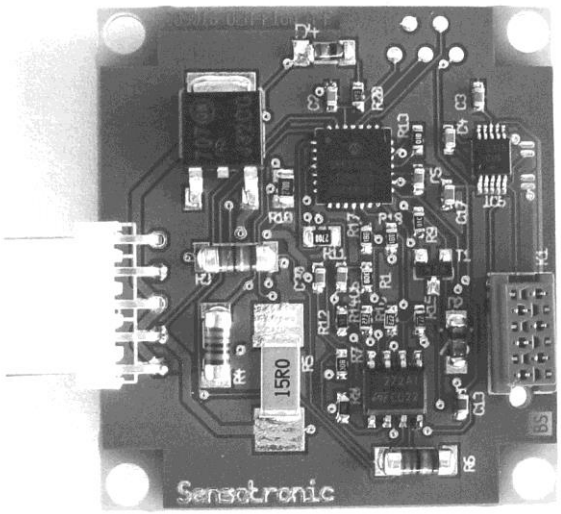
Instruction Manual

OEM Module Flow A-F



Valid from: 01.01.2020
Hardware version: 309016.2 and following
Software version: 1.3.02

Responsible: J. Schwarz

Table of Content:

1. Description

The OEM module Flow A-F is designed to work with hot-wire flow sensors.

The module drives the hot-wire sensor and generates a signal proportional to the actual flow dependent power consumption of the heated wire. Using a calibration curve, this value can be converted into the actual flow value. The compensation wire in the flow sensor is thereby used to compensate the influence of the gas temperature on the measured signal.

Due to the basic accuracy of the hot wire flow sensors for accurate measurement it is only necessary to determine the 'zero offset value' during flow-less phase using the auto-zero function.

2. Electrical Specification

Supply voltage:	5 V DC ± 5%; other voltages on request (For 5 V version min. 4.75 V is required)	
Current consumption:	110 to 280 mA (depending on gas flow)	
Working principle:	Constant temperature mode	
Interface:	RS-232 with level converter (EIA/TIA-232 compatible)	
	Data rate:	57600 Baud
	Data bit:	8
	Stop bit:	1
	Parity:	none
	Handshake:	none
External wire cleaning:	TTL compatible H level (approx. 250 ms pulse length)	
Digital I/O (optional):	TTL compatible signal, user specific level	
AD conversion:	Resolution:	12 bit
	Conversion time:	approx. 2 ms
	max. data rate:	500 Samples per second
Accuracy:	± 5% from measured value ± 0.2 l/min (between 0 and 150 l/min) (board only; accuracy also depends on hot wire sensor)	

3. Mechanical Specification

Dimensions:	37 x 41 mm (L x W) Height max. 8 mm (for 5 V versions)
Weight:	approx. 10 g
Mounting holes:	4 x Ø 3.2 mm

Connectors:	Board supply and communication:	MicroMatch 6-pole
	Flow sensor cable:	Molex 5-pole

4. Electrical Connections

The module has a 6-pin board connector for supply voltage, communication and data output and a 5-pole connector for the SpiroQuant A flow sensor.

Board connector K1:

Pin	Signal/Function
1	RS-232 Rx
2	RS-232 Tx
3	Ground signal
4	Digital I/O for external control (option)
5	External sensor clean signal (H level active)
6	Supply voltage

Table 1: Board connector K1

The connector K1 is a 6-pin AMP MicroMatch.
The Digital I/O Pin 4 can be used for external control of board functions (must be software-implemented on customer request).

