Direct EGR Flow Meter

MODEL TEG-F20

Specification Sheet

TEG-F20 Specification Sheet Ver. 2011-0310

Sokken

1. Overview

Sokken model TEG series is an EGR Flow meter to measure the direct exhaust recirculation flow from an EGR valve to the intake manifold for diesel/GDI engines. A special designed laminar flow meter to withstand the high exhaust temperature is enabled to insert it in to the EGR line and measure the direct recirculation exhaust flow with fast response. The flow meter is consisted of a flow meter, pressure transducer and control/display unit. The flow meter outputs mass flow rate and volumetric flow rate at 20degC, 1atm. The removable laminar flow element allows you to clean it by yourself.

2. Specifications

Specifications of Flow measurement

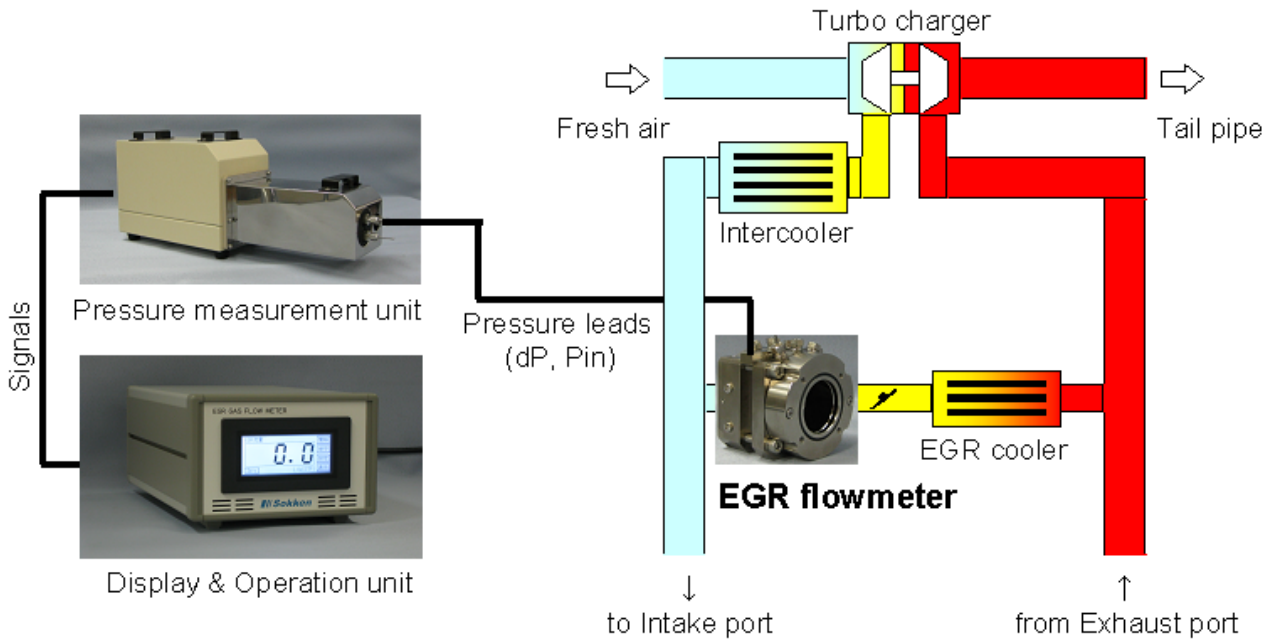
	Specification	Notes
Principle	Laminar flow meter （differential pressure flow meter）	
Flow range	1 to 20 L/s (stp) 1 to 24 g/s	
Operating gas temp.	Room temperature to 200 degC	durability 300degC
Operating line pressure	65 to 300 kPa（abs）	durability 400kPa
Accuracy	+/- 3 % F.S.	Calibrated with Air
Response	Approx. 40Hz	
Pressure drop	1.5 kPa @200degC, 20L/s(STP)	
Flow diameter	I.D. 32mm	
Length of measurement part	60 mm	
Material of laminar element	SUS304	
Material of body	A5052 with Ni plating	
Dimensions	W80, H80, L60	
Connection	P.C.D. 49 M4	See drawing of exterior

