KEYENCE

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

CLAMP-ON
to Monitor
Micro Flow
Anywhere

FD-X Series

Mount and Monitor Micro Flow in Seconds

Clamp-On Micro Flow Sensor
FD-X Series

Utilize Everywhere

- Any Application
- Any Liquid
- Any Location

Hassle-Free Design

- No Impact on Process
- No Special Tools Needed
- No Maintenance

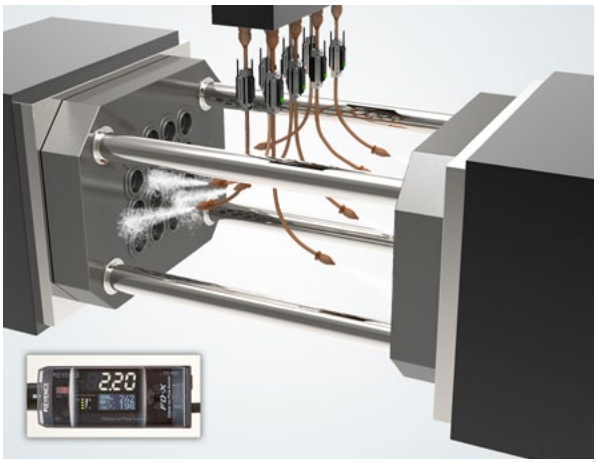
Unmatched Detection

- Unique Monitoring Modes
- High Repeatability
- Fast Response Time

Utilize Everywhere

Spraying / Coating

Easily monitor for clogs in spraying lines and ensure the proper amount of liquid has been applied.



Flow of Release Agent for Molds/Dies

Ensure that release agents are properly being applied to prevent mold or die damage.

Coating Spray Amount Confirmation

Verify that a consistant amount of coating material is applied uniformly across components.

Filling/Injecting

Ensure the appropriate amount of liquid has passed through the system.

Proper Chemical Mixing

Reliable monitoring of mixing fluids is necessary to ensure that appropriate liquid balances are met.

Product Filling

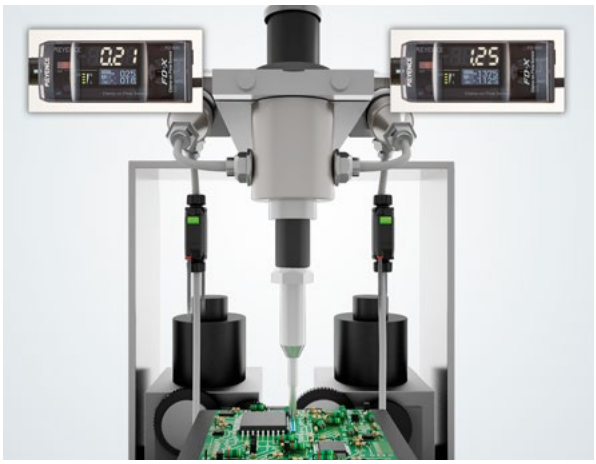
Verify the correct amount of product has been added to a package or container.

Dispensing

Confirm that the proper amount of liquid is being dispensed or applied when necessary.

Sealant Dispensing

Monitor the flow of sealant material (ex. FIPG) to prevent potentially harmful gaps in material.



Specialized Liquid Application

Precise application of specialized liquids (ex. flux, adhesives, chemicals, etc.) can be confirmed to ensure proper assembly.

Cooling/Lubricating

Monitor cooling and lubricating lines to prevent overheating or damage.

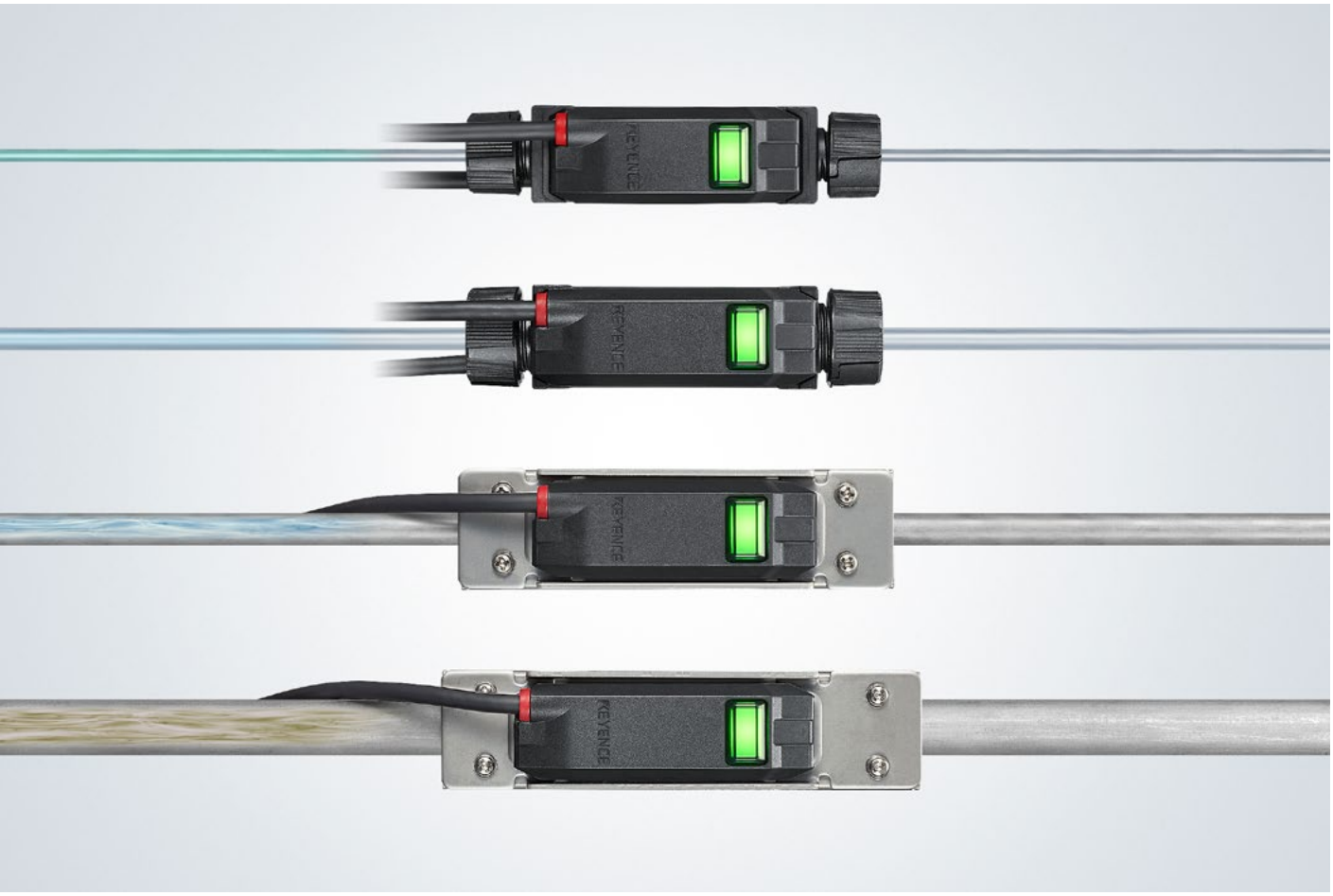
Chiller Flow Confirmation

Prevent costly overheating by monitoring all cooling lines individually to catch potential concerns.

Part Lubrication Monitoring

Ensure a steady flow of lubricant or oil on all parts to prevent machine damage, even in harsh environments.

Utilize Everywhere



Any Liquid

Viscous Liquids

The FD-X Series provides stable detection of all liquids, including those that are highly viscous (ex. grease, adhesives, etc), due to its high power.

Corrosive Liquids

The non-contact detection method allows for corrosive liquids to be easily monitored without the fear of damaging the unit.

Sanitary Liquids

The risk of contamination is eliminated because no process modifications are necessary and the sensor does not touch the liquid.

Any Tube/Pipe

The FD-X Series is compatible with metal pipes, plastic tubes, and uniform rubber hosing. These sensors will be able to easily Clamp-On pipes/tubes ranging from 3 mm to 14 mm(0.12" to 0.55").

Plastic/Rubber Pipes: ø3-12 mm(0.12"-0.47")
Metal Pipes: ø3-14 mm(0.12"-0.55")

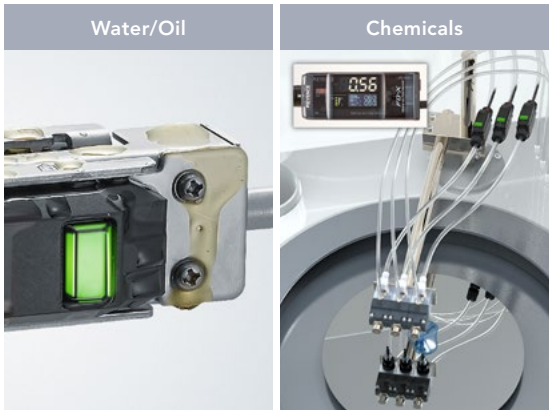
Any Space

The impressively small FD-X Series heads are approximately 1/10 the size of a conventional Coriolis Flow Meter. This allows the FD-X Series to be used in tight spaces and on multiple lines in close proximity.

