KEYENCE

96M16997

Instruction Manual

Clamp-on Flow Sensor

FD-H Series

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> *** For details on flow sensor installation, see the included "Installation Guide."**

Overview of the Clamp-on Flow Sensor

FD-H Series

	Model	Principle	Built-in temperature sensor
Standard	FD-Hxx	Hybrid	✓
High-temperature	FD-HxxK	Hybrid	-
Hose	FD-HxxF	Delta time of flight (TOF)	-

Flow rate measurement with no pipe modification

Display unit (LCD display)

M12 Power supply port

Multi-port

Up to two sensors of the following types can be connected to the Multi-port.

(For temperature sensors, only two of the same model of sensor can be connected at the same time.) When connecting two sensors use Y-connector FD-HY1.

Concentration
management

Refractive Index Concentration Sensor
FI-C

Liquid level
management

Guide Pulse Level Sensor
FL

Temperature
management

Clamp-on Temperature Sensor
FI-T

1. Before Operation

■ Symbols

This instruction manual uses the following symbols to alert readers to important messages. Be sure to read these messages carefully.

⚠ DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a situation which, if not avoided, could result in product damage as well as property damage.
▶ Important	Indicates cautions and limitations that must be followed during operation.
✎ Point	Indicates additional information on proper operation.
Reference	Indicates tips for better understanding or useful information.

Safety Precautions

■ General precautions

⚠ DANGER	1. Do not use this product out of the specification ranges. Comply with the contents described in this instruction manual when using the product. 2. Do not use this product in an application where death, serious injury, or serious property damage is possible should a failure of the product occur, such as nuclear power plants, on aircraft, trains, ships, or vehicles, used within medical equipment, playground equipment, roller coasters and other rides, etc. 3. Do not use this product for the purpose of protecting a human body or a part of a human body. 4. This product is not intended for use as an explosion-proof product. Do not use this product in a hazardous location and/or potentially explosive atmosphere.
⚠ WARNING	1. Do not modify this product. 2. If the product is used in a manner not specified by this manual, the protections provided by the product may be impaired.
▶ Important	Do not use the FD-H Series as a measurement instrument for trade or certification.

■ Precautions for handling

⚠ WARNING	When installing this product on a high-temperature pipe, the product may become hot. Use caution to prevent burns and/or injury.
NOTICE	Do not drop the FD-H, hit it against something, or apply excessive force.

■ Precautions for wiring

⚠ CAUTION	Use the FD-H within its rated range. This sensor should be used with a DC power supply. Do not apply AC voltage. Also, do not use a load that exceeds the permitted range.
NOTICE	1. Check the wire colors during wiring. 2. Use an insulated stabilizing power supply. 3. Do not apply excessive tensile force to the cable. 4. Ensure that the cable tip is not submerged in water during wiring work. 5. Do not place the cables connected to this product together with power supply cables for other products. 6. Isolate the cables as far away as possible from any source of noise. 7. Do not use an M12 power supply cable with a total length longer than 30 m (20 m when using IO-Link). 8. When temperature, concentration, or level sensors are connected to the Multi-port, do not use cables with a length longer than 20 m between the display unit and the devices. 9. When the flow sensor's display unit and sensing elements are separated, do not use a cable with a length longer than 20 m. 10. If this product is at risk of being struck by lightning or similar hazards are present, implement countermeasures such as installing a separate isolator and a lightning arrester. 11. Each cable is heat resistant up to 80°C. If the pipe surface temperature meets or exceeds 80°C, ensure the product does not touch the pipe directly.

■ Precautions for installation

⚠ CAUTION	Do not install this product in a location where it may become submerged in a liquid. Doing so may lead to electric shock and damage due to insulation defects.

NOTICE	1. Install the FD-H in a location where the inside of the pipe is always filled with fluid. 2. To prevent a situation where flow detection is affected by a partially filled pipe/hose, it is recommended to install the unit in a position where the display surface is perpendicular to the ground. 3. When installing the FD-H on a vertical pipe, choose a position where the fluid flows in the upward direction. 4. To improve the detection stability, it is recommended that the sensor be installed in a location with a straight section of pipe five times the inner diameter of the pipe upstream of it. * Even if such a section is not available, the pipe being filled with fluid will provide signal strength enabling detection. 5. Do not install the FD-H in a location exposed to radiant heat from a heat source. 6. When installing the FD-H in a location where vibrations occur, fix the pipe in place with supports as close to the main unit as possible. Excessive vibration may lead to unstable operation or load on the pipe. 7. To avoid interference between detection signals, do not install multiple units closely in series. 8. When installing the flow sensor on a high-temperature pipe, insulating the area surrounding the pipe and flow sensor may prevent heat from being released, leading to damage. 9. When installing the high-temperature model (FD-HxxK) on a pipe that reaches temperatures of 140°C or higher, use the display unit separate from this model. Also, switch the couplant with an ultra-high-temperature couplant (sold separately). 10. When using the high-temperature model (FD-HxxK) close to 180°C, the signal strength may drop due to couplant deterioration over a long period of time. This problem can be fixed by switching to a new ultra-high-temperature couplant. 11. Only the standard model (FD-Hxx) is designed for outdoor use. In this situation, (1) be sure to use the protection cover (FD-HP2) and cable (FD-HCB10G) designed for outdoor use. (2) Integrate the detection head and display unit. (3) Do not connect sensors to the Multi-port.

■ Other precautions

▶ Important	1. When power is applied to this product, it enters an approximately 15 second "startup" process before it is ready to be used. Do not use the outputs from the product during this period. 2. Initial drift may occur after the power is turned ON. To detect subtle flow differences, let the FD-H warm up for approximately 15 to 30 minutes before use. 3. Do not bring a strong magnetic force or magnetic field close to the FD-H.

This product includes open source software components. For information about these open source software components, refer to the "License Information" on the "Help" menu in [FD-H/FI History Reader], which is software that can be downloaded from the Internet.

Precautions on Regulations and Standards

■ CE and UKCA Markings

Keyence Corporation has confirmed that this product complies with the essential requirements of the applicable EU Directive(s) and UK regulations, based on the following specifications. Be sure to consider the following specifications when using this product in the Member States of European Union and in the United Kingdom.

● EMC Directive (CE) and Electromagnetic Compatibility Regulations (UKCA)

• Applicable Standard   (BS) EN 61326-1, Class A

Install this product where there is no harmful surge effect (e.g. 30m or less for indoor use. 10m or less for outdoor use.).

Remarks: These specifications do not give any guarantee that the end-product with this product incorporated complies with the essential requirements of EMC Directive and Electromagnetic Compatibility Regulations. The manufacturer of the end-product is solely responsible for the compliance on the end-product itself according to EMC Directive and Electromagnetic Compatibility Regulations.

■ CSA Certificate

This product complies with the following CSA and UL standards and has been certified by CSA.
• Applicable standard   CAN/CSA C22.2 No.61010-1
                             UL61010-1
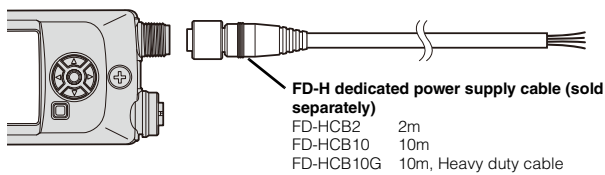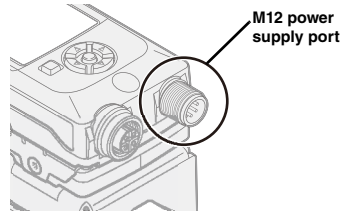Be sure to consider the following specifications when using this product as a product certified by CSA.
• Use this product under pollution degree 3.
• Indoor use only
• Use this product at the altitude of 2000m or less
• Use a CSA/UL certified power supply that provides Class 2 output as defined in the CEC (Canadian Electrical Code) and NEC (National Electrical Code) or a CSA/UL certified power supply that has been evaluated as a Limited Power Source as defined in CAN/CSA-C22.2 No.60950-1/UL60950-1.

2. Installation and Wiring

* For details on flow sensor installation, see the included "Installation Guide."
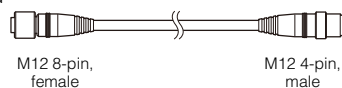
Connecting the M12 Power Supply Cable

The display unit has one power supply port which is a M12 8-pin connector (of which 6 pins are used). Please use the dedicated 6 core cable.

M12 power supply port

FD-H dedicated power supply cable (sold separately)
FD-HCB2   2m
FD-HCB10   10m
FD-HCB10G   10m, Heavy duty cable

Converting to M12 4-pin

A conversion cable can be used to change from M12 8-pin to M12 4-pin. This is useful when establishing an IO-Link connection.

M12 8-pin, female   M12 4-pin, male

FD-HCC2   M12 power supply cable with 8-pin to 4-pin conversion, 2m
FD-HCC10   M12 power supply cable with 8-pin to 4-pin conversion, 10m
FD-HCC0   8-pin to 4-pin conversion connector

Channel Functions

The FD-H Series has four I/O wires corresponding to channels (Ch1 to Ch4) that can be assigned to control output, external input, and analog output according to the chart below.
Use "3. Initial Settings" > "H. Initial Settings [I/O]" to assign the wires.

Wire color	Function
Brown	Power supply +20-30 V
Blue	GND
Black (Ch1)[*1]	Control output or analog (selectable)
White (Ch2)	Control output, analog output, or external input (selectable)[*2]
Gray (Ch3)	Control output or external input (selectable)[*2]
Pink (Ch4)	Control output (fixed)

*1   IO-Link wire during an IO-Link connection. It is not possible to switch to IO-Link communication if analog output is selected.
*2   Two external input wires are required by the bank input function, set Ch2 and Ch3 to external input to use this function.
*3   When using an M12 8-pin to 4-pin conversion cable or a conversion connector, the brown, blue, black (Ch1), and white (Ch2) wires can be used as follows.

(1) Brown   (2) White (Ch2)
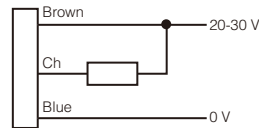(3) Blue   (4) Black (Ch1)

Wiring

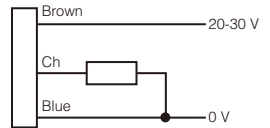Independently insulate any unused input/output wires.

▭ Load (input device)   ⊘ Analog current input device

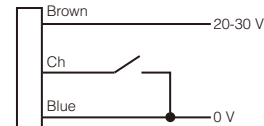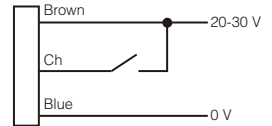### (1) Wiring for channel assigned to control output

• NPN

Brown — 20-30 V
Ch
Blue — 0 V

• PNP

Brown — 20-30 V
Ch
Blue — 0 V

(2) Wiring for channel assigned to external input

• NPN

Brown — 20-30 V
Ch
Blue — 0 V

• PNP

Brown — 20-30 V
Ch
Blue — 0 V

(3) Wiring for channel assigned to analog output

Brown — 20-30 V
Ch
Blue — 0 V
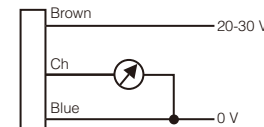
* It is possible to switch between 4-20 mA and 0-20 mA using settings.

The wiring varies according to the channel assignment.

Connecting to the Multi-port

The display unit has one Multi-port to which temperature, concentration, and liquid level sensors can be connected.

Multi-port

Use a Y-shaped connector (FD-HY1) to connect up to two sensors, such as a temperature sensor and a concentration sensor, at the same time.

Remove the cover with a flathead screwdriver and connect an M12 connector cable (sold separately).
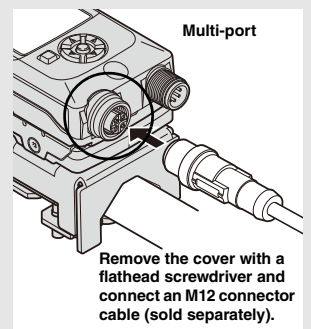
■ Connectable sensors

Models that can be connected		Maximum number of connectable units per FD-H display unit	Temperature measurement	Concentration measurement	Level measurement
Temperature sensor	FI-T	2	✓	-	-
Concentration sensor	FI-C	1	✓	✓	-
Level sensor	FL	1	-	-	✓

3. Initial Settings

Settings During Initial Startup (Initialization)

A Language

Initial Settings
Language
ENGLISH
日本語
中文
DEUTSCH
● Select

Press ●
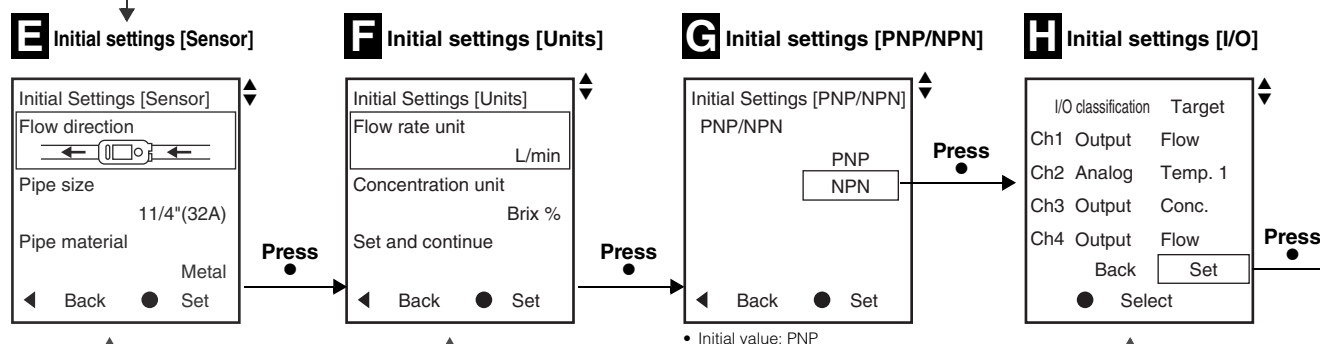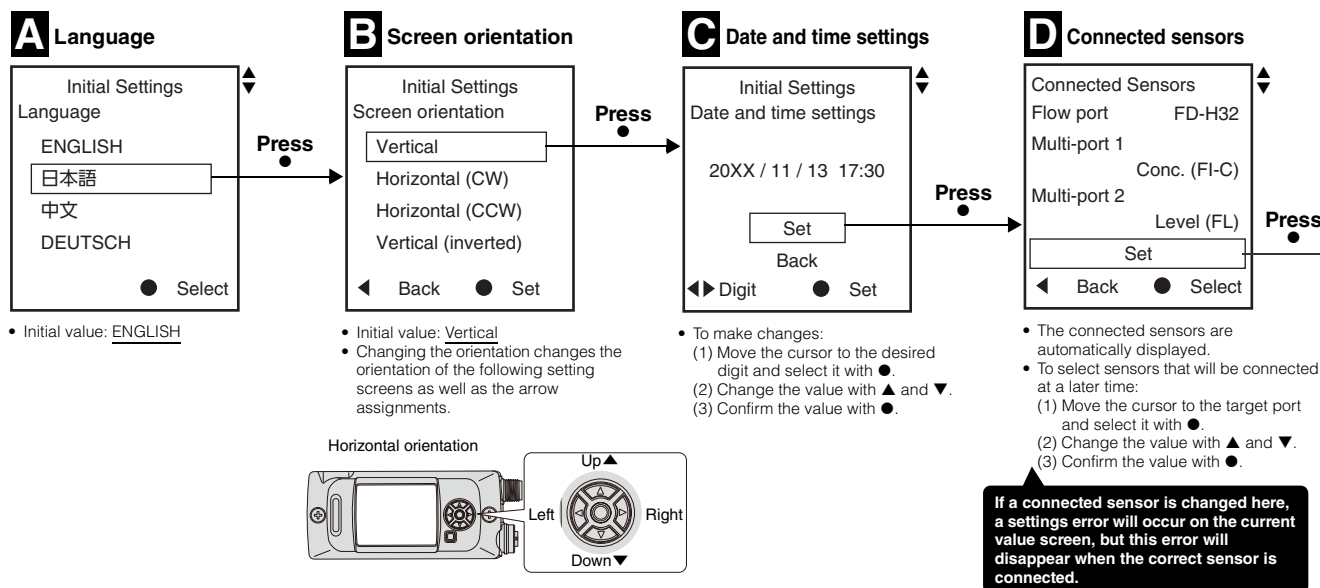
- Initial value: ENGLISH

B Screen orientation

Initial Settings
Screen orientation
Vertical
Horizontal (CW)
Horizontal (CCW)
Vertical (inverted)
◀ Back ● Set

Press ●

- Initial value: Vertical
- Changing the orientation changes the orientation of the following setting screens as well as the arrow assignments.

