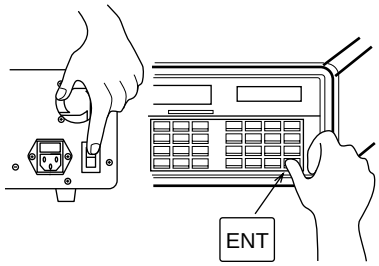
Initializing Current Settings

Turn the power switch "ON" while pressing ENT.

LS-3100 Series



LS-3100(W) Series



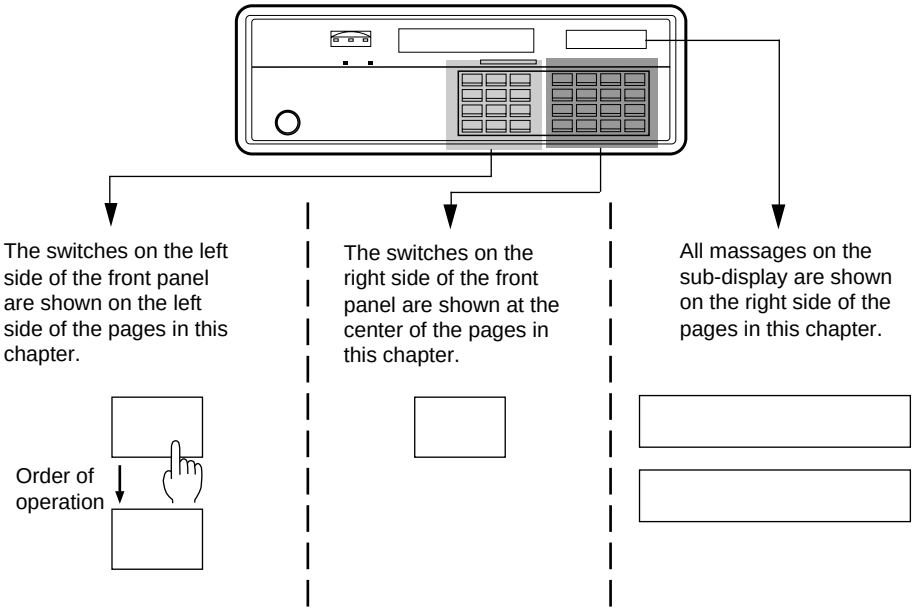
"MEMORY INITIALIZED" is displayed on the sub-display.

```
MEMORY
INITIALIZED
```

All prior settings are cleared and memory initialization is completed.

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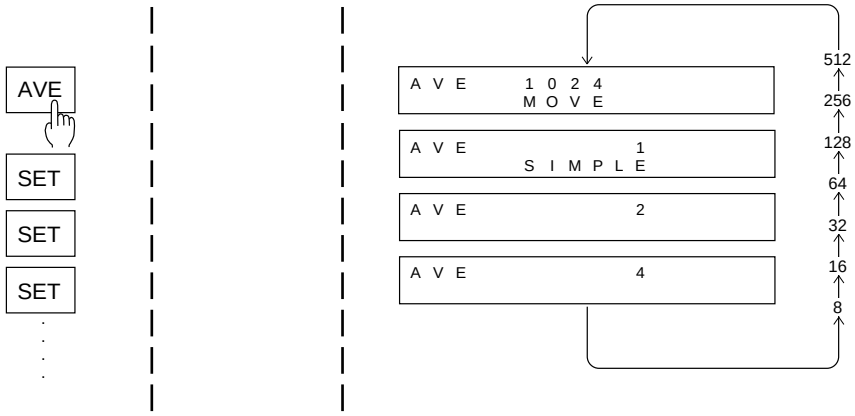
How to Use This Chapter



3-1. Common Settings

Setting the Number of Measurements for Averaging

See page 93 for Measurement Procedures.



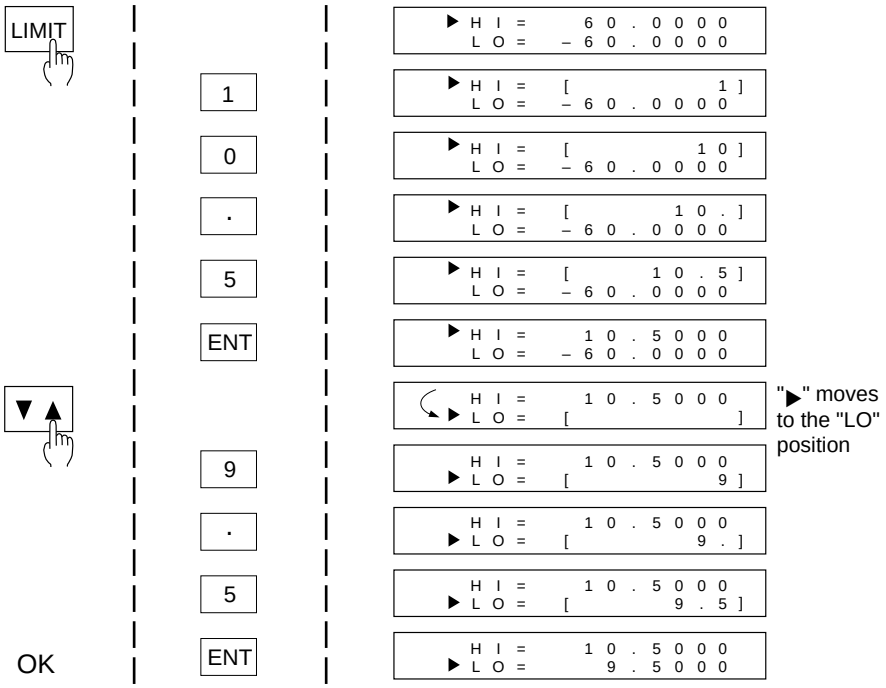
- After initialization, the number of measurements for averaging is automatically set to 1024. "----" appears on the main display for about 3 seconds, even after a workpiece has entered the measurement range.
- The sampling time required for one measurement is 2.5 m sec. The sampling time then required for 1024 measurements is 2.56 sec. (2.5 x 1024). The time required to display an averaged measurement changes depending on the number of measurements being made.

If highly accurate measurement is needed, select 512 or higher as the number of measurements for averaging.

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Tolerance Settings

The following procedure shows how to set the upper limit to 10.5 mm, and lower limits to 9.5 mm.



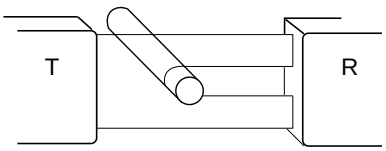
For details on tolerance setting for 7-step differentiation, refer to pages 23 through 26.

3-2. Measurement Procedures

Outer Diameter Measurements

■ **Applications**

- Measuring piston outer diameter
- Measuring flat cable width
- Measuring capacitor outer diameter



■ **Setting**

After "MEMORY INITIALIZED" is displayed, the segment mode is automatically set to DIA (outer diameter measurement).

For details on AVERAGE setting, refer to "AVERAGE", and for details on tolerance setting, refer to "Tolerance Settings" shown above.

- The number of measurements for averaging is set to 1024 after settings are initialized.
  "----" appears on the display for about 3 seconds, even after a target is placed within the measuring range.

- In the DIA mode, "----" appears on the main display when no workpiece is within the measuring range.

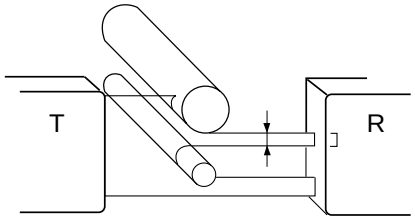
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Gap Measurement 1

(When part of the target is outside the optical axis)

■ Applications

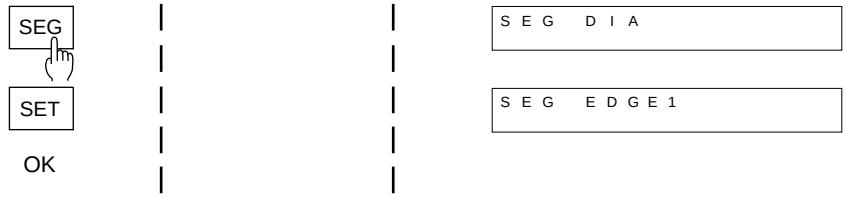
- Measuring gap between rollers in a copy machine
- Measuring gap between magnet roller and doctor blade



■ Setting

1. Initialize settings ("MEMORY INITIALIZED" is displayed.)

2.

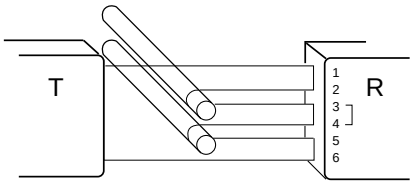


Gap Measurement 2

(When all of the target is within the optical axis)

■ Applications

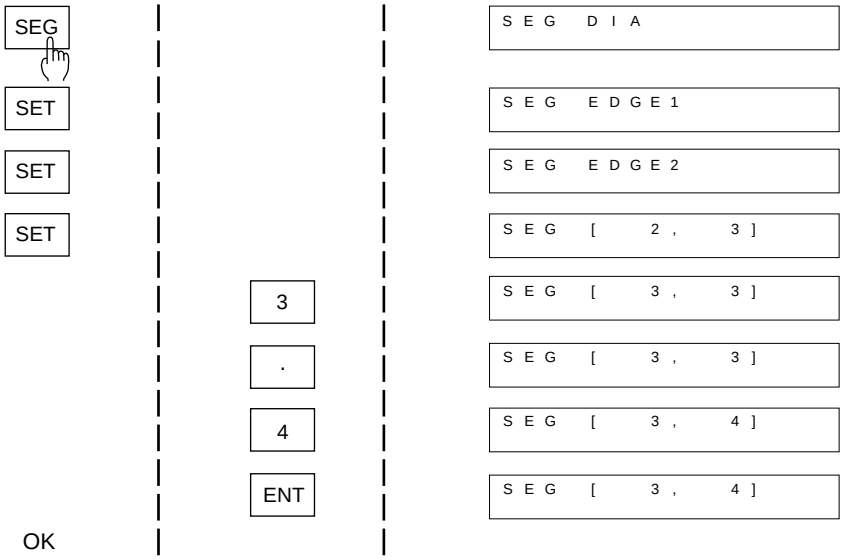
- Measuring pitch of capacitor leads
- Measuring pitch of IC leads



■ Setting

1. Initialize settings ("MEMORY INITIALIZED" is displayed.)

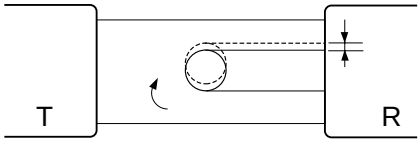
2.



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Measuring Roundness
(When target is rotating)

■ Applications
- Detecting uneven rubber roller in a copying machine
- Detecting uneven rubber roller on a printer



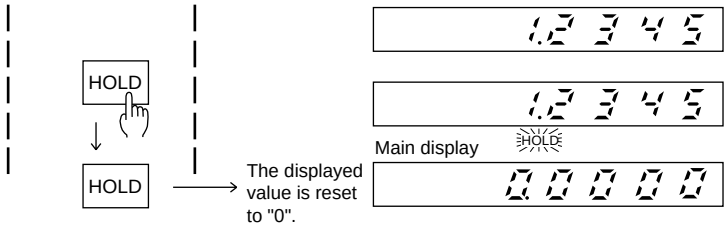
■ Setting
1. Initialize settings ("MEMORY INITIALIZED" is displayed.)

2.



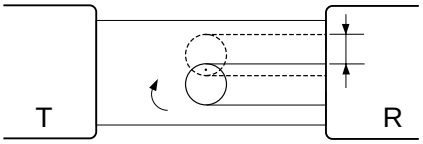
When the measurement mode is set to "P-P", the displayed value is retained until HOLD is pressed or until an external signal is input through the hold synchronous input terminal.

3. Resetting displayed values (When 1. 2 3 4 5 appears on the main display)



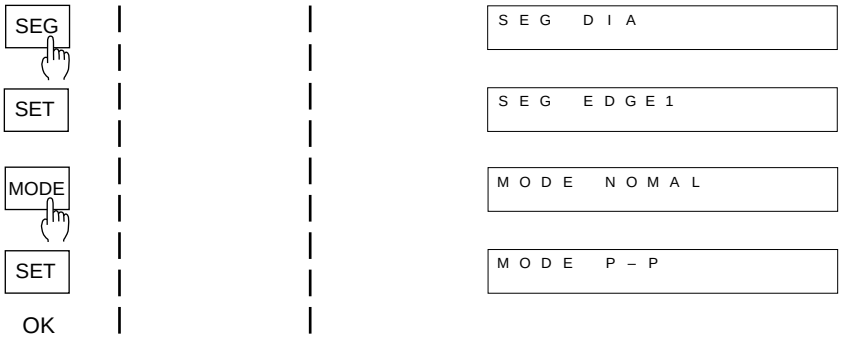
Measuring Eccentricity
(When target is rotating)

■ Applications
- Measuring eccentricity of rubber rollers
- Measuring shaft eccentricity for automobile



■ Setting
1. Initialize settings ("MEMORY INITIALIZED" is displayed.)

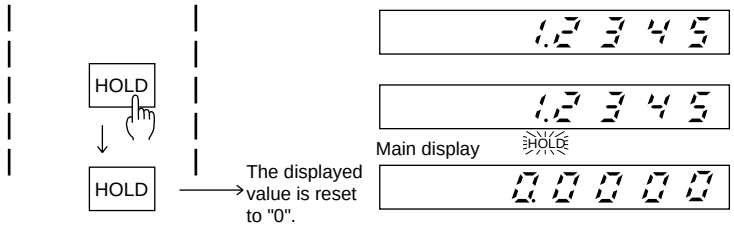
2.



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When the measurement mode is set to "P-P", the displayed value is retained until HOLD is pressed or until an external signal is input through the hold synchronous input terminal.

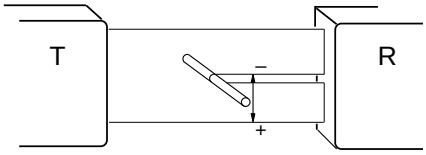
3. Resetting displayed values (When 1. 2 3 4 5 appears on the main display)



Measuring Target Displacement within the Measuring Range

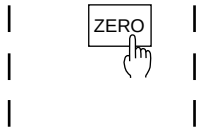
■ **Applications**

- Measuring disk head movement
- Measuring camera lens movement



■ **Setting**

1. Initialize settings ("MEMORY INITIALIZED" is displayed.)
   Follow the same procedure as that for "Gap Measurement 1".
   To reset the current value to "0", press ZERO.

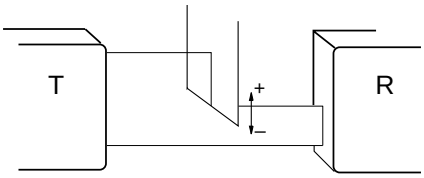


To reset the displayed value to "0" again, press ZERO twice.

Measuring Edge Movement

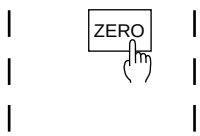
■ **Applications**

- Measuring paper feed for copying machines
- Controlling sheet edges
- Measuring dot printer wire movement



■ **Setting**

1. Initialize settings ("MEMORY INITIALIZED" is displayed.)
   Follow the same procedure as that for "Gap Measurement 1".
   To reset the current value to "0", press ZERO.



To reset the displayed value to "0" again, press ZERO twice.

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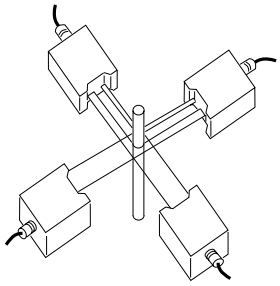
3.3 Using LS-3100D(W) Controller with 2 Scanning Heads

Measuring Outer Diameters in the X and Y Axes

The LS-3100D(W) uses 2 scanning heads for this measurement.

■ Applications

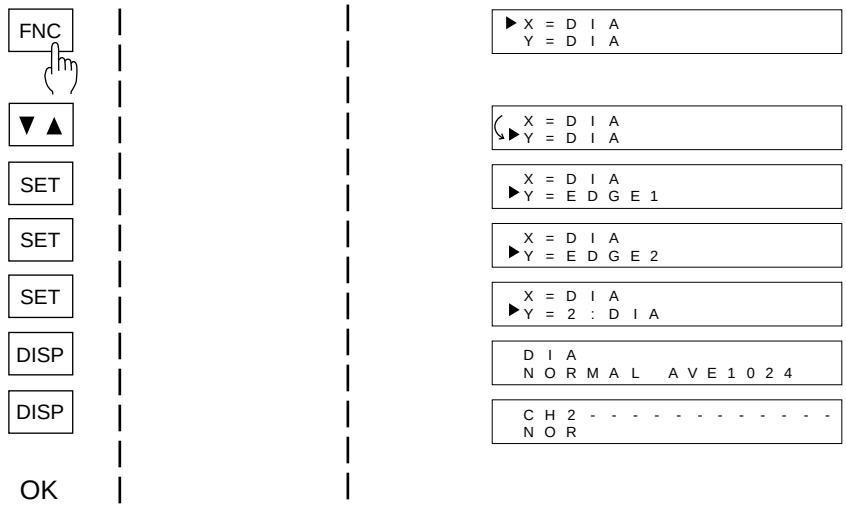
- Measuring outer diameter of coated wire in the X and Y axes
- Measuring outer diameter of extrusion molded parts



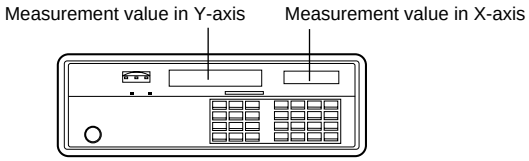
■ Setting

1. Initialize settings

2.



In the above setup, measurements from scanning head 1 are displayed on the main display, and measurements from scanning head 2 are displayed on the sub-display.



For details on tolerance setting, refer to p.23-26, 39, 40, 43 in this manual.

This appendix does not cover all of the LS-3100(W) functions. In addition to the applications covered in this appendix, the LS-3100(W) can be used for several other types of measurements.

For more details on functions and measurements, read chapter 4. (A cross reference between this appendix and chapter 4 is given below.)

Setting number of measurements for averaging p.21
Tolerance settings p.23-26, 39, 40, 43
Measuring outer diameter
Gap measurement 1
Gap measurement 2
Measuring roundness
Measuring eccentricity
Measuring target displacement within the measuring range
Measuring edge movement
Measuring outer diameter in the X and Y axes
– p.30-32, 40-41, 89-96

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CHAPTER 4

FUNCTIONS AND CONTROLS

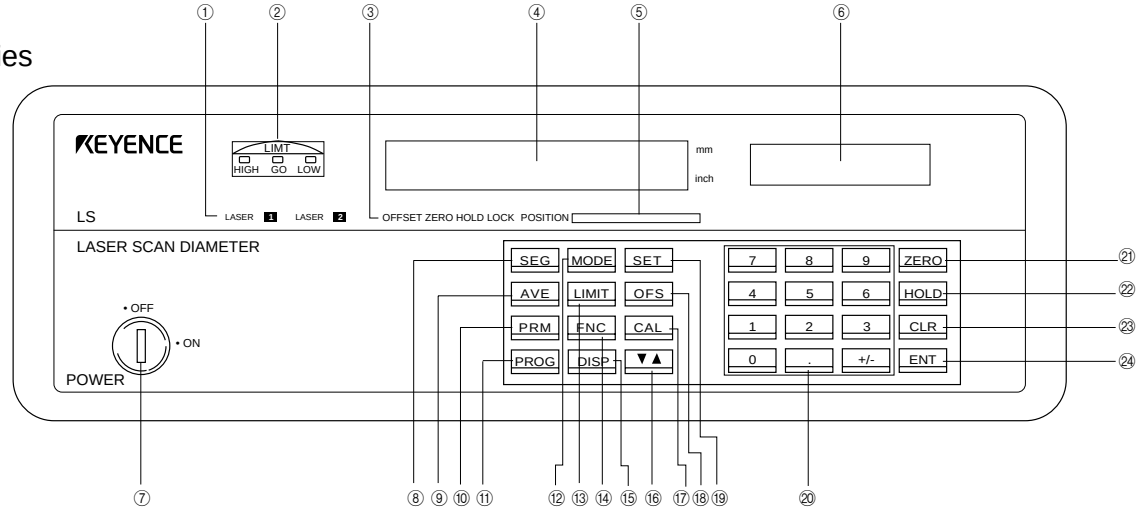
4-1. Part Names

Controller

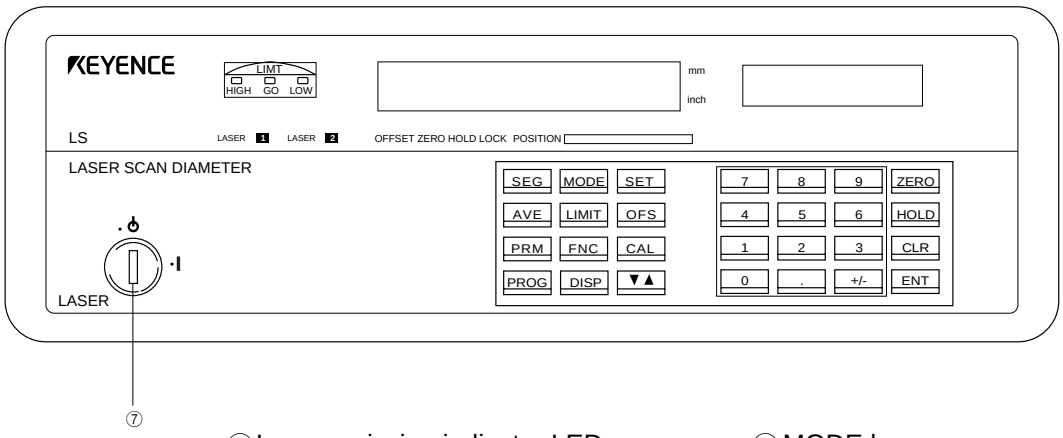
Model: LS-3100(W)/3100D(W)

Front Panel

LS-3100 Series



LS-3100(W) Series

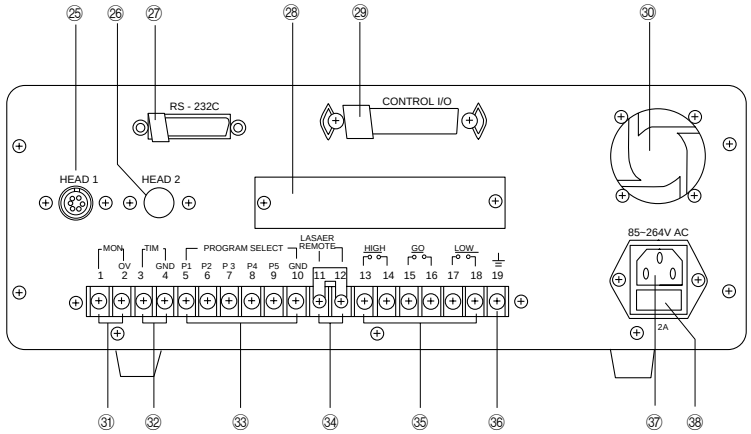


① Laser emission indicator LED
② Comparator output LEDs
③ Current setting indicator
④ Main display (CH1)
⑤ Target position indicator
⑥ Subdisplay (CH2)
⑦ Key-operated power switch
(LS-3100(W) Series: Key-operated laser switch)
⑧ SEGMENT key
⑨ AVERAGE key
(for number of measurements)
⑩ PARAMETER key
⑪ PROGRAM key
⑫ MODE key
⑬ LIMIT key (for 3-level comparator output only)
⑭ FUNCTION key
⑮ SUBDISPLAY key
⑯ UP/DOWN key
⑰ CALIBRATION key
⑱ OFFSET key
⑲ SET key
⑳ Numeric keys
㉑ AUTO ZERO key
㉒ HOLD key
㉓ CLEAR key
㉔ ENTER key

