

# High-Precision Fuel Flow Meters

**FP/FX/FZ Series Detectors**

**FM Series Display Units**



**FP Series:** For flow rate measurement in bench tests and actual running tests.

**FX Series:** For high-accuracy performance tests of flow rates starting from near-zero.

**FZ Series:** For continuous measurement of mode fuel consumption, etc.

We supply a wide range of high-precision flow meters for advanced automobile development and testing. Select the flow meter that best meets your test purpose needs.

**ONO SOKKI**

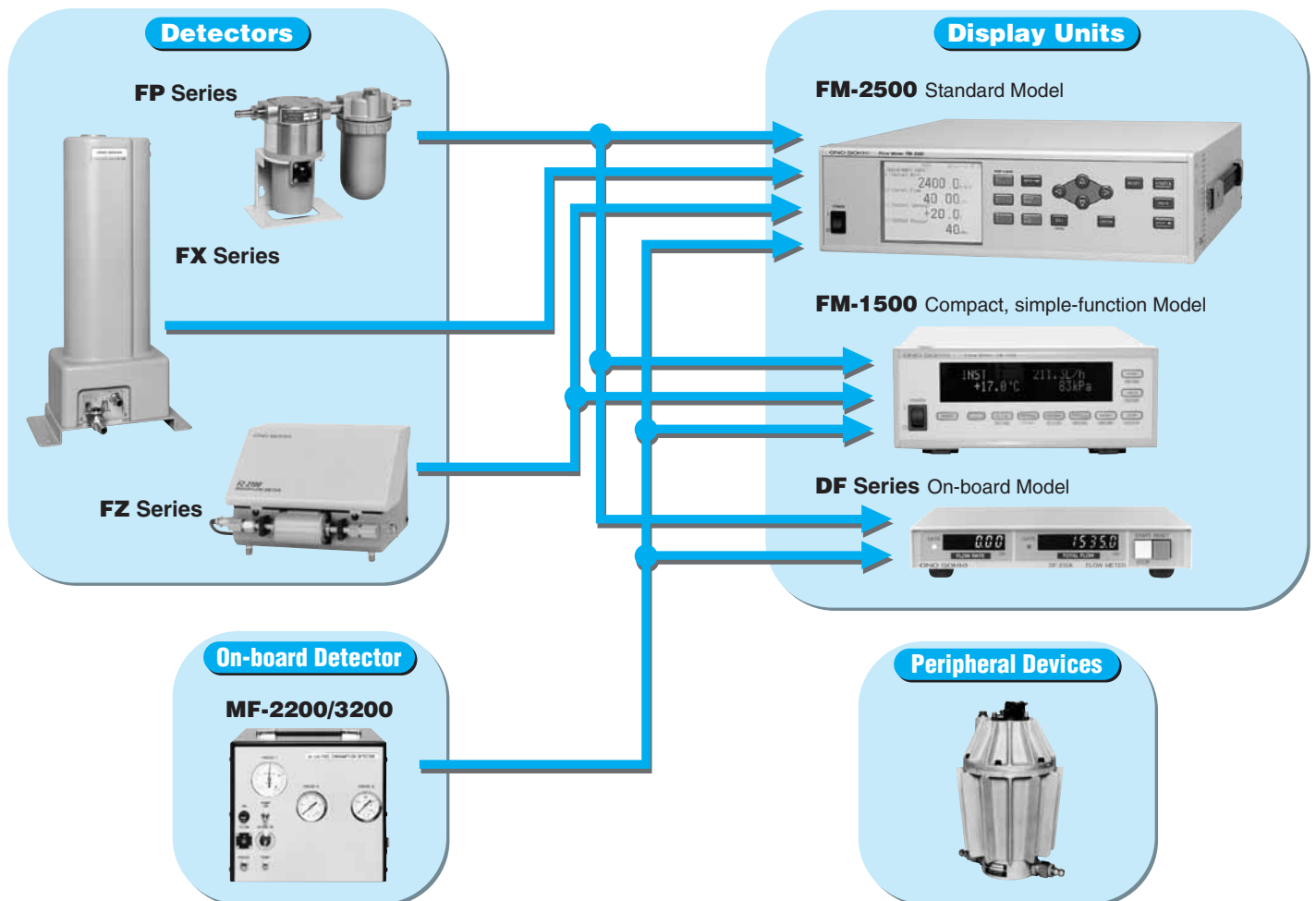
# High-Precision Fuel Flow Meter Series that Support Automobile Energy Conservation Countermeasures

The global warming phenomenon is one of several global environmental conservation problems that need to be tackled, and the further reduction of fuel consumption is one of the important issues currently being addressed. At Ono Sokki, we have been manufacturing automobile-related measuring and control instruments for over half a century. With regard to the measurement of fuel consumption, which is an important factor in automobile measurement applications, we have endeavored to develop and manufacture various types of measuring instruments that meet the needs of our customers, and to further increase measurement accuracy. There are three series of flow detectors, the FP, FX, and FZ Series, and we also provide the FM Series display units to enable you to select the optimum combination for your test purpose needs.

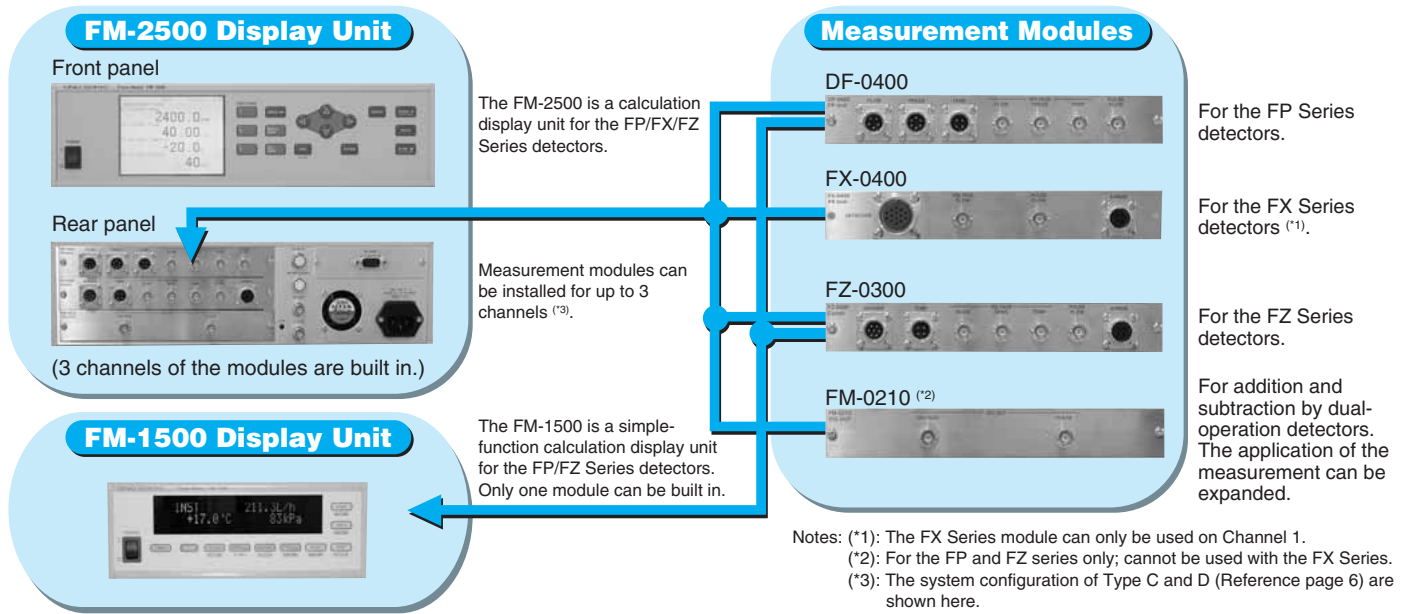
## Features

- |                            |  |
|----------------------------|--|
| <b>FP Series Detectors</b> | <ul style="list-style-type: none"> <li>● Volumetric flow measurement</li> <li>● Capable of continuous long-term flow rate measurement</li> <li>● Can also be mounted in an automobile for measurement applications</li> </ul>  |
| <b>FX Series Detectors</b> | <ul style="list-style-type: none"> <li>● Gravity flow measurement</li> <li>● Capable of performing measurement from zero flow (ultra-wide range)</li> <li>● Can perform continuous measurement up to a maximum of 1000 g (FX-1130)</li> <li>● Simple configuration with minimal pressure loss</li> </ul> |
| <b>FZ Series Detectors</b> | <ul style="list-style-type: none"> <li>● Mass flow measurement</li> <li>● Capable of long-term continuous measurement without being affected by temperature or pressure</li> <li>● Density measurement enabled</li> </ul>  |

