SUNX

INSTRUCTION MANUAL

Ultra High-speed Laser Displacement Sensor (CCD Style)
HL-C1 series

Bornier : IP 20

ME-HLC1 No.0296-00

A UDIN Composants & systèmes d'automatisme
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Contents

Cautions Concerning Safety

⚠ Warning	Indicates the possibility that death or serious injury to the user could result if a handling error is made.

- If this product is used in applications where this bodily injury or massive extended damage could develop, incorporate safety countermeasures such as a double safety mechanism.
- Do not use this product in a flammable gas atmosphere. It could cause an explosion.

⚠ Caution	Indicates the possibility that the user could be injured or property damage could occur if a handling error is made.

- Configure an emergency stop and interlock circuit using an external circuit.
- Do not use this product under conditions other than those shown in the specifications for rating, environmental conditions, etc. Doing so could cause abnormal heat generation or smoke emission.
- Do not attempt to disassemble or modify this product. Doing so could cause electric shock or smoke emission.
- Fasten the electric wires securely with the terminal screws.
- If the wires are not adequately tightened, it could cause abnormal heat generation or smoke emission.
- Do not touch the terminals while the power is on. Doing so could cause electric shock.

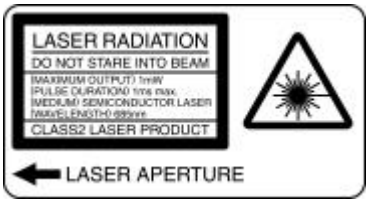
⚠ Cautions Concerning Handling of Laser Light

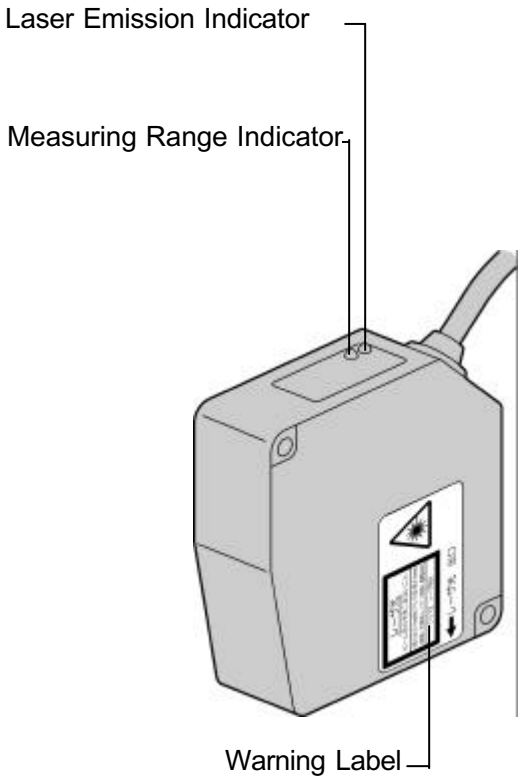
A semiconductor laser is used as the sensor's light source. The laser is classified based on IEC standards (EN 60825).

Wavelength	685nm
Maximum Output	1mW
Class	2

Cautions:

1) Be careful to never look directly at the laser beam or look directly at its reflection from a mirror surface.
2) Mount the sensor at a height that is higher than eye level or lower than eye level, so that the beam will not shine directly into your eyes during operation.
   The safety distance (Nominal Optical Harm Distance: NOHD) is approximately 0.6m, but make sure the laser beam hits a diffusing reflector or an absorbing body.
3) Laser beam emission can be stopped, using the timing input supplied at the input terminal (see TM1 and TM2 on page 3-5 and page 5-5). Or, select "Open circuit" for the input operation of the timing input terminal (see page 5-22) to use the terminal for a remote interlock input.
4) The sensor head in this device is not equipped with a function that stops laser radiation automatically when it is disassembled, so be sure to contact SUNX if it breaks down.
   There is danger of laser radiation occurring if the head is disassembled for repairs, etc.
5) Do not use the device in operation methods other than those specified in this Instruction Manual.
   Caution - You may be exposed to hazardous laser radiation if the device is controlled or adjusted in procedures not specified in this manual.
6) Read the contents of the warning label shown below carefully before use.
   The warning label is affixed to the side of the sensor head. The English warning label is packed with the sensor, so be sure to follow the instructions printed on it during use.


LASER RADIATION
DO NOT STARE INTO BEAM
CLASS2 LASER PRODUCT
LASER APERTURE


Laser Emission Indicator
Measuring Range Indicator
Warning Label

Correct Handling Method

Be careful of the following points when installing and using this product.

1. About Warming Up Time

- Allow at least 30 minutes of warming up time after turning on the power to assure optimum performance.

2. About the Use Environment

■ Ambient Temperature, Humidity, Luminance

- Use this product in the temperature specification range (sensor head: 0 to +45°C, controller: 0 to +50°C, compact console: 0 to +40°C). If the sensor is to be stored, the temperature range during storage should be -20 to +70°C
- The service life of a semiconductor laser is dependent on the ambient temperature during use. If the product is used near a heat source, take measures to lower the ambient temperature of the sensor head as far as possible. As well, because the sensor itself emits a heat, mount the sensor on a body having a good heat radiation performance.
- Use the sensor in a range of 35 to 85% RH relative humidity. However, avoid use in places where there is a possibility of sudden temperature fluctuations which could cause condensation to occur.
- Concerning illumination, use the sensor in a location where the luminance at the light sensor from incandescent lamps is 3,000 lx or less.

■ Power Supply Voltage

- The power supply voltage should be within the rated voltage range of 21.6 to 26.4V DC during use.

■ Environment

- If the external surge voltage exceeds 500V [± (1.2×50) μs unipolar full wave voltage], the internal circuit may be destroyed. If there is danger of external surge voltages exceeding 500V, install a surge protector between the power supply and the input terminal.
- Water or oil, or fingerprints, etc. on the sensor's light emitter or light receptor surfaces refracts light, and dust or dirt cuts off the light, so be sure to keep the sensor clean at all times so these substances do not adhere. When cleaning these parts, wipe them off using a soft lint-free cloth or lens cleaning paper.

- Set the sensor head so that stray light such as sunlight or light with the same wavelength, etc. does not enter the light receptor. If an extraordinary accuracy is necessary, install a light shielding plate or the like at the sensor.
- The sensor head is a waterproof device, but this does not mean that it can be mounted underwater or in places where rain falls. Also, due to their construction, the controller and connectors are not dustproof, waterproof or corrosion resistant, so do not use it in an environment where such characteristics are required.
- Do not use this product in places where flammable or corrosive gases are generated, places where there is a lot of dust, where there is dripping water, where it will be exposed to direct sunlight or where there are severe vibrations or impacts.

3. Noise Countermeasures

- Do not run the sensor cable along (bundled in parallel with) other wiring, and keep it at least 100mm from other wires. Also run the cable so that it is separate from the high voltage lines and power circuit lines. If running the lines in parallel cannot be avoided, shield the cable by running it through a grounded electrical conduit, etc.
- For input signal lines and output signal lines, run them separately, not in parallel, with power lines and power supply lines, keeping them at least 100mm apart. In addition, keep all the various signal lines as short as possible when connecting them.
- Install this product as far away as possible from high-voltage lines, power lines, high voltage device, wireless devices and machines which generate a large starting and stopping surge.
- If a large amount of electrical noise is generated in the power supply, the analog outputs will be affected. In such a case, use a noise filter or a noise dampened transformer.
- Use shielded cables for signal wires such as those for serial input and output and I/O terminals to reduce electric noise, and connect the shielding wire to the frame ground.
- It is easy for analog outputs to be influenced by noise, especially from external sources, so use shielded wires, and keep the wiring as short as possible.
- Use an exclusive class D ground in accordance with the functional ground terminal, and avoid grounding this device in common with other devices. If it is grounded in common with other devices, the opposite effect may be obtained.

4. Insulation Resistance and Voltage Resistance

- Do not perform insulation resistance and voltage resistance tests between the power supply, input and output signals and the metal parts of the controller.

5. Power Supply

- Select a power supply with a ripple of 0.5V or less (P-P) and a current capacity of 2A or more.
- When a commercial switching regulator is used, always use it with the frame ground (F.G.) terminal connected to ground to avoid the influence of high frequency noise.
- When using a transformer in the power supply, be sure to use an insulated transformer. If an auto transformer (single turn transformer) is used, this product or the power supply may be damaged.
- Do not turn the controller's power on again within 10 seconds after turning the power off.
- Use an insulated type power supply with a built-in protective circuit to protect against abnormal voltages from the power line.
- If a power supply without an internal protective circuit is used, be sure to supply power via a protective element such as a fuse.

6. Instantaneous Power Failures

- If the duration of an instantaneous power failure is 10ms or less, operation continues.
- If the duration of an instantaneous power failure is 10 to 45ms, one of the following occurs.
  (1) Operation continues.
  (2) The analog output changes temporarily and the BRIGHT and DARK indicators blink, then the sensor recovers automatically.
  (3) The state changes to the reset state.
- If the duration of an instantaneous power failure is more than 45ms, the state changes to the reset state.

7. Installation

■ Controller

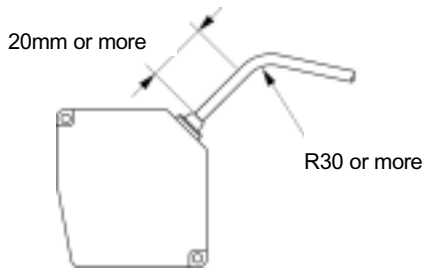
- Install the controller unit in accordance with "Considerations Concerning Heat Radiation" on page 2-2, assuring plenty of space around the unit. If it is installed in a manner that is not in accordance with instructions, it could cause malfunction due to the rise in temperature, etc.
- If the controller is mounted on a control board, etc. internally where air circulation is blocked, the ambient temperature will rise due to heat generated by the controller, so use forced cooling.
- If multiple units are installed in series, they can be mounted against each other only if they are installed vertically.
- Ventilation holes for heat radiation are provided in the controller body. Be sure to provide adequate space for the radiating heat to dissipate.

■ Wire Connections, Connectors

- Connect all the wiring securely in accordance with the input and output circuit explanations and according to the markings indicated on the body. Be careful not to make mistakes in wiring.
- When connecting and disconnecting connectors, and when making all connections, make sure that the controller's power is turned off.
- When connecting and disconnecting connectors, be sure to take hold of the connector body, being careful not to exert undue force on the cables.
- Be careful not to touch the terminals or let foreign matter get in the connector when disconnecting the connectors.
- Be careful to keep from applying force to each of the cables near to the connectors. Also, do not bend the cables near the connectors, as this causes the wires to be broken.

■ Cables

- Do not pull the cable at a force more than 29.4N when routing the cable after fixing the sensor head and controller. Do not allow 30mm or a shorter bending radius in the cable path. Also, do not bend the cable at a place within 20mm of the sensor head's cable inlet.



- If the sensor head is to be used in a situation where it is moved during operation, mount it so that the cable will not be flexed during movement. If flexure is necessary, use an extension cable that can be replaced.

Warranty

■ Warranty Period

The warranty period for this product is 1 year from the date of purchase or from the date of delivery to the place specified by your company.

■ Extent of Warranty

If this product should break down or if a defect becomes apparent which is the responsibility of SUNX during the warranty period, SUNX will promptly provide a replacement product or the necessary replacement parts, or will replace or repair the defect parts free of charge at the place where the product was purchased or at the place where delivery was made.

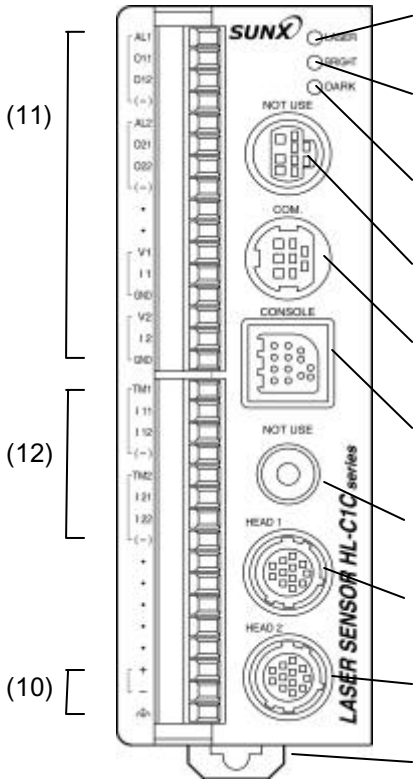
However, it will be considered as not being covered by the provisions of this warranty if any of the following cases applies to the breakdown or defect.

(1) The breakdown or defect was caused by specifications, standards, handling methods, etc. instructed by your company.
(2) The breakdown or defect was caused by modifications in construction, performance or specifications, etc. which SUNX was not involved in were performed after purchase or after delivery.
(3) The breakdown or defect occurred due to phenomena which it was impossible to foresee in the technologies which were applied after purchase or during the warranty period.
(4) The product was used without heeding the conditions and environmental restrictions included in the operation manual.
(5) This product is incorporated into your company's equipment and that equipment, with functions and construction, etc. which are generally provided in the industry, suffered avoidable damage.
(6) The breakdown or defect was caused by natural disaster or other irresistible force.

In addition, the warranty mentioned here is limited to the purchased or delivered products only, and does not cover any incidental damages resulting from breakdown of or defects in this product.
The above contents presuppose that the product was purchased and used within the borders of Japan.
Please contact our company's representative separately if you have requests concerning purchase or use of this products in nations other than Japan, or about specifications, warranty and service, etc.

CHAPTER 1
NAMES AND FUNCTIONS OF PARTS

1-1 Controller



(1) Laser Emission Indicator (Green)

(2) BRIGHT Indicator (Red)

(3) DARK Indicator (Red)

(4) Cannot be used.

(5) COM. Port

(6) Connector for Compact Console Connection

(7) Cannot be used.

(8) Sensor Head 1 Connector

(9) Sensor Head 2 Connector

(13) DIN Rail Mounting Hook

(1) Laser Emission Indicator (Green)
Lights up during laser emission from sensor head 1 or sensor head 2, or immediately before laser emission.

(2) BRIGHT Indicator (Red)
Lights up when the amount of light emitted by sensor head 1 or sensor head 2 is excessive, making measurement impossible.

(3) DARK Indicator (Red)
Lights up when the amount of light emitted by sensor head 1 or sensor head 2 is insufficient, making measurement impossible.

(4) Cannot be used.
This port is for adjustments performed at the factory before shipping.

(5) COM. Port
Used for RS-232C communications with a personal computer.

(6) Connector for Compact Console
This enables measurement values to be displayed using the compact console and connection of the compact console exclusive connection cable when setting each setting.

(7) Cannot be used.
This port is for adjustments performed at the factory before shipping.

(8) Sensor Head 1 Connection Connector
The controller operates the sensor head connected to this connector as sensor head 1.

(9) Sensor Head 2 Connection Connector
The controller operates the sensor head connected to this connector as sensor head 2.
For a system with only one sensor head connected to the controller, connect to the sensor head 1 connector (8).

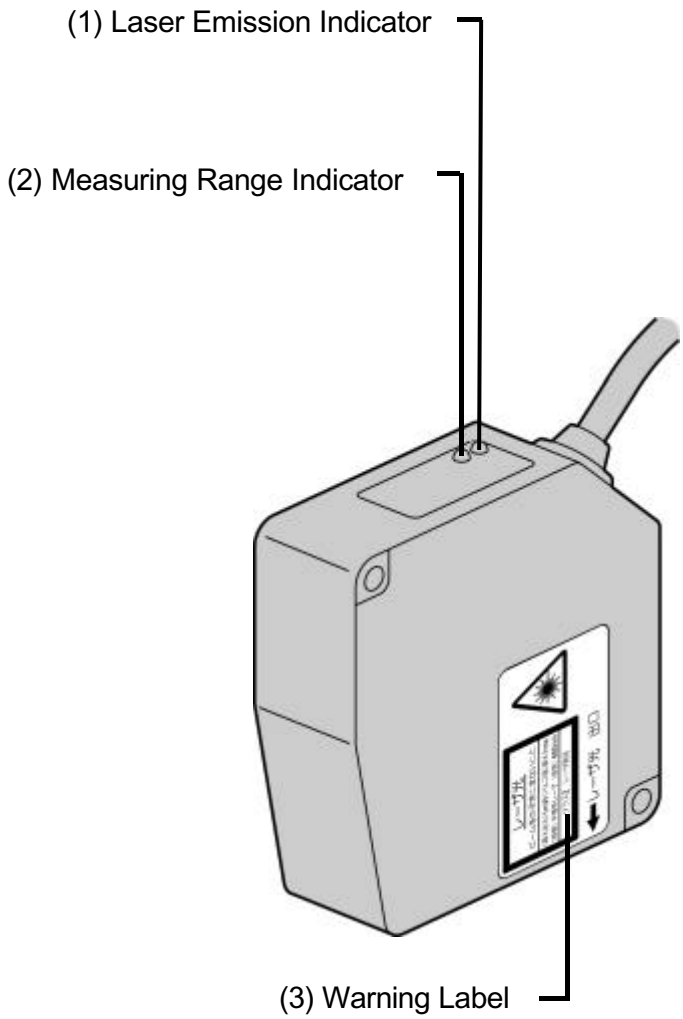
(10) Power Supply Terminal
Supplies 24V DC.

(11) External Output Terminal

(12) External Input Terminal

(13) DIN Rail Mounting Hook
Can be mounted on a 35mm width DIN rail quickly.

1-2 Sensor Head



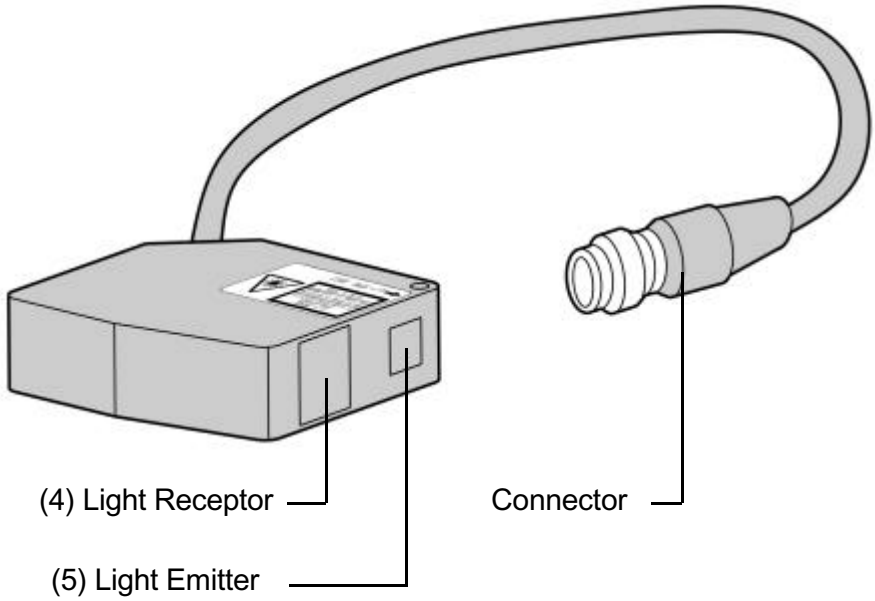
(1) Laser Emission Indicator (Green)
Lights up during laser emission or immediately before laser emission.

(2) Measuring Range Indicator (Yellow)
Blinks when within the measuring range and lights up when near the center of the measuring range.

(3) Warning Label
Shows the laser emission position. Be careful of the description contents.

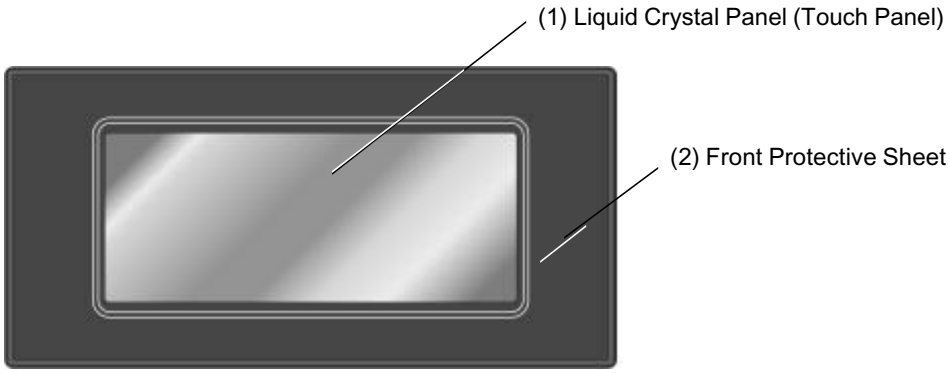
(4) Light Receptor
Receives light reflected from the measured object.

(5) Light Emitter
Emits laser light.

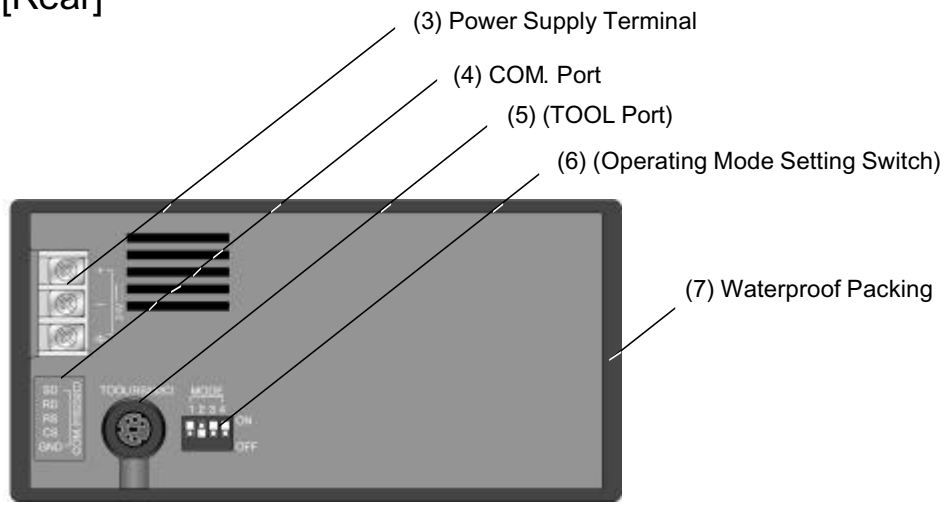


1-3 Compact Console

[Front]



[Rear]



(1) Liquid Crystal Panel (Touch Panel)
Measuring data and the various setting values are displayed in this panel. The setting can also be changed and data input by touching the panel.

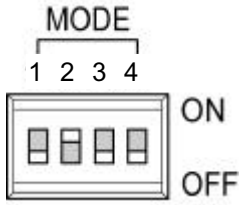
(2) Front Protective Sheet
A sheet is affixed to the liquid crystal panel when the sensor is shipped to protect it and keep it from getting dirty.

(3) Power Supply Terminal
Supplies 24V DC for the operation power supply.

(4) COM. Port
This port is used for connecting the compact console to the controller using the exclusive cable provided with the console.

(5) (TOOL Port)
This port is for use in case the compact console is connected to a personal computer and screen data are being created. Exclusive screen data are already stored internally in this device, so do not use this terminal.

(6) (Operating Mode Setting Switch)
Use this product in the state shown below in order to protect the exclusive screen data.



Switch No.	Setting
1	OFF
2	ON
3	OFF
4	OFF

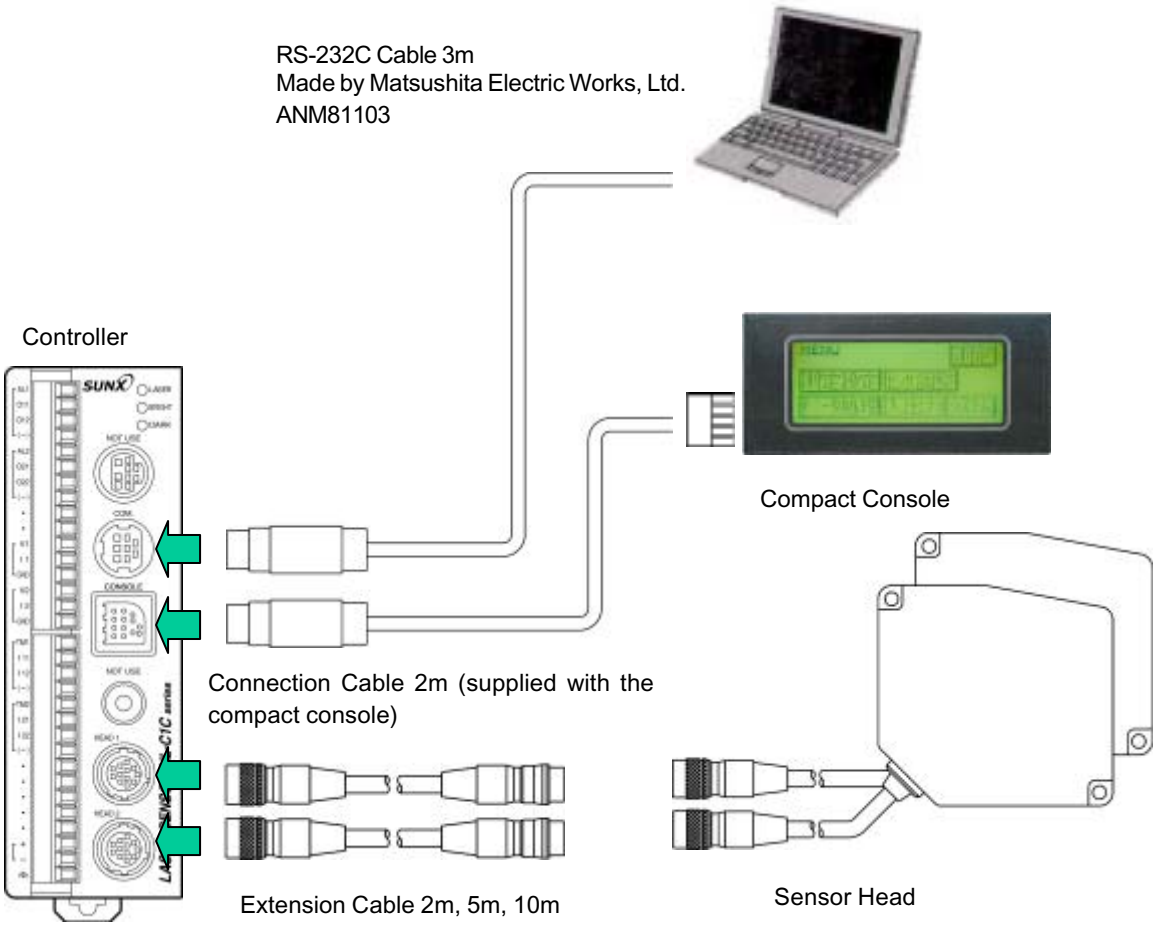
(Settings when shipped from the factory)

(7) Waterproof Packing
This packing assures that the panel is waterproof from the front.
One packing is supplied when the product is shipped.

— MEMO —

CHAPTER 2
INSTALLATION

2-1 System Configuration



For a system with only one sensor head connected to the controller, connect to the sensor head 1 (HEAD 1) connector.

2-2 Installation Environment and Installation Space

■ Avoid installation in the following places:

- Places where the ambient temperature exceeds the specification range (sensor head: 0 to +45°C, controller: 0 to +50°C, compact console: 0 to +40°C).
- The relative humidity exceeds the range of 35 to 85% relative humidity.
- The luminance at the light receptor exceeds 3,000 lx (incandescent lamp).
- The place is subject to sudden temperature fluctuations which could cause condensation.
- There are corrosive or flammable gases in the atmosphere.
- There is lots of dust iron chips or salt.
- The atmosphere contains benzene, paint thinner, alcohol or other organic solvents, or where there is danger of strong alkaline substances such as ammonia or caustic soda adhering to the sensor.
- There is severe vibration or impacts.
- The place is exposed to direct sunlight.
- Water, oil or chemicals, etc. could get on the product.
- Loads are applied to the sensor head.

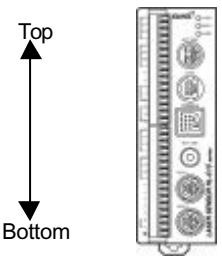
■ Considerations Concerning Noise

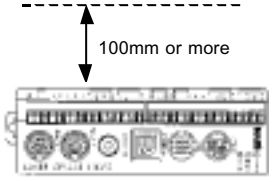
- Mount the sensor as far away as possible from high voltage lines, high voltage equipment, power lines, power equipment, equipment that generates large starting and stopping surges, welders, inverter motors, and other equipment that generates electric noise.
- Mount the sensor as far as possible from equipment with a transmitter such as amateur radio equipment.
- Be careful not to let excessive static electric charges be applied to the panel surface since it could destroy the LCD unit.

■ Considerations Concerning Heat Radiation

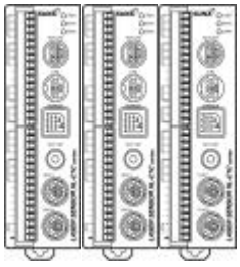
- Do not mount the sensor on a heater, transformer or other device that radiates large amounts of heat such as high capacity resistors.
- If the controller is mounted internally on a control board in a place where air circulation is blocked, the ambient temperature will rise due to heat generated by the controller, so use forced cooling.
- Mount the controller with the following orientation to facilitate heat dissipation.

【If it is mounted vertically】 【If it is mounted horizontally】 【If multiple units are mounted side by side】





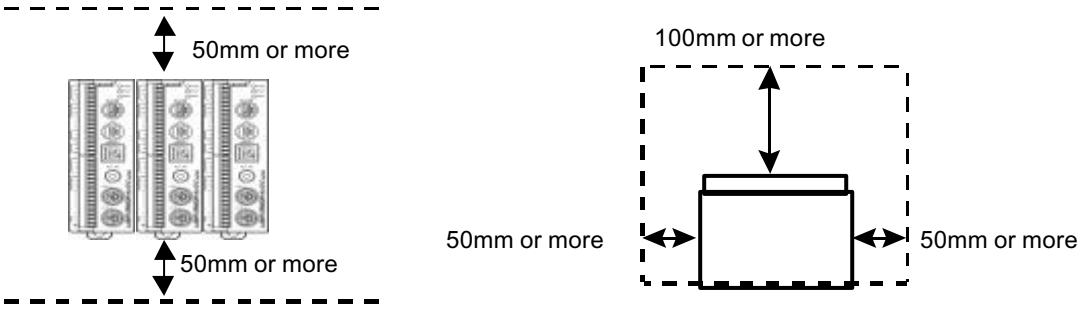
Mount the controller with the side containing slits facing up.



Mount the controller in the orientation shown in the figure above.

■ Installation Space

- Mount the controller so that it is separated from surrounding ducts and other devices by 50mm or more to enable replacement and wiring, etc.
- If a panel door or other device is placed in front of the controller unit, separate it from the controller by 100mm or more to avoid the influence of radiation noise or heat generation.
- Assure that there is an allowance of 100mm or more from the controller's front surface in order to enable connection of the sensors and wiring, etc.



2-3 Mounting the Controller

The controller can be mounted by fastening it with screws or by using a DIN rail.

■ Mounting the Controller with a DIN Rail

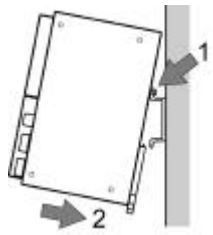
The controller can be mounted or removed from a 35mm width DIN rail (DIN EN 50022) with a one touch operation.

[Mounting]

1. Hang the top on the DIN rail.
2. Push the bottom of the controller to fasten it on the rail.

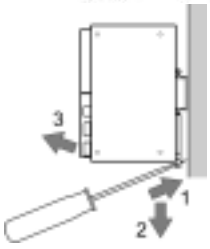
[Removal]

1. Insert the blade of a flat-bladed screwdriver in the mounting lever.
2. Pull down the mounting lever.
3. Raise the controller up and remove it from the rail.



■ Mounting the Controller with Screws

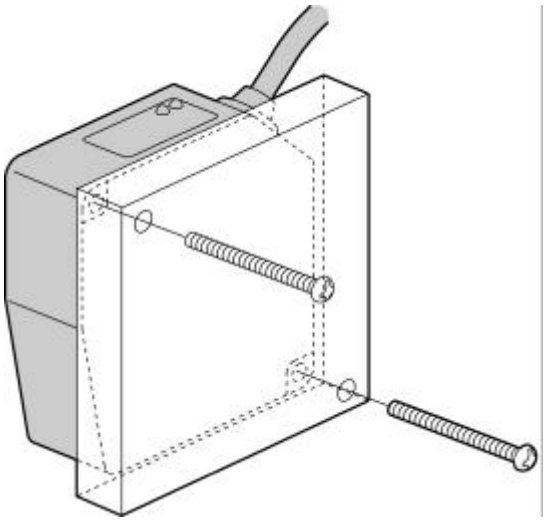
- While referring to the external dimensioned diagram shown on page 10-2, use M3 screws to fasten the controller. Do not tighten the screws beyond 0.5N・m.
- To avoid breakage of the inside of the controller, do not insert the screw tip 3.5mm or more from the side of the case.
- Do not use other than the four screw holes prepared on the side of the case.



2-4 Mounting the Sensor Head

■ Mounting the Sensor Head

- Fasten the sensor securely with M5 screws, using the 2 holes in the corners of the sensor head. Contain the tightening torque to within 1.2N·m.
- Mount the sensor head so that it is approximately 85mm from the object to be measured.
- Mount the sensor head so that its front is normal to the measured object.



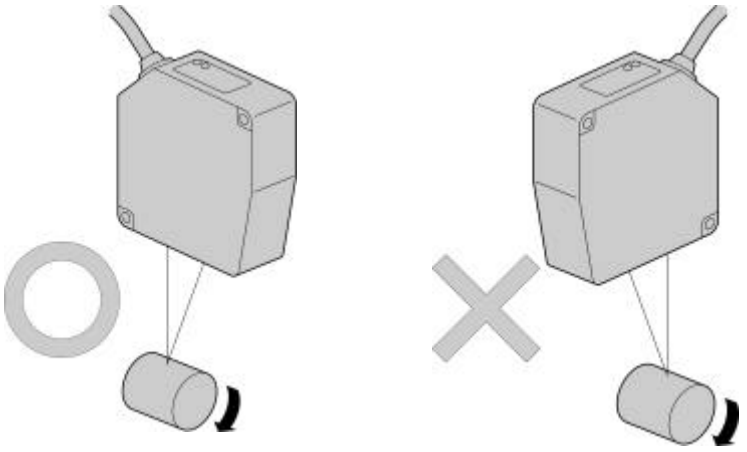
- Operate the sensor head within the temperature specification range (sensor head: 0 to +45ºC, controller: 0 to +50ºC, compact console: 0 to +40ºC).
- If the sensor is to be stored, the temperature range during storage should be -20 to +70ºC.
- The service life of a semiconductor laser is dependent on the ambient temperature during use. If the sensor is used near a heat source, take cooling measures to lower the ambient temperature of the sensor head as far as possible. As well, because the sensor itself generates a heat, mount the sensor head on a body having a good heat radiation performance. (Note)
- Use the sensor in a range of 35 to 85% relative humidity. However, avoid use in places where there is a possibility of sudden temperature fluctuations which could cause condensation to occur.
- Concerning illumination, use the sensor in a location where the luminance at the light sensor from incandescent lamps is 3,000 lx or less.
- Mount the sensor head so that stray light such as sunlight or light with the same wavelength, etc. does not enter the light receptor. Particularly in cases where accuracy is required, use it with a shading plate, etc. installed.
- Do not mount the sensor head in places where flammable or corrosive gases are generated, places where there is a lot of dust, where there is dripping water, where it will be exposed to direct sunlight or where there are severe vibrations or impacts.

Note: When installing two sensor heads in parallel at a 20mm or less interval, mount each sensor head on an aluminum or iron plate having 200cm^2 or more a surface area.

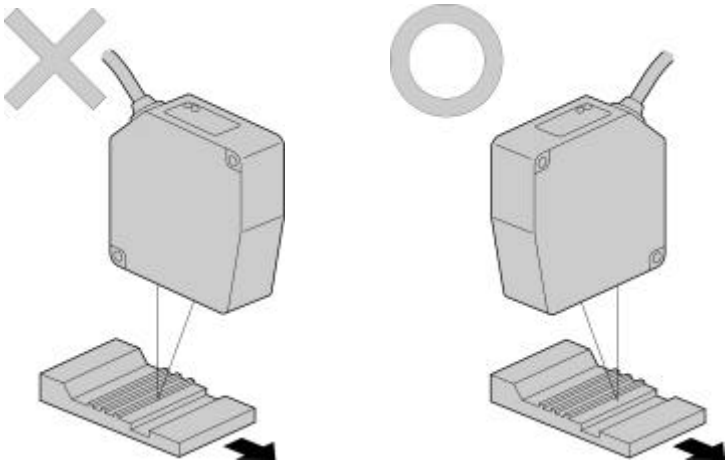
■ Sensor Head Mounting Direction

Mount the sensor head in the orientation shown below to obtain accurate measurements.

- Rotating objects

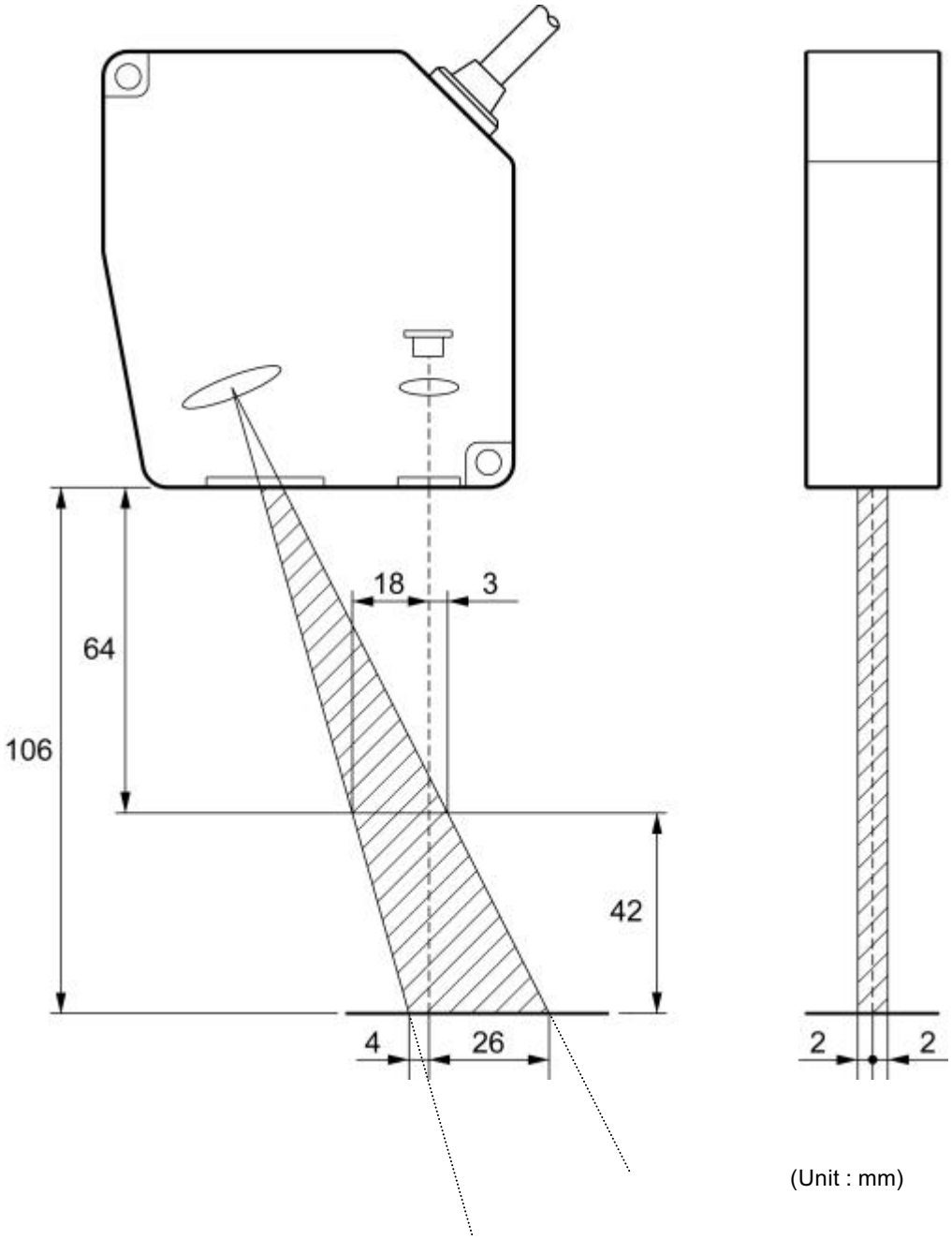


- Objects with level differences or grooves
- Objects with great changes in color



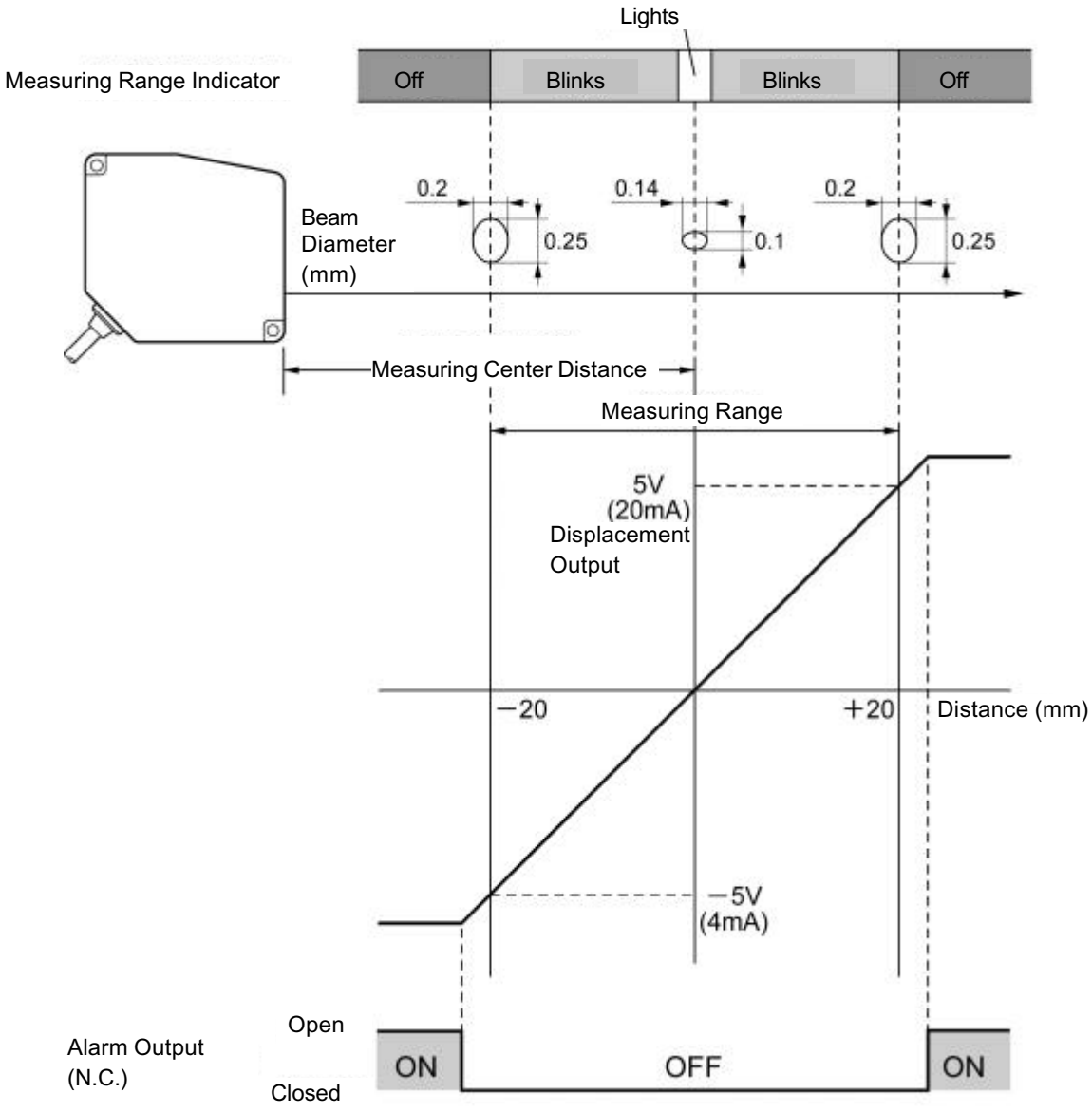
■ Mutual Interference

If two or more sensor heads are mounted close to each other, there will be no mutual interference if the neighboring sensor's laser spot is outside the shaded portion shown in the figure below.
Mount the other sensor heads so that their laser spot does not enter the shaded area.



(Unit : mm)

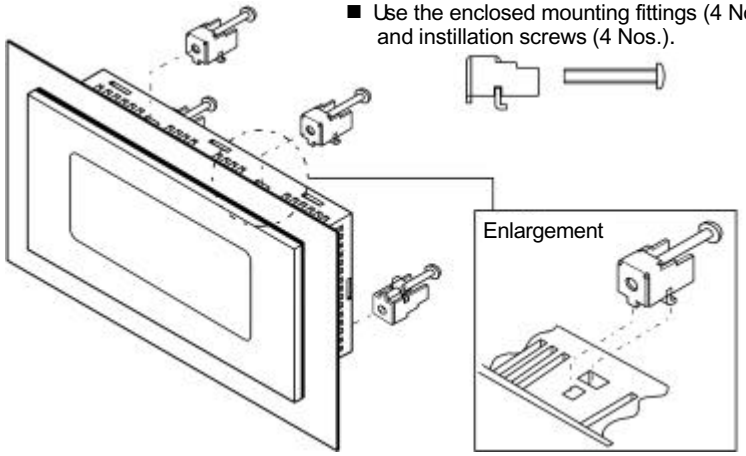
■ Output Characteristics and Measuring Range Indicator



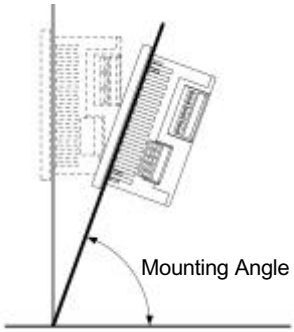
* With the analog output set at 20mm (at 5V) and -20mm (at -5V)

2-5 Mounting the Compact Console

Mount the installation plate using the enclosed mounting fittings (4 Nos.) and installation screws (4 Nos.).
(1) Insert the compact console unit in the mounting plate.
(2) Fit the mounting plate in the groove in the compact console unit, then tighten the screws, fastening the compact console to the mounting plate.



- Tighten the screws with a tightening torque of 0.1 to 0.25N･m.
- Use a panel with a thickness of 1.0 to 6.0mm.
- If the mounting angle is 60 to 0° (horizontal), use an operating voltage of 25V DC or less.

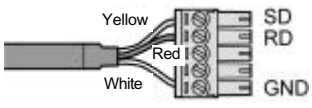


■ Clearances During Mounting

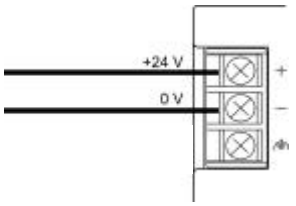
When mounting the compact console, if other parts are mounted on the panel and wiring is to be done, it is recommended that a clearance of 30 to 50mm be allowed around the compact console to prevent damage to cables and improve workability, etc. Also, do not cover the slits in the console body.

■ Wiring the connection cable terminal (supplied)

- The wiring of the connection cable terminal is shown in the figure on the right.
- Before connecting to the controller, turn off both the compact console and controller.
- To avoid a broken wire caused by vibration, fix the connection cable on the compact console side.



■ Wiring the Power Supply



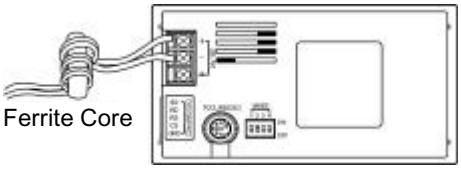
- Connect the power cable at the terminals provided on the back of the main body.
- Use twisted wires for the power supply lines to minimize the effect of noise.
- Use an insulated type power supply with a built-in protective circuit for the power supply to protect against abnormal voltages from the power line.
- An uninsulated type is used in the regulator internally in the compact console. If a power supply is used that does not have a built-in protective circuit, be sure to power supply to the compact console via a fuse or other protective element.
- The power supply voltage should be within the rated voltage range of 21.6 to 26.4V DC during use.
- Use M3 screws to fasten the compact console. It is recommended that compression terminals be used on the ends of the wires.

● Open end Terminals

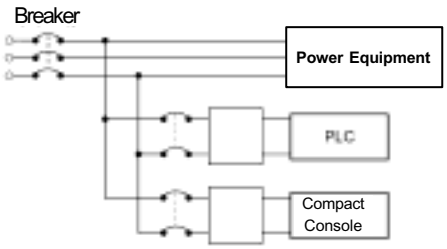
● Round Type Terminals

Maker	Shape	Model Name	Applicable Wire	Tightening Torque
JST Mfg. Co., Ltd.	Round Type	1.25-MS3	0.25 to 1.65mm^2	0.5 to 0.6N·m
	Open End Type	1.25-B3A		
	Round Type	2-MS3	1.04 to 2.63mm^2	
	Open End Type	2-N3A		

- Tighten the screws on the terminal block with a tightening torque of 0.5 to 0.6N·m or less. If force greater than that is brought to bear, it could damage the device.
- If compression terminals are not used, use wire with a diameter of 0.5 to 1.25mm^2.
- As a condition for compliance with the European EMC Director, install a ferrite core (Seiwa Electric MFG. CO., Ltd.E04RC281613 or comparable product) on the wires to the terminal block as shown below.



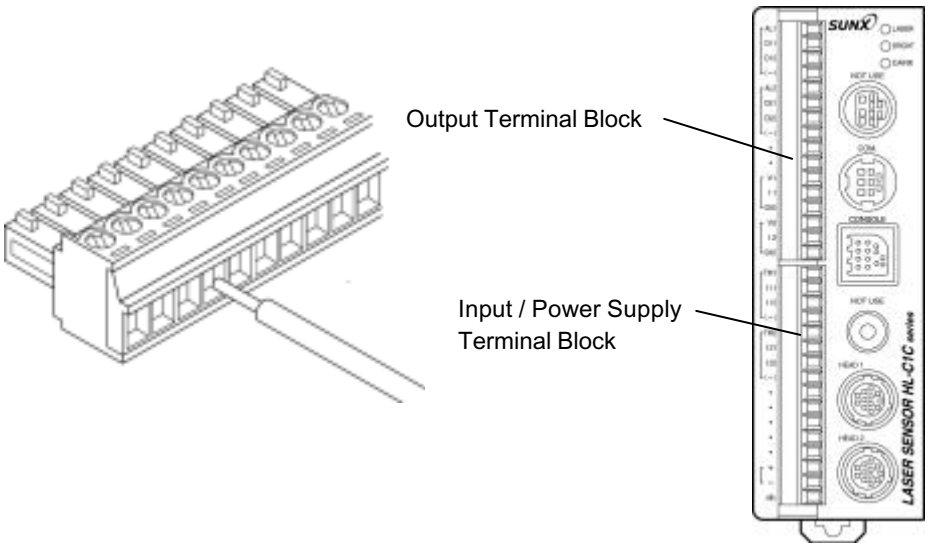
-Separate the wiring to the compact console, PLC and power equipment into separate systems.



Insulated DC Power Supply

CHAPTER 3
INPUT AND OUTPUT TERMINAL BLOCKS

3-1 Wiring Terminal Blocks



■ Terminal Blocks

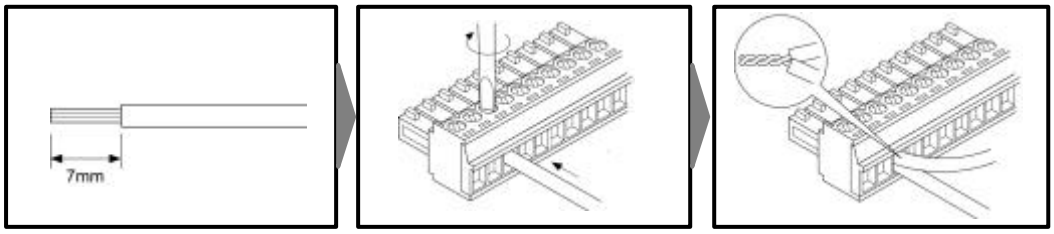
The adopted terminal block is removable from the controller and can be tightened with screws. Use the following tools and cables.

	Maker	Model
Enclosed Terminal Block Socket (Comparable product)	Phoenix Contact (Co., Ltd.)	MC1, 5/16-ST-3, 5 (Color: Green)

	Maker	Model	Product No.	Tightening Torque
Tightening Tools (Tip width 0.4 ×2.5)	Phoenix Contact (Co., Ltd.)	SZS 0.4 ×2.5	1205037	0.22 to 0.25N·m

	Size	Conductor Cross Sectional Area
Applicable Wire (twisted wire)	AWG#24 to 16	0.3 to 1.25mm^2

■ Wiring Method



1. Strip the insulation off the end of the wire.
2. Insert the wire in the terminal block until it hits the back side, then fasten it in place by tightening the screw.
3. If two or more wires are inserted into the same terminal, twist the wires together, then insert them.

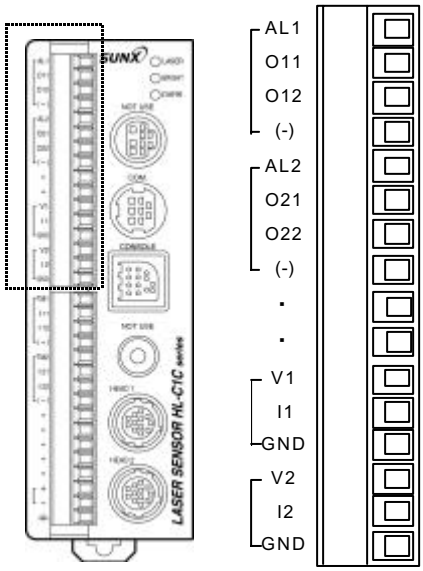
■ Use the device correctly.

Be sure to turn the power OFF first, then carry out wiring and remove or install the terminal block.

Do not use wires that have been tinned with solder. They may break when subjected to vibration.

3-2 Output Terminals

■ Terminal Layout



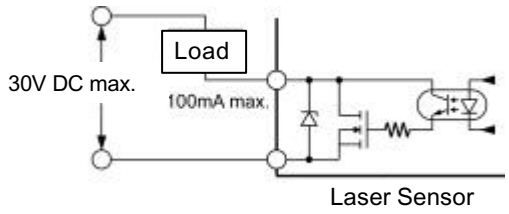
Symbol	Content
AL1	Alarm Output (Sensor Head 1)
O11	Judgment Output 1 (Sensor Head 1)
O12	Judgment Output 2 (Sensor Head 1)
(-)	External Insulated GND
AL2	Alarm Output (Sensor Head 2)
O21	Judgment Output 1 (Sensor Head 2)
O22	Judgment Output 2 (Sensor Head 2)
(-)	External Insulated GND
・	Not used
・	Not used
V1	Analog Voltage Output (Sensor Head 1)
I1	Analog Current Output (Sensor Head 1)
GND	Analog Output Ground
V2	Analog Voltage Output (Sensor Head 2)
I2	Analog Current Output (Sensor Head 2)
GND	Analog Output Ground

Note: Terminals with a "・" mark are unused terminals. However, some of these terminals have been connected to the internal circuitry, so do not use them as relay terminals in wiring, etc.

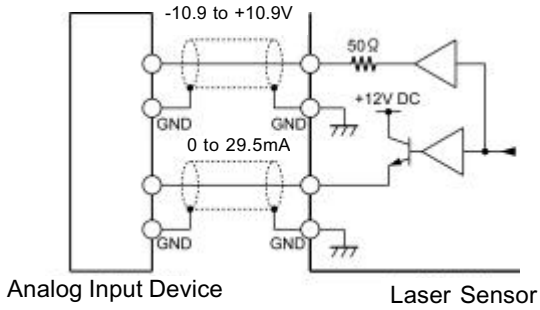
An alarm output is issued upon excessive or insufficient amount of the light. Judgment of the light amount is made in each measurement period. Therefore the alarm output may be unstable during measurement of a body that has a small amount of the light and large variation in the light amount.

■ Output Circuit

- Alarm Output, Judgment Output



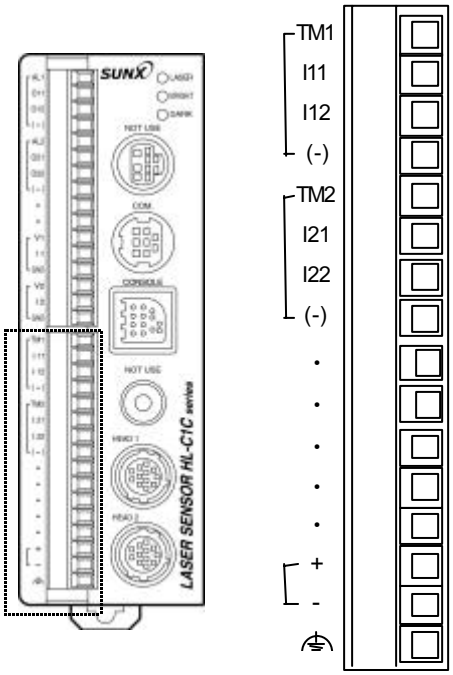
- Analog Output Circuit



Notes: 1) Be careful not to create a short circuit between analog output terminals or apply voltage to them.
2) Use shielded wires for analog outputs.

It takes about 10 to 25 seconds (variable according to the sampling period) after the power is turned on until the output settles. The analog output in the interval varies in the output range. For this reason the circuit configuration should allow the output in the entire range. As well, do not use the output in this interval.

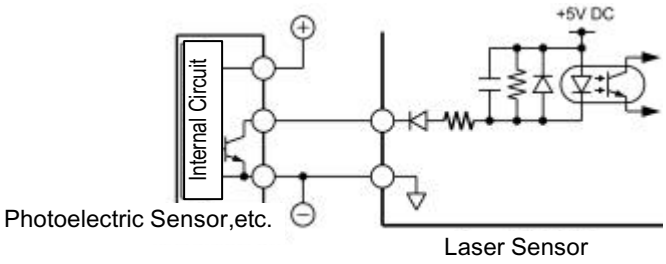
3-3 Input Terminals



Symbol	Content
TM1	Timing Input (Sensor Head 1)
I11	Zero Set ON Input (Sensor Head 1)
I12	Zero Set OFF Input (Sensor Head 1)
(-)	External Insulated GND
TM2	Timing Input (Sensor Head 2)
I21	Zero Set ON Input (Sensor Head 2)
I22	Zero Set OFF Input (Sensor Head 2)
(-)	External Insulated GND
·	Not Used
·	Not Used
·	Not Used
·	Not Used
·	Not Used
+	24V DC Input for Power Supply
-	Power Supply Ground
⏚	Function Ground

Note : Terminals with a "·" mark are unused terminals. However, some of these terminals have been connected to the internal circuitry, so do not use them as relay terminals in wiring, etc.

■ Input Circuit



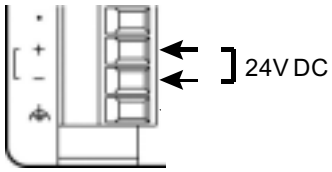
- A continuous 2ms or more input is accepted at the Zero Set ON and Zero Set OFF input terminals.
- Do not add the Zero Set ON and Zero Set OFF inputs simultaneously. Allow 2ms or more interval between the inputs.
- Add a Zero Set ON input only when the sensor head is within the measurement range
- If the batch input mode is selected (see page 5-23), add the timing input, Zero Set ON input and Zero Set OFF input at either the sensor head 1 or sensor head 2 input terminal.

3-4 Wiring Power Supply

■ Terminal Layout

- Use the + terminal and - terminal on the input terminal block to wire the power supply, supplying 24V DC.
- Use twisted wires for the power supply to minimize the effect of noise.

Rated Voltage	24V DC
Permissible Voltage Fluctuation Range	21.6 to 26.4V DC
Current Consumption	1 Sensor Head: Approx. 0.43A 2 Sensor Heads: Approx. 0.55A
Inrush Current	8A or less

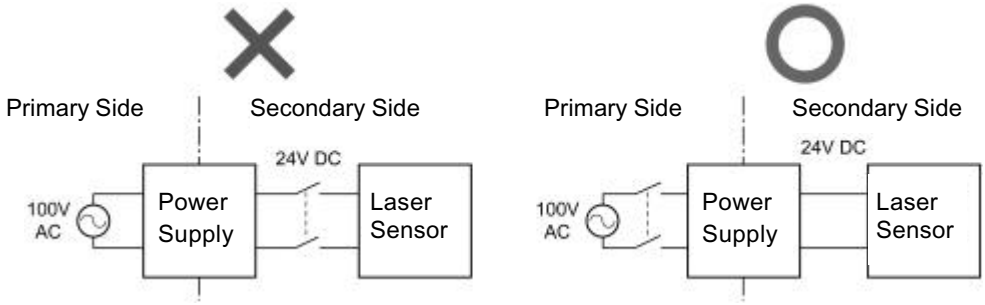


■ Use an insulated power supply with an internal protective circuit that has a sufficient capacity.

- A large current far exceeding the rated current flows temporarily when the power is turned on. Use an insulated power supply with an internal protective circuit that has a sufficient capacity (by a margin of 2A or more current capacity) to protect the circuit against irregular voltages in the power line, and check the power-on operation.
- An uninsulated type is used in the controller's regulator.
- If a power supply without an internal protective circuit is used, be sure to supply power to the controller via a protective element such as a fuse.

■ Switch the power supply on and off at the primary side.

- Switch the power supply on and off at the primary side (100V AC). If it is switched on and off at the secondary side (24V DC), the controller's fuse may burn out.



■ To improve noise resistance

- Wire the controller, input device and power device so that they run on respective separate systems.
- If there is particular concern about noise from the input and output circuits, it is recommended that power be supplied separately for the controller and the input and output power supplies.

■ Give consideration to the power supply sequence.

- Give consideration to a power supply sequence in which the controller's power supply is turned Off before the input and output power supplies.
- If the input and output power supplies are turned Off before the controller power supply, the controller will detect a change in the input signal level and may malfunction as a result.
- Do not turn the controller's power supply On again within 10 seconds after it is turned Off.
- It takes about 10 to 25 seconds (variable according to the sampling period) after the power is supplied until the controller becomes ready for operation (after completion of start-up). Do not use the output in the interval because the outputs (judgment output, alarm output and analog output) vary during start-up.

■ Instantaneous Power Failures

- If the duration of an instantaneous power failure is 10ms or less, operation continues.
- If the duration of an instantaneous power failure is 10 to 45ms, one of the following occurs.
  (1) Operation continues.
  (2) The analog output varies temporarily and the BRIGHT and DARK indicators blink, then the sensor recovers automatically.
  (3) The state changes to the reset state.
- If the duration of an instantaneous power failure is more than 45ms, the state changes to the reset state.

■ Use this product correctly.

- When wiring the power supply, be sure to turn the power supply Off.

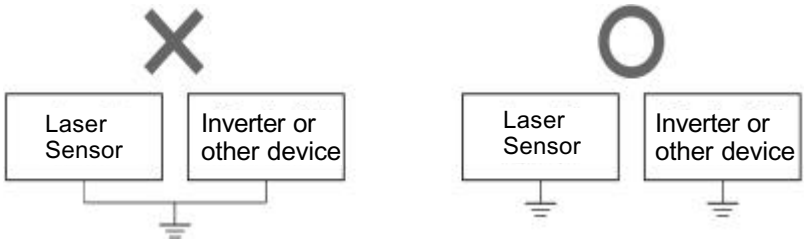
3-5 Grounding

■ Grounding when the effects of noise are great

- Under conditions of normal use, this product has sufficient noise resistance, but under an environment where there are particularly high noise levels, ground it securely.

■ Use an exclusive ground

- Use 2mm^2 or more wires and establish a class D ground with a ground resistance of 100 Ω or less.
- Make the grounding point as close to the controller as possible, and keep the ground wire distance short.
- If the laser sensor is grounded in common with another device, there could be a reverse effect, so be sure to use connect an exclusive ground.

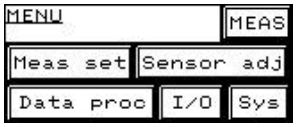


CHAPTER 4
MEASURING METHODS

4-1 Basic Operation of the Compact Console

■ Outline of the Contents of Each Screen

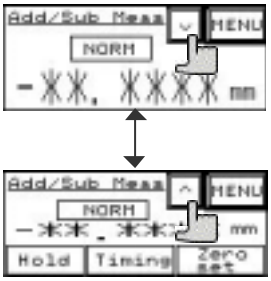
MENU Screen



Screen Name	Screen Contents
MENU	This is the main menu screen. All the screens can be accessed via this screen.
Measure	This displays the measurement values. Also, switching to the hold mode, zero set, timing inputs and other settings can be performed.
Measurement Settings	This screen is used to set the sampling period, sensor head operation and calculation formula.
Sensor adjustment	Sets the correction value (span, shift) in the measurement.
Data Processing	Sets the average number of samples, high pass filter and low pass filter.
Input/output	Used to select the input or output function and set the upper and lower limit value, etc.
System	Saves or initializes the setting contents, displays the screen version, etc.

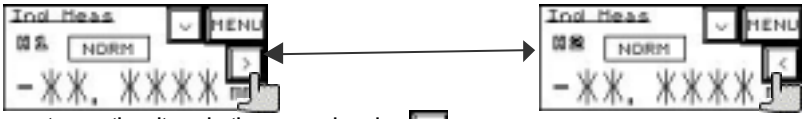
■ Shifting Screen Levels

Touching each of the item keys in the MENU screen changes the screen to each respective operating screen. Operating screens are arranged in a hierarchy structure. Move to the screen for the desired function, then set the necessary settings. Here, the method of shifting to different screen levels is explained.



: Shift down 1 level

: Shift up 1 level



: Advance to another item in the same level

: Return to the previous item in the same level.

■ Selecting from the items

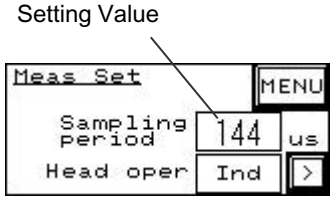
Here we explain how to select the item having the choices such as sampling period and average number of samples.

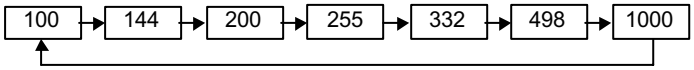
If sampling period is selected in the measurement setting screen

The value shown in the frame is the current setting value.

In the example, it shows that 144 μs is selected.

Touching the number causes the setting value to change. The setting values can be changed in the following sequence.

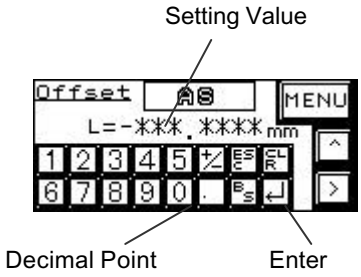


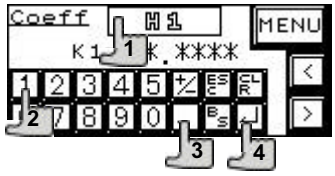


■ Inputting a Value

Here, we explain the value input method for upper and lower limit or offset, etc. A keyboard is displayed for the items which can be input.

1. Touch the frame above the setting value to change the mode to the number input mode, and causes the cursor to blink.
2. Input the desired number from the keyboard.
3. Touch the decimal point on the keyboard to input the numbers below the decimal point.
4. Finally, touch the enter key to fix the setting.

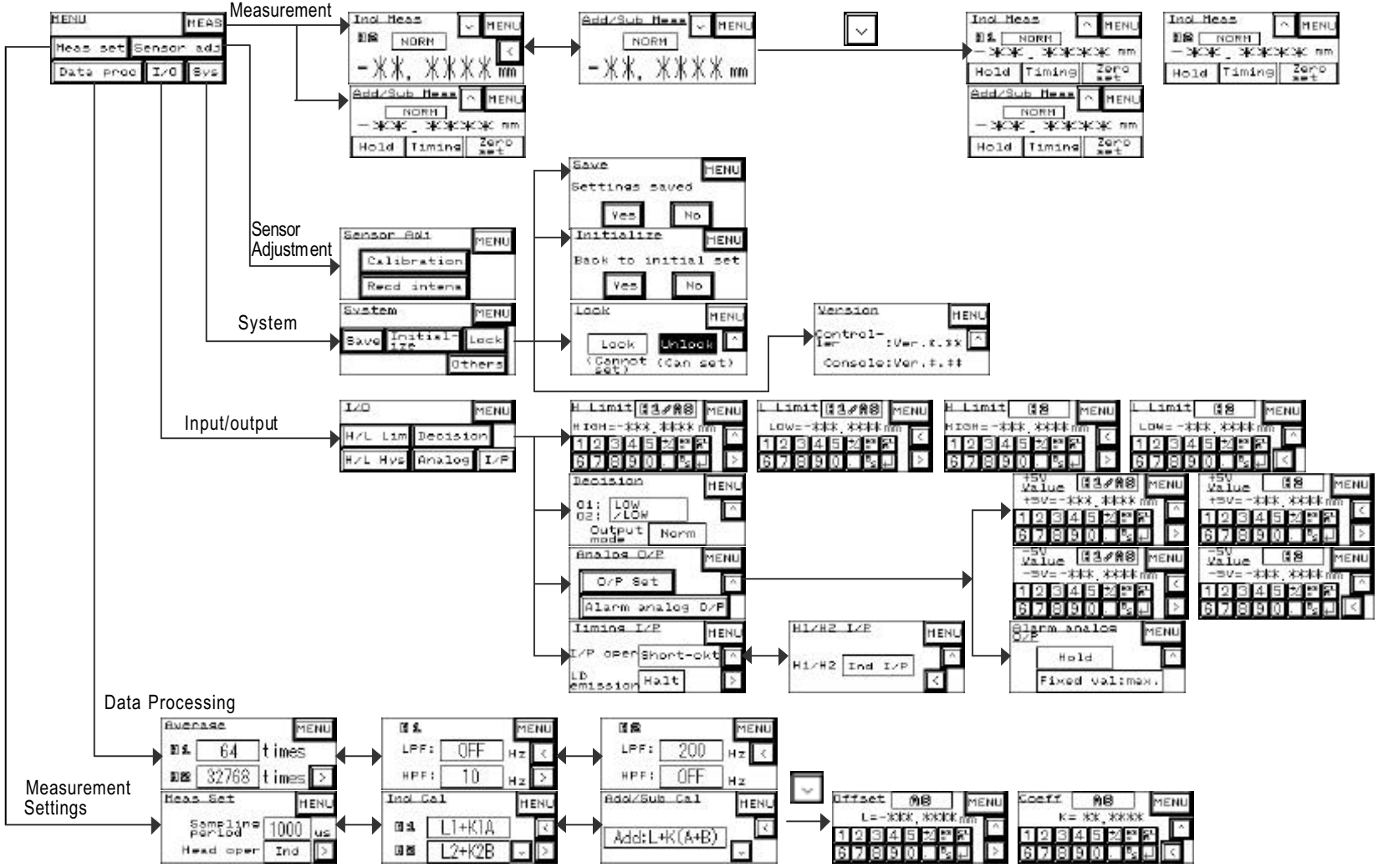




■ Caution

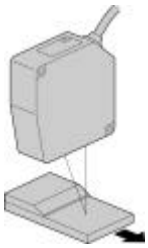
- Before connecting the compact console and controller, be sure to turn off both units.
- When the controller is connected with the compact console, the controller stops measuring two periods at every approx. 40ms to assure communication with the compact console.

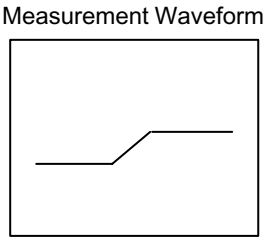
■ Flow of Each Screen



4-2 Measuring Height

Here we explain measurement of the difference in height of the measured object with respect to a reference surface. Here, the basic operation method is explained with the method of measuring the surface shape of a plate used as an example.





■ Procedure

1. Check all connections.

Confirm that the controller, sensor head and compact console are connected.

2.Turn on the power.

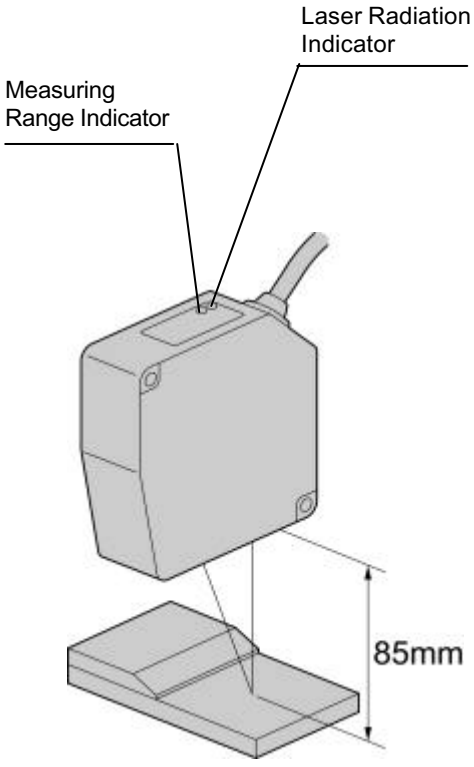
When the controller and sensor head have completed their automatic start up, the laser radiation indicator (green) will light up and the laser will radiate. If the measurement object is within the measuring range, a measurement value is displayed in the compact console.

3. Adjust the position of the sensor head.

Set the orientation of the measurement object and the sensor head with reference to “Mounting the Sensor Head" on page 2-4.

While observing the measuring range indicator (yellow) of the sensor head or measurement display on the compact console, adjust the mounting position of the sensor head so that the approximate measurement center distance is in the center of the measurement object's variation range.

The measuring range indicator (yellow) will blink when the distance from the measurement object is within the measuring range, and it will stay lighted up when near the reference distance.

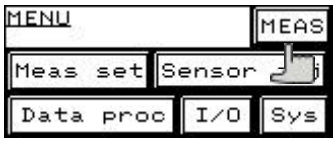


4. Perform Zero Setting

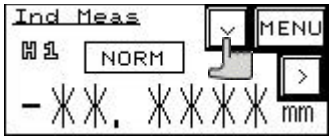
Touch the [⌄] button on the compact console's measurement display screen and switch to the sub screen one level down.

Touch [Zero set] to perform zero setting. The display value and the analog output will become "0", and the change in height will be measured after that. See page 5-4 concerning details of zero setting.

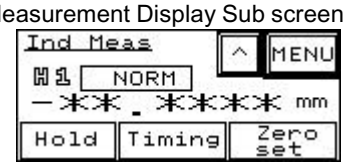
MENU Screen



Measurement Display Screen

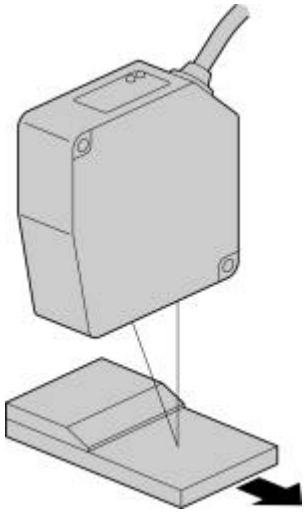


Measurement Display Sub screen



5. Measure the surface shape of the measurement object.

Move the measurement object or the sensor head horizontally and measure the measurement item's surface shape.



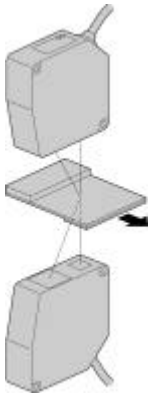
● **Supplementary Explanation**

If there is deviation in the measurement values due to the state of the measurement object's surface, see Calibration on page 5-23.

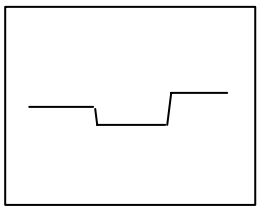
If the sampling period (page 5-7), average number of samples (page 5-11) and digital filter (pages 5-12, 13) are changed to correspond to the measurement object's moving speed, displacement rate and displacement contents, more stable measurements can be obtained.

4-3 Measuring Thickness

Here, we explain concerning measurement of the changes in thickness of the measurement object with respect to the reference thickness. The example here shows the basic operation method for measuring the thickness of a plate using two sensor heads.



Measuring Waveform



■ Procedure

1. Check all connections.

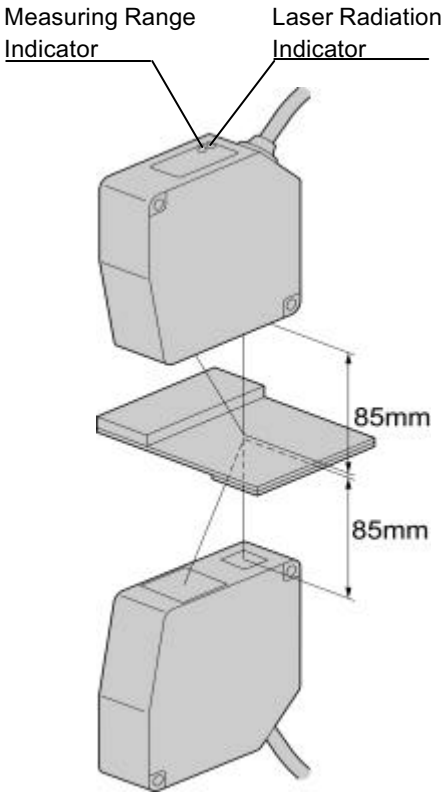
Confirm that the controller, sensor heads and compact console are connected.

2. Turn on the power.

When the controller and sensor heads have completed their automatic start up, the laser radiation indicators (green) will light up and the lasers will emit light. If the measurement object is within the measuring range, a measurement value is displayed in the compact console.

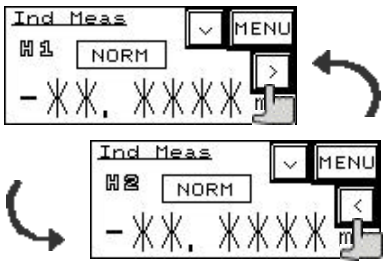
3. Adjust the position of the sensor heads.

- Set the orientation of the measurement object and the sensor heads with reference to "Mounting the Sensor Head" on page 2-4.
- While observing the yellow measuring range indicator of the sensor head or measurement display on the compact console, adjust the mounting position of the sensor head so that the approximate measurement center distance is in the center of the measurement object's variation range.
- The yellow measuring range indicator blinks when the distance to the object is in the measuring range, and it is lit approximately at the measurement center distance.

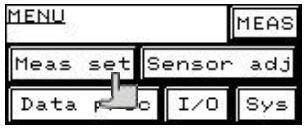


- Change over between the sensor head 1 (H1) and sensor head 2 (H2) display in the measurement display screen of the compact console.

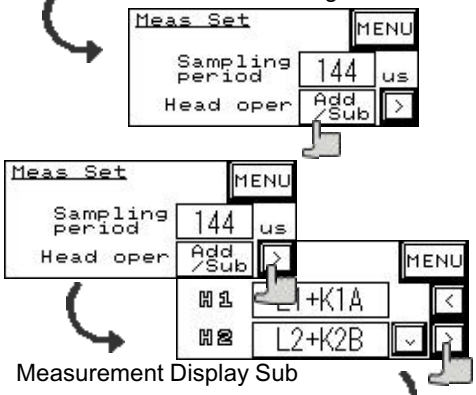
- If "add/subtract" is selected for the head operation, change to "independent" while referring to page 5-8.



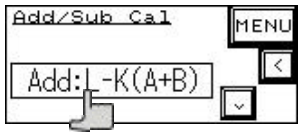
MENU Screen

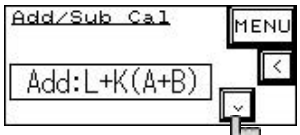


Measurement Setting Screen

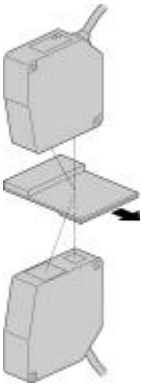


Measurement Display Sub

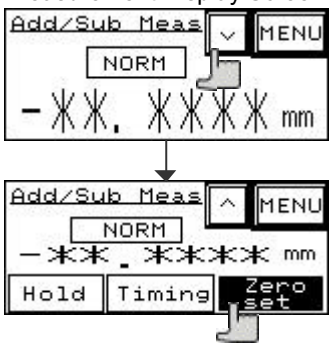




Offset Screen



Measurement Display Screen



4. Set the head operation to calculations.

After returning to the MENU screen by pressing [MENU], touch [Meas set] and display the measurement setting screen.

Touch the [Head Operation] key, and display [Add /Sub].

5. Set the Add/subtract Calculation formula.

Advance 2 screens from the measurement setting screen (touch the [>] key 2 times), then display the Add/subtract Calculation Screen. Touch the Calculation Formula key and display [Add:L-K(A+B)]

6. Set it so that the actual thickness will be displayed.

In the sub screen in the next level below the "Add/subtract Calculation" screen (touch the [⌄] key), input the offset value L using a value that will enable the actual measurement value to be displayed on the measurement value display (see page 5-9).

The L input range is ±999.999mm.

After the setting is fixed, touch the [MENU] button and return to the MENU screen.

7. Measure the thickness of the measurement object.

Move the measurement object or the sensor heads horizontally and measure the thickness of the measurement object.

If you are measuring the amount of difference in the thickness from the reference work piece, touch the [⌄] key in the measurement display screen in step 6, move to the sub screen one level below, then touch [Zero set] and perform zero setting.

CHAPTER 5
FUNCTION ITEM

5-1 List of Functions

			Page
Measurement	Measurement	Displays the measurement values. Changes the hold mode. Allows zero setting, timing and display hold inputs.	5-2
	Hold Mode	Changes the hold mode between NORM. / P-P / PEAK and VALLEY.	5-2
	Zero Set	Sets the measurement value and analog output forcibly to zero.	5-4
	Timing	Holds the judgment output, measurement value and analog output to avoid unnecessary variation in the output and laser radiation.	5-5
	Display Hold	Holds the measurement value displayed on the compact console only.	5-6
Measurement Settings	Sampling Period	Changes the sampling period in order to measure work pieces with a low amount of reflected light with stability.	5-7
	Sensor Head Operation	Changes over between independent measurement with two heads and add/subtract measurement.	5-8
	Calculation Formula	Sets the calculation formula selection, offset and coefficient for each sensor head.	5-9
Data Processing	Average Number of Samples	Changes the average number of samples.	5-11
	Low Pass Filter	Changes the cutoff frequency of the low pass filter to avoid the influence of steep changes.	5-12
	High Pass Filter	Changes the cutoff frequency of the high pass filter to avoid the influence of gentle changes.	5-13
Input/output	Upper / Lower Limit Setting	Sets the upper and lower limit values of the judgment output.	5-14
	Hysteresis Setting	Sets the hysteresis of the upper and lower limit values.	5-15
	Judgment Output Selection	Selects the judgment output operation pattern. Switches to the test output mode.	5-17
	Output Mode	Uses the judgment output as a light amount alarm output.	5-18
	Analog Output Setting	Sets the analog output corresponding to the measurement value.	5-19
	Analog Output During Alarm	Changes over between analog output hold and fixed out-of-range output issued upon an alarm.	5-21
	Input Selection	Reverses the input operation of the timing input. Laser emission during timing input continues. Switches to independent/batch input.	5-22
Sensor Adjustment	Calibration	Sets the span and shift for calibration.	5-24
	Amount of Light Received	Displays the amount of light received.	5-28
System	Save	Saves the contents of each setting in memory.	5-29
	Initialization	Recovers the factory shipment settings.	5-30
	Lock (Touch Key Lock)	Prohibits setting of or changes to the compact console and prevents wrong settings through inadvertent operations.	5-32
	Version	Displays the controller and compact console versions.	5-33

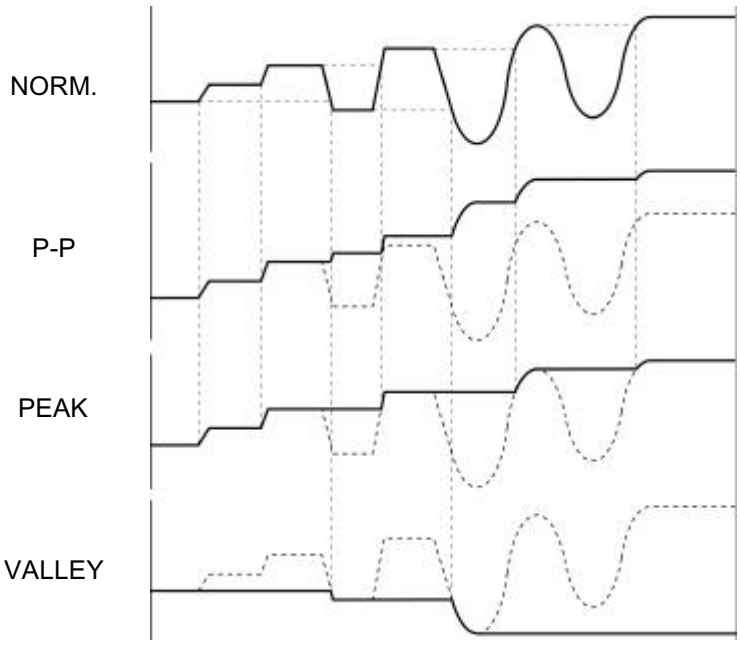
5-2 Explanation of Functions

5-2-1 Hold Mode

This device has 4 hold modes, and the measurement results in the set mode are displayed / output.

Hold Mode	Function
NORM.	Outputs the amount of displacement from the measurement center distance in real time. Ordinarily, this mode is used.
P-P	This mode holds and outputs the difference between the maximum value and the minimum value. It is used for vibration measurements or eccentricity.
PEAK	Holds and outputs the maximum measurement value.
VALLEY	Holds and outputs the minimum measurement value.

■ Output Changes in Each Hold Mode

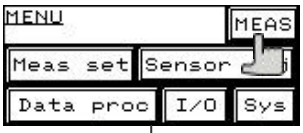


■ Setting the Hold Mode

1. Display the measurement display screen.

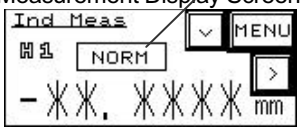
When [MEAS Measurement] is touched in the MENU Screen and the measurement display screen is displayed, the currently set hold mode is displayed in the hold mode key area.

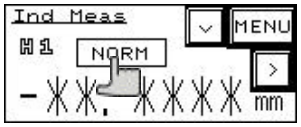
MENU Screen



Hold Mode Key

Measurement Display Screen





2. Display the set hold mode by the "Hold Mode" key in the measurement display screen.

- The hold value up to that moment is reset when the hold mode is changed.
- Zero setting can be performed even in the hold mode, but the hold value is reset when zero setting is input or zero setting is canceled.
- If the hold mode is changed after zero setting, zero setting is canceled.
- The hold value is reset during changeover from the timing input state to non-input state or during changeover of the sampling period or smoothing setting.
- If the power is turned on after a hold mode other than NORM. is saved, be sure to perform one of the above conditions to reset the hold value.
- Do not change the hold mode in other than the measurement range. Otherwise the correct measurement value may not be displayed.
- If display hold (see page 5-6) is set, the measurement displayed at the timing is maintained and the measurement value displayed at the compact console does not change. The analog output, judgment output and other outputs are issued according to the selected hold mode.
- The displayed measurement value, analog output, and judgment output are maintained in the timing input state and they do not change even if the hold mode is switched.
- Follow the following sequence when changing the sampling period, setting the low or high pass filter, and changing the hold mode from NORM.
  1) Changing the sampling period
  2) Setting the low or high pass filter
  3) Changing the hold mode from NORM.

Reference Default Setting: NORM.

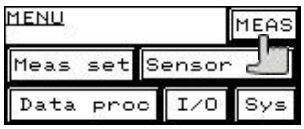
5-2-2 Zero Set

The amount of displacement is displayed in reference to the center of measurement of the sensor head during regular operation. After a zero setting input is added, the amount of displacement in reference to the current position is displayed. Therefore the measurement value and analog output at the timing of zero setting are forcibly reset to zero. Use this function to reset the measurement value of the reference workpiece to zero and measure the displacement amount or make judgment of the upper or lower limit.

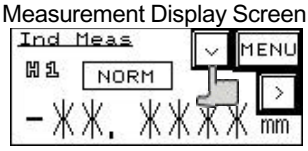
1. From the measurement display screen, touch [▽] and display the sub screen.

Touch [MEAS] from the MENU screen. Next, change to the sub screen that is at the next level below by touching [▽].

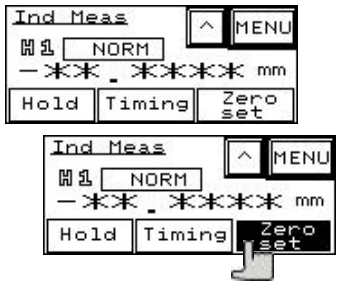
MENU Screen



Measurement Display Screen



Measurement Display Sub screen



2. Touch [Zero set] to change the measurement value to "0".

- The analog output also changes to 0 simultaneously. (Voltage output = 0V, Current output = 12mA)
- In independent operation, zero set can be performed for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2).
- In add/subtract operation, the analog output of sensor head 1 and sensor head 2 becomes "0".
- In the zero set state, [Zero set] is displayed in reverse highlighting.
- Zero Set is canceled if the Zero Set key is touched again.
- Cancel zero setting to return the reference position of measurement to the center of measurement (default).
- Zero set is canceled if the hold mode is changed.
- Change over the head operation (independent/add and subtract measurement) to cancel zero setting.
- The state is maintained in the P-P hold mode even if zero setting is canceled.
- Do not add a Zero Set ON and Zero Set OFF inputs simultaneously at the input terminal.
- Perform zero setting only when the sensor head is in the measurement range.

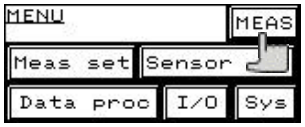
Reference Default setting: OFF

- **Supplementary Explanation**
  - For independent and add and subtraction measurement, see "Sensor Head Operation" on page 5-8.
  - If zero setting is performed and the sensor head setting exceeds the analog output range, the analog output is reversed. Be sure to measure within the analog output range (voltage output: ±10.9V, current output: 0 to 29.5mA). Among all, care should be taken when an enlarged output is selected in the analog output setting or addition and subtraction measurement is made with two sensor heads.

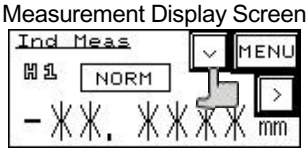
5-2-3 Timing

The judgment output (O1 and O2) immediately before the mode selection, measurement value and analog output are held in the timing input mode. Laser emission can be halted or continued according to a setting. Add the input in other than the measurement or judgment state to eliminate unnecessary output changes or laser radiation.

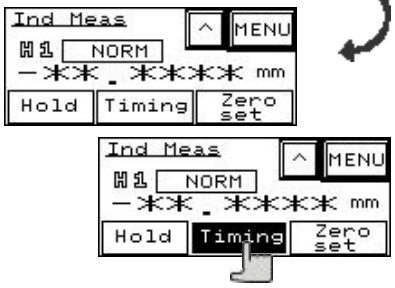
MENU Screen



Measurement Display Screen



Measurement Display Sub screen



1. From the measurement display screen, touch [▽] and display the sub screen.

Touch [MEAS] Measurement] from the MENU screen. Next, change to the sub screen that is at the next level below by touching [▽].

2. Touch [Timing] to hold the judgment output and measurement value.

- The analog output is held.
- The alarm output is issued.
- During independent operation, this operation is executed for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2).
- During add/subtract operation, the operation is executed simultaneously for both sensor heads.
- [Timing] is displayed in reverse highlighting when in the timing input state.
- Touching [Timing] again cancels the timing input state.
- Change over the timing at the compact console when the timing is not input at the terminal. If the timing is input at the terminal, the timing input cannot be turned on or off at the compact console (Priority on terminal input).
- Laser emission can be halted or continued while the timing is input, so that the timing can be used as a laser emission control.
- While the timing is input, the measuring range indicator of the sensor head is unlit without relations to the laser emission setting (halt or continue).
- When the timing input is interrupted (in laser emission halt setting), an alarm is issued for a maximum of 6ms (varies according to the sampling period).
- The timing input state is not stored in memory when saving is executed.

Reference Default Setting: OFF

- **Supplementary Explanation**

If zero setting is executed while the timing input is added, the measurement value is reset to "0" and the analog output and judgment output change in interlock.

5-2-4 Display Hold

Only the measurement value displayed on the compact console is held. Use this function to read a momentary measurement value.

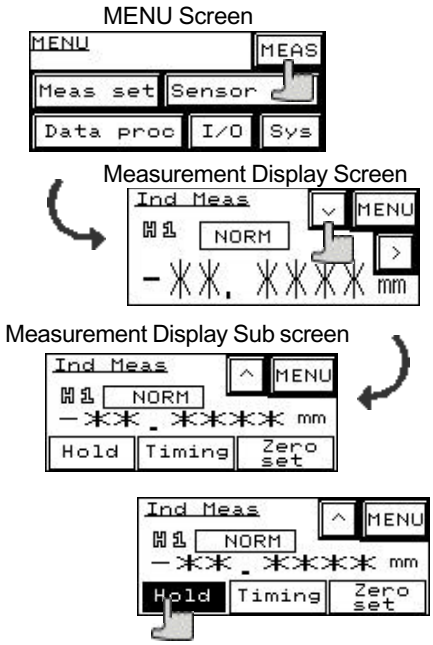
1. From the measurement display screen, touch [⌄] and display the sub screen.

Touch [MEAS] from the MENU screen. Next, change to the sub screen that is at the next level below by touching [⌄].

2. If [Hold] is touched, the measurement value is held.

- The analog output, judgment output and alarm output are not held.
- During independent operation, this operation is executed for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2).
- [Hold] is displayed in reverse highlighting when in the hold state.
- Touching [Hold] again cancels the hold state.
- The data is not stored in memory even if saving is executed.

Reference Default Setting: OFF



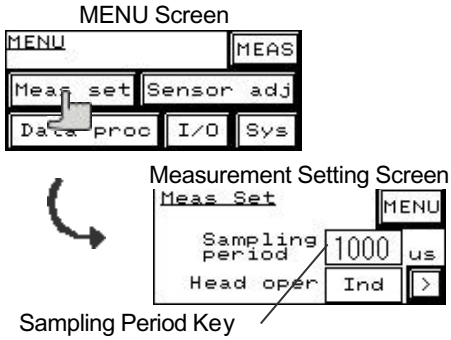
5-2-5 Sampling Period

In cases where work pieces with a low reflected light amount, such as black rubber, are measured, stable measurements can be taken by extending the sampling period and enabling a sufficient amount of light to be picked up by the sensor. If the sampling period is short and not enough light can be picked up, the sensor enters the alarm state, so switch the sampling period to a longer duration setting.

Period [μs]	100	144	200	255	332	498	1000
Frequency [kHz]	10	7	5	4	3	2	1
Measurement Object	Bright	⟷					Dark

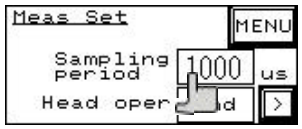
1. Display the measurement setting screen.

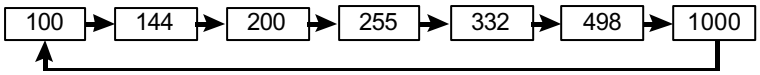
If [Meas set] is touched in the MENU screen and the measurement setting screen displayed, the currently set sampling period is displayed.



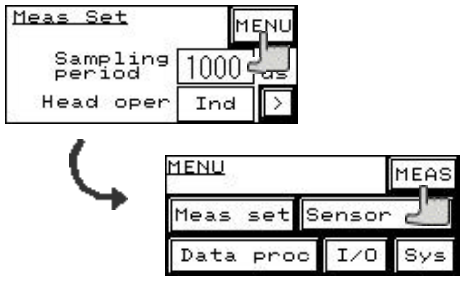
2. Display the optimum sampling period using the "Sampling Period" key.

- The sampling period is set for the 2 sensor heads in common, so it cannot be set for each sensor head.
- Each time the key is touched, the display changes, with the sequence of settings changing as shown below.





3. After returning to the [MENU] screen by touching the MENU key, change to the measurement display screen by touching [MEAS].



Reference Default Setting: 144μs

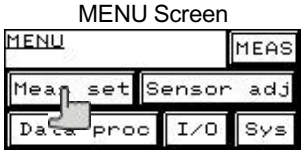
- **Supplementary Explanation**
  - It takes from 0.3ms to 3s after the sampling period is changed until the new sampling period becomes valid. The time necessary for changeover becomes longer with a longer sampling period. It is maximum about 3s with 100μs. During the interval, laser radiation is stopped and the laser emission indicator of the sensor head is unlit. The measuring range indicator keeps the state immediately before the changeover of the sampling period. The alarm output in the interval is unknown.
  - For changing the sampling period, setting the low or high pass filter, or changing the hold mode from NORM. be sure to refer to page 5-3.

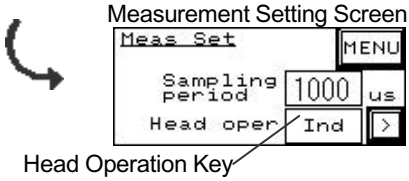
5-2-6 Sensor Head Operation

2 sensor heads can be used to measure independently, or they can be combined to take thickness measurements or level difference measurements, etc., and calculations made to determine the measurement results. The measurement value display and the analog output and judgment output can also be switched.

1. Display the measurement setting screen.

If [Meas set] in the MENU screen is touched, the measurement setting screen will be displayed. This screen displays the currently set head operation.



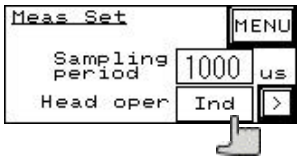


2. Operate the sensor head using the "Head Operation" key, and display the sensor head operation.

The measurement display and screen contents differ according to the sensor head operation set here.

Each time the key is touched, the display changes as shown below.

[Ind] ⟷ [Add /Sub]



3. After returning to the MENU screen by touching [MENU], change the screen to the measurement display screen by touching [Meas set].

MENU Screen

Reference Default setting: Independent

● **Supplementary Explanation**

- The measurement display screen shows the one corresponding to the independent or add/subtract head operation mode.
- Change from "independent" to "add/subtract" to output the result of addtion or subtraction to the sensor head 1 side. On the sensor head 2 side, the result of independent calculation at sensor head 2 is output.
- When "independent" is changed to "add/subtract" or "add/subtract" is changed to "independent", the hold mode of both sensor heads 1 and 2 changes to NORM. automatically. The hold mode can be changed after the head operation is switched.
- Do not change the hold mode of sensor head 2 using an RS-232C command in the "add/subtract" mode. If the mode is changed erroneously, return to the NORM. mode.
- When "independent" is changed to "add/subtract", the timing and zero setting input operations change to "batch input" and, accordingly, the input is simultaneous for sensor heads 1 and 2. (For "batch input", see page 5-23.)
- If zero setting is performed and the sensor head setting exceeds the analog output range, the analog output is reversed. Be sure to measure within the analog output range (voltage output: ±10.9V, current output: 0 to 29.5mA). Among all, care should be taken when an enlarged output is selected in the analog output setting or addition and subtraction measurement is made with two sensor heads put, concerning batch input.)

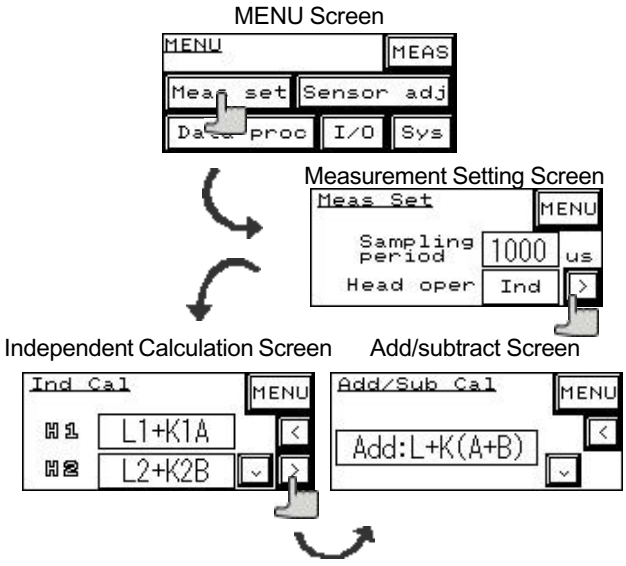
5-2-7 Calculation Formulas

L1 + K1A L2 + K2B	This is the normal output state, with the near side output as a negative value.
L1 - K1A L2 - K2B	This is selected to output the height of the measurement object as a positive value, etc. or in cases when the positive and negative measurement values are output with the opposite sign. It is used to reverse the analog output.
L + K (A + B)	This is selected to add the measurement values of sensor head 1 and sensor head 2.
L - K (A + B)	This is selected when measuring thickness.
L + K (A - B)	This is selected when measuring level differences.
L - K (A - B)	Use the formula to invert the polarity of difference between the measurement outputs from sensor heads 1 and sensor head 2.
A	Displays the measurement or calculated value of sensor head 1.
B	Displays the measurement or calculated value of sensor head 2.
L	This value is used to shift the measurement value so that it matches the actual measurement value.
K	This is used in special cases such as changing the degree of fluctuation between the 2 sensor heads. Ordinarily, it is left at 1.

1. Display the measurement setting screen.

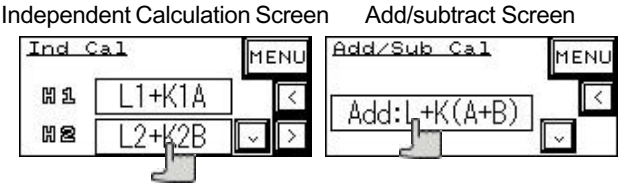
Touch [Meas set] in the MENU screen. The screen will change to the measurement setting screen.

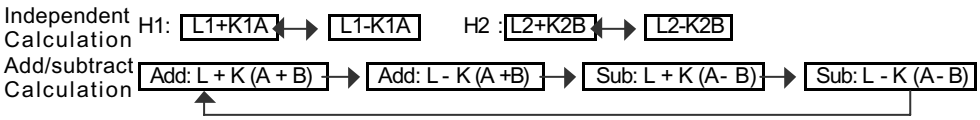
2. Using the [>] key is touched, the independent calculation screen will be displayed in the case of an independent operation, and in the case of a calculation operation, the "add/subtract" calculation screen is displayed.



3. Select the calculation formula.

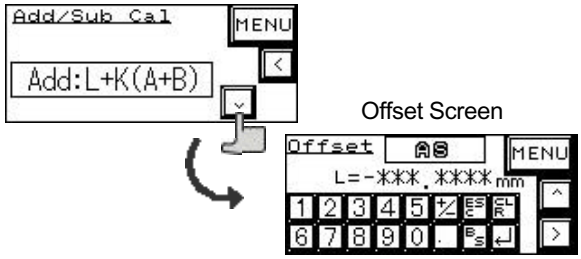
- Touch the calculation formula key and display the calculation formula to be selected.
- Each time the key is touched, the display changes as shown below.





4. Using the [∨] move to the Offset screen on the next lower level.

In the Offset screen, the current value and a keyboard for inputting numeric values are displayed.

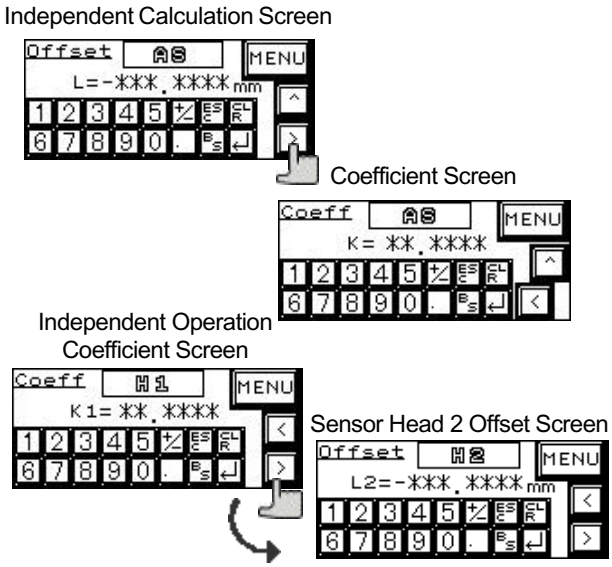


5. Set the Offset "L".

- If necessary, input the Offset "L".
- See page 4-2 concerning the keyboard input method.
- There is no problem in operation even if the default value "0" is left as it is.

6. Set the coefficient "K".

- Touch [>] in the Offset screen and display the coefficient screen.
- If necessary, set the coefficient "K". However, ordinarily, the default value "1" is left as it is.
- In the case of independent operation, touch [>] and set the Offset "L" and coefficient "K" for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2.)



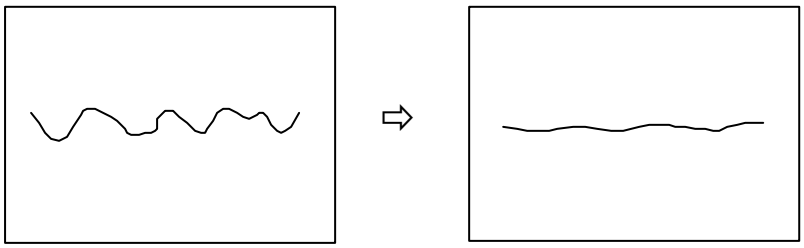
Reference Input Range: L1, L2, L = ±999.9999mm K1, K2, K = 0.0001 to 99.9999
Default Settings: L1 = L2 = L=0, K1 = K2 = K = 1

● Supplementary Explanation

- "A" and "B" in the calculation formula for the add/substract mode indicate the results of independent calculation of sensor head 1 and sensor head 2, respectively.
  For example, "L + K (A + B)" indicates "L + K {(L1 + K1A) + (L2 + K2B)}.
- If the calculation value exceeds the ±99.9999mm range due to the coefficient and offset settings, the display in the compact console displays only 3 digits, and any digits beyond 3 digits are ignored.
- Use calculation so that the result does not exceed the ±999.9999mm range. If the range is exceeded, the correct output is not obtained at the serial port.

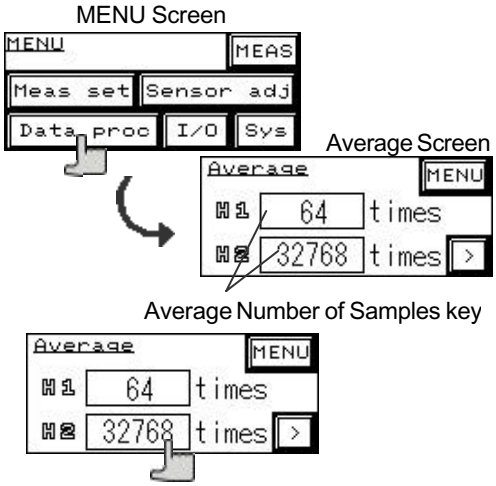
5-2-8 Average Number of Samples

The measurement result can be smoothed so that stable measurement values are obtained. The number of samples can be set in 16 steps between OFF and 32,768 times.



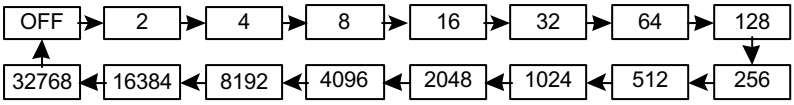
1. Touch [Data proc] **.**

Touching [Data proc] in the MENU screen and displaying the average screen displays the currently set average number of samples and the average number of samples key.



2. The maximum average number of samples is displayed in the "Average Number of Samples" key.

Set the average number of samples for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2). Each time the key is touched, the display value changes in the sequence shown below.

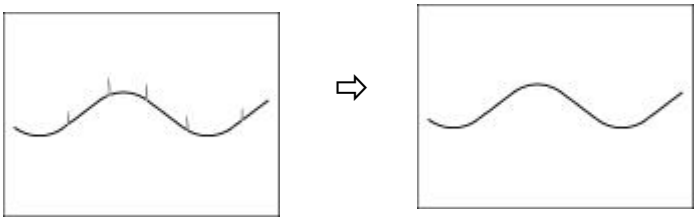


3. After returning to the MENU screen by the [MENU] **key, change to the measurement display screen by the** [MEAS] **key.**

Reference Default Setting: 64 times

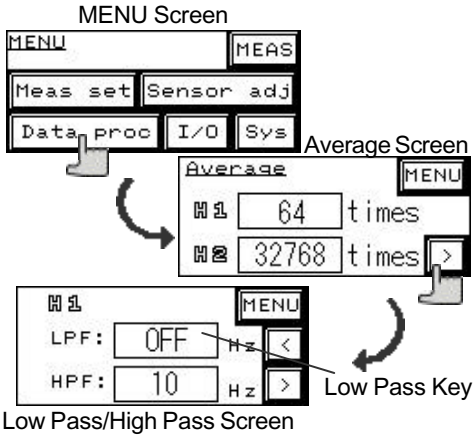
5-2-9 Low Pass Filter

If, for example, machining state of a metal surface generates noise and hinders an accurate measurement, this setting can reduce its influence and enable a stable displacement measurement.



1. Touch [Data proc].

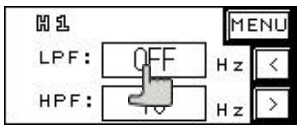
Touch [Data proc] in the MENU screen. From the Average Screen, touch [>] once more and enter the Low Pass/High Pass Screen. The currently set cutoff frequencies will be displayed.

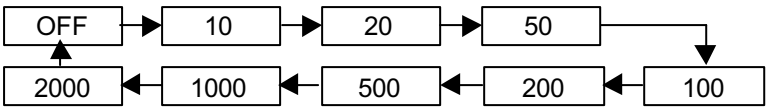


2. Display the optimum cutoff frequency using the "Low Pass" key.

Set the frequency for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2).

Each time the key is touched, the display value changes in the sequence shown below.





3. After returning to the MENU screen by the [MENU] key, change to the measurement display screen by the [MEAS] key.

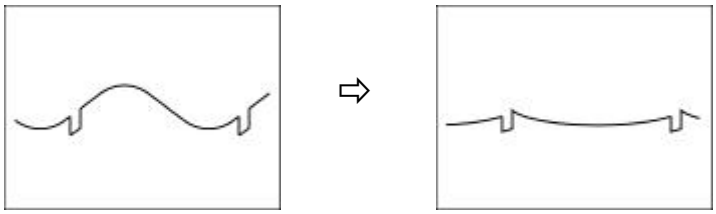
Reference Default Setting: OFF

● **Supplementary Explanation**

- Set the cutoff frequency of the low pass filter to a value larger than the cutoff frequency of the high pass filter.
- When changing the sampling frequency, setting the low or high pass filter, or changing the hold mode from NORM., be sure to refer to page 5-3.

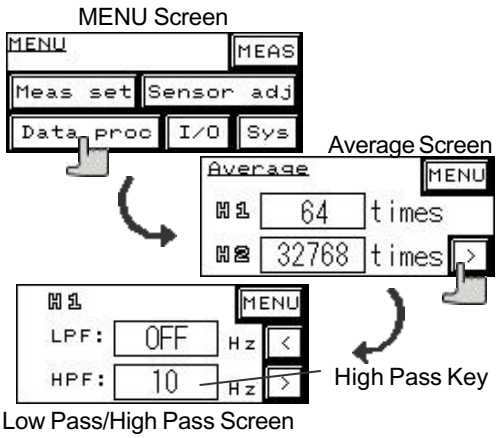
5-2-10 High Pass Filter

If joints or grooves are being measured in the midst of great changes such as runout or inclination in an eccentric rotating object etc., this setting minimizes the effects of gradual changes and makes it possible to detect the joints or grooves.



1. Touch [Data proc] **.**

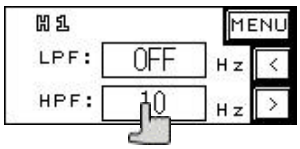
Touch [Data proc] in the MENU screen. From the Average Screen, touch [>] once more and enter the Low Pass/High Pass Screen. The currently set cutoff frequencies will be displayed.

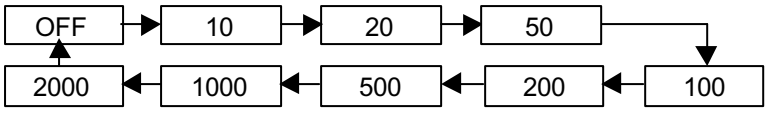


2. Display the optimum cutoff frequency using the "High Pass" key.

Set the frequency for each sensor head (H1: Sensor Head 1, H2: Sensor Head 2).

Each time the key is touched, the display value changes in the sequence shown below.





3. After returning to the MENU screen by the [MENU] **key, change to the measurement display screen by the** [Meas set] **key.**

Reference Default Setting: OFF

● **Supplementary Explanation**

- Set the cutoff frequency of the high pass filter to a value smaller than the cutoff frequency of the low pass filter.
- To use timing input together with this setting, select "LD emission continue" for the timing input laser emission setting.
- The filter effect varies according to the sampling frequency. Set the cutoff frequency at a value no smaller than 1/100 of the sampling frequency (see the table on page 5-7). Be sure to make actual measurement and check before determining.
- When changing the sampling frequency, setting the low or high pass filter, or changing the hold mode from NORM., be sure to refer to page 5-3.

5-2-11 Upper and Lower Limit and Hysteresis Settings

■ Upper and Lower Limit Settings

Set the upper and lower limits of the judgment output issued at O1 and O2. The upper and lower limit values can be set for each sensor head.

1. Display the Input/output Screen.

Touch [I/O] in the MENU screen. The input/output screen will be displayed.

2. Display the upper limit value screen and set the upper limit value.

Touch [H/L Lim] in the input/output screen. The current setting value and keyboard for inputting numbers will be displayed.

Here the upper limit value is the upper limit value for sensor head 1 (H1) in the case of independent operation and is the upper limit value for the add/subtract calculation value (AS: ADD/SUB) in the case of add/subtract operation.

This setting value is common for all hold modes.

See page 4-2 for the keyboard input method.

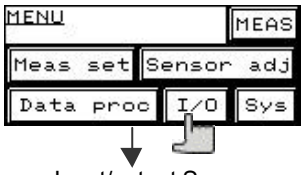
3. Display the lower limit value screen.

From the upper limit value screen, touch [>] to go to the lower limit screen. The current setting value and a keyboard for inputting numbers will be displayed.

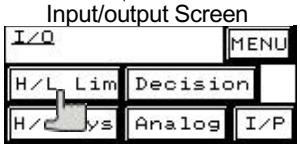
Here the lower limit value is the lower limit value for sensor head 1 in the case of independent operation and is the lower limit value for the add/subtract calculation value (AS: ADD/SUB) in the case of add/subtract operation.

This setting value is common for all hold modes.

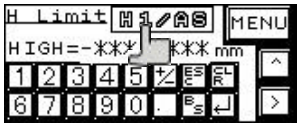
MENU Screen



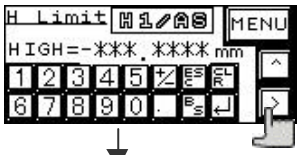
Input/output Screen



Upper Limit Value Screen



Upper Limit Value Screen

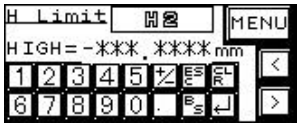


Lower Limit Value Screen

4. Set the upper limit value for sensor head 2.

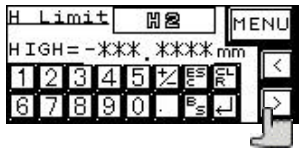
In the case of independent operation, touch [>] again.
Set the upper limit value in the upper limit value screen for sensor head 2. In the case of add/subtract operation as well, setting the upper and lower limit setting values for sensor head 2 causes execution of the judgment operation.

Lower Limit Value Screen

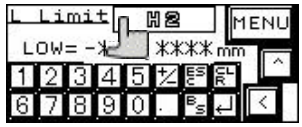


5. Set the lower limit value for sensor head 2.

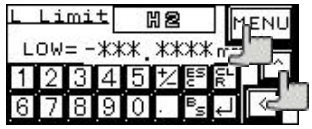
Touch [>] again.
Set the lower limit value in the lower limit value screen for sensor head 2.



6. Return to the MENU screen by touching the [MENU] key or return to the input/output screen by touching [^].



Reference input Range: Upper Limit Value, Lower Limit Value = ±999.9999mm
(However, set values so that the upper limit value becomes larger than the lower limit value.)



Default Settings:
Sensor Head 1 Upper Limit Value = Add/subtract Calculation Upper Limit Value = + 20.0000mm
Sensor Head 1 Lower Limit Value = Add/subtract Calculation Lower Limit Value = - 20.0000mm
Sensor Head 2 Upper Limit Value = + 20.0000mm
Sensor Head 2 Lower Limit Value = - 20.0000mm

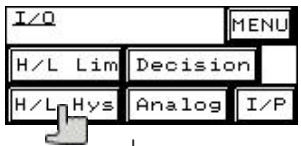
■ Hysteresis Setting

Set the hysteresis for the upper and lower limit values to avoid chattering. Because the resolution changes according to the workpiece to be measured, average number of samples and so on, set the operating conditions and use the P-P mode to obtain an approximate resolution before setting the hysteresis. The hysteresis can be set for each sensor head.

1. Display the upper limit hysteresis screen from the input/output screen.

Touch [I/O] in the MENU screen. The input/output screen will be displayed.
Touch [H/L Hys] in the input/output screen to open the upper limit hysteresis screen. A keyboard is displayed so that the current setting and value can be input.

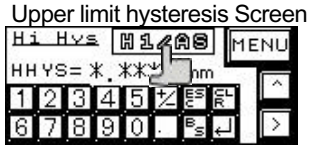
Input/output Screen



2. Set the upper limit hysteresis.

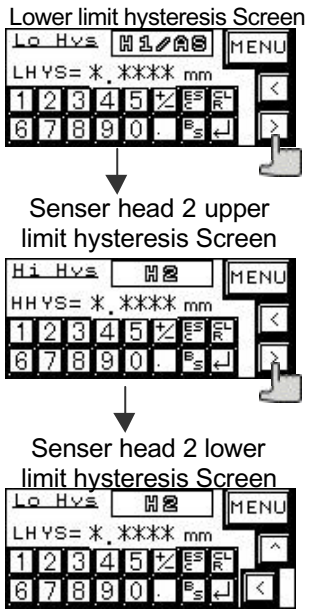
Here, input the hysteresis for the upper limit value of sensor head 1. The hysteresis input here works evenly in the upper and lower value areas around the upper limit value.
For details, see "● On hysteresis" on page 5-16. For the keyboard entry method, refer to page 4-2.

Upper limit hysteresis Screen



3. Set the lower limit hysteresis.

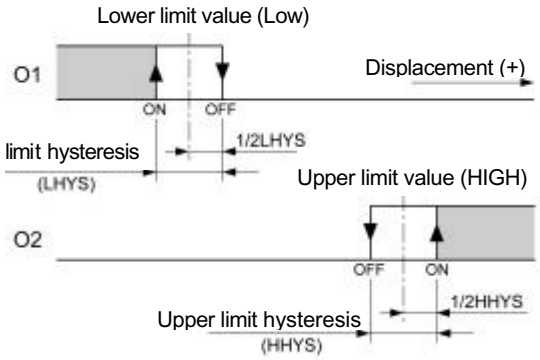
Touch [>] in the upper limit hysteresis screen to change to the lower limit hysteresis screen. A keyboard is displayed so that the current setting and value can be entered. Enter the hysteresis for the lower limit value of sensor head 1. Similarly to the upper and lower limit setting procedure, set the hysteresis for sensor head 2.



● **On hysteresis**

The hysteresis can be set for each of the upper and lower values of each of the sensor heads. The relationship between the set hysteresis value and activation and deactivation of the output is shown in the figure on the right. The hysteresis works evenly to the upper or lower limit value.

* "Output ON" (active output) indicates an open terminal.



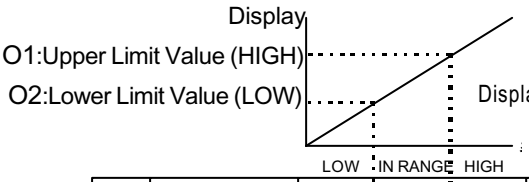
Reference

Input range : Upper or lower limit hysteresis = 0.0000 to 2.0000mm
However, input an even number for the least significant digit.

Initial setting: Upper or lower limit hysteresis = 0.0300mm (for both sensor heads 1 and 2)

5-2-12 Judgment Output Selection

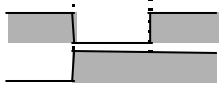
The judgment output (O1 and O2) can be selected from the four types listed in the table below.



Logical Output and Judgment

Output \ Judgment	LOW	INRANGE	HIGH
O1	1	0	1
O2	0	1	1

1: Output state

O1 O2	LOW $\overline{\text{LOW}}$		Select to distinguish the side of the measurement value around the lower limit value setting. The upper limit setting is ignored.
O1 O2	LOW HIGH		Select to distinguish between the upper limit and lower limit when the measurement value exceeds either limit.
O1 O2	LOW or HIGH IN RANGE		Select to distinguish between deviation from the upper or lower limit value and containment in the range. Use this for OK/NG judgment.
O1 O2	Logical Output		Select to distinguish whether the measurement value is below the lower limit value, above the upper limit value or within the range. Build an external logical circuit to judge two outputs and separate them into three states.

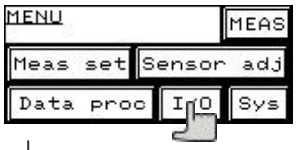
: Output state

* The "output state" indicates that the terminal is open.

1. Display the input/output screen.

Touch [I/O] in the MENU screen and display the input/output screen.

MENU Screen



2. Display the judgment select screen.

Touch [Decision] in the input/output screen and display the judgment select screen.

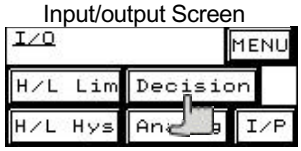
The currently selected output type is displayed.

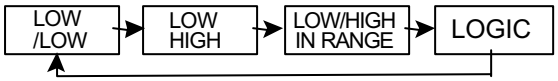
Select the output type with the output type key.

This setting is common for both sensor head 1 and sensor head 2.

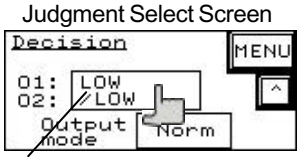
Each time the key is touched, the setting changes in the sequence shown below.

Input/output Screen





Judgment Select Screen



Reference Default Setting: LOW/HIGH

Output Type Key

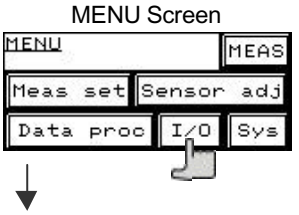
* The upper line in "LOW/$\overline{\text{LOW}}$" is not displayed on the screen of the compact console.

5-2-13 Output Mode

This makes it possible to distinguish whether the amount of light at each sensor head is excessive or insufficient when measurement is impossible. This is used mainly during installation and when trouble occurs etc., and is used as supplementary information when searching for the cause of being unable to take measurements.

1. Display the input/output Screen

Touch [I/O] in the MENU screen and display the input/output screen.

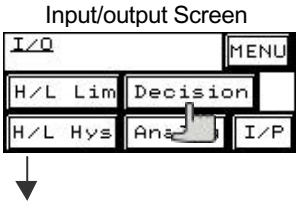


2. Display the judgment select screen.

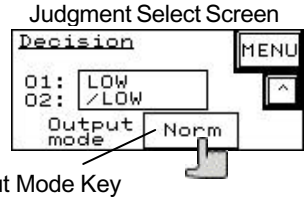
Touch [Decision] in the input/output screen and display the judgment select screen.

Display [Test] using the output mode key.

When [Test] is selected, the output becomes proportional to the amount of the light without relations to the upper and lower limit settings. Be careful not to make inadvertent changes.



O1	BRIGHT output
O2	DARK output



When under normal use conditions, return to "Normal" and use it in that state.

This setting is common for sensor head 1 and sensor head 2.

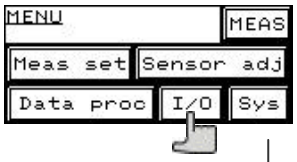
Reference Default Setting: Normal

5-2-14 Analog Output Setting

This function causes the output to correspond to the desired measurement value at an analog output of+5V (20mA) and at -5V (4mA). It can be used for scaling of the analog output or for making the output greater or smaller, etc.
When this function is used, the analog output corresponding to measurement values ranging between, for example, 70 and 90mm, can be assigned to outputs ranging from -5V (for 70mm) to +5V (for 90mm).

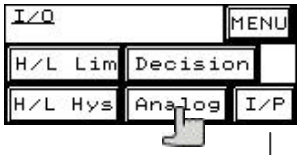
1. Display the input/output screen.
Touch [I/O] in the MENU screen and display the input/output screen.

MENU Screen



Input/output Screen

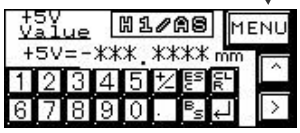
2. Display the analog output screen.
Touch [Analog] in the input/output screen and display the analog output screen.



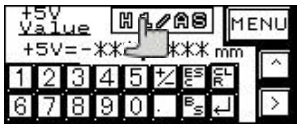
Analog Output Screen

3. Display the output setting screen.
Touch [O/P Set] in the analog output screen. The current measurement value setting corresponding to +5V (20mA) and a keyboard for inputting numbers are displayed.
The value here is the value for sensor head 1 (H1) in the case of independent operation, and it is the value corresponding to the add/subtract calculation value (AS: ADD/SUB) in the case of add/subtract operation.

+5 V Value Screen



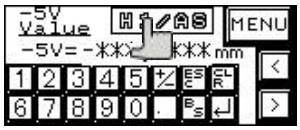
4. Set the measurement value which +5V is to correspond to.
See page 4-2 concerning the method for keyboard input.



+5 V Value Screen

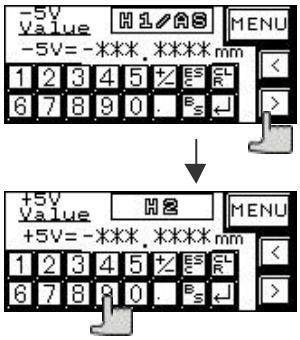
5. Set the measurement value which -5V is to correspond to.
Touch [>] in the +5V value screen and display the currently set measurement value corresponding to -5V (4mA) and the keyboard.
The value here is the value for sensor head 1 in the case of independent operation, and corresponds to the add/subtract calculation value in the case of add/subtract operation.

-5 V Value Screen



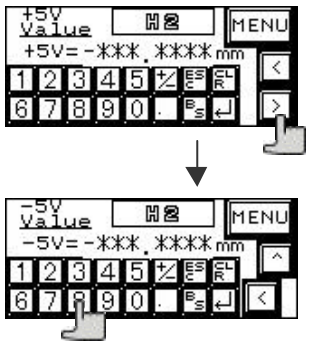
6. Set the measurement value corresponding to +5V for sensor head 2.

Touch [>] again in the case of independent operation.
Set the measurement value that you would like to correspond to +5V (20mA) for sensor head 2.



7. Set the measurement value corresponding to -5V for sensor head 2.

Touch [>] again.
Set the measurement value that you would like to correspond to -5V (4mA) for sensor head 2.



8. Return to the MENU screen by the [MENU] key or to the analog output screen by touching [^], or the input/output screen by touching [^] again.

Reference Input Range: +5V Value, -5V Value = ±999.9999mm

Default Settings

Sensor Head 1 +5V Value = Add/subtract Calculation Value +5V Value = +20.0000mm
Sensor Head 1 -5V Value = Add/subtract Calculation Value -5V Value = -20.0000mm
Sensor Head 2 +5V Value = +20.0000mm
Sensor Head 2 -5V Value = -20.0000mm

- **Supplementary Explanation**

If the sensor head exceeds the analog output range when zero setting is performed, the analog output is inverted. Make sure that the measurement value is contained within the analog output range (voltage output: ± 10.9V, current output: 0 to 29.5mA).
Care should be taken when an enlarged output is used in the analog output setting or addition/subtraction measurement is made with two sensor heads.

5-2-15 Analog Output During Alarm

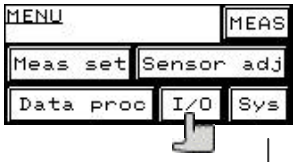
You can switch between the data having been output immediately before and a fixed value as an analog output issued when measurement is disabled (with an alarm output) due to an excessive or poor amount of light or deviation from the range. When the fixed value setting is selected, either the maximum value (voltage output: +10.9V, current output: max. 29.5mA*) or minimum value (voltage output: -10.9V, current output: 0mA) of the analog output is issued upon an alarm.

* Varies according to the load impedance.

1. Display the input/output screen.

Touch [I/O] in the MENU screen and display the input/output screen.

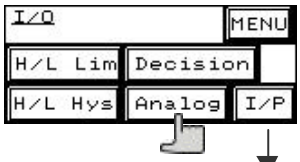
MENU Screen



2. Display the analog output screen.

Touch [Analog] in the input/output screen and display the analog output screen.

Input/output Screen



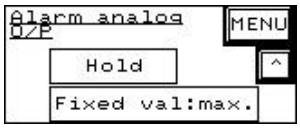
3. Display the analog output screen when there is an alarm.

If [Alarm analog O/P] is touched in the analog output screen, the currently selected status is displayed. If you are changing the setting, touch the Select key. One of the following settings which are displayed can be selected, so select one.

[Hold] ⟷ [Fixed val]

Analog Output Screen

Analog Output During Alarm Screen

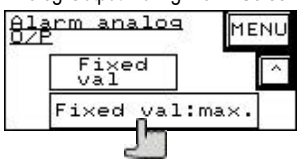


4. Select the content of the fixed value.

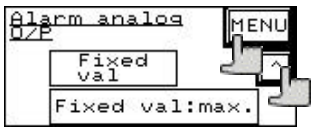
If you selected a fixed value, it is possible to select output of the maximum value or the minimum value for the analog output during an alarm.

[Fixed val: max.] ⟷ [Fixed val: min.]

Analog Output During Alarm Screen



5. Return the MENU screen by touching [MENU] or return to the input/output screen by touching [^].



Reference Default Value: Hold

- **Supplementary Explanation**

The analog output is held without relations to the setting described herein in the timing input state (= upon alarm).

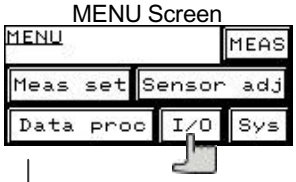
5-2-16 Input Selection

■ Input Operation

The timing signal at the input terminal functions as an input upon a short circuit by default setting. Use this function to activate the input upon an open circuit.

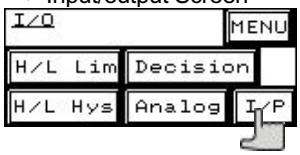
1. Display the input/output screen.
Touch [I/O] in the MENU screen and display the Input/output screen.

MENU Screen



2. Display the timing input screen.
Touch [I/P] in the input/output screen and display the timing input screen.

Input/output Screen

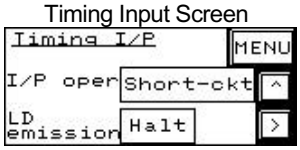


3. Change the operation using the "input operation" key.
Each time the key is touched, the selection switches back and forth between the two selections shown below.

[Short-ckt] ⟷ [Open]

Reference Default Setting: During Short Circuit

Timing Input Screen



- **Supplementary Explanation**

The zero set ON input and zero set OFF input are always valid upon a short circuit without relations to the setting given herein.

■ LD Emission

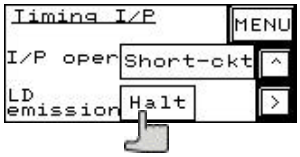
If you desire to continue laser emission without interruption even during timing input, it can be changed here.

Timing Input Screen

1. Display the timing input screen.
Touch [I/O] in the MENU screen, then touch [I/P] in the input/output screen and display the timing input screen.

2. Change the operation using the "LD emission" key.
Each time the key is touched, the selection switches back and forth between the two selections shown below.

Timing Input Screen



[Halt] ⟷ [Cont]

Reference Default Setting: Stop

■ Two-sensor Head Input Mode

If the 2 sensor heads are operating independently, ordinarily, the timing and zero set inputs are input independently for each sensor head, but even during independent operation, batch input is set in cases where input of these values to the 2 sensor heads simultaneously is desired for measuring the same work piece, etc.

1. Display the timing input screen.

Touch [I/O] in the MENU screen, then touch [I/P] in the input/output screen and display the timing input screen.

2. Display the H1/H2 input screen.

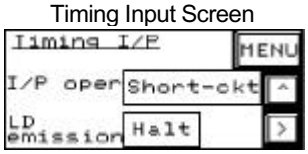
Touch [>] in the timing input screen and display the H1/H2 input screen.

3. Change the setting with the "H1/H2" key.

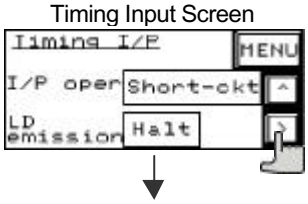
Each time the key is touched, the selection switches back and forth between the two selections shown below.

[Ind I/P] ◄——► [Lump I/P]

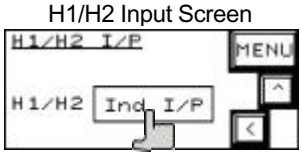
Timing Input Screen



Timing Input Screen



H1/H2 Input Screen



Reference Default Setting: Independent Input

● **Supplementary Explanation**

- This setting is valid for the timing input, zero set ON input and zero set OFF input.
- If the type of operation is switched from independent operation to add/subtract operation, the input method switches automatically to "Batch Input".
- When desiring to switch back to independent operation to add/subtract operation, it returns to the state it was in before being switched to add/subtract operation.
- When the batch input is set, add the timing input, zero set ON input and zero set OFF input to either the sensor head 1 or sensor head 2 terminal.
- If an open input operation and batch input mode are selected, connect all input terminals (TM1, I11, I12, TM2, I21 and I22) to an external isolated ground terminal while opening the terminals for either sensor head 1 or sensor head 2 to use them.

5-2-17 Calibration

In some cases, deviations in the measurement value occur due to the color, material and surface conditions of the measurement object. Correction for such deviations is called calibration.
In calibration, span and shift are set for each sensor head. There are 2 ways to set these values. One is to perform auto setting by moving a piece of work past the sensors, and the other is to input previously measured values directly.
Setting by moving the work piece past the sensors.

* Before starting calibration (either in the automatic or input mode), be sure to check for the following settings.

Hold mode: NORM.	Independent calculation formula: L1 + K1A, L2 + K2B
Zero set: OFF	Independent calculation offset L1, L2: 0.0000mm
Timing: OFF	Independent calculation coefficient K1, K2: 1.0000
Display hold: OFF	Low pass filter: OFF
Sensor head operation: Independent	High pass filter: OFF

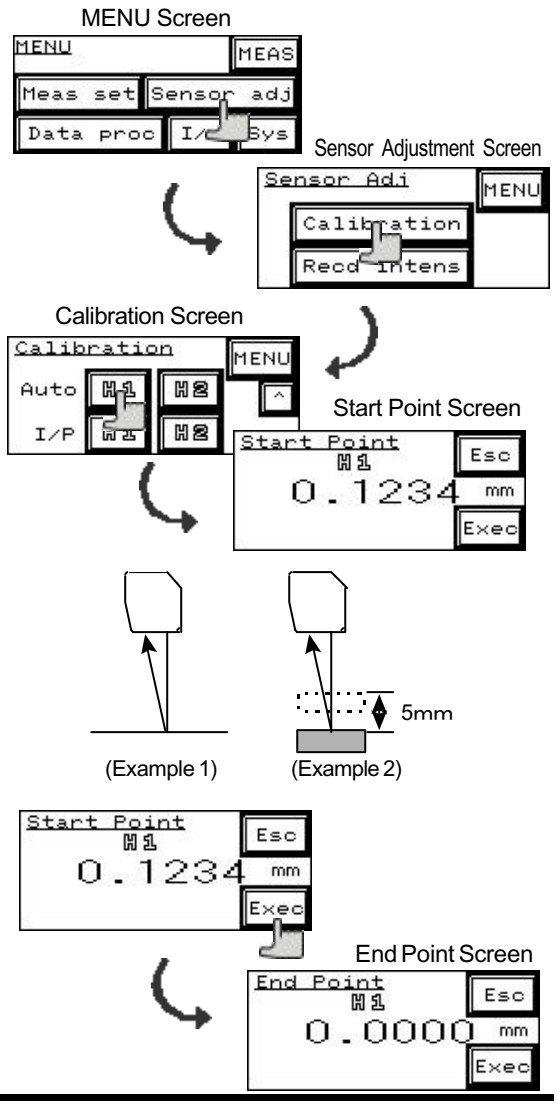
■ Automatically Setting the Span and Shift

In the automatic calibration mode, designate the starting and ending points to set the offset. The shift and span are automatically determined so that the starting point becomes “0” and the ending point becomes the offset.

1. Display the Calibration screen.
Touch Sensor adj in the MENU screen, then touch Calibration in the sensor adjustment screen and display the Calibration screen.

2. Select the sensor head that is to be calibrated.
Select the desired head from the "Auto" row in the calibration screen. The start point screen is displayed and the current measurement value is displayed. During the procedure, wait for (sampling frequency) multiplied by (average number of samples) until the measurement value becomes stable.

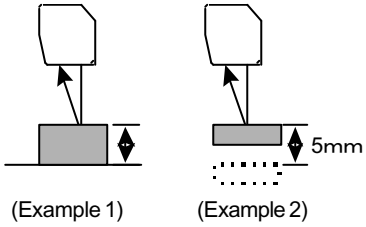
3. Determine the position where the measurement value should be “0”.
Touch "Exec" in the start point screen at a position where the measurement value should be "0" (example 1) or where the workpiece is located at the other extreme of displacement (example 2). The displayed measurement changes to "0" and the end point screen is displayed.



4. Place the work piece in the measuring position, then touch Exec .

Place the work piece in the measuring position or move the work piece that is to be moved in the opposite direction and measure the work's height or measure the work piece's movement.

When Exec is touched, the measurement value is held and the screen changes to the correction screen.



5. Input the displacement distance.

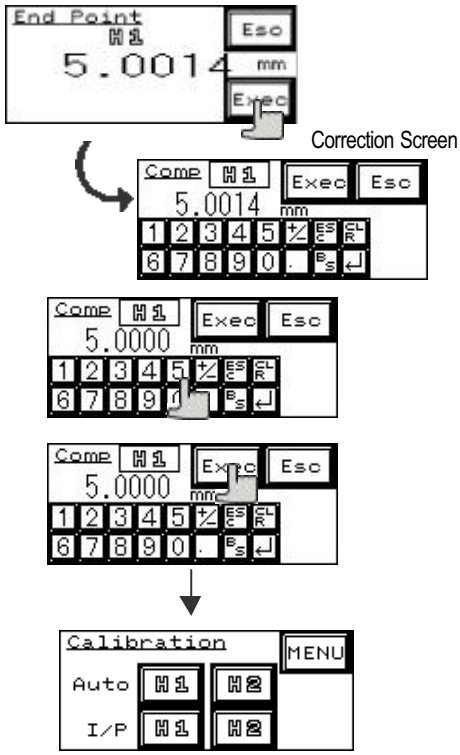
Input either the actual height of the work piece or input the distance the work piece was moved. See page 4-2 concerning the keyboard input method.

After fixing the input, touch Exec to start correction. The span and shift will be set automatically and the screen changes to the calibration screen.

To correct or stop the automatic setting operation while in progress, touch Esc. If you still have not proceeded to execution in the Correction screen, the set shift value is canceled and the screen returns to the calibration screen.

Reference Default Setting: Span 1.0000
Shift 0.0000mm
Input range: Span 0.9000 to 1.1000
Shift ± 20.0000mm

See the next page on direct input methods, steps 1, 2 and 4 for checking the calibration setting values (span, shift) and changing them.



● **Supplementary Explanation**

- During automatic calibration, span or shift exceeding the input range is adjusted to the maximum or minimum value forcibly. After finishing automatic determination, use direct input (see next page) to check the settings. If the span or shift value is the maximum or minimum value, possibility of incorrect calibration exceeding the setting range is highly probable. Perform automatic calibration again.
- If the automatic calibration setting screen is opened in the display hold mode, the measurement value having been valid at the time of display hold mode selection is maintained and calibration cannot be made correctly. In this case, press Esc to exit from automatic calibration then perform calibration again. The display hold mode is automatically canceled when automatic calibration setting is canceled.

■ Direct Input of Span and Shift

If you know that calibration values (span, shift) for the same measurement object have already been used, those values can be input directly.

1. Display the Calibration screen.

Touch [Sensor adj] in the MENU screen, then in the sensor adjustment screen, touch [Calibration] and go to the calibration screen.

2. Select the sensor head for which the calibration value is to be input.

If the sensor head for which the calibration value is to be input is selected form the "Input" side of the calibration screen, the screen changes to the span screen and the current span setting together with a keyboard for inputting numbers is displayed.

3. Input the span.

See page 4-2 concerning the keyboard input method.

4. Input the shift.

Touching [>] in the span screen causes the currently set shift value and a keyboard for inputting numbers to be displayed, so if necessary, input the shift value.

5. Return by touching either [MENU] or [<] [>].

Return to the MENU screen by touching [MENU] or if you are setting the calibration values for the other sensor head, move to the input screen for the other sensor head using the [<] or [>] keys.

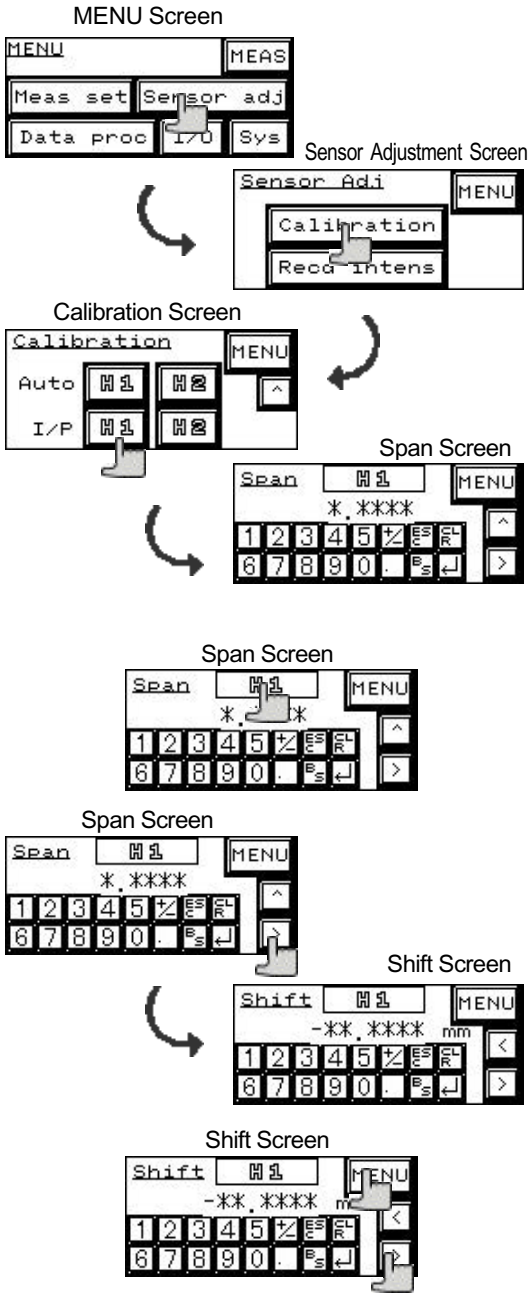
Reference

Input Range:

Span	0.9000 to 1.1000
Shift	±20.0000mm

Default Setting:

Span	1.0000
Shift	0.0000mm



- **About Span and Shift in Calibration and Coefficient and Offset in Calculation Formulas**

The span and shift in calibration can be set and the coefficient K and offset L in the calculation formulas can be set independently.

The calibration span is a correction value to match the measurement value's deviation with the actual displacement.
The coefficient K in the calculation formulas indicate whether the size of the measurement value with respect to the actual displacement is great or small. Ordinarily, this setting is left at its initial setting "1".

The calibration shift and calculation formula offset both shift the value with respect to the actual displacement.
The calibration shift is for the purpose of correcting the deviation in the measurement value, so its input range is ±20.0000mm.
In contrast with that, the calculation formula's offset is used to increase or decrease the value to display the actual dimensions, so its input range is wider, at ±999.9999mm.
The same effect is obtained through either of the settings, but including the deviation in the measurement value if the measurement value is increased or decreased by the offset in the calculation formula, it is easier to get a grasp of the amount of shift, so set the calibration shift on "0".

5-2-18 Amount of Light Received

This displays the peak amount of light received at the measuring point.

1. Display the sensor adjustment screen.

Touch [Sensor adj] in the MENU screen and display the sensor adjustment screen.

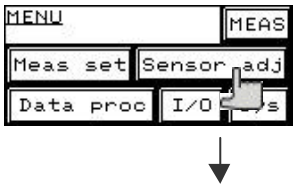
2. Display the amount of light received screen.

Touch [Recd intens] in the sensor adjustment screen and display the amount of light received screen. If it is less than 150, then the amount of light received is insufficient and the DARK state occurs. If the value is greater than 1,023, the amount of light received is excessive and the BRIGHT state occurs.

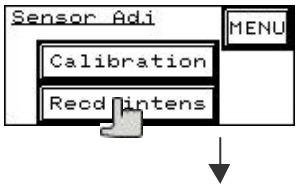
3. Touch [MENU] or [^] to return.

Touch [MENU] to return to the MENU screen and touch [^] to return to the sensor adjustment screen.

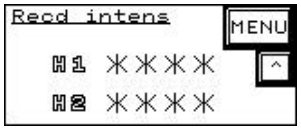
MENU Screen



Sensor Adjustment Screen



Amount of Light Received Screen



5-2-19 Save

All setting data except for the timing input mode and display hold mode is saved.
When the power is turned on, the settings are those having been saved last time. If settings are changed and the new data is not saved, changes are abandoned when the power is turned off.

1. Display the system screen.

Touch [Sys] in the MENU screen and display the system screen.

2. Touch [Save] and display the save screen.

The screen will change to the save screen from the system screen by touching [Save].

3. Execute save by touching [Yes].

If you do not desire to save the settings, return to the system screen by touching [No] or return to the MENU screen by touching [MENU].

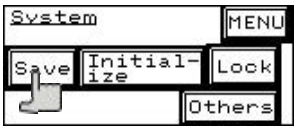
4. The end screen will be displayed when the save execution is completed.

When execution of the save operation is completed, the screen will change to the end screen, so touch [MENU] to return to the MENU screen.
Do not turn the power off until the screen changes to the end screen.
If the power is turned off before that, it could result in the data being destroyed and the system being unable to start normally, so exercise caution.

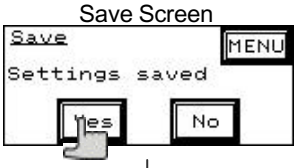
When the power is turned on, all the settings return to the setting contents that were saved at the time of the previous save operation (the most recently saved contents).
If you change the settings, be sure not to turn the power off until you save the new settings.

MENU Screen

System Screen



Save Screen



End Screen

- **Supplementary Explanation**

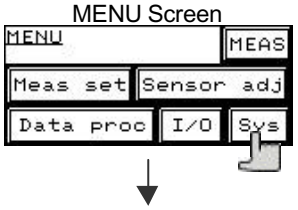
  * The timing input mode and display hold mode are not saved.

5-2-20 Initialization

This erases all the settings and restores the initial settings set at factory.
Setting contents are not saved even by initialization, so if you would like to retain the initialized state after the power is turned off, execute "Save".

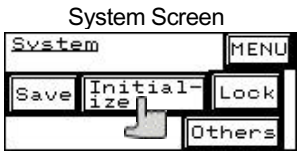
1. Display the system screen.

Touch [Sys] in the MENU screen and display the system screen.



2. Touch [Initial-ize] to display the Initialize screen.

Tough [Initial-ize] in the system screen, then go to the initialize screen.



3. Execute initialization by touching [Yes].

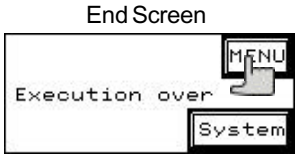
If you do not desire to execute initialization, return to the system screen by touching [No] or return to the MENU screen by touching [MENU].

4. When execution is completed, the screen changes to the end screen.

When saving of the settings is completed, the screen changes to the end screen, so return to the MENU screen by touching the [MENU] key.

Do not turn the power off until the screen changes to the end screen.

If the power is turned off before that, it could result in the data being destroyed and the system being unable to start normally, so exercise caution.



See the list of default values on page 5-31 concerning the contents of the default values.

- **Supplementary Explanation**

Setting contents are not saved even by initialization, so if you would like to retain the initialized state after the power is turned off, execute "Save". (See page 5-29.)

■ List of Default Values

Function Item		Default Value	Page Mentioned
Measurement	Hold Mode	NORM.	5-2
	Zero Set	OFF	5-4
	Timing	OFF	5-5
	Display Hold	OFF	5-6
Measurement Setting	Sampling Period	144 μs	5-7
	Sensor Head Operation	Independent	5-8
	Independent Calculation Formula	L1+K1A, L2+K2B	5-9
	Add/subtract Calculation Formula	L+K(A+B)	5-9
	Independent - Add/subtract Calculation Offset: L, L1, L2	0.0000mm	5-9
	Independent - Add/subtract Calculation Coefficient: K, K1, K2	1.0000	5-9
Data Processing	Average Number of Samples	64 times	5-11
	Low Pass Filter	OFF	5-12
	High Pass Filter	OFF	5-13
Input/output	Upper Limit Setting: Upper Limit Value	+20.0000mm	5-14
	Lower Limit Setting: Lower Limit Value	-20.0000mm	5-14
	Hysteresis Setting: Upper Limit Hysteresis	0.0300mm	5-15
	Hysteresis Setting: Lower Limit Hysteresis	0.0300mm	5-15
	Judgment Output Selection	LOW/HIGH	5-16
	Output Mode	Normal	5-18
	Analog Output Setting: +5V Value	+20.0000mm	5-19
	Analog Output Setting: -5V Value	-20.0000mm	5-20
	Analog Output During Alarm	Hold	5-21
	Analog Output Fixed Value During Alarm	max.(+10.9V)	5-21
	Timing Input Operation	During short circuit	5-22
	Laser Emission During Timing Input	Stopped	5-22
	Two Sensor Head Input Mode	Independent Input	5-22
Sensor Adjustment	Calibration: Span	1.0000	5-24
	Calibration: Shift	0.0000mm	5-24
System	Lock (Touch Key Lock)	Canceled	5-32

5-2-21 Lock

Data setting and modification at the compact console can be prohibited to protect the data from inadvertent operation of the compact console. When the data is locked, all operations other than screen display change and unlocking are disabled. However, saving can be executed. To validate the key lock setting even after the power is turned off, execute saving.

MENU Screen

1. Display the system screen.

Touch [Sys] in the MENU screen and display the system screen.

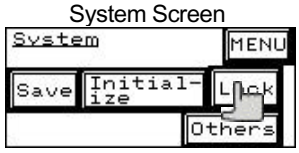
2. Touch [Lock] and display the lock screen.

The screen changes to the lock screen when [Lock] is touched in the system screen and the current state is displayed in reverse highlighting.

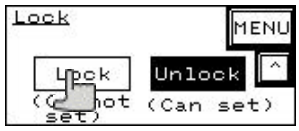
To set the console in the locked state, touch [Lock], and to release the locked state, touch [Esc] and cause the screen to be shown in reverse highlighting.

The screen can be changed even in the locked state, so setting values can be displayed and setting contents can be confirmed.

System Screen



Lock Screen



3. Return to the MENU screen by the [MENU] button, or touch [^] to return to the system screen.

Reference Default Setting: Canceled

- **Supplementary Explanation**

  Saving can be executed. To validate the key lock setting even after the power is turned off, execute saving.

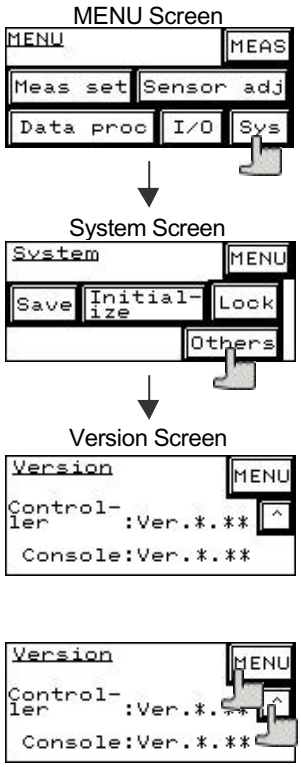
5-2-22 Version

This displays the controller and compact console version.

1. Display the system screen.
Touch [Sys] in the MENU screen and display the system screen.

2. Display the version screen.
If [Others] is touched in the system screen, the screen changes to the controller version screen. The version of the controller that is displayed is the same version as the rating nameplate attached to the side of the controller.
The version displayed at the console is the same as the one specified in the ratings nameplate on the back of the operation screen of the compact console.

3. Return to the previous screen by touching either [MENU] or [^].
Touch [MENU] to return to the MENU screen and touch [^] to return to the system screen.



CHAPTER 6
RS-232C CONTROL

6-1 Communications Specifications

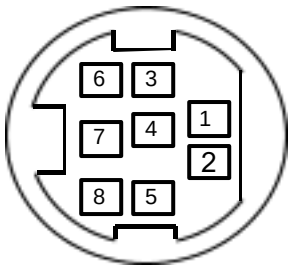
Transmission Speed	115,200 bps
Communications Method	Full Duplex
Synchronization Method	Asynchronous
Transmission Code	ASCII
Data Length	8 bits
Parity Check	None
Stop Bit Length	1 bit
End Code	CR (0DH)
BCC	Yes

* To omit BCC calculation, enter "** " (2AH, 2AH) as a BCC.

■ Pin Arrangement

Pin No.	I/O	Signal Name
1	OUT	SD (TXD)
2	IN	RD (RXD)
3	OUT	RS (RTS)
4	IN	CS (CTS)
5	IN	DR (DSR)
6	——	SG (GND)
7	IN	CD (DCD)
8	OUT	ER (DTR)

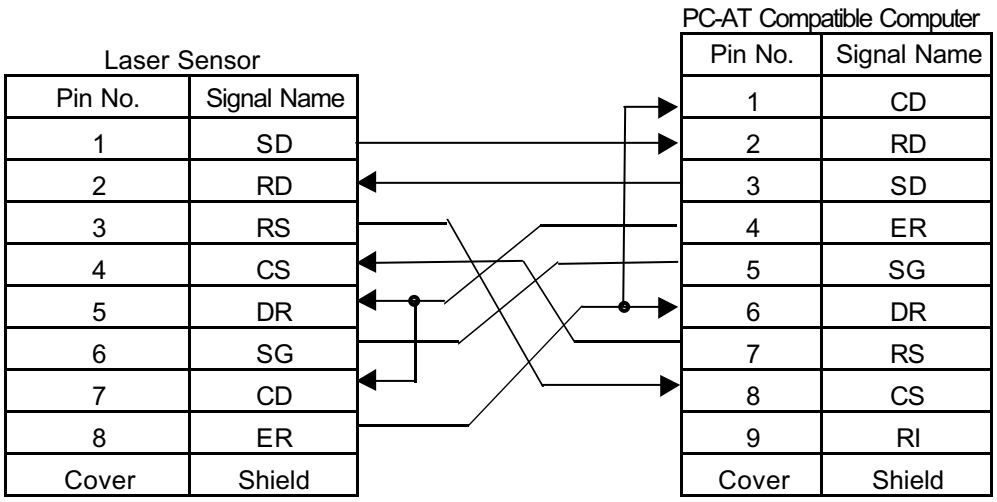
Connector Pin Arrangement



Compatible Connector (Reference)

Hoshiden
Connector TCP6180

■ Wiring Example



3-meter RS-232C Cable: Use the ANM81103 <made by Matsushita Electric Works, Ltd.>

■ Set the Communications Specifications.

- Set the communications specifications for the controller side.

The RS-232C communications specifications for the controller side are fixed to those shown in the communications specifications table shown on page 6-1 and there is no need to set.

- Set the communications specifications on the personal computer side.

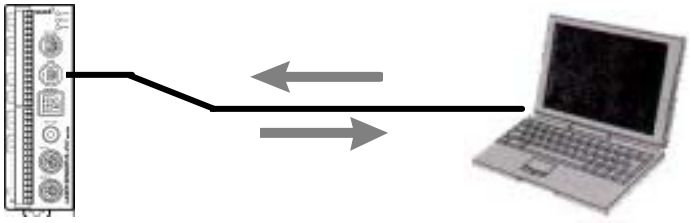
While referring to the manual of your PC, define the same RS-232C communications specifications of the PC as those of the controller.

- **Supplementary Explanation**

If the settings have been changed for communications, the changes may not be reflected on the screen of the compact console at that time. In such a case, change the settings so that the changes will be reflected on the screen display by operating the touch switches.

■ Sending and Receiving Data

Description is made here to explain the method of transmission of commands from the PC to the controller for giving, changing, or monitoring various parameters or reading measurement values.



1. Send a command from the PC to the controller.

2. Upon reception of the command, the controller sends back a response and executes the command.

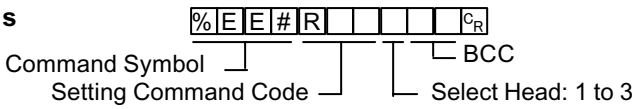
If no response is sent back, the command does not reach the controller.

* During RS-232C control, the controller stops measuring two periods each time a communication session is held, for the communication with an external device.

■ Data Transmission Format

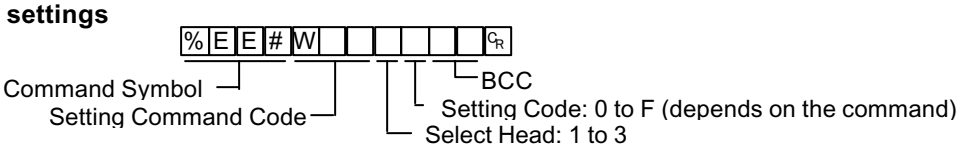
The transmission format of commands and data sent from the PC to the controller is shown below. Only upper case letters can be used.

1. Read settings

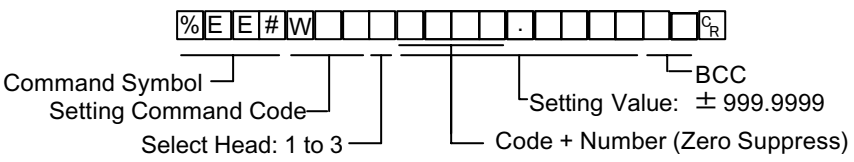


BCC: See page 6-17.

2. Change the settings



3. Set a number



■ Select Sensor Head

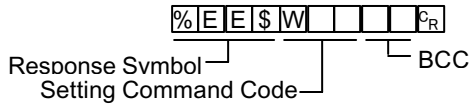
The specification for select sensor head differs depending on the setting contents of the sensor head's operation.

Select Sensor Head	Sensor Head Operation	
	Independent Operation	Add/subtract Operation
1	Sensor Head 1	Add/subtract Calculation
2	Sensor Head 2	Sensor Head 2
3	Sensor Head not specified.	

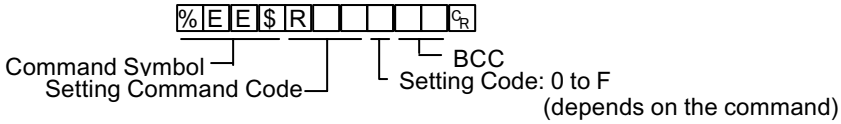
■ Format of Response Data

The format of the response data sent from the controller to the PC is shown below.

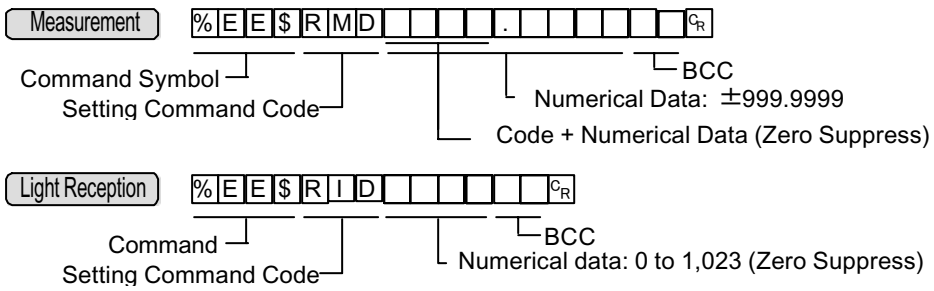
1. If setting is completed.



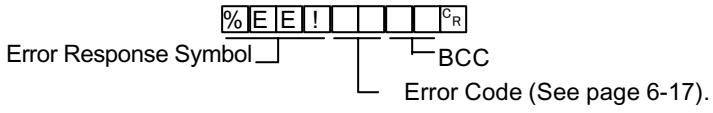
2. If the settings are being confirmed.



3. If data are being read



4. If there is an error



6-2 List of Commands

Item			Command		Selected Sensor Head	Setting Code	Content	Page
Measure-ment	1	Read Measurement	RMD		1/2	—	Read once.	6-7
		Read light amount received	RID			—	Read once.	
	2	Hold Mode	RHM	WHM		0	NORM.	6-7
						1	P-P	
						2	PEAK	
						3	VALLEY	
	3	Zero Set	RZS	WZS		0	OFF	6-8
						1	ON	
		Timing	RTI	WTI		0	OFF	
						1	ON	
Measurement Settings	4	Sampling Period	RSP	WSP	3	0	1,000µs	6-8
						1	498µs	
						2	332µs	
						3	255µs	
						4	200µs	
						5	144µs	
						6	100µs	
	5	Sensor Head Operation	RHF	WHF		0	Independent Operation	6-9
						1	Add/subtract Operation	
	6	Independent Calculation	RMT	WMT	1/2	0	L+KA	6-9
						1	L-KA	
		Add/subtract Calculation Formula	RNT	WNT	3	0	L+K(A+B)	
						1	L-K(A+B)	
						2	L+K(A-B)	
						3	L-K(A-B)	
	7	Independent Calculation Offset	RML	WML	1/2	—	±999.9999mm	6-10
		Independent Calculation Coefficient	RMK	WMK		—	0.0001 to 99.9999	
		Add/subtract Calculation Offset	RNL	WNL	3	—	±999.9999mm	
		Add/subtract Calculation Coefficient	RNK	WNK		—	0.0001 to 99.9999	
Sensor Adjustment	8	Span	RCL	WCL	1/2	—	0.9000 to 1.1000	6-11
		Shift	ROF	WOF		—	±20.0000mm	

Item			Command		Selected Sensor Head	Setting Code	Content	Page
Data Processing	9	Average	RAV	WAV	1/2	0-F	OFF, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768 times	6-11
	10	Low Pass Filter	RLP	WLP		0-8	OFF, 10, 20, 50, 100, 200, 500, 1,000, 2,000Hz	6-12
		High Pass Filter	RHP	WHP				
Input/output	11	Upper Limit Value	RHL	WHL	1/2	—	±999.9999mm	6-13
		Lower Limit Value	RLL	WLL		—	±999.9999mm	
		Upper Limit Hysteresis	REH	WEH		—	0.0000 to 2.0000mm	
		Lower Limit Hysteresis	REL	WEL		—	0.0000 to 2.0000mm	
	12	Analog Output	RAH	WAH		—	±999.9999mm	6-14
			RAL	WAL		—	±999.9999mm	
	13	Judgment Output Selection	RJM	WJM	3	0	LOW/$\overline{\text{LOW}}$	6-14
						1	LOW/HIGH	
						2	L or H/IN RANGE	
						3	LOGIC	
	14	Analog Output During Alarm	RAA	WAA		0	Hold	6-15
						1	Fixed Value	
		Fixed Value	RFM	WFM		0	+10.9V, 29.5mA	
						1	-10.9V, 0mA	
		Timing Input Operation	RTM	WTM		0	Operation During a Short Circuit	
						1	Operation During an Open Circuit	
		Input Mode	RIM	WIM		0	Independent Input	
						1	Batch Input	
		Output Mode	ROM	WOM		0	Normal	
						1	Test	
		Laser Emission Control	RTE	WTE		0	Stop Emission During Timing	
						1	Continue Emission During Timing	
		Laser Emission Delay	RLE	WLE		0	No Delay	
						1	Delay	
System	15	Save	MMR		—	—	—	6-16
		Initialize	INT			—	—	

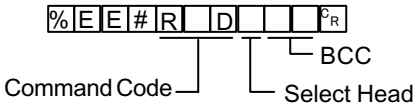
For the selected sensor head, see "Select Sensor Head" on page 6-4.

6-3 Explanation of Commands

The commands are described here. For detail functions, refer to Chapter 5.
(In the send/receive data example, BCC is omitted.)

6-3-1 Read Measurement, Read Light Amount Received

Function	Command Code	Content
	Read	
Read Measurement Value	RMD	Read 1 time.
Read Light Amount Received	RID	Read 1 time.



Select Sensor Head: See page 6-4.

Example

(1) Read the add/subtract calculation value (it is shown with BCC omitted).
(In the sensor head operation, "add/subtract operation" should be selected.)

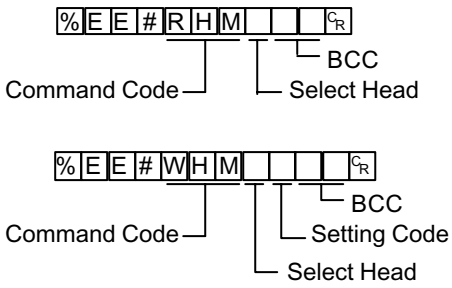
Send: %EE#RMD1CR
Respond: %EE$RMDSP+15.6789CR

(2) Read the amount of light received by sensor head 1 (it is shown with BCC omitted).

%EE#RID1CR → %EE$RIDSP549CR

6-3-2 Hold Mode

Function	Command Code		Setting Code	Content
	Read	Set		
Hold Mode	RHM	WHM	0	NORM.
			1	P-P
			2	PEAK
			3	VALLEY



Example

(1) Read the setting contents (it is shown with BCC omitted).
If the sensor head 1 hold mode is "NORM".

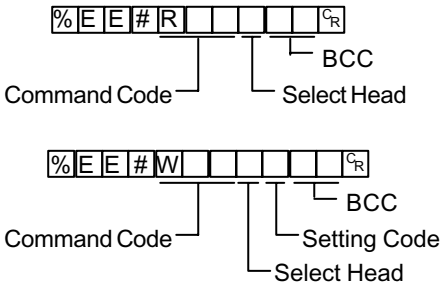
Send: %EE#RHM1CR
Respond: %EE$RHM0CR

(2) Change the setting (it is shown with BCC omitted).
The sensor head 2 hold mode is changed to "P-P".

%EE#WHM21CR → %EE$WHMCR

6-3-3 Zero Set, Timing

Function	Command Code		Setting	Content
	Read	Set		
Zero Set	RZS	WZS	0	OFF
			1	ON
Timing	RTI	WTI	0	OFF
			1	ON



Example

(1) Read the setting contents (it is shown with BCC omitted).

If sensor head 1 is in the zero set state.

Send: %EE#RZS1CR → Respond: %EE$RZS1CR

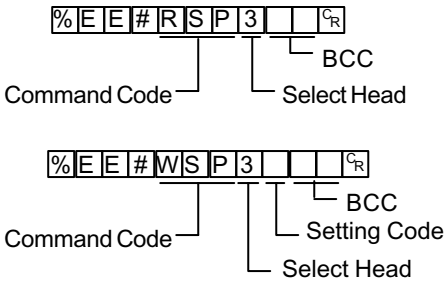
(2) Change the setting (it is shown with BCC omitted).

Timing is turned ON for sensor head 2.

%EE#WTI21CR → %EE$WTICR

6-3-4 Sampling Period

Function	Command Code		Setting	Content
	Read	Set		
Sampling Period	RSP	WSP	0	1,000μs
			1	498μs
			2	332μs
			3	255μs
			4	200μs
			5	144μs
			6	100μs



Example

(1) Read the setting contents (it is shown with BCC omitted).

If the sampling period is 144μs

Send: %EE#RSP3CR → Respond: %EE$RSP5CR

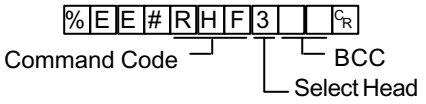
(2) Change the setting (it is shown with BCC omitted).

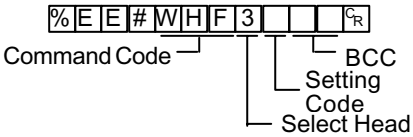
The sampling period is changed to 255μs.

%EE#WSP33CR → %EE$WSPCR

6-3-5 Sensor Head Operation

Function	Command Code		Setting	Content
	Read	Set		
Sensor Head Operation	RHF	WHF	0	Independent operation
			1	Add/subtract operation





Example

(1) Read the setting contents (it is shown with BCC omitted).

If the sensor head operation is independent operation

Send: %EE#RHF3CR → Respond: %EE$RHF0CR

(2) Change the setting (it is shown with BCC omitted).

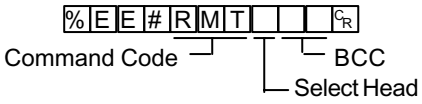
Set the sensor head operation on add/subtract operation.

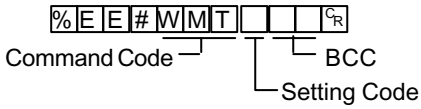
%EE#WHF31CR → %EE$WHFCR

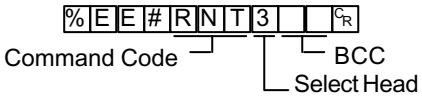
In add/subtract operation, the sensor head 1 setting contents become the settings in add/subtract operation.

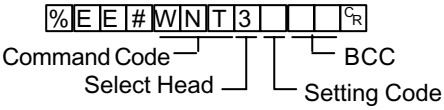
6-3-6 Independent Calculation Formula, Add/subtract Calculation Formula

Function	Command Code		Setting	Content
	Read	Set		
Independent Calculation Formula	RMT	WMT	0	L+KA
			1	L-KA
Add/subtract Calculation Formula	RNT	WNT	0	L+K(A+B)
			1	L-K(A+B)
			2	L+K(A-B)
			3	L-K(A-B)









Example

(1) Read the setting contents (it is shown with BCC omitted).

If the sensor head 2 calculation formula is "L-KA".

Send: %EE#RMT2CR → Respond: %EE$RMT1CR

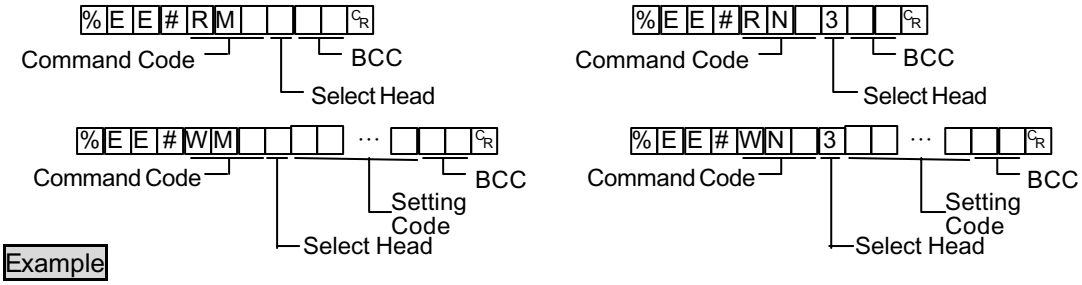
(2) Change the setting (it is shown with BCC omitted).

Change the add/subtract calculation formula to "L-K(A-B)".

%EE#WNT33CR → %EE$WNTCR

6-3-7 Calculation Offset, Calculation Coefficient

Function	Command Code		Setting Code	Setting Value Range
	Read	Set		
Independent Calculation Offset	RML	WML	□□□□.□□□□ Code + Number (Zero Suppress)	±999.9999mm
Independent Calculation Coefficient	RMK	WMK	□□.□□□□ Number (Zero Suppress)	0.0001 to 99.9999
Add/subtract Calculation Offset	RNL	WNL	□□□□.□□□□ Code + Number (Zero Suppress)	± 999.9999mm
Add/subtract Calculation Coefficient	RNK	WNK	□□.□□□□ Number (Zero Suppress)	0.0001 to 99.9999



Example

(1) Read the setting contents (it is shown with BCC omitted).

If the sensor head 1 calculation offset is +5.1200mm.

Send

%EE#RML1CR

Respond

%EE$RMLSPSP+5.1200CR

(2) Change the setting (it is shown with BCC omitted).

Set the add/subtract calculation coefficient to 1.5000.

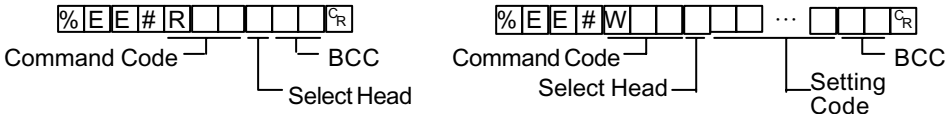
%EE#WNK3SP1.5000CR

%EE$WNKCR

As for selecting the sensor head, see page 6-4, "Select Sensor Head".

6-3-8 Calibration: Span, Shift

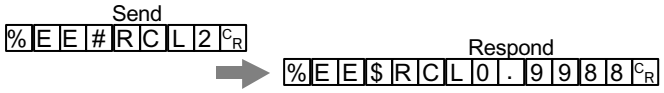
Function	Command Code		Setting Code	Setting Value Range
	Read	Set		
Span	RCL	WCL	□.□□□□	0.9000 to 1.1000
Shift	ROF	WOF	□□□□.□□□□ (Code + Number (Zero Suppress))	±20.0000mm



Example

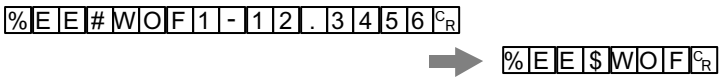
(1) Read the setting contents (it is shown with BCC omitted).

If the sensor head 2 span is 0.9988.



(2) Change the setting (it is shown with BCC omitted).

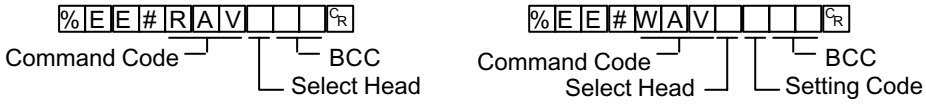
Set the sensor head 1 shift to -12.3456mm.



6-3-9 Average

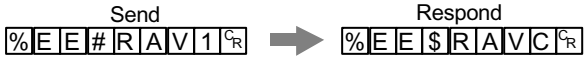
Function	Command Code		Setting Code	Content
	Read	Set		
Average	RAV	WAV	0	OFF
			1	2 times
			2	4 times
			3	8 times
			4	16 times
			5	32 times
			6	64 times
			7	128 times

Setting Code	Content
8	256 times
9	512 times
A	1,024 times
B	2,048 times
C	4,096 times
D	8,192 times
E	16,384 times
F	32,768 times



(1) Read the setting contents (it is shown with BCC omitted).

If the sensor head 1 average number of samples is 4,096 times.



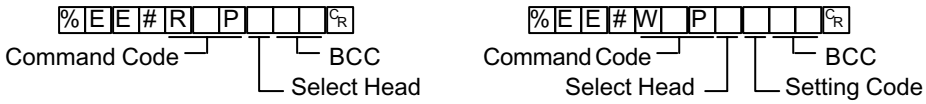
(2) Change the setting (it is shown with BCC omitted).

Turn the sensor head 2 average number of samples setting OFF.

6-3-10 Low Pass Filter, High Pass Filter

Function	Command Code	
	Read	Set
Low Pass Filter	RLP	WLP
High Pass Filter	RHP	WHP

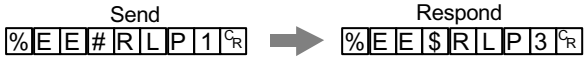
Setting Code	Content
0	OFF
1	10Hz
2	20Hz
3	50Hz
4	100Hz
5	200Hz
6	500Hz
7	1000Hz
8	2000Hz



Example

(1) Read the setting contents (it is shown with BCC omitted).

If the sensor head 1 low pass filter's cutoff frequency is 50Hz.

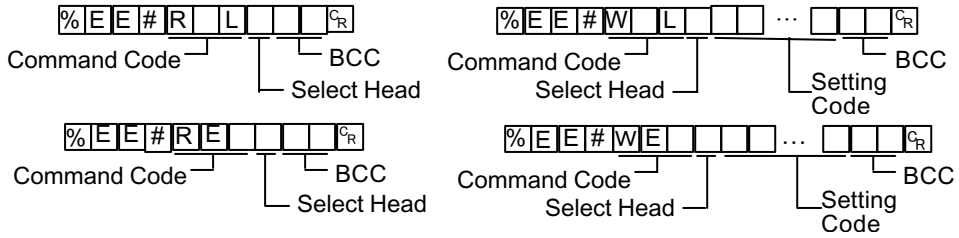


(2) Change the setting (it is shown with BCC omitted).

Set the sensor head 2 high pass filter cutoff frequency at 500Hz.