Specifications of operation unit and others

Operation style	LCD touch panel	
Display contents	Flow rate(operating, stp, mass) Pressure drop Line pressure Gas temperature Control temperature	
Calculation cycle	500Hz	
Analog output	+/-10V	Resolution 2.5mV
Digital communication	Ethernet 100BASE-TX RJ-45	
Power supply	AC100V 10A	
Dimensions	W130, D250, H180 (measurement unit) W210, D350, H140 (operation unit)	

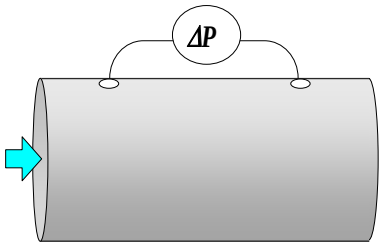
3. System

EGR flow meter consists of flow meter body, measurement unit and operation unit.



Schematic of installation

4. Principle



EGR flow meter is based on Laminar Flow meter. The differential pressure across a capillary is proportional to the volumetric gas flow rate assuming the flow in the capillary is laminar flow. This is called Hagen Poiseuille's law.

A standard volumetric flow rate at 20degC, 1 atm is derived from volumetric flow rate, line pressure and gas temperature.

The flow meter estimates composition of gas from A/F ratio. Gas density is derived from composition ratio of N2, O2, CO2, CO, H2O, and H2. A mass flow rate is derived from gas density and standard volumetric flow rate.

4.1. Volumetric flow rate Q_{OPE}

Volumetric flow rate at flow meter is given by next equation.

$$Q_{OPE} = \frac{\mu_{20(Air)}}{\mu_{T(EX)}} \times K_{20} \times \Delta P$$

$\mu_{20(Air)}$: Viscosity of air at 20degC

$\mu_{T(EX)}$: Viscosity of EGR gas at inlet temperature of flow meter

K_{20}: Coefficient of flow rate

ΔP: Differential pressure

The viscosity of EGR gas is derived from estimated composition of EGR gas

The coefficient K_{20} is written in follow equation.

$$K_{20} = A \times X^{B}$$

Where, A and B are calibrated coefficient.

$$X = \Delta P \times \left(\frac{P_{in}}{T} \right) \times \left(\frac{\mu_{20(AIR)}}{\mu_{T(AIR)}} \right)^{2}$$

P_{in}: Absolute pressure at inlet of flow meter

T: Gas temperature

4.2. Standard volumetric flow rate Q_{STP}

Standard volumetric flow rate at 20degC, 1 atm is derived from next equation.

