FS1023-DL

Liquid Flow Sensor Module

The FS1023-DL liquid flow sensor module measures the flow rate using the thermo-transfer (calorimetric) principle.

The FS1023-DL 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 with protective coating.

The non-linear flow output curve allows for sensitivity from low to full-scale flow rates. The FS1023-DL provides digital I2C and analog output.

Module Picture



Features

- Liquid flow: 0 to 3 liters/min
- Robust “solid” isolation technology
- Resistant to vibration and pressure shock
- Minimal flow resistance
- Digital I2C output
- Analog voltage output
- Supply voltage: 5V

Applications

- Water dispensers
- Liquid metering or switch
- Process controls and monitoring

NSF COMPONENT

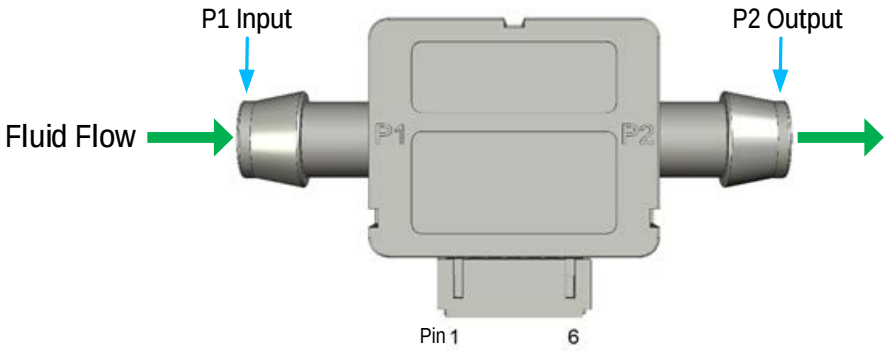
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1. Pin Information

1.1 Pin Assignments



Top View

1.2 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 [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	85	°C

2.2 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V_{IN}	Supply Voltage	4.7	5	5.5	V
T_{AMB}	Ambient Operating Temperature (in air)	0		70	°C
P_{STAT}	Static Pressure			30	PSI

2.3 Electrical Characteristics

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
I_{VIN}	Current Consumption			20	25	mA
F_{LQ}	Liquid Flow Range		0		3	Liter/ min
V_{AOUT}	Analog Voltage Output	At 0 liters/min		0.5		V
		At 3 liters/min		4.5		
V_{DOUT}	Digital Output	At 0 liters/min		409		Counts
		At 3 liters/min		3660		
τ_H	Flow Response Time [1]			5		msec

1. The flow response time includes a 10% to 90% rise time for the flow sensor to electrically respond to any flow change. Measurements may be affected by the pneumatic interface.

3. Typical Flow Graphs

Figure 2 and Figure 3 show the typical digital and analog output versus flow.

