Description

The FS1027-DG Gas Flow Sensor Module measures the flow rate using the thermo-transfer (calorimetric) principle.

The FS1027-DG offers key advantages over resistor-based flow solutions. The sensor utilizes thermopile sensing, which provides an excellent signal-to-noise ratio. The sensor comprises a "solid" thermal isolation technology with protective coating.

The FS1027-DG provides calibrated linear output through digital I2C and analog interface.

Features

- Gas flow: 0 to 200 liters/min
- Robust "solid" isolation technology
- Resistant to vibration and pressure shock
- Minimal flow resistance
- Fast response: < 5ms
- Digital I2C output
- Analog voltage output
- Supply voltage: 5V

Typical Applications

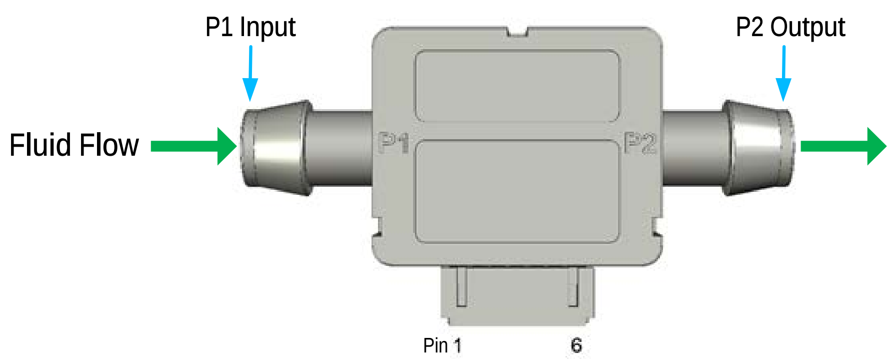
- Ventilators
- Gas metering equipment
- Process controls and monitoring

FS1027-DG Flow Sensor Module

NSF
COMPONENT

Pin Assignments

Figure 1. Pin Assignments for Module – Top View



Pin Descriptions

Table 1. Pin Descriptions

Pin Number	Pad Name	Description
1	VDD	Supply voltage
2	GND	Ground
3	OUTPUT	Flow analog output
4	SDA	Serial data
5	SCL	Serial clock
6	NC	Do not connect[a]

[a] "NC" stands for not connected / no connection required / not bonded.

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 FS1027-DG at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions might affect device reliability.

Table 2. Absolute Maximum Ratings

Symbol	Parameter	Conditions	Minimum	Maximum	Units
V_{IN}	Supply Voltage		2.7	5.5	V
T_{STOR}	Storage Temperature		0	105	°C

Operating Conditions

The FS1027-DG is optimized for operating at 5V in room temperature.

Table 3. Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Units
V_{IN}	Supply Voltage		5		V
T_{AMB}	Ambient Operating Temperature (in air)	0	25	85	°C
P_{CM}	Common-Mode Pressure			30	PSI

Electrical Characteristics

Table 4. Electrical Characteristics

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
I_{VIN}	Current Consumption			21		mA
F_{LQ}	Gas Flow Range		0		200	Liters/min
V_{AOUT}	Analog Output	At 0 liters/min		0.5		V
		At 200 liters/min		4.5		
V_{DOUT}	Digital Output	At 0 liters/min		409		Counts
		At 200 liters/min		3686		
E_{Flow}	Flow Accuracy[a]			1.5	5	% Reading
τ_H	Flow Response Time[b]			5		msec

