KEYENCE

Clamp-On Flow Sensor

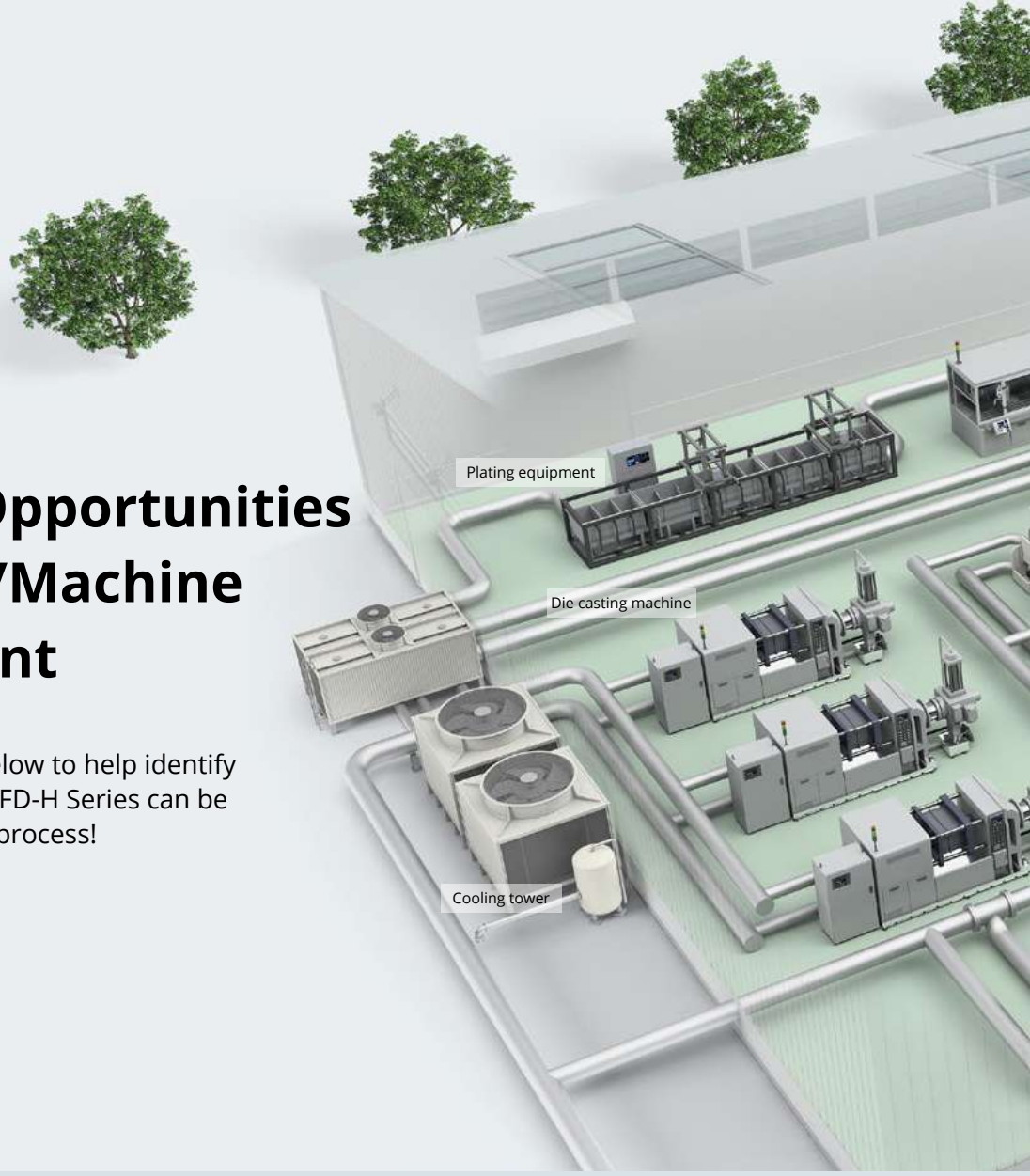
NEW FD-H Series



The Next Evolution in

Clamp-On Technology

Scan for More

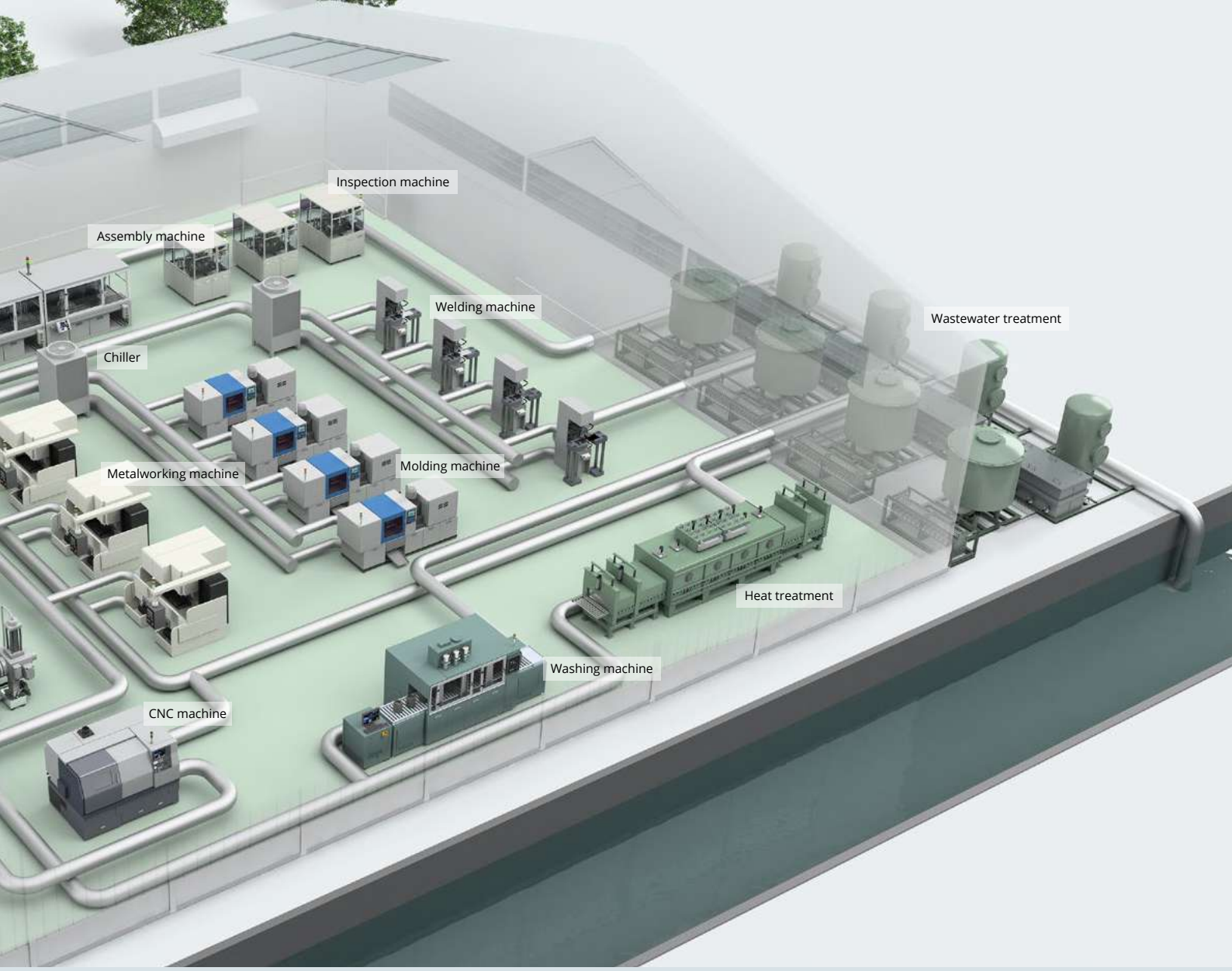


Countless Opportunities for Process/Machine Improvement

Consider the questions below to help identify different areas where the FD-H Series can be a benefit to a machine or process!

Which processes or machines in your facility utilise liquids?

Liquid Examples		Process & Machine Examples	
Water	Oils	Molding/Casting	Parts Washing
Chemicals	Coolants	Welding	CNC/Grinding
Grease	Adhesives	Induction Heating	Assembly
DI Water	Product	Wastewater Treatment	Mixing



What are the risks if the liquid does not flow properly?

Many risks and problems can arise if liquids are not flowing properly. Consider the potential negative impacts to your machines or processes if the liquid is not flowing correctly.

- **Damaged Equipment**
- **Downtime**
- **Scrapped Parts**
- **Wasted Resources**

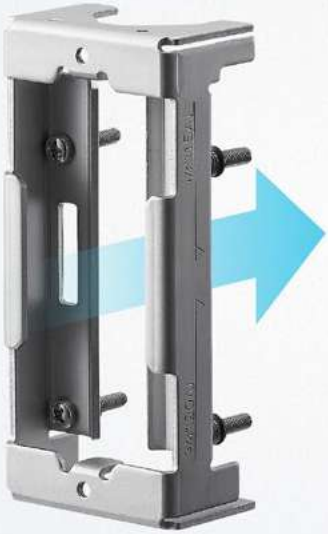
How are you currently monitoring liquid flow?

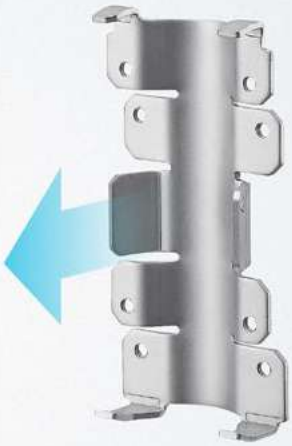
To prevent problems, it is necessary to continuously monitor flow and recognise potential issues quickly. Consider if your current monitoring techniques are adequate.

- **Nothing**
- **Visual Checks**
- **Mechanical Sensors**
- **High Accuracy Meters**

All you need to do is
CLAMP-ON







Never cut a pipe again!



Benefits of Clamp-On:

KEYENCE is the world leader in Clamp-On flow monitoring. This revolutionary technology has made flow monitoring possible in more places than ever before by making implementation easier and less cumbersome than conventional flow sensors.

No Pipe Modifications	No Pressure Loss
No Downtime	No Contamination
Fast Installation	No Leakage
No Clogging	No Maintenance

FD-H Series

Clamp-On Liquid Flow Sensor



→ Pg. 6

Utilise Anywhere

- Any Pipe
- Any Liquid
- Any Condition



→ Pg. 8

Unmatched Features

- Intuitive Display
- Universal Connectivity
- Impressive Accuracy



→ Pg.10

Complete Process Monitoring

- Flow Sensing
- Concentration Sensing
- Temperature Sensing

Utilise Anywhere

Scan for More

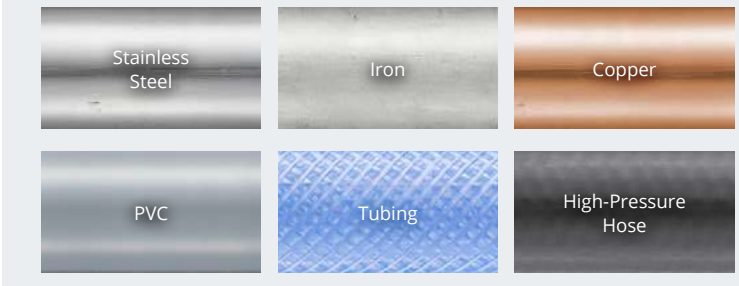


Iron / Copper / Stainless Steel
[8 A to 32 A]

Rigid Plastic / PVC
[ø13 to ø44]

Hose / Tube [ø13 to ø63]
Hose Type

High-Pressure Hose [ø13 to ø63]
Hose Type



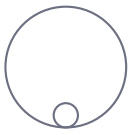
Any Pipe

Including Flexible Hoses

Monitor flow on more pipes than ever before, including braided hoses. Clamp-on flow monitoring has never been more versatile.



Standard Type
Hight-Temp Type
ø13 to ø44



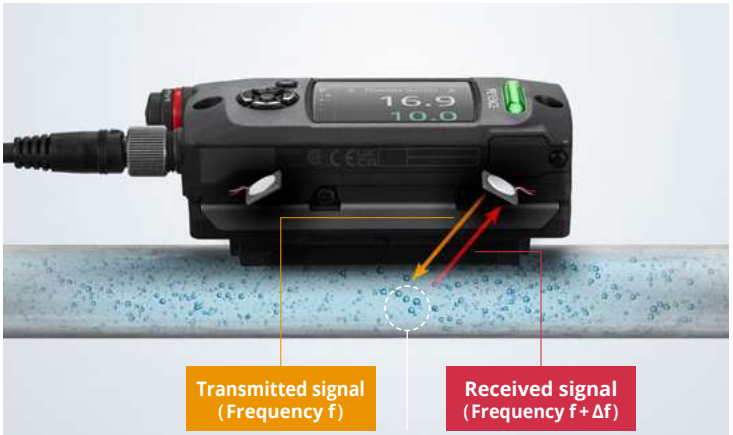
Hose Type
ø13 to ø63



Any Liquid

Stable and Reliable Detection

Improvements in the sensing technology in the FD-H Series make it possible to detect the majority of liquids. From DI water to high viscosity liquids, the FD-H Series can provide consistently stable detection from outside of the pipe or hose.



