SLI Liquid Flow Meter Series

Media Isolated Microfluidic Flow Meter

- Liquid flow rates up to 10 ml/min
- Non-invasive measurement
- Different interface options
- 40 ms flow detection response time

Product Summary

The SLI Liquid Flow Meter enables fast, non-invasive measurements of very low liquid flow in the µl/min- to ml/min-range. Excellent chemical resistance is ensured: The flow path of the SLI Liquid Flow Meter is formed by a simple, straight glass capillary. The fourth generation MEMS sensors combine a thermal high precision sensor element with amplification circuits and digital intelligence for linearization and temperature compensation on one single microchip – the product's core element.

Interface Options

Digital
- I^2C-Bus
- RS485-Bus
- USB Cable

Analog
- Voltage Output (0-10 V)
- Additional operation modes

For more information on communication, please refer to page 2 of this document.

1 Sensing Performance

Table 1: Model specific performance of SLI (all data for medium **H_2O**, 23°C)

Parameter	SLI-0430	SLI-1000	SLI-2000	Unit
H_2O Full scale flow rate	80	1000	5000	µl/min
H_2O Sensor output limit[a]	120	1100	5500[b]	µl/min
Accuracy below full scale (whichever error is larger)	5.0 0.15	5.0 0.2	5.0 0.2	% of m.v.[c] % of full scale
Repeatability below full scale (whichever error is larger)	0.5 0.01	0.5 0.02	0.5 0.02	% of m.v. % of full scale
Temperature coefficient (additional error / °C; whichever is larger)	0.13 0.003	0.1 0.004	0.1 0.004	% m.v. / °C % full scale / °C
Mounting orientation sensitivity[d]	<0.4	1.0	1.5	% of full scale
Flow detection response time τ_{63}	40			ms
Response time on power-up	120			ms
Operating temperature	+10…+50			°C
Ambient storage temperature[e]	-10…+60			°C
Maximum recommended operating pressure	50	15	15	bar
Burst pressure	150	30	30	bar

[a] Flow rate at which the sensor output saturates. See section 2 for performance between full scale and saturation point
[b] Extended range up to 10500 µl/min, see section 2 for performance specifications
[c] Measured value
[d] Maximum additional offset when mounted vertically
[e] Non-condensing, flow path empty

Table 2: Model specific performance of SLI (all data for medium **IPA**, 23°C)

Parameter	SLI-0430	SLI-1000	SLI-2000	Unit
IPA full scale flow rate	500	10'000		µl/min
			80	ml/min
Sensor output limit[a]	600	11'000		µl/min
			90	ml/min
Accuracy below full scale (whichever error is larger)	20	20	10	% of m.v.[b]
	1	1	0.5	% of full scale
Repeatability below full scale (whichever error is larger)	1	1	1.5	% of m.v.
	0.05	0.05	0.03	% of full scale
Temperature coefficient (additional error / °C; whichever is larger)	0.5	0.4	0.35	% m.v. / °C
	0.025	0.02	0.02	% full scale / °C

[a] Flow rate at which the sensor output saturates

[b] Measured value

1.1 Calibration Field Information

The SLI Liquid Flow Meters hold calibrations for two liquids, one for water (H_2O) and one for isopropyl alcohol (IPA). Each calibration is stored on a separate calibration field (CF):

- Calibration field 0: H_2O (factory default)
- Calibration field 1: IPA
- Calibration field 2 (SLI-2000 only, starting from SN 1627-00000): H_2O extended range

The default calibration field (i.e. the active calibration field at power up) can be permanently changed via I²C or RS485 commands. Alternatively, the default calibration field can be changed using the USB-RS485 Sensor Viewer which is part of the Liquid Flow Meter Kit and also available in the download center on the Sensirion liquid flow webpage. www.sensirion.com/liquidflow-download

