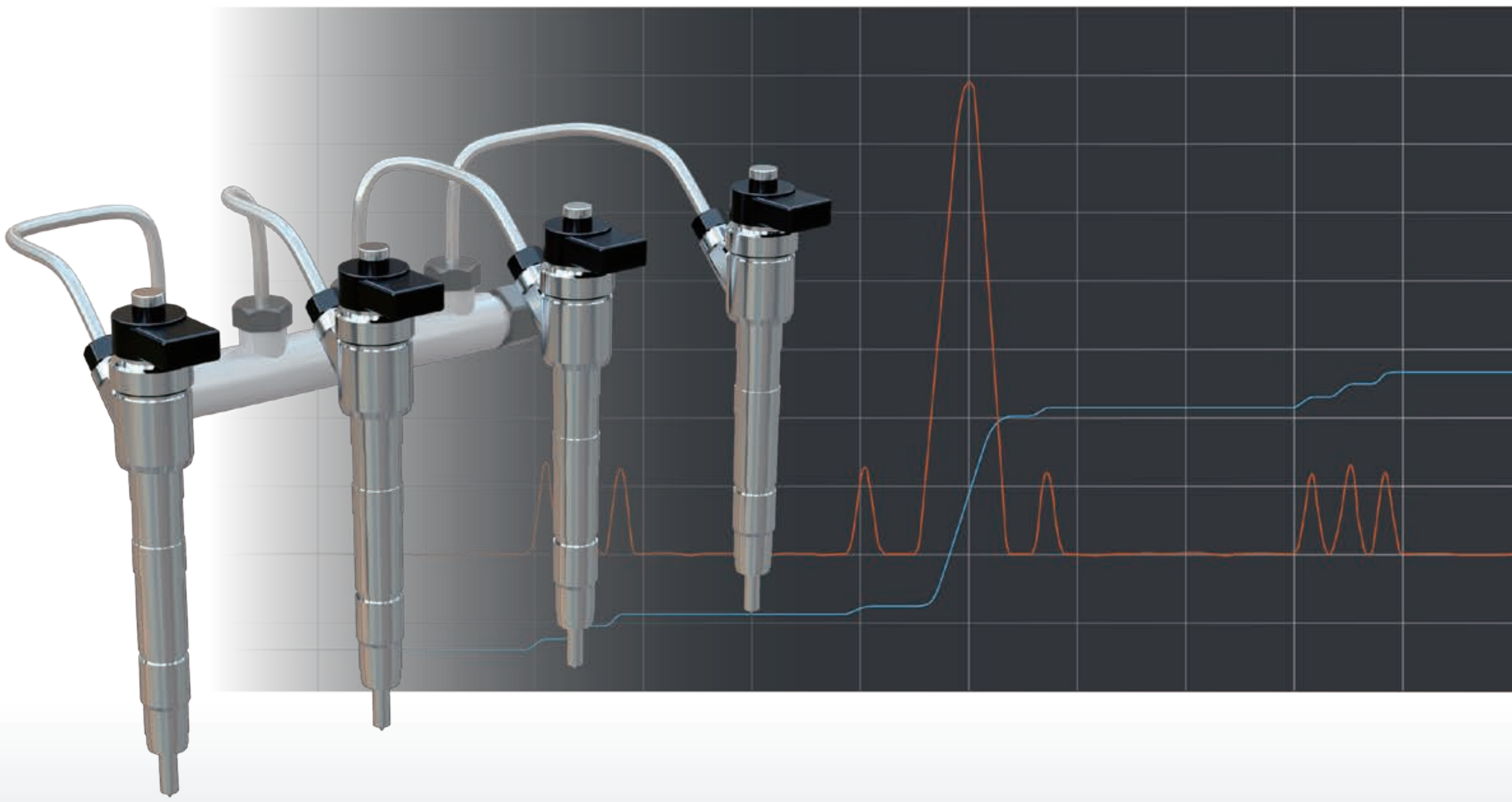
Multi-Stage Injection Analyzer

FJ-8000 series

High-precision, high-resolution fuel injection measurement up to 15 stages in the environment near to an actual vehicle measurement



ONO SOKKI

Multi-stage fuel injection measurement system for continuously evolving fuel injection systems

Injection Detecting Section

Injection measurement in the environment near to an actual vehicle measurement

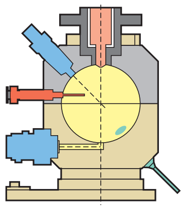
Temperature correction using FP-213

Temperature correction coefficient of fuel is obtained in real time.

