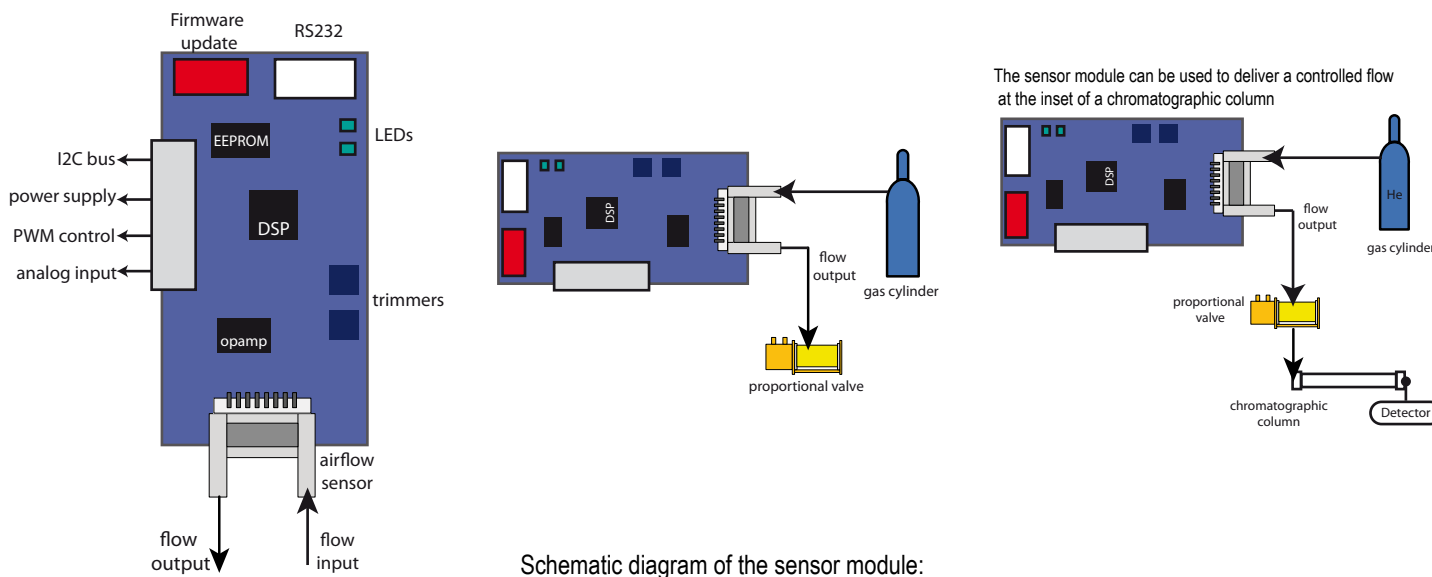


MCQ Sensor Module

Digital Mass Flow Meter and Controller

Rev. March 2010 V 1.0 (Preliminary)

Technical Data Sheet



Specifications and main characteristics :

- Unique dynamic range: 0.01 sccm – 200 sccm.
- Power supply: digital 3.3V – analog 10V.
- Accuracy: 1 % of set point (from 10 to 100% FS)
0,2% FS (from 0 to 10% FS)
- UART interface.
- I2C interface.
- Custom Firmware update.
- 1 PWM channel output for valve and actuator control.
- Low cost
- High modularity
- Designed for OEM applications

The sensor module can be used both for the measure and for the control of gas mass flow. It has been conceived for all the customers that want to realize applications where control of gas flow rate is required. The sensor module allows to develop a mass flow controller that meets their own requirements. The module is based on an airflow sensor that senses mass flow rate and flow direction from the heat transfer that it creates across the surface of a resistor bridge heater circuit. The board mounts an operational amplifier, an analog filter and a DSP microcontroller that realizes the data acquisition, the digital filtering, the linearization and the thermal compensation.

