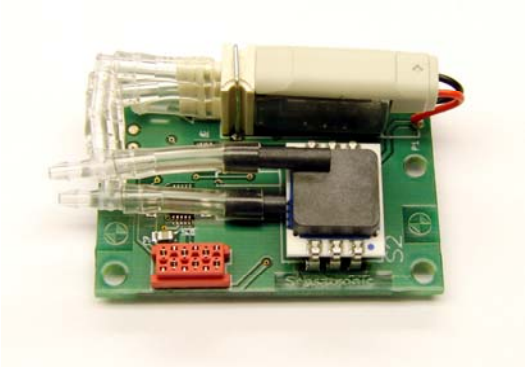
Instruction Manual

OEM Module Flow-H



Valid from: 01.03.2013
Hardware version: 303016.6 and following
Software version: 1.4.02

Responsible: J. Schwarz

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1. Description

The OEM module Flow-H is designed to work with flow-pressure transducers (flow to differential pressure) like our DP Flow sensors. It can be used to measure the breathing gas flow in respiratory machines.

The module is supplying a differential pressure value, which can be used to calculate a corresponding flow value using the characteristic curve of the flow transducer. Moreover the module delivers a flow value based on a standard curve for DP Flow transducers.
The measurement is performed with a high-precision pressure sensor giving a temperature compensated signal.

The unit is equipped with a micro valve for zero offset measurement of the pressure sensor. This feature is working even during gas flow through the flow transducer and without leakage to the ambience.

2. Electrical Specification

Supply voltage:	5 V DC ±5%; other voltages on request	
Current consumption:	< 15 mA (normal operation)	
	< 150 mA (zero offset measurement, valve active)	
Interface:	RS-232 with level converter (EIA/TIA compatible)	
	Data rate:	19200 Baud
	Data bit:	8
	Stop bit:	1
	Parity:	none
	Handshake:	none
AD conversion:	Resolution:	12 bit
	Conversion time:	approx. 10 ms
	Max. data rate:	100 Samples/s

3. Mechanical Specification

Dimensions:	43 x 30 x 17 mm (L x W x H)
Weight:	approx. 20 g

4. Absolute Maximum Ratings

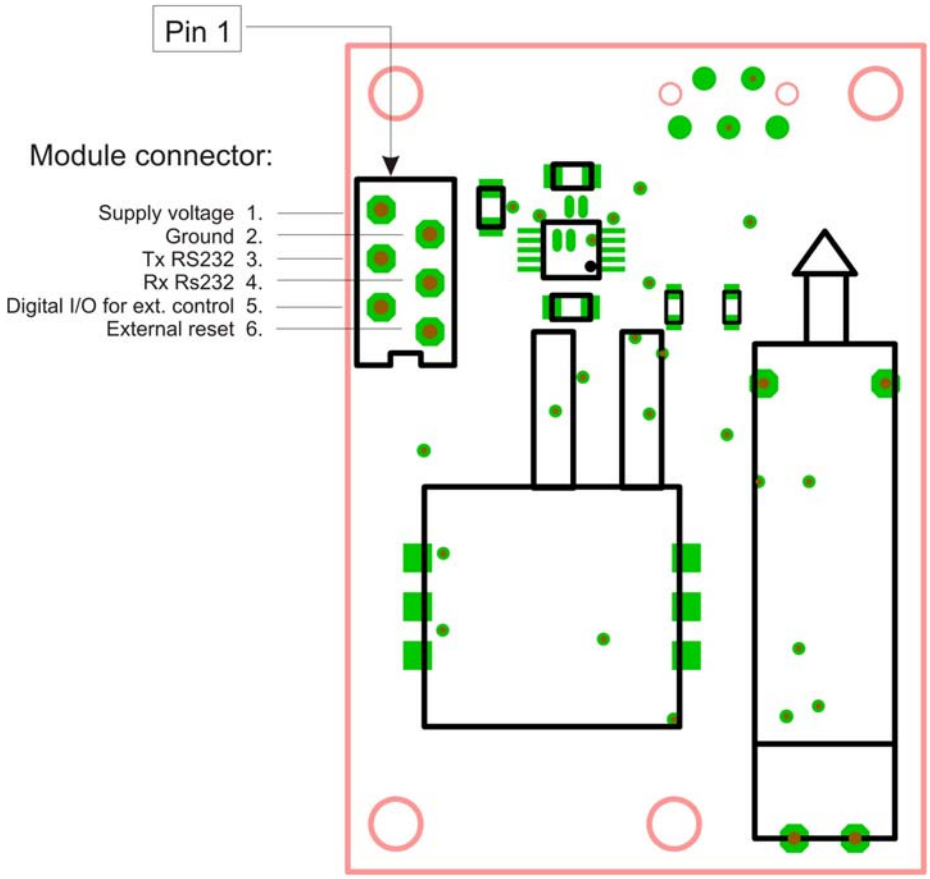
Operating pressure:	± 10 mbar
Max. proof pressure:	150 mbar
Burst pressure:	200 mbar
Max. supply voltage:	5.25 V DC (for 5 V DC versions)
Min. supply voltage:	4.75 V DC (for 5 V DC versions)
Working temperature range:	0...70 °C
Storage temperature range:	-40...125 °C

