

Flowell

Liquid Mass Flow Meter for four independent channels

Flowell Product Summary

The Flowell Liquid Flow Meter enables extremely sensitive and fast measurements of ultra low liquid mass flows. This particularly small and light device operates with high pressure resistant total media isolation and hardly any dead volume.

The FLOWELL is an accessory of the MFCS that enables to measure the flow rates with a very high precision. More precisely the FLOWELL is composed of:

- 3 flow meters, named A, B and C, measuring flow rate from $-7\mu\text{L}/\text{min}$ to $7\mu\text{L}/\text{min}$ with a precision of around 0.1%, (Four flow rates calculated)
- 4 reservoirs that can be pressurized with the MFCS,
- A software connection to a computer

Associated with the MFCS (MicroFluidic Control System), it constitutes the MAESFLO.

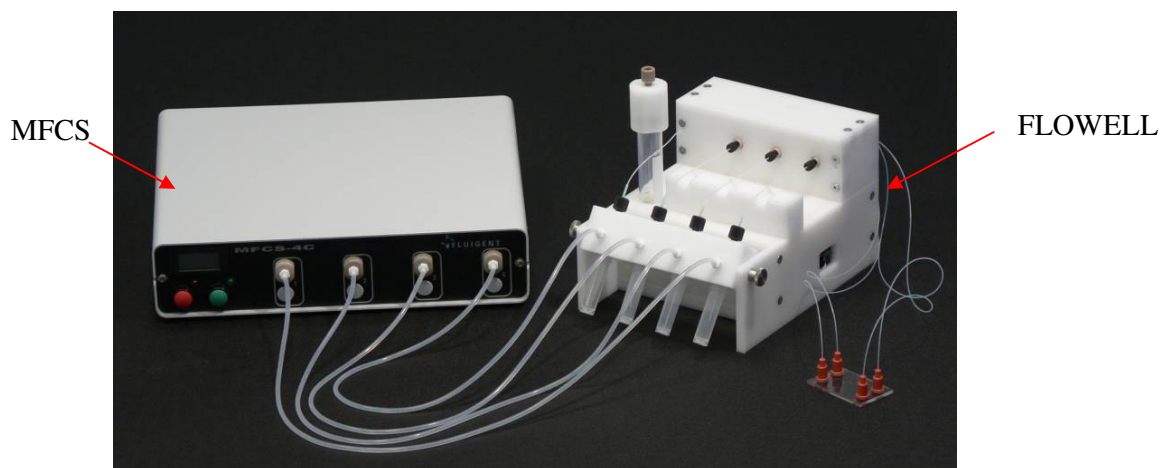


Figure 1: Flowell and MFCS (MicroFluidic Control System)

The unique performance of this device is based on unsurpassed CMOSens® sensor technology which combines a high precision sensor element with the amplification and A/D converter circuit and digital signal processing on one single CMOS chip. This results in superior resolution, fast response time and large dynamic range at lowest power consumption.

Excellent chemical resistance and bio-compatibility is ensured. The medium only gets in contact with the internal fused silica capillary, PEEK™ screw fittings, DELRIN and Polypropylen.

This multi sensor is made for Microfluidic systems. Typical applications include precise liquid flow measurement and metering for liquid chromatography, lab-on-a-chip systems, drug delivery, life sciences and quality testing.

