KEYENCE

96M0558

Instruction Manual

High-speed, High-Accuracy
Digital Displacement Sensor

EX-V Series

Safety Precautions

This instruction manual describes the operation and function of the EX-V. Read this manual carefully to ensure safe use and maximum performance from your EX-V.

Symbols

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

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

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

Note: Provides additional information on proper operation.

General precautions

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

Warning and cautions specific to the EX-V Series

Operating environment

For optimum performance of the EX-V, always maintain a proper operating environment.

⚠ CAUTION

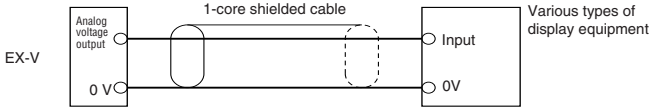
To prevent malfunction, do not install the EX-V in the following places:

- ***Places directly exposed to sunlight.***
- ***Places where the ambient temperature drops below 0°C or exceeds 50°C.***
- ***Places where the relative humidity drops below 35% or exceeds 85%.***
- ***Places where temperature fluctuations may cause condensation.***
- ***Places where the EX-V may be exposed to corrosive or flammable gas.***
- ***Places exposed to airborne dust or corrosive substances such as salt or metal particles.***
- ***Places where the EX-V may be subjected to vibration or impact.***
- ***Places where water, oil or chemicals may splash the EX-V .***
- ***Places where the EX-V may be affected by noise interference.***

Connecting the EX-V to analog input equipment

Take the following countermeasures to prevent the EX-V from malfunctioning due to noise interference.

Note 1: Use a 1-core shielded cable for the output line. When using an analog voltage signal, do not use a cable longer than 10 m. If the cable needs to be longer than 10 m, convert the voltage signal into a current signal.



Note 2: Keep the wiring and connection cables separate.
Note 3: Isolate the wiring and connection cables from high-voltage or power lines; otherwise noise may cause the EX-V to malfunction.

MEMO

How this manual is organized

Chapter 1 **Preparation**

Describes the package contents, and explains the mounting and adjusting procedures of the controller and sensor head.

Chapter 2 **Quick Guide to Basic Mode Operation**

Explains the kinds of the measurement modes and the selection procedure. Selecting the mode best suited to your detection purpose allows you to quickly operate the sensor by easy setting.

Chapter 3 **Use of Common Functions**

Explains the functions common to the respective modes and the setting procedure.

Chapter 4 **Use of Data Processing Functions**

Explains the setting and operation procedures of the respective functions.

Chapter 5 **Troubleshooting**

Explains the error messages displayed when an error has occurred, and countermeasures to be taken.

Chapter 6 **Specifications and Dimensions**

Read as necessary.

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Read as necessary.

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This index helps you quickly find proper EX-V function/operation according to your purpose.
Select action or operation you need to find the proper page and description.

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Chapter 1

Preparation

Describes the package contents, and explains the mounting and adjusting procedures of the controller and sensor head.

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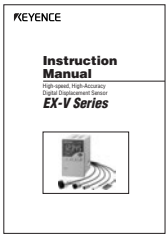
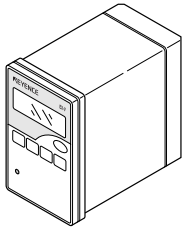
1.1 Checking the Package Contents

The EX-V series package includes the following parts and equipment. Check that all the parts and equipment are included in the package.

• Instruction manual: 1



• Controller: 1



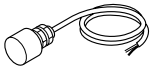
• Sensor head:
Ordered one of the following

EX-305V

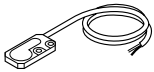
EX-110V

EX-416V

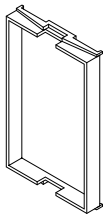
EX-422V



EX-614V



• Panel mounting frame: 1



1.2 Part Names and Functions

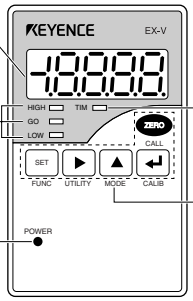
This section explains the part names and functions.

■ Controller

Display
Displays the measured value. The value is displayed in green when the measured value is within the tolerance range. The value is displayed in red when the measured value is out of the tolerance range.

Comparator output indicators
Illuminates when the comparator output (HIGH, GO, LOW) is turned on.
Indicates the type of displayed tolerance limit value when setting or calling the tolerance limit value.

POWER indicator
Illuminates green:
When operation is normally performed
Illuminates red:
When the control output is reset to OFF



TIMING input indicator
Illuminates when a timing signal is input.

Operation keys

■ Displays and functions

Display	Function
Numeric value (±19.999)	The operation result is displayed as a numeric value.
FFFF (HIGH output: ON, Analog voltage output: +5.8 V)	"FFFF" is displayed when the operation result is above the display range.
-FFFF (LOW output: ON, Analog voltage output: -5.8 V)	"-FFFF" is displayed when the operation result is below the display range.
- - - - (HI, GO and LOW outputs: OFF, Analog voltage output: 0V)	There is no operation result to be displayed.

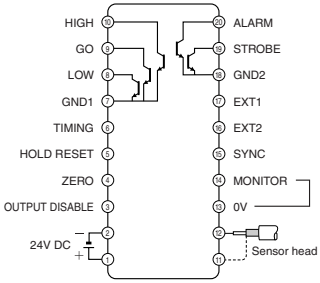
■ Operation keys

Key	Function
ZERO	• Resets the value on the display to "0000" (zero). If the offset function is selected, the value on display is reset to the offset value. (*For details, see page 40.*) • Initializes all function settings during function setting.
SET FUNC	• Calls the tolerance limit setting mode. (*For details, see page 25.*) • Calls the function setting modes ("A" to "D") to perform setting of each function. (*For details, see pages 48, 57, 64, and 74.*)
CALL ↵ CALIB	• Calls the adjustment mode. • Saves each setting. • Cancels each error message. • Calls the tolerance limit value during measurement. (*For details, see page 27.*)
▶ UTILITY	• Selects each setting. • Calls the common function selection modes ("E" to "J").
▲ MODE	• Sets each function number. • Calls the measurement mode.

1.3 Terminal Names and Connections

This section explains the terminal names and functions.

EX-V□□ NPN type

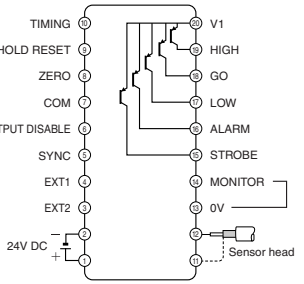


No.	Terminal name	Function
1, 2	Power supply	24 VDC ±10%
3	Comparator output disable input OUTPUT DISABLE	Resets the comparator output to OFF when this terminal is short-circuited to the grounding terminal.
4	Auto-zero input ZERO	Resets the value on the display to "0000" (offset value when the offset function is selected) when this terminal is short-circuited to the grounding terminal.
5	Hold-reset input HOLD RESET	When this terminal is short-circuited to the grounding terminal: 1. Cancels the hold state of the open collector output. 2. Resets each hold mode data.
6	Timing input TIMING	Inputs a timing signal when this terminal is short-circuited to the grounding terminal.
7	Grounding GND1	
8	LOW output LOW	Outputs when the displayed value is lower than the LOW limit value.
9	GO output GO	Outputs when the displayed value is within the tolerance range.
10	HIGH output HIGH	Outputs when the displayed value is higher than the HIGH limit value.
11, 12	Sensor head connection	Connects the sensor head.
13, 14	Monitor output MONITOR	Outputs ±5 V in proportion to the displayed value.
15	Synchronous input SYNC	Stops sensor head oscillation and holds the output when this terminal is short-circuited to the grounding terminal.
16, 17	External setting input EXT1,2	Calls the preset four kinds of tolerance limit values. This input is enabled when the panel-lock function is set to ON.
18	Grounding GND2	
19	Strobe input STROBE	Turns ON during the sampling period. This terminal is enabled only when the internal trigger function is used. (N.O.)
20	Alarm output ALARM	Outputs when the sensor head has open circuit. (N.C.)

⚠ CAUTION

Since the power GND, GND1 and GND2 are connected through choke coils, make sure so that no potential difference develops.

EX-V□□P PNP type



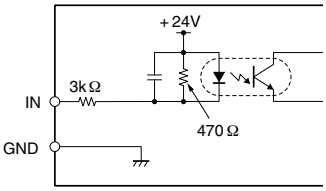
No.	Terminal name	Function
1, 2	Power supply	24 VDC ±10%
3, 4	External setting input EXT1/2	Calls the preset four kinds of tolerance limit values. This input is enabled when the panel-lock function is set to ON.
5	Synchronous input SYNC	Stops sensor head oscillation and holds the output when the specified voltage is applied to this terminal.
6	Comparator output disable input OUTPUT DISABLE	Resets the comparator output to OFF when the specified voltage is applied to this terminal.
7	Common COM	A common terminal for input.
8	Auto-zero input ZERO	Resets the value on the display to " 0000" (offset value when the offset function is selected) when the specified voltage is applied to this terminal.
9	Hold-reset input HOLD RESET	When the specified voltage is applied to this terminal: 1. Cancels the hold state of the open collector output. 2. Resets each hold mode data.
10	Timing input TIMING	Inputs a timing signal when the specified voltage is applied to this terminal.
11, 12	Sensor head connection	Connects the sensor head.
13, 14	Monitor output MONITOR	Outputs ±5 V in proportion to the displayed value.
15	Strobe input STROBE	Turns ON during the sampling period. This terminal is enabled only when the internal trigger function is used. (N.O.)
16	Alarm output ALARM	Outputs when the sensor head has open circuit. (N.C.)
17	LOW output LOW	Outputs when the displayed value is lower than the LOW limit value.
18	GO output GO	Outputs when the displayed value is within the tolerance range.
19	HIGH output HIGH	Outputs when the displayed value is higher than the HIGH limit value.
20	Plus common V1	Applies the voltage that is supplied to the output, between V1 = DC-. +30 V or less.

1.4 Input/output Circuits

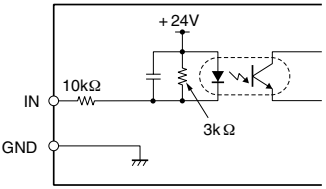
EX-V□□ NPN type

■ Input circuit

TIMING, HOLD RESET

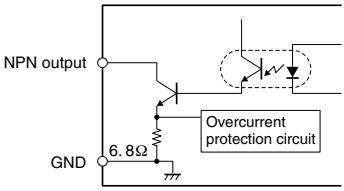


ZERO, EXT1 • 2, OUTPUT DISABLE, SYNC



■ Output circuit

HIGH, GO, LOW, STROBE, ALARM

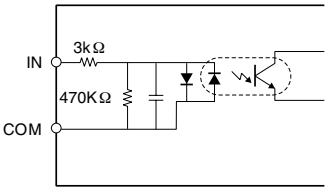


NPN open-collector, 40 V, 100 mA max.

EX-V□□P PNP type

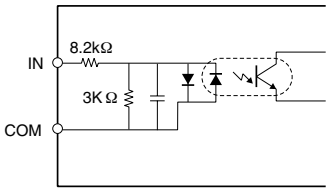
■ Input circuit

TIMING, HOLD RESET



ON voltage:
10 V or more
ON current:
3 mA or more
OFF voltage:
5 V or less
OFF current:
1.5 mA or less

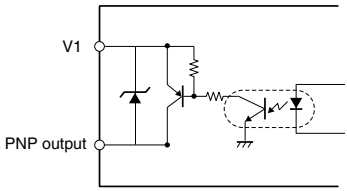
ZERO, EXT1 • 2, OUTPUT DISABLE, SYNC



ON voltage:
10 V or more
ON current:
1.5 mA or more
OFF voltage:
3 V or less
OFF current:
0.1 mA or less

■ Output circuit

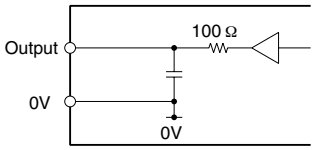
HIGH, GO, LOW, STROBE, ALARM



PNP open-collector, 30 V, 100 mA max.

Common between NPN type and PNP type

■ MONITOR output



■ Settings of the external setting input terminals EXT1 and EXT2

Terminal name / Tolerance limit value No.	EXT1	EXT2
0	OFF	OFF
1	ON	OFF
2	OFF	ON
3	ON	ON

For the NPN type, ON is when the EXT terminal is short-circuited to the GND terminal. For the PNP type, ON is when a voltage is applied across the EXT terminal and the COM terminal.

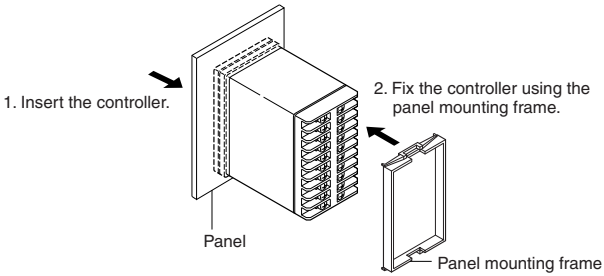
1.5 Mounting

This section explains the mounting procedure for the controller and sensor head and the wiring connections.

1.5.1 Mounting and dismounting the controller

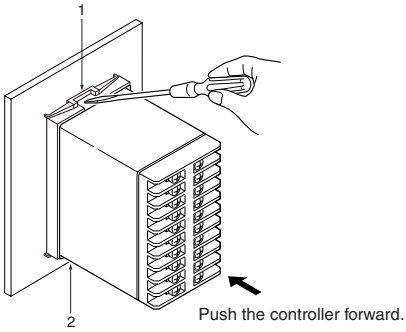
Mounting

Insert the controller from the front of the panel and fix it using the panel mounting frame.



Dismounting

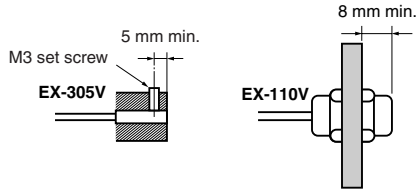
While raising the catches at sections 1 and 2 with a flat blade screwdriver, push the controller forward from the back.



1.5.2 Mounting the sensor head

Mounting

- Tighten the EX-305V set screw and EX-110V nut away from the tip of the sensor head as shown in the figure.



- Referring to the measuring distance in the table below, determine the distance between the tip of the sensor head and target.

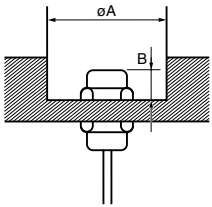
Model	Measuring distance (mm)
EX-305V	1
EX-110V	2
EX-416V	5
EX-422V	10
EX-614V	4

Note: After making the adjustment, do not change the position of the nut or screw. If the position is changed, the output characteristics may change even when the nut or screw is positioned in the range shown in the figure.

Flush-mounting

To flush-mount the sensor head in a metal base, follow the guidelines given in the table below.

Distance (mm) / Model	A	B
EX-305V	10	9
EX-110V	12	9
EX-416V	35	10
EX-422V	55	20
EX-614V	16 x 32	5

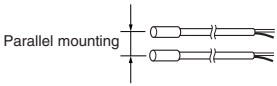


* The table above shows the dimensions to use when the metal base is iron.
* The table above shows the dimensions to satisfy the specifications when the sensor head is flush-mounted after the output characteristics have been adjusted with no metal present around the head.

When mounting two or more sensor heads of the same model in parallel

- The sensor may not output the correct voltage due to mutual interference. Make sure that the distance between sensor heads adjacent to each other is larger than the values shown in the table below. (This allows the display resolution specification to be satisfied when the number of measurements to average is "64".)
- When two sensor heads are mounted in parallel, mutual interference can be prevented by alternately oscillating the sensor heads using the synchronous input terminal (☞ *page 4*).

Distance (mm) / Model	Parallel mounting
EX-305V	80
EX-110V	300
EX-416V	650
EX-422V	310
EX-614V	245



Tightening torque

To tighten the EX-305V set screw, apply a torque of 0.2 N•m or less.
To tighten the nut of the other sensor heads, apply a torque shown in the table below or less.

EX-110V	EX-416V	EX-422V
10 N• m max.	20 N• m max.	10 N• m max.

⚠ CAUTION

- ***If the applied tightening torque exceeds the specified one, the sensor head may be deformed or malfunction.***
- ***If the sensor cable is installed in the same conduit as high voltage lines or power lines, the sensor may malfunction. Be sure to keep the wiring separate.***

Note: Do not change the sensor cable length (3 m). If the cable is extended or cut, the characteristics will change.

1.6 Adjustment

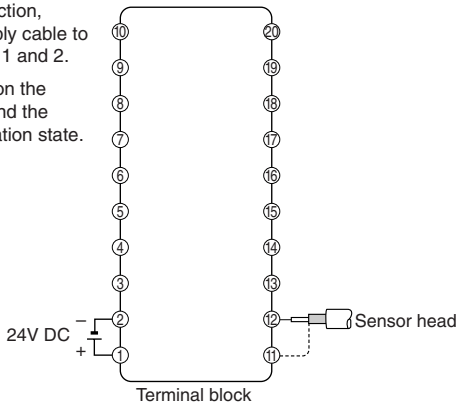
Though the EX-V series has been factory-adjusted, follow the procedure described below to adjust the sensor using your actual target in order to satisfy the specifications. When the sensor head has been replaced, be sure to make this adjustment.