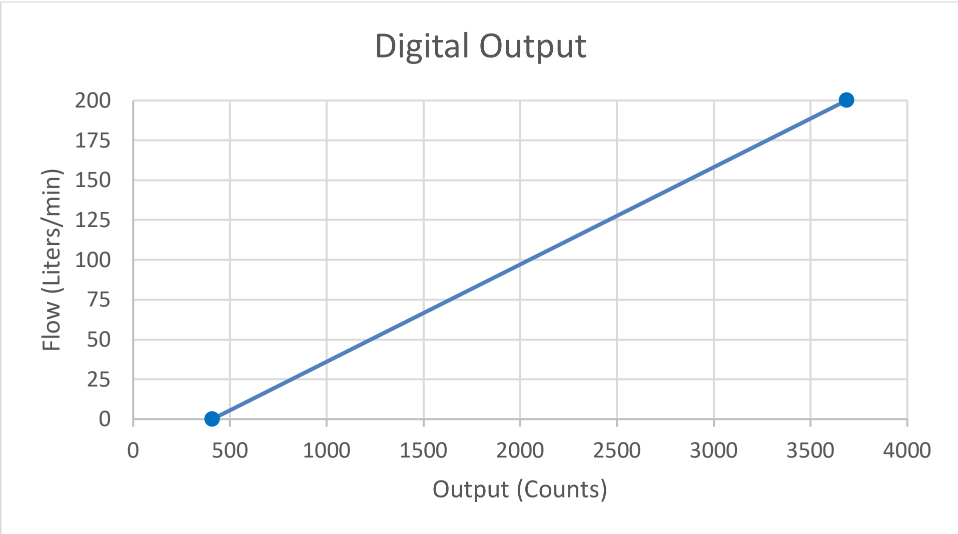
[a] Calibration Standard Condition: 25°C, 1bar.

[b] The flow response time includes a 10% to 90% rise time for the flow sensor to electrically respond to any gas flow change. Measurements might be affected by the pneumatic interface.

Flow Graphs

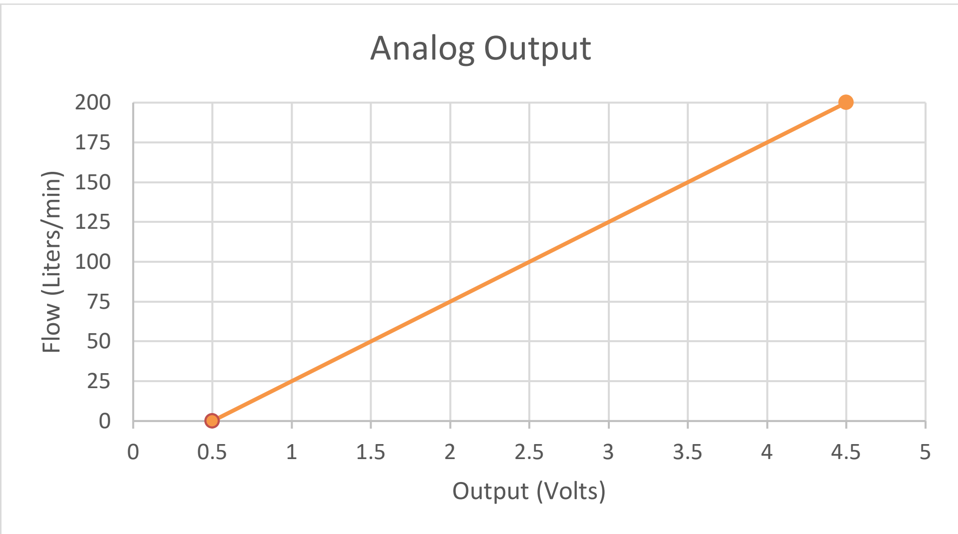
The graph in Figure 2 and Figure 3 shows the digital and analog output versus flow, at 25°C.

Figure 2. Digital Output



Flow (Liters/min)	Digital Output (Counts)
0	409
200	3686

Figure 3. Analog Output

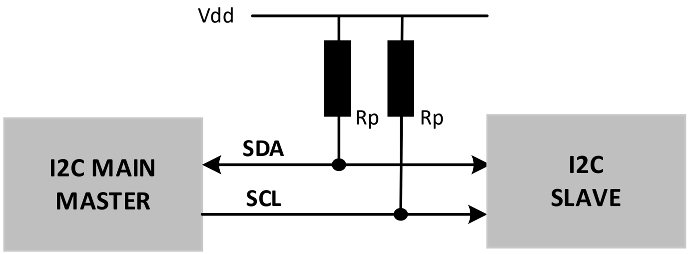


Flow (Liters/min)	Analog Output (Volts)
0	0.5
200	4.5

I2C Sensor Interface

The FS1027-DG includes a digital I2C two-wire interface with a bidirectional data line (SDA) and a clock line (SCL). The two lines are open drain and connected to the supply voltage via two pull-up resistors (Rp). The FS1027-DG operates as a slave device on the I2C bus with support of 100kHz and 400kHz bit rates.

