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THE SENSOR COMPANY

SLF3C-1300F Liquid Flow Sensor With Thermal Conductivity Feature

Made to Measure – More than flow

- Thermal conductivity measurement
- Low flow sensing up to ±40 ml/min
- Calibrated for H_2O 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 SLF3C-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. Additionally, this version of the SLF3x family sports thermal conductivity feature that enables the measurement of concentrations or distinguishing between different liquids.

The SLF3C-1300F sensor features a digital interface (I^2C) via a 6-pin standard electrical connector.

The SLF3C-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 Flow Measurement

The following Table 1 and Table 2 list the specifications of the SLF3C-1300F liquid flow sensor. The product comes fully calibrated for water (H_2O) and Isopropyl alcohol (IPA).

Parameter	SLF3C-1300F	Unit
H_2O Full scale flow rate	±40	ml/min
H_2O 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 SLF3C-1300F (all data for medium H_2O, at 23 °C, and for VDD 3.5 V)

Parameter	SLF3C-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 SLF3C-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.

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1.1 Specification Charts

The SLF3C-1300F liquid flow sensor shows bi-directional, linear transfer characteristics. The product comes fully calibrated for water (H_2O) and Isopropyl alcohol (IPA).

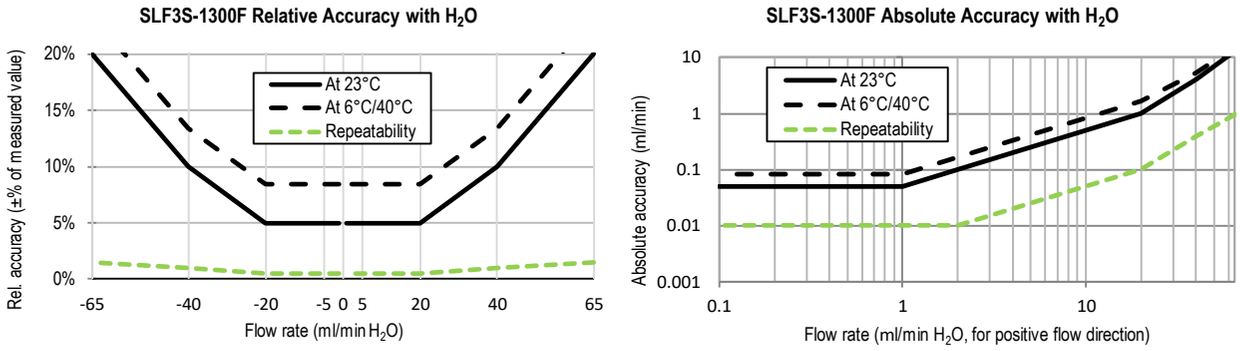


Figure 1: Left: Liquid flow sensor accuracy and repeatability across the flow range of the SLF3C-1300F. Relative error in ±% of measured value for H_2O. **Right:** Liquid flow sensor accuracy and repeatability across the positive flow range of the SLF3C-1300F. Absolute error in ml/min for H_2O.

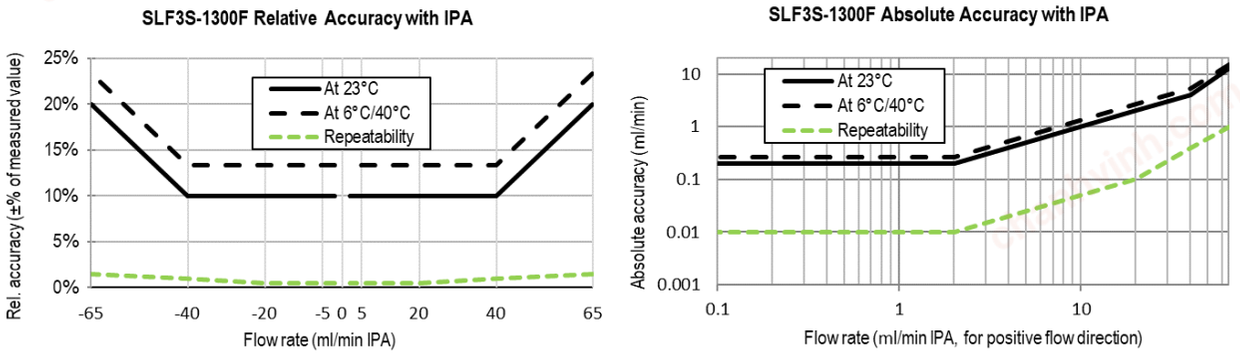


Figure 2: Left: Liquid flow sensor accuracy and repeatability across the flow range of the SLF3C-1300F. Relative error in ±% of measured value for IPA. **Right:** Liquid flow sensor accuracy and repeatability across the positive flow range of the SLF3C-1300F. Absolute error in ml/min for IPA.

2 Sensor Performance Thermal Conductivity Feature

The following Table 3 lists the specifications of the thermal conductivity feature of the SLF3C-1300F sensor. To use the feature, the flow needs to be stopped (zero flow condition).

Parameter	SLF3C-1300F	Unit
Output for air	100	a.u.
Output for water	10’000	a.u.
Maximum expected drift over lifetime	400	a.u.
Repeatability	30	a.u.

Table 3: Specifications for liquid flow sensor SLF3C-1300F (all data for VDD 3.5 V and at 23°C)

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3 Specifications

3.1 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 4: Electrical characteristics

3.2 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.
I²C 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 4.1

Table 5: Timing specifications

3.3 Absolute Minimum and Maximum Ratings

Stress levels beyond those listed in Table 6 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 6: 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.

