FS1025-DG

Gas Flow Sensor Module

The FS1025-DG Gas Flow Sensor Module measures the flow rate using the thermo-transfer (calorimetric) principle.

The FS1025-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 FS1025-DG provides calibrated linear output through digital I^2C and analog interface.

FS1025-DG Module Picture

Features

- Gas flow: 0 to 150 liters/min (in nitrogen or air)
- Robust “solid” isolation technology
- Resistant to vibration and pressure shock
- Minimal flow resistance
- Fast response: < 5ms
- Digital I^2C output
- Analog voltage output
- Supply voltage: 5V

Applications

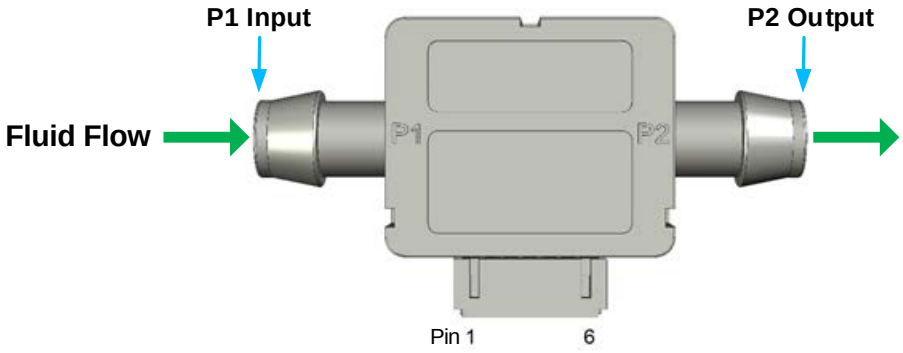
- Ventilators
- Gas metering equipment
- Process controls and monitoring

NSF COMPONENT

Contents

1. Pin Information

1.1 Pin Assignments



FS1025-DG Module Pin Assignments – Top View

1.2 Pin Descriptions

Pin Number	Pin 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. [1]

1. “NC” stands for not connected / no connection required / not bonded.

2. Specifications

2.1 Absolute Maximum Ratings

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by warranty.

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

2.2 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V_{IN}	Supply Voltage	-	5	-	V
T_{AMB}	Ambient Operating Temperature (in air)	0	20	85	°C
P_{CM}	Common-Mode Pressure	-	-	30	PSI

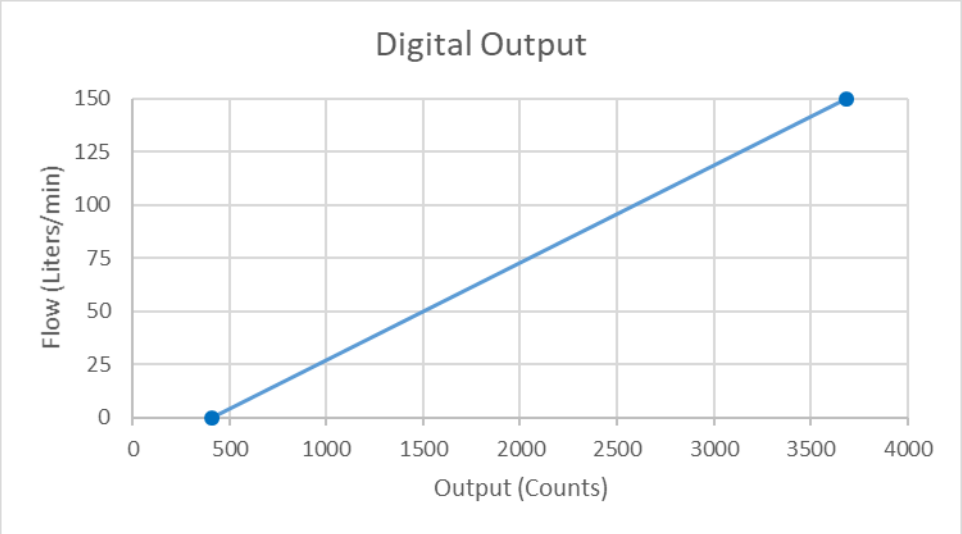
2.3 Electrical Specifications

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
I_{VIN}	Current Consumption	-	-	21	-	mA
F_{LQ}	Gas Flow Range	Tested with nitrogen or air, room temperature.	0	-	150	Liters/min
V_{AOUT}	Analog Output	At 0 liters/min.	-	0.5	-	V
		At 150 liters/min.	-	4.5	-	
V_{DOUT}	Digital Output	At 0 liters/min.	-	409	-	Counts
		At 150 liters/min.	-	3686	-	
E_{Flow}	Flow Accuracy[1]	-	-	1.5	5	% Reading
τ_H	Flow Response Time[2]	-	-	5	-	msec