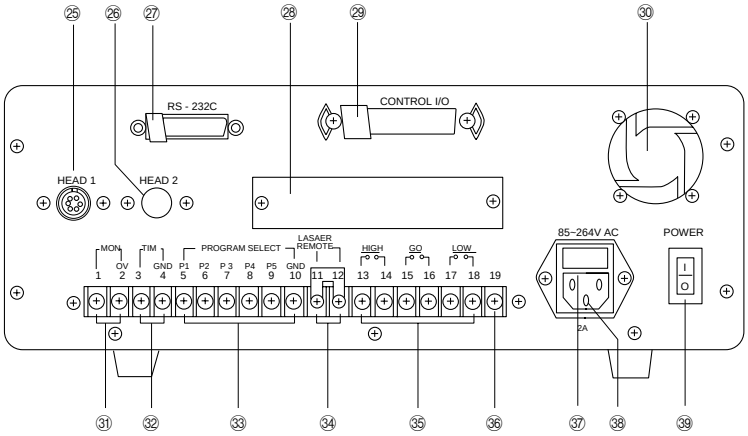
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Back Panel

Model: LS-3100



Model: LS-3100(W)

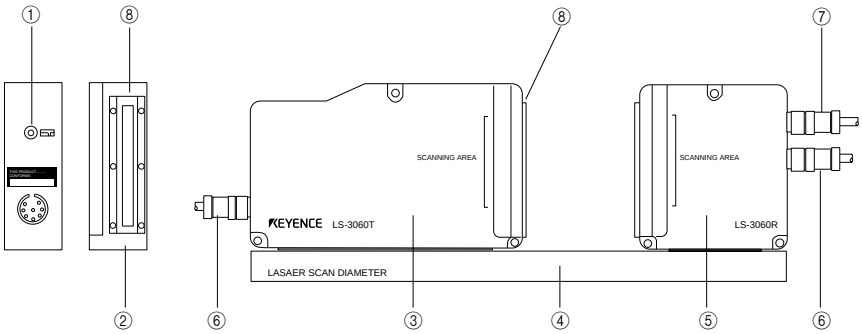


㉕ SCANNING HEAD connector port
㉖ SCANNING HEAD connector port (for second scanning head)
㉗ RS-232C connector port
㉘ Expansion I/O port (for optional BCD or GP-IB interface board)
㉙ 36-pin connector port (Control I/O port)
㉚ Cooling fan
㉛ Analog voltage output terminals
㉜ Hold synchronous input terminal
㉝ Program selector input terminals
㉞ Laser emission control input terminals
㉟ Comparator output terminals
㊱ Earth ground terminal [1.]
㊲ Power cable receptacle
㊳ Fuse holder (2A)
㊴ POWER switch (LS-3100(W) series only)

1. Not used for the LS-3100(W) series.

Scanning Heads

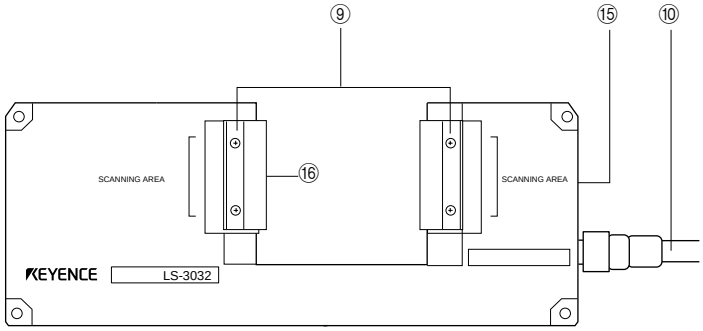
Model: LS-3060



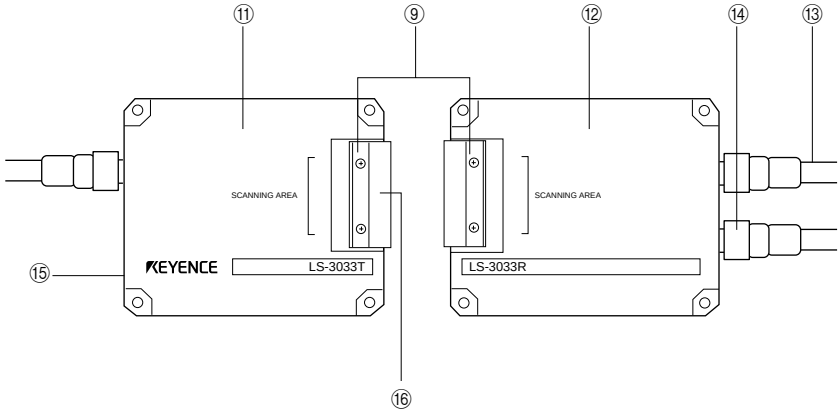
① Laser emission indicator LED
② Protective cover glass
③ Transmitter (T)
④ Detachable frame
⑤ Receiver (R)
⑥ 8-pin connector cable between (T) and (R)
⑦ 6-pin connector cable between the controller and the scanning head
⑧ Laser aperture

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Model: LS-3032/3034/3036



Model: LS-3033/3033 SO

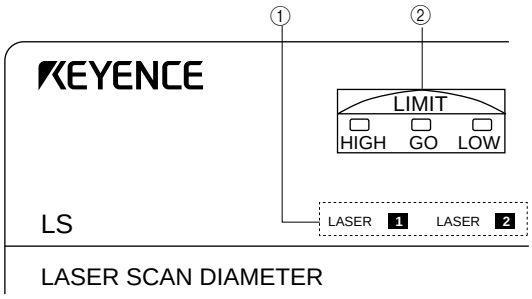


⑨ Protective cover glass
To prevent lens from being damage or dust from accumulating on the lens surface (Spares are available for replacement.)

⑩ Connector cable between the controller and the scanning head (3 m)
⑪ Transmitter (T)
⑫ Receiver (R)
⑬ 6-pin connector cable between the controller and the scanning head
⑭ 8-pin connector cable between (T) and (R)
⑮ Laser emission indicator LED
⑯ Laser aperture

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4-2. Indicators and Displays

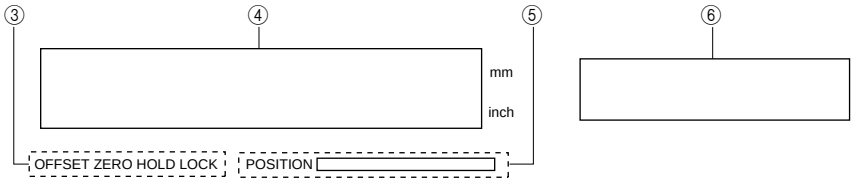


① Laser Emission Indicator LEDs

Light when laser is being or about to be emitted from the scanning head. Only LED [1] lights when one scanning head is used. Both LED [1] and LED [2] light when two scanning heads are used.

② Comparator Output LEDs

Three LEDs, HIGH, LOW, and GO, are provided. HIGH and LOW light respectively when the measured value is above the preset upper limit and below the preset lower limit. GO lights when the measured value is within the range between these two limits.



③ Current Setting Indicator

Lights when one of OFFSET, AUTO-ZERO, HOLD, or PANEL LOCK has been selected.

④ Main Display (Channel 1)

Shows a measured value.

⑤ Target Position Indicators

Indicate where the target is located in the measurement area.

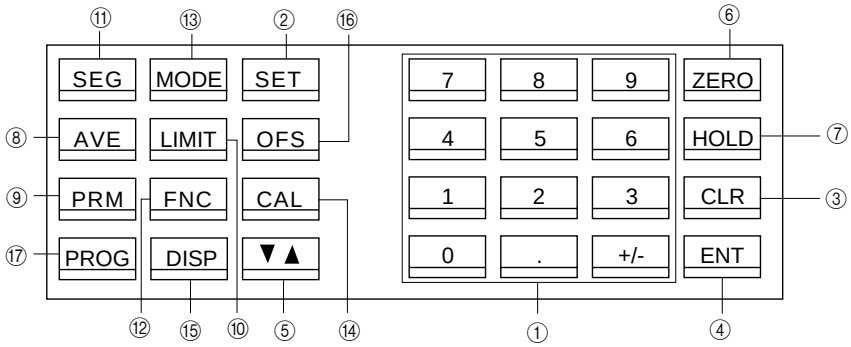
⑥ Subdisplay (Channel 2)

Shows preset values when only one scanning head is used. It shows a measured value when two scanning heads are used.

A measured value is displayed in 8 digits and updated 10 times per second.

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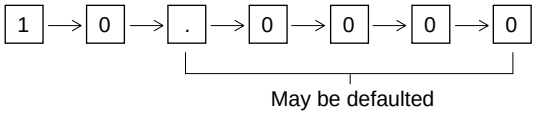
4-3. Panel Keys

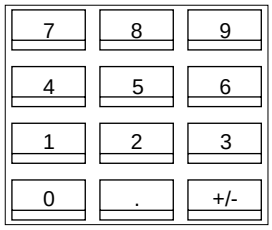


① Numeric Keys

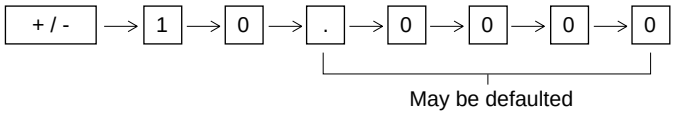
Enter numbers, a decimal point, and + or - sign. See the following examples:

- Entering +10.0000



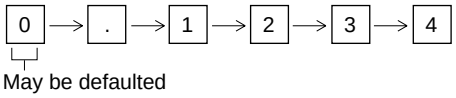


- Entering -10.0000



"+" and "-" alternate each time +/- is pressed. Note that the "+" sign is not displayed. This key can be pressed to select a positive or negative number as long as you have only up to 3-digit integers.

- Entering 0.1234



- When you first enter any number by using numeric keys, [ ] appears on both sides of this number. This indicates that the key input can be accepted. Any incorrect entry can be deleted using CLR only in this mode.

② SET Key

Changes parameter, setting, and ON/OFF status.

③ CLR Key

Deletes the desired number. Press ENT to regain the initial data.

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④ ENT Key

Registers the desired number.

Turn ON the power while pressing and holding ENT to return to the factory settings.

➪ *See P.89 to P.96 for the factory settings.*

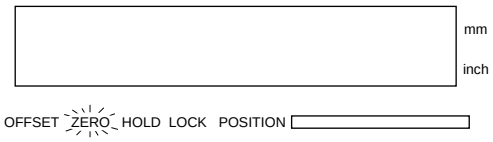
⑤ UP/DOWN Key

When making certain settings, two of the following items, value, mode or ON/OFF status, appear at the same time on the subdisplay (CH2). Press this key to move the cursor up and down to change one of the preset value or status.

⑥ ZERO (Auto-Zero) Key

Resets the displayed value to "0".

1. Press ZERO to reset the displayed and output values to 0.0000 mm or 0.0000 inch. The "ZERO" indicator below the main display lights when this key is pressed. From this moment, the main display will only show the changes in measured value based on the value that has been reset.



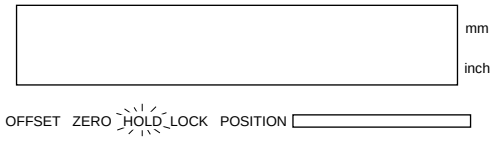
2. Press ZERO again to cancel this mode. The "ZERO" indicator goes out when this key is pressed.

- This function is available only for the measured value appearing on the main display (CH1). Use FNC to reset the measured value on the subdisplay (CH2) to 0.
  ➪ *See P.39*
- This key is invalid when the measurement mode is set to "P-P". At this time, press HOLD to reset the measured value.
  ➪ *See P.20*
- It is also possible to remotely reset the measured value or cancel this mode by sending a signal through one of the control I/O connector pins.
  ➪ *See P.43*

⑦ HOLD Key

Holds the displayed and output values.

1. Press HOLD to hold the displayed and output values just before this key is pressed. The "HOLD" indicator below the main display lights when this key is pressed.



2. Press HOLD again to cancel this mode. The "HOLD" indicator goes out when this key is pressed.

- If the measurement mode is set to "P-P", "PEAK", or "BOTTOM", the previously measured value is reset when this mode is cancelled.
- It is possible to use this mode only on the main (CH1) display or on both the main and subdisplay (CH2). To do this, choose the desired mode using PRM.

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⑧ AVE Key

(Selector key for number of measurements for averaging and averaging method)

Sets the desired number of measurements and averaging method.

1. Use AVE to display the current number and method.

2. To change the number of measurements, use UP/DOWN to move the cursor up. Then, use SET to specify the number. Each time you press SET, the number will increment in the following order: "1, 2, 4, 8 ••••• 512, and 1024". Note also that the number of measurements is set automatically to the currently displayed number. Therefore, you do not need to press any other key to finalize this number.

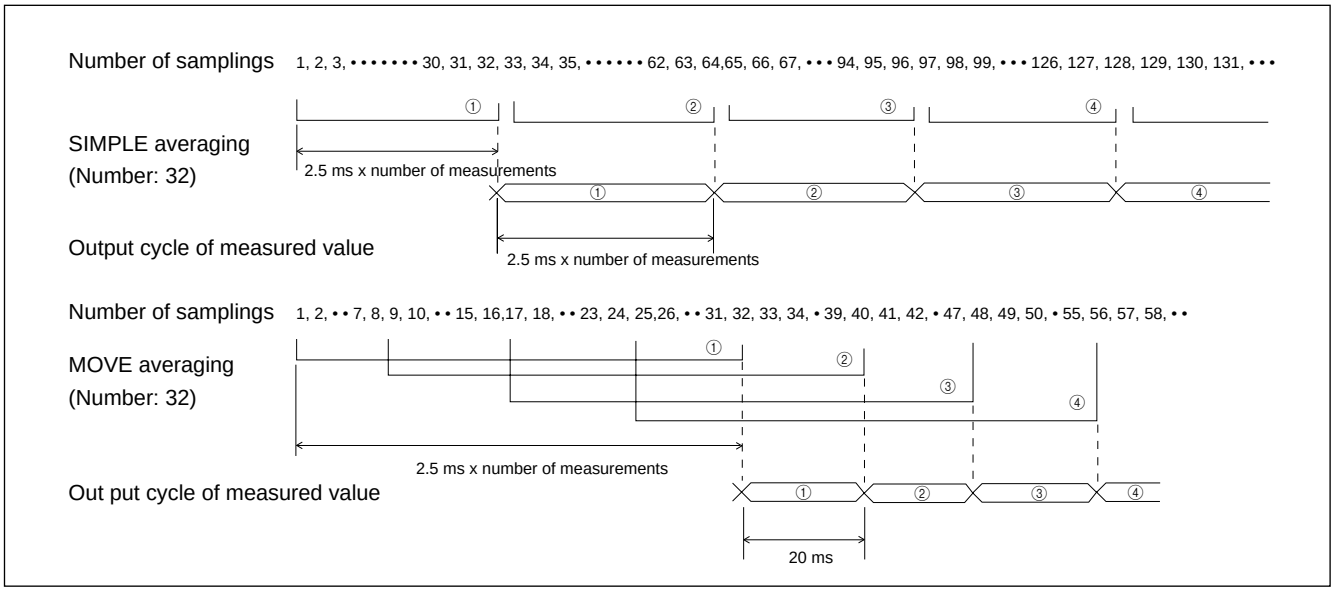
```
AVE    ▶1024
       MOVE
```

3. To change the measurement method, use UP/DOWN to move the cursor down. Then, use SET to change the averaging method. Each time you press SET, SIMPLE and MOVE display alternately.

```
AVE     1024
       ▶SIMPLE
```

See the timing diagrams below for the difference between these two methods.

Averaging Methods



* MOVE is valid only when the number of measurements is set to a number between 16 and 1024.

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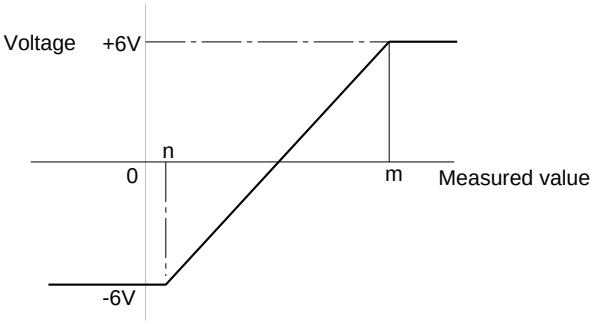
⑨ PRM Selector Key

Displays sequentially the following 9 items: preset analog range, "LIMIT", "DIGIT SUPPRESS", "HOLD", "BAUD RATE", "UNIT", "BUZZER", "HEAD2", and "POSITION CHECK". Display the desired item first and make the necessary changes. See the instructions below for making settings in each item.

Analog Voltage Range

In this mode, measured value is converted into an analog voltage between -6 V and +6 V. Match the desired measurement range and the above voltage range. By matching these ranges, the measured value can be converted into its corresponding voltage.

Determine the upper and lower limits (m) and (n) as shown below. These values correspond respectively to +6 V and -6 V. This automatically determines the conversion rate of the measurement range against the voltage range.



1. Use PRM to display the analog voltage range as shown below. UP/DOWN is not used in this mode.

```
▶ + 6 V =       6 0 . 0 0 0 0
  - 6 V =   -   6 0 . 0 0 0 0
```

2. Enter the desired value in mm or inch that corresponds to +6 V.

3. Press ENT to register.

4. When ENT is pressed, the cursor moves down to the second line and the current preset value corresponding to -6 V disappears.

```
  + 6 V =       2 0 . 0 0 0 0
▶ - 6 V =
```

5. Enter the desired value in mm or inch that corresponds to -6 V.

6. Press ENT to register and finish.

```
▶ + 6 V =       2 0 . 0 0 0 0
  - 6 V =         0 . 0 0 0 0
```

7. Use CLR to delete incorrect data and enter the correct one if required.

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Example of Operation

You are to measure the diameter of round bars. The reference diameter is 10 mm, and you wish to convert a difference of 1 mm into 1 V.
In this case, first set 100.000 mm to 0 V. Then, to represent each 1 mm change in diameter from the reference by 1 V, set the reference plus 6 mm to +6 V and the reference minus 6 mm to -6 V. That is, +6 V = 16 mm and -6 V = 4 mm.

Step	Key operation	Display
1	Use PRM to display analog voltage range.	▶+ 6 V = 6 0 . 0 0 0 0 - 6 V = - 6 0 . 0 0 0 0
2	Press "1".	▶+ 6 V = [1] - 6 V = - 6 0 . 0 0 0 0
3	Press "6".	▶+ 6 V = [1 6] - 6 V = - 6 0 . 0 0 0 0
4	Press ".".	▶+ 6 V = [1 6 .] - 6 V = - 6 0 . 0 0 0 0
5	Press "0" four times.	▶+ 6 V = [1 6 . 0 0 0 0] - 6 V = - 6 0 . 0 0 0 0
6	Press ENT	+ 6 V = 1 6 . 0 0 0 0 ▶- 6 V =
7	Press "4".	+ 6 V = 1 6 . 0 0 0 0 ▶- 6 V = [4]
8	Press ".".	+ 6 V = 1 6 . 0 0 0 0 ▶- 6 V = [4 .]
9	Press "0" four times.	+ 6 V = 1 6 . 0 0 0 0 ▶- 6 V = [4 . 0 0 0 0]
10	Press ENT.	▶+ 6 V = 1 6 . 0 0 0 0 - 6 V = 4 . 0 0 0 0

Note

- The LS controller is factory-set to +6 V = 60 mm and -6 V = - 60 mm.
- A range of 0.024 mm to 240 mm can be specified.
- Make sure that the value corresponding +6 V is greater than that for -6 V.
- When your reference value is an integer with no decimals, steps 4, 5, 8 and 9 can be omitted.

LIMIT

You can set the following 3 parameters in LIMIT:

- 3-step or 7-step differentiation
- Tolerance limits when 7-step differentiation is selected
- Comparator output type; Relay or open-collector (if the measured value is above the upper limit or below the lower limit).

Note

- Use FNC to set the tolerance limits for the measured value appearing on the subdisplay (CH2). ➪ *See P.32*

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Tolerance Limits and Comparator Output

■ 3-step differentiation

Choose the 3-step differentiation first, then set the tolerance limits using LIMIT. When "ON" appears on the display, the comparator output is sent through each of the relays and open-collectors (HIGH, GO, or LOW).
➪ See P.63, 64

Tolerance limit	Condition	Output (Relay)	Output (Open-collector)
	HI < X	HIGH	HI1 (CH1)
HI			
	HI ≥ X ≥ LO	GO	GO (CH1)
LO			
	X < LO	LOW	LO1 (CH1)

Note: X represents a measured value.

■ 7-step differentiation

Choose the 7-step differentiation first, then set the tolerance limits using PRM. When "ON" appears on the display, the comparator output is sent through each of the relays and open-collectors (HI3, HI2, HI1, GO, LO1, LO2, or LO3). ➪ See P.63

Tolerance limit	Condition	Output (Relay)	Output (Open-collector)
	HI3 < X	HIGH	HI3 (CH1)
HI3			
	HI3 ≥ X > HI2	HIGH	HI2 (CH1)
HI2			
	HI2 ≥ X > HI1	HIGH	HI1 (CH1)
HI1			
	HI1 ≥ X ≥ LO1	GO	GO (CH1)
LO1			
	LO1 > X ≥ LO2	LOW	LO1 (CH1)
LO2			
	LO2 > X ≥ LO3	LOW	LO2 (CH1)
LO3			
	LO3 > X	LOW	LO3 (CH1)

Note: X represents a measured value.

- It is possible to set the tolerance limits for both 3-step and 7-step differentiation. However, only the tolerance limits of the type of differentiation you have selected are valid. Therefore, the comparator output is sent according to these limits.

- In 7-step differentiation, measured values can be correctly checked only when the values assigned to the tolerance limits meet the following condition: HI3>HI2>HI1>LO1>LO2>LO3

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Procedure

■ **Switching between 3-step and 7-step differentiations**

1. Use PRM to display "LIMIT" (on the subdisplay).

2. To switch between two types of differentiation, use UP/DOWN to move the cursor up.

```
LIMIT    ▶7CLASSES
           ON
```

3. Each time you press SET, "7 CLASSES" and "3 CLASSES" are displayed alternately. Choose the desired type of differentiation.

■ **Turning comparator output function ON/OFF**

1. Use PRM to display "LIMIT" (on the subdisplay).

2. Use UP/DOWN to move the cursor down.

```
LIMIT    ▶7CLASSES
           ON
```

3. Each time you press SET, "ON" and "OFF" are displayed alternately.

4. Display "ON" to obtain the comparator output function, or "OFF" to cancel this output function.

■ **Setting tolerance limits (3-step differentiation)**

1. First select 3-step differentiation as mentioned above, then use LIMIT to set the tolerance limits.
➪ *See P.29*

2. If you press PRM after having set the tolerance limits, "DIGIT SUPPRESS" will be displayed.

■ **Setting tolerance limits (7-step differentiation)**

1. First select 7-step differentiation as mentioned above, then use PRM to set the tolerance limit.

2. "HI1" and "LO1" will appear on the subdisplay. Use UP/DOWN to move the cursor up for HI1 or down for LO1.

```
LIMIT      7CLASSES
           ▶ON
```

3. Enter the desired values and press ENT to register.

4. Press PRM.

5. "HI2" and "LO2" will appear on the subdisplay. Enter the desired values and press ENT to register.

```
▶HI 2=      30.0000
 LO2= -     30.0000
```

6. Press PRM to display "HI3" and "LO3", enter the desired values, and press ENT to register.

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Example of Operation

You are to measure the diameter of round bars. The reference diameter is 10 mm. You wish to perform a 7-step differentiation with the following tolerance limits: ±0.1 mm, ±0.2 mm, ±0.3 mm.

Step	Key operation	Display
1	Press PRM to display "LIMIT".	LIMIT 3CLASSES ▶ON
2	Use UP/DOWN to move cursor up.	LIMIT ▶3CLASSES ON
3	Use SET to display "7 CLASSES".	LIMIT ▶7CLASSES ON
4	Press PRM to display "HI1" and "LO1".	▶HI 1 = - 10.0000 LO1 = - 10.0000
5	Enter 10.1000 for HI1 and 9.9000 for LO1, then press ENT.	HI 1 = 10.1000 ▶LO1 = 9.9000
6	Press PRM again to display "HI2" and "LO2".	▶HI 2 = 30.0000 LO2 = - 30.0000
7	Enter 10.2000 for HI2 and 9.8000 for LO2, then press ENT.	HI 2 = 10.2000 ▶LO2 = 9.8000
8	Press PRM again to display "HI3" and "LO3".	▶HI 3 = 60.0000 LO3 = - 60.0000
9	Enter 10.3000 for HI3 and 9.7000 for LO3, then press ENT.	HI 3 = 10.3000 ▶LO3 = 9.7000

DIGIT SUPPRESS

Deletes fractions from measured value on the display. DIGIT SUPPRESS is useful when there is a relatively large difference from one measured value to another. The possibly applicable cases are listed below.