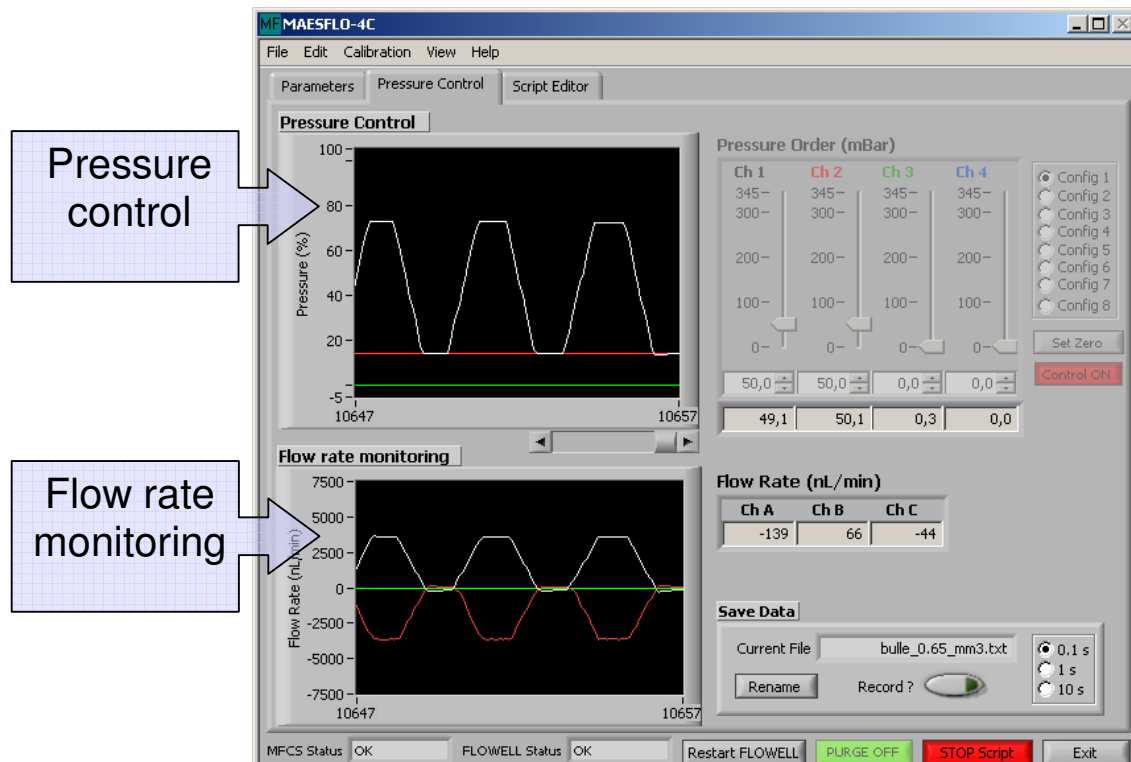


Figure 2: MAESFLO software interface for real time measurement and control of both MFCS and Flowell

In short, here are the main characteristics of the FLOWELL:

- Resolution down to 1,8 nL/min
- High pressure resistance, totally media isolated
- Flow path made of fused silica, Polypropylen and PEEK™
- Minimized swept volume (0,5µL)
- Outstanding repeatability of all measurements
- Calibrated, linear output
- USB digital interface
- Dedicated software

Introductory Description

The Flowell Liquid Flow Meter therefore provides unbeatable performance at very attractive system cost. The different types of this sensor cover a measurement range up to 7µl/min (H₂O) with a lowest detectable flow of 1.8 nl/min. Achieving this measurement with an ultra fast response time, the Flowell continues to set a new standard wherever liquid mass flow in the nano- to micro liter range has to be measured or controlled.

According to each application, the Flowell Liquid Flow Sensor can be adapted either to precise measurement or to fast changing flows. The customers can tune the precision of the measurements and the response time down to a few milliseconds. Table n° shows the different response time and precision in function of the bit definition of the flow meters:

Resolution	Precision	Response time
9 bits	22 nL/min	0.8 ms
10 bits	13 nL/min	1,3 ms
11 bits	9 nL/min	2,4 ms
12 bits	6 nL/min	4,6 ms
13 bits	4 nL/min	8,9 ms
14 bits	2.8 nL/min	17,5 ms
15 bits	2 nL/min	34,8 ms
16 bits	1.8 nL/min	69,3 ms

Table 1: set up of the flow meter sensors: varying the bit resolutions, you can tune the precision and the response time to fit your experiment specifications (precision is expressed here as mean square deviation at zero flow rate)

The Flowell device measures true liquid mass flow. You simply have to connect the MFCS to reservoirs in order to pressurize them and the specified flow range can be directly measured by the Flowell. Very high repeatability, a main goal for most processes, is ensured even for ultra low flows and different types of media.