1. Calibration Standard Condition: 25°C, 1bar, nitrogen gas.
2. 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.

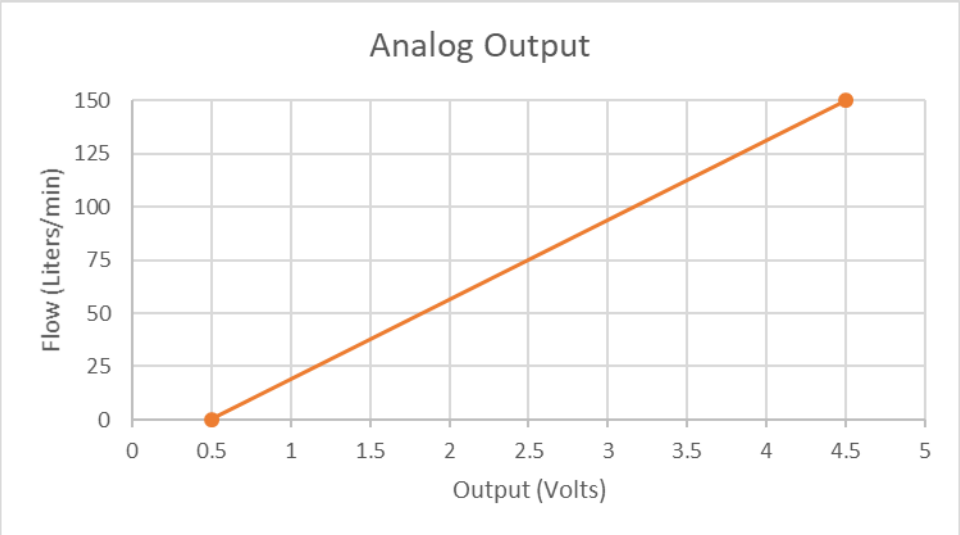
3. Flow Graphs

The graphs in Figure 1 and Figure 2 shows the digital and analog output versus flow, at 25°C, with nitrogen.



Flow (Liters/min)	Digital Output (Counts)
0	409
150	3686

Figure 1. Digital Output



Flow (Liters/min)	Analog Output (Volts)
0	0.5
150	4.5

Figure 2. Analog Output

4. I²C Sensor Interface

The FS1025-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 FS1025-DG operates as a slave device on the I²C bus with support of 100kHz and 400kHz bit rates.

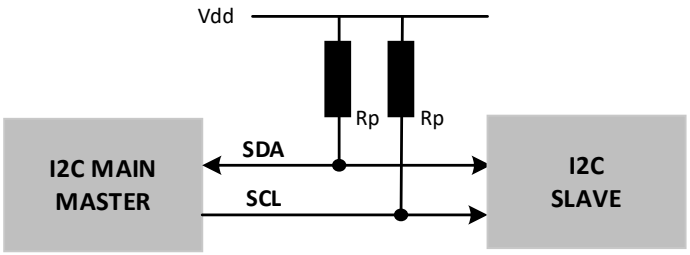


Figure 3. I²C Master-Slave Configuration

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.

4.1 Sensor Slave Address

The FS1025-DG default I²C address is **50_{HEX}**. The device will respond only to this **7-bit address**.

4.2 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.

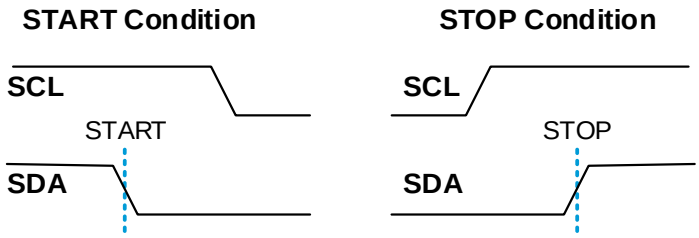


Figure 4. START and STOP Condition Waveform

4.3 Digital Output Measurements

The FS1025-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 FS1025-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 FS1025-DG (slave) to master (see Figure 5).

The checksum used for data integrity is returned from the FS1025-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 6).