- When the number of measurements for averaging is set to a small number
- When the target is vibrating
- When it is not necessary to obtain precise measurements

This prevents errors involved in reading measured values.

- This function can be used for both the main display and subdisplay. It becomes invalid when the subdisplay is used to show measured values in P-P, PEAK, or BOTTOM mode.
- Although fractions are not displayed, the target is measured down to 0.0001 mm and comparator output sent based on these measured values.

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Procedure

1. Use PRM to display "DIGIT SUPPRESS" (on the subdisplay).



2. Use UP/DOWN to move the cursor up or down, then use SET to choose how many fractions you wish to delete. Each time you press SET, the subdisplay will show "0", "1", "2", "3", "4", and "0" again.

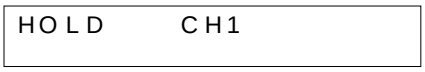
3. Note that they represent the number of digits to be deleted starting from the rightmost (smallest) fraction.

HOLD

Selects whether to use HOLD function (see P.20) only for CH1 or for both CH1 and CH2.

Procedure

1. Use PRM to display "HOLD" (on the subdisplay).



2. Each time you press SET, "CH1" and "CH2" are displayed alternately. Display "CH1" only for CH1 or "CH2" for both CH1 and CH2.

BAUD RATE

Selects the data transmission speed via RS-232C interface.

Procedure

1. Use PRM to display "BAUD RATE" (on the subdisplay).



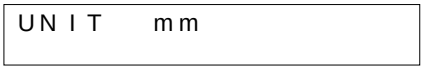
2. Each time you press SET, the baud rate will increment from 75 to 19200. Display the desired choice.

UNIT

Selects the unit of measurement between mm and inch.

Procedure

1. Use PRM to display "UNIT" (on the subdisplay).



2. Use SET to display "mm" or "inch".

   The unit selected in this mode will be applied to other values such as tolerance limits and calibration values.

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BUZZER

Turns ON/OFF the beep during panel key operation.

Procedure

1. Use PRM to display "BUZZER" (on the subdisplay).

BUZZER ON

2. Use SET to display "ON" or "OFF".

HEAD2

Selects whether to use two scanning heads or not.

Procedure

1. Each time you press SET, "ON" and "OFF" are displayed alternately.
2. Display "ON" to use two scanning heads or "OFF" to use just one head.

HEAD2 ON

The controller must be equipped with the optional PC board for the second scanning head. If not, an error message "H2-Err" appears on the main display. In such a case, display "HEAD2 OFF" (on the subdisplay). This will cause "H-Err" to appear on the main display. Then, turn OFF the power once, then turn it ON again. You can now perform measurements using only the first scanning head (HEAD1).

POSITION CHECK
(Model: LS-3033/3060 only)

Checks whether the transmitter and receiver are aligned in terms of the optical axis of the laser. This alignment is required when these units are removed from the detachable frame during operation.
➪ *See "Mounting Scanning Head" in Chapter 5 on P.65 for details.*

Procedure

1. Use PRM to display "POSITION CHECK".

HEAD1 POSITION CHECK

2. Align the transmitter and receiver in terms of the optical axis.
3. When two scanning heads are used, press PRM again to display "HEAD2" above "POSITION CHECK", and align the second set of transmitter and receiver.

HEAD2 POSITION CHECK

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⑩ LIMIT (Tolerance limits for 3-step differentiation) Key

This key is used to set the tolerance limits (upper and lower) for measured values on the main display (CH1). If the measured value is above the upper or below the lower limit, the comparator output is sent through the corresponding relay and open-collector.

➪ *See P.24 for the relationship between the tolerance limits and types of output obtained.*

• Use FNC to set the tolerance limits for the subdisplay (CH2).

➪ *See P.39*

Procedure

1. Use LIMIT to display the current tolerance limits.
2. HI and LO represent respectively the upper and lower limits.
3. Use UP/DOWN to move the cursor up or down.

```
▶HI=      60.0000
 LO= -    60.0000
```

4. Enter the desired tolerance limits.
   Make sure that the value for HI is greater than that for LO.
5. Press ENT to register.
6. Use UP/DOWN again to move the cursor, and enter another tolerance limit.
7. Use CLR to delete any incorrect entry.

Example of Operation

You are to measure the diameter of round bars. The reference diameter is 10 mm. You wish to perform a 3-step differentiation with the tolerance limits of ±0.1 mm (upper limit=10.1 mm, lower limit=9.9 mm).

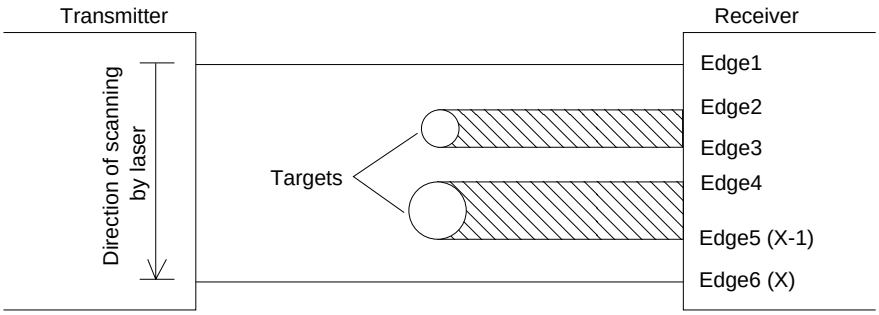
Step	Key operation	Display
1	Press LIMIT to display current tolerance limits.	▶HI= 60.0000 LO= - 60.0000
2	Enter tolerance limit.	▶HI=[10.1000] LO= - 60.0000
3	Press ENT to register.	▶HI= 10.1000 LO= - 60.0000
4	Press UP/DOWN to move cursor.	HI= 10.1000 ▶LO= - 60.0000
5	Enter another tolerance limit.	HI= 10.1000 ▶LO=[- 9.9000]
6	Press ENT to register.	HI= 10.1000 ▶LO= 9.9000

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⑪ SEG (Segment) Key

Definition of Segment

Targets placed within the measurement area interrupt the passage of the laser beam, thus creating a light-dark pattern. The border between the light and dark regions is referred to an "edge". Also, each dark or light region separated by the edge is called a "segment".



The desired pair of edges is to be selected from those shown above, and the distance between these two edges measured.

Note

- The edges are numbered in the order that they are scanned by the laser (from top to bottom).
- The desired pair from among up to 126 edges can be selected.

Description

4 types of segment pairs, DIA, EDGE1, EDGE2, (m,n), can be measured. The description of measurement for each pair is given below.

DIA: This mode is applicable to measurement of targets' outer diameters. In the above figure, the distance between edge 2 and edge (X-1) is measured. When there is only one target, its outer diameter is measured. When there are two or more targets, the distance between the upper edge of the upper most target to the lower edge of the lower most target is measured.

EDGE1: The width of the uppermost region where the laser is not interrupted by the target is measured. This mode is applicable to measurement of changes in targets' diameters. In the above figure, the distance between edge 1 and edge 2 is measured.

EDGE2: The width of the lowermost region where the laser is not interrupted by the target is measured. In the above figure, the distance between edge (X-1) and edge X is measured.

(m,n): The distance between two desired edges is measured. When measuring two or more targets, this mode is applicable to measurement of the outer diameter of each target or to measurement of the gap between two targets.

In (m,n) mode, both "m" and "n" represent the edge numbers ranging from 1 to 126. Make sure that the number specified for "n" is greater than that for "m".

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Procedure

1. Press SEG to display the current segment pair (on the subdisplay).

SEG DIA

2. Each time you press SET, the subdisplay will sequentially show "DIA", "EDGE1", "EDGE2", "(m,n)", then "DIA" again. Display the desired segment pair. You do not need to press any other key. (When two scanning heads are used, the subdisplay will sequentially show "DIA", "EDGE1", "EDGE2", "(m,n)", "2:DIA", "2:EDGE1", "2:EDGE2", "2:(m,n)", and "DIA" again.)

3. To measure the distance between two desired edges, select the (m,n) mode.

SEG (5, 2)

4. Use SET to display "(m,n)" first.

SEG (m, n)

5. Enter the desired edge numbers.

➪ *See the example of operation given below for details.*

6. Press ENT to register.

Example of Operation

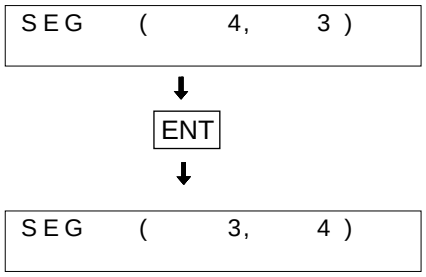
You are to measure the gap between two round bars (between edges 3 and 4). Suppose that the currently registered edges are 2 and 3.

Step	Key operation	Display
1	Press SEG.	SEG DIA
2	Use SET to display current edges (2 and 3).	SEG (2 , 3)
3	Press "3".	SEG (3 , 3)
4	Press ".".	SEG (3 , 3)
5	Press "4".	SEG (3 , 4)
6	Press ENT.	SEG (3 , 4)

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Note

- If you enter invalid numbers (other than 1 through 126) and press ENT, the initial edge numbers will remain on the subdisplay.
- Basically, two numbers are entered in this mode. If by mistake you enter the larger number on the left and smaller number on the right, and press ENT, the smaller number will appear on the left and larger number on the right.



- Clear objects can be used as targets only in DIA, EDGE1, and EDGE2 modes, but not in SEG (m,n) mode.
- Use CLR to delete any incorrect values.
- In the above example operation, if you need to change only the first edge number, that is, from 2 to 1, follow only steps 1, 2, 3, and 6.
- Similarly, if you need to change only the second edge number, that is, from 3 to 5, follow only steps 1, 2, 4, 5, and 6.

⑫ FNC (Function) Key

Is used for the following settings:

- Segment selector
  Selection of measurement points (2-point simultaneous measurement)
- Segment check
  Inhibiting output of measurements obtained under abnormal conditions
- Output channel
  Selection of output channel for displaying measured values X and Y and calculation of equations using these values
- MODE, OFFSET, and LIMIT for CH2
  Selection of mode for CH2, offset value, and tolerance limit

Description of each setting is given below.

Segment Selector

In this mode, two segments are to be specified for simultaneous 2-point measurement. Just as with the SEG key, any of four types of segments can be specified respectively for segment selectors X and Y. (See P.30.) By selecting two different segments, the LS controller can measure two different segments at the same time.

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Procedure 1: Measuring 2 Segments with 1 Scanning Head

1. Use FNC to display the current segments for X and Y.

```
▶X =    D I A
 Y =    D I A
```

2. Use UP/DOWN to move the cursor up.

3. Each time you press SET, "DIA", "EDGE1", "EDGE2", "(m,n)", and "DIA" will sequentially appear on the right of "X=". Display the desired segment.
   * "m" and "n" in (m,n) represent two desired edge numbers.

```
▶X =    EDGE I
 Y =    D I A
```

4. When you have selected "(m,n)", enter the desired edge numbers, and press ENT to register.
➪ *See P.31.*

   Once you select "(m,n)" for X, "(m,n)" will be automatically selected for Y.

```
▶X =    (  2 ,  3  )
 Y =    (  1 ,  2  )
```

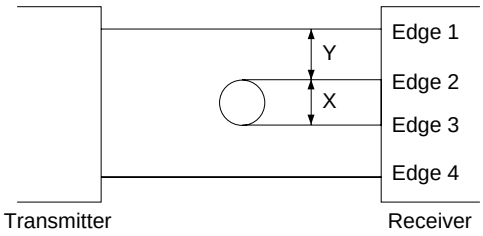
5. Use UP/DOWN to move the cursor down.

```
 X =    (  2 ,  3  )
▶Y =    (  1 ,  2  )
```

6. Repeat steps 3 and 4.

Example of Operation

You are to measure the outer diameter and eccentricity of the round bars using one scanning head.



Step	Key operation	Display
1	Use FNC to display current segments.	▶X = D I A Y = D I A
2	Use UP/DOWN to move cursor up.	▶X = D I A Y = D I A
3	Use SET to display: (1) "X= DIA" (2) "X= (m,n)". Enter 2 for "m" and 3 for "n", and press ENT.	▶X = D I A Y = D I A ▶X = (2 , 3) Y = (1 , 2)

(To be continued)

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4	Use UP/DOWN to move cursor down.	X = D I A ▶Y = D I A X = (2 , 3) ▶Y = (1 , 2)
5	When you have selected "DIA" in step 3, use SET to display "Y= EDGE1". When you have selected "(m,n)" in step 3, enter 1 for "m" and 2 for "n", and press ENT.	X = D I A ▶Y = EDGE I X = (2 , 3) ▶Y = (1 , 2)

Procedure 2: Using 2 Scanning Heads

Press PRM first, and check that "HEADS2 ON" is displayed on the subdisplay.

1. Use FNC to display current segments.

2. Use UP/DOWN to move cursor up.

3. Each time you press SET, the subdisplay will sequentially show "DIA", "EDGE1", "EDGE2", "(m,n)", "2:DIA", "2:EDGE1", "2:EDGE2", "2:(m,n)", and "DIA" again. Display the desired segment.
* "m" and "n" in (m,n) represent two desired edge numbers.
* "2:" in "2:DIA", for example, represents the second scanning head.

4. When you have selected "(m,n)", enter the desired numbers, and press ENT to register.
➪ *See P.31.*

▶X = (2 , 3)
Y = (1 , 2)

5. Use UP/DOWN to move the cursor down.

X = (2 , 3)
▶Y = (1 , 2)

6. Repeat steps 3 and 4.

Example of Operation

Measuring the outer diameter of 2 round bars at the same time using 2 scanning heads

Step	Key operation	Display
1	Use FNC to display current segments.	▶X = D I A Y = D I A
2	Use UP/DOWN to move cursor up.	▶X = D I A Y = D I A
3	Use SET to display "X= DIA"	▶X = D I A Y = D I A

(To be continued)

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4	Use UP/DOWN to move cursor down.	X = D I A ▶Y = D I A
5	Use SET to display "Y=2:DIA".	X = D I A ▶Y = 2 : D I A

Note

- Some combinations of segments cannot be used with the LS controller. See the table below. ("✓" indicates valid combinations.)

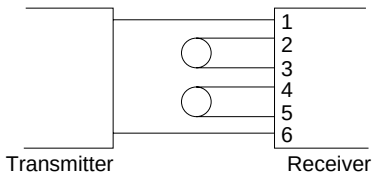
Segment selector Y \ Segment selector X	DIA	EDGE1	EDGE2	(m,n)	2: DIA	2: EDGE1	2: EDGE2	2: (m,n)
DIA	✓	✓	✓		✓	✓	✓	✓
EDGE1	✓	✓	✓		✓	✓	✓	✓
EDGE 2	✓	✓	✓		✓	✓	✓	✓
(m,n)				✓	✓	✓	✓	✓
2: DIA	✓	✓	✓	✓	✓	✓	✓	
2: EDGE 1	✓	✓	✓	✓	✓	✓	✓	
2: EDGE 2	✓	✓	✓	✓	✓	✓	✓	
2: (m,n)	✓	✓	✓	✓				✓

- Even when you have selected the segments using segment selectors X and Y, these segments will be replaced by those selected using SEG. When using SEG, be sure to select the same segments again.

Segment Check

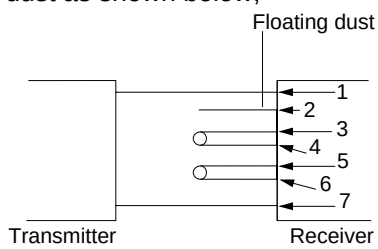
This mode is applicable to segment mode (m,n). In this mode, you are to register the number of segments. If the number of segments detected during measurement is not the same as the registered one, error message " - - - - " will appear. When this happens, the measured value is ignored.
This prevents incorrect measurements due to dust, drops of oil, or any other particles on the scanning head. The error message will also appear when the target is displaced from the measurement area.

- Non-clear targets are being measured.



Segment selectors
X=(2. 3)
Y=(4. 5)

The registered number of edges is 6. If more than 6 edges are detected due to dust as shown below, " - - - - - " will be displayed.



* The segment check mode does not function with segment pairs in the DIA, EDGE1, and EDGE2 modes.

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Procedure

Check first that segment pair, (m,n), has been selected.

1. Use FNC to display "X SEG CHECK OFF".

```
X SEG CHECK OFF
              4
```

2. Use SET to display "ON" on the right of "SEG CHECK" to activate the segment check mode.

```
X SEG CHECK ON
              4
```

* When the currently selected segment pair is DIA, EDGE1, or EDGE2, "Y SEG CHECK" will be displayed.

3. Enter the correct number of edges.

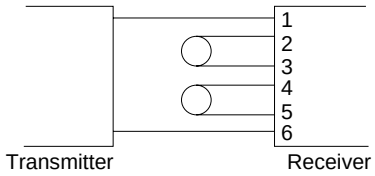
4. Press ENT to register.

5. Press FNC to display "Y SEG CHECK OFF".

6. Repeat steps 3 and 4.

Example of Operation

You are to measure the outer diameter of two round bars at the same time using one scanning head. You need to use the segment check mode to prevent incorrect measurements. In this case, the number of edges is 6.



Segment selectors
X=(2. 3)
Y=(4. 5)

Step	Key operation	Display
1	Use FNC to display "X SEG CHECK OFF".	X SEG CHECK OFF 4
2	Press SET.	X SEG CHECK ON 4
3	Enter "6".	X SEG CHECK ON [6]
4	Press ENT to register.	X SEG CHECK ON 6
5	Press FNC.	Y SEG CHECK OFF 4
6	Press SET.	Y SEG CHECK ON 4
7	Press "6".	Y SEG CHECK ON [6]
8	Press ENT to register.	Y SEG CHECK ON 6

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Output Channel

The LS controller is equipped with two output channels (CH1 and CH2) having their own displays and output terminals for simultaneous 2-point measurement.
In this mode, you are to select which output channel to display or output each of the measured values for X and Y. You can also choose to select the equation containing X and Y as variables and obtain the result.

Types of output for CH1 and CH2

Channel	Display	Output
CH1	Main display 3 comparator LEDs (HI, GO, LO)	3-step comparator output (relay) ➪ *See P.64.* 7-step comparator output (control I/O) ➪ *See P.62.* Analog voltage output ➪ *See P.47.* RS-232C ➪ *See P.49.* BCD (option) ➪ *See P.68.* GP-IB (option) ➪ *See P.70.*
CH2	Subdisplay	3-step comparator output (control I/O) ➪ *See P.62.* RS-232C GP-IB (option)

* For the subdisplay you can use DISP to display the current settings, measured value for CH1 in one of the measurement modes, or measured value for CH2. Therefore, the subdisplay may not show the measured value of the segment you have selected. However, the comparator output and the BCD output will be sent based on the measured value of the segment selected using the segment selectors.

Procedure

1. Use FNC to display the current segment pairs for the output channels.



2. Use UP/DOWN to move the cursor up.

3. Each time you press SET, the subdisplay will sequentially show "X", "Y", "X+Y", "X-Y", "(X+Y)/2", "(X-Y)/2", "-X", "-Y", "-(X+Y)", "-(X+Y)/2", and "X" again.
   Choose the desired segment selector or equation.

4. Use UP/DOWN to move the cursor down.



5. Repeat step 3.

Equations
It is possible to choose the desired equation having X and Y as variables. You can display and output the result of the equation through CH1 or CH2 or both. Eight equations are available as mentioned in step (3) of the above procedure.

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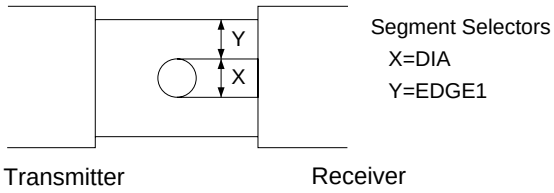
Equation	Display or output
-X -Y	Negative X or Y value, or Remainder of OFFSET value from which X or Y is subtracted (if OFFSET value is registered)
X+Y	Addition of X and Y
X-Y	Subtraction of Y from X
(X+Y)/2	Average of X and Y
(X-Y)/2	Subtraction of Y from X, then division by 2
-(X+Y)	Addition of X and Y, and negative of this result, or Negative remainder of OFFSET value from which addition of X and Y is subtracted (if OFFSET value is registered)
-(X+Y)/2	Negative average of X and Y Negative remainder of OFFSET value from which average of X and Y is subtracted (if OFFSET value is registered)

➪ *See P.43 or OFFSET value.*

Example of Operation

You are to measure the outer diameter of the round bar and its eccentricity with one scanning head. The measured value of the diameter will be displayed and output through CH1. The measured value of the eccentricity will be displayed and output through CH2. Suppose that the following parameters have been set for CH1:

MODE: NORMAL
AVE: 512 MOVE
OFFSET: 0.0000
LIMIT: HI 20.0000
LO -20.0000



Step	Key operation	Display
1	Use FNC to display current segment selectors.	▶X = D I A Y = D I A
2	Use UP/DOWN to move cursor up.	▶X = D I A Y = D I A
3	Use SET to display "X=DIA".	▶X = D I A Y = D I A
4	Use UP/DOWN to move cursor down.	X = D I A ▶Y = D I A
5	Use SET to display "Y=EDGE1".	X = D I A ▶Y = E D G E I
6	Use FNC to display current equations for output channels.	▶C H 1 = X C H 2 = X + Y
7	Use UP/DOWN to move cursor up.	▶C H 1 = X C H 2 = X + Y

(To be continued)

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8	Use SET to display "CH1=X"	▶C H 1 = X C H 2 = X + Y
9	Use UP/DOWN to move cursor down.	C H 1 = X ▶C H 2 = X + Y
10	Use SET to display "CH2=Y".	C H 1 = X ▶C H 2 = Y

After step 10, each time you press FNC, the subdisplay will show the current measurement mode (one of NORMAL, P-P, PEAK, BOTTOM), OFFSET value, and tolerance limits. Be sure to select the parameters for CH2 in the same manner as you do for CH1.

MODE, OFFSET, and LIMIT for CH2

Use FNC to select the MODE, OFFSET, and LIMIT parameters. Note that only 3-step differentiation is available for CH2 and that its output is sent through the corresponding control I/O connector pins.
Enter the desired parameters for MODE, OFS (OFFSET), and LIMIT.
➪ *See P.40 for MODE, P.43 for OFFSET, and P.29 or LIMIT.*

Procedure

1. First select the desired segment pair for the segment selectors and equations for the output channels.
   ➪ *See P.32 and P.35.*
2. Press FNC once to display the current measurement mode.
3. Each time you press SET, the subdisplay will show sequentially "NORMAL", "P-P", "PEAK", and "BOTTOM". Display the desired mode.
4. Press FNC again to display the current OFFSET value.
5. Enter the desired value, and press ENT to register.
   * OFFSET value is factory-set to "0.0000". Do not change it unless otherwise required.
6. Press FNC again to display the current tolerance limits.
7. Use UP/DOWN to move the cursor up.
8. Enter the desired value, and press ENT to register.
9. Use UP/DOWN to move the cursor down.
10. Enter the desired value, and press ENT to register.

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Example of Operation

Continued from P.39, you are to select "P-P" for measurement mode and "0.1 mm" for tolerance upper limit. By selecting 0.1 mm, the comparator output will be sent through CH2 if the measured value is above this limit.

Step	Key operation	Display
11	Press FNC once to display current mode.	CH2 MODE NORMAL
12	Use SET to display "P-P".	CH2 MODE P-P
13	Use FNC to display current OFFSET value.	CH2 OFFSET 0.0000
14	Do not change OFFSET value. Press FNC again to display current tolerance limits.	CH2 ▶H 60.0000 L -60.0000
15	Use UP/DOWN to move cursor up.	CH2 ▶H 60.0000 L -60.0000
16	Enter "0.1000".	CH2 ▶H [0.1000] L -60.0000
17	Press ENT to register.	CH2 ▶H 0.1000 L -60.0000

- When you finish setting the parameters, use DISP to show measured values for CH2 on the subdisplay.
- Even when the subdisplay shows the current settings or measured value in one of the measurement modes for CH1, the comparator output and BCD output will be sent based on the measured value for CH2.