1.6.1 Connection

1. Connect the core and shielding wires of the sensor head to sensor head connection terminals 11 and 12 of the controller.

2. After making the connection, connect the power supply cable to power supply terminals 1 and 2.

   The POWER indicator on the controller illuminates, and the sensor enters the operation state.

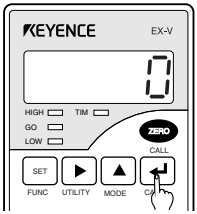


Note: Let the sensor warm up for 30 minutes or more after supplying power to it, and then start the adjustment.

1.6.2 Adjusting the output characteristics

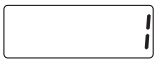
1. Press the ↵ key for at least 2 seconds.

   The sensor displays "0" and enters the adjustment mode.



2. With no metal object present around the sensor head, press the ↵ key.

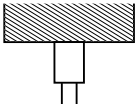
   The sensor displays "1" and moves to the next setting step.



Note 1: Do not touch the metal area of the sensor head with your hand.

Note 2: Make sure that no metal object is present within a radius of 15 centimeters around the sensor head.

3. Bring the sensor head in contact with the target.

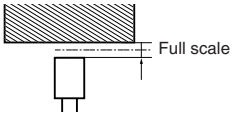


4. Press the ↵ key.

   The sensor displays "2" and moves to the next setting step.

5. Move the sensor head.

   Move the sensor head so that the distance between the sensor head and target is the full scale of the measuring distance (maximum distance) of the sensor head.

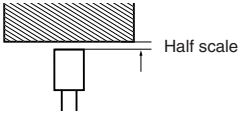


6. Press the ↵ key.

   The sensor displays "3" and moves to the next setting step.

7. Move the sensor head.

   Move the sensor head so that the distance between the sensor head and target is half the measuring distance (half scale).



8. Press the ↵ key.

   The sensor displays "End".

9. After pressing the ↵ key, restart the sensor.

   The sensor starts measurement.

Reference: To stop the adjustment, press the SET key. Then, the sensor starts measurement without making the adjustment.

Note: If the distance between the sensor head and target is improperly adjusted during the adjustment, "Err 6" is displayed. Press the ↵ key to cancel the error, and then readjust the distance.

Chapter 2

Quick Guide to Basic Mode Operation

Explains the kinds of the measurement modes and the selection procedure. Selecting the mode best suited to your detection purpose allows you to quickly operate the sensor by easy setting.

2.1 Measurement Modes 12

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2.1.2 Eccentricity/vibration mode 12
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2.2.2 Setting the eccentricity/vibration mode 18
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2.4 Tolerance Limit Value Setting 25

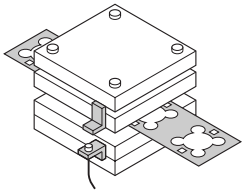
2.5 Checking the Tolerance Limit Values (Calling the tolerance limit values) 27

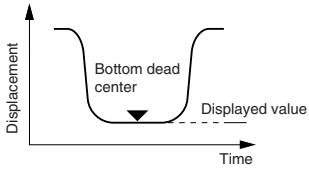
2.1 Measurement Modes

The EX-V series provides the following four measurement modes: "Bottom-dead-center mode", "Eccentricity/vibration mode", "Thickness/gap mode" (which are basic modes for quick operation), and "Manual mode" (which allows users to perform setting as desired). This section explains the major functions of each mode.

2.1.1 Bottom-dead-center mode

This mode is used to measure the displacement of the origin position of a machine with stroke movements such as a press. When the displacement of the bottom dead center or origin position is out of the preset tolerance range, the sensor outputs an Alarm signal.



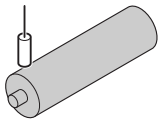


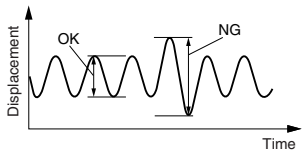
Major applications

- Detecting the bottom dead center position of a press
- Detecting the bottom dead center position of a press-fit machine
- Detecting the bottom dead center position of a welding machine
- Pressure control for a injection molding machine
- Measuring the depth of the recess on a piston head

2.1.2 Eccentricity/vibration mode

This mode is used to measure the roller eccentricity or abnormal machine vibration. When the amplitude of the runout or vibration is larger than the preset tolerance limit value, the sensor outputs an Alarm signal.



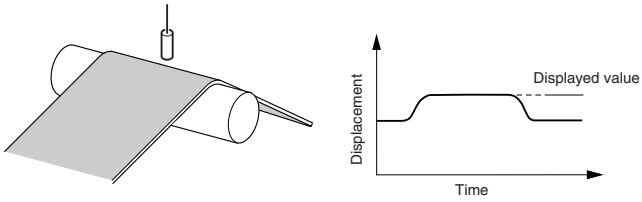


Major applications

- Measuring roller eccentricity
- Measuring surface plate runout
- Detecting runout due to improper chucking
- Measuring drill bit eccentricity

2.1.3 Thickness/gap mode

This mode is used to measure target thickness or gap with a direct reading value. When the thickness or gap is larger or smaller than the preset upper or lower value for the tolerance limit, the sensor outputs an Alarm signal.



Major applications

- Measuring hoop material thickness
- Checking grindstone abrasion
- Thickness control during polishing ceramic components

2.1.4 Manual mode

In addition to the modes above, the manual mode is available. The manual mode provides the following six data processing modes to allow adaptable measurement. For details, see pages that describe each data processing mode.

Data processing mode	Function	Reference page
Normal measurement	Displays/outputs the measured value continuously.	76
Peak hold	Measures the maximum value during a specified period.	76
Bottom hold	Measures the minimum value during a specified period.	78
Peak-to-peak hold	Measures the difference between the maximum and minimum values during a specified period.	79
Sample hold	Measures the value at a specified time.	81
Average hold	Measures the simple average of measured values during a specified period.	82

2.2 Quick Guide to Basic Mode Operation

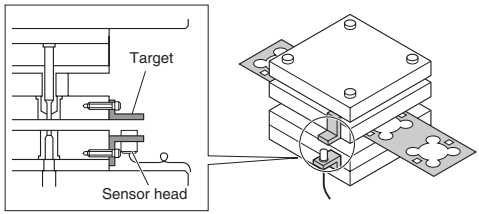
This section describes the major measurement modes and an easy setting method.

2.2.1 Setting the bottom-dead-center mode

The following example explains how to mount the EX-V series to a press.

The basic operation is the same when mounting the EX-V series to other devices. Be sure to adjust the output characteristics before performing the following procedure. (⇨ *Refer to page 9.*)

1. Secure the sensor head to the lower die of the press.
   - Referring to the figure below, prepare the sensor head mounting jig and a target.
   - *Refer to pages 7 and 8 for the position of the sensor head nut and the tightening torque.*



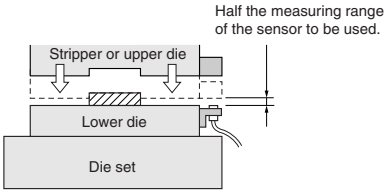
Note: Be sure to use an IRON target with sufficient area for detection. (⇨ *p.95*)

Reference: When the comparator output is already connected to the emergency stop or another input for the facility, short-circuit the OUTPUT DISABLE input (terminal ③) and grounding terminal (terminal ⑦) to disable the comparator output before making the adjustment.

* After making the adjustment, be sure to disconnect these terminals to enable the comparator output.

2. Adjust the distance between the sensor head and target.

   Move the press an inch at a time and lower the stripper (or upper die) to the bottom dead center position. (Refer to the figure below.)



   Adjust the distance between the sensor head and target so that the distance between them is about half the measuring distance when the stripper is in the bottom dead center position. The controller's display shows a value close to the half scale.

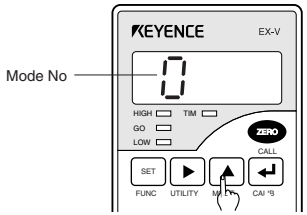
In the case of the EX-305V, the value is close to "0.5".

* The distance between the sensor head and target should be more than the full scale when the stripper is in the top dead center position.

Sensor model	Measuring distance (mm) (Full scale)	Half scale (mm)
EX-305V	1	0.5
EX-110V	2	1
EX-416V	5	2.5
EX-422V	10	5
EX-614V	4	2

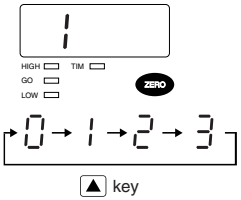
3. Press the ▲ key for at least 2 seconds.

   The sensor enters the mode setting state and displays the mode number.



4. Press the ▲ key to display "1" which indicates the "bottom-dead-center" mode.
   - Pressing the ▲ key changes the mode number sequentially.

Mode No.	Measurement mode
0	Manual
1	Bottom-dead-cente
2	Eccentricity/vibration
3	Thickness/gap



   - The measurement mode is factory-set to manual.

   For the initial setting of each measurement mode, refer to "4.1 Table of Data Processing Functions" on page 46.

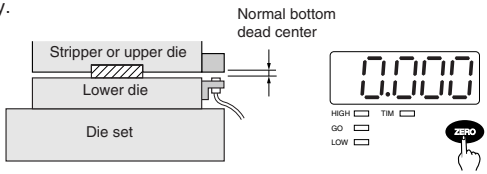
5. Press the ↵ key to save the measurement mode setting.

   The sensor returns to the measurement state.

Note: Changing the measurement mode initializes all preset values except for the tolerance limit values.

6. Activate the machine and check the bottom dead center position during normal operation. Press the [ZERO] key to set this position as the reference point.

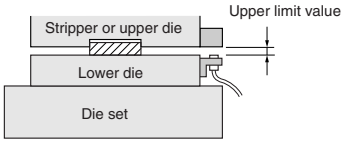
   When the [ZERO] key is pressed, "0.000" appears on the measured value display.



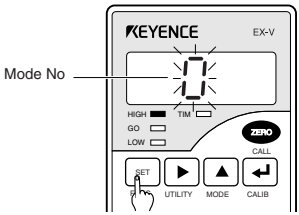
Reference: To compensate for the slight variation in the bottom dead center position at press startup or the influence of temperature fluctuation, refer to "Previous value comparison function [*d*]" on page 56.

7. Set the upper value for the tolerance limit.

   For a press, set the threshold value to the amount of the rise of the bottom dead center due to swarf.

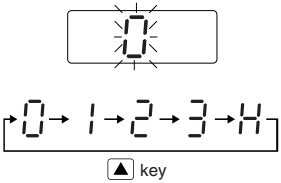


   1) Press the [SET] key.
      - The sensor enters the tolerance limit setting mode.
      - The setting number is displayed.



Note: Press the [SET] key for a short time. When the key is pressed for 2 seconds or longer, the sensor enters the function setting mode and displays "AbCd". If you accidentally put the sensor into the function setting mode, press the [SET] key again to return to the measurement state.

   2) Press the [▲] key to display the desired setting number.
      - Pressing the [▲] key changes the setting number sequentially.
      - "H" indicates the hysteresis setting. (⇨ *Refer to page 85.*)



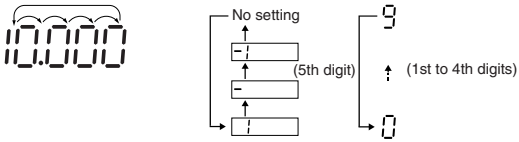
Reference: Four kinds of tolerance limit values ("0" to "3") can be saved in the memory. The registered setting numbers can be switched using external signals. (⇨ *Refer to page 4.*)

   3) Press the [↵] key.
      - The sensor automatically enters the HIGH limit value setting mode.
      - The setting value is displayed in red and the HIGH indicator illuminates.

4) Press the ▶ or ▲ key to display the desired value.

- Pressing the ▶ key changes the flashing digit to the right.

- Pressing the ▲ key changes the value.
- All digits flash when the fifth digit and sign can be changed.



Example

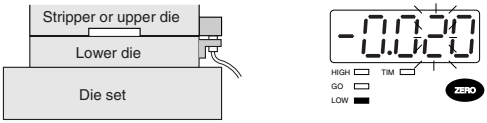
When setting the tolerance to +20 μm, specify "0020".

5) Press the ↵ key.

The HIGH limit setting value is saved. The sensor automatically enters the LOW limit value setting mode.

8. Set the lower value for the tolerance limit and press the ↵ key.

- For a press, set the threshold value to the amount of the lowering of the bottom dead center due to the absence of a target.
- Set the LOW limit value using the same procedure as in steps 7 3) and 4), and press the ↵ key to save the value.



Note 1: The output is disabled during the tolerance limit value setting. When the output is already on, however, the output is retained.

Note 2: Pressing the ↵ key does not save the changes if [HIGH setting value – Hysteresis] is smaller than [LOW setting value + Hysteresis]. In this case, "Err 1" is displayed. Press the ↵ key again to cancel the error, and then specify the correct values.

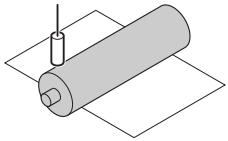
2.2.2 Setting the eccentricity/vibration mode

The following example explains the procedure for roller eccentricity measurement.

The basic operation is the same when mounting the EX-V series to other devices. Be sure to adjust the output characteristics before performing the following procedure (☞ *page 9*).

1. Mount the sensor head to the machine.

☞ *For the sensor head mounting procedure, read "Mounting the sensor head" (pages 7 and 8).*



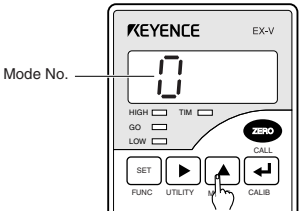
Note: Be sure to use an IRON target with sufficient area for detection. (☞ *page 95*)

Reference: When the comparator output is already connected to the emergency stop or another input for the facility, short-circuit the OUTPUT DISABLE input (terminal 3) and grounding terminal (terminal 7) to disable the comparator output before making the adjustment.

* After making the adjustment, be sure to disconnect these terminals to enable the comparator output.

2. Press the ▲ key for at least 2 seconds.

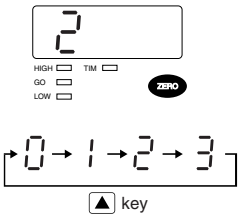
   The sensor enters the mode setting state and displays the mode number.



3. Press the ▲ key to display "2" which indicates the "eccentricity/vibration" mode.

   • Pressing the ▲ key changes the setting number sequentially.

Mode No.	Measurement mode
0	Manual
1	Bottom-dead-center
2	Eccentricity/vibration
3	Thickness/gap



- The measurement mode has been factory-set to manual.

For the initial setting of the functions for each measurement mode, refer to "4.1 Table of Data Processing Functions" (page 46).

4. Press the [↵] key to save the measurement mode setting.

   The sensor returns to the measurement state.

Note: Changing the measurement mode initializes all preset values except for the tolerance limit values.

5. Activate the machine and check the runout value during normal operation.

   The value displayed in this step is the runout per cycle.

6. Set the upper value for the tolerance limit.

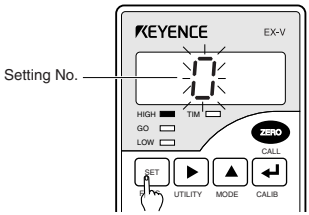
   Calculate the upper limit value by adding the upper limit value of the required tolerance to the value displayed during normal operation, and set the value as the HIGH limit value.

Example

When the runout value during normal operation is "10 μm" and the tolerance is "+30 μm", set the HIGH limit value to "0.040". When the runout value exceeds "40 μm", the comparator output is turned on.

1) Press the [SET] key.

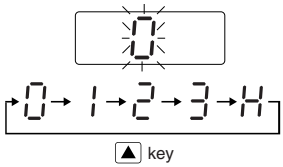
   - The sensor enters the tolerance limit setting mode.
   - The setting number is displayed.



Note: Press the [SET] key for a short time. When the key is pressed for 2 seconds or longer, the sensor enters the function setting mode and displays "RbCd". If you accidentally put the sensor into the function setting mode, press the [SET] key again to return to the measurement state.

2) Press the [▲] key to display the desired setting number.

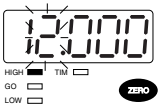
   - Pressing the [▲] key changes the setting number sequentially.
   - "H" indicates the hysteresis setting (*page 85*).



Reference: Four kinds of tolerance limit values ("0" to "3") can be saved in the memory. The registered setting numbers can be switched using external signals (*page 4*).

3) Press the ↵ key.

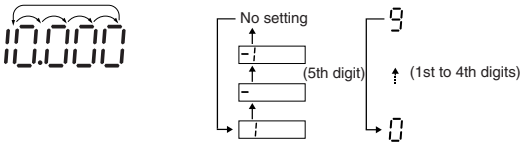
- The sensor automatically enters the HIGH limit value setting mode.
- The setting value is displayed in red and the HIGH indicator illuminates.



4) Press the ▶ or ▲ key to display the desired value.

- Pressing the ▶ key changes the flashing digit to the right.

- Pressing the ▲ key changes the value.
- All digits flash when the fifth digit and sign can be changed.



5) Press the ↵ key.

The HIGH limit setting value is saved. The sensor automatically enters the LOW limit value setting mode.

6) Press the ↵ key again.

7. Activate the machine to check whether the comparator output correctly works according to the tolerance limit setting values.
   - The GO comparator output indicator on the controller illuminates when the measured value is within the tolerance range. The HIGH indicator illuminates when the measured value is higher than the upper limit value. The LOW indicator illuminates when the measured value is lower than the lower limit value.
   - To perform fine adjustment of the tolerance limit values, repeat steps 5) and 6) described above.

