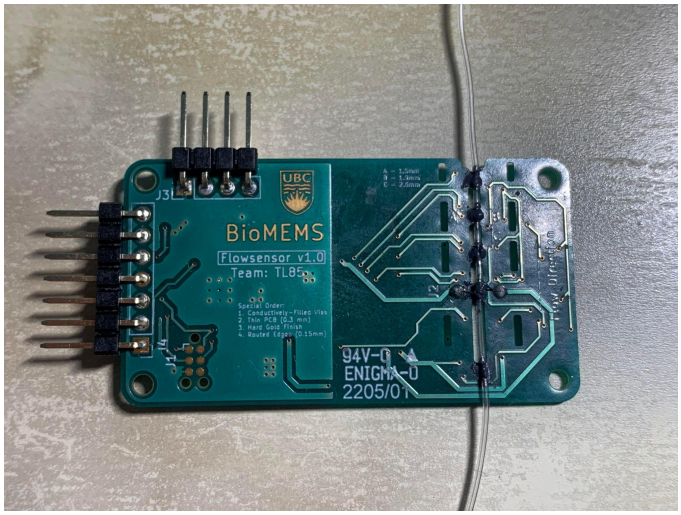
Flow Rate Sensor Specifications

Media Isolated Microfluidic Flow Rate Sensor

- Measures up to 80 uL/min
- Non-invasive measurement
- Simple UART Output
- 15 Seconds Response Time



Electrical Characteristics

Parameter	Min	Nominal	Max	Unit
Supply Voltage	1.8	3.3	3.6	V
Supply Current	-	10	600 (1)	mA
Response Time	14	15	16	s

Note 1: Drains up to 600 mA while applying power to the heater wires

Measurement Characteristics

Parameter	Min	Nominal	Max	Unit
H2O Flow Rate Full Scale	-	-	80	uL/min
H2O Accuracy Below 55 uL/min	-	-	5	% full scale
H2O Accuracy Below 80 uL/min	-	-	18	% full scale

All test results taken with the following parameters

- Supply Voltage = 3.3V
- Ambient Temperature = 23 C
- Water = DDW (Distilled, Deionized Water)

Operation & Storage Characteristics

Parameter	Min	Nominal	Max	Unit
Storage Temperature	-10	23	60 (2)	C
Operating Temperature	10 (3)	23	50 (3)	C
Storage & Operating Humidity	-	-	95	%RH
Maximum Reagent temperature	-	-	30 (4)	C

Note 2: The Tygon tubing may have a lower storage temperature than this figure

Note 3: These figures are best guesses, they have not been tested

Note 4: The maximum temperature the reagent will be heated to during the measurement process

Mechanical Characteristics

Parameter	Min	Nominal	Max	Unit
Measurement Tube Inner Diameter (5)	0.184	-	0.254	mm
H2O Pressure Drop @ full scale	-	-	10 (6)	mbar
Total Internal Volume	-	-	2	uL
Max Pressure	-	-	2000 (7)	mbar

Note 5: Measurement tube consists of alternating sections of stainless steel 29G tubes and 0.01’’ID, 1/32’’OD Tygon tubes

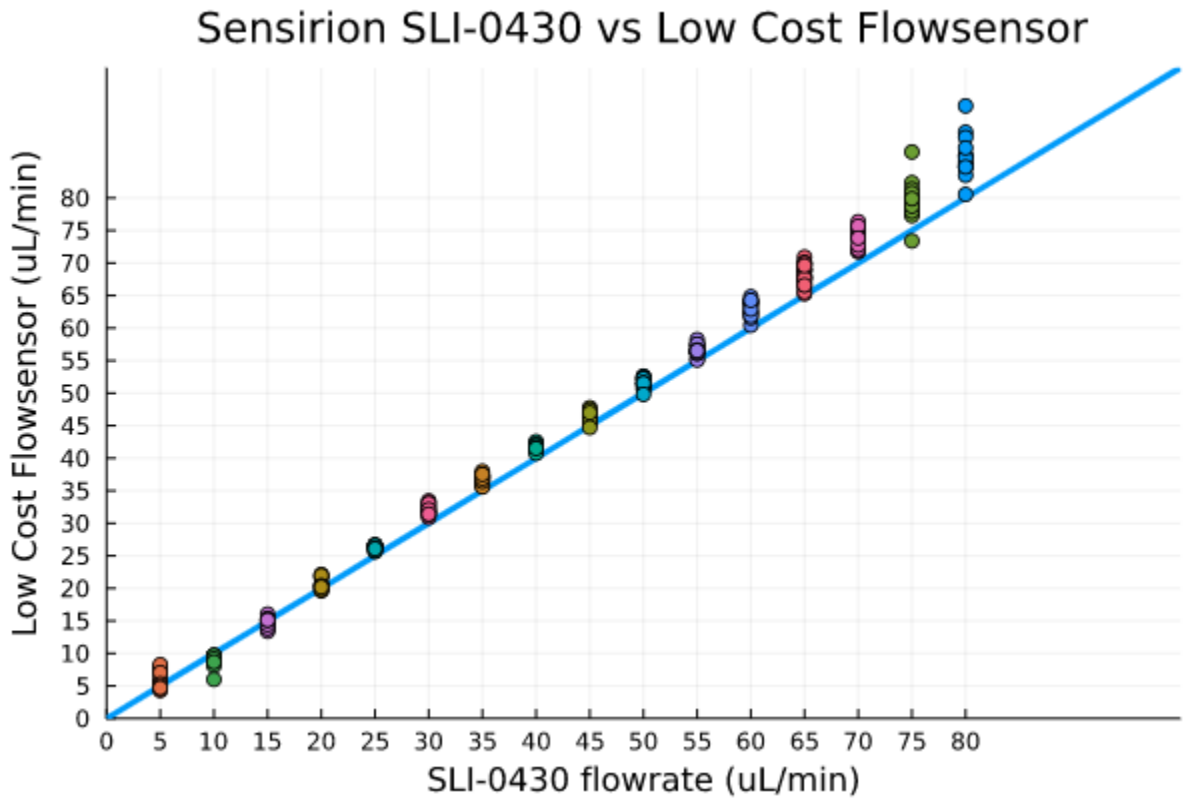
Note 6: Theoretical, calculated with 80uL/min as flow rate

