

SLF3S-1300F Liquid Flow Sensor

Made to Measure – The Next Level in Liquid Flow Sensing

- Low flow sensing up to ± 40 ml/min
- Calibrated for H₂O and IPA
- Temperature compensated
- Turn down ratio 200:1 or better
- Very compact and light-weight form factor
- Response time below 20 ms



Product Summary

The SLF3S-1300F is Sensirion's compact liquid flow sensor designed for high-volume applications. It enables precise and reliable measurements of dynamic liquid flow rates up to 40 ml/min bi-directionally.

The SLF3S-1300F sensor features a digital interface (I²C) via a 6-pin standard electrical connector.

The SLF3S-1300F builds on the latest generation CMOSens® sensor chip that is at the heart of Sensirion's flow sensing platform and allows achieving an outstanding performance. The patented CMOSens® technology combines the sensor element, signal processing and digital calibration on a small CMOS chip. The well-proven CMOS technology is perfectly suited for high-quality mass production and is the ideal choice for demanding and cost-sensitive OEM applications.

Benefits of Sensirion's CMOSens® Technology

- High reliability and long-term stability
- Best signal-to-noise ratio
- Industry-proven technology with a track record of more than 20 years
- Designed for mass production and high process capability

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1 Sensor Performance

The following Table 1 and Table 2 list the specifications of the SLF3S-1300F liquid flow sensor for. The product comes fully calibrated for water (H₂O) and Isopropyl alcohol (IPA).

Parameter	SLF3S-1300F	Unit
H ₂ O Full scale flow rate	±40	ml/min
H ₂ O Sensor output limit ¹	±65	ml/min
Accuracy ² (whichever error is larger)	±5 0.05	% of measured value ml/min
Repeatability ² (whichever error is larger)	±0.5 0.01	% of measured value ml/min
Temperature coefficient ³ (additional error / °C; whichever is larger)	0.2 0.002	% measured value / °C ml/min / °C
Mounting orientation sensitivity ⁴	<0.02	ml/min

Table 1: Specifications for liquid flow sensor SLF3S-1300F (all data for medium H₂O, at 23 °C, and for VDD 3.5 V)

Parameter	SLF3S-1300F	Unit
IPA Full scale flow rate	±40	ml/min
IPA Sensor output limit ¹	±65	ml/min
Accuracy (whichever error is larger)	±10 0.2	% of measured value ml/min
Repeatability (whichever error is larger)	±0.5 0.01	% of measured value ml/min
Temperature coefficient ³ (additional error / °C; whichever is larger)	0.2 0.004	% measured value / °C ml/min / °C
Mounting orientation sensitivity ⁴	<0.05	ml/min

Table 2: Specifications for liquid flow sensor SLF3S-1300F (all data for medium IPA, at 23 °C, and for VDD 3.5 V)

¹ Flow rate at which the sensor output saturates. See section 1.1 for performance between full scale and saturation point.

² Accuracy respectively repeatability specifications valid for flow rates below ±20 ml/min. See the charts in section 2 for the accuracy and repeatability specifications, respectively, between ±20 ml/min and full scale.

³ Additional accuracy error in case liquid and ambient temperatures are similar but both deviating from 23 °C.

⁴ Maximum additional error when flow channel is vertical.

1.1 Specification Charts

The SLF3S-1300F liquid flow sensor shows bi-directional, linear transfer characteristics. The product comes fully calibrated for water (H₂O) and Isopropyl alcohol (IPA).

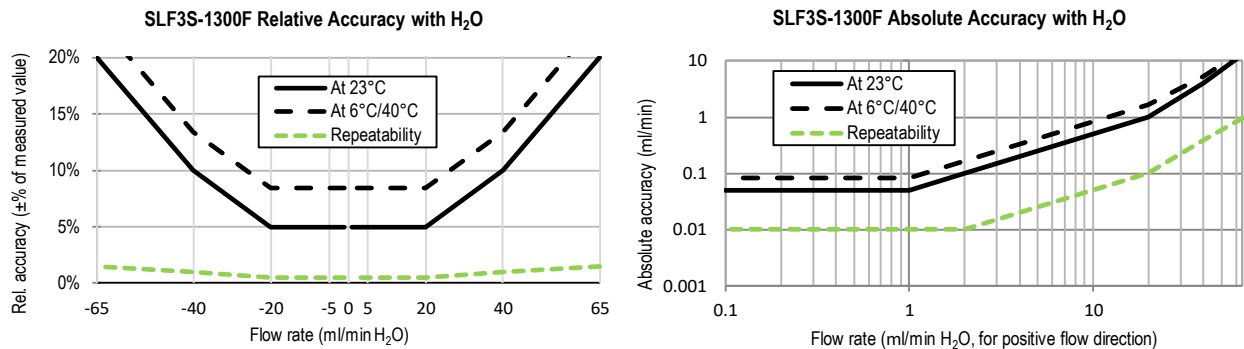


Figure 1: Left: Liquid flow sensor accuracy and repeatability across the flow range of the SLF3S-1300F. Relative error in $\pm\%$ of measured value for H₂O. Right: Liquid flow sensor accuracy and repeatability across the positive flow range of the SLF3S-1300F. Absolute error in ml/min for H₂O.

