KEYENCE

Sensing Guide Pulse Level Sensor

FL Series

NEW Separate Display Unit

Unaffected by foam or bubbles on the surface

Build-up resistant, maintenance free

Eliminating False Detection

THE INDUSTRY'S FIRST SENSING GUIDE PULSE LEVEL SENSOR

Water | Oil | Chemicals | Viscous Liquids

STABLE DETECTION OF EVERY TYPE OF LIQUID

LIQUID LEVEL SENSOR
[THE NEXT GENERATION]

Our unique algorithm for liquid level detection
allows for monitoring of every type of liquid.
Continuous stable detection has been achieved
under any environment.
This is a new-generation of level sensing that
eliminates all factors of false detection
that were problems with conventional level sensors.

Sensing Guide Pulse Level Sensor *FL Series*

IO-Link CE cSPus CERTIFIED EHEDG TYPE EL CLASS I DECEMBER 2019 3A

*FL-S001 only

Conventional Issues Eliminated

Conventional level sensors were commonly associated with false readings and unstable detections. Along with these concerns, external factors such as build-up, foam, and rust would further amplify these issues with conventional level sensors. These problems are eliminated with the new Sensing Guide Pulse Level Sensor.

Your benefit

The FL Series solves all of the problems associated with conventional level sensors, to provide reliable readings and stable detection. This helps to prevent costly downtime from situations such as boil-dry, tank overflow, or unintended liquid depletion.

Stable Detection Achieved

Industry First

When guide pulse technology was discovered, the concept of level sensing was forever changed. The FL series harnessed this detection method and enhanced it with its unique "TriSense Technology." This includes three unparalleled algorithms that expand the versatility and usability of this series.

Your benefit

While guide pulse technology improved upon conventional issues, the unique sensing style of the FL series extends this technology much further. This includes being able to detect liquids more than just of water, ignore obstacles in the environment, and automatically adjust detection to account for build-up.

Integration Simplified

Industry First

The FL series can be setup in seconds with only three simple steps. It can also integrate into any situation with its variety of output options, including four independent level outputs. Along with this, the multiple models available allow it to be used in any environment.

Your benefit

With the FL Series, innovative technology does not have to require a complex setup. The immediate startup process will save valuable time on initial setup. Between its multiple output options and various models available, the FL series will provide stable detection that lasts in any environment.

Conventional level sensing methods present unique problems

CONVENTIONAL METHOD 1

FLOAT TYPE

This type monitors a “float” that sits on the surface of the liquid. Since moving parts are required, it is subject to false detection due to breakage or the float becoming stuck.

PROBLEMS

- False detection caused by the float becoming stuck
- False detection caused by breakage of the float
- False detection caused by bubbles/foam on the surface
- Not compatible with viscous liquids

CONVENTIONAL METHOD 2

ELECTRODE TYPE

This type works by measuring the conductivity between electrodes. Since it can only detect electrical conductivity, detection is affected by the environment.

PROBLEMS

- False detection caused by coatings/rust
- False detection caused by condensation
- Not compatible with non-conductive liquids
- Not compatible with viscous liquids

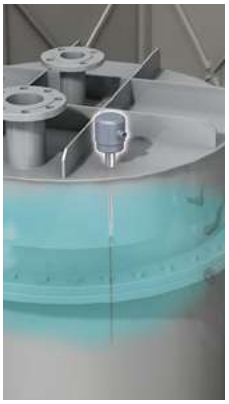
CONVENTIONAL METHOD 3

ULTRASONIC TYPE

This type uses the reflection principle of ultrasonic sound waves. Since sound waves tend to spread, detection is affected by objects inside the tank.

PROBLEMS

- False detection caused by spreading sound waves
- False detection caused by ripples
- False detection caused by vapor from the liquid
- False detection caused by bubbles/foam on the surface



CONVENTIONAL METHOD 4

CAPACITANCE TYPE

This type monitors the capacitance generated between the liquid and tank wall. Detection is affected by the changes in the property or temperature of the liquid.

PROBLEMS

- False detection caused by changes in the liquid property
- False detection caused by a change in temperature
- Adjustment using an empty tank is required
- Not applicable with plastic tanks

False detection caused by these factors can be eliminated

BUILD-UP

Even when viscous foreign materials or metal powders adhere to the probe (sensing section), false detection is prevented.

VAPOR

Even when the liquid is heated and emits vapor in the tank, sensing is stable without any false detection.

RIPPLES

Even when the liquid surface has ripples caused by a mixing propeller in the tank, detection is stable without any false detection.

CONDENSATION

Even when condensation forms on the probe (sensing section) due to a difference in the temperatures inside and outside of the tank, there is no worry for false detection. Liquid temperature up to 150°C 302°F* is acceptable.

FOAM

Even when foam forms on the surface due to mixing of the liquid, the FL Series can measure the surface immediately below the foam instead of the upper surface of the foam.

RUST/COATING

Even in environments where a coating or rust accumulates continuously on the probe (sensing section), stable sensing is ensured.

CHANGE IN PROPERTY

Even when several different liquids are being mixed or the property of the liquid changes due to temperature variation, detection is stable.

OBSTACLES

Detection is stable without being affected by any obstacles such as heaters or mixing propellers inside the tank.

* When the sanitary type is used

TECHNOLOGY

New liquid level detection technology achieves truly stable detection

INDUSTRY FIRST SENSING GUIDE PULSE METHOD

=

GUIDE PULSE METHOD

+

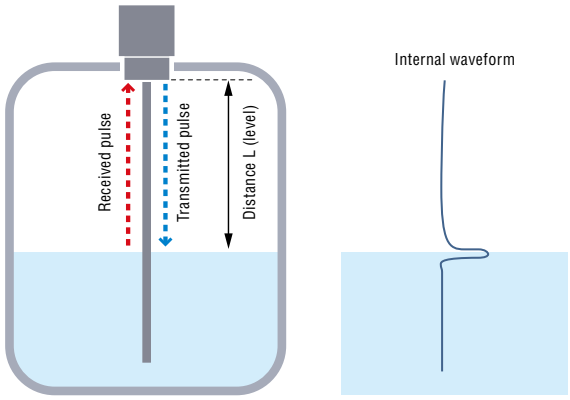
TRISENSE TECHNOLOGY

The foundation of the FL Series is rooted in the guide pulse method of detection, which involves no moving parts. This method was further reinforced by TriSense Technology, originally developed by KEYENCE, resulting in a new “Sensing Guide Pulse Method.” The algorithms, which can handle various sensing conditions, eliminate false detection and achieve stable detection all of the time.

BASIC DETECTION PRINCIPLE OF THE FL SERIES

GUIDE PULSE METHOD DETECTION PRINCIPLE

The sensor transmits a pulse signal to the liquid along the guide probe. It then receives the pulse signal reflected off of the liquid surface and determines the distance (level) from the time between the transmission and reception of the pulse signal. The detected distance L is determined by using the formula L = 1/2 × T × C, where T is the time between the transmission and reception, and C is the speed of the pulse.



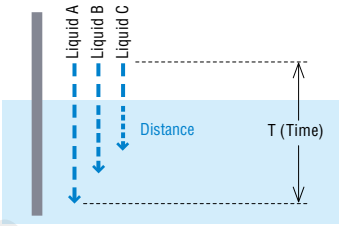
1. SENSING OF ANY LIQUID

The sensor automatically adjusts to properly detect any liquid. Along with water, other liquids such as oils and chemicals can now be detected with ease.

Automatic relative permittivity identification algorithm

The sensor automatically determines and adjusts to the type of liquid being measured, by monitoring the speed of the pulse signal passing through the liquid. Unlike conventional guide pulse level sensors, various types of liquids such as water, oils, or chemicals can be detected without any adjustment.

* Relative permittivity = Liquid surface reflectance



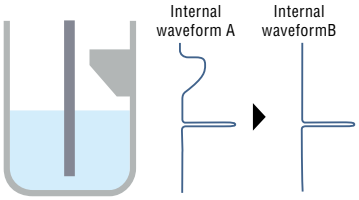
2. SENSING OF THE INSTALLATION ENVIRONMENT

The environment around the probe is recognized and ignored. Even when the space is limited or there is an obstacle nearby, the sensor learns its installation environment in real time* and eliminates the risk of false detection.