Note 7: Experimental result where a force equivalent to 2 bars of pressure were applied to the syringe connected to the flow sensor

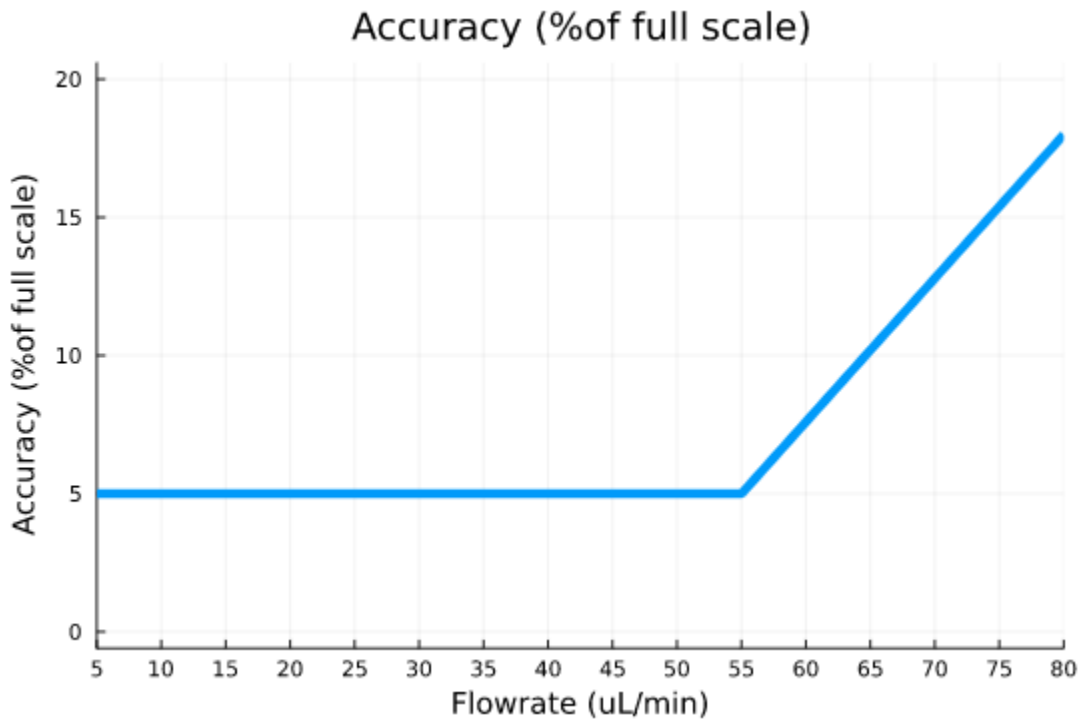
Specification Charts

Distilled, Deionized Water (DDW)