$$Q_{STP} = \frac{293.15}{T} \times \frac{P_{in}}{101.325} \times Q_{OPE}$$

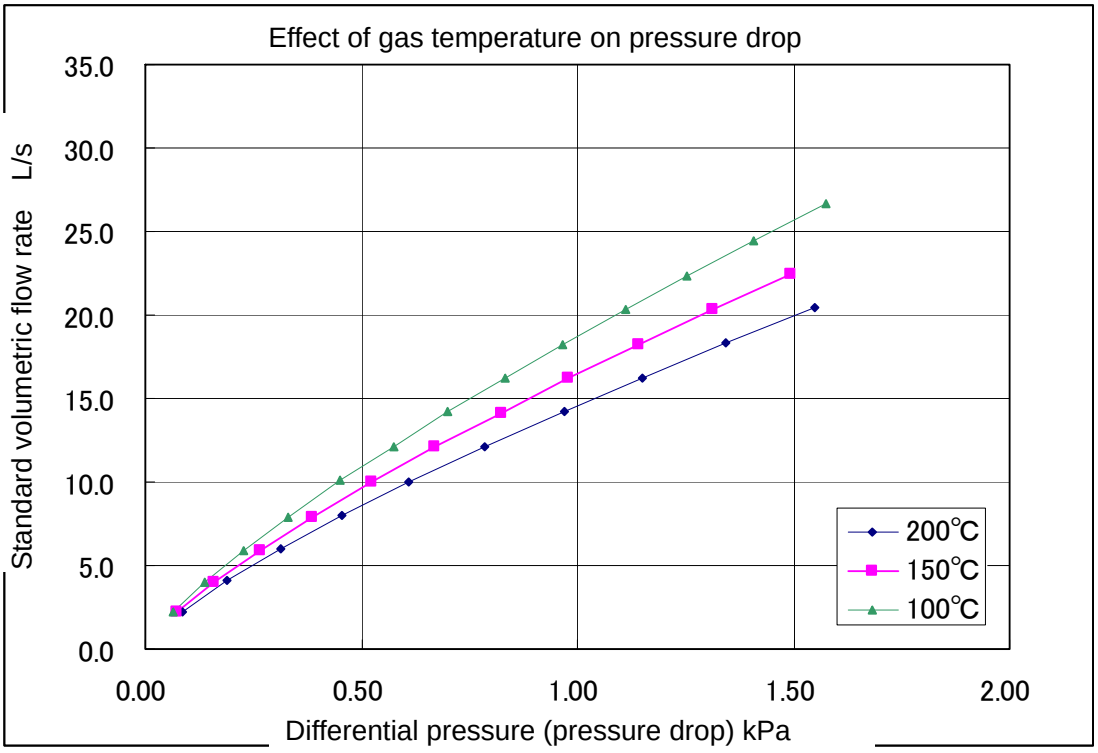
4.3. Mass flow rate

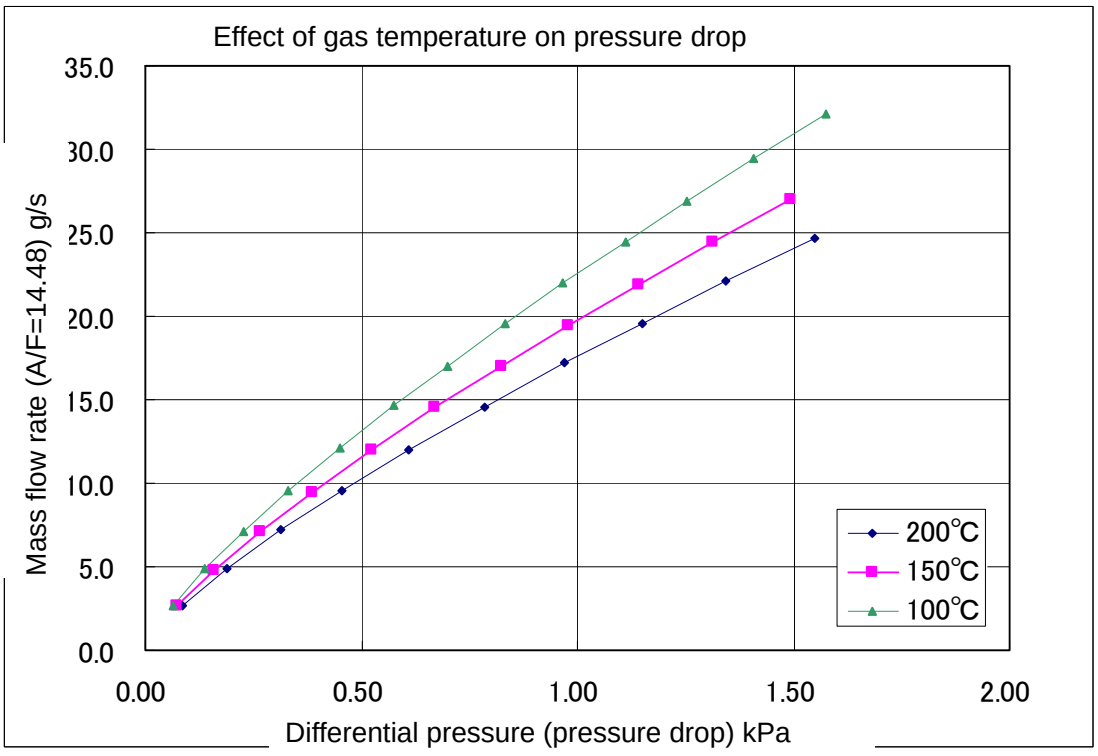
The mass flow rate(g/s) equals standard volumetric flow rate(L/s) multiplied by gas density(g/L)

5. Pressure drop

Increase in flow rate makes increase in pressure loss.

