

---

# Upchurch Scientific Nano Flow Sensor User's Guide



Oak Harbor, WA 98277

Tel: 800.426.0191 - 360.679.2528

Fax: 800.359.3460 - 360.679.3830

Email: [customerservice.upchurch@idexcorp.com](mailto:customerservice.upchurch@idexcorp.com)

Internet: [www.upchurch.com](http://www.upchurch.com)

(V30) Version 1.5 3-7-07

---

---

## Table of Contents

I. Introduction.....	3
General Description	
Unpacking	
II. Specifications.....	4
Technical	
Performance	
III. Installation.....	5-6
Cautions	
Electrical Connections	
Communication Cable Connections	
Software Installation	
Fluidic Connections	
IV. Operation.....	7-12
General Operation	
Notes on Nano Flow Rates	
Software	
Calibration	
Terminal Communication	
VI. Troubleshooting.....	13
VII. Notes.....	14

# Introduction

## *Description*

The Nano Flow Sensor will monitor and report the flow rate of a wide variety of solutions in 1/32" OD or other capillary tubing (70-495µm with sleeves). This non-invasive sensor uses proprietary MEMS-based thermal anemometry technology to display highly accurate flow rate data in the range of 1.5nL/min to 8µL/min. While it comes pre-calibrated for aqueous solutions, the calibration procedure will allow the Nano Flow Sensor to monitor virtually any solvent compatible with the wetted materials (PEEK and fused silica).



Figure 1: End User Nano Flow Sensor

## *Unpacking the Nano Flow Sensor*

Inspect contents for damage and/or shortage. Keep the original packaging for storing and protecting the sensor while not in use. The information on the package is also useful for serial number and calibration information and if the device needs to be returned to the manufacturer.



Figure 2: Package contents: Nano Flow Sensor, Quick Start Guide, Software CD, Universal Power Supply, RS-232 Cable, MicroTight Fittings for 1/32" OD Tubing

# Nano Flow Sensor Specifications

## *Technical Specifications*

Power Requirements	Voltage: 12Vdc, 100mA
Communication	3-wire RS-232 19,200 baud, 8 data bits, 1 stop bit, no parity, no flow control
Environmental Conditions	Temperature range: 0–40°C. Humidity: Maximum relative humidity 80% Operating Altitude: Up to 10,000 ft (3,000m)
Safety Certification	UL 61010A-1 CAN/CSA-C22.2 No. 1010.1-92

## *Performance Specifications*

Flow Rate	Range: 1.5nL/min to 8µL/min Accuracy: Greater than 98% typical (dependent on calibration accuracy) Repeatability: ±0.08% of reading per day
Sensor Update Rate	2Hz
Pressure Rating	5,000 psi (345 bar)
Wetted Materials	PEEK™ and Fused Silica
Swept Volume	800nL (150µm ID fused silica)

# Installation

## Cautions

- Do not supply more than 18VDC to the unit or it will be damaged
- Rinse the flow sensor after using buffer solutions to prevent the formation of crystals that can plug the thru-hole of the sensor
- Use only the supplied cables for connection to the sensor
- Operate within the temperature range of 0-40°C only
- Do not apply more than 5,000 psi to the flow sensor for risk of breaking the internal fused silica tube

## Electrical Connections

The flow sensor uses a universal AC to DC power converter to supply power to the unit. Attach the appropriate socket configuration to the power supply as shown in the image below. Plug the adapter into any AC power socket. Make sure that the power switch is turned to the OFF or 0 position. Insert the DC power plug into the power receptacle on the back of the flow sensor.



Figure 3: Attaching socket to power supply

## Communication Cable Connections

An RS-232 serial cable is provided to establish a data connection with the flow sensor. Connect the four pin MINI-DIN plug into the socket on the back of the unit, and the nine pin DSUB connector to any available COM port on the host PC.



Figure 4: Power and communication connections to the Nano Flow Sensor.

## Software Installation

The software package “**USI Nano Flow**” has been provided to log and display the flow sensor output in easy-to-use Windows® compatible software. To install the program, insert the CD labeled **Flow Sensor Software** into an available CD drive. The file explorer window will open, and the **setup** icon should be visible. Double click on the folder to display the setup program. Double click the **setup** icon to start the installation process. If the file explorer window did not automatically open, go to **Run** under the Start menu and type “E:setup.exe” where “E:” indicates the drive containing the CD-ROM.

The **USI Nano Flow Setup** window will be displayed. Click on the **Next>** button to proceed. Click the **Next>** button again to accept the default installation directory. The **Ready to Install the Application** window will appear. Click the **Next>** button to install. After the software has been installed, click the **Finish** icon to exit the installer. The software is now ready for use.