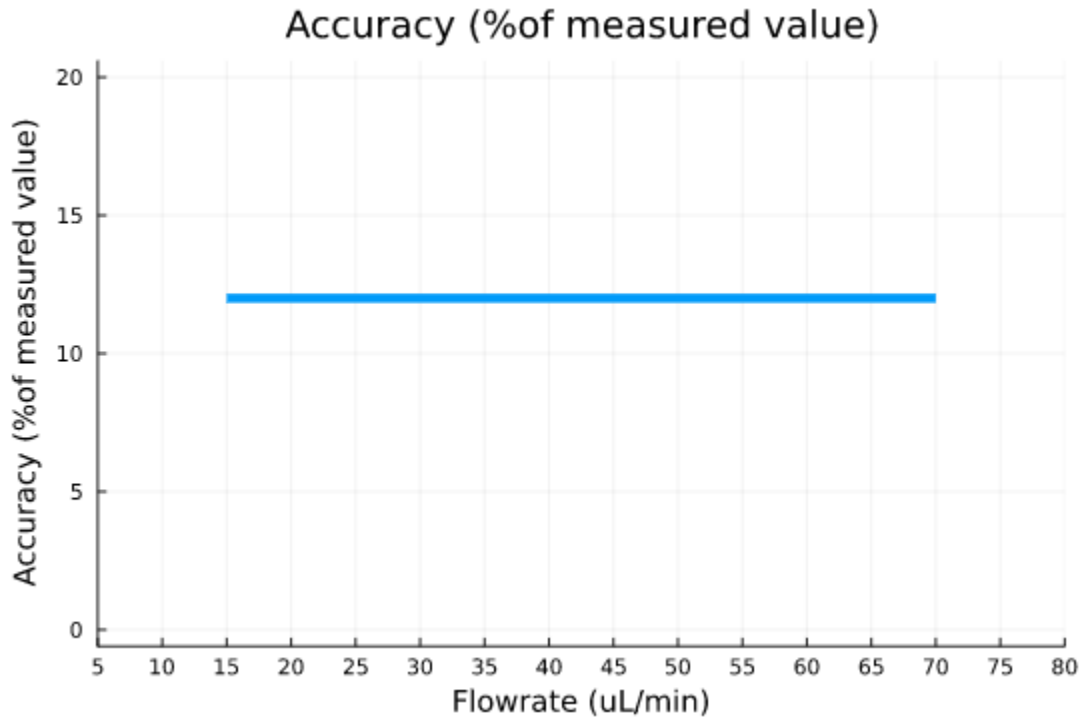
Benchmark Result with Fluigent System (SLI-0430)



Accuracy (%of f.s.)



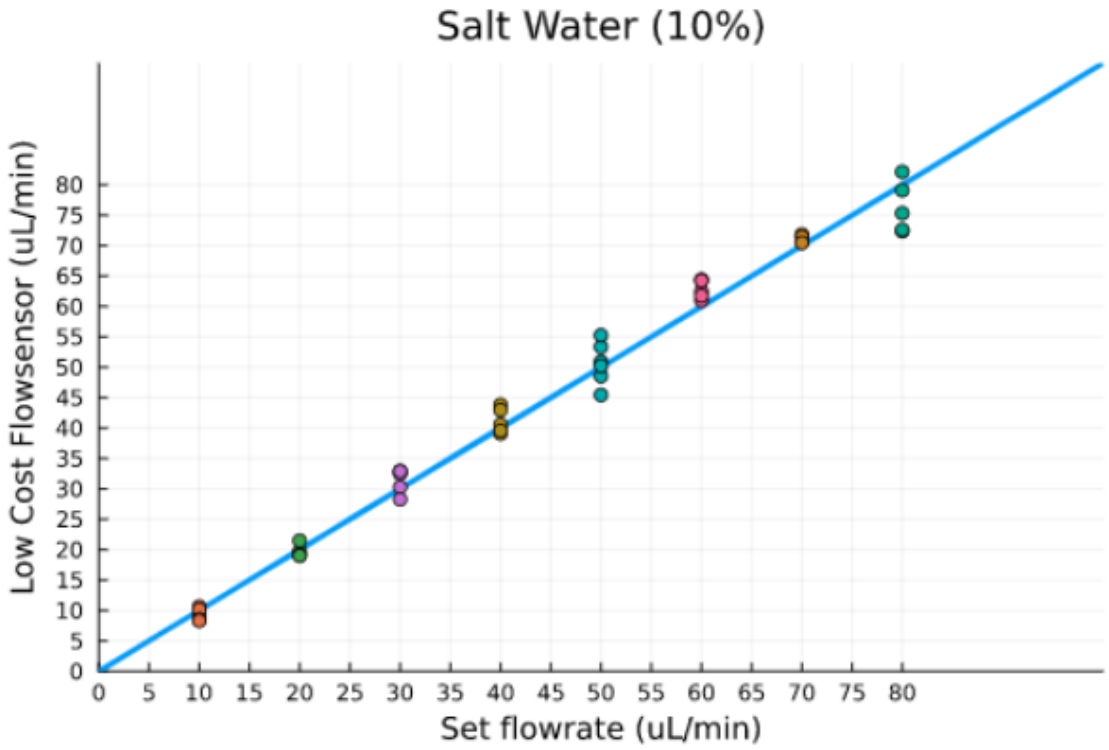
Accuracy (%of m.v.)



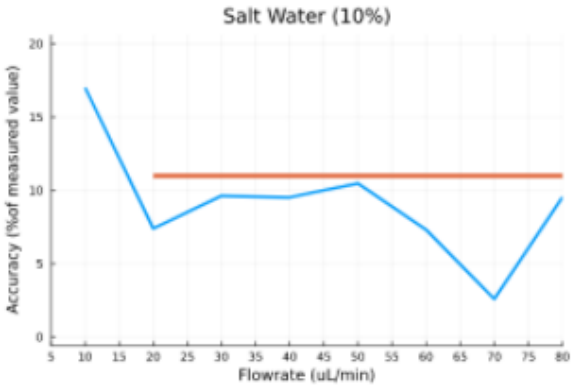
	variable	mean	min	median	max	nmissing	eltype
1	:abs_err	4.5975	1.6	3.25	14.15	0	Float32
2	:measurement_err	14.8148	5.22	9.08187	65.4	0	Float32
3	:fullscale_err	5.74687	2.0	4.0625	17.6875	0	Float32
4	:flow	42.5	5	42.5	80	0	Int32