Automatic environment update algorithm

The sensor automatically stores data from the waves being reflected by the environment around the probe. By sensing and differentiating the waves reflected from the surroundings, it eliminates false detection caused by changes in the installation environment. The data of waves reflected from the surroundings is updated in real time, ensuring the detection of the liquid surface only.

* When using the automatic environment update function



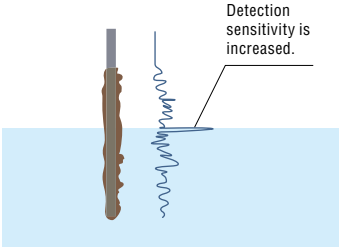
Data of A is automatically stored and converted into internal waveform B after difference calculation.

3. SENSING OF THE PROBE CONDITION

The probe, which transmits pulse signals, is continuously monitoring for buildup. Based on this data, the FL Series is able to appropriately adjust its sensitivity to ensure stable detection.

Probe sensing algorithm

The sensor automatically optimizes liquid level detection by differentiating between the liquid level and build-up on the probe. This ensures stable detection for long periods of time. If there is too much accumulation or environmental changes to conduct stable detection, a warning signal can be issued before problems occur.



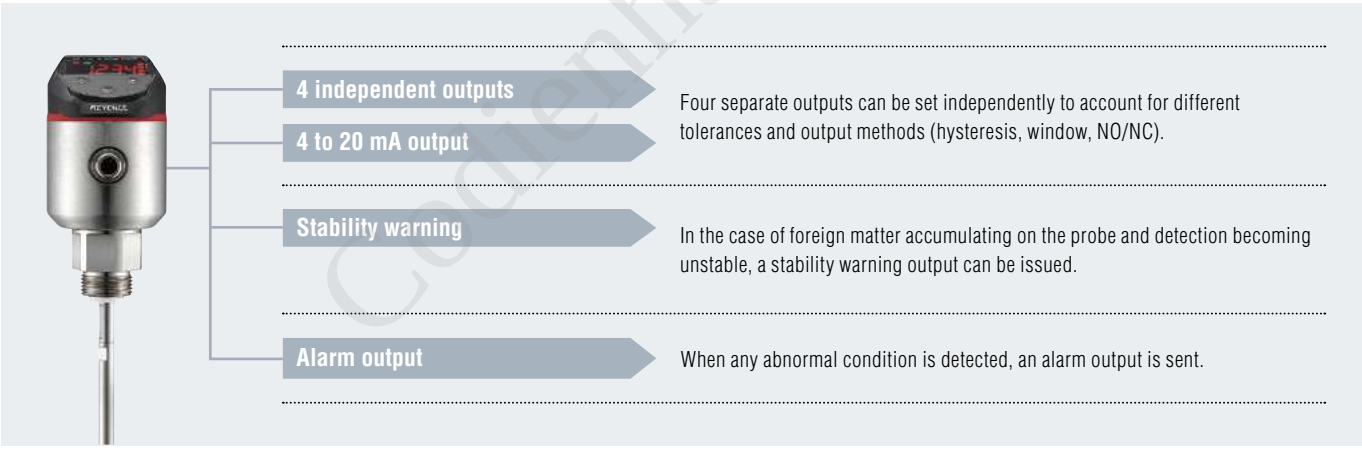
Functions ensuring ease of use

START UP IMMEDIATELY AFTER INSTALLATION

Startup is almost immediate after installation of the probe. Simply input the probe length and necessary output thresholds directly on the unit to start stably detecting liquid level. This eliminates the need for empty tank adjustment and other time consuming tasks associated with conventional level sensors.

AVAILABLE OUTPUTS (When used standalone)

In addition to four independent outputs and one analog output (4 to 20 mA), stability warning and alarm outputs are provided as standard.



SCALING FUNCTION

The liquid level can be displayed not only in mm, cm, m and inch but also as a capacity (%). The sensor also features an “offset function” to allow addition/subtraction to the display values and an “auto-zero function” to set any level to zero. Multiple display options are available to account for any situation.

Three unique models for any condition

STANDARD TYPE

Controller model
FL-001

Not only water but also oils, coolants, and other non-corrosive liquids can be detected.

- Water/oil model
- Applicable for liquids containing solid particulates
- Applicable for viscous liquids

Application: Coolant tank

SANITARY TYPE

Controller model
FL-S001

This model features CIP/SIP-compatible fluid-end materials and can be used in food or chemical industries.

- Food/chemical industry model
- Ready for CIP/SIP cleaning
- Applicable for viscous liquids

[Cap included]

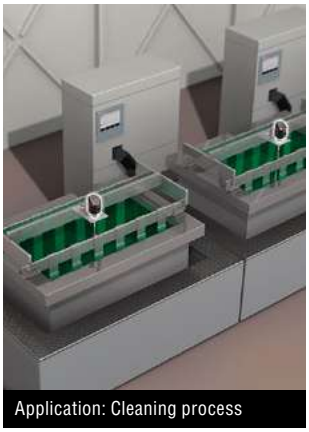
Application: Chocolate tank

PLASTIC TYPE

Controller model
FL-C001

This model can be used for all chemical liquids including hydrochloric acid, nitric acid, and hydrogen fluoride.

- Chemical tank model
- Applicable for corrosive liquids
- Applicable for viscous liquids



Application: Cleaning process

Connect Additional Sensors for Enhanced Fluid Management

Level sensor

FL Series

+ Flow Rate

Monitor both level and flow simultaneously

Mult-port for connecting additional sensors

No pipe modifications necessary, simply clamp onto the pipe or hose and start monitoring liquid flow.

Clamp-On Flow Sensor **FD-H** Series NEW

+ Display unit

Add a display unit to the FL Series for remote viewing

Display Unit **FI-1000** NEW

COMPLETE PROCESS MONITORING

Extend Beyond Level Sensing to Understand the Full System

When it comes to day-to-day fluid management, it is important to manage not just the fluid level, but a number of different parameters, including flow rate, temperature, and concentration. Connecting to the FD-H Series flow sensors or FI family of process sensors can reduce costs and improve overall quality by providing a complete and reliable picture of the entire process.

Avoid Costly Manufacturing Issues	Examples of Complete Process Monitoring
Downtime	Heat transfer control for molds [Flow Rate + Temperature]
Scrapped Parts	Monitoring of mold release agent [Flow Rate + Level]
Equipment Damage	Quality control during quenching [Flow Rate + Concentration]
	Coolant reservoir monitoring/filling [Flow Rate + Concentration + Level]

+ Concentration

Digital Refractometer

When used in conjunction with a Y-shaped connector, it can also be linked with a concentration sensor or temperature sensor.

Probe type

Probe and in-line type models are available to monitor concentration in tanks and pipes.

Digital Refractometer **FI-C** Series NEW

In-Line type

+ Temperature

Clamp-On Temperature Sensor

Monitor temperature from outside of the pipe with compatible sizes ranging from 1/8" to 8"

Clamp-On Temperature Sensor **FI-T** Series NEW

CONTROLLER (Required)

Standard type
FL-001

Sanitary type
FL-S001

OP-87558 cap for sanitary type controller included

Plastic type
FL-C001

PROBE (Required)

FL-P20 (200 mm 0.66')	**FL-P100** (1000 mm 3.28')	**FL-P180** (1800 mm 5.91')
FL-P40 (400 mm 1.31')	**FL-P120** (1200 mm 3.94')	**FL-P200** (2000 mm 6.56')
FL-P60 (600 mm 1.97')	**FL-P140** (1400 mm 4.59')	
FL-P80 (800 mm 2.62')	**FL-P160** (1600 mm 5.25')	

Compatible with probes up to 6000 mm (19.7') long. Contact KEYENCE for information on specifications.

FREE-CUT DESIGN

The probe of the standard type can be cut to a required length according to the measurement range.

* Free-cut is available with the standard type only.
* The minimum length for the probe is 100 mm 0.33'.

FL-SP20 (200 mm 0.66')	**FL-SP100** (1000 mm 3.28')	**FL-SP180** (1800 mm 5.91')
FL-SP40 (400 mm 1.31')	**FL-SP120** (1200 mm 3.94')	**FL-SP200** (2000 mm 6.56')
FL-SP60 (600 mm 1.97')	**FL-SP140** (1400 mm 4.59')	
FL-SP80 (800 mm 2.62')	**FL-SP160** (1600 mm 5.25')	

STANDARD COMPLIANCE

These units have been evaluated for compliance with the Hygienic Equipment Design Criteria of the EHEDG and 3-A Sanitary Standards.