⑬ MODE Key

Switching Measurement Modes

- **NORMAL**
  Measured value is displayed or output as is.
- **P-P (PEAK to PEAK)**
  The difference between the maximum (Peak) and minimum (Bottom) values measured during the specified period is displayed and output.
- **PEAK (PEAK HOLD)**
  The maximum value measured during the specified period is displayed and output.
- **BOTTOM (BOTTOM HOLD)**
  The minimum value measured during the specified period is displayed and output.

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- "Specified period" refers to the duration of time from when a measurement mode is set until when the mode is cancelled by pressing HOLD or inputting a signal through terminal TIM.

- Use FNC to set the measurement mode for CH2.

➪ *See P.39.*

Procedure

1. Press MODE to display the current measurement mode.

```
MODE  NORMAL
```

2. Each time you press SET, the subdisplay will show sequentially "NORMAL", "P-P", "PEAK", and "BOTTOM". Display the desired mode.

⑭ CAL (Calibration) Key

In this mode, the LS controller can be calibrated to correct possible measurement errors arising from irregularities on the target surface or inclination of the target. Have ready two gauges of known dimension for calibration. The LS controller can be calibrated for each of segment selectors X and Y.

Procedure

1. Press CAL to calibrate segment selector X. "CAL X" will appear on the subdisplay. At this time, the segment pair (SEG) remains the same. However, the number of measurements for averaging (AVE) and measurement mode (MODE) will be set respectively to "1024, MOVE" and "NORMAL". The LS controller will be reset to the initial parameters when the calibration is over. Also, the hold and auto-zero functions are cancelled, and the offset function is invalid during calibration.

```
CAL X ▶   0.0000
          0.0000
```

2. Place a reference gauge in the measurement area to display the measured value (on the main display). Make sure that the displayed value is not changing before you proceed to the next step.

3. Enter the known dimension of the reference gauge, then press ENT to register. The cursor will move down, and the initial value will disappear automatically when you press ENT.

```
CAL X     10.0000
          ▶
```

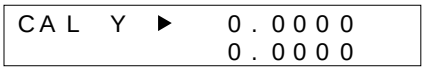
4. Place another reference gauge in the measurement area, enter its dimension, and press ENT to register.

5. When the parameters are correctly set, "CALIB OK" will appear on the subdisplay. If not, "CALIB ERROR" will appear. Check the measured value and reference gauges for any errors, and repeat steps 1 to 4.

```
CALIB   OK
```


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6. Press CAL to calibrate segment selector Y. "CAL Y" will appear on the subdisplay. You can display "CAL Y" by pressing CAL either when "CALIB OK" appears or when "CAL X" has just been displayed by pressing CAL. ("CAL X" and "CAL Y" display alternately each time you press CAL.)



7. Repeat steps 2 to 5 just as you do for calibrating segment selector X.

8. When you finish the calibration, press any of SEG, MODE, AVE, LIMIT, OFS, PRM, FNC, PROG, or DISP to return to the measurement mode.

Note

- To return to the factory calibration, enter "0.0000" on the upper and lower lines of the subdisplay.
- When "CALIB ERROR" appears on the subdisplay, press CAL to display the return to the previous status.
- When you use only one of the segment selectors X and Y, you can calibrate only the selector you use. When you finish the calibration, first check that "CALIB OK" appears on the subdisplay, then press any of the keys mentioned in Step 8 to return to the measurement mode.
- When you measure the diameter of two round bars with only one scanning head, the measurement position differs one from the other. To ensure higher accuracy, it is recommended that the reference gauge be placed at each position and segment selectors X and Y be calibrated separately.
- For even higher accuracy, the closer the dimension of the reference gauge to the target size, the better.
- You cannot enter negative values.
- The value entered on the lower line of the subdisplay must be greater than that on the upper line. If not, "CALIB ERROR" will appear.

Example of Operation

You are to measure a diameter of round bars that can vary from 10 mm to 20 mm. Two gauges, each having 10.0100 mm and 20.1000 in diameter are used for calibration.

Step	Key operation	Display
1	Press CAL to display "CAL X".	CAL X ▶ 0.0000 0.0000
2	Enter "10.0100".	CAL X ▶[10.0100] 0.0000
3	Press ENT to register. Cursor will move down.	CAL X 10.0100 ▶ 0.0000

(To be continued)

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4	Enter "20.1000".	CAL X 10.0100 ▶[20.1000]
5	Press ENT to register. "CALIB OK" will appear.	CALIB OK
6	Press CAL to display "CAL Y".	CAL Y▶ 0.0000 0.0000
7	Repeat steps 2 to 5 to calibrate Y.	

⑮ DISP (Subdisplay) Key

One of the following items appears on the subdisplay:

- Status of settings during panel key operation
- Measured value for CH1 in NORMAL, P-P, PEAK, or BOTTOM mode
  Measured value in any of the desired mode can be displayed regardless of the mode set using MODE. The comparator output and BCD output will be sent based on the mode set using MODE.
- Current settings for CH1
  Current parameters or modes set using SEG, MODE, or AVE can be displayed.
- Measured values for CH2
  Each time you press DISP, the values or parameters mentioned in (2), (3), and (4) will display alternately.

* These values or parameters cannot be changed on the subdisplay.

⑯ OFS (Offset) Key

Offset value is set in this mode. This value is added to the measured value, and the total value is displayed and output. Any value between -999.9999 and 9999.9999 can be specified as an offset value. If the diameter of a round bar or width of a sheet material is too large to measure with one scanning head, offset value can be used to measure it using two scanning heads. In this case, the diameter or width is displayed or output in absolute value.

* Use FNC to set the offset value for CH2.
➪ *See P.39.*

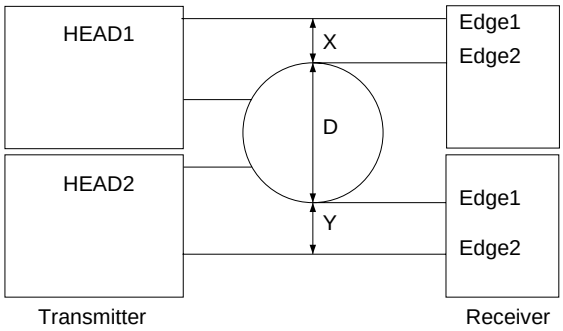
Procedure

1. Press OFS.
2. Enter the desired offset value.
3. Press ENT to register.

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Example of Operation

You are to measure the diameter of a round bar. This diameter, supposedly 100 mm, is displayed and output in absolute value.



Place two scanning heads as shown above.
Enter the following segment pair for the segment selectors and equation for the output channel:

Segment selector X= EDGE 1 or EDGE 2
Y= 2: EDGE 1 (when EDGE 2 is selected for X) or
2:EDGE 2 (when EDGE 1 is selected for X)
Output channel CH1= -(X+Y)

With the above parameters, you will obtain values X and Y in the figure. Value D, diameter of the target, is obtained by subtracting values X and Y from the width of the measuring area. To obtain the width of the measuring area, add values X, Y, and D. This width is used as the offset value.

See P.37 for the segment selectors and output channels.
Have ready a target of known diameter. Suppose that its diameter is 100.1000 mm, and that values X and Y are measured to be 35.2345 mm and 36.1234 mm, respectively.

Step	Key operation	Display
1	Use FNC to set segment pair for X and Y. ➪ *See P. 32.*	X = EDGE 1 ▶Y = 2 : EDGE 2
2	Use FNC to set equation for CH1 and CH2. Values X and Y are obtained. ➪ *See P.37.*	CH1 = X ▶CH2 = Y
3	Use DISP to display X and Y. Take a note of these values.	35.2345 CH2 36.1234 NOR
4	Use FNC again to set equation for CH1 and CH2. Target diameter is to be displayed and output through CH1.	▶CH1 = -(X+Y) CH2 = Y
5	Press OFS to display "OFFSET".	OFFSET 0.0000
6	Enter "171.4579". * 171.4579 is the total of X, Y, and D.	OFFSET [171.4579]
7	Press ENT to register, or press CLR and reenter correct value.	OFFSET 171.4579

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⑰ PROG (Program) Key

The LS controller can store the currently displayed settings. Up to 10 types of settings can be stored with each assigned a program number. Each type of settings can be retrieved through its program number for quicker operation.

* BAUD RATE, BUZZER ON/OFF, HOLD type, HEAD2 ON/OFF, and POSITION CHECK cannot be stored.

Storing (SAVE) Settings

1. Enter the desired parameters.
2. Press PROG to display "PROG".

```
PROG    1    ▶LOAD
              SAVE
```

3. Enter the desired program No.
4. Press ENT to register. At this moment, only the program No. has been selected.
5. Use UP/DOWN to move the cursor down to "SAVE".
6. Press SET to display "SA OK?". Press ENT to accept or CLR to cancel.

```
PROG    5     LOAD
            ▶SA  OK ?
```

7. When you enter ENT, the settings will be stored under the selected program No. When you press CLR, you can resume from step 3.

Example of Operation

Storing the current settings under program No.6.

Step	Key operation	Display
1	Press PROG.	PROG 2 ▶LOAD SAVE
2	Enter "6".	PROG [6] ▶LOAD SAVE
3	Press ENT.	PROG 6 ▶LOAD SAVE
4	Use UP/DOWN to move cursor down.	PROG 6 LOAD ▶SAVE
5	Press SET.	PROG 6 LOAD ▶SA OK ?
6	Press ENT to accept.	PROG 6 LOAD ▶SAVE

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Retrieving (LOAD) Settings

1. Press PROG to display "PROG".
2. Enter the desired program No.

```
PROG    1    ▶LOAD
             SAVE
```

3. Press ENT to accept. At this moment, only the program No. has been selected.
4. Use ON/OFF to move the cursor up to "LOAD".
5. Press SET to display "LO OK?". Press ENT to accept or CLR to cancel.

```
PROG    2    ▶LO OK?
             SAVE
```

6. When you press ENT, the settings stored under the specified program No. will be retrieved.
7. When you press CLR, you can resume from step 3.

Example of Operation

Retrieving program No.3

Step	Key operation	Display
1	Press PROG.	PROG 1 ▶LOAD SAVE
2	Enter "3".	PROG [3] ▶LOAD SAVE
3	Press ENT.	PROG 3 ▶LOAD SAVE
4	Use UP/DOWN to move cursor up to "LOAD".	PROG 3 ▶LOAD SAVE
5	Press SET.	PROG 3 ▶LO OK? SAVE
6	Press ENT to retrieve.	PROG 3 ▶LOAD SAVE

- Program can be retrieved by using the program selector input terminals or control I/O connector port. ➪ *See P.62.*
- See P.49 for storing and retrieving programs through the RS-232C interface.

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Table of I/O Terminals

Analog Voltage Output

Analog voltage signal for CH1 can be obtained through the MON terminals. The LS controller has been factory-set to convert a range from -60 mm to +60 mm into a voltage range from -6 V to +6V. (No voltage signal is provided for CH2. If voltage signal for CH2 is required, consult the KEYENCE distributor.)

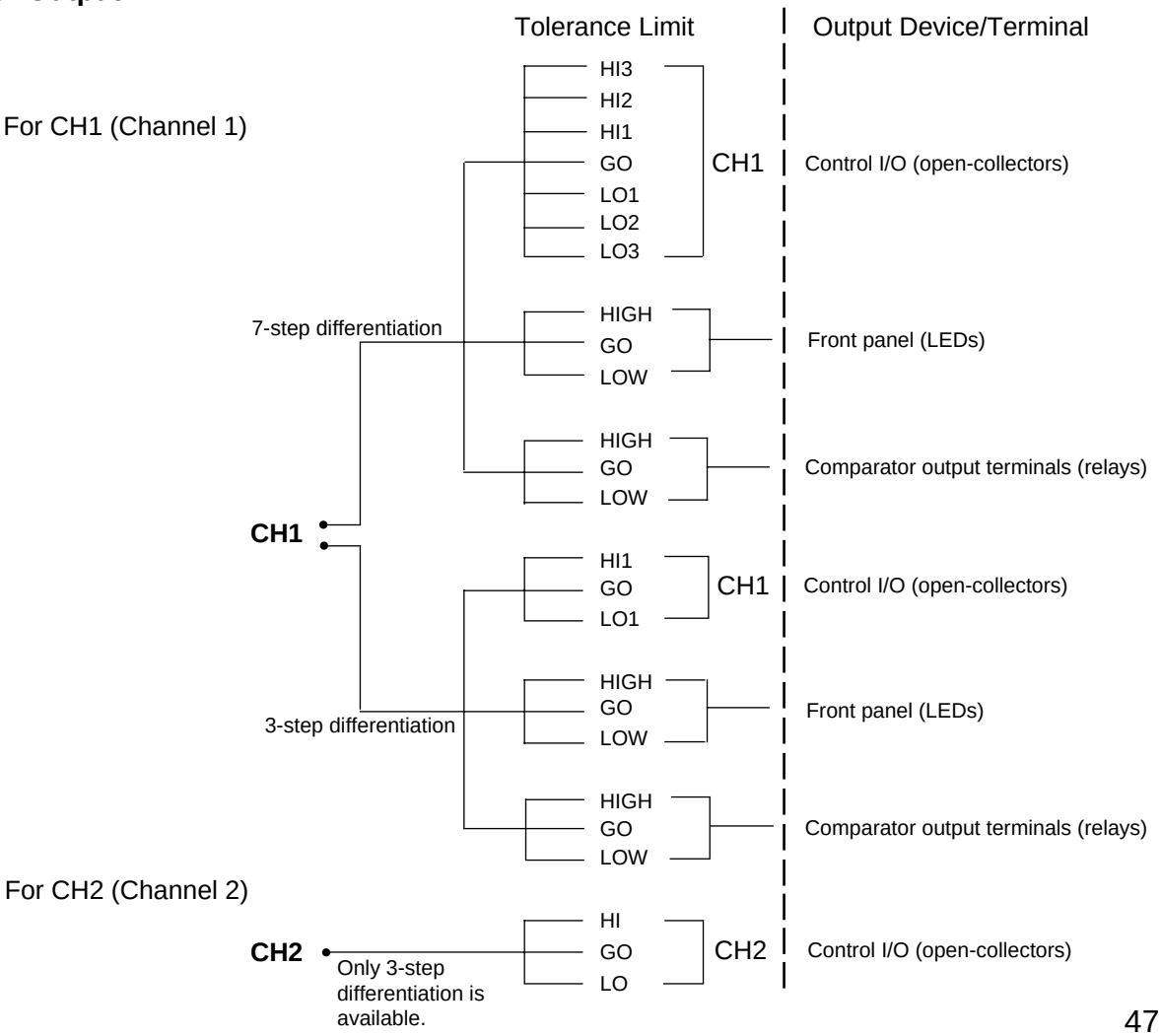
Analog voltage range: A range between -6 V and +6 V can be set to match a desired measurement range. Any value between -999.9999 and 9999.9999 can be selected. Note, however, that the difference between the maximum and minimum measurements (those that you specify to correspond respectively to +6 V and -6 V) must fall within a range between 0.024 mm and 240 mm.

Calibration: When the segment selectors are calibrated, the analog voltage signal through these terminals and RS-232C interface is automatically sent based on the calibrated value.

Offset: When the segment selectors are calibrated, the selected offset value is added to the analog voltage signal sent through these terminals and RS-232C interface.

The analog voltage which appears on the main display and that which is output through the MON terminals are always the same.

Comparator Output



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Program Selector Input Terminals

The desired program No. can be selected from external equipment using the following terminals:

<Terminal Block> program selector input:
Programs 1 to 5 selectable

<Control I/O> terminals #2 to #11:
Programs 1 to 10 selectable (program selector input)

Note that when two or more terminals are grounded at the same time, the program with the smallest number will be selected.

AUTO ZERO Terminals

Auto Zero function can be activated or deactivated from external equipment using the following terminals:

<Control I/O> zero set terminal:
Ground to activate Auto Zero function

<Control I/O> zero reset terminal:
Ground to deactivate Auto Zero function

Auto Zero function can be activated as many times as desired without being deactivated.

HOLD Terminal

Hold function can be activated or deactivated from external equipment using the following terminals:

<Terminal Block> HOLD synchronous input:
Ground to activate and open to deactivate HOLD function

<Control I/O> synchronous input:
Ground to activate and open to deactivate HOLD function

Unlike Auto Zero function, no terminal is provided for deactivating the Hold function. That is, while each of the above terminals is grounded, the Hold function remains activated. However, this function remains deactivated when the terminal is left open.

Laser Emission Control Input Terminal

The laser emission indicator LED lights when this terminal is left open, stopping the emission of the laser beam. For shipment, a jumper is provided.

<Terminal Block> Laser Remote:
Ground to stop and open to release the emission

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4-4. I/O Terminal

RS-232C I/O Terminal

The LS controller is provided with the RS-232C interface, which allows the LS controller to communicate with an external computer. Data transmission or change of the settings can be remotely performed.

Specifications

The LS controller employs the RS-232C interface (recommended standard by EIA: Electronic Industries Association) for data transmission. LS controller is defined as "MODEM".

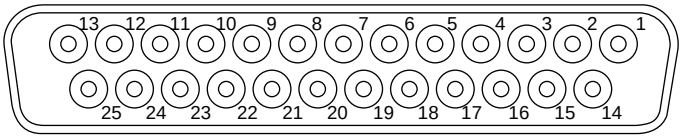
Communication parameters

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

*Selectable by setting

Pin Assignment

D-sub 25 pin female connector



Pin 20 is internally connected to the power source via a pull-up resistor. This pin remains ON unless it is grounded. Therefore, measurement data can be output regardless of whether pin 20 is connected to external equipment.

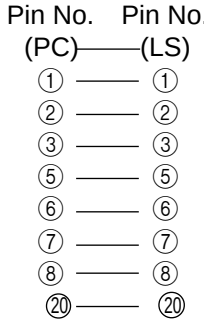
Pin No.	Modem signal code	Modem signal	Direction
1	Shield	Shield (to signal ground)	–
2	SD (TXD)	Input data from external equipment	Input
3	RD (RXD)	Output measurement data to external equipment	Output
5	CS (CTS)	ON (High) at power-on	Output
6	DR (DSR)	ON (High) at power-on	Output
7	SG (GND)	Signal ground	–
8	CD (DCD)	ON (High) at power-on	Output
20	ER (DTR)	Enables output of measurements to external equipment when ON (High)	Input

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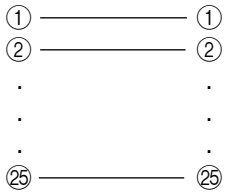
Connector Pin Assignment

Use straight type cable.

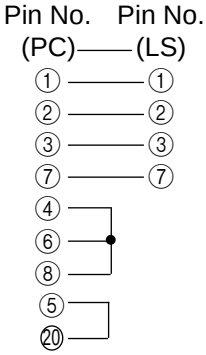
Connection example 1



In addition to the pin connections shown here, all identically-numbered pins of PC and LS controller can be connected.



Connection example 2



Remote Operation

The settings and data output can be performed using external equipment such as a computer, instead of the front panel keys of the LS controller. This operation method is referred to as remote operation. The items which can be remotely operated are divided into four sections (setting of measurement conditions, setting of output conditions, output of measurement data and output of setting status), and are described in the following.
"Format" used in the following description means input form.

Setting Measurement Conditions

Set the measurement conditions for the desired program. The format differs with the setting item, as described below.

Format:
([P$] [S$] [H$]) [COMMAND] CR

- Head No. (Scanning head No.)
- Segment No. (Segment Selector)
- Program No.

Note that one or more of the commands in ( ) can be omitted.
When [P$] is omitted, the current program No. will be valid.
When [S$] is omitted, the current segment selector will be valid.
When [H$] is omitted, the current scanning head will be valid.

[P$] [S$] [H$] List

Function	Command	Description
Specifying [P$] (Program No.)	P1	Specifies program No. 1
	P2	Specifies program No. 2
	P3	Specifies program No. 3
	P4	Specifies program No. 4
	P5	Specifies program No. 5
	P6	Specifies program No. 6
	P7	Specifies program No. 7
	P8	Specifies program No. 8
	P9	Specifies program No. 9
	PA	Specifies program No. 10
Specifying [S$] (Segment selector)	X	Specifies segment selector X
	Y	Specifies segment selector Y
Specifying [H$] (Scanning head No.)	1	Specifies scanning head No. 1
	2	Specifies scanning head No. 2

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[COMMAND] List

Function		Command	Description
Specifying segment check		SS SR Nn	Specifies segment check ON Specifies segment check OFF Specifies the number of segments ("n") for segment check
Specifying measurement segment		D E F Sm, n	Specifies DIA Specifies EDGE1 Specifies EDGE2 Specifies values ("m" and "n") for SEG (m, n) (m < n)
Commands for setting functions	Setting number of measurements for averaging	A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 AA	Sets 1 Sets 2 Sets 4 Sets 8 Sets 16 Sets 32 Sets 64 Sets 128 Sets 256 Sets 512 Sets 1024
	Setting averaging method	BS BM	Sets simple (SIMPLE) averaging Sets sequential (MODE) averaging (Valid only when the number of measurements is set to any of 16, 32, 64, 128, 256, 512 and 1,024)
	Setting program to be loaded	LDn	Loads program No. "n"
	Setting program to program No. "n"	SVn	Saves current settings into be saved
	Locking panel key operation	RS RR	Locks panel key operation Cancels locking of panel key operation
	Setting measurement unit	UM UI	Sets "mm" Sets "inch"
	Setting channel to which HOLD function is applied	J1 J2	Sets CH1 only Sets both CH1 and CH2
	Setting AUTO ZERO function	ZS ZR	Sets AUTO ZERO function Cancels AUTO ZERO function
	Setting HOLD function	HS HR	Sets HOLD function Cancels HOLD function

- When the command for locking of panel key operation is entered, any change of settings cannot be performed using the panel keys. At this time, setting indicator LOCK lights.
- If there is an error in the format, all the commands in that format are disregarded.
- Only one command for setting various functions can be entered for one format.

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Entry Examples

- To specify "1" for program No., "Y" for segment selector, "1" for scanning head No., and SEG (3, 4) for measurement segment: "P1Y1S3,4 CR"
- To specify "2" for program No., "X" for segment selector, and "OFF" for segment check: "P2XSR CR"
- To specify "3" for program No., "X" for segment selector, "1" for scanning head No., and "DIA" for measurement segment: "P3D CR"
- To set the number of measurements for averaging to 1,024, while not changing the other settings on the front panel: "AA CR"

Setting Output Conditions

Sets the output conditions (processing methods for measured values) for the desired program. The format differs with the setting item, as described below.

Format:
([P$] [C$]) [COMMAND] CR
- Channel No.
- Program No.

Note that one or more of the commands in ( ) can be omitted.
When [P$] is omitted, the current program No. will be valid.
When [C$] is omitted, the current channel No. will be valid.