The ultrasonic pulse gets reflected by bubbles and particles

Any Condition

Standard Type | High-Temp Type

Bubbles in the liquid flow have long been a problem for clamp-on flow sensors, but not anymore. The new hybrid detection method, utilised by the FD-H Series, makes it possible to continue detecting in the presence of bubbles or particulates to provide unmatched stability.



Nearly Any Temperature

Hight-Temp Type

Even under extreme circumstances where the pipe temperature is exceedingly hot, the FD-H Series can still provide a solution. The High Temperature models offer excellent heat resistance and can be exposed to pipe temperatures of up to 180°C.

Unmatched Features



Detachable Display

View all the pertinent data and make adjustments with ease by separating the display from the sensing head. Accessibility is no longer limited by sensor placement.

Rotatable Display



Current values | Clear menus | Real-time graphing | Historical data

All-In-One Display

Everything at Your Fingertips

No manuals necessary with clear menus and even clearer displays. From easy to read graphs to historical data, the FD-H provides display options for any user.

One year of data is stored and can be output via USB

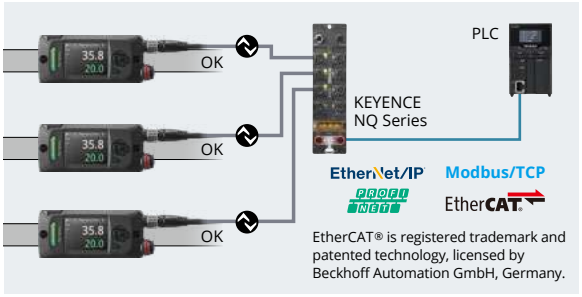




Built-In Temperature Sensor

Standard Type

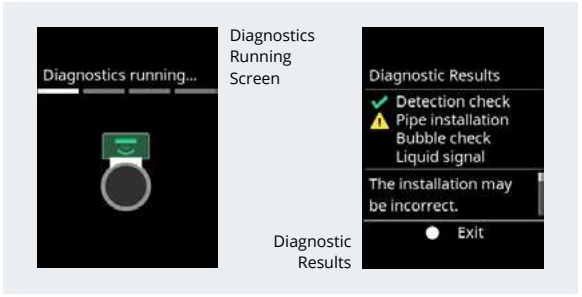
Monitor flow and temperature with one unit, eliminating the need for additional equipment, installation, and setup. Combining flow and temperature data will allow you to understand your system better than ever.



Universal Connectivity

Control Outputs, Analogue Outputs, & IO-Link

The FD-H Series allows users to mix and match control outputs, analog outputs, and inputs to fit any setup. The FD-H Series also offers IO-Link communication to provide limitless data over a network.



Diagnostic Function

Built-In Troubleshooting Ensures Stability

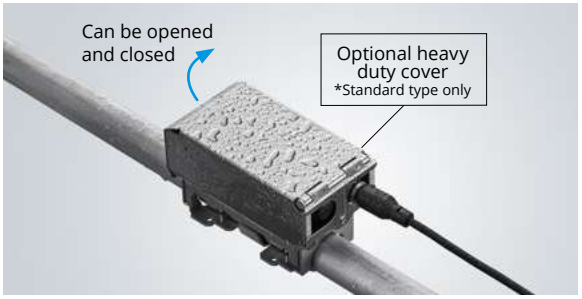
No more guessing why the stability is low. The FD-H Series offers a built-in diagnostics function that will check multiple factors and then make appropriate recommendations to improve stability.



Impressive Accuracy

Standard Type High-Temp Type

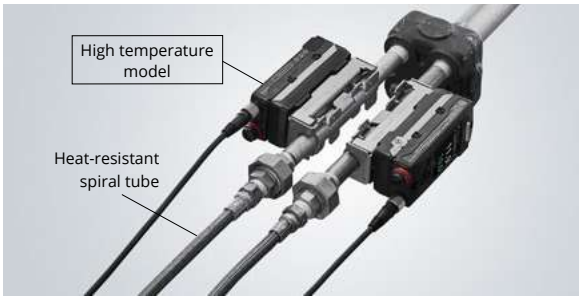
The FD-H Series provides an impressive absolute accuracy specification of ±3% of the reading value. This makes the FD-H Series capable of general detection, as well as more precise detection when needed.



Environmentally Resistant

Waterproof, Dustproof, & Impact Resistant

The FD-H is designed for the factory environment and boasts enclosure ratings of IP65 and IP67. Along with this, an optional heavy duty cover is available to prevent impact damage if necessary.



Mounts in Tight Spaces

No More Bulky Flow Sensors

Space is always at a premium on machines, and this is extremely apparent when it comes to piping. The small size and detachable display make the FD-H Series the perfect size to fit nearly anywhere.

COMPLETE PROCESS MONITORING

Extend Beyond Flow Sensing to Understand the Full System



+ Concentration

NEW **Digital Refractometer**
FI-C Series
Pg.12



+ Temperature

NEW **Temperature Sensor**
FI-T Series
Pg.14

Consolidate your monitoring into one display

Scan for More



Multi-Port

Look at more than just flow!

Concentration | Temperature

Introducing Complete Process Solutions

Monitor and manage multiple variables all through one centralised device.

The FD-H Series does not stop at simply monitoring flow, it can also integrate with up to two other devices to provide a complete picture of your machine's performance. Along with flow rate, other variables like concentration and temperature can be centralised into the FD-H to help optimise your equipment usage and prevent costly downtime.

Avoid Costly Manufacturing Issues

Downtime	Scrapped Parts	Equipment Damage

Examples of Complete Process Monitoring

- Heat transfer control for molds [Flow Rate + Temperature]
- Quality control during quenching [Flow Rate + Concentration]
- Coolant reservoir monitoring/filling [Flow Rate + Concentration]



Coolant management for grinding or CNC machines



Cooling water management for die casting machines

Concentration

FI-C Series

Digital Refractometer

Probe type

Digital Refractometer
Probe Type
FI-C20D NEW



Tool-Free
Maintenance

Built-in temperature sensor

In-Line type

Digital Refractometer
In-Line Type
FI-C40F NEW

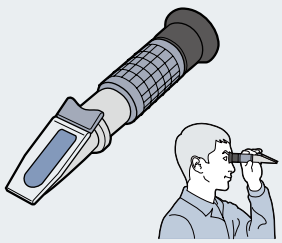


Built-in temperature sensor

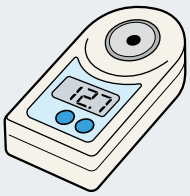
Replace Frustrating Conventional Refractometers

Handheld refractometers represent a costly and labour-intensive way of monitoring the concentration of specific liquids. Since they depend on an operator to regularly check the Brix% of the liquid, they are prone to inconsistent readings, missed readings, and delays in detecting problems that could damage machinery or parts. By continuously monitoring concentration with a digital refractometer, operator interaction is eliminated and problems are detected immediately.

Conventional Refractometers



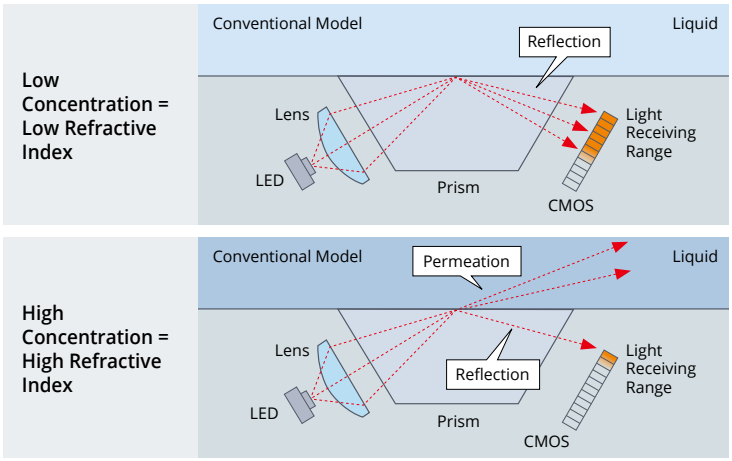
Handheld Type



Digital Handheld Type



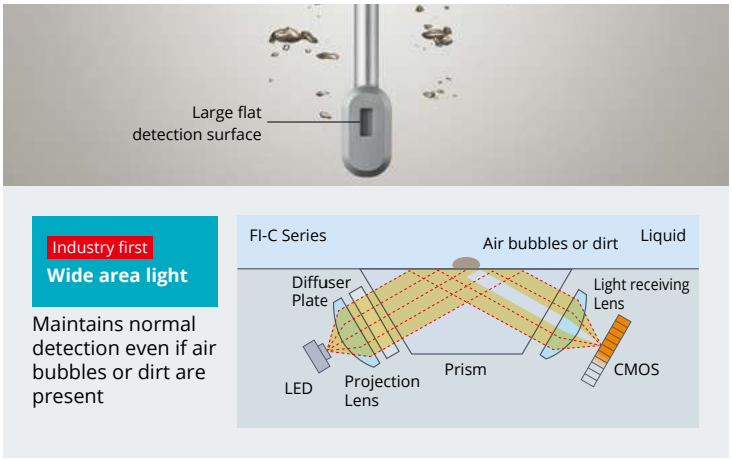
FD-H Series



Measuring Refractivity

Using Light Reflection to Indicate Concentration

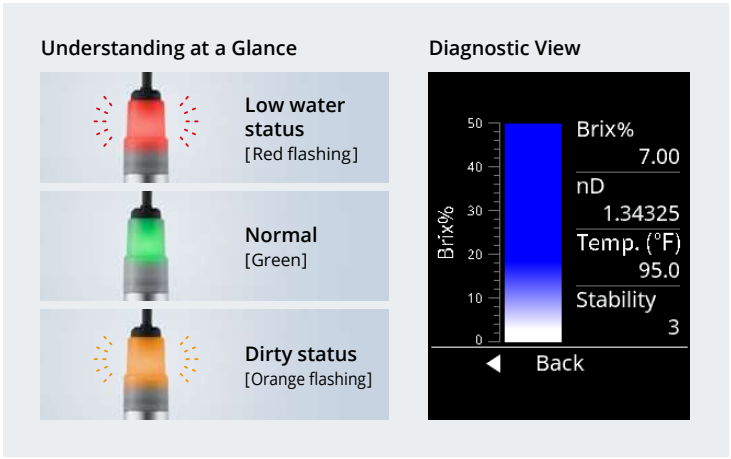
The FI-C Series operates by measuring the refractive index of the liquid and converting this value to a Brix%. This is done by monitoring how much light is reflected off of the inner surface, as opposed to being absorbed by the liquid. As concentration changes, so does the refractive index. This is especially useful for water-based coolants.



Stable and Reliable Detection

Not Impacted by Bubbles or Debris

By utilising an innovative wide area light method, the FI-C Series is able to provide consistent and stable detection in harsh conditions. The wide area light ensures that bubbles and dirt on the lens do not affect detection. The surface is also rugged and resistant to scratching from particulates that may be in the liquid.

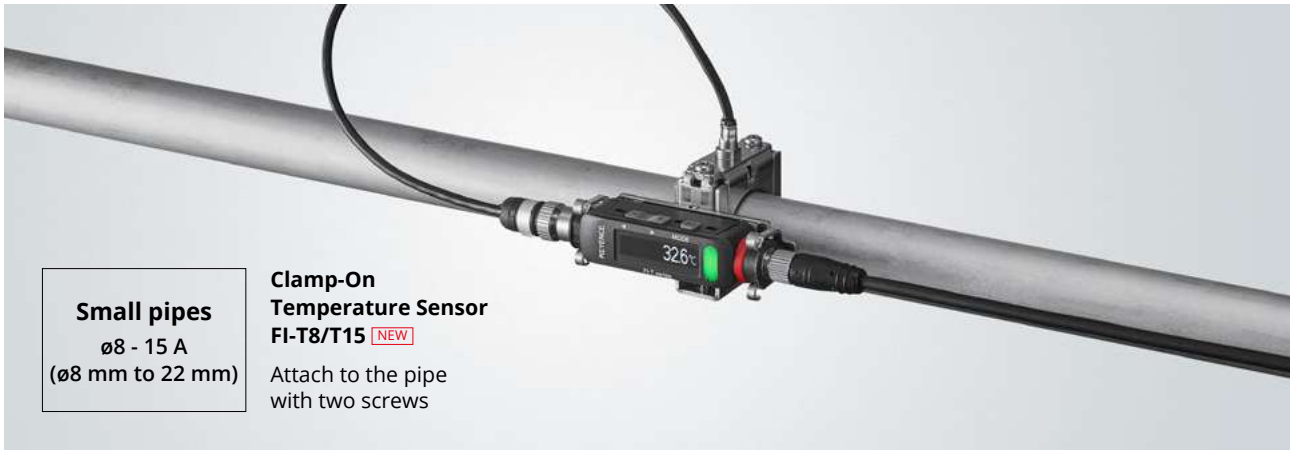


Understanding at a Glance

Large Status Indicator & Detailed Display

Both the in-line and probe type models feature a large three-colour indicator light. This indicator can display the concentration status, as well as alert operators to unseen issues in the tank or pipe. By looking at the display on the FD-H or FI-1000, it is even easier to understand the current situation with all the necessary information on one screen.