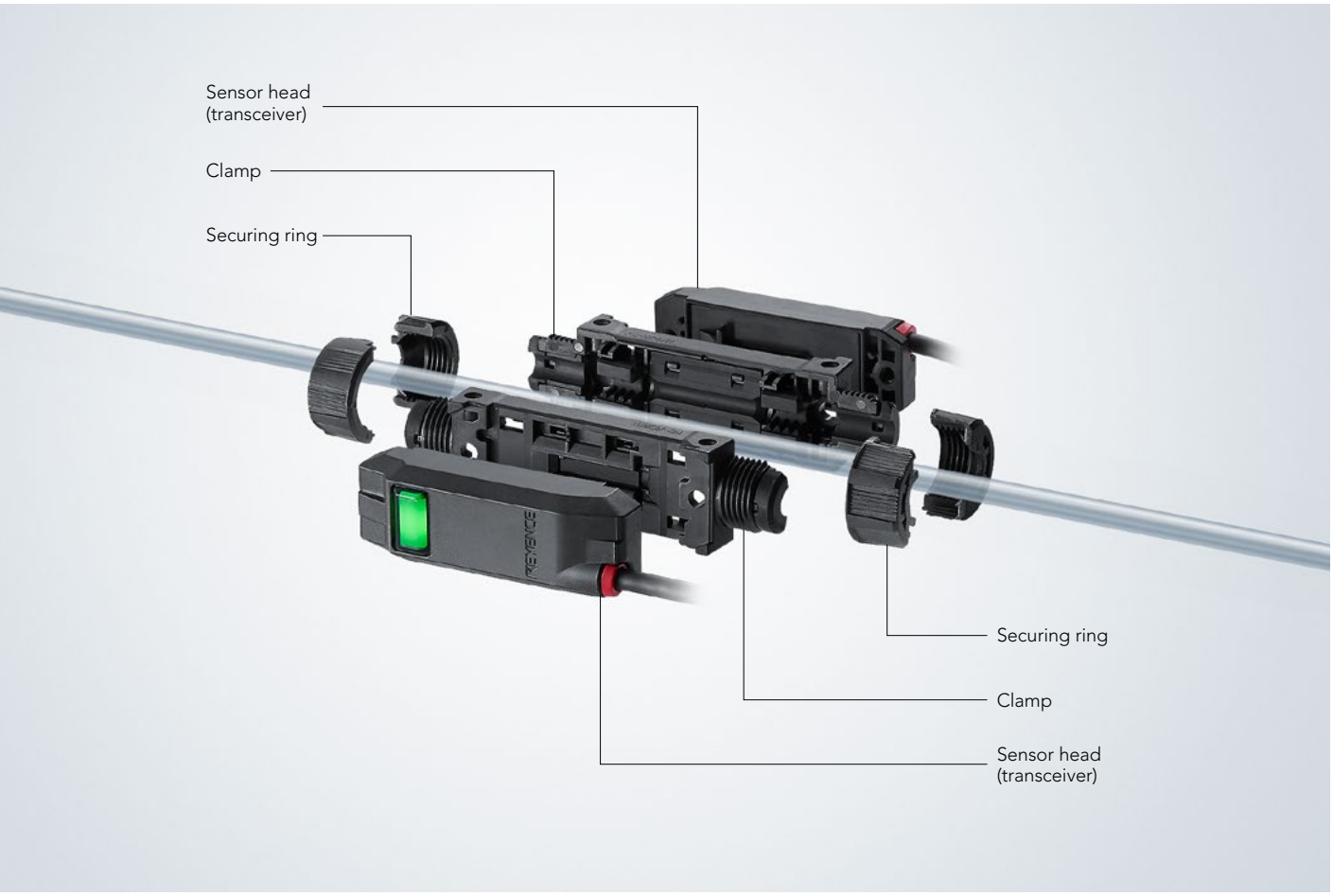
Any Environment

IP68G	Chemical Resistant

The superior environmental resistance of the FD-X Series allows it to be exposed to water, oil, and chemicals without damage. The resin models feature a Carbon Fiber Reinforced Body for high chemical resistance, particularly useful in the semiconductor industry.



Hassle-Free Design



Zero Impact on Process

Clamp Directly on the Pipe/Tube

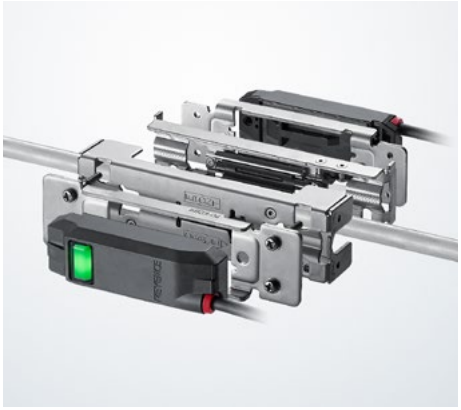
The Clamp-On design fits securely around the pipe or tube, without any impedance of flow. Simply Clamp-On and begin monitoring.

No Clogging

Unlike conventional mechanical type flow sensors, the FD-X Series will not clog, as there is no physical contact with the liquid.

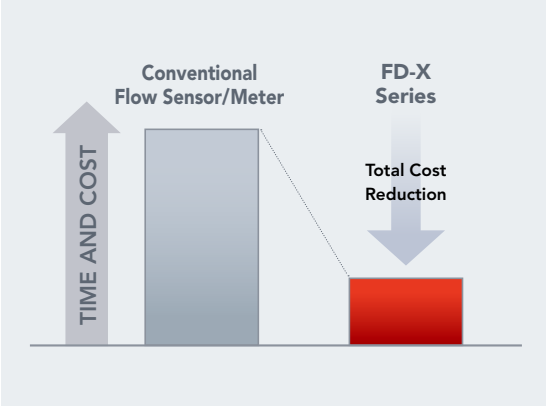
No Pressure Loss

Maintaining proper pressure is key in micro flow applications. That is why the FD-X Series is specially designed to prevent any pressure loss.



No Pipe Modification Necessary

The elimination of the time and money associated with system modifications, machine downtime, and the purchasing of additional components, make the FD-X Series a viable solution in any situation.



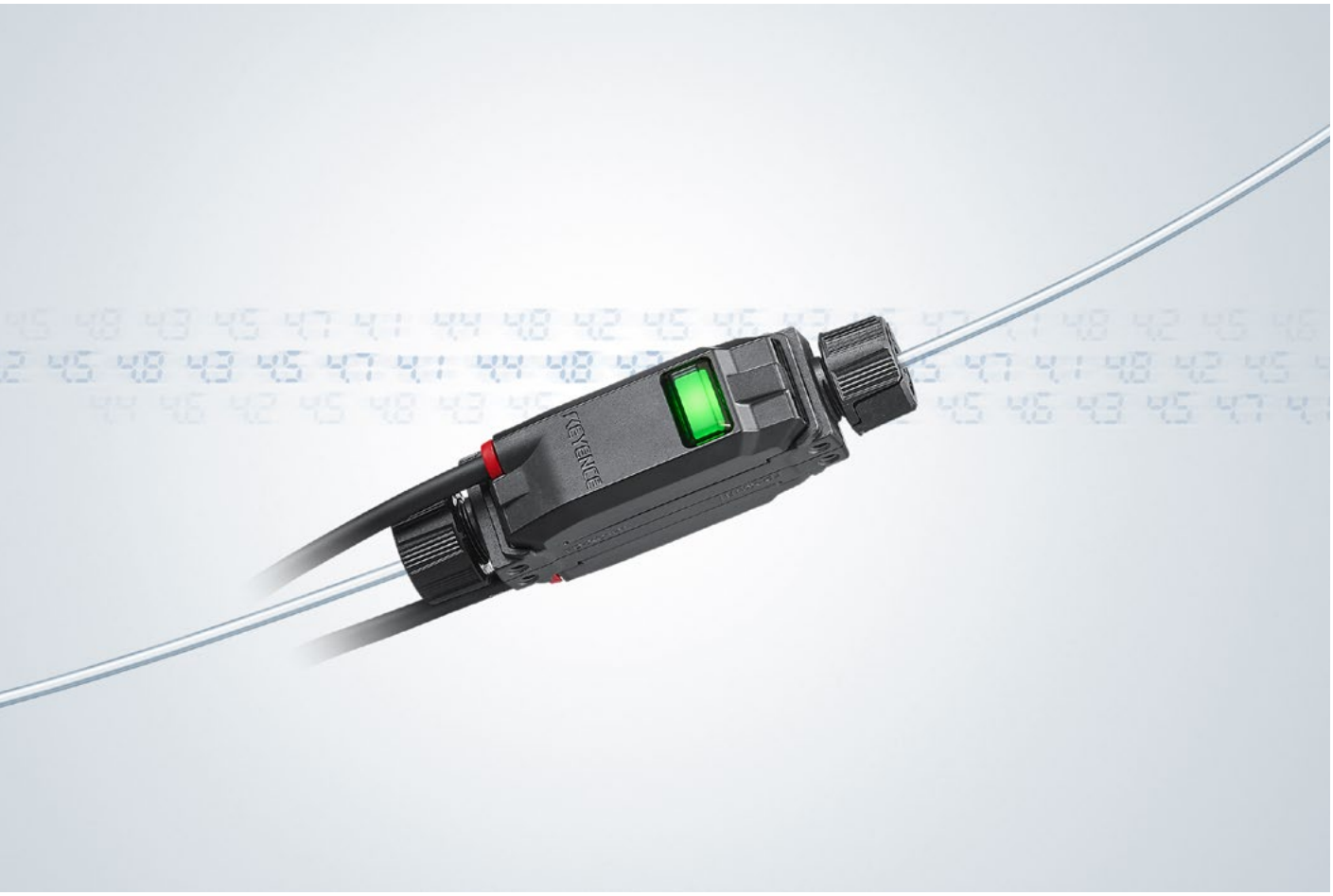
No Special Tools Required

Installation requires zero specialized knowledge or tools. Both models simply require a Phillips-head screwdriver to securely install the FD-X Series in seconds.

No Maintenance

Since the FD-X Series does not come in contact with the liquid, the need for maintenance is virtually eliminated. This is unlike mechanical and coriolis type meters, which are prone to clogging or damage and consistently require maintenance.

Unmatched Detection



Range of Monitoring Options

Instantaneous Flow

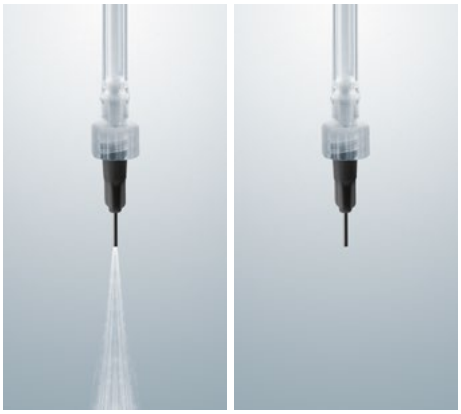
Monitor the current flow rate of liquid moving through the system.
Examples: Clog Detection and Cooling Water Monitoring

Accumulated Flow

Detect the amount of liquid that has passed through the system over a given period of time.
Examples: Fill Amount Confirmation and Liquid Usage Monitoring

Shot/Dispense Monitoring

Track the amount of liquid that is being dispensed quickly during one or multiple shots.
Examples: Spray Amount Confirmation and Intermittent Adhesive Dispensing



Micro Flow Detection

From a drop of water to a small spray of coating material, the FD-X Series is designed to detect some of the lowest flows imaginable with industry leading reliability.