## Configuration Diagram



## FM-2500/1500 Display Units

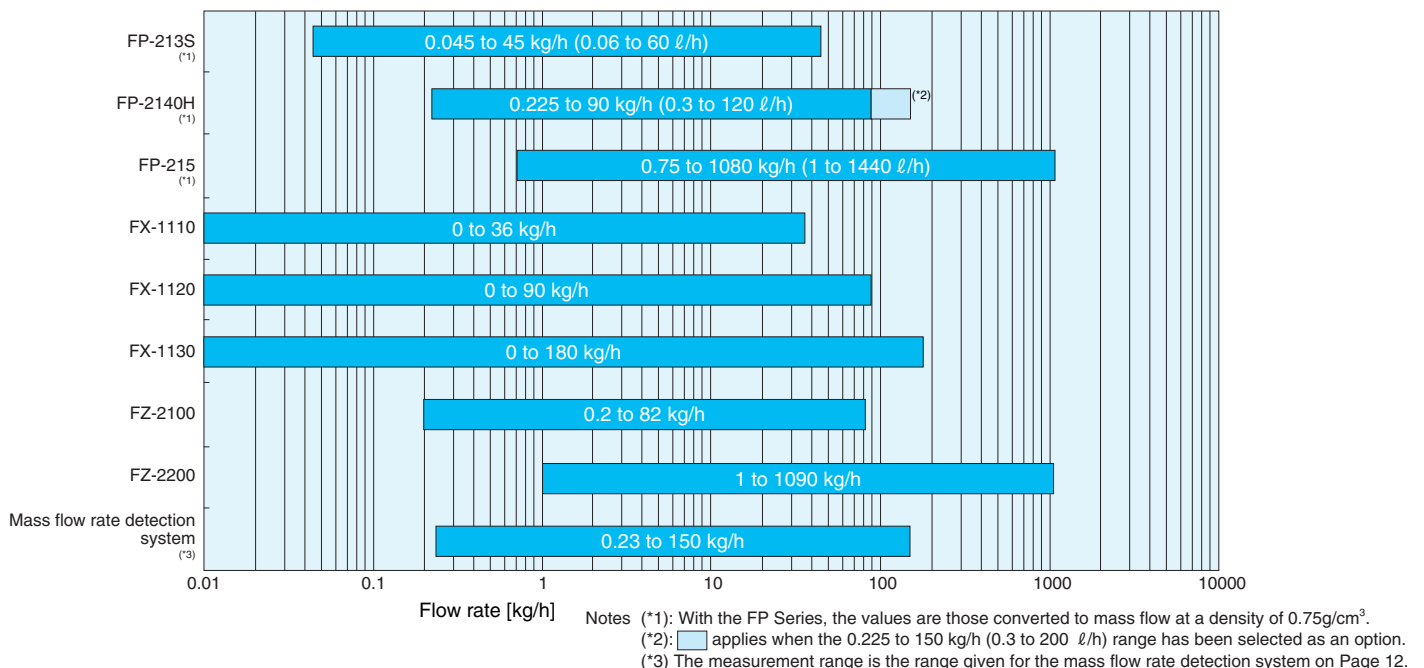


## Combination of Detectors and Measurement Modules for FM-1500/2500

System configuration		Detectors			Measurement modules				Display units	
Type	Reference page no.	FP Series	FX Series	FZ Series	DF-0400	FX-0400	FZ-0300	FM-0210	FM-2500	FM-1500
<b>A</b>	P. 6	Yes			Yes				Yes	
<b>B</b>	P. 6	Yes			Yes					Yes
<b>C, D</b>	P. 6	Yes*			Yes*			Yes	Yes	
<b>A</b>	P. 9		Yes			Yes			Yes	
<b>A</b>	P. 11			Yes			Yes		Yes	
<b>B</b>	P. 11			Yes			Yes			Yes
<b>C, D</b>	P. 11			Yes*			Yes*	Yes	Yes	
<b>E</b>	P. 12	Yes		Yes	Yes		Yes		Yes	

Note: "Yes\*" indicates that two sets of the same detector and measurement module are required for dual operation.

## FP/FX/FZ Series Detectors Measurement Range Comparison Chart





The piston method is used for volumetric flow rate detection, and there are three measurement flow ranges: 0.06 to 60 l/h, 0.3 to 120 l/h, and 1 to 1440 l/h depending on the model.

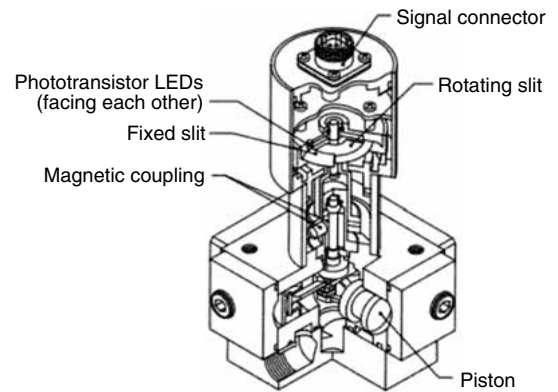
The flow rate ratio of 1:400 or more enables a wide measurement range. If the application is measurement of engine fuel consumption, measurement can be performed for minute quantities such as during idling, through to the large quantities generated under high-speed, high-load engine conditions.

The detector is compact and lightweight, and, as it can be easily mounted in a vehicle, it is ideal not only for test bench fuel consumption measurement, but also for the measurement of fuel consumption during actual running tests.

### ■ Features

- Wide measurement range thanks to a flow rate ratio of 1:400 or more
- Capable of compensating for errors caused by pulsating or backflow by means of a function for detecting the direction of rotation
- High reproducibility and high-speed response result in superb reliability
- Capable of simultaneous measurement of temperature and pressure during flow rate measurement (FP-2240HA/2250A)

### ■ The Detection Principle



Four pistons are arranged radially in the flow detection unit, and move back and forth repeatedly according to the flow of fluid from the inlet to the outlet. The pistons are rotated by the crankshaft, and their movement is transmitted to the magnetic-coupled rotation detection unit. The rotary encoder mounted on the rotation detection unit generates pulse signals in accordance with the amount of piston movement.

### ■ Detector Specifications







Item	Model Name	FP-213S	FP-213	FP-2140H	FP-2240HA	FP-215	FP-2250A
Measurement parameters	Flow rate	Yes	Yes	Yes	Yes	Yes	Yes
	Temperature	–	–	–	Yes	–	Yes
	Pressure	–	–	–	Yes	–	Yes
Applicable fluids	Gasoline	Yes	Yes	Yes	Yes	Yes	Yes
	Light oil	Yes	Yes	Yes	Yes	Yes	Yes
	Kerosene	Yes	Yes	Yes	Yes	Yes	Yes
	Standard petroleum oils	–	Yes	Yes	Yes	Yes	Yes
	Alcohol products	–	Option	Option	Option	Option	Option
Measurement range	Flow rate	0.06 to 60 l/h (1 to 1000 ml/min, 0.02 to 16.7 ml/s)		0.3 to 120 l/h <sup>(1)</sup> (5 to 2000 ml/min, 0.8 to 33.3 ml/s)		1 to 1440 l/h (20 to 24000 ml/min, 0.3 to 400 ml/s)	
	Temperature	–	–	–	0 to +99.9 °C	–	0 to +99.9 °C
	Pressure	–	–	–	0 to 980 kPa	–	0 to 980 kPa
Accuracy	Flow rate	Within $\pm 0.5\%$ of reading (over the entire 0.06 to 60 l/h range)	Within $\pm 0.0009$ l/h (from 0.06 to 0.18 l/h) Within $\pm 0.5\%$ of reading (from 0.18 to 60 l/h)	Within $\pm 0.2\%$ of reading (over the entire 0.3 to 120 l/h range)		Within $\pm 0.018$ l/h (from 1 to 3.6 l/h) Within $\pm 0.5\%$ of reading (from 3.6 to 1440 l/h)	
	Temperature	–	–	–	Class B	–	Class B
	Pressure	–	–	–	$\pm 0.5\%$ of F.S.	–	$\pm 0.5\%$ of F.S.
Pressure loss	0.01 kPa max. (excluding filter pressure loss)	8 kPa max. <sup>(3)</sup> (at 40 l/h, for gasoline)	2 kPa max. <sup>(3)</sup> (at 60 l/h, for gasoline)		7.5 kPa max. <sup>(3)</sup> (at 500 l/h, for light oil)		
Minimum resolution	0.01 ml			0.1 ml		1 ml	
Maximum pressure	980 kPa	980 kPa <sup>(2)</sup>				3.4 MPa <sup>(2)</sup>	980 kPa <sup>(2)</sup>
Operating temperature range	0 to +60 °C			0 to +65 °C <sup>(2)</sup>			
Filter	EH-106 provided as standard			EH-1050 provided as standard		Provided as standard	
Weight	Approx. 2.5 kg (including filter)	Approx. 2 kg (including filter)	Approx. 5 kg (including filter)	Approx. 6 kg (including filter)	Approx. 14 kg (including separately-attached filter)		
External dimensions	See (1) on Page 14	See (2) on Page 14	See (3) on Page 14	See (4) on Page 14	See (5) on Page 14	See (6) on Page 14	

(1): 0.3 to 200 ml/h flow rate measurement range can also be provided.

(2): Please consult us if you require specifications other than those given above.

(3): If the inlet pressure is lower than the pressure loss and if the outlet is open to the atmosphere, the instantaneous flow rate may be uneven.

## FP Series Flow Detectors

<p><b>FP-213S</b></p> 	<p><b>Small flow rate, low pressure loss type</b></p> <ul style="list-style-type: none"> <li>• Measurement range: 0.06 to 60 ℓ/h</li> <li>• Accuracy of within ±0.5% of reading</li> <li>• Measuring range: 1/1000</li> <li>• Low power loss (max. 10 Pa), ideal for measuring the amount of fuel consumption of motorcycles and heating equipment</li> </ul>	<p><b>FP-213</b></p> 	<p><b>Small flow rate type</b></p> <ul style="list-style-type: none"> <li>• Measurement range: 0.06 to 60 ℓ/h</li> <li>• Accuracy within ±0.5% of reading</li> <li>• Measuring range: 1/1000</li> </ul>
<p><b>FP-2140H</b></p> 	<p><b>Standard flow rate type</b></p> <ul style="list-style-type: none"> <li>• Measurement range: 0.3 to 120 ℓ/h</li> <li>• Accuracy within ±0.2% of reading</li> <li>• Measuring range: 1/400</li> </ul>	<p><b>FP-2240HA</b></p> 	<p><b>Simultaneous measurement of standard flow rate, temperature and pressure type</b></p> <ul style="list-style-type: none"> <li>• Measurement range: 0.3 to 120 ℓ/h</li> <li>• Accuracy within ±0.2% of reading</li> <li>• Measuring range: 1/400</li> <li>• Simultaneous measurement of temperature and pressure</li> </ul>
<p><b>FP-215</b></p> 	<p><b>Large flow rate type</b></p> <ul style="list-style-type: none"> <li>• Measurement range: 1 to 1440 ℓ/h</li> <li>• Accuracy within ±0.5% of reading</li> <li>• Measuring range: 1/1440</li> <li>• Ideal for measuring the flow rate of engines used in buses, trucks, and other large vehicles, as well as maritime engines</li> </ul>	<p><b>FP-2250A</b></p> 	<p><b>Simultaneous measurement of standard flow rate, temperature and pressure type</b></p> <ul style="list-style-type: none"> <li>• Measurement range: 1 to 1440 ℓ/h</li> <li>• Accuracy within ±0.5% of reading</li> <li>• Measuring range: 1/1440</li> <li>• Simultaneous measurement of temperature and pressure</li> <li>• Ideal for measuring the flow rate of engines used in buses, trucks, and other large vehicles, as well as maritime engines</li> </ul>

## MF Series On-Board Flow Detectors (Incorporating the FP-2140H)

MF-Series fuel flow detectors are one unit type with small and light weight for on board measurement. FP-2140H detector and fuel pump/heat exchanger/relief valve/pressure reducing valve etc. are assembled internally for matching the actual running condition such as fuel return processing function etc. They are compatible with DF-210A/211A or FM-series.