Horizontal orientation

Up ▲
Left ◀ ▶ Right
Down ▼

C Date and time settings

Initial Settings
Date and time settings

20XX / 11 / 13 17:30

Set
Back
◀▶ Digit ● Set

Press ●

- To make changes:
  (1) Move the cursor to the desired digit and select it with ●.
  (2) Change the value with ▲ and ▼.
  (3) Confirm the value with ●.

D Connected sensors

Connected Sensors
Flow port   FD-H32
Multi-port 1
                 Conc. (FI-C)
Multi-port 2
                 Level (FL)
Set
◀ Back ● Select

Press ●

- The connected sensors are automatically displayed.
- To select sensors that will be connected at a later time:
  (1) Move the cursor to the target port and select it with ●.
  (2) Change the value with ▲ and ▼.
  (3) Confirm the value with ●.

If a connected sensor is changed here, a settings error will occur on the current value screen, but this error will disappear when the correct sensor is connected.

E Initial settings [Sensor]

Initial Settings [Sensor]
Flow direction
← |■□◦|
Pipe size
                 1 1/4"(32A)
Pipe material
                 Metal
◀ Back ● Set

Press ●

Item	Options (underlined items are initial values)
Common across all FD-H Series Flow Sensors	
Flow direction	From the LED side, Toward the LED side (* Select with the illustration.)
Pipe size	
• FD-H10(K)	1/4" (8A), 3/8" (10A)
• FD-H20(K)	1/2" (15A), 3/4" (20A)
• FD-H32(K)	1" (25A), 1 1/4" (32A)
Hose size	
• FD-H22F	13~, 15~, 17~, 19~, 21~
• FD-H32F	23~, 25~, 27~, 29~, 31~
• FD-H47F	33~, 36~, 39~, 42~, 45~
• FD-H63F	48~, 51~, 54~, 57~, 60~
Standard (FD-H) or high-temperature (FD-HxxK) flow sensor connected	
Pipe material	Metal, Resin
Hose (FD-HxxF) flow sensor connected	
Hose type	Standard, High-pressure
Level sensor (FL) connected	
Probe input (FL)*1	200mm increments, 1mm increments. (standard only)
Probe length*2	100 to 12000 mm (200 mm)
Flow sensor + temperature sensor (FI-T) × 2 connected	
Heat transfer calculation*3	Disabled, Enabled

*1 With the FL-C001/S001 connected, select "200mm increments."
*2 If a value exceeding 2000 mm is entered with the FL-001/C001/S001 connected, the sensor will operate with the value set to 2000 mm.
*3 Setting Heat transfer calculation to "Enabled" allows the setting of Heat transfer unit on the [F] Initial Settings [Units] screen and the assignment of Heat transfer on the [H] Initial Settings [I/O] screen.

Select "High pressure" for black rubber, high-pressure hoses and other such pressure-resistant hoses and "Standard" for all other hoses (braided hoses and soft plastic tubes).

F Initial settings [Units]

Initial Settings [Units]
Flow rate unit
                 L/min
Concentration unit
                 Brix %
Set and continue
◀ Back ● Set

Press ●

Item	Options (underlined items are initial values)
Flow sensor connected	
Flow unit	L/min, m³/h, G/min
Temperature sensor connected	
Temp. unit*	°C, °F
Concentration sensor (FI-C) connected	
Concentration unit	Brix%, nD (refractive index)
Level sensor connected	
Level unit*	mm, inch
Heat transfer calculation = Enabled on previous screen	
Heat transfer unit	MJ/h, kW, kBTU/h*

*

▶ Important **When changing the unit of measurement be sure to check and abide by the laws and regulations of the country and location in which the product will be used.**

G Initial settings [PNP/NPN]

Initial Settings [PNP/NPN]
PNP/NPN
                 PNP
                 NPN
◀ Back ● Set

Press ●

- Initial value: PNP

H Initial settings [I/O]

I/O classification Target
Ch1 Output Flow
Ch2 Analog Temp. 1
Ch3 Output Conc.
Ch4 Output Flow
Back Set
● Select

Press ●

I/O classification	Output	Analog	Input*3
Settable channels	Ch1,*1 *2 Ch2, Ch3, Ch4	Ch1,*1 Ch2	Ch2, Ch3
Options*4	Flow Temp.1 (xx) Temp.2 (xx) Conc. Level Heat tranfer Error	Flow Temperature 1 (xx) Temperature 2 (xx) Concentration Level Heat transfer	- - - -

Functions can be assigned for each channel such as "Output" with "Flow" and "Analog" with "Temperature."

*1 Ch1 is the IO-Link wire during an IO-Link connection. It is not possible to switch to IO-Link communication if "Analog" is selected.
*2 Only Ch1 supports pulse output.
*3 Two external input wires are required by the bank input function. Set Ch2 and Ch3 to "Input" to use this function.
*4 Temperature 1 and Temperature 2 can be selected when devices with temperature measuring functions (FD-H standard / FI-T / FI-C) are assigned to the connected sensors. Concentration and Level can be selected when the FI-C or FL is assigned, respectively, to the connected sensors. Heat transfer can be selected when Heat transfer calculation is set to "Enabled" on screen [E].
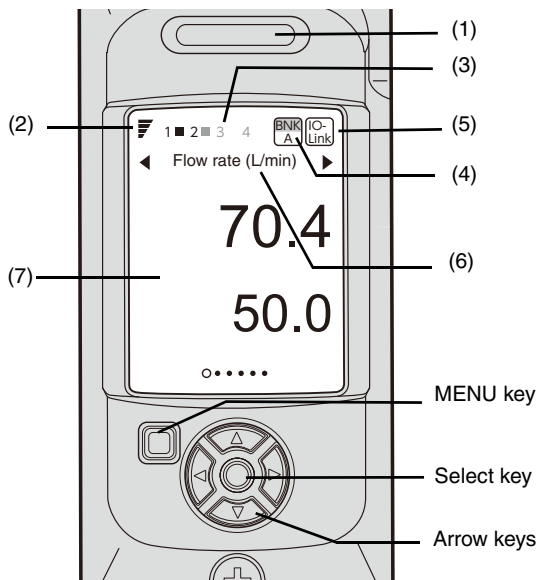
Final check screen

Press ●

Exit

To current value screen

4. Viewing the Current Value 123

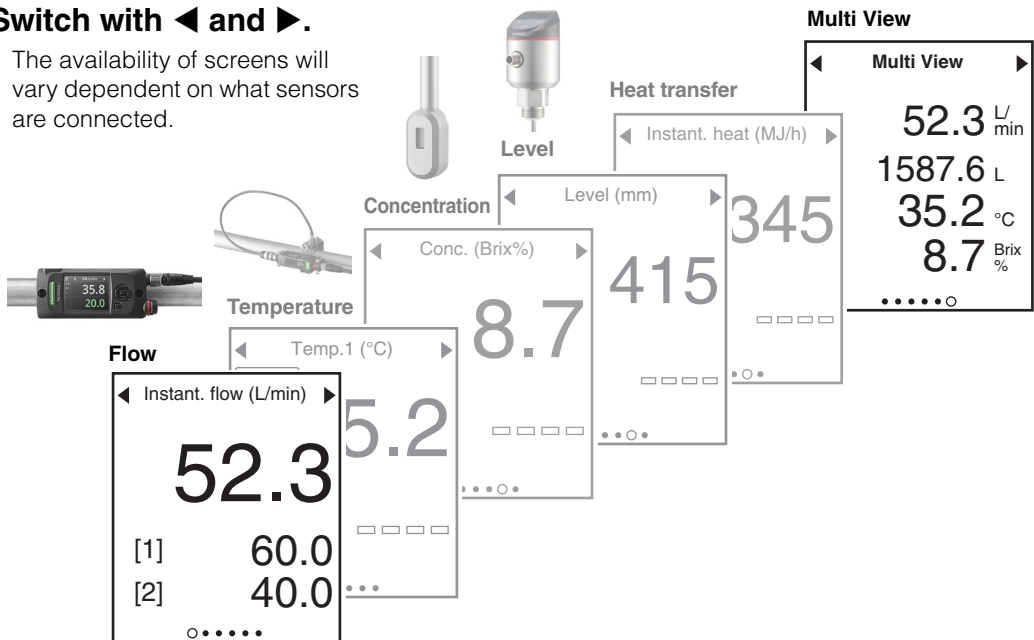## Parts of the Display

No.	Name	Function
(1)	**Status indicator**	Lights according to the status of the output. Flashes red when an error occurs. (For details, see Page 17.)
(2)	**Flow sensor stability indicator**	This indicator varies according to the reception strength of the flow sensor's ultrasonic signal: 4 bars: High signal strength 2 or 3 bars: Medium signal strength 1 bar: Low signal strength All OFF: No signal Reference: The stability is displayed for the "Flow" and "Multi View" on the current value screen and on the "Heat transfer" screen.
(3)	**Output indicators (1) to (4)**	Show the status of outputs 1 to 4, lighting when an output is ON and turning OFF when an output is OFF. * Indicators are not displayed for channels to which a control output has not been assigned.
(4)	**Bank number**	Displays the selected bank (A, B, C, or D) of the enabled bank input function.
(5)	**IO-Link communication indicator**	Displayed when IO-Link communication is in progress.
(6)	**Screen type**	Indicates the screen type: flow, temperature, concentration, level, etc. Using the left and right keys you can cycle through the display screens.
(7)	**Main display area**	Displays the current value and set value.

MENU key

Select key

Arrow keys

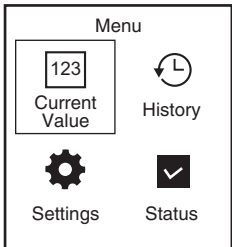## Current Value Screen Overview

Switch with ◀ and ▶.

* The availability of screens will vary dependent on what sensors are connected.

Multi View

| ◀ Multi View ▶ |
| 52.3 L/min |
| 1587.6 L |
| 35.2 °C |
| 8.7 Brix% |

Heat transfer

◀ Instant. heat (MJ/h) ▶

345

Level

◀ Level (mm) ▶

415

Concentration

◀ Conc. (Brix%) ▶

8.7

Temperature

◀ Temp.1 (°C) ▶

5.2

Flow

| ◀ Instant. flow (L/min) ▶ |
| 52.3 |
| [1] 60.0 |
| [2] 40.0 |

Go to the MENU screen with ■.

Menu

123
Current Value

History

Settings

Status

Switch the display with ●.

Change display

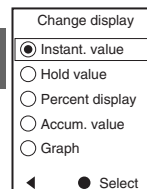◉ Instant. value
○ Hold value
○ Percent display
○ Accum. value
○ Graph

◀ ● Select
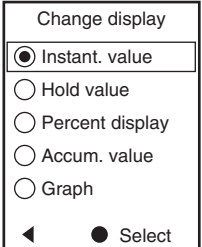
For details, see the following page.

Display Change

To change the displayed screen, open the sub menu by pressing ● on any screen.

Change display
- ⦿ Instant. value
- ○ Hold value
- ○ Percent display
- ○ Accum. value
- ○ Graph

◄ ● Select

(1) Instantaneous value
Checking the current value

Flow rate (L/min)

Instantaneous flow rate

◄ Instat.flow (L/min) ►

52.3

[1] 40.0
[3] 40.0   50.0

Ch

Set value (upper limit)[*1]

Set value (lower limit)[*1]

Changing the set value
Use ▲ and ▼ to move the cursor to the set value to change it. → Select it with ●. → Fine-tune the value with ▲ and ▼.

[1]   40.0
[3]   40.0   50.0
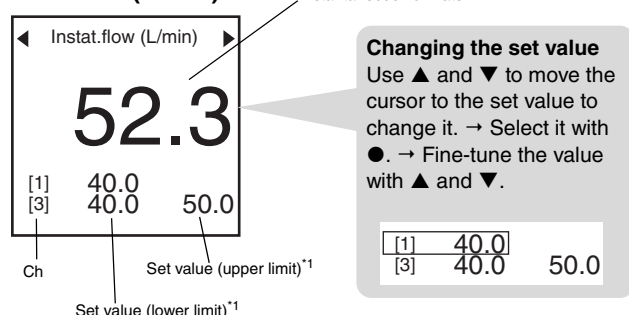
Hold down ■ + ◄ (or ►) on this screen to adjust the following items.
- **[Flow rate] Origin adjustment**
- **[Concentration] Teach**
- **[Level] Zero shift**

*1 In standard mode, one value can be displayed and set per channel. In area mode, two values—the upper limit (High) and lower limit (Low)—can be displayed and set per channel.

(2) Hold value
Checking the peak and bottom values

Flow rate (L/min)

Instantaneous flow rate

◄ Flow rate (L/min) ►

12.3

Peak   35.3
Bottom   9.4

Displays the maximum value (Peak) and minimum value (Bottom) since power was turned ON.

Instantaneous value

Peak   35.3

Bottom   12.3
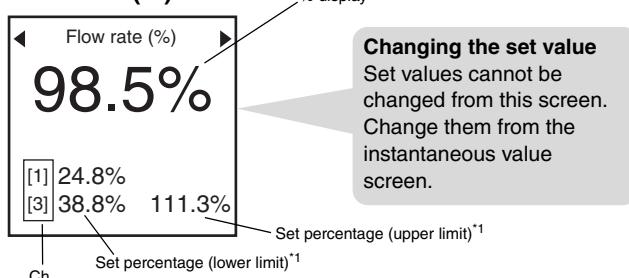   9.4
Power turned ON   Time
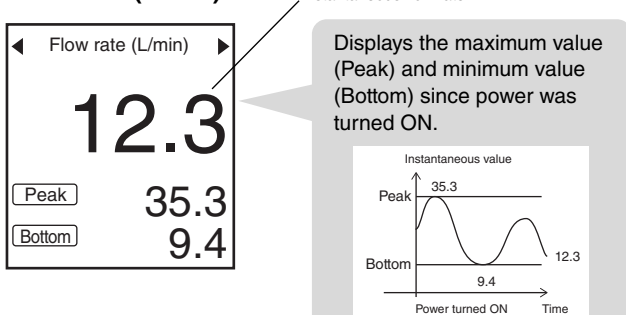
Hold Reset
Hold down ■ + ◄ (or ►) on this screen to reset the hold values to zero.