Impressive Repeatability

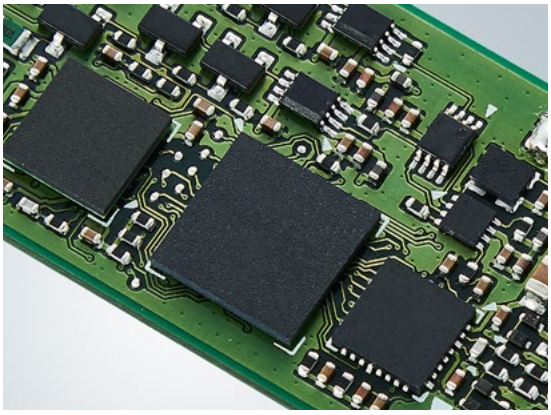
Depending on the model and pipe material, the FD-X Series is able to achieve a repeatability of ±0.1% of F.S. when monitoring instantaneous flow and ±0.003 mL when monitoring shot amounts.

FD-XS8 repeatability
(example: ø6 mm 0.24" pipe, 50 ms response time)

	Instantaneous flow	Shot amount
Plastic piping/ tubing	±0.1% of F.S.	±0.003 mL
Metal piping	±0.3% of F.S.	±0.008 mL

High-Speed Monitoring

The FD-X Series offers one of the industries fastest response times at 50 ms. This is achieved through the use of an innovative triple-core parallel processor and other advanced circuit design techniques.



Expansive Connectivity

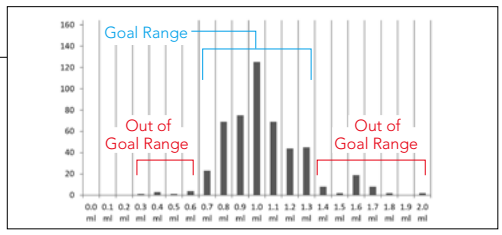
The FD-X Series continuously records various bits of liquid usage data directly on the unit. This information can be viewed directly on the amplifier or exported to a PC with a standard USB type cable.

Saved Data	
Instantaneous flow rates	Accumulated flow
Shot amounts	Output status changes, alarm information

Usage Examples

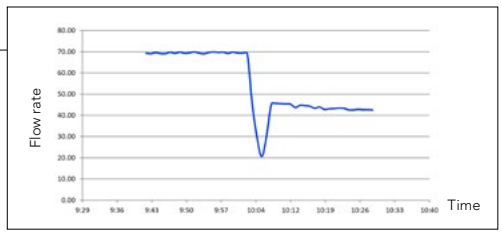
Coating/Dispensing Management

The unit can automatically record the dispensing or spray amount for each shot. This information can then be exported and used to monitor distribution and ensure consistency.



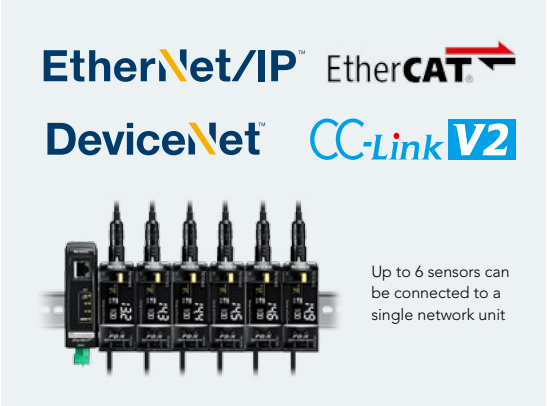
Instantaneous Flow Monitoring

Recognize flow rate trends by monitoring the MAX and MIN flow rates for consecutive periods of time. This helps to quickly identify process abnormalities.



Network Compatible

Through the use of the KEYENCE NU Series, it is possible to communicate with the FD-X Series on a variety of network platforms (EtherNet/IP™, CC-Link, DeviceNet, and more).



*EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

IO-Link Compatible

The FD-X Series allows for direct connection to an IO-Link Master Unit with a M12 connector cable. This enables communication of the output status, instantaneous flow rate, dispense rate, and much more.

FS-MC8N/P Compatible

By connecting to a KEYENCE FS-MC8N/P unit, it is possible for the FD-X controller settings to be saved and loaded when necessary. This makes troubleshooting and replacement easier than ever before.

Additional Features

Easy to Use Controller

Setup is a breeze with the intuitive FD-X Series controller. Boasting two easy to read displays, push button calibration, and an easy to navigate menu structure, this controller ensures that the unit is operational within minutes.

Full-Auto Tuning

Simply press and hold the SET button during ideal flow to generate an appropriate set point.

Target Calibration

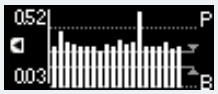
To ensure proper readings, it is possible to calibrate the device to a known amount of liquid that passes through the unit.

DIN/Panel Mountable

With both DIN and Panel mount controllers, the FD-X Series is sure to fit anywhere

Intuitive Displays

The OLED screen provides a variety of display options.

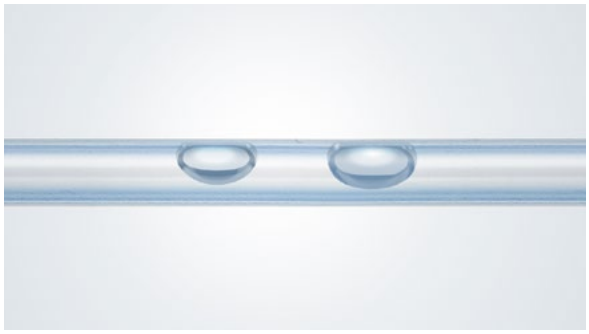


Graphs displaying shot/ dispensing amounts

Timeline of instantaneous flow rates

Graph flow rates or shot amounts directly on the amplifier to quickly and clearly recognize trends or issues.

Easy Bubble Detection

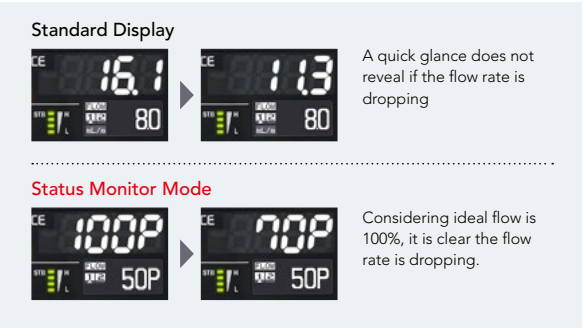


Prevent bubbles from damaging the system or process with a specialized bubble detection mode.

Highly Visible Indicator

The highly visible indicator provides a clear indication of the current situation and possible future issues.

Simplified Monitoring

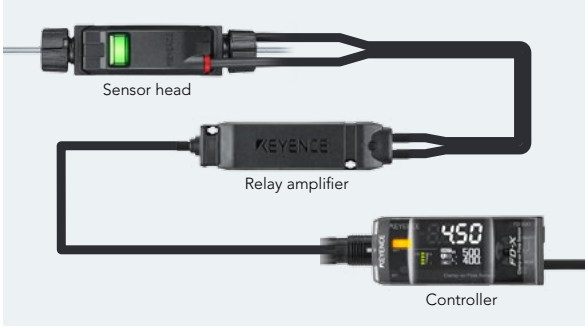


Simplify the display even further by representing the flow as a percentage of the optimal flow rate.

Simulation Mode

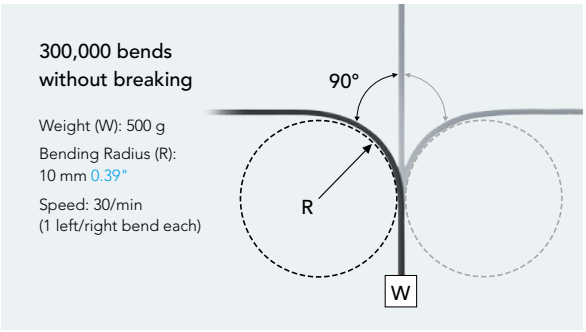
Confirm that the output wires are connected properly without needing to change the actual flow rate.

Heat Reducing Design



To prevent excesive heat generation in the head, the FD-X Series adopted a unique in-amp-cable design.

High Flex Cabling



Flexible cabling allows the FD-X Series to be used on robots without the risk of breakage due to repeated bending.

STEP1 Clamp Set and Sensor Head Selection

For plastic piping/tubing

1. Select the clamp set based on the outer diameter of the piping.

2. Select the corresponding sensor head.

Target pipe diameter		A Clamp set			B Sensor head			Rated flow range
Pipe outer diameter*	Installable range	Appearance	Model	Weight	Appearance	Model	Weight	
ø3	ø2.7 to 3.7 0.11" to 0.15"		FD-XC1R1	Approx. 50 g		FD-XS1	Approx. 230 g	0 to 1000 mL/min
1/8" (3.18 mm)								
ø4	ø3.5 to 4.5 0.14" to 0.18"		FD-XC1R2	Approx. 50 g				
ø6	ø5.5 to 6.5 0.22" to 0.26"		FD-XC8R1	Approx. 55 g		FD-XS8	Approx. 250 g	0 to 3000 mL/min
1/4"(6.35 mm)	ø5.9 to 6.9 0.23" to 0.27"		FD-XC8R2	Approx. 60 g				
ø8	ø7.5 to 8.5 0.30" to 0.33"		FD-XC8R3	Approx. 60 g				0 to 8000 mL/min
3/8"(9.53 mm)	ø9.0 to 10.0 0.35" to 0.39"		FD-XC20R1	Approx. 75 g		FD-XS20	Approx. 260 g	0 to 15 L/min
ø10	ø9.5 to 10.5 0.37" to 0.41"		FD-XC20R2	Approx. 80 g				
ø12	ø11.5 to 12.5 0.45" to 0.49"		FD-XC20R3	Approx. 80 g				0 to 20 L/min
1/2"(12.7 mm)	ø12.2 to 13.2 0.48" to 0.52"		FD-XC20R4	Approx. 80 g				

*The dimensions in inch are not Nominal dimensions B of JIS/ANSI standards. 1 inch = 25.4 mm

