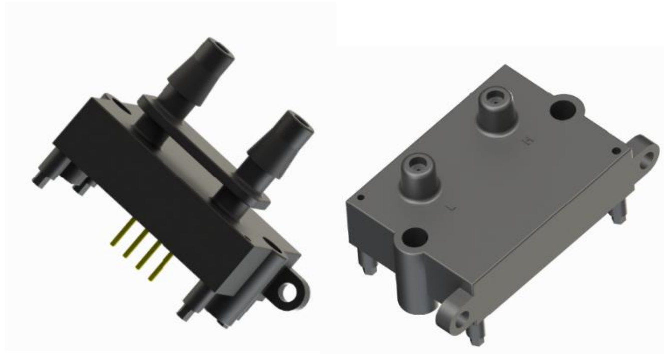
Differential Pressure Sensor

MDP200 Series

Features

- *Pressure range up to ±500Pa with high accuracy of ±3.0% m.v.*
- *Pressure based on thermal micro-flow measurement*
- *Outstanding hysteresis and repeatability*
- *Linearized and temperature compensated*
- *Digital I²C with 16bit resolution*
- *Cost Effective*
- *RoHS and REACH compliant*
- *Digital I2C Output*
- *Detects pressure difference as low as 0.02 Pascal*



Applications

- *Medical CPAP and Ventilator*
- *HAVC and building control solution*
- *Burner Control*
- *Filter Monitoring*
- *Process Control and Automation*

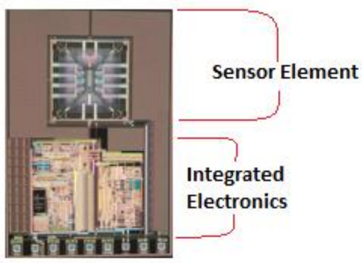
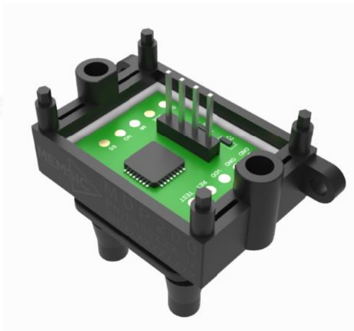


Image of flow sensor



General Description

ACEINNA's MDP200 series MEMS differential pressure sensors measure ultra-low gas pressures covering the range of up to ±500Pa (±2 inH2O). The technology is based on ACEINNA's highly successful proprietary CMOS thermal accelerometers already sold in millions. ACEINNA's thermal flow sensing element is monolithically integrated with CMOS signal processing circuitry and embedded software capable of converting gas flow rates to a digital format. The signal is linearized and temperature compensated. MDP200 series offers incredible sensitivity detecting pressure down below 0.02 Pascal near zero differential pressure. Other features include wide dynamic range, superb long-term stability, and outstanding repeatability and hysteresis.

1. Performance[1]

Parameter	-500 Pa
Measurement Range	±500Pa
Zero-point Accuracy[2]	±0.03 Pa
Span Accuracy[2]	± 3.0% m.v
Total Error (0ºC - 50ºC)	±3.5% m.v
Zero-point Repeatability and Hysteresis[2]	±0.03 Pa
Resolution (Near Zero)/Lowest Detectible Pressure	0.016 Pa
Response Time/Communication Update Rate	≤8ms (7 ms typical)
Span Repeatability and Hysteresis[3]	0.5% m.v.
Over Pressure	1.5Bar
Span Shift due to Temperature Variation	0.05 %m.v. per °C
Offset Shift due to Temperature Variation	<0.03Pa
Offset Stability	<TBD
Non-Linearity(BFSL)	0.3%FS (0-100 Pa) 0.4%FS (0-200 Pa) 0.8%FS(0-500 Pa)
Orientation Sensitivity	< resolution - port @ 90º vs. 270º <0.05 Pa – port @ 90º vs. 180º
Gas Flow Through Sensor[3]	100 ml/min @ 500 Pa

1. All sensor specifications are valid with air as medium at 21°C temperatures with 1 standard atmospheric pressure (101325Pa), 50% RH, and a 3.3V DC power supply, unless otherwise specified. Customized versions are available, please contact factory for calibration under other conditions of pressure ranges, temperatures, and gases

2. Accuracy specifications apply over operating conditions. With 16-bit resolution, this accuracy represents the total of non-linearity, hysteresis, zero and span shift, repeatability and temperature effects.