* Hold values can also be reset with ■ (MENU) → "Settings" → "4. Useful functions" → "Hold reset" or by turning the power OFF.
* Executing the hold reset will reset all the hold values of the enabled monitored values.

(3) Percent display
Displaying relative values

Flow rate (%)

% display

◄ Flow rate (%) ►

98.5%

[1] 24.8%
[3] 38.8%   111.3%

Ch

Set percentage (upper limit)[*1]

Set percentage (lower limit)[*1]

Changing the set value
Set values cannot be changed from this screen. Change them from the instantaneous value screen.
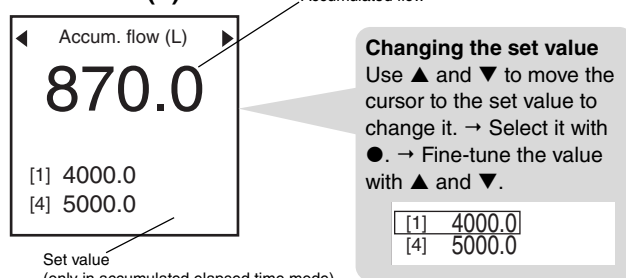
Preset Calibration
Hold down ■ + ▲ on this screen or the (1) instantaneous value screen to register the flow rate that will be referenced as 100%.
* The reference heat transfer is registered on the heat transfer screen.

*1 In standard mode, one percentage can be displayed per channel. In area mode, two percentages—the upper limit (High) and lower limit (Low)—can be displayed per channel.

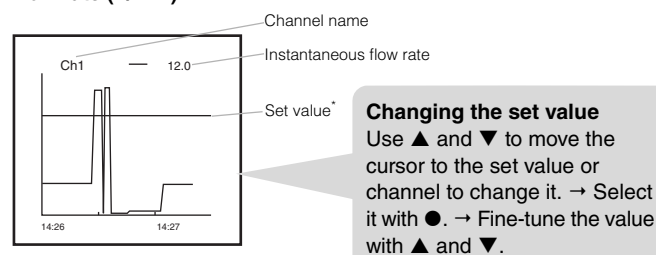## (4) Accumulated value
Checking the totalized flow

Total Flow (L)

Accumulated flow

◄ Accum. flow (L) ►

870.0

[1] 4000.0
[4] 5000.0

Set value
(only in accumulated elapsed time mode)

Changing the set value
Use ▲ and ▼ to move the cursor to the set value to change it. → Select it with ●. → Fine-tune the value with ▲ and ▼.

[1]   4000.0
[4]   5000.0

Reset Total
Hold down ■ + ◄ (or ►) on this screen to reset the accumulated value to zero.
* The accumulated heat transfer is reset on the heat transfer screen.

* The accumulated value can also be reset with ■ (MENU) → "Settings" → "4. Useful functions" → "Accumulated flow (Heat transfer) reset."
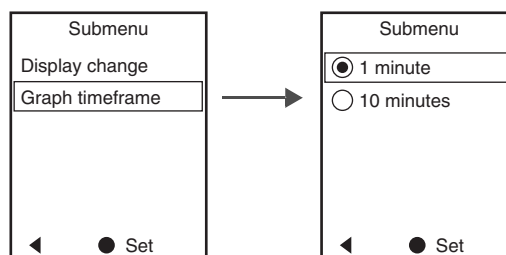
(5) Graph
Visually checking transitions

Flow rate (L/min)

Channel name
Instantaneous flow rate

Ch1 — 12.0

Set value*

14:26   14:27

Changing the set value
Use ▲ and ▼ to move the cursor to the set value or channel to change it. → Select it with ●. → Fine-tune the value with ▲ and ▼.

●: **The duration of the graph can be changed from the sub menu.**

Submenu

Display change

Graph timeframe

◄ ● Set

→

Submenu

⦿ 1 minute

○ 10 minutes

◄ ● Set

Select from two graph durations.

* In area mode, the range between the upper and lower limits of the set value is displayed on a graph. Changes can be made from this screen with ▲ and ▼.
Graph sampling is performed at intervals of 1 second (with the 1 minute setting) and 10 seconds (with the 10 minutes setting).
* The display shows 0 for up to 30 seconds after the power turns ON.

Display Menus by Monitored Value

Monitored value (Switch with ◀ and ▶.)	Flow	Temperature 1	Temperature 2	Concentration	Level	Heat transfer
Conditions for displaying monitored values	Flow Sensor connected	When one or more devices capable of measuring temperature are connected, "Temperature 1" is displayed. When two or three of these devices are connected, "Temperature 2" is displayed.[*1]		Concentration Sensor FI-C connected	Level Sensor (FL) connected	"Heat transfer calculation" set to "Enabled" on the Initial Settings screen.
Instantaneous value	✓	✓	✓	✓	✓	✓
Value before conversion	—	—	—	✓[*2] Concentration before span	—	—
Hold value	✓	✓	✓	✓	✓	✓
Percent display	✓	—	—	—	✓[*3]	✓
Accumulated value	✓	—	—	—	—	✓
Graph	✓	✓	✓	✓	✓	✓
Unique item	—	—	—	—	✓[*4] Tank view	—

*1 Devices capable of measuring temperature
This refers to (1) the FI-T Temperature Sensor, (2) the FD-H Series Standard Model, and (3) the FI-C Concentration Sensor. If all three are connected at the same time, two of them are displayed with the following priority: (1) > (2) > (3).
(Example: If two (1) FI-T Temperature Sensor units are connected to a (2) FD-H Series Standard Model, priority is given to (1), so Temperature 1 displays the temperature of one FI-T unit and Temperature 2 displays the temperature of the other FI-T unit.)

*2 Concentration before span
When the unit for the concentration value is Brix%, performing a span adjustment of the concentration enables the selection of this display, allowing the original Brix% to be checked.

*3 On the percent display screen for the level, standard registration is not necessary. The probe length is assumed to be 100% for the display.
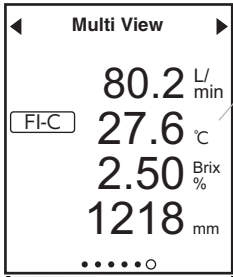
*4 Tank view
Can be used to visually check the liquid level. When level output is assigned to a channel, the set value can also be adjusted from this screen.
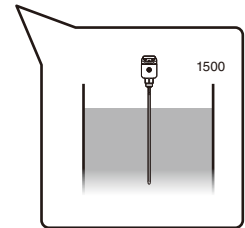
List Display (Multi View)

The Multi View screen displays a list of the selected monitored values. It is useful in displaying information from multiple connected sensors at the same time.

Multi View

◀ Multi View ▶

FI-C

80.2 L/min
27.6 ℃
2.50 Brix %
1218 mm
• • • • • ○

Current Value

● → ◀ or Apply and return

Select up to four items to display.

Display content
☑ Instant. flow
☑ Accum. flow
☑ Temp.1
☐ Temp.2
☑ Conc.

◀ ● Select

Selectable items

Instant. flow
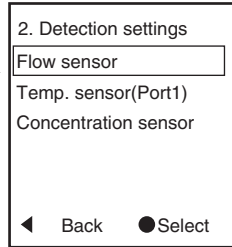Accum. flow
Temp.1
Temp.2
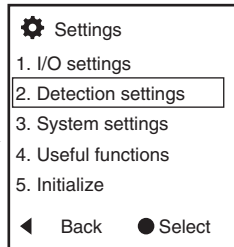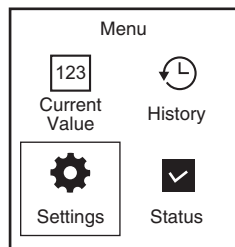Conc.
Level
Instant. heat
Accum. heat

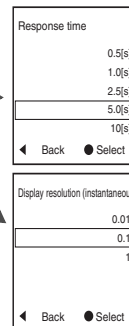* The selectable items vary depending on the connected sensors.

5. Setup ⚙

Setting Method

Select the category to set.

Menu
```
123   🕐
Current  History
Value
⚙     ☑
Settings  Status
```

```
⚙ Settings
1. I/O settings
2. Detection settings
3. System settings
4. Useful functions
5. Initialize
◀ Back   ● Select
```

```
2. Detection settings
Flow sensor
Temp. sensor(Port1)
Concentration sensor
◀ Back   ● Select
```

Set the parameter.

```
Flow sensor
Response time
                5.0[s]
Display resolution (instant.)
                0.1
Display resolution (accum.)
                0.1
◀ Back   ● Select
```

```
Response time
        0.5[s]
        1.0[s]
        2.5[s]
        5.0[s]
        10[s]
◀ Back  ● Select
```

```
Display resolution (instantaneous)
        0.01
        0.1
        1
◀ Back  ● Select
```

---

1. I/O settings
I/O settings can be changed for each channel.

Output   Ch1 Ch2 Ch3 Ch4

Change the detection mode and output logic.

	Setting item	Options	See: chapter8
1	Target[*1]	Flow, Temp. 1, Temp. 2, Conc. , Level, Heat transfer, Error, ---	D-1
2	Detection mode[*1]	Standard, Area, Accum. (elapsed time), Pulse output[*2], Bubble detection, Low liquid detection, Stability alert, Error	D-2
3	Logic	N.O., N.C.	D-2
▶ When 1 = "Flow rate" and 2 = "Pulse output"			
4	Pulse weight (Flow)	0.02 to 999.99 (L) (initial value: 1.00 s) 0.01 to 9.9999 (m³/h) (initial value: 0.0100 s)	D-2
▶ When 1 = "Heat transfer" and 2 = "Pulse output"			
5	Pulse weight (Heat)	0.02 to 999.99 (MJ) (initial value: 1.00 s)	D-2

*1 The "Target" and "Detection mode" selections will vary depending on the sensors which are connected.
*2 Only Ch1 can be set to pulse output mode.

Analog   Ch1 Ch2

Change the upper and lower limits for the analog output.

	Setting item	Options	See: chapter8
1	Analog target[*1]	Flow, Temp. 1, Temp. 2, Conc. , Level, Heat transfer	D-3
2	Analog output current	4-20mA, 0-20mA	D-3
3	Analog lower limit	Analog lower limit value corresponding to 4mA or 0mA (depending on selection above).	D-3
4	Analog upper limit	Analog upper limit value corresponding to 20mA	D-3

*1 The "Analog target" selections will vary depending on the sensors which are connected.

Input   Ch2 Ch3

Change the input function.

	Setting item	Options	See: chapter8
1	Input function[*1]	Disabled, Accum. flow reset, Zero flow, Flow origin adjustment, Concentration hold, Accum. Heat reset, Bank change[*2]	D-4

*1 The "Input function" selections will vary depending on the sensors which are connected.
*2 To use the bank switching function, Ch2 and Ch3 must both be set to external input and one of their functions must be assigned to "Bank change."

```
1. I/O settings
Ch1: Output  Flow
Ch2: Analog  Temp. 2

                NPN
◀ Back   ● Select
```
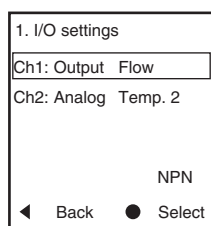
The items assigned to each channel on the Initial Settings screen are listed and can be changed.
The "Output," "Analog," and "Input" assignments cannot be changed here. **To change them, perform Initialization > Initialize I/O settings, see section 5 for details.**

---

2. Detection settings (1/2)
Configure detection settings for each sensor.

Flow sensor (first half)

This is the list of settings when using a flow sensor (FD-H).

	Setting item	Options	See: chapter8
1	Response time	0.5 s, 1 s, 2.5 s, 5 s, 10 s, 30 s, 60 s, 120 s, 200 s	D-5
2	Resolution (instant.)		
	• FD-H10(K)/H20(K)	0.01, 0.1, 1 (L/min) 0.001, 0.01, 0.1, 1 (m³/h)	
	• FD-H32(K)	0.01, 0.1, 1 (L/min) 0.001, 0.01, 0.1, 1 (m³/h)	-
	• FD-H22F/H32F	0.01, 0.1, 1 (L/min) 0.001, 0.01, 0.1, 1 (m³/h)	
	• FD-H47F/H63F	0.01, 0.1, 1 (L/min) 0.001, 0.01, 0.1, 1 (m³/h)	
3	Resolution (accum.)		-
	• FD-H10(K)/H20(K)	0.01, 0.1, 1 (L) 0.0001, 0.001, 0.01 (m³/h)	
	• FD-H32(K)	0.01, 0.1, 1 (L) 0.0001, 0.001, 0.01 (m³/h)	
	• FD-H22F/H32F	0.01, 0.1, 1 (L) 0.0001, 0.001, 0.01 (m³/h)	
	• FD-H47F/H63F	0.01, 0.1, 1 (L) 0.0001, 0.001, 0.01 (m³/h)	
4	Display averaging	0 to 10 s (initial value: 1 s)	D-6
5	Hysteresis		
	• FD-H10(K)/H22F	0 to 9999 (L/min) (initial value: 0.5)	
	• FD-H20(K)/H32F	0 to 9999 (L/min) (initial value: 1.5)	D-2
	• FD-H32(K)/H47F	0 to 9999 (L/min) (initial value: 5.0)	
	• FD-H63F	0 to 9999 (L/min) (initial value: 8.0)	
6	Zero cut flow rate		
	• FD-H10(K)	0 to 9999 (L/min) (initial value: 0.3)	
	• FD-H20(K)	0 to 9999 (L/min) (initial value: 0.5)	
	• FD-H32(K)	0 to 9999 (L/min) (initial value: 1.0)	
	• FD-H22F	0 to 9999 (L/min) (initial value: 0.5)	D-7
	• FD-H32F	0 to 9999 (L/min) (initial value: 1.0)	
	• FD-H47F	0 to 9999 (L/min) (initial value: 2.0)	
	• FD-H63F	0 to 9999 (L/min) (initial value: 5.0)	
7	Flow direction	From the LED side, Toward the LED side (* Select with the illustration.)	
8	Pipe material		
	• FD-H**/FD-H**K	Metal, Resin	D-8
	Hose type		
	• FD-H**F	Standard, High-pressure	
9	Pipe size		
	• FD-H10(K)	1/4" (8A), 3/8" (10A)	
	• FD-H20(K)	1/2" (15A), 3/4" (20A)	
	• FD-H32(K)	1" (25A), 1 1/4" (32A)	
	Hose size		D-8
	• FD-H22F	13~, 15~, 17~, 19~, 21~	
	• FD-H32F	23~, 25~, 27~, 29~, 31~	
	• FD-H47F	33~, 36~, 39~, 42~, 45~	
	• FD-H63F	48~, 51~, 54~, 57~, 60~	
10	Accum. flow reset	Automatic, Manual	D-2
11	Detection hold time	0 to 60 s (initial value: 5 s)	D-9
12	Bubble detect. one-shot	0.1 to 10.0 s (initial value: 1.0 s)	D-2

Continue to Flow sensor (second half)

Flow sensor (second half)

From Flow sensor (first half)

	Setting item	Options	See: chapter 8
13	Span adjustment	0.100 to 10.000 (initial value: 1.000)	D-10
14	Additional settings	OFF, Additional settings	D-10
▶ When 14 = "Additional settings"			
15	Flow detection mode (* FD-H**/H**K only)	Hybrid, Delta TOF	D-10
16	Flow detection mode (* FD-H**F only)	Standard, High power[*1]	D-10
17	Pipe O.D.		D-10
	• FD-H10(K)	13.00 to 18.00 (mm)	
	• FD-H20(K)	18.00 to 28.00 (mm)	
	• FD-H32(K)	28.00 to 44.00 (mm)	
	Hose I.D.		
	• FD-H22F	3.00 to 22.99 (mm)	
	• FD-H32F	6.00 to 32.99 (mm)	
	• FD-H47F	15.00 to 47.99 (mm)	
	• FD-H63F	20.00 to 63.00 (mm)	
18	Pipe thickness (* FD-H**/H**K only)		D-10
	• FD-H10(K)	0.10 to 6.00 (mm)	
	• FD-H20(K)	0.10 to 8.00 (mm)	
	• FD-H32(K)	0.10 to 10.00 (mm)	
▶ When 15 = "Hybrid"			
19	Pipe sound velocity	1000 to 4000 (m/s) (initial value: 3240 [when Pipe material = Metal], 2300 [when Pipe material = Resin])	D-10
▶ When 15 = "Delta TOF" or when using a hose model (FD-H**F)			
20	Liquid ultrasonic vel.	300 to 1900 m/s (initial value: 1497 m/s)	D-10
21	Kinematic viscosity	0.01 to 500.00 cSt (initial value: 0.89 cSt)	D-10

[*1] If "Hose type" is set to "High pressure," the initial value will be "High Power."