For metal piping

1. Select the clamp set based on the outer diameter of the piping.

2. Select the corresponding sensor head.

Target pipe diameter			A Clamp set			B Sensor head			Rated flow range
Pipe outer diameter*	A name	Installable range	Appearance	Model	Weight	Appearance	Model	Weight	
ø3	—	ø2.8 to 5.5 mm 0.11" to 0.22"		FD-XC1M	Approx. 190 g		FD-XS1	Approx. 230 g	0 to 1000 mL/min
1/8" (3.18 mm)	—								
ø4	—								
ø6	—	ø5.5 to 8.3 mm 0.22" to 0.33"		FD-XC8M	Approx. 210 g		FD-XS8	Approx. 250 g	0 to 3000 mL/min
1/4"(6.35 mm)	—								
ø8	—								0 to 8000 mL/min
3/8"(9.53 mm)	—	ø8.3 to 10.8 mm 0.33" to 0.43"		FD-XC20M1	Approx. 240 g		FD-XS20	Approx. 260 g	0 to 15 L/min
ø10	—								
ø10.5	6A								
ø12	—	ø10.8 to 14 mm 0.43" to 0.55"		FD-XC20M2	Approx. 250 g				0 to 20 L/min
1/2"(12.7 mm)	—								
ø13.8	8A								

* The dimensions in inch are not Nominal dimensions B of JIS/ANSI standards. 1 inch = 25.4 mm

STEP2 Controller Selection

Controllers

Type	Appearance	Model	Control output	External input	Analog current output	Network Compatibility	Cable	Weight (with cable)
DIN-rail mount type, main unit		**FD-XA1**	2 outputs (selectable NPN/ PNP)	2 inputs	1 output	IO-Link	7-core loose wires cable, 2 m 6.56'	Approx. 210 g
DIN-rail mount type, expansion unit Up to 7 expansion units per main unit		**FD-XA2**			—	NU Series • EtherNet/IP™ • CC-Link • DeviceNet™ • EtherCAT®	4-core loose wires cable, 2 m 6.56'	Approx. 180 g
Panel mount type, main unit		**FD-XA5**			1 output	IO-Link	7-core loose wires connector cable included, 2 m 6.56'	Approx. 210 g

Network Communication Unit, Mulit-Output Unit (select as needed)

Contact your local KEYENCE representative for more details

Network Communication Unit **NU** Series

Multi-output unit **FS-MC8N/P** Controller settings can be saved and written

STEP3 Optional Parts Selection (if needed)

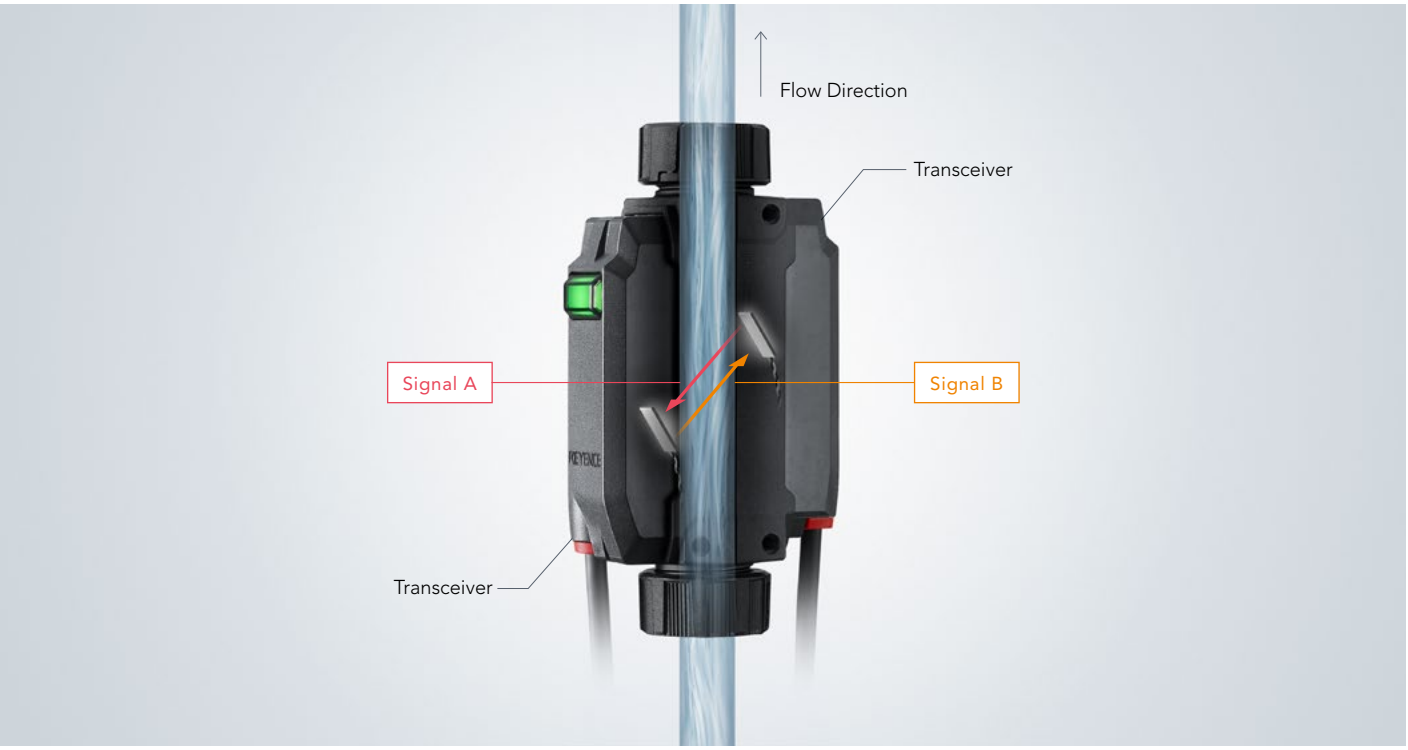
Installation

Type	Appearance	Model	For use with	Description	Weight
Securing bracket for plastic clamp set		**OP-88294**	FD-XC1R1/XC1R2 FD-XC8R1/XC8R2/XC8R3 FD-XC20R1/XC20R2/XC20R3/ XC20R4	For securing the plastic clamp set to a jig, etc. Use when clamping to a soft plastic tube.	Approx. 55 g
Metal clamp set mounting bracket		**OP-88297**	FD-XC1M/XC8M	For securing the metal clamp set to a jig, etc. Use with metal piping with an outer diameter of ø8.3 mm 0.33" or less if heavy vibration or shocks occur in the installation area.	Approx. 60 g
PEEK screw set		**OP-88295**	FD-XC1R1/XC1R2 FD-XC8R1/XC8R2/XC8R3 FD-XC20R1/XC20R2/XC20R3/ XC20R4/OP-88294	Use if the chemical resistance of the SUS screws included with the plastic clamp sets (FD-XCxRx) or plastic clamp securing brackets (OP-88294) is a concern.	Approx. 3 g
DIN securing bracket (for main unit)		**OP-88311**	FD-XA1	Allows attachment without a DIN rail.	Approx. 15 g
End unit (for expansion)		**OP-26751**	FD-XA1/XA2	Secure main and expansion units when mounted together on a DIN rail. Always use when connecting multiple units. (Pack of 2)	Approx. 15 g

Wiring

Type	Appearance	Model	For use with	Description	Weight
Sensor head-controller extension cable, 2 m 6.56'		**OP-88292**	FD-XS1/XS8/XS20	A cable that further extends the 2 m 6.56' cable between the sensor head's relay amp and the controller. Connectors are on both ends. *The cable between the relay amp and controller can be extended up to 12 m 39.37' long.	Approx. 110 g
Sensor head-controller extension cable, 5 m 16.40'		**OP-88293**			Approx. 240 g
Loose wires/ M12 adapter		**OP-88296**	FD-XA1/XA5 cables, or cables with cross sectional area 0.14 to 0.34 mm² and outer diameter ø3.5 to 6 mm 0.14" to 0.24"	A connector that converts loose wires to a M12 4-pin connector. Useful for connecting to IO-Link compatible master units.	Approx. 12 g

Operating Principles

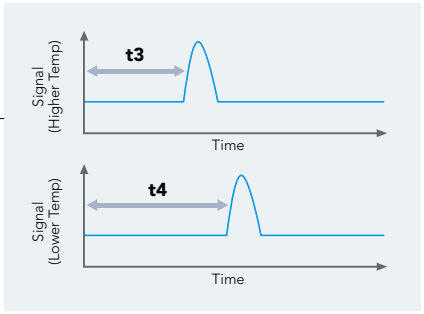


Delta TOF

Conventional ultrasonic flow sensors monitor flow by measuring the time it takes for an ultrasonic pulse to travel from a transmitting element to a receiving element. As the flow rate increases, the signal is accelerated and the transmission time decreases. This transmission time can then be directly correlated to the instantaneous flow rate. The FD-X Series improves upon this method by simultaneously monitoring two signals (one moving in the direction of flow and one moving against the direction of flow). By doing this, the readings remain consistent and stable regardless of external factors such as clogging or temperature changes.

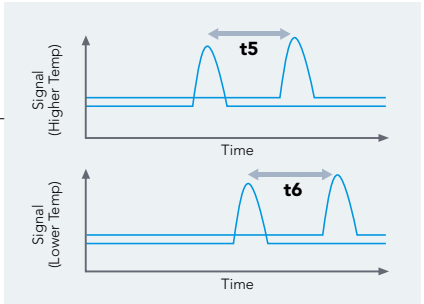
Basic Principle

The duration of the pulse is easily influenced by external factors.



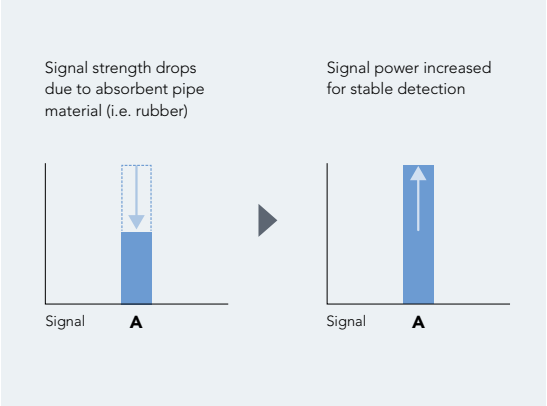
Delta TOF

External factors do not affect detection as the time difference between signals A and B remains the same.



