High Performance Flow Sensor Module

FS2012 Series
Datasheet

Description

The FS2012 mass flow sensor module measures the flow across a sensing surface using the thermo-transfer (calorimetric) principle. The FS2012 is capable of measuring gas or liquid medium.

The FS2012 offers key advantages over other flow solutions. The sensor utilizes series of MEMS thermocouples, which provide excellent signal-to-noise ratio. The solid thermal isolation along with the silicon-carbide film coating offers excellent abrasive wear resistance and long-term reliability.

The high temperature material used in the flow channel housing and base allows for a wide operating temperature.

Wetted materials consist of a proprietary modified PPO plastic, epoxy, and silicon carbide.

Typical Applications

- Process controls and monitoring
- Oil and gas leak detection
- HVAC and air control systems
- CPAP and respiratory devices
- Automotive MAF
- Liquid dispensing systems

Features

- Gas or liquid mediums
- Robust solid isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Low-power application
- High-temperature flow housing
- Low signal-to-noise ratio
- Analog output: 0V to 5V
- Digital output: I^2C
- Supply voltage: 5V
- Module operating temperature range: 0°C to +85°C
- 53.35 x 24.0 mm module with 6-pin header

FS2012 Flow Sensor Module

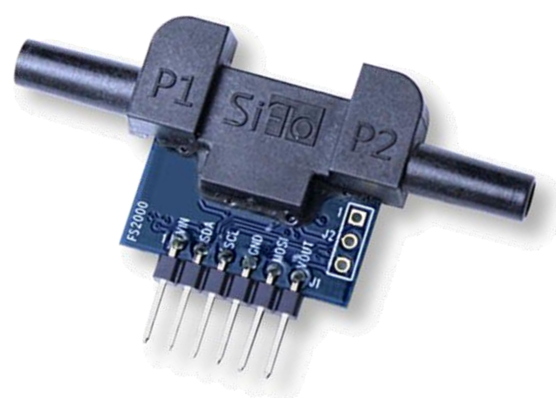

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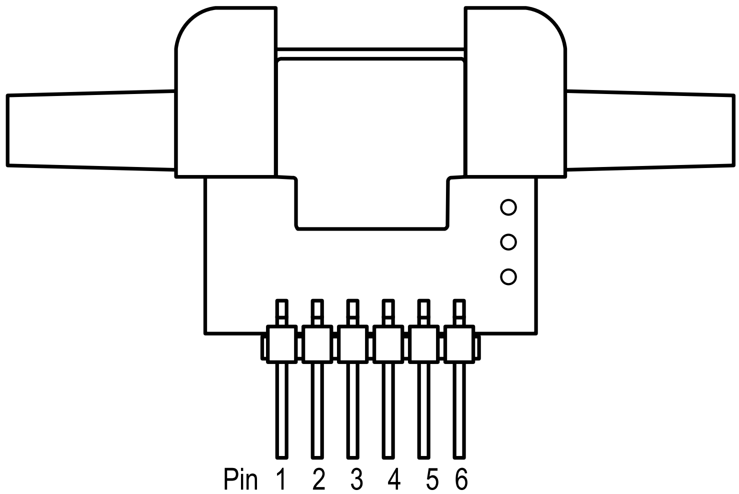
Figure 1. Pin Assignments for Module – Top View



2. Pin Descriptions

Table 1. Pin Descriptions

Pin Number	Pad Name	Type	Description
1	V_{IN}	Input	Supply voltage
2	SDA	Input/Output	Serial data
3	SCL	Input	Serial clock
4	GND	Ground	Ground
5	MOSI		Do not connect
6	V_{OUT}	Output	Analog output

3. Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the FS2012 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Table 2. Absolute Maximum Ratings

Symbol	Parameter	Conditions	Minimum	Maximum	Units
V_{IN}	Supply Voltage		-0.3	5.5	V
T_{STOR}	Storage Temperature		-50	130	°C

4. Operating Conditions

Table 3. Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Units
V_{IN}	Supply Voltage	4.75	5.0	5.25	V
T_{AMB}	Ambient Operating Temperature	0	–	85	°C

5. Electrical Characteristics

Table 4. Electrical Characteristics

Note: See important notes at the end of the table.

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
I_{VIN}	Current Consumption			30		mA
Gas Flow[a], [c], [d] Nitrogen (N_2) at Temperature = 23.5 ± 1.5°C						
F_{NG}	Gas Flow Range	FS2012-1020-NG	0		2 (2000)	SLPM (SCCM)
		FS2012-1100-NG	0		10 (10000)	SLPM (SCCM)
E_{NG}	Flow Accuracy	FS2012-1020-NG; 0.1 to 2 SLPM		±1	±4	% Reading
		FS2012-1100-NG; 0.5 to 10 SLPM				
V_{OUT_ANG}	Analog Voltage Output		0	–	5	V
OFF_{ZERO_NG}	Analog Zero Offset		0	0.003	0.005	V
Liquid Flow[a], [b], [c], [d] DI Water at Temperature = 23.5 ± 1.5°C						
F_{LQ}	Liquid Flow	FS2012-1001-LQ	0		0.5 (500)	SLPM (SCCM)
		FS2012-1002-LQ	0		1.0 (1000)	SLPM (SCCM)
E_{LQ}	Flow Accuracy	FS2012-1001-LQ; 20 to 450 SCCM		±2.5	±7	% Reading
		FS2012-1002-LQ; 20 to 800 SCCM				
V_{OUT_ALQ}	Analog Voltage Output		0	—	5	V
OFF_{ZERO_LQ}	Zero Offset		0	0.003	0.005	V

[a] Direction of flow is from P1 In to P2 Out.