**MF-2200:** For gasoline engines; measures the flow rate of in-tank type electronic fuel spray system engines.

**MF-3200:** For diesel engines.

- Accuracy within ±0.2% (reading)
- Compact size and light weight enabled by the use of component blocks
- A fuel cooling function is provided as standard.
- Simultaneous measurement of temperature and pressure together with the flow rate



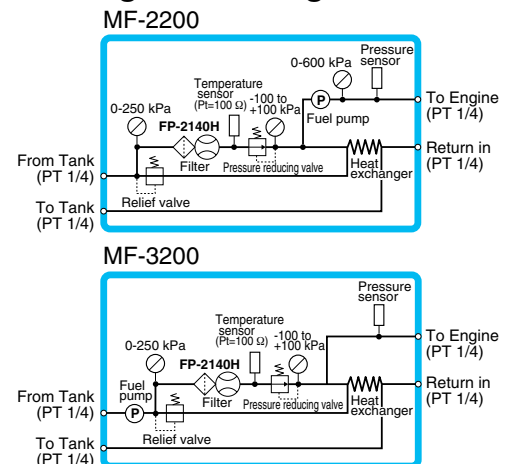
MF-2200

MF-3200

### Specifications

Item	Model Name	MF-2200	MF-3200
Measurement parameters		Flow rate, temperature, pressure	
Flow detector used		FP-2140H	
Applicable fluids		Gasoline	Light oil
Measurement range	Flow rate	0.3 to 120 ℓ/h	
	Pressure	0 to 980 kPa	
	Temperature	0 to 99.9°C	
Measurement accuracy	Flow rate	Within ±0.2% of reading	
	Pressure	±0.5% of F.S.	
	Temperature	Class B	
Return processing		Pressure control system (using a precision pressure reducing valve)	
Operating temperature range		0 to 65°C (both the temperature of the fluid and the ambient temperature)	
Weight		Approx. 15 kg	
External dimensions		260 (W) x 243 (H) x 243 (D)mm	

### Configuration Diagrams

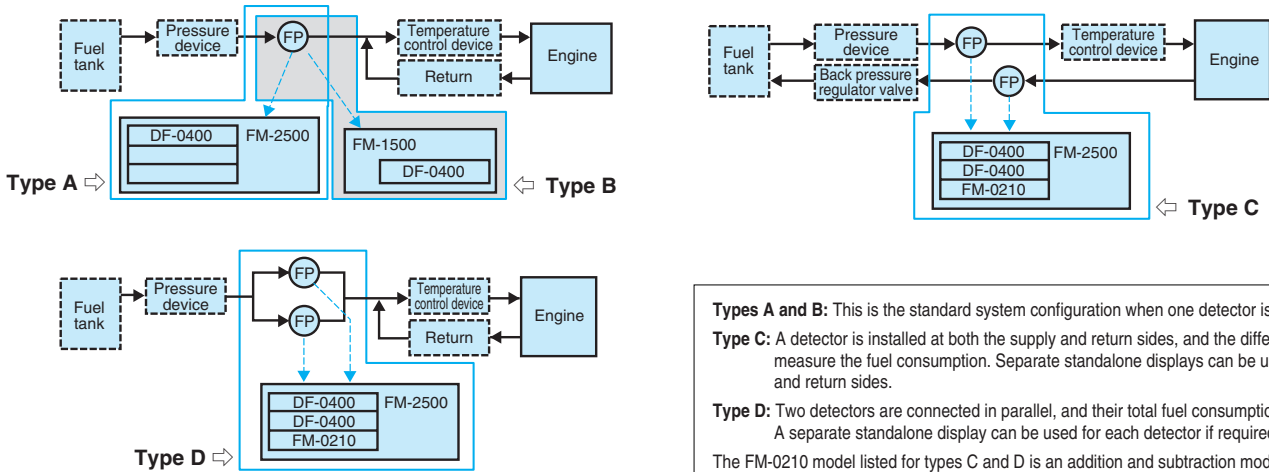


# FM-2500/1500 Display Unit Specifications<sup>(\*)</sup> (when DF-0400 is built in FM-1500/2500)

Item	Model Name	FM-2500	FM-1500				
Compatible flow detectors		FP-213S, FP-213, FP-2140H, FP-2240HA, FP-215, FP-2250A					
Compatible revolution detectors		MP-910, MP-981, LG-916	-				
Displaying device		LCD with CFL backlight, 320 x 240 dots	Fluorescent display tube (20 characters x 2 lines), 5 x 8 dot text format				
Displayed items and number of digits	Time measurement	Elapsed interval time	7 digits 00000.00 s				
		Total elapsed time	7 digits 00000.00 s				
	Revolution measurement	Number of revolutions	7 digits 000000.0 r/min	-			
		Average number of revolutions per interval	7 digits 000000.0 r/min (= number of revolutions for the elapsed interval time / interval time)	-			
		Number of revolutions for the elapsed interval time	7 digits 0000000 REV.	-			
		Average number of revolutions over the total elapsed time	7 digits 000000.0 r/min (= number of revolutions for the total elapsed time / total interval time)	-			
		Number of revolutions for the total elapsed time	7 digits 0000000 REV.	-			
	Pressure measurement	Pressure	4 digits 0000 kPa	-			
	Temperature measurement	Temperature	4 digits ±000.0°C	-			
	Flow rate measurement <sup>(*)</sup> <sup>(**)</sup> <sup>(***)</sup>	Applicable detectors	FP-213S/213	FP-2140H/2240HA	FP-215/2250A	-	
			(g/s, ml/s)	0000.000	00000.00	000000.0	-
		Instantaneous flow rate	(g/min, ml/min)	000000.0	0000000	0000000	-
			(kg/h, l/h)	0000.000	00000.00	000000.0	←←←
		Elapsed period flow	(g, ml)	0000.000	00000.00	000000.0	←←←
			(kg, l)	0.000000	00.00000	000.0000	-
		Total elapsed flow	(g, ml)	0000.000	00000.00	000000.0	←←←
			(kg, l)	0.000000	00.00000	000.0000	-
Average flow rate per period		Same as for instantaneous flow rate (elapsed interval flow rate / interval time)				←←←	
Average flow rate over the total elapsed time		Same as for instantaneous flow rate (total elapsed time flow rate / total elapsed time)				-	
Amount of spray		(mg/st, mm <sup>3</sup> /st)	00000.00	00000.00	000000.0	-	
Average amount of spray per period		(mg/st, mm <sup>3</sup> /st)	00000.00	00000.00	000000.0	-	
Average amount of spray over the total elapsed time	(mg/st, mm <sup>3</sup> /st)	00000.00	00000.00	000000.0	-		
Measurement time	Instantaneous	Specifiable within the range of 1 to 10 seconds (in 1-second increments)		1-second			
	Elapsed	Up to the measured start time to stop time, depending on the elapsed time measurement mode					
Elapsed time measurement mode	Manual	Elapsed time up to the start time to stop time specified at the panel or by an external start to stop signal					
	Flow rate setting method	Elapsed time/accumulated revolutions from the start signal up to the specified cumulative flow rate	Elapsed time from the start signal up to the specified cumulative flow rate				
	Time setting method	Cumulative flow rate/accumulated revolutions from the start signal up to the specified elapsed time	Cumulative flow rate from the start signal up to the specified elapsed time				
	Revolutions setting method	Cumulative flow rate/elapsed time from the start signal up to the specified accumulated revolutions	-				
Voltage output	Output specifications <sup>(*)</sup>	Flow rate	0 to 10 V/Low to High (the Low and High values are variable)	0 to 10V/0 to F.S. (the F.S. value can be selected from the following) 100/200/300/500/1000/1500 (kg/h, l/h)			
		Pressure	Same as above	0 to 10V/0 to F.S. (the F.S. value can be selected from the following) 200/500/980/1000 (kPa)			
		Temperature	Same as above	0 to 10V/0 to 100°C			
Pulse output	Pulse output <sup>(*)</sup>	Selectable from A:Direct, B:0.001, C:0.01, D:0.1, E:1 (ml/P or g/P), but varies according to the sensor.					
	Output specifications	Frequency range:0 to 100 kHz, Output H level: at least 2.4 V, L level:max. 0.8 V					
External dimensions		See (13) on Page 15	See (14) on Page 15				

(\*)1: In the above table, " - " indicates that these specifications are not included in the FM-1500 model.  
 (\*)2: The mass flow rate is converted at the density set in advance. (Three points are set for the FM-2500, and one point for the FM-1500).  
 (\*)3: The position of the decimal point is "120 P/R x multiplier 10". If FP-213S/213, FP-2140H/2240HA, or FP-215/2250A was selected, the decimal point moves to the right when the digit is incremented.  
 (\*)4: For both the FM-2500 and the FM-1500, the voltage output update interval is 0.1 s, and the accuracy is ±0.1%/F.S.  
 (\*)5: FP-213S/213: A, B and C; FP-2140H/2240HA: A, C and D; FP-215/2250A: A, D and E.

## Equipment Configuration Examples



# DF Series On-Board Flow Meters

## DF-200 Series On-Board Flow Meters

The DF series are compact, lightweight, thin profile vehicle-mounted flow meters for use with the FP Series detectors and the MF Series detectors.

The DF-210A measures instantaneous flow rates and cumulative flow rates.

The DF-211A is an extension unit for the DF-210A and measures elapsed time, temperature, and pressure.

### Options

#### DF-021 Battery Box

The DF-021 is a portable battery box that uses dry batteries.