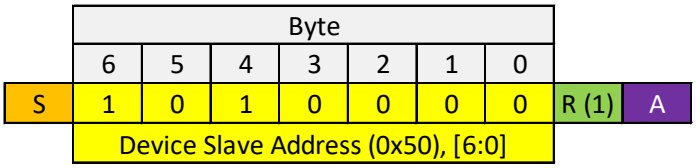


Figure 5. Flow Data Read Command

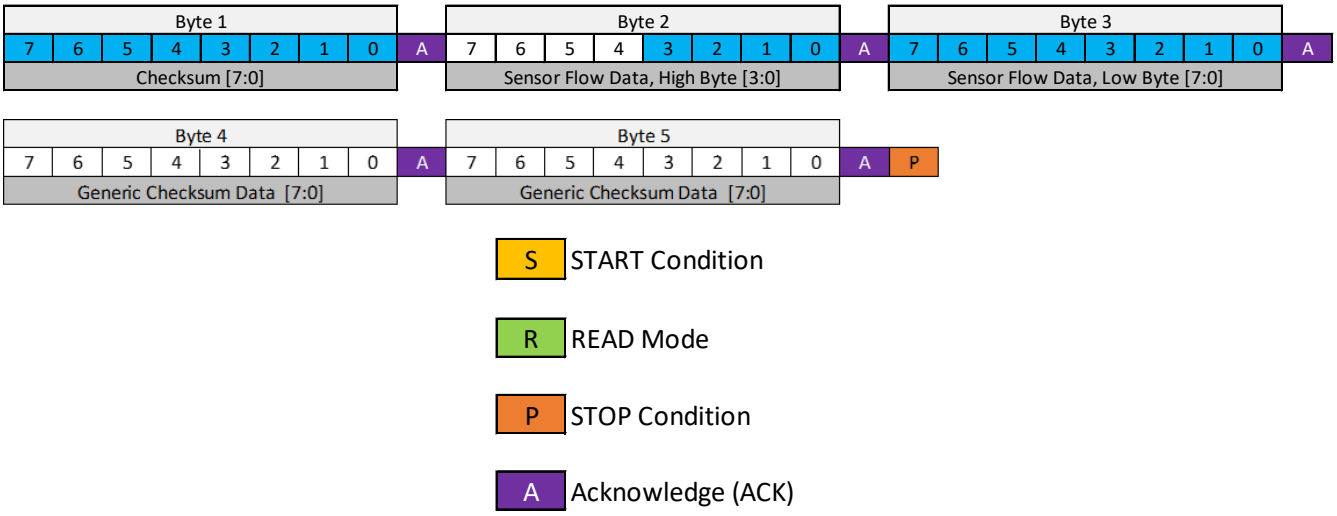


Figure 6. Flow Data from FS1025-DG

4.4 Calculating Flow Output

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

$$Flow\ rate\ (\text{liters/min}) = \frac{Output\ (\text{counts}) - 409}{3277} * 150 \qquad \textbf{Equation 1}$$

$$Flow\ rate\ (\text{liters/min}) = \frac{Output\ (\text{analog}) - 0.5}{4} * 150 \qquad \textbf{Equation 2}$$

4.5 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 6 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.

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

5. 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).

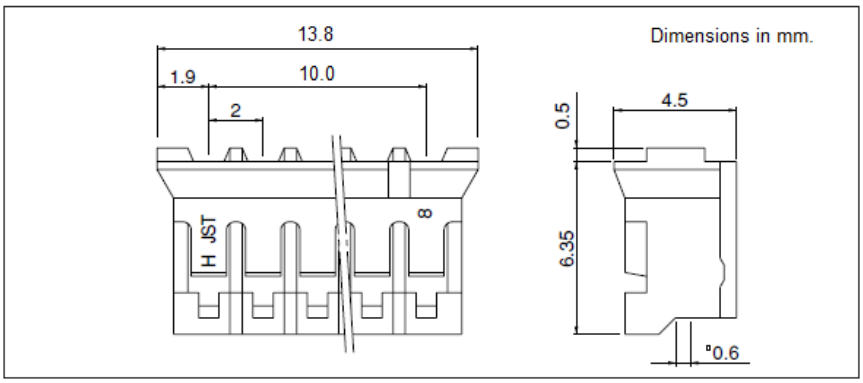


Figure 7. Receptacle Drawing

6. Module Material

The wetted contact surface of the FS1025-DG consists of the following:

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

7. Tubing Guidance

The FS1025-DG module has barb tube endings. Soft tubing with a nominal 7/16-inch (11.1mm) internal diameter is recommended for use. A clamp may be necessary to secure the tubing over the barb.

8. Package Outline Drawings

The package outline drawings are located at the end of this document and are accessible from the Renesas website. The package information is the most current data available and is subject to change without revision of this document.