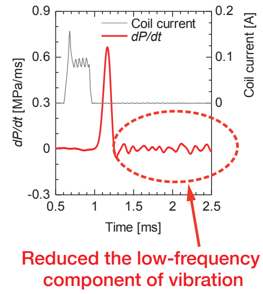
Measurement of fuel injection rate more closely to an actual vehicle environment

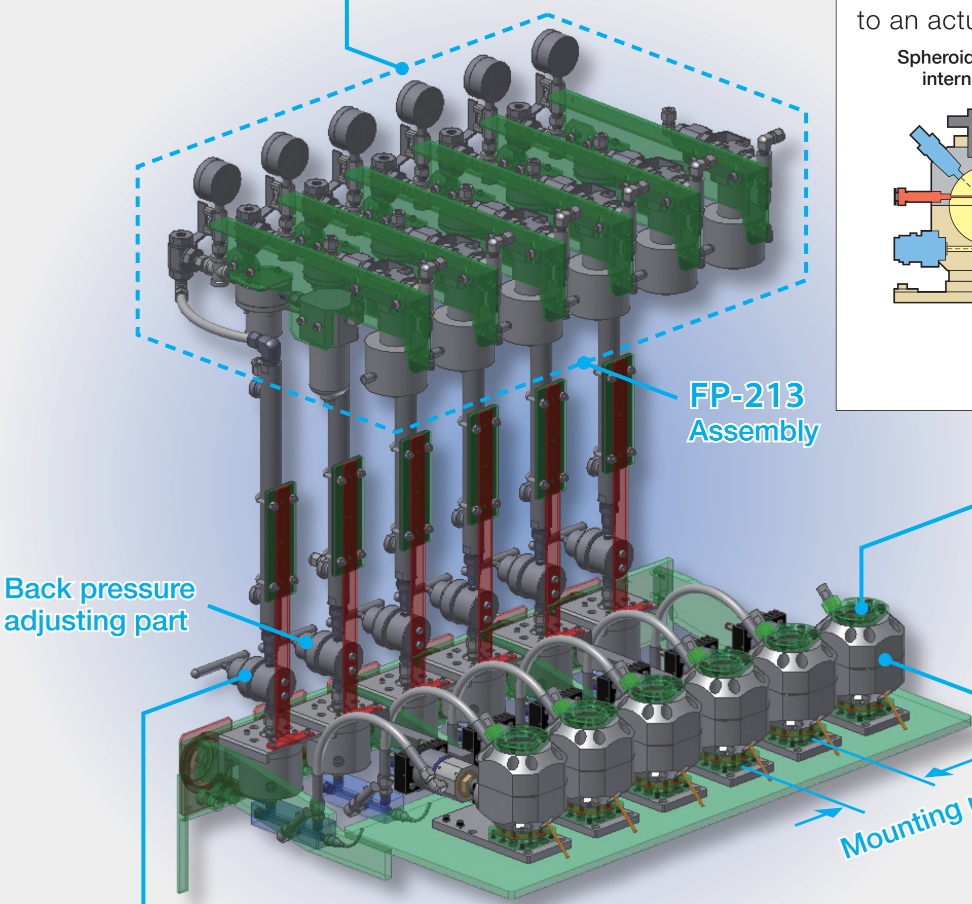
The detectors with an improved internal structure minimize the post-injection impact of reflected waves, helping to achieve injection rates measurement near to an actual vehicle environment.

Spheroidizing of an internal shape



Waveform of fuel injection rate after improved





Example of detection system for 6 cylinders

Supports injection measurement system of up to 8 cylinders.

Supports high back pressure

Supports up to 13 MPa pressure which is near to an internal cylinder pressure.

Mounting pitch

Minimum mounting pitch：97 mm (When a detector of 100 mm^3/str, or 200 mm^3/str is used.)