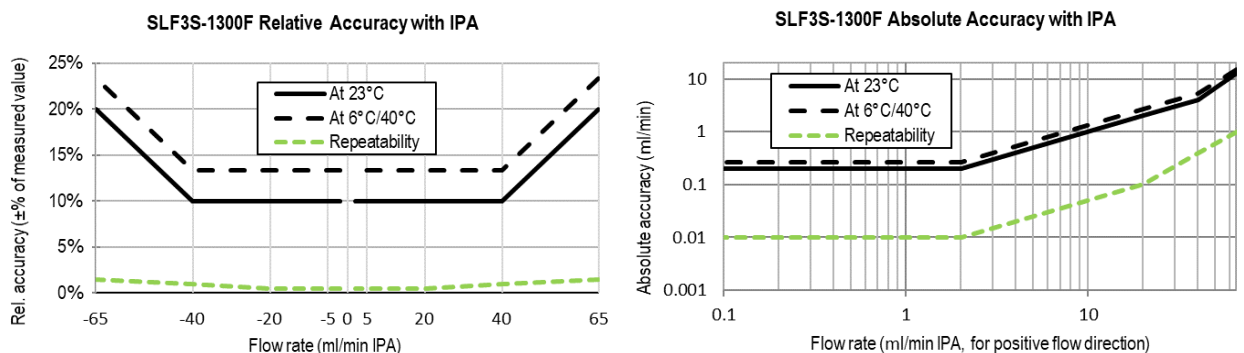


Figure 2: Left: Liquid flow sensor accuracy and repeatability across the flow range of the SLF3S-1300F. Relative error in $\pm\%$ of measured value for IPA. Right: Liquid flow sensor accuracy and repeatability across the positive flow range of the SLF3S-1300F. Absolute error in ml/min for IPA.

2 Specifications

2.1 Electrical Specifications

Parameter	Symbol	Conditions	Min.	Typical	Max.	Units	Comments
Supply voltage DC	V _{DD}		3.2	3.5	3.8	V	
Power-up/down level	V _{POR}		2.3	2.5	2.7	V	
Supply current	I _{DD}	Measurement		4.5	6	mA	
		Idle mode		0.05	0.6	mA	

Table 3: Electrical characteristics

2.2 Timing Specifications

Parameter	Symbol	Min.	Typical	Max.	Units	Comments
Power-up time	t _{PU}			25	ms	Time to sensor ready
Soft reset time	t _{SR}			25	ms	Time between soft reset command and sensor ready
Warm-up time	t _w		50		ms	Time needed until sensor output is within specification according to section 1.1 at 50% full scale flow rate.
I ² C SCL frequency	f _{I2C}		400	1000	kHz	
Update rate liquid flow value and High Flow flag	f _{flow}	1800	2000	2200	Hz	
Update rate temperature value and Air-in-Line flag	f _{temp}	73	83	111	Hz	
Recommended sensor read out frequency	f _{ro}	10	50-200	2000	Hz	Recommendations are based on explanations in section 3.1

Table 4: Timing specifications

2.3 Absolute Minimum and Maximum Ratings

Stress levels beyond those listed in Table 5 may cause permanent damage to the sensor or affect its reliability. These are stress ratings only and functional operation of the sensor at these conditions is not guaranteed. Ratings are only tested each at a time.

Parameter	Rating	Unit
Operating temperature	+5 ... +50	°C
Maximum relative humidity for long-term exposure	40°C dew point or 95 %RH, whichever is lower; non-condensing	n/a
Short term storage temperature ⁵	-20 ... +60	°C
Short term storage humidity ⁵	0...95 %RH; non-condensing	% RH
ESD HBM (human body model)	< 2 (class 1C)	kV
Supply voltage V _{DD}	-0.3 to 5.5	V
Burst pressure	25	bar

Table 5: Absolute minimum and maximum ratings

ESD Warning: The sensor is susceptible to ESD damages, especially when touching the connector pins. During handling and testing, suitable ESD precautions must be taken.

Please note, that the sensor chip is not electrically isolated from the flow channel and the medium passing through it. Therefore, a voltage difference between sensor and medium should be avoided at all times through proper system grounding and design.

⁵ Flow path empty. Short term storage refers to temporary conditions during e.g. transport.

2.4 Pin Assignment

The liquid flow sensor is equipped with a 6-pin connector (Molex part number: 53261-0671; 1.25 mm pitch PicoBlade header, 6 circuits) for electrical connection, see Table 6 below for the pin assignment.

Pad	Description	Comments
1	n.c.	Nonfunctional, connect to GND or leave floating
2	SDA (data)	Serial data, bidirectional
3	VDD	Supply voltage
4	GND	Ground
5	SCL (clock)	Serial clock, bidirectional
6	n.c.	Nonfunctional, connect to GND or leave floating

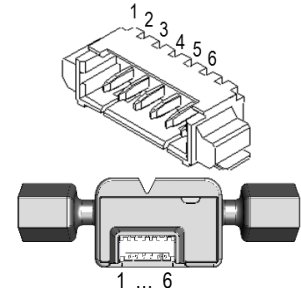


Table 6: Pin assignment

The sensor is compatible with the mating standard connector (Molex part number 51021-0600) and the PicoBlade Standard Cable Assembly series 15134-06xx (PicoBlade-to-PicoBlade cable assembly, available in different lengths). These parts can be ordered from the usual electronics on-line distributors.

