

CCD Laser Micrometer VG Series

Instruction Manual

Preface

Thank you for selecting the KEYENCE VG Series CCD Laser Micrometer.
Please read this manual carefully to get the best results from this equipment.
Keep the manual beside you for later reference.

Configuration of this instruction manual

This instruction manual consists of the following three sections:

	Page
1. Preparation for Measurement	5 to 14
(Be sure to read this section for safety operation.)	
2. Operations and Functions	15 to 38
3. Specifications and Characteristics	39 to 52

Contents of the Package

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

- Controller (VG-301) -----1
- sensor head (VG-036T/R) -----1 each
- sensor head mounting bracket-----1 set
- Laser beam shield cover -----1
- Power switch key -----2
- Laser beam axis alignment tool -----1
- Instruction manual -----1

Caution 	Turn the power OFF when connecting or disconnecting the sensor head connector and power supply cables. Otherwise, the laser diode or other electronic components may become degraded or damaged.
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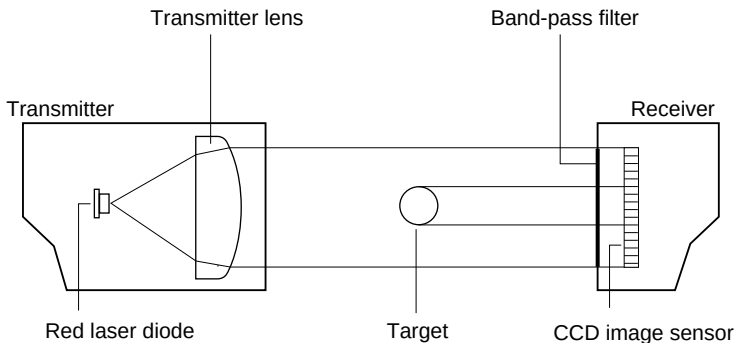
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Features

- **5 μm resolution and 780 c/s sampling rate**
A 5000-bit CCD image sensor is used as the light-receiving element enabling high-speed, accurate measurements.
- **Wide measuring area: 35 x 300 mm**
The visible parallel laser covers a wide measuring area, expanding the freedom degree of on-line measurement regardless of the target size.
- **4 measurement modes to accommodate a wide range of applications**
The CCD is capable of checking target position information, which allows you to select the best from various measurement modes.
- **Automatic measurement for moving targets**
The self-timing function enables on-line measurement of moving targets at the optimal position without an additional sensor for synchronous input.
- **LED display including indicator LEDs in a compact controller**
The two-color LEDs represent GO and NG respectively. The tolerance comparator output (NPN open collector), analog voltage output, and RS-232C I/O allow the VG Series to connect to PCs, PLCs and printers.
- **Versatile functions support fast product changeover**
Tolerance memory (8 sets), tolerance teaching, AUTO-ZERO, and measurement position display are standard.
- **Stable measurement based on a complete set of diagnostic functions**
Self-diagnostics, AUTO-GAIN (Received light quantity adjustment)

Operating Principle

The red laser beam emitted from the visible laser diode in the transmitter is converged into a parallel beam by the transmitter lens. When the laser beam is interrupted by a target, a shadow with an area proportional to the target size is projected on the receiver. The one-dimensional CCD image sensor scans and calculates the shadow area and position at a 780 c/s sampling rate to measure target dimension or position.



Section 1

Preparation for Measurement

This section lists describes safety precautions for use and details the settings for the sensor head.
(Be sure to read this section for safety precautions.)

1.1 Safety Precautions

The VG employs a visible semiconductor laser as its light source (FDA: Class II / IEC Class 1 product). The laser cannot harm human skin, but can be harmful to the eyes if looked at directly. Looking at the laser from any angle other than directly is safe.

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



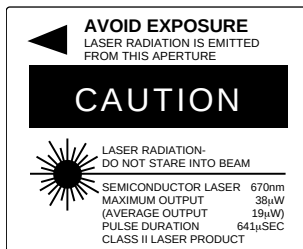
1. **Use of controls or adjustments, or the performance of procedures other than those specified herein, may result in hazardous radiation exposure.**
2. **Do not dismantle the sensor head.**
The VG controller is not designed to stop laser emission automatically when the sensor head is dismantled. Contact KEYENCE if the VG sensor head is damaged and needs repairs.
3. **To prevent eye damage, do not look into the laser beam.**

1.2 Safety Features

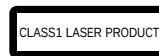
The VG Series has several built-in safety functions to prevent leaser-related accidents.

1. **Laser ON alarm LED**
Mounted on the sensor head and the controller's front panel.
You can identify whether the LEDs are lit even when you wear protective glasses.
2. **Laser Beam Shield Cover**
The sensor head comes with a shield cover to cut off the leaser beam. Be sure to close the cover if you suspect any risk of emission during operation.
3. **Warning Label**
The following warning label is affixed to the sensor head

FDA Class II



IEC Class 1



4. **Laser control terminal**
This terminal is used to control laser emission remotely and is located on the back of the controller.
5. **Key-operated power switch**
This switch turns the controller ON/OFF. The key can then be removed when set to "OFF". Without the key inserted, the power will not be turned ON.

1.3 Hints on Correct Use

Caution 	Turn the power OFF when connecting or disconnecting the sensor head connector and power supply cables. Otherwise, the laser diode or other electronic components may become degraded or damaged.
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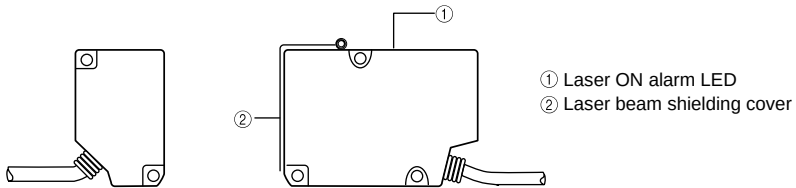
- **Operating Environment**
Be sure to keep the laser emitting surface (transmitter) and the laser receiving surface (receiver) free from any substance that refracts light (such as water or oil). If dirt or dust adheres to the surface, wipe it off using a soft cloth moistened with alcohol.
 - **Noise interference prevention**
Isolate the sensor cables from high-voltage or power lines to prevent the VG controller from malfunctioning due to noise interference.
 - **Cable Extension**
The cable between the controller and the sensor head can be extended up to 10 m by connecting extension cables.
VG-C7T: 7-m cable for transmitter
VG-C7R: 7-m cable for receiver
 - **Mounting the sensor head**
Avoid mounting the sensor head in areas subject to vibration because the sensor head includes precision components such as the optical lens. If the installation site has a high level of noise, it may cause the laser diode to deteriorate or become damaged. In this situation, take precautions, for example by insulating the sensor head.
 - **Power supply**
When using a switching regulator, be sure to earth-ground the frame ground terminal and ground terminal.
 - **Warm up**
Adjust light quantity (AUTO-GAIN) and start measurement at least 30 minutes after turning on the power. Values measured within 30 minutes of startup may be inaccurate.
- Note:** To obtain the stable measurement accuracy, be sure to adjust light quantity (AUTO-GAIN function) before measurement.

1.4 Part Names

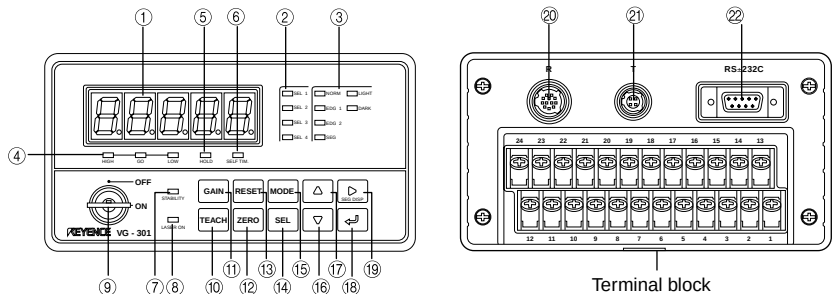
1.4.1 Sensor head

Receiver

Transmitter



1.4.2 Controller



Front Panel

Display

1. Display
2. Tolerance No. (Upper/lower limit no.) indicator (See Page 25)
The indicator, corresponding to the chosen upper/lower limit no., lights.
3. Measurement mode indicators (see Page 19)
4. HI/GO/LO output indicators (see Page 25)
The appropriate LED lights based on where in the tolerance range the output falls.
5. HOLD function indicator (see Page 34)
Lights when the SAMPLE HOLD function has been set by the external synchronous input from terminal No. 18. (Goes off for the moment of synchronous input.)
6. Self-timing function indicator (see Page 34)
Lights when the Self-timing function has been set by the internal synchronous input. (Goes off at the moment of synchronous input.)
7. Receiver stability alarm indicator
Lights when the receiver stability alarm turns on due to a decrease in light quantity or when the optical axis is completely shut off.
Also outputs through terminal No. 8 (Alarm output terminal)
8. Laser ON alarm indicator
Lights when laser is emitted.

Operation keys

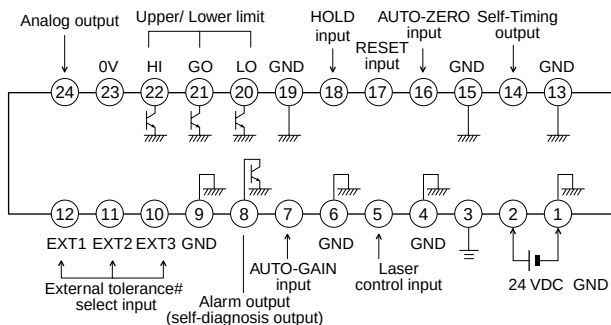
9. Key-operated power switch
10. TEACH key (Teaching function key; see Page 27)
11. GAIN key (AUTO-GAIN function key, optical axis check function key; see Page 13)
12. ZERO key (AUTO-ZERO function key; see Page 32)
13. RESET key (Resets error display, stops measurement or output, initializes settings of each menu).
14. SELECT key (Upper/lower limit selector key; see Pages 26 and 37)
15. MODE key (Menu selector key; see Page 16)
16. DOWN key
17. UP key
18. ENTER key (Registers the function or setting.)
19. SEG DISP key (Measurement position display function key; see Page 23, digit shift key)

Back Panel

Connector

20. Receiver connector
21. Transmitter connector
22. RS-232C connector

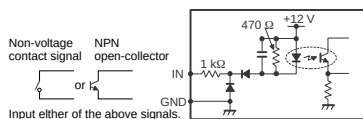
Connections



Terminals 1, 4, 6, 9, 13, 15, and 19 are common.

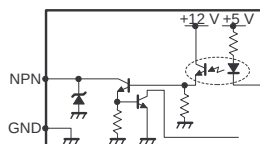
Input Circuit

HOLD, RESET, AUTO ZERO, external tolerance selector, AUTO GAIN, and laser control inputs

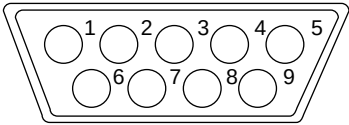


Output Circuit

Tolerance comparator, Self-Timing, and alarm outputs

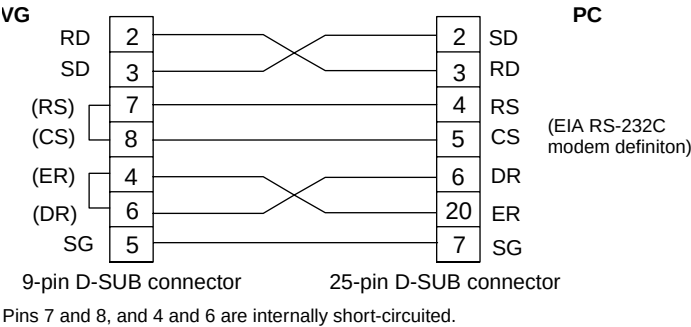


1.5 RS-232C Connector Pin Assignment



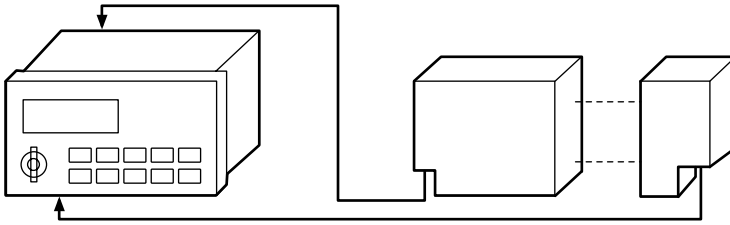
Pin No.	Signal	Function	Input/output
1	—	—	—
2	RD(RXD)	Outputs measured data	Output
3	SD(TXD)	Inputs data from external unit	Input
4	—	—	—
5	SG(GND)	Signal ground	—
6	—	—	—
7	—	—	—
8	—	—	—
9	—	—	—

1.5.1 Connection to a personal computer

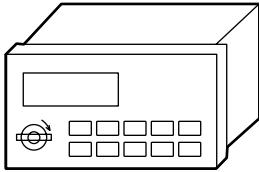


1.6 Preparation for Operation

1. Be sure that the power switch is OFF.
2. Connect the controller to the sensor head, and the power cable.

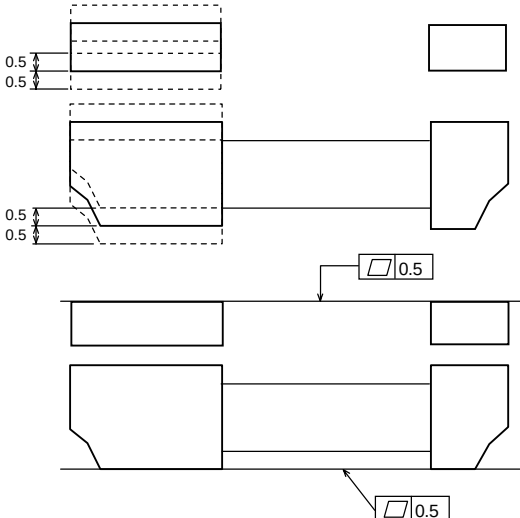


3. Turn the power switch to ON.



4. Mount the sensor heads

To eliminate measurement errors caused by misalignment of the laser axis between the transmitter and receiver, mount the sensor head within the allowable tolerance (mounting surface flatness of 0.5 mm or less).



5. While "Ga i n" is blinking, adjust the light quantity (AUTO-GAIN) in the following order.
 - 1) Press **RESET** to clear "Ga i n".
 - 2) Press **GAIN** and **↵** at the same time and start adjusting light quantity.

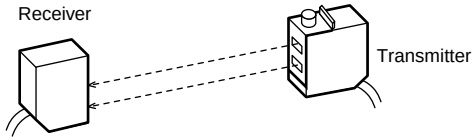
1.7 Checking Optical Axis Alignment and Adjusting Light Quantity (AUTO-GAIN)

To maintain measurement accuracy, follow the procedures given below.

1.7.1 Optical axis alignment

Use the Optical Axis Check function to check whether the optical axis of the transmitter and receiver are aligned. Mount the sensor heads correctly using the dimensions of the sensor head and the surface texture of the base.

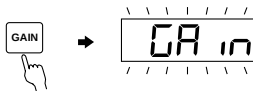
1. Mount the sensor heads within allowable tolerances (see Page 12, "Preparation for Operation").
2. Secure the accessory "Laser beam axis alignment tool (slit)" to the transmitter lens surface using screws.



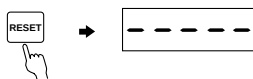
3. Press **GAIN** for at least 3 seconds. If the optical axis of the transmitter and receiver are aligned, "Good" will appear. (Pressing **GAIN** without mounting the slit will cause "Error" to appear. However, you can continue the operation after mounting the slit.)



4. If the following messages appear, the transmitter and receiver are not aligned. Adjust the tilt of the transmitter so that "Good" will appear.
Xi -Er: The center of the optical axis is positioned above the CCD
Lo -Er: The center of the optical axis is positioned below the CCD.
5. Press **GAIN** to reset the Optical Axis Check function. "Ga i n" will blink indicating it is reset.



6. Remove the slit, and press **RESET** to return to the measurement mode (red "-----" appears).



1.7.2 Adjustment of light quantity (AUTO-GAIN)

To maintain stable measuring accuracy, adjust the light quantity whenever mounting the sensor head or changing the settings. Periodic calibration is required when the laser beam transmission varies due to a dusty environment. Be sure to adjustment the light quantity using the AUTO-GAIN function after the system has warmed up.

1. Press  and  at the same time. When the light quantity adjustment is completed, green "-----" will appear.



* Adjustment of light quantity can also be performed using the external input terminal (by short-circuiting terminals 6 and 7).

2. Select the measurement mode and start measurement.

The voltage across a high-capacity capacitor is used to maintain the adjusted light quantity data obtained by AUTO-GAIN for about 1 month (at a temperature of 25°C). If the sensor is left without supply power for more than 1 month, the data may be lost. If this occurs, "Ga i n" will blink when the power is turned on. If this happens, press  to clear the display and adjust the light quantity again.

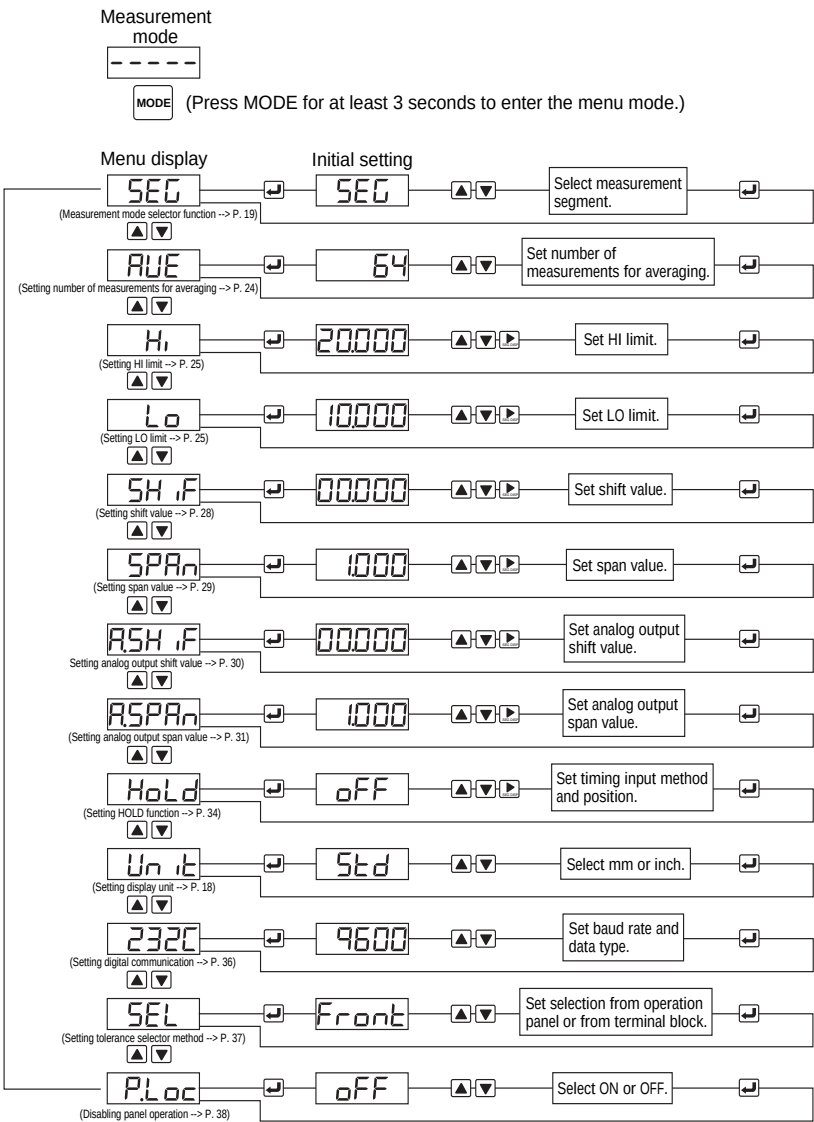
Section 2

Operations and Functions

This section describes the operations and function settings required to practically measure the targets.