In a “Mass Flow Controller” arrangement the module can be connected to a proportional valve for flow regulation. The DSP microcontroller can be programmed to accomplish the PID control to manage the valve in answer to the information gathered by the flow sensor mounted on board. If desired MCQ can provide you with the proper components depending on the maximal absorbed current. Furthermore, the board could be easily integrated in custom devices. Just to give an idea, it could be used for providing a controlled airflow at the inlet of a chromatographic column, or to calibrate and control an already existing gas delivery system.

PERFORMANCE SPECIFICATION	Accuracy	N2, 20°C, 101.325 kPa (1 atm)	
		10 - 100% FS	1% of set point
		< 10% FS	0,2% of FS
	Repeatability	0,16% of reading	
	Response Time	Sensor: 4 ms	
		Controller: 50 ms	
	Power Supply	Regulated 3.3V for digital and 10V for analog DC	
Operation Pressure	Max 25 psi		
Working Temperature	0 - 50° C		
OPERATING SPECIFICATION	Mass Flow Rates	0.01 sccm – 200 sccm (standard) FS: 50 sccm - 100 sccm - 500 sccm (on request)	
	Gases	All non-aggressive gases	
	Input channel	1 Digital Input	
		I2C BUS	
		UART 115.200 BPS	
Output Channel	1 PWM channel for actuator control		
	2 programmable output analog channels: 0 - 5V, Max 80mA		

Technical concepts

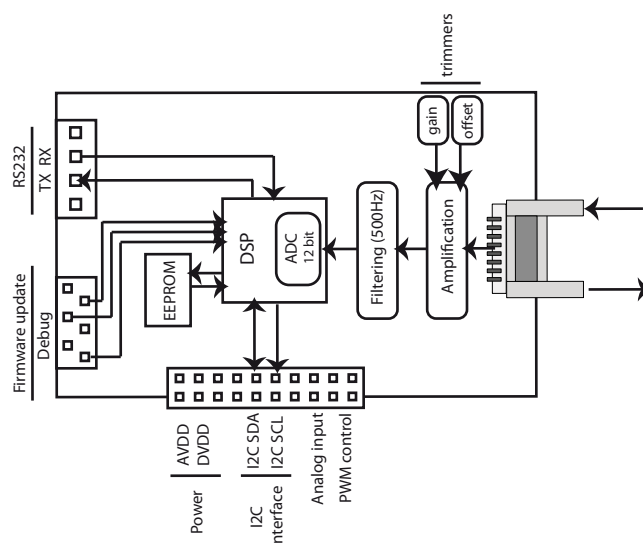


Figure 2. Block diagram of the sensor module board.

Description:

The sensor module can measure flows as low as 0.058sccm, with a sampling rate up to 20Hz. The module detects the gas mass flow through the measure of heat transfer. In presence of gas flow the upstream and downstream distribution is disturbed and the induced asymmetry is measured.

To obtain a measure of the gas flow, it is only necessary to connect the gas inlet to the sensor module entrance. In this way, a flow rate up to 200sccm can be determined. It is also possible to increase the measurement range by applying the sensor module in a bypass configuration, as reported in figure. In this configuration, only a fraction of the total flow passes through the sensor. The amount of it can be calculated from the ratio of the cross sectional area of the two tubes.

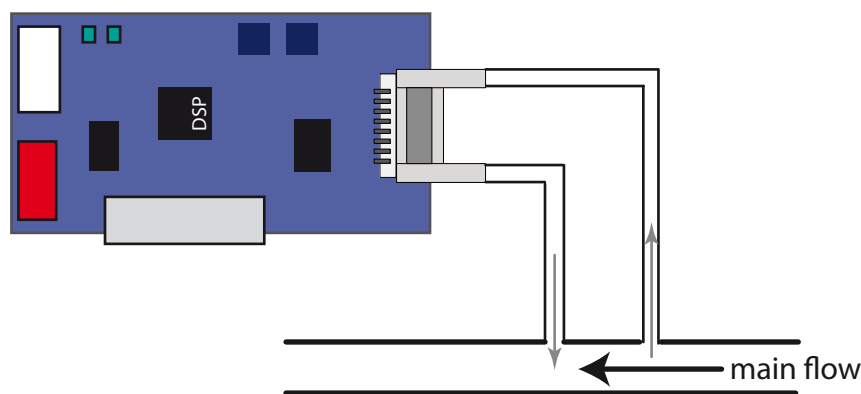


Figure 3. Typical bypass configuration that can be realized to measure higher flows