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3.4 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 7 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

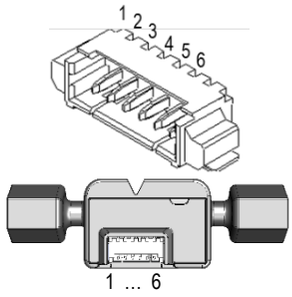


Table 7: Pin assignment

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.

4 Sensor Output Signal Description

4.1 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 5).
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.

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

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 α = 0.0125.

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

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 α = 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 4.3).
Please refer to relevant literature for more information about exponential smoothing.

4.2 Temperature Measurement

The temperature is measured every ~12 ms (see Table 5) 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.

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4.3 Extended Features for Failure Mode Detection

The SLF3C-1300F sensor uses Sensirion's latest flow chip generation. This enables detecting failures like air-in-line or flow rates exceeding the output limit of the sensor. Such conditions are indicated as signaling flags to the user.

In addition to the flow rate and temperature values, the user can therefore read out several signaling flags (see section 5.3.1), including two flags for failure mode detection as well as a flag indicating whether exponential smoothing is used as averaging algorithm of the flow rate data (see section 4.1).

The two signaling flags for failure mode detection, the *Air-in-Line* and the *High Flow flag*, report if an air-in-line or high flow event occurred at least once since the last readout took place. For example, if the sensor is read out after 50 ms have passed since the last readout took place, the corresponding signaling flag will be output as "high", if an air-in-line or high flow condition was detected at least once at any time during these last 50 ms.

When using Sensirion's Viewer Software, the user has to select *Signaling Flags* under the *Type of Measurement* dropdown menu to display the signaling flags while taking measurements. While the sampling time is faster than 100 ms, an air-in-line condition is displayed as a "1" and a high flow condition is displayed as a "2". If both conditions occur simultaneously this is hence displayed as "3". When the sensor has entered exponential smoothing and bit 5 of the signal flag output is set to high, the signaling flag output as displayed in the Viewer Software hence changes to 33, 34, 35 respectively.

The following sections provide further details about the two available failure mode detection signaling flags.

4.3.1 Detection of High Flow Rates

During priming or flushing of fluidic systems, much higher flow rates than the sensor's output limit might be needed. The sensor is not damaged in these situations as long as the maximum recommended operating pressure is not exceeded. However, high flow rates (that exceed the output limit of the sensor) cause the sensor to saturate or output incorrect flow rate measurements. By checking the *High Flow* flag this potential error can be monitored and detected reliably.

In cases where the output limit is exceeded, bit 1 of the signaling flag output is set to high (= 1). The bit 1 in the signaling flag output stays high until it is read out.

4.3.2 Detection of Air-in-Line

Owing to the thermal measurement principle of Sensirion's liquid flow sensors, the sensors can differentiate between air and liquid media filling the flow channel.

When air is passing through the sensor, the bit 0 of the signaling flag output is set to high (= 1). The bit 0 in the signaling flag output stays high until it is read out. See below.

Since the air bubble has an impact on the flow velocity profile inside the sensor's flow channel, the *High Flow flag* (see below) might also be set at the beginning and at the end of the air bubble.

The output of the signaling flags as well as the typical flow rate signal are visualized in the following graphs 1 to 5, while an air bubble travels through the sensor's flow channel from left to right.

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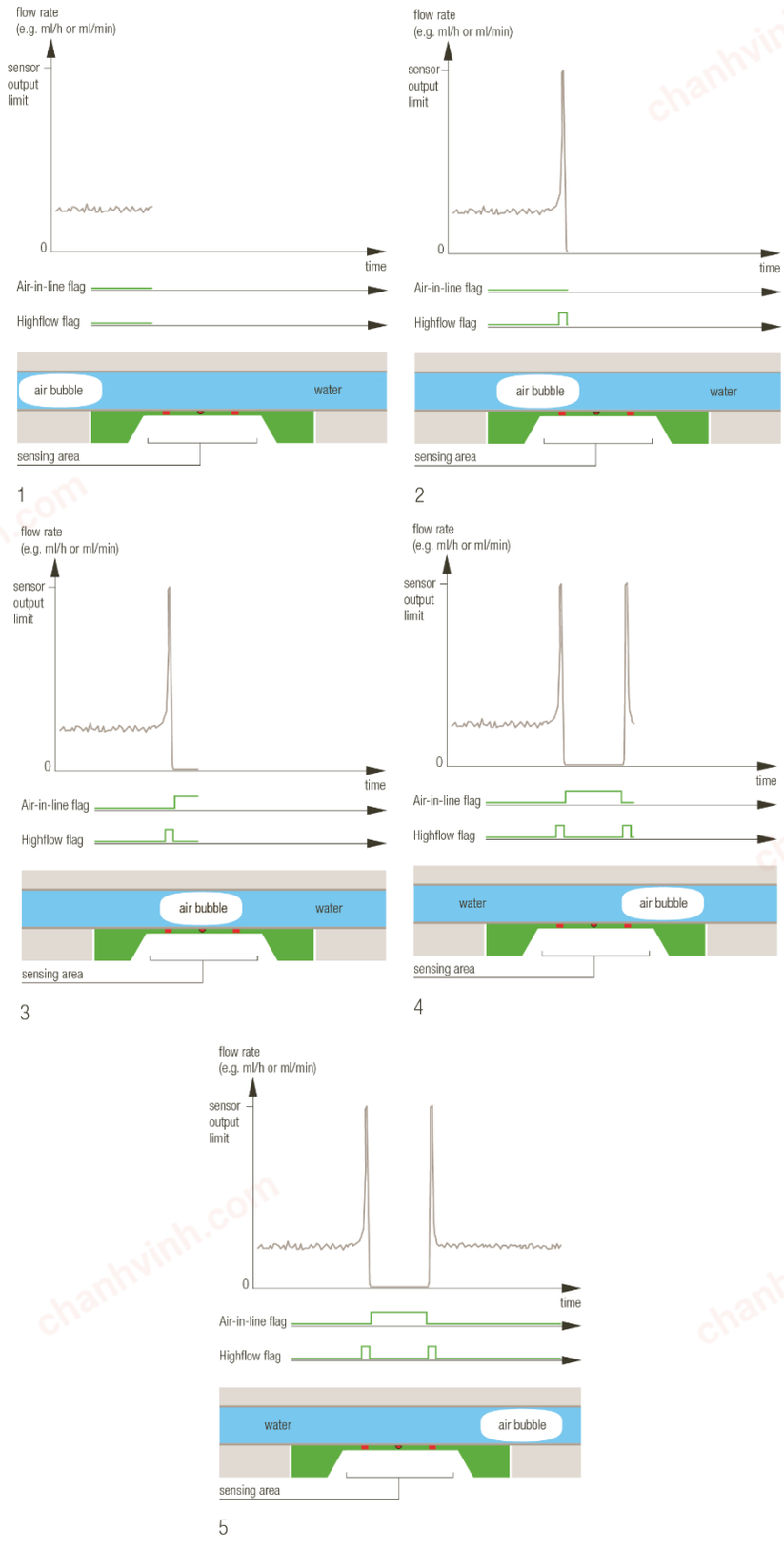


