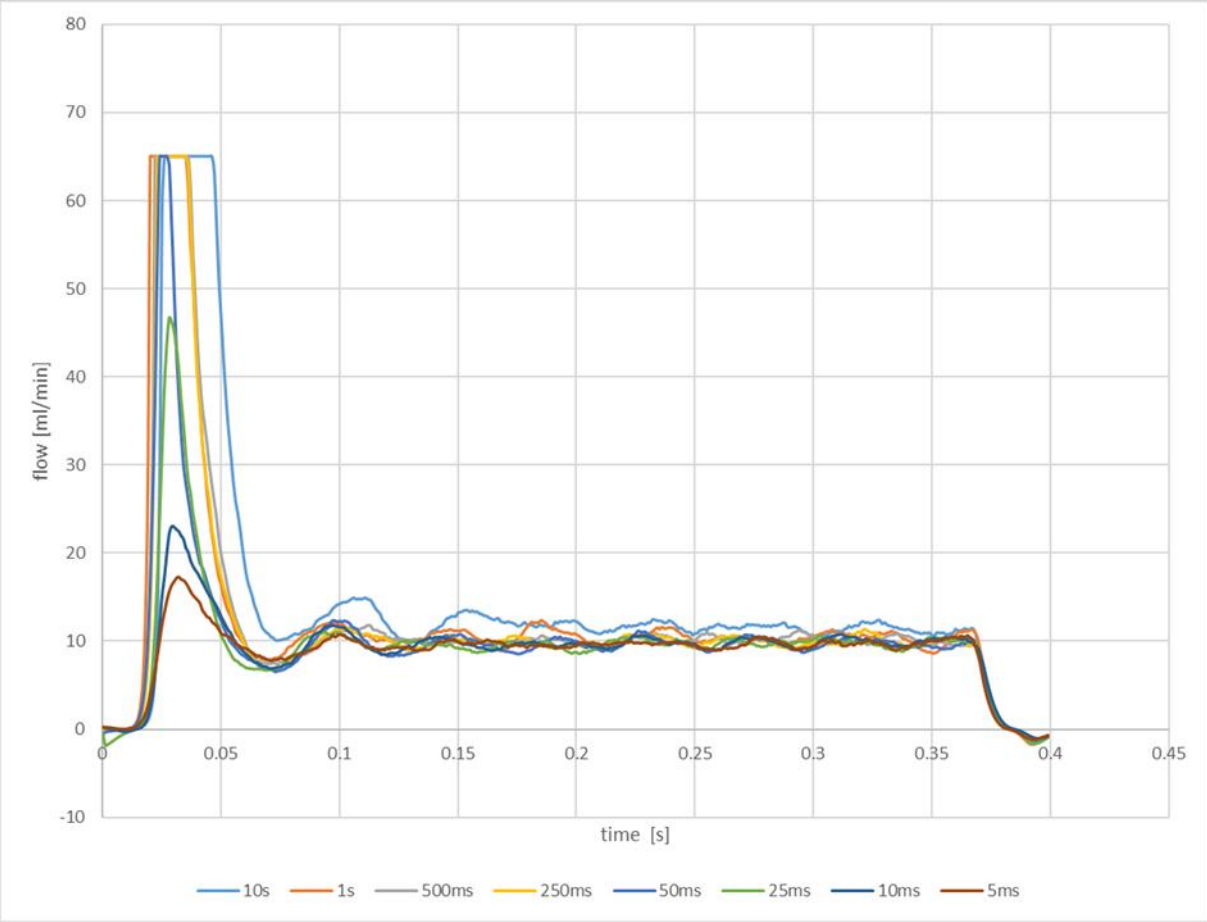
USING THE AUTO HEATER MANAGEMENT IN DISPENSING APPLICATIONS

Application note for products of the SLF3x- and LD2x-family

Summary
In liquid dispensing applications, the thermal flow measurement principle can introduce inaccuracies in the flow reading by emitting too much heat during the stagnant flow condition between the dispenses. This excess heat can lead to an overshoot of the flow rate during the first milliseconds of the next dispense. This effect can be reduced or avoided by managing the heating power of the CMOSens chip used in Sensirion liquid flow sensors. This application note explains which parameters can be adjusted and how the command is created which needs to be sent to the sensor to enable the feature with the chosen parameters.