6-3-11 Upper Limit and Lower Limit Values and Hysteresis

Function	Command Code		Setting Code	Setting Value Range
	Read	Set		
Upper Limit Value	RHL	WHL	□□□□.□□□□	±999.9999mm
Lower Limit Value	RLL	WLL	Code + Number (Zero Suppress)	
Upper Limit Hysteresis	REH	WEH	□.□□□□	0.0000 to 2.0000mm
Lower Limit Hysteresis	REL	WEL		



Example

(1) Read the setting contents (it is shown with BCC omitted).

If the add/subtract calculation upper limit value is +123.4567mm.

Send

%EE#RHL1CR

Respond

%EE$RHL+1234.4567CR

(2) Change the setting (it is shown with BCC omitted).

Set the sensor head 2 lower limit value to -98.7654mm.

%EE#WLL2SP-98.7654CR

%EE$WLLCR

(3) Read the setting (it is shown with BCC omitted).

For an upper limit hysteresis of sensor head 2 of 0.0050mm.

%EE#REH2CR

%EE$REH0.0050CR

(4) Change the setting (it is shown with BCC omitted).

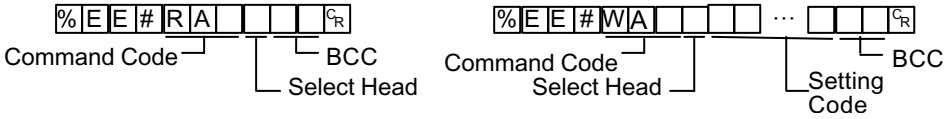
Change the lower limit hysteresis of add/subtract calculation to 1.1000mm.

%EE#WEL11.1000CR

%EE$WELCR

6-3-12 Analog Output

Function	Command Code		Setting Code	Setting Value Range
	Read	Set		
Analog Output +5V	RAH	WAH	□□□□.□□□□ (Code + Number (Zero Suppress))	±999.9999mm
Analog Output -5V	RAL	WAL		



Example

(1) Read the setting contents (it is shown with BCC omitted).

If the +5V (20mA) of sensor head 1 corresponds to +5.0000mm.

Send: %EE#RAH1CR

Respond: %EE$RAHSPSP+5.0000CR

(2) Change the setting (it is shown with BCC omitted).

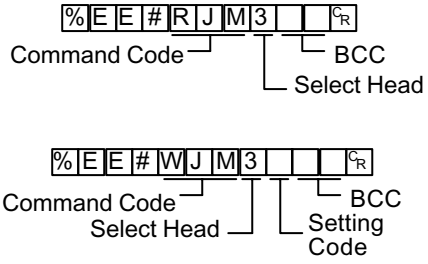
Set the sensor head 2 -5V (4mA) to correspond to -10.0000mm.

%EE#WAL2SP-10.0000CR

→ %EE$WALCR

6-3-13 Judgment Output Selection

Function	Command Code		Setting Code	Content
	Read	Set		
Judgment Output Selection	RJM	WJM	0	LOW/$\overline{\text{LOW}}$
			1	LOW/HIGH
			2	L or H/IN RANGE
			3	LOGIC



Example

(1) Read the setting contents (it is shown with BCC omitted).

If the judgment output selection is "LOW/HIGH".

Send: %EE#RJM3CR → Respond: %EE$RJM1CR

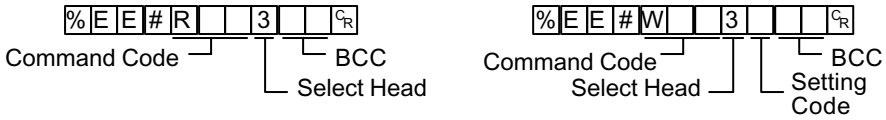
(2) Change the setting (it is shown with BCC omitted).

Change the judgment output selection to "LOGIC".

%EE#WJM33CR → %EE$WJMCR

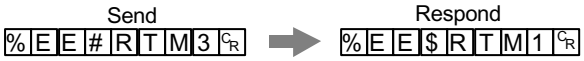
6-3-14 Other

Function	Command Code		Setting Code	Content
	Read	Set		
Analog output during alarm	RAA	WAA	0	Hold
			1	Fixed Value
Fixed Value	RFM	WFM	0	+10.9V, 29.5mA
			1	-10.9V, 0mA
Timing Input Operation	RTM	WTM	0	Operation during a short circuit
			1	Operation during an open circuit
Input Mode	RIM	WIM	0	Independent Input
			1	Batch Input
Output Mode	ROM	WOM	0	Normal
			1	Test
Laser Emission Control	RTE	WTE	0	Stop emission during timing
			1	Emission during timing
Laser Emission Delay	RLE	WLE	0	No delay
			1	Delay



Example

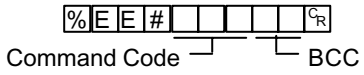
(1) Read the setting contents (it is shown with BCC omitted).
If the timing operation is "Operation during open circuit".



(2) Change the setting (it is shown with BCC omitted).
Set the input mode on "Independent Input".

6-3-15 System

Function	Command Code
Save	MMR
Initialize	INT



Example

(1) Save the setting contents (internal memory) (it is shown with BCC omitted).

Send: %EE#MMRCR → Respond: %EE$MMRCR

(2) Initialize the setting contents (it is shown wit BCC omitted).

%EE#INTCR → %EE$INTCR

6-4 List of Error Codes

Error Code	Type of Error	Content
21	Data Error	A data error occurred during communications (framing error, parity error, BCC error).
22	Overrun Error	The receiving buffer of the controller has overflowed and no more data can be received.
41	Format Error	There was an error in the command symbol (there was no "#") there were too many or not enough digits in the setting figures, etc., so that the command format is not correct.
		An unsupported undefined command code was sent.
		Selection of a command code that cannot be selected was attempted, or a selection was made outside the selection range.
		Setting of a value outside the range, either a setting code or a setting value, was attempted.

Causes and Correction Methods

- Error codes 21 and 22: two causes are probable: (1) temporary trouble caused by electric noise or the like and (2) trouble in the controller or the PC. Turn the controller off then on again and reboot the PC.

- In the case of error code 41, check if there is not some error in the sent data. If there is an error, correct it. If the error persists though there is no error in the data, the controller may be faulty. Turn the controller off then on again.

BCC (Block Check Code)

- If you are omitting BCC calculation, inp"∗∗" (2AH, 2AH) in the BCC.

CHAPTER 7
INSPECTION

7-1 Inspection

Inspect the laser sensor periodically to make sure of its performance and assure that it is used under the best possible conditions.

■ Major Inspection Items

- Check if the input and output terminal connections are loose or disconnected.
- Check if there is any dirt or dust, or fingerprints, etc. on the glass parts of the sensor head's light emitter and receptor.
- Check if the power supply voltage is within the rated voltage range (21.6 to 26.4V DC).
- Check if the operating ambient temperature is within the specification range (sensor head: 0 to +45°C , controller: 0 to +50°C , compact console: 0 to +40°C).
- Check if the ambient humidity during use is in the 35 to 85% RH range.

7-2 Maintenance

■ Cautions During Maintenance

- When cleaning the sensor, be sure to turn off the power supply and that the laser has stopped radiating.
- Some parts of the sensor body are made of molded plastic, so when wiping off dirt, etc. and cleaning it, do not use organic solvents such as paint thinner or benzene.
- Avoid the application of strong pressure when wiping the glass of the light emitter and receptor. If the glass is scratched, it will cause errors in measurement.

1) Clean the light emitter and receptor on the front of the sensor head.

If oil, fingerprints or other substances that reflect light, and dust, dirt or other substances that block the light are adhering to the sensor head's light emitter or receptor, it could cause errors in measurement. Check these parts periodically and keep them clean.

- In the case of large particles of dirt or dust, blow them off using an air blower such as is used for cleaning camera lenses.
- For fine particles of dust, fingerprints, etc., use a soft lens cleaning cloth or lens cleaning paper to wipe off the glass gently.
- For stubborn dirt, add a small quantity of alcohol, and wipe off the glass surfaces carefully.

2) Cleaning of Other Places

- Gently wipe off any dirt adhering to the controller or compact console with a clean, soft cloth.

CHAPTER 8
TROUBLESHOOTING

8-1 Treatment Methods when Trouble Occurs

Content of Trouble	Cause	Treatment Method	Related Pages
- The compact console's display does not change. - The compact console's touch keys do not function. - ERFF is displayed at the upper right of the compact console's screen.	The connection cables are not connected correctly.	Check the connection condition of the connection cables.	—
	There is a disconnection in the connection cables.	If the connectors and cables are disconnected from the compact console, reconnect them in accordance with the wiring method shown in 3-1.	2-8 3-2
	Power is not being supplied to the controller.	Supply a 24V D C power supply to the controller.	3-6
	The controller's operation is stopped.	Turn the power to the controller On again.	3-6
The laser beam is not issued.	The timing input is turned on.	Check the input signal at the terminal and timing input setting.	3-5, 5-5, 22,23
There is variation in measurement values.	The sensor head's light emitter/receptor is soiled.	Remove the dirt from the sensor head's light emitter/receptor.	7-1
	The average number of samples is set at a small number.	Set the average number of samples at the correct level.	5-11
	The sensor head's mounting direction is not correct.	Check the sensor head's mounting direction.	2-5
	The sensor head or the measurement object is tilted.	Check the sensor head's mounting position and the measurement object's placement position.	2-4,5
Correct measurement values are not displayed.	The cutoff frequency setting of the low pass or high pass filter is incorrect.	Set the correct cutoff frequency for the purpose.	5-12,13
	Calibration is not set correctly.	Set the calibration correctly.	5-24 to 27
	The sensor head or measurement object is tilted.	Check the sensor head's mounting position and the measurement object's placement position.	2-4,5
	Measurement is being done outside the measuring range.		
	The hold mode is not correct.	Change the hold mode to correspond to the measurement contents.	5-2
	Shift and offset are set.	Check the shift and offset values.	5-9 5-24 to 27
	The sensor head's light emitter/receptor is soiled.	Remove the dirt from the sensor head's light emitter/receptor.	7-1
The analog output does not change.	A large value is set for the offset or a small value is set for the coefficient in the calculation formula.	Check the analog output setting and offset and coefficient settings of the calculation formula.	5-9,18
The analog output is not correct.	The analog output setting is not correct.	Check the analog output settings.	5-18
Serial communications cannot be done.	The connection cables are not connected correctly.	Check the connection condition of the connection cables.	6-1
	The baud rate setting is not correct.	Check the settings of the personal computer connected to the sensor.	6-1
	The data format setting is not correct.	Check the settings of the personal computer connected to the sensor.	6-1
	The send command is not correct.	Check the send command and send the correct command.	6-3 to 16

8-2 Lock

- To prevent setting errors by inadvertent operation of the compact console, setting of the compact console and change operations can be prohibited.
- Set the key lock and release the key lock with reference to page 5-32.
- When setting the key lock, it becomes impossible to do any operations except change screen displays and release the key lock. However, saving can be executed. To keep the data lock setting valid even after the power is turned off, execute saving.

8-3 Initialization

- Initialization erases all the setting contents and returns them to the default factory settings.
- Carry out initialization with reference to page 5-30.
- Settings are not updated during initialization. To maintain the initialized state even after the power is turned off, execute saving.

— MEMO —

CHAPTER 9
SPECIFICATIONS

9-1 Sensor Head

Model name		HL-C108B-BK
Measuring center distance		85mm
Measuring range		±20mm
Light source		Visible Semiconductor Laser (Wavelength: 685nm, 1mW max., Class 2)
Beam diameter (*1)		Approx. 100× 140 μm
Receiving element		Linear Image Sensor
Resolution		6 μm
Linearity		±0.1% F.S.
Thermal characteristics		±0.01% F.S./°C
Display indicators	Laser emission indicator	Green LED Lights when laser is radiating.
	Measuring range indicator	Yellow LED Flashed within the measuring range and Lights up when near the measuring range center (measuring center ±0.5mm).
Protection		IP67 (excluding the connector)
Insulation resistance		20MΩ or more with a DC 500V Megger (Between charged parts as a unit and the case)
Voltage withstandability		500V AC, one minute (Between charged parts as a unit and the case)
Vibration resistance		10 to 55Hz (Period: one minute) Compound Amplitude 1.5mm in X, Y, Z directions for 2 hours
Shock resistance		196m / s^2 in X, Y, Z directions, 3 times
Ambient luminance		3,000 lx or less (Luminance at the light receptor surface)
Ambient temperature		0 to +45°C, Storage: -20 to +70°C
Ambient humidity		35 to 85% RH, Storage: 35 to 85% RH
Cable length		0.5m
Weight		500g approx. (including the cable)

Note: The measuring conditions are as follows unless otherwise specified: connection with controller (HL-C1C), source voltage: 24V DC, ambient temperature: 20°C, sampling frequency 144 μs, average number of samples: 64 times, measuring center distance, target of measurement: white ceramics.

(*1) The size at the measuring center distance. Defined at the center light intensity of 1/e^2 (about 13.5%). There are light leaks outside the defined range, and if the reflectance at the circumference of the check point is greater than at the detection point, the results may be influenced by that effect.

9-2 Controller

Model name		NPN Output Type HL-C1C
Supply voltage		24V DC ±10% Incl. ripple 0.5V (P-P)
Current consumption		When 2 sensors are connected: Approx. 550mA When 1 sensor is connected: Approx. 430mA
Sampling period		100μs, 144μs, 200μs, 255μs, 332μs, 498μs, 1,000μs
Serial input/output		RS-232C
Thermal characteristics		±0.01% F.S./°C
Analog output	Voltage	Output voltage: -5 to +5V / F.S. (Variable according to analog output setting; max. voltage at power-up: ±10.9V) Output range: -10.9 to +10.9V, max. 2mA, output impedance 50Ω
	Current(*1)	Output current: 4 to 20mA / F.S. (Variable according to analog output setting; max. current at power-up: +29.5mA) Output range: 0 to 29.5mA (Max. 25mA at max. load impedance) Load impedance: 250Ω max.
Alarm Output		N-channel FET Open Drain Max. inrush current: 100mA Applied Voltage: 30V DC or less (While alarm output is 0V) ON impedance: 5Ω or less
	Output Operation	ON when the amount of light is excessive or insufficient.
	Short Circuit Protection	Incorporated
Judgment Output (O1, O2)		N-channel FET Open Drain Max. inrush current: 100mA Applied Voltage: 30V DC or less (While comparative output is 0V) ON resistance: 5Ω or less
	Output Operation	Opened or closed when the threshold value is reached. Determined according to judgment output mode selection. (The threshold value varies according to the hysteresis setting.)
	Short Circuit Protection	Incorporated
Timing Input (Laser emission)		Laser emission stops or continues when there is a short circuit or open circuit. Determined according to the input mode selection.
Zero Set ON Input		Zero set goes ON when there is a short circuit.
Zero Set OFF Input		Zero set goes OFF when there is a short circuit.
Display Lamps	Laser Emission Indicator	Green LED (Lights up when the laser beam is being issued at sensor head 1 or 2 or immediately before it is issued.)
	BRIGHT Indicator	Red LED (Lights up upon disabled measurement due to excessive amount of light at sensor head 1 or 2.)
	DARK Indicator	Red LED (Lights up upon disabled measurement due to poor amount of light at sensor head 1 or 2.)

Connection heads		Maximum 2 sensor heads
Setting / Data display		Compact console (option)
Calibration (*2)	Shift	±20.0000mm
	Span	0.9000 to 1.1000
Average number of samples (*2)		OFF, 2 to 32,768 times (16 steps)
Digital filters (*2)		High Pass: OFF, 10 to 2,000Hz (9 steps) Low Pass: OFF, 10 to 2,000Hz (9 steps)
Calculation functions (*2)		L±KA, L±KB, L±K (A±B) A, B: Head 1, Head 2 measurement values L=±999.9999, K= 0.0001 to 99.9999
Hold functions (*2)		NORMAL / P-P / PEAK / VALLEY
Insulation resistance		20MΩ or more with a 500V DC Megger (between live part and enclosure)
Voltage with standability		500V AC for one min. (between live part and enclosure)
Vibration resistance		10 to 55Hz (Period: one minute) Compound Amplitude 0.75mm X Y, Z directions, 30 minutes
Shock resistance		196m /s^2 X, Y, Z directions, 3 times
Ambient temperature		0 to 50℃ (No dew condensation), Storage: -20 to 70°C
Ambient humidity		35 to 85% RH, Storage:35 to 85% RH
Weight		300g approx.

Note: The measuring conditions are as follows unless otherwise specified: connection with sensor head (HL-C108B-BK), source voltage: 24V DC, ambient temperature: 20°C, sampling frequency: 144μs, average number of samples: 64 times, measuring center distance, target of measurement: white ceramics.

(*1) The maximum output current of the analog current output varies according to the load impedance.

(*2) Can be set from the compact console or using commands from an external device through RS-232C.

9-3 Compact Console

Model		HL-C1DP
Supply voltage		24V DC ±10% incl. ripple 0.5V (P-P)
Current consumption		200mA or less
Display	Display element	STN monochrome LCD
	Back light	Green LED
	Life of LCD	Average 50,000 hours (*1)
Touch panel	Operation force	0.98N or less
	Life	1,000,000 times or more
Ambient temperature		Operating: 0 to +40°C, Storage: -20 to +60°C (icing allowed.)
Ambient humidity		Operating: 20 to 85% RH, storage: 10 to 85% RH (icing allowed)
Vibration resistance		Durability: 10 to 55Hz, complex amplitude: 0.75mm, 10min. in each of X, Y and Z directions
Shock resistance		Durability: 98 m/s^2 or more, 4 times in each of X, Y and Z directions
Superimposed noise resistance		1,000V (P-P) or more, pulse width 50ns for 1μs between power terminals
Electrostatic noise resistance		5,000V or more (surface of panel)
Environment resistance		IP65 (in initial state) (*2) Dust proof and drip proof only at front face of panel. (Waterproof packing is used for surfaces in contact with panel.)
Weight		260g approx.

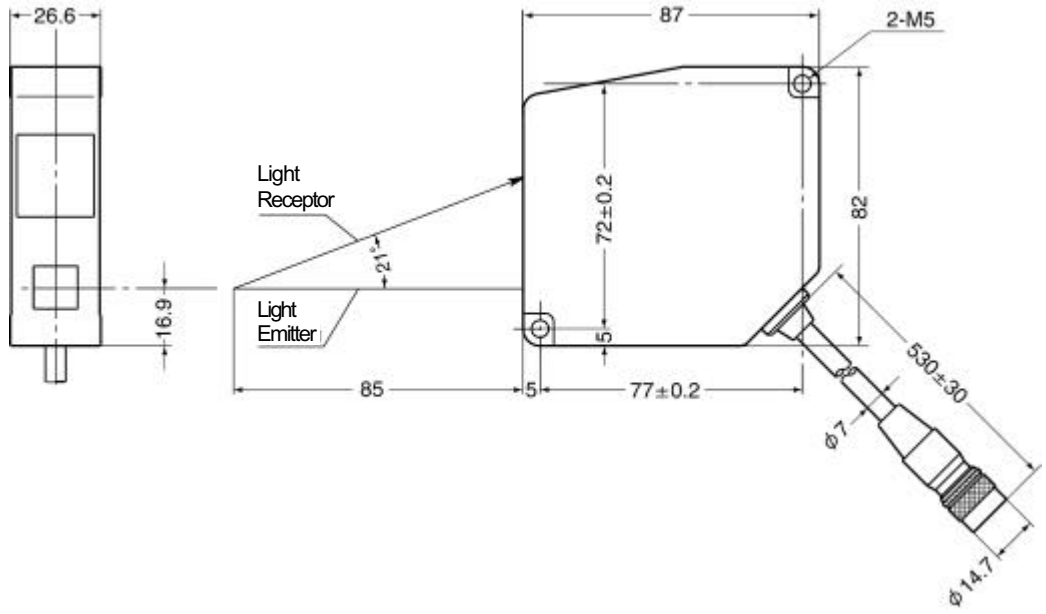
(*1): Indicates the average life of operation at room temperature +25°C.
(*2): Change the waterproof packing when reinstalling.

— MEMO —

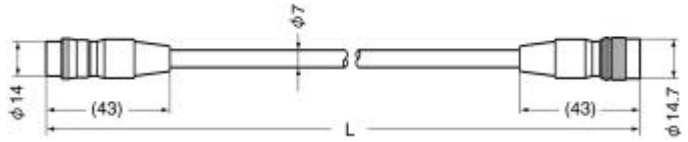
CHAPTER 10
DIMENSIONS

10-1 Sensor Head

(Unit : mm)



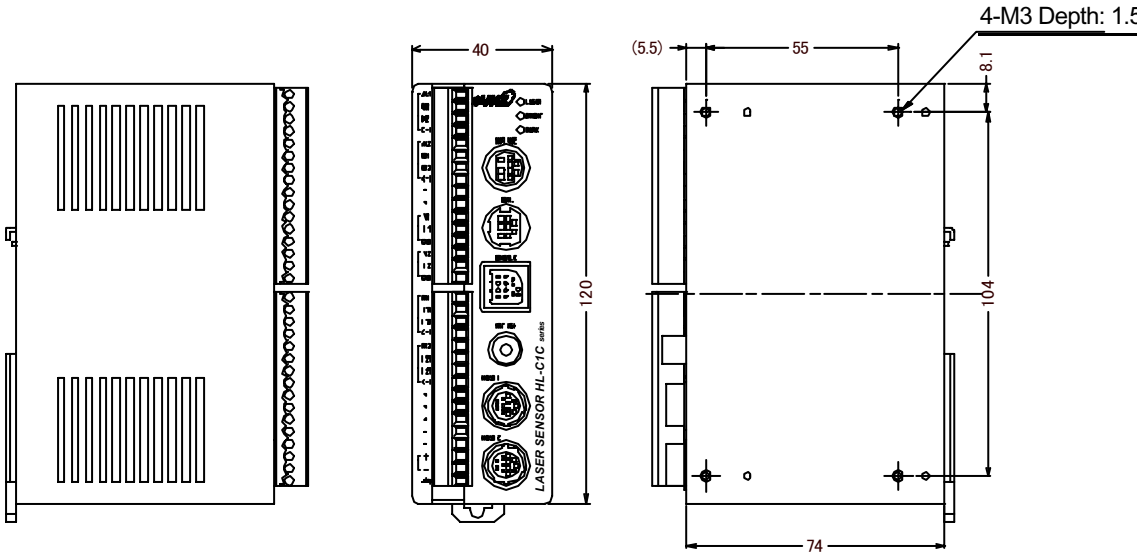
Extended Cable



Model Name	Length L (mm)
HL-C1CCJ 2	2,000
HL-C1CCJ 5	5,000
HL-C1CCJ 10	10,000

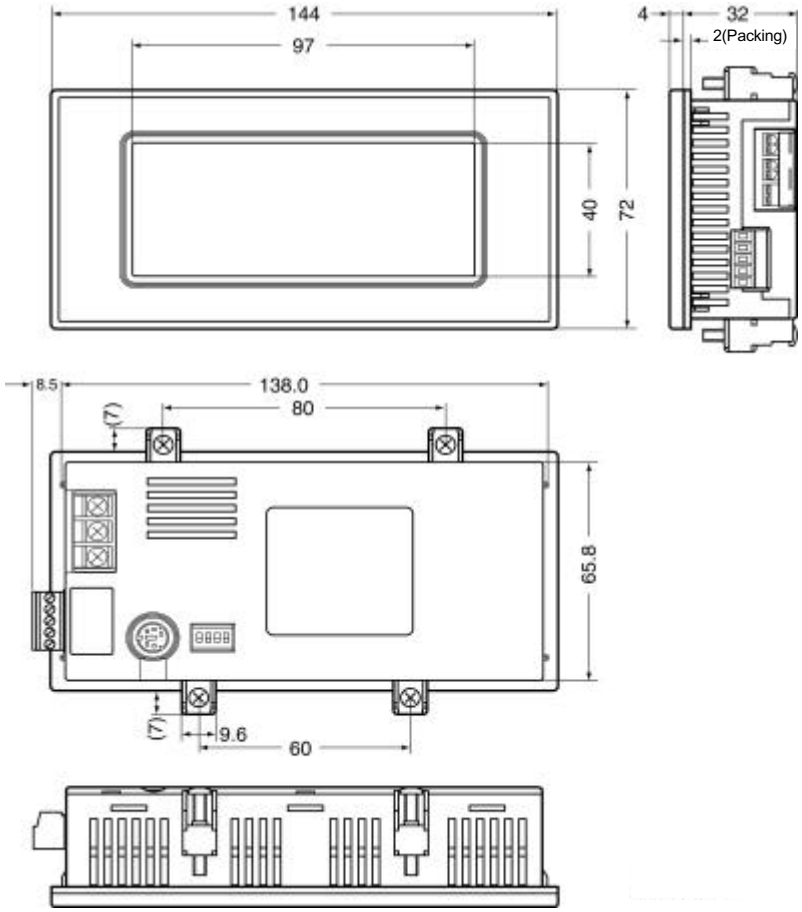
10-2 Controller

(Unit : mm)

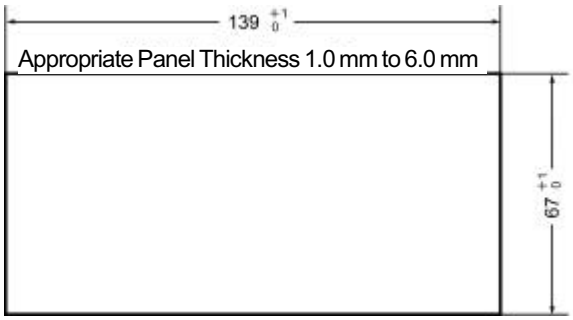


10-3 Compact Console

(Unit : mm)



Panel Cutting Method



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