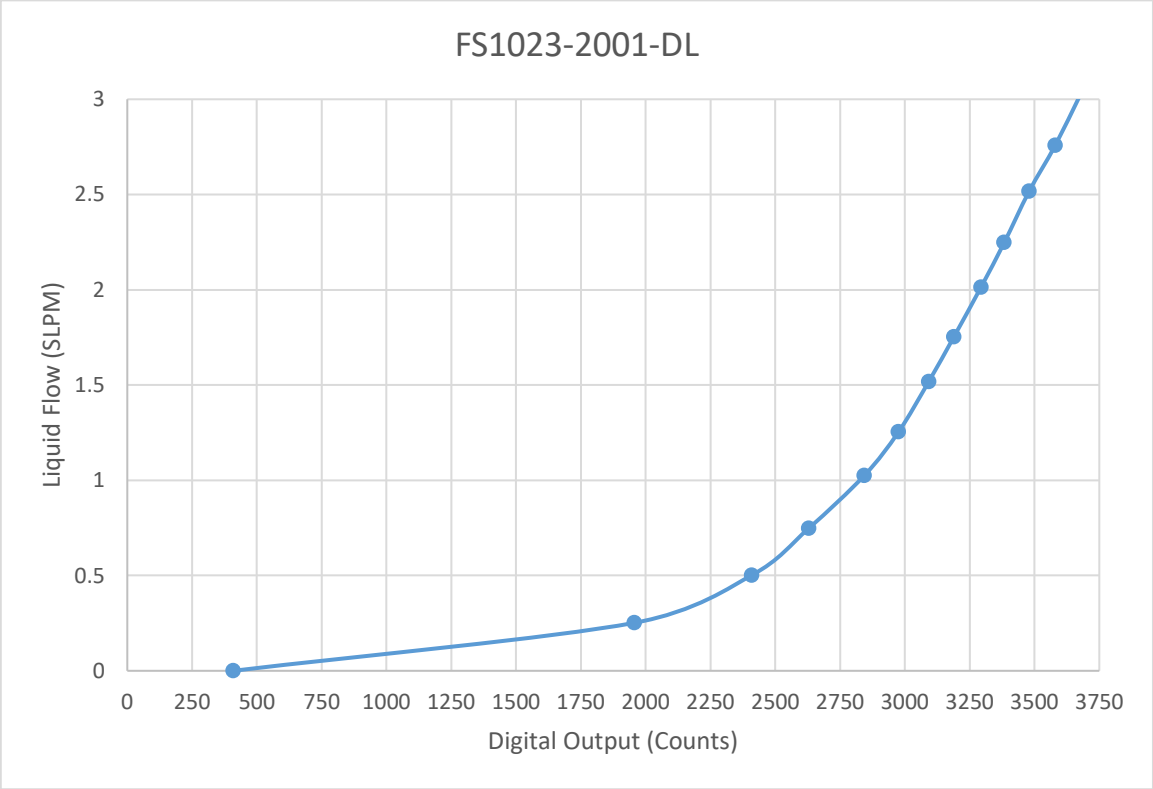


Figure 1. Digital Output Curve

Flow (Liters/min)	Digital Output (Counts)
0	409
0.252	1957
0.501	2408
0.748	2629
1.026	2844
1.253	2975
1.518	3092
1.753	3189
2.012	3293
2.247	3383
2.516	3479
2.758	3580
3.027	3678