1 Introduction and physical background

In many liquid flow applications, the sensor monitors an intermittent flow characterized by relatively long (seconds to minutes) waiting periods followed by relatively short dispense processes (milliseconds to seconds). During the period of stagnant flow, the heater-element on the CMOSens chip emits excess heat into the liquid. At the very first moment of the dispense, this excess heat leads to an overshoot in the flow rate. This overshoot is purely a sensor effect and does not reflect the real flow conditions in this moment. With this, it lowers the accuracy of the calculated dispensed volume.
In the graphic below, this overshoot is shown for different waiting times, between dispenses. One can see that the longer the waiting time, the more pronounced the effect becomes.



2 Automatic Heater Management

To reduce this overshoot, Sensirion offers an auto heater management functionality in its flow sensors which use the SF06-chip (SLF3x, LD2x).

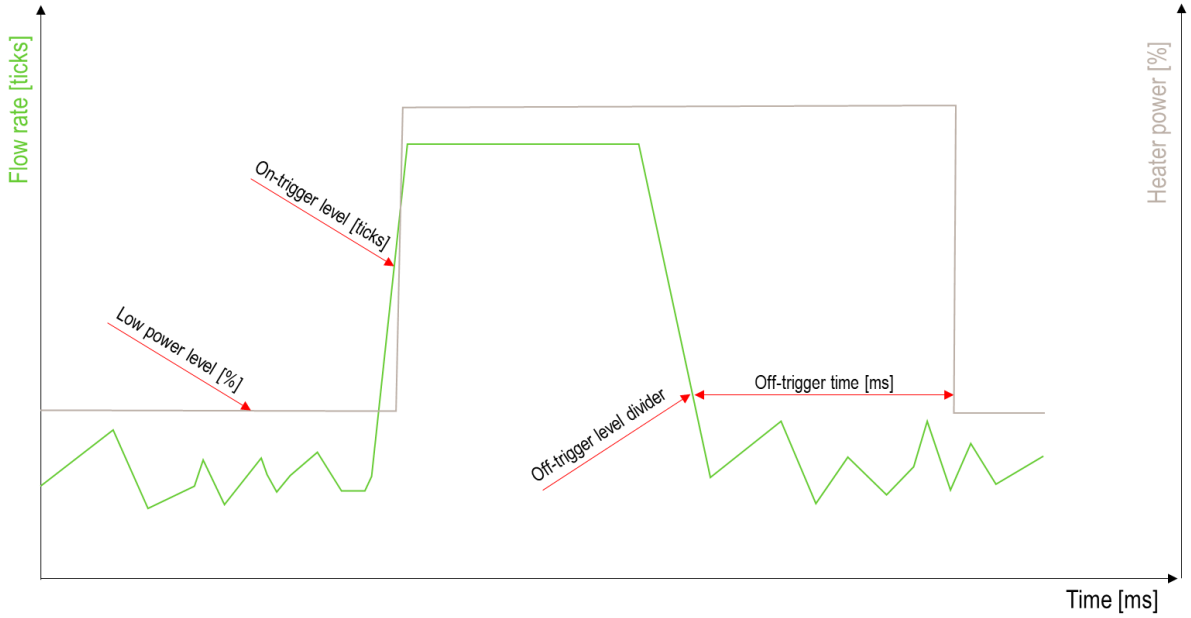
2.1 Explanation of the procedure

To start the flow measurement with the automatic heater management activated, a special command is sent to the sensor. With the argument, the parameters for the heater management can be modified.

To generate the special command an excel tool provided by Sensirion is used. In there the arguments can be set and the command is created. This command must then be sent to the sensor to initiate the measurement mode.