3. MDP200 operates based on thermal mass flow principle. Gas flow is required to measure the pressure difference.

2. Environment

Parameter	-500 Pa
Operating Temperature	-20°C to +80°C
Storage Temperature	-40°C to +85°C
Relative Humidity (Non-Condensing)	To 95%
Radiated Susceptibility	**5** V/m
ESD	4/(8) kV
Shock	50G @ 5 ms, G_{Peak}
Vibration (5-2000 Hz)	20, G_{rms}
Media Compatibility	N_2, O_2, Air
Orientation Sensitivity	TBD
Protection	IEC IP30
Barb Strength	4, lbf (3 orthogonal directions)

3. Electrical

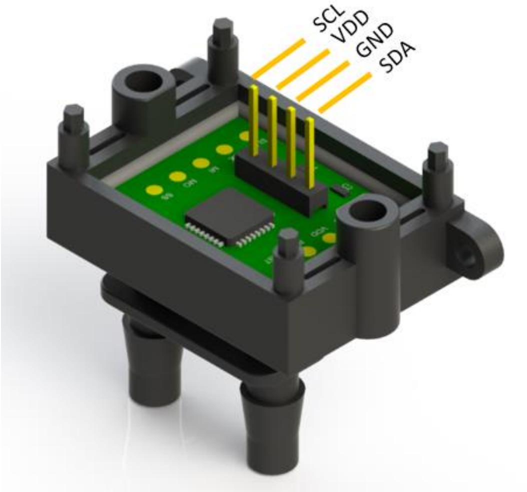
Parameter	-500 Pa
Input Voltage Range	3.0-3.6 Vdc
Supply Current	7 mA
Interface	I^2C
Resolution	16 Bit (bi-direction)
Bus Clock Frequency	< 400 KHz
I2C Default Address	0x31

4. Material

Parameter	Description
Wetted Material	FR4, Silicon Nitride, Silicon Oxide, Silicon, Epoxy, Lead-free solder, PBT (polybutylene terephthalate)
Standard Compliant	RoHS and REACH

5. I²C Interface

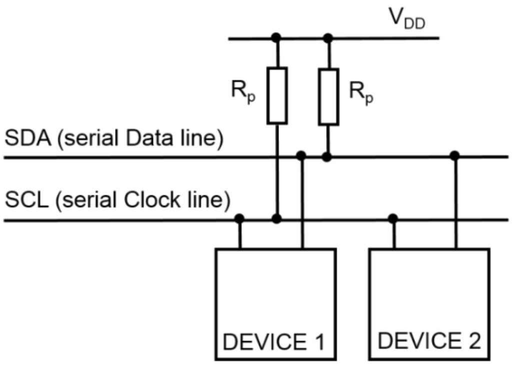
5.1. Pinout Configuration



Pin	Name	Description
1	SCL	Serial Clock Line for I²C bus
2	VDD	Power Supply
3	GND	Ground
4	SDA	Serial Data Line for I²C bus