Figure 4. I2C Master-Slave Configuration



The recommended pull-up resistor (Rp) values depend on the system implementation, but a value between 2.2kΩ and 10kΩ can be used.

The capacitive load on both SDA and SCL should be the same, hence the signal lengths should be similar to avoid asymmetry.

Sensor Slave Address

The FS1027-DG default I2C address is 50_{HEX}. The device will respond only to this 7-bit address.

I2C Communication

The START condition is used to initiate I2C communication by the master. The sensor transmission is initiated when the master sends a 0 START bit (S). A HIGH to LOW transition on the SDA line while the SCL is HIGH indicates the beginning of a transmission.

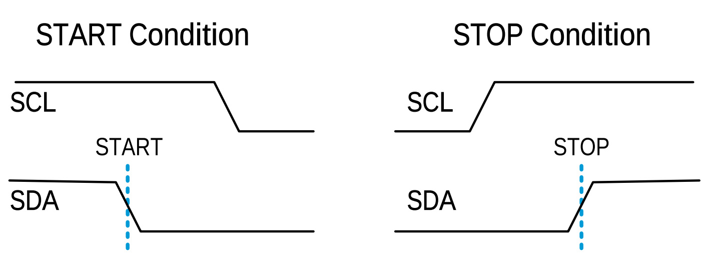
The STOP condition is used to stop I2C communication by the master. The transmission is terminated when the master sends a 1 STOP bit (P). A LOW to HIGH transition on the SDA line while the SCL is HIGH indicates the end of a transmission.

All transfers consist of 8 bits and a response bit: 0 for Acknowledge (ACK) or 1 for Not Acknowledge (NACK). After the ACK is received, another data byte can be transferred or the communication can be stopped with a STOP bit.

The master expects an ACK back from the slave after each byte is transmitted. The slave pulls the SDA low to indicate that it has received a byte and then it frees the I2C bus again. If the slave does not initiate an ACK, then it will consider it a NACK.

Data on the SDA line is always sampled on the rising edge of the SCL line and must remain stable while SCL is HIGH to prevent false START or STOP conditions.

Figure 5. START and STOP Condition Waveform



Digital Output Measurements

The FS1027-DG continuously measures in operation.

The data is sent in byte packages. Each byte is followed by an ACK from the slave. The most significant bit (MSB) is transmitted first.

To read the data, the following command is sent to the FS1027-DG.

After the START bit, the master device sends the 7-bit slave address followed by an eighth bit = 1 (READ). The READ bit indicates a transmission from the FS1027-DG (slave) to master. See Figure 6.

The checksum used for data integrity is returned from the FS1027-DG followed by the two bytes of flow data.

The flow data is a 12-bit integer. Only the least significant four bits in the high byte are valid. See Figure 7.

Figure 6. Flow Data Read Command

	Byte								
	6	5	4	3	2	1	0		
S	1	0	1	0	0	0	0	R (1)	A
	Device Slave Address (0x50), [6:0]								

Figure 7. Flow Data from FS1027-DG

Byte 1									Byte 2									Byte 3								
7	6	5	4	3	2	1	0	A	7	6	5	4	3	2	1	0	A	7	6	5	4	3	2	1	0	A
Checksum [7:0]									Sensor Flow Data, High Byte [3:0]									Sensor Flow Data, Low Byte [7:0]								