Clamp-On Temperature Sensor



Small pipes
ø8 - 15 A
(ø8 mm to 22 mm)

Clamp-On Temperature Sensor FI-T8/T15 NEW

Attach to the pipe with two screws

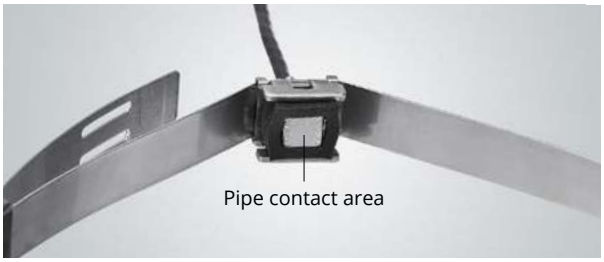


Medium/ large pipes
20 A to 200 A
(ø22 mm to 220 mm)

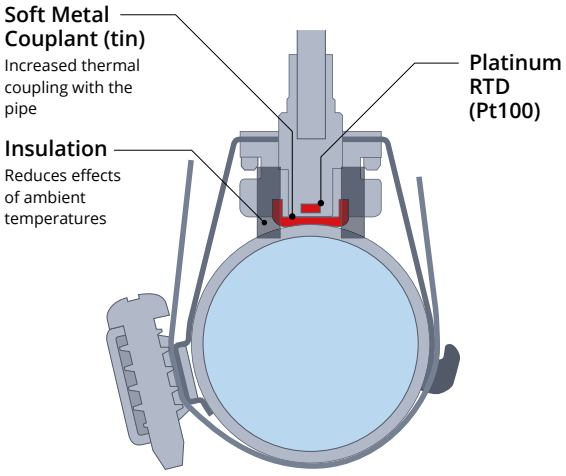
Clamp-On Temperature Sensor FI-T25/T50/T100/T200 NEW

Attach to the pipe with metallic bands

Innovative Design Ensures Stable Temperature Monitoring



The FI-T Series utilise several innovative techniques to provide the most reliable temperature measurement from outside the pipe. The contact point between the FI-T Series and the pipe is made of a soft metal that conforms to the shape of the pipe easily to ensure minimal air gaps. Along with this, special insulation is utilised to greatly minimise the effects of the ambient temperature. Lastly, a platinum RTD is used to ensure a dependable readings.





FD-H Series



Easy Installation

No Pipe Modification Necessary

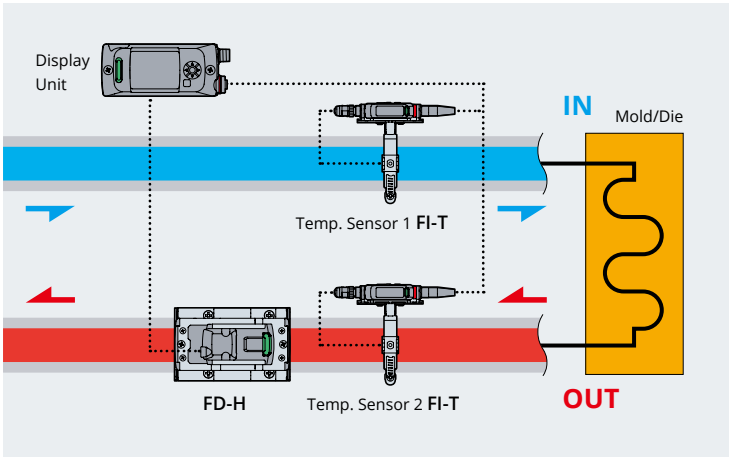
Eliminate downtime and installation time by simply clamping the FI-T Series temperature sensor on the outside of the pipe. The FI-T Series offers several different models that are compatible with a range of pipes from ø8 - 220 A (ø8 mm to 220 mm) in size. All of these models can be mounted in seconds to start monitoring temperature immediately.



Dedicated Display Amplifier

Easy to Read OLED Display

The FI-T Series can be connected to the FD-H, FI-1000, or even used by itself. In all situations, the FI-T offers a dedicated display that can be mounted near the unit for monitoring with a quick glance. The OLED display can be easily read and also allows for quick adjustments on the fly.



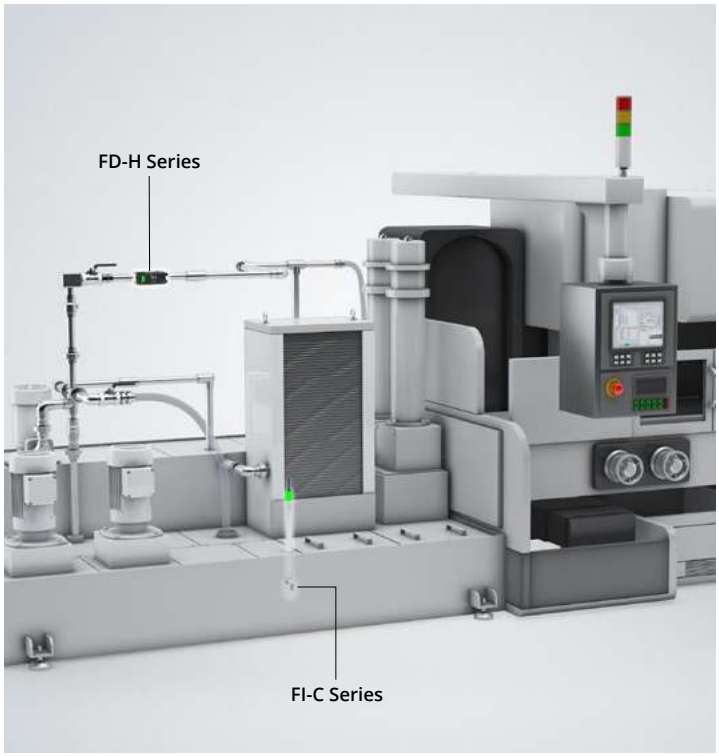
Heat Transfer Monitoring

No Calculations Needed

When you combine two FI-T Temperature Sensors with the FD-H Series, it is possible to calculate the amount of heat that is being transferred into or out of a system. By monitoring the heat transfer rate, it is easier to recognise potential issues before they arise. This is ideal for molding or casting applications where heat transfer is key.

APPLICATIONS

Complete process monitoring applications

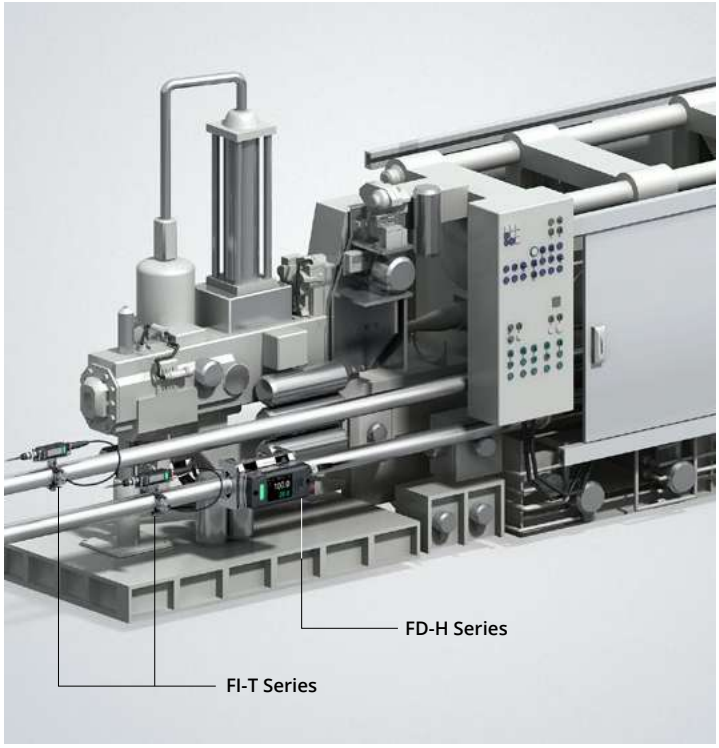


Metalworking Machines

(CNC Machines/Grinders)

Liquid	Water-soluble coolant
Flow Rate	FD-H Series
Concentration	FI-C Series
Temperature	FI-C/FI-T Series

Simultaneous monitoring of the flow rate, concentration, and temperature of water-soluble coolant ensures the quality of parts is maintained and potential issues are detected immediately. Everything from proper coolant concentration to potential flow obstructions can be monitored in one system.



Die Casting Machines

Liquid	Cooling water for dies
Flow Rate	FD-H Series
Temperature	FI-T Series
Liquid	Water-soluble mold-release agent
Concentration	FI-C Series

In addition to monitoring the flow rate of the mold cooling water, two temperature sensors are installed on the inlet and outlet sides to measure the heat transfer. By monitoring the heat transfer, it is easy to recognise that proper heating and cooling of the dies is occurring. In addition, monitoring the concentration of the water-soluble mold-release agent ensures the product releases properly each time.



Molding Machines

(Engineering plastics and glass-reinforced resins)

Liquid	Oil for mold temperature control
Flow Rate	FD-H Series
Temperature	FI-T Series

High-temperature oil is used when molding engineering plastics or glass-reinforced resins, and it is important for quality control to maintain mold temperatures properly. In addition to monitoring the oil flow to detect mold clogs, a temperature sensor can check the temperature of the oil leaving the thermolator to ensure that it is within the correct range.



Induction Hardening Machines

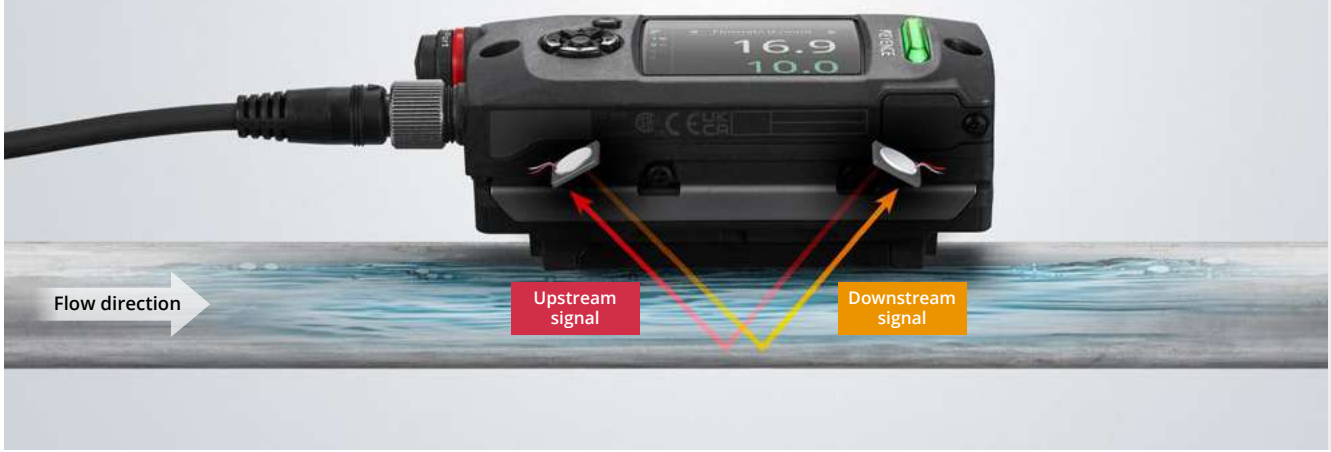
Liquid	Quenching water
Flow Rate	FD-H Series
Concentration	FI-C Series
Temperature	FI-C/FI-T Series

Proper tempering is key when it comes to induction hardening. Not only is the flow rate of the liquid important but also the temperature and concentration of the liquid. All of these variables can be monitored simultaneously to ensure the proper quality and strength of these parts.