2.1 Operation Flow

- To set parameters and functions for operation using the measurement mode selector function, follow the setting menu in the flow chart below.



2.2 Initial Settings for Menus

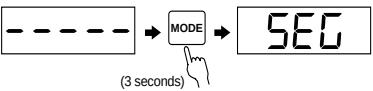
Each menu has the default value listed below.

Menu	Display	Initial value (mm)	Initial value (inch)
Measurement mode selector	SEG	NORM (Normal)	←
Number of averaging measurements	AUE	64	←
High limit	Xi	20.000	1.000
Low limit	Lo	10.000	0.500
Shift value	SHiF	00.000	0.0000
Span value	SPAn	1.000	←
Analog output shift value	ASHiF	00.000	0.0000
Analog output span value	ASPA	1.000	←
HOLD function	XoLd	OFF	←
Display unit	Un i t	Std (mm)	Inch
RS-232C	232C	9600, CR	←
Tolerance selector function	SEL	Front (Front panel)	←
Panel lock function	PLOc	OFF	←

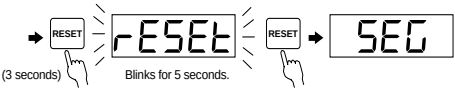
2.2.1 Initializing all the settings

All settings can be initialized as shown below.

1. Press **MODE** for 3 seconds to enter the menu mode.
(If already in the menu mode, skip to step 2.)



2. Press **RESET** for 3 seconds. "rESEt" will blink for 5 seconds. During that period, press **RESET** again. The menu mode is called again when the initialization is completed.



2.2.2 Initializing the setting on each menu

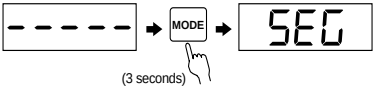
Press **RESET** when each menu is set. The initial value will appear.

2.3 Setting the Display Unit

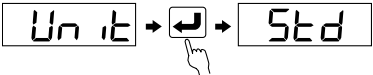
Choose to display the measured value in millimeters or inches.

2.3.1 Select the required unit

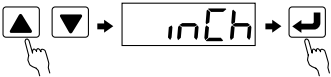
1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip to step 2.)



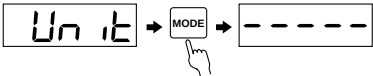
2. Use / to display "Un i t". Press  to start setting.



3. Use / to select "i nCh" for inches or "Std" for millimeters. Press  to complete setting.



4. If you have no more settings to change, press  to return to the measurement mode.



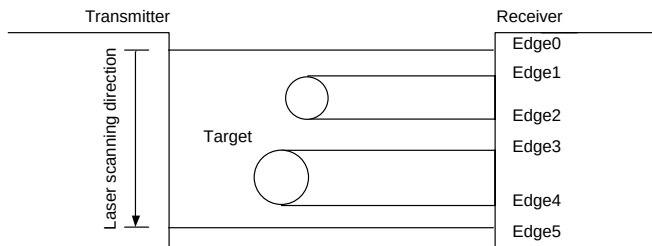
Note: When changing the unit, all the settings are automatically initialized for the specified unit at that time. If you change the display unit, be sure to perform the settings again.

2.4 Selecting the Measurement Mode

You can choose the required mode, based on your application, from a choice of 4 measurement modes (NORMAL, EDGE LIGHT, EDGE DARK, and SEGMENT).

2.4.1 Before selecting the mode

The 5,000 discrete image points of the CCD image sensor in the VG receiver are arranged in order from 1, the top of the receiver, to 5000, the bottom of the receiver. The scanning direction during measurement is from top to bottom. When a target enters the measuring area, the shadow generated by the target and the uninterrupted portion of the beam register on the receiver. The boundary between the bright area and the shadow area is called an "EDGE". Each area separated by an edge is called a "SEGMENT".



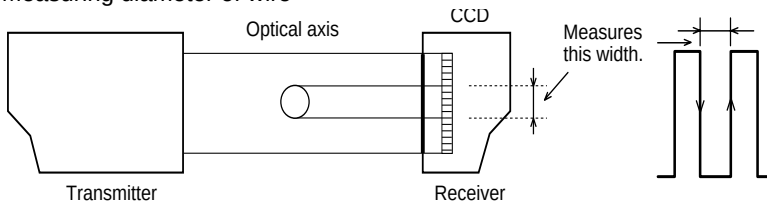
2.4.2 Explanation of each Mode

Measurement of target diameter or width

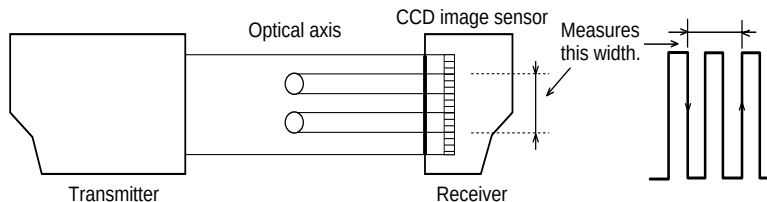
1. *NORMAL (normal mode)*

Measures the width (segment) of the shadow area generated by the target, between the first falling edge and the last rising edge.

1) Measuring diameter of wire



2) Measuring diameter of washer



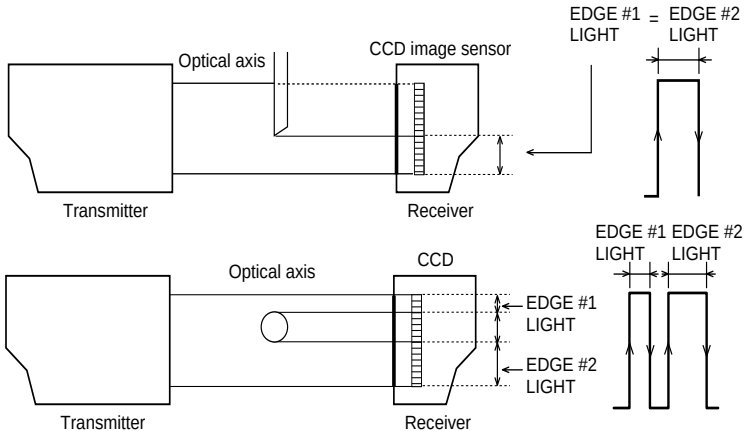
Measurement of clearance

2. *EDGE LIGHT mode*

You can select between EDGE #1 LIGHT and EDGE #2 LIGHT.

EDGE #1 LIGHT --> Measures the width between the first rising edge and the first falling edge (the first bright area).

EDGE #2 LIGHT --> Measures the last rising edge and the last falling edge (the last bright area).



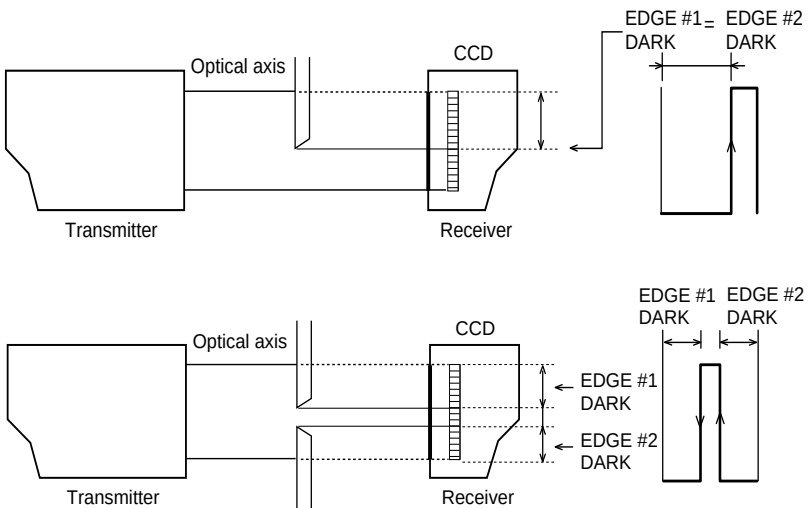
Measurement of amplitude of edge control or shaft eccentricity

3. *EDGE DARK mode*

You can select the mode between EDGE #1 DARK and EDGE #2 DARK.

EDGE #1 DARK → Measures the width between the first falling edge and the first rising edge (the first shadow area).

EDGE #2 DARK → Measures the width between the last falling edge and the last rising edge (the last shadow area).