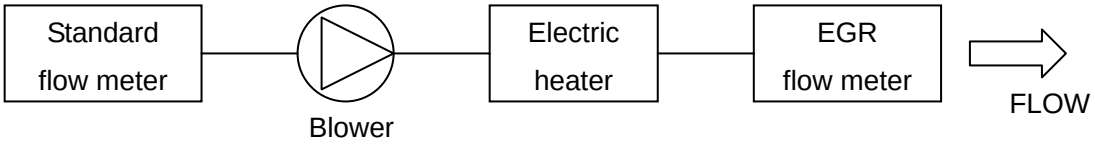
The following figure shows correlation of differential pressure (pressure drop) and flow rate.





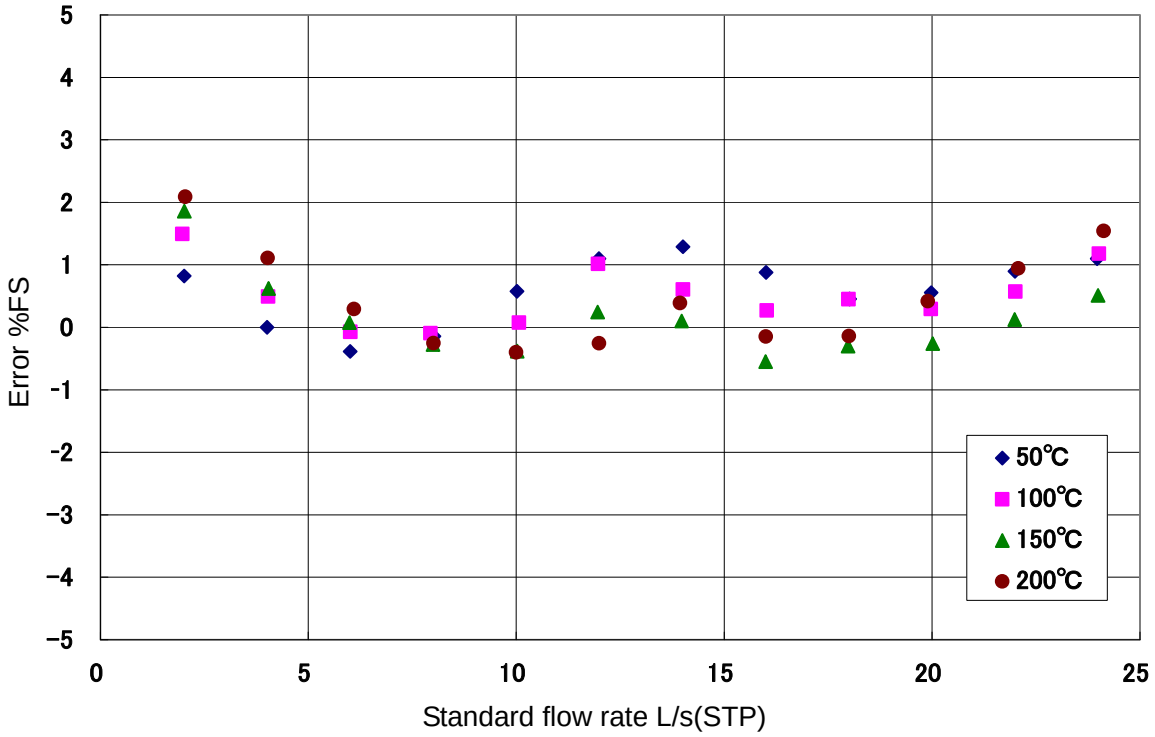
6. Calibration

EGR flow meters are calibrated with standard laminar flow meter. Calibration gas is heated air.