FL-CP20 (200 mm 0.66')	**FL-CP100** (1000 mm 3.28')	**FL-CP180** (1800 mm 5.91')
FL-CP40 (400 mm1.31')	**FL-CP120** (1200 mm 3.94')	**FL-CP200** (2000 mm 6.56')
FL-CP60 (600 mm 1.97')	**FL-CP140** (1400 mm 4.59')	
FL-CP80 (800 mm 2.62')	**FL-CP160** (1600 mm 5.25')	

When used standalone

Standard power supply cable

The following are standard PVC cables.

Straight cable
OP-87564 (2 m 6.6')
OP-87565 (5 m 16.4')
OP-87566 (10 m 32.8')

L-shaped cable
OP-87568 (2 m 6.6')
OP-87569 (5 m 16.4')
OP-87570 (10 m 32.8')

Stainless steel power supply cable

The following are PVC cables with stainless steel (SUS316L) connectors. Use in situations where rust is a concern for the connectors.

Straight cable
OP-87647 (2 m 6.6')
OP-87648 (5 m 16.4')
OP-87649 (10 m 32.8')

L-shaped cable
OP-87650 (2 m 6.6')
OP-87651 (5 m 16.4')
OP-87652 (10 m 32.8')

Oil-resistant power supply cable

The following are PUR cables with high resistance to oil environments.

Straight cable
OP-87582 (2 m 6.6')
OP-87583 (5 m 16.4')
OP-87584 (10 m 32.8')

L-shaped cable
OP-87586 (2 m 6.6')
OP-87587 (5 m 16.4')
OP-87588 (10 m 32.8')

IO-Link cable

The following cables include a M12 8-pin connector on one side and a M12 4-pin connector on the other.

Straight cable
OP-88444 (2 m 6.6')
OP-88445 (5 m 16.4')
OP-88446 (10 m 32.8')

When used with a display unit

Display unit

The FL Series can be connected to a separate display, which can also be connected to up to two additional devices.

FI-1000

Display unit power supply cable

A power supply cable for the FI-1000 (M12 6-core, loose wire, PVC).

FD-HCB2 (2 m 6.6')
FD-HCB10 (10 m 32.8')

FL to display unit cable

A cable with an M12 8-pin connector at one end and an M12 4-pin connector at the other.

Straight cable
OP-88444 (2 m 6.6')
OP-88445 (5 m 16.4')
OP-88446 (10 m 32.8')

*The cable between the FL-Series and FI-1000 can be extended up to 20 m 65.6' by adding M12-M12 connector cables (e.g. OP-85504 5 m 16.4' PVC).

Separate display unit bracket

A bracket for mounting the display unit.

FD-HB1

Display unit protection cover

Protects the display unit.

FD-HP1

OPTIONAL ACCESSORIES

Gasket for FL-001
(Inorganic fiber + Oil-resistant rubber)
OP-87548

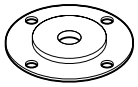
Seal material for improved mounting sealability.

Condensation prevention attachment for FL-001 (SUS303)
OP-87551

**Installing this attachment between the device and the tank prevents condensation when the medium is at a lower temperature than the ambient temperature and condensation forms on the bottom of the device.
Includes two gaskets (OP-87548).**

Flange plate for FL-001 (SUS303)
Corresponding to G3/4 JIS5K50A
OP-87573

Corresponding to G3/4 JIS5K65A
OP-87574



**Use for mounting via a flange plate.
Includes one gasket (OP-87548).**

Nut for FL-001 G3/4 (SUS303)
OP-87642

Use for mounting to a top panel with a nut.

Cap for FL-S001
OP-87558
[Included with FL-S001]

**This cap offers improved waterproof performance beyond the IP67 rating of the device with no cap. The cap includes a transparent plastic window on the top for checking the display.
Material: SUS304, PPSU, EPDM**

Tube for FL-C001
OP-87560

**This tube offers protection for the power supply cable in corrosive environments.
Material: FKM, PPS**

Gasket for FL-C001
OP-87561
(FFKM)

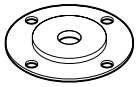
OP-87562
(FKM)

Seal material for improved mounting sealability.

Cap for FL-C001
OP-87563

**This cap offers protection for the operating surface of the device in corrosive environments. The cap prevents the display from being visible.
An O ring (FKM) is included for the cap.**

Flange plate for FL-C001 (PVC)
Corresponding to G3/4
JIS5K50A
OP-87577
Corresponding to G3/4 JIS5K65A
OP-87578



**Use for mounting via a flange plate.
Gasket supplied separately.**

Nut for FL-C001 G3/4 (PPS)
OP-87645

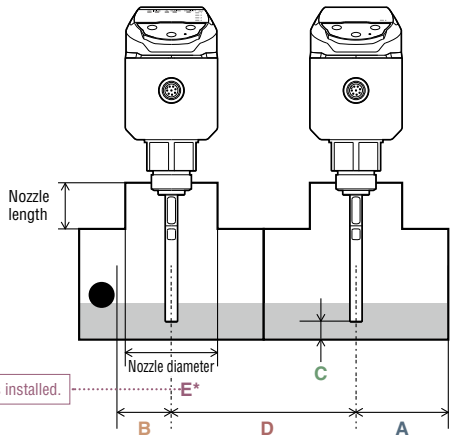
Use for mounting to a top panel with a nut.

Situation 1

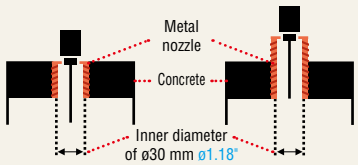
Detecting the liquid level inside a tank/bath

To ensure stable detection, install the sensor so that the installation distances are greater than or equal to the recommend distances for A through E below.

- A : Min. distance from wall
- B : Min. distance from obstacles
- C : Min. distance from bottom
- D : Min. distance between adjacent FL sensors
- E : Min. diameter for metal or plastic nozzles



Unit: mm inch

Tank/bath material	Liquid	Model	A	B	C	D	E*	Notes
Metal	Water	FL-001	30 1.18"	50 1.97"	10 0.39"	150 5.91"	30 1.18"	·Since false detection will occur if the probe is touching the wall, a distance of at least 30 mm 1.18" is recommended for A. If the probe will not be touching the wall, a distance of 30 mm 1.18" or less is possible. The closer the probe is to the metal wall, the greater the signal strength will be, resulting in greater detection stability. ·Protrusions or uneven surfaces inside the tank/bath will be considered obstacles. As such, ensure a distance of B or more.
		FL-S001	30 1.18"	50 1.97"	10 0.39"	150 5.91"	30 1.18"	
		FL-C001	30 1.18"	50 1.97"	10 0.39"	300 11.81"	30 1.18"	
	Oil	FL-001	30 1.18"	100 3.94"	10 0.39"	150 5.91"	30 1.18"	
		FL-S001	30 1.18"	100 3.94"	10 0.39"	150 5.91"	30 1.18"	
		FL-C001	30 1.18"	100 3.94"	10 0.39"	300 11.81"	30 1.18"	
Plastic	Water	FL-001	30 1.18"	50 1.97"	10 0.39"	1500 59.06"	30 1.18"	·Metal flanges offer higher signal strength than plastic flanges, resulting in greater detection stability. ·Use plastic bolts to secure a plastic flange. Metal bolts may be considered obstacles, reducing detection stability. As such, ensure a distance of B or more. ·If metal (including brackets) is present on the exterior of the plastic wall, it may be considered as an obstacle when the guide pulse passes through the plastic, reducing detection stability. As such, ensure a distance of B or more.
		FL-S001	30 1.18"	50 1.97"	10 0.39"	1500 59.06"	30 1.18"	
		FL-C001	30 1.18"	50 1.97"	10 0.39"	1500 59.06"	30 1.18"	
	Oil	FL-001	30 1.18"	100 3.94"	10 0.39"	1500 59.06"	30 1.18"	
		FL-S001	30 1.18"	100 3.94"	10 0.39"	1500 59.06"	30 1.18"	
		FL-C001	30 1.18"	100 3.94"	10 0.39"	1500 59.06"	30 1.18"	
Concrete	Water	FL-001	200 7.87"	50 1.97"	10 0.39"	1500 59.06"	30*1 1.18"	·Concrete reduces signal strength, resulting in unstable detection. Ensure A is 200 mm 7.87" or more. For concrete top panels, installation of a metal nozzle (figure below) is recommended.  *1 This inner diameter is for use of a metal nozzle with a length greater than or equal to the thickness of the concrete top panel. If a metal nozzle is not used, refer to the supplemental information under 2 below.
		FL-S001	200 7.87"	50 1.97"	10 0.39"	1500 59.06"	30*1 1.18"	
		FL-C001	200 7.87"	50 1.97"	10 0.39"	1500 59.06"	30*1 1.18"	
	Oil	FL-001	200 7.87"	100 3.94"	10 0.39"	1500 59.06"	30*1 1.18"	
		FL-S001	200 7.87"	100 3.94"	10 0.39"	1500 59.06"	30*1 1.18"	
		FL-C001	200 7.87"	100 3.94"	10 0.39"	1500 59.06"	30*1 1.18"	

* Values in the table are typical examples. * Do not secure the probe directly.