Temperature sensor

* These settings are displayed when a temperature sensor (FI-T) is assigned as a "Connected Sensors" on the Initial Settings screen.

	Setting item	Options	Details
1	Averaging time	0.1 s, 10 s, 20 s, 30 s, 60 s, 120 s, 300 s	For details on these settings, see the instruction manual of the FI-T Temperature Sensor.
2	Hysteresis	0.0 to 2.0(°C) (initial value: 0.2)	
3	Offset	−20.0 to +20.0 (°C) (initial value: 0.0)	
4	Ambient correction	OFF, ON(Steel), ON(SUS)	
5	Screen orientation	Standard, Reverse	

* If two temperature sensors are connected, one more set of the above items is displayed.

Concentration sensor

* These settings are displayed when a concentration sensor (FI-C) is assigned as a "Connected Sensors" on the Initial Settings screen.

	Setting item	Options	Details
1	Response time	1 s, 2.5 s, 5 s, 10 s, 30 s, 60 s, 120 s, 200 s	For details on these settings, see the instruction manual of the FI-C Concentration Sensor.
2	Resolution*	0.01, 0.1	
3	Hysteresis	0.00 to 10.00 (Brix%) (initial value: 0.20)	
4	Span adjustment*	0.100 to 30.000 (initial value: 1.000)	
5	Teaching target value	-9.99 to 99.99 (initial value: 0.00)	
6	Special temp. correct.*	0.000 to 10.000 (initial value: 1.000)	
7	Temperature offset	−20.0 to +20.0 (°C) (initial value: 0.0)	
8	Low liquid sensitivity	High, Medium, Low, OFF	
9	Stability alert	3 or less, 2 or less, 1 or less, OFF	

* This is only displayed when the concentration unit is "Brix%."

Level sensor

* These settings are displayed when a level sensor (FL) is assigned as a "Connected Sensors" on the Initial Settings screen.

	Setting item	Options	Details
1	Probe length	Displays the value set on the Initial Settings screen (the value cannot be changed).	
2	Response time	0.4 s, 1 s, 4 s, 10 s	
3	Scaling	OFF, ON	
▶ When 3 = "ON"			
4	1st point input value	−19999 to 19999 (initial value: 0)	For details on these settings, see the instruction manual of the FL Level Sensor.
5	1st point display value	−19999 to 19999 (initial value: 0)	
6	2nd point input value	−19999 to 19999 (initial value: 1000)	
7	2nd point display value	−19999 to 19999 (initial value: 1000)	
8	Decimal point position	1st digit, 2nd digit, 3rd digit, 4th digit	
9	Hysteresis	0 to 19999 (initial value: 5)	
10	Offset	0 to 19999 (initial value: 0)	
11	Automatic ambient update	OFF, ON	
12	Mask (controller side)*	0 to 12000 (initial value: 0)	
13	Mask (probe end)*	0 to 12000 (initial value: 0)	
14	Sensitivity setting	High sensitivity, Low sensitivity	
15	Stability alert	OFF, ON	D-11

* Controller side indicates the mask distance from the base of the FL. Probe end indicates the mask distance from the tip of the FL probe.

Heat transfer

* These settings are only displayed when "Heat transfer calculation" is set to "Enabled" on the Initial Settings screen.

	Setting item	Options	See: chapter 8
1	Resolution (instant.)	0.01, 0.1, 1 (MJ/h)	-
2	Resolution (Accum.)	0.01, 0.1, 1 (MJ)	-
3	Hysteresis	0.00 to 50.00 (initial value: 2.50)	D-2
4	Specific heat setting	Water, Numeric entry	D-12
▶ When 4 = "Numeric entry"			
5	Specific heat	0.100 to 10.000 (initial value: 4.186 MJ/°Cm^3)	D-12
6	Zero cut temp. diff	0.0 to 20.0(°C) (initial value: 0.5)	D-12
7	Reset total	Automatic, Manual	D-2
8	Temp. sensor position	Port 1 → port 2, Port 2 → port 1	D-12
9	Energy transfer mode	Automatic switching, Heating mode, Cooling mode	D-12

Reference — If a set sensor (FL, etc.) is connected to an initialized FD-H Series display unit, the settings of the sensor are applied to the display unit.

■ Initial value list

Model	FD-H10/ H10K	FD-H20/ H20K	FD-H32/ H32K	FD-H22F	FD-H32F
Standard mode set value (set area mode lower limit)	3.0 L/min 0.18 m^3/h	10.0 L/min 0.60 m^3/h	30 L/min 1.8 m^3/h	6.0 L/min 0.36 m^3/h	20.0 L/min 1.20 m^3/h
Set area mode upper limit	18.0 L/min 1.08 m^3/h	60.0 L/min 3.60 m^3/h	180 L/min 10.8 m^3/h	36.0 L/min 2.16 m^3/h	120.0 L/min 7.20 m^3/h

Model	FD-H47F	FD-H63F	FI-C20D/ C40F	Temperature (FI-T/FD-H standard/ FI-C)	FL-001/C001/S001
Standard mode set value (set area mode lower limit)	30 L/min 1.8 m^3/h	50 L/min 3.0 m^3/h	Brix 5.0 %	15.0 °C	Ch1: [Probe length] − 30 Ch2: [Probe length] × 3/4 − 5 Ch3: [Probe length] × 1/4 − 5 Ch4: 10
Set area mode upper limit	180 L/min 10.8 m^3/h	300 L/min 18.0 m^3/h	Brix 15.0 %	70.0 °C	Ch1: [Probe length] − 25 Ch2: [Probe length] × 3/4 Ch3: [Probe length] × 1/4 Ch4: 15

3. System settings
Change indicator, screen, and other such system settings.

Indicator settings

	Setting item	Options	See: chapter 8
1	Indicator mode	Based on Output 1, Output 1 + Predictive maint., Based on Output 2, Based on Output 3, Based on Output 4, Multi-judgment	D-13
▶ When 1 = "Output 1 + Predictive Maint."			
2	Predictive maint. ratio	0.1 to 10.0 (initial value: 1.1)	D-13
3	Indicator color	Green-Off, Green-Red, Always Off	D-14

Display settings

	Setting item	Options	See: chapter 8
1	Screen orientation	Vertical, Horizontal (CW), Horizontal (CCW), Vertical (inverted)	-
2	Screen brightness	Turn off when inactive, Brightness 1, Brightness 2, Brightness 3, Brightness 4, Brightness 5	D-15
3	Language	ENGLISH, 日本語, 中文, DEUTSCH	-
4	Key lock method	Standard, With password	D-16
When 4 = "With password"			
5	Password	0000 to 9999 (initial value: 0000)	D-16

Communication setting

	Setting item	Options	Details
1	IO-Link process data	0_Flow rate 1_Multi 2_Heat	For details on this setting, see the IO-Link instruction manual.

History settings

	Setting item	Options	Details
1	Date and time settings[*1]	YYYY/MM/DD	-
2	Event history target	Exclude ON/OFF, Include ON/OFF	Page 12

[*1] If the date and time setting is changed here, all the history data will be deleted to prevent this data from becoming inconsistent. (A confirmation message will be displayed before the deletion.)

4. Useful functions
Execute functions such as adjusting the zero point and resetting the accumulated flow.

	Setting item	Options	Description	Details
1	[Flow rate] Origin adj.	Back Execute Terminate	Executes origin adjustment, **which will set the current instantaneous flow rate to zero.** When this function is executed, it will average the flow rate for 20 seconds and set this value as "zero."	D-17
2	[Conc.] Teaching	Back Execute Terminate	Executes concentration teaching, **which will set the current concentration as a known value.**	Instruction manual of the FI-C Concentration
3	[FL] Zero shift	Back Execute Terminate	Executes a zero shift, **which will set the current level value of the FL Level Sensor to zero.**	Instruction manual of the FL Level Sensor
4	[FL] Calibration	Back Execute Terminate	Executes calibration, **which will record the signal reflected by the surrounding obstacles in order to calibrate the detection of the FL Level Sensor.**	
5	Hold reset	Back Execute	**Resets the hold values of all enabled monitored values.**	Page 6
6	Accum. flow reset	Back Execute	**Resets the accumulated flow value to zero.**	Page 6
7	Accum. Heat transfer reset	Back Execute	**Resets the accumulated heat transfer to zero.**	Page 6

5. Initialize
Initialize or restart the sensor.

Setting item	Items to initialize (indicated with check marks)		
	I/O settings[*1]	Other settings	History data
Restart device[*2]	-	-	-
Initialize settings[*3]	✓	✓	-
Clear history data[*4]	-	-	✓
Initialize I/O settings[*5]	✓	-	-
Initialize all[*3]	✓	✓	✓

[*1] The I/O settings refer to "G: Initial Settings [PNP/NPN]" and "H: Initial Settings [I/O]" under Initial Settings (chapter 3) and "1. I/O settings" under Setup (chapter 5).
[*2] After initialization is executed, the current value screen appears.
[*3] After initialization is executed, the "A: Language" settings screen under Initial Settings (chapter 3) appears.
[*4] After initialization is executed, the "5. Initialize" screen remains displayed.
[*5] After initialization is executed, the "G: Initial Settings [PNP/NPN]" settings screen under Initial Settings (chapter 3) appears.

6. Connected sensors

Confirm the settings (the connected sensors) selected on screens **D** under "3. Initial Settings." This screen can also be used to check which sensors are assigned to Temperature 1 and Temperature 2.
These settings cannot be changed here.

```
6. Connected Sensors
Flow port
                      FD-H20
Multi-port 1
                         FI-C
Multi-port 2
                           FL
◀    Back
```

7. Simulation
Change values during a simulation of sensor readings to check the corresponding operation of the control and analog outputs.

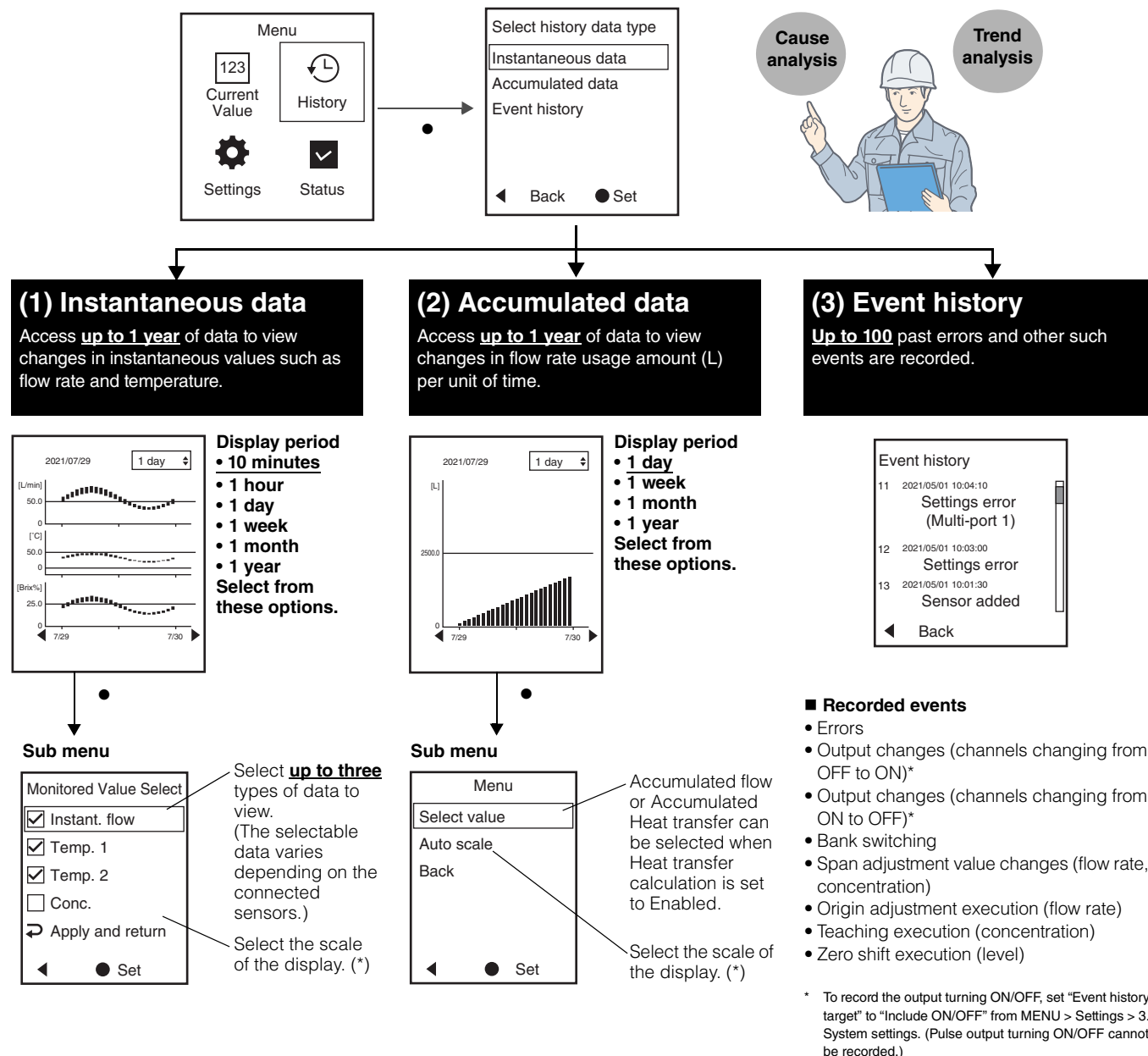| Setting item	Options	Description
Flow		A sensor's status can be simulated with entered values to check the operation of the sensor's output and indicators. This is useful when checking the wiring and the operation prior to passing fluid through the pipe or when troubleshooting.
Temp. 1		
Temp. 2	Value in the displayable range	
Conc.		• **Items changed according to simulation values**
Level		1. Control output evaluation 2. Indicators
Heat transfer		3. Analog output 4. IO-Link process data
Error*	None, Yes	* "Error" only affects the error output behavior and indicators.