Byte 4									Byte 5									
7	6	5	4	3	2	1	0	A	7	6	5	4	3	2	1	0	A	P
Generic Checksum Data [7:0]									Generic Checksum Data [7:0]									

S	START Condition
R	READ Mode
P	STOP Condition
A	Acknowledge (ACK)

Calculating Flow Output

The flow rate for the digital and analog output are calculated with Equation 1 and Equation 2, respectively.

$$Flow\ rate\ (\text{liters/min}) = \frac{Output\ (\text{counts}) - 409}{3277} * 200 \quad \text{Equation 1}$$

$$Flow\ rate\ (\text{liters/min}) = \frac{Output\ (\text{analog}) - 0.5}{4} * 200 \quad \text{Equation 2}$$

Calculating Checksum

The checksum used for data integrity is the 2's complement (negative) of the 256-modulo (8-bit) sum of the data bytes (does not include I2C address).

Figure 7 shows the 5 bytes read:

Example:

Byte 1, 0xCC (Checksum)

Byte 2, 0x01

Byte 3, 0x99

Byte 4, 0x01 or 0x00

Byte 5, 0x99 or 0x00

The 256-modulo (8-bit) sum is calculated as:

$$sum = 0x01 + 0x99 + 0x01 + 0x99 = 0x134$$

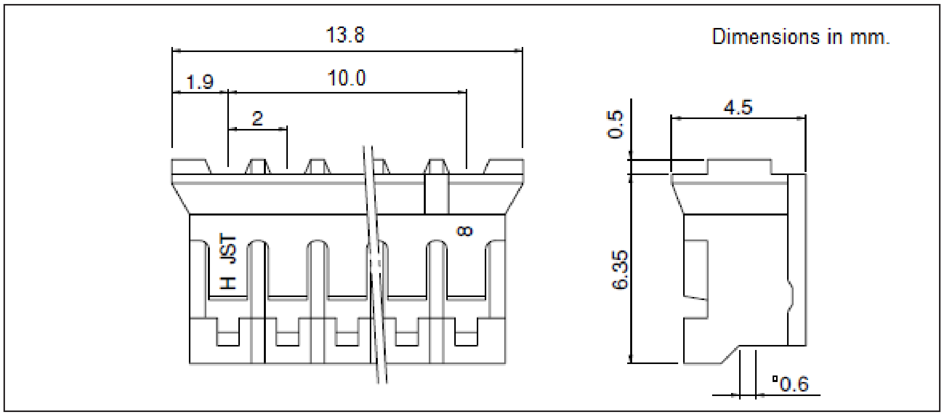
Validating the data payload is done by calculating the sum and adding it to the checksum. If the result is 0x00, then the data is valid.

$$checksum + sum = 0xCC + 0x134 = 0x00$$

Electrical Connector

A 6-position receptacle (not provided) is required to mate to the board crimp style connector. A part number example is PHR-6 (JST).

Figure 8. Receptacle Drawing



Module Material

The wetted contact surface of the FS1027-DG consists of the following:

- Housing – Polyphenylene Ether (PPE) + Polystyrene (PS) blend resin
- Parylene
- Gasket – Silicone

Tubing Guidance

The FS1027-DG module has barb tube endings. Soft tubing with a nominal 5/8inch (15.88mm) internal diameter is recommended for use. A clamp may be necessary to secure the tubing over the barb.

Mechanical Drawings

The package outline drawings are appended at the end of this document and are accessible from the link below. The package information is the most current data available.

www.idt.com/us/en/document/psc/fs1027-package-outline-drawing640-x-315-mm-modulemod0d1

Ordering Information

Orderable Part Number	Description and Package	Shipping Packaging	Temperature
FS1027-1001-DG	0 to 200 liter/min gas flow sensor module with digital and analog voltage output	Box	0°C to +85°C

Revision History

Revision Date	Description of Change
September 25, 2020	Updated flow accuracy spec, flow output charts, and checksum example.
April 28, 2020	Initial release.