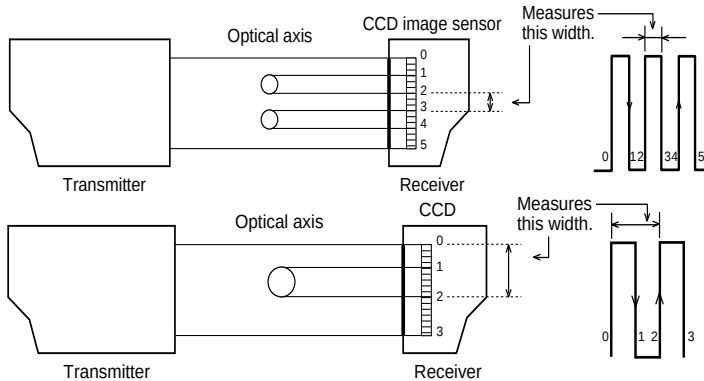
Positioning or measurement of dimensions and inner diameter of complex-shaped targets

4. SEGMENT mode

Measures the width (segment) between the specified edges.

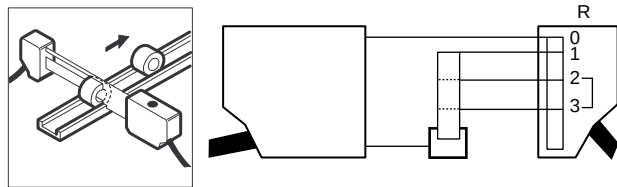
The maximum number of edges which can be specified is 10 including the two at both ends of the CCD image sensor.

(1) Measuring inner diameter of bearing



2.4.3 Setting the measurement mode

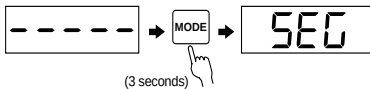
Example Select SEGMENT mode to measure inner diameter of bearing.



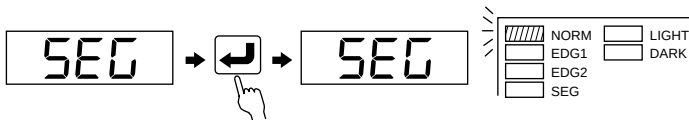
Number of edges: 3

Segment to be measured: Edge #2 to Edge #3

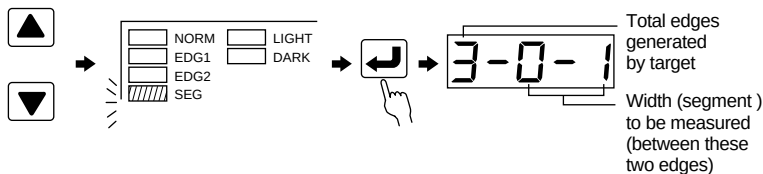
1. Press **MODE** for 3 seconds to enter the menu mode.



2. Use **▲/▼** to display red "SEG". Press **↵**. When "SEG" turns green and the measurement mode indicator LED blinks, you can select the measurement mode.

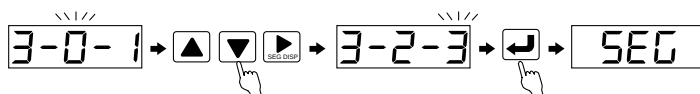


- Use / to select SEGMENT mode and press . When "SEG" blinks, you can set the values.

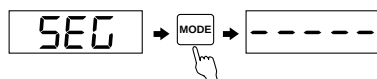


Note: When the target is set within the measuring area, the system automatically counts the total edges and displays the value.

- Use // to set 2 edges between which the width (segment) is measured. Press to complete the setting.



- If you have no more function setting, press to start measurement.

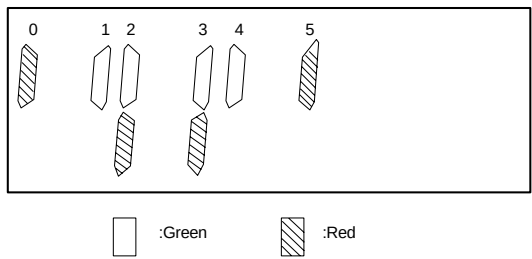
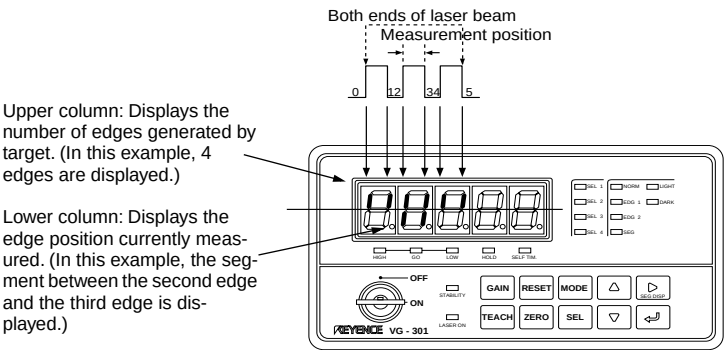
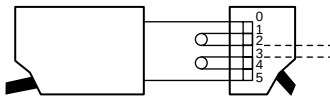


2.5 Information on Useful Function

2.5.1 Segment Position Display function

By pressing  during measurement, you can check the number of edges generated by the target and their positions. When the number of edges exceeds 10, the upper column of the display turns red.

Example: Pressing  while inner diameter of ring is being measured.



2.6 Setting the Number of Averaging Measurements

You can choose the number of averaging measurements from 7 set values depending on detection conditions.
Set the number of averaging measurements to a small value for quick judgments and to a large value when you want to ignore any sudden displacement.

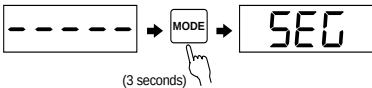
No. of averaging measurements	1	4	16	64	256	1024	4096
Response time (ms)	3.9	7.8	23.4	85.8	668.2	2665	6658.6

Notes: The shift averaging method is used, which averages each sampling when the number of averaging measurements is set to 64 or less, and averages every 1024 samplings when the number of averaging measurements is 4096.

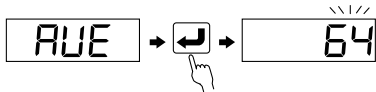
The simple averaging method is used when the number of averaging measurements is 256 or 1024.

2.6.1 Setting the number

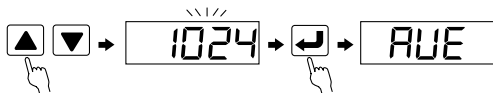
1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



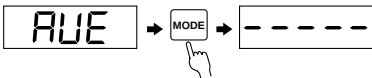
2. Use / to display "AUE" in red, and press . When the number of averaging measurements blinks in green, you can set the value.



3. Use / to select the number of averaging measurements and press . When the setting is completed, "AUE" appears.



4. If you have no more function setting, press  to return to the measurement mode.



2.7 Setting the Upper/Lower (Tolerance) Limit

You can choose the tolerance limit from 8 sets of values. Select the desired tolerance using the key operation or from an external signal.

The tolerance limit setting menu includes the following settings:

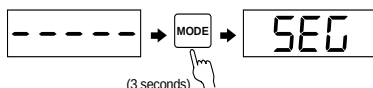
Tolerance No. 1 to No. 8 high limit setting: "Xi"

Tolerance No. 1 to No. 8 low limit setting: "Lo"

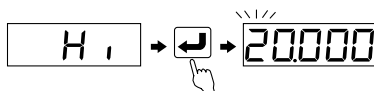
2.7.1 Setting the tolerance limit

Example Set tolerance No. 2 high limit to +5.000.

1. Press key for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



2. Use to display "Xi" and press . When the green high limit value and the upper limit indicator "HIGH" blink, you can set the high limit. (At this time, tolerance No. indicator "SEL1" is lit.)



3. Use to select the tolerance No. (In this example, "SEL2" is selected.)



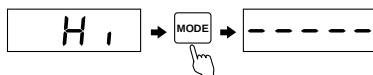
4. Use to set the high limit, and press to complete the setting.



Notes: When setting a negative value, use to blink the leftmost digit. Press repeatedly until the display value color changes from green to red and "-" appears in the leftmost digit. When the value is set starting from the tens digit, "-" disappears. However, the display value in red shows that the setting value is negative.

To return to the positive value setting, press repeatedly until the display value color changes from red to green.

5. If you have no more function setting, press to return to the measurement mode.



2.7.2 Relationship between tolerance No. and tolerance indicator

Tolerance indicators No. 5 to No. 8 are lit and displayed in combination with the following ON/OFF patterns of tolerance indicators No. 1 to No. 4.

Tolerance No.	No.1	No. 2	No. 3	No. 4
Tolerance Indicator	☒ SEL1 ☐ SEL2 ☐ SEL3 ☐ SEL4	☐ SEL1 ☒ SEL2 ☐ SEL3 ☐ SEL4	☐ SEL1 ☐ SEL2 ☒ SEL3 ☐ SEL4	☐ SEL1 ☐ SEL2 ☐ SEL3 ☒ SEL4
Tolerance No.	No. 5	No. 6	No. 7	No. 8
Tolerance Indicator	☒ SEL1 ☐ SEL2 ☐ SEL3 ☒ SEL4	☐ SEL1 ☒ SEL2 ☐ SEL3 ☒ SEL4	☐ SEL1 ☐ SEL2 ☒ SEL3 ☒ SEL4	☒ SEL1 ☐ SEL2 ☒ SEL3 ☒ SEL4

Tolerance No. 1 to No. 8 are factory-set as below:

Display unit	Upper limit	Lower limit
mm	20.000	10.000
Inch	1.000	0.500

If upper limit is equal or smaller than lower limit, the setting is not accepted. Try again with different values.

Note: Panel Lock Function

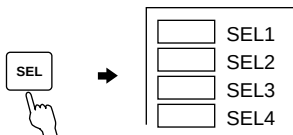
The panel lock function is used to disable front panel operation. When the panel lock function is turned ON, any key operation other than  is disabled. However, you can still check tolerance settings and segment position using  /  /  (See P.38 sec 2.16).