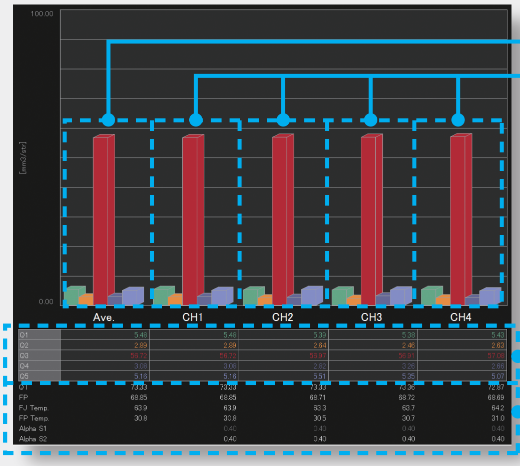
* Please consult us for the mounting pitch less than 97 mm.

Real-time Data Display

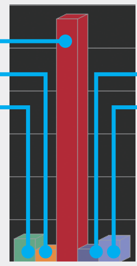
Real-time display of five types of data

1. Bar graph

Bar graph display of injection quantity for each cylinder, and each injection stage

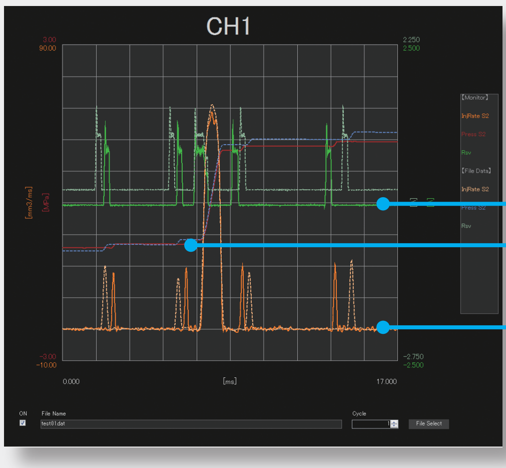


Display up to 15 stages of injection quantity



2. Injection rate monitor

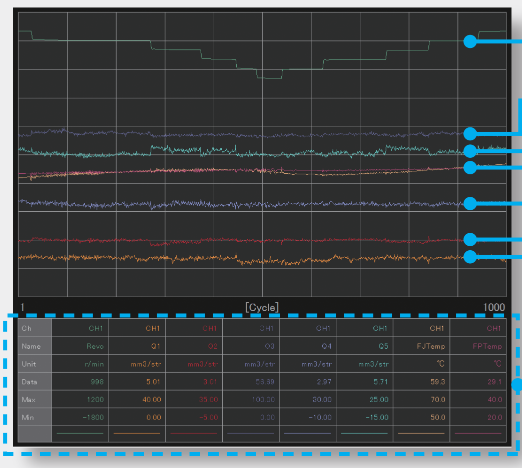
Simultaneous display of injection rate, pressure, and external input signal for 1ch (injection command etc.).
The current data can be overlaid on the saved existing data



* ----- represents the data which has been stored.

3. Trend graph

Trend display up to 8 types, 3000 cycles of data

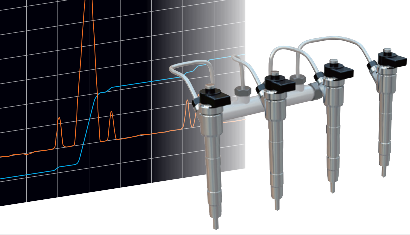


4. Dual monitor

Simultaneous display of trend graph and bar graph

5. Numerical monitor

Display of numerical data for each cylinder including injection quantity, injection period and detector internal temperature