Figure 3: Detection of air-in-line events with the SLF3C-1300F. The graphs illustrate the air-in-line and high-flow flags while a bubble is passing though the sensor from left to right.

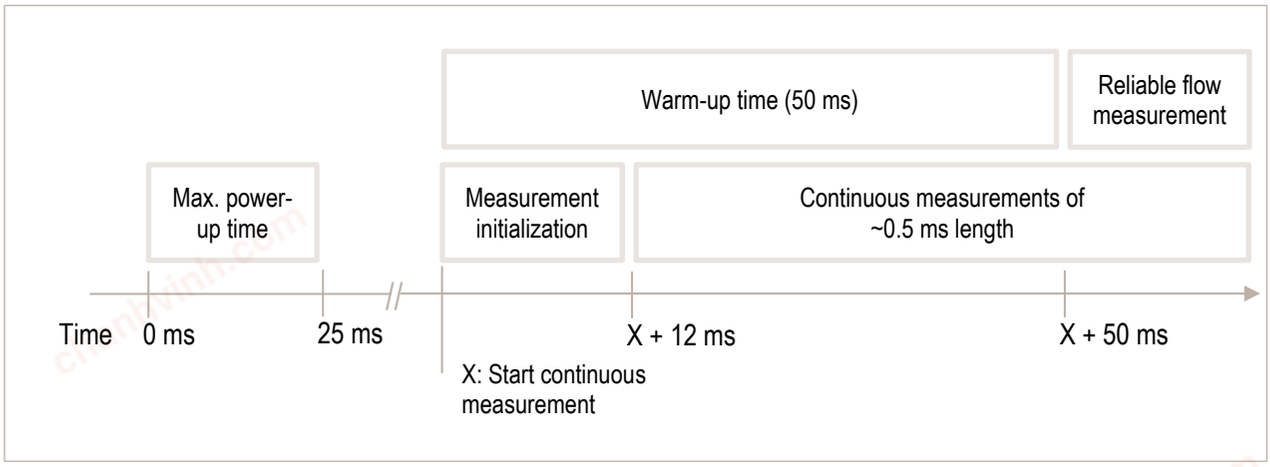
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4.4 Sensor Start-Up and Warm-Up Behavior

The maximum time for system power-up is 25 ms until the sensor responds to communication requests.

After reset or start-up of the sensor, the sensor's internal heater is turned off and must be started by performing a *Start Continuous Measurement* command (see section 5.3.1). The very first measurement is delayed by approximately 12 ms for the SLF3C-1300F liquid flow sensor.

Due to the thermal measurement principle, a total warm-up time of typically 50 ms is necessary for a reliable measurement. This includes the 12 ms needed for measurement initialization.



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4.5 Thermal Conductivity Feature

For a precise thermal conductivity measurement using the SLF3C-1300F sensor, the following recipe should be followed:

4.5.1 Priming

1. Completely fill the sensor with the liquid to be measured
   ⇨ If several different liquids shall be measured one after each other, flush thoroughly with the new liquid to avoid carry-over of the previous liquids to consecutive measurements.
2. Completely halt the flow (stop the pump, close the valve)

4.5.2 Zero-flow confirmation

For a precise thermal conductivity measurement, it is necessary that the medium is standing still inside the sensor. This can be verified by measuring the flow rate and confirming that there is no flow. As is pointed out in the SLF3x sensor datasheets, after starting the measurement it takes a short time before the flow measurement reaches the best accuracy. Therefore, the first measurement should be discarded.

3. Start the flow measurement (start continuous measurement, I^2C command 0x3608)
4. Wait 100 milliseconds
5. Read out the first flow measurement and discard it (send I^2C read header; see the SLF3x sensor datasheets for details)

6. Wait 100 milliseconds.
7. Read out the flow measurement again (send I^2C read header; see the SLF3x sensor datasheets for details.)
   ⇨ Only proceed if the flow rate is zero (within the experimental uncertainty). Otherwise, repeat steps 6 and 7 to continue reading the flow rate every 100 milliseconds until the flow has come to a full stop.