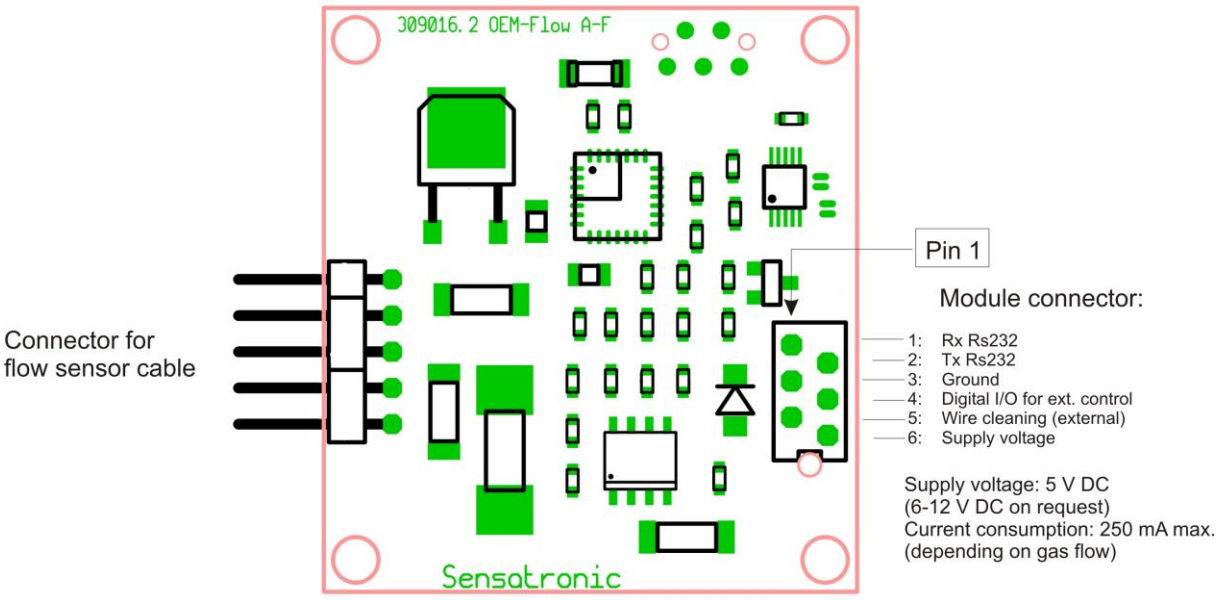


Figure 1: Main components of the PCB

The flow sensor can be connected using the 5-pin connector. It is recommended to limit the length of the sensor connection cable to 0.5 m. Pin 5 of the connector is used for Ground signal connection of the flow sensor cable shielding.

Attention: The Digital I/O pin is expecting a TTL compatible signal, even if the board is powered with supply voltage other than 5 V DC.

To use the external wire cleaning function, it is possible to apply a 5V logic level (TTL High) to pin 5 of connector K1. This pulse should remain for approx. 250 ms.

5. Communication

The data exchange with the board is realized using a RS-232 serial interface. The communication is initialized by the host system sending a request byte to the module.

Depending on this byte the module is sending several data as shown in the table below:

Request byte	Answer from module
0x01	Sends one status byte and two analog flow data bytes (high, low)
0x02	Sends two analog flow data bytes only (high, low)
0x03	Sends the status byte and two flow value bytes (high, low)
0x04	Sends one status byte only
0x08	Sending a '0x08' will force the module to clean the wires by glowing approx. 65 msec. after sending the byte. This function is only effective in zero flow condition (see Chapter 7)
0x10	The module is sending one status byte and two analog flow data bytes continuously approx. every 2 ms (continuous mode)
0x20	End of analog flow value continuous mode.
0x22	The module is sending one status byte and two flow value data bytes continuously approx. every 2 ms (continuous mode)
0x24	End of flow value continuous mode.
0x25	Sends one status byte and two analog flow data bytes (high, low); internal digital filtering de-activated
0x26	Sends two analog flow data bytes only (high, low); internal digital filtering de-activated
0x40	Auto-zero function (see Chapter 8)
0xA3	Sends the firmware version in ASCII format
0xA5	Sends the internal serial number of the board in ASCII format
0x98	CPU reset

Table 2: Request byte

There may be other than the stated commands implemented; however it is strongly recommended only to use the commands listed above to prevent damage of the module or unexpected operational state.

The status byte can be used to observe the module and sensor status and to determine the validity of the data send afterwards:

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Significance	Measured value is new (since last AD conversion)	Wire cleaning active (measured value during this time can not be used for flow calculation)	Heated wire broken or out of range	Compensation wire broken or out of range	Zero value of flow sensor out of range	Insufficient power supply or analog circuit failure	Auto-zero complete	X
Active at	1	1	1	1	1	1	1	X

Table 3: Status byte

For example, a status byte '11000000' means: following data is new compared to last AD conversion; wire cleaning is active (don't use the data for flow calculation)
The status byte sent is valid only for the data bytes sent afterwards. The status byte will be generated prior to every new data request.