### *Fluidic Connections*

MicroTight® Fittings are included for 1/32" OD capillary tubing to the Nano flow sensor. Sleeves are also available to connect to other capillary tubing sizes. Slide the female nut, then ferrule over the capillary, with the coned end of the ferrule pointed towards the end of the tubing. Insert the assembly into the receiving port on the flow sensor, carefully pushing the tubing until it bottoms out in the port. Tighten the female nut until the fitting is finger tight. Do not use any tools to tighten these fittings. Due to the nature of most capillary sized tubing, it is possible to damage the tubing if the fittings are overtightened.



Figure 5: Fluidic connections to the Nano Flow Sensor

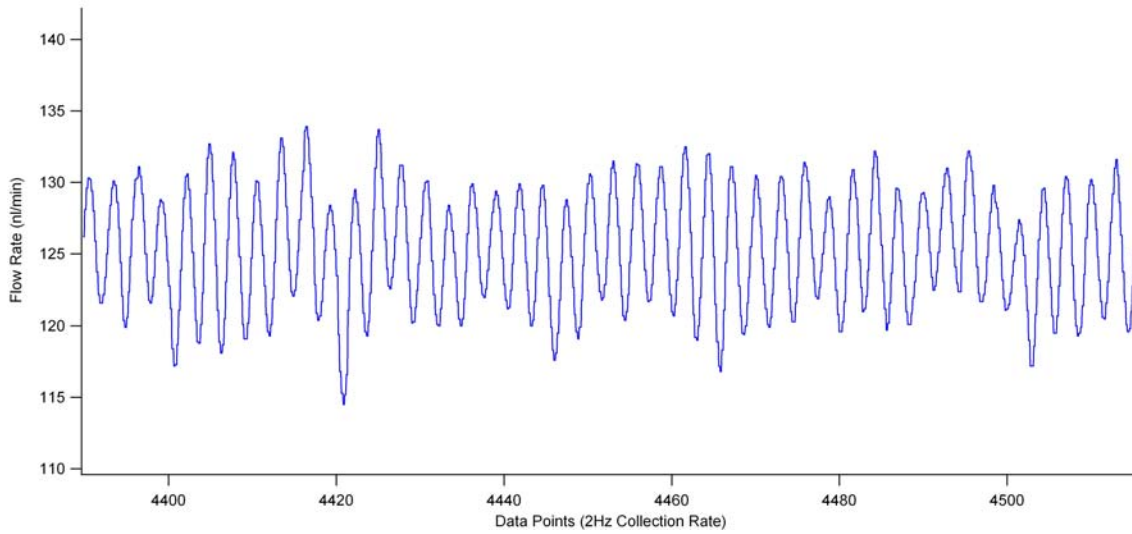
# Operation

## General Operation

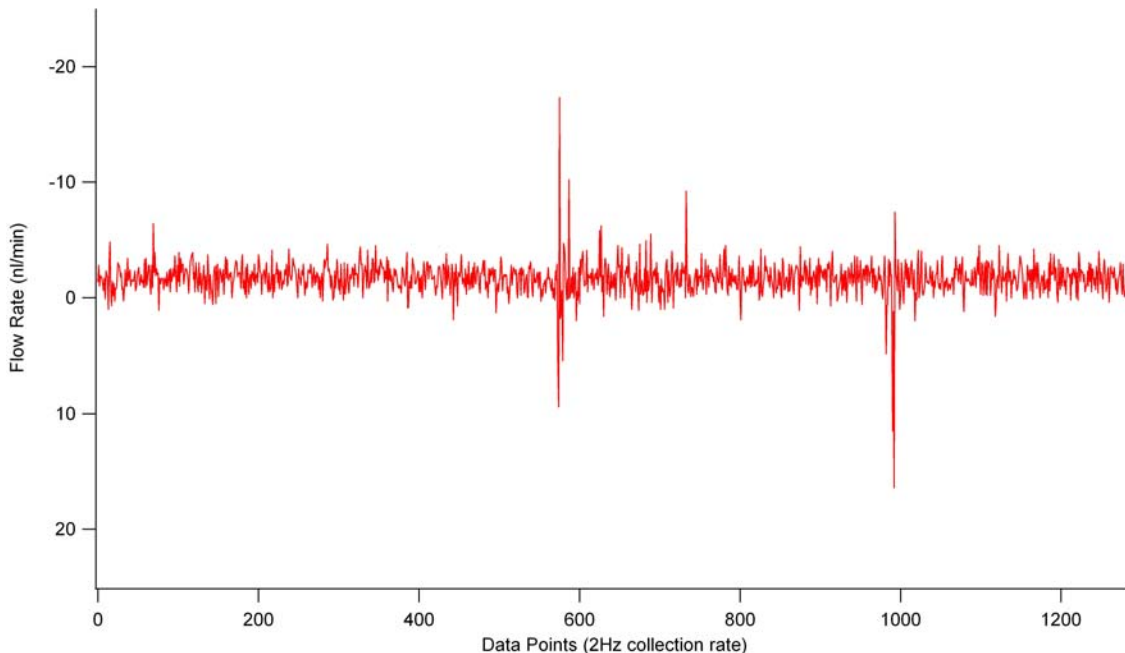
The Nano Flow Sensor will report real time flow rate passing through a tube with a 2Hz readout rate. The flow rate will be displayed on the LCD on the front of the unit and can also be reported and logged using the included software or using a terminal program.