Reference	• This function does not affect the Accumulated flow and Accumulated Heat transfer settings or the recorded data of the history function. It does affect the graph display on the current value screen. • Normal detection operation is stopped during simulation execution. (A confirmation message will be displayed before the simulation is executed.)

6. Viewing the History ⏱

Usage

From the moment its initial settings are completed, the FD-H Series records the data of each monitored value to the display unit. This history data can be viewed on a graph for quick troubleshooting and the setting of production conditions.


```
Menu
[123]        (⏱)
Current    History
Value
 ⚙         ✓
Settings   Status
```

```
Select history data type
Instantaneous data
Accumulated data
Event history

◄  Back   ● Set
```

Cause analysis   **Trend analysis**

(1) Instantaneous data
Access **up to 1 year** of data to view changes in instantaneous values such as flow rate and temperature.


```
2021/07/29   [1 day ▼]
[L/min]
50.0
0
[°C]
50.0
0
[Brix%]
25.0
0
◄ 7/29        7/30 ►
```

Display period
• **10 minutes**
• 1 hour
• 1 day
• 1 week
• 1 month
• 1 year
Select from these options.

Sub menu

```
Monitored Value Select
☑ Instant. flow
☑ Temp. 1
☑ Temp. 2
☐ Conc.
↩ Apply and return
◄        ● Set
```

Select **up to three** types of data to view.
(The selectable data varies depending on the connected sensors.)

Select the scale of the display. (*)

(2) Accumulated data
Access **up to 1 year** of data to view changes in flow rate usage amount (L) per unit of time.


```
2021/07/29   [1 day ▼]
[L]



2500.0



0
◄ 7/29        7/30 ►
```

Display period
• **1 day**
• 1 week
• 1 month
• 1 year
Select from these options.

Sub menu

```
Menu
Select value
Auto scale
Back
◄        ● Set
```

Accumulated flow or Accumulated Heat transfer can be selected when Heat transfer calculation is set to Enabled.

Select the scale of the display. (*)

(3) Event history
Up to 100 past errors and other such events are recorded.

```
Event history
11  2021/05/01 10:04:10
        Settings error
         (Multi-port 1)
12  2021/05/01 10:03:00
        Settings error
13  2021/05/01 10:01:30
        Sensor added
◄     Back
```

■ **Recorded events**
• Errors
• Output changes (channels changing from OFF to ON)*
• Output changes (channels changing from ON to OFF)*
• Bank switching
• Span adjustment value changes (flow rate, concentration)
• Origin adjustment execution (flow rate)
• Teaching execution (concentration)
• Zero shift execution (level)

*   To record the output turning ON/OFF, set "Event history target" to "Include ON/OFF" from MENU > Settings > 3. System settings. (Pulse output turning ON/OFF cannot be recorded.)

---

*   Display scales

● **Auto scale**
An easy-to-view display for the data in a specific period of time.
The maximum value of the Y-axis on the graph automatically changes to the optimal value for the currently viewed data.

● **Fixed scale**
An easy-to-view display for continuous comparison of data from multiple time axes.
The scale is fixed to the maximum value of the Y-axis on the currently viewed screen.

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Supplemental Information on History Data

■ Meaning of the display period and data for "(1) Instantaneous data"

Display period	Data interval	Recording period	Data meaning
10 minutes	Every 10 seconds	Last 7 days	Instantaneous data is sampled, recorded, and displayed every 10 seconds.
1 hour	Every minute		
1 day	Every hour	Last year	Instantaneous data from the peak value to the bottom value is sampled, recorded, and displayed every 10 minutes.
1 week	Every day		
1 month	Every day		
1 year	Every month		

■ Meaning of the display period and data for "(2) Accumulated data"

Display period	Data interval	Recording period	Data meaning
1 day	Every hour	Last year	The accumulated flow at each data interval is recorded. (Example: if the display period is "1 day," the accumulated flow is graphed every hour.)
1 week	Every day		
1 month	Every day		
1 year	Every month		

■ Data recorded for "(3) Event history"

- Events are displayed in order of occurrence with the latest event displayed first. Events are saved once every 5 seconds.
- If multiple instances of the same event occur in a 5-second period, they are recorded as one event. If different types of events occur in a 5-second period, they are recorded sequentially.
- When more than 100 events are recorded, the old data is overwritten.

Deleting History Data

To delete the data, execute "Clear history data" or "Initialize all" from MENU > Settings > 5. Initialize.

Outputting Data to a PC

History data can be output to a PC from the USB (mini B) port of the FD-H.
Data can be output in CSV format for analysis or to be graphed for trend monitoring.

KEYENCE website
www.keyence.com/glb

This function requires specialized software that can be downloaded from the KEYENCE website.

If using the unit in an environment where it is not possible to download software over the Internet, contact the nearest KEYENCE office.

USB
(mini B)

USB

Supported OS
Windows10/8/7
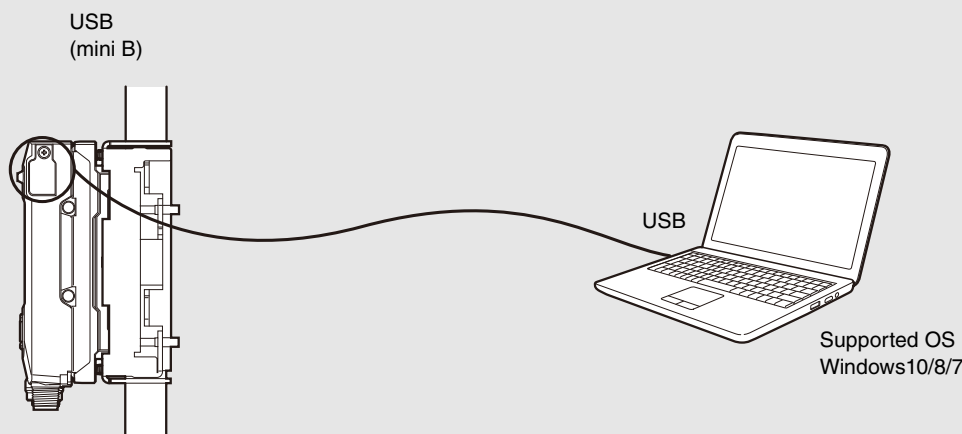
Items that can be output in CSV format
(1) At 10 second intervals, the instantaneous data and stability [Flow rate, Temperature, Concentration, Level, Heat transfer] from the last 7 days*
(2) At 10 minute intervals, the instantaneous data and stability [Flow rate, Temperature, Concentration, Level, Heat transfer] from the last year*
(3) At hourly intervals, the totalized data [Flow rate, Heat transfer] from the last year
(4) Up to 100 events

*   Stability does not apply to Temperature and Heat transfer.

For details on how to output these items, see the "FD/FI History Reader Instruction Manual" downloadable from the KEYENCE website.

7. Checking the Status ☑

Usage

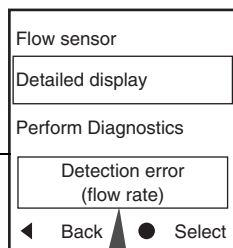The detection status of each sensor is displayed under "Status." If there are problems, their solutions can be checked.
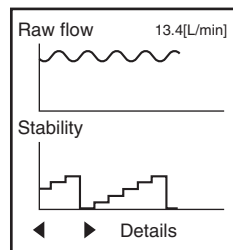
```
        Menu
  ┌─────┐    ┌───┐
  │ 123 │    │ 🕐 │
  └─────┘    └───┘
  Current   History
   Value
    ⚙       ☑
  Settings  Status
```

Press ● →

```
  ☑ Status
  ✔ Flow sensor
  ⚠ Conc. sensor
  ✖ Level sensor

  ◀ Back   ● Select
```

```
  ✔ No problem
  ⚠ Drop in stability
  ✖ Error
```

Press ● → **To the sensor's status screen**

Flow

```
  Flow sensor

  Detected display

  Perform Diagnostics
  ┌─────────────────┐
  │  Detection error│
  │   (flow rate)   │
  └─────────────────┘
  ◀  Back    ●  Select
```

If an error has occurred, the error details are displayed.

→

(1) Detailed display
Displays detailed information related to accuracy.
This screen lists important items to check when unsatisfactory accuracy errors exist. One example is the zero cut setting for instantaneous values.

```
  Raw flow    13.4[L/min]
  〰〰〰〰〰

  Stability
  ▁▂▃▄▅

  ◀  ▶   Details
```

Press ▶ →

```
  Detailed display
  Raw flow
            12.3[L/min]
  Display flow rate
            13.5[L/min]
  Response time
            5.0[s]
  ◀
```
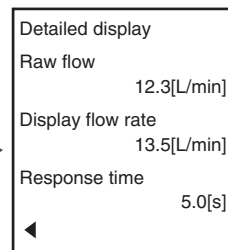
* The raw flow value is the value excluding items such as span adjustment and the zero cut flow rate.

[Checkable items]
- Raw flow value, Display flow rate, Response time, Zero cut flow rate, Pipe material, Pipe size (hose outer diameter), Span adjustment

Only in Additional settings:
Flow detection mode, Pipe O.D., Hose I.D., Pipe thickness, Pipe sound velocity, Liquid sound velocity, Kinematic viscosity

(2) Diagnostic execution
This function is useful in analyzing the causes of low stability.
The detection operation is paused for approximately 15 seconds to diagnose where the problem is.

Press ● on the confirmation screen
* Detection and judgment are paused (the instantaneous flow rate is viewed as 0) during diagnostic execution.

```
  Diagnostics running...
  ▮▮▮▮▯▯

      📡
      ○
```

→

```
  Diagnosis Results
  ✔ Detection check
  ✔ Pipe installation
  ⚠ Bubble check
     Liquid signal
  The pipe may not be filled
  with fluid due to an
  excessive amount of air
  bubbles.
           ● Exit
```
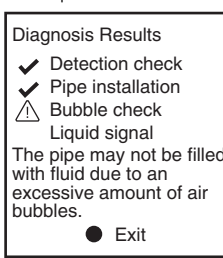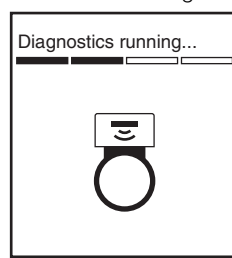
Diagnosis result	Cause	Countermeasure
Detection operation check	An error may have occurred on the FD-H.	Contact the nearest KEYENCE office.
Installation check	The installed sensor may be unstable, preventing the couplant from forming a good contact.	Check if the installation status and the screw tightening torque are appropriate.
	When using the high-temperature model at ultra-high temperatures for a long period of time, the couplant may deteriorate.	Replace the couplant with a new one.
Air bubble amount	(Hybrid) The pipe may appear to not be filled with fluid due to air bubbles affixing to the inner wall of the pipe because of an excessive amount of air bubbles or a low flow velocity. The flow velocity distribution may not be uniform close to couplings.	Countermeasures that may improve the situation include reviewing the installation position (moving the sensor away from couplings), increasing the flow velocity, and replacing the pipe with a new one.
	(Delta TOF) There may be an excessive amount of air bubbles.	Moving the sensor away from the location where air bubbles form (such as immediately after a cyclone filter) may improve the situation. Hybrid mode (standard models and high-temperature models) is recommended.
Signal strength	The pipe may not be filled with fluid or the pipe or fluid may prevent detection (dirty pipe, lined pipe, ultra-high-pressure hose, high-attenuation fluid, etc.)	Countermeasures that may improve the situation include reviewing the installation position and replacing the pipe with a new one.
	The installed hose model sensor may be unstable, preventing the couplant from forming a good contact.	Check if the mounting and the settings of the two pipe size dials are correct. When good contact cannot be obtained due to reasons such as the hose being flat and outer diameter errors, set these dials to one smaller size.

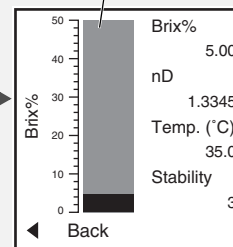### Temperature

```
  Temp. sensor 1



  ┌─────────────────┐
  │   Head error    │
  │  (Temperature 1)│
  └─────────────────┘
  ◀  Back
```
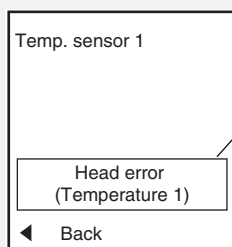
Error details (when an error occurs)

Concentration

```
  Temperature sensor

  Detailed display


  ┌──────────────────┐
  │ Low liquid detection│
  │  (Concentration) │
  └──────────────────┘
  ◀  Back   ● Select
```

●→
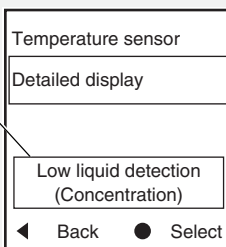
Displays the stability of concentration detection.

```
  50┤▮        Brix%
  40┤▮          5.00
  30┤▮        nD
  20┤▮          1.3345
  10┤▮        Temp. (℃)
   0┤█          35.0
    └────────  Stability
  ◀  Back         3
```

Liquid level

```
  Level sensor

  Stability 3



  ┌─────────────────┐
  │  Stability alert │
  │     (Level)     │
  └─────────────────┘
  ◀  Back   ● Select
```
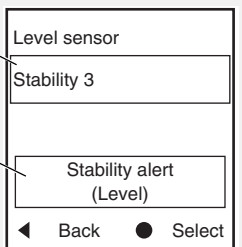
FL status value (signal stability: max. 10)

Error details (when an error occurs)

FI-C stability (max. 4)

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8. Detailed Setting Descriptions

Detection Mode Related

### D-1 Control output (Ch1, Ch2, Ch3, Ch4)

The settable detection mode varies depending on the monitored value of the sensor assigned to the channel. Refer to the chart below for details. (Example: if Concentration is assigned to a channel, the detection modes (1) Standard, (2) Area, and (6) Low liquid detection can be selected.)