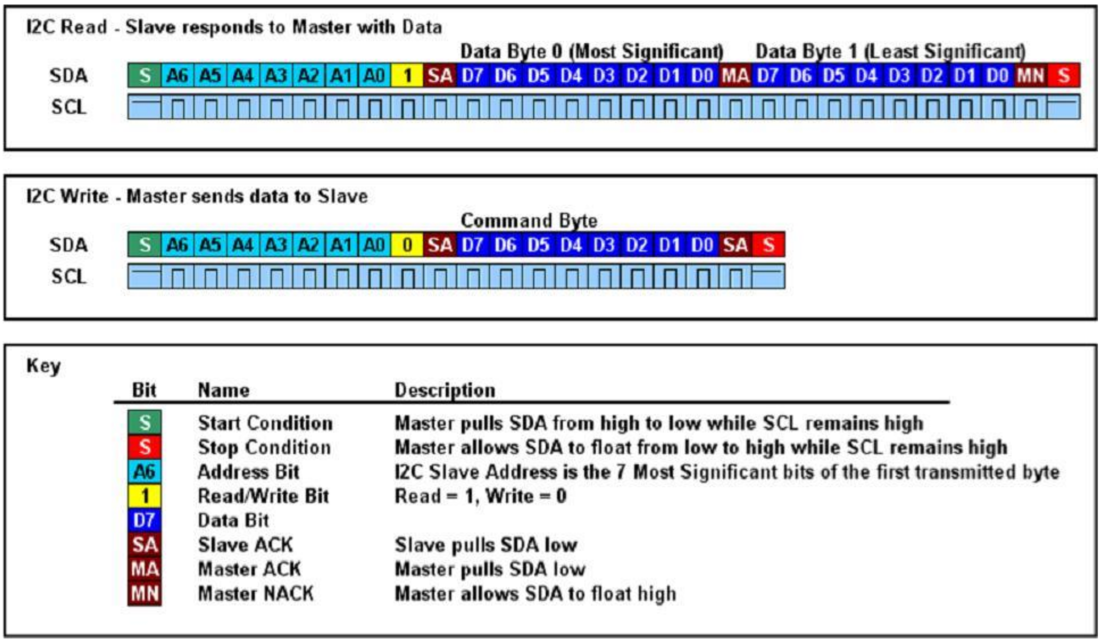
5.2. External Interface

Each SCL and SDA line must be connected to V_{DD} with about 4.7k Ohm pull-up resistor as shown below. The MDP200 has a V_{DD} input range of 3.0-3.6V but recommended VDD is 3.3V (calibration condition).



5.3. I²C Read and Write Timing

MDP200's communication interface is Phillips I²C compatible as shown below, the recommended frequency of SCL line is approximately100 kHz.



5.4. Trigger measurement operation

MDP200 works in slave mode. The default 7-bit address is 0x31 with a following bit is either write bit(0) or read bit(1).

To trigger a measurement, master writes a command 0xC1 to slave (sensor), then wait at least 7ms. The master can read out 2 bytes differential pressure data from the register 0 followed by 1 byte CRC code.

To read differential pressure data, the first byte transmitted must be 0x63 which indicates that master will read from sensor whose slave address is 0x31. Immediately with master generating pulses of 3 bytes, the master can read out the 2 bytes data and 1 byte CRC code

For example, the master triggers the measurement first, then read out the data in register 0, there are 3 steps as the following:

(1) Master write into sensor the trigger command 0xC1.

Slave address + write bit	Measurement trigger command
0x62	0xC1

(2) Wait at least 7ms, master then writes into slave's register address 0x00. This specifies that master will read data from register 0 from the slave

Slave address + write bit	Register address
0x62	0x00

(3) Master reads differential data

Slave address + read bit	16 SCL pulses
0x63	High Byte, Low Byte, CRC Code

Once slave receives the address and read bit (0x63) from master, slave will return a 2 bytes differential pressure data and 1 byte CRC code showed in the table below.

High Byte	Low Byte	CRC Code

With the pulses of 3 bytes generated master, slave will return 2 bytes differential pressure data and 1 byte CRC code.

Notes:
a. Slave returns a high byte first, then the low byte, and at last the CRC code
b. Trigger measurement command is recommended to be sent after data reading is completed.

5.5. Data Format

The output data from slave's register 0 is 2 bytes signed integer data. If the data is divided by 64, the result will be the differential pressure which is from -510 to 510 Pa.