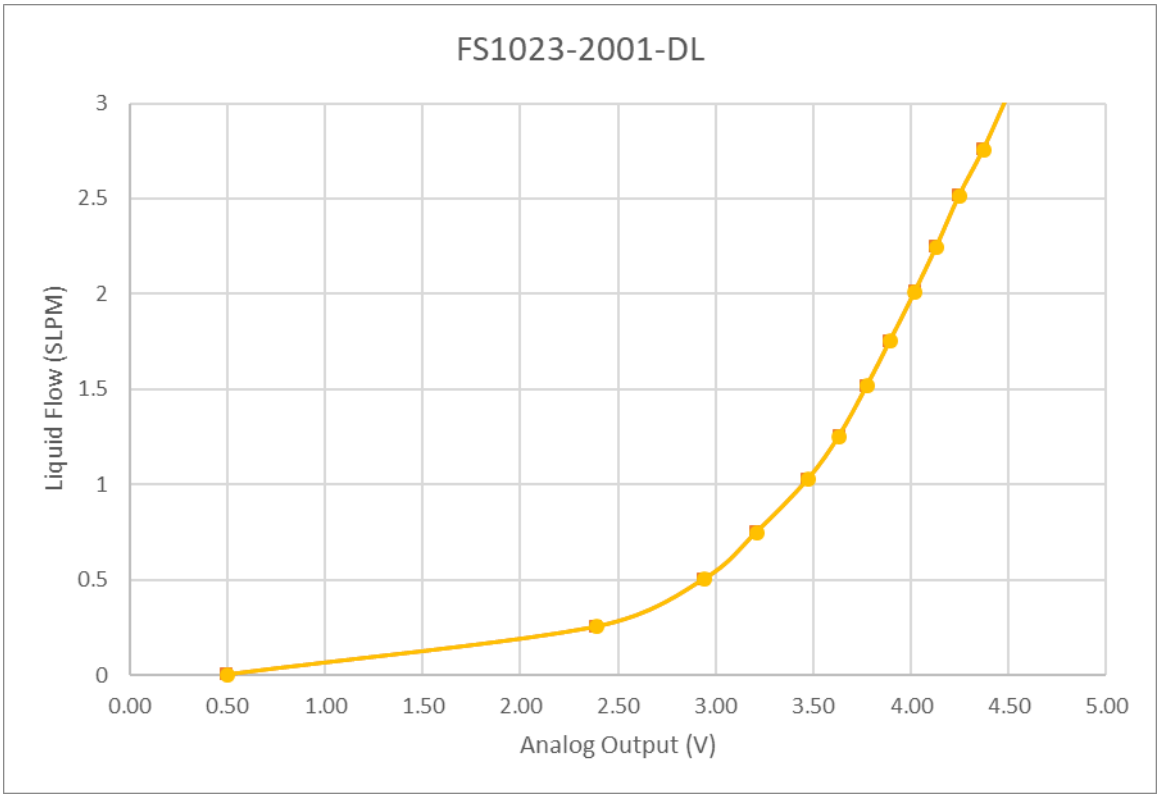


Figure 2. Analog Output Curve

Flow (Liters/min)	Analog Output (V)
0	0.50
0.252	2.39
0.501	2.94
0.748	3.21
1.026	3.47
1.253	3.63
1.518	3.77
1.753	3.89
2.012	4.02
2.247	4.13
2.516	4.25
2.758	4.37
3.027	4.49

4. I2C Sensor Interface

The FS1023-DL 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 are connected to the supply voltage via two pull-up resistors (Rp). The FS1023-DL operates as a slave device on the I2C bus with support of 100kHz and 400kHz bit rates.

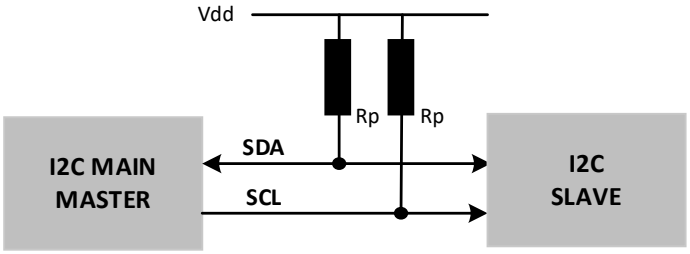


Figure 3. I2C Master-Slave Configuration

The recommended pull-up resistor (Rp) values depend on the system implementation; however, 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.

4.1 Sensor Slave Address

The FS1023-DL 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.

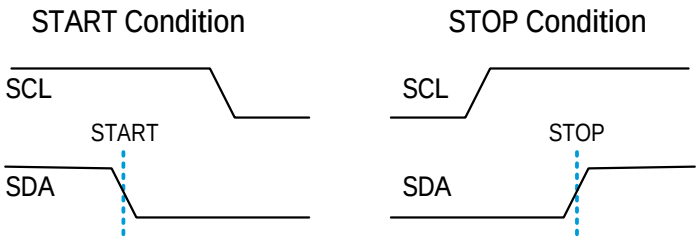


Figure 4. START and STOP Condition Waveform

4.3 Digital Output Measurements

The FS1023-DL 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 FS1023-DL.

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 FS1023-DL (slave) to master (see Figure 6).

The checksum used for data integrity is returned from the FS1023-DL 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).