Batteries used: SUM2D (Type C), 8 batteries

Battery life (when alkaline manganese batteries are used):

Approx. 8 hours when the DF-210A is used on its own

Approx. 4 hours when the DF-210A and DF-211A are used at the same time

Weight: Approx. 1.2 kg (including the batteries)

#### DF-022 Remote Box

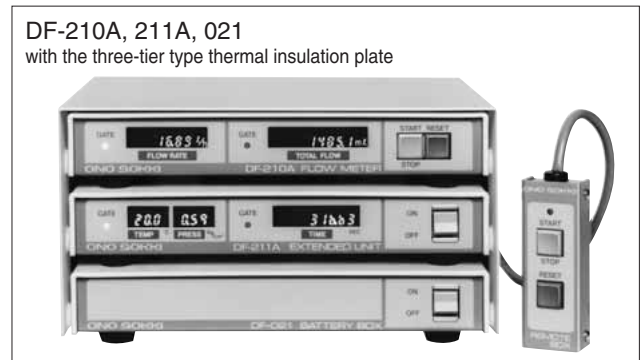
The DF-022 provides remote START, STOP, and RESET switching for cumulative measurement.

#### DF-024/025 Protective Heat-Resistant Mounting Units

These heat-resistant units prevent exposure to heat generated by the sun when the DF-210A and DF-211A are mounted on a vehicle dashboard.

**DF-024:** Two-tier type (DF-210A + 211A, DF-210A + 021)

**DF-025:** Three-tier type (DF-210A + 211A + 021)



## Specifications

Item	Model Name	DF-210A	DF-211A <sup>(*)</sup>
Applicable flow detectors		MF-2200, MF-3200, FP-213S, FP-213, FP-2140H, FP-2240HA, FP-215, FP-2250A	
Displaying device		Green LEDs	
Measurement parameters and number of digits	Instantaneous flow rate <sup>(2)</sup>	5 digits 000.00 l/h	—
	Cumulative flow rate <sup>(2)</sup>	7 digits 000000.0 ml	—
	Elapsed time	—	7 digits 00000.00s
	Temperature	—	3 digits 00.0°C
	Pressure	—	3 digits 000 kPa
Voltage output	Instantaneous flow rate <sup>(3)</sup>	0 to 10V/0 to 100 l/h 0 to 10V/0 to 1000 l/h Linearity: ±0.5% of F.S.	—
	Temperature	—	0 to 10 V/0 to 100 °C Linearity: ±0.5% of F.S.
	Pressure	—	0 to 10 V/0 to 980 kPa Linearity: ±0.5% of F.S.
Pulse output	Flow rate <sup>(2)</sup>	0.01 ml/pulse or 0.1 ml/pulse TTL level, duty approx. 1:1	—
Measurement time	Instantaneous flow rate	1 second, automatically repeated	—
	Cumulative flow rate	From start to stop	—
	Elapsed time	—	From start to stop
Data memory function <sup>(4)</sup>		Provided	—
Power requirements		11 to 15 VDC, approx. 4 VA	
Operating temperature range		0 to +50 °C	
Weight		Approx. 1 kg	
Accessories provided		DC power cable (3.5 m length): 1	Cable to connect DF-210A and DF-211A DC power cable (15 m length), for remote use (15 cm)
External dimensions		See (7) on Page 14	

(\*) DF-211A is required when the detector is MF-2200/3200 or FP-2240HA/2250A.

(2): The position of the decimal point for the "Instantaneous flow rate" and "Cumulative flow rate" measurement parameters and the pulse output are applicable when the MF-2200/3200/FP-2140H/2240HA detectors are used. When the FP-213S/213 is used, the value must be multiplied by 0.1. When the FP-215/2250A is used, the value must be multiplied by 10.

(3): For analog output, the specification is 0 to 10V/0 to 100 l/h when the MF-2200/3200/FP-213S/213/2140H/2240HA is used, and 0 to 10V/0 to 1000 l/h when the FP-215/2250A is used.

(4): When the power is off, cumulative flow rate values can be stored in the memory backup battery.

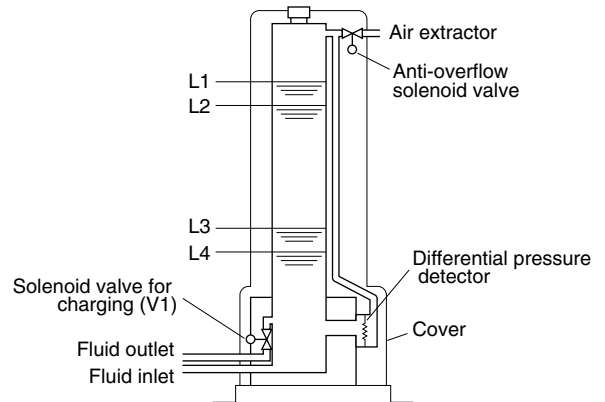
**High accuracy: Within  $\pm 0.2\%$  of the reading  $\pm 0.01\%$  of F.S. (FX-1100 Series)**  
**This high-precision flow detector is ideal for engine performance tests.**

The FX-Series flow detectors are capable of measuring the instantaneous flow and cumulative flow directly from gravity of the fuel. The high accurate differential pressure detector at the bottom of FX-series detects the changes of the pressure which comes from the fuel consumption. No need to consider the density variations caused by temperature. Therefore, measurement can be performed from near-zero flow rates and these flow meters are ideal of engine performance test.

### Features

- High-accuracy flow rate measurement over a wide range
- Built-in air extractor function to counteract the mixing in of air bubbles
- Alarm function to warn of overflows and low fluid levels
- Density corrections due to changes in the temperature are no longer required.
- Increased pressure and pressure feed are available as options.

### The Detection Principle



If the fluid level falls below L3, the pressure signal generated by the detector causes the solenoid valve V1 to open and more fluid to flow in. When the fluid level reaches L2, valve V1 closes. Measurement of the flow rate starts after the specified time for the surface of the fluid to reach the fixed level has elapsed. As the fluid level falls from L2 as it is being consumed, the output from the differential pressure transducer changes in accordance with the gravity of the consumed fluid, and the gravity flow rate is obtained from this changed amount.

Alarms are generated if the fluid reaches the L1 overflow level or falls to the L4 insufficient fluid level.

### Detector Specifications

Item	Model Name	FX-1110	FX-1120	FX-1130
Applicable fluids	Gasoline		Yes	
	Light oil		Yes	
	Kerosene		Yes	
	Alcohol products		Option	
Measurement range		0 to 10 g/s (0 to 36 kg/h)	0 to 25 g/s (0 to 90 kg/h)	0 to 50 g/s (0 to 180 kg/h)
Accuracy <sup>(*)</sup>		$\pm 0.2\%$ of reading, $\pm 0.01\%$ of full scale		
Instantaneous flow rate resolution		0.001 g/s	0.01 g/s	
Cumulative flow rate resolution		0.01 g		0.1 g
Max. cumulative quantity (single fill operation)		200 g	500 g	1000 g
Max. pressure		196 kPa		
Operating temperature range <sup>(*)</sup>		0 to +40 °C (non-condensing)		
Open-atmosphere processing		Solenoid valve for overflow protection		
Inlet, outlet, and return joints		R3/8	R1/2	
		Internal diameter: $\phi 6$ External diameter: $\phi 9$ Ribbed joint (for both IN and OUT)	Internal diameter: $\phi 12$ External diameter: $\phi 16$ Ribbed joint (for both IN and OUT)	
Weight		Approx. 13 kg		
External dimensions		See (8) on Page 14		

(\*)1 If the temperature changes rapidly during measurement, the above accuracy cannot be guaranteed.

(\*)2 Vapor may be produced in this temperature range, and may prevent normal measurement.





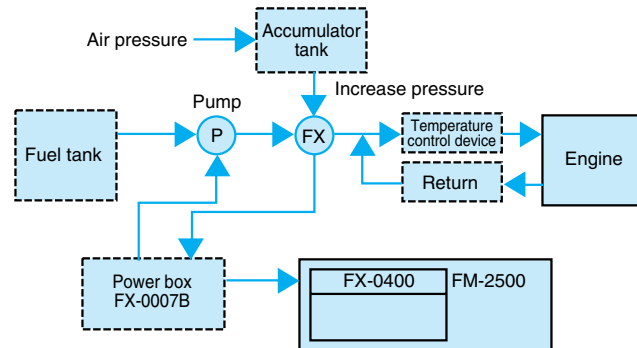
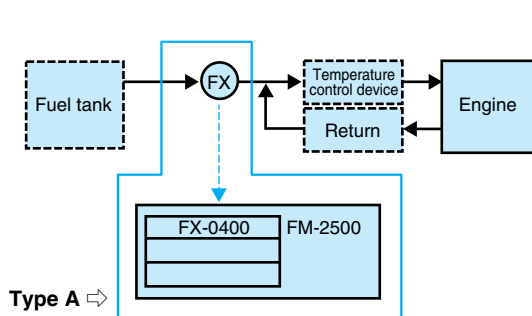
## FM-2500 Display Unit Specifications (when FX-0400 is built in FM-2500)