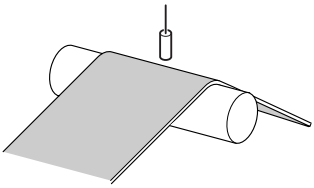
2.2.3 Setting the thickness/gap mode

The following example explains the procedure for sheet material thickness measurement.

The basic operation is the same when mounting the EX-V series to other devices. Be sure to adjust the output characteristics before performing the following procedure (*page 9*).

1. Mount the sensor head to the machine.

   For the sensor head mounting procedure, read "Mounting the sensor head" (pages 7 and 8).



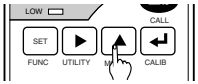
Note: Be sure to use an IRON target with sufficient area for detection. (*page 95*)

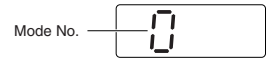
Reference: When the comparator output is already connected to the emergency stop or another input for the facility, short-circuit the OUTPUT DISABLE input (terminal 3) and grounding terminal (terminal 7) to disable the comparator output before making the adjustment.

* After making the adjustment, be sure to disconnect these terminals to enable the comparator output.

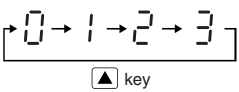
2. Press the ▲ key for at least 2 seconds.

   The sensor enters the mode setting state and displays the mode number.





3. Press the ▲ key to display "3" which indicates the "thickness/gap" mode.
   - Pressing the ▲ key changes the setting number sequentially.



Mode No.	Measurement mode
0	Manual
1	Bottom-dead-center
2	Eccentricity/vibration
3	Thickness/gap

   - The measurement mode has been factory-set to manual.

   For the initial setting of the functions for each measurement mode, refer to "4.1 Table of Data Processing Functions" (page 40).

4. Press the ↵ key to save the measurement mode setting.

   The sensor returns to the measurement state.

Note: Changing the measurement mode initializes all preset values except for the tolerance limit values. If you accidentally put the sensor into the function setting mode, press the SET key again to return to the measurement mode.

5. Set the upper value for the tolerance limit.

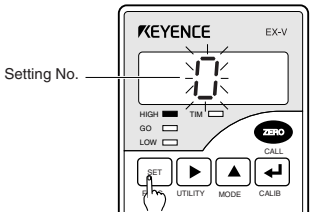
   - Place the reference target in the correct measuring position and check the normal thickness measurement.
   - Calculate the upper limit value by adding the upper limit value of the required tolerance to the normal thickness measurement, and set the value as the HIGH limit value.

Example

When the normal thickness measurement is "1 mm" and the tolerance is "±0.1 mm", set the HIGH limit value to "1.100" and the LOW limit value to "0.900".

1) Press the SET key.

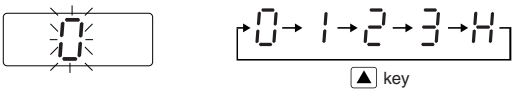
   • The sensor enters the tolerance limit setting mode.
   • The setting number is displayed.



Note: Press the SET key for a short time. When the key is pressed for 2 seconds or longer, the sensor enters the function setting mode and displays "RbCd". If you accidentally put the sensor into the function setting mode, press the SET key again to return to the measurement state.

2) Press the ▲ key to display the desired setting number.

   • Pressing the ▲ key changes the setting number sequentially.
   • "H" indicates the hysteresis setting (*page 85*).



Reference: Four kinds of tolerance limit values ("0" to "3") can be saved in the memory. The registered setting numbers can be switched using external signals (*page 4*).

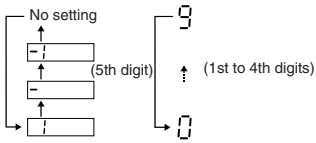
3) Press the ↵ key.

   • The sensor automatically enters the HIGH limit value setting mode.
   • The setting value is displayed in red and the HIGH indicator illuminates.

4) Press the ▶ or ▲ key to display the desired value.

- Pressing the ▶ key changes the flashing digit to the right.

- Pressing the ▲ key changes the value.
- All digits flash when the fifth digit and sign can be changed.



5) Press the ↵ key.

The HIGH limit setting value is saved. The sensor automatically enters the LOW limit value setting mode.

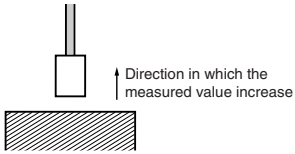
6. Set the lower value for the tolerance limit.

- Set the lower limit value.
- Use procedures 3) and 4) in step 5 to set the LOW limit value. Then, press the ↵ key to save the value.

Note 1: The output is disabled during the tolerance limit value setting. When the output is already on, however, the output is retained.

Note 2: Pressing the ↵ key does not save the changes if [HIGH setting value - Hysteresis] is smaller than [LOW setting value + Hysteresis]. In this case, "Err i" is displayed. Press the ↵ key again to cancel the error, and then specify the correct value.

Reference: When the thickness/gap mode is selected, in the initial setting state the measured value becomes larger as the distance between the sensor head and target is shorter. When you want to make the measured value smaller as the distance is shorter, set function "d" (inverse/normal display function) to normal. For details, see page 73.

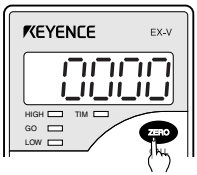


2.3 Auto-Zero Function

The displayed value can be instantaneously reset to "0000" by pressing the [ZERO] key or input through the AUTO-ZERO input terminal. The increase or decrease in the value measured after activating the auto-zero function can be displayed using "±" (plus or minus). This function simplifies zero-point adjustment at product type changeovers.

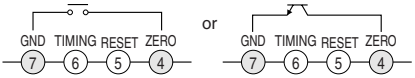
Using the front panel key

- Press the [ZERO] key to reset the displayed value to "0000".
- The value displayed just as the key is released is reset to "0000".



Using the AUTO-ZERO input terminal

Short-circuit the ZERO ④ and GND ⑦ terminals to activate the auto-zero function.



Canceling the auto-zero function (Restoring the value reset using the auto-zero function)

Press the [ZERO] key for 3 seconds to cancel the auto-zero function.

Note 1: When an offset value is set, the offset value is displayed when the auto-zero function is activated. For details, see "Offset function [H]" (⇨ *pages 40 and 41*).

Note 2: When using the internal trigger function (⇨ *page 46*), adjust the trigger level after activating the auto-zero function. (The internal trigger function works with regard to the value displayed after the auto-zero function is activated.)

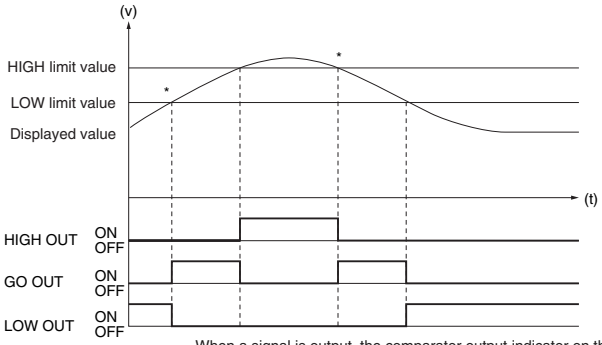
⚠ CAUTION

If frequently activating the auto-zero function using the external input terminal, set the panel-lock function to ON to protect the memory. Then, the displayed value will not be stored in the internal memory.
For details of the panel-lock function, see "Panel-lock function [L]" (⇨ page 43).

2.4 Tolerance Limit Value Setting

You can set the allowable range for the tolerance limit value. After the comparator of measured values, signals are output at three levels: when the measured value exceeds the upper limit (HIGH), when it is below the lower limit (LOW), and when it is within the allowable range (GO). The measured value is displayed in green for the GO output and in red for the HIGH and LOW outputs.

Operation diagram

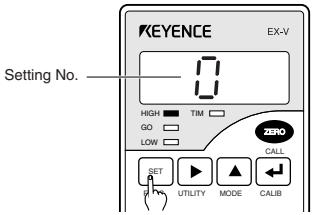


When a signal is output, the comparator output indicator on the controller's front panel illuminates.

* With the factory setting, a hysteresis of 5 digits is applied when the output changes from LOW to GO or HIGH to GO.

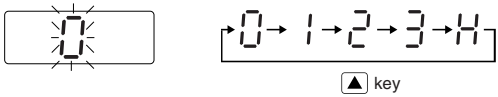
Setting the tolerance limit values

1. Press the SET key.
   - The sensor enters the tolerance limit setting mode.
   - The setting number is displayed.



2. Press the ▲ key to display the desired setting number.

   Pressing the ▲ key changes the setting number sequentially.

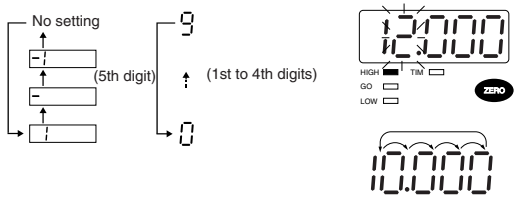


2

3. Press the ↵ key.
   - The sensor automatically enters the HIGH limit value setting mode.
   - The setting value is displayed in red and the HIGH indicator illuminates.

Note: Setting the panel-lock function to ON allows the terminals to switch the setting number for the tolerance limits. For details of the panel-lock function, see "Panel-lock function [J]" (➪ *page 43*).

4. Press the ▶ or ▲ key to display the desired value.
   - Pressing the ▶ key changes the flashing digit to the right.
   - Pressing the ▲ key changes the value.
   - All digits flash when the fifth digit and sign can be changed.



5. Press the ↵ key.
   - The HIGH limit setting value is saved. The sensor automatically enters the LOW limit value setting mode.
   - Set the LOW limit value using the same procedure as in steps 3 and 4.

Note 1: The output is disabled during the tolerance limit value setting. When the output is already on, however, the output is retained.

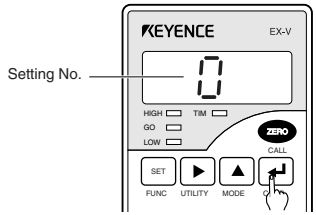
Note 2: Pressing the ↵ key does not save the changes if [HIGH setting value - Hysteresis] is smaller than [LOW setting value + Hysteresis]. In this case, "Err 1" is displayed. Press the ↵ key again to cancel the error, and then specify the correct values.

2.5 Checking the Tolerance Limit Values (Calling the tolerance limit values)

The preset tolerance limit values can be checked during measurement.

1. Press the ↵ key.

   The preset setting number ("0" through "3") is displayed.



Note: Press the ↵ key for a short time. When the key is pressed for 2 seconds or longer, the sensor enters the adjustment mode. If you accidentally put the sensor into the adjustment mode, "0" appears at the right end on the display. At this time, press the SET key to return to the measurement state.

2. Press the ↵ key.

   The HIGH indicator flashes and the preset HIGH limit value appears on the display.

3. Press the ↵ key again.

   The LOW indicator flashes and the preset LOW limit value appears on the display.

4. Press the ↵ key to return to measured value display.

Note 1: The EX-V series internally performs measurement and comparison even while displaying the tolerance limit value. When the measured value exceeds the tolerance limit value while the tolerance limit value is called out on the display, the displayed value changes from green to red to indicate that the measured value is out of the tolerance range.

Note 2: When you want to change the preset value while calling out the tolerance limit value on the display, press the SET key. This allows you to enter the tolerance limit setting mode. Refer to "2.4 Tolerance Limit Value Setting" (*pages 25 and 26*).

MEMO

Chapter 3

Use of Common Functions

Explains the functions common to the respective modes and the setting procedure.

3.1 Table of Functions and Function Numbers 30

3.2 Function Setting Flow 31

3.2.1 Selecting the function using the ▶ key 31
3.2.2 Display scaling function [E] 33
3.2.3 Monitor (analog voltage) output setting function [F] 36
3.2.4 Digits function/decimal point function [G] 39
3.2.5 Offset function [H] 40
3.2.6 Output form selection function [I] 42
3.2.7 Panel-lock function [J] 43

3.1 Table of Functions and Function Numbers

Use the operation keys to set the functions of each mode. This section describes the table of functions "E" through "u".

Table of functions and function numbers

Function code	Function	Function No.									
		0	1	2	3	4	5	6	7	8	9
E	Display scaling	Setting the scaling function for the displayed value									
F	Monitor (analog voltage) output setting	Setting the scaling function for the monitor (analog voltage) output and selecting the output method									
G	Digits	5 digits	5 digits	5 digits	5 digits	4 digits	4 digits	4 digits	High-accuracy mode		
	Decimal point	4th digit	3rd digit	2nd digit	No decimal point	4th digit	3rd digit	2nd digit	2nd digit		
H	Offset	Setting the numeric value (initial value: 0.000)									
I	Output form	N.O. Normal	N.C. Normal	N.O. Hold	N.O. Off-delay						
u	Panel-lock (selection)	OFF	ON (terminal)								

* The setting in each shaded column of the table above shows the factory-set value.

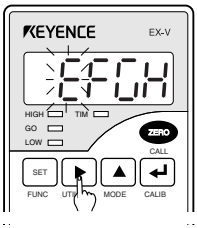
3.2 Function Setting Flow

This section explains how to set functions "E" through "U" using the ▶ key.

3.2.1 Selecting the function using the ▶ key

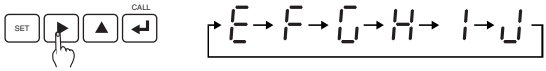
Select the function to be set from functions "E" through "U" and then enter the desired function number or numeric value.

1. Press the ▶ key for at least 2 seconds.
   - The sensor enters the common function selection mode.
   - The function parameter of the flashing function code can be set.

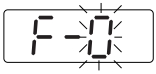


2. Press the ▶ key to select the function to be set.

   Pressing the ▶ key changes the flashing digit to the right.



3. Press the ▲ or ↵ key to enter the function number setting state.



4. Set the function parameter.

   ➪ *For details of each function, see pages 33 to 43.*

5. Press the SET key.

   The sensor saves the setting and returns to the measurement state.

6. To set two or more functions, repeat steps 1 through 5 described above.

Reference 1: When the initial setting for a function is changed, the setting is displayed in red.

Reference 2: To return to the common function selection mode without changing the setting, press the SET key.

Note 1: When you return to the measurement state by pressing the SET key even after entering a function number or numeric value, the number or value is not saved.

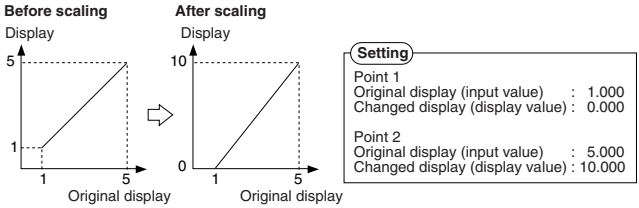
Note 2: The output is disabled for the time between entering the common function selection mode with the ▶ key and returning to the measurement state after setting. However, if the output is already on before the sensor enters the common function selection mode, the output is retained.

3.2.2 Display scaling function [E]

This function is used to change the ratio of the displayed value relative to the measured value (input value from the sensor head). To perform scaling, enter the desired display value respectively for two desired correction points.

Example

To display the original display value changing from "1" to "5" as a value changing from "0" to "10"

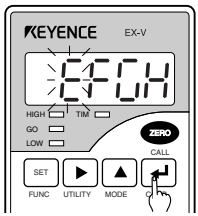


1. Press the ▶ key for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the ▶ key to select function "E".

   Check that "E" is flashing.

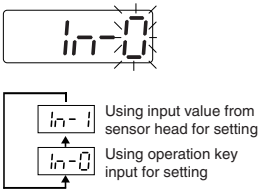


3. Press the ↵ key to enter the display scaling function setting state.

4. Press the ▲ key to select the input method. After the selection, press the ↵ key to save the input method setting.

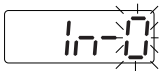
   • Pressing the ▲ key changes the input method number.

Function No.	Function
In-0	Using operation key input for setting
In-1	Using input value from sensor head for setting



   • Select "0" or "1" and follow the procedure described below according to the selected input method.

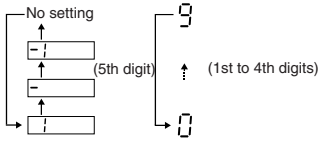
When selecting " In-0"



5. Set the input value for correction point 1.
   Use the ▶ or ▲ key to set the desired numeric value.

- The value on the flashing digit can be changed.
- Pressing the ▶ key changes the flashing digit to the right.

- Pressing the ▲ key changes the value.



- All digits flash when the fifth digit and sign can be changed.

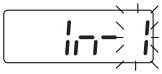
6. Press the ↵ key to save the input value for correction point 1. Then, the sensor enters the display value setting state.

   The display value is displayed in green.

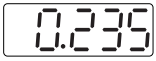
7. Set the display value for correction point 1 in the same procedure as step 5, and use the ↵ key to save the setting value.

8. Set and save the input and display values for correction point 2.
   - Repeat steps 5 and 6 to set and save the input and display values for correction point 2.
   - After saving the display value for point 2, the sensor returns to the measurement state.