8. Stop the flow measurement (stop continuous measurement, I^2C command 0x3FF9; see the SLF3x sensor datasheets for details.)
9. Wait 0.5 milliseconds for the flow measurement to terminate.

4.5.3 Thermal conductivity measurement

The thermal conductivity measurement itself is triggered by a single command, after which the result can be read out exactly once. If another thermal conductivity measurement shall be performed, the thermal conductivity measurement command needs to be sent again.

10. Trigger the thermal conductivity measurement (I^2C command 0x3646; see section 4 below)
11. Wait 2.3 seconds for the measurement to complete
12. Read out the thermal conductivity measurement result as well as the temperature and the delta-temperature signals (send I^2C read header; see section 5 below)
    ⇨ Check that the delta-temperature signal (see section 5.3.3 below) is low (below ±0.02 °C). If there is a larger delta-temperature, this is a sign that the liquid temperature and the sensor temperature have not yet reached the equilibrium. In this case, repeat the concentration measurement from step 10. Otherwise use the measurement result depending on the application, for example as described in the next section.

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5 Digital Interface Description

The sensor's digital interface is compatible with the I²C protocol. This chapter describes the available command set. For detailed information about the I²C protocol, please consult the document "NXP I²C-bus specification and user manual" (http://www.nxp.com/documents/user_manual/UM10204.pdf).
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.

5.1 I²C Address

The sensor's I²C address is 8. The I²C header is formed by the I²C address followed by a read or write bit.

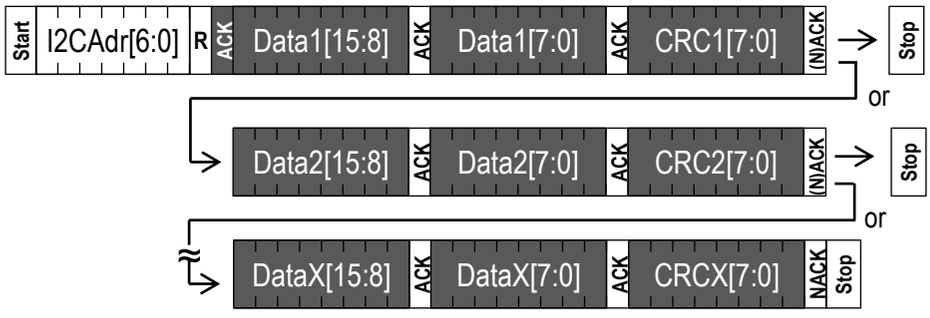
5.2 I²C Sequences

The commands are 16-bit. Data is read from the sensor in multiples of 16-bit words, each followed by an 8-bit checksum to ensure communication reliability.

I²C master sends the write header and writes a 16 bit command



I²C master sends the read header and receives multiple 16bit words with CRC byte.



Dark areas with white text indicate that the sensor controls the SDA (Data) line.

I²C sequences can be aborted with a NACK and STOP condition.

5.3 I²C Commands

The command set consists of the following commands:

- Start continuous flow measurement command
- Stop flow measurement command
- Read thermal conductivity and temperature
- Soft reset
- Read product identifier and serial number

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5.3.1 Start Continuous Flow Measurement

The sensor measures both the flow rate and the temperature. Both measurement results can be read out through one single I²C read header while a continuous measurement is running.
There are two calibrations for H_2O and IPA stored on the sensor. The applicable calibration needs to be chosen by the respective I²C command listed below.

Command	Medium	Command code (Hex)	Description
Start continuous measurement	Water	0x3608	This command starts the continuous measurement mode for H_2O. Outputs are the liquid flow rate, the sensor's temperature and the signaling flags.
	Isopropyl alcohol	0x3615	This command starts the continuous measurement mode for IPA. Outputs are the liquid flow rate, the sensor's temperature and the signaling flags.

Table 8: I²C command to start continuous measurement

After the command has been sent, the chip continuously measures and updates the measurement results as described in section 4. New results (flow, temperature, and signaling flags) can be read continuously with a single I²C read header for each set of measurements.
After the start measurement command is sent:

- the first measurement result is available after 12 ms;
- small accuracy deviations (% m.v.) can occur while the sensor warms-up (see section 4.4).

While no measurement data is available yet, the sensor will respond with a NACK to the I²C read header (I²C address + read bit).

Preceding command	Consecutive read	Description
Continuous measurement	Byte1: Flow 8msb Byte2: Flow 8lsb Byte3: CRC Byte4: Temp 8msb Byte5: Temp 8lsb Byte6: CRC Byte7: Signaling flags 8msb Byte8: Signaling flags 8lsb Byte9: CRC	After a start continuous measurement command, the measurement results can be read out. The temperature and the consecutive bytes don't need to be read out (every time). The read sequence can be aborted by a NACK and a STOP condition. Bit 0 and bit 1 of the signaling flags are used to detect air-in-line and high flow events. Bit 5 of the signaling flags indicates whether the sensor uses exponential smoothing for flow data averaging. Bit 2 … 4 and 6 … 15 are reserved for future use.

Table 9: Consecutive reads after I²C command to start continuous measurement

Bit	Signaling flag (set to high = 1, set to low = 0)
0	*Air-in-Line flag*
1	*High Flow flag*
2-4	*Unused, reserved for future use.*
5	*Exponential smoothing active*
6-15	*Unused, reserved for future use.*

Table 10: Bit assignment of 16 bit signaling flags

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5.3.2 Stop Continuous Flow Measurement

Command	Command code (Hex)	Description
Stop continuous measurement	0x3FF9	This command stops the continuous measurement and puts the sensor in idle mode. After it receives the stop command, the sensor needs up to 0.5 ms to power down the heater, enter idle mode and be receptive for a new command.