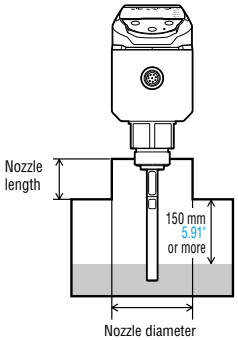
Supplemental information for nozzle installation

1 With a nozzle diameter of ø30 to ø100 mm ø1.18" to ø3.94"

Since the nozzle will be considered an obstacle, be sure to follow the procedure below.

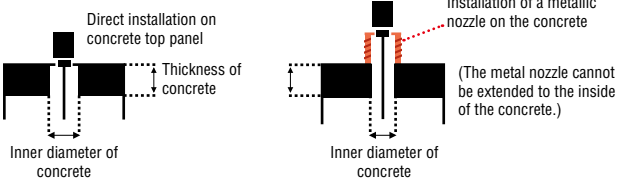
1. Configure the mask setting using the nozzle length as the mask setting length.
2. Perform calibration after the liquid level height has dropped to 150 mm 5.91" or more from the discharge hole of the nozzle.

* The above is not necessary if the nozzle diameter is ø100 mm ø3.94" or more.



2 When metal nozzles cannot be used on the inside of a concrete top panel

When installing the device as shown below, the guide pulse is absorbed by the concrete and the detection signal is dampened.



Accordingly, the inner diameters shown in the table below must be ensured for the concrete.

		Inner diameter of concrete
Thickness of concrete	Less than 300 mm 11.81"	ø200 mm ø7.87" or more
	300 mm 11.81" or more	ø400 mm ø15.75" or more

Situation 2

Detecting the liquid level inside a pipe

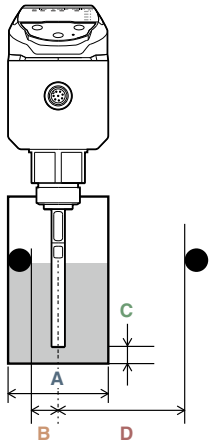
To ensure stable detection, install the sensor so that the installation distances are greater than or equal to the recommend distances for A through D below.

A : Min. inner diameter of pipe

B : Min. distance from obstacles in the pipe

C : Min. distance from bottom

D : Min. distance from metal outside the pipe



Unit: mm inch

Pipe material	Liquid	Model	A	B	C	D	Notes
Metal	Water	FL-001	30 1.18"	50 1.97"	10 0.39"	–	·Detection is possible with high signal strengths in metal pipes, so installation is possible in a pipe with a diameter as small as ø30 mm ø1.18". ·Protrusions or uneven surfaces on the inner wall of the pipe, as well as fluid supply inlets or drain outlets, will be considered obstacles. As such, ensure a distance of B or more. In addition, guide pulses cannot pass through metal, so obstacles outside the pipe (D) will have no effect. *1 For oil, if the pipe inner diameter is ø100 mm ø3.94" or more, install the device at least 30 mm 1.18" from the center. Also provide 20 mm 0.79" between the device and the inner wall of the pipe.
		FL-S001	30 1.18"	50 1.97"	10 0.39"	–	
		FL-C001	30 1.18"	50 1.97"	10 0.39"	–	
	Oil	FL-001	30*1 1.18"	100 3.94"	10 0.39"	–	
		FL-S001	30*1 1.18"	100 3.94"	10 0.39"	–	
		FL-C001	30*1 1.18"	100 3.94"	10 0.39"	–	
Plastic	Water	FL-001	60 2.36"	50 1.97"	10 0.39"	50 1.97"	·Metal on the outside of plastic pipes (such as L-shaped angles or U-shaped bolts) will be considered obstacles. As such, ensure a distance of D or more. If D cannot be ensured, use plastic pieces instead of metal. *2 These values are for oil with a relative permittivity of 5. To obtain higher signal strength using oil with a relative permittivity of less than 5, metal is recommended for the pipe material. *3 Since the signal strength will be greater when using a metal flange, installation of the device is possible with a minimum of ø80 mm ø3.15" for A.
		FL-S001	60 2.36"	50 1.97"	10 0.39"	50 1.97"	
		FL-C001	80 3.15"	50 1.97"	10 0.39"	50 1.97"	
	Oil*2	FL-001	200*3 7.87"	100 3.94"	10 0.39"	100 3.94"	
		FL-S001	200 7.87"	100 3.94"	10 0.39"	100 3.94"	
		FL-C001	400 15.75"	100 3.94"	10 0.39"	100 3.94"	

* Values in the table are typical examples. * Do not secure the probe directly.

UNDETECTABLE AREAS (COMMON FOR ALL INSTALLATIONS)

Depending on the model and probe length, the following undetectable areas exist at the root of the FL unit and at the tip.
Stable detection will not be possible within this undetectable area.

Unit: mm inch

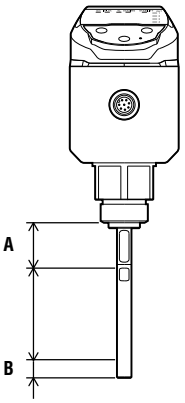
	Liquid : Water		Liquid : Oil	
Model	A	B	A	B
FL-P20	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P40	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P60	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P80	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P100	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P120	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P140	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P160	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P180	25 0.98"	10 0.39"	50 1.97"	30 1.18"
FL-P200	25 0.98"	10 0.39"	50 1.97"	30 1.18"

Unit: mm inch

	Liquid : Water		Liquid : Oil	
Model	A	B	A	B
FL-SP20	25 0.98"	28 1.10"	50 1.97"	48 1.89"
FL-SP40	25 0.98"	29 1.14"	50 1.97"	49 1.93"
FL-SP60	25 0.98"	32 1.26"	50 1.97"	52 2.05"
FL-SP80	25 0.98"	33 1.30"	50 1.97"	53 2.09"
FL-SP100	25 0.98"	37 1.46"	50 1.97"	57 2.24"
FL-SP120	25 0.98"	38 1.50"	50 1.97"	58 2.28"
FL-SP140	25 0.98"	39 1.54"	50 1.97"	59 2.32"
FL-SP160	25 0.98"	43 1.69"	50 1.97"	63 2.48"
FL-SP180	25 0.98"	44 1.73"	50 1.97"	64 2.52"
FL-SP200	25 0.98"	45 1.77"	50 1.97"	65 2.56"

Unit: mm inch

	Liquid : Water		Liquid : Oil	
Model	A	B	A	B
FL-CP20	25 0.98"	21 0.83"	25 0.98"	41 1.61"
FL-CP40	25 0.98"	22 0.87"	25 0.98"	42 1.65"
FL-CP60	25 0.98"	24 0.94"	25 0.98"	44 1.73"
FL-CP80	25 0.98"	25 0.98"	25 0.98"	45 1.77"
FL-CP100	25 0.98"	27 1.06"	25 0.98"	47 1.85"
FL-CP120	25 0.98"	28 1.10"	25 0.98"	48 1.89"
FL-CP140	25 0.98"	29 1.14"	25 0.98"	49 1.93"
FL-CP160	25 0.98"	31 1.22"	25 0.98"	51 2.01"
FL-CP180	25 0.98"	32 1.26"	25 0.98"	52 2.05"
FL-CP200	25 0.98"	33 1.30"	25 0.98"	53 2.09"



MOUNTING TO A TANK

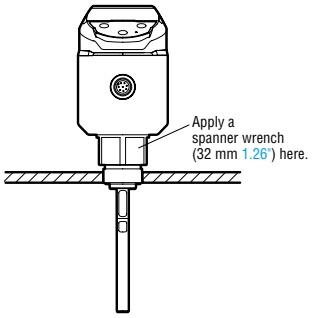
Standard type **FL-001**

The FL-001 can be installed to a tank in two ways.