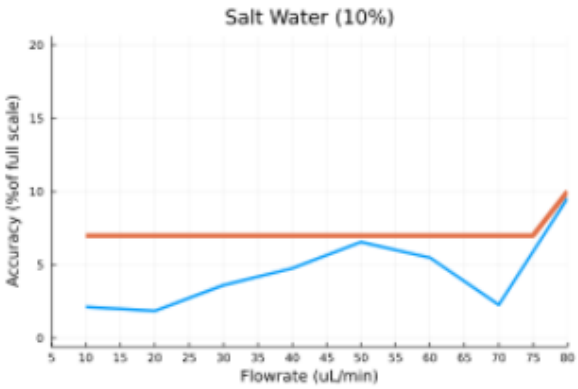
abs_err: uncertainty in uL/min
measurement_err: accuracy in %of measured value
fullscale_err: accuracy in %of full scale
flow: Data taken between these set flow rates

Saline Solution (10% Concentration)

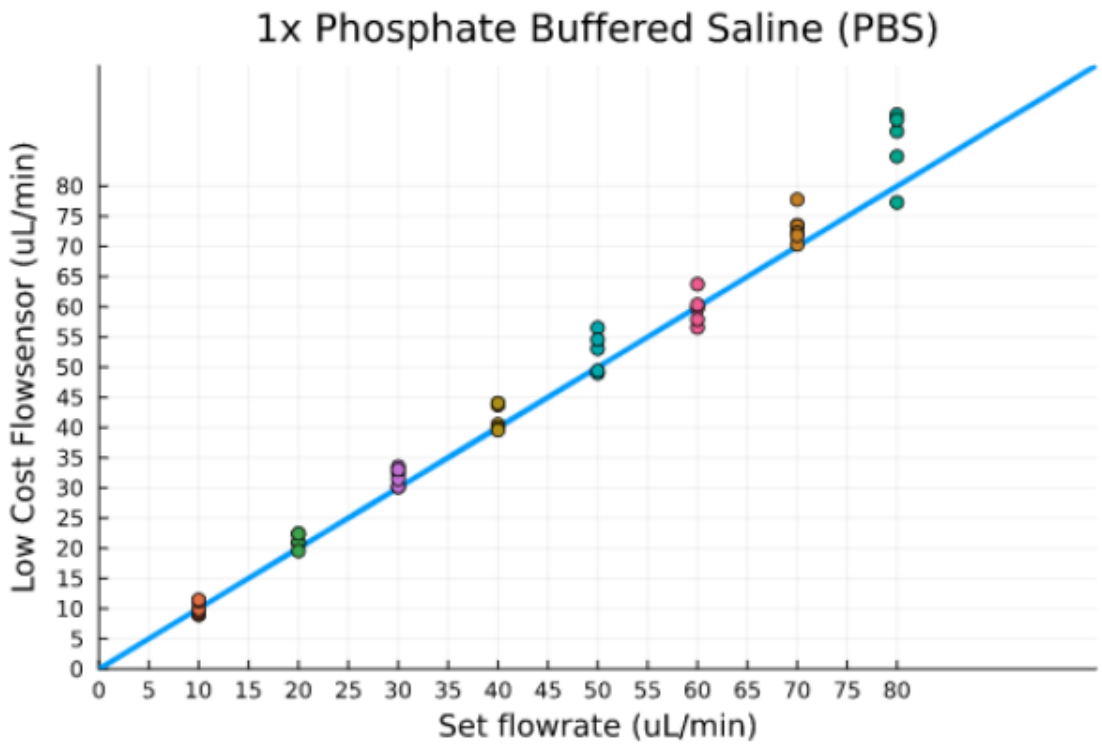


	variable	mean	min	median	max	nmissing	eltype
1	:abs_err	3.62	1.48	3.35	7.64	0	Float32
2	:measurement_err	9.18634	2.58571	9.5375	17.0	0	Float32
3	:fullscale_err	4.525	1.85	4.1875	9.55	0	Float32
4	:flow	45.0	10	45.0	80	0	Int32