Detection mode	Target monitored value assigned to the channel							
	Bank	Flow	Temperature 1, Temperature 2	Concentration	Level	Heat transfer	Error	---
(1) Standard	✓	✓	✓	✓	✓	✓	-	-
(2) Area	✓	✓	✓	✓	✓	✓	-	-
(3) Accumulated (elapsed time)	✓	✓	-	-	-	✓	-	-
(4) Pulse output (Ch1 only)	-	✓	-	-	-	✓	-	-
(5) Bubble detection	-	✓	-	-	-	-	-	-
(6) Low liquid detection	-	-	-	✓	-	-	-	-
(7) Stability alarm	-	-	-	-	✓	-	-	-
(8) Error output	-	-	-	-	-	-	✓	-

D-2 Detection mode

(1) Standard

Flow | Temperature | Concentration | Level | Heat transfer

Usable with bank function

When the instantaneous value falls below the set value, the output is switched.
This mode can be used to detect drops in the supply flow rate.
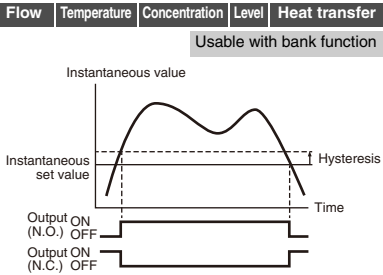
Reference Switching between N.O and N.C.: "1. I/O settings" on page 8, changing the hysteresis: "2. Detection settings" on pages 8 to 9

(2) Area

Flow | Temperature | Concentration | Level | Heat transfer

Usable with bank function

When the instantaneous value is outside of a certain range, the output is switched.
This mode can be used to detect excessive or insufficient supply flow rates.
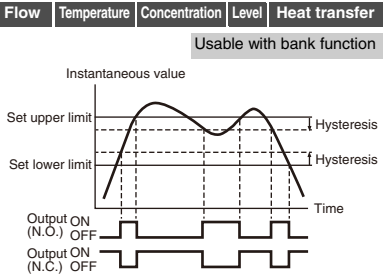
Reference Switching between N.O and N.C.: "1. I/O settings" on page 8, changing the hysteresis: "2. Detection settings" on pages 8 to 9

(3) Accumulated (elapsed time)

Flow | Heat transfer

Usable with bank function

An output is generated when the accumulated flow reaches the set value.
This mode can be used to detect if a certain amount of fluid has passed through the pipe.
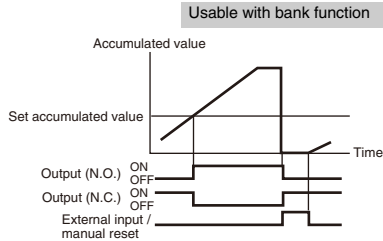
Reference
- The upper limit of the displayable range for accumulated values is 8 digits for flow rate and 9 digits for heat transfer. (Example: If the flow rate display resolution (accumulated) is 0.1 L, the upper limit is 9999999.9 L.) The value of the upper limit will be displayed for any values that exceed this limit. If "Accumulated flow (heat transfer) reset" is set to "Automatic," the value will be reset to 0 automatically if it reaches the upper limit of the display. (Detection settings on Page 8 to 9)
- Setting "Input function" to "Accumulated flow (heat transfer) reset" allows the accumulated value to be reset with external input. (I/O settings on page 8)
- While the reset total input signal is applied, the accumulated value is fixed to 0.

(4) Pulse output

Flow | Heat transfer

Ch1 only

This outputs one pulse per selected flow pulse weight (or heat pulse weight). For example, if a flow pulse weight of 0.1 is selected, one pulse is output per 0.1 L. This mode can be used to control or display the totalized amount on an external device such as a counter.
The flow pulse weight and heat pulse weight can be changed.
(I/O settings on page 8)

Reference The output pulse turns ON/OFF every half value of the pulse weight.
(Figure on the right: integrated flow pulse weight set to 1 L)
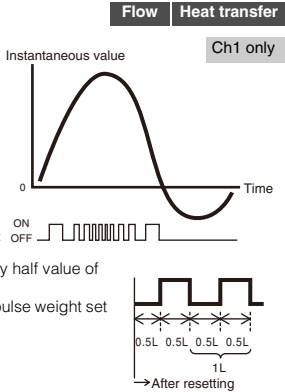
(5) Bubble detection

Flow

This is a mode dedicated for flow sensors.
This outputs by capturing sharp drops in the ultrasonic signal when bubbles pass the sensor. One-shot output is performed with a settable time of 0.1 to 10 seconds. (Detection settings on Page 8) (Bubble detection output duration)
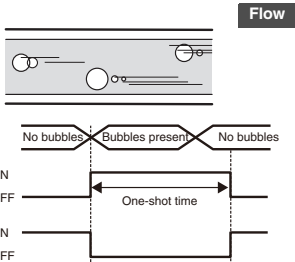
Reference The detectable bubble size varies depending on the pipe, fluid, and flow velocity. Perform on-site tests to determine this size.

(6) Low liquid detection

Concentration

This is a mode dedicated for concentration sensors.
This outputs when it detects a low liquid condition due to the sensing element not being in contact with the fluid.
The "Low liquid detection sensitivity" can be set to four levels: "High," "Medium," "Low," and "OFF." (Detection settings on Page 9)
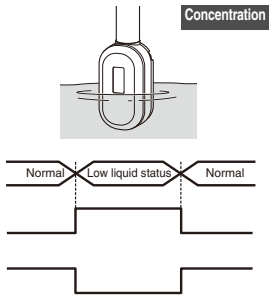
#### (7) Stability alarm

Level

This is a mode dedicated for level sensors.
It outputs when there are drops in sensor stability. It notifies the user when probe maintenance is necessary due to foreign particles accumulating on the probe and detection becoming unstable.
An output is generated when the measurement stability (status value) is 2 or lower.
(For details on stability, see the instruction manual of the FL Series Level Sensor.)

(8) Error output

Common for all sensors
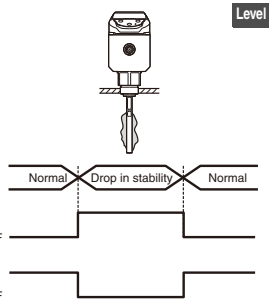
Generates output when an error occurs on a connected sensor/display unit. Assigning an output to "Error" in Settings > I/O settings automatically assigns this output to common error output mode.
An output is generated when one of the following errors occurs:
- Settings error
- Memory error
- Concentration sensor dry water detection
- Level sensor stability alarm
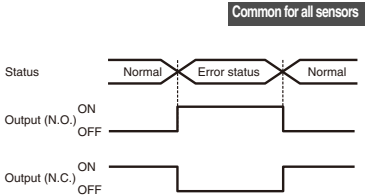
For details, see "Errors" and "Output Status by Error Category" on page 20.

Analog/External Input Related

D-3 Analog output (Ch1, Ch2)

The instantaneous values for the lower and upper limits of analog output can be adjusted.

	Target monitored value assigned to the channel					
	Flow	**Temperature 1**	**Temperature 2**	**Concentration**	**Level**	**Heat transfer**
Initial analog upper limit (20 mA)	Upper limit of the rated flow rate	100°C	100°C	Upper limit of the rated concentration	Probe length	See the Heat transfer Calculation Setup Guide.
Initial analog lower limit	0 L/min	0°C	0°C	0%	0 mm	0 MJ/h

Initial status

The analog output type can be selected from 4-20 mA and 0-20 mA.
(4-20 mA is shown in the figure on the right.)
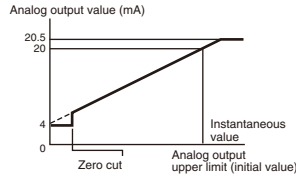
When the settings are changed

Negative flow rates can also be specified.

Example 1

Analog output upper limit	100 L/min
Analog output lower limit	10 L/min
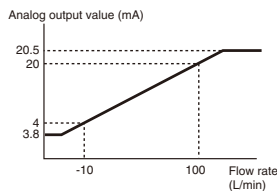
Example 2

Analog output upper limit	10 L/min
Analog output lower limit	100 L/min
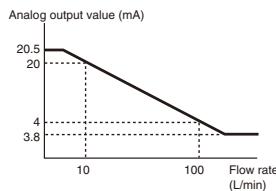
Reference
- The analog output value becomes 3.5 mA (when set to 4-20 mA) or 0 mA (when set to 0-20 mA) depending on the error type. For details, see "Errors" and "Output Status by Error Category" on page 20.
- The update cycle of the analog output is 300 ms or less.

D-4 External input (Ch2, Ch3)

The external input function can be selected according to the connected sensor.

|	Connected Sensors					
Input function	**Flow**	**Temperature 1**	**Temperature 2**	**Concentration**	**Level**	**Heat transfer**
(1) Accumulated flow reset	✓	-	-	-	-	-
(2) Zero flow	✓	-	-	-	-	-
(3) Origin adjustment	✓	-	-	-	-	-
(4) Concentration hold	-	-	-	✓	-	-
(5) Accumulated Heat transfer reset	-	-	-	-	-	✓
(6) Bank (Sets Ch2 and Ch3 to bank input.)	✓	✓	✓	✓	✓	✓

Reference The minimum input time is 20 ms.

(1) Accumulated flow reset

Flow

Resets the accumulated flow display value to 0.
For details, see "(3) Accumulated (elapsed time) under Detection mode" (page 14).

(2) Zero flow

Flow

This forcibly sets the instantaneous flow rate to zero while the external input signal is applied.
This is useful in preventing the flow rate from being displayed and an output occurring at an unnecessary time such as when the pipe is not full or flowing.
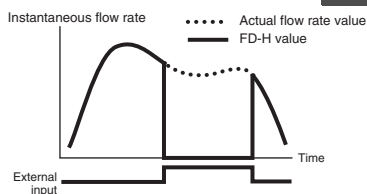
Reference While this signal is applied, analog output is equivalent to 0 mL/min and the accumulated flow is stopped.

(3) Origin adjustment

Flow

"Origin adjustment" can be executed from an external input. This is useful in periodically adjusting the zero point from an external device.
This function averages the instantaneous flow rate over approximately 20 seconds and sets this value as "zero."
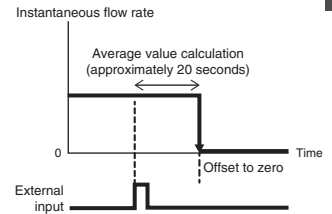
Perform this function when the pipe is filled with fluid and the fluid is not moving.

(4) Concentration hold

Concentration

The current concentration is held while this input is ON.
For details, see the instruction manual of the FI-C Series Concentration Sensor.

(5) Accumulated Heat transfer reset

Heat transfer

Resets the accumulated heat transfer display value to 0.
For details, see "(3) Accumulated (elapsed time) under Detection mode" (page 14).

(6) Bank

Common for all sensors

**Only enabled when Ch2 and Ch3 are set to bank input**

Standard, area, and accumulated elapsed time modes use set values to output signals. Bank input can be used to access four types of set values (banks A, B, C, and D). This can be used to evaluate different target products by having a PLC switch between optimal set values for each.

Ch2 (white wire)	Ch3 (gray wire)	Bank
OFF	OFF	A
ON	OFF	B
OFF	ON	C
ON	ON	D

For example, if Ch1 is assigned to area mode for flow rate, Ch2 is assigned to bank input 1, Ch3 is assigned to bank input 2, and Ch4 is assigned to area mode for temperature, it is possible to switch between up to four patterns for upper and lower limits on set flow rate and temperature values.

When Ch2 and Ch3 are set to bank input, the set values of banks A, B, C, and D can be changed from the current value screen. The set values of each bank can be configured without having the corresponding external inputs applied.
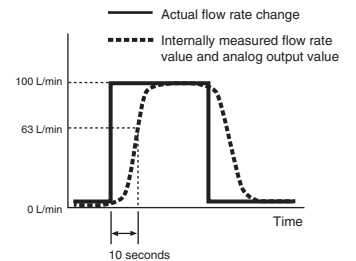
Current value screen
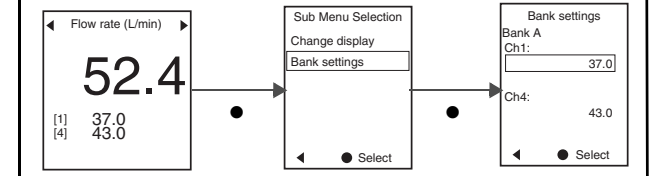
Flow Sensor Detection Settings

D-5 Response time

The response time is the time required for the internal evaluation value and the analog output to register/display at least 63% of the change in the instantaneous flow rate.
Example:
When the response time is 10 seconds, if the actual flow rate increases from 0 to 100 L/min instantaneously, the instantaneous flow rate value of the sensor will show 63 L/min or more within 10 seconds (63 L/min is 63% of 100 L/min).

D-6 Display averaging

Displays the average current value (instantaneous value). As this set value becomes larger, the display becomes more stable.

Reference Display averaging only affects the current value display. The control output and the analog output evaluations are not affected by this setting.

D-7 Zero cut flow rate

If the instantaneous flow rate is within a certain range, the FD-H is forced to recognize the instantaneous flow rate as 0. This value is called the "zero cut flow rate."
The zero cut flow rate on the FD-H Series is set with a range. If 5 L/min is specified, zero cutting is set to a range of ±5 L/min. (If the instantaneous value falls below –5 L/min, a negative value is displayed.)

Legend: - - - Actual flow rate — FD-H value
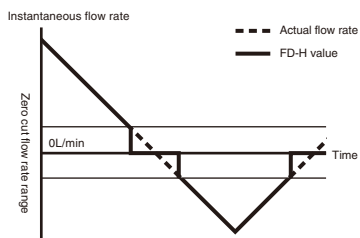
| Reference | When the instantaneous flow rate is within the zero cut range, the control output, analog output, and accumulated flow treat the flow rate as 0 L/min. |

D-8 Pipe material and standard pipe size

● Pipe material and hose type

The FD-H Series has been adjusted for optimal performance according to the pipe material and hose type, so select the correct items.

Options	Standard model / high-temperature model
Metal	Metal pipe made of stainless steel, carbon steel, copper, etc.
Resin	Hard plastic pipe made of hard PVC, etc.

Options	Hose model
Standard	Braided hose, resin tube, etc. (hose other than a high-pressure hose)
High pressure	High-pressure hose such as a black rubber hose

● Standard pipe size

The FD-H Series calculates the flow rate according to the initial pipe thickness corresponding to the "Pipe O.D." setting on the Initial Settings screen (Page 4) or Detection settings screen (Page 8).

Model Pipe size	FD-H10(K) 1/4"(8A)	3/8"(10A)	FD-H20(K) 1/2"(15A)	3/4"(20A)	FD-H32(K) 1"(25A)	1 1/4"(32A)
Outer diameter, thickness (mm) When Pipe material = Metal	Ø13.8, t=2.3	Ø17.3, t=2.3	Ø21.7, t=2.8	Ø27.2, t=2.8	Ø34.0, t=3.2	Ø42.7, t=3.5
Outer diameter, thickness (mm) When Pipe material = Resin	Ø13, t=2	Ø18, t=2.5	Ø22, t=3	Ø26, t=3	Ø32, t=3.5	Ø38, t=3.5

	Initial hose inner diameter corresponding to hose outer diameter (mm)				
FD-H22F	**13~**	**15~**	**17~**	**19~**	**21~**
When Hose type = Standard	8	10	12	13.5	15
When Hose type = High-pressure	6.3	9.5	9.5	12.7	12.7
FD-H32F	**23~**	**25~**	**27~**	**29~**	**31~**
When Hose type = Standard	17	19	21.5	21.5	25
When Hose type = High-pressure	15.9	19	19	19	25.4
FD-H47F	**33~**	**36~**	**39~**	**42~**	**45~**
When Hose type = Standard	25	25	32	32	38
When Hose type = High-pressure	25.4	25.4	31.8	31.8	38.1
FD-H63F	**48~**	**51~**	**54~**	**57~**	**60~**
When Hose type = Standard	38	38	45	48	50
When Hose type = High-pressure	38.1	38.1	45	48	50.8

| Reference | Errors will occur if the pipe used has a different thickness than this initial value. To correct these errors, see "D-10 Correction of flow rate value." |

D-9 Detection hold time

This sets the maximum length of time to hold the previous display status and output status when the FD-H Series cannot detect the fluid because due to a loss of the ultrasonic signal ("Stability" is 0).
This is useful in maintaining an output as much as possible when detection is not possible due to the pipe temporarily not being filled with fluid.
"Detection hold time" can be set between 0 (OFF) and 60 seconds.
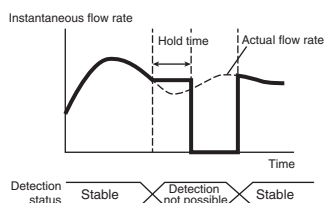
| Reference | • During the hold period, the previous values of the instantaneous flow rate, control output, internal evaluation, and analog output are maintained. In this period, the accumulated flow is totalized according to the hold value.
• If detection becomes possible again beforethe set hold period ends, the FD-H automatically clears the hold status and returns to normal operation. |

D-10 Correction of flow rate value

To improve the detection accuracy of the flow rate value, use this function, which can correct the instantaneous flow rate value.