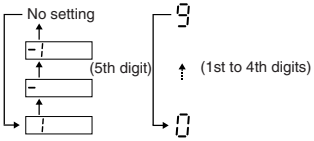
When " In-1 " is selected



5. Set and save the input value for correction point 1 using the value measured by the sensor (input from the sensor head).
   - Move the sensor head or target to the distance to be set as correction point 1.
   - Press the ↵ key to save the measured value.



6. Use the ▶ or ▲ key to set the display value for correction point 1.
   - Pressing the ▶ key changes the flashing digit to the right.
   - Pressing the ▲ key changes the value.
   - All digits flash when the fifth digit and sign can be changed.



7. Press the ↵ key to save the setting value.

8. Set and save the values for correction point 2.
   - Repeat steps 5 through 7 to set and save the input and display values for correction point 2.
   - After saving the display value for point 2, the sensor returns to the measurement state.

Note 1: The input and display values for display scaling can be set between -19999 and +19999.

Note 2: To set the scaling function, be sure to satisfy the following conditions. If these conditions are not satisfied, "Err2" is displayed and the setting procedure is disabled. When the error message is displayed, press the ↵ key to cancel the error message and retry the setting.
(1) Input value 1 - input value 2 ≠ 0
(2) Display value 1 - display value 2 ≠ 0
(3) After scaling, the display value is within the range of ±19.999 when the input value is "0".
(4)
$$0.0001 \leq \left| \frac{(\text{display value 1 - display value 2})}{(\text{input value 1 - input value 2})} \right| \leq 15$$

Note 3: When using the internal trigger function (*page 46*), adjust the trigger level after performing scaling. (The internal trigger function works with regard to the value displayed after scaling is performed.)

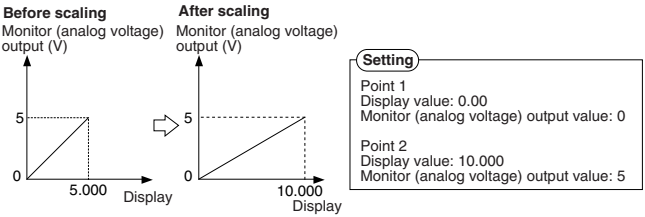
3.2.3 Monitor (analog voltage) output setting function [F]

This function is used to change the ratio of the analog voltage output value relative to the displayed value, provided that the output voltage is between -5 and +5 V. By performing scaling, you can change the output voltage value to the desired level. In addition, you can select either of the following two output methods: one outputs analog voltage according to the displayed value and the other outputs the input value from the sensor head.

Reference: The initial state outputs the voltage equal to the displayed value.

Output scaling

The ratio of the analog voltage output relative to the displayed value can be changed, provided that the output voltage is between -5 and +5 V. To perform scaling, enter the desired monitor (analog voltage) output value respectively for two desired correction points.

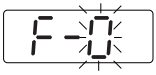


1. Press the ▶ key for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the ▶ key to make "F" flash.

3. Press the ▲ or ↵ key to enter the monitor output setting mode.



4. Press the ↵ key with "F-0" displayed.

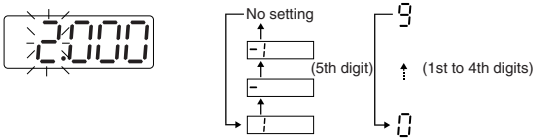
   The sensor enters the monitor output scaling setting state.

5. Set the display value for correction point 1.

   The display value is displayed in red.

   • The value on the flashing digit can be changed.
   • Pressing the ▶ key changes the flashing digit to the right.

   • Pressing the ▲ key changes the value.



   • All digits flash when the fifth digit and sign can be changed.

6. Press the ↵ key to save the display value for correction point 1.
   • Then, the sensor enters the monitor output value setting state.

7. Set the monitor output value for correction point 1 in the same procedure as step 5, and use the ↵ key to save the setting value.
   • The monitor output value is displayed in green.

8. Repeat steps 5 through 7 to set and save the display and monitor output values for correction point 2.
   • After saving the monitor output value for point 2, the sensor returns to the measurement state.

Note 1: The display and monitor output values for monitor output scaling can be set between -19999 and +19999.

Note 2: To set the scaling function, be sure to satisfy the following conditions. If these conditions are not satisfied, "Err3" is displayed and the setting procedure is disabled. When the error message is displayed, press the ↵ key to cancel the error message and retry the setting.

(1) Display value 1 - display value 2 ≠ 0

(2) Monitor output value 1 - monitor output value 2 ≠ 0

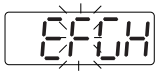
(3) $$0.001 \leq \left| \frac{\text{(monitor output value 2 - monitor output value 1)}}{\text{(display value 2 - display value 1)}} \right| \leq 6$$

Selecting the output method

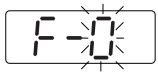
1. Press the ▶ key for at least 2 seconds.

   The sensor enters the common function selection mode.

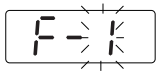
2. Press the ▶ key to make "F" flash.



3. Press the ▲ or ↵ key to enter the monitor output setting mode.

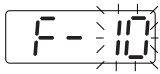


4. Press the ▲ key to display "F-1".
   Press the ↵ key to enter the monitor output method selection state.

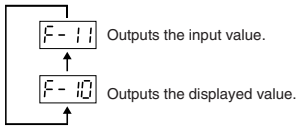


5. Select the desired output method.

   Pressing the ▲ key changes the function number.



Function No.	Function
F-10	The sensor outputs analog voltage according to the displayed value.
F-11	After scaling or filtering the signal input from the sensor head, the sensor outputs the signal.



Reference: When using the hold mode in the bottom-dead-center or eccentricity/vibration mode (in which only the operation result is retained and displayed), set the output method to "F-11". This allows you to check the current change of the measured value.

6. Press the ↵ key to save the output method setting.

   After saving the setting, the sensor returns to the measurement state.

3.2.4 Digits function/decimal point function [5]

The digits function is used to delete the last digit on the display. The decimal point function is used to place the decimal point on the desired position.

Table of function number

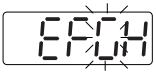
Function No.	Number of displayed digits	Decimal point position	Display
0	5 digits	4th digit	18.888
1	5 digits	3rd digit	188.88
2	5 digits	2nd digit	1888.8
3	5 digits	No decimal pointt	18888
4	4 digits	4th digit	18.88
5	4 digits	3rd digit	188.8
6	4 digits	2nd digit	180.0
7*	High-accuracy	2nd digit	1888.8

* Only with the 1-mm type and 2-mm type, the high-accuracy mode can be used. The least significant digit shows sub-micron.

Setting function "5"

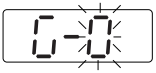
1. Press the ▶ key for at least 2 seconds.

   The sensor enters the common function selection mode.



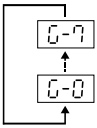
2. Press the ▶ key to make "5" flash.

3. Press the ▲ or ↵ key to enter the digits/decimal point setting state.



4. Press the ▲ key to select the desired function number.

   Pressing the ▲ key changes the function number sequentially.



5. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

Note 1: Even when the number of displayed digits is set to 4 digits, the tolerance limit values are displayed with 5 digits. The actual measured value (including the last digit), instead of the displayed value, is used for comparison with the tolerance limit values.

Note 2: When the decimal point position on the display is shifted, that of the tolerance limit values is shifted to the same position.

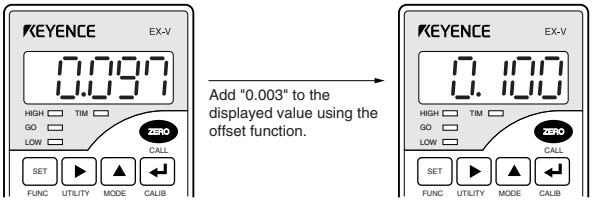
Note 3: When changing the sensor to the high accuracy mode while the internal trigger function (☞ *page 46*) is activated, adjust the trigger level after the changing. (The internal trigger function works with regard to the value displayed after the changing.)

3.2.5 Offset function [H]

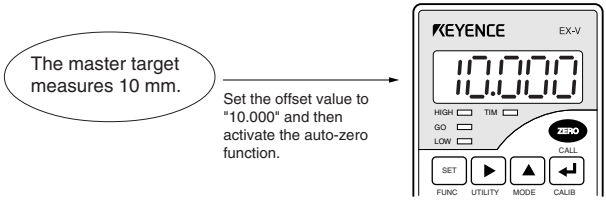
The offset function allows any value to be added to or subtracted from the displayed value. When an offset value is preset, activating the auto-zero function displays the offset value.

Applications of the offset function

- The displayed value can be changed to a desired value by performing addition or subtraction.



- The displayed value can be reset to the dimension of the master target that was previously measured.

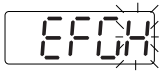


Setting function "H"

1. Press the ▶ for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the ▶ key to make "H" flash.

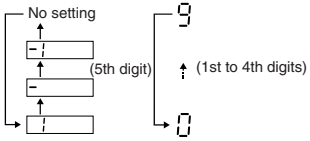


3. Press the ▲ or ↵ key to enter the offset setting state.

4. Use the ▶ or ▲ key to set the desired numeric value.

- The value on the flashing digit can be changed.
  Pressing the ▶ key changes the flashing digit to the right.

- Pressing the ▲ key changes the value.



- All digits flash when the fifth digit and sign can be changed.

Reference: Pressing the [ZERO] key in this step resets the display to "0000".

5. Press the ↵ key.

   The sensor saves the setting value and returns to the measurement state.

Reference: The offset value can be set within the range of ±19.999.

Note: When using the internal trigger function (☞ *page 46*), adjust the trigger level after entering the offset value. (The internal trigger function works with regard to the displayed value.)

3.2.6 Output form selection function [i]

This function is used to select the output form from the open-collector (HIGH, GO, LOW) to output the signal for indicating that the measured value is out of the tolerance range.

Function No.	Name	Operation
0	N.O. normal output	The comparator output serves as a normally open (a-contact) signal.
1	N.C. normal output	The comparator output serves as a normally closed (b-contact) signal.
2	N.O. hold output	N.O. normal output is retained, and the output continues until the reset signal is input. However, GO output is not retained.
3*	N.O. off-delay output	N.O. normal output is delayed by 60 ms.

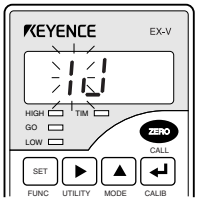
* "3" is displayed only when normal measurement in the manual mode or continuous measurement in the thickness/gap mode is selected.

Setting function " i"

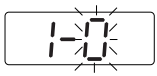
1. Press the ▶ key for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the ▶ key to make " i" flash.

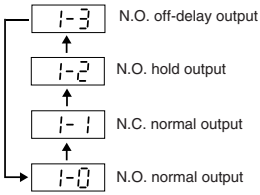


3. Press the ▲ or ↵ key to enter the output form selection state.



4. Press the ▲ key to select the desired function number.

   Pressing the ▲ key changes the function number sequentially.



5. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

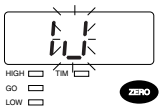
3.2.7 Panel-lock function [ل]

The panel-lock function is used to inhibit front panel key operation. Use this function to prevent the accidental pressing of the keys, which may cause malfunctions. When the panel-lock function is set to ON, all key operations are ignored, except for pressing the ↵ key (for calling the tolerance limit values) and pressing SET or ▶ for at least 2 seconds (for entering the common mode selection mode). When switching the setting number of the tolerance limit values through the terminal, set the panel-lock function to ON.

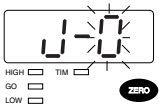
1. Press the ▶ key for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the ▶ key to select function "ل".

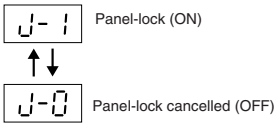


3. Press the ▲ or ↵ key to enter the panel-lock selection state.



4. Press the ▲ key to select the desired function number.

   Pressing the ▲ key changes the function number.



5. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

CAUTION

If frequently activating the auto-zero using the external terminal, set the panel-lock function to ON to protect the memory. (Values can be written into the memory 100,000 times.)

Note 1: While the panel-lock function is set to ON, the sensor does not write the value displayed when the auto-zero function is activated into the internal non-volatile memory. (Once the power is turned off, the auto-zero function is cancelled.)

Note 2: While the panel-lock function is set to ON, the setting number of the tolerance limit values can be switched through the external terminal.

MEMO

Chapter 4

Use of Data Processing Functions

Explains the setting and operation procedures of the respective functions.

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4.1 Table of Data Processing Functions

All functions of each measurement mode are specified with the operation keys. The following tables list function codes "A" to "d" and their functions.

Table of functions and function numbers

■ **Mode 0: Manual mode**

Function code	Function	Function No.									
		0	1	2	3	4	5	6	7	8	9
A	No of averaging measurements	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
	Low-pass filter	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9
b	Measurement type	NR	PH	BH	PP	SH	AH				
C	Measurement period	External input	Internal trigger ↓	Internal trigger ↑	Flicker						
d	Previous value comparison	Disabled	Enabled								

■ **Mode 1: Bottom-dead-center mode**

Function code	Function	Function No.									
		0	1	2	3	4	5	6	7	8	9
A	No of averaging measurements	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
	Low-pass filter	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9
b	Measurement type	Simple bottom-dead-center	Limited bottom-dead-center	Limited PP							
C	Measurement period	External input	Internal trigger ↓	Internal trigger ↑							
d	Previous value comparison	Disabled	Enabled								

■ **Mode 2: Eccentricity/vibration mode**

Function code	Function	Function No.									
		0	1	2	3	4	5	6	7	8	9
A	No of averaging measurements	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
	Low-pass filter	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9
b	Measurement type	Simple difference	Cyclical difference	Difference between peaks (bottoms)							
C	Measurement period	External input	Internal trigger ↓	Internal trigger ↑							

■ **Mode 3: Thickness/gap mode**

Function code	Function	Function No.									
		0	1	2	3	4	5	6	7	8	9
A	No of averaging measurements	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
	Low-pass filter	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9
b	Measurement type	Continu-ous	Intermitt-ent	Average							
C	Measurement period	External input	Internal trigger ↑	Internal trigger ↓	Flicker						
d	Inverse/normal display	Normal	Inverse								

* The setting in each shaded column of the table above shows the factory-set value.

4.2 Details of Bottom-dead-center Mode

This section describes function codes "A" to "d" specified with the SET key for the bottom-dead-center mode.

4.2.1 No. of averaging measurements/Digital filter [A]

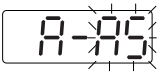
Sets the number of averaging measurements or the digital filter function.

- **No. of averaging measurements function**
  You can specify the number of averaging the measured signals input from the sensor head. This function is effective to ignore sporadic changes or to obtain quick comparator output.
- **Digital filter function**
  You can display the signals input from the sensor head by eliminating the signals higher than a specified frequency. This function is effective to ignore abrupt fluctuations and to obtain a smooth curve display.

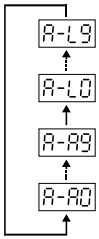
Setting function "A"

1. Press the SET key for at least 2 seconds.
   The sensor enters the common function selection mode.
2. Check that "A" flashes.

3. Press the ▲ or ↵ key.
   The function number for the No of averaging measurements or the digital filter is displayed.



4. Press the ▲ key to select the desired function number.
   - Pressing the ▲ key changes the function number sequentially.
   - Pressing the [ZERO] key resets the display to "A-A0".



5. Press the ↵ key.
   The sensor saves the setting and returns to the measurement state.

No. of averaging measurements vs. time for averaging measurements

Display	No. of averaging measurements [1.]	Time for averaging measurements (ms) [2.]
A-A0	1	0.025
A-A1	2	0.05
A-A2	4	0.1
A-A3	8	0.2
A-A4	16	0.4
A-A5	64	1.6
A-A6	256	6.4
A-A7	1024	25.8
A-A8	4096	103.2
A-A9	16384	412.8

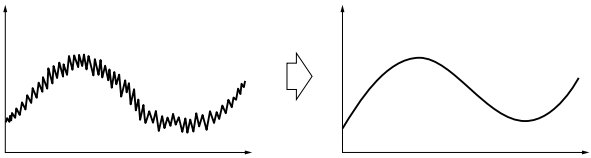
1. The factory setting is "A-A5" (64).
2. This does not represents the output response time. For details of the output response time, refer to page 97.

Details of digital filter setting

Filter No. (Displayed value)	Cut-off frequency
A-L0	1000 Hz
A-L1	500 Hz
A-L2	200 Hz
A-L3	150 Hz
A-L4	100 Hz
A-L5	50 Hz
A-L6	20 Hz
A-L7	10 Hz
A-L8	5 Hz
A-L9	1 Hz

Display example

Applying the display filter changes the display as follows:



4.2.2 Measurement type [b]

The following three types of measurement are available:

Function No.	Measurement type	Description	Reference page
b-0	Simple bottom-dead-center	Measures the "minimum value" detected during a specified period.	50
b-1	Limited bottom-dead-center	Measures the "minimum value" detected during a specified period (sampling period).	50, 51
b-2	Limited peak-to-peak hold	Measures the difference between the maximum and minimum values during a specified period.	52

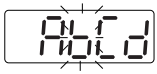
Select or set the measurement type in the following procedure:

Setting function "b"

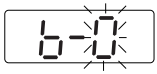
1. Press the [SET] key for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the [▶] key to make function "b" flash.