The standard calibration media is water, but using the sensors in “Raw data” mode, the raw data are also available allowing one to calibrate the flow meter with any kind of liquids. In general, all liquids which are compatible with fused silica, Polypropylen and PEEK™, can be used with the Flowell.

In addition to the flow signal, the Flowell device provides information about the temperature on the CMOSens® sensor element. Both liquid flow and temperature data are accessed through the software.

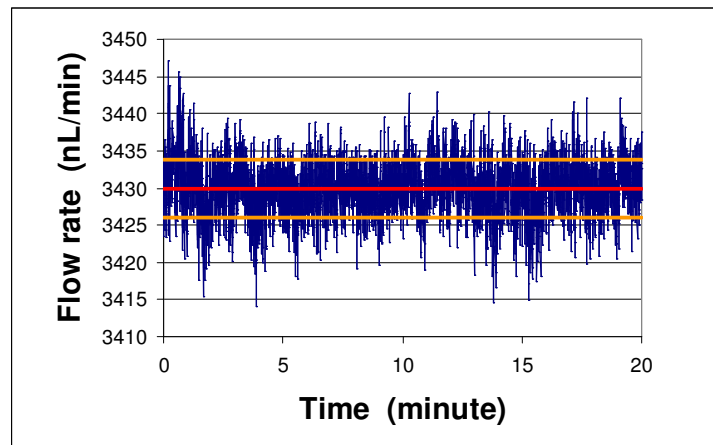


Figure 3: example of the high precision of both the MFCS control system and the FLOWELL measurement device: here a flow rate is flowed into a simple capillary using the MFCS and the flow rate is measured by one of the 3 flowmeters of the FLOWELL (standard deviation equals 0.1% of the measured value for 20min minimum)

The USB interface allows you to directly connect the Flowell device to a PC using proprietary solution with Labview™ interface.

CMOSens® Technology

CMOSens® is the base technology for all Flowell. The unification of digital semiconductor chip and sensor technology serves as a platform for highly integrated system solutions with excellent sensor precision and reliability. With CMOSens®, the on-chip sensor element forms an integrated whole with a high-end amplification and A/D converter circuit. Due to the compact single-chip design, CMOSens® based sensors are very resistant to electromagnetic disturbances (EMC), another important technical advantage of this high end sensor technology. As a result, CMOSens® based sensor modules offer excellent sensor precision, fast response time and a very large dynamic measurement range.

CMOSens® liquid mass flow sensors are formed by mounting the highly sensitive microchip on the outside of a straight fused silica capillary. Sophisticated packaging enables the system to measure precisely the liquid flow in the capillary through the tubing material while guaranteeing a total media isolation.

Liquid Mass Flow Sensor Performance

Parameter	Flowell	Units
Maximum Flow	7	µl/min
Calibrated Minimum Flow	0,25	µl/min
Resolution at Minimum Flow	0,025	% of full scale
Repeatability at Minimum Flow	1,8	nl/min
Non-Linearity (calibrated range)	0,8	% of measured value
Default flow Detection Response Time	5,2	% of measured value
Response Time On Power-Up	70	ms (see table 1)
	50	ms

Table 2: Flowell characteristics

Sensor Principle and Media Types

The Flowell device detects liquid mass flow by measuring heat transfer through the tubing material of a standard fused silica capillary. On a microchip outside the capillary, a heating resistor on a thermally optimized membrane is kept above ambient temperature. In the presence of liquid flow inside the capillary, the temperature distribution up- and downstream is disturbed. This asymmetry is then measured by two temperature sensors. Due to the minimal thermal mass of the system, symmetrical arrangement, and accurate temperature measurement, the revolutionary specifications of the Flowell devices are achieved while providing total media isolation and pressure resistance. The above-mentioned thermal principle depends on the type of liquid used.