Table 11: I²C command to stop continuous measurement

When the sensor is in continuous measurement mode, the measurement must be stopped before it can accept another command. The only exception is the soft reset command.
In idle mode the sensor will consume less power.

5.3.3 Start TC-Measurement

The sensor measures the thermal conductivity, the sensor temperature, and the delta-temperature (a measure for the temperature difference between the liquid and the sensor). All three signals can be read simultaneously.

Command	Command code (Hex)	Description
Trigger single thermal conductivity measurement	0x3646	This command starts the thermal conductivity measurement. The measurement takes approx. 2.3 seconds. After completion, the heater is switched off and the sensor enters idle mode.

Table 12: I²C command to perform the thermal conductivity measurement.

After the command has been sent, the sensor performs one thermal conductivity measurement. The measurement takes approximately 2.3 seconds. When the measurement finishes, the sensor's heater is automatically switched off, the sensor enters idle mode, and the result can be read out anytime by sending a single I2C read header.
If the result is requested while no measurement data is available yet, the sensor will respond with a NACK to the I²C read header (I²C address + read bit).

Preceding command	Consecutive read	Description
Trigger single thermal conductivity measurement	Byte1: Thermal Conductivity 8msb Byte2: Thermal Conductivity 8lsb Byte3: CRC Byte4: Temperature 8msb Byte5: Temperature 8lsb Byte6: CRC Byte7: Delta-Temperature 8msb Byte8: Delta-Temperature 8lsb Byte9: CRC	After the thermal conductivity measurement is finished, the measurement results can be read out. The temperature and the delta temperature signals don't need to be read out (every time). The read sequence can be aborted by a NACK and a STOP condition.

Table 13: Read out of thermal conductivity measurement and auxiliary data.

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5.3.4 Soft Reset

Command	I²C address + W bit + command code (Hex)	Consecutive read	Description
General call reset	0x0006	NA	This sequence resets the sensor with a separate reset block, which is as much as possible detached from the rest of the system on chip. Note that the I²C address is 0x00, which is the general call address, and that the command is 8 bit, i.e., the soft reset command must not be preceded by an I²C write header. The reset is implemented according to the I²C specification.

Table 14: Reset command

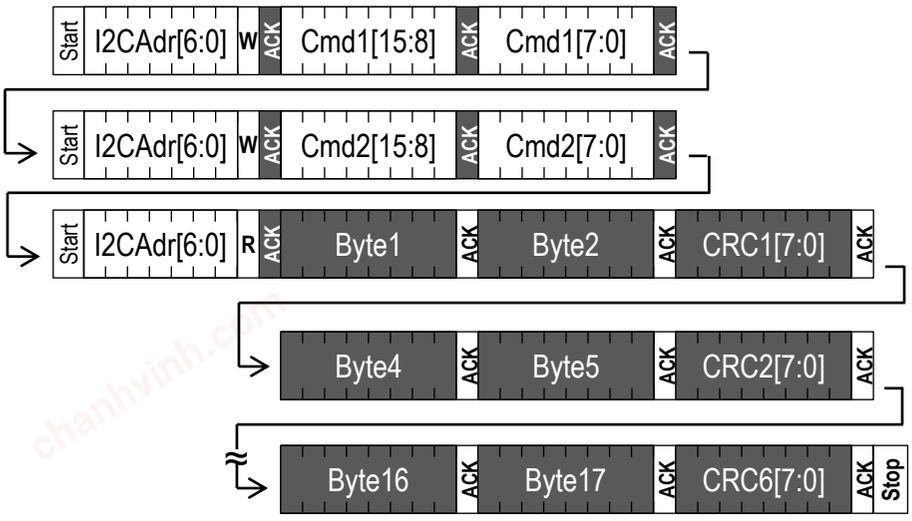
After the reset command, the sensor will take maximum 25 ms to reset. During this time the sensor will not acknowledge its address nor accept commands.

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5.3.5 Read Product Identifier and Serial Number

The product identifier and serial number can be read out after sending a sequence of two commands.

First the I²C master sends two consecutive write headers and writes 16 bits for each command. Then the I²C master sends the read header and receives 6 words of 16 bit with a CRC byte after each word.



Dark areas with white text indicate that the sensor controls the SDA (Data) line.

Command	Command code (Hex)	Consecutive read	Description
Read product identifier	0x367C 0xE102	Byte1: Product number [31:24] Byte2: Product number [23:16] Byte3: CRC Byte4: Product number [15:8] Byte5: Product number [7:0] Byte6: CRC Byte7: Serial number [63:56] Byte8: Serial number [55:48] Byte9: CRC Byte10: Serial number [47:40] Byte11: Serial number [39:32] Byte12: CRC Byte13: Serial number [31:24] Byte14: Serial number [23:16] Byte15: CRC Byte16: Serial number [15:8] Byte17: Serial number [7:0] Byte18: CRC	Note that both commands need to be preceded with an I²C write header (I²C address + W). The second command returns: - 32 bit product and revision number. The number is listed in the table below. *Note that the last 8 bits are the sensor's revision number and are subject to change in case of an update of the specifications.* - 64 bit unique serial number

Table 15: Read product identifier

Product	Product number
SLF3C-1300F	0x07030401

Table 16: Product number for SLF3C-1300F

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5.4 Checksum Calculation

The 8-bit CRC checksum transmitted after each data word is generated by a CRC algorithm. Its properties are displayed in Table 17. The CRC covers the contents of the two previously transmitted data bytes. To calculate the checksum only these two previously transmitted data bytes are used.