5.6. Reset Command

MDP200's circuit can be reset to initial status by writing reset command 0xFE into device.

Note:
The device will not work normally until 2 seconds after writing reset command. Do not write any data into device within 2 seconds after writing reset command or there will be unpredictable error.

5.7. CRC-8 Redundant Data Transmission

MDP200 use cyclic redundancy checking (CRC) technique for error detection in I2C transmission. The master appends an 8-bit checksum to the actual data sequence. The checksum holds redundant information about the data sequence and allows the receiver to detect transmission errors. The computed checksum can be regarded as the remainder of a polynomial division, where the dividend is the binary polynomial defined by the data sequence and the divisor is a "generator polynomial". The MDP200 implements the CRC-8 standard based on the generator polynomial x8 + x5 + x4 +1.

Note:
CRC is only used for data transmitted from slave to master. For details regarding cyclic redundancy checking, please refer to the relevant literature.

The master's program must use the 2 bytes differential pressure reading from MDP200's register 0 and polynomial x8 + x5 + x4 +1 to calculate out the one byte result data. Then compare the result data calculated by master and the CRC code from MDP200. If they are not equal, it indicates that there is error in I2C communication. The master must discard the measurement data and trigger measurement again, then read from MDP200's register 0 until the result data and the CRC code are equal. Appendix at the end of this document is C code for reference.

6. Altitude Correction

The MDP200 series utilizes a thermal principal to measure pressure difference to achieve high sensitivity, robustness and stability. Changes in altitude from the calibration condition (sea level) require output adjustment as shown below:

Air pressure above sea level can be calculated as:

$$p = 101325(1 - 2.25577 * 10^{-5} h)^{5.25588}$$

Where

p is air pressure (Pa)

h is altitude above sea level (m)

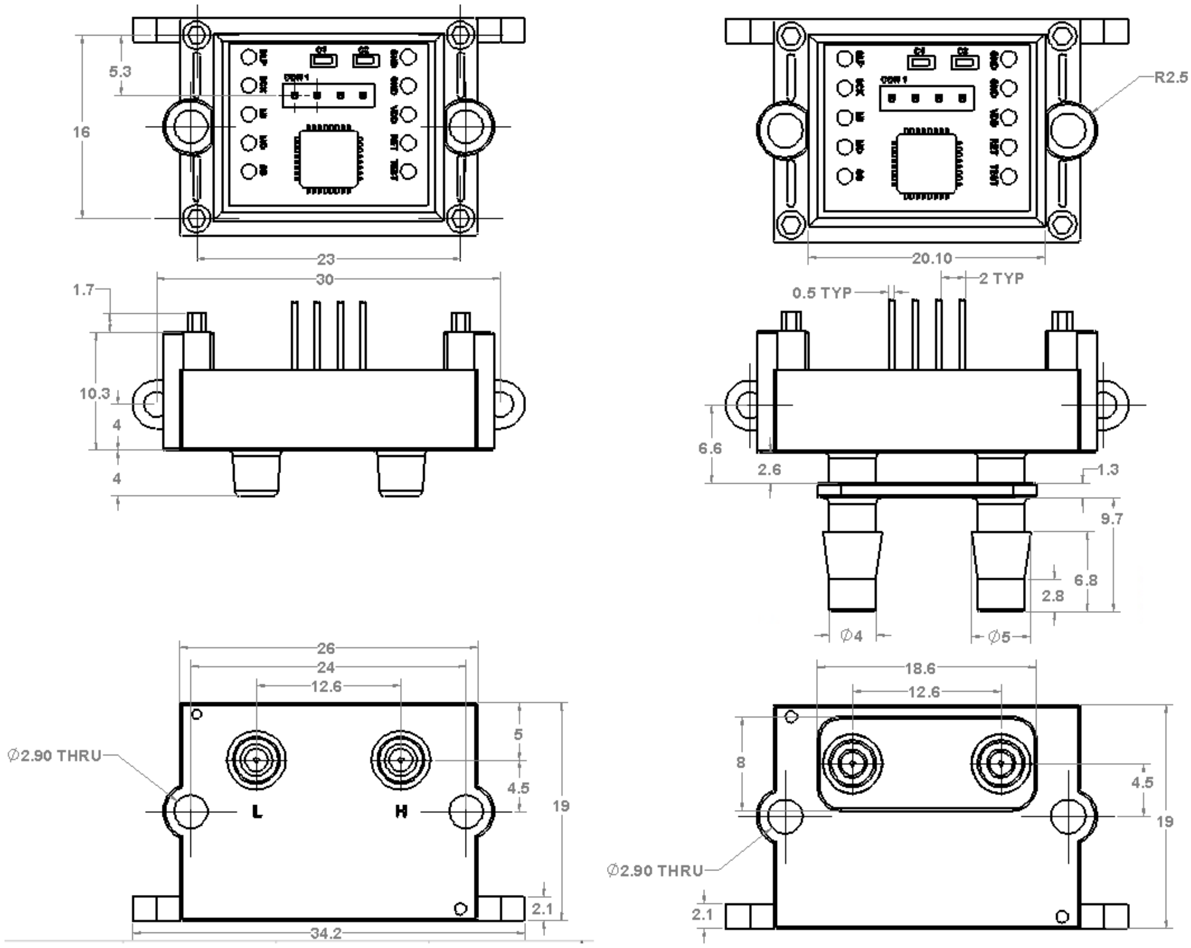
Altitude (meters)	Correction Factor
0	1.00
250	1.03
425	1.05
500	1.06
750	1.09
1000	1.13
1500	1.20
2000	1.27
3000	1.44