2.7.3 Teaching function

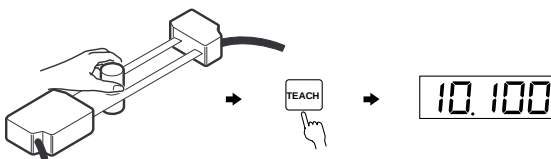
The teaching function is used as one method for setting tolerance limits. The tolerance limit can be set simply by placing the target within the measuring area and then pressing the  /  keys. The tolerance limit is set.

Example SEL4 low limit is registered in the normal mode using a target of 10.100 mm in diameter.

1.  or the tolerance number is set through the external selector input.



2. The upper limit target is placed within the measuring area and the  key is pressed. The measured value of the target's diameter appears in green and the "HIGH" LED blinks.



3.  /  is used to display the low limit setting mode (where the lower limit indicator "LOW" is blinking).



4. Pressing  completes the setting.
(When no target is set, "-----" appears.)

Notes: When canceling the setting, use  to clear the teaching function setting.

When high limit is equal or lower than low limit, "Er r -4" appears. Press  to clear the error display and retry setting.

When setting upper/lower tolerance limits, two targets, one for setting the upper limit and one for setting the lower limit, are required. First, set the lower tolerance limit following the above procedures, then set the upper tolerance limit.

Note: Panel Lock Function

The panel lock function is used to disable front panel operation. When the panel lock function is turned ON, any key operation other than  is disabled. However, you can still check tolerance settings and segment position using  /  /  (See P.38 sec 2.16).

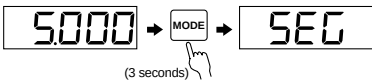
2.8 Setting the Shift Value

The VG Series allows you to change the displayed value by adding or subtracting the desired value to/from the displayed value.

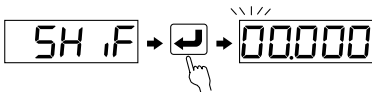
2.8.1 Setting the shift value

Example Change the displayed value from 5.0 to 15.0 (shift value:10.000).

1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



2. Use / to display "SX i F" and press . When the shift value display blinks, you can set the value.



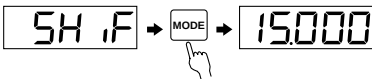
3. Use // to set the shift value and press . When "SX i F" appears, the setting is completed.



Notes: When setting a negative value, use  to start the leftmost digit blinking. Press  repeatedly until the display value color changes from green to red and "-" appears in the leftmost digit. When the value is set starting from the tens digit, "-" disappears. However, the display value in red shows that the setting value is negative.

To return to the positive value setting, press  repeatedly until the display value color changes from red to green.

4. If you have no more function setting, press  to return to the measurement mode.



Note: The shift value can be set within the following range.

mm	-99.995 to +99.995
Inch	-9.9999 to +9.9999

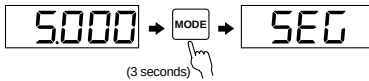
2.9 Setting the Span Value

The VG Series allows you to change the displayed value by multiplying it by the desired value.

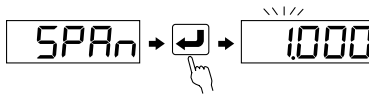
2.9.1 Setting the span value

Example Change the displayed value from 5.0 to 7.5 (span value:1.5).

1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



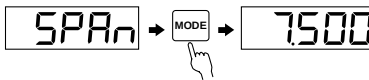
2. Use / to display "SPAn" and press . When the span value display blinks, you can set the value.



3. Use // to set the span value and press . When "SPAn" appears, the setting is completed.



4. If you have no more function setting, press  to return to the measurement mode.



Note: The span value can be set within the range from 0.100 to 3.000.

2.9.2 Calculating the shift value and span value

Prepare 2 targets which have been accurately measured. Assign the actual measurement data and the VG-measured data to the following equation. Obtain the shift value and span value from this equation.

$$\text{Actual measurement value} = \text{Span value} \times \text{VG-measured value} + \text{Shift value}$$

This method is useful to calibrate the display value error caused by target shape.

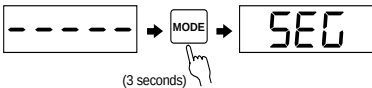
2.10 Setting the Analog Output Shift Value

The VG Series allows you to change the analog voltage output value by adding or subtracting the desired value to/from the output value.

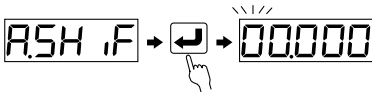
2.10.1 Setting the value

Example Change the voltage output from 3.0 V to 5.0 V (shift value: 6.000).

- 1. Press for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



- 2. Use / to display "ASX i F" and press . When the shift value display blinks, you can set the value.



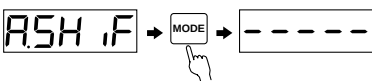
- 3. Use // to set the shift value and press . When "ASX i F" appears, the setting is completed.



Notes: When setting a negative value, use to set the leftmost digit blinking. Press repeatedly until the display value color changes from green to red and "-" appears in the leftmost digit. When the value is set starting from the tens digit, "-" disappears. However, the display value in red shows that the setting value is negative.

To return to the positive value setting, press repeatedly until the display value color changes from red to green.

- 4. If you have no more function setting, press to return to the measurement mode.



Note: The shift value can be set within the following range.

mm	-99.995 to +99.995
Inch	-9.9999 to +9.9999

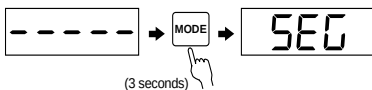
2.11 Setting the Analog Output Span Value

The VG Series allows you to change the analog voltage output value by multiplying it by the desired value.

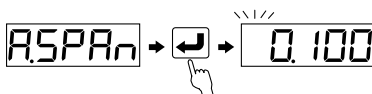
2.11.1 Setting the value

Example Change the analog voltage output from 1.0 V to 1.5 V (span value: 1.5).

1. Press **MODE** for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



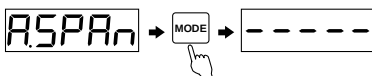
2. Use **▲/▼** to display "ASPA_n" and press **↵**. When the span value display blinks, you can set the value.



3. Use **▲/▼/▶** to set the span value and press **↵**. When "ASPA_n" appears, the setting is completed.



4. If you have no more function setting, press **MODE** to return to the measurement mode.



Note: The span value can be set within the range from 0.100 to 3.000.

2.11.2 Calculating the analog output shift value and span value

Assign the VG-measured value to the following expression to calculate the shift value and span value.

$$\text{Output value (V)} = \frac{1}{3} (\text{Span value} \times \text{VG-measured value} + \text{Shift value}) \text{ [mm]}$$

$$\text{Output value (V)} = \frac{25}{3} (\text{Span value} \times \text{V G-measured value} + \text{Shift value}) \text{ [inch]}$$

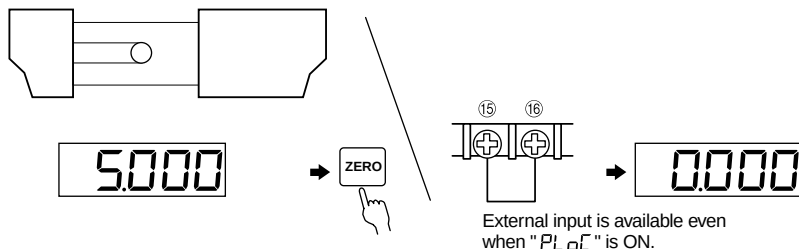
2.12 AUTO-ZERO Function

AUTO-ZERO automatically sets the current measured value to 0.000 using the front panel ZERO key or the external input. (The analog output value is equal to the analog shift value.)

This function enables the measured value of the reference target to be 0.000.

2.12.1 Setting AUTO-ZERO

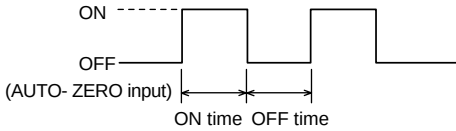
1. To set the AUTO-ZERO from the front panel, check that "PLOC" (panel lock function) is OFF.
2. Set the sensor head at the desired position and press ZERO. When "0000" appears, the setting is completed.
(AUTO-ZERO can also be set by shorting external input terminals 15 and 16).



Notes: When operating AUTO-ZERO through the front panel key or the external terminal, the setting value is stored in the system (even after the power is turned off). When "PLOC" is ON, AUTO-ZERO can be used through the external signal, but the setting value is not stored. If you often use AUTO-ZERO through the external signal, set "PLOC" to ON.

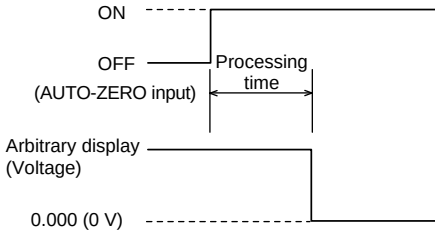
To reset AUTO-ZERO press ZERO for 3 seconds. AUTO-ZERO is reset and the shift value displayed returns to the initial value (0).

2.12.2 Minimum input time from the external terminal



ON time	1.3 ms
OFF time	1.3 ms

2.12.3 AUTO-ZERO processing time



Processing time	3.9 ms
-----------------	--------

2.12.4 AUTO-ZERO allowable range

AUTO-ZERO can be set from any numeric display value or analog output value except when the calculation is disabled ("----" appears) or the range over occurs ("FFFF" appears).

Note: If you use AUTO-ZERO with a target whose measured value exceeds 10.000, the decimal point shifts 1 digit to the right when the display value drops below "-9995".

-9995 → - 10.00

2.13 Setting the HOLD Function

The VG system can hold the display value through the external or internal synchronization.