6. Calculation of flow values

The flow values bytes represent the calculated flow value in LPM. The flow value is calculated using the following method:

Flow value high byte * 256 + flow value low byte = flow value. The flow value is transmitted in a resolution of 0.01 l/min.

Example: Flow high byte = 16hex
Flow low byte = A3hex

16 hex * 256 + A3hex = 22 * 256 + 163 = 5795 = 57.95 l/min

The analog flow value data bytes represent the analog value of the measured flow signal.
The first byte is the higher byte as HEX value; the second data byte is the lower byte. For example, a received '02B6' is a decimal value of 694. This value must be reduced by the zero offset value.
Using this result, the corresponding flow can be calculated as follows:

Example: Zero offset value = 200 digit;
Received value = 02B6hex = 694;

-> analog flow output = 494 digit

This analog flow value can be used to calculate the flow as well. An appropriate equation is needed that fits to the characteristics of the flow sensor used.

The zero offset value is equal to the flow value at 'Flow = 0'. For an accurate measurement of the zero offset value, it is recommended to calculate the average value over a series of measurements; especially in 'no-flow' condition, the sensor is very sensitive to slight gas movement.

7. Wire cleaning (Flow sensor)

During wire cleaning the measured values do not correlate with the flow passing the sensor. The board is not performing automatic wire cleaning. When the host system is requesting a wire cleaning, it must be guaranteed that the flow passing the sensor is zero. Otherwise the cleaning procedure will not be successful. During active wire cleaning the corresponding status bit 6 is set to 1.
When the wire cleaning is finished, the sensor signal turns back to the zero value. Due to the behaviour of the flow sensor and the electronic circuit, the signal performs an 'under-swing' as seen in figure 2.

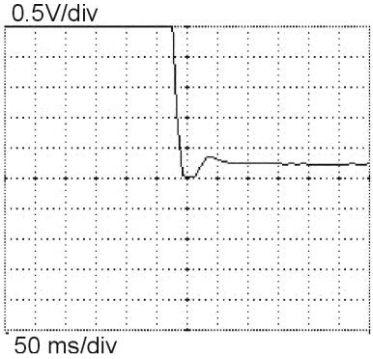


Figure 2: Signal after wire cleaning

Normally it takes 100 … 150 ms until the signal is stable after a wire cleaning. During this time the status bytes sent from the module can contain several status bit set indicating sensor errors etc.

To force the wire cleaning with an external signal, use the 'External wire cleaning' input. Applying a TTL compatible (5V DC) signal can force the module to perform the wire cleaning. However, the duration of this signal should not exceed 250 ms.

8. Auto-zero function

The board is providing a so called 'auto-zero' function. The purpose is to reduce the tolerances of the board itself and the connected flow sensor to increase the measuring accuracy.
It is needed to call the auto-zero function after switching on the main system or after changing the flow sensor. The function is called by sending a 40 hex request byte. It is necessary to have a zero-flow condition during auto-zero. The module will perform a hardware adjustment. As a result, the zero flow value will be in an exactly defined range.

Deviation from the valid range can be caused either by a present flow passing the sensor, by an inoperable flow sensor (defective or 'out-of-specification' wires) or a general system or connection error.
After performing the auto-zero, the board is sending a status byte with bit 1 set active. If the adjusted value is out of the valid range, the status bit 3 is also set active, f. e. 00001010. Bit 3 remains 1 until a new auto-zero is requested by sending 0x40. The following measured values should not be used for further operation. It is recommended to perform another auto-zero. If the status bit 3 remains active, a sensor failure may be the reason.

9. General application hints

Due to the characteristics of the flow sensor it is recommended to place the sensor in the expiratory gas way. This gives the opportunity of determining the zero point during inspiration and reduces the problem of flow direction detection. Otherwise the flow direction information must be taken from the breathing mechanics of the respiratory machine.

**Please note: The data value range in this version is from 0 to 4095 (12 bit resolution). To be compatible with OEM-Flow A module (10 bit resolution);
each value has to be divided by 4 before starting the flow value calculation. At flow = zero (after auto-zero function) the flow value should be in the range of 195 to 205 digits.**