[b] Board circuitry is not protected from liquids.

[c] SLPM: Standard liter per minute.

[d] SCCM: Standard cubic centimeter per minute.

6. Functional Description

The FS2012 digital flow sensor accurately measures the mass flow rate of a liquid or gaseous medium across the sensor using the calorimetric principle.

The MEMS flow sensor comprises a resistive heater and two clusters of thermocouples (thermopiles), each positioned symmetrically upstream and downstream of the heater. The thermopile output changes according to the rate of flow, and it is proportional to the amount of heat sensed from the heater.

7. I^{2}C Sensor Interface

The FS2012 operates as a slave device via the digital I^{2}C compatible communication protocol bus with support for 100kHz and 400kHz bit rates. To accommodate multiple devices, the protocol uses two bi-directional open-drain lines: a Serial Data Line (SDA) and a Serial Clock Line (SCL). Pull-up resistors to VDD are required. Several slave devices can share the bus, and multiple master devices on the same bus are supported. If two or more masters attempt to initiate a data transfer simultaneously, an arbitration scheme is employed with a single master always winning the arbitration. Note that it is not necessary to specify one device as the master in a system; any device that transmits a START bit and a slave address becomes the master for the duration of that transfer.

7.1 Sensor Slave Address

The FS2012 default I^{2}C address is $07_{HEX.}$ The device will respond only to this address.

7.2 Data Read

The FS2012 is programmed to continuously output data to the I^{2}C bus.

- Number of bytes to read out: 2
- First returned byte: MSB
- Second returned byte: LSB

8. Calculating Flow Sensor Output

The entire output of the FS2012 is 2 bytes. The flow rate for gas and liquid parts is calculated as follows:

Output Data

- Number of bytes to read out: 2
- First returned byte: MSB
- Second returned byte: LSB

Gas Part Configurations (-NG ending for part code number)

- Conversion to SLPM
- Flow in SLPM = [(MSB << 8) + LSB] / 1000

Liquid Part Configurations (-LQ ending for part code number)

- Conversion to SCCM
- Flow in SCCM = [(MSB << 8) + LSB] / 10

9. Analog Output

The voltage output is ratiometric to the full scale span. Use the following conversion for the range examples.

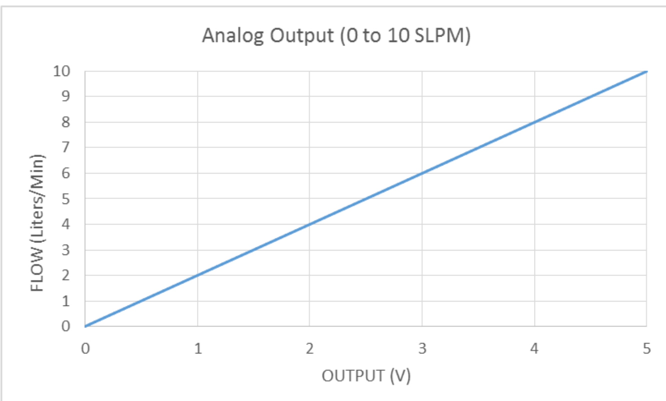
Gas (SLPM)

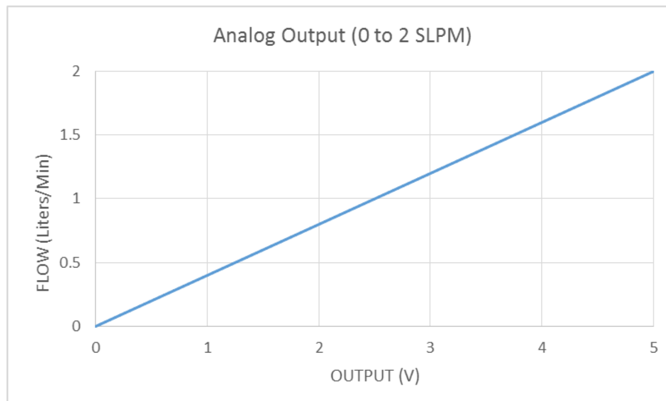
- 0 to 2 SLPM: Flow = 0.4 × Output (V)
- 0 to 10 SLPM: Flow = 2 × Output (V)

Liquid (SCCM)

- 0 to 500 SCCM: Flow = 100 × Output (V)
- 0 to 1000 SCCM: Flow = 200 × Output (V)