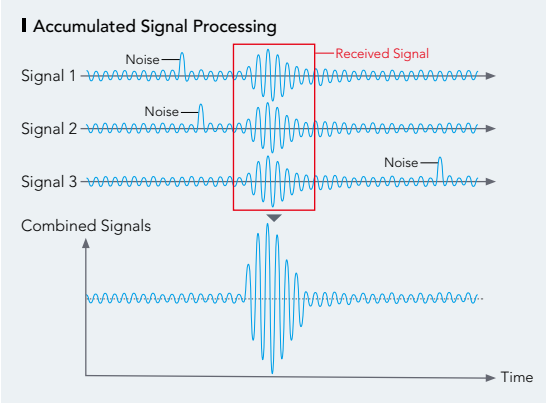
Automatic Power Control

The stable transmission of the ultrasonic signal is imperative for consistent and reliable detection. To ensure stability on a large variety of pipe material, the FD-X Series utilizes an Automatic Power Control function, which identifies signal strengths and adjusts accordingly. This ensures stable detection on everything from steel pipes to rubber hoses.



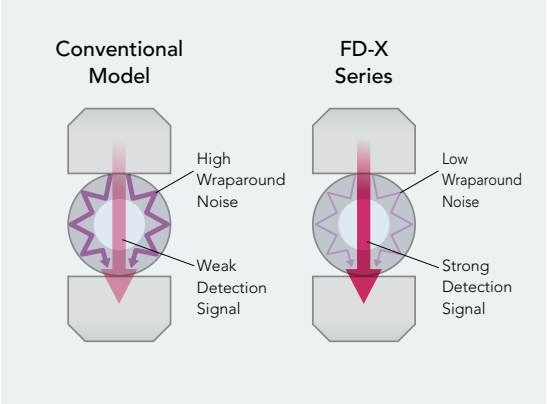
Accumulated Signal Processing

By utilizing a unique signal processing methodology, the FD-X Series bases its detection on not just one signal transmission but multiple signal transmissions. This allows the unit to combine signals and completely ignore any external noise.



Guided Wave Technology

The effects of noise generated by the ultrasonic detection signal can be detrimental to stable detection. To prevent this, the FD-X Series has adopted several innovative noise reducing techniques, including guided wave technology, which prevents the signal from wrapping around the pipe and hampering detection.



Sensor head

Sensor head model			FD-XS1			FD-XS8			FD-XS20				
Supported pipe materials			Metal pipes, Plastic pipes (soft/hard)*1										
Supported fluids			Liquids (water, oil, adhesive, grease, chemical solutions, etc.)*1										
Supported fluid temperature(Pipe surface temperature)			0°C (no freezing on the pipe surface) to 100°C 32 to 212°F										
Supported diameter	Plastic pipe/tube attachment	Clamp set model	FD-XC1R1		FD-XC1R2	FD-XC8R1	FD-XC8R2	FD-XC8R3	FD-XC20R1	FD-XC20R2		FD-XC20R3	FD-XC20R4
		Outer diameter of pipe	ø3 0.12"	1/8"(3.18 mm)	ø4 0.16"	ø6 0.24"	1/4"(6.35 mm)	ø8 0.31"	3/8"(9.53 mm)	ø10 0.39"		ø12 0.47"	1/2"(12.7 mm)
		Attachable range	ø2.7 to 3.7 0.11" to 0.15"		ø3.5 to 4.5 0.14" to 0.18"	ø5.5 to 6.5 0.22" to 0.26"	ø5.9 to 6.9 0.23" to 0.27"	ø7.5 to 8.5 0.27" to 0.33"	ø9.0 to 10.0 0.35" to 0.39"	ø9.5 to 10.5 0.37" to 0.41"		ø11.5 to 12.5 0.45" to 0.49"	ø12.2 to 13.2 0.48" to 0.52"
	Metal pipe attachment	Clamp set model	FD-XC1M			FD-XC8M			FD-XC20M1			FD-XC20M2	
		Outer diameter of pipe	ø3 0.12"	1/8"(3.18 mm)	ø4 0.16"	ø6 0.24"	1/4"(6.35 mm)	ø8 0.31"	3/8"(9.53 mm)	ø10 0.39"	ø10.5 0.41"	ø12 0.47"	1/2"(12.7 mm)	ø13.8 0.54"
		A designation	—	—	—	—	—	—	—	—	6A	—	—	8A
		Attachable range	ø2.8 to 5.5 0.11" to 0.22			ø5.5 to 8.3 0.22" to 0.33"			ø8.3 to 10.8 0.33" to 0.43"			ø10.8 to 14 0.43" to 0.55"	
Rated flow range			0 to 1000 mL/min			0 to 3000 mL/min		0 to 8000 mL/min	0 to 15.00 L/min			0 to 20.00 L/min	
Zero cut flow rate*2 (variable, default)			20 mL/min			40 mL/min			0.10 L/min				
Display resolution (Displayed on controller)	Instantaneous flow rate		0.1/1/10 mL/min						0.001/0.01/0.1 L/min				
	Shot amount		0.001/0.01/0.1/1 mL						0.001/0.01/0.1 L				
Repeatability *3	Plastic pipe/tube attachment	Response time: 50ms*4 F.S.	±0.6%			±0.1%							
		Response time: 50ms*4 Instantaneous flow rate	±6 mL/min			±3 mL/min		±8 mL/min	±15 mL/min			±20 mL/min	
		Response time: 500 ms Instantaneous flow rate	±1.9 mL/min			±1.0 mL/min		±2.6 mL/min	±4.7 mL/min			±6.3 mL/min	
	Metal pipe attachment	Response time: 50ms*4 F.S.	±1%			±0.3%		±0.15%					
		Response time: 50ms*4 Instantaneous flow rate	±10 mL/min			±9 mL/min		±12 mL/min	±23 mL/min			±30 mL/min	
		Response time: 500 ms Instantaneous flow rate	±3.2 mL/min			±2.9 mL/min		±3.8 mL/min	±7.2 mL/min			±9.5 mL/min	
Hysteresis			Variable										
Integrated unit display(displayed on controller)			0.1/1/10/100/1000/10000 mL						0.01/0.1/1/10/100 L				
Display method			Status indicator										
Environmental esistance	Enclosure rating		IP65/IP67 (IEC60529), IP68G (JIS C0920) *5										
	Ambient temperature		0 to 60°C (No freezing) 32 to 140°F			-10 to 60°C (No freezing) 14 to 140°F							
	Ambient humidity		35% to 85% RH (No condensation)										
	Vibration resistance		10 to 55 Hz, double amplitude 1.5 mm 0.06", 2 hours each for X,Y,Z direction										
	Shock resistance		50G 11 ms 3 times each for X,Y,Z direction										
Material	Sensor head		Head body: PPS/PPSU, in-cable amplifier: PPS, cable: PVC, controller connector: PPS/PBT/POM										
	Clamp set	For plastic pipe	Body, fixing screw: PPS, detection surface: special rubber, pipe support rubber: FKM, sensor head fixing screw: SUSXM7										
		For metal pipe	Metal: SUS304/SUSXM7, detection surface: special rubber, clamp support rubber: FKM, sensor head fixing screw: SUSXM7										

*1 Liquid must allow for the passage of an ultrasonic pulse, as well as not contain large air pockets or excessive bubbles. Readings may become unstable depending on the type of pipe. *2 The zero cut flow rate can be changed in the settings. When using the unit with a low flow rate range, perform an origin adjustment when the fluid is not moving if you change the zero cut flow rate. *3 This specification is valid when the flow velocity distribution is stable. This value does not take into account the effects of pulsation or fluctuations in flow velocity distribution due to facility factors. Convert the F.S. (full scale value) listed in the table according to the rated flow range. *4 The longer the response time is set, the more repeatability is improved. As a guideline, use √ (50 ms/response time) times. *5 The connector part of the sensor head cable is IP65 / IP67.

Shot amount repeatability (Typical values)

Sensor head model			FD-XS1			FD-XS8			FD-XS20				
Plastic pipe/tube attachment	Clamp set model		FD-XC1R1		FD-XC1R2	FD-XC8R1	FD-XC8R2	FD-XC8R3	FD-XC20R1	FD-XC20R2		FD-XC20R3	FD-XC20R4
	Diameter of pipe		ø3 0.12"	1/8"(3.18 mm)	ø4 0.16"	ø6 0.24"	1/4"(6.35 mm)	ø8 0.31"	3/8"(9.53 mm)	ø10 0.39"		ø12 0.47"	1/2"(12.7 mm)
	Shot time	50 ms	±0.005 mL			±0.003 mL		±0.004 mL	±0.006 mL			±0.008 mL	
		1 s	±0.015 mL			±0.008 mL		±0.012 mL	±0.019 mL			±0.023 mL	
		10 s	±0.044 mL			±0.024 mL		±0.036 mL	±0.057 mL			±0.071 mL	
Metal pipe attachment	Clamp set model		FD-XC1M			FD-XC8M			FD-XC20M1			FD-XC20M2	
	Diameter of pipe		ø3 0.12"	1/8"(3.18 mm)	ø4 0.16"	ø6 0.24"	1/4"(6.35 mm)	ø8 0.31"	3/8"(9.53 mm)	ø10 0.39"	6A(10. 5 mm)	ø12 0.47"	1/2"(12.7 mm)	8A(13.8 mm)
	Shot time	50ms	±0.007 mL			±0.008 mL			±0.009 mL			±0.012mL	
		1 s	±0.021 mL			±0.025 mL			±0.027 mL			±0.036mL	
		10 s	±0.063 mL			±0.075 mL			±0.083 mL			±0.112mL	

*1 Repeatability of the shot amount is the typical value for water, response time of 50 ms, no zero cut flow rate setting and after origin adjustment. *2 Variations due to facility factors (such as pulsation, valve control, liquid pooling, change in flow velocity distribution) are not taken into account in this value.