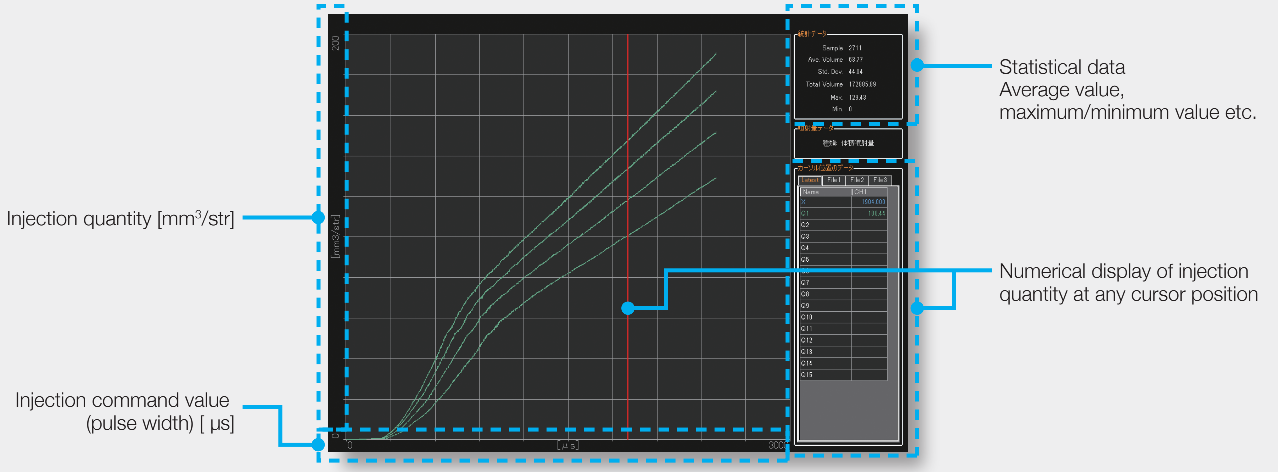


Data Analysis

Analyzing sampled data in various methods

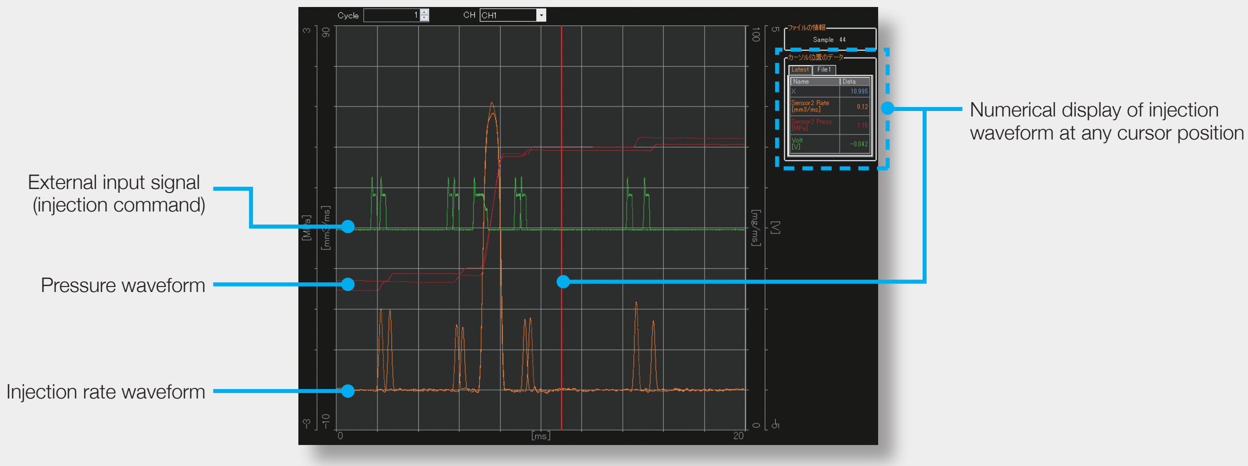
●TQ-Q graph (Injection command value-Injection quantity graph)

TQ-Q graph shows changes in fuel injection quantity in response to fuel injection commands. The horizontal axis represents fuel injection commands while the vertical axis represents fuel injection quantity.



●Injection rate graph

A fuel injection rate graph shows pressure waveform, fuel injection rate waveform and waveform of a selected channel for each cylinder.



●T-Q graph (Horizontal axis: cycle Vertical axis: injection quantity)

Displays the variation of injection quantity for each cylinder at one cycle.

●N-Q graph (Horizontal axis: rotation speed Vertical axis: injection quantity)

Displays the change in the injection quantity for each cylinder at pump rotating speed.

●Histogram

Displays the distribution of fuel injection quantities for preset stages.

●Statistical data

Displays the injection quantity, injection period, average of detector internal temperature, standard deviation, and maximum/minimum value.