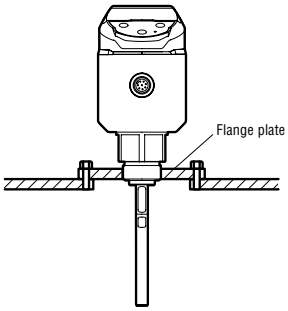
- Bore a screw hole for mounting and attach the controller directly to the tank.
- Use a flange plate to mount the controller.

The FL-001 can be rotated 340 degrees after mounting.

Direct mounting to a tank



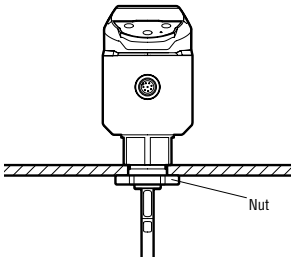
Mounting via a flange plate



MOUNTING TO A TOP PANEL

Standard/Plastic type **FL-001, FL-C001**

Bore a through hole in the top panel placed on a bath and mount the controller with a nut (SUS nut: **OP-87642**, plastic nut: **OP-87645**). The plate thickness is 6 mm 0.24" or less for the OP-87642, and 5 mm 0.20" or less for the OP-87645. Avoid use in environments affected by high temperature or high vibration.



MOUNTING TO A TANK (PLASTIC)

Plastic type **FL-C001**

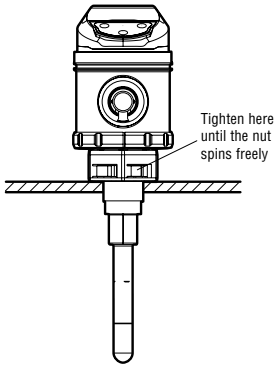
The FL-C001 can be installed to a plastic tank in two ways.

- Bore a screw hole for mounting and attach the controller directly to the tank.
- Use a flange plate to mount the controller.

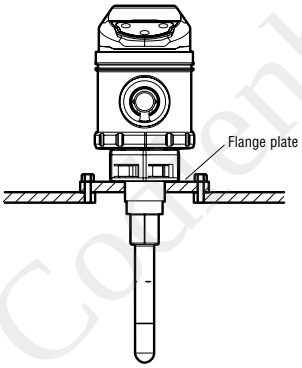
In both cases, tighten the mounting nut until it spins freely. At least 8 mm 0.31" of plate thickness is required.

The FL-C001 can be rotated 360 degrees after mounting.

Direct mounting to a plastic tank



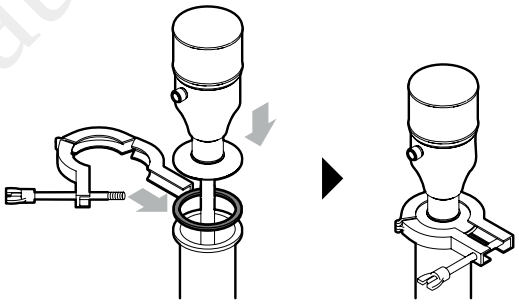
Mounting via a flange plate



MOUNTING TO A TANK (METAL)

Sanitary type **FL-S001**

A 2S ferrule is used to mount the FL-S001A to a metal tank.
Use a gasket and a mounting part for the sanitary type of size 2S.
Since the FL-S001 is mounted via a ferrule, the device can be mounted and rotated freely 360 degrees.



SPECIFICATIONS

Model		Standard (G3/4)	Sanitary type	Plastic type
		FL-001	FL-S001	FL-C001
Measurement range		100 to 2000 mm 3.94" to 78.74"	200 to 2000 mm 7.87" to 78.74"	
Relative permittivity of measurable media*1		2 or more		3 or more
Resolution*2		1 mm 0.04"		
Linearity*2		±3 mm ±0.12"		
Temperature characteristics		0.1 mm/°C		
Undetectable area	From the top end*3	25 mm 0.98"	25 mm 0.98"	25 mm 0.98"
	From the bottom end*3*4	10 mm 0.39"	45 mm 1.77" max.	33 mm 1.30" max.
Response time of comparator output		0.4 s minimum		
Sideways torque of the probe		6 N·m		
Tank pressure		-0.1 to +0.5 MPa	-0.1 to +1 MPa	-0.1 to +0.1 MPa
Material	Fluid end	Probe: SUS304 Housing bottom seal section: PTFE Packing: FKM (bottom of the shielded part)	Sheath: PFA Probe: SUS304 (do not connect this directly)	Sheath: PFA Probe: SUS304 (do not connect this directly)
	Housing	Metal section of the housing: SUS304, SUS303 Plastic section of the housing: PBT, PAR, NBR, HNBR, PET	Metal section of the housing: SUS304 Plastic section of the housing: PBT, PAR, HNBR, EPDM, PTFE, PPSU, PET	Plastic section of the housing: PPS, PPSU, FKM, PVC Cable connector: Ni-plated brass
Connection bore diameter		G3/4	2S ferrule	G3/4 on the dedicated probe side
Output	Comparator output/ Alarm output	NPN/PNP open collector (selectable) 30 VDC max., 50 mA max. for each Residual voltage: 2 V max. for NPN, 2.5 V max. for PNP, N.O./N.C. switchable		
	Analog output	4 to 20 mA, maximum load resistance: 350 Ω (Response time: 0.1 s after comparator output determined [90% response]) Ripple when target remains stationary (P-P) 2% of F.S. max.		
Network compatibility		IO-Link*5		
Analog output accuracy	Resolution	1 mm 0.04"		
	Zero accuracy	±0.1 mA (Zero point = 4 mA)		
	Full scale accuracy	±0.2 mA (Full scale = 20 mA)		
Environmental resistance	Ambient temperature	-20 to +60°C -4 to +140°F	-20 to +60°C -4 to +140°F	-10 to +60°C 14 to 140°F
	Relative humidity	35 to 85% (No condensation)		
	Target medium temperature	-20 to +100°C -4 to +212°F	-20 to +150°C -4 to +302°F	-10 to +110°C 14 to 230°F
	Vibration resistance	10 to 55 Hz, 0.75 mm 0.03" double amplitude in X, Y and Z directions, 2 hours respectively		
	Shock resistance	300 m/s^2 in 6 directions, 3 times respectively		
Enclosure rating		IP67		
Power supply voltage		10 to 30 VDC, ripple (P-P) 10% included, Class 2 or LPS		
Current consumption		300 mA max. (at 10 V)/120 mA max. (at 30 V) (excluding load)		
Applicable cable		8-pin M12 connector		
Weight		400 g 14.12 oz	670 g 23.65 oz	380 g 13.41 oz

*1 These values were measured at the position of 100 mm 3.94" or less from the wall of a metal tank. Contact KEYENCE for the case of a plastic tank.

*2 These values were measured under the following conditions.

Medium	Water
Tank material	Metal
Linearity range	Between 6 cm 2.36" from the top and 1 cm 0.39" from the bottom
Average time	4 s

*3 The case of water detection. For the case of oil detection, refer to the table below.

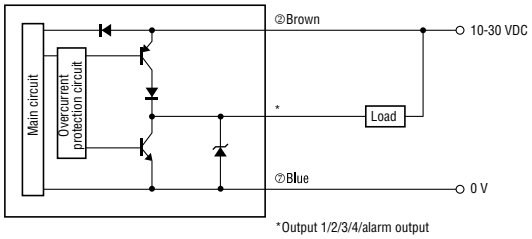
	FL-001	FL-S001	FL-C001
From the top end	50 mm 1.97"	50 mm 1.97"	50 mm 1.97"
From the bottom end	30 mm 1.18"	65 mm 2.56" max.	53 mm 2.09" max.

*4 For the sanitary/plastic types, the undetectable area from the bottom end varies depending on the length of the probe.