Controller

Model		FD-XA1	FD-XA2	FD-XA5
Type		DIN rail type, main unit	DIN rail type, expansion unit	Panel type, main unit
Display method		Output indicator, 4-digit 7 segment display, OLED, Stability level display		
Display refresh frequency		Instantaneous flow: approx. 5 times/second, Discharge amount/Accumulated flow approx. 30 times/second		
Response time		50 ms/100 ms/500 ms/1 s/2.5 s/5 s/10 s/30 s/60 s (selectable, default: 500 ms)		
Integration data storage interval		Written to the memory every 10 seconds		
Memory back up*1		EEPROM (data storage period: more than 10 years, number of data rewritable times: 1 million times or more)		
Detection mode (selectable)	ch.1	Instantaneous flow rate mode/Area mode/Pulse output (+) mode/Integrated flow mode/Shot mode		
	ch.2	Instantaneous flow rate mode/Area mode/Pulse output (-) mode/Shot mode/Error output mode/Bubble alert mode/Error + bubble alert mode		
Input/output	Output ch.1/2	NPN/PNP setting switch Open collector output: 30 V or lower, main unit: 50 mA or lower/ch.*2/expansion unit: 20 mA or lower/ch., residual voltage: 2 V or lower		
	Analog output	4-20 mA/0-20 mA (selectable) load resistance: 500ohms or lower	—	4-20 mA/0-20 mA (selectable) load resistance: 500ohms or lower
	External input 1/2	Flow rate zero input/shot sampling input/integrated flow reset input/zero shift input (selectable) Short circuit current: NPN 1 mA or lower/PNP 2 mA or lower, input time: 20 ms or longer		
Network support		IO-Link*3	Supports NU series	IO-Link*3
Power source	Power supply voltage	20 to 30 VDC including 10% ripple (P-P), Class 2		
	Current consumption	195 mA or lower (including the sensor head, excluding the load current)	185 mA or lower (including the sensor head, excluding the load current)	195 mA or lower (including the sensor head, excluding the load current)
Protection circuit		Power supply reverse connection protection, power surge protection, output short circuit protection, output surge protection		
Addition of expansion units		Up to 7*4 per main unit		—
Environmental resistance	Ambient temperature	-10 to +50°C (No freezing) 14 to 122°F		
	Ambient humidity	35% to 85% RH (No condensation)		
	Vibration resistance	10 - 55 Hz, double amplitude 1.5 mm 0.06", 2 hours each for X,Y,Z direction		
	Shock resistance	100 m/s² (approx. 10G) 16 ms pulse, 1000 times each for X,Y,Z direction		
Material		Main body case/front sheet: PC Key top: POM Cable: PVC		

*1 Internal data from full time recording can be read via USB (Ver.2.0) communication. *2 20 mA or lower/ch when adding expansion units. *3 IO-Link: Specification v1.1/COM2(38.4kbps) is supported. If the end of the cable needs to be an M12 connector when supporting IO-Link communication, connect an M12 conversion connector (OP-88296) to the cable. *4 Refer to the Instruction Manual for the number of connected units to N-bus devices.

Multi-Output Unit

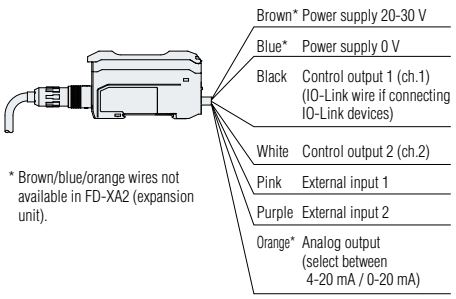
Model		FS-MC8N / FS-MC8P
Model	NPN output	**FS-MC8N**
	PNP output	**FS-MC8P**
Number of inputs and outputs		Separate control output: 8, common output: 1, common input: 1
Response time		Depends on the response time settings of the connected expansion units
Unit expansion		Up to 8 expansion units can be connected. (However, each dual output type will be treated as 2 expansion units.) Allowable passing current: 1200 mA or less
Indicators		STATUS indicator (green and red two-color display) MEMORY indicator (orange) LOCK indicator (orange)
Separate control outputs, common output	NPN output	NPN open-collector, 30 V or less, 20 mA or less per output, residual voltage: 1.4 V or less
	PNP output	PNP open-collector, 30 V or less, 20 mA or less per output, residual voltage: 1.6 V or less
External input time		Input time of the connected expansion units +11 ms
Protection circuit		Protection against reverse power connection, reverse output connection, output overcurrent, and output surge
Power supply	Power supply voltage*1	10 to 30 VDC (including 10% ripple (P-P) or less), class 2 or LPS
	Power consumption*2	690 mW or less (when used as a solitary unit) (26 mA or less at 24 V/38 mA or less at 12 V [excluding the load current])
Environmental resistance	Ambient temperature	-20°C to +55°C -4°F to +131°F (no freezing)
	Vibration resistance	10 to 55 Hz; double amplitude 1.5 mm 0.06" ; 2 hours each for X, Y, and Z axes
	Shock resistance	500 m/s²; 3 times each for X, Y, and Z axes
Case material		Main unit and cover: polycarbonate
Weight		Approx. 110 g

*1 Match the rated power supply voltage of the expansion units to be connected to expand the system.
*2 The power consumption including the loads when the maximum number of units are connected is 38 W max.

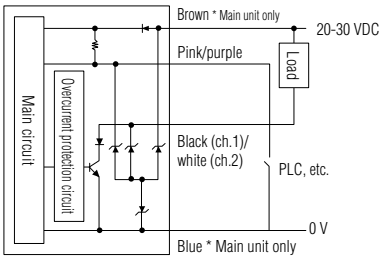
I/O Circuit Diagrams

Controller

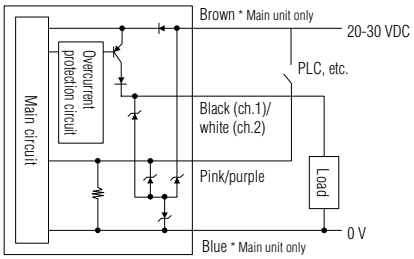
FD-XA1/XA2/XA5



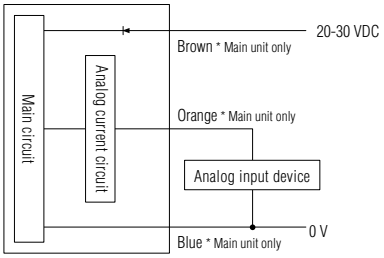
When using in NPN mode



When using in PNP mode

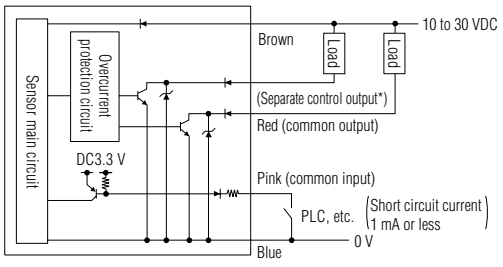


Analog output circuit diagram



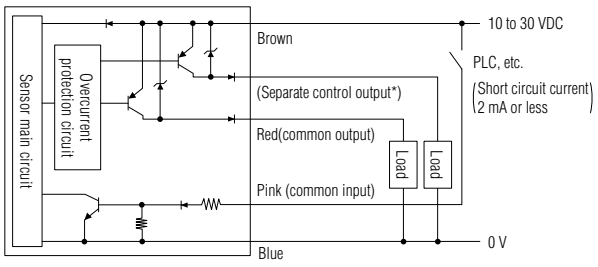
Multi-Output Unit

FS-MC8N



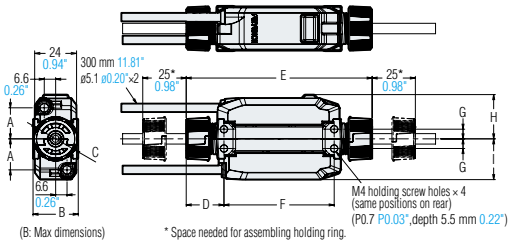
* Black, white, orange, yellow, green, purple, grey, pink / purple

FS-MC8P



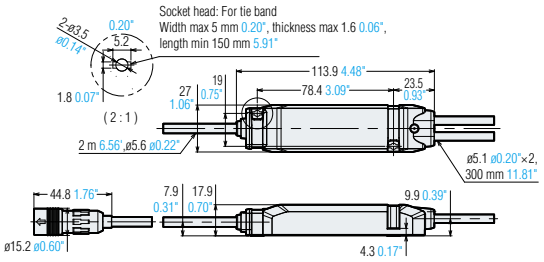
Sensor head

FD-XS1/XS8/XS20 + plastic piping clamp set

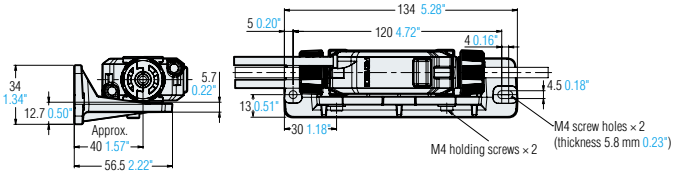


Sensor head	Clamp set	A	B	C	D	E	F	G	H	I
FD-XS1	FD-XC1R1	14.6 0.57"	24.6 0.97"	ø22 0.87"	21.3 0.84"	106 4.17"	63.4 2.50"	4 0.16"	22.2 0.87"	20.2 0.80"
	FD-XC1R2	15 0.59"	24.6 0.97"	ø22 0.87"	21.3 0.84"	106.5 4.19"	63.9 2.52"	4.4 0.17"	22.6 0.89"	20.6 0.81"
FD-XS8	FD-XC8R1	17.9 0.70"	26 1.02"	ø25.5 1.00"	21.4 0.84"	106.1 4.18"	63.4 2.50"	5.6 0.22"	25.5 1.00"	23.5 0.93"
	FD-XC8R2	18 0.71"	26 1.02"	ø25.5 1.00"	21.4 0.84"	106.3 4.19"	63.6 2.50"	5.7 0.22"	25.6 1.01"	23.6 0.93"
	FD-XC8R3	18.9 0.74"	26 1.02"	ø25.5 1.00"	21.4 0.84"	107.3 4.22"	64.6 2.54"	6.6 0.26"	26.5 1.04"	24.5 0.96"
FD-XS20	FD-XC20R1	22.4 0.88"	30 1.18"	ø29.5 1.16"	21.5 0.85"	112.8 4.44"	69.9 2.75"	7.3 0.29"	30 1.18"	28 1.10"
	FD-XC20R2	22.7 0.89"	30 1.18"	ø29.5 1.16"	21.5 0.85"	113.3 4.46"	70.4 2.77"	7.6 0.30"	30.3 1.19"	28.3 1.11"
	FD-XC20R3	23.7 0.93"	30 1.18"	ø29.5 1.16"	21.5 0.85"	114.4 4.50"	71.5 2.81"	8.6 0.34"	31.3 1.23"	29.3 1.15"
	FD-XC20R4	24 0.94"	30 1.18"	ø29.5 1.16"	21.5 0.85"	114.8 4.52"	71.9 2.83"	8.9 0.35"	31.6 1.24"	29.6 1.16"