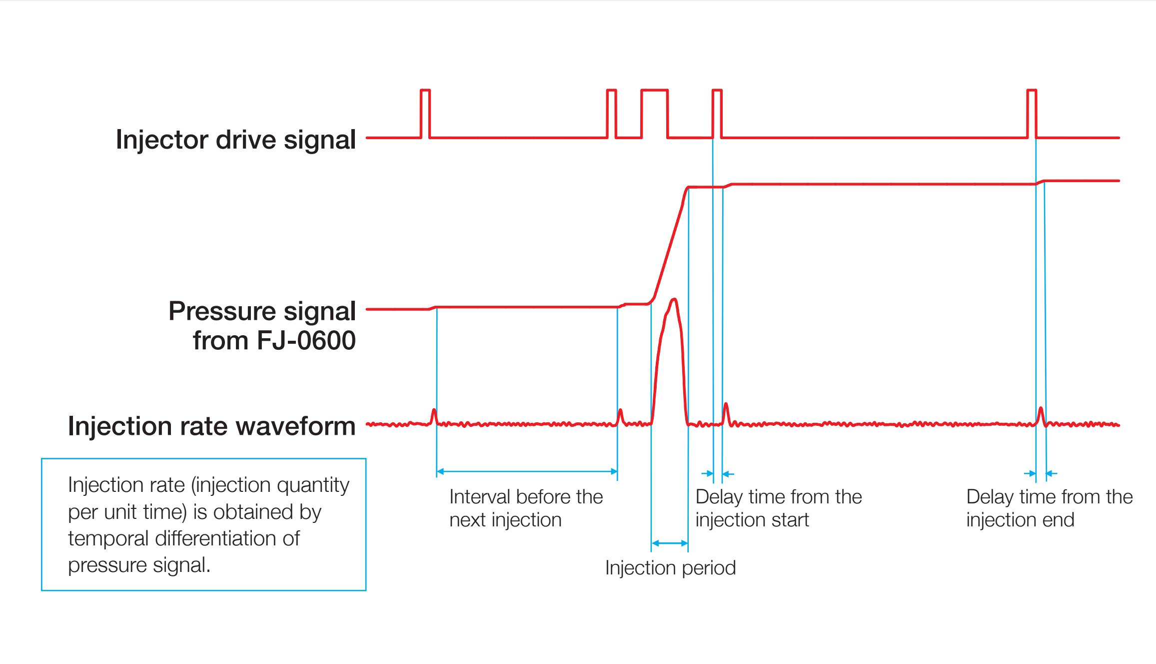
●Data list

Data is listed in table format of injection quantity, injection period, and detector internal temperature in one cycle.

High-speed Sampling

High-precision analysis of fuel injection timing with high-speed sampling

High-speed sampling (injector drive signal 1MHz, pressure signal 200 kHz) allows injection timing analysis with high accuracy, such as interval before the next injection, and delay time of injection start/end.



Option

Wide variety of options responding to user's needs

●Mass conversion measurement

Fuel injection quantity is converted into mass based on the density provided by the FZ series Coriolis-type flow detector.

●Analog output function

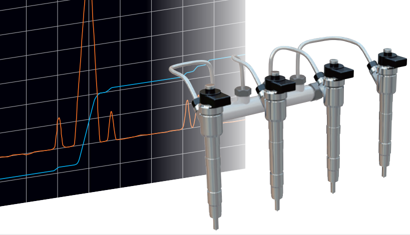
Outputs injection rate waveform, pressure waveform to an external device (oscilloscope etc.)