The Flowell is calibrated for water. Nevertheless the sensor guarantees an outstanding repeatability for a wide range of different media though offset; sensitivity and measurement range may change. It is recommended to characterize the sensor output separately when starting to perform such measurements. Units calibrated directly for other liquid types are available on request.

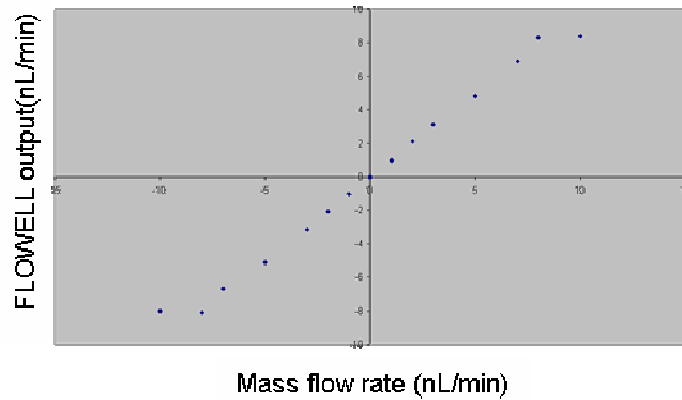


Figure 4: Flowwell transfer characteristics. The applied liquid flow is displayed vs. the digital output of the Flowwell for H₂O in calibrated data mode. Beyond the limits of the output (-7 μL/mn; +7 μL/mn), the signal remains constant.

Mechanical Specifications

Parameter	Flowell	Units
Sensors characteristics		
Operating Temperature	+10...+50	°C
Ambient storage temperature	0...+60	°C
Inner diameter	150	μm
Length	30	mm
Wetted material	Glass, PEEK	
Max pressure	200	bar
Flowell specifications		
Sensors number	3	
External dimension	11 x 13 x 18	cm (height x width x length)
Weight	500	g

Table 3 : Mechanical Specifications

Remark

In order to avoid irreversible clogging of the sensor the additional usage of an appropriate inline filter is highly recommended;

Ordering Information

For laboratory use and technology evaluation, the Flowell can be ordered with a MFCS.

The laboratory package contains:

- Flowell-V1.0
- PC Software (MFCS and Flowell software)
- Data Cable USB
- Microfluidic connection kit,
- Tutorial kit
- User manual

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. 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 FLUIGENT products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless FLUIGENT 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 FLUIGENT shall be 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.

Warranty

FLUIGENT 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 FLUIGENT's published specifications of the product. Within such period, if proven to be defective, FLUIGENT shall repair and/or replace this product, in FLUIGENT's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to FLUIGENT within fourteen (14) days after their appearance; such defects shall be found, to FLUIGENT's reasonable satisfaction, to have arisen from FLUIGENT's faulty design, material, or workmanship;
- the defective product shall be returned to FLUIGENT'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 FLUIGENT for the intended and proper use of the equipment. EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, FLUIGENT 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. FLUIGENT 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.

FLUIGENT 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.

FLUIGENT 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. FLUIGENT 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.

Electromagnetic Compatibility

Emissions.....EN 55011 Class A at 10 m

FCC Part 15A above 1 GHz

ImmunityIndustrial levels per

EN 61326:1997 + A2:2001,
Table 1
EMC/EMICE, C-Tick, and FCC Part 15
(Class A) Compliant
Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:
Low-Voltage Directive (safety).....73/23/EEC
Electromagnetic Compatibility
Directive (EMC)89/336/EEC

CE Statement

These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult a dealer or an experienced radio/TV technician for help.

Headquarters and Sales Office

PEPINIERE COCHIN
29, rue du Faubourg St Jacques
75014 Paris—FRANCE

Tel +331 4633 1628
Fax +331 4633 1668
contact@fluigent.com
www.fluigent.com