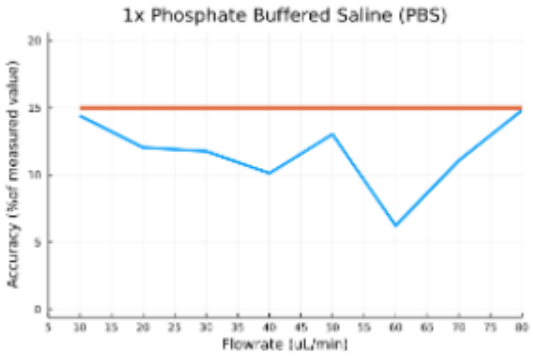


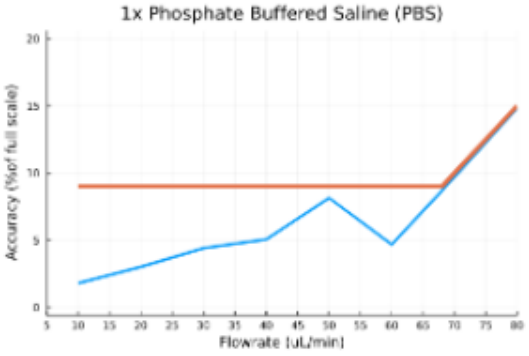


1x Phosphate Buffered Saline

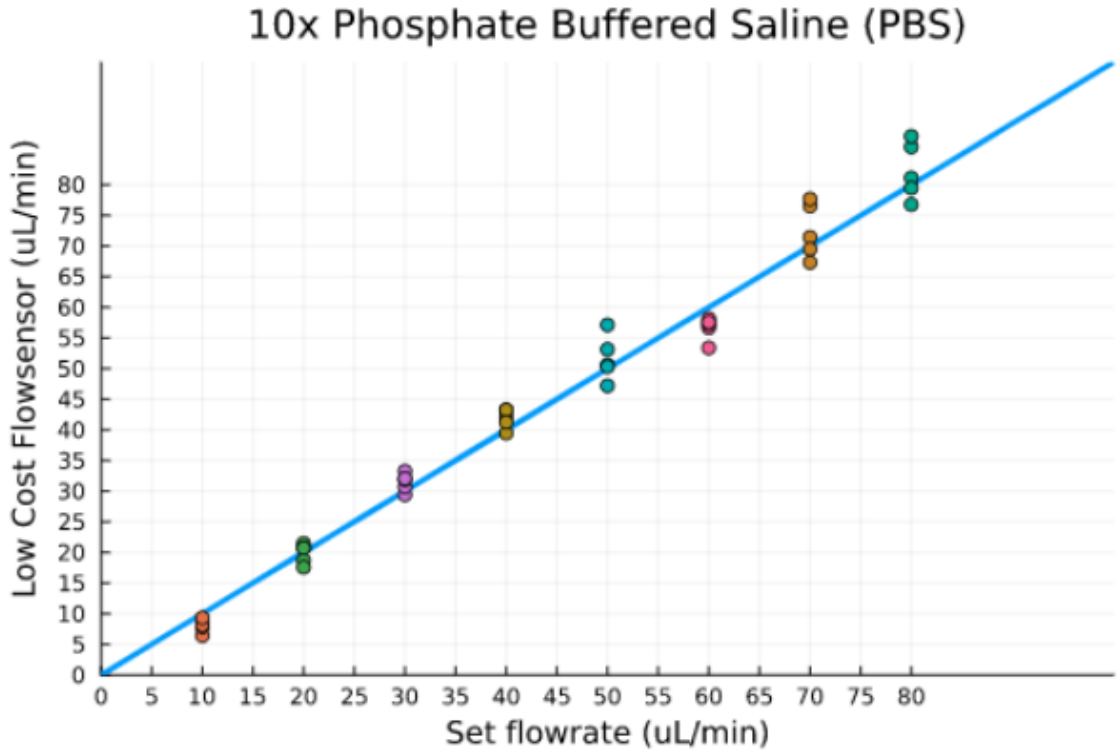


	variable	mean	min	median	max	nmissing	eltype
1	:abs_err	5.1625	1.44	3.895	11.85	0	Float32
2	:measurement_err	11.6892	6.23334	11.9083	14.8125	0	Float32
3	:fullscale_err	6.45312	1.8	4.86875	14.8125	0	Float32
4	:flow	45.0	10	45.0	80	0	Int32