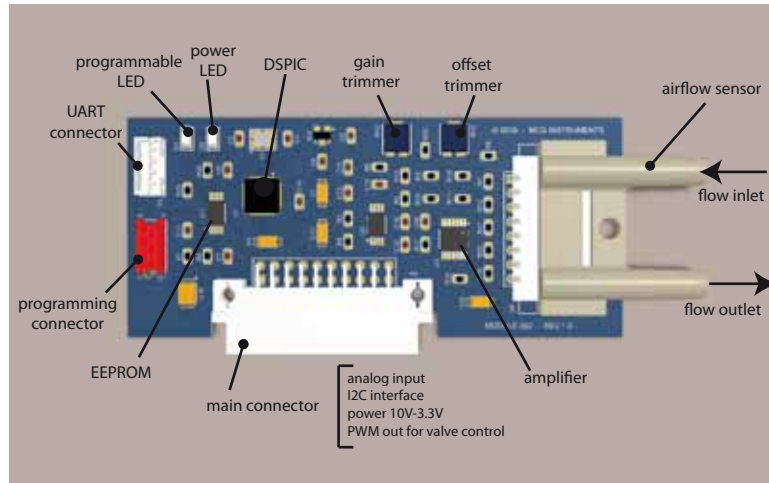
All non-aggressive and non-corrosive gases can be measured with the sensor module. Standard calibration is provided for nitrogen and air, however, upon request, MCQ can provide you the calibration for a specific gas.

Operating principles

The voltage signal is acquired from the airflow sensor and it is passed through an amplification stage, whose gain and offset may be regulated by two trimmers on the board. The signal is then filtered with a 4-poles Butterworth low-pass filter with a cut frequency of 500Hz. The signal is processed by the 12-bit AD converter of the DSP microcontroller. The sensor module is endowed with an EEPROM with 512Mb, where calibration tables or specific configurations can be stored. Data can be accessed by both the I2C bus and the UART interface, and communication interfaces are completely programmable by the user.

Connections:

Main components and connections in the sensor module board.



Main Connector:

(PCN10-20P-2.54DS, Hirose Electric Co Ltd)

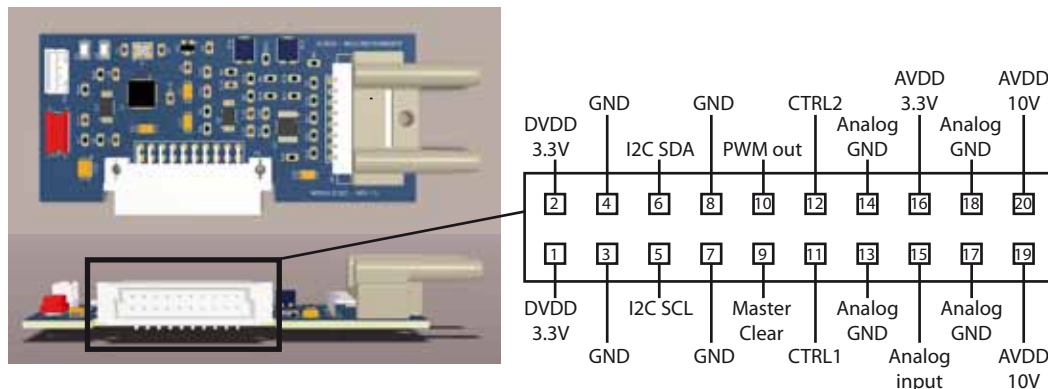


Figure 5. Pin connections in the main connector board.