2 Specifications Charts

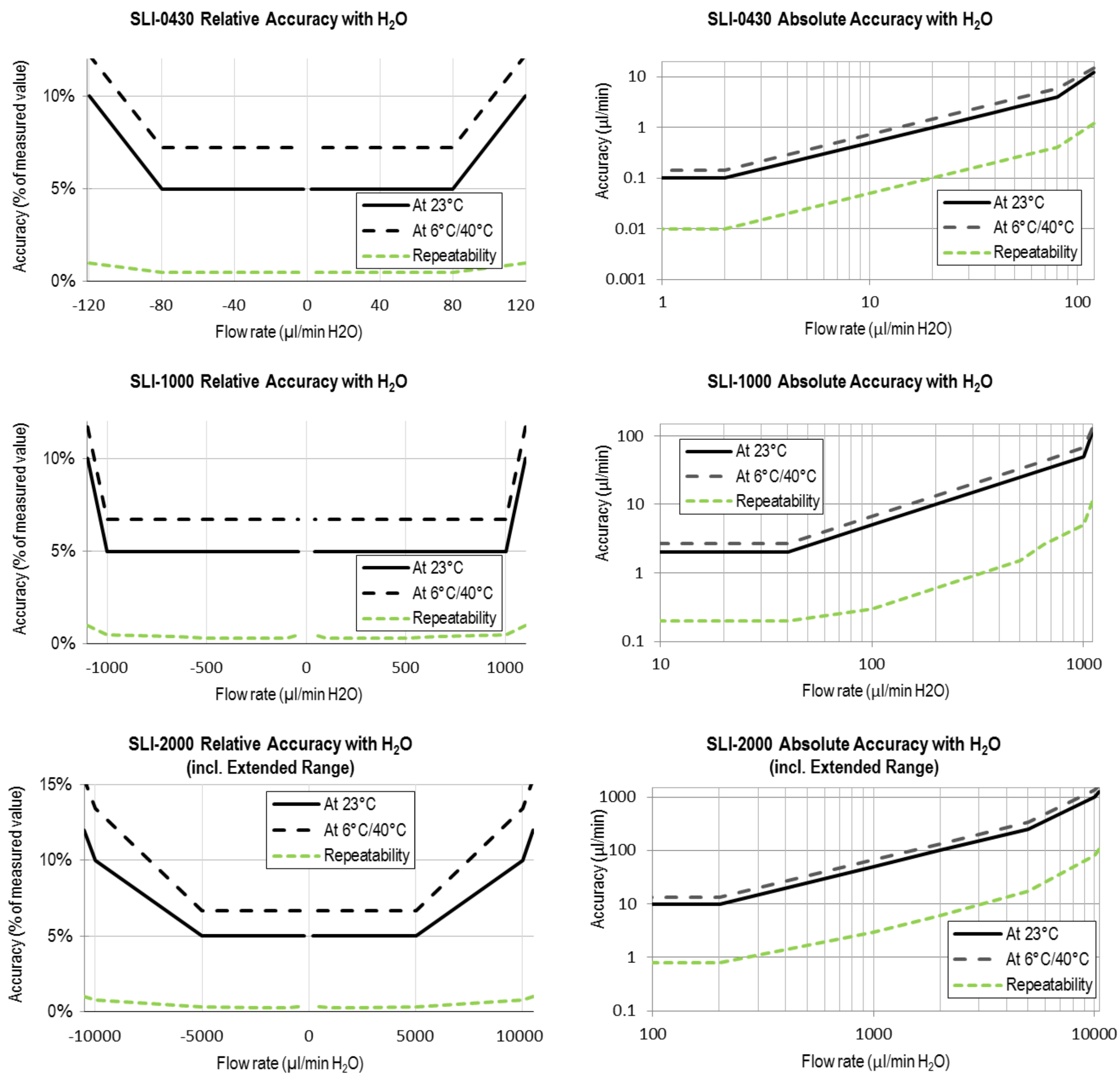


Figure 1: Flow meter accuracy and repeatability across the flow range. Relative error in % of measured value (left column) and absolute error in µl/min (right column) for H_2O