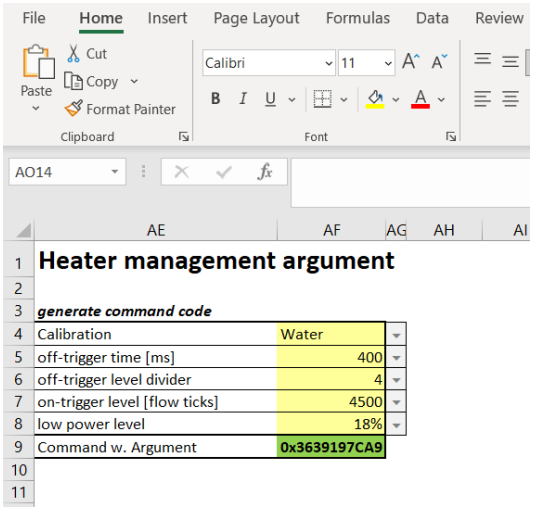
The adjustable parameters are:

- **Calibration:** Defines which calibration is used (water or IPA)
- **Low power level**: Defines the power level to what the heat power is reduced.
- **On-trigger level**: Defines the flow rate which sets the heater power back to 100%. The unit is an integer which the sensor outputs natively. In order to convert this number to a flow rate, one needs to divide the number by the scale factor given in the data sheet (liquid flow rate in ml/min = sensor output / scale factor). Keep in mind that the flow rate measurement is not at full accuracy in this moment as the heater is in low-power-mode.
  Off-trigger divider: This defines the flow rate below which the heater is reduced (after staying below this flow rate for the off-trigger time). It is given as divider of the on-trigger level.
- **Off-trigger time:** Timespan for which the flow rate must stay below the off-trigger level to initiate the reduction of the heater power.



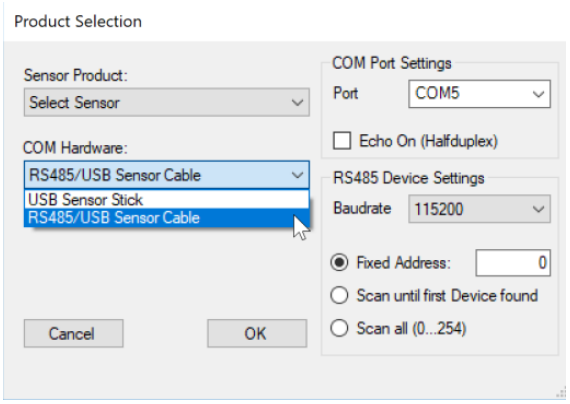
2.2 Sensirion Auto Heater Management Argument Creator

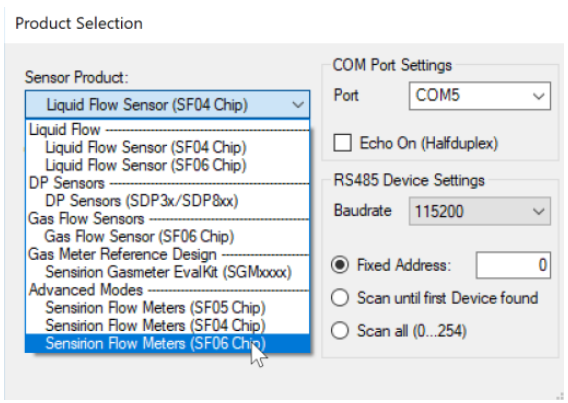
To generate the HEX-command which is sent to the sensor to start the measurement, one must use the excel sheet (LQ_AN_Auto-Heater-Management_D2.xlsx) provided by Sensirion. In there the HEX-code is calculated, based on the user-adjusted parameters.
See a screenshot of the excel-file below. The input is done via dropdown-menu in cells AF4-AF8 while the generated HEX-code is shown in cell AF9.