[P$] [C$] List

Function	Command	Description
Specifying program No.	P1	Specifies program No. 1
	P2	Specifies program No. 2
	P3	Specifies program No. 3
	P4	Specifies program No. 4
	P5	Specifies program No. 5
	P6	Specifies program No. 6
	P7	Specifies program No. 7
	P8	Specifies program No. 8
	P9	Specifies program No. 9
	PA	Specifies program No. 10
Specifies output channel	V	Specifies output channel CH1
	W	Specifies output channel CH2

[COMMAND] List

	Function	Command	Description
Commands for setting functions	Setting tolerance differentiation output	IS	Sets tolerance differentiation output to ON
		IR	Sets tolerance differentiation output to OFF
	Setting tolerance differentiation level	T3	Sets 3-level differentiation
		T7	Sets 7-level differentiation (3 or 7)
	Setting tolerance range for 7-level differentiation	TAn	Sets value ("n") for HIGH3
		TBn	Sets value ("n") for HIGH2
		TCn	Sets value ("n") for HIGH1
		TDn	Sets value ("n") for LOW1
		TEn	Sets value ("n") for LOW2
		TFn	Sets value ("n") for LOW3
	Setting values ("m" and "n") for analog output voltage setting	ASm, n	Sets "m" for +6 V, and "n" for -6 V (m > n)

(To be continued)

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	Function	Command	Description
Commands for setting functions	Setting arithmetic operation method	C0 C1 C2 C3 C4 C5 C6 C7 C8 C9	Sets method "X" Sets method "Y" Sets method "X+Y" Sets method "X-Y" Sets method "(X+Y)/2" Sets method "(X-Y)/2" Sets method "-X" Sets method "-Y" Sets method "-(X+Y)" Sets method "-(X+Y)/2"
	Setting measurement mode	MN MP ME MB	Sets NORMAL mode Sets P-P mode Sets PEAK mode Sets BOTTOM mode
	Setting tolerance range for 3-level differentiation	Hn Ln	Sets value ("n") for HIGH (upper tolerance limit) Sets value ("n") for LOW (lower tolerance limit)
	Setting OFFSET value	On	Sets value ("n") for OFFSET value
	Setting display digit deletion	Gn	Sets the number of display digits to be deleted

Note:

- Entry of the bracketed commands ([ ]) can be omitted.
  - When no [command for specifying program No.] is entered, the program currently used on the front panel is specified.
  - When no [command for specifying output channel] is entered, CH1 is specified.

- When there is an error in the format, all the commands in that format are disregarded.

- Only one command for setting functions can be entered for one format.

Entry examples

- To specify "3" for program No., CH2 for output channel, and 10.0000 mm for OFFSET value: "P3WO10.0000 CR"

- To specify 1.2345 mm for LOW1 of tolerance range for 7-level differentiation, while not changing the other settings on the front panel: "TD1.2345 CR"

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Output of Measurement Data

Specifies the output method of the processed measurements which are displayed on the main display (CH1) and sub-display (CH2), and outputs them according to the specified method.

Input format: [COMMAND] CR

Function	Command	Description
Specifying data output method of data outputting	X0	Outputs measurement data of CH1 once
	X1	Outputs measurement data of CH1 continuously
	X2	Outputs measurement data of CH2 once
	X3	Outputs measurement data of CH2 continuously
	X4	Outputs measurement data of CH1 and then that of CH2 once
	X5	Outputs measurement data of CH1 and CH2 alternately and continuously
	X6	Stops continuous output

Output data format:

• At normal measurement

Measurement in "mm"

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
									CR
'-' or 10^3digit	10^2digit	10^1digit	10^0digit	Decimal point	10^{-1}digit	10^{-2}digit	10^{-3}digit	10^{-4}digit	

Measurement in "inch"

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
									CR
'-' or 10^2digit	10^1digit	10^0digit	Decimal point	10^{-1}digit	10^{-2}digit	10^{-3}digit	10^{-4}digit	10^{-5}digit	

When there is no 1st, 2nd and 3rd data, signal corresponding to blank (SPACE) is output, allowing these digits to be displayed as blank.

• At erroneous measurement

Measurement in "mm" or "inch"

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
-	-	-	-	-	-	-	-	-	CR

Measurement data processed on the basis of the current settings is output, according to the specified command, 10 ms max. after the command has been received.
When "X4" or "X5" command is entered, the values of CH1 and CH2 obtained when the command is received by the LS are output in order of CH1 and CH2.

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Output of Setting Status

Specifies and outputs the setting status of the desired program.
The format differs with the setting information to be output, as described below.

Format:

([P$] [Ø$]) [COMMAND] CR

- Output Channel
- Program No.

Note that one or both of the commands in ( ) can be omitted.
When [P$] is omitted, the current program No. will be valid.
When [Ø$] is omitted, CH1 will be specified.

[P$] [Ø$] List

Function	Command	Description
Specifying program No.	P1	Specifies program No. 1
	P2	Specifies program No. 2
	P3	Specifies program No. 3
	P4	Specifies program No. 4
	P5	Specifies program No. 5
	P6	Specifies program No. 6
	P7	Specifies program No. 7
	P8	Specifies program No. 8
	P9	Specifies program No. 9
	PA	Specifies program No. 10
Specifying output channel	V	Specifies CH1
	W	Specifies CH2

[COMMAND] List

Function	Command	Description
Specifying and outputting setting information	X?	Outputs setting information of segment selector X
	Y?	Outputs setting information of segment selector Y
	XS?	Outputs whether segment check for segment selector X is set to ON or OFF
	YS?	Outputs whether segment check for segment selector Y is set to ON or OFF
	XN?	Outputs preset value of segment check for segment selector X
	YN?	Outputs preset value of segment check for segment selector Y
	TA?	Outputs preset value of HIGH3 for 7-level differentiation
	TB?	Outputs preset value of HIGH2 for 7-level differentiation
	TC?	Outputs preset value of HIGH1 for 7-level differentiation
	TD?	Outputs preset value of LOW3 for 7-level differentiation
	TE?	Outputs preset value of LOW2 for 7-level differentiation

(To be continued)

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Function	Command	Description
Specifying and outputting setting information	TF?	Outputs preset value of LOW1 for 7-level differentiation
	I?	Outputs whether comparator output is set to ON or OFF
	T?	Outputs differentiation level (3- or 7-level)
	AS?	Outputs preset value for analog output voltage scaling
	A?	Outputs preset value for number of measurements for averaging
	B?	Outputs averaging method (simple or sequential)
	U?	Outputs measurement unit ("mm" or "inch").
	J?	Outputs setting information for HOLD/AUTO ZERO function.
	Z?	Outputs whether AUTO ZERO function is set to ON or OFF.
	HO?	Outputs whether HOLD function is set to ON or OFF.
	C?	Outputs which arithmetic operation method is set
	M?	Outputs measurement mode
	H?	Outputs preset upper tolerance limit for 3-level differentiation
	L?	Outputs preset lower tolerance limit for 3-level differentiation
	O?	Outputs preset OFFSET value
	G?	Outputs preset number of deleted display digits

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The output data format from the controller is as follows:

Output data format

● **Segment selector**

When DIA is specified:

1st data	2nd data	3rd data	4th data
D	I	A	CR

When EDGE1 is specified:

1st data	2nd data	3rd data	4th data	5th data	6th data
E	D	G	E	1	CR

When SEG (1, 2) for the 2nd scanning head is specified:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data	9th data
2	:	S	0	0	1	,	0	0	2	CR

● **Segment check**

When segment check is set to ON:

1st data	2nd data	3rd data
O	N	CR

When value for segment check is set to 4:

1st data	2nd data
4	CR

● **7-level differentiation**

Example: When HIGH3 is set to 60.0000 mm:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
SP	SP	6	0	.	0	0	0	0	CR

* For HIGH2, HIGH1, LOW1, LOW2, or LOW3, the data is output in the same way as the above.

* SP (SPACE) appears in the digit where there is no data.

● **Comparator output (ON or OFF)**

When it is set to ON:

1st data	2nd data	3rd data
O	N	CR

● **Differentiation level (3 or 7)**

Example: When differentiation level is set to 3:

1st data	2nd data
3	CR

● **Analog output voltage scaling**

Example: When 60.0000 mm is set for +6 V and -60.0000 mm for -6 V:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
SP	SP	6	0	.	0	0	0	0	,

11th data	12th data	13th data	14th data	15th data	16th data	17th data	18th data	19th data	20th data
-	SP	6	0	.	0	0	0	0	CR

* SP (SPACE) appears in the digit where there is no data.

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● **Number of measurements for averaging**
When 16 is set:

1st data	2nd data	3rd data
1	6	CR

When 1,024 is set:

1st data	2nd data	3rd data	4th data	5th data
1	0	2	4	CR

● **Averaging method**
When simple averaging is set:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data
S	I	M	P	L	E	CR

When sequential averaging is set:

1st data	2nd data	3rd data	4th data	5th data
M	O	V	E	CR

● **Measurement unit**
When "mm" is set:

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

When "inch" is set:

i	n	c	h	CR

● **Channel for HOLD or AUTO ZERO**
When HOLD or AUTO ZERO function is set for only CH1:

1st data	2nd data	3rd data	4th data
C	H	1	CR

When HOLD or AUTO ZERO function is set for both CH1 and CH2:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data
C	H	1	,	C	H	2	CR

● **AUTO ZERO function (ON or OFF)**
When AUTO ZERO function is set to ON:

1st data	2nd data	3rd data
O	N	CR

When AUTO ZERO function is set to OFF:

1st data	2nd data	3rd data	4th data
O	F	F	CR

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● **HOLD function (ON or OFF)**
When HOLD function is set to ON:

1st data	2nd data	3rd data
O	N	CR

● **Arithmetic operation method**
When "X" is set:

1st data	2nd data
X	CR

When "X+Y" is set:

1st data	2nd data	3rd data	4th data
X	+	Y	CR

When "(X+Y)/2" is set:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data
(	X	+	Y	)	/	2	CR

● **Measurement mode**
When NORMAL is set:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data
N	O	R	M	A	L	CR

When P-P is set:

1st data	2nd data	3rd data	4th data
P	-	P	CR

● **3-level differentiation**
Example: When upper limit is set to 10.0000 mm and lower limit to -10.0000 mm:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
SP	SP	1	0	.	0	0	0	0	CR
-	SP	1	0	.	0	0	0	0	CR

*SP (SPACE) appears in the digit where there is no data.

● **OFFSET function**
Example: When OFFSET value is set to 12.3456 mm:

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	8th data	9th data	10th data
SP	SP	1	2	.	3	4	5	6	CR

* SP (SPACE) appears in the digit where there is no data.

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● **Display digit suppress function**

When the number of suppressed display digits is 0:

1st data	2nd data
0	C_R

When the number of suppressed display digits is 3:

1st data	2nd data
3	C_R

Program Example in BASIC

Program 1

Pressing the space key of the computer allows the measured values to appear on the computer display.

```
100   OPEN "COM1:4800,N,8,1,RS,CS,DS,CD" FOR RANDOM AS #1
110   A$=INKEY$
120   IF A$<>" " THEN 110
130   PRINT #1, "X0"
140   INPUT #1, B$
150   PRINT B$
160   GOTO 110
```

Program 2

The following settings are specified through the computer: SEG (2, 3), NORMAL mode, upper and lower tolerance limits (20.0000 mm and 10.0000 mm), number of measurements for averaging (512), and simple averaging mode. After these settings are stored under program No. 3, the measured values are displayed.

```
100  OPEN "COM1:4800,N,8,1,RS,CS,DS,CD" FOR RANDOM AS #1
110  PRINT #1, "S2, 3"  ——— Sets SEG (2, 3)
120  PRINT #1, "MN"     ——— Sets NORMAL mode
130  PRINT #1, "H20"    ——— Sets upper limit to 20.0000 mm
140  PRINT #1, "L20"    ——— Sets lower limit to 10.0000 mm
150  PRINT #1, "A9"     ——— Sets the number of measurements
                            for averaging to 512
160  PRINT #1, "BS"     ——— Sets simple averaging method
170  PRINT #1, "SV3"    ——— Saves settings into program
                            No.3
180  For I=1 TO 2000: NEXT I
190  PRINT #1, "X0"
200  PRINT #1, A$  ————————┐
210  PRINT A$      ————————┴—Display measured values
220  GOTO 190
```


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Program 3

The following settings are specified through the computer: simultaneous measurement of DIA and EDGE1, 100 samplings for each of DIA and EDG1, and display of maximum, minimum and average values of these measurements.

```
100   DIM D$ (100), E$ (100)
110   OPEN "COM1:4800,N,8,1,RS,CS,DS,CD" FOR RANDOM AS #1
120   PRINT #1, "X1D" ——— Sets segment selector X, measurement part 1, and DIA
130   PRINT #1, "Y1E" ——— Sets segment selector Y, measurement part 1, and EDGE1
140   PRINT #1, "VC0" ——— Sets output channel CH1 and arithmetic operation "X"
150   PRINT #1, "VMN" ——— Sets output channel CH1 and NORMAL mode
160   PRINT #1, "WC1" ——— Sets output channel CH2 and arithmetic operation "Y"
170   PRINT #1, "WMN" ——— Sets output channel CH2 and NORMAL mode
180   PRINT "START or END ? (Press [S] or [E] key)"
190   PRINT                                                    Displays prompt for
200   A$=INPUT$ (1)                                            starting or ending
210   IF A$="E" OR A$="e" THEN END                             measurement
220   IF A$<> "S" AND A$<> "S" THEN 200
230   PRINT #1, "X5" —— Sets continuous output of CH1 and then CH2 data
240   FOR I=1 TO 100
250     INPUT #1, D$ (I)      — Inputs data
260     INPUT #1, E$ (I)
270   NEXT I
280   PRINT #1, "X6" —— Stops continuous output
290    FOR I=1 TO 500 :NEXT I                                  Processors or discards
300   IF EOF (1) = 0 THEN INPUT #1, DAMMY$ : GOTO 300          data received after
310   DMAX=-10000 :DMIN=10000 :DSUM=0                          continuous output has
320   EMAX=-10000 "EMIN=10000 :ESUM=0                          been stopped
330   FOR I=1 TO 100
340   D=VAL (D$ (I))
350   IF D>DMAX THEN DAMX=D
360   IF D<DMIN THEN DMIN=D                                    Performs arithmetic
370   DSUM=DSUM+D                                              operation to obtain
380   E=VAL (E$ (I))                                           maximum, minimum, and
390   IF E>EMAX THEN EMAX=E                                    average values
400   IF E<EMIN THEN EMIN=E
410   ESUM=ESUM+E
420   NEXT I
430   DAVE=DUSM/100
440   EAVE=ESUM/100
450   PRINT                  "[DIA]        [EDGE]"
460   PRINT USING "MAX = ####,#### mm ####, #### mm" ; DMAX, EMAX     Displays
470   PRINT USING "MIN = ####, #### mm ####, #### mm" ; DMIN, EMIN    maximum,
480   PRINT USING "AVE = ####, #### mm ####, ####  mm" ;DAVE, EAVE    minimum and
490   PRINT                                                           average
500   GOTO 180                                                        values
```

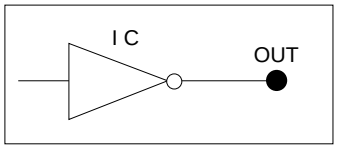
Note: The baud rate is set to 4800 bps in these 3 examples. Set the baud rate according to your requirements.

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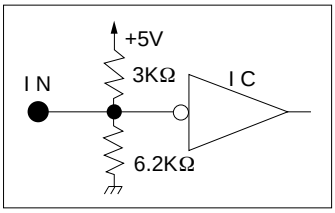
36-pin Connector (Control I/O)

Specifications

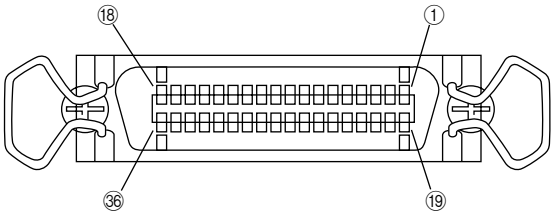
Output
- TTL open-collector (7406 or equivalent)
- Max. applicable voltage: 30 V
- Max. sink current: 40 mA



Input
- TTL voltage level, negative logic (74LS19 or equivalent)



Pin assignment



Pin No.	Signal	Pin No.	Signal
1	GND	19	Comparator output for CH1: LO2
2	Program No. 1 selector input: P1	20	GND
3	Program No. 2 selector input: P2	21	Comparator output for CH1: LO1
4	Program No. 3 selector input: P3	22	GND
5	Program No. 4 selector input: P4	23	Comparator output for CH1: GO
6	Program No. 5 selector input: P5	24	GND
7	Program No. 6 selector input: P6	25	Comparator output for CH1: HI1
8	Program No. 7 selector input: P7	26	GND
9	Program No. 8 selector input: P8	27	Comparator output for CH1: HI2
10	Program No. 9 selector input: P9	28	GND
11	Program No. 10 selector input: P10	29	Comparator output for CH1: HI3
12	Synchronous input: TIM	30	GND
13	GND	31	Comparator output for CH2: LO
14	AUTO ZERO input: ZERO SET	32	GND
15	GND	33	Comparator output for CH2: GO
16	AUTO ZERO RESET input: ZERO RESET	34	GND
17	Comparator output for CH1: LO3	35	Comparator output for CH2: HI
18	GND	36	GND

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Input Signal

Program (No. 1 to 10) selector input: P1 to P10

- Used to select the desired program from external equipment.
- When pin 2 (3, 4, ••• or 11) is grounded with GND for an instant, program No. 1 (2, 3, ••• or 10) is selected.
- When two or more pins are grounded at the same time, the program with the smallest number will be selected.

Synchronous input: TIM

- When pin 12 (TIM) is grounded with pin 13, the measured value is retained. This value can be retained until pin 12 is disconnected from pin 13. (The measured value is also retained when terminal 3 on the back panel is grounded with terminal 4).

AUTO ZERO input: ZERO SET

- When pin 14 (ZERO SET) is grounded with pin 15 (ZERO SET pulled LOW), the measured value is reset to "0" (mm or inch) for use as a reference. This allows a variation from this reference to be output as a measured value.
- The AUTO ZERO input uses a one-shot circuit that accepts only the first LOW signal and ignores the following ones. This input, therefore, must be reset first to input another AUTO ZERO input signal.

AUTO ZERO RESET Input: ZERO RESET

- When pin 16 (ZERO RESET) is grounded with pin 15 (ZERO RESET pulled LOW), the AUTO ZERO input is cleared, and normal measurement is resumed.
- The AUTO ZERO RESET input uses a one-shot circuit that accepts only the first LOW signal and ignores the following ones. This input, therefore must be reset first before inputting another AUTO ZERO RESET signal.

Output Signal

Comparator outputs: LO3, LO2, LO1, GO, HI1, HI2, HI3, LO, GO, and HI

- Each comparator output is sent through the corresponding open-collector.
- LO 3 to HI3 are used for 7-step differentiation with CH1. LO, GO, and HI are used for 3-step differentiation CH2 at simultaneous 2-point measurement.
- LO1, GO, and HI1 can be used also for 3-step differentiations.

Functions of Terminal Blocks

Analog Voltage Output Terminals

Analog voltage proportional to the measured value is output.
±6 V is equal to ±60 mm (when voltage range of ±6 V is set to ±60 mm measuring range).

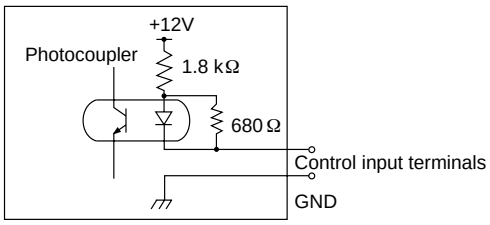
Output impedance: 0 Ω, Current capacity: 10 mA

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Control Input Terminals

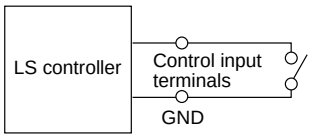
Input specifications

Internal circuit

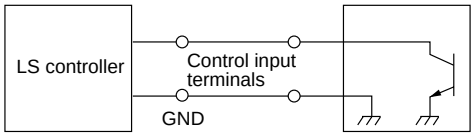


Example of connection

•Contact (relays or switches)



•Solid-state (transistors) Open-collector output



Hold Synchronous Input Terminals

- When terminal 3 is grounded with terminal 4, the displayed and output values are retained.
- When terminal 3 is disconnected from terminal 4, normal measurement is resumed.
- When the LS controller is set to the P-P, PEAK, or BOTTOM mode, the previous measured value is reset by grounding terminal 3 with terminal 4 and then disconnecting these terminals.

Program Selector Input Terminals

The desired program No. 1 to 5 can be selected from external equipment using these terminals.
When terminal 5 (6, 7, 8, or 9) is grounded with terminal 10 for an instant, program No. 1 (2, 3, 4, or 5) is selected and retrieved.

* When two or more terminals are grounded at the same time, the program with the smallest number will be selected.

Laser Emission Control Input Terminals (LASER REMOTE)

When terminals 11 and 12 are connected, the laser emission indicator LED on the front panel lights. And, laser is emitted approx. 5 seconds after the connection is made. When terminal 11 is disconnected form terminal 12, the laser emission indicator LED goes out, and the laser emission stops.

The LS controller is delivered with a jumper inserted between terminals 11 and 12.

Control Output Terminals

Output Specifications

Relay: SPST-NO contact, 250 VAC, 2 A (resistive load)

Comparator Output Terminals

- HIGH OUT terminals: HI

Comparator output is sent through these terminals when the measured value is above the upper tolerance limit.

- LOW OUT terminals: LO

Comparator output is sent through these terminals when the measured value is below the lower tolerance limit.

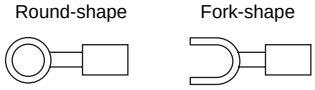
- GO OUT terminals: GO

Comparator output is sent through these terminals when the measured value is within the tolerance range.

Note

Use a crimp contact for wiring as shown below. Be sure to use a cable with at least 0.4-mm sheath.

Round-shape Fork-shape



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CHAPTER 5

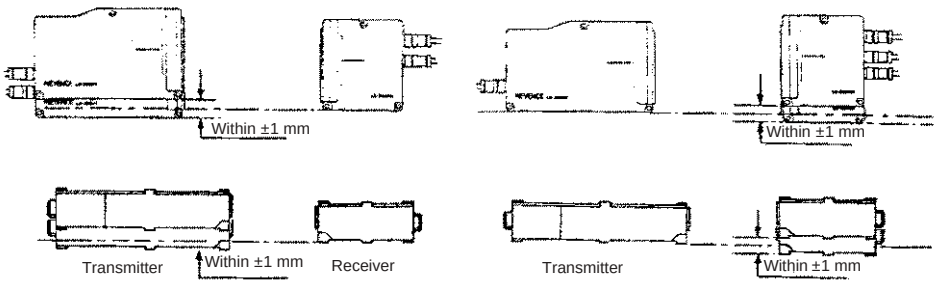
MOUNTING SCANNING HEAD

5-1. Alignment of Optical Axis (LS-3060 and LS-3033 only)

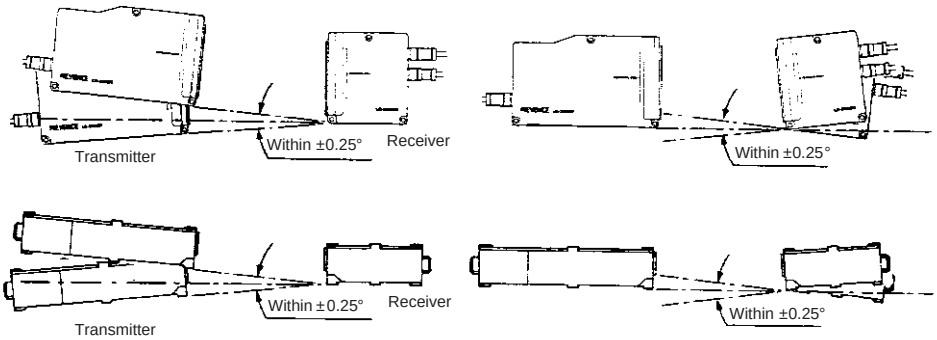
The LS-3060 is delivered with the transmitter and receiver (scanning head) mounted to the detachable frame. When using the LS-3060 with the transmitter and receiver removed from the frame on when using the LS-3033, be sure to align them in terms of the optical axis of the laser. (See the figure below.) Misalignment of the optical axis will cause measurement errors. (A special optical axis checker is available with the LS-3060 and LS-3033. Refer to "5-2. Checking Alignment of Optical Axis" on page 66 for the alignment procedures.)

Allowance for Aligning Transmitter and Receiver

Deviation in height or width



Inclination in height or width



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5-2. Checking Alignment of Optical Axis (LS-3033 and LS-3060 only)

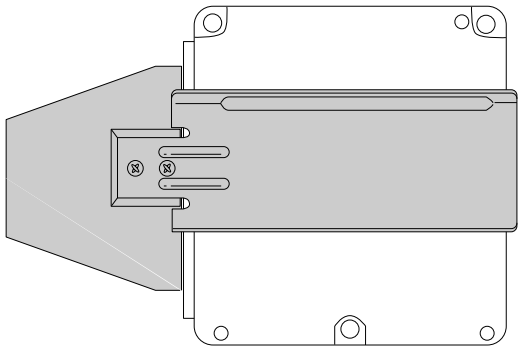
Not applicable to LS-3033 SO (8073).