2.13.1 Setting HOLD

OFF

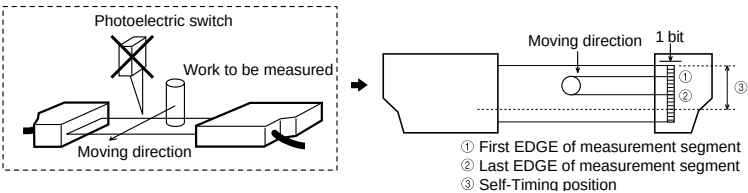
The measured value is displayed as is.

SELF.t Self-Timing function

Automatically takes timing (synchronizes) within the sensor at the moment when the target reaches the pre-specified position within the detecting range.

Within the detecting range from 0 to 35 mm, the position can be set in units of 1 mm.

Note: When measuring the target continuously on the line, this function is useful because no photoelectric switch or other external sensor is needed for timing.



Conventional method

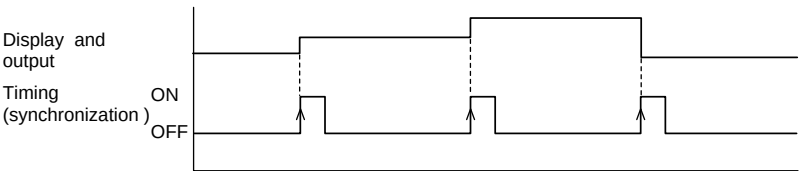
Using the VG Series

SXold SAMPLE HOLD function

Holds the display at the moment through the EDGE synchronous input from HOLD terminal (by short-circuiting between terminals No. 18 and No. 19).

2.13.2 Timing chart

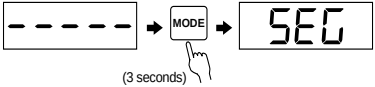
Display and output when using HOLD (Self-Timing function, SAMPLE HOLD function)



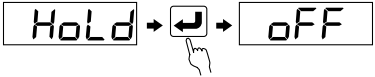
2.13.3 Setting Self-Timing

Example Perform Self-Timing when the first EDGE reaches 20 mm from the CCD bit 1 during measurement in the normal mode.

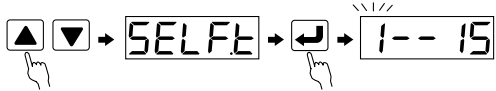
1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



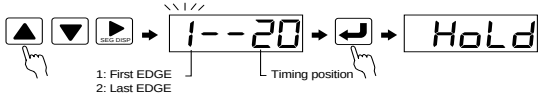
2. Use / to display "HoLD" and press . When the setting display blinks, you can set Self-Timing.



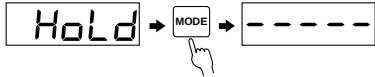
3. Use / to select "SELF t".



4. Use // to select the first EDGE or last EDGE of the segment to be measured, and set the position at which you want to take timing in units of mm (or 0.1 inch when the inch mode has been selected). Check that the setting value is correct and press  to complete the setting.



5. If you have no more function setting, press  to return to the measurement mode.



Note: When the HOLD or Self-timing function is set, the selected function indicator lights. Once the system starts measurement, the indicator goes off after each time interval (synchronization), which allows you to check that the function is activated.

Self-Timing position setting allowable range

mm	1 to 34 mm
Inch	0.1 to 1.3 inch

2.14 RS-232C

The VG system can communicate with the KP Series data printer, personal computers, and the KV Series programmable logic controller through the RS-232C port.

2.14.1 Communication protocol

Baud rate	300, 600, 1200, 2400, 4800, 9600 bps (selectable)
Data bit length	8 bits
Parity check	Even
Stop bit	1 bit
Data delimiter	CR, CR+LF, STX+ETX (selectable)

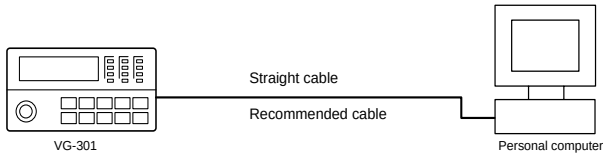
* You can select the setting only for the baud rate and data delimiter.

2.14.2 Connection example

Connecting to a personal computer

Baud rate: 300 to 9600

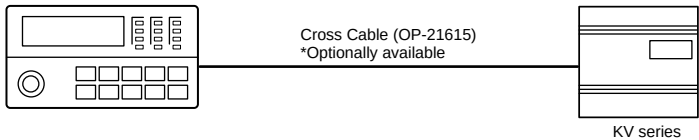
Data delimiter: CR, CR + LF



Connecting to KV Series

Baud rate: 9600

Data delimiter: STX + ETX



2.15 Setting the Tolerance Selection Method

Select between "Front" (front panel key operation) and "rEAR" (external tolerance select input) for the pre-registered 8 setting values.

2.15.1 Key operation

By pressing  repeatedly, the select No. is displayed sequentially.

2.15.2 External tolerance select input

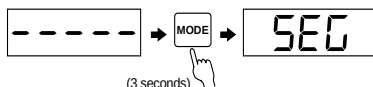
Call select No. using the combination of inputs to terminals Nos. 10, 11, and 12. The relationship between the select No. and the signal input to EXT 1 to 3 is shown below.

Select No.	1	2	3	4	5	6	7	8
EXT1	OFF	OFF	OFF	OFF	ON	ON	ON	ON
EXT2	OFF	OFF	ON	ON	OFF	OFF	ON	ON
EXT3	OFF	ON	OFF	ON	OFF	ON	OFF	ON

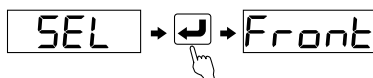
2.15.3 Setting the external tolerance select input

Example Set the external tolerance select "rEAR".

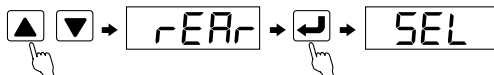
1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



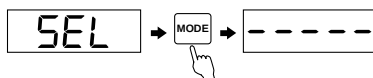
2. Use  to display "SEL" and press . When the select method setting is displayed, you can set the input method.



3. Use  to set the select method to "rEAR" and press  to complete the setting.



4. If you have no more function settings, press  to return to the measurement mode.

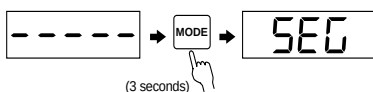


2.16 Setting the Panel Lock Function

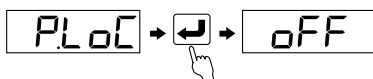
The panel lock function is used to disable front panel operation. When the panel lock function is turned ON, any key operation other than  is disabled. However, you can still check tolerance settings and segment position using //.

2.16.1 Setting the panel lock function

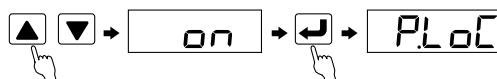
1. Press  for 3 seconds to enter the menu mode.
(If already in the menu mode, skip this step and go to step 2.)



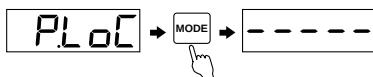
2. Use / to display "PLoC" and press . You can set the panel lock function.



3. Use / to display "on" and press return to complete the setting.



4. If you have no more function setting, press  to return to the measurement mode.



Note: To Reset the panel lock function and return to the menu mode, press  for at least 3 seconds.

Section 3

Specifications and Characteristics

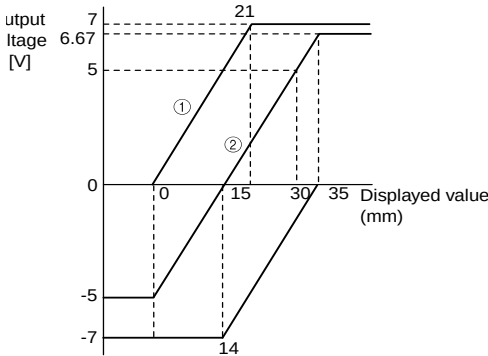
This section covers the output characteristics and specifications of the VG Series.

3.1 Analog Output

The VG series is equipped with an analog voltage output, enabling it to calculate various data and record measured data in conjunction with KEYENCE's RV3 series analog controller and a printer or plotter.

3.1.1 Output range

The analog output range is $\pm 7V$.



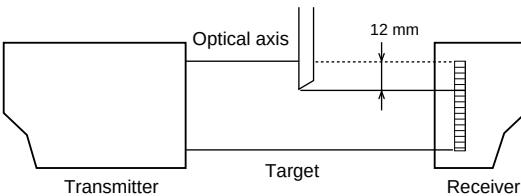
3.1.2 Relationship between displayed value and analog output

The relationship between the displayed value and the analog output is expressed below.

$$\text{Analog output} = \frac{\text{Displayed value (mm)}}{3} = \frac{25}{3} \text{ Display value (inches)}$$

(When the shift value of displayed value and analog output is "0", and the span value is "1")

Example: When measuring the width of the shadow in EDGE DARK mode



Displayed value: 12.000

$$\begin{aligned} \text{Current analog output} &= \frac{12.000}{3} \\ &= 4 \text{ V} \end{aligned}$$

Notes: Because the analog output shift value is "0" at shipment, voltage output shown in graph 1 is obtained. When the displayed value exceeds 21 mm, output is saturated.

When using 0 to 35 mm, assign "-15.000" to analog output shift value "ASXiF" (see graph 2).

3.2 RS-232C Code

Using the RS-232C interface, the VG system can communicate with external units such as computers. Also, data transfer and setting modification can be externally controlled. See “RS-232C” on page 36 and “Pin assignment diagram” on page 11.

3.2.1 Remote control

By transmitting the ASCII code from an external unit such as a computer, various settings of the VG system can be externally controlled.

* ASCII codes can be also transmitted.