FD-H Series Detection Principles

In the absence of air bubbles

Delta TOF [Time of Flight Method]



When many bubbles are present

Pulse Doppler Standard model | High temperature model



The ultrasonic pulse is reflected back by bubbles and particulates

Standard model

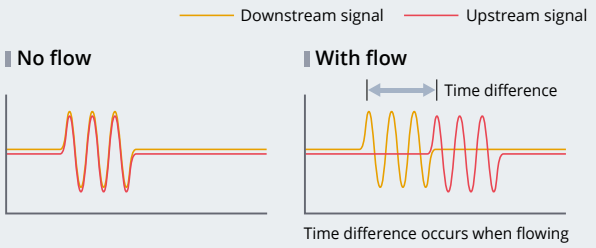
High temperature model

Measurement accuracy

±3.0% of RD

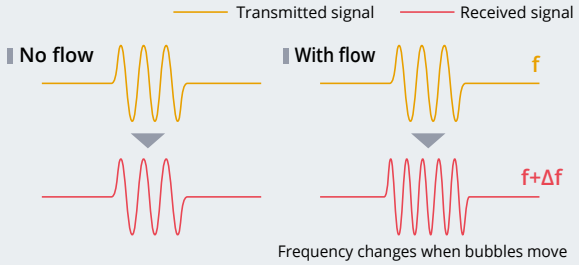
The FD-H Series is equipped with a proprietary algorithm that allows it to achieve a measuring accuracy of ±3.0% of RD (reading value). It is also resistant to environmental changes, like ambient temperature fluctuations, and can provide stable detection for a long period of time.

Delta TOF [Time of Flight Method]



Delta TOF determines the flow rate by monitoring two ultrasonic signals (one moving in the direction of flow and one moving against the direction of flow) and measuring the difference in time to move through the liquid. This time difference correlates to the flow rate. By using two signals, the readings remain consistent and stable regardless of external factors such as temperature changes.

Pulse Doppler

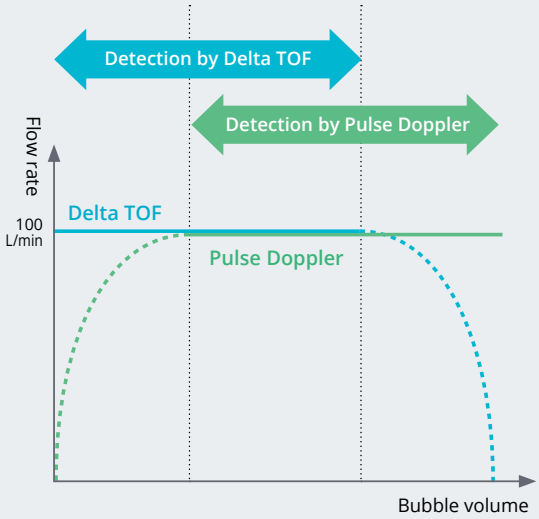


The Pulse Doppler method works when there are bubbles or particulates in the liquid by transmitting and receiving a pulse on the same element. The element transmits a pulse that is reflected back by a bubble or particulate in the liquid. Based on the speed of the liquid, the pulse returns back at a different frequency. This difference in frequency correlates to the flow rate.

Hybrid Detection Principle

Delta TOF without bubbles	Pulse Doppler with bubbles

Automatically switches the detection method based on the amount of bubbles present





Both detection methods are continuously being monitored. The unit will switch accordingly as the amount of bubbles in the liquid changes. This ensures a seamless transition and no delays in detection.

Standard model

High temperature model

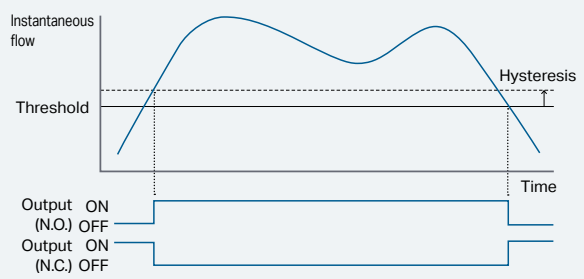
Span adjustment not required
Automatic correction of liquid sound velocity

Conventional ultrasonic flow meters typically require a span adjustment to provide accurate monitoring due to the differences in properties from one liquid to another. The FD-H Series calculates the liquid sound velocity automatically and uses this information to set the appropriate span adjustment and ensure precise detection.

Various Detection Modes to Suit Any Application

Find out if the instantaneous flow has decreased

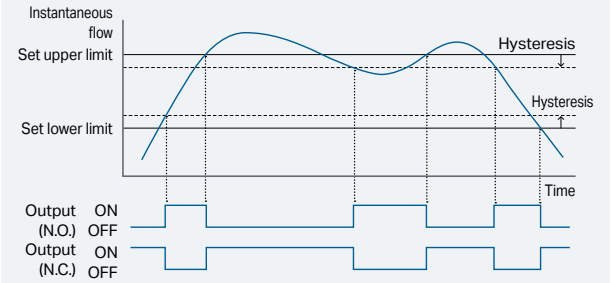
Instantaneous Flow Mode



Output switches depending on the threshold value set for instantaneous flow.

Find out if the instantaneous flow is outside an acceptable range

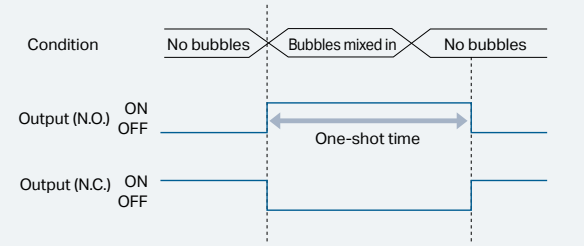
Area Mode



Output switches when the instantaneous flow falls outside the acceptable range.

Find out if bubbles have gotten into the fluid

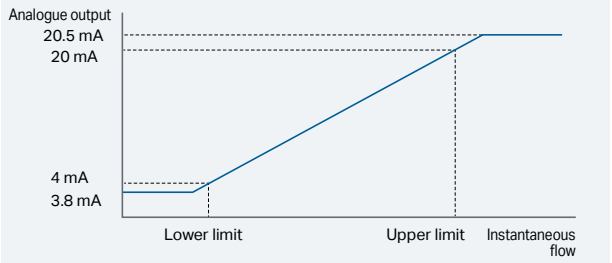
Bubble Detection Mode



This mode detects bubbles within the pipe and provides a one-shot output.

Monitor variations in the flow rate

Analogue Output



The signal is output from 4–20 mA or 0–20 mA depending on the specified lower and upper limits. (Above image depicts 4–20 mA.)

Mix and Match IO to Fit Your Needs

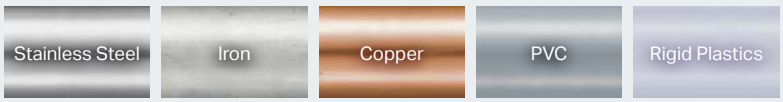
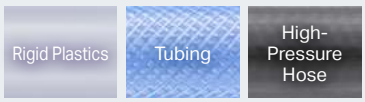
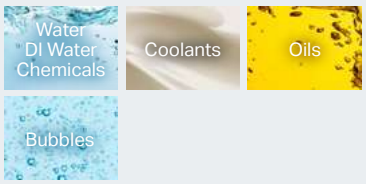
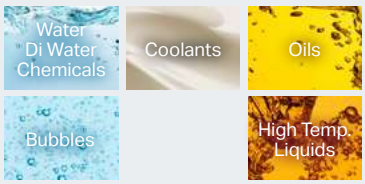
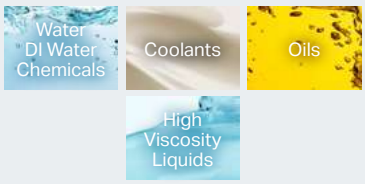
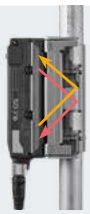
Ch1 (black wire)	Control output *2	Analogue output	
Ch2 (white wire)	Control output *2	Analogue output	External input *3
Ch3 (grey wire)	Control output *2		External input *3
Ch4 (pink wire)	Control output *2		

Standard (instantaneous flow)	Area	Instantaneous flow	Temperature (FI-T/FD-H/FI-C)	Integrated flow reset *1	Flow-rate zero input *1
Accumulated flow *1	Pulse output *1 (Ch1 only)	Concentration	Instantaneous heat transfer	Flow-rate zero-point adjustment *1	Bank input
Bubble detection *1	Error output				

*Sensors must be connected to the display unit.

*1 Flow sensor only *2 Concentration sensor: low liquid detection output; Temperature sensor (when two units are connected): Accumulated heat pulse output (Ch1only), accumulated heat output can be assigned separately.
*3 Concentration sensor: concentration hold; Temperature sensor (when two units are connected): Accumulated heat reset can be assigned separately.

Three Unique Types

	Standard Type	High-Temperature Type	Hose Type
Model			
Pipe O.D.	ø13 to ø44	ø13 to ø44	ø13 to ø63
Compatible pipes			
Compatible liquids			
Detection principle	Hybrid Detection Principle Delta TOF + Pulse Doppler	Hybrid Detection Principle Delta TOF + Pulse Doppler	Delta TOF
Additional points	Compatible fluid temperature up to 85°C	Compatible fluid temperature up to 180°C	Compatible fluid temperature up to 100°C
	Built-in temperature sensor	-	-
	Measuring accuracy ±3.0% of RD	Measuring accuracy ±3.0% of RD	-
	Repeatability ±0.3% of F.S.*	Repeatability ±0.3% of F.S.*	Repeatability ±0.3% of F.S.*
	Automatic correction of liquid sound velocity	Automatic correction of liquid sound velocity	-
Unique Features	Reflective type 	Reflective type 	Transmission type 
	Built-in temperature sensor The built-in thermistor enables simultaneous measurement of flow rate and temperature. 	**High temperature 180°C compatible** Use with temperatures up to 180°C with a couplant (sold separately). (Up to 140°C when not used) 	**Hose mounting** The bracket design maintains uniform pressure on six sides of the hose. Stable long-term detection is possible even with hoses that are easily deformed. 

*When response time is 5.0 s

Clamp-on Flow Sensor FD-H Series

Standard Type

Model	Rated flow	Supported pipe sizes	Pipe outer diameter
FD-H10	20 L/min	1/4" (8 A)	ø13–16
	30 L/min	3/8" (10 A)	ø16–18
FD-H20	60 L/min	1/2" (15 A)	ø18–23
	100 L/min	3/4" (20 A)	ø23–28
FD-H32	200 L/min	1" (25 A)	ø28–37
	300 L/min	1 1/4" (32 A)	ø37–44

Rigid piping
Built-in temperature sensor
Compatible with fluids with bubbles
IO-Link



High-Temperature Type

Model	Rated flow	Supported pipe sizes	Pipe outer diameter
FD-H10K	20 L/min	1/4" (8 A)	ø13–16
	30 L/min	3/8" (10 A)	ø16–18
FD-H20K	60 L/min	1/2" (15 A)	ø18–23
	100 L/min	3/4" (20 A)	ø23–28
FD-H32K	200 L/min	1" (25 A)	ø28–37
	300 L/min	1 1/4" (32 A)	ø37–44

Rigid piping
Compatible with fluids with bubbles
IO-Link



Hose Type

Model	Rated flow	Pipe outer diameter
FD-H22F	60 L/min	ø13–22.9
FD-H32F	200 L/min	ø23–32.9
FD-H47F	300 L/min	ø33–47.9
FD-H63F	500 L/min	ø48–63

Hoses/Tubes
High-viscosity liquid compatible
IO-Link



140°C or lower

Between 140–180°C



Ultra-high-temperature couplant Required
If the fluid temperature exceeds 140°C, 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
	FD-HCB10	M12 power supply cable 6-core cable PVC 10 m

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
	FD-HCC10	M12 power supply cable 8-pin female to 4-pin male PVC 10 m
	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



Display unit protection cover Optional
FD-HP1









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

*Can also be used with the FI-1000.

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

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

	OP-85503	2 m PVC
	OP-85504	5 m PVC
	OP-88075	2 m PUR
	OP-88076	5 m PUR

■ To output historical data to a PC: USB cable OP-51580 (2 m) or OP-86941 (5 m) can be used. Historical data that can be output includes: 1) Instantaneous data and stability for every 10 seconds over the past 7 days, 2) Instantaneous data and stability for every 10 minutes over the past year, 3) Accumulated flow data for every hour over the past year, 4) Accumulated heat transfer data for every hour over the past year, and 5) Up to 100 events.

Sensors That Can Connect to the Multi-Port

FD-H Series





M12 Multi-Port

The Y-shaped connector below is required when connecting more than one device

FD-HY1



Multi-Port Configurations

Using the Y-shaped connector, you can connect a mix of concentration, level, or temperature sensors. (Up to one each for the concentration and level sensors, and up to two temperature sensors.)

Display Unit (Standalone)

If not using an FD-H flow sensor, please use the following display model.