FS1027 Package Outline Drawing

64.0 x 31.5 mm Module

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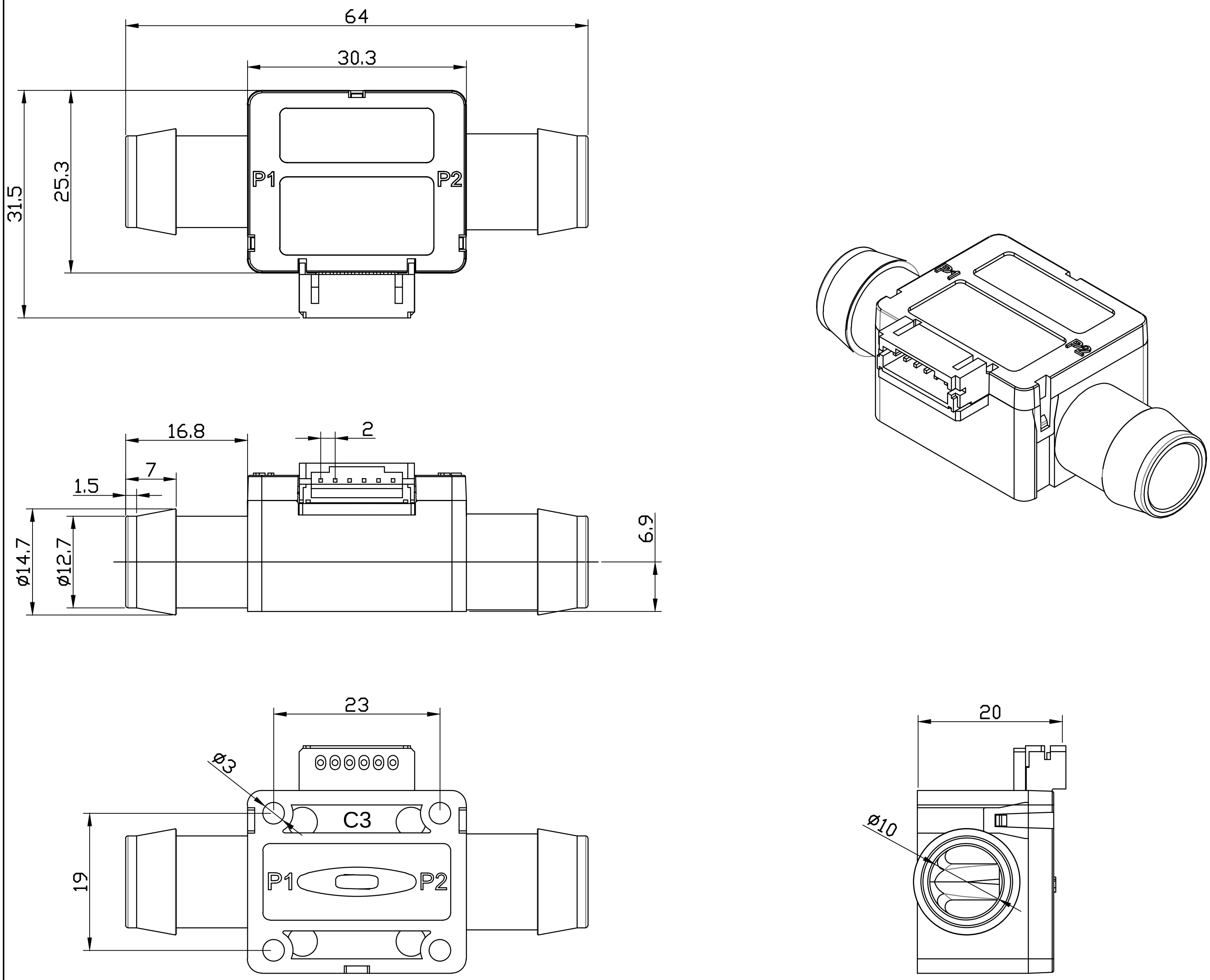

Package Revision History		
Date Created	Rev No.	Description
Nov 28, 2017	Rev 00	Initial Release

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