Flow schematic of calibration

Result of flow calibration TEG-F20



Standard flow rate L/s(STP)

Calibration data（sample）

7. Specification of pressure sensor and thermo sensor

	specification	notes
Differential pressure gauge	Differential pressure of flow element	
Range	+/- 3kPa	
Accuracy	+/- 1%FS (linearity + repeatability + hysteresis)	
Response	500Hz(-3dB), 1.6ms (step response: T0-90%) without pressure lead tube	
Calibration temperature	70degC	
Max. line pressure	3.5MPa	Durability
Max. differential pressure	4kPa	Durability
Operating temperature	70degC	controlled

Absolute pressure gauge	Absolute pressure at inlet of flow meter	
Range	0-300kPa	
Accuracy	+/-1%FS (linearity + repeatability + hysteresis)	
Response	1ms, without pressure lead tube	
Calibration temperature	70degC	
Max. line pressure	400kPa	Durability
Operating temperature	70degC	controlled

Thermo sensor	Gas temperature at inlet and outlet of flow meter	
Range	0-300degC (K type thermocouple)	
Accuracy	+/-1degC	

8. Option, custom made products

Length of sensor cables, pipe connections, and data acquisition software for windows PC are provided as your request.

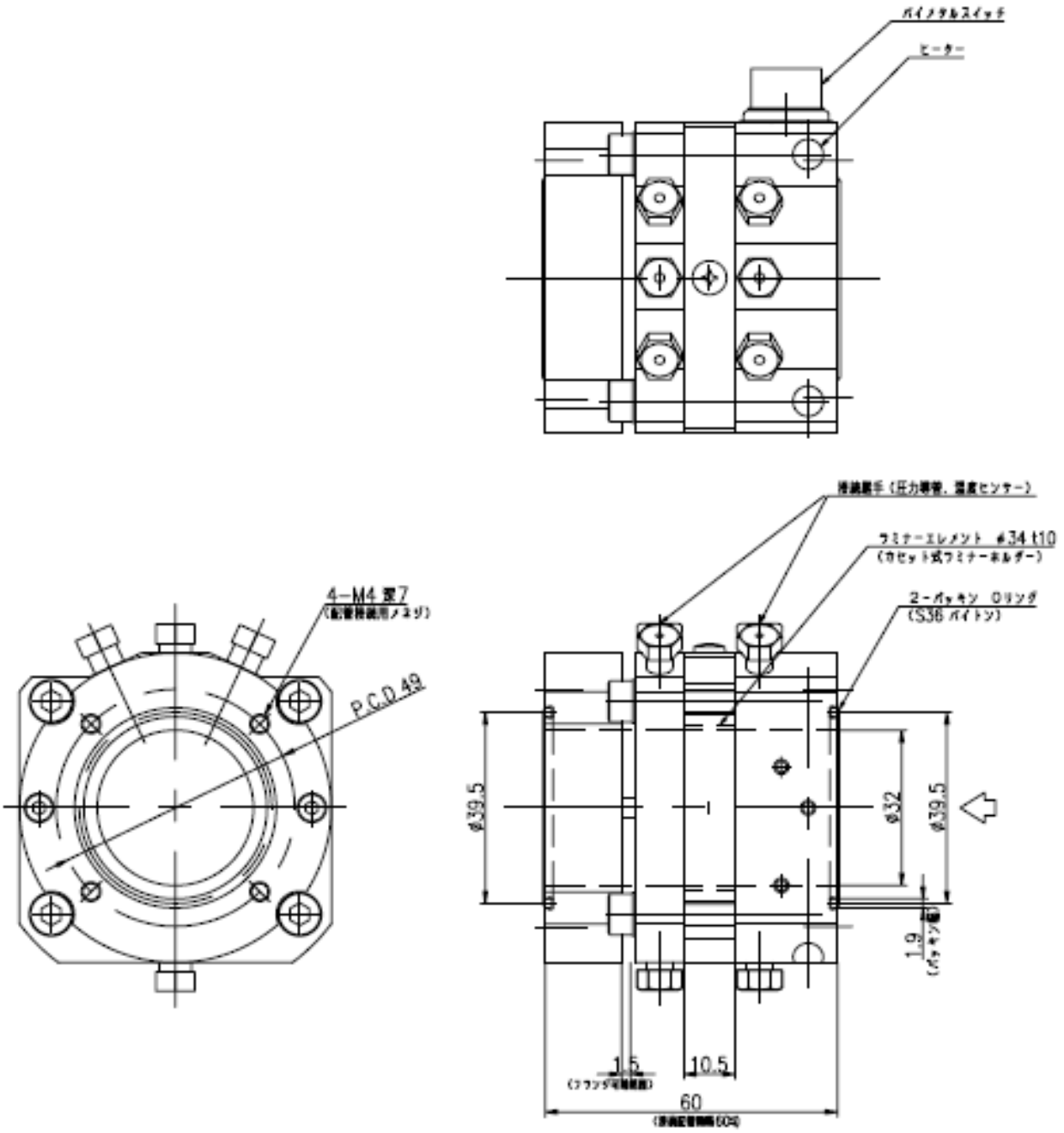
9. Cautions

- Maximum operating temperature of pressure lead tube is 200degC.
- Flow meter body includes electric heater. Please avoid to splash flow meter body with water.
- EGR gas with large amount of condensation water might cause error in flow rate.
- Please consider installation angle of the flow meter body not to choke the pressure lead tube with condensation water.