Item	Model Name	Specifications			
Compatible flow detectors		FX-1110, FX-1120, FX-1130			
Compatible revolution detectors		MP-910, MP-981, LG-916			
Displaying device		LCD with CFL backlight, 320 x 240 dots			
Displayed items and number of digits	Time measurement	Elapsed interval time	7 digits 00000.00 s		
		Total elapsed time	7 digits 00000.00 s		
	Number of revolutions measurement	Number of revolutions	7 digits 00000.0 r/min		
		Average number of revolutions per interval	7 digits 00000.0 r/min (= number of revolutions for the elapsed interval time /interval time)		
		Number of revolutions for the elapsed interval time	7 digits 0000000 REV.		
		Average number of revolutions over the total elapsed time	7 digits 00000.00 r/min (= number of revolutions for the total elapsed time/total interval time)		
	Flow rate measurement <sup>(*)</sup>	Applicable detectors	FX-1110	FX-1120	FX-1130
		Instantaneous flow rate	7 digits 0000.000 (g/s, ml/s)	00000.00 (g/s, ml/s)	00000.00 (g/s, ml/s)
			7 digits 000000.0 (g/min, ml/min)	0000000 (g/min, ml/min)	0000000 (g/min, ml/min)
		Elapsed period flow	7 digits 00000.00 (kg/h, l/h)	000000.0 (kg/h, l/h)	000000.0 (kg/h, l/h)
			7 digits 00.00000 (g, ml)	00.00000 (g, ml)	00.00000 (g, ml)
		Total elapsed flow	7 digits 00.00000 (kg, l)	00.00000 (kg, l)	00.00000 (kg, l)
			7 digits 00000.00 (g, ml)	00000.00 (g, ml)	000000.0 (g, ml)
		Average flow rate per period	7 digits 00.00000 (kg, l)	00.00000 (kg, l)	00.00000 (kg, l)
			7 digits 00.00000 (g, ml)	00.00000 (g, ml)	00.00000 (g, ml)
Average flow rate over the total elapsed time		Same as for instantaneous flow rate (total elapsed time flow rate/total elapsed time)			
Amount of spray	7 digits 00000.00 (mg/st, mm <sup>3</sup> /st)	000000.0 (mg/st, mm <sup>3</sup> /st)	000000.0 (mg/st, mm <sup>3</sup> /st)		
Average amount of spray per period	7 digits 00000.00 (mg/st, mm <sup>3</sup> /st)	000000.0 (mg/st, mm <sup>3</sup> /st)	000000.0 (mg/st, mm <sup>3</sup> /st)		
Average amount of spray over the total elapsed time	7 digits 00000.00 (mg/st, mm <sup>3</sup> /st)	000000.0 (mg/st, mm <sup>3</sup> /st)	000000.0 (mg/st, mm <sup>3</sup> /st)		
Measurement time	Instantaneous	Specifiable within the range of 1 to 10 seconds (in 1-second increments)			
	Elapsed	Up to the measured start time to stop time, depending on the elapsed time measurement mode			
Elapsed time measurement mode	Manual	Elapsed time up to the start time to stop time specified at the panel or by an external start to stop signal			
	Flow rate setting method	Elapsed time/accumulated revolutions from the start signal up to the specified cumulative flow rate			
	Time setting method	Cumulative flow rate/accumulated revolutions from the start signal up to the specified elapsed time			
	Revolutions setting method	Cumulative flow rate/elapsed time from the start signal up to the specified accumulated revolutions			
Alarm output		Overflow (L1 level): Monitor display and external contact output Low fluid (L4 level): Monitor display and external contact output			
Fluid fill operation control	Setting range for the time for the fluid surface to reach the fixed level	2 to 99 s			
	Setting range for the fluid level	0 to 95%			
Voltage output	Flow rate	0 to 10 V/Low to High (the Low and High values are variable). Output of the immediately prior value during charging			
	Output specifications	Output update interval: 0.1 s, Accuracy: 0.1% of F.S.			
Pulse output	Pulse output <sup>(*)</sup>	Selectable from A: 0.001, B: 0.01, C: 0.1, D: 1 (ml/P or g/P), but varies according to the sensor. (No output during charging)			
	Output specifications	Frequency range: 0 to 100 kHz, Output H level: at least 2.4 V, L level: max. 0.8 V			
External dimensions		See (13) on Page 15			

(\*)1: The mass flow rate is converted at the density set in advance.

(\*)2: FX-1110: A and B; FX-1120: B and C; FX-1130: C and D.

## Equipment Configuration Examples



This is the standard system configuration when one detector is used.

### Increased pressure type:

An accumulator tank is used to enable an increase in pressure. Use this method when fuel cannot be supplied due to reasons such as not being able to install the detector in a high position. (The FX-0007B power box is an option.)

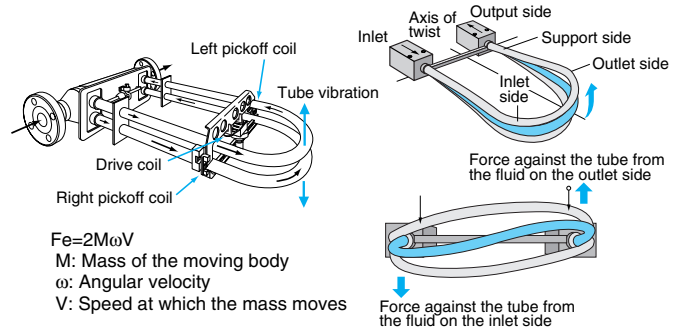
**Measurement accuracy: Within  $\pm 0.1\%$  of the reading value**  
**High response, high-precision detectors for the continuous measurement of mode tests, etc.**

The FZ Series flow detectors use the principle of the Coriolis force which is generated when the movement of a mass and rotation occur simultaneously. They are capable of high-accuracy, continuous measurement of mass flow, and are ideal for applications such as measuring the amount of fuel consumption in mode tests, and fuel consumption behavior when the speed is accelerated or decelerated.

### ■ Features

- Continuous measurement without being affected by temperature, pressure, or density
- High measurement accuracy (up to a ratio of 40:1 within  $\pm 0.1\%$  of the reading accuracy)
- Density measurement enabled
- The case provided with each detector is capable of purging internal air.

### ■ The Detection Principle



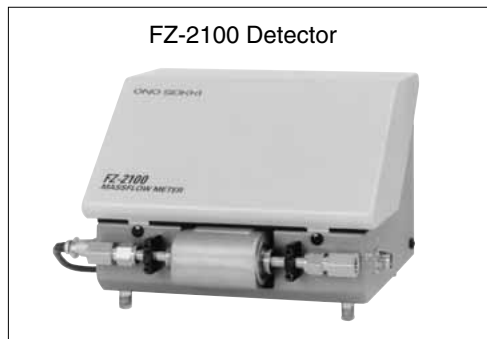
The fluid that entered from the inlet passes through the tube and goes out through the outlet. With this flow meter, the application of its inherent vibration to the tube causes a movement equivalent to the angular velocity, thereby generating a Coriolis force. As shown in the figures above, since the tube for which the Coriolis force is being generated generates a twist proportional to the mass flow rate, the mass flow rate is calculated from the amount of this twist.

### ■ Detector Specifications

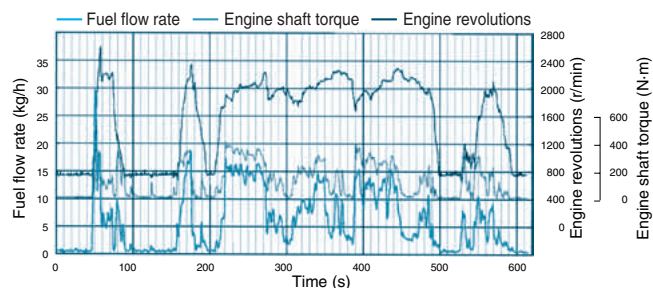
Item		Model Name	FZ-2100	FZ-2200
Measurement parameters	Flow rate			Yes
	Temperature			Yes
Applicable fluids <sup>(*)</sup>	Gasoline			Yes
	Light oil			Yes
	Kerosene			Yes
	Standard petroleum oils			Yes
	Alcohol products			Option
Measurement range	Normal mass flow rate		0.2 to 82 kg/h	1 to 1090 kg/h
	Normal volume flow rate		0 to 109 l/h at 0.75 g/cm <sup>3</sup>	0 to 1453 l/h at 0.75 g/cm <sup>3</sup>
	Maximum flow rate		108 kg/h	2180 kg/h
	Density <sup>(**)</sup>		0 to 1 g/cm <sup>3</sup>	
Accuracy	Flow rate		$\pm 0.1\%$ of reading at 2 to 82 kg/h $\pm(0.002 \text{ kg/h/flow rate}) \times$ within 100% of the reading at 0.2 to 2 kg/h	$\pm 0.1\%$ of reading at 2 to 82 kg/h $\pm(0.027 \text{ kg/h/flow rate}) \times$ within 100% of the reading at 1 to 27 kg/h
	Density		Within $\pm 0.1\%$ of reading at 0.76 g/cm <sup>3</sup>	
	Density renewal characteristic		$\pm 0.0002 \text{ g/cm}^3$	
	Density temperature characteristic		$\pm 0.000015 \text{ g/cm}^3/^\circ\text{C}$	
Pressure loss (when measuring gasoline)			Approx. 100 kPa at 82 kg/h	Approx. 100 kPa at 1090 kg/h
Withstand pressure			10 MPa	
Operating temperature range <sup>(**)</sup>			0 to 40°C	
Weight			Approx. 12 kg	Approx. 9 kg
External dimensions			See (9) on Page 15	See (10) on Page 15

(\*)1): Can also be used with CNG and LPG gases (option). Please consult us for details.

(\*\*): Please consult us for temperatures and densities that exceed the above ranges.