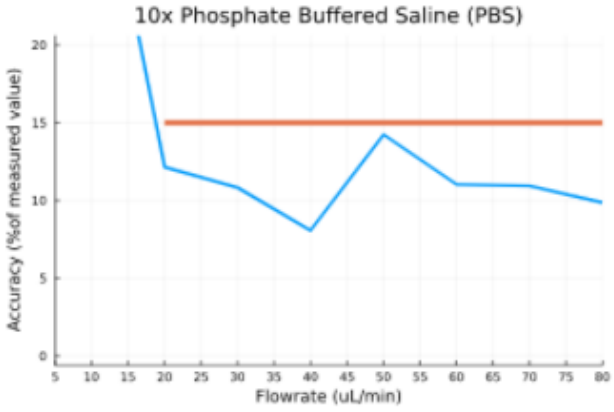


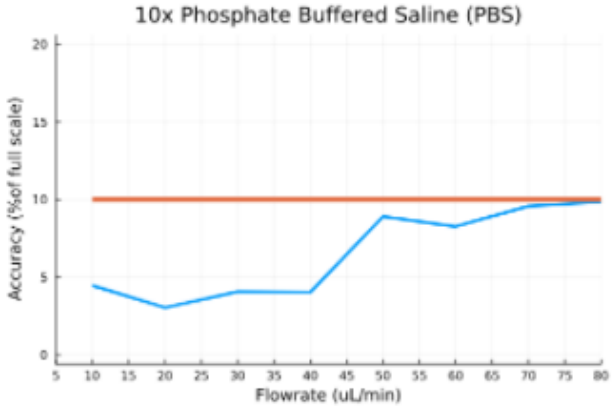


10x Phosphate Buffered Saline

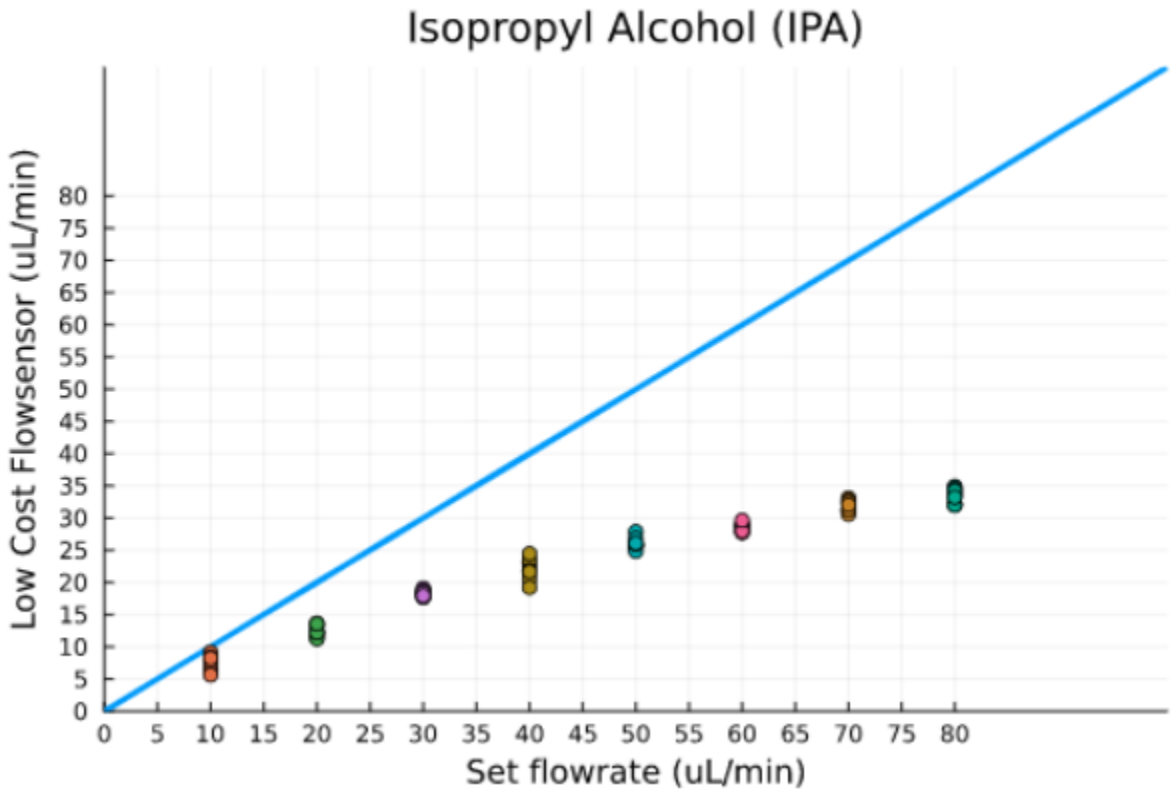


	variable	mean	min	median	max	nmissing	eltype
1	:abs_err	5.22125	2.43	5.095	7.89	0	Float32
2	:measurement_err	14.1046	8.075	10.9881	35.7	0	Float32
3	:fullscale_err	6.52656	3.0375	6.36875	9.8625	0	Float32
4	:flow	45.0	10	45.0	80	0	Int32