Property	Value
Name	CRC-8
Protected data	read data
Width	8 bit
Polynomial	0x31 (x8 + x5 + x4 +1)
Initialization	0xFF
Reflect input	False
Reflect output	False
Final XOR	0x00
Example	CRC (0xBEEF) = 0x92

Table 17: Checksum definition

5.5 Conversion to Physical Values

Conversion of the liquid flow rate and temperature sensor signals to a physical value is done with the scale factor.

5.5.1 Scale Factors

Parameter	SLF3C-1300F
Liquid Flow Rate	500 $(ml/min)^{-1}$
Temperature	200 $°C^{-1}$
Thermal conductivity	1 (arbitrary units)
Delta-temperature	1000 $(°C)^{-1}$

Table 18: Scale factors

5.5.2 Liquid Flow Rate

The digital calibrated liquid flow rate signal read from the sensor is a 16 bit signed integer number (two's complement number ranging from -32768 … 32767. Note that with the sensor's output limit being ±65 ml/min, it will only output values in the range -32500 … 32500). The integer value can be converted to the physical value by dividing it by the scale factor (liquid flow rate in ml/min = sensor output ÷ scale factor).

5.5.3 Thermal Conductivity

The thermal conductivity signal read from the sensor is a 16-bit signed integer number (two's complement number ranging from -32768 … 32767). The value is provided in arbitrary units such that the signal is 100 for air and 10'000 for water. Use this signal to identify the medium which is inside the sensor or to determine the concentration of a binary mixture.

5.5.4 Temperature

The digital calibrated temperature signal read from the sensor is a 16 bit signed integer number (two's complement number ranging from -32768 … 32767). The integer value can be converted to the physical value by dividing it by the scale factor (temperature in °C = sensor output ÷ scale factor).

5.5.5 Delta Temperature

The difference temperature between the sensor chip and the liquid inside the sensor is read from the sensor as a 16 bit signed integer number (two's complement number ranging from -32768 … 32767). The integer value can be converted to the physical value by dividing it by the scale factor (delta-temperature in °C = sensor output / scale factor).

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6 Fluidic Specifications and Connections

Parameter	SLF3C-1300F
Wetted materials	Polyphenylene sulfide (PPS), stainless steel 316L, epoxy-based adhesive
Fluidic connector ports (fittings)	UNF ¼"-28 flat bottom
Recommended torque for fitting connection	0.5 Nm ± 10 %
Recommended tubing ID	2 mm
Pressure drop (at 40 ml/min, H_2O, 23 °C)	< 4 mbar

Table 19: Fluidic specifications and connections

7 Mechanical Specifications

Parameter	SLF3C-1300F
Largest dimensions	~ (48 x 15.5 x 8.9) mm^3
Weight	~ 3.0 g
Inner diameter	~ 1.4 mm
Inner volume	~ 58 µl
Maximum recommended operating pressure[6]	12 bar
Rated burst pressure[6]	25 bar

Table 20: Mechanical specifications

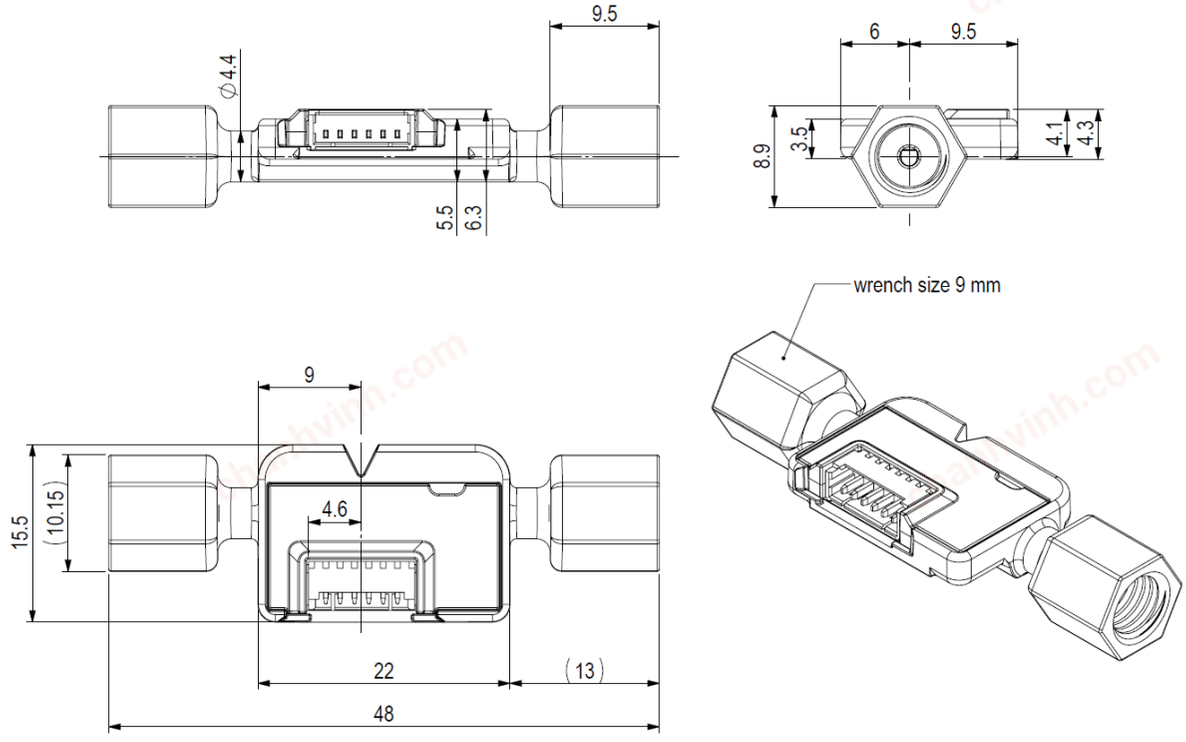


Figure 4: Dimensions of SLF3C-1300F (all dimensions in mm)

[6] Pressure ratings at 23°C, apply to sensor only; pressure rating of the fitting interface has to be assessed separately.