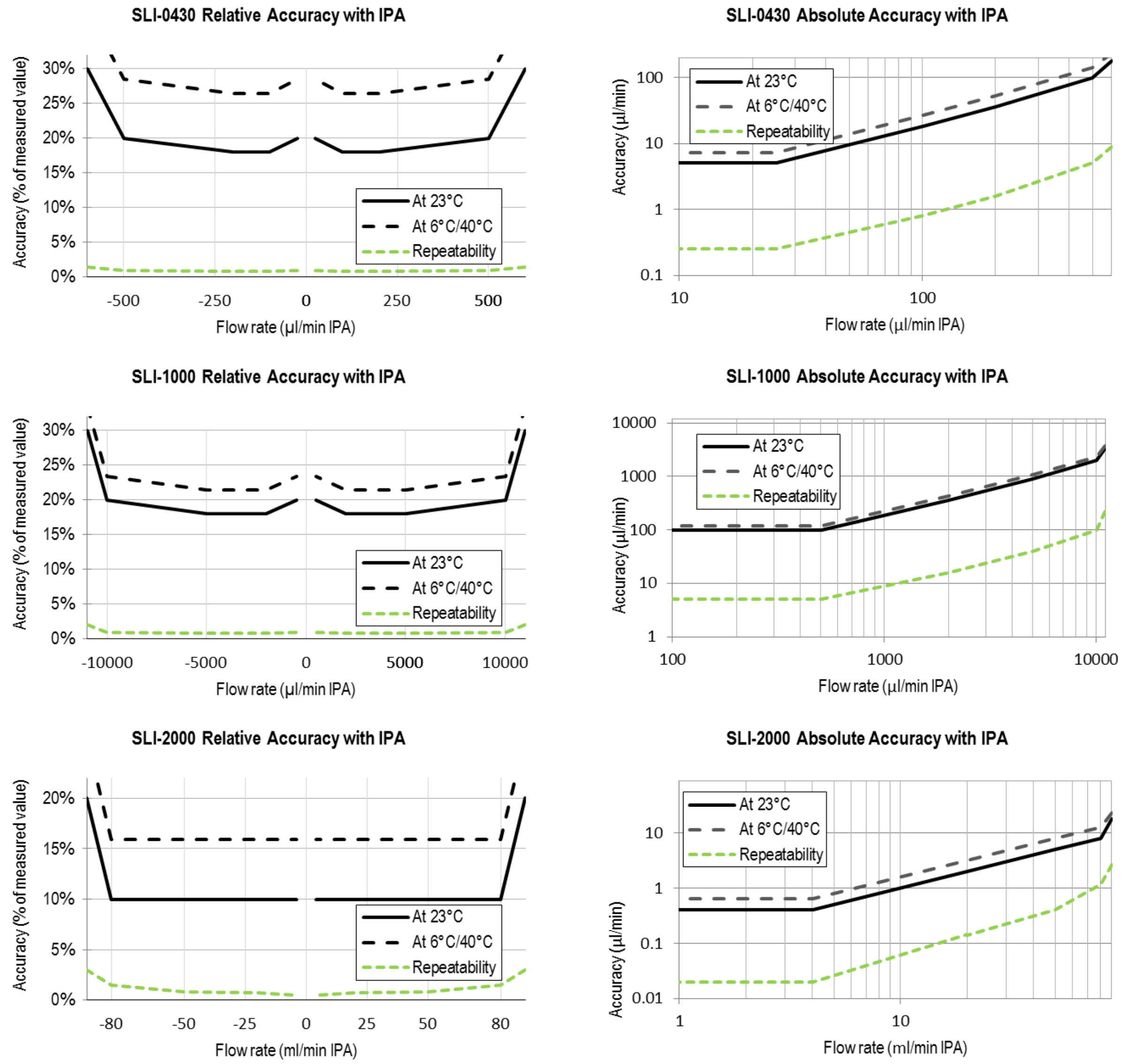


Figure 2: Flow meter accuracy and repeatability across the flow range. Relative error in % of measured value (left column) and absolute error in µl/min or ml/min in case of the SLI-2000 (right column) for IPA

3 Communication with the Sensor

The SLI flow meter shows bidirectional, linear transfer characteristics. The product comes fully calibrated for water and IPA.

