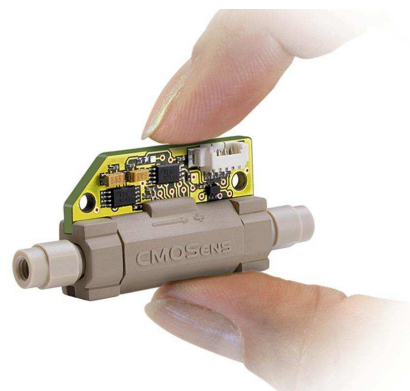


# LG16

## Media Isolated Microfluidic Flow Sensor

- Liquid flow rates up to 5000  $\mu\text{l}/\text{min}$
- Resolutions down to sub  $\text{nl}/\text{min}$
- Totally non invasive, pressures up to 200 bar
- Digital I<sup>2</sup>C interface or analog out 0-5 V



## 1 Introduction LG16

The LG16 Liquid Flow Sensor series enables fast, non invasive measurements of very low liquid flow rates below 5  $\text{ml}/\text{min}$ . This product line is especially suited for OEM volume applications requiring small sized components with high performance at low cost. Excellent chemical resistance and bio-compatibility are ensured: The flow path of the LG16 Liquid Flow Sensors is formed by a simple, straight glass capillary. This Swiss made, non invasive sensors are based on Sensirion's patented CMOSens<sup>®</sup> Technology (US Patent 6,813,944 B2). 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 products core element.

## 2 Sensing Performance

Table 1: Model specific performance of LG16 (all data for medium  $\text{H}_2\text{O}$ , 20°C, 1 bar<sub>abs</sub> unless otherwise noted)

Parameter	LG16-0025	LG16-0150	LG16-0480	LG16-1000	LG16-2000	
Maximum Flow Rate	1.50	7.00	50	1000	5000	$\mu\text{l}/\text{min}$
Lowest Calibrated Flow (LCF)	0.07	0.4	1.0	30	200	$\mu\text{l}/\text{min}$
Digital Resolution at LCF (16 bit)	0.084	0.24	0.60	12	150	$\text{nl}/\text{min}$
Accuracy <sup>a</sup> above LCF	10	5.0	5.0	5.0	5.0	% of measured value
Accuracy below LCF	0.5	0.25	0.1	0.15	0.2	% of full scale
Signal Noise, 16 bit digital output	4.5	4.5	4.5	4.5	4.5	LSB
- at LCF	0.002	0.010	0.025	0.25	3.0	$\mu\text{l}/\text{min}$
- at Maximum Flow Rate	0.004	0.040	0.300	5.0	20	$\mu\text{l}/\text{min}$
Signal Noise, analog output	tbd	tbd	tbd	tbd	tbd	mV
Temperature Coefficient	0.15	0.09	0.13	0.1	0.1	(% m.v.) / K
Mounting Orientation Sensitivity <sup>b</sup>	-	<0.4	<0.4	10	15	% of full scale
Flow Detection Response Time $\tau_{63}$	40			40		ms
Response Time On Power-Up	120			120		ms
Digital Sampling Rate, 16 bit	74			74		ms
Digital Sampling Rate, 9 bit	1			1		ms
Operating Temperature	+10...+50			+10...+50		°C
Ambient storage temperature	0...+60			0...+60		°C

## 3 Output Signals

The OEM flow sensor LG16 shows bi-directional, linear transfer characteristics. The product comes fully calibrated for water – for volume applications flow calibration for methanol or other media is available on request.

The LG16 can be ordered as analog output version (0...5V, LG16-xxxx-A) or as digital output version (LG16-xxxx-D). Digital communication between a master and the LG16-xxxx-D sensor runs via the standard I<sup>2</sup>C-interface. The

<sup>a</sup> Better available on request.

<sup>b</sup> Normal position: Horizontal flow channel, connector up

physical interface consists of two bus lines, a data line (DATA) and a clock line (SCK). 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 I<sup>2</sup>C communication refer to the Sensirion "User Manual I<sup>2</sup>C-Mode SF04".

## 4 Electrical and Mechanical Specifications

### 4.1 Electrical Specifications

Table 2: DC Characteristics.

Parameter	Conditions	Min.	Typ.	Max.	Units
Power Supply DC, VDD	for digital out I <sup>2</sup> C type	3.5	7.0	12 <sup>a</sup>	V
	for analog out type	6.0	7.0	12 <sup>a</sup>	V
Operating Current	V <sub>DD</sub> = 3.5 V, no load		6.5		mA
	V <sub>DD</sub> = 12 V, no load		6.5		mA
Analog Out Voltage Range	negative to positive maximum flow (LG16-xxxx-A only), zero flow =2.5V	0.2		4.8	V
Load at Analog Out		10		∞	kΩ

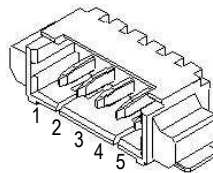
Table 3: I<sup>2</sup>C Output Characteristics (LG16-xxxx-D only).