*5 Compatible with IO-Link Specification V1.1/COM 2 (38.4 kbps).

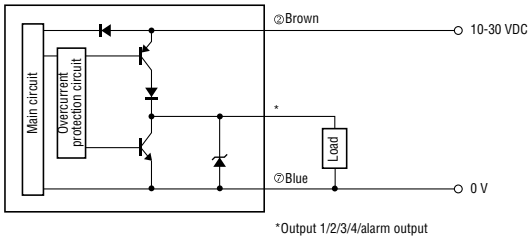
I/O CIRCUIT DIAGRAM/PIN ASSIGNMENT(When FL is used standalone)

When NPN output is selected



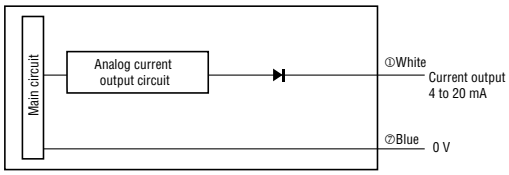
*Output 1/2/3/4/alarm output

When PNP output is selected

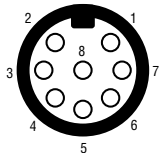


*Output 1/2/3/4/alarm output

Analog output circuit diagram



Pin assignment for the M12 connector cable



1	White	Analog output 4 to 20 mA
2	Brown	10 to 30 VDC power supply
3	Green	OUT3
4	Yellow	OUT4
5	Gray	OUT1
6	Pink	OUT2*
7	Blue	0 V
8	Red	Alarm output

* IO-Link compatible pin when connected to an IO-Link device

SPECIFICATIONS

Model		FI-1000
Display		QVGA 2.0 model: color LCD, status indicator light
Display update cycle		Approx. 10 times/second
Data accumulation	Accumulation period	Approx. 1 year
	Data reading	USB2.0
Power supply I/O connector		M12 8-pin connector (male)
I/O (switchable)	Output (Ch1/2/3/4)	NPN/PNP setting switching, open collector output 30 VDC or less, max. 100 mA/ch or less, residual voltage 2.5 V or less
	Analog output (Ch1/2)	4–20 mA/0–20 mA (switchable), load resistance 500 Ω or less
	External input (Ch2/3)	Short circuit current: 1.5 mA or less; input time: 20 ms or more
Power supply	Power voltage	20–30 VDC, ripple (P-P) 10% included, Class 2/LPS
	Current consumption	55 mA or less (display unit standalone, excluding load current)*1
Protection circuit		Protection against reverse power connection, power supply surges, output short circuits, and output surges
Network compatibility		IO-Link*2
Environmental resistance	Enclosure rating	IP65/IP67 (IEC60529)*3
	Operating ambient temperature	–20°C to +50°C –4°F to +122°F (no freezing)
	Operating ambient humidity	35–85% RH (no condensation)
	Vibration resistance	10–500 Hz; Power spectral density: 0.816 G²/Hz; X, Y and Z directions
	Shock resistance	100 m/s² (approx. 10 G), 16 ms pulses, 1000 times each for X, Y and Z directions
Material		Body: PPS / PET / POM; Display window: PAR
Weight		Approx. 120 g 4.23 oz

*1 455 mA or less including load. When connecting devices such as temperature sensors, please add on the current consumption of each sensor (to a maximum of 830 mA or less).
*2 Supports IO-Link specification v.1.1/COM2 (38.4 kbps). Setting files can be downloaded from the KEYENCE website (www.keyence.com). IO-Link is a trademark or registered trademark of PROFIBUS Nutzerorganisation e.V. (PNO). *3 When a USB connection is in use, IP65/67 compliance is impaired.

I/O Circuit Diagram (When Using Separate Display Unit)

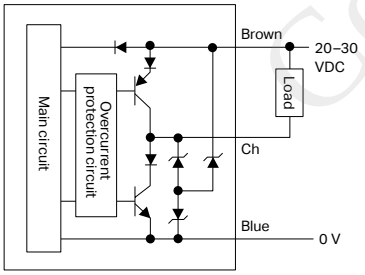
The FI-1000 Series allows users to allocate control outputs, external inputs, and analog outputs to 4 different I/O channels (Ch1 to Ch4) according to the settings.

Wire color	Role
Brown	Power supply + 20–30 V
Blue	GND
Black (Ch1)*1	Choose from control output or analog output
White (Ch2)	Choose from control output, analog output, or external input*2
Gray (Ch3)	Choose from control output or external input*2
Pink (Ch4)	Control output (Fixed)

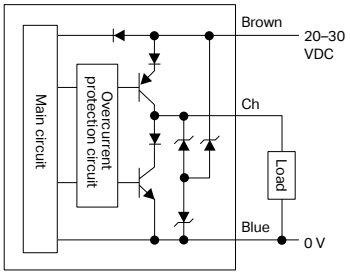
* IO-Link compatible wire when connected to an IO-Link module.

(1) Wiring of channel to which control output has been selected

When NPN is selected

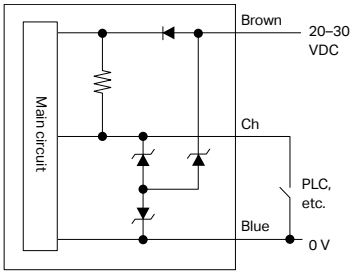


When PNP is selected

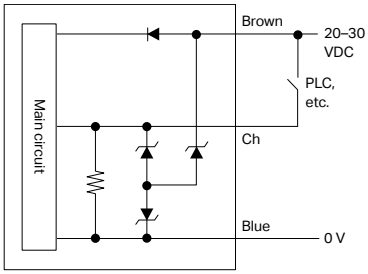


(2) Wiring of channel to which external input has been selected

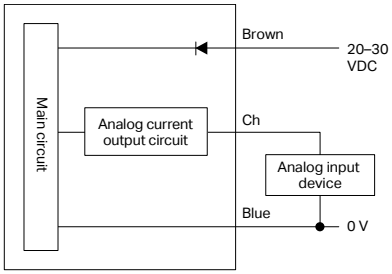
When NPN is selected



When PNP is selected



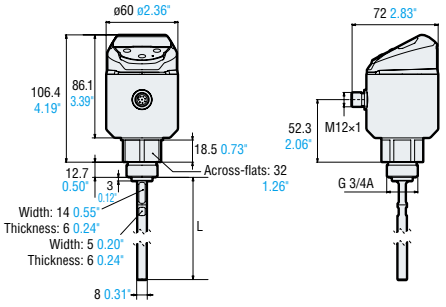
(3) Wiring of channel to which analog output has been selected



*Can be switched to 4–20 mA or 0–20 mA using the settings

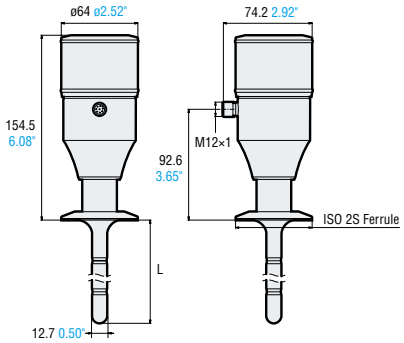
Level sensor

FL-001 When FL-P is attached



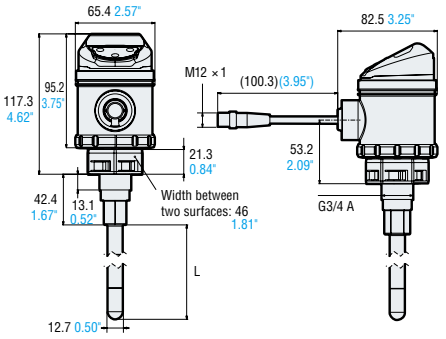
	Min.	Max.
L: Probe length	100 3.94"	2000 78.74"

FL-S001 When FL-SP is attached



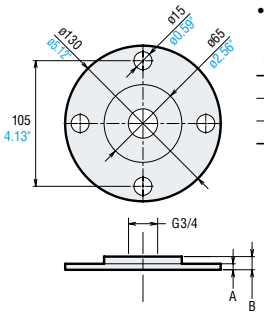
	Min.	Max.
L: Total length	217 8.54"	2034 80.08"

FL-C001 When FL-CP is attached



	Min.	Max.
L: Total length	203 7.99"	2015 79.33"

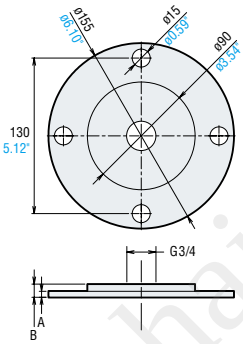
OP-87573 / 87577



• Corresponding to JIS 5K 50A
(It "corresponds" to JIS 5K 50A because its thickness is not exactly the same as the specified thickness.)