Digital Sampling Time, 16 bit	74 ms
Digital Sampling Time, 9 bit	1 ms

3.1 Electrical Specifications

Table 3: DC Characteristics

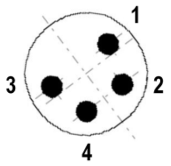
Parameter	Conditions	Min.	Typ.	Max.	Units
Power Supply DC, VDD	Sensor only	4	5	6	V
	RS485 cable	4	5	6	V
	Analog cable	12	24	36	V
Operating Current	VDD = 4-6 V, no load	5	5.5	6	mA
	RS485 cable		20	70	mA
	Analog cable		4.3		mA

3.2 Electrical Connector and Pinout

The flow meter is equipped with a male connector type M8, 4-pin, threaded lock according to IEC 61076-2-101 (Ed. 1)/ IEC 60947-5-2, and is compatible with Sensirion's SCC1 interface cables.

Table 3: Electrical pinout

Pin	
1	SDA (data)
2	GND
3	VDD
4	SCL (clock)



3.3 Communication via USB cable

The Sensirion USB Sensor Cable provides an easy to use USB Interface for laboratory and desktop use.

For further information please see the SCC1-USB Sensor Cable datasheet, available on www.sensirion.com/liquidflow-download.

3.4 Digital Communication via RS485-Bus

The SCC1-RS485 Sensor Cable for flow sensors allows the communication via RS485 interface for use in a demanding industrial automation environment. In addition to the standard commands available in the I²C interface of the sensor, the incorporated microcontroller of the cable provides more complex logic such as a dispense volume totalizer, automatic dispense detection, automatic heater control and data buffer for asynchronous read-out.

For further information please see the SCC1-RS485 Sensor Cable datasheet, available on www.sensirion.com/liquidflow-download.

3.5 Analog Communication

The SCC1-ANALOG Sensor Cable allows simple and quick readout of Sensirion's liquid flow meters by converting the digital sensor reading to a 0...10.5 V analog voltage output. Additionally, a digital (high/low) output with two different modes of operation is available (Flow Switch / Volume Counter)

For further information please see the SCC1-USB Sensor Cable datasheet, available on www.sensirion.com/liquidflow-download.

3.6 Digital Communication via I²C-Bus

Digital communication between a master and the SLI sensor runs via the standard I²C-interface. The physical interface consists of two bus lines, a data line (SDA) and a clock line (SCL) which need to be connected via pull-up resistors to the bus voltage of the system.

These lines can be used on 3.3V or 5.0V level with a clock frequency of 100 kHz. For the detailed specifications of this I²C communication, please refer to specific I²C Application Notes from Sensirion.

4 Fluidic Connection

Table 5: Fluidic Specifications and Pressure Rating

Parameter	SLI-0430	SLI-1000	SLI-2000
Wetted Materials:			
• Internal sensor tube material	Quartz Glass (Fused Silica)	Borosilicate Glass 3.3	
• Fitting material	PEEK		
• Sealing material	None	FEP	
Fluid connector ports (Fittings)	¼-28 flat-bottom for 1/16” or 1/8” OD plastic tubing[a]		
Pressure drop (at full scale flow rate, H_2O, 23°C)	1 mbar	<1 mbar	<1 mbar
Pressure drop (at full scale flow rate, IPA, 23°C)	7 mbar	5 mbar	2 mbar
Total internal volume	5 µl	25 µl	80 µl

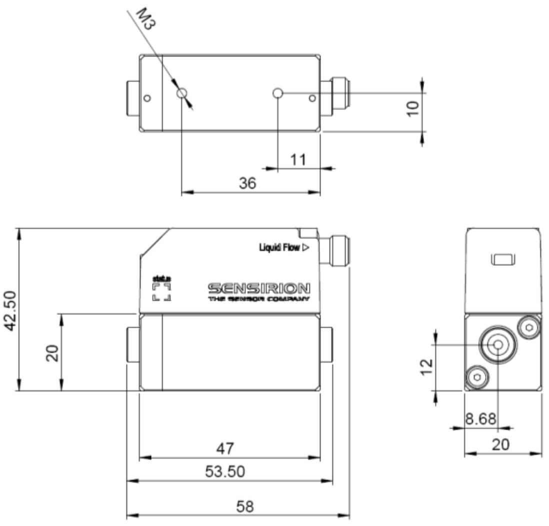
[a] 1/8” OD tubing with 2 mm minimum ID is recommended for the SLI-2000.