Use the POSITION CHECK function to check whether the transmitter and receiver (scanning head) are aligned in terms of the optical axis.
The procedure is as follows:

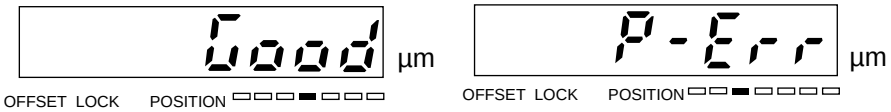
1. Use PRM to display "HEAD1" and "POSITION CHECK" on the subdisplay.

HEAD 1 POSITION CHECK

2. Attach the optical axis checker to the receiver.



3. When the transmitter and receiver are aligned in terms of the optical axis, "GOOD" will appear. If not, "P-Err" will appear.



4. When 2 scanning heads are used, press PRM again to display "HEAD2" and "POSITION CHECK". (To use 2 scanning heads, the optional PC board for the second scanning head is required.) Then, use the optical axis checker to check whether the transmitter and receiver of the second scanning head are aligned in the same manner as those of the first scanning head.

HEAD 2 POSITION CHECK

When you use the LS-3033SO (8073), note the following:

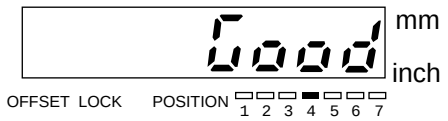
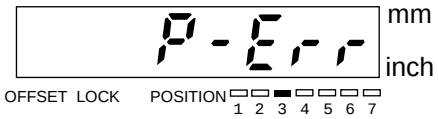
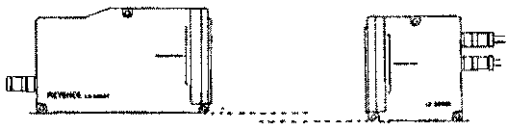
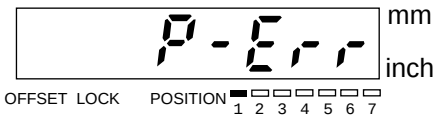
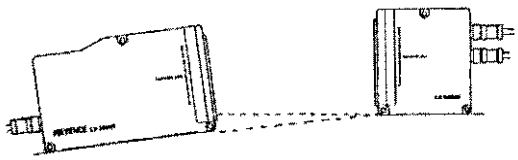
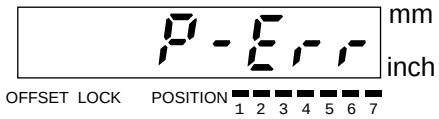
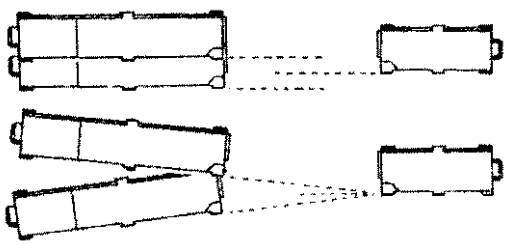
1. Optical axis alignment — Install the transmitter and receiver so that the both reference base edge are aligned. This also completes the optical alignment. The optical axis checker, which is provided for standard LS-3033, cannot be used for LS-3033SO (8073). No optical axis checker is provided for LS-3033SO (8073) for this reason.

2. Transmitter-to-receiver distance — Set this distance to 120 mm.

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Error Messages
(For Models LS-3060 and LS-3033)

In the POSITION CHECK mode, the target position indicator LEDs show whether the transmitter and receiver (scanning head) are aligned in terms of the optical axis.

Display	Description
 "GOOD" appears, and target position indicator LED 4 lights.	The transmitter and receiver are aligned .
 "P-Err" appears, and LED 3 or 5 lights.	 When the transmitter is positioned higher than the receiver as shown above, LED 3 lights. When the transmitter is positioned lower than the receiver, LED 5 lights.
 "P-Err" appears, and LED 1 or 7 lights.	 When the transmitter is tilted with the laser emitting surface facing upward as shown above, LED 1 lights. When the transmitter is inclined with the surface facing downward, LED 7 lights.
 "P-Err" appears, and all the LEDs light.	 When the transmitter and receiver are positioned as shown above, all the LEDs light.

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CHAPTER 6

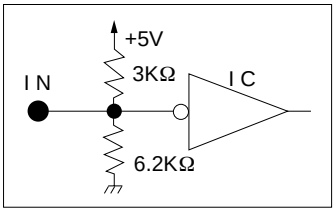
OPTIONAL INTERFACE BOARDS

The optional interface boards shown in this chapter can be factory-attached by the manufacturer at your request.

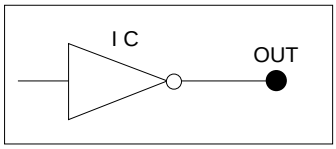
6-1. BCD Output

Specifications

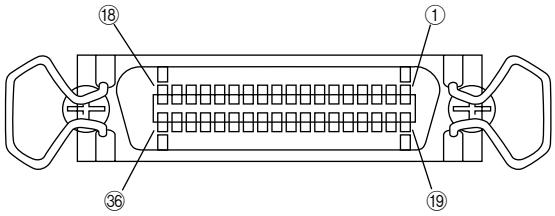
Input
TTL voltage level, negative logic
(74LS19 or equivalent)



Output
TTL voltage level, positive logic
(74LS04 or equivalent)



Pin Assignment



Pin No.	Signal	Pin No.	Signal
1	BCD output: 10^{-4} (1)	19	BCD output: 10^{0} (4)
2	BCD output: 10^{-4} (2)	20	BCD output: 10^{0} (8)
3	BCD output: 10^{-4} (4)	21	BCD output: 10^{1} (1)
4	BCD output: 10^{-4} (8)	22	BCD output: 10^{1} (2)
5	BCD output: 10^{-3} (1)	23	BCD output: 10^{1} (4)
6	BCD output: 10^{-3} (2)	24	BCD output: 10^{1} (8)
7	BCD output: 10^{-3} (4)	25	BCD output: 10^{2} (1)
8	BCD output: 10^{-3} (8)	26	BCD output: 10^{2} (2)
9	BCD output: 10^{-2} (1)	27	BCD output: 10^{2} (4)
10	BCD output: 10^{-2} (2)	28	BCD output: 10^{2} (8)
11	BCD output: 10^{-2} (4)	29	BCD output: 10^{3} (1)
12	BCD output: 10^{-2} (8)	30	BCD output: 10^{3} (2)
13	BCD output: 10^{-1} (1)	31	BCD output: 10^{3} (4)
14	BCD output: 10^{-1} (2)	32	BCD output: 10^{3} (8)
15	BCD output: 10^{-1} (4)	33	Strobe output signal ($\overline{\text{STROBE OUT}}$)
16	BCD output: 10^{-1} (8)	34	External trigger enable input ($\overline{\text{ETE IN}}$)
17	BCD output: 10^{0} (1)	35	External trigger input ($\overline{\text{EXT TRIG IN}}$)
18	BCD output: 10^{0} (2)	36	GND

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Output Signal

BCD Output

- BCD positive logic signal that represents measured values
  Measured value is output every 20 ms when the MOVE averaging mode (number of measurements for averaging: 16 to 1,024) is set, or every "2.5 ms x number of measurements for averaging" when the SIMPLE averaging mode is set.
- When the measured value is negative, "1011" is output as the 10^3 digit.

Strobe Signal (STROBE OUT)

Negative logic signal with pulse width of approx. 500 μs that represents output timing of BCD signal

Input Signal

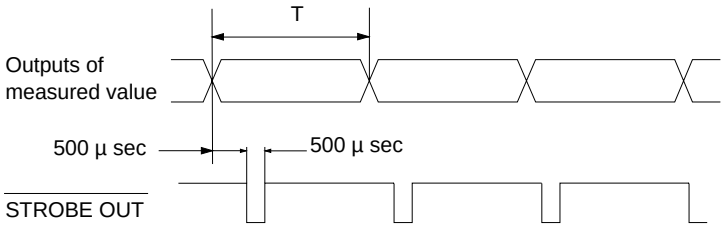
External Trigger Enable Input (ETE IN)

Input	Level	Output
ETE IN	HIGH (Input level is HIGH even when this pin is open.)	Measured value is output every 20 ms when the MOVE averaging mode (number of measurements for averaging: 16 to 1,024) is set, or every "2.5 ms x number of measurements for averaging" when the SIMPLE averaging mode is set.
	LOW	Measured value is output only when EXT TRIG IN signal is received.

- When ETE IN is pulled low inputting EXT TRIG IN signal allows measured values to be output at the desired timing.
- Pull ETE IN low, if STROBE OUT signal cannot be received by external equipment when ETE IN is pulled high.

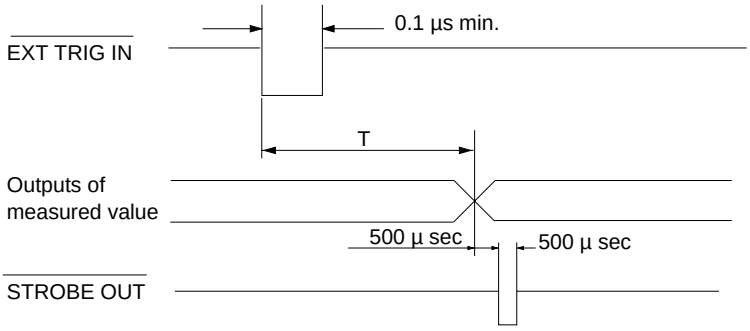
Timing Diagram

- When ETE IN is pulled high:



T:
(MOVE averaging)
Number of measurements for averaging
=16 to 1,024: 20 ms
(SIMPLE averaging)
2.5 ms x number of measurements for avaraging

- When ETE IN is pulled low:



T:
(MOVE averaging)
Number of measurements for averaging = 1 to 8 : 2.5 ms(max.)
Number of measurements for averaging = 16 to 1,024 : 20 ms(max.)
(SIMPLE averaging)
2.5 ms x number of measurements for averaging (max.)

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External Trigger Input (EXT TRIG IN)

When EXT TRIG IN is pulled low with ETE IN pulled low, the measured value is output after a max. of 20 ms (MOVE averaging, number of measurements for averaging: 16 to 1,024), or a max. of "2.5 ms x number of measurements for averaging" (SIMPLE averaging). The output value is retained until EXT TRIG IN is pulled low again.

6-2. GP-IB Interface I/O

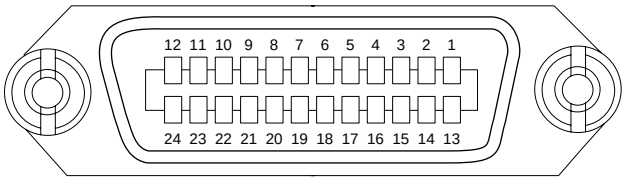
Specifications

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

Transmission code	ASCII
Logic level	Logic 0 (HIGH state): +2.4 V min. Logic 1 (LOW state): +0.4 V max. (Bidirectional transceiver is used.)
Number of connectable devices	15 max. (including controller)
Total cable length	20 m max.*
Cable length between 2 devices	4 m max.

* Varies according to the number of interconnected devices.

Pin Assignment



Pin No.	Signal	Function
1	DIO1	Data bus
2	DIO2	Data bus
3	DIO3	Data bus
4	DIO4	Data bus
5	EOI	Indicates that the data transmission is completed.
6	DAV	Indicates that the data is valid.
7	NRFD	Indicates that the data reception is impossible.
8	NDAC	Indicates that the data reception is not completed.
9	IFC	Initializes the interface.
10	SRQ	Allows devices on the line to request interrupt to the controller.
11	ATN	Determines whether the data is interface message or device message.
12	Shield	Shield
13	DIO5	Data bus
14	DIO6	Data bus
15	DIO7	Data bus
16	DIO8	Data bus

(To be continued)

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Pin No.	Signal	Function
17	REN	Allows the controller to remotely enable or disable devices on the line.
18	GND (DAV)	Ground for control bus
19	GND (NRFD)	Ground for control bus
20	GND (NDAC)	Ground for control bus
21	GND (IFC)	Ground for control bus
22	GND (SRQ)	Ground for control bus
23	GND (ATN)	Ground for control bus
24	Logic GND	Signal ground

Interface Functions

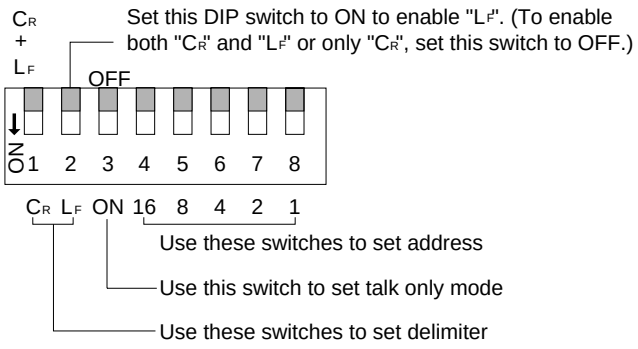
The interface bus functions of the LS controller are as follows:

Code	Functions	
SH1	All transmission-handshaking functions	Provided
AH1	All reception-handshaking functions	Provided
T5	Basic talker function	Provided
	Serial polling function	Provided
	Talk only function	Provided
	Function that releases a device from being a talker as soon as the device is specified as a listener	Provided
L4	Basic listener function	Provided
	Function that releases a device from being a listener as soon as the device is specified as a talker	Provided
SR1	All service-request functions	Provided
RL0	Function that allows the controller to remotely enable or disable devices on the line	Not provided
PP0	Parallel polling function	Not provided
DC1	All device-clear functions	Provided
DT1	All device-trigger functions	Provided
C0	Controller function	Not provided
E2	3-state driver	Provided

Initial Setting

Be sure to turn OFF the power of the LS controller, then set these switches.

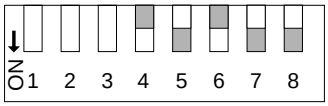
Since the GP-IB allows up to 15 devices to be interconnected, an address must be assigned to each device. To assign the address, use the DIP switches on the back panel of the LS controller. (See the figure below). The talk only mode or delimiter can also be set using these switches.



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Setting Address

Use the 1st to 5th DIP switches from the right (4, 5, 6, 7 and 8 in the figure) to set the address. Addresses "0" to "30" can be set. To set the address to "11", set the DIP switches as shown below.
With the LS controller, the address has been factory-set to "0".



Setting Talk Only Mode

To set the LS controller to the talk only mode, set the 3rd DIP switch from the left (3 in the figure) to ON (down).
With the LS controller, the talk only mode has been factory-set to OFF (up).

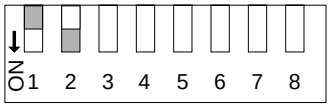
* When the LS controller is set to the talk only mode, outputs are sent only through CH1.

Setting Delimiter

Use the 1st and 2nd DIP switches from the left (1 and 2 in the figure) to select the delimiter for data transmission.

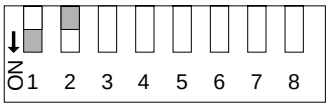
- **To set the delimiter to "LF":**

Set the 1st and 2nd DIP switches respectively to OFF and ON (as shown below).



- **To set the delimiter to "CR":**

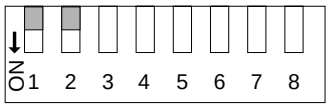
Set the 1st and 2nd DIP switches respectively to ON and OFF (as shown below).



- **To set the delimiter to "CR + LF":**

Set both the 1st and 2nd DIP switches to OFF (as shown below).

* With the LS controller, the delimiter has been factory-set to "CR + LF".



EOI (End of Identify) can be output from the controller simultaneously when the delimiter is transmitted from the LS controller. Select the appropriate command to select how EOI is output.
Thus, you can select whether EOI is output simultaneously when the delimiter is transmitted. In addition, you can output EOI alone from the controller without transmitting the delimiter from the LS controller.

Interface Messages

The responses to commands sent from the controller (computer, etc.) are as follows:

Command		Response
IFC	InterFace CLear	Initializes the interface, selected device or all devices on the line.
"SDC"	Selcted Device CLear	
"DCL"	Device CLear	
"GET"	Group Execute Trigger	Reads measured values into the GP-IB buffer.

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Listener-talker Functions

Setting Functions and Outputting Measured Values or Other Data

By sending commands from an external device (computer, etc.) to the LS controller, you can remotely set the various functions, or output measured values or other data from the LS controller.
* For sending commands, ASCII character codes can be used.

The commands and formats are the same as those for the RS-232C. See section "RS-232C" in this manual.

The following commands can be used on the GP-IB in addition to those for the RS-232C.

Command	Description
ES	Transmits EOI (End of Identify) simultaneously when the delimiter is transmitted.
EO	Transmits EOI (End of Identify) only.
ER	Cancels EOI (End of Identify) transmission.
QS	Enables SRQ (Service Request) transmission.
QR	Disables SRQ (Service Request) transmission.
K1	Outputs measured value of CH1 once when "GET" is received.
K2	Outputs measured value of CH2 once when "GET" is received.
K3	Outputs measured value of CH1 once and then that of CH2 once when "GET" is received.

- When the power is turned ON, "ES", "QR", and "K1" (see the table above) are set.
- When "SRQ" transmission is enabled, bits DIO7 and DIO1 are set to "1" if the transmitted command has a syntax error.

Format:

Commands for setting functions [CR] *

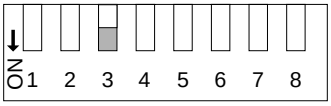
With the RS-232C the delimiter for data output from the LS controller is "CR". However, the delimiter varies according to the setting when the GP-IB is used.

* The delimiter for commands sent from an external device (computer, etc.) to the LS controller can be any of "CR", "LF", "CR + LF" and "EOI".

Talk Only Mode

To set the LS controller to the talk only mode, set the 3rd DIP switch from the left (3 in the figure) on the back panel to ON.
When the LS controller is set to the talk only mode, it only talks, continuously outputting the preset values. The listener function does not work.

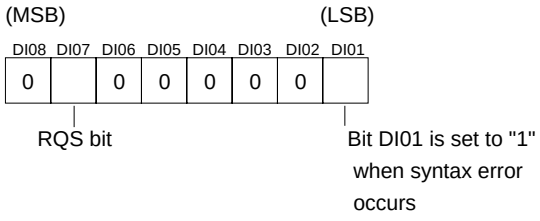
Note that outputs are sent only through CH1 when the LS controller is in the talk only mode.



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Status Byte

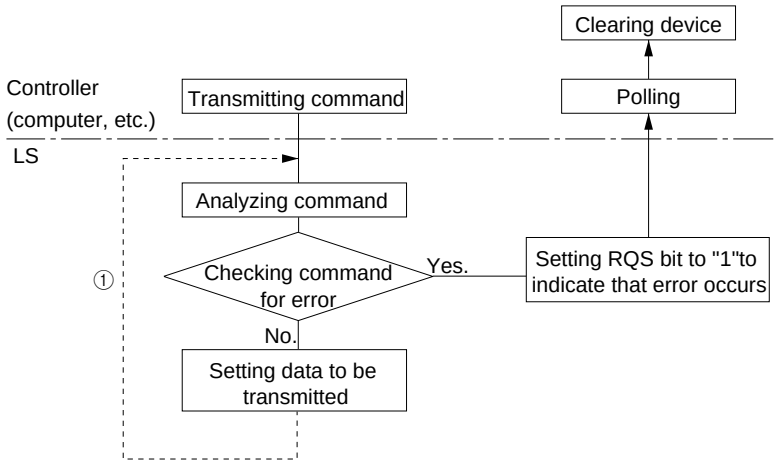
When the LS controller receives serial polling signal from the controller, the LS controller transmits a status byte.
The content of the status byte is as shown below.



Basic Sequence

When Selecting and Setting Function

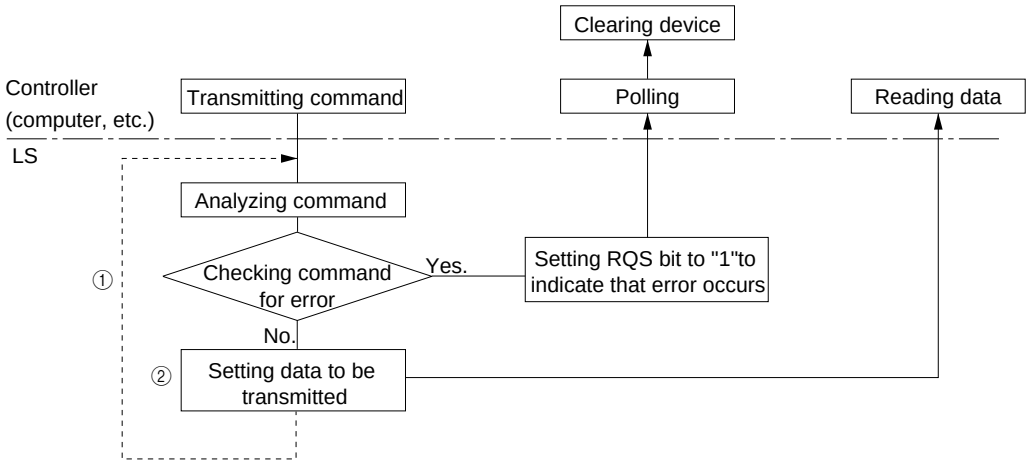
When 2 or more commands are transmitted, loop 1 is executed repeatedly.



When Reading Output Data

Data cannot be read into the LS controller in the talk only mode.

When 2 or more commands are transmitted, loop 1 is executed repeatedly.
When the command to continuously output measured values (such as "X1") is transmitted, operation 2 is executed repeatedly.



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Example of Program

When connecting LS controller with external computer

Program

The following settings are specified through the computer: DIA (segment mode), CH1=X (output channel mode), NORMAL (measurement mode), MOVE (averaging mode), 512 (the number of measurements for averaging). Then, the measured value is displayed once on the computer.

```
100  ISET IFC
110  CMD DELIM=0
120  WBYTE &H3F, &H41, &H20, &H4;
130  PRINT @0;"D"
140  PRINT @0;"C0"
150  PRINT @0;"MN"
160  PRINT @0;"A9"
170  PRINT @0;"BM"
180  PRINT @0;"X0"
190  LINE INPUT @0;A$
200  PRINT A$; "mm"
210  END
```

Program line#	Description
100	Clears interface.
110	Sets delimiter to "CR +LF".
120	Sets talker address for PC to "1". Sets listener address for LS controller to "0".
130	Transmits commands to LS controller. "D": Sets "DIA" as segment mode.
140	"C0": Sets "CH1=X" as output channel mode.
150	"MN": Sets NORMAL as measurement mode.
160	"A9": Sets 512 as the number of measurements for averaging.
170	"BM": Sets MOVE as averaging mode.
180	"X0": Allows LS controller to output measured value once.
190	Receives measured value once from LS controller.
200	Displays measured value.
210	Terminates program.

The above program provides the following status:
Talker address for PC: 1
Listener address for LS controller: 0
Delimiter sent from LS controller: CR + LF
Talk only mode of LS controller: OFF

Take the following precautions when using the LS controller.

Be sure to turn OFF the power of the LS controller to set the address or delimiter using the DIP switches on the back panel.

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CHAPTER 7

HINTS ON CORRECT USE

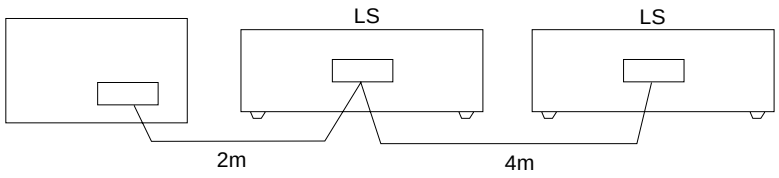
General

- When noise interference may occur in the surroundings, connect the LS controller to an external device (computer, etc.) using an electromagnetic-interference protection cable(s). Be sure to turn OFF the power of the LS controller before connecting it to an external device.
- Supply power to the computer or other device(s) before supplying power to the LS controller. If power is supplied to the LS controller first, it may malfunction due to noise occurring when another device starts up.