	A	B
OP-87573	5 0.20"	11 0.43"
OP-87577	14 0.55"	21.5 0.85"

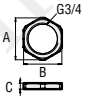
OP-87574 / 87578



• Corresponding to JIS 5K 65A
(It "corresponds" to JIS 5K 65A because its thickness is not exactly the same as the specified thickness.)

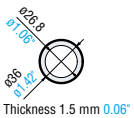
	A	B
OP-87574	5 0.20"	11 0.43"
OP-87578	14 0.55"	21.5 0.85"

OP-87642 / 87645



	A	B	C
OP-87642	35 1.38"	32 1.26"	5 0.20"
OP-87645	39.8 1.57"	35.7 1.41"	15 0.59"

OP-87548

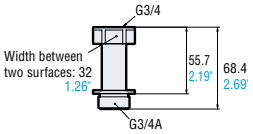


Thickness 1.5 mm 0.06"

OP-87561 / 87562

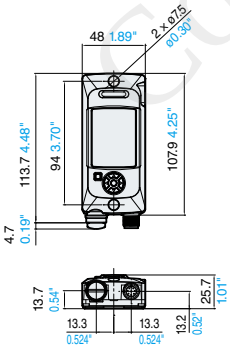
Thickness 2 mm 0.08"

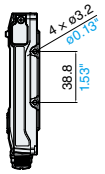
OP-87551



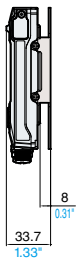
Display unit

FI-1000

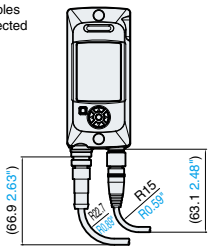




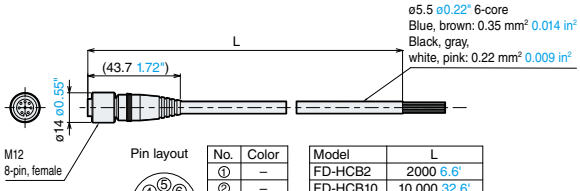
FI-1000+ FD-HB1



When cables are connected



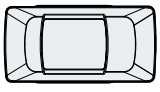
Power supply cable for display unit FD-HCB2/HCB10

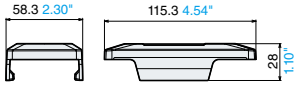


No.	Color
①	–
②	–
③	Black
④	Gray
⑤	Brown
⑥	White
⑦	Blue
⑧	Pink

Model	L
FD-HCB2	2000 6.6'
FD-HCB10	10,000 32.6'

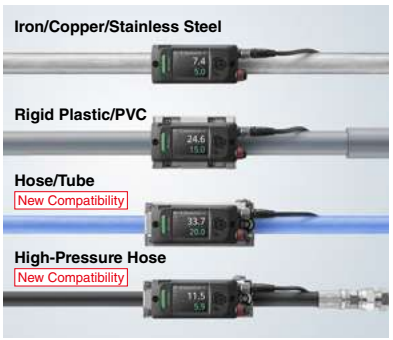
Display unit protection FD-HP1



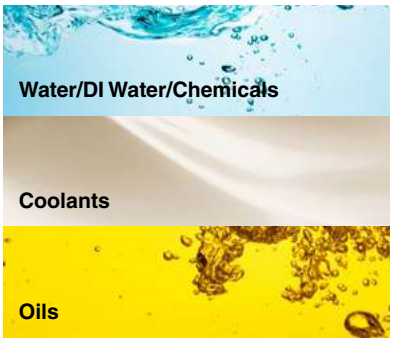


Utilize Anywhere

Any Pipe



Any Liquid



Any Condition

Standard Type

Model	Rated flow	Supported pipe sizes	Pipe outer diameter
FD-H10	20 L/min 5.3 gal/min	1/4" (8 A)	ø13–16 ø0.51"–0.63"
	30 L/min 7.9 gal/min	3/8" (10 A)	ø16–18 ø0.63"–0.71"
FD-H20	60 L/min 15.9 gal/min	1/2" (15 A)	ø18–23 ø0.71"–0.91"
	100 L/min 26.4 gal/min	3/4" (20 A)	ø23–28 ø0.91"–1.10"
FD-H32	200 L/min 52.8 gal/min	1" (25 A)	ø28–37 ø1.10"–1.46"
	300 L/min 79.3 gal/min	1 1/4" (32 A)	ø37–44 ø1.46"–1.73"

Rigid piping

IO-Link

Built-in temperature sensor

Compatible with fluids with bubbles

High-Temperature Type

Model	Rated flow	Supported pipe sizes	Pipe outer diameter
FD-H10K	20 L/min 5.3 gal/min	1/4" (8 A)	ø13–16 ø0.51"–0.63"
	30 L/min 7.9 gal/min	3/8" (10 A)	ø16–18 ø0.63"–0.71"
FD-H20K	60 L/min 15.9 gal/min	1/2" (15 A)	ø18–23 ø0.71"–0.91"
	100 L/min 26.4 gal/min	3/4" (20 A)	ø23–28 ø0.91"–1.10"
FD-H32K	200 L/min 52.8 gal/min	1" (25 A)	ø28–37 ø1.10"–1.46"
	300 L/min 79.3 gal/min	1 1/4" (32 A)	ø37–44 ø1.46"–1.73"

Rigid piping

IO-Link

Compatible with fluids with bubbles

Hose Type

Model	Rated flow	Pipe outer diameter
FD-H22F	60 L/min 15.9 gal/min	ø13–22.9 ø0.51"–0.90"
FD-H32F	200 L/min 52.8 gal/min	ø23–32.9 ø0.91"–1.295"
FD-H47F	300 L/min 79.3 gal/min	ø33–47.9 ø1.299"–1.886"
FD-H63F	500 L/min 132.1 gal/min	ø48–63 ø1.89"–2.48"

Hoses/Tubes

IO-Link

High-viscosity liquid compatible

140°C 284°F or lower

Between
140–180°C 284–356°F

Ultra-high-temperature couplant Required

If the fluid temperature exceeds 140°C 284°F, it is necessary to change the couplant and separate the display unit from the sensor.

FD-HK1: for FD-H10K
FD-HK2: for FD-H20K
FD-HK3: for FD-H32K

Stabilization bracket Optional

Can be used to secure hose models to walls, etc. Can be used with any of the four different hose models.

FD-HFB1

Power supply cables Required

Dedicated power supply cable

Appearance	Model	Overview
	FD-HCB2	M12 power supply cable 6-core cable PVC 2 m 6.6'
	FD-HCB10	M12 power supply cable 6-core cable PVC 10 m 32.8'

For IO-Link communication

Can be converted to 4 pins using the below.

Appearance	Model	Overview
	FD-HCC2	M12 power supply cable 8-pin female to 4-pin male PVC 2 m 6.6'
	FD-HCC10	M12 power supply cable 8-pin female to 4-pin male PVC 10 m 32.8'
	FD-HCC0	8-pin female to 4-pin male adapter

Accessories (Display Unit Related)

Heavy Duty Protection Cover

Standard models only

Heavy duty protection cover
FD-HP2

Heavy duty power supply cable
FD-HCB10G
M12 6-core cable
PVC 10 m 32.8'

Display unit protection cover Optional
FD-HP1

Separate display unit bracket Optional **FD-HB1**

Connection cable when separating the display Optional

A dedicated cable for when using the display unit separated from the sensor.