7. Effects on Hose Lengths

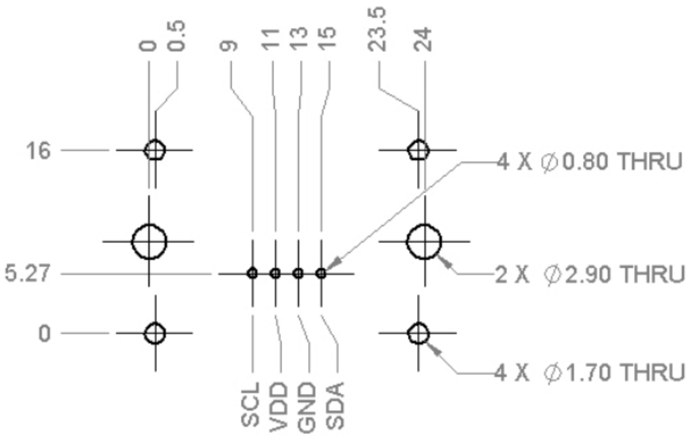
Since the MDP200 series utilizes a thermal measurement principal with air flowing through the sensor, long tubing length has an impact to the sensor output due to frictional losses. The amount of impact depends on the hose material, internal diameter and total length leading to and away from the sensor. In general, tubing length shorter than 1 meter has less 1% (m.v.) impact. Refer to application notes on tubing length effect of MDP200 series for details.

8. Mechanical Specifications

MANIFOLD MOUNT VERSION BARB FITTING VERSION



9. Foot Print



10. Ordering Information

Options	Ranges		Calibration		Housing	
MDP200	**-500**	500Pa	**B**	Bi-Directional	T	Manifold
			U	Uni-Directional	Y	Barb

Example: MDP200-500BY = MDP200 differential pressure sensor, 500 Pascal, Bi-Directional, Barb Fitting

11. Revision History

Date	Author	Version	Changes
June 2017	O. Silpachai	1.0	Initial Release
July 2017	J. Pern	1.1	Revised Zero-Point Accuracy and Repeatability. Improvement of Null DP test setup (H and L ports common)
Sept 2017	J. Pern	1.2	Updated I^2C Communication section and foot print section