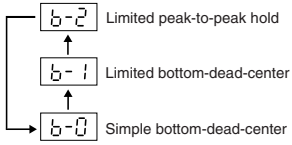


3. Press the [▲] or [↵] key to select the measurement type.



4. Press the [▲] key to select the desired function number.

   - Pressing the [▲] key changes the function number sequentially.
   - Pressing the [ZERO] key resets the display to "b-0".



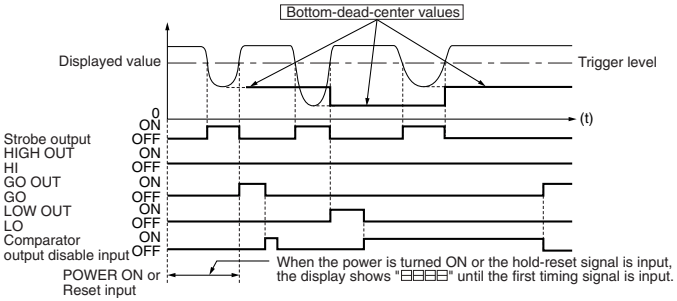
5. Press the [↵] key.

   The sensor saves the setting and returns to the measurement state.

Simple bottom-dead-center measurement function (Internal trigger) [b-U]

Measures the "minimum value" detected during a specified period.

* The external trigger mode is not available for the simple bottom-dead-center measurement. For the internal trigger setting, only a trigger level and trigger hysteresis can be specified.



- If a comparator output disable input turns ON before the comparator operation, the comparator output does not turn ON.
- The trigger level is factory-adjusted to the full scale.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

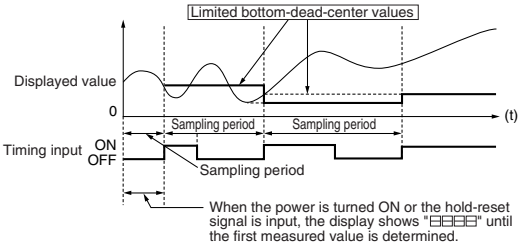
Limited bottom-dead-center measurement function [b- L]

Measures the "minimum value" detected during a specified period (sampling period).
For the limited bottom-dead-center measurement function, the sampling period can be specified with the combination of the trigger mode and delay time settings.

☞ *For the details of the trigger mode and delay time, refer to pages 53 to 55.*

Timing diagram

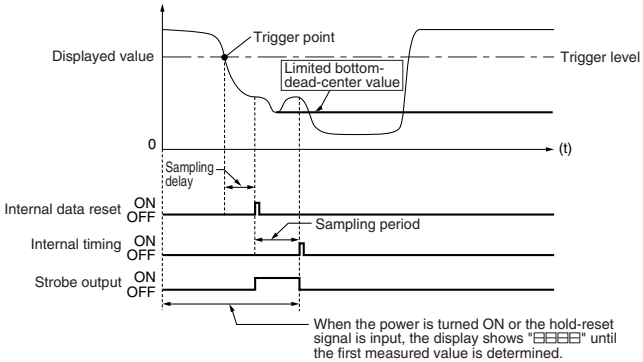
■ **External trigger mode**



- If a comparator output disable input turns ON before the comparator operation, the comparator output does not turn ON.
- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input. The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Internal trigger mode (Example of internal trigger DOWN ↓)**



- The sampling operation starts when the sampling delay time elapses after the measured value falls below the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the "limited bottom-dead-center value" is displayed/output.
  For the internal trigger down ↓ operation, the trigger point is the instant when the measured value exceeds the trigger level.
- If a comparator output disable input turns ON before the comparator operation, the comparator output does not turn ON. Refer to page 50 for details.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.
- The trigger level is factory-adjusted to the full scale.

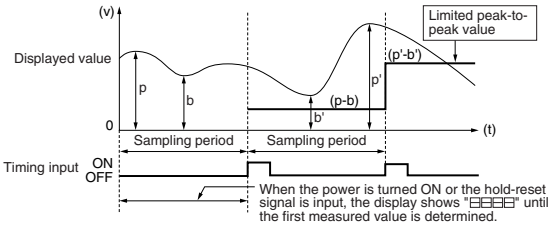
Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

Limited peak-to-peak hold function [b-2]

Measures the difference between the maximum and minimum values during a specified period (sampling period).
For the limited peak-to-peak hold function, the sampling period can be specified with the combination of the trigger mode and delay time settings.
☞ *For the details of the trigger mode and delay time, refer to pages 53 to 55.*

Timing diagram

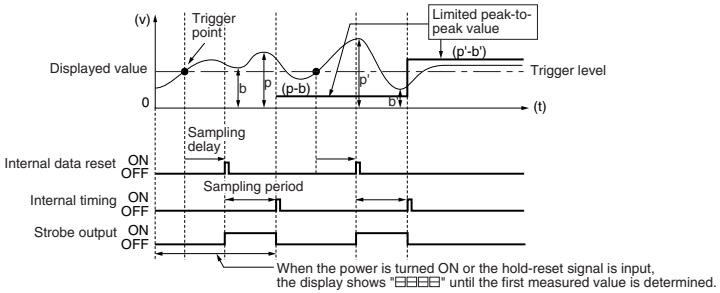
■ **External trigger mode**



- If a comparator output disable input turns ON before the comparator operation, the comparator output does not turn ON. ☞ *Refer to page 50 for details.*
- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held and start the measurement again, short-circuit the hold-reset and GND terminals.

Internal trigger mode (Example of internal trigger up ⎍)



- If a comparator output disable input turns ON before the comparator operation, the comparator output does not turn ON. ☞ *Refer to page 50 for details.*
- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the "peak-to-peak value" is displayed/output.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.
- For the internal trigger down ⎌ operation, the trigger point is the one when the measured value falls below the trigger level.
- The trigger level is factory-adjusted to the full scale.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

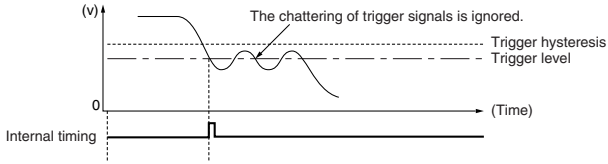
4.2.3 Measurement period [C]

This function sets/selects the sampling period to use the hold measurement.

Function No.	Function	Description
C-0	External input	Specifies the sampling period by using the timing and hold-reset inputs.
C-1	Internal trigger up ⎍	Turns ON trigger signals when the measured value exceeds a specified trigger level.
C-2	Internal trigger down ⎏	Turns ON trigger signals when the measured value falls below a specified trigger level.

Trigger level and trigger hysteresis

■ **For internal trigger down ⎏ operation**



- By setting the trigger hysteresis, the chattering of the internal trigger signals can be ignored.
- The trigger level and trigger hysteresis are specified with numerical values.

Note 1: The trigger level can be set within the range of ±19.999.

Note 2: The trigger hysteresis can be set up to +19.999.

* The trigger hysteresis is factory-adjusted to 10 digits.

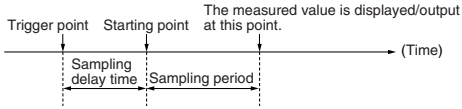
Sampling delay and sampling period

■ **Sampling delay**

Specify the time between the instant when the trigger signal turns ON and the beginning of the sampling period.

■ **Sampling period**

Specify the length of the sampling period after the hold-reset input.



- The sampling delay time and sampling period are specified with time length. The unit of the setting display is "ms".

Example

1000.1 = 1000.1 ms

Note 1: The sampling delay time and sampling period can be specified within the range of 0.1 to 19999.9 ms.

Note 2: When the measurement type is set to "b-0", settings "C-0", "C-1", "C-22" and "C-23" cannot be selected.

4

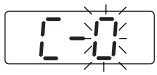
Setting function "C"

1. Press the SET key for at least 2 seconds.

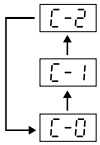
   The sensor enters the common function selection mode.

2. Press the ▶ key to make function "C" flash.

3. Press the ▲ or ↵ key to select the function setting mode.



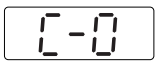
4. Press the ▲ key to select the desired function.



When "C-0" is selected:

5. Press the ↵ key.

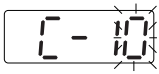
   The sensor saves the setting and returns to the measurement state.



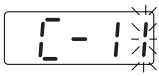
When "C-1" or "C-2" is selected:

5. Press the ↵ key to specify each function.

   C-00: Trigger level setting
   C-01: Trigger hysteresis setting
   C-02: Sampling delay setting
   C-03: Sampling period setting



6. Press the ▲ key to specify functions "10" to "13".



7. Press the ↵ key to specify each function.

   - Specify the trigger level and trigger hysteresis based on the displayed value.
   - The sampling delay and sampling period are specified as time length (ms).

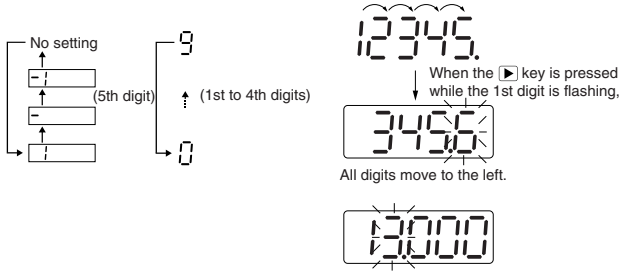
8. Press the ▲ or ▶ key to specify the desired value.

   - The value of the flashing digit can be changed. Pressing the ▶ key changes the flashing digit to the right.

   For trigger level/trigger hysteresis setting

   - Pressing the ▲ key changes the value.
   - All digits flash when the fifth digit and sign can be changed.

   For sampling delay/sampling period setting



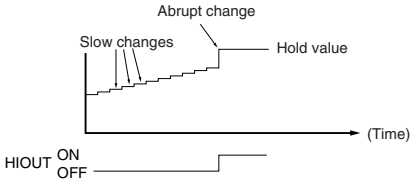
Reference: Pressing the [ZERO] key here resets the display to "0000".

9. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

4.2.4 Previous value comparison function [d]

Compares the average of the previously measured values with the current measured value and displays only abrupt changes among slow changes.
When any hold function (peak hold, peak-to-peak hold or sample hold) is used, this function is effective to ignore small differences caused by temperature fluctuation or the unstable status during warm-up time.



Note: If the displayed value is out of the preset tolerance range, the input value is not used in the comparison calculation of the next input.

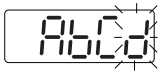
4

Setting function "d"

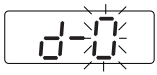
1. Press the [SET] key for at least 2 seconds.

   The sensor enters the common function selection mode.

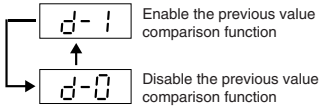
2. Press the [▶] key to make function "d" flash.



3. Press the [▲] or [↵] key to select the previous value comparison function.



4. Press the [▲] key to select the desired function number.



5. Press the [↵] key.

   The sensor saves the setting and returns to the measurement state.

Note: To reset the values used for the previous value comparison, short-circuit the No. 11 reset terminal and GND terminal.

4.3 Details of Eccentricity/vibration Mode

This section describes function codes "A" to "C" specified with the SET key for the eccentricity/vibration mode.

4.3.1 No. of averaging measurements/Digital filter [A]

Sets the number of averaging measurements or the digital filter function.
☞ *Refer to pages 47 and 48 for details.*

4.3.2 Measurement type [b]

The following three types of measurement are available:

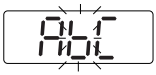
Function No.	Measurement type	Description	Reference page
b-0	Simple difference	Measures the difference between the maximum and minimum values detected during a specified period (sampling period).	58, 59
b-1	Cyclical difference	Automatically measures the difference between the maximum and minimum values detected in each sensor input cycle.	59
b-2	Difference between peaks (bottoms)	Measures the difference between the maximum and minimum values of the peak (bottom) values during a specified period (sampling time).	60

Select or set the measurement type in the following procedure:

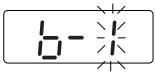
Setting function "b"

1. Press the SET key for at least 2 seconds.
   The sensor enters the common function selection mode.

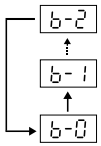
2. Press the ▶ key to make function "b" flash.



3. Press the ▲ or ↵ key to select the measurement type.



4. Press the ▲ key to select the desired function number.
   - Pressing the ▲ key changes the function number sequentially.
   - Pressing the [ZERO] key resets the display to "b-0".



5. Follow one of the procedures below according to the selected function number:

   - When "b-0" or "b- 1" is selected:
     Press the ↵ key.

     The sensor saves the setting and returns to the measurement state.

   - When "b-2" (Difference between peaks [bottoms] measurement) is selected:

     1) Select "b-20" or "b-2 1" and then press the ↵ key to confirm the selection.

        "b-20": Difference between peak values measurement
        "b-2 1": Difference between bottom values measurement

     2) Specify the hysteresis to determine the peak (bottom) value as necessary.

     3) Press the ↵ key.

        The sensor saves the setting and returns to the measurement state.

Note 1: The hysteresis can be set within the range of 0 to 19.999.

Note 2: The hysteresis is factory-adjusted to 10 digits.

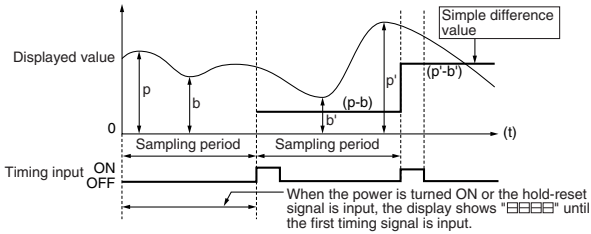
Simple difference measurement function [b-0]

Measures the difference between the maximum and minimum values detected during a specified period (sampling period).

For the simple difference measurement function, the sampling period can be specified with the combination of the trigger mode and delay time settings.
➪ *For the details of the trigger mode and delay time, refer to pages 61 to 63.*

Timing diagram

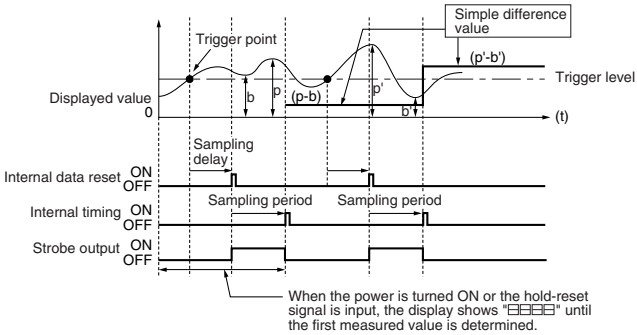
■ **External trigger mode**



- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Internal trigger mode (Example of internal trigger UP⎍)**

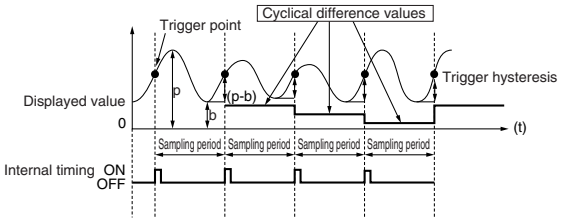


- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the "difference between the maximum and minimum values" is displayed/output.
- For the internal trigger down ⎎ operation, the trigger point is the instant when the measured value falls below the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

Cyclical difference measurement function [b- ⁄]

Automatically measures the difference between the maximum and minimum values detected in each sensor input cycle.



- When the measured value exceeds the minimum value by the amount of a specified trigger hysteresis, the sampling starts. When a cycle completes and the measured value again exceeds the minimum value by the amount of a specified trigger hysteresis, the difference in one cycle is determined.
- When the power is turned ON or the hold-reset signal is input, the display shows "----" until the measured value exceeds the minimum value by the amount of a specified trigger hysteresis.

Difference between peaks (bottoms) [b-2]

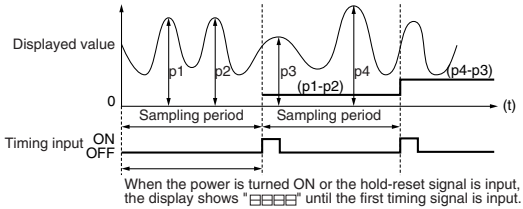
Measures the difference between the maximum and minimum values of the peak (bottom) values during a specified period (sampling time).
The following two types of measurement are available:

1. "b-20" Difference between peak values measurement: Measures the difference between the maximum and minimum values of the peak values.
2. "b-2 i" Difference between bottom values measurement: Measures the difference between the maximum and minimum values of the bottom values.

Timing diagram

For "b-20" measurement

■ **External trigger mode**

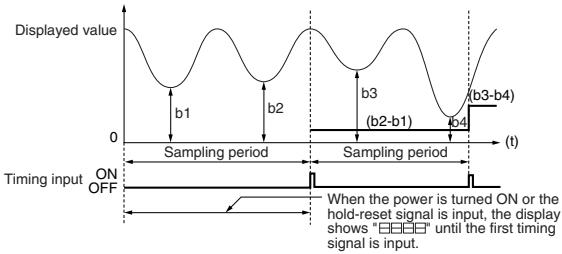


- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.
- The EX-V series determines the peak value when the measured value decreases from the maximum value by a specified hysteresis value. Take this into account when inputting the timing signal.

Reference: To clear the measured value being held and start the measurement again, short-circuit the hold-reset and GND terminals.

For "b-2 i" measurement

■ **External trigger mode**



- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.
- The EX-V series determines the bottom value when the measured value increases from the minimum value by a specified hysteresis value. Take this into account when inputting the timing signal.