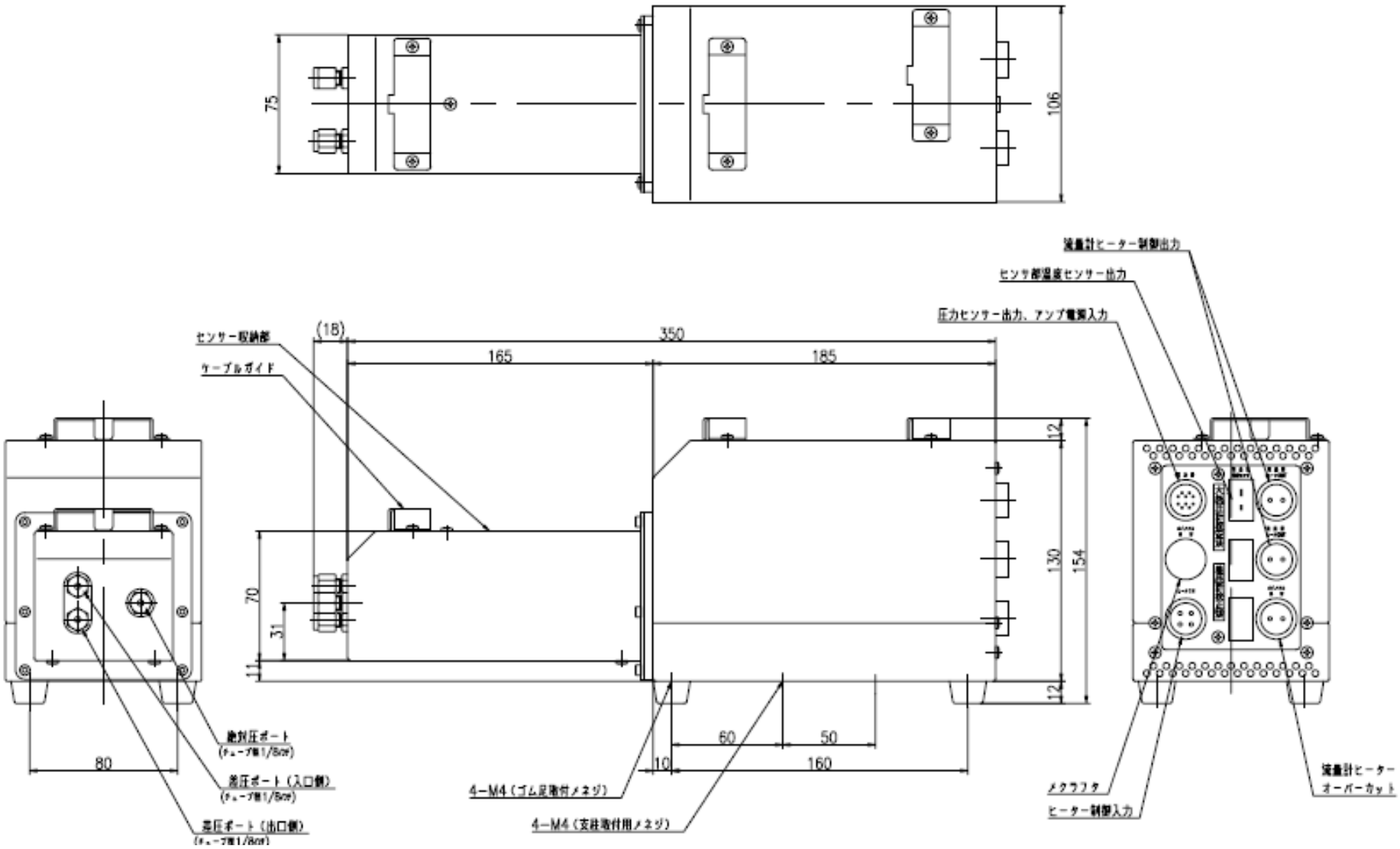
10. Packages and data sheets

- Flow meter body, measurement unit, operation unit
- Pressure leads tube(1m), A set of sensor cables(15m), Power supply cable
- Flow calibration data sheet
  Calibration method: Comparisons of air flow rate with standard laminar flow meter
  Number of flow calibration points: 11points(0%, 10%, …90%, 100% of rated flow)