Parameter	Conditions	Min.	Typ.	Max.	Units
I <sup>2</sup> C Bus Clock Frequency			100		kHz
Max. Output Current	Data line			Tbd	μA
Output Voltage Swing	Transmitter output not loaded	tbd		Tbd	V
	I <sub>out</sub> = 50 μA		Tbd		V
Power-Off Output Resistance			Tbd		MΩ

### 4.2 Electrical Connector and Pinout

Connector Type: 5 pin Molex PCB Header 53261-0590 (right angle) . Assembled flat ribbon cable included.

Pin	
1	DATA (bi-directional)
2	SCK
3	VDD
4	GND
5	Analog out



### 4.3 Connection for Analog Operation and for Digital Communication via I<sup>2</sup>C-Bus

Digital communication between LG16-xxxx-D type sensors and an I<sup>2</sup>C master works on both 5V or 3.3V level. The DATA and SCK lines need to be connected via pull-up resistors with the bus voltage of the system. The individual I<sup>2</sup>C address of each sensor on the I<sup>2</sup>C bus can be set with a special interface tool.

To assure correct operation with analog output signals of the LG16-xxxx-A type sensors pin 2 (SCK) and pin 4 (GND) have to be connected.

<sup>a</sup> Keep supply voltage below 9V for high precision applications; exceeding 12V will lead to permanent damage of the sensor

#### 4.4 Mechanical Specifications and Pressure Rating

Inside the LG16 flow sensors a highly sensitive microsensor-chip is mounted on the outside of a straight glass capillary and allows to measure the flow through the wall (US Patent 6,813,944 B2) using a thermal principle.

Table 4: Mechanical Specifications and Pressure Rating

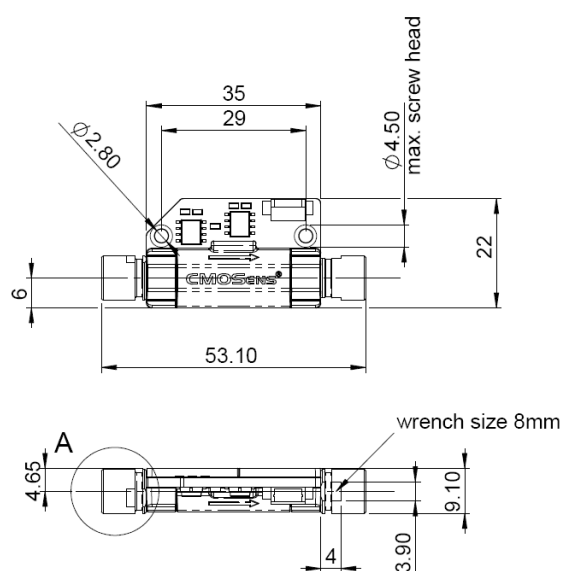
Parameter	LG16-0025	LG16-0150	LG16-0480	LG16-1000	LG16-2000
Fluid Connector Ports (Fittings)	UNF 6-40 for 1/32" OD tubing VICI® (Valco) Nanovolume™ compatible			¼-28 for 1/16" or 1/8" OD plastic tubing	
Wetted Materials:					
<ul style="list-style-type: none"><li>Internal Sensor Capillary Material</li></ul>	Quartz Glass (Fused Silica)			Borosilicate Glass 3.3 (Duran®)	
<ul style="list-style-type: none"><li>Fitting Material</li></ul>	100% PEEK™ (polyetheretherketone)				
<ul style="list-style-type: none"><li>Additional Sealing Material</li></ul>	None			Teflon®	ETFE(Tefzel®)
Overpressure Resistance	200 bar 2900 psi		100 bar 1450 psi	5 bar 70 psi	3 bar 40 psi
Maximum Pressure Drop (at max. flow rate)	1.5 bar	5 mbar	5 mbar	2 mbar	1 mbar
Internal Sensor Capillary, Inner Diameter	25 µm	150 µm	480 µm	1.0 mm	1.8 mm
Total Internal Volume	1 µl	1.5 µl	6.5 µl	tbd	tbd
Total Mass	6 g				

#### Attention Fragile

Mechanical shocks and connecting to the fittings without suitable tools leads to stress on the internal thin walled glass capillary and can cause it to break.  
Test for leakage after every time new connections are made.



## 5 Physical Dimensions



## 6 Ordering Information

The LG16 flow sensors can be ordered for OEM volume applications. Each model is available with analog output (ending "-A") or with digital output (ending "-D").

Fluid connection material is not included.

Product	Article Number
LG16-2000-A	1-100403-01
LG16-2000-D	1-100404-01
LG16-1000-A	1-100405-01
LG16-1000-D	1-100406-01
LG16-0480-A	1-100407-01
LG16-0480-D	1-100408-01
LG16-0150-A	1-100409-01
LG16-0150-D	1-100410-01
LG16-0025-A	1-100427-01
LG16-0025-D	1-100428-01

## 7 Important Notices

### 7.1 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.

### 7.2 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.

### 7.3 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

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### 7.4 RoHS and WEEE Statement

The LG16 product family complies with requirements of the following directives:

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 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), OJ 13.02.2003; esp. its Article 4.



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