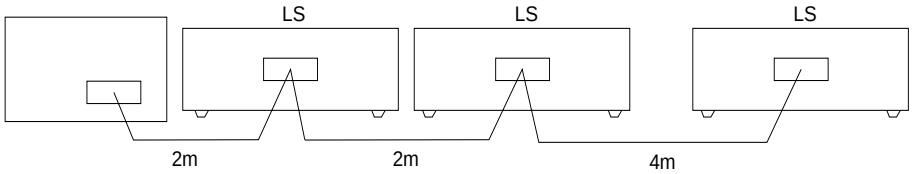
GP-IB Interface I/O

- Up to 15 devices can be interconnected using the GP-IB bus.
- The total cable length for connecting the devices should be 20 m or shorter, provided that it does not exceed "2 m x number of devices". Also, the length of each cable should not exceed 4 m. When 3 devices are connected, for example, the maximum total cable length is 6 m, and when 4 devices are connected, it is 8 m. (See the figure below.)
  To make long-distance transmission of data, use an appropriate signal transmission system instead of the GP-IB bus.

Connecting 3 devices



Connecting 4 devices



When using the GP-IB, set the address and delimiter applicable to the program to be executed or device(s) to be connected.

Targets

When the shape or glossiness of targets varies, measurement error may occur. In such a case, place a target of known dimension in the measuring area and calibrate the LS controller using CAL. (Two targets of different size are required.)

Measuring Conditions

When the target is vibrating, measured values may vary significantly. In such a case, set the number of measurements for averaging to a larger number to ensure highly accurate measurement.

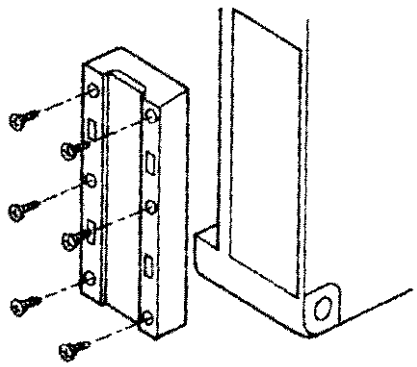
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Compatibility

- With the LS series, the controller and scanning head are calibrated as a pair. To satisfy the specifications, therefore, be sure to combine a controller and scanning head having the same serial number.
- The transmitter and receiver are also calibrated as a pair.
- When using 2 scanning heads, connect them respectively to the specified connector port of the controller.

Operating Environment

- Be sure to operate the LS controller in a place where the temperature is within a range between 0 and 45°C. (0 to 40°C for LS-3036/3060)
- Fluctuation in ambient temperature may cause measurement error. Always maintain the ambient temperature at a constant level. If the ambient temperature changes by 10°C, it takes approx. 60 minutes for the temperature distribution in the LS controller to become uniform.
- Be sure to keep the laser emitting surface (transmitter) and the laser receiving surface (receiver) free from any substance refracting light (such as water or oil).
- Blow off dirt or dust on the protective glass using clean air. If dirt or dust still remains, wipe it off using a soft cloth moistened with alcohol.
- The protective glass can be replaced. See the figure below to replace the glass.



Countermeasures against Noise

- Do not mount the scanning head to the place where a certain level of electrical noise is applied or transferred. Isolate the scanning head if electrical noise may be occured. Otherwise, laser diode may deteriorate or become damaged.
- Keep the wiring or connection cable away from high-voltage lines or power lines to prevent the LS controller from malfunctioning because of noise.
- Be sure to earth-ground the LS controller through the earth ground terminal (No. 19). Insulating the scanning head is also effective in reducing noise.

Fuse

When the fuse is blown, replace it with the following one:
Midget fuse: F-7142 2A or equivalent

Cooling Fan

Do not block the cooling fan on the back panel. Blocking it will overheat the LS controller, causing malfunction.

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CHAPTER 8

ERROR MESSAGES

H-Err

- If no scanning head is connected to the controller or the connected scanning head malfunctions, an error message appears on the main display (CH1).

  When 1 scanning head is used:
  If no scanning head is connected or the connected scanning head mal functions, "H-Err" appears.

  When 2 scanning heads are used:
  When "HEAD2 ON" is selected using PRM:
  If no scanning head is connected to the HEAD1 connector port or the scanning head connected to that port malfunctions, "H-Err" appears.

  If no scanning head is connected to the HEAD2 connector port or the scanning head connected to that port malfunctions, "H2-Err" appears.

  When "HEAD2 OFF" is selected using PRM:
  Since the LS controller judges that no scanning head is to be connected to the HEAD2 connector port, "H-Err" appears.

- When "H-Err" or "H2-Err" appears, turn OFF the power. Then, make sure that the problem with the scanning head is removed or that the scanning head is connected properly, then turn ON the power.

- Turn OFF the power to cancel error message "H-Err" or "H2-Err".

P-Err

When the transmitter and receiver are not aligned in terms of the optical axis, "P-Err" appears on the main display (CH1). Align them correctly.

Note: Ignore this message when using model LS-3033 SO.

CALIB ERROR

When the LS controller is not calibrated correctly, "CALIB ERROR" appears on the main display (CH1). Carefully read the description for the calibration procedures, and calibrate the LS controller again using a proper gauge.

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CHAPTER 9

TROUBLESHOOTING GUIDE

If any conditions occur that could be considered as equipment failure or malfunction, follow the inspection procedures given below.

Check item	Problem	Details of inspection	Corrective action	Reference page
Measurement value display	• Measured value is not displayed. • Nothing appears on the display.	• Is the power switch ON? • Is the AC power cable connected?	• Turn ON the switch. • Connect the AC power cable.	p. 5
	"------" is displayed.	• Are targets in position? • Is the entire scanning area completely covered? • Is the appropriate measuring segment selected? • Is the scanning head properly connected? • Is there any dust or dirt on the laser emitting/receiving window? • Is the laser emission indicator LED lamp lit? • Wasn't "------" displayed immediately after turning ON the power switch? • Wasn't "------" displayed immediately after switching the measurement modes? • Wasn't "------" displayed immediately after shorting the laser emission remote control terminal? • Isn't the number of measurements for averaging set to a large value? • Is there condensation forming on the equipment?	• Correctly place the targets within the effective measurement area. • Correctly select the appropriate measuring segment. • Turn the power switch OFF, then after connecting the scanning head, turn the power switch ON • Remove dust or dirt from the laser emitting/receiving window. • Short LASER REMOTE terminals. • Wait approximately 10 seconds after turning ON the power switch before operation. • Wait approximately 3 seconds after changing measurement modes before resuming operation. • Wait approximately 10 seconds after shorting this terminal. • In the Average mode, maximum of approximately 2.6 seconds are required until the measurement value is displayed after the target is positioned in the measurement area. • Change the location.	p. 84 p. 28 p. 15 p. 21

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Check item	Problem	Details of inspection	Corrective action	Reference page
Measurement Value Display	The measurement display value contains unusual dispersion.	• Are the targets correctly placed in the measurement area? • Is a standard edge placed within the measurement area? • Is there any dust or dirt on the laser aperture? • Is there any dust or dirt on the targets? • Is there a large fluctuation of ambient temperature?	• Correctly place the target within the measurement area. • Place a standard edge within the measurement area. • Remove any dust or dirt. • Remove any dust or dirt. • Maintain the constant operating temperature.	
	Abnormal measurement values are being displayed.	• Do the serial numbers match between the controller and scanning head? • Has calibration been correctly performed? • Is the laser beam correctly aligned? • Is the target tilted or has it moved from the original position? • Are the targets correctly placed within the measurement area? • Is a reference edge placed within the measurement area? • Is there any dust or dirt on the target? • Isn't the controller set to the analog output range setting mode?	• Connect a scanning head with the matching serial number. • Correctly perform calibration. • Check whether or not the laser beam is correctly aligned in the laser beam alignment check mode. If the beam is not correctly aligned, refer to the error message as indicated in the display and adjust the mounting conditions accordingly. • Correctly place the targets. • Correctly place the targets within the measurement area. • Place a reference edge within the measurement area. • Remove any dust or dirt from the target. • Set the appropriate measurement mode.	p. 14 p. 41 p. 65 p. 84
	"H-Err" is displayed.	Is the scanning head properly connected?	Turn the power OFF, then after correctly connecting the scanning head, turn the power ON.	p. 78
Analog output	No output. (0 V output)	Is the measurement value displayed?	To make sure that the target is correctly measured, correctly position the controller and targets.	
	Voltage above +6 V or below -6 V is output.	Is the analog output range correctly set?	Check that the analog output range is correctly set.	p. 22

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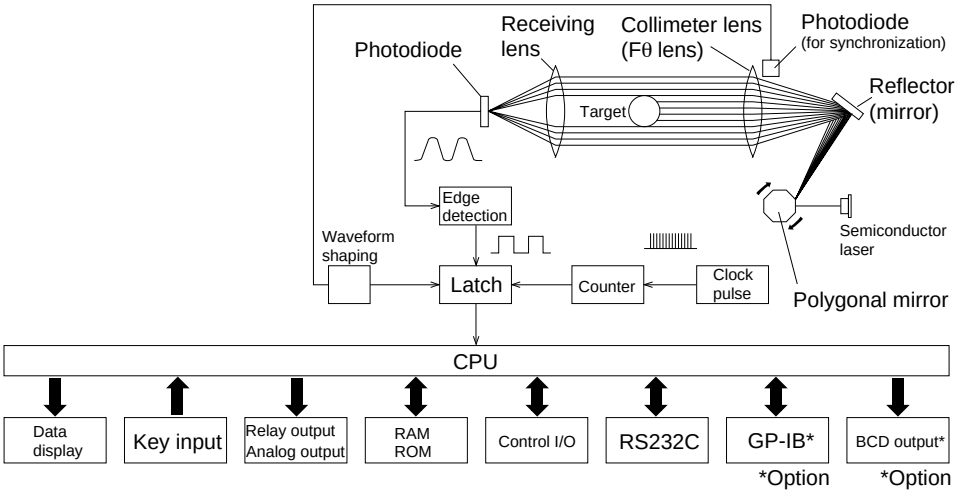
Check item	Problem	Details of inspection	Corrective action	Reference page
Computer output	Computer data is not output.	• Is the baud rate correctly set?	• Set the controller and computer to the same baud rate. Note, however, that some computers may not recognize correct measurements when set to a high baud rate.	p. 27
		• Is the cable connector securely connected to the port?	• Check that the cable connector is securely connected to the port.	p. 49
		• Has the computer been turned ON before the controller?	• Be sure to turn ON the computer first, then controller.	
		• Is the correct program used?	• Send a message such as "X0" from the computer to access the controller.	

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APPENDIX A

OPERATING PRINCIPLE

Laser beam emitted by semiconductor is reflected first by the polygonal mirror, then by the reflector mirror. Laser beam is scanned according to the rotational angle of the polygonal mirror during this process. Then, scanned beams pass through the collimator lens so that they run parallel to each other. These beams are directed at the target and converged onto a photodiode by another lens. The beams thus collected are converted into an electric signal corresponding to the light-dark pattern produced.
The dimension of the target is determined by the width of "dark" region measured in terms of time.



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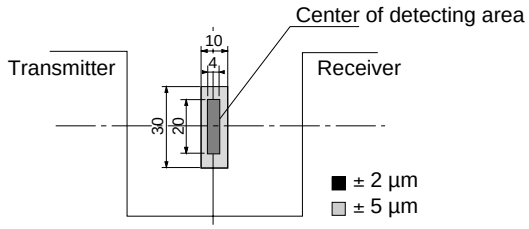
APPENDIX B

CHARACTERISTICS

Measuring Area vs. Accuracy

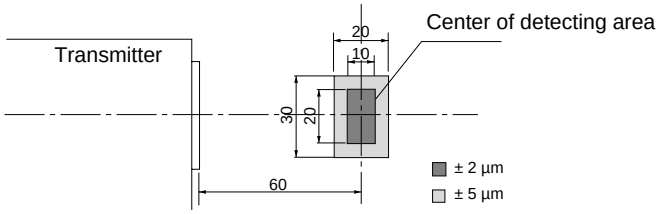
Data

LS-3032



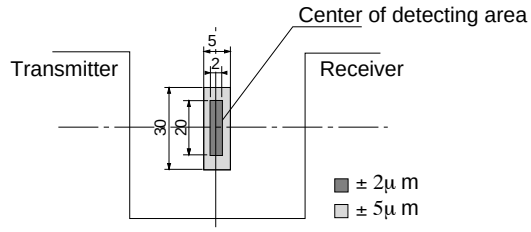
When a rod 10 mm in diameter is measured.

LS-3033



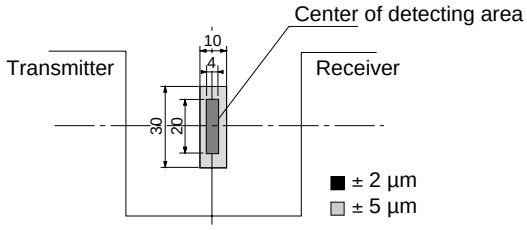
When a rod 10 mm in diameter is measured with a transmitter-to-receiver distance set to 120 mm.

LS-3034/3033 SO



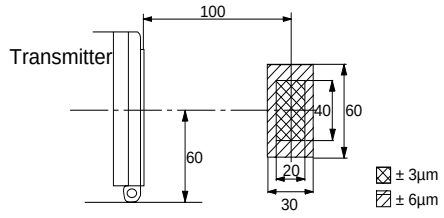
When a rod 10 mm in diameter is measured.

LS-3036



When a rod 10 mm in diameter is measured.

LS-3060



When a rod 20 mm in diameter is measured.

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Temperature Characteristics (Typical)

When a rod 10 mm in diameter is measured at the center of the measuring area [reference temperature: 20°C (68°F)].

LS-3032

Temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)
Drift	+2.2 μm	+1.1 μm	0	-1.4 μm	-3.2 μm

LS-3033*

Temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)
Drift	+2.0 μm	+0.8 μm	0	-1.0 μm	-2.2 μm

LS-3034

Temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)
Drift	+2.6 μm	+1.3 μm	0	-1.4 μm	-3.2 μm

LS-3036

Temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)
Drift	+3.7 μm	+1.7 μm	0	-1.7 μm	-3.5 μm

When a rod 20 mm in diameter is measured at the center of the measuring area [reference temperature: 20°C (68°F)].

LS-3060

Temperature	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)
Drift	+8.6 μm	+4.3 μm	0	-4.2 μm	-8.4 μm

* Contact us for the data of LS-3033SO (8073)

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APPENDIX C

SPECIFICATIONS

Controller

Type			**Multi-functional (for connecting 2 scanning heads)**
Model			**LS-3100(W) [LS-3100D(W)]**
Display	**Measured value**		Main display: 7-segment green LED (8 digits) Subdisplay: 16 character x 2 line LCD (Backlight color: yellow-green)
	Minimum display unit		0.0001 mm (0.00001 inches)
	Display range		-999.9999 to 9999.9999
	Measuring range		mm/inch selectable
	Target position indicator		Green LED (7 levels)
	Comparator output indicator		Green LED x 3 (HI/GO/LO)
	Laser emission indicator		Green LED x 2 (HEAD 1/HEAD 2)
Terminal block I/O	**Control input**	**Hold synchronous**	Non-voltage input (contact/solid state)
		LASER REMOTE	
		PROGRAM SELECT (Program Nos. 1 to 5)	
	Control output	**Analog voltage**	±6 V, Output impedance: 0 Ω
		Control output	Relay output: SPST-NO contact x 3, 250 VAC, 2 A (resistive load)
36-pin connector I/O	**Control input**	**Hold synchronous**	TTL voltage level, negative logic
		AUTO ZERO SET/RESET	
		PROGRAM SELECT (Program Nos. 1 to 5)	
	Control output	**7-level**	NPN open-collector: 40 mA max. (30 V max.)
		3-level	
Interface port	**RS-232C**		Measurement data output and control input (baud rate: 75 to 19200 bps selectable)
	GP-IB[1.]		Measurement data output and control input
	BCD[1.]		Measurement data output (8 digits)
Power supply			85 to 264 VAC, 50/60 Hz
Power consumption			65 VA max.
Ambient temperature			0 to +40°C (32 to 104°F), No freezing
Relative humidity			35 to 85%, No condensation
Weight			Approx. 4.6 kg

1. Available as an option.

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Scanning Head

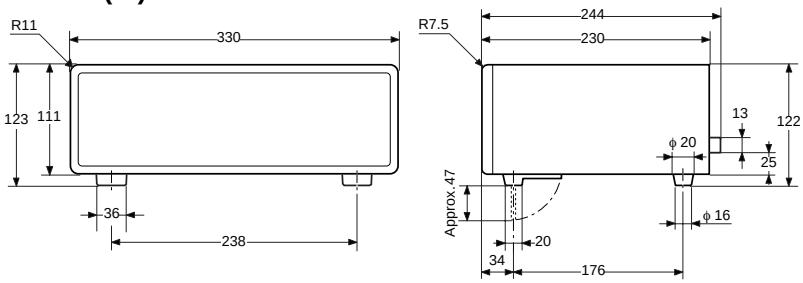
Type		Fine measuring		Standard			Wide range
Scanning head type		Single-body	Separate	Single-body	Separate	Single-body	Separate
Model		LS-3034	LS-3033 SO (8073)	LS-3032	LS-3033	LS-3036	LS-3060
Measuring range	Unit: mm	0.08 to 30[1.]		0.3 to 30	0.5 to 30	0.3 to 30	0.8 to 60
	Unit: in	0.00315 to 1.18110		0.01181 to 1.18110	0.01969 to 1.18110	0.01181 to 1.18110	0.03150 to 2.36220
Minimum target width	Unit: mm	0.08		0.3	0.5	0.3	0.8
	Unit: in	0.00315		0.01181	0.01969	0.01181	0.03150
T and R distance		60	120	60	120±40	60	200±50
Light source		Invisible infrared semiconductor laser				Visible red semiconductor laser	
Maximum output		3.0 mW, Continuous wave				0.5 mW, Continuous wave	
Wavelength		780 nm				670 nm	
Class	FDA	Class I				Class II	
	IEC 825-1 11.1993	Class 1					
	DIN EN 60825-1 07.1994	klasse 1					
Measuring accuracy		± 2 μm max.[2.]					± 3 μm max.[3.]
Repeatability		0.3 μm					0.5 μm
Display resolution		0.1 μm					
Laser scan rate		400 scans/s					
Laser scan velocity		63 m/s					126 m/s
Laser scan range		Approx. 33 mm					Approx. 65 mm
Enclosure rating		IP-60					
Ambient temperature		0 to +45°C (32 to 113°F), No freezing				0 to +40°C (32 to 104°F), No freezing	
Relative humidity		35 to 85%					
Weight		0.8 kg	Transmitter: 0.5 kg Receiver: 0.4 kg	0.8 kg	Transmitter: 0.5 kg Receiver: 0.4 kg	0.8 kg	Approx. 2.5 kg (including the base)

1. When the outer diameter is measured.
2. When a rod 10 mm in diameter is measured in 2 x 20 mm, 4 x 20 mm, or 10 x 20 mm measuring area.
3. When measuring a rod 20 mm in diameter in 20 x 40 mm measuring area.

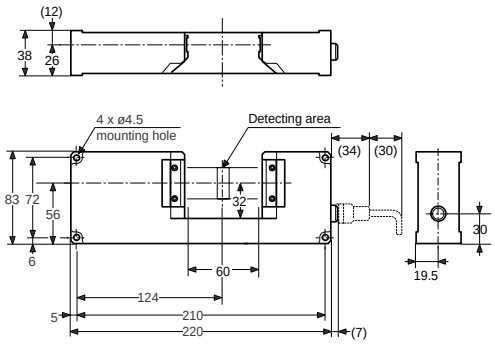
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DIMENSIONS

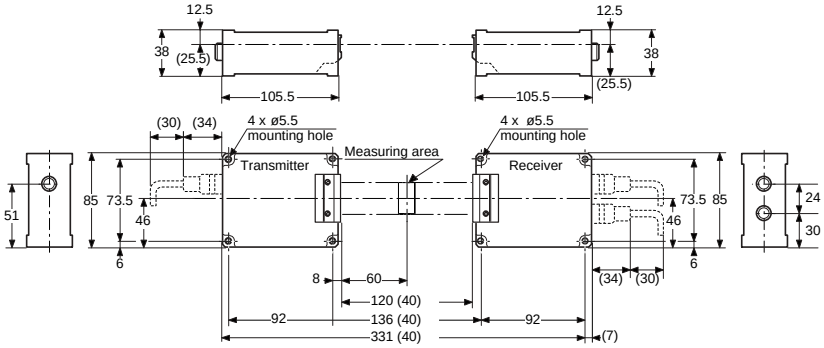
Controller
LS-3100(W)



Scanning Head
LS-3032/3034/3036

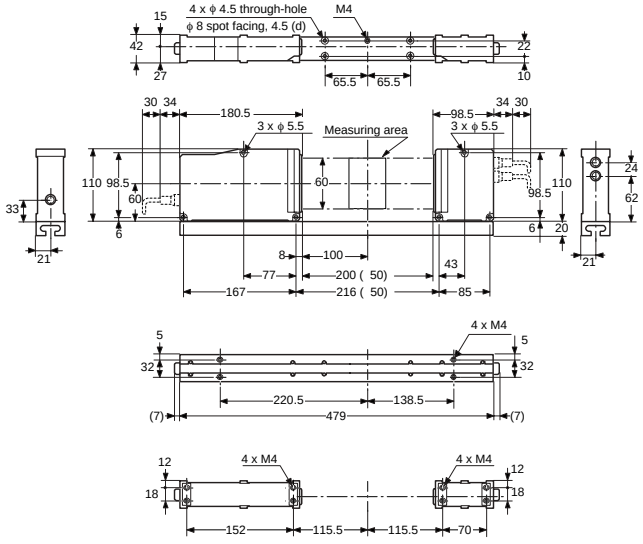


LS-3033/3033 SO (8073)

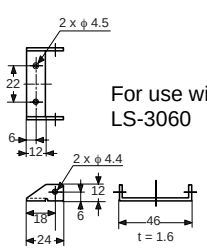


The transmitter-to-target distance for the LS-3033SO(8073) cannot be changed.

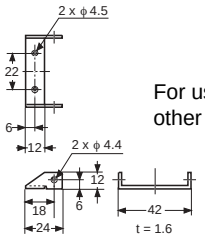
LS-3060



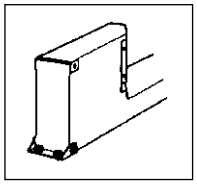
Scanning Head Mounting Bracket



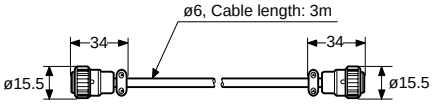
For use with LS-3060



For use with other models



Bracket mounted on scanning head



- For connecting the controller and the scanning head: 3 m
- For connecting the transmitter and the receiver
  LS-3033/3033SO(8073): 3 m
  LS-3060: 0.7 m

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APPENDIX E

QUICK REFERENCE TABLE

Modes (Function) and Key Operations

- This table shows what keys are used to set parameters for each functions.
- First, press the key indicated by ▭ once, then press the key indicated by ▭→ twice or more to display the desired function.
- See also the flowchart of each key for better understanding the status of settings at each step and also learning how to enter parameters.

Mode		Page	Output channel		Remarks
			CH1 (main display)	CH2 (subdisplay)	
AVERAGE (Number of measurements)		P.21	AVE → SET		Number and type selected in this mode are used for all measurements.
SIMPLE, MOVE (Type of averaging)		P.21	AVE → SET		
Analog scale		P.22	PRM → PRM	———	Analog output through CH2 is not available.
LIMIT (Tolerance limits)	7 CLASSES (7-step)	P.23	PRM → PRM	———	7-step comparator output is sent through CH1 only.
	3 CLASSES (3-step)	P.29 P.39	LIMIT	FNC → FNC	
HOLD (Use of HOLD for CH2)		P.27	HOLD is always available.	PRM → PRM	HOLD can be activated or deactivated for CH2.
BAUD RATE		P.27	PRM → PRM		
UNIT		P.27	PRM → PRM		Unit can be switched between mm and inch.
BUZZER (Beep)		P.28	PRM → PRM		Beep during panel key operation can be turned ON/OFF.
HEAD2 (Use of head 2)		P.28	PRM → PRM		"ON" must be selected when 2nd scanning head is used.
POSITION CHECK (Optical axis alignment)		P.28	PRM → PRM		Available with LS-3060 and LS-3033 only. (except for LS-3033 SO)
DIGIT SUPPRESS (Display of decimal points)		P.26	PRM → PRM		Measured value can be displayed without decimals.
SEGMENT		P.30	SEG → SET		Segment entered using SEG can also be entered using segment selector X.
Segment selector		P.32	FNC → FNC	Example ▶ X = DIA Y = 2:EDGE1	
Output channel		P.37	FNC → FNC	Example ▶ CH1 = X CH2 = X+Y	Equation can be selected using segment selectors X and Y.