3.2.2 Measured value output

RS-232C Code Table I

Function	Command ¹	Description
Measured value output	M	Outputs measured value once.
	4D H	
	N	Outputs measured value continuously.
	4E H	
	O	Stops continuous output of measured value.
	4F H	

1. Upper column: Character code
Lower column: ASCII code

When receiving an ASCII code listed in Code Table I, the VG system transmits the currently measured value once or continuously.

Notes: Ignores received commands other than “0” (4FH) during the continuous output.

Ignores “0” (4FH) received except during the continuous output.

Transmits the data once at the time of data registration (at timing signal input) when Self-Timing mode, or SAMPLE HOLD mode is used during the continuous output.

Data format

Outputs display value through the RS-232C. (Decimal point is not transmitted.)

During normal operation

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data
+	1	2	3	4	5	CR
—	0	9	8	7	0	CR

When calculation is disabled or range over occurs

1st data	2nd data	3rd data	4th data	5th data	6th data	7th data	
Z	Z	Z	Z	Z	Z	CR	(Display — — — —) or (Display F F F F)

3.2.3 Setting the functions

RS-232C Code Table II

Function	Command ¹	Description
HOLD	T	Turns HOLD function ON.
	54H	
RESET	P	Turns RESET function ON.
	50H	
RESET clear	U	Clears the RESET function.
	55H	
AUTO-ZERO	V	Transmits AUTO-ZERO.
	56H	
AUTO-GAIN	S	Transmits AUTO-GAIN.
	53H	

1. Upper column: Character code
Lower column: ASCII code

When an ASCII code (or corresponding character code) listed in Code Table II is transmitted, the specified function is activated.

Note: For the RESET operation, reset input terminal "CLOSE" has the first priority. RESET codes "P" (54H) and "U" (55H) are not activated when reset input terminal is set to CLOSE.

Data format

When receiving code

Normal operation

1st data	2nd data	3rd data	4th data	5th data
P	A	S	S	CR

When error occurs

1st data	2nd data	3rd data	4th data	5th data	6th data
E	R	R	O	R	CR

3.2.4 Function selectors

RS-232C Code Table III

Function	Command ¹	Description
Measurement mode selector	A 0	Normal mode
	41H 30H	
	A 1	EDGE #1 LIGHT mode
	41H 31H	
	A 2	EDGE #1 DARK mode
	41H 32H	
	A 3	EDGE #2 LIGHT mode
	41H 33H	
	A 4	EDGE #2 DARK mode
	41H 34H	
	A 5 m n 41H 35H m' n'	Segment specification ²
Number of Averaging measurements selector	B 1	1
	42H 31H	
	B 2	4
	42H 32H	
	B 3	16
	42H 33H	
	B 4	64
	42H 34H	
	B 5	256
	42H 35H	
	B 6	1024
	42H 36H	
	B 7	4096
	42H 37H	
Tolerance select	C 1	Tolerance No. 1
	43H 31H	
	C 2	Tolerance No. 2
	43H 32H	
	C 3	Tolerance No. 3
	43H 33H	
	C 4	Tolerance No. 4
	43H 34H	
	C 5	Tolerance No. 5
	43H 35H	
	C 6	Tolerance No. 6
	43H 36H	
	C 7	Tolerance No. 7
	43H 37H	
	C 8	Tolerance No. 8
	43H 38H	

Function	Command ^{3.}	Description
Setting value selector ^{2.}	D CR	Upper limit (High) value
	44H ^{2BH} _{2DH} 0DH	
	E CR	Lower limit (Low) value
	45H ^{2BH} _{2DH} 0DH	
	F CR	Display shift value
	46H ^{2BH} _{2DH} 0DH	
	G CR	Display span value
	47H 0DH	
	H CR	Analog output shift value
	48H ^{2BH} _{2DH} 0DH	
Timing input selector ^{4.}	I CR	Analog output span value
	49H 0DH	
	J 0	Timing OFF
	4AH 30H	
	J 1	SAMPLE HOLD ON
	4AH 31H	
	J 2 1	Self-Timing 1st
Panel lock selector	4AH 32H 31H	
	J 2 2	Self-Timing 2nd
	4AH 32H 32H	
	K 0	Panel lock OFF
Tolerance select input selector	4BH 30H	
	K 1	Panel lock ON
	4BH 31H	
Timing input selector ^{4.}	L 0	Input from front panel keys
	4CH 30H	
	L 1	Input from terminal block
Tolerance select input selector	4CH 31H	

1. Upper column: Character code

Lower column: ASCII code

2. $0 \leq m$ and $n \leq 9$, and $m < n$

m' and n' are ASCII codes corresponding to the character codes m and n , respectively.

3. is the ASCII code corresponding to the character code within the range from 0 to 9. The specification range includes high value, low value, and display shift value. Analog shift value is ± 99995 (The least significant digit must be 0 or 5). Display span value and analog span value are within the range from 0100 to 3000.

4. is 01 to 34 (01 to 13 in the inch mode).

When an ASCII code (or corresponding character code) listed in Code Table III is transmitted, the specified function is activated.

Data format

When receiving code

Normal operation

1st data	2nd data	3rd data	4th data	5th data
P	A	S	S	CR

When error occurs

1st data	2nd data	3rd data	4th data	5th data	6th data
E	R	R	O	R	CR

3.2.5 Information output

RS-232C Code Table IV

Function		Command ¹⁻	Description	Response format
Information output	Measurement mode information	RA	Normal	N CR
			EDGE #1 LIGHT mode	E 1 L CR
			EDGE #1 DARK mode	E 1 D CR
		52H 41H	EDGE #2 LIGHT mode	E 2 L CR
			EDGE #2 DARK mode	E 2 D CR
			Segment specification	S m n CR ²⁻
	Number of averaging measurements information	RB	1	1 CR
			4	4 CR
			16	16 CR
			64	64 CR
		52H 42H	256	256 CR
			1024	1024 CR
			4096	4096 CR
	Tolerance select No. information	RC	Tolerance No. 1	1 CR
			Tolerance No. 2	2 CR
			Tolerance No. 3	3 CR
			Tolerance No. 4	4 CR
		52H 43H	Tolerance No. 5	5 CR
			Tolerance No. 6	6 CR
			Tolerance No. 7	7 CR
			Tolerance No. 8	8 CR

Function		Command ¹	Description	Response format
Information output	Setting value information ³	R D b ⁴	Upper limit (High) value	□ □ □ □ □ CR
		52H 44H b		
		R E b ⁴	Lower limit (Low) value	□ □ □ □ □ CR
		52H 45H b		
		R F	Display shift value	□ □ □ □ □ CR
		52H 46H		
		R G	Display span value	□ □ □ □ CR
		52H 47H		
		R H	Analog output shift value	□ □ □ □ □ CR
		52H 48H		
		R I	Analog output span value	□ □ □ □ CR
		52H 49H		
	Timing input information	R J	OFF	OFF CR
			HOLD terminal	SH CR
		52H 4AH	Self-Timing	ST □ □ □ CR ⁵
	Alarm information	R K	Stability output	S - - - CR
			HI output	- H - - CR
		52H 4BH	GO output	- - G - CR
			LO output	- - - L CR
	Tolerance select input	R L	Front panel	F CR
		52H 4CH	Terminal block	R CR

1. Upper column: Character code

Lower column: ASCII code

2. $0 \leq m$ and $n \leq 9$, and $m < n$, where n is the specified segment No.

3. b is the ASCII code corresponding to the character code within the range from 0 to 9. The specification range includes high value, low value, and display shift value. Analog shift value is ± 99995 . (The least significant digit must be 0 or 5.) Display span value and analog span value is within the range from 0100 to 3000. (In the inch mode, analog span value is ± 99999 .)

4. b is the ASCII code corresponding to the character code within the range from 1 to 8.

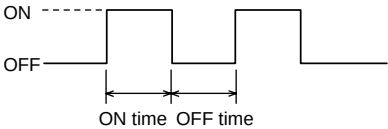
5. The first □ is the character code 1 or 2. The last two digits are 01 to 34 (01 to 13 in the inch mode).

When an ASCII code (or corresponding character code) listed in Code Table IV is transmitted, the specified function is activated.

3.3 Minimum Input Time and Output Response Time

3.3.1 Minimum input times

The minimum input time for the terminals (HOLD input, AUTO-ZERO input, AUTO-GAIN input, RESET input, and tolerance setting value selector input) is shown below.



ON time	1.3 ms
OFF time	1.3 ms

When each input terminal receives the input signal simultaneously, the operation priority is given as below.

RESET input → AUTO-ZERO input → HOLD input → AUTO-GAIN input → Tolerance selector input

Note: Use a switch sensor of non-voltage output type for the timing input terminal and other terminals. Also, the KEYENCE DC two-wire proximity switch EV Series (DC) can be connected. However, some DC two-wire proximity switches made by other manufactures may not activate VG inputs.

3.3.2 VG control output response time

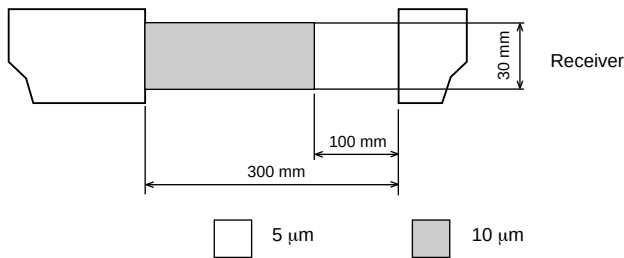
The VG control output response time is listed below.