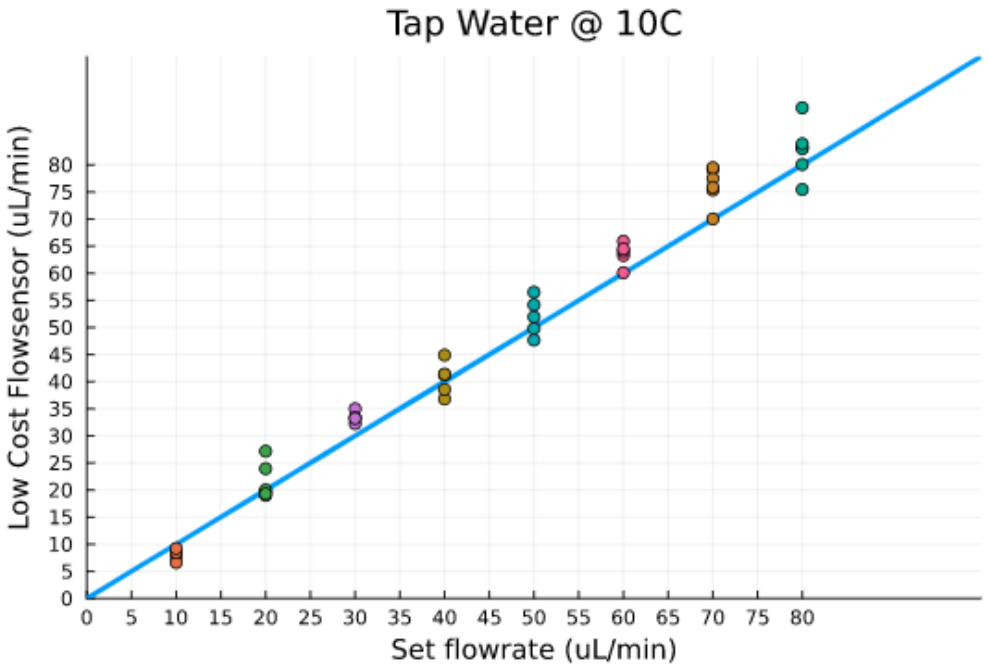
Isopropyl Alcohol



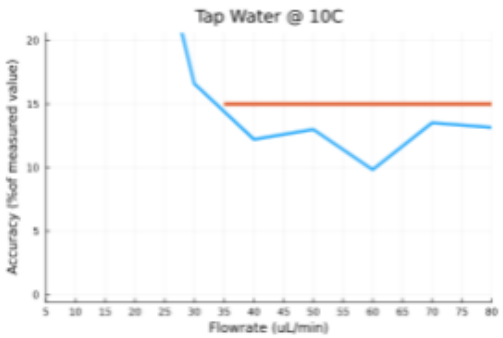
Sensor requires recalibration to measure IPA.

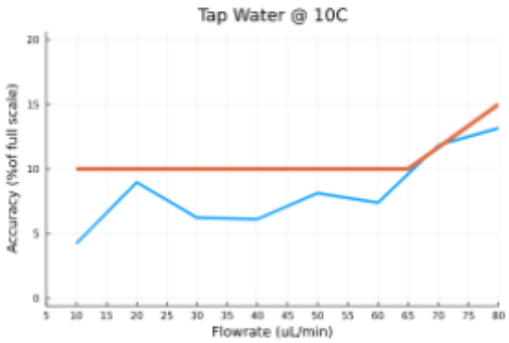
Reagent Temperature Variation

Water @ 10C

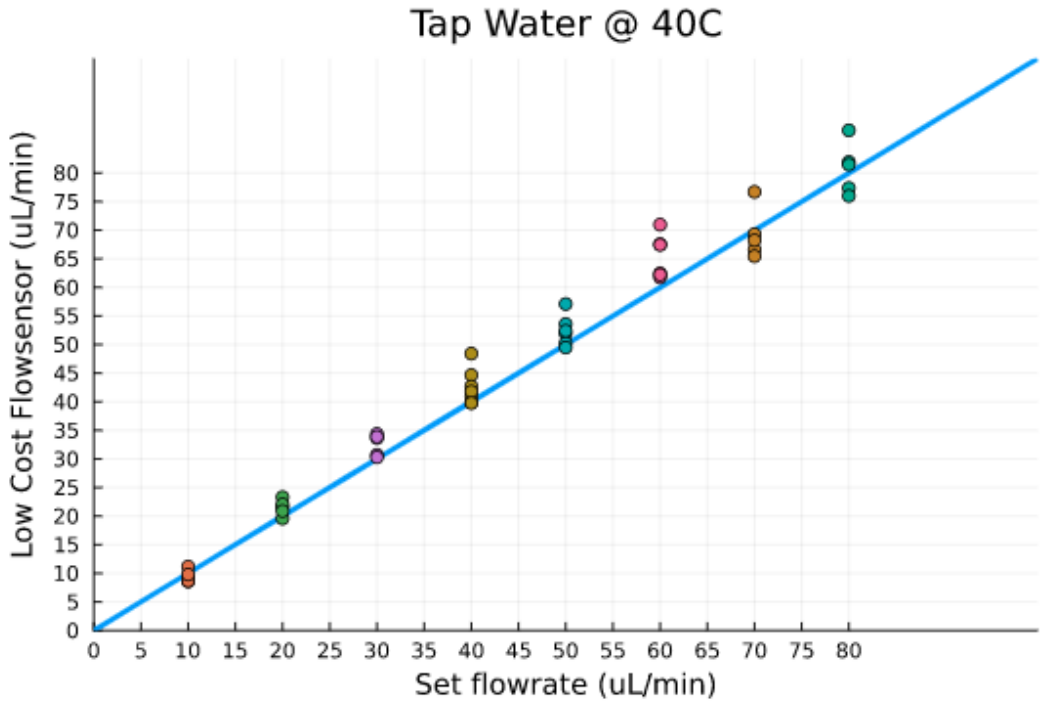


	variable	mean	min	median	max	nmissing	eltype
1	:abs_err	6.6025	3.38	6.2	10.53	0	Float32
2	:measurement_err	18.4999	9.83334	13.3455	35.85	0	Float32
3	:fullscale_err	8.25313	4.225	7.75	13.1625	0	Float32
4	:flow	45.0	10	45.0	80	0	Int32