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Mode	Page	Output channel		Remarks
		CH1 (main display)	CH2 (subdisplay)	
SEGMENT CHECK	P.35	PRM → PRM		Number of edges can be checked during measurement.
MODE (Measurement mode)	P.40	MODE → SET	FNC → FNC	NORMAL, P-P, PEAK, and BOTTOM are available.
CALIBRATION	P.41	CAL → CAL		Segment selectors X and Y can be calibrated.
DISPLAY (Switching items on subdisplay)	P.43	DISP → DISP		For items that can be displayed, see P.89.
OFFSET	P.43	OFS	FNC → FNC	
PROGRAM (Storing and retrieving program)	P.45	PROG		
ZERO	P.20	ZERO	———	
HOLD	P.20	HOLD		Use PRM to use HOLD for CH1 and CH2.

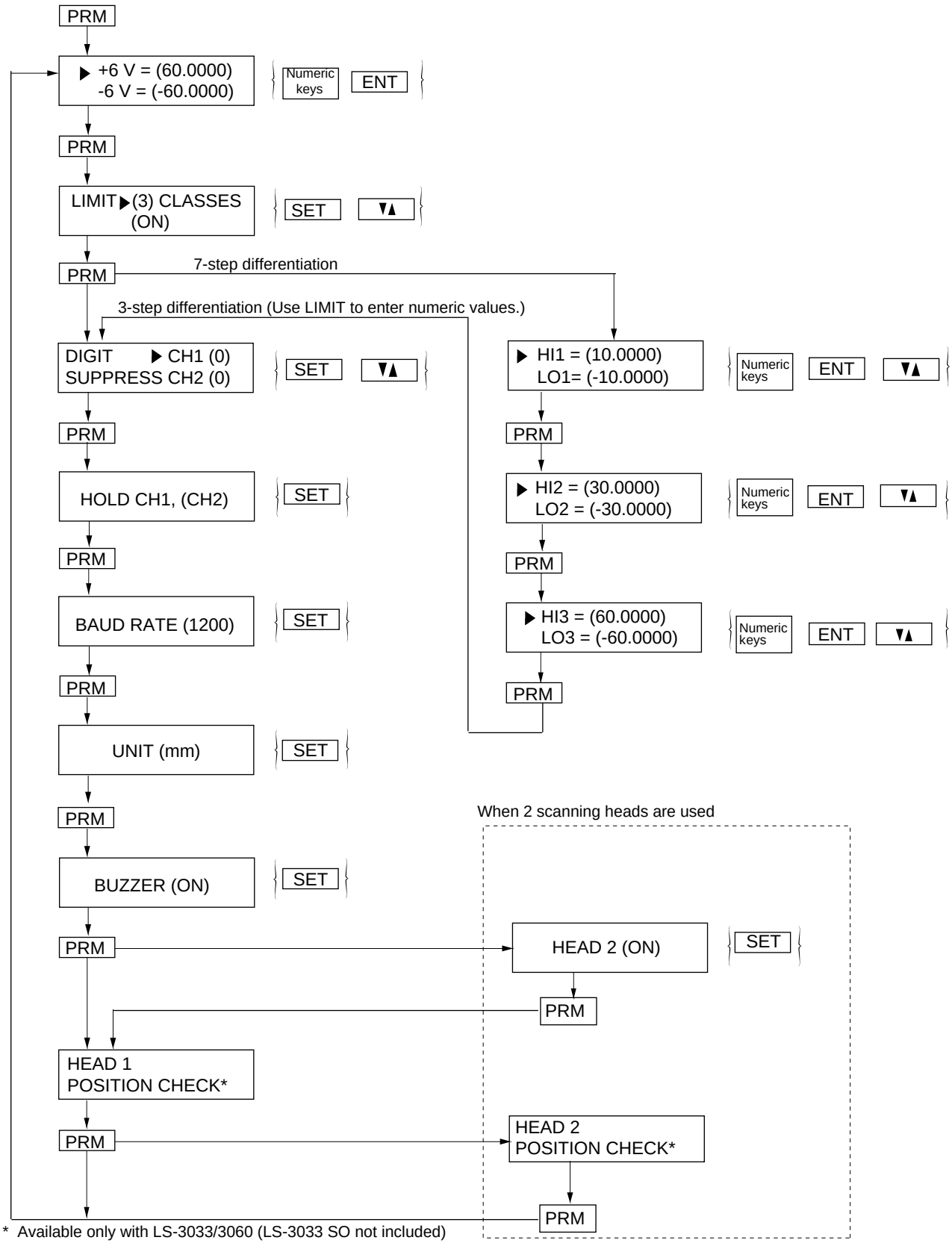
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APPENDIX F

KEY FLOWCHARTS

PRM (Parameter)

Variable, parameter, or status in ( ) is to be set using a key in { }.
Note that those in ( ) in this flowchart are factory settings.

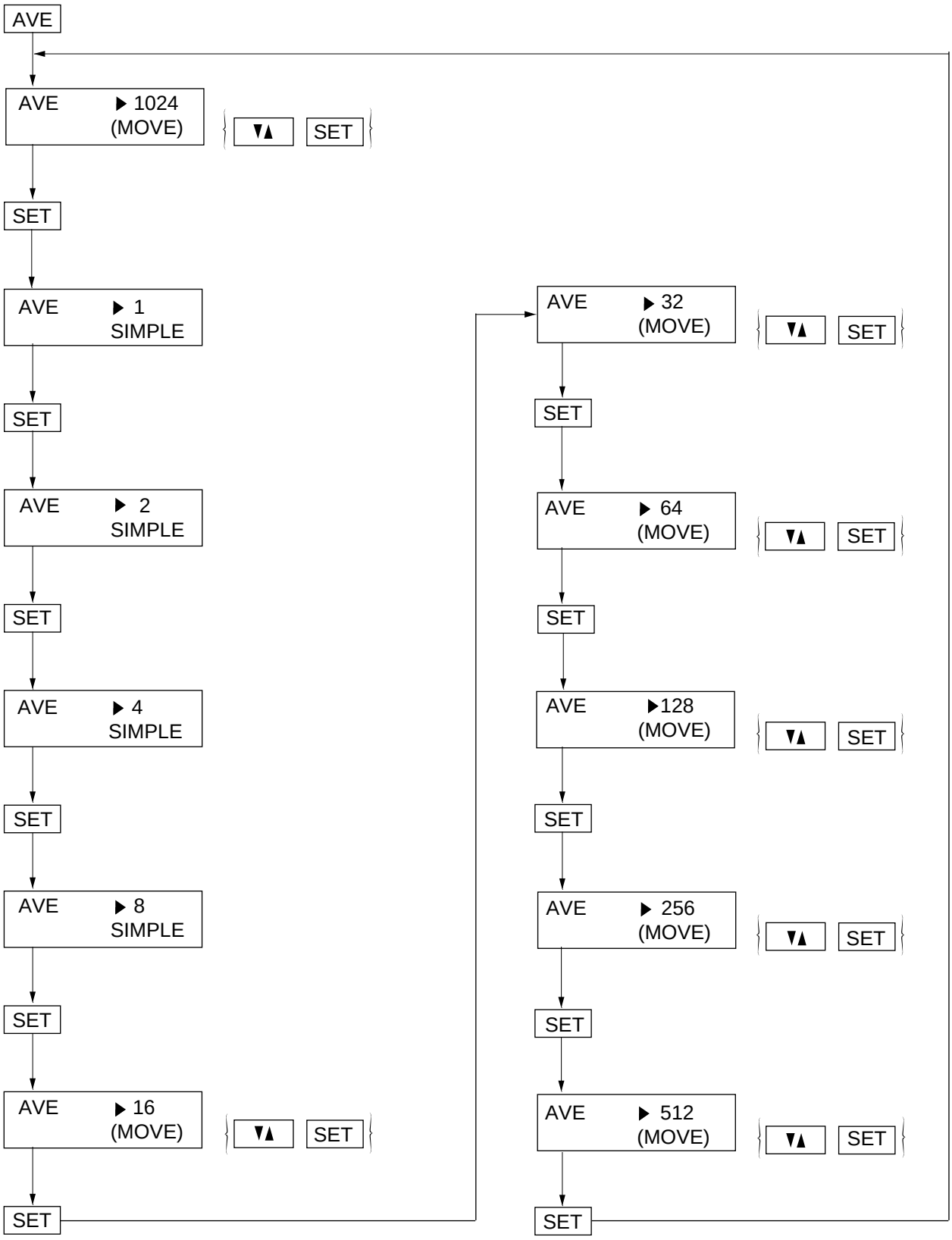


* Available only with LS-3033/3060 (LS-3033 SO not included)

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AVE (Average)

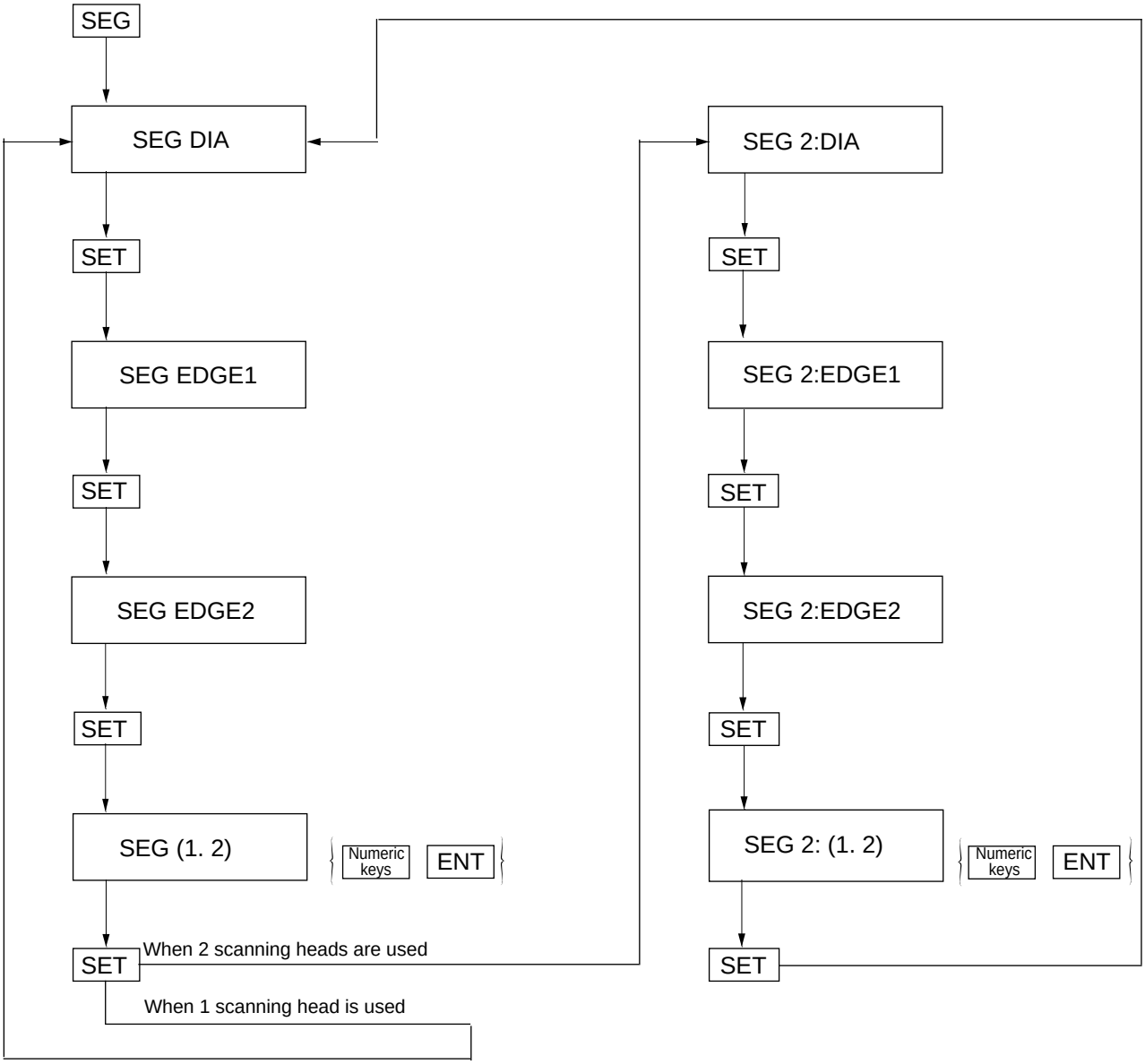
* Variable, parameter, or status in ( ) is to be set using a key in { }.
Note that those in ( ) in this flowchart are factory settings.



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SEG (Segment)

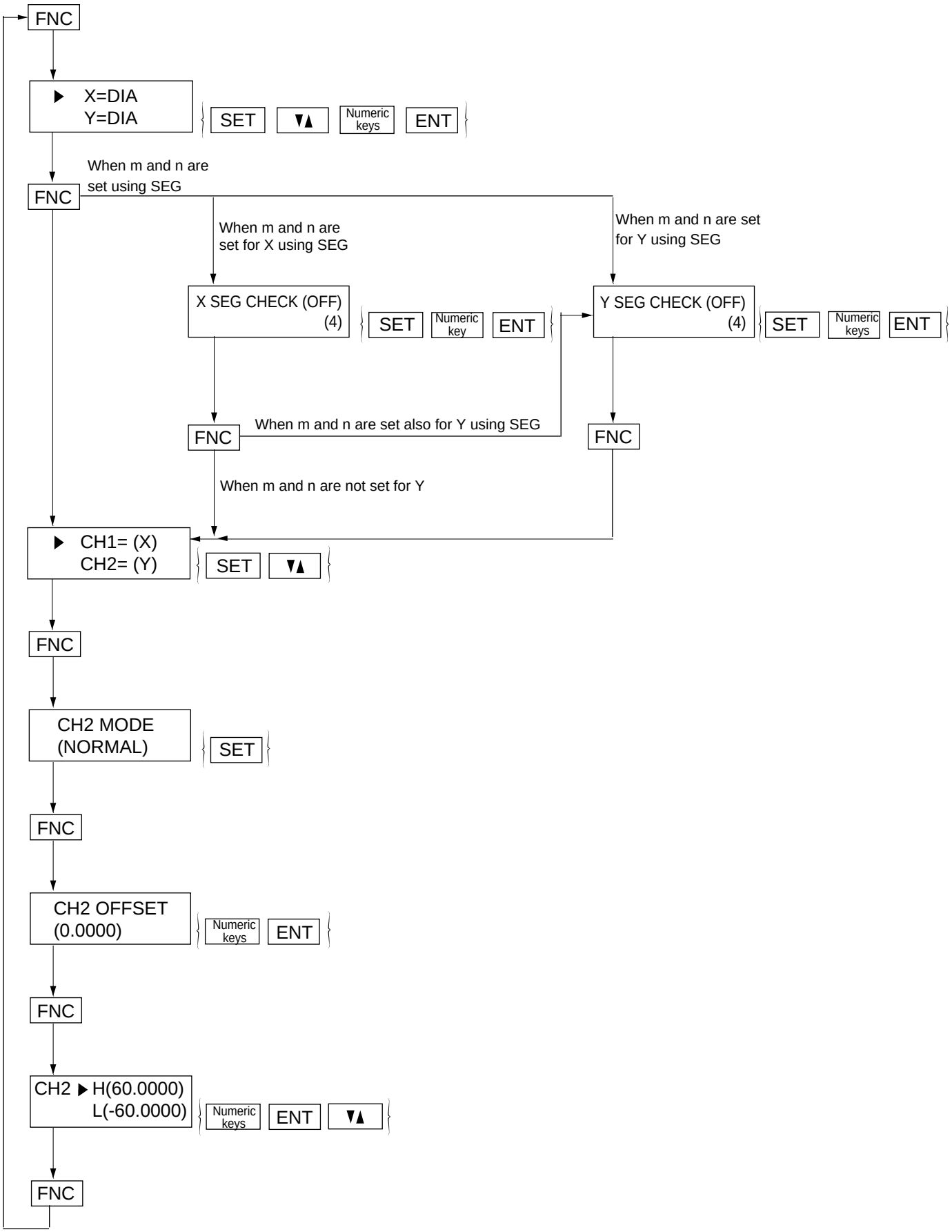
* Variable, parameter, or status in ( ) is to be set using a key in { }.
Note that those in ( ) in this flowchart are factory settings.



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FNC (Function)

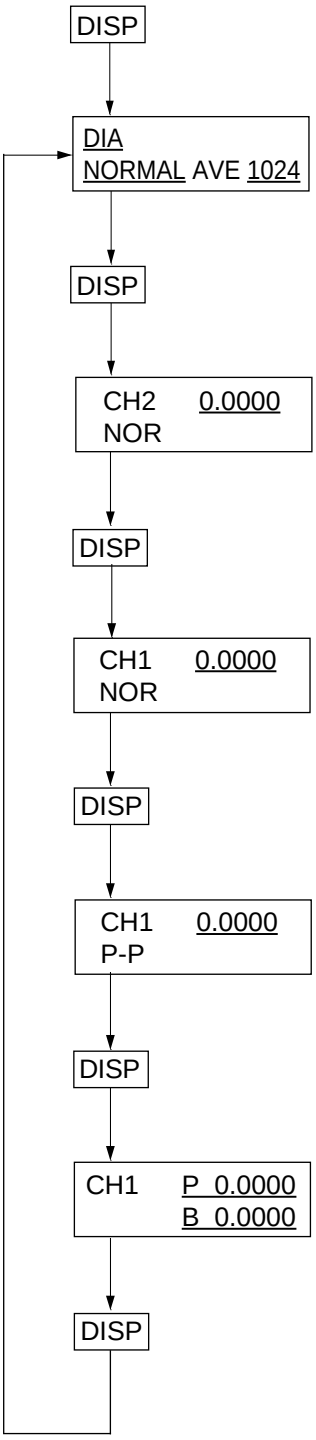
* Variable, parameter, or status in ( ) is to be set using a key in { }.
Note that those in ( ) in this flowchart are factory settings.



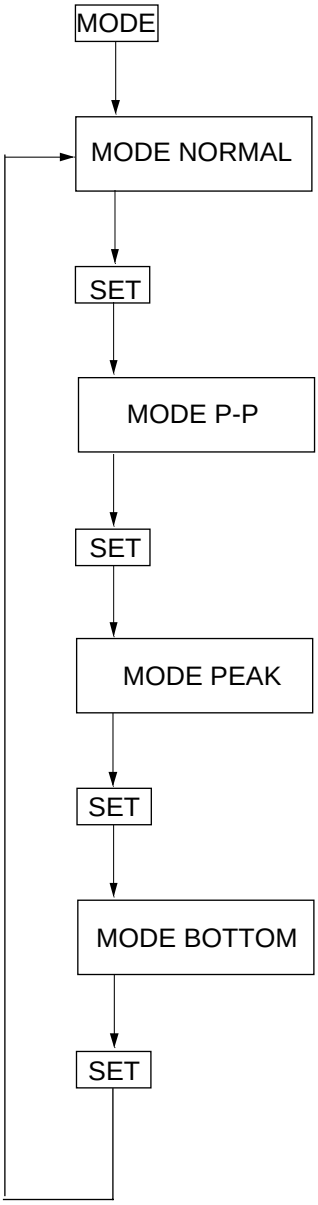
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DISP (Display)

* Underlined modes and values vary according to the current settings and the values measured. Settings cannot be changed in the DISP mode. Note that the underlined values are factory settings.



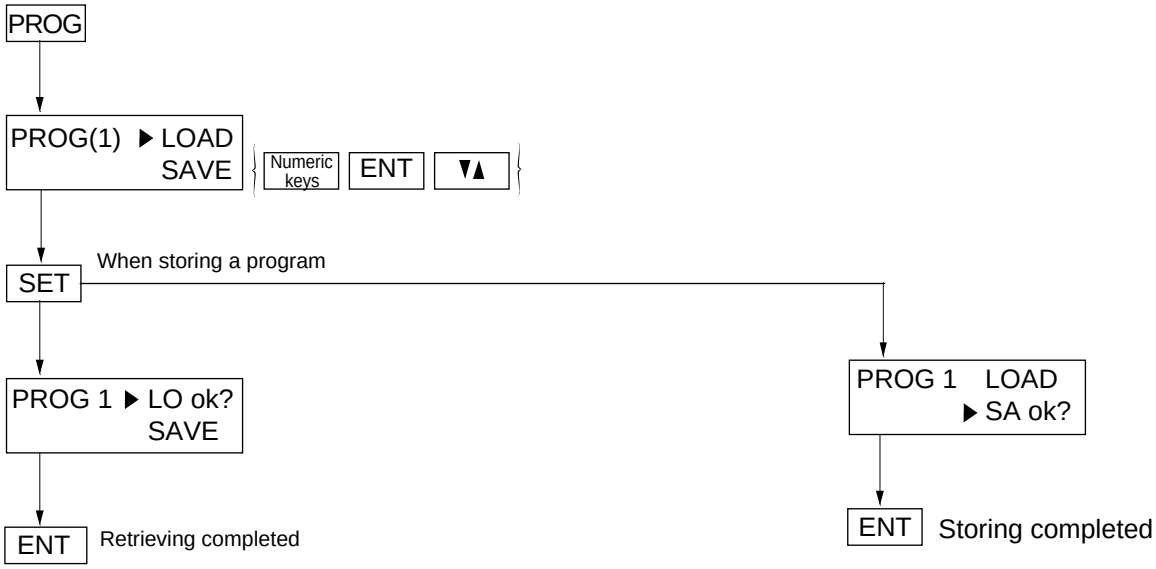
MODE



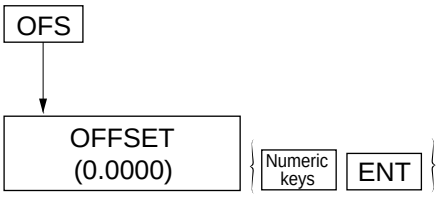
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PROG (Program)

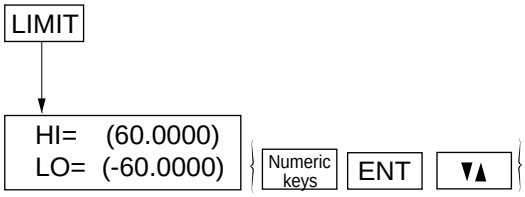
* Variable, parameter, or status in ( ) is to be set using a key in { }.
Note that those in ( ) in this flowchart are factory settings.



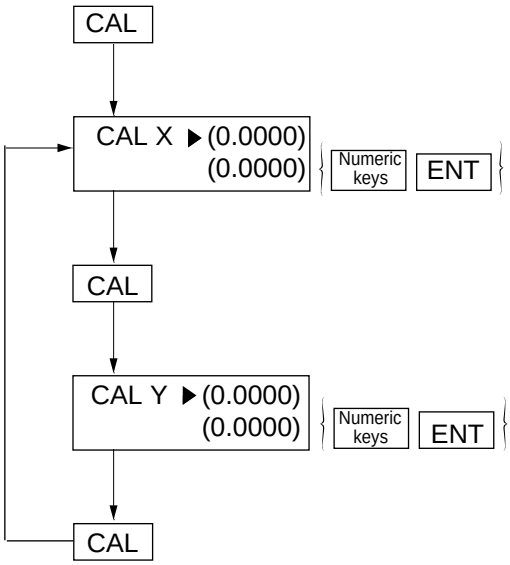
OFS (Offset)



LIMIT



CAL (Calibration)



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