### Example of actual fuel mass flow rate data at the north American transient test mode



# FM-2500/1500 Display Unit Specifications<sup>(\*1)</sup> (when FZ-0300 is built in FM-2500/1500)

Item		Model Name	FM-2500	FM-1500		
Compatible flow detectors			FZ-2100, FZ-2200			
Compatible revolution detectors			MP-910, MP-981, LG-916	—		
Displaying device			LCD with CFL backlight, 320 x 240 dots	Fluorescent display tube (20 characters x 2 lines), 5 x 8 dot text format		
Displayed items and number of digits	Time measurement	Elapsed interval time	7 digits 00000.00 s			
		Total elapsed time	7 digits 00000.00 s			
	Revolution measurement	Number of revolutions	7 digits 000000.0 r/min		—	
		Average number of revolutions per interval	7 digits 000000.0 r/min (= number of revolutions for the elapsed interval time/interval time)		—	
		Number of revolutions for the elapsed interval time	7 digits 0000000 REV.		—	
		Average number of revolutions over the total elapsed time	7 digits 00000.00 r/min (= number of revolutions for the total elapsed time/total interval time)		—	
		Number of revolutions for the total elapsed time	7 digits 0000000 REV.		—	
	Temperature measurement	Instantaneous temperature	4 digits ±000.0 °C		—	
	Flow rate measurement <sup>(*2)</sup>	Applicable detectors	FZ-2100	FZ-2200	—	
			Instantaneous flow rate	(g/s, ml/s) 000.0000	00000.00	—
			(g/min, ml/min) 000000.0	0000000	—	
		(kg/h, l/h) 00000.00	000000.0	←		
		Elapsed period flow	(g, ml) 00000.00	00000.00	←	
			(kg, l) 00.00000	00.00000	—	
			Total elapsed flow	(g, ml) 00000.00	00000.00	←
		(kg, l) 00.00000	00.00000	—		
		Average flow rate per period	Same as for instantaneous flow rate (elapsed interval flow rate/interval time)		←	
		Average flow rate over the total elapsed time	Same as for instantaneous flow rate (total elapsed time flow rate/total elapsed time)		—	
		Amount of spray	(mg/st, mm <sup>3</sup> /st) 00000.00	000000.0	—	
		Average amount of spray per period	(mg/st, mm <sup>3</sup> /st) 00000.00	000000.0	—	
Average amount of spray over the total elapsed time	(mg/st, mm <sup>3</sup> /st) 00000.00	000000.0	—			
Density measurement	Density	5 digits 0.0000 g/cm <sup>3</sup>		←		
	Converted temperature setting	000.0 °C (density calculation performed for the three specified temperature points)		000.0 °C (density calculation performed for one specified temperature point)		
Measurement time	Instantaneous	Specifiable within the range of 1 to 10 seconds (in 1-second increments)		1-second		
	Elapsed	Up to the measured start time to stop time, depending on the elapsed time measurement mode				
Elapsed time measurement mode	Manual	Elapsed time up to the start time to stop time specified at the panel or by an external start to stop signal				
	Flow rate setting method	Elapsed time/accumulated revolutions from the start signal up to the specified cumulative flow rate		Elapsed time from the start signal up to the specified cumulative flow rate		
	Time setting method	Cumulative flow rate/accumulated revolutions from the start signal up to the specified elapsed time		Cumulative flow rate from the start signal up to the specified elapsed time		
	Revolutions setting method	Cumulative flow rate/elapsed time from the start signal up to the specified accumulated revolutions		—		
Voltage output	Output specifications <sup>(*3)</sup>	Flow rate	0 to 10 V/Low to High (the Low and High values are variable)		0 to 10 V/0 to F.S. (the F.S. value can be selected from the following) 100/200/300/500/1000/1500 (kg/h, l/h)	
		Temperature, Density	Same as above		0 to 10 V/0 to F.S. (The full scale values are 100°C for temperature and 1 g/cm <sup>3</sup> for density)	
Pulse output	Pulse output <sup>(*4)</sup>	Selectable from A: 0.001, B: 0.01, C: 0.1, D: 1 (ml/P or g/P), but varies according to the sensor.				
	Output specifications	Frequency range: 0 to 100 kHz, Output H level: at least 2.4 V, L level: max. 0.8 V				
External dimensions			See (13) on Page 15	See (14) on Page 15		

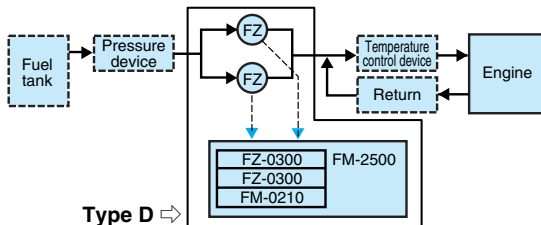
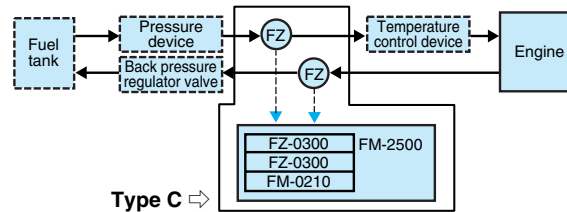
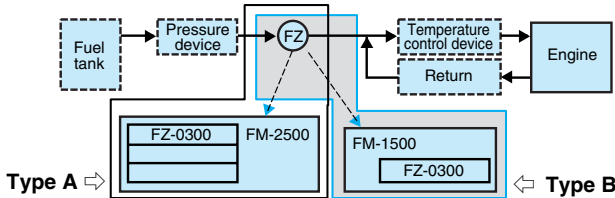
(\*1): In the above table, "—" indicates that these specifications are not included in the FM-1500 model.

(\*2): The position of the decimal point is not always the same for the FZ-2100 and FZ-2200.

(\*3): For both the FM-2500 and the FM-1500, the voltage output update interval is 0.1 s, and the accuracy is ±0.1%/F.S.

(\*4): FZ-2100: A and B; FZ-2200: C and D.

## Equipment Configuration Examples



**Types A and B:** This is the standard system configuration when one detector is used.

**Type C:** A detector is installed at both the supply and return sides, and the difference is used to measure the fuel consumption. (Please consult us when using this type.)

**Type D:** Two detectors are connected in parallel, and their total fuel consumption amount measured. A separate standalone display can be used for each detector if required.

The FM-0210 model listed for types C and D is an addition and subtraction module for two detectors.

# Mass Flow Rate Measurement Systems (Applications)

## ■ Mass Flow Rate Detection System

This system uses two detectors, the FP-2140H volumetric flow detector and the FZ-2200 mass flow detector. High-accuracy volumetric flow rate measurement values are converted using density measurement values and displayed as mass values. Separate display units can be used for each of the detectors if required.

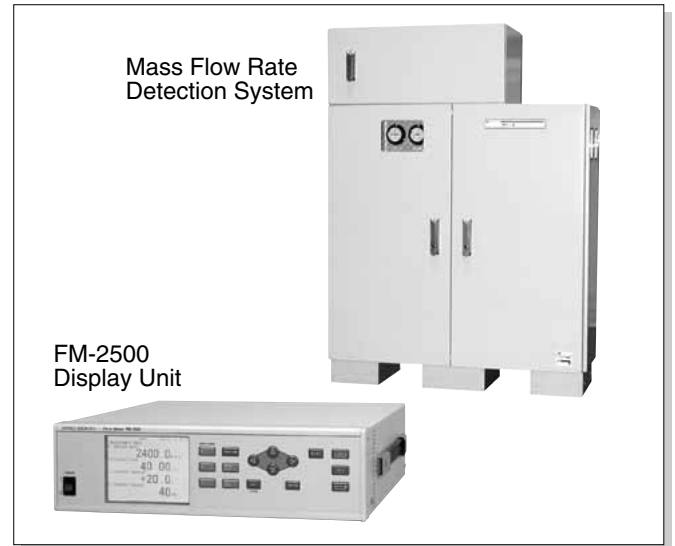
- Continuous measurement without being affected by temperature, pressure or density
- Wide measurement range (measurement accuracy of  $\pm 0.35\%$  of the reading up to a ratio of 1000:1)
- Density measurement enabled
- A function for removing air bubbles to enable the supply of bubble-free fuel is provided.
- A device for initial air extraction when workpieces are replaced is provided.

Item	Specification	
Measurement parameters	Flow rate	Yes
	Temperature	Yes
Applicable fluids	Gasoline	Yes
	Light oil	Yes
	Kerosene	Yes
	Standard petroleum oils	Yes
	Alcohol products	Option
Measurement range	Normal mass flow rate	0.23 to 150 kg/h at 0.75 g/cm <sup>3</sup>
	Normal volume flow rate	0.3 to 200 l/h
	Maximum flow rate	225 kg/h (300 l/h at 0.75 g/cm <sup>3</sup> )
	Density	0 to 1 g/cm <sup>3</sup>
Accuracy	Flow rate	$\pm 0.35\%$ of reading at 0.3 to 200 l/h
	Density	Within $\pm 0.1\%$ of reading at 0.76 g/cm <sup>3</sup>
	Density repeatability	$\pm 0.0002$ g/cm <sup>3</sup>
	Density temperature characteristic	$\pm 0.000015$ g/cm <sup>3</sup> /°C
Pressure loss	-	
Operating temperature range	0 to 40°C	
Weight	Approx. 200 kg (including the solenoid controller)	

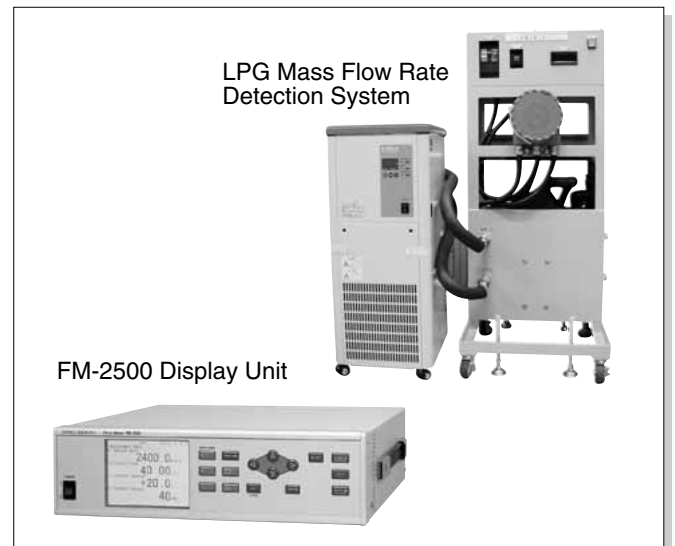
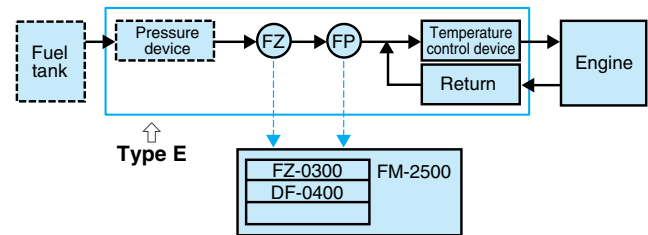
## ■ LPG Mass Flow Rate Detection System

This system uses the FZ-2100 mass flow detector for high-accuracy detection of the mass of an LPG flow rate.

