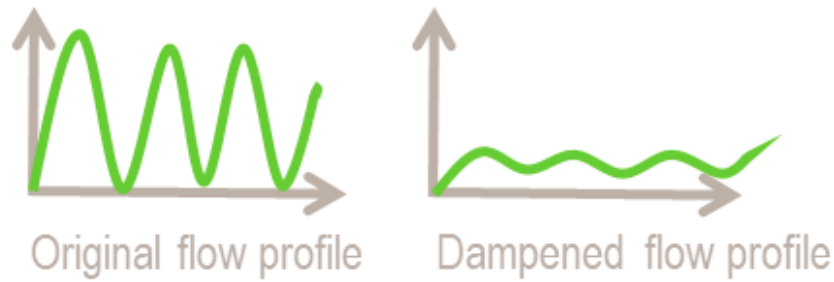


Pulsation Damping

Application Note for Liquid Flow Sensors



This application note describes how to dampen flow pulsations using common fluidic components. It primarily addresses the ml/min flow range. The example setup includes an orifice restrictor and damping tube to provide a considerable damping effect with low internal volume.

If you find this concept useful for your application and want to use it in your product, contact Sensirion's technical support for further assistance.

1 Introduction

In many applications, liquid flow is delivered by a pump or valve that creates a non-continuous flow rate. Examples are peristaltic pumps, piston pumps, (piezo) membrane pumps, and valves. Besides the flow source, a fluidic system is made of several additional components. They all influence the way a generated pulse is dampened while propagating through the system. The particular combination of resistance and capacity, i.e. the specific design of your fluidic system, defines the damping of such a pulse down- or upstream of the pump and therefore also the way the pulse arrives at and is measured by Sensirion's liquid flow sensor.

Sensirion liquid flow sensors are calibrated under steady-state conditions, i.e. non-pulsating flow rates, over the sensor's specified measurement range. Due to their high sampling rate in combination with a fast response time, it is possible to measure and visualize pulsating or quickly changing flow rates.

There are two main effects which can impact the sensor output in case of pulsating flows:

- The actual peak flow rates of a pulsating flow can be much higher than the average flow rate set at the pump and can therefore exceed the sensor's output limit (check the sensor datasheet for the output limit specification). When the measurement saturates at the sensor's output limit, flow rates above the output limit are not recorded correctly.
- Exceedingly fast changes in the flow rate can lead to a distortion of the flow profile and thus of the sensor signal output. This will result in incorrect measurement results.

2 Test Instructions

It can be challenging to implement effective pulsation damping for a fluidic system before you have gathered some basic experience with the concept. The following components can be used to assist in evaluating pulsation dampening on Sensirion's liquid flow sensors:

- 1/4"-28 flat bottom to barb adapter for 1/8" (e.g. the Value Plastics ABR013-J1A-1 found in the SLx eval kits)
- 1/8" hose barb orifice restrictor, approx. 0.4mm hole size e.g. ISM RH-18-016PC
- 50cm silicone tubing 1/8" ID (used as damping tube)
- 5cm silicone tubing 1/8" ID (used to connect orifice to sensor/pump)

To test the pulsation damping with a Sensirion liquid flow sensor, install the restrictor on the outlet (downstream) side of the sensor and the damping tube between sensor and pump or valve in one of the following configurations:

In → Pump/Valve → Damping Tube → Sensor → Connection Tube → Restrictor → Out

In → Sensor → Connection Tube → Restrictor → Damping Tube → Pump/Valve → Out

The restrictor should not be installed on the inlet (upstream) side of the sensor. The orifice causes turbulence in the direction of the flow and will disturb the measurement. This is especially the case for flow rates higher than a few ml/min.

Always start testing with DI water. Ensure chemical compatibility of the wetted materials before using other media for your measurement.

Complete flow dampeners are also available from some pump manufacturers, such as the FPD 06 from KNF Flodos.

To view and log data for a later analysis of the measured data, use the free Sensirion Sensor Viewer Software. The sampling rate should be set to 2 ms when examining pulsating flows. The Viewer Software can also calculate the total volume of water that has flowed through the sensor in a set period of time. This can be compared to a weight scale to assess the accuracy of your measurement setup.

3 Measurement Example

Figure 1 demonstrates the effectiveness of the pulsation damping when used with a peristaltic pump. Note that without damping, the pulses exceed the output limit of the SLF3S-1300F sensor (65ml/min).

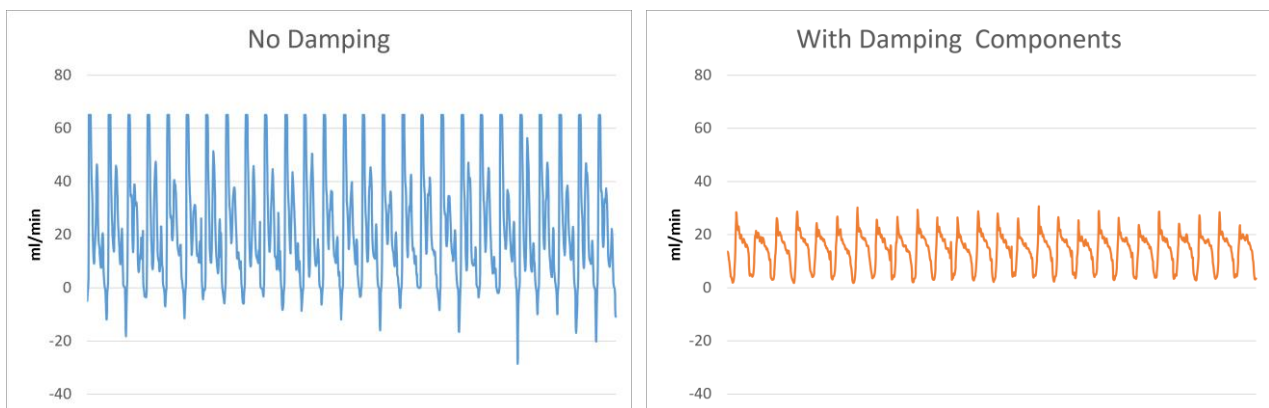


Figure 1. Measurement data of the SLF3S-1300F with and without flow damping components.

4 Next Steps

Contact Sensirion technical support for further assistance with pulsation dampening. Sensirion can review your measurement results and advise you with aspects or dimensions if you want to build your own pulsation damping system.

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 data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer purchases or uses 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 is 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. See application note "ESD, Latchup and EMC" for more information.

Warranty

SENSIRION solely warrants to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product is 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 as sole and exclusive remedy, in SENSIRION's discretion, repair this product or send a replacement product, 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 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.

The Buyer shall at its own expense arrange for any dismantling and reassembly that is necessary to repair or replace the defective product. This warranty does not apply to any product which has not been installed or used within the specifications recommended by SENSIRION. 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 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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