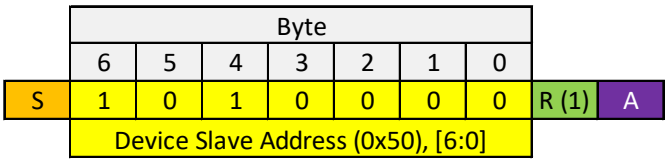


Figure 5. Flow Data Read Command

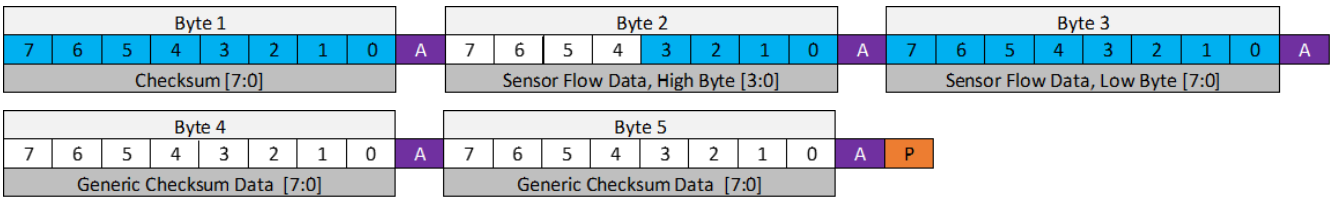


Figure 6. Flow Data from FS1023-DL

4.4 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:

(EQ) 1 $$sum = 0x01 + 0x99 + 0x01 + 0x99 = 0x134$$

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.

(EQ) 2 $$checksum + sum = 0xCC + 0x134 = 0x00$$

4.5 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).

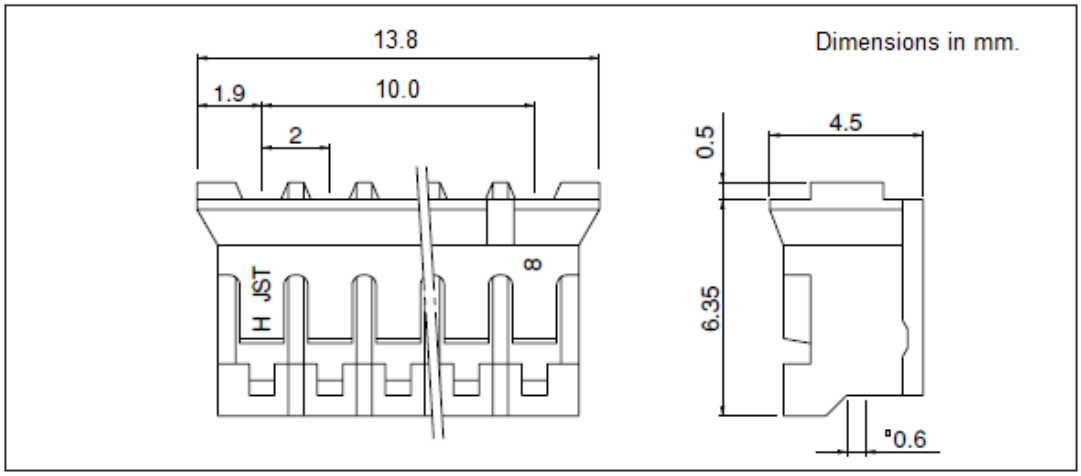


Figure 8. Receptacle Drawing

4.6 Module Material

The wetted contact surface of the FS1023-DL consists of the following:

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

4.7 Tubing Guidance

The FS1023-DL module has barb tube endings. Soft tubing with a nominal 3/8inch (9.5mm) internal diameter is recommended for use. A clamp may be necessary to secure the tubing over the barb.

5. Package Outline Drawings

The package outline drawings are located at the end of this document and are accessible from the Renesas website (see Ordering Information for POD links). The package information is the most current data available and is subject to change without revision of this document.