●General analog input/output function

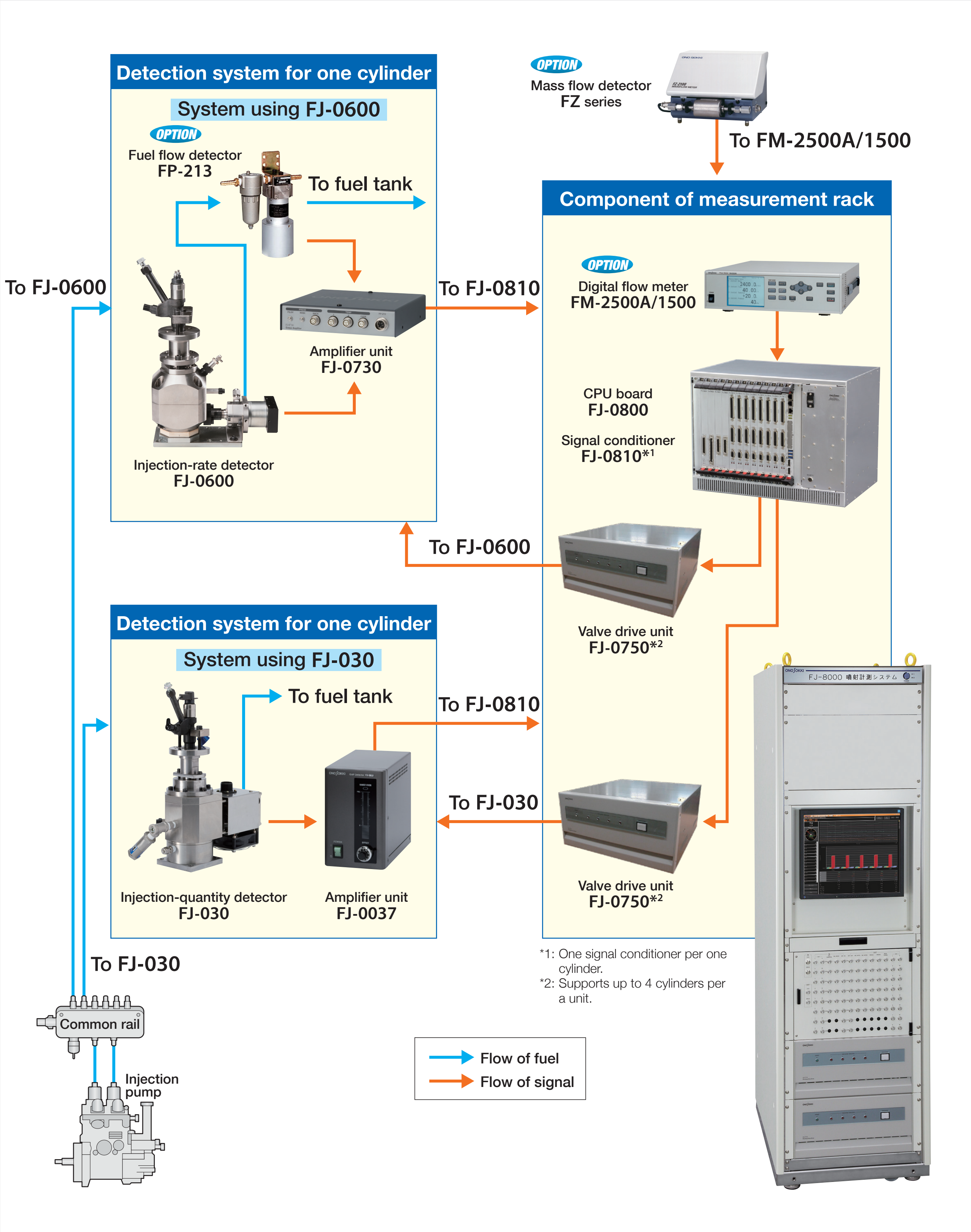
Analog signal inputs are sampled in a manner synchronized with the pump rotation speed. Fuel injection quantity, detector internal temperature and other measurements are output to external devices such as a logger.

●Interlock function

If measurements being monitored go out of the preset range, the measurements taken before and after that period will be saved for subsequent access.

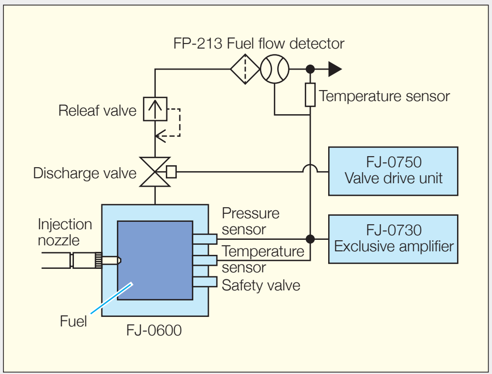


System Configuration



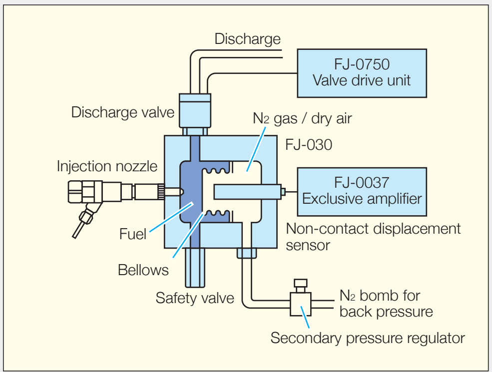
Detection Principle of Injection Quantity

FJ-0600 Injection-rate detector (constant volume)



FJ-0600 is developed by applying Zeuch method. When fuel is injected to the airtight container which has been filled with fuel, a container internal pressure rises in proportion to the injected fuel quantity. By using this fact, the injection quantity and injection rate are measured.

