DATASHEET

ASM10-XXXPD SERIES

VERSION 1.0

AIoTSensing Inc.
Webste: http://www.aiotsensing.com

History of Revision

Datasheet Rev.	Date	Note
1.0	May/23/2024	Released

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1. Features

- Pressure ranges from ±125Pa,±250Pa,±1 inH2O
- Differential pressure type
- Calibrated over temperature range of -10°C to 60°C
- 24-bit digital output for pressure and 24-bit digital output for temperature.
- I2C Communication interface
- 3.3V power supply
- Package size is 10mm x10mm
- Gel coating option for the anti-moisture requirement

2. Applications

- Medical breathing
- Industrial controls
- HVAC
- Environmental controls
- Portable equipment

3. Descriptions

The ASM10-XXXPD series are high precision MEMS sensor family offers state-of-the-art pressure transducer technology to produce a digital output, fully conditioned, multi-order pressure and temperature compensated outputs. This series provides JEDEC standard SOIC-16 package with the dual vertical ports. It is available in differential, asymmetric differential configurations. With the dual ports, a reference measurement is possible to minimize errors due to changes in ambient pressure.

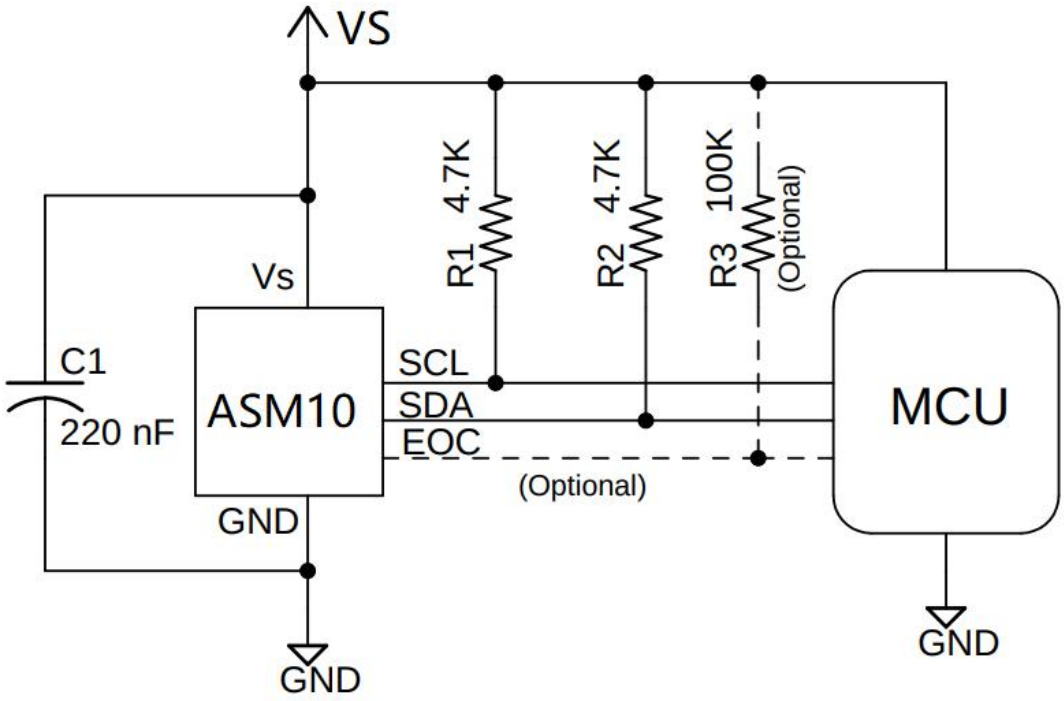
Combining the pressure sensor with a signal-conditioning ASIC in a single package simplifies the use of advanced silicon micro-machined pressure sensors. The pressure sensor can be mounted directly on a standard printed circuit board, calibrated pressure signal can be acquired from the digital interface. This eliminates the need for additional circuitry, such as a compensation network or microcontroller containing a custom correction algorithm.

This series is intended for use with non-corrosive, non-ionic working fluids such as air and dry gases.

4. Environmental Specifications

Pressure Sensor Maximum Ratings	Environmental Specifications
• Supply Voltage (Vs) 3.63 Vdc • Lead Temperature (soldering 2~4sec.) 270°C • Device Temperature (reflow soldering) 245°C	• Temperