

## Description

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 uses thermopile sensing, which provides an excellent signal-to-noise ratio. The sensor comprises a "solid" thermal isolation technology and silicon-carbide coating, which protects it from abrasive wear and provides robustness and long-term reliability. In comparison, other sensors typically contain a fragile membrane above an etched cavity for the thermal isolation base.

The FS1025-DG provides a digital I2C and analog output.

## Typical Applications

- Ventilators
- Gas metering equipment
- Process controls and monitoring

## Features

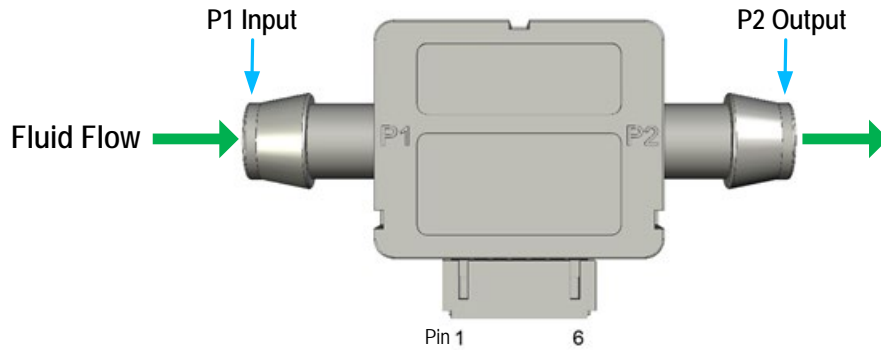
- Gas flow: 0 to 150 liters/min
- Robust "solid" isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Low-power application
- Minimal flow resistance
- Fast response: < 5ms
- Digital I2C output
- Analog voltage output
- Supply voltage: 5V
- Module operating temperature range: 0°C to +85°C

## FS1025-DG Flow Sensor Module



## Pin Assignments

Figure 1. Pin Assignments for Module – Top View



## Pin Descriptions

Table 1. Pin Descriptions

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

[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 FS1025-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 FS1025-DG is optimized for operating at 5V in room temperature. A regulated 5V supply voltage must be used to conform to the output curves provided. Variations in the supply voltage will result in a slightly different output curve.

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	20	85	°C
$P_{CM}$	Common-Mode Pressure			30	PSI

## Electrical Characteristics

Table 4. Electrical Characteristics

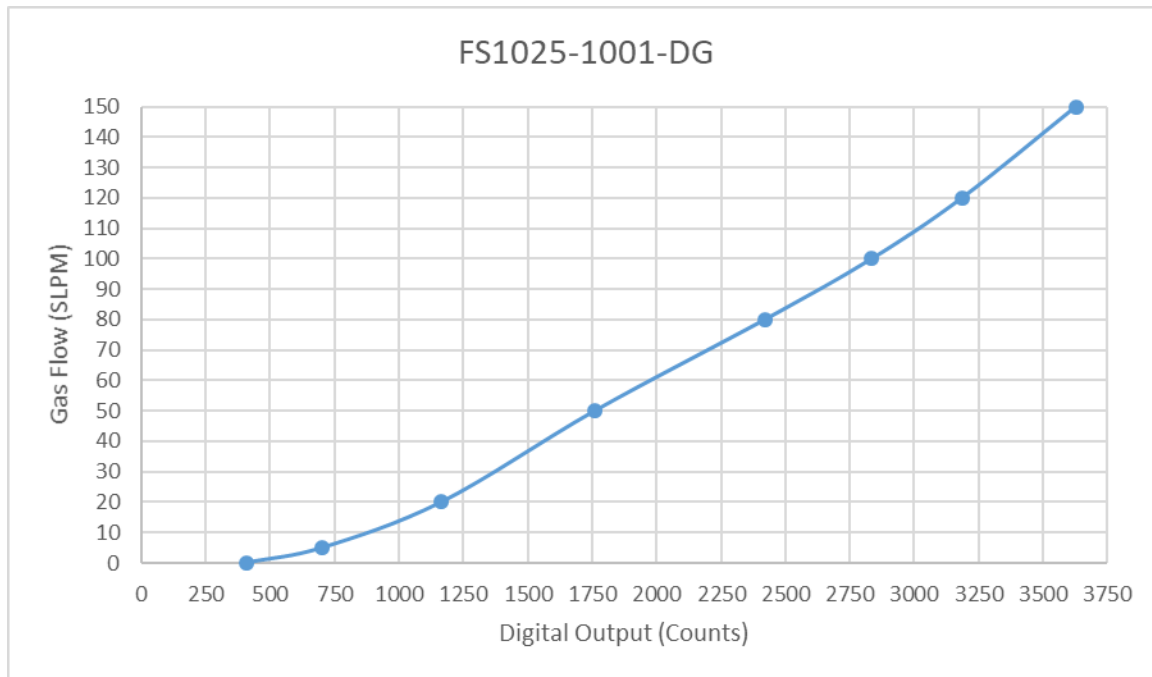
Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
$I_{VIN}$	Current Consumption			10	15	mA
$F_{LQ}$	Gas Flow Range		0		150	Liter/min
$V_{AOUT}$	Analog Voltage Output	At 0 liters/min		0.5		V
		At 80 liters/min		3.0		
		At 150 liters/min		4.5		
$V_{DOUT}$	Digital Output	At 0 liters/min		409		Counts
		At 100 liters/min		2835		
		At 150 liters/min		3630		
$\tau_H$	Flow Response Time <sup>[a]</sup>			5		msec

[a] 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

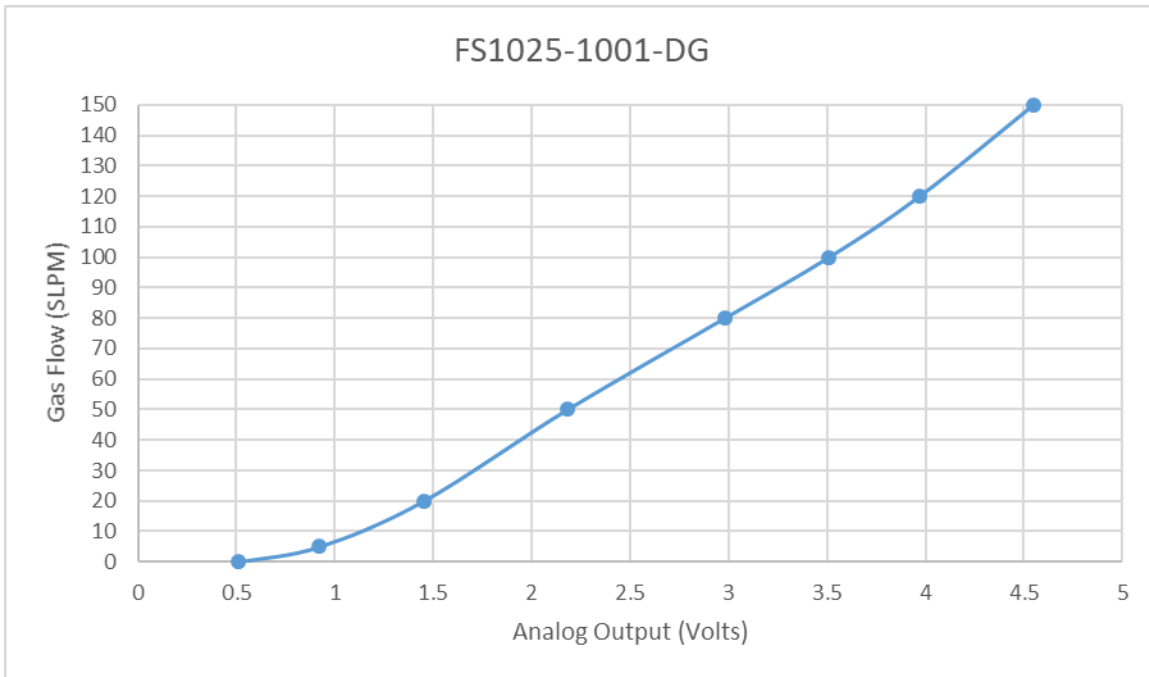
The graphs in Figure 2 and Figure 3 shows the digital and analog output versus flow.

Figure 2. Digital Output Curve



Flow (Liters/min)	Digital Output (Counts)
0	409
5	703
20	1165
50	1760
80	2420
100	2835
120	3185
150	3627

Figure 3. Analog Output Curve

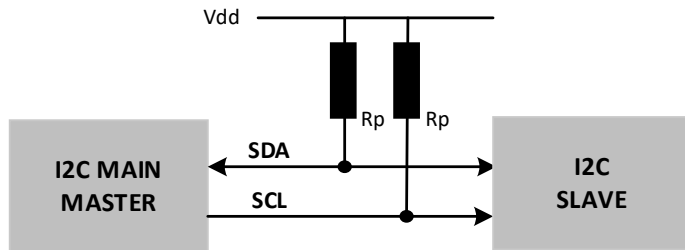


Flow (Liters/min)	Analog Output (Volts)
0	0.51
5	0.92
20	1.45
50	2.18
80	2.98
100	3.51
120	3.97
150	4.55

## 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 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, therefore, the signal lengths should be similar to avoid asymmetry.

## Sensor Slave Address

The FS1025-DG default I2C address is 50<sub>HEX</sub>. 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.

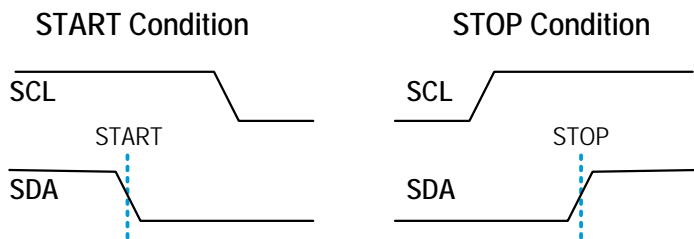
The STOP condition is used to stop I2C communication by the master. The transmission is terminated when the master sends a 1 STOP bit (P). A LOW-to-HIGH transition on the SDA line while the SCL is HIGH indicates the end of a transmission.

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

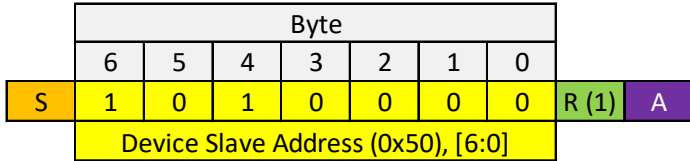


## Digital Output Measurements

The 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.

Figure 6. Flow Data Read Command

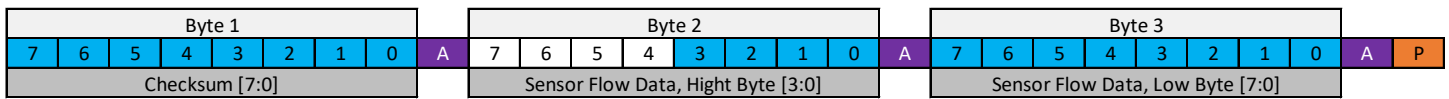


After the START bit, the master device sends the 7-bit slave address followed by an eighth bit = 1 (READ). The READ bit indicates a transmission from the FS1025-DG (slave) to master (see Figure 6).

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 7).

Figure 7. Flow Data from FS1025-DG



**S** START Condition

**R** READ Mode

**P** STOP Condition

**A** Acknowledge (ACK)

## 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). This can be calculated using:

$$checksum = 1 + \sim(sum)$$

Example:

If the I2C payload bytes from a normal read operation are { 0xC9, 0x0B, 0x28, 0x04, 0x00 }, the 256-modulo (8-bit) sum is calculated as:

$$sum = 0x0B + 0x28 + 0x04 + 0x00 = 0x37$$

Then the checksum is calculated as:

$$checksum = 0x01 + \sim(0x37) = 0x01 + 0xC8 = 0xC9$$

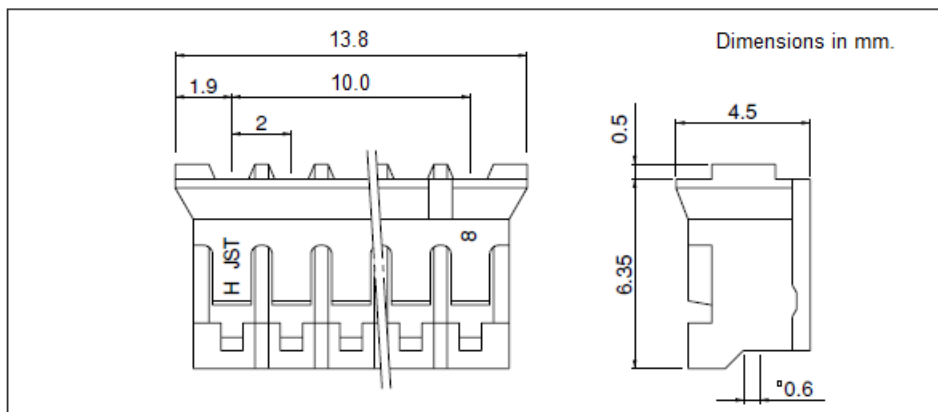
Validating the data payload is done by calculating the sum and adding it to the checksum. If the result is 0x00, then the data is valid.

$$checksum + sum = 0xC9 + 0x37 = 0x00$$

## Electrical Connector

A six-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 FS1025-DG consists of the following:

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



## Tubing Guidance

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

## Package Outline 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.

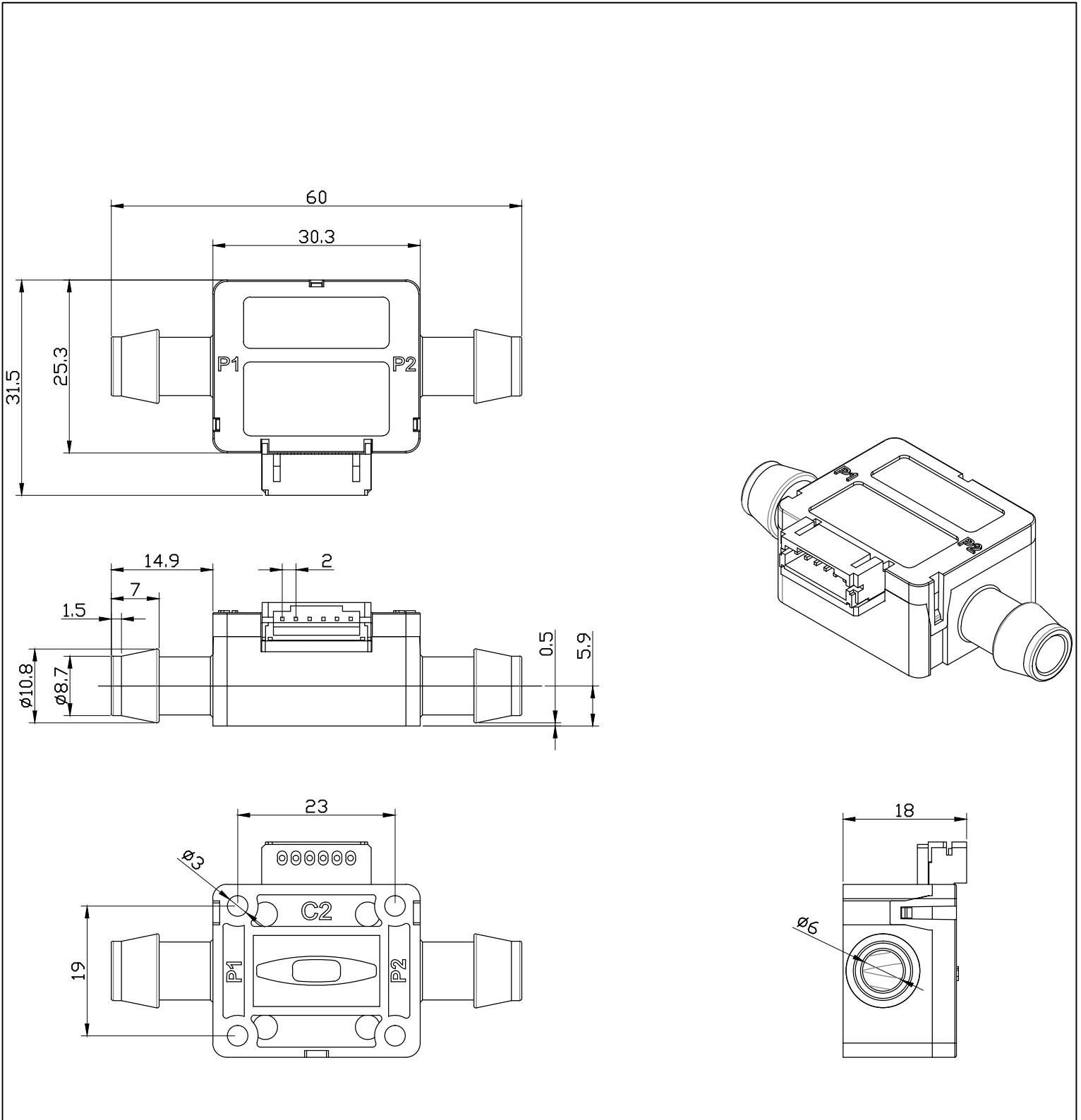
<https://www.idt.com/document/psc/fs1025-package-outline-drawing600-x-315-mm-modulemod0d1>

## Ordering Information

Orderable Part Number	Description and Package	Shipping Packaging	Temperature
FS1025-1001-DG	0 to 150 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
April 30, 2020	Initial release.



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

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### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

### Contact Information

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