FI-1000



M8 4-pin to M12 4-pin cable

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

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

When extending the cable length beyond 2 m



M12 4-pin to M12 4-pin cable

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

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

Clamp-on Temperature Sensor FI-T Series



Model	Supported pipe sizes	Pipe outer diameter
FI-T8	1/8", 1/4" (6 A/8 A)	ø8–14
FI-T15	3/8", 1/2" (10 A/15 A)	ø14–22
FI-T25	3/4", 1" (20 A/25 A)	ø22–38
FI-T50	1 1/4", 1 1/2", 2" (32 A/40 A/50 A)	ø38–70
FI-T100	2 1/2", 3", 3 1/2", 4" (65 A/80 A/90 A/100 A)	ø70–126
FI-T200	5", 6", 8" (125 A/150 A/200 A)	ø126–220



M8-M8 extension cable

Optional

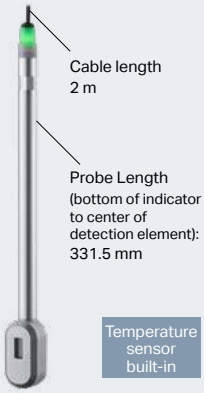
Maximum extension of 20 m from display amplifier to head

OP-88673 PVC 2 m
OP-88672 PVC 10 m

*If using the FI-T temperature sensor on its own, use a 4-pin M8 connector cable. (Examples: OP-87625 (PVC, 2 m), OP-87626 (PVC, 10 m), OP-87628 (PUR, 2 m), OP-87629 (PUR, 10 m)

Digital Refractometer FI-C Series

Probe Type



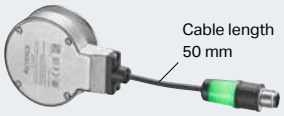
Model	Installation
FI-C20D	Probe type

Options

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

*Only one extension pipe can be used per setup

In-Line Type



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

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

Flow Sensors (FD-H)

IO-Link

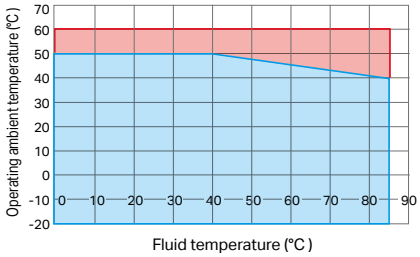
Type		Standard model / High-temperature model (K)						Hose model			
Model		FD-H10 FD-H10K		FD-H20 FD-H20K		FD-H32 FD-H32K		FD-H22F	FD-H32F	FD-H47F	FD-H63F
Supported pipe diameter	Pipe outer diameter	ø13–16	ø16–18	ø18–23	ø23–28	ø28–37	ø37–44	ø13–22.9	ø23–32.9	ø33–47.9	ø48–63
	A nominal	8 A	10 A	15 A	20 A	25 A	32 A	—			
	B nominal	1/4"	3/8"	1/2"	3/4"	1"	1 1/4"				
Supported pipe materials		Metal piping, hard plastic piping*1						Soft plastic piping, all hoses (braided hoses, pressure-resistant rubber hoses, etc.)*1			
Supported fluids		All fluids (water, oil, chemicals, etc.)*1									
Supported fluid temperatures		Standard model : 0–85°C (no freezing on pipe surface)*2 High-temperature model : 0–180°C (no freezing on pipe surface)*2, 3						0–100°C (no freezing on pipe surface)*2			
Rated flow		20 L/min	30 L/min	60 L/min	100 L/min	200 L/min	300 L/min	60 L/min	200 L/min	300 L/min	500 L/min
Zero cut flow (variable, initial value)		0.3 L/min		0.5 L/min		1.0 L/min		0.5 L/min	1.0 L/min	2.0 L/min	5.0 L/min
Detection principle		Delta TOF + Pulse Doppler						Delta TOF			
Function for automatic correction for speed of sound in liquid		Yes						—			
Display		QVGA 2.0 model: colour LCD, status indicator light									
Display update cycle		Approx. 10 times/second									
Display resolution	Instantaneous flow (L/min)	0.01/0.1/1 (default value: 0.1)				0.01/0.1/1 (default value: 1)		0.01/0.1/1 (default value 0.1)		0.01/0.1/1 (default value: 1)	
	Integrated flow (L)	0.01/0.1/1 (default value: 0.1; up to 8 digits)				0.01/0.1/1 (default value: 1; up to 8 digits)		0.01/0.1/1 (default value: 0.1; up to 8 digits)		0.01/0.1/1 (default value: 1; up to 8 digits)	
Response time		0.5 s / 1.0 s / 2.5 s / 5.0 s / 10.0 s / 30.0 s / 60.0 s / 120.0 s / 200.0 s									
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 rate unit		L/min m³/h									
Pulse output increments (L)		0.02–999.99									
Pipe temperature measurement accuracy (ambient temperature of 25°C)*4		Standard model: ±2.0°C (pipe temperature 0–50°C), ±3.0°C (pipe temperature 50–85°C) High-temperature model: —						—			
Heat calculation function*7	Unit	MJ/h, kW, kBTU/h									
	Display resolution	Instantaneous value (MJ/h): 0.01/0.1/1 (default value 0.1); Integrated value (MJ): 0.01/0.1/1 (default value 0.1)									
	Pulse output increments (MJ)	0.02–999.99									
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)	Instantaneous flow mode / area mode / pulse output mode / integrated flow mode / bubble detection mode / error output NPN/PNP setting switching, open collector output 30 VDC or less, max. 100 mA/Ch or less, residual voltage 2.5 V or less									
	Analogue output (Ch1/2)	4–20 mA/0–20 mA (switchable), load resistance 500 Ω or less									
	External input (Ch2/3)	Integrated reset input / flow-rate zero input / zero-point adjustment input / bank input 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	240 mA or less (when using flow sensor standalone; with analogue output; excluding load current)*8									
Protection circuit		Protection against reverse power connection, power supply surges, output short circuits, and output surges									
Network compatibility		IO-Link*9									
Environmental resistance	Enclosure rating	IP65/67 (IEC 60529)*10									
	Operating ambient temperature	Sensor head: −20 to +60°C (no freezing); Display unit: −20 to +50°C (no freezing)*2									
	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 axes									
Material	Display unit	Body: PPS/PET/POM; Display window: PAR									
	Sensor head	Body: Standard model: PPS/PET/PAR/SUS304; High-temperature model: PEEK/PPS/PET/PAR/SUS304 Sensor element: special rubber; Mounting bracket: SUS304/SUSXM7						Body: PPS/PET/PAR/SUS304; Cable: PVC Sensor element: 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 For fluids through which ultrasonic waves propagate, and which do not contain a large quantity of bubbles. Detection may be unstable depending on the type and condition of the pipe.
*2 When the display unit is mounted directly on the sensor head, there is a de-rating according to the ambient temperature and fluid temperature.
*3 When using with fluids at temperatures of 140°C or greater, equip with the separately sold ultra-high-temperature couplant FD-HK1/HK2/HK3. Furthermore, the display unit must be separated from the sensor based on the de-rating.
*4 This is the guaranteed value from verification performed at KEYENCE inspection facilities. Measurement error may occur depending on the type and condition of the customer's pipes, the type of fluid, the fluid temperature and other factors. *5 This is the value for when the zero point is adjusted, for a constant 25°C environment, taking into account the linearity and span error.
*6 In a state where flow velocity distribution is stable. Does not include pulsation and fluctuations in flow velocity distribution due to equipment factors. Please also convert the given F.S. (full scale) using the rated flow range.
*7 Can be used when two temperature sensors (sold separately) are connected.
*8 640 mA or less including load. When connecting devices such as temperature sensors, please add on the current consumption of each sensor (up to a maximum of 830 mA or less).
*9 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).
*10 When a USB connection is in use, IP65/67 compliance is impaired.

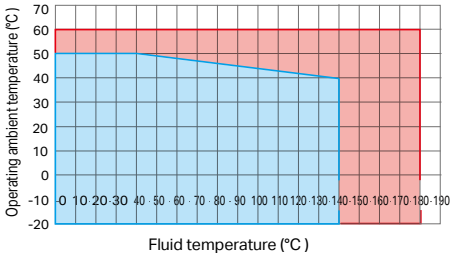
Derating Charts

Display unit integration OK Display unit separation required

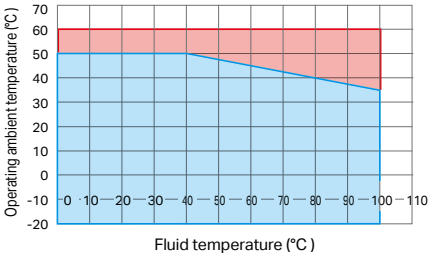
Standard model



High-temperature model



Hose model



Temperature Sensors (FI-T)

IO-Link

Model			FI-T8	FI-T15	FI-T25	FI-T50	FI-T100	FI-T200
Supported pipe diameter	Pipe outer diameter		ø8–14	ø14–22	ø22–38	ø38–70	ø70–126	ø126–220
	A nominal		6 A, 8 A	10 A, 15 A	20 A, 25 A	32 A, 40 A, 50 A	65 A, 80 A 90 A, 100 A	125 A, 150 A 200 A
	B nominal		1/8", 1/4"	3/8", 1/2"	3/4", 1"	1 1/4", 1 1/2", 2"	2 1/2", 3" 3 1/2", 4"	5", 6", 8"
Supported pipe materials			Metal piping					
Supported temperature range			−20 to +180°C*1					
Display resolution			0.1°C					
Response time			5 s (50% response), 15 s (90% response)*2					
Display amplifier averaging time			0.1 s / 10.0 s / 20.0 s / 30.0 s / 60.0 s / 120.0 s / 300.0 s					
Measurement accuracy (ambient temperature of 25°C)			±0.5°C (pipe temperature −20 to +80°C)*2, 3 ±1.0°C (pipe temperature 80–180°C)*2, 3					
Hysteresis			Variable					
Measurement principle			Pt100 4-wire type					
Display method			Organic EL, status indicator light					
Power supply I/O connector			M8 4-pin connector					
Current consumption			20 mA or less (excluding load current)*4					
When used standalone*5	I/O (switchable)	Output (Ch1/Ch2)	Control output: switching NPN/PNP setting Open collector output: 30 VDC or less, maximum 100 mA/ch or less, residual voltage 2.5 V or less					
		Analogue output (Ch2)	4–20 mA / 0–20 mA (switchable), load resistance 260 Ω or less					
	Power voltage		20–30 VDC, ripple (P-P) 10% included; Class2/LPS					
	Protection circuit		Protection against reverse power connection, power supply surges, output short circuits, and output surges					
	Network compatibility		IO-Link*6					
Environmental resistance	Enclosure rating		IP65/IP67 (IEC60529)					
	Operating ambient temperature		−10 to +60°C (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	Display amplifier		PBT / PAR / POM / SUS303					
	Sensor head		Head: PPS / SUS303 / Sn; Pipe clamp unit: SUS304; Cable: fluororesin					
	Display amplifier mounting bracket		SUS304					
Weight			Approx. 70 g	Approx. 80 g	Approx. 65 g	Approx. 70 g	Approx. 100 g	Approx. 120 g

*1 When pipe temperature is 100°C or more, the display amplifier cannot be mounted on the pipe clamp unit. Install the amplifier so it is insulated from the heat from the pipe.
*2 This is the guaranteed value from verification performed at KEYENCE inspection facilities. Measurement error may occur depending on the type and condition of the customer's pipes and fluid, the ambient temperature and other factors.
*3 This is the value for a constant 25°C environment, taking into account absolute error and repeatability.
*4 During standalone use, 220 mA or less including load. *5 When connecting to a FD-H Series/FI-1000 model, please follow the specifications of the display unit.
*6 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).