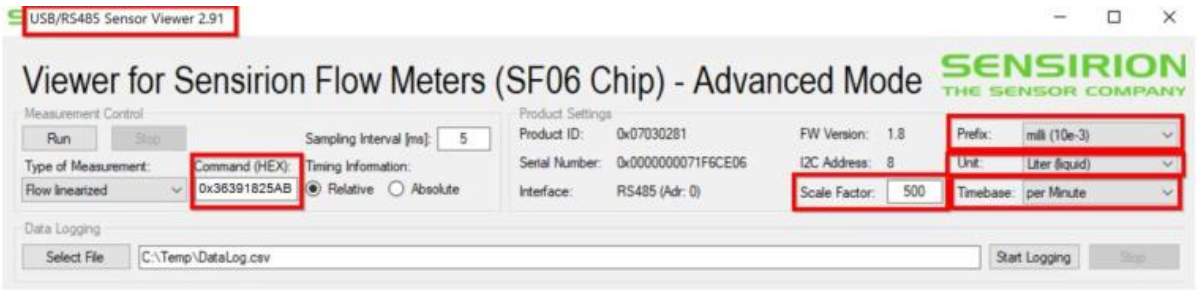
2.3 Testing parameter set

In order to test the chosen parameters one can enter the generated HEX-code into the Sensirion Sensor Viewer software, start the measurement and see the effect. Please not that therefore the Sensor Viewer needs to be started in “Advanced Mode”. To enter the advanced mode, start the Sensor Viewer and after choosing the USB-sensor cable, select the SF06-chip in the Advanced Mode.





Afterwards the sensor viewer starts in advanced mode in which the generated HEX-command can be entered in the box in the left part. Please not that in advanced mode, the scale factors and units of the sensor must be entered manually.



2.4 Optimization Strategy

When trying to optimize the auto heater parameters we suggest starting with a measurement with the feature turned off (normal measurement mode). Sensirion also recommends optimizing the feature in the final fluidic setup and with the final liquids.

- Choose the correct calibration for your liquid. Either water or isopropyl alcohol
- Calculate the flow rate in ticks to define the on-trigger-level. The on-trigger-level should be in the rising edge of the dispense pulse and clearly above the baseline noise level between dispense pulses.
- When optimizing the low-power-level start with reducing the heater power stepwise and observe how the overshoot is reduced. If the heater power is reduced too much, the overshoot will get larger again. Therefore, it is better to start from the top and search the low-power-level with which the overshoot becomes minimal.
- Calculate the desired flow rate below which the heater should be turned off. From this, determine the necessary off-trigger-divider (off-trigger-flow-rate [ticks] = on-trigger-level [ticks] / off-trigger-divider). Make sure the off-trigger-flow-rate is higher (with some margin) than the baseline between dispense cycles.
- Set the off-trigger time according to your dispense-cycles.

2.5 Signaling Flags

SLF3x and LD2x products send automatic signaling flags when certain criteria are fulfilled (e.g. when flow signal saturates). When the sensors are operated in auto heater management, these flags loose their meaning. If a flag is output, it should be disregarded. Consequently, one should not rely on the flags to monitor the behavior of the system.

1 Headquarters and Subsidiaries

Sensirion AG
Laubisrütistr. 50
8712 Stäfa
Switzerland

phone: +41 44 306 40 00
fax: +41 44 306 40 30
info@sensirion.com
www.sensirion.com

Sensirion Taiwan Co. Ltd
phone: +886 3 5506701
info@sensirion.com
www.sensirion.com

Sensirion Inc., USA
phone: +1 312 690 5858
info-us@sensirion.com
www.sensirion.com

Sensirion Japan Co. Ltd.
phone: +81 3 3444 4940
info-jp@sensirion.com
www.sensirion.com/jp

Sensirion Korea Co. Ltd.
phone: +82 31 337 7700~3
info-kr@sensirion.com
www.sensirion.com/kr

Sensirion China Co. Ltd.
phone: +86 755 8252 1501
info-cn@sensirion.com
www.sensirion.com/cn

To find your local representative, please visit www.sensirion.com/distributors

Revision History of the Application Note "SLF3x-HeaterMgmt" – for INTERNAL USE only

Revision	Date	Changes Chapter	Description	Author
0.1	Jun 2022	all	First preliminary version	PARE
0.2	Feb 2024	2.5	Added explanation about signalling flags	KDOM

