**Preliminary Product Specifications**

**SLQ-QT500 Liquid Flow Meter**

High Purity Flow Meter

- For hydrocarbons and water-based liquids
- For high and low viscosity fluids
- Maximum flows up to 120 ml/min
- High Speed Flow Measurement
- Totally Non-Invasive, Straight flow channel
- Digital RS485 Interface

## Introduction SLQ-QT500

The SLQ-QT Liquid Flow Meter series enables fast, non-invasive measurements of liquids in semiconductor applications. The SLQ-QT500 extends the series’ capabilities to higher viscosities, and also enables the measurement of water based liquids such as TARC, acids, bases and DI water. The sensor is available with two calibrations: H₂O and isopropanol (IPA). The fluidic part of the device comprises a single straight flow path without any moving elements. Due to the short response time, the SLQ-QT500 allows monitoring highly dynamic processes such as fast dosing operations. Benefits are highly increased process reliability and reduced consumption of precious media.

## Preliminary Key Specifications – subject to change

Table 1: Specifications of SLQ-QT500 (all data at 23°C, 1 bar unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SLQ-QT500</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Flow Rate (water based)</td>
<td>2000ᵃ</td>
<td>µl/sec</td>
</tr>
<tr>
<td>Maximum Flow Rate (hydro carbon based)</td>
<td>2000ᵇ</td>
<td>µl/sec</td>
</tr>
<tr>
<td>Repeatability (1σ)</td>
<td>2.0</td>
<td>% of m.v.ᶜ</td>
</tr>
<tr>
<td>Flow Detection Response Time</td>
<td>&lt;50</td>
<td>ms</td>
</tr>
<tr>
<td>Digital Interface (via RS485 Sensor Cable)</td>
<td>RS485</td>
<td></td>
</tr>
<tr>
<td>Power Supply DC, VDD</td>
<td>4.5 – 5.5</td>
<td>V</td>
</tr>
<tr>
<td>Protection Class</td>
<td>IP43</td>
<td></td>
</tr>
<tr>
<td>Internal Capillary, Inner Diameter</td>
<td>4.5</td>
<td>mm</td>
</tr>
<tr>
<td>Attached tubing - inner / outer diameter</td>
<td>4.35 / 6.35 (¼”)</td>
<td>mm (inch)</td>
</tr>
<tr>
<td>Response Time On Power-Up</td>
<td>&lt; 120</td>
<td>ms</td>
</tr>
<tr>
<td>Optimal Heat Up Time (for constant flow meas.)</td>
<td>500 – 1500</td>
<td>ms</td>
</tr>
<tr>
<td>Mounting Orientation Sensitivityᵈ</td>
<td>&lt; 20</td>
<td>µl/s</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>+20 ... +25</td>
<td>°C</td>
</tr>
<tr>
<td>Pressure Drop (IPA @ 2000 µl/sec)</td>
<td>&lt;&lt; 1</td>
<td>mbar</td>
</tr>
<tr>
<td>Maximum Operating Pressure</td>
<td>10ᵉ</td>
<td>bar</td>
</tr>
<tr>
<td>Burst Pressure</td>
<td>40ᶠ</td>
<td>bar</td>
</tr>
<tr>
<td>Ambient Storage Temperature (empty channel)</td>
<td>-10... +60</td>
<td>°C</td>
</tr>
</tbody>
</table>

ᵃ Maximum flow rate of 5000 µl/sec for water based liquids on demand available
ᵇ Maximum flow rate of 8200 µl/sec for hydrocarbon based liquids on demand available
ᶜ Measured value
ᵈ Normal position: horizontal flow channel, connector horizontally. For IPA @ 23°C
ᵉ The PFA tubing starts to widen over time at higher pressures than 10 bar. This results in a continuous pressure drop that would have to be compensated
ᶠ Burst pressure is not limited by the quartz capillary in the sensor, but by the PFA tubing
3 Smart RS485 Sensor Cable

The sensor comes equipped with Sensirion's RS485 Sensor Cable. A microprocessor is integrated in the Sensor Cable, which allows easy switching between different calibration modes (H₂O, IPA), as well as an automatic flow detection feature. The latter allows the sensor to be operated in a minimum power mode at zero flow, which gives optimal heater control between dispenses. Up to 1000 data points can be stored in an internal buffer which allows an uncritical read-out of the measurement in terms of timing. A Totalizator function offers the additional possibility of direct read out of the total integrated volume of dispenses.