FJ-030 Injection-quantity detector (constant pressure)

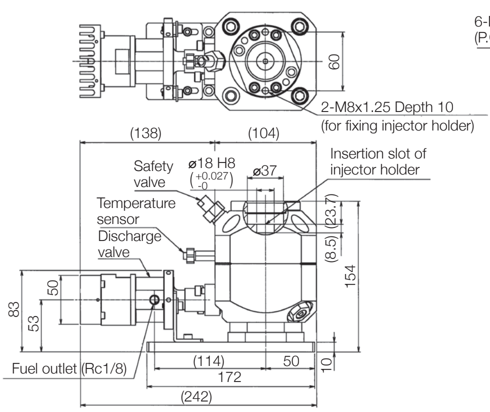


This is the method to calculate the injection quantity before and after the injection by the bellows position. The injected fuel is discharged with the solenoid valve after the measurement is completed, for the preparation of the next injection. High pressure gas is added from inside of the bellows, which becomes the back pressure for the nozzle.

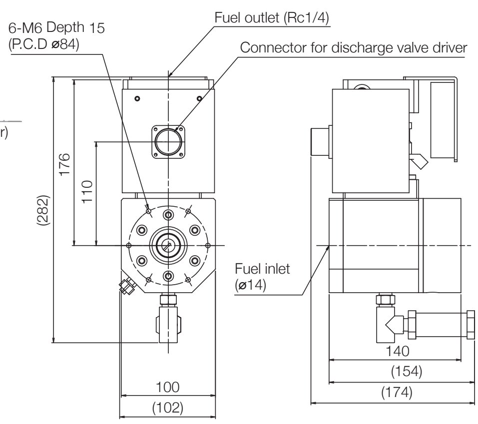
Outer Dimensions

(Unit : mm)

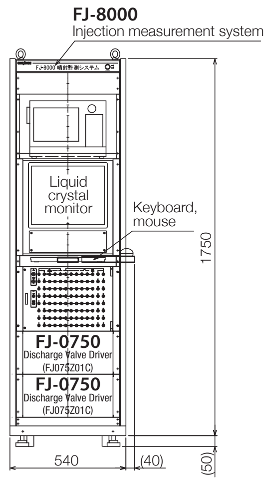
FJ-0600



FJ-030



FJ-8000 system



Specification (FJ-0600/030)

Item \ Model name	FJ-0600	FJ-030
Measurement range*1	Total injection quantity: 0.1 to 100, 200, 300, 400 mm^3/str	
	Support injection quantity: up to 20 % of total injection quantity	
Measurement accuracy	±0.1 % or less of full scale (Measurement injection quantity: 20 % or less of full scale) ±0.5 % or less of reading value (Measurement injection quantity: 20 % or more of full scale)	
Resolution	1/1000 of max. measurement injection quantity	
Injection period	1 to 50 Hz (60 to 3000 r/min)	
Fuel temperature	10 to 120 °C (Inside of the detector)	
Nozzle back pressure	1 to 4 MPa, 1 to 13 MPa (option)	1 MPa (Adjustable by option)
Back pressure medium	Fuel	N_2 gas or dry air (Prepared by customer)
Pressure detector	Semiconductor type (for back pressure measurement) Piezoelectric type (for injection quantity measurement)	Semiconductor type (for back pressure measurement) (option)
Temperature detector	Resistance temperature detector (Pt100 Ω)	Resistance temperature detector (Pt100 Ω) (Option)
Major fucntion*2	Measurement of fuel injection quantity and injection rate of the multi-stage fuel injection system for gasoline and diesel engine	
Number of cylinders*3	Max. 8 cylinders	
Number of injection stages*4	Max. 15 stages	
Measurement item*2	Fuel injection quantity (each stage and total injections), fuel injection rate, number of injections, pump rotation speed, temperature, and back pressure	
Fuel injection quantity*2	Instantaneous value, average value, integrated value, standard deviation, max. value, min. value, injection period, injection interval, and cylinder-to-cylinder deviation	
Display item*5	1. Real-time measurement display (bar graph and numerical display of each stage injection quantity + total injection quantity) 2. Histogram of injection quantity 3. Cycle injection quantity graph (T-Q graph) 4. Rotation speed-injection quantity graph (N-Q graph) 5. Injection period (each injection and interval) 6. Measurement data of each number of injecton (1 to 5 stages and total injection quantity, temperature, rotation speed, and back pressure) 7. Injection rate waveform 8. Average value, integrated value, standard deviation, max. value, min. value and cylinder-to-cylinder deviation of each injection quantity	
Memory capacity	Max. 50000 cycles in 1 cylinder	