5. Connectors

The module has an input to connect the differential pressure sensor with the flow transducer and a 6-pin electrical connector for supply voltage and communication.

Pin	Signal/Function
1	Supply voltage 5 V DC
2	Ground signal
3	RS-232 Transmit (Tx)
4	RS-232 Receive (Rx)
5	Digital I/O for external control (optional)
6	External module reset

The connector is a 6-pin AMP MicroMatch type 7-215083-6. Cables with customer specific length are available on request.



The flow transducer can be connected directly to the module. For later determination of the flow direction, it is important to realize that the pressure sensor gives a signed output signal showing the flow direction.

Pin 5 of the board connector can be configured on customer request. For serial boards this pin has no function.

⚠ **ATTENTION! Signals on pin 5 and 6 of the board connector have to be TTL compatible, even if the board is powered with supply voltage higher than 5 V DC.**

Pin 6 of the board connector can be used to reset the control unit. This pin should be pulled down (0 V) for at least 50 ms and released afterwards to reset the controller in case of an undefined status.

6. Communication

Data exchange is performed using the RS-232 interface. The module is generally working in the ‚slave' mode; all communication activities need a command sent from the host system (except in continuous mode).
The host system has to send a request byte (a command) and the board will react sending one or more bytes back.

Request Byte	Answer from Module
01hex	The module is sending one status byte and two data bytes (first data byte is the higher one; single mode)
02hex	The module is sending two data bytes (first data byte is the higher one; single mode)
03hex	Sends the status byte and two flow value bytes (high, low) as signed value (see Chapter 7)
04hex	The module is sending only the status byte.
08hex	The module is performing a zero offset measurement and is sending a status byte and two data bytes when finished. The data bytes represent the zero offset. The zero offset measurement takes approx. 0.5 sec.
10hex	The module starts to run in continuous mode. One status byte and two data bytes (signed differential pressure value) are sent per data set every 10 msec.
20hex	The module is stopping the continuous mode (pressure value).
30hex	The module starts to run in continuous mode. One status byte and two data bytes (signed flow value) are sent per data set every 10 msec.

40hex	The module is stopping the continuous mode (flow value).
A3hex	Sends the firmware version in ASCII format
A5hex	Sends the internal serial number of the board in ASCII format
98hex	Reset of CPU (by software command).

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 components.

The status byte can be used to check the status of the module and to determine the validity of the data following the status byte. The status byte is valid only for the data following and will be generated newly corresponding to each data acquisition. The status byte contains the following information:

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Significance	Measured value is new (since last AD conversion)	Not used	Not used	Malfunction with valve has been detected (valve current outside valid range)	The data bytes following represent the zero offset value of the pressure sensor (will be set after zero offset measure-ment)	The supply voltage of the module is outside the specified range	Not used	Not used
Active at	1	X	X	1	1	1	X	X

Example:
A received status byte ‘10001000’ (88hex) has the following meaning: data bytes following are new since last AD conversion; data bytes following represent the zero offset value.
The status byte is valid only for the set of data following. For the next AD conversion (10 ms later) a new status byte will be generated.

When the host system requests data in an interval shorter than 10 ms, bit 7 of the status bit will be set to zero. The data set following will be the same as from the last request.
It is recommended always to request status byte and data bytes to be sure the data set is valid.