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8 Mechanical Mounting of the SLF3C-1300F Sensor

For mechanical mounting of the SLF3C-1300F sensors, Sensirion provides a mounting clamp. The SLF3x mounting clamp is made from POM (Polyoxymethylene).
See Figure 5 below for the two possible mounting orientations of the clamp and how to correctly insert the SLF3C-1300F sensor into the clamp.

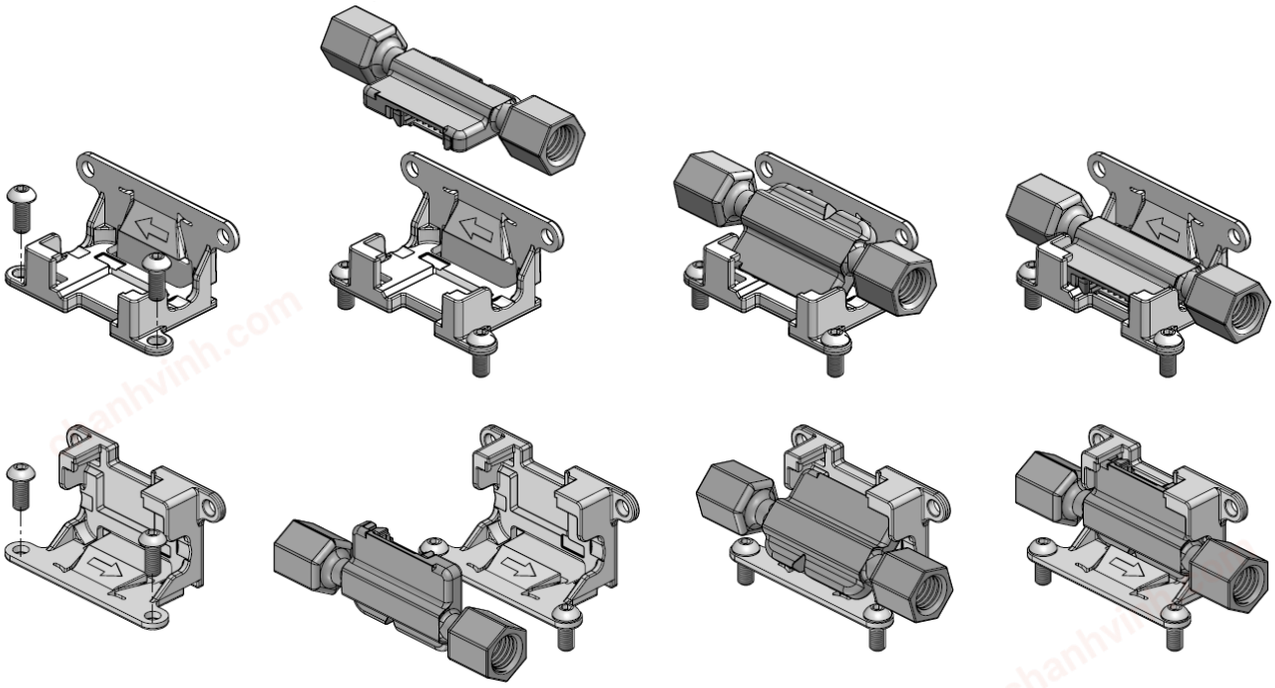


Figure 5: Mounting guidelines for the SLF3C-1300F sensor into the SLF3x mounting clamp

The arrow visible on the clamp's clip holding down the sensor indicates the positive flow direction of the SLF3C-1300F sensor. The 6-pin connector is facing the front of the clamp to allow for an easily accessible cable connection. Standard M2.5 sized screws can be used for the fixation of the clamp.

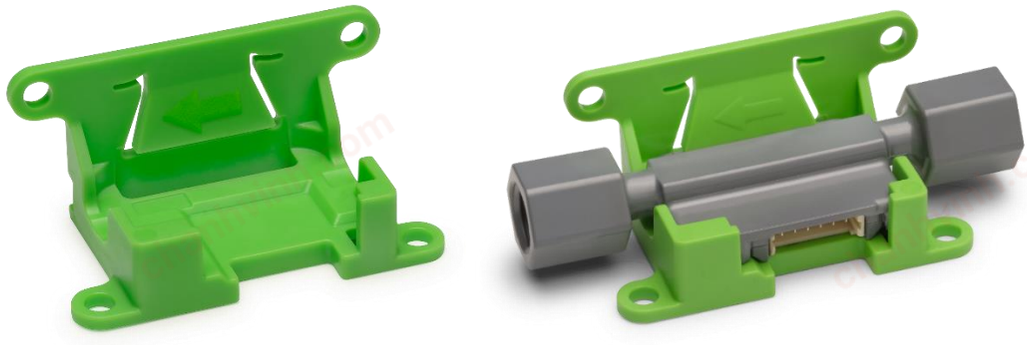


Figure 6: Pictures of the SLF3x mounting clamp with and without sensor installed

See Figure 7 for detailed dimensions of the SLF3x mounting clamp.