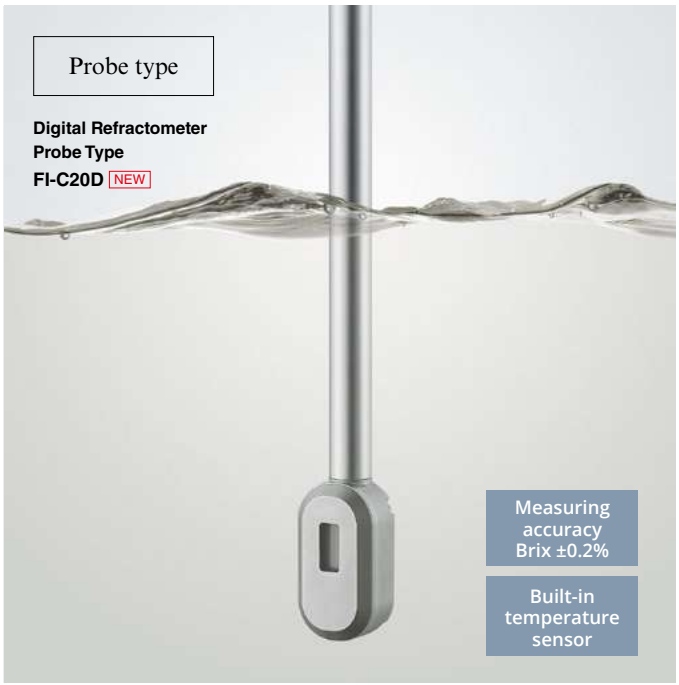
Appearance	Model	Overview
	FD-HCS2	Display unit separation connection cable PVC 2 m 6.6'

Can be extended an additional 18 m 59.1' (for a total of 20 m 65.6') using these M12-M12 connector cables.

	OP-85503	2 m 6.6' PVC
	OP-85504	5 m 16.4' PVC
	OP-88075	2 m 6.6' PUR
	OP-88076	5 m 16.4' PUR

Probe type

Digital Refractometer
Probe Type
FI-C20D NEW

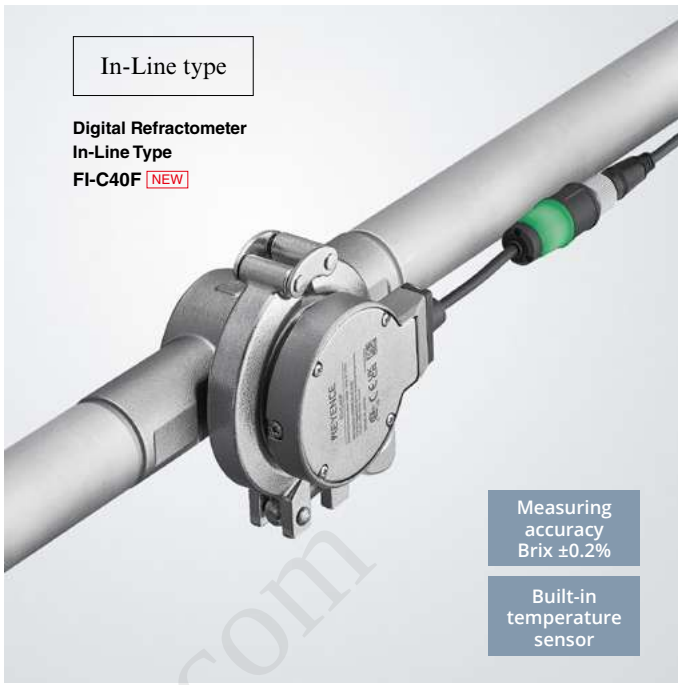


Measuring accuracy Brix ±0.2%

Built-in temperature sensor

In-Line type

Digital Refractometer
In-Line Type
FI-C40F NEW

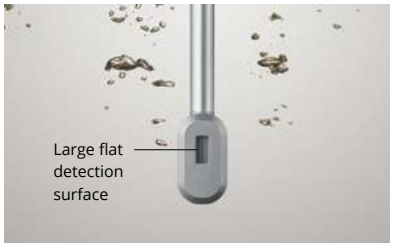


Measuring accuracy Brix ±0.2%

Built-in temperature sensor

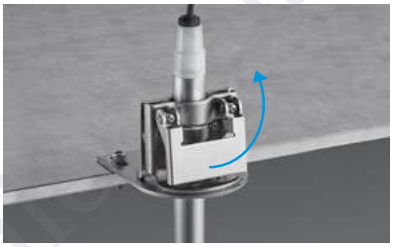
Stable & Reliable Detection

Stably measure the refractivity (Brix%) of the liquid regardless of bubbles or build-up.



Tool-Free Maintenance

No tools are required to remove and clean the units, greatly minimizing downtime.



Large Status Indicator

Understand the current situation at a glance, including recognizing potential issues.

Lineup

Probe Type

Model	Installation
FI-C20D	Probe type

Options

Appearance	Model	Overview
	**FI-CDB1**	Dedicated bracket for probe type
	FI-CD1	Extension pipe* 0.4 m 1.3'
	FI-CD2	Extension pipe* 0.8 m 2.6'

*Only one extension pipe can be used per setup

Cable length 2 m 6.6'

Probe Length (bottom of indicator to center of detection element): 331.5 mm 13.05"

In-Line Type

Model	Installation
FI-C40F	2S ferrule attached to dedicated pipe attachment

Cable length 50 mm 1.97"

Options

Appearance	Model	Overview
	**FI-CF1**	Pipe attachment Rc3/4
	FI-CF3	Pipe attachment NPT3/4
	**FI-CF2**	Pipe attachment Rc1-1/2
	FI-CF4	Pipe attachment NPT1-1/2

Display unit

FI-1000 display unit or FD-H Series flow sensor required for display.

When extending the cable length beyond 2 m 6.6'

M12 4-pin to M12 4-pin cable

Maximum extension of 20 m 65.6' from display unit to concentration sensor (with FI-C40F cable length considered to be 0 m 0')

Model	Overview
OP-85503	2 m 6.6' PVC
OP-85504	5 m 16.4' PVC
OP-88075	2 m 6.6' PUR
OP-88076	5 m 16.4' PUR

Small pipes
1/8" to 1/2"

Clamp-On Temperature Sensor
FI-T8/T15 NEW

Attach to the pipe with two screws

Medium/large pipes
3/4" to 8"

Clamp-On Temperature Sensor
FI-T25/T50/T100/T200 NEW

Attach to the pipe with metallic bands

Easy Installation

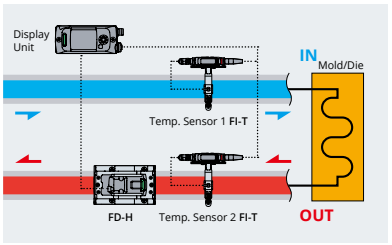
No pipe modifications necessary. The unit clamps onto the pipe in seconds.

Dedicated Display Amplifier

The easy to read OLED display allows users to understand the current situation quickly.

Heat Transfer Monitoring

Connect multiple units to a flow sensor to determine heat transfer in to or out of a system.



Lineup

Model	Supported pipe sizes	Pipe outer diameter
FI-T8	1/8", 1/4" (6 A/8 A)	ø8–14 ø0.31"–0.55"
FI-T15	3/8", 1/2" (10 A/15 A)	ø14–22 ø0.55"–0.87"
FI-T25	3/4", 1" (20 A/25 A)	ø22–38 ø0.87"–1.50"
FI-T50	1 1/4", 1 1/2", 2" (32 A/40 A/50 A)	ø38–70 ø1.50"–2.76"
FI-T100	2 1/2", 3", 3 1/2", 4" (65 A/80 A/90 A/100 A)	ø70–126 ø2.76"–4.96"
FI-T200	5", 6", 8" (125 A/150 A/200 A)	ø126–220 ø4.96"–8.66"

Display amplifier

Head

M8-M8 extension cable Optional
Maximum extension of 20 m 65.6' from display amplifier to head
OP-88673 PVC 2 m 6.6'
OP-88672 PVC 10 m 32.8'

*If using the FI-T temperature sensor on its own, use a 4-pin M8 connector cable. (Examples: OP-87625 (PVC, 2 m 6.6'), OP-87626 (PVC, 10 m 32.8'), OP-87628 (PUR, 2 m 6.6'), OP-87629 (PUR, 10 m 32.8')"

Display unit

Can be connected to FI-1000 or FD-H Series for complete process solution.

M8 4-pin to M12 4-pin cable

Maximum extension of 20 m 65.6' from the display unit to the temperature sensor display amplifier

Model	Overview
OP-88456	2 m 6.6' PVC
OP-88457	5 m 16.4' PVC
OP-88071	2 m 6.6' PUR
OP-88072	5 m 16.4' PUR