> The FD-H Series standard model and high-temperature model **perform this correction automatically by automatically calculating the liquid sound velocity when in hybrid mode.** There is no need for these models to perform span adjustment according to fluid changes.

(1) Span adjustment

The span adjustment value can be set from 0.100x to 10.000x which will act as a multiplier on the sensor's internal detected value.
This is useful when the instantaneous value (which is the actual flow rate value) is known. The sensor's readings can be scaled up or down to closer match the known value. This setting can also be used with (2) Additional settings.
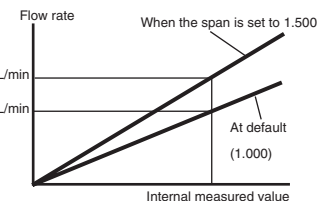
(2) Additional settings

This is useful in improving the accuracy. This setting can also be used with (1) Span adjustment.

● Flow detection mode (with a standard model or high-temperature model)

Changes the detection principle. Normally use "Hybrid."

	Detection principle	**Delta time of flight**	**Pulse doppler**
	Features	• High accuracy	• Resistant to bubbles and particles
Flow detection mode	**Hybrid**	✓	✓
	Delta time of flight	✓	-

| Reference | The FD-H**F Series Flow Sensor can only detect using the "Delta time of flight" principle. |

● Flow detection mode (with a hose model)

If you are not able to improve stability on a standard hose through mounting, the "High power" setting for high-pressure hoses may improve the stability.

Flow detection mode	Features
Standard	**Optimal settings for a standard hose**
High power	**Optimal settings for a high-pressure hose**

● Pipe O.D., Pipe thickness (with a standard model or high-temperature model)

If the "Pipe size" setting differs from the outer diameter and thickness of the actual pipe used, the correct dimensions can be entered to resolve any errors in the readings arising from this difference.

● Hose I.D. (with a hose model)

If the actual hose inner diameter is known, the correct dimension (inner diameter) can be entered to resolve any errors in the readings arising from the difference between the setting and the actual diameter.

● Pipe sound velocity (in hybrid mode)

Use this setting to improve the accuracy of the ultrasonic speed correction function in hybrid mode. Entering the correct pipe sound velocity leads to improved accuracy. General data is shown below.

Pipe	Pipe ultrasonic speed (m/s)	Pipe	Pipe ultrasonic speed (m/s)
Carbon steel	3240	**Copper**	2260
Stainless steel	3120	**Hard PVC pipe**	2300

● Liquid ultrasonic velocity (in delta time of flight mode or with a hose model)

Under the above conditions, the flow rate is calculated with water set as the standard fluid to detect. If the fluid being detected is not water and if the ultrasonic velocity is known, entering this value improves the detection accuracy. General data is shown below.

Liquid	Liquid ultrasonic speed (m/s)	Liquid	Liquid ultrasonic speed (m/s)
Water (25°C)	1497	**Water-soluble coolant**	1490
Ocean water (concentration: 3.5%)	1510	**Oil-based coolant**	1250
Ethylene glycol	1650	**Silicone oil**	990
Glycerin	1920	**Fluorinert**	650

● Kinematic viscosity

Enter the kinematic viscosity of the fluid being detected. As the flow rate increases, the flow velocity distribution of a fluid normally changes from a laminar flow to a turbulent flow. This change may slightly affect the accuracy. Correctly entering the kinematic viscosity allows for improved accuracy through internal correction.

Level Sensor Detection Settings

D-11 Stability alarm

This alarm occurs when the measurement stability (status value) drops. This setting is initially turned ON. To prevent undesired alarms, turn this setting OFF. (For details on stability, see the instruction manual of the FL Series Level Sensor.)

Heat Transfer Calculation Settings

D-12 Heat transfer calculation usage examples

"Heat transfer calculation" is a setting that can be used when one flow sensor and two FI-T temperature sensors are connected and "Heat transfer calculation" is set to "Enabled." Usage examples are shown below.

Heat extraction calculation for metal die coolant

It is possible to calculate heat extraction by attaching temperature sensors to the IN and OUT sides of the metal die coolant for a die-casting machine and using these sensors together with a flow sensor, enabling the visualization and management of coolant efficiency.

Heat transfer calculation for air conditioning management (heating and cooling)

It is possible to automatically calculate the heat transfer by attaching temperature sensors to the low- and high-temperature sides of a building's air conditioning system and using these sensors together with a flow sensor. During cooling, one temperature sensor has a large value and the other a small one and vice-versa during heating, but the current operation can be evaluated and the FD-H can automatically switch between these two modes.

> **For details, see the "Heat Transfer Calculation Setup Guide."**

System Settings

D-13 Indicator mode

Select the operation of the display unit's status indicator.

### • Output * operation mode (* = 1, 2, 3, 4)

The indicator lights and turns OFF according to the evaluation of the desired channel (there is no relation to the N.O./N.C. setting).
For example, if Ch2 is set to Output: Flow rate, Area mode, the indicator turns ON when the instantaneous value is in the area and turns OFF when this value is outside the area (see chart below).
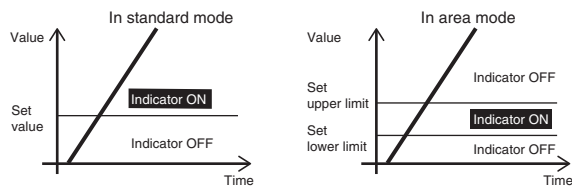
Reference
- For the accumulated elapsed time mode, Analog output, and Pulse output of the Flow rate and Heat transfer, the indicator will turn ON when the Flow rate meets or exceeds the Zero cut flow rate and will turn OFF when it drops below this threshold.
- For the Analog output of the Temperature, Concentration, and Level, the indicator will be constantly ON.
- The indicator will remain OFF if the corresponding channel is set to a value other than those listed above (such as external input).

• Output 1 + Predictive Maintenance mode

When the instantaneous value is close to dropping below the set value due to build up in the pipe, the status indicator flashes. This display mode provides users with early notification of the problem.
For example, if the "Predictive maintenance ratio" is "1.1," the predictive maintenance threshold is the set value times 1.1. The predictive maintenance status activates (the indicator flashes) when the instantaneous value is between the set value and this threshold. To define the bottom 10% of the set value as the predictive maintenance range, set the "Predictive maintenance ratio" to "0.9."
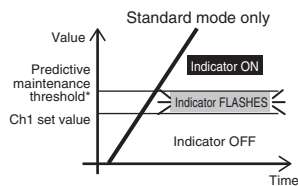
* Predictive maintenance threshold = set value × predictive maintenance ratio

Reference
- The hysteresis set on the output is not considered. The predictive maintenance status activates solely according to the set value and the predictive maintenance threshold.
- Excluding the flashing indicator, the operation is the same as that for "Output 1 operation mode".
- The predictive maintenance status does not activate if the output 1 detection mode is set to something other than "Standard" and if Ch1 is not set to output.
- The predictive maintenance status does not activate if the output 1 Target is set to something other than "Flow rate."

• Multi-judgment

If all the channels whose detection mode is set to "Standard" or "Area" are ON, the status indicator lights. If even one of these channels is OFF, the status indicator turns OFF.
For example, if Ch1 to Ch4 are set to area mode, the status indicator turns ON if all the channels are within their areas. If even one channel is outside its area, the status indicator turns OFF.

Operation in Multi-judgment mode

Ch1	Output 1	ON	ON	OFF
Ch2	Output 2	ON	OFF	OFF
Ch3	Output 3	ON	ON	OFF
Ch4	Output 4	ON	ON	OFF
		↓	↓	↓
Status indicator		ON	OFF	OFF

D-14 Indicator color

Changes the lighting pattern and color of the display unit's status indicator.
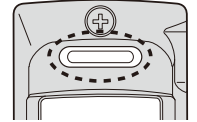
Indicator color		ON Status	OFF Status
	Green-Off	Green	OFF
	Green-Red	Green	Red
	Always Off	OFF	OFF

Reference
- Regardless of this setting, the indicator always flashes red when an error occurs.
- If a FI-T Temperature Sensor and FI-C Concentration Sensor are connected to the Multi-port, the Indicator color setting is also applied to the lighting color of the sensor heads.
- When using the display unit separate from the sensor, the set indicator color is also applied to the detection head.

D-15 Screen brightness

Adjust the brightness of the display unit.

	Brighter ←				→ Darker	
Screen brightness	Brightness 5	Brightness 4	Brightness 3	Brightness 2	Brightness 1	Turn off when inactive*

* If "Turn off when inactive" is selected, the LCD turns OFF when no key operations are performed on the display unit. When the power supply starts or a key operation occurs, the LCD display turns ON at Brightness 5. If no operations are performed for approximately 10 seconds, the display turns OFF again.

Reference This setting does not affect the screen brightness of connected sensors.

D-16 Key Lock

This function prevents operation mistakes by locking/disabling key operations. This is effective in preventing the settings from being changed easily.
To require a password when canceling the key lock, set "Key lock method" to "With password."

■ Enabling/disabling the key lock

(1) On the current value screen, hold down ■ + ▼.

(2) If "With password" has been selected, enter the security code.

Reference
- If the security code entered is incorrect, an error will occur and the normal screen will appear with the key lock still enabled.
- Even when the key lock is enabled, pressing ◄ and ► on the current value screen switches the displayed monitored value.

Useful Function

D-17 [Flow] Origin adjustment

This function samples the instantaneous flow rate at the time the origin adjustment is executed for approximately 20 seconds and sets this flow rate average as "zero." Perform an origin adjustment after the installation of the sensor and the initial settings have been completed.

> **Perform this function when the pipe is filled with fluid and the fluid is not moving.**
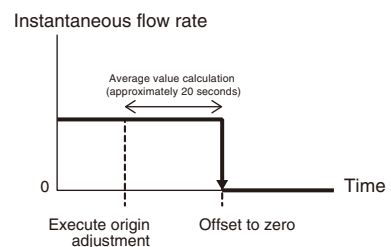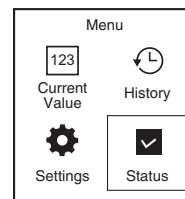

Reference This function can also be executed with external input. (Page 15)

9. Troubleshooting

If the product is not operating as intended, first check the information in this chapter.

> ***   Also use chapter "7. Checking the Status," because it may provide clues for solving the problem. (Page 13)**

Problem	Cause	Solution
■ The flow rate behaves oddly.		
The instantaneous flow rate is not stable.	• The pipe is not filled with fluid. • The sensor is affected by pulsation or air bubbles. • Cavitation is occurring due to pressure changes.	• Install the sensor so that the display is perpendicular, not parallel, to the ground. • Increase the response time of the unit. • Increase the Detection hold time of the unit.
	The flow velocity distribution is not uniform.	• Increase the response time of the unit. • Install the FD-H on as straight a section of pipe as possible. • Avoid installing the FD-H just after an expansion, reduction, or a valve.
	The FD-H is affected by noise.	Increase the response time of the unit.
	The FD-H is affected by vibrations.	• Increase the response time of the unit. • Implement countermeasures against vibration such as supporting the pipe.
The instantaneous flow rate does not change from "0." Flow rate (L/min) **0.0**	The fluid is not flowing.	Check whether valves are open or closed and check the pipe and the filter for clogging.
	The fluid is flowing; however, the flow rate is less than the zero cut flow rate.	Adjust the zero cut flow rate.
	When using the external input function, the flow rate zero input is selected and the external input is being applied.	• Check if the input wiring is correct. • If the input wire and output wire are in contact, separate them. • If the flow rate zero input has been set accidentally, select a different input option.
	The stability is zero.	• See the "■ The stability is low." item.
• A value is displayed even though no fluid is flowing through the pipe. • The accumulated flow is totalized even though no fluid is flowing through the pipe.	The origin adjustment has not been performed correctly.	Perform the origin adjustment again when the pipe is filled with fluid and the fluid is still.
	The pipe is not filled with fluid.	• Install the pipe in a manner so that it is always filled with fluid. • Install the sensor so that the display is perpendicular, not parallel, to the ground.
	The zero cut flow rate setting is too low.	Increase the zero cut flow rate.
The display does not turn ON.	• The power is not turned ON. • The cable is damaged.	• Check the power supply capacity. • Check the wiring for crossed wires or loose connections. • Check whether the sensor cable is broken.
	System settings > Screen brightness is set to "Turns off when inactive."	Change the setting to something other than "Turns off when inactive."

| Problem	Cause	Solution
■ The accuracy is poor.		
The flow rate value differs greatly from the actual flow rate value.	The product has not been installed correctly.	Check whether the sensor head has been installed correctly.
	The pipe size selected in the settings differs from that of the actual pipe.	• Adjust the flow rate span according to the actual flow rate value. • Alternatively, use the Additional settings to correctly enter the pipe information such as size and thickness.
	The origin adjustment has not been performed correctly.	Perform the origin adjustment again when the pipe is filled with fluid and the fluid is still.
	The characteristics of the fluid largely differ from those of water (model FD-HxxF or when set to Delta time of flight mode).	• Adjust the flow rate span according to the actual flow rate value. • If the actual flow rate value is unknown, enter the ultrasonic velocity and the kinematic viscosity.
	The flow velocity distribution is not uniform due to drift.	• Change the installation position. • Adjust the flow rate span according to the actual flow rate value. • Ensure the straight section of pipe is sufficiently long and install the sensor away from joints.
■ The stability is low.		
• The flow rate occasionally becomes "0." • One stability indicator is lit or all indicators are OFF.	The sensor head is not properly fixed in place on the pipe.	• Check whether the clamp has been installed correctly. • Check that the screws have not been partially tightened and are not loose.
	The pipe is not filled with fluid.	• Install the pipe in a manner so that it is always filled with fluid. • Install the sensor so that the display is perpendicular, not parallel, to the ground.
	The FD-H is affected by foreign particles or air bubbles. (model FD-HxxF or when set to Delta time of flight mode).	• Increase the Detection hold time of the unit. • If air bubbles or foreign particles are expected to be present inside the pipe, change the installation location or remove these items by way of high-pressure washing.
	The detection signal is obstructed by the front or back surface of the pipe.	• Remove the sensor head from the pipe, and then attach it in a different location. • If there is rust or dirt on the pipe surface, avoid this area when installing the sensor. • If there is a seam on the back side of the pipe where the sensor head comes in contact with the pipe, move the sensor head away from the seam before installation.
	When using a hose model, the sensing elements are not closely connected due to reasons such as the hose being flat and outer diameter errors.	Set the dial for selecting the outer diameter to one smaller size.
	• When using a hose model, the hose is preventing the sensing elements from being closely connected (examples: uneven surfaces and surfaces made of metal mesh). • The hose does not transmit ultrasonic waves (examples: ultra-high-pressure-resistant hoses and deteriorated hoses).	Connect to a different hose, or insert a short length of pipe between hoses and try the standard/high-temperature model.
	The special rubber where contact is made with the pipe is deformed or damaged.	If the special rubber is deformed, contact the nearest KEYENCE office.
	The sensor is damaged.	Contact the nearest KEYENCE office.
■ An error is displayed.		
An error is displayed.	See "Errors" (page 20).	
■ Keys are locked on a connected sensor.		
Keys are locked on a sensor.	The sensors are designed so that the keys are locked when connected to the display unit. To change the settings, use the display unit.	