For more information on the fluidic connection please find: “Application Note Sensor Ports and Tubing Connections” in the Download Center on our webpage (www.sensirion.com/liquidflow-download).

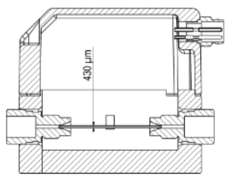
5 Mechanical Specifications

Table 6: Mechanical Specifications

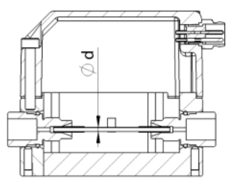
Parameter	SLI-0430	SLI-1000	SLI-2000
Largest dimensions	58 x 42.5 x 20 mm		
Total mass	53 g		
Inner diameter d	430 µm	1.0 mm	1.8 mm
Protection class	IP 65		



SLI-0430



SLI-1000 / SLI-2000



All dimensions in mm

6 Ordering Information

For OEM applications, the liquid flow meter can be purchased in larger quantities without any additional parts. For optimum performance, Sensirion recommends using the SLI liquid flow meters in combination with the SCC1 interface cables.

For laboratory use and technology evaluation, the Liquid Flow Meter Kit SLI-XXXX can be ordered.

This laboratory-package contains:

- Liquid Flow Meter SLI-XXXX
- Fitting Material for 1/8'' tubing
- PC Software (Viewer & Data Export Tool)
- SCC1-USB Sensor Cable with USB connector for plug-and-play connection to a PC
- SCC1-Analog Sensor Cable with 0-10 V voltage output.

Table 9: Ordering information

Product	Article Number
SLI-0430 Liquid Flow Meter	1-100836-02
SLI-1000 Liquid Flow Meter	1-100835-01
SLI-2000 Liquid Flow Meter	1-100895-01
Flow Meter Kit SLI-0430	1-100893-01
Flow Meter Kit SLI-1000	1-100879-01
Flow Meter Kit SLI-2000	1-100894-01

Interface Cables:

SCC1-RS485 Sensor Cable Pigtail 2m	1-100804-01
SCC1-RS485 Sensor Cable Pigtail 5m	1-101122-01
SCC1-ANALOG Sensor Cable Pigtail 2m	1-101072-01
SCC1-ANALOG Sensor Cable Pigtail 10m	1-101219-01
SCC1-USB Sensor Cable 2m	1-101007-01

Important Notices

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 (including death). 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 datasheet 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.

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.

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.

SENSIRION is only liable for defects of this product arising under the conditions of operation provided for in the datasheet and proper use of the goods. SENSIRION explicitly disclaims all warranties, express or implied, for any period during which the goods are operated or stored not in accordance with the technical specifications.

SENSIRION does not assume any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. All operating parameters, including without limitation recommended parameters, must be validated for each customer's applications by customer's technical experts. Recommended parameters can and do vary in different applications.

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.

CE, RoHS, REACH and WEEE Statement

The flow meters of the SLI series comply with requirements of the following directives and regulations:

CE

- The device fully complies with norm EN 50081-2 (Emission Test Series), EN 50082-2 (Immunity Test Series) and ESD protection when used in combination with the SCC1-RS485 or SCC1-ANALOG Sensor Cables.
- EU Directive 1907/2006/EC concerning Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)
- EU Directive 2002/96/EC on waste electrical and electronic equipment (WEEE), OJ13.02.2003; esp. its Article 6 (1) with Annex II.
- EU Directive 2002/65/EC on the restriction of certain hazardous substances in electric and electronic equipment (RoHS), OJ01.01.2011

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