  Gas temperature: room temperature, 50degC, 100degC, 150degC, 200degC, 250degC
- Inspection sheet
  Display, analog output, temperature control

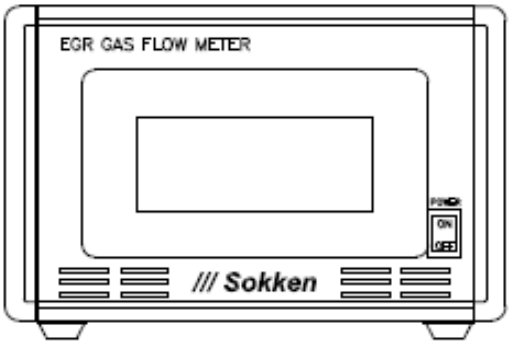
11. Exterior

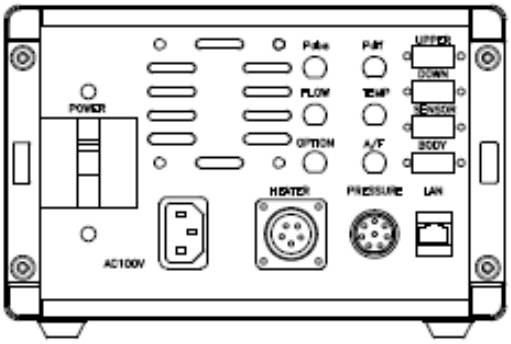


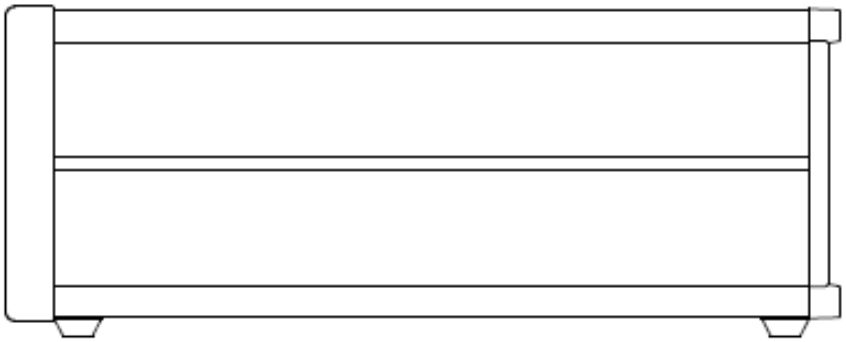
The exterior of flow meter body



The exterior of measurement unit







The exterior of operation unit