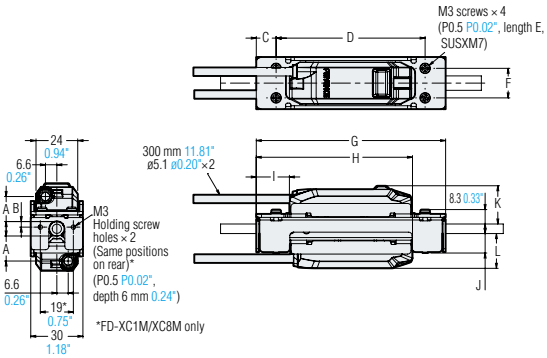
Relay amplifier



FD-XS1/XS8/XS20 securing bracket installed (optional, sold separately, OP-88294)

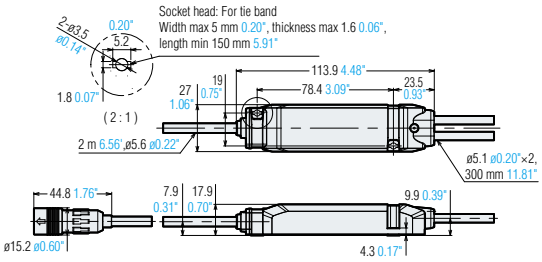


FD-XS1/XS20 + metal piping clamp set

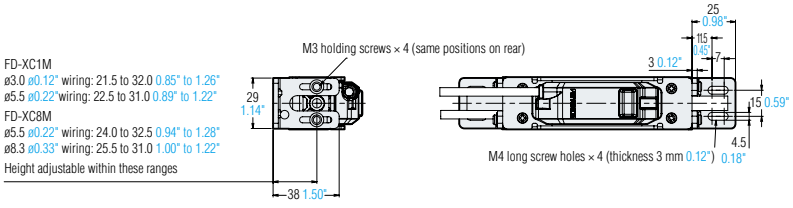


Sensor head	Clamp set	A	B	C	D	E	F	G	H	I	J	K	L
FD-XS1	FD-XC1M	12.7 0.50"	2.2 0.09"	10.8 0.43"	79.9 3.15"	20 0.79"	16 0.63"	102.5 4.04"	83.5 3.29"	22 0.87"	10.7 0.42"	20.3 0.80"	18.3 0.72"
FD-XS8	FD-XC8M	14.4 0.57"	4.2 0.17"	11.4 0.45"	85.7 3.37"	23 0.91"	17 0.67"	108.9 4.29"	89.4 3.52"	19.1 0.75"	11.2 0.44"	22 0.87"	20 0.79"
FD-XS20	FD-XC20M1	17.3 0.68"	—	11.9 0.47"	95.8 3.77"	26 1.02"	17.5 0.69"	119.5 4.70"	94.4 3.72"	19.7 0.78"	11.4 0.45"	24.9 0.98"	22.9 0.90"
	FD-XC20M2	17.3 0.68"	—	11.4 0.45"	98.8 3.89"	30 1.18"	18 0.71"	121.5 4.78"	93.9 3.70"	19.2 0.76"	12.9 0.51"	24.9 0.98"	22.9 0.90"

Relay amplifier

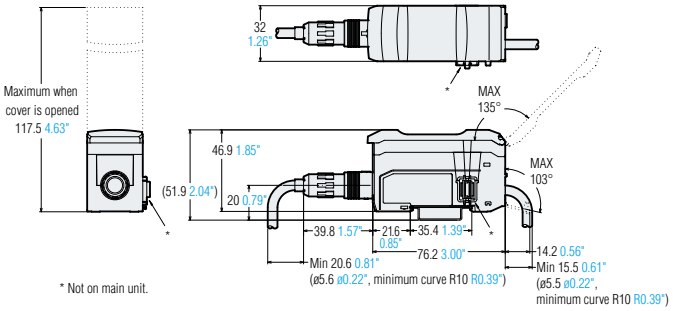


FD-XS1/XS8 securing bracket installed (optional, sold separately, OP-88297)

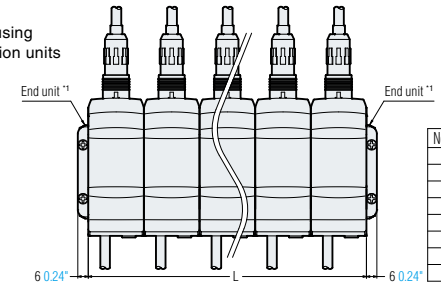


Controller

DIN rail mount type **FD-XA1** (main unit) / **XA2** (expansion unit)



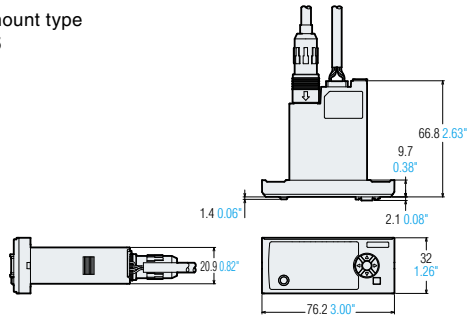
When using expansion units



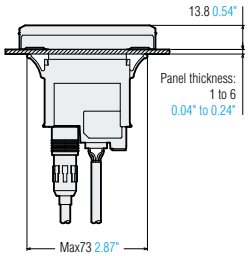
No. of expansion units	L
1	32 1.26"
2	64 2.52"
3	96 3.78"
4	128 5.04"
5	160 6.30"
6	192 7.56"
7	224 8.82"
8	256 10.08"

*1 When using expansion units, be sure to use the end units (sold separately)

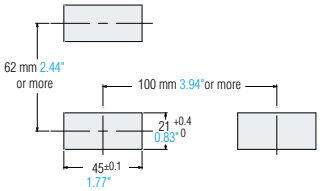
Panel mount type **FD-XA5**



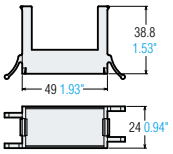
Assembled on panel



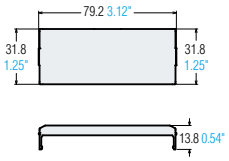
Panel cutting dimensions



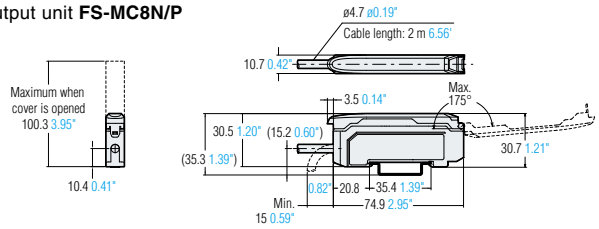
Panel mounting accessory



Protective cover



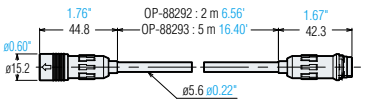
Multi-output unit **FS-MC8N/P**



Optional cables

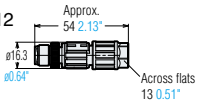
Sensor head-Controller extension cable

OP-88292/88293



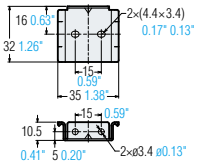
Loose wires-M12 adapter connector

OP-88296



DIN amplifier securing bracket (for main unit)

OP-88311



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GP-M Series

Key Features

> Multiple adapter options ensure fit

> Clog resistent step flush diaphram

> Rotatable display requiring no union joint

Sensors

Appearance	0 Rated pressure range	Fluid type	Thread diameter	Model
	-14.50 to +14.50 PSI (-100 to +100 kPa)	Gas Liquid	G3/4	**GP-M001**
	-14.5 to +145.0 PSI (-0.1 to +1 MPa)			**GP-M010**
	-14.5 to +362.6 PSI (-0.1 to +2.5 MPa)			**GP-M025**
	0 to +1450 PSI (0 to +10 MPa)	Liquid		**GP-M100**
	0 to +3626 PSI (0 to +25 MPa)			**GP-M250**
	0 to+5802 PSI (0 to +40 MPa)			**GP-M400**

Accessories

Adapters

Appearance	Type	Model
	R male 1/8	**OP-87281**
	R male 1/4	**OP-87282**
	R male 3/8	**OP-87280**
	G female 1/4	**OP-87283**
	NPT male 1/8	**OP-87284**
	NPT male 1/4	**OP-87285**
	Rc female 1/2	**OP-87286**

Do not use unauthorized adapters.

Display protection cover

Appearance	Material	Model
	Polysulfone	**OP-87289**

Throttles (Attach to the adapter before use)

Appearance	Material	Applicable adapter	Model
	SUS303	**OP-87280/OP-87281 OP-87282/OP-87284 OP-87285**	**OP-87311**
	SUS303	**OP-87283**	**OP-87312**

It is recommended to attach a throttle to the **GP-M100/M250/M400**.
For the other models, use it when excessive pulses or surge pressure is expected.