Reference: To clear the measured value being held and start the measurement again, short-circuit the hold-reset and GND terminals.

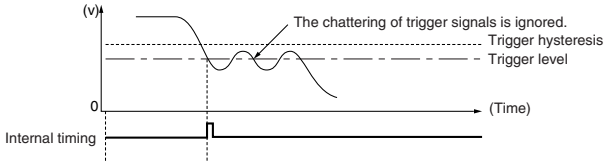
4.3.3 Measurement period [C]

This function sets/selects the sampling period to use the hold measurement.

Function No.	Function	Description
C-0	External input	Specifies the sampling period by using the timing and hold-reset inputs.
C-1	Internal trigger up ⎍	Turns ON trigger signals when the measured value exceeds a specified trigger level.
C-2	Internal trigger down ⎏	Turns ON trigger signals when the measured value falls below a specified trigger level.

Trigger level and trigger hysteresis

■ **For internal trigger down ⎏ operation**



- By setting the trigger hysteresis, the chattering of the internal trigger signals can be ignored.

Note: When the cyclical difference measurement function is selected, the trigger hysteresis is used differently from the operation above. *Refer to the timing diagram on page 59 for details.*

- The trigger level and trigger hysteresis are specified with numerical values.

Note 1: The trigger level can be set within the range of ±19.999.

Note 2: The trigger hysteresis can be set up to +19.999.

* The trigger hysteresis is factory-adjusted to 10 digits.

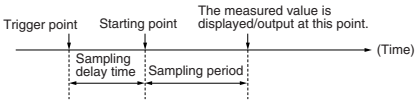
Sampling delay and sampling period

■ **Sampling delay**

Specify the time between the instant when the trigger signal turns ON and the beginning of the sampling period.

■ **Sampling period**

Specify the length of the sampling period after the hold-reset input.



- The sampling delay time and sampling period are specified with time length. The unit of the setting display is "ms".

Example

1000.1 = 1000.1 ms

Note 1: The reset delay and sampling delay can be specified within the range of 0.0 to 19999.9 ms.

Note 2: When "b-1" is selected as the measurement type, only "C-11" is displayed to be set.

Note 3: When "b-2" is selected as the measurement type, only "C-0" is displayed to be set.

4

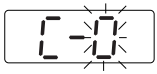
Setting function "C"

1. Press the [SET] key for at least 2 seconds.

   The sensor enters the common function selection mode.

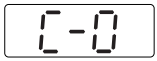
2. Press the [▶] key to make function "C" flash.

3. Press the [▲] or [↵] key to select the function setting mode.



4. Press the [▲] key to select the desired function.

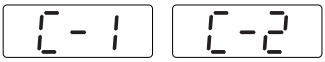
When "C-0" is selected



5. Press the [↵] key.

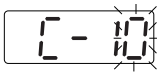
   The sensor saves the setting and returns to the measurement state.

When "C-1" or "C-2" is selected

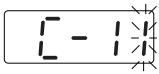


5. Press the ↵ key to specify each function.

   C-00: Trigger level setting
   C-01: Trigger hysteresis setting
   C-02: Sampling delay setting
   C-03: Sampling period setting

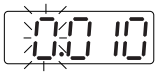


6. Press the ▲ key to specify functions "10" to "13".



7. Press the ↵ key to specify each function.

   - Specify the trigger level and trigger hysteresis based on the displayed value.
   - Specify the sampling delay and sampling period as time length (ms).

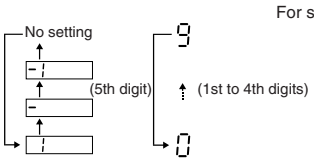


8. Press the ▲ or ↵ key to specify the desired value.

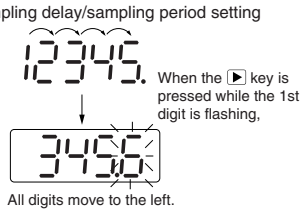
   - The value of the flashing digit can be changed. Pressing the ↵ key changes the flashing digit to the right.

For trigger level/trigger hysteresis setting

   - Pressing the ▲ key changes the value.
   - All digits flash when the fifth digit and sign can be changed.



For sampling delay/sampling period setting



Reference: Pressing the [ZERO] key here resets the display to "0000".

9. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

4.4 Details of Thickness/gap Mode

This section describes function codes "A" to "d" specified with the SET key for the thickness/gap mode.

4.4.1 No. of averaging measurements/Digital filter [A]

Sets the number of averaging measurements or the digital filter function.
☞ *Refer to page 47 for details.*

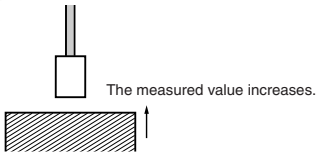
4.4.2 Measurement type [b]

The following three types of measurement are available:

Function No.	Measurement type	Description	Reference page
b-0	Continuous	Displays/outputs the measurement result continuously.	65
b-1	Intermittent	Measures the value at a specified instant.	66, 67
b-2	Average	Calculates the average of the measured values during a specified period (sampling period).	67, 68

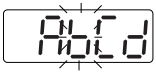
Select or set the measurement type in the following procedure:

Reference: The thickness/gap mode is adjusted to increase measured values when the distance between the sensor head and a target decreases. If you want to decrease measured values when the measuring distance decreases, set function "d" to "d-0", normal display.

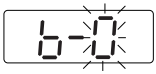


Setting function "b"

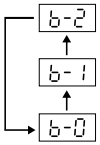
1. Press the SET key for at least 2 seconds.
   The sensor enters the common function selection mode.
2. Press the ▶ key to make function "b" flash.



3. Press the ▲ or ↵ key to select the measurement type.



4. Press the ▲ key to select the desired function number.
   - Pressing the ▲ key changes the function number sequentially.
   - Pressing the [ZERO] key resets the display to "b-0".



5. Press the ↵ key.

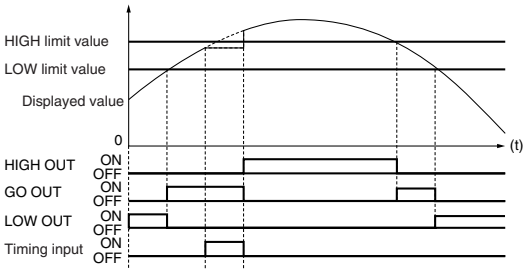
   The sensor saves the setting and returns to the measurement state.

Continuous measurement function [b-0]

Displays/outputs the measurement result continuously.

* The measurement period can be specified with external inputs only. The internal trigger or flicker signal cannot be used.

Timing diagram



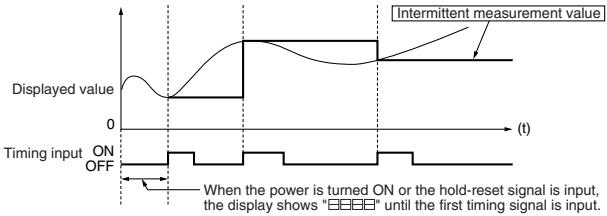
Reference: While the timing input is turned ON, the display and comparator output is held.

Intermittent measurement function [b- i]

Measures the value at a specified instant.
For the intermittent measurement function, you can select the method to specify the timing by the combination of the trigger mode and delay time.
➪ *For the details of the trigger mode and delay time, refer to pages 69 and 70.*

Timing diagram

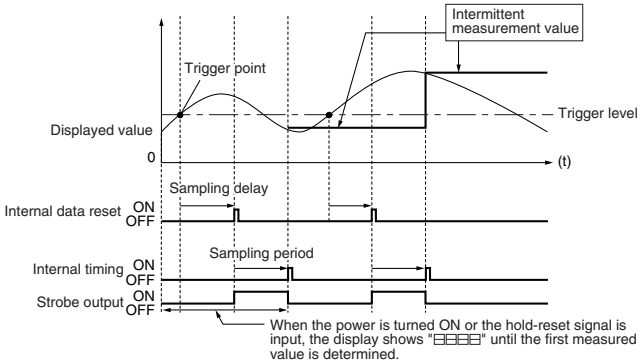
■ **External trigger mode**



- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held, short-circuit the hold-reset and GND terminals.

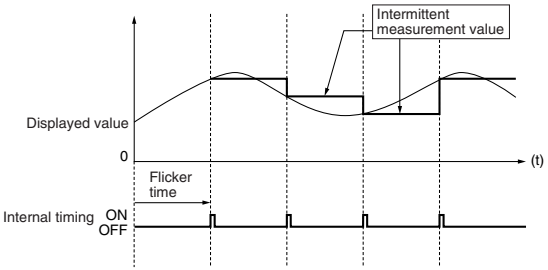
■ **Internal trigger mode (Example of internal trigger up ⎍)**



- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the value at the instant is displayed/output.
- For the internal trigger down ⎎ operation, the trigger point is the instant when the measured value falls below the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



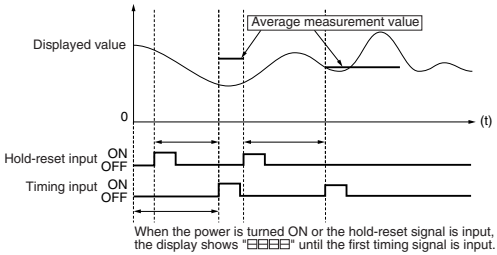
- When the power is turned ON or the hold-reset signal is input, the display shows "----" until the first measured value is determined.
- The internal timing signal is input once at every flicker time and the measured value at the instant is displayed/output.

Average measurement function [b-2]

Calculates the average of the measured values during a specified period (sampling period).
For the average measurement function, you can select the method to specify the timing by the combination of the trigger mode and delay time.
➪ *For the details of the trigger mode and delay time, refer to pages 69 and 70.*

Timing diagram

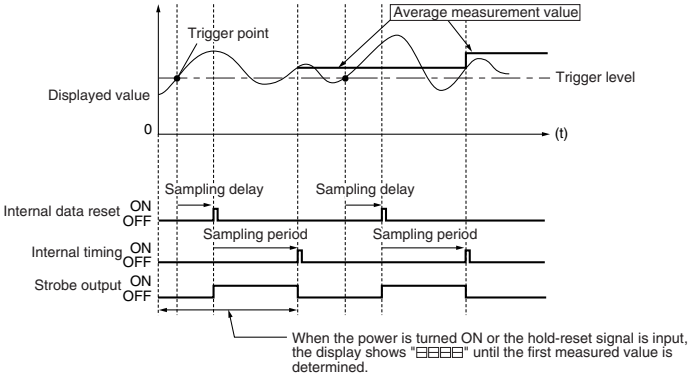
■ **External trigger mode**



- The sampling period is between the UP edge of the hold-reset input and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To start the measurement again, short-circuit the hold-reset and GND terminals.

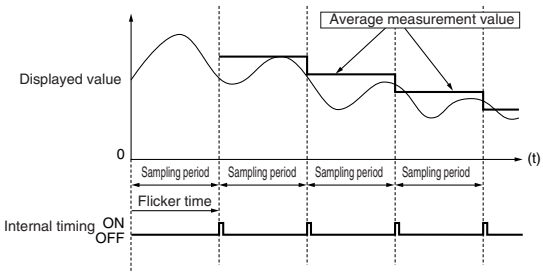
■ **Internal trigger mode (Example of internal trigger up ⎍)**



- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the value at the instant is displayed/output.
- For the internal trigger down ⎎ operation, the trigger point is the instant when the measured value falls below the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



- When the power is turned ON or the hold-reset signal is input, the display shows "----" until the first measured value is determined.
- The internal timing signal is input once at each flicker time and the value at the instant is displayed/output.

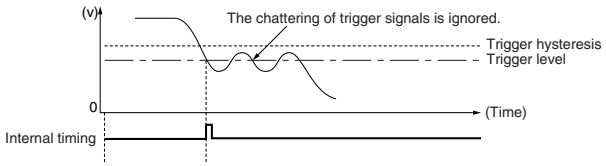
4.4.3 Measurement period [C]

This function sets/selects the sampling period to use the hold measurement.

Function No.	Function	Description
C-0	External input	Specifies the sampling period by using the timing and hold-reset inputs.
C-1	Internal trigger up ⎍	Turns ON trigger signals when the measured value exceeds a specified trigger level.
C-2	Internal trigger down ⎏	Turns ON trigger signals when the measured value falls below a specified trigger level.
C-3	Flicker	Turns ON internal trigger signals in a specified cycle.

Trigger level and trigger hysteresis

■ **For internal trigger down ⎏ operation**



- By setting the trigger hysteresis, the chattering of the internal trigger signals can be ignored.
- The trigger level and trigger hysteresis are specified with numerical values.

Note 1: The trigger level can be set within the range of ±19.999.

Note 2: The trigger hysteresis can be set up to +19.999.

* The trigger hysteresis is factory-adjusted to 10 digits.

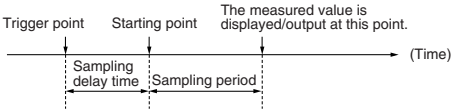
Sampling delay and sampling period

■ **Sampling delay**

Specify the time between the instant when the trigger signal turns ON and the beginning of the sampling period.

■ **Sampling period**

Specify the length of the sampling period after the hold-reset input.



- The sampling delay time and sampling period are specified with time length. The unit of the setting display is "ms".

Example

1000.1 = 1000.1 ms

■ **Flicker time**

- Turns ON the internal trigger signals in a specified cycle. Set the flicker time to repeat the measurement continuously in a specific cycle.
- The flicker time is specified with time length. The unit of the setting display is "ms".

Note 1: The sampling delay and sampling period can be specified within the range of 0.0 to 19999.9 ms.

Note 2: The flicker time can be specified within the range of 0.1 to 19999.9 ms.

Note 3: When "b-0" is selected as the measurement type, only "C-0" is displayed to be set.

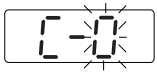
Setting function "C"

1. Press the SET key for at least 2 seconds.

   The sensor enters the common function selection mode.

2. Press the ▶ key to make function "C" flash.

3. Press the ▲ or ↵ key to select the function setting mode.



4. Press the ▲ key to select the desired function.

   Select one of settings "0" to "3" and follow the procedures according to the selected function number.

When "C-0" is selected:

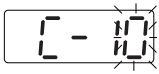
5. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

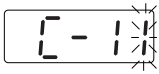
When "C-1" or "C-2" is selected:

5. Press the ↵ key to specify each function.

   C-00: Trigger level setting
   C-01: Trigger hysteresis setting
   C-02: Sampling delay setting
   C-03: Sampling period setting



6. Press the ▲ key to specify functions "00" to "03".



7. Press the ↵ key to specify each function.

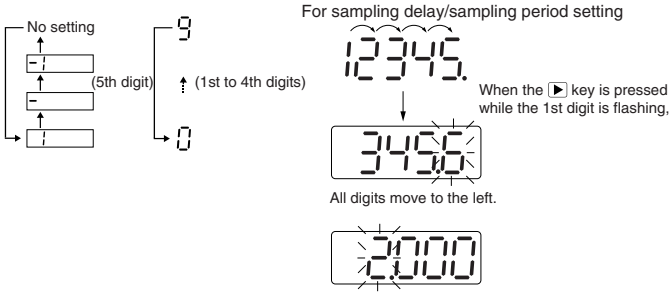
   - Specify the trigger level and trigger hysteresis based on the displayed value.
   - Specify the sampling delay and sampling period as time length (ms).

8. Press the ▲ or ▶ key to specify the desired value.

   • The value of the flashing digit can be changed. Pressing the ▶ key changes the flashing digit to the right.

   For trigger level/trigger hysteresis setting

   • Pressing the ▲ key changes the value.



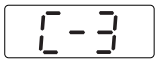
   • All digits flash when the fifth digit and sign can be changed.

Reference: Pressing the [ZERO] key here resets the display to "0000".

9. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

When "C-3" is selected

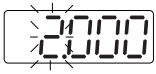


5. Press the ↵ key to specify each function.

6. Press the ▲ or ▶ key to specify the desired value.

   • The value of a flashing digit can be changed. Pressing the ▶ key moves the flashing digit to the right.

   • Pressing the ▲ key changes the value.



   • All digits flash in the state where the fifth digit or the sign is selected.

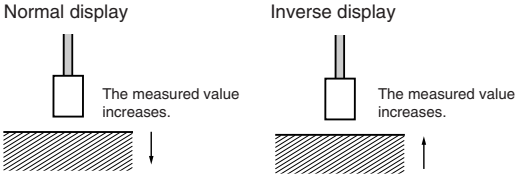
7. Press the ↵ key.

   The sensor saves the setting and returns to the measurement state.

4.4.4 Inverse/normal display function [d]

Selects the "inverse display" or "normal display".

Function No.	Function	Description
d-0	Normal display	The measured value increases when the distance between the sensor head and a target increases.
d-1	Inverse display	The measured value increases when the distance between the sensor head and a target decreases.

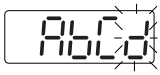


The inverse display is useful when the thickness or height of a target is measured.

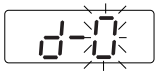
Setting function "d"

1. Press the SET key for at least 2 seconds.
   The sensor enters the common function selection mode.

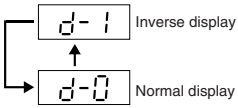
2. Press the ▶ key to make function "d" flash.