10.Specifications and Related Information

Specifications

Type		Standard model / high-temperature model (K)						Hose model			
Model		FD-H10/FD-H10K		FD-H20/FD-H20K		FD-H32/FD-H32K		FD-H22F	FD-H32F	FD-H47F	FD-H63F
Pipe size	Outer diameter of pipe (mm)	13 to 16	16 to 18	18 to 23	23 to 28	28 to 37	37 to 44	13 to 22.9	23 to 32.9	33 to 47.9	48 to 63
	DN (Diameter Nominal)	8A	10A	15A	20A	25A	32A			-	
	NPS (Nominal Pipe Size)	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"				
Supported pipe materials		Metal, Hard plastic[*1]						Soft plastic, Hoses (braided hoses, high-pressure rubber hoses, etc.)[*1]			
Supported fluids		Liquids (water, oil, chemicals, etc.)[*1]									
Supported fluid temperature		Standard model: 0°C to 85°C (no freezing on the pipe surface)[*2, 3] High-temperature model: 0°C to 180°C (no freezing on the pipe surface)[*2, 3]						0°C to 100°C (no freezing on the pipe surface)[*2]			
Rated flow rate		20L/min	30L/min	60L/min	100L/min	200L/min	300L/min	60L/min	200L/min	300L/min	500L/min
Zero cut flow rate (variable, initial value)		0.3L/min		0.5L/min		1.0L/min		0.5L/min	1.0L/min	2.0L/min	5.0L/min
Detection principle		Propagation time difference + Pulse doppler						Propagation time difference			
Liquid sound velocity automatic correction function		Available						-			
Display		QVGA 2.0" LCD color monitor, Status indicator									
Display update cycle		Approx. 10 Hz									
Display resolution	Instantaneous flow rate (L/min)	0.01/0.1/1 (initial value: 0.1)				0.01/0.1/1 (initial value: 1)		0.01/0.1/1 (initial value: 0.1)		0.01/0.1/1 (initial value: 1)	
	Accumulated flow (L)	0.01/0.1/1 (initial value: 0.1 / max. 8 digits)				0.01/0.1/1 (initial value: 1 / max. 8 digits)		0.01/0.1/1 (initial value: 0.1 / max. 8 digits)		0.01/0.1/1 (initial value: 1 / max. 8 digits)	
Response time		0.5s/ 1.0s/ 2.5s/ 5.0s/ 10.0s / 30.0s/ 60.0s/ 120.0s/ 200.0s									
Measurement accuracy	Between 10 and 100% of F.S.	±3.0% of RD[*4, 5]						-			
	Between 0 and 10% of F.S.	±0.3% of F.S.[*4, 5]									
Repeatability[*4, 6]		0.5 s: ±1.0%, 1 s: ±0.7%, 2.5 s: ±0.45%, 5 s: ±0.3%, 10 s: ±0.2%, 30 s: ±0.15%, 60 s: ±0.1% of F.S.									
Hysteresis		Variable									
Flow units		L/min m³/h G/min									
Pulse output units (L)		0.02 to 999.99									
Pipe temperature measurement accuracy (ambient temperature of 25°C)[*4]		Standard model: ±2.0°C (pipe temperature of 0°C to 50°C), ±3.0°C (pipe temperature of 50°C to 85°C) High-temperature model: -						-			
Heat transfer calculation function[*7]	Unit	MJ/h, kW, kBTU/h									
	Display resolution	Instantaneous value (MJ/h): 0.01/0.1/1 (initial value: 0.1) Accumulated value (MJ): 0.01/0.1/1 (initial value: 0.1)									
	Pulse output unit (MJ)	0.02 to 999.99									
Data accumulation	Accumulation period	Approx. 1 year									
	Data reading	USB2.0									
I/O wiring connection port		M12 8-pin connector (male)									
I/O (switchable)	Output (Ch1/2/3/4)	Instantaneous flow rate mode / Area mode / Pulse output mode / Accumulated flow mode / Bubble detection mode / Error output NPN/PNP setting switchable, Open collector output 30 VDC or less, Max. 100 mA/Ch, Residual voltage: 2.5 V or less									
	Analog output (Ch1/2)	4 to 20 mA/0 to 20 mA (switchable), Load resistance: 500 Ω or less									
	External input (Ch2/3)	Reset total input / Zero flow input / Origin adjustment input / Bank change input Short-circuit current: 1.5 mA or less, Input time: 20 ms or more									
Power supply	Power supply voltage	20 to 30 VDC including 10% ripple (p-p), Class2/LPS									
	Current consumption	240 mA or less (when using a flow sensor / load current excluded)[*8]									
Protection circuit		Power supply reverse connection protection, Power supply surge protection, Short-circuit protection for each output, Surge protection for each output									
Network compatibility		IO-Link[*9]									
Environmental resistance	Enclosure rating	IP65/IP67 (IEC60529)[*10]									
	Ambient temperature	Detection head: −20°C to +60°C (no freezing), Display unit: −20°C to +50°C (no freezing)[*2]									
	Ambient humidity	35%RH to 85%RH (no condensation)									
	Vibration resistance	10 to 500 Hz, power spectral concentration: 0.816 G²/Hz, XYZ axes									
	Shock resistance	100 m/s² (approx. 10G), 16 ms pulse, XYZ axes, 1000 times for each axis									
Material	Display unit	Body: PPS/PET/POM, Display: PAR									
	Detection head	Body: Standard model PPS/PET/PAR/SUS304 High-temperature model: PEEK/PPS/PET/PAR/SUS304 Sensing elements: special rubber, Mounting bracket:SUS304/SUSXM7						Body: PPS/PET/PAR/SUS304, Cable: PVC, Sensing elements: special rubber, Mounting bracket: PPS/PBT/POM/SUS304/SUSXM7			
Weight		Standard model: Approx. 440 g High-temperature model: Approx. 490 g		Standard model: Approx. 480 g High-temperature model: Approx. 540 g		Standard model: Approx. 620 g High-temperature model: Approx. 680 g		Approx. 770 g	Approx. 880 g	Approx. 1130 g	Approx. 1360 g

*1 Liquid must allow ultrasonic signals to propagate, as well as not contain large air pockets or excessive bubbles. Readings may become unstable depending on the type of pipe and liquid status.
*2 Perform derating depending on the ambient temperature and liquid temperature when the detection head and display unit are integrated.
*3 For use with fluid temperatures of 140°C or higher, install an FD-HK1/2/3 ultra-high-temperature couplant (sold separately). Alternatively, the display unit must be used separately from the sensor on the basis of derating.
*4 This value is guaranteed by KEYENCE inspection facilities. Errors will be introduced by factors such as the condition and type of pipes as well as the temperature and type of liquid.
*5 This is the value when considering linearity + span error in a stable environment with a temperature of 25°C after executing origin adjustment.
*6 This specification is valid when the flow velocity distribution is stable. This value does not take into account the affects of fluctuations in flow velocity distribution due to facility factors. Convert the F.S. (full scale value) listed in the table according to the rated flow range.
*7 This can be used when two temperature sensors (sold separately) are connected.
*8 640 mA or less with the load included. When connecting sensors such as temperature sensors, add each sensor's current consumption (830 mA or less).
*9 IO-Link: Compatible with specification v1.1/COM2 (38.4kbps). The setting file (IODD) can be downloaded from the KEYENCE website (www.keyence.com/glb).
    IO-Link is a trademark or registered trademark of PROFIBUS Nutzerorganisation e.V. (PNO).
*10 The IP65/67 enclosure rating is lost when a USB connection is established.

Derating

GB FD-H IM
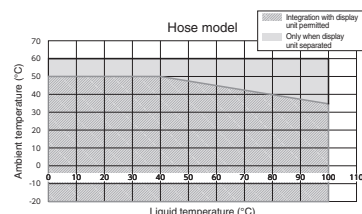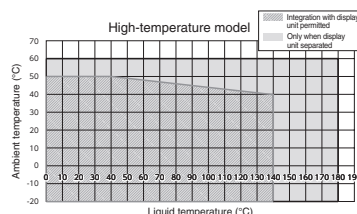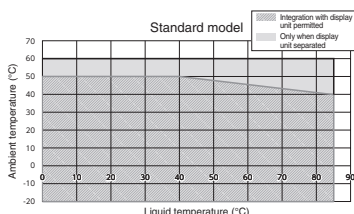
Keyboard Shortcuts

Display	Applicable screen	Command
[Flow rate] Origin adjustment, [Concentration] Teach, [Level] Zero shift	Instantaneous value screen for the current value of each monitored value	Hold down ■ + ◀ or ■ + ▶.
Hold reset	Hold value screen for the current value of each monitored value*	
Reset Total	Accumulated value screen for the current value of the flow or heat transfer	
Reference flow rate on Percent display	Instantaneous value and percent display screens for the current value of the flow or heat transfer	Hold down ■ + ▲.
Key Lock	Current value screen	Hold down ■ + ▼.
Keys Unlocked		

* Executing the hold reset will reset all the hold values of the monitored values.

Errors

Display	Category	Cause	Solution
Errors common for all sensors			
Memory error / EEPROM error / System error	**(4) General error**	FLASH memory or EEPROM error	• Perform a complete initialization. • If the problem persists, contact the nearest KEYENCE office.
Time error	**(4) General error**	Time error	Reset the time. If the problem persists, contact the nearest KEYENCE office.
Overcurrent	**(4) General error**	Excessive current (more than 100 mA) is flowing through a channel from Ch1 to Ch4, indicating a potential short circuit or a draw exceeding the specifications.	• Check if the output wires are connected correctly and are not in contact with other wires. • Check if the load is within the rated range of the output.
Pulse output error	**(4) General error**	The frequency of the pulse output has exceeded 500 Hz.	Increase the pulse weight value.
Communication error	**(3) Sensor error**	The sensor registered in the initial settings is not properly connected.	Check the sensor connections.
Settings error	**(3) Sensor error**	A sensor different from that registered in the initial settings is connected.	Connect the sensors indicated in the settings or change the settings to the appropriate connected sensor.
Flow sensor (FD-H) errors			
Reverse flow error	**(1) Notification**	The fluid flows in the opposite direction of the setting.	Check if the set flow direction matches the actual direction.
Out of temperature range (flow rate)	**(1) Notification**	The temperature measured by the FD-H is outside the detection range (standard model only).	Use this product within the specified temperature range.
Bubble detection	**(1) Notification**	Air bubbles were detected with the detection mode assigned to "Bubble detection."	Implement countermeasures against air bubbles in the equipment as necessary.
Temperature sensor (FI-T) errors			
Out of detection range (Temperature)	**(1) Notification**	The temperature measured by the FI-T is outside the detection range.	Use this product within the specified temperature range.
Head error (Temperature)	**(3) Sensor error**	The FI-T detection head is disconnected from the FI-T display amplifier or the cable connecting them is broken.	Check the connection between the FI-T detection head and display amplifier.
Concentration sensor (FI-C) errors			
Detection in progress (Concentration)	**(1) Notification**	Searching for detected waveform.	The waveform is searched for immediately after insertion into the tank. Wait for this operation to finish.
Out of range (Concentration)	**(1) Notification**	The concentration measured by the FI-C is outside the detection range.	Use this product within the specified concentration range.
Out of temperature range (Concentration)	**(1) Notification**	The temperature measured by the FI-C is outside the detection range.	Use this product within the specified temperature range.
Stability alarm (Concentration)	**(2) Alert**	The FI-C detection stability is low.	Perform maintenance on the FI-C detecting surface.
Low liquid detection (Concentration)	**(3) Sensor error**	The FI-C is not in contact with the fluid.	Use this product with the FI-C sensing elements in contact with the fluid.
Level sensor (FL) errors			
Out of range (Level)	**(1) Notification**	The liquid level measured by the FL is outside the detection range (−20000 or 20000).	Use this product within the specified liquid level range.
Stability alarm (Level)	**(2) Alert**	The FL detection stability is low.	Perform maintenance on the FL probe.
Calibration (Level)	**(4) General error**	Calibration failed.	For details, see the instruction manual of the FL Series.
Detection error (Level)	**(3) Sensor error**	There is a problem in the installation environment or an error in the settings. The sensor may also be affected by noise.	For details, see "ErSt," "ErwA," and "ErJU" in the instruction manual of the FL Series.
Probe disconnection error (Level)	**(3) Sensor error**	The probe is disconnected.	Properly connect the probe.

Output Status by Error Category

Category	Control output (other than error output)	Error output	Analog output	Status indicator	History data
(1) Notification	Normal operation	OFF*	Normal operation	Normal operation	Normal operation
(2) Alert	Normal operation	ON*	Normal operation	Normal operation	Normal operation
(3) Sensor error	Corresponding channel: OFF*	ON*	The value of the corresponding sensor is fixed as follows. • When 4-20 mA is set: 3.5 mA • When 0-20 mA is set: 0 mA	Flashing red	Records as if the instantaneous value of the corresponding sensor is zero
(4) General error	Normal operation	ON*	Normal operation	Flashing red	Normal operation

* When set to N.O. When set to N.C., this output is reversed.

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KEYENCE CORPORATION

1-3-14, Higashi-Nakajima, Higashi-Yodogawa-ku,
Osaka, 533-8555, Japan
PHONE: +81-6-6379-2211

www.keyence.com/glb

AUSTRIA Ph: +43 (0)2236 378266 0	**HONG KONG** Ph: +852-3104-1010	**NETHERLANDS** Ph: +31 (0)40 206 6100	**TAIWAN** Ph: +886-2-2721-1080
BELGIUM Ph: +32 (0)15 281 222	**HUNGARY** Ph: +36 1 802 7360	**PHILIPPINES** Ph: +63-(0)2-8981-5000	**THAILAND** Ph: +66-2-078-1090
BRAZIL Ph: +55-11-3045-4011	**INDIA** Ph: +91-44-4963-0900	**POLAND** Ph: +48 71 368 61 60	**UK & IRELAND** Ph: +44 (0)1908-696-900
CANADA Ph: +1-905-366-7655	**INDONESIA** Ph: +62-21-2966-0120	**ROMANIA** Ph: +40 (0)269 232 808	**USA** Ph: +1-201-930-0100
CHINA Ph: +86-21-3357-1001	**ITALY** Ph: +39-02-6688220	**SINGAPORE** Ph: +65-6392-1011	**VIETNAM** Ph: +84-24-3772-5555
CZECH REPUBLIC Ph: +420 220 184 700	**KOREA** Ph: +82-31-789-4300	**SLOVAKIA** Ph: +421 (0)2 5939 6461	
FRANCE Ph: +33 1 56 37 78 00	**MALAYSIA** Ph: +60-3-7883-2211	**SLOVENIA** Ph: +386 (0)1 4701 666	
GERMANY Ph: +49-6102-3689-0	**MEXICO** Ph: +52-55-8850-0100	**SWITZERLAND** Ph: +41 (0)43 455 77 30	

Specifications are subject to change without notice. A6WW1-MAN-2062