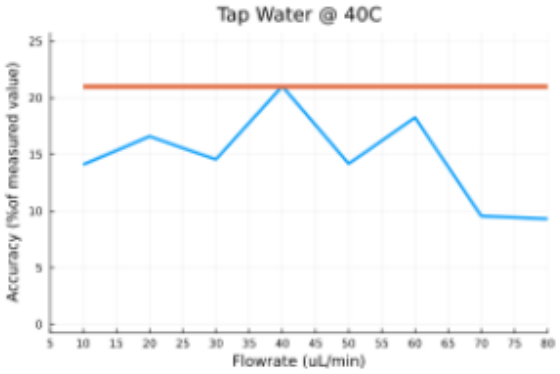


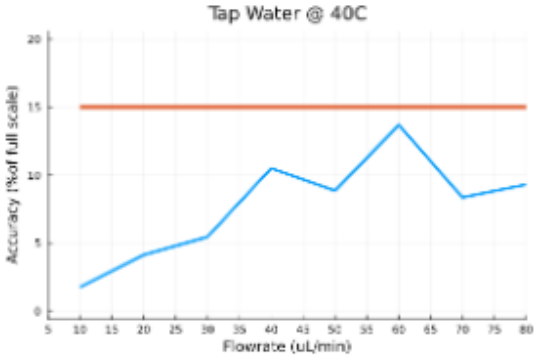


Water @ 40C

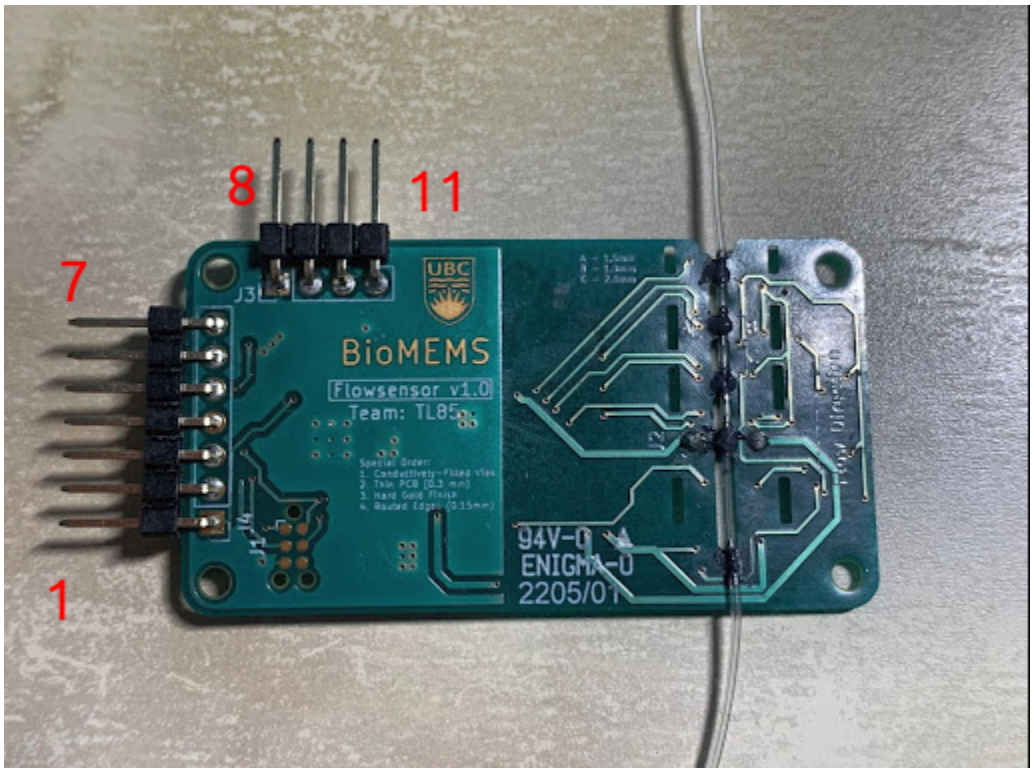


	variable	mean	min	median	max	nmissing	eltype
1	:abs_err	6.2125	1.41	6.89	10.96	0	Float32
2	:measurement_err	14.701	9.3125	14.3733	21.025	0	Float32
3	:fullscale_err	7.76562	1.7625	8.6125	13.7	0	Float32
4	:flow	45.0	10	45.0	80	0	Int32





Pinout



In the picture above, the pins are numbered 1 to 7 from bottom to top and 8 to 11 from left to right.

Pin Number	Pin Description
1, 9	VDD
2	SWCLK
3, 8	GND
4	SWDIO
5	NRST
6	VCP_TX
7	VCP_RX
10,11	Do not connect

Calibration

Manual calibration is required. Here are the resources required for the calibration step.

1. STLINK–V3
2. Access to the github repo
   https://github.com/jackyruth/Low_Cost_Microfluidic_Flowsensor.git
3. A system to drive a reference flow rate

Here are the steps to calibrate the sensor

1. Connect the STLINK–V3 to the sensor, see the product specification sheet for the sensor pinout diagram
2. Program ‘stm32/data_collection’ firmware
3. Drive a constant flow rate through the sensor and store the data. Preferably, the collected data corresponds to flow rates between 5 uL/min and 80 uL/min in increments of 5 uL/min
4. Push the data through ‘julia/flowrate_detection.jl’ which outputs three calibration constants A, B and C
5. Change the calibration constants in ‘julia/functional_firmware’

Program the ‘julia/functional_firmware’ and the device should start returning proper flow rate measurements.

Mechanical Specs

Dimensions of the sensor are 28.75x53.00 mm.

The PCB is 0.3mm thin with conductively filled vias to reduce thermal resistance.

Mounting holes are for M2 screws.

The wetted materials are stainless steel tubing cut from 29G needles and 0.01’’ ID 1/32’’ OD Tygon tubing.