You may need a female connector PCN10C-20S-2.54DSA (Hirose Electric Co Ltd) to connect the sensor to an external board.



Figure 6. Female connector (PCN10C-20S-2.54DSA) to connect the sensor to an external board.

Power supply: The board needs an analog power input of 10V and a digital power input of 3.3V with a maximum current of 100mA. Both power inputs are supplied through the pins in the main connector.

I2C: The Sensor Module communicates and transmits data via a two-wire I2C bus system.

Analog set-point: the analog input could be used to provide the sensor with an analog set point. This input put in use the ADC channel of the DSP microcontroller. If needed, the customer can use it to convert an analog signal exploiting the high performances of the DSP mounted on board. Set point ranges between 0.5V, that corresponds to a zero flow, and 2.5V corresponding to 200sccm flow.

Control outputs: three pins are provided for the control of external devices, one of those implements the PWM output for valve control. CTRL1 and CTRL2 are conceived for a future use.

UART Connection:

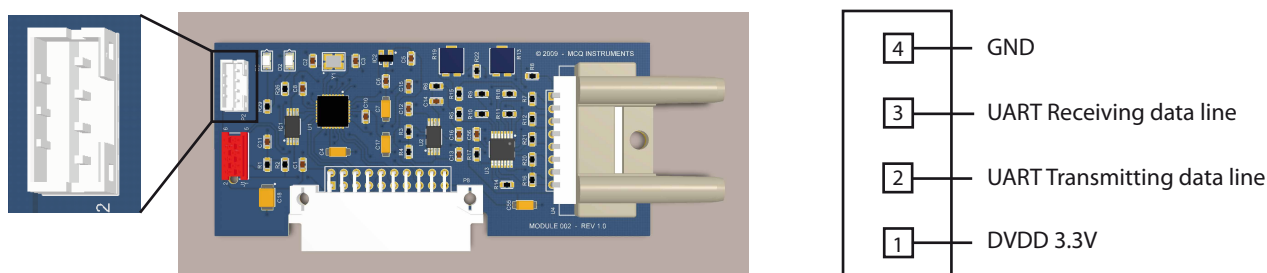


Figure 7. Pin connections in the UART connector

UART 115.200 BPS.

Service Connector:

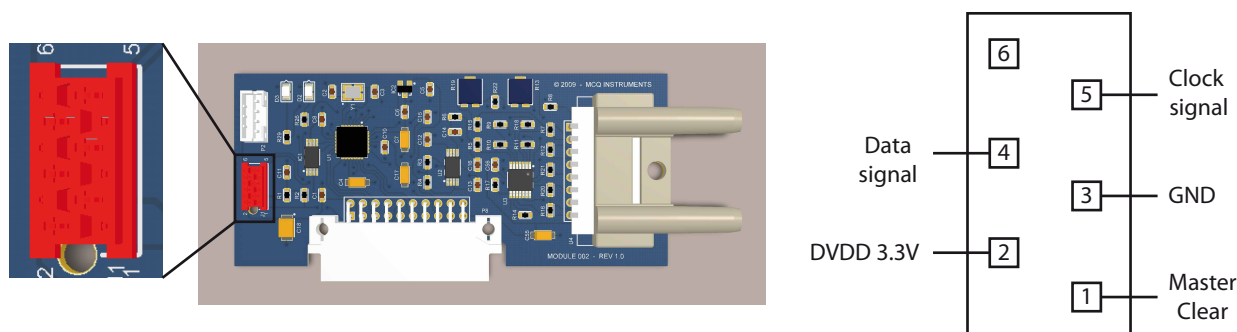


Figure 8. Pin connections in the service connector.

This service connector is conceived for debug and firmware update operations.