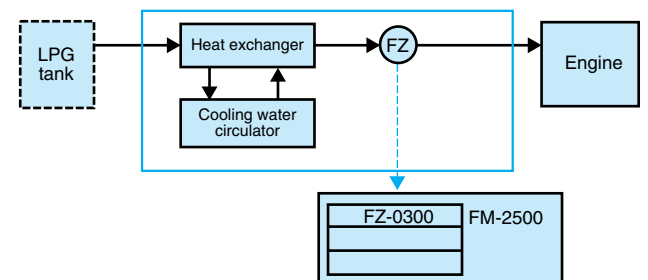
Item	Specification	
Measurement parameters	Flow rate	Yes
	Density	Yes
	Temperature	Yes
Measurement range	Mass flow rate	0.2 to 60 kg/h
	Density	0 to 1.0 g/cm <sup>3</sup>
	Temperature	-20 to +55°C
Accuracy	Flow rate	$\pm 0.1\%$ of reading at 0.2 to 60 kg/h $\pm (0.002 \text{ kg/h/flow rate}) \times 100\%$ of reading at 2 kg/h or less
	Density	Within $\pm 0.1\%$ of reading at 0.76 g/cm <sup>3</sup>
	Temperature	Class B
Pressure loss	1MPa	
Operating temperature range	0 to 40°C	
Weight	Approx. 200 kg	



Mass Flow Rate Detection System (delineated by —)



LPG Mass Flow Rate Detection System (delineated by —)





# Flow Meter Peripheral Devices

## MF-113 Pressure Increase & Reduction Unit



The MF-113 is used to increase the pressure at the fuel supply side and to reduce the pressure at the detector output side.

Applicable fluids : Gasoline, light oil, kerosene  
 Max. flow rate : Approx. 100 ℓ/h  
 Pressure increase adjustment range : 50 to 200 kPa  
 Pressure reduction adjustment range : 20 to 70 kPa  
 Withstand pressure : 200 kPa  
 Joint : Ribbed joint  
           R3/8 Internal diameter: ø6 mm  
           External diameter: ø9 mm  
 (for both IN and OUT on the pressure increase and reduction unit)  
 Power supply : 12 VDC, approx. 3A  
 Weight : Approx. 13 kg  
 External dimensions: 305 (W) x 332 (H) x 305 (D) mm

## MF-015 Automatic Air Extraction Tank



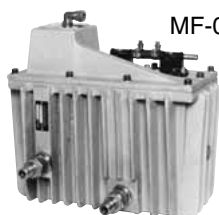
The MF-015 is an automatic air extraction device that uses a precision float valve. When fluid enters the flow line, the air is automatically extracted to the atmosphere.

Applicable fluids : Gasoline, light oil, kerosene  
 Max. flow rate : Approx. 100 ℓ/h  
 Tank capacity : 0.7 ℓ  
 Withstand pressure : 200 kPa  
 Joint : Ribbed joint  
           R1/4 Internal diameter: ø6 mm  
           External diameter: ø9 mm  
 (for both IN and OUT)  
 Weight : Approx. 1.8 kg  
 External dimensions: ø93 (W) x 212 (H) mm

## MF-034/035 Return Processing Fuel Tanks



MF-034



MF-035

### Specifications

Item	Model Name	MF-034	MF-035
Applicable fluids		Gasoline, light oil, kerosene	
Max. inlet flow rate (net consumption)		Approx. 80 ℓ/h	Approx. 120 ℓ/h
		(light oil 15°C when the inlet pressure is 50 kPa)	
Max. return flow rate (max. circulated flow)		Approx. 250 ℓ/h	Approx. 400 ℓ/h
Max. allowable inlet pressure		50kPa	
Internal capacity		Approx. 1.2 ℓ	Approx. 2.0 ℓ
Outer wall area (including heat sink fins)		0.218 m <sup>2</sup>	0.372 m <sup>2</sup>
Inner wall area		0.085 m <sup>2</sup>	0.130 m <sup>2</sup>
Fuel inlet fitting		ø6.5 mm external diameter, straight pipe	ø8 mm external diameter, straight pipe
Fuel outlet fitting		ø12 mm external diameter, ø6 mm internal diameter, hose joint	ø15.5 mm external diameter, hose joint
Fuel return fitting		ø12 mm external diameter, ø6 mm internal diameter, hose joint	ø15.5 mm external diameter, hose joint
Tank fastening screws		1/4-20 bolt UNC female screw: 1 location M10 x 1.5 stud bolt: 2 pcs.	M6 bolt: 1 pc. M10 stud bolts: 2 pcs.
Weight		Approx.3.4 kg	Approx.5.7 kg
External dimensions		See (11) on Page 15	See (12) on Page 15

## Table of Compatible Filters and Filter Elements

Item	Compatible detectors	For FP-213S/213	For FP-2140H/2240HA	For FP-215/2250A
For models with standard specifications	Filter	EH-106	EH-1050	* (See Note)
	Element	Provided together with the main unit	EH-015	* (See Note)
For models that can detect alcohol products	Filter	—	EH-107	* (See Note)
	Element	—	EH-107	* (See Note)

\* Note: Please contact us for details.

### • EH-1050

1 MPa withstand pressure element provided (paper, 5μm)

### • EH-106

1 MPa withstand pressure element provided (paper, 5μm)

### • EH-107

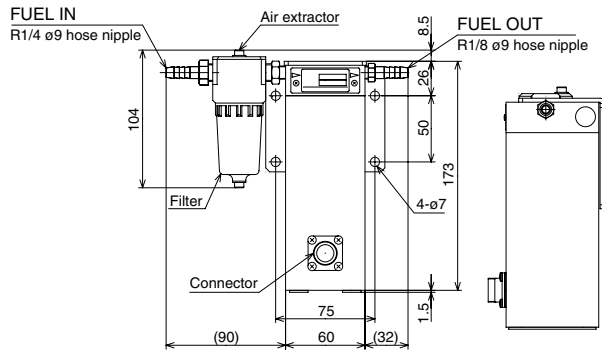
1 MPa withstand pressure element provided (stainless steel, 5μm)

## EH-049 Regulator Valve / EH-059 Relief Valve

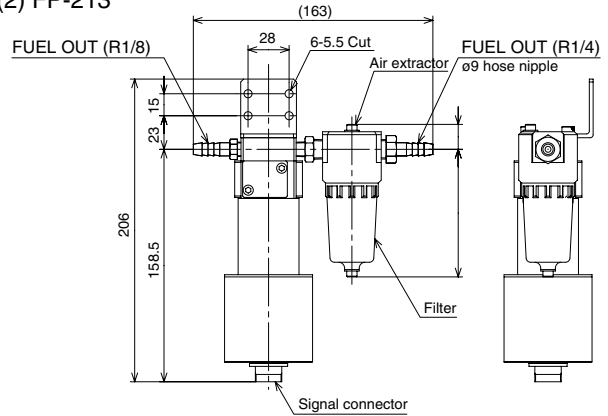
Item	Model Name	EH-049	EH-059
Settable pressure range		20 to 70 kPa	50 to 200 kPa
Withstand pressure		Max. 0.8 Mpa	
Operating temperature range		0 to 70°C	
Connector fitting diameter		Rc1/4 (for both IN and OUT)	
Body material		Aluminum	
Weight		500 g	