9. Ordering Information

Part Number	Package Description	Carrier Type	Temperature Range
FS1025-1001-DG	0 to 150 liter/min liquid flow sensor module with digital and analog voltage output (see MOD01)	Box	0° to +85°C

10. Revision History

Revision	Date	Description
1.02	Sep 2, 2022	Updated reference with nitrogen gas. Reformatted to the latest template.
1.01	Sep 25, 2020	Updated flow accuracy spec, flow output charts, and checksum example.
1.00	Apr 28, 2020	Initial release.

FS1025 Package Outline Drawing

60.0 x 31.5 mm Module

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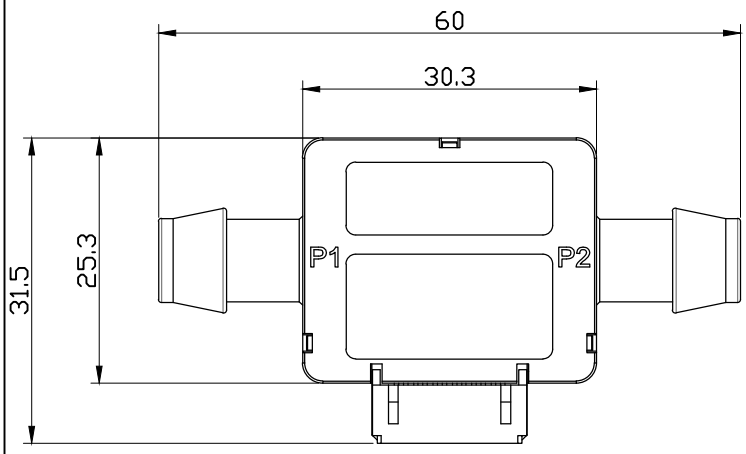

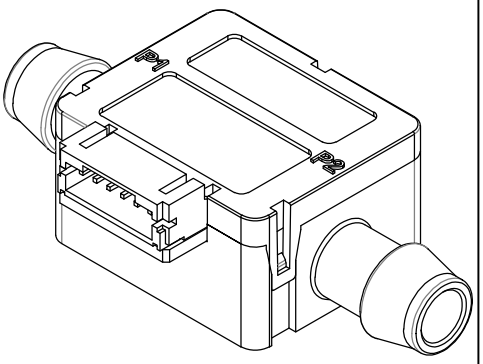

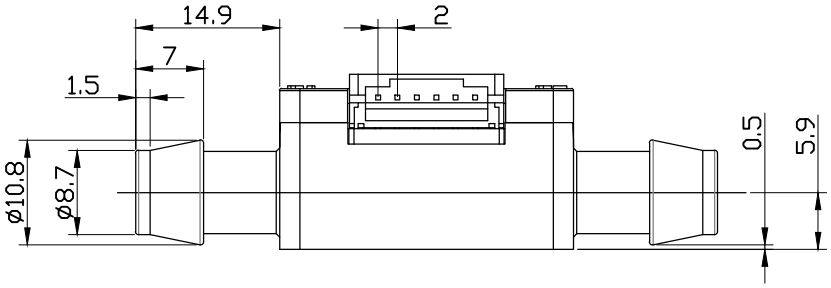

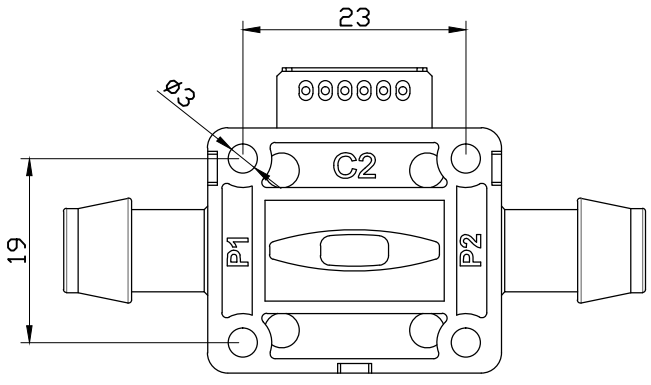

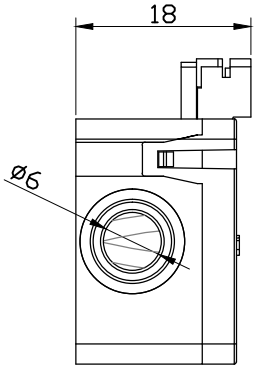

Package Revision History		
Date Created	Rev No.	Description
Nov 28, 2017	Rev 00	Initial Release

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