## NOTES FOR MONITORING NANO-FLOW RATES

The Nano Flow Sensor is extremely sensitive to nano changes in flow rates. It will often pick up pump noise that may have not been previously realized. The image below demonstrates the flow sensor on the outlet of a pump flowing at 125nl/min. The pump has a stepper motor and the consistently spaced variations in the flow below correlate to each step of the stepper motor.



Also, temperature can have a very large effect on flow rates at the nano and micro levels. The following graph shows the output of the flow sensor filled with stationary water (without a pump attached on the inlet). When the inlet tubing of the flow sensor is touched the heat from the hand is enough to allow the slightest bit of fluid movement in the sensor. This happens at the 600 and 1000 data points.



Working at the nano and low micro flow rates creates several challenges. Take care to thermally isolate your system and find the most consistent pumping system available in the nano flow rate ranges. Also using thicker wall connection tubing helps insulate the fluid from thermal changes.

### Using the Software

Make sure the flow sensor is operable by applying power as outlined above.



Figure 6: Active display on LCD shows the unit is receiving power

To run the software, go to **Programs** in the **Start** menu, select the **USI Nano Flow** folder and **USI Nano Flow** program icon. The application will launch.



Figure 7: Software interface

Look in the upper left part of the screen for the **Sensor Com Port** pulldown menu. The com port that is used is designated by either **ASRLx:** or **COMx**, where **x** is the number of the com port that is connected to the sensor. Click the pulldown menu arrow, and choose the appropriate com port. To display and log sensor data, click the **Start** button below **Com Port Control**. Sensor data should be updated in the **Sensor Data** text box and the **Sensor Flow Graph** window.

The strip chart display uses automatic scaling for Y axis data, which shows the flow sensor response. To override this feature, move the mouse pointer just to the left of the Y axis scale, and press the right mouse button. A popup menu will be displayed. Click the **AutoScale Y** selection box to enable or disable automatic Y axis scaling. To manually set the scaling limits for the Y axis, double click on either the maximum or minimum number on the Y axis scale to highlight it, then enter the desired number. Click anywhere on the graph to accept the change.

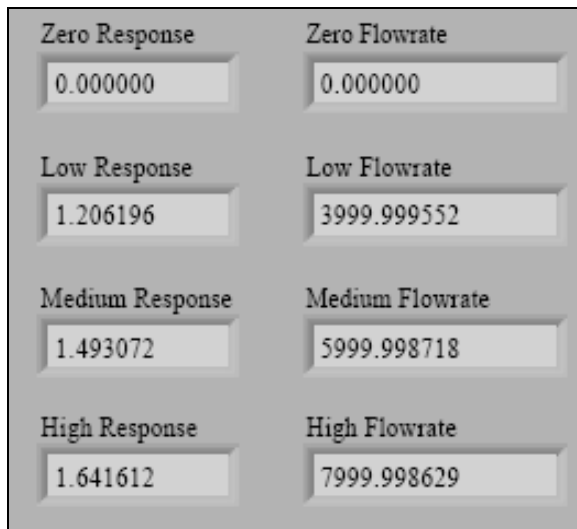
### Logging Sensor Data

The sensor data can also be logged to a file by clicking on the **Start** button below **Log Sensor to File**. A standard Windows file select dialog box will appear. Enter a filename and click **OK** to continue. Flow data will be logged to the log file. To stop logging data, click the **Stop** button below **Log Sensor to File**. The data can be imported into any analysis program that can read .txt files, or into an "Excel" spreadsheet if a comma is selected as the delimitator.