Concentration Sensors (FI-C)

Type		Probe type	Pipe type	
Model	Main unit	**FI-C20D**	**FI-C40F**	
	Attachment	—	**FI-CF1/CF3**	**FI-CF2/4**
Detection principle		Refractive index (surface light source)		
Rated concentration range		Brix: 0–20% (nD: 1.32500–1.37000)	Brix: 0–40% (nD: 1.32500–1.41000)	
Display range		Brix: 0–25%	Brix: 0–50%	
Supported fluids		Non-corrosive aqueous solutions (such as water-soluble coolants, mold release agents, etc.)*1		
Supported fluid temperature		0–70°C (no freezing)		
Connection diameter		—	FI-CF1: Rc3/4 (20 A); FI-CF3: NPT3/4	FI-CF2: Rc1 1/2 (40 A); FI-CF4: NPT1 1/2
Rated pressure range		—	1.0 MPa or less	
Pressure resistance		—	2.0 MPa	
Display resolution		Brix: 0.01/0.1% (default value: 0.1) (nD: 0.00001)		
Response time		1.0 s / 2.5 s / 5.0 s / 10.0 s / 30.0 s / 60.0 s / 120.0 s / 200.0 s		
Measurement accuracy		Brix: ±0.2%*2, 3 (nD: ±0.0003)		
Concentration unit		Brix nD*4		
Temperature measurement accuracy		±1.0°C*2		
Display method		Status indicator light		
Current consumption		25 mA or less		
Environmental resistance	Enclosure rating	IP65/IP67 (IEC60529)		
	Operating ambient temperature	−10 to +60°C (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	Liquid end materials (main body)	Sensor element: synthetic quartz Body: aluminium die-cast (nickel chrome plating) / SUS304 Pipe: aluminium alloy (anodised); Gasket: FKM	Sensor element: sapphire Body: SCS16A; Gasket: FFKM	
	Liquid end materials (attachment)	—	Body: SCS16A; Gasket: FKM	
	Other materials	Indicator light: PPSU / TPU / PBT Cable: PUR	Body: SUS304; PPS indicator light: PPSU / TPU / PBT Cable: PVC	
Weight		Approx. 480 g	Main body: approx. 410 g; FI-CF1/CF3: approx. 790 g; FI-CF2/CF4: approx. 1360 g	

*1 Use water as the solvent, and use materials that are soluble in water. If the particles are not water soluble, such as with slurry, the refractive index may not change.
*2 This is the guaranteed value from verification performed at KEYENCE inspection facilities. Measurement error may occur depending on the type, condition and temperature of the fluid used by the customer, as well as other factors. *3 This is the value obtained when sucrose solution is used in a constant 20°C environment, and absolute error and repeatability is taken into account.
*4 When using solutions other than sucrose solutions, concentration can be adjusted via span adjustment.

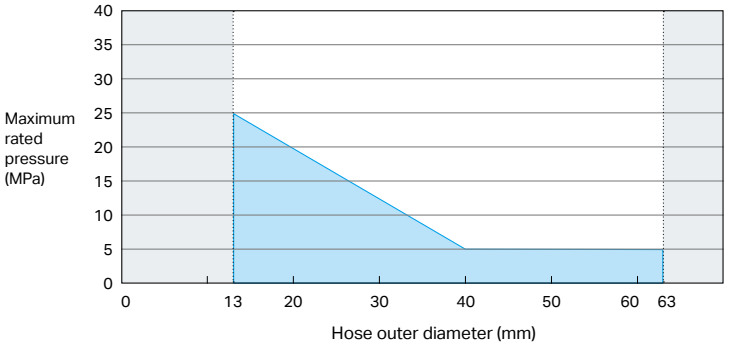
Standalone Display Unit (FI-1000)

Model		**FI-1000**
Display		QVGA 2.0 model: colour LCD, status indicator light
Display update cycle		Approx. 10 times/second
Heat calculation function*1	Unit	MJ/h, kW, kBTU/h, GJ/h, MW, MBTU/h
	Display resolution	Instantaneous value (MJ/h): 0.01/0.1/1 (default value 0.1); Integrated value (MJ): 0.01/0.1/1 (default value 0.1)
	Pulse output increments (MJ)	0.02–999.99
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
	Analogue 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)*2
Protection circuit		Protection against reverse power connection, power supply surges, output short circuits, and output surges
Network compatibility		IO-Link*3
Environmental resistance	Enclosure rating	IP65/IP67 (IEC60529)*4
	Operating ambient temperature	–20°C to +50°C (no freezing)
	Operating ambient humidity	35–85% RH (no condensation)
	Vibration resistance	10–500 Hz; Power spectral density: 0.816 G^2/Hz; X, Y and Z directions
	Shock resistance	100 m/s^2 (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

*1 Available when the separately sold flow meter FD-R Series and two temperature sensors are connected.
*2 455 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).
*3 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). *4 When a USB connection is in use, IP65/67 compliance is impaired.

Recommended High-Pressure Hose Characteristics

When utilizing the FD-H Series with a high-pressure hose, consider how reinforced (number of resin/metal layers) the hose may be by checking the maximum rated pressure and outer diameter. If the hose is highly reinforced it may affect the stability of detection. Please utilize the chart on the right to determine if the pipe characteristics fall in the acceptable blue range. If the characteristics do not fall in this range, testing may be necessary.



Flow Sensors (FD-H)

The FD-H Series allows users to allocate control outputs, external inputs, and analogue outputs to 4 different I/O channels (Ch1 through Ch4) according to the user's settings.

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

*1 IO-Link compatible wire when connected to an IO-Link module. Also note that only Ch1 supports pulse output.

*2 When using the bank input function, two external input wires are necessary. Set both Ch2 and Ch3 to external input.

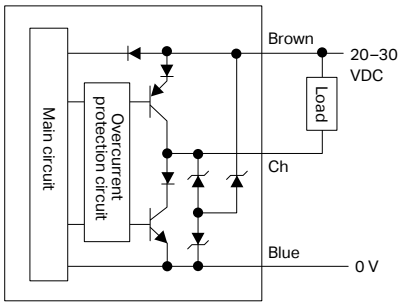
*3 When using a M12 8-pin-4-pin conversion cable or adapter, the four wires—brown, blue, black for Ch1, and white for Ch2—can be used as follows.



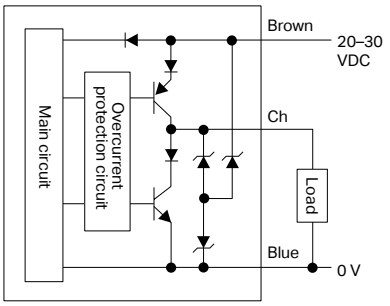
① Brown ③ Blue
② White (Ch2) ④ Black (Ch1)

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

When NPN is selected

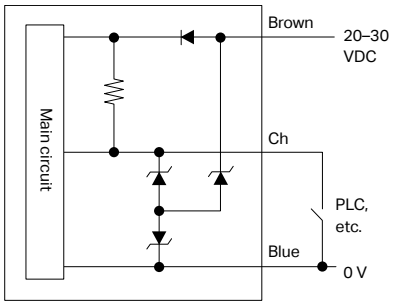


When PNP is selected

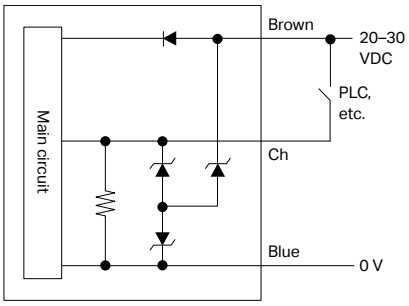


(2) Wiring of channel to which external input has been selected

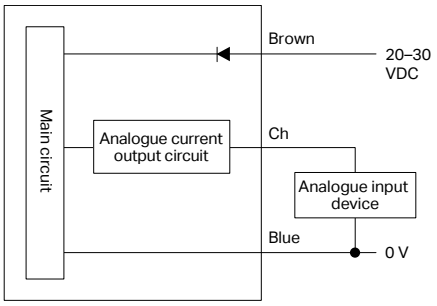
When NPN is selected



When PNP is selected



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

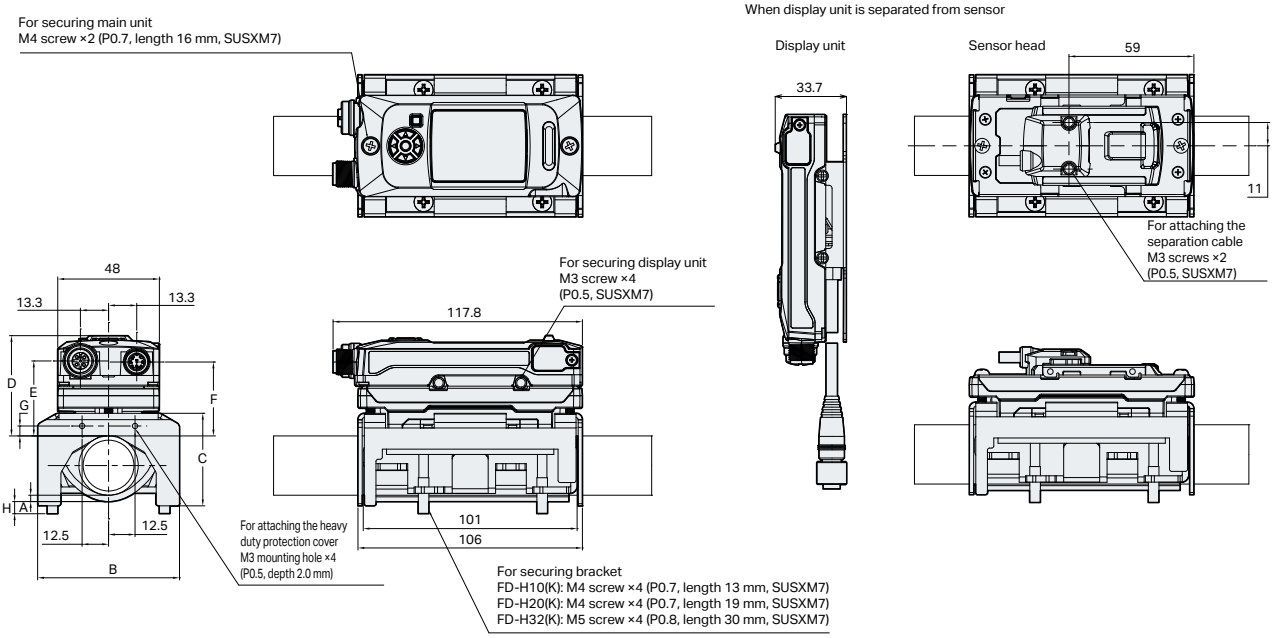


*Can be switched to 4–20 mA or 0–20 mA using the settings

Flow Sensors (FD-H)

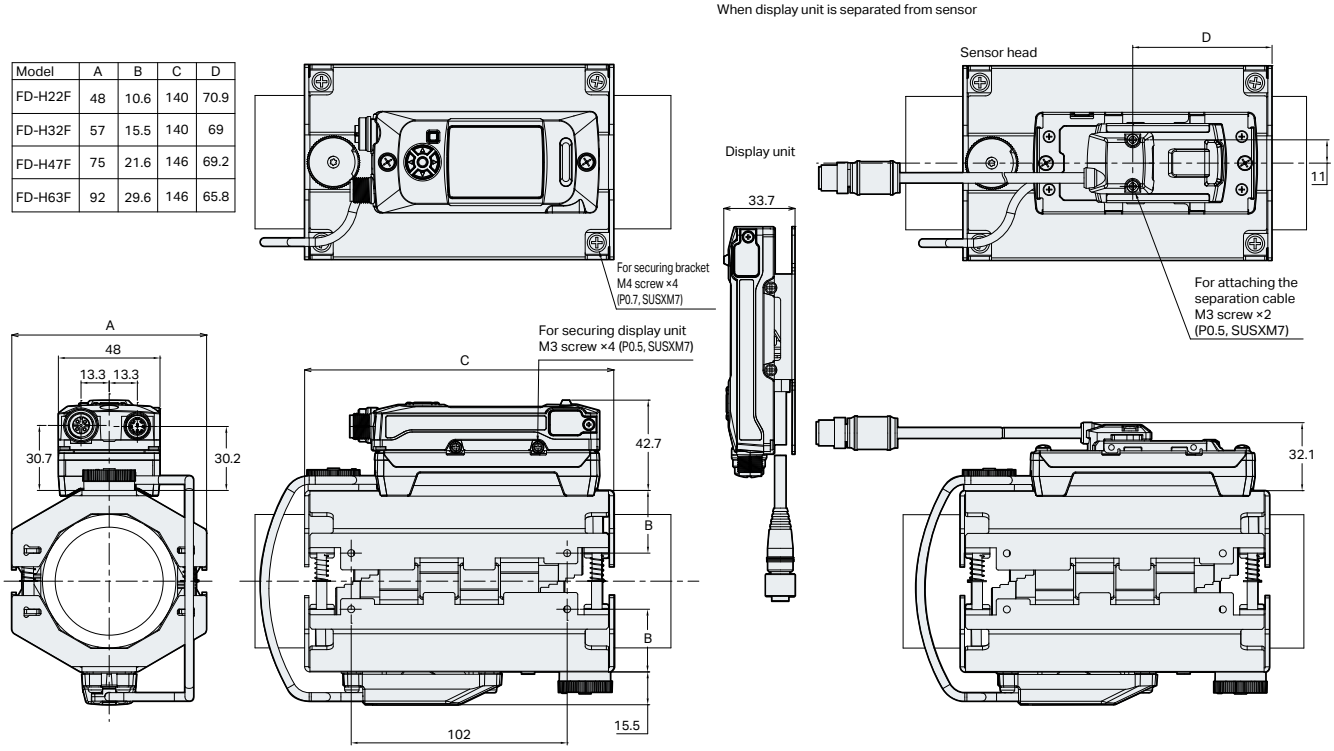
Standard models / High-temperature models