Furthermore, the RS485 Sensor Cable offers bus capability for simultaneous measurement with multiple sensors, and robust long range communication for demanding environments and lines of 100 m and more.

Separate documentation is available on request for
- Sensirion RS845 Sensor Cable
- Communication Protocol according to RS485 Sensirion HDLC Standard
- Communication via Sensirion Driver DLL for Windows
- Support Documents for Dosing Monitoring

Table 2: Specifications of digital interface

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SLQ-QT500 operated with the RS485 Sensor Cable</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Interface</td>
<td>RS485</td>
<td></td>
</tr>
<tr>
<td>Power Supply DC, VDD(^a)</td>
<td>4.5 – 5.5</td>
<td>V</td>
</tr>
<tr>
<td>Operating Current (typical)</td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>Operating Current (max., during communication)</td>
<td>100</td>
<td>mA</td>
</tr>
</tbody>
</table>

Ground of power supply and ground of the communication system have to be connected.

\(^a\) If the sensor is operated without the RS485 Sensor Cable, the needed power supply is 3.3 - 3.7 V.
4 Mechanical Specifications

Fig. 1 shows the general design of the SLQ-QT500 sensor. The microsensor chip position allows optimal bubble detection in a typical mounting geometry. Hereby, the mounting holes are used to install the sensor in a ‘hanging’ position, in which the chip lies on top of the flow channel. Very small bubbles will therefore pass though the flow channel in close proximity to the sensor chip, which ensures optimal bubble detection.

![Chip position](Image)

**Fig. 1: Design of the sensor. Chip lies on top of the flow channel, if sensor is installed in a ‘hanging’ position. Two mounting holes are lying on diagonally opposing corners of the sensor. The inlet of the sensor (for positive flow) is at the side of the electrical connector.**

The electrical connector is located at the inlet side of the sensor. The sensor chip is not positioned at the center of the flow path in the sensor, but near to the outlet side. This additional gain in flow path length before the chip on the inlet side gives maximum stabilization of the laminar flow profile, and a gain in repeatability at high flow rates. The sensor is therefore measuring fully bi-directional, with optimized precision for positive flows.

For the dimensions of the sensor, see Fig. 2.
4.1 Materials

Table 3: Wetted Materials

<table>
<thead>
<tr>
<th>Part</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Tubing ¼&quot;</td>
<td>PFA</td>
</tr>
<tr>
<td>Capillary</td>
<td>Quartz</td>
</tr>
</tbody>
</table>

Table 4: Non-Wetted Materials

<table>
<thead>
<tr>
<th>Part</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>PPS</td>
</tr>
<tr>
<td>Screws and electrical connector</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Cables</td>
<td>Copper, ETFE</td>
</tr>
</tbody>
</table>

4.2 Labels

The SLQ-QT500 is equipped with two labels on opposite sides of the housing. Both labels are solvent resistant and contain information about:

- Sensirion product name
- Calibrations on the sensor: calibration field (CF), liquid (H₂O or IPA), maximum calibrated flow rate
- Serial number as number and encoded in 2D bar code
- Positive flow direction marked by arrow
5  Liquid Temperature Management

Due to the used microsensor technology, the amount of thermal energy introduced into the liquid is very small. It is generally recommended to avoid heat-up of the liquid in the thermal flow meter however, by turning off the micro heater when the liquid is not flowing. For instruction on how to control the sensor’s micro heater and on the low power mode refer to separate documentation.

When measuring according to the instruction for dosing measurements, the heat-up behavior of the liquid is given in table 5.

Table 5: Heat-up behavior (for IPA)