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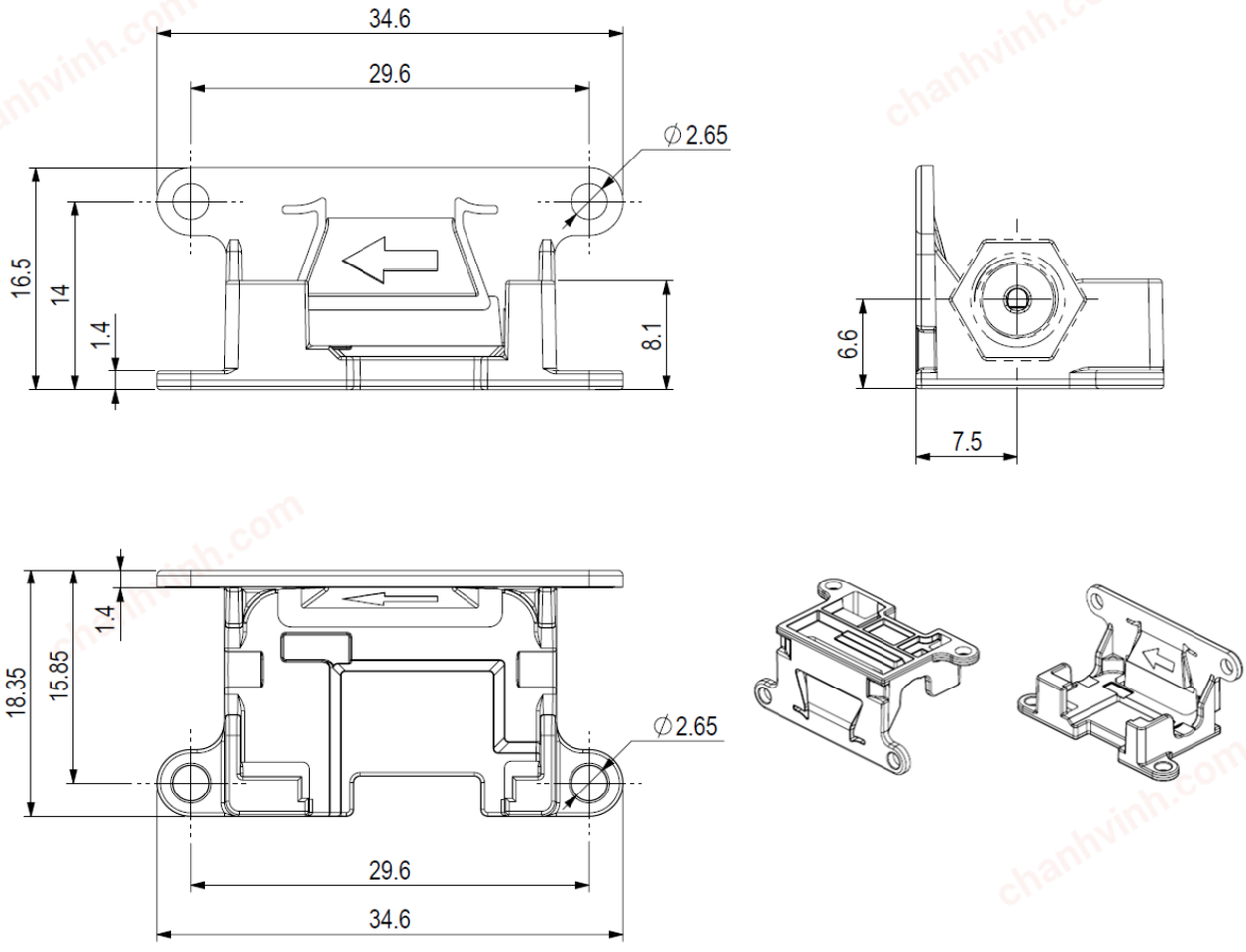


Figure 7: Dimensions of the SLF3x mounting clamp (all dimensions in mm)

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9 Ordering Information

Use the product names and article numbers shown in the following table when ordering SLF3C-1300F liquid flow sensors, 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
SLF3C-1300F liquid flow sensor	40 ml/min, with ¼"-28 flat bottom ports	3.000.570
Accessories	Description	Article Number
SLF3x mounting clamp	POM, green (mounting support for mechanical fixation)	1.000.062

10 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) mm^3. 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 SLF3C-1300F sensors as bulk good.

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11 Important Notices

11.1 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.

11.2 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.

11.3 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 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.

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Revision History of the SLF3C-1300F Datasheet – for INTERNAL USE only

Revision	Date	Changes Chapter	Description	Author
0.1	May 2018	all	First preliminary version	SJUN
0.2	August 2018	6, 7 8	Prototypes made from gray PEI featuring flat bottom ports with hexagon head Ordering Information added	SJUN
0.3	November 2018		Update based on characterisation status and for D2 release	SJUN
0.4	April 2018		Update based on characterisation status (pressure ratings, PPS) and for D1 release (product number, signalling flags, ordering information)	SJUN
1.0	June 2019	all	Update for final release and product launch of the SLF3S-1300F	SJUN
0.9	June 2021	All	Updated from SLF3S-1300F to SLF3C-1300F. Included chapters from TC-App-note. Preliminary version	PARE
1.0	July 2021	all	Repeatability for TC feature added. Released version	PARE