3. Press the ▲ or ↵ key to enter the inverse/normal display selection mode.



4. Press the ▲ key to select the desired function number.



5. Press the ↵ key.
   The sensor saves the setting and returns to the measurement state.

4.5 Details of Manual Mode

This section describes function codes "A" to "d" specified with the SET key for the manual mode.

4.5.1 No. of averaging measurements/Digital filter [A]

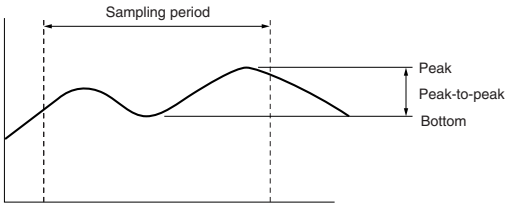
Sets the number of averaging measurements or the digital filter function.
☞ *Refer to page 47 for details.*

4.5.2 Measurement type [b]

The following six types of measurement are available:

Function No.	Measurement type		Description	Reference page
b-0	NR	Normal measurement	Displays/outputs the measured value continuously.	76
b-1	PH	Peak hold	Measures the maximum value during a specified period.	76, 77
b-2	BH	Bottom hold	Measures the minimum value during a specified period.	78, 79
b-3	PP	Peak-to-peak hold	Measures the difference between the maximum and minimum values during a specified period.	79, 80
b-4	SH	Sample hold	Measures the value at a specified time.	81, 82
b-5	AH	Average hold	Measures the simple average of measured values during a specified period.	82, 83

Hold mode

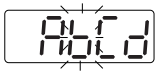


Select or set the desired measurement type in the following procedure:

Setting function "b"

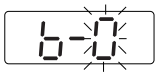
1. Press the [SET] key for at least 2 seconds.

   The sensor enters the common function selection mode.



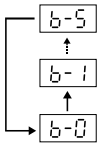
2. Press the [▶] key to make function "b" flash.

3. Press the [▲] or [↵] key to select the measurement type.



4. Press the [▲] key to select the desired function number.

   • Pressing the [▲] key changes the function number sequentially.
   • Pressing the [ZERO] key resets the display to "b-0".



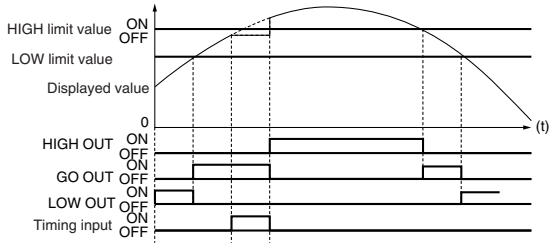
5. Press the [↵] key.

   The sensor saves the setting and returns to the measurement state.

Normal measurement function [b-0]

Displays/outputs the measured value continuously.

Timing diagram



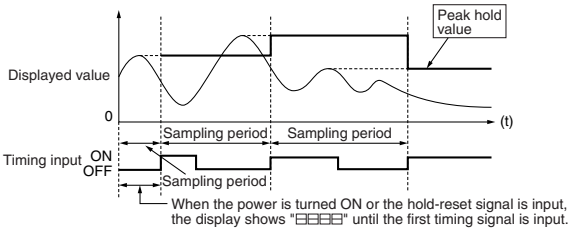
* When the timing input is turned ON, the display and comparator output is held.

4

Peak hold function [b-1]

Measures the "maximum value" during a specified period (sampling period). For the peak hold function, the sampling period can be specified with the combination of the trigger mode and delay time settings.

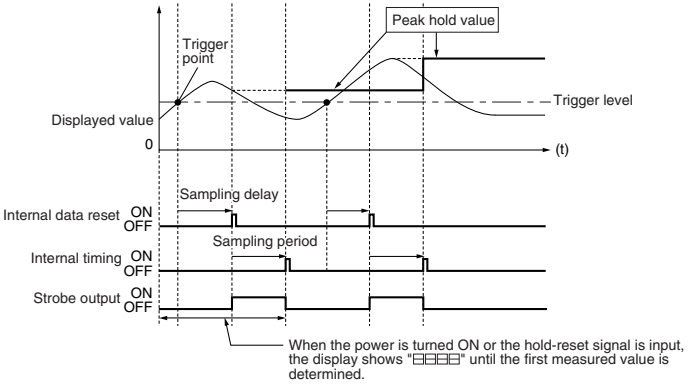
- *For the details of the trigger mode and delay time, refer to pages 69 and 70.*
- *For the details of flicker delay, refer to pages 70 to 73.*



- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

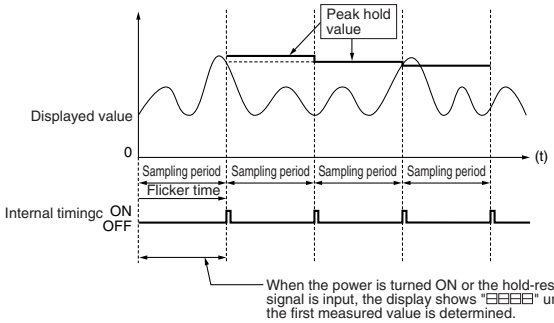
■ **Internal trigger mode (Example of internal trigger up ⎍)**



- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the peak value is displayed/output.
- For the internal trigger down ⎎ operation, the trigger point is the instant when the measured value falls below the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



- The internal timing signal is input once at each flicker time and the "maximum value" during the sampling period is displayed/output.

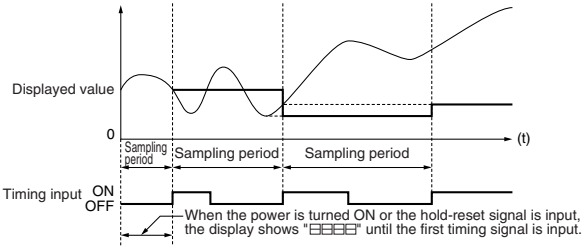
Bottom hold function [b-2]

Measures the "minimum value" during a specified period (sampling period). For the bottom hold function, the sampling period can be specified with the combination of the trigger mode and delay time settings.

- *For the details of the trigger mode and delay time, refer to pages 69 and 70.*
- *For the details of flicker delay, refer to pages 70 to 73.*

Timing diagram

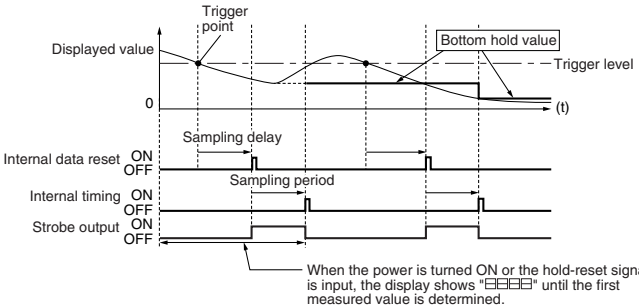
■ **External trigger mode**



- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

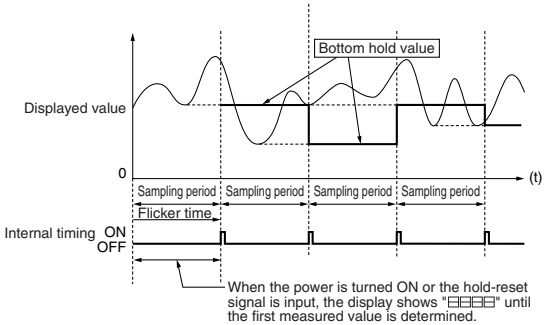
■ **Internal trigger mode (Example of internal trigger DOWN ↓)**



- The sampling operation starts when the sampling delay time elapses after the measured value falls below the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the bottom value is displayed/output.
- For the internal trigger up ↑ operation, the trigger point is the instant when the measured value exceeds the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



- The internal timing signal is input once at each flicker time and the "minimum value" during the sampling period is displayed/output.

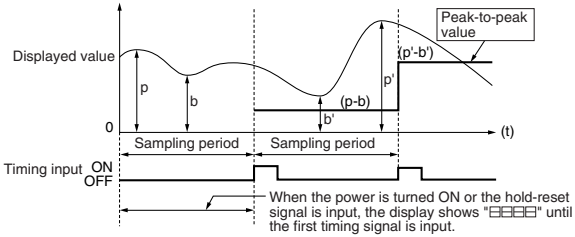
Peak-to-peak hold function [b-3]

Measures the "difference between the maximum and minimum values" during a specified period (sampling period).
For the peak-to-peak hold function, the sampling period can be specified with the combination of the trigger mode and delay time settings.

For the details of the trigger mode and delay time, refer to pages 69 and 70.
For the details of flicker delay, refer to pages 70 to 73.

Timing diagram

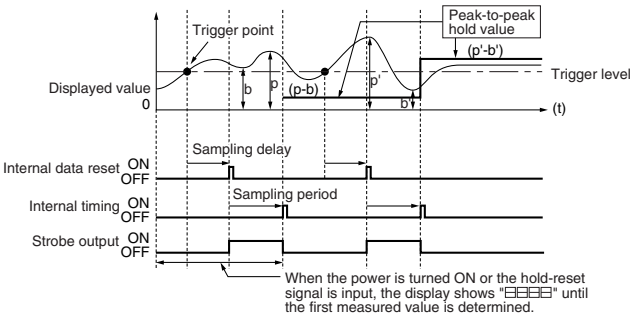
■ **External trigger mode**



- The sampling period is between the UP edge of the timing input (hold-reset input) and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

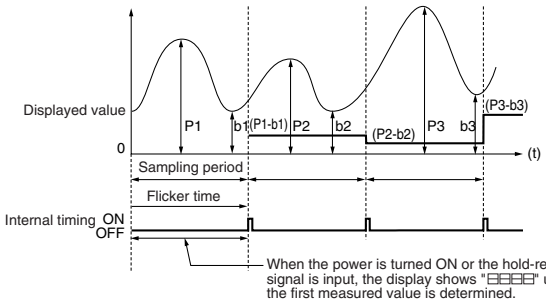
■ **Internal trigger mode (Example of internal trigger DOWN ↴)**



- The sampling operation starts when the sampling delay time elapses after the measured value falls below the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the "difference between the maximum and minimum values" is displayed/output.
- For the internal trigger up ↱ operation, the trigger point is the instant when the measured value exceeds the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



- The internal timing signal is input once at each flicker time and the "difference between the maximum and minimum values" during the sampling period is displayed/output.

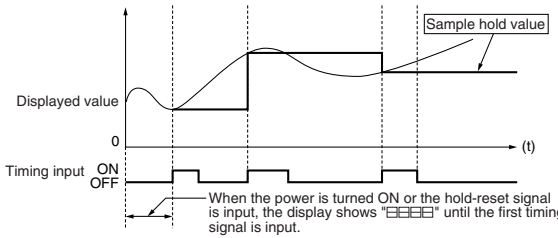
Sample hold function [ь-Ч]

Measures the value at a specified time.
For the sample hold function, the timing can be specified with the combination of the trigger mode and delay time settings.

- *For the details of the trigger mode and delay time, refer to pages 69 and 70.*
- *For the details of flicker delay, refer to pages 70 to 73.*

Timing diagram

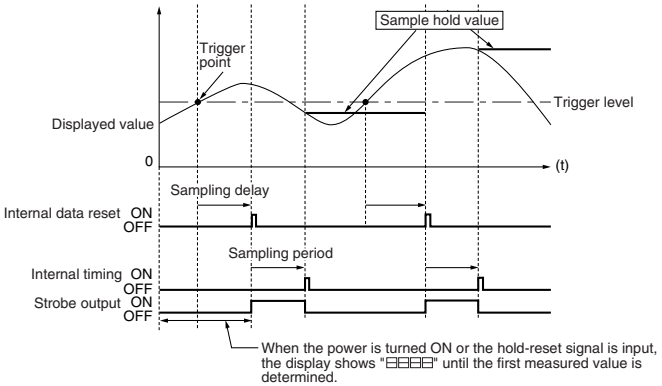
■ **External trigger mode**



- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To clear the measured value being held, short-circuit the hold-reset and GND terminals.

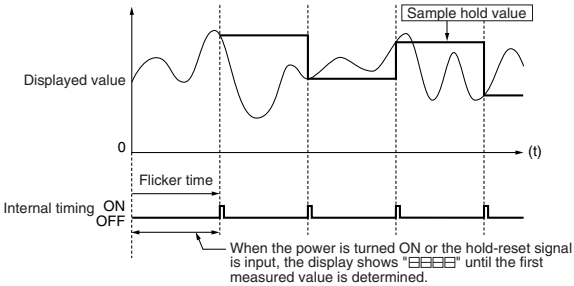
■ **Internal trigger mode (Example of internal trigger up ⎍)**



- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the measured value at the instant is displayed/output.
- For the internal trigger down ⎎ operation, the trigger point is the instant when the measured value falls below the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



- The internal timing signal is input once at each flicker time and the value at the instant is displayed/output.

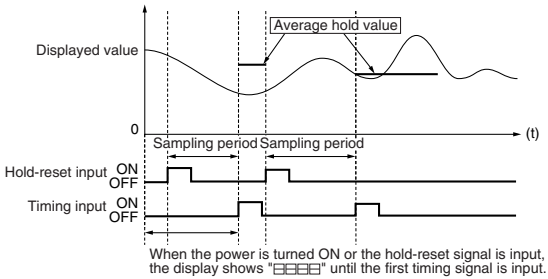
Average hold function [b-5]

Measures the simple average of measured values during a specified period (sampling period).
For the average hold function, the sampling period can be specified with the combination of the trigger mode and delay time settings.

For the details of the trigger mode and delay time, refer to pages 69 and 70.
For the details of flicker delay, refer to pages 70 to 73.

Timing diagram

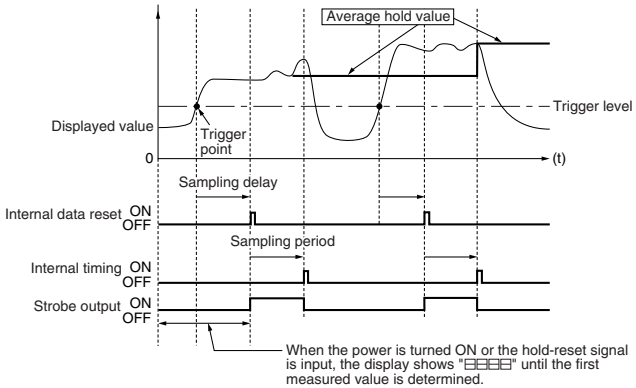
■ **External trigger mode**



- The sampling period is between the UP edge of the hold-reset input and the UP edge of the next timing input.
- The value measured at the instant when the timing input turns ON is displayed/output.

Reference: To start the measurement again, short-circuit the hold-reset and GND terminals.

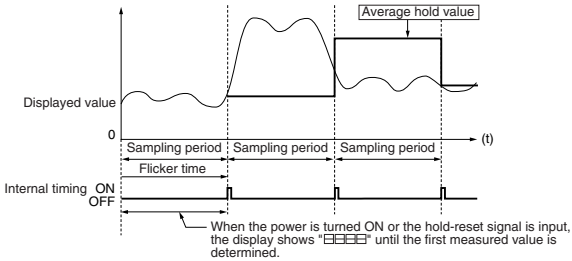
■ **Internal trigger mode (Example of internal trigger up ⎍)**



- The sampling operation starts when the sampling delay time elapses after the measured value exceeds the trigger level. When the sampling period elapses, the internal timing signal is turned ON and the measured value at the instant is displayed/output.
- For the internal trigger down ⎎ operation, the trigger point is the instant when the measured value falls below the trigger level.
- The instant when the sampling starts, the strobe output turns ON.
- Turning the strobe output from ON to OFF results in the off-delay of 2 ms for updating the comparator output.

Reference: To clear the measured value being held and to start the measurement again, short-circuit the hold-reset and GND terminals.

■ **Flicker mode**



- The internal timing signal is input once at each flicker time and the value at the instant is displayed/output.

4.5.3 Measurement period [C]

This function sets or selects the sampling period to use the hold measurement.

➲ *Refer to pages 70 to 73 for details.*

4.5.4 Previous value comparison function [d]

Compares the average of the previously measured values with the current measured value and displays only abrupt changes among slow changes.

➲ *Refer to page 56 for details.*

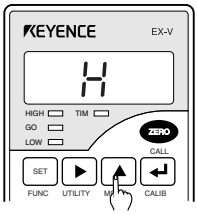
4.6 Hysteresis Setting

With the EX-V series, the hysteresis for the comparator output (HIGH/GO/LOW OUT) is factory-adjusted to 5 digits.
Change the hysteresis by following the procedures below when necessary.

1. Press the [SET] key.

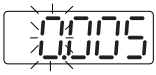
   The sensor enters the tolerance limit setting mode.

2. Press the [▲] key to display "H".



3. Press the [↵] key.

   The sensor enters the hysteresis setting mode.

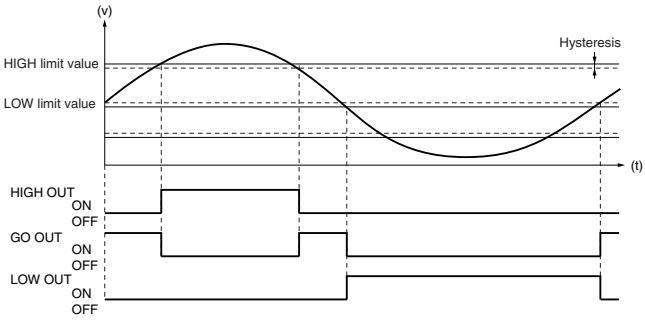


4. Press the [▶] or [▲] key to set the desired hysteresis value.

5. Press the [↵] key.

   The sensor saves the specified hysteresis value and returns to the measurement mode.