### Calibrating the Sensor with a New Solvent

Whenever it is required to measure the flow rate of a solvent other than water, an easy four step calibration routine must be performed. The software is set-up to automatically run through each step. For optimum accuracy, it is necessary to have a pump that is capable of delivering three flow rates within the flow rate range of the sensor. The more stable and accurate pump will result in a higher quality calibration. A “bad” calibration can result in an off-scale response from the sensor (typically 8499nl/min), a large amount of response fluctuation and a decrease in accuracy.

The sensor must be calibrated at four individual points. Enter the four flow rates that you would like to calibrate the sensor at in the text boxes in the middle of the screen. It is recommended to calibrate the first point at zero flow. To proceed with the calibration routine, click **Cal Zero**, **Cal Low**, **Cal Medium**, or **Cal High** as appropriate (order of routine is not significant), and follow the on screen instructions. When the point is calibrated, the new value will be written to the sensor and displayed on the screen. As the flow rate response is monitored during the calibration steps the response should reflect the difference in the four flow rates and also appear to be stable and consistent. Repeat the above instructions to save the new calibration to a file when finished.



Zero Response	Zero Flowrate
0.000000	0.000000
Low Response	Low Flowrate
1.206196	3999.999552
Medium Response	Medium Flowrate
1.493072	5999.998718
High Response	High Flowrate
1.641612	7999.998629

Figure 7: Display of current calibration values, response increases with flow rate

### Saving and Loading Calibration Values

A sensor calibration may be saved to a file for later retrieval. Make sure the calibration factors have been read from the sensor by clicking on **Read Sensor Cal**. The calibration factors for the sensor will be displayed in the appropriate boxes on the screen. To save those values, click on **Save Cal to File**. *It is recommended to save the factory calibration values to your PC using this method when you receive the flow sensor.* Choose an appropriate filename and click **OK** to save. To program the sensor with saved values, click **Load Cal from File**. The calibration factors will be read from the file and will be displayed on the screen. To program the sensor with those values, click **Write Sensor Cal**.

### Software Command Table

The following table summarizes the software commands.

Software Command	Command Function
Sensor COM Port	Used to select COM port that is connected to the flow sensor.
COM Port Control	Starts or stops RS-232 communication with the flow sensor. The value of the Sensor COM Port control is read when the Start button is clicked.
Sensor Output	Tells the flow sensor to pause or resume transmitting data.
Reset Sensor	Resets the sensor.

Log Sensor to File	Log sensor data to a file when data is updated on the screen. Click Stop to end data logging.
Read Sensor Cal	Read calibration factors from the sensor and display on the screen.
Write Sensor Cal	Calibrate sensor with factors that are displayed on the screen.
Load Cal from File	Read calibration factors from a PC data file and display on the screen.
Save Cal to File	Write calibration factors that are displayed on the screen to a PC data file.
Zero Flow	Use this flow rate to calibrate the sensor at the zero flow rate point. The default value is 0nL/min.
Low Flow	Use this flow rate to calibrate the sensor at the low flow rate point. The default value is 4000nL/min.
Medium Flow	Use this flow rate to calibrate the sensor at the medium flow rate point. The default value is 6000nL/min.
High Flow	Use this flow rate to calibrate the sensor at the high flow rate point. The default value is 8000nL/min.
Cal Zero	Calibrate the flow sensor at the zero flow rate shown in the Zero Flow box, and update the calibration factor on the screen when finished. This value is also saved to the sensor.
Cal Low	Calibrate the flow sensor at the low flow rate shown in the Low Flow box, and update the calibration factor on the screen when finished. This value is also saved to the sensor.
Cal Medium	Calibrate the flow sensor at the medium flow rate shown in the Medium Flow box, and update the calibration factor on the screen when finished. This value is also saved to the sensor.
Cal High	Calibrate the flow sensor at the high flow rate shown in the High Flow box, and update the calibration factor on the screen when finished. This value is also saved to the sensor.
Exit	Stops execution of the software.

#### *Terminal Communication*

All of the following commands will work to communicate to the Nano Flow Sensor using a terminal program such as HyperTerminal. See page 4 for communication parameters. All commands are followed by a carriage return (ASCII 13). This communication protocol can also be used for designing LabView programs or integrating the flow sensor into existing LabView programs.

To verify RS232 communication, issue the **v** command to get the version number. If a number with format x.xx is displayed, then two way communication is working.