6. Ordering Information

Part Number	Package Description	Carrier Type	Temperature Range
FS1023-2001-DL	0 to 3 liter/min liquid flow sensor module with digital and analog voltage output (see MOD1)	Tray	0° to +70°C

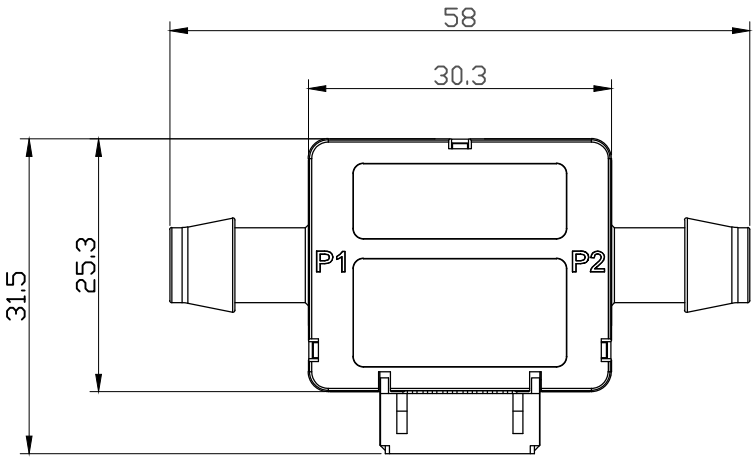
7. Revision History

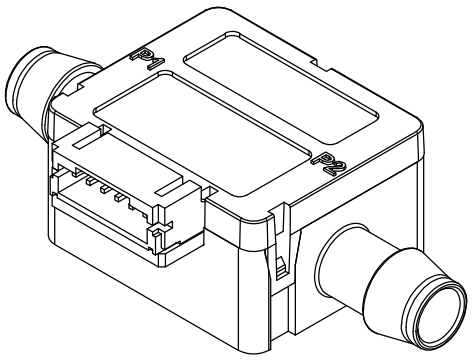
Revision	Date	Description
2.0	Jul 1, 2021	Corrected current consumption
1.0	Mar 2, 2021	Initial release.

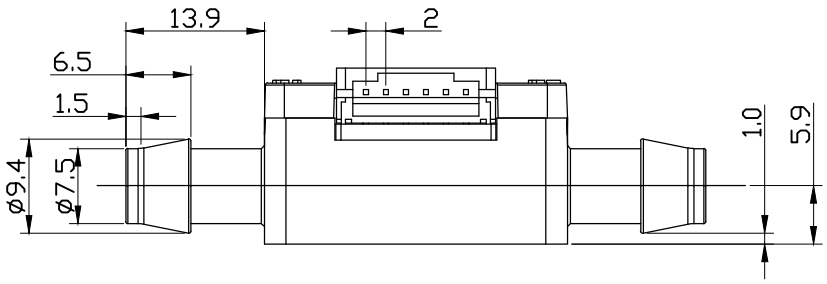
FS1023 Package Outline Drawing

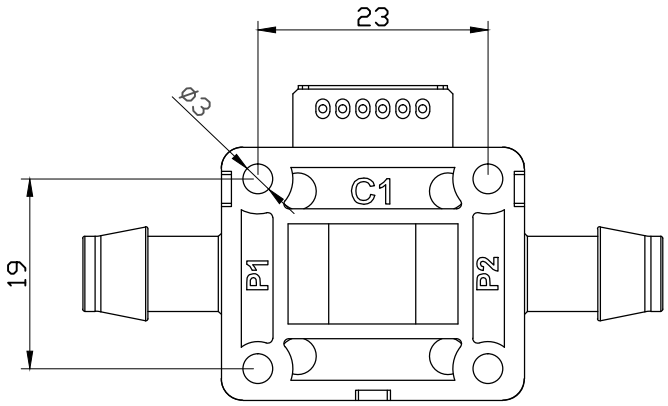
58.0 x 31.5 mm Module

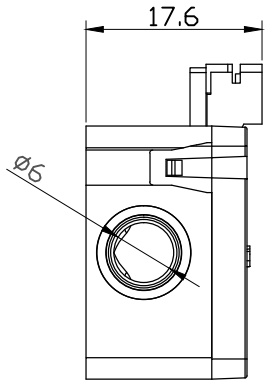
MOD0D1, PSC-4740-01, Rev 00, Page 1











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

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