Timing diagram



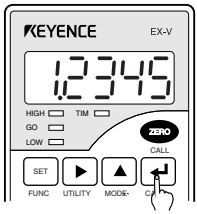
The hysteresis can be set within the range of 0 to +19999 digits.

4.7 Initialization

All specified functions can be reset to the initial settings.

Note: When the functions are initialized, the adjustment data for the output characteristics will also be erased. Be sure to adjust the output characteristics again after the initialization. (*Refer to page 9.*)

1. Hold down the ↵ key and turn ON the power of the sensor.
   - The sensor displays "U-□□".
   - Now the sensor is reset to the initial settings.
     For the details of the initial settings, refer to "4.1 Table of Data Processing Functions" on page 46.



* "□□" displayed above is an example.
When values other than "□□" are displayed, the initialization is successful.

2. Press the ↵ key again.

   The sensor enters the measurement state.

3. Turn OFF the power once and turn it ON again.

Chapter 5

Troubleshooting

Explains the error messages displayed when an error has occurred, and countermeasures to be taken.

5.1 Error Messages 88

5.2 Troubleshooting List 89

5.1 Error Messages

When the EX-V series detects an error during the operation, it displays one of the following error messages. Check the error and cause from the table below and take an appropriate countermeasure to solve the problem.

Display	Cause	Countermeasure
Err0	The sensor head is disconnected or the connection is insecure.	Check the wiring and connect the sensor head again. (When the hold mode is used, this error is not reset until the next timing input is turned ON.)
	The adjustment is improper.	Adjust the sensor again.
Err1	Tolerance limit input value error	Press the ↵ key to reset the error and set the tolerance limit value again.
Err2	Display scaling error	Press the ↵ key to reset the error and set the display scaling again.
Err3	Monitor output scaling error	Press the ↵ key to reset the error and set the monitor output scaling again.
Err4	The internal data overflowed when the simple average measurement was used in an external trigger mode.	Turn ON the hold-reset terminal input.
Err5	The flicker input time is specified as 0 second.	Press the ↵ key to reset the error and set the proper value.
Err6	The measuring distance is improper during the sensor head adjustment.	Press the ↵ key to reset the error and set the proper value.
Err7	The hysteresis is set to "0" for the difference between peaks (bottoms) measurement.	Press the ↵ key to reset the error and set the proper value.

* When the error messages other than above are displayed, contact your nearest KEYENCE office.

5.2 Troubleshooting List

When the EX-V series does not function properly, check the following list and take an appropriate countermeasure against the problem.

Symptom	Check point	Countermeasure	Reference page
Measured values are not displayed.	Is a timing input turned ON?	Input a timing signal.	–
	Is the trigger level for the internal trigger properly set?	Adjust the trigger level.	–
Display remains "0000".	If the eccentricity/ vibration mode or peak-to-peak hold mode is selected, are there any changes in the measured value during the sampling period?	The eccentricity/vibration mode and peak-to-peak hold mode display the difference in the measured values. If the measured value does not change, the display remains "0000".	–
	Is the sensor head cable short-circuited?	When a short circuit occurs in the core and shielding wires of the sensor head coaxial cable, the display remains "0000". Check the wiring.	–
The displayed value is too large (small).	Is the auto-zero or offset function is selected?	The auto-zero and offset functions add/subtract a certain value to/from the measured value. If these functions are selected, reset them and try the measurement again.	40
The displayed value is unstable.	Is the sensor head securely mounted?	Check that the sensor head mounting jig is secure.	7
"FFFF" or "-FFFF" is displayed.	Is the resulted value out of the display range?	Check that any great value is not specified as an offset value.	40

MEMO

Chapter 6

Specifications and Dimensions

Read as necessary.

6.1 Specifications 92

6.2 Characteristics Charts 93

6.3 Minimum Input Time and Output Response Time 96

6.4 Dimensions 98

6.1 Specifications

Shape		Cylindrical	Threaded	Cylindrical, threaded		Thin profile
		ø5.4 x 18 mm	M10 x 18 mm	ø14.5 x 20 mm	ø22 x 35 mm	14 x 30 x 4.8 mm
Model	Sensor head	EX-305V	EX-110V	EX-416V	EX-422V	EX-614V
	Amplifier unit *1	EX-V01 (P)	EX-V02 (P)	EX-V05 (P)	EX-V10 (P)	EX-V64 (P)
Measuring range		0 to 1 mm	0 to 2 mm	0 to 5 mm	0 to 10 mm	0 to 4 mm
Display range		-19999 to 19999				
Linearity		±0.3% of F.S.				
Resolution (No. of averaging measurements: 64)		0.4 µm	0.4 µm	1 µm	2 µm	1 µm
Sampling rate		40000 samplings max./sec. *2				
Display rate		20/sec.				
Display character		7-segment 2-color LED				
Range-over alarm		±FFFF is displayed.				
Control input	Timing input	EX-V □ □ NPN open-collector or non-voltage contact signal EX-V □ □ P 10 to 30 V applied				
	Reset input					
	Auto-zero input					
	Comparator output disable input					
	Synchronous input					
	External setting input					
Control output	Tolerance setting	Upper/lower 2-level setting x 4 patterns (selectable)				
	HIGH, GO, LOW	EX-V □ □ : NPN open collector 100 mA max. (40 V or less), residual voltage 1 V or less EX-V □ □ P: PNP open collector 100 mA max. (30 V or less), residual voltage 1 V or less				
	Response time	0.075 ms (at maximum speed)				
	Off-delay time	60 ms				
Strobe output		EX-V □ □ : NPN open collector 100 mA max. (40 V or less), residual voltage 1 V or less (N.O.) EX-V □ □ P : PNP open collector 100 mA max. (30 V or less), residual voltage 1 V or less (N.O.)				
Alarm output		EX-V □ □ : NPN open collector 100 mA max. (40 V or less), residual voltage 1 V or less (N.C.) EX-V □ □ P : PNP open collector 100 mA max. (30 V or less), residual voltage 1 V or less (N.C.)				
Analog voltage output	Output voltage	±5 V				
	Impedance	100 Ω				
	Response time	0.075 ms (at maximum speed)				
Temperature fluctuation		0.07% of F.S./° C *3				
Rating	Power supply	24 VD±10%, Ripple (P-P): 10% max.				
	Current consumption	240 mA max.				
Environmental resistance	Ambient temperature: Sensor head	-10 to +60° C				
	Ambient temperature: Amplifier unit	0 to +50° C				
	Relative humidity	35 to 85%, No condensation				
	Vibration	10 to 55 Hz, 1.5 mm double amplitude in X, Y and Z directions, 2 hours respectively				
Weight	Sensor head (including 3-m cable)	Approx. 45 g	Approx. 55 g	Approx. 75 g	Approx. 200 g	Approx. 60 g
	Controller	Approx. 235 g				
Major functions		Auto-zero function, Offset function, Measurement modes (15 types), Tolerance limit value memory function (4 patterns)				

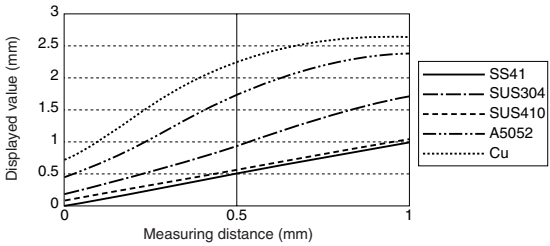
* The above data was obtained using an iron target (S45C, SS41, t = 1 mm). When measuring aluminum, copper, or stainless steel targets, refer to the linear characteristics for these materials.

1. The EX-VxxP is a PNP output type.
2. When the digital filter function is used, the sampling rate is 20000 sampling/sec.
3. When the distance between the sensor head and the target is within 50% of the measuring range.

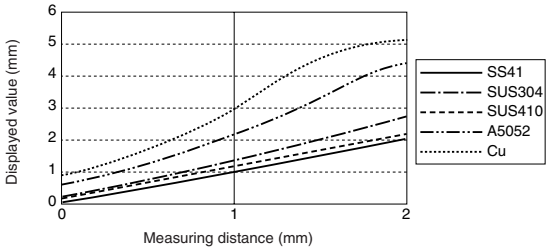
6.2 Characteristics Charts

Linear characteristics for various material (Typical)

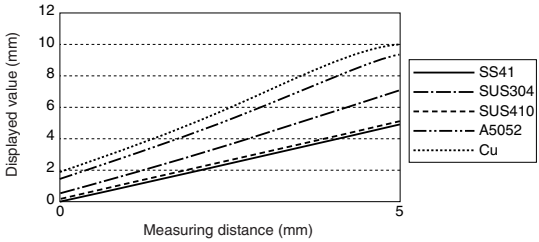
■ **EX-305V**



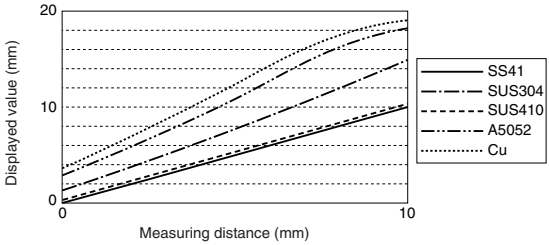
■ **EX-110V**



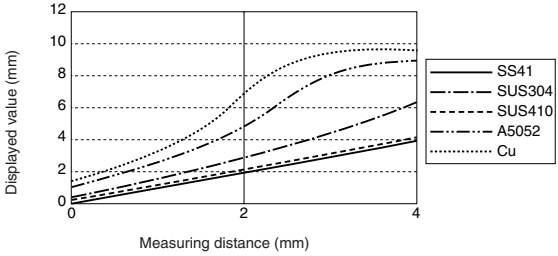
■ **EX-416V**



■ **EX-422V**



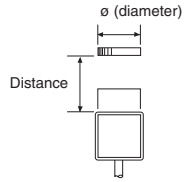
■ **EX-614V**



6

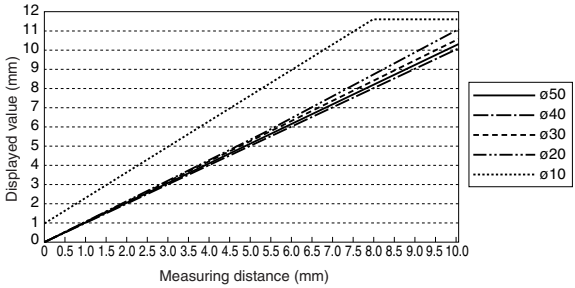
Output characteristics for measuring targets of various diameters (Typical)

Measurement sketch

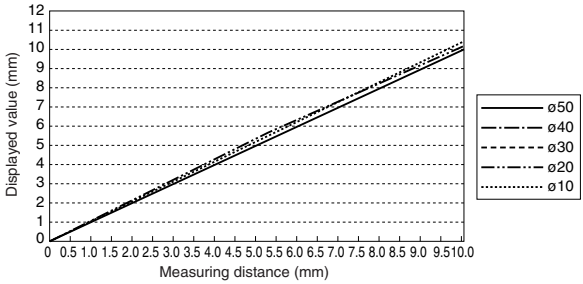


■ **When the EX-V10 and EX-422V are used (Target: Iron [S45C, t = 30 mm])**

■ **When calibrated using a standard target (80 x 80 mm):**



■ **When calibrated using targets of various diameters:**



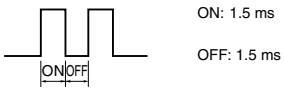
6.3 Minimum Input Time and Output Response Time

This section describes the minimum input time and the output response time of the EX-V series.

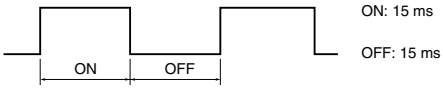
Minimum input time

The minimum input time required for the TIMING, HOLD RESET, ZERO, OUTPUT DISABLE and EXT1/EXT2 is as follows:

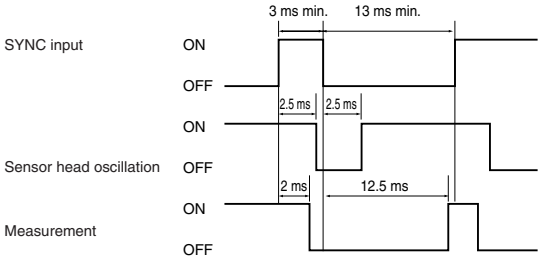
■ TIMING and HOLD RESET



■ ZERO, OUTPUT DISABLE and EXT1/EXT2



■ SYNC



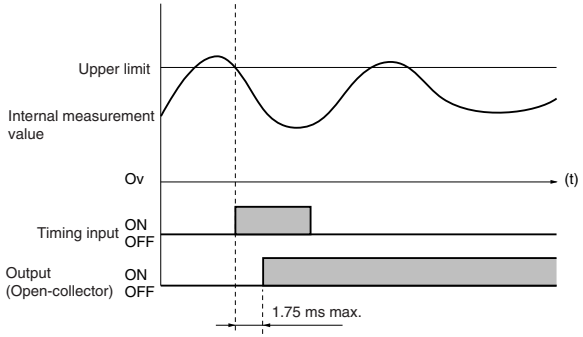
Note: The minimum input time does not include the processing time after the signal is received.

Output response time

■ In Normal mode

No. of averaging measurements		Maximum response time
A-0	(1)	0.075 ms
A-1	(2)	0.1 ms
A-2	(4)	0.15 ms
A-3	(8)	0.25 ms
A-4	(16)	0.45 ms
A-5	(64)	1.65 ms
A-6	(256)	6.475 ms
A-7	(1024)	25.825 ms
A-8	(4096)	103.225 ms
A-9	(16384)	412.825 ms

■ When Hold mode is used:

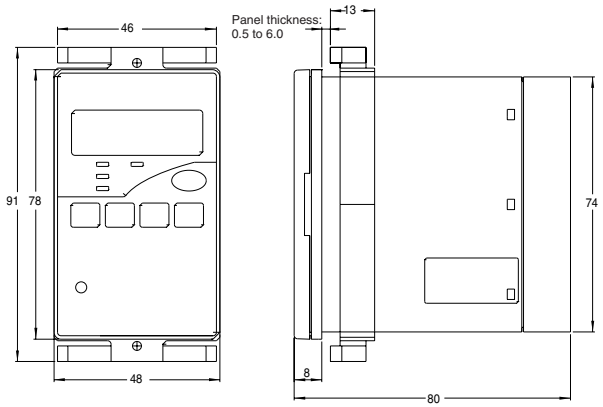


When any hold mode is used, the output response time is fixed to 1.75 ms regardless of the number of averaging measurements.

6.4 Dimensions

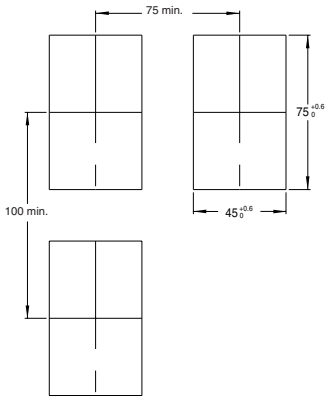
■ Controller

Unit: mm



■ Panel cutout

Unit: mm

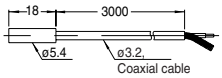


6

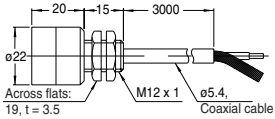
■ Sensor head

Unit: mm

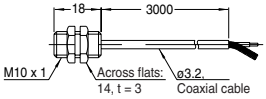
EX-305V



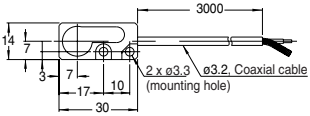
EX-422V



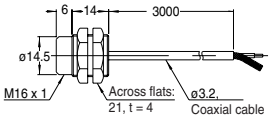
EX-110V

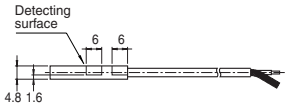


EX-614V



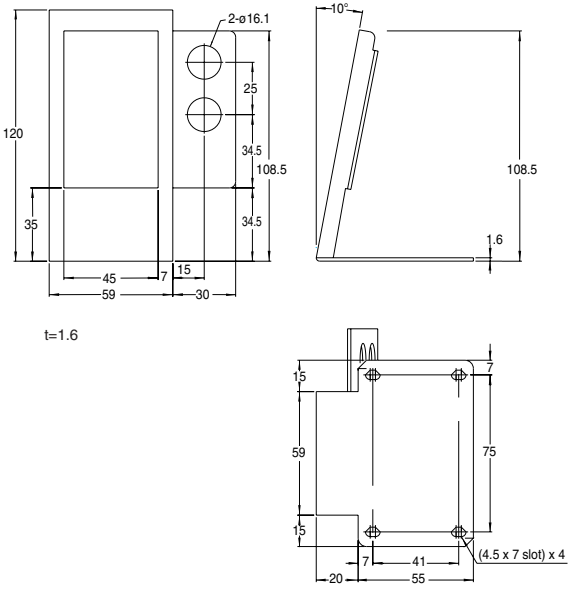
EX-416V





■ Mounting bracket (OP-35407)

Unit: mm



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Read as necessary.

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