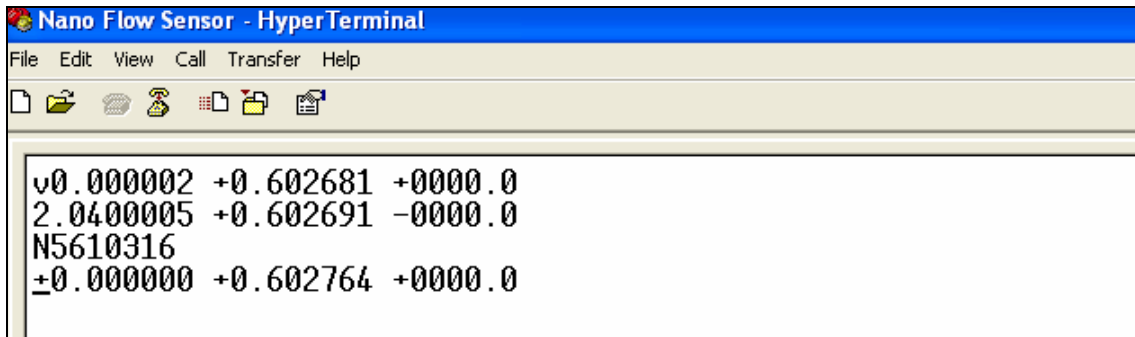


Figure 8: Sample RS-232 output during version inquiry

### MAIN COMMAND SUMMARY - TERMINAL COMMUNICATION

Command	Function
r	reset CPU
v	print firmware version number
set	enter setup submenu
cal	enter calibration submenu
epr	enter EEPROM submenu
g	start A2D conversions
s	stop A2D conversions

### SETUP SUBMENU COMMAND SUMMARY

Command	Function
q	leave setup submenu
or	set end of line character for data output to \r
ol	set end of line character for data output to \n
ob	set end of line characters for data output to \n\r
on	set end of line character for data output to NULL
d	display current calibration values

### CALIBRATION SUBMENU COMMAND SUMMARY

Command	Function
q	leave calibration submenu
w	save changes and leave calibration submenu.
z	calibrate the zero flow datapoint
l	calibrate the low flow datapoint

m	calibrate the medium flow datapoint
h	calibrate the high flow datapoint
a	accept the on-screen value for the datapoint (use after entering z,l,m,or h)
<CR>	hit carriage return to abort calibration for datapoint (after z,l,m, or h has been entered)

**EEPROM SUBMENU COMMAND SUMMARY**

<b>Command</b>	<b>Function</b>
q	leave EEPROM submenu
pr	reset current calibration values to factory stored calibration values (use this in case of faulty calibration)

# Troubleshooting

If any of the below scenarios apply to problems you are seeing with the sensor, try each step in order and go on to the next step if the problem is not resolved

If the display will not light up on the flow sensor when power is applied, then...

- Check the power cable to make sure both ends are held firmly in place
- Ensure you are using the supplied power supply
- Cycle the power
- Call Upchurch Scientific Technical Support

If RS-232 communication cannot be established, then...

- Check to make sure the comm. cables are connected firmly
- Check to make sure you are attempting to communicate with the proper COM port, change if necessary
- Cycle the power
- Call Upchurch Scientific Technical Support

If there is flow going through the sensor but no increase in response, then...

- Check to make sure all the comm. cables are connected firmly
- Cycle the power
- Plug the outlet of the sensor and continue flowing, watch for a pressure rise and for leaks around the sensor body
- Call Upchurch Scientific Technical Support

If there is no flow going through the sensor and backpressure is rising, then...

- Attempt to flow in the reverse direction
- Run methanol through the flow sensor
- Call Upchurch Scientific Technical Support

If the sensor exhibits unexpected response, then...

- Review notes on nano flow (page 8-9)
- Attempt to thermally isolate the sensor connection tubing
- Ensure the composition of the flow through the sensor is not changing
- Call Upchurch Scientific Technical Support

If sensor response is constantly 8499 or repeatedly goes to 8499nl/min, then...

- Check to make sure the flow supply is not exceeding the maximum flow rate of the sensor (8 $\mu$ l/min)
- Look at the current calibration values in the sensor (page 10 or 14)
- Do the calibration values increase with flow rate? Recalibrate the sensor if not (page 10 or 14)
- Restore factory calibration values (page 14)
- Call Upchurch Scientific Technical Support

---

# Notes



Oak Harbor, WA 98277  
Tel: 800.426.0191 – 360.679.2528  
Fax: 800.359.3460 – 360.679.3830  
Email: [customerservice.upchurch@idexcorp.com](mailto:customerservice.upchurch@idexcorp.com)  
Internet: [www.upchurch.com](http://www.upchurch.com)  
(V30) Version 1.5 3-7-07