<table>
<thead>
<tr>
<th>Heater Setting</th>
<th>Flow Situation</th>
<th>Examined Waiting Time</th>
<th>Heat up of liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater off &amp; analog cell off</td>
<td>flow / no flow</td>
<td>unlimited</td>
<td>&lt; 0.3 °C</td>
</tr>
<tr>
<td>Heater off &amp; analog cell on</td>
<td>flow / no flow</td>
<td>unlimited</td>
<td>&lt; 1 °C</td>
</tr>
<tr>
<td>Heater on</td>
<td>no flow</td>
<td>1 second after heater turned on</td>
<td>&lt; 0.075 °C</td>
</tr>
<tr>
<td>Heater on</td>
<td>no flow</td>
<td>2 seconds after heater turned on</td>
<td>&lt; 0.15 °C</td>
</tr>
<tr>
<td>Heater on</td>
<td>no flow</td>
<td>&gt; 2 seconds after heater turned on</td>
<td>&lt; additional 0.1°C / second, maximal 4°C</td>
</tr>
<tr>
<td>Heater in low power mode a</td>
<td>constant flow X ml/min</td>
<td></td>
<td>≈ 0.03 °C / X</td>
</tr>
<tr>
<td>Heater in low power mode a</td>
<td>no flow</td>
<td>unlimited</td>
<td>&lt; 1°C</td>
</tr>
</tbody>
</table>

6  Fluidic Connections

The sensor comes equipped with ¼” PFA tubing attached. The PFA tubing is part of the sensor and guarantees retaining full performance. It must never be disassembled or replaced.

It is possible to shorten the tubing when necessary, however:

- it is not possible to replace the tubing with other tubing of the same or other sizes
- for optimal performance the tubing on the inlet side is recommended to remain straight for low viscosity liquids at high flow rates
- on the outlet side, the tubing can be cut or bent as needed, without affecting sensor performance for positive flow (normal requirements for handling PFA tubing apply)
- ensure to leave tubing of sufficient length for connecting the sensor to your system

Basic guidelines:

- For photo resist or other liquids with viscosity of 10 cP and more, or for any liquid at low flow rates, there are no strict requirements for the inlet length.
- For optimal accuracy when using low-viscosity liquids such as H₂O at high flow rates, ensure that the tube remains straight on the inlet side if possible. For optimal repeatability of the sensor it is sufficient to fix the tubing geometry after installation.

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a Low power mode is only available when Sensor is operated with the RS485 Sensor Cable
7 Repeatability

For flow rates up to 2000 µl/sec the expected repeatability is <2% of measured value for both calibrations (H₂O and IPA). This repeatability can only be expected for a process at constant temperatures and a fixed tubing geometry and sensor mounting. Moving of tubing or sensor will result in an offset of the measurement due to a changed flow profile inside of the sensor. The measurement is most sensitive to these conditions for high flow rates and low viscosity liquids.

Optimal use of the sensor is achieved if the sensor and tubing is fixed after installation in the equipment. Should the sensor or tubing be moved afterwards, a reset of the expected measurement output for a specific dispense might have to be made.

8 Flow Meter Lifetime

The expected lifetime of the flow meter is 3 years of constant operation, under the condition that the sensor is used

- with non-depositing and non-abrasive liquids
- in a clean and dry environment free of aggressive vapours
- in an environment with constant temperature within the range specified in chapter 2.
- in compliance with all other handling instructions.

9 Limitation of Particle Contamination

The flow path of each SLQ-QT500 flow meter is flushed with ultra-pure water as a final production step before packaging. The flow meter is then sealed in PE foil under ISO 5 clean room conditions. The particle count limit for the flushing process is <1 detected particle per 1 ml of water, and the detection limit for particles is 100 nm diameter.

10 On-Site Flow Path Cleaning

The most important rules for handling the sensor are:

- avoid letting fluid dry in the flow meter that could leave deposits
- never attempt to mechanically clean the sensors inner flow channel.

Since the sensor relies on a thermal measurement through the quartz glass wall of the inner flow channel, precautions must be taken to avoid any build-up or deposits that could alter the thermal properties of the capillary. The precision of measurements could be affected. When changing from one liquid to another, sufficient cleaning procedures have to be performed to avoid non-soluble depositions on the flow channels wall.

Before storing the sensor, always drain the fluid, flush with cleaning agent, and allow to air dry. In most cases flushing with acetone and finally IPA will suffice. The cleaning agent (detergent, solvent, etc) should be chosen for its effectiveness in removing the liquid media and compatibility with wetted materials.

Flow meters do not require periodic cleaning unless the medium has a tendency to leave deposits, or flow meters have been disconnected from the fluidic path and were not properly flushed. The residue left by the drying fluids can alter sensor performance or even plug the capillary. You may try cleaning it by flushing with acetone and IPA.
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.

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. SENSIRION is only liable for defects of this product arising under the conditions of operation provided for in the data sheet 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.

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11.4 RoHS and WEEE Statement
The SLQ-QTxxx product family complies with requirements of the following directives:


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