⚠ **It is recommended not to request data in an interval shorter than 10 ms in single mode.**

The data set sent by the module represents the measured output of the pressure sensor. The length of the data set is always two byte, even if the transmitted value is smaller than 256. The first byte represents the higher value of the data set.

The board is sending the measured values in a 2 byte hex format as 16 bit output (MSB first):

	Min	Typ	Max	Unit
Zero pressure offset	15990	16384	16777	Counts
Output at max. specified pressure	29097	29490	29883	Counts
Output at min. specified pressure	2883	3277	3670	Counts

The output value is calculated as (first data byte) * 256 + (second data byte).

7. Calculation of flow values and direction

The value range of the transmitted data is from 3277 to 29490 (counts). Values below the zero pressure value represent one flow direction; values above the zero pressure value represent the opposite flow direction.

Please note, that the real zero offset is not 0 (counts), but a value determined with zero offset function. Therefore, the zero offset function has to be performed once prior to calculate the flow values out of the pressure value.

Example:
The zero offset value has been measured as 16384 (counts).

1. The data value received is f. e. 18563 (counts). The resulting pressure value is (18563 - 16384) = 2179 (counts).

2. The data received is f. e. 13904 (counts). The resulting pressure value is (13904 - 16384) = -2480 (counts). This means, we have measured a pressure value of 2480 (counts) in the reversed flow direction.

⚠ **For an accurate measurement it is mandatory to perform a zero offset measurement. The zero offset of the pressure sensor can vary based on ambient conditions (temperature etc.) and supply voltage accuracy (see chapter 8).**

Based on the received digital values the corresponding differential pressure values can be calculated using the characteristic curve of the flow transducer.
For this calculation the following is important:

The digital values range of 3277 to 29490 represents a pressure range of -10 mbar to +10 mbar. Therefore, the resolution of this module is approx. 1310 counts per mbar. With respect to the real zero offset, the differential pressure can be calculated as follows:

Example:
The digital value corrected by the zero offset is 2179 (counts). In this example, the resulting differential pressure is 2179 / 13107 * 10 mbar = 1.662 mbar.

Using the calibration curve of the flow transducer, the corresponding gas flow can be calculated based on this differential pressure value.

Another option to receive a flow value is the 03hex function. This function gives the status byte and a flow value (two signed hex values) with a resolution of 0.01 l/min.

Example 1:
If the received flow value bytes are 16hex and A3hex, the corresponding flow value is calculated as follows:

16hex * 256 + A3hex = 5795 in decimal. The flow represented by this value is 57.95 l/min

Example 2:
If the received flow value bytes are FEhex and 43hex, the corresponding flow value is calculated as follows:

FEhex * 256 + 43hex = 65091 in decimal. The valid range for a two byte signed value is from -32767 to 32768. To convert the received value to the valid range it must be reduced by 65536. So the flow represented by this value is 65091 - 65536 = -445 = -4.45 l/min. The (-) indicates the flow direction.

8. Zero offset measurement of the pressure sensor

The zero offset measurement of the pressure sensor can be performed during normal operation. The procedure takes about 0.5 sec. During this time the zero offset is calculated. Then a status byte and two data bytes are sent from the module. Bit 3 of the status byte is set 1 indicating that the following data set is representing the zero offset.
For the zero offset measurement it is not necessary to have a (flow = 0) condition in the flow transducer. However, it is recommended to perform the zero offset measurement in times of lower gas flow. For good accuracy of the zero offset measurement, it is recommended that the gas flow is not exceeding 100 l/min.

⚠ **For an accurate zero offset measurement it is recommended that the gas flow through the flow transducer is not exceeding 100 l/min.**

During zero offset measurement (approx. 0.5 sec) no data will be sent from the module.

9. Receiving of serial number and firmware version number

It is possible to receive the serial number and firmware version number from the module. For details about the commands see chapter 6.
The module is sending the serial number and/or firmware version number in ASCII format.

Example:
After sending a A5hex request byte, the serial number will be returned as follows:

HEX	31	30	30	31	36	30	30	30	31

ASCII	1	0	0	1	6	0	0	0	1

The serial number has a fixed length of 9 bytes. The revision number of the firmware is always 6 bytes long.

Example:
After sending a A3hex request byte, the firmware version number will be returned. The module is sending the following:

HEX	31	2E	32	2E	30	30
ASCII	1	.	2	.	0	0

The firmware version number is ‘1.2.00’.