Application hint: mass flow controller

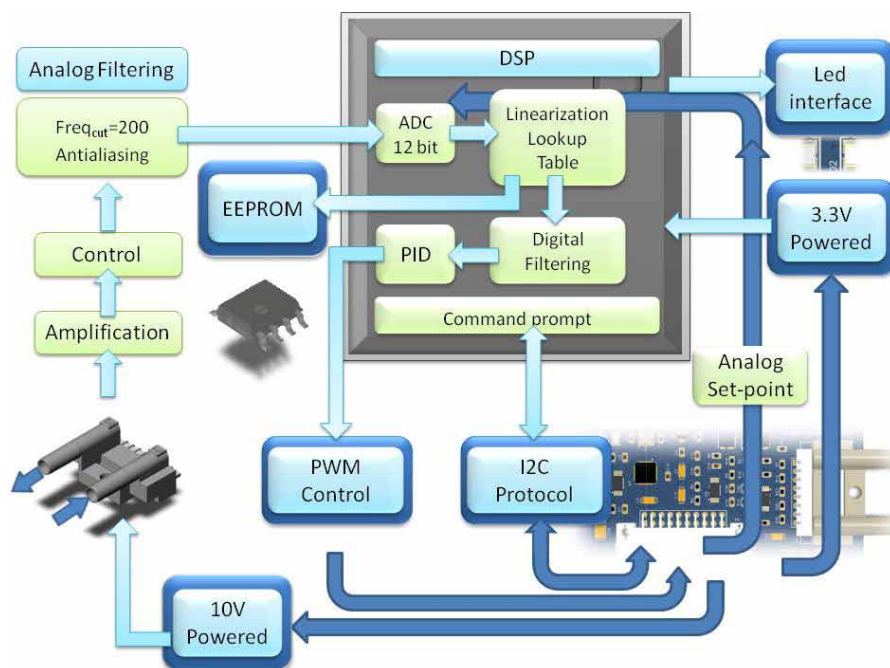
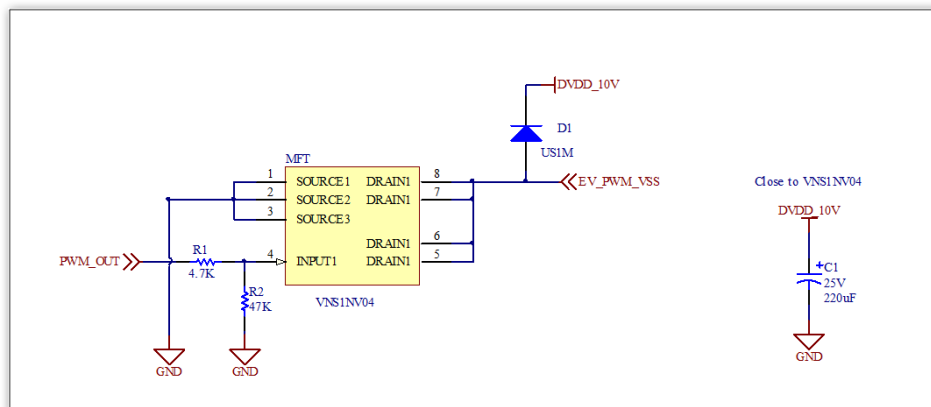


Figure 9. Block diagram of the sensor module board when it is used to realize a mass flow controller.

For those who want to realize their own mass flow controller, the sensor module can be connected to a proportional valve. It is possible to implement a PID control to regulate the valve after the flow rate reading. A block diagram is shown in the picture.

Suggested valve amplification circuit:

In the image below a suggested amplification circuit for the valve control is shown. The component used is a single channel omni-fet fully auto-protected power MOSFET, the VNS1NV04.



Label	Features	Component	Manufacturer Code	Manufacturer
MFT	power mosfet M03 40V 1.7A	Power mosfet	VNS1NV04	ST microelectronics
D1	diode ultra-fast 1000V 1A	Ultra Fast diode	US1M	Vishay General Semiconductor
C1	220 µF 25V	Polarized Capacitor Electrolytic	-	-
R1	4.7 kΩ	Resistor	-	-
R2	47 kΩ	Resistor	-	-

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