# Dimensional Diagrams

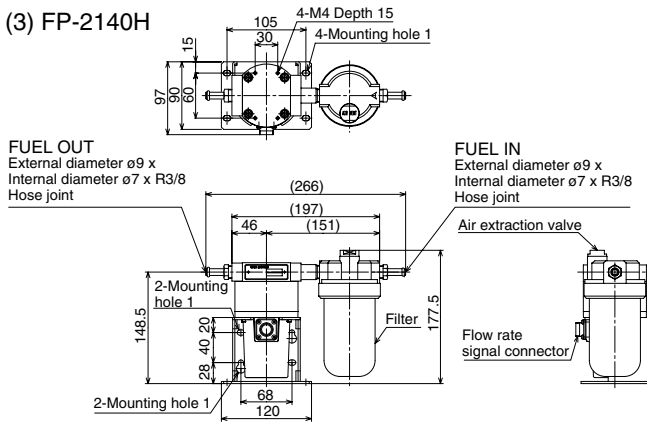
(1) FP-213S



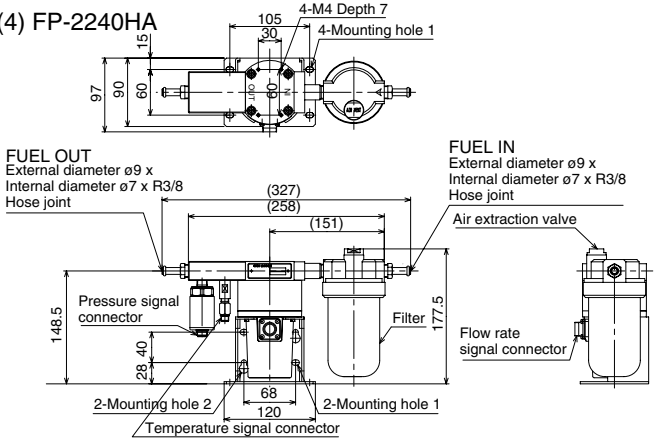
(2) FP-213



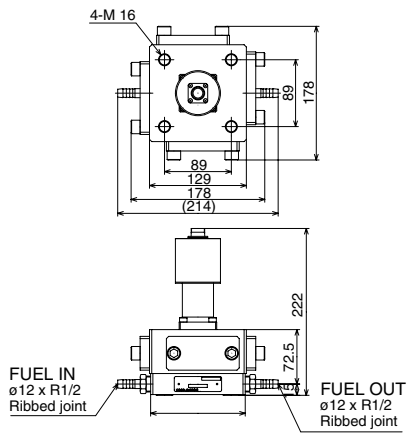
(3) FP-2140H



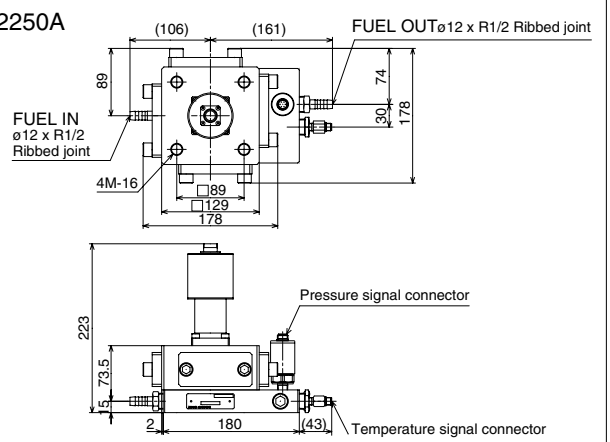
(4) FP-2240HA



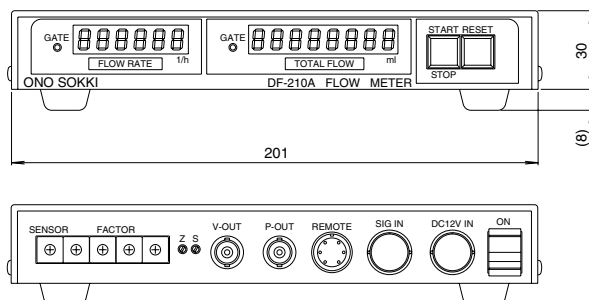
(5) FP-215



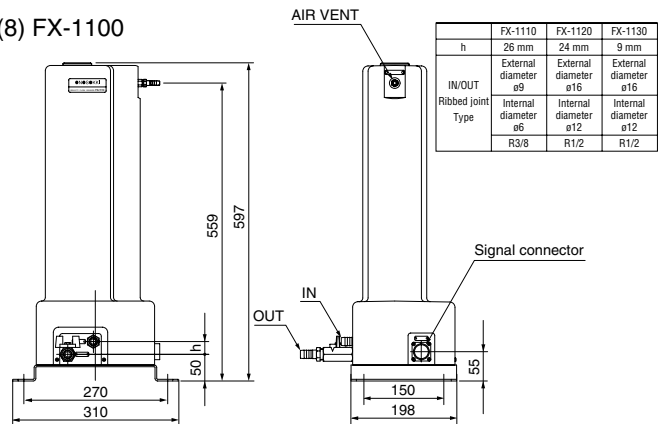
(6) FP-2250A



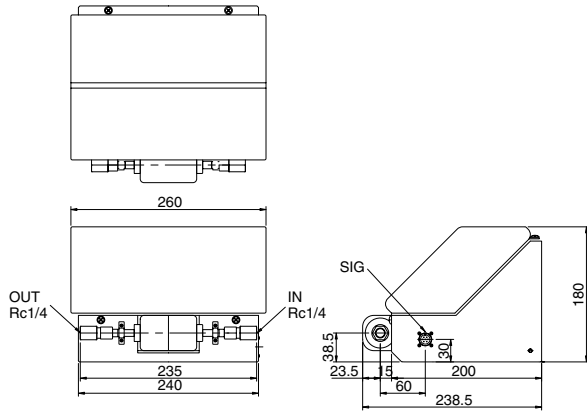
(7) DF-210A



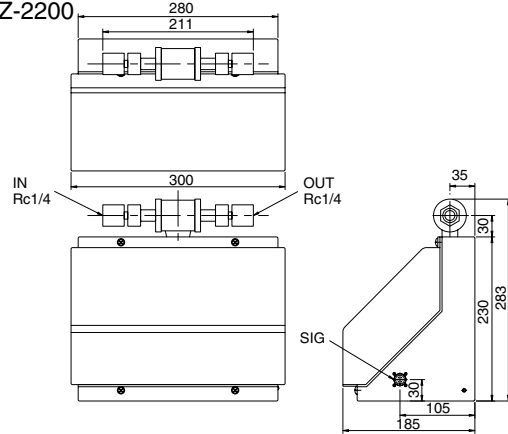
(8) FX-1100



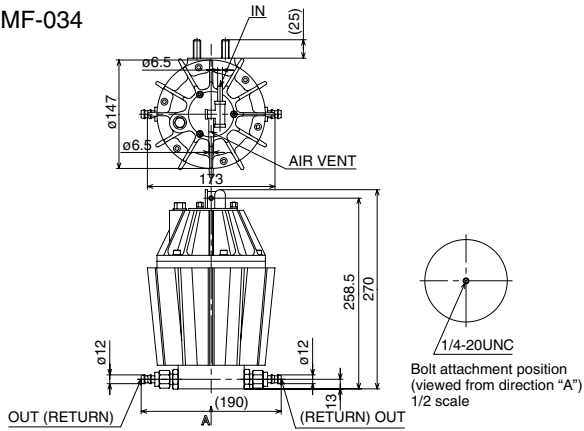
(9) FZ-2100



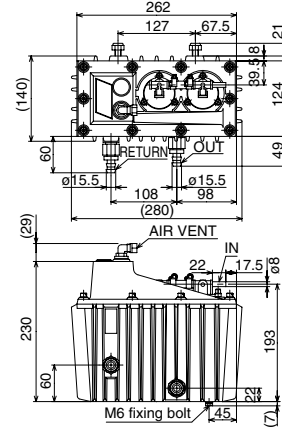
(10) FZ-2200



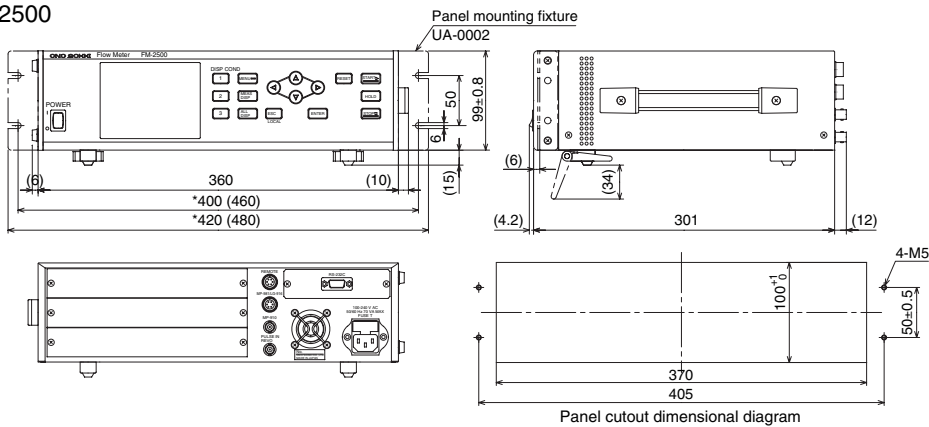
(11) MF-034



(12) MF-035



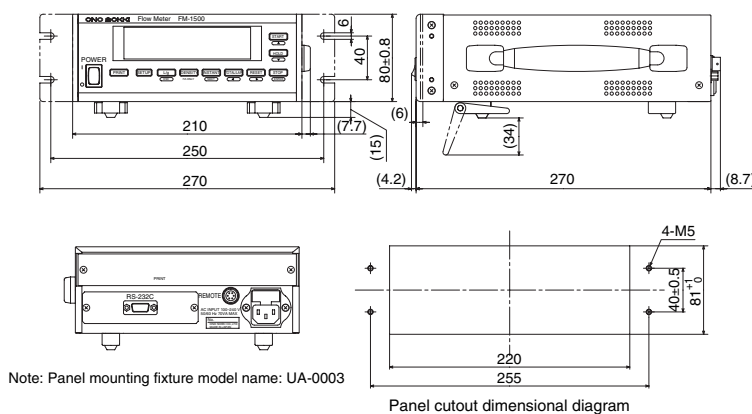
(13) FM-2500



Note 1  
The dimensions with the "\*" mark are the values for the panel cutout dimensions in the figure on the right, while the values within the parentheses ( ) are for the 480-mm rack.

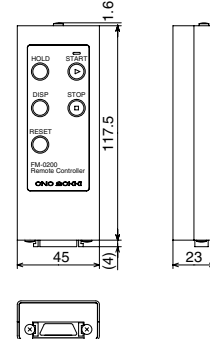
Note 2  
Mounting fixture model names  
UA-0001: For the 480-mm rack  
UA-0002: For panel mounting

(14) FM-1500



Note: Panel mounting fixture model name: UA-0003

(15) FM-0200 Remote box



## ■ FM-2500/1500 Display Unit Common Specifications (\*\*1)

Item		Model Name	FM-2500	FM-1500	
Displaying	Device		LCD with CFL backlight, 320 x 240 dots	Fluorescent display tube (20 characters x 2 lines), 5 x 8 dot text format	
Interface (**2)	Remote (**3)	Commands	Start, Stop, Hold, Reset, Display		
		Input levels	H: +2.4 V to 15 V, L: +0.8 V max.		
	RS-232C (**4)	Transmission method: asynchronous full-duplex mode, data length: 8 bits, transmission speed: 9600, 19200, 38400, 57600, 115200 bits/s			
	GPIB	Option (Model name FM-0263)			
Memory functions	Measurement memory	Capacity	300 addresses	-	
		Capture timing	Automatic save when Hold or Stop, automatic incrementing of addresses from 001 to 300		
	Memory backup	Memory capacity	1 Mbyte (SRAM)		
		Data backup period	Approx. 1.5 months (at 25°C), battery: coin-type vanadium lithium secondary battery		
Standard specifications	Environmental conditions	Storage temperature/ humidity range	-20 to 60°C, 10 to 90% RH (non-condensing)		
		Operating temperature/ humidity range	0 to 40°C, 10 to 90% RH (non-condensing)		
	Weight	Approx. 7 kg (when measurement modules are installed in 3 channels)	Approx. 4.2 kg		
	Power supply	Power supply	100 to 240 VAC, 50/60 Hz		
		Max. power consumption	40 VA or less External fuse: 2A	30 VA or less External fuse: 2A	
	Insulation resistance	At least 10 MΩ (500 VDC rated power supply)			
	Withstand voltage	1500 VAC for one minute			
	Compatible shock-resistance standard	JIS C 0041:1999 (peak acceleration: 300 m/s <sup>2</sup> , shock application period: 18 ms)			
Compatible vibration-resistance standard	JIS C 0040:1999 (vibration acceleration: 10 m/s <sup>2</sup> , vibration frequency range: 10 to 150 Hz)				

(\*1): The above specifications are specifications that are common to the FM-2500 and FM-1500 (Pages 6/9/11). Moreover, " - " indicates specifications that are not included with the FM-1500.

(\*2): Only one interface can be installed. The RS-232C interface cannot be used if a GPIB interface is installed.

(\*3): The model name of the Remote Box is FM-0200, and the external dimensions are given on Page 15.

(\*4): With the FM-1500, the DP414 digital printer (option) can be used to print out measured values. (RS-232C interface)

- CE marking is available depending on the model. Please consult us.
- Signal cables between revolution/fuel flow detectors and displaying units are sold separately.
- FM-1500 can not be compatible with FX-series detectors.

**ONO SOKKI**

\* Outer appearance and specifications are subject to change without prior notice.

URL: <http://www.onosokki.co.jp/English/english.htm>

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