Model	A	B	C	D	E	F	G	H
FD-H10	2	38	25.3	47.4	35.4	34.9	5.2	Max 1.6
FD-H20	Max 2.5	48	30	47.4	35.4	34.9	4.1	Max 3.4
FD-H32	Max 4.2	67	43.7	47.4	35.4	34.9	4.7	Max 5.7
FD-H10K	2	38	25.3	56.4	44.4	43.9	5.2	Max 1.6
FD-H20K	Max 2.5	48	30	56.4	44.4	43.9	4.1	Max 3.4
FD-H32K	Max 4.2	67	43.7	56.4	44.4	43.9	4.7	Max 5.7



Hose models

Model	A	B	C	D
FD-H22F	48	10.6	140	70.9
FD-H32F	57	15.5	140	69
FD-H47F	75	21.6	146	69.2
FD-H63F	92	29.6	146	65.8

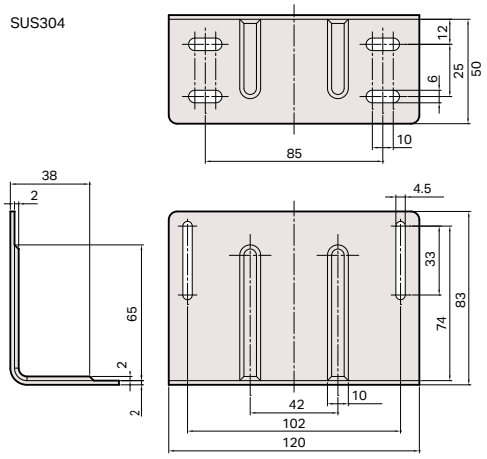


Flow Sensor (FD-H)

Stabilisation bracket

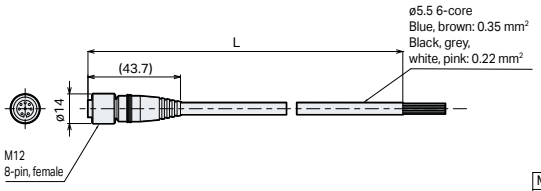
FD-HFB1

SUS304



FD-H power supply cables

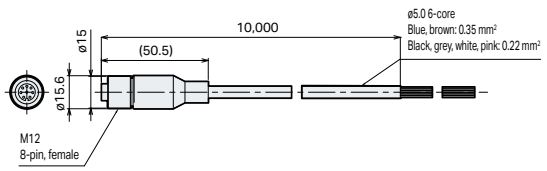
M12 power supply cable 8-core **FD-HCB2/HCB10**



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

Model	L
FD-HCB2	2000
FD-HCB10	10,000

M12 power supply cable (for heavy duty use) 8-core **FD-HCB10G**

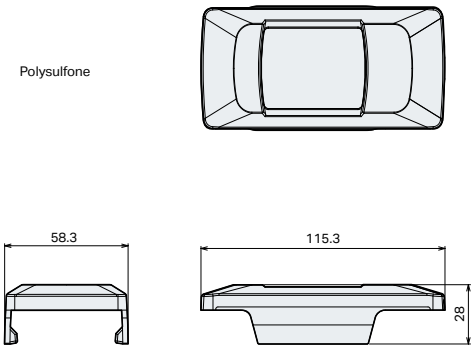


No.	colour
①	–
②	–
③	Black
④	Grey
⑤	Brown
⑥	White
⑦	Blue
⑧	Pink

FD-H display unit protection cover

FD-HP1

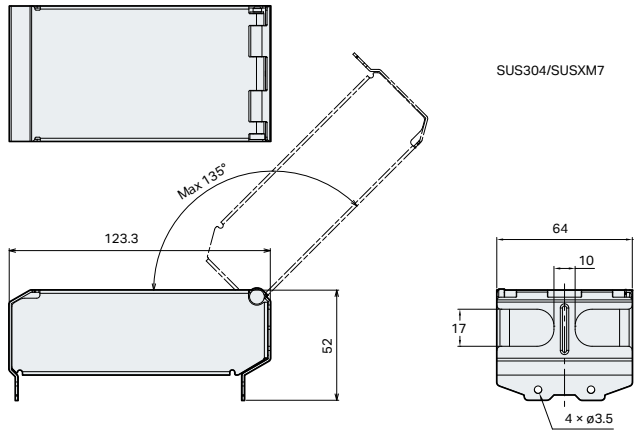
Polysulfone



FD-H display unit heavy duty protection cover

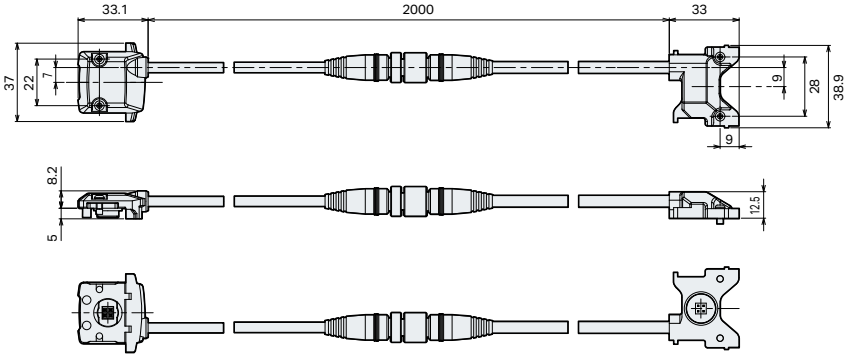
FD-HP2

SUS304/SUSXM7



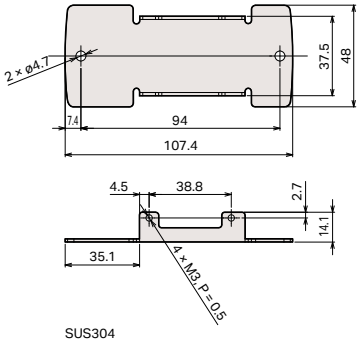
Display unit separation cable

FD-HCS2



Display unit separation bracket

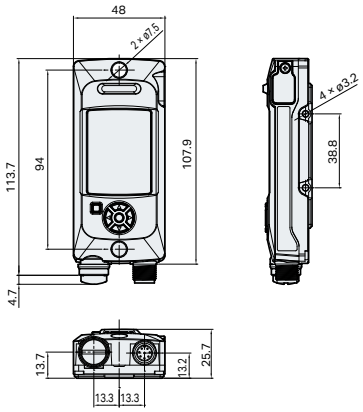
FD-HB1



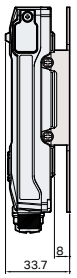
SUS304

Display Unit (FI-1000)

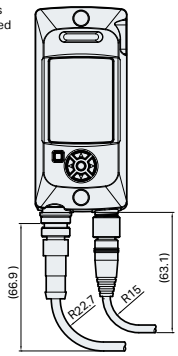
FI-1000



FI-1000 + FD-HB1

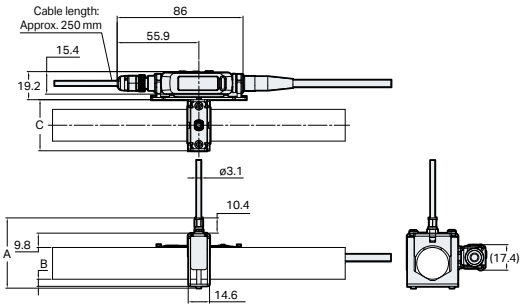


When cables are connected



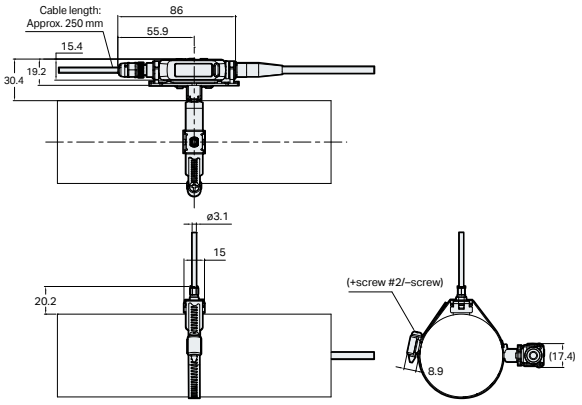
Temperature Sensors (FI-T)

FI-T8/T15

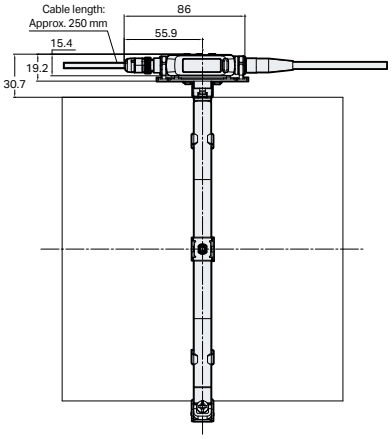


Model	A	B	C
FI-T8	40.4	Max. 4.7	26.5
FI-T15	48	Max. 5.4	34.9

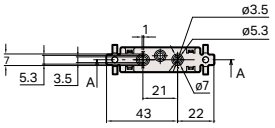
FI-T25/T50

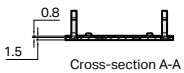


FI-T100/T200

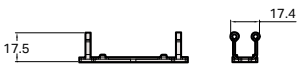


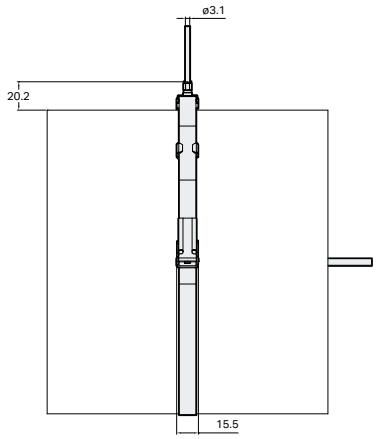
Amplifier stabilisation bracket

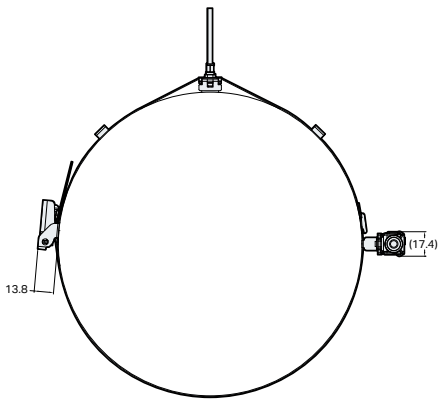




Cross-section A-A

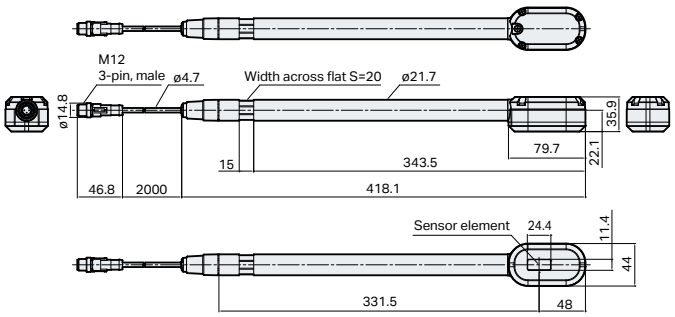




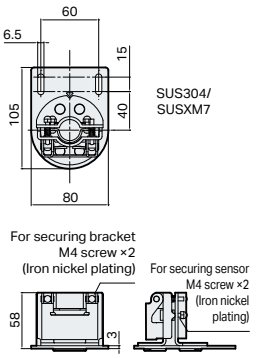


Probe type

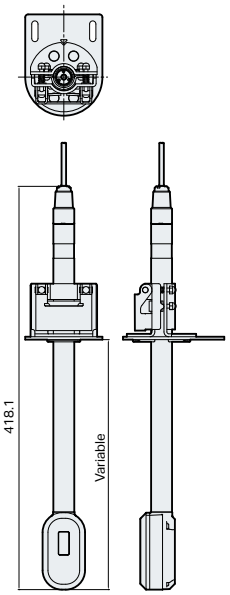
FI-C20D standalone



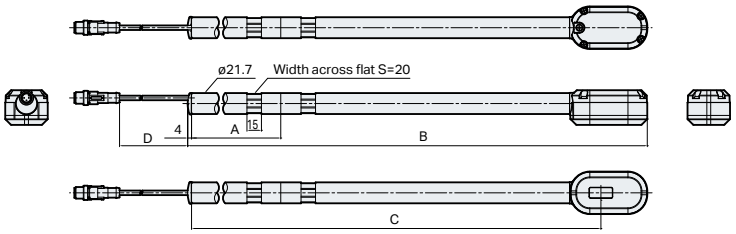
FI-CDB1



FI-C20D + FI-CDB1



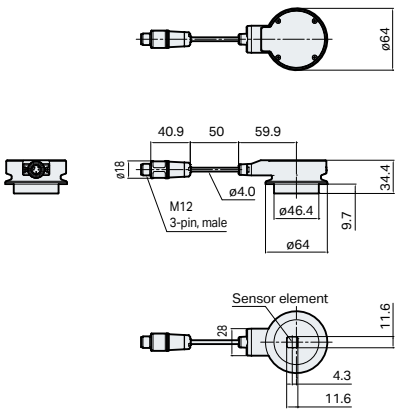
FI-C20D + FI-CD1/CD2



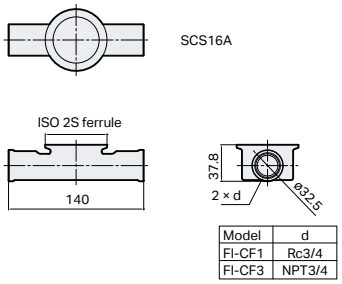
Model	A	B	C	D
FI-CD1	400	783.5	731.5	1634.6
FI-CD2	800	1183.5	1131.5	1234.6