Specification (Other related models)

Model name	Product name	Description
FP-213*6	Fuel flow detector (for calibration)	Fuel flow detector for injection quantity calibration Measurement range:0.06 to 60 ℓ/h Measurement accuracy: ±0.5 % reading value (when 0.18 to 60 ℓ/h), ±0.0009 ℓ/h or less (when 0.06 to 0.18 ℓ/h)
FJ-0730	Amplifier unit	Amplifier for FJ-0600 : 1 unit is required for 1 detector. (Place it near by the detector)
FJ-0037		Amplifier for FJ-030 : 1 unit is required for 1 detector. (Place it near by the detector)
FJ-0810	Signal conditioner	Number of connecting detectors : 1ch, select either FJ-030 or FJ-0600
		Pressure signal input section : Injection quantity (for FJ-0600, back pressure)
		Displacement signal input section : Injection quantity (for FJ-030)
		Temperature signal input section : Injection quantity detector internal temperature, temperature of FP-213 Fuel flow detector
		Flow signal input section : Pulse signal from the FP-213 Fuel flow detector
		Injection rate signal output section : 0 to 5 V/ 0 to FS mm^3/ms (When calibrating), FS value is 100 mm^3/ms, 200 mm^3/ms, 300 mm^3/ms, or 400 mm^3/ms depending on measurement range. *Outputs individually for each injection stage. *Digital low pass flter attached (1, 1.2, 1.5, 2, 2.5, 3, 4, 6, 8 kHz and through)
		Angle pulse signal input section : Reference pulse: 1 P/R (required) Angle pulse: Select from 360, 720, 900, 1800, or 3600 P/R
FJ-0800	CPU	Number of signal conditioners : Max. 8ch
FJ-0750	Valve drive unit	Number of valve drives : Max. 4ch (Two units are required for more than 5ch.)
FJ-0870	Injection time/interval time measurement function	Measures/displays the injection period and interval.
FJ-0871	Injection start/end delay time measurement function	Measures the time from rising /falling of the external input pulse (drivng pulse/TTL level positive logic of the normal injector) to the injection start time, and to the injection end time.
FJ-0872	Injection rate monitor /data output function	Detector signals and injection rate waveforms for each stage of any selected cylinder are displayed and saved. Signals from detectors sampled at 200 kHz can be displayed and output for customized processing and analysis. Up to 100 samples.
FJ-0873	Trend graph monitor function	Selected 16ch data of selected cylinder (rotation speed, injection quantity of each cylinder, back pressure, injection period, temperature, etc.) are displayed as a trend graph in every cycle. *Display is switched in every 8ch.
FJ-0874	Analog input function	Up to 16ch input Input signal: 0 to 10 V Voltage signal from external measuring instruments is sampled every 1 P/R and converted into physical quantities for saving on data sheets (CSV format). A/D board is required.
FJ-0875	Analog output function	Select 16ch from max. 136ch including injection quantity, pump rotation speed, injection period, injection interval, rising time, falling time, pressure, temperature, etc. (Injection rate is provided as standard). D/A board is required.
FJ-0876	Injection step judgment function	Whether fuel has been injected or not is determined based on the following criteria using injector driving signals. - Fuel injected or not between a rise of the first injector driving signal and a rise of the second signal - Fuel injected or not within a given time after a rise of injector driving signal
FJ-0877	Bulk modulus correction function	Reads the internal temperature and bulk modulus coefficient data of the detector, and corrects the bulk modulus coefficient in temperature by those data to display the highly accurate injection quantity.
FJ-0878	Mass conversion measurement function	Converts the injection quantity to mass by obtaining the density data.

*1: The detector of other detection range (100 mm^3/str or less, 400 mm^3/str or more) can be optionally made. The minimum injection quantity differs according to the detection capacity.
*2: Because of its specific design structure, the FJ-030 injection quantity detector can have a delay in detection. For that reason, its measurements (injection periods and intervals) should be used only as guides.
*3: Measurement for 1 cylinder is also available.
*4: System of 5 stages and 10 stages are also available.
*5: The value is offline display except for real-time injection quantity display.
*6: FP-2140H (wide measurement range type: 0 to 120 ℓ/h), FP-213S (low pressure loss type: 0.01 kPa or less) can also be used.

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

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