Cables: Please refer to the GP-M Series Brochure

AP-V80 Series

Key Features

> IP67 full stainless steel structure

> Up to 7,250 PSI range

> Up to 100°C (212°F) heat resistance

Sensor Heads

Appearance	Pressure port	Pressure type	-29.9 0 29.9 145.0 1,450 2,900 7,250	Model
Sensor head  Pressure port	NPT 1/8	Compound	-29.9 to +29.9 inchHg	**AP-10SK**
		Negative	-29.9 to 0 inchHg	**AP-11SK**
		Positive (Low)	0 to 14.5 PSI	**AP-12SK**
		Positive	0 to 145 PSI	**AP-13SK**
	NPT 1/4 (with a throttle)	Positive (High)	0 to 1,450 PSI	**AP-14SK**
			0 to 2,900 PSI	**AP-15SK**
			0 to 7,250 PSI	**AP-16SK**

Amplifiers

Type		Appearance	Model NPN	Model PNP
DIN	Standard	 Includes brackets for installation without DIN rail.	**AP-V80W**	**AP-V80WP**
	Differential pressure		**AP-V82W**	**AP-V82WP**
Panel	Standard		**AP-V85W**	**AP-V85WP**
	Differential pressure		**AP-V87W**	**AP-V87WP**

Accessories

Appearance	Designation	Model
	Panel mounting bracket kit for **AP-V85W(P)**	**OP-51476**
 OP-51605 AP-V85W	Panel spacer kit for **AP-V85W(P)**	**OP-51605**
	Head connectors (x2)	**OP-42367**

AP-C30 Series

Key Features

> Compact size

> Large display

> Various mounting options

AP-C40/V40 Series

Key Features

> Small heads

> Fast response time

> Pre-programmed modes for various applications

FL Series

Liquid Level Sensors

Key Features

> Completely trouble-free operation

> Sensing Guide-Pulse Technology

> Multiple output options

3 Different Models Designed for Varying Applications

		
Standard type FL-001	Sanitary type FL-S001	Plastic/Chemical type FL-C001
• Water/oil model • Applicable for liquids containing solid particulates • Applicable for viscous liquids	• Food/chemical industry model • Ready for CIP/SIP cleaning • Applicable for viscous liquids	• Chemical tank model • Applicable for corrosive liquids • Applicable for viscous liquids

Sensors

CONTROLLER (Required)	PROBE (Required)
Standard type FL-001 	FL-P20 (200 mm 0.66') FL-P40 (400 mm 1.31') FL-P60 (600 mm 1.97') FL-P80 (800 mm 2.62') FL-P100 (1000 mm 3.28') FL-P120 (1200 mm 3.94') FL-P140 (1400 mm 4.59') FL-P160 (1600 mm 5.25') FL-P180 (1800 mm 5.91') FL-P200 (2000 mm 6.56')
Sanitary type FL-S001 	FL-SP20 (200 mm 0.66') FL-SP40 (400 mm 1.31') FL-SP60 (600 mm 1.97') FL-SP80 (800 mm 2.62') FL-SP100 (1000 mm 3.28') FL-SP120 (1200 mm 3.94') FL-SP140 (1400 mm 4.59') FL-SP160 (1600 mm 5.25') FL-SP180 (1800 mm 5.91') FL-SP200 (2000 mm 6.56') 
Plastic/Chemical type FL-C001 	FL-CP20 (200 mm 0.66') FL-CP40 (400 mm 1.31') FL-CP60 (600 mm 1.97') FL-CP80 (800 mm 2.62') FL-CP100 (1000 mm 3.28') FL-CP120 (1200 mm 3.94') FL-CP140 (1400 mm 4.59') FL-CP160 (1600 mm 5.25') FL-CP180 (1800 mm 5.91') FL-CP200 (2000 mm 6.56') 

Cables

Appearance	Standard power supply cable	Model
Straight cable OP-87564 (2 m 6.6') OP-87565 (5 m 16.4') OP-87566 (10 m 32.8') 	The following are standard PVC cables.	**OP-87564** **OP-87565** **OP-87566**
L-shaped cable OP-87568 (2 m 6.6') OP-87569 (5 m 16.4') OP-87570 (10 m 32.8') 		**OP-87568** **OP-87569** **OP-87570**
Straight cables OP-87647 (2 m 6.6') OP-87648 (5 m 16.4') OP-87649 (10 m 32.8') 	The following are PVC cables with stainless steel (SUS316L) connectors. Use in situations where rust is a concern for the connectors.	**OP-87647** **OP-87648** **OP-87649**
L-shaped cables OP-87650 (2 m 6.6') OP-87651 (5 m 16.4') OP-87652 (10 m 32.8') 		**OP-87650** **OP-87651** **OP-87652**
Straight cables OP-87582 (2 m 6.6') OP-87583 (5 m 16.4') OP-87584 (10 m 32.8') 	The following are PUR cables with high resistance to oily environments.	**OP-87582** **OP-87583** **OP-87584**
L-shaped cables OP-87586 (2 m 6.6') OP-87587 (5 m 16.4') OP-87588 (10 m 32.8') 		**OP-87586** **OP-87587** **OP-87588**

Accessories: Please refer to the FL Series Brochure

FD-Q Series

Clamp-On Flow Sensors

Key Features

> No pipe modification necessary

> Detects a large variety of liquid types

> Adapts to all sorts of pipe materials

Flow Sensors

Appearance	Maximum rated flow range	Connection Bore Diameter	Model
	20 L/min 5.2 gal/min	1/4"(8 A)	**FD-Q10C**
	30 L/min 7.9 gal/min	3/8"(10 A)	
	60 L/min 15.9 gal/min	1/2"(15 A)	**FD-Q20C**
	100 L/min 26.4 gal/min	3/4"(20 A)	
	200 L/min 52.8 gal/min	1"(25 A)	**FD-Q32C**
	300 L/min 79.3 gal/min	1 1/4"(32 A)	
	400 L/min 105.7 gal/min	1 1/2"(40 A)	**FD-Q50C**
	500 L/min 132.1 gal/min	2"(50 A)	

Accessory

Appearance	Name	Material	Model
	Display Protection Cover	Polysulfone	**FD-QP1**

Cables *When using the sensor without the controller

Appearance	Material	Connector type	Cable termination	Length	Model
	PVC (Polyvinyl chloride)	M12 4 pins L-shape	Loose wire	2 m 6.6'	**OP-75722**
				10 m 32.8'	**OP-87274**
	PUR (Polyurethane) (Oil Resistant)	M12 4 pins L-shape	Loose wire	2 m 6.6'	**OP-87640**
				10 m 32.8'	**OP-87641**

Controller *When using the sensor with the controller

Appearance	Type	Control output	External input	Analog output	Model
	Main unit	2 outputs max.	1 input max.	1 output max.	**MU-N11**
	Expansion unit			—	**MU-N12**

* Power supply cable is not included.

Sensor-to-controller cable *When using the sensor with the controller

Appearance	Cable material	Sensor side	Controller side	Length	Model
	PVC (Polyvinyl chloride)	M12 4-pin L-shape	Connector	2 m 6.6'	**OP-88027**
				10 m 32.8'	**OP-88028***

* The 10 m 32.8' cable includes one spare connector for the controller side.

Power supply cable for controller *When using the sensor with the controller

Appearance	Applicable unit	Cable material	Controller side	Cable end	Length	Model
	Main unit	PVC (Polyvinyl chloride)	Connector	4-core loose wires	2 m 6.6'	**MU-CB4**
	Expansion unit			2-core loose wires	2 m 6.6'	**MU-CB2**
	Main unit			M12 4-pin straight	0.3 m 1.0'	**MU-CC4**

FD-R Series

Clamp-On Flow Meters

Key Features

> No pipe modification necessary

> Compatible with countless liquids and pipe materials

> Integrated temperature monitoring

Flow Meters

Supported pipe size (Outer diameter)	Appearance	Rated flow velocity range	Flow rate range (Typical)	Weight	Model
1 1/2" (40A) (ø44 to ø55)		0.3 m/s to 5 m/s	36 to 400 L/min 9 to 100 gal/min 2.4 to 24 m³/h	Approx. 2.5 kg	**FD-R50**
2" (50A) (ø55 to ø64)			36 to 600 L/min 9 to 150 gal/min 2.4 to 36 m³/h		
2 1/2" (65A) (ø64 to ø83)			90 to 1000 L/min 24 to 260 gal/min 5.4 to 60 m³/h	Approx. 3.0 kg	**FD-R80**
3" (80A) (ø83 to ø100)			90 to 1500 L/min 24 to 390 gal/min 5.4 to 90 m³/h		
4" (100A) (ø100 to ø127)			220 to 2500 L/min 60 to 660 gal/min 12 to 150 m³/h	Approx. 3.3 kg	**FD-R125**
5" (125A) (ø127 to ø152)			220 to 3700 L/min 60 to 990 gal/min 12 to 220 m³/h		
6" (150A) (ø152 to ø191)			570 to 5500 L/min 150 to 1400 gal/min 36 to 330 m³/h	Approx. 3.5 kg	**FD-R200**
8" (200A) (ø191 to ø220)			570 to 9500 L/min 150 to 2500 gal/min 36 to 570 m³/h		

*The minimum flow rates (zero cut flow rates) can be changed in the settings.

Cables

Specifications	Appearance	Length	Material	Weight	Model
Indoor use (standard)		2 m 78.74'	PVC Brass nickel plating	Approx. 55 g	**OP-75721**
		10 m 393.70'		Approx. 220 g	**OP-85502**
Indoor use (oil resistant)		2 m 78.74'	PUR Zinc nickel plating	Approx. 75 g	**OP-87636**
		10 m 393.70'		Approx. 260 g	**OP-87637**
Outdoor use		10 m 393.70'	PUR SUS316L	Approx. 310 g	**OP-88196**

Cable gland *When supplying AC power to the unit

Appearance	Material	Compatible cable outer diameter	Number of pieces	Weight	Model
	PA/FKM/EPDM	ø7 to ø12	2 Pieces	Approx. 20 g 2 pieces	**OP-88199**

Accessories

Description	Appearance	Usage	Weight	Model
Protection cover		Prevent damage to the main unit or unintended settings changes Material : SUS304, Polycarbonate	Approx. 285 g	**FD-RP1**
Modular cable		Send recorded data stored in FD-R to a computer	Approx. 72 g	**OP-26487**
RS-232C conversion adapter [9-pin]			Approx. 25 g	**OP-26401**

Clamp-On Micro Flow Sensors

FD-X Series

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Please read the instruction manual carefully in order to safely operate any KEYENCE product.

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KEYENCE CORPORATION OF AMERICA

Head Office 500 Park Boulevard, Suite 200, Itasca, IL 60143, U.S.A. **PHONE:** +1-201-930-0100 **FAX:** +1-855-539-0123 **E-mail:** keyence@keyence.com

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KEYENCE CANADA INC.

Head Office **PHONE:** +1-905-366-7655 **FAX:** +1-905-366-1122 **E-mail:** keyencecanada@keyence.com
Montreal **PHONE:** +1-514-694-4740 **FAX:** +1-514-694-3206 **Windsor** **PHONE:** +1-905-366-7655 **FAX:** +1-905-366-1122

KEYENCE MEXICO S.A. DE C.V.

PHONE: +52-55-8850-0100 **FAX:** +52-81-8220-9097
E-mail: keyencemexico@keyence.com

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