Number of averaging measurements	Response time
1	3.9 ms
4	7.8 ms
16	23.4 ms
64	85.8 ms
256	668.2 ms
1024	2665 ms
4096	6658.6 ms

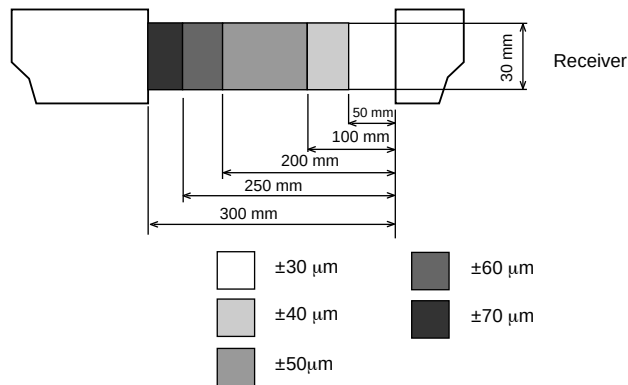
3.4 Measuring Area and Accuracy

The following example shows the accuracy area when the distance between the transmitter and the receiver is set to 300 mm.

Resolution (when the number of measurement for averaging is 16)



Linearity (when the number of measurement for averaging is 256)



Note: The above resolution data and linearity data are obtained by measuring a knife edge as the target.

3.5 Troubleshooting Guide

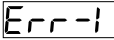
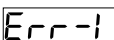
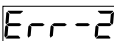
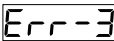
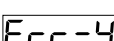
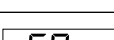
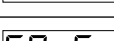
If any conditions occur that could be considered as equipment failure or malfunction, follow the inspection procedures given below. If equipment failure or malfunction still continues after the corrective action has taken, contact KEY-ENCE.

Problem	Details of inspection	Corrective action
"-----" is displayed.	Is the sensor head properly connected?	Connect the sensor head correctly.
	Terminals No. 4 and No. 5 on the terminal block are short-circuited?	Short-circuit between terminals No. 4 and No. 5.
	Is a standard edge (target) placed within the measuring area?	Check whether the edge is placed within the optical axis.
	Is there any dust or dirt on the sensor head filter glass?	Wipe off dust or dirt using a soft cloth.
	Has light quantity been adjusted?	Adjust light quantity.
Measured value is unstable (display is unstable). Resolution is unstable. Accuracy is not obtained.	Is equipment influenced by noise?	Keep the wiring or connection cable away from high-voltage lines or power lines.
	Is the system subject to vibration?	Minimize vibration near the measurement site.
	Is the number of measurement for averaging set at high rate?	Set a large value to the number of measurement for averaging unless extremely quick response time is required.
	Is equipment influenced by disturbance light?	Protect the sensor head transmitter/receiver surface from direct exposure to external light.
	Is there any dust or dirt on the sensor head filter glass?	Wipe off dust or dirt using a soft cloth.
	Has light quantity been adjusted?	Adjust light quantity.
	Is optical axis aligned?	Re-align optical axis.
	Is voltage output in proportion to displacement?	Calibrate output value using span adjustment function.
	Is the distance between transmitter and receiver or target and receiver large?	Set transmitter and receiver or target and receiver as close as possible unless otherwise is required.
	Is the target measurement position dispersed?	Maintain the stable measurement position.
Laser beam is not emitted.	(1) Is key-operated switch turned ON? (2) Are terminals No. 4 and No. 5 on the terminal block short-circuited?	Check (1) and (2).
Panel switch does not work.	Is panel lock set?	Set panel unlock (see Page 38).

3.6 Error Messages

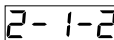
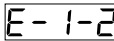
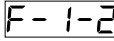
If an abnormality occurs during the measurement, the appropriate error number appears, which describes the possible cause of error. See the error message list below for proper troubleshooting.

Error message list

Display	Mode	Cause
	AUTO-GAIN	Laser is turned off.
	Measurement position display	Laser is turned off.
	Measurement position display	AUTO-GAIN has not been performed.
	AUTO-GAIN	Light quantity is insufficient, or target is set.
	Teaching	You were trying to set the upper limit value lower than lower limit value (or vice versa).
	Power-on	AUTO-GAIN has not been performed. ^{1.}
	Power-on	Backup memory is insufficient. ^{2.}

1. If "Ga in" appears again after you perform AUTO-GAIN and turn on the power, contact KEYENCE.
2. If this error occurs, contact KEYENCE.

Error message list in the segment mode

Display	Cause
	Normal condition
	Laser is not lit.
	More than 9 edges are placed.

Note: To clear the error display, press .

3.7 Specifications

Model	Sensor head	VG-036
	Controller	VG-301
Measuring area		35 mm x 300 mm
T-to-R distance		0 to 300 mm
Light source		Visible red semiconductor laser, wavelength: 670 nm, FDA: Class II / IEC: Class 1, Maximum output: 38 μ W, Pulse duration: 641 μ s
Light-receiving element		CCD 5000 bit, Scan time: 1.3 ms
Smallest detectable object¹		0.5 mm dia. opaque material
Resolution²		5 μ m (Number of measurements for averaging: 16)
Linearity²		$\pm 0.1\%$ of F.S. (F.S. = 30 mm) ³ .
Display resolution		5 μ m
Analog output	Voltage	± 7 V
	Resolution (ripple)	2 mV (number of averaging measurements: 4096)
	Impedance	100 Ω
Output⁴	Control	HI, GO, LO: NPN open-collector 100 mA, 40 V max.
	Self-timing	NPN open-collector 100 mA, 40 V max. (one-shot output time: 1.3 ms)
	Alarm (Stability)	NPN open-collector 100 mA, 40 V max. (N.C.)
Response time		3.9 ms (Number of measurements for averaging: 1)
Temp. fluctuation	Sensor head	0.01% of F.S./°C (F.S. = 30 mm)
	Controller	0.005% of F.S./°C (F.S. = 30 mm)
Control input		- Upper/lower limit select input - Reset input - AUTO-ZERO input - Laser remote input - AUTO-GAIN input - Hold input Note: All inputs are NPN open-collector or non-voltage contact signals.
Function		- Measured value display (Switched to upper/lower limit display) - Self-timing - Measurement mode selection - Measurement position display - Teaching - Self-diagnosis (intensity monitor) - Upper/lower limit selection - AUTO-GAIN (received light quantity adjustment) (8 sets of upper/lower limits are selectable.) - Scaling (displayed value, analog output value) - Number of averaging measurements (7-level selectable) - AUTO-ZERO
Interface		RS-232C
Power supply		24 VDC $\pm 10\%$, Ripple (P-P) 10% max.
Current consumption		330 mA max.
Enclosure rating (sensor head)		IP-60
Ambient light²		Incandescent lamp: 1000 lx max. Fluorescent lamp: 8000 lx max.
Ambient temperature		Sensor head: 0 to 40°C (32 to 104°F) Controller: 0 to 50°C (32 to 122°F) No freezing
Relative humidity		35 to 85%, No condensation
Vibration		10 to 55 Hz double amplitude in X, Y and Z directions, 2 hours respectively
Material		Sensor head: Die-cast aluminium/Controller: Polycarbonate
Weight (including cable)		Sensor head: approx. 360 g (transmitter), approx. 320 g (receiver)/Controller: approx. 800 g

1. Typical data obtained when the T-to-R distance was 100 mm and the receiver-to-target distance was 50 mm.

2. Typical data obtained when the T-to-R distance was 100 mm, the receiver-to-target distance was 50 mm and a knife edge was used to interrupt the laser beam.

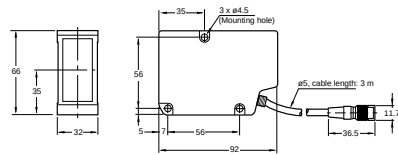
3. F.S (= 30 mm) indicates the range resulting from 2.5 mm subtraction from each end of the 35 mm measuring range.

3.8 Dimensions

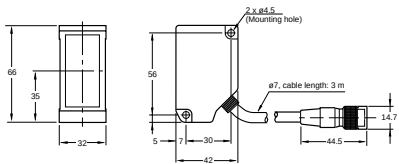
Sensor head

Unit: mm

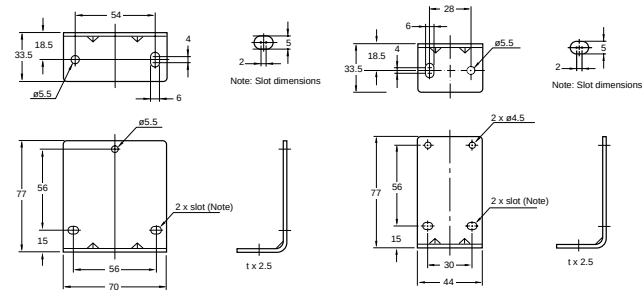
Transmitter



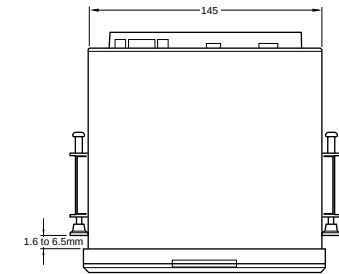
Receiver



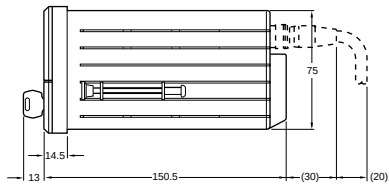
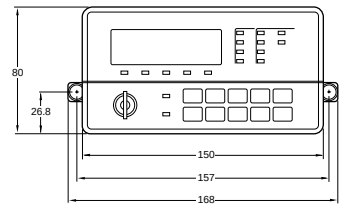
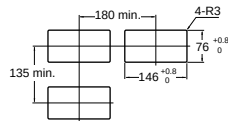
Sensor head mounting bracket



Controller



Panel cut dimensions



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