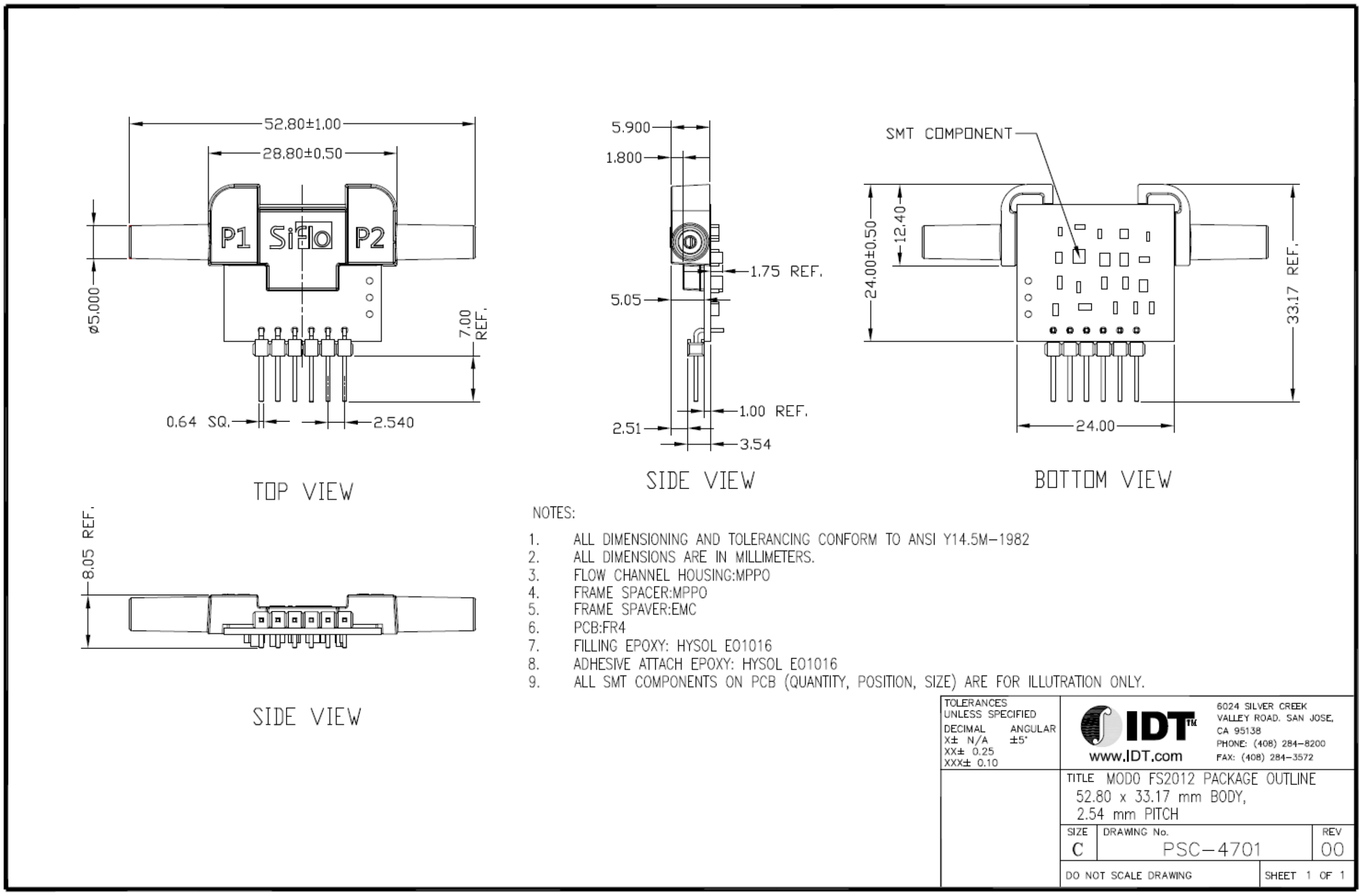
Figure 2. Analog Output Example





10. Mechanical Drawings

Figure 3. FS2012 Module Dimensions



11. Ordering Information

Note: The part code depends on the application. In the part code, NG refers to "non-corrosive gas" and LQ refers to "liquid."

- For NG parts, the calibration gas is nitrogen. Other calibration gases are available on request.
- For LQ parts, the calibration fluid is DI water.

Orderable Part Number	Description and Package	Shipping Packaging	Temperature
FS2012-1020-NG	0 to 2 SLPM calibrated gas flow sensor mounted on a circuit board with a flow housing; digital I^2C and analog output	Box	0°C to +85°C
FS2012-1100-NG	0 to 10 SLPM calibrated gas flow sensor mounted on a circuit board with a flow housing; digital I^2C and analog output	Box	0°C to +85°C
FS2012-1001-LQ	0 to 0.5 SLPM (500 SCCM) calibrated liquid flow sensor mounted on a circuit board with a flow housing; digital I^2C and analog output	Box	0°C to +85°C
FS2012-1002-LQ	0 to 1.0 SLPM (1000 SCCM) calibrated liquid flow sensor mounted on a circuit board with a flow housing; digital I^2C and analog output	Box	0°C to +85°C

12. Revision History

Revision Date	Description of Change
July 19, 2017	Initial release of the preliminary datasheet.

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