3 Sensor Output Signal Description

3.1 Flow Rate Measurement

After the sensor receives the “start continuous measurement” command it enters the continuous measurement mode and continuously performs measurements of ~0.5 ms duration. Therefore, the flow rate value is updated every 0.5 ms (see Table 4).

The output flow rate value corresponds to the average \bar{x} of all individual 0.5 ms measurements x_i since the last read out. This has the benefit that the user can read out the sensor at his own desired speed, without losing information and thus prevents aliasing. During the first 100 ms of averaging, the averaged value is obtained as the arithmetic mean.

$$\bar{x} = \sum_{i=1}^N \frac{x_i}{N} \quad \text{for } t < 100 \text{ ms}$$

When the reading speed is slower than 100 ms, the sensor will continue to average, but with a different algorithm. In this algorithm exponential smoothing is used, with a smoothing factor $\alpha = 0.0125$.

$$S_k = \alpha \cdot x_i + (1 - \alpha) \cdot S_{k-1}, \quad S_0 = \bar{x}, \quad \text{for } t > 100 \text{ ms}$$

Where S_0 is the arithmetic mean value after the first 100 ms and the output flow rate value corresponds to the last available S_k .

With an exponential smoothing factor of $\alpha = 0.0125$, the user receives approximately an average value of the last 100 ms. In order not to lose information, the sensor should be read out at least once every 100 ms. When the sensor has entered exponential smoothing, this is indicated by bit 5 in the signaling flag output of the sensor being set to high (=1) (see section 3.3).

Please refer to relevant literature for more information about exponential smoothing.

3.2 Temperature Measurement

The temperature is measured every ~12 ms (see Table 4) with the help of an additional onboard temperature sensor. It provides the sensor's temperature, which is influenced by the ambient and fluid temperatures as well as the operating conditions of the sensor. The temperature values are not averaged as described above. The read out temperature value corresponds always to the latest temperature measurement available.

3.3

8 Ordering Information

Use the product names and article numbers shown in the following table when ordering SLF3S-1300F liquid flow sensors, the SLF3S-1300F evaluation kit, or the SLF3x mounting clamp. All products and accessories are available via Sensirion's worldwide distribution network. Please find an overview for your region under: www.sensirion.com/distributor-search.

Product	Description	Article Number
SLF3S-1300F liquid flow sensor	40 ml/min, with 1/4"-28 flat bottom ports	3.000.091
Evaluation kit SLF3S-1300F, ready to use	Sensor, USB interface, mounting support (for detailed contents see below)	3.000.120
Accessories	Description	Article Number
SLF3x mounting clamp	POM, green (mounting support for mechanical fixation)	1.000.062

For fast and easy technology evaluation, Sensirion offers a comprehensive SLF3S-1300F evaluation kit. Each SLF3S-1300F evaluation kit contains:

- f* **1 pc SLF3S-1300F** liquid flow sensor
- f* **1 pc SLF3x mounting clamp** to enable mechanical fixation of the sensor
- f* **1 pc SCC1-USB Sensor Cable** with USB connector for plug-and-play connection to a PC
- f* **1 pc adapter cable** from 6-pin connector to 4-pin M8 which serves as link between sensor and SCC1-USB Sensor Cable, 15 cm length
- f* **1 pc ribbon cable** from 6-pin connector to pigtail, 30 cm length
- f* **A set of fluidic fittings**
- f* **PC Software** (Viewer & Data Export Tool)

9 Packaging Information

Standard shipment includes only the sensor, neither cables, SLF3x mounting clamp, nor fluidic connection material.

The SLF3x liquid flow sensors are shipped in trays of 50 pcs each.

The tray dimension is (350 x 260 x 19.5) mm³. By piling them up, the height per tray can be considered as 15 mm.

The SLF3x mounting clamp is packaged in bags of 250 pieces (+/- 2%). The weight of one bag is ~0.5 kg.

Note: The clamp is delivered separately from the SLF3S-1300F sensors as bulk good.

10 Important Notices

10.1 Warning, Personal Injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless SENSIRION and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SENSIRION shall be allegedly negligent with respect to the design or the manufacture of the product.

10.2 ESD Precautions

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product. See application note "ESD, Latchup and EMC" for more information.

10.3 Warranty

SENSIRION warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in SENSIRION's published specifications of the product. Within such period, if proven to be defective, SENSIRION shall repair and/or replace this product, in SENSIRION's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to SENSIRION within fourteen (14) days after their appearance;
- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

This warranty does not apply to any equipment which has not been installed and used within the specifications recommended by SENSIRION for the intended and proper use of the equipment. EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, SENSIRION MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DECLINED.

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SENSIRION reserves the right, without further notice, (i) to change the product specifications and/or the information in this document and (ii) to improve reliability, functions and design of this product.

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