In-Line type

FI-C40F

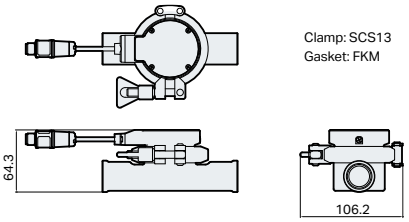


FI-CF1/CF3

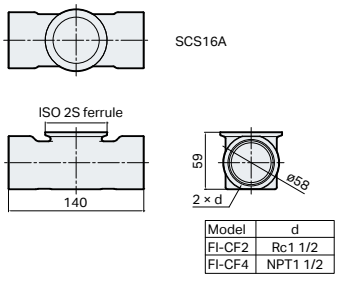


Model	d
FI-CF1	Rc3/4
FI-CF3	NPT3/4

FI-C40F + FI-CF1/CF3

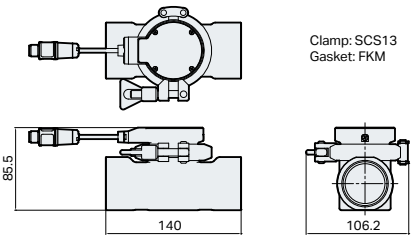


FI-CF2/CF4



Model	d
FI-CF2	Rc1 1/2
FI-CF4	NPT1 1/2

FI-C40F + FI-CF2/CF4



Heavy Duty Type Digital Pressure Sensors **GP-M Series**

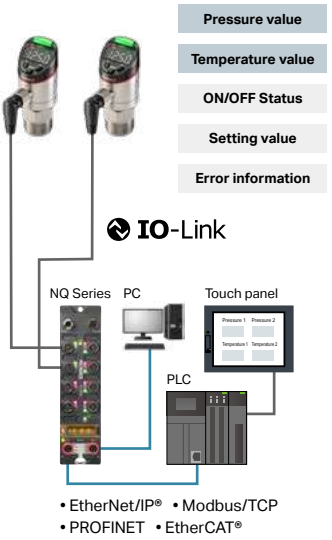


KEY FEATURES:

- Easy installation and integration
- Robust design and high environmental resistance IP67
- Early detection of process deviations



Check pressure and temperature data directly at the machine



Sensor

Appearance	Model	0 Rated pressure range	Fluid type	Thread diameter
	**GP-M001T**	−100 to +100 kPa	Gases Liquids	G3/4
	GP-M010T	− 0.1 to +1 MPa		
	GP-M025T	− 0.1 to +2.5 MPa		
	GP-M100T	0 to +10 MPa	Liquids	
	GP-M250T	0 to +25 MPa		
	GP-M400T	0 to +40 MPa		

Cable

Specifications	Model	Material	Sensor side	Cable termination	Length (m)
Standard	**OP-75721**	PVC (polyvinyl chloride)	M12 4 pins Straight	Loose wires	2
	OP-87272				5
	OP-85502				10
	OP-75722		M12 4 pins L-shaped		2
	OP-87273				5
	OP-87274				10
Oil resistant	**OP-87636**	PUR (polyurethane)	M12 4 pins Straight		2
	OP-88067				5
	OP-87637				10
	OP-87640		M12 4 pins L-shaped		2
	OP-88068				5
	OP-87641				10

Clamp-On Micro-Flow Sensor **FD-X Series**



KEY FEATURES:

- Monitor micro-flow in tubes or pipes from ø3 mm to ø13.8 mm
- Compatible with any liquid, even highly viscous liquids like grease, FIPG, and adhesives
- Small shot amounts can be monitored precisely with built-in calibration tools



Dispensing



Filling



Spraying

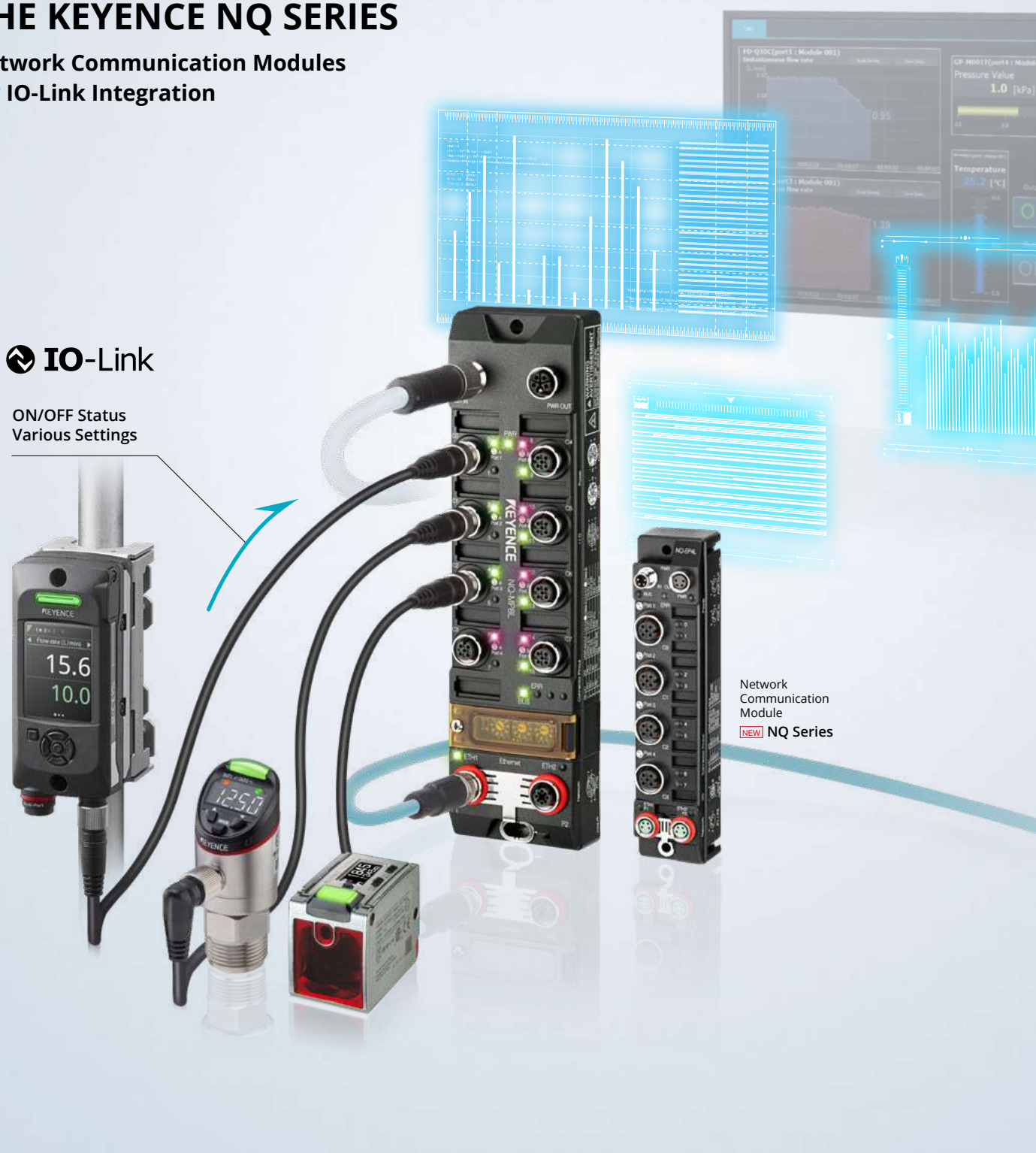
Supported pipes	Supported pipe diameters		Clamp set		Sensor head		Rated flow range
	Pipe outer diameter*	Installable range	Appearance	Model	Appearance	Model	
Plastic piping/ tubing	ø3	ø2.7 to 3.7		**FD-XC1R1**		**FD-XS1**	0 to 1000 mL/min
	3.18 mm						
	ø4	ø3.5 to 4.5		**FD-XC1R2**			
	ø6	ø5.5 to 6.5		**FD-XC8R1**		**FD-XS8**	0 to 3000 mL/min
	6.35 mm	ø5.9 to 6.9		**FD-XC8R2**			
	ø8	ø7.5 to 8.5		**FD-XC8R3**			0 to 8000 mL/min
	9.53 mm	ø9.0 to 10.0		**FD-XC20R1**		**FD-XS20**	0 to 15 L/min
	ø10	ø9.5 to 10.5		**FD-XC20R2**			
	ø12	ø11.5 to 12.5		**FD-XC20R3**			0 to 20 L/min
	12.7 mm	ø12.2 to 13.2		**FD-XC20R4**			
Metal piping	ø3	ø2.8 to 5.5 mm		**FD-XC1M**		**FD-XS1**	0 to 1000 mL/min
	3.18 mm						
	ø4						
	ø6	ø5.5 to 8.3 mm		**FD-XC8M**		**FD-XS8**	0 to 3000 mL/min
	6.35 mm						
	ø8						0 to 8000 mL/min
	9.53 mm	ø8.3 to 10.8 mm		**FD-XC20M1**		**FD-XS20**	0 to 15 L/min
	ø10						
	ø10.5						
	ø12	ø10.8 to 14 mm		**FD-XC20M2**			0 to 20 L/min
	12.7 mm						
	ø13.8						

*Inch notation does not refer to the B-nominal in the JIS or ANSI standards, but to the standard whereby 1 inch = 25.4 mm.
*For a complete FD-X Series setup, please reference the FD-X Series brochure or contact your local KEYENCE office.

Network Communication Module **NQ Series**

INTRODUCING THE KEYENCE NQ SERIES

Network Communication Modules for IO-Link Integration





Simplified Integration

Any System

Any Device

Any Location



Intuitive Software

Direct or Remote Connection

Automatic Device Recognition

Easy Real-Time Configuration



Unmatched Monitoring

Fully Customisable Displays

Reduced Downtime

Improved Preventive Maintenance

EtherNet/IP

PROFINET

EtherCAT

Modbus/TCP

Various Network Protocols

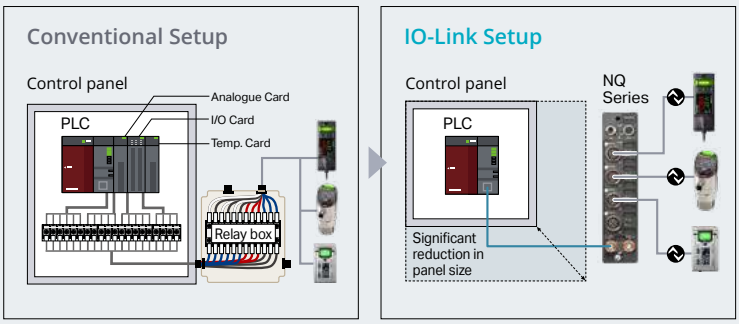
EtherNet/IP®

PROFINET

Modbus/TCP and more

What is IO-Link?

IO-Link communication allows sensors to share large amounts of information with an IO-Link Master Unit via a single connection point. The master unit then converts this information to a common network protocol to communicate with a PLC, greatly reducing wiring.



Complete Process LineUp

KEYENCE offers a full lineup of process devices beyond the FD-H and FI Series

Do you monitor pressure?

GP-M Series

Heavy Duty Digital Pressure Sensors



The GP-M Series can monitor both gas and liquid pressure.

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Do you have smaller (< 8 A) pipes or tubes ?

FD-X Series

Clamp-On Flow Sensor



The FD-X Series is ideal for micro-flow monitoring in small tubes or pipes.

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Do you network your sensors to access more data and control?

NQ Series

Network Communication Module

The NQ Series IO-Link communication modules allow users to gather data from sensors and devices around a machine and convert it to a common network communication format. This device simplifies wiring, while providing a level of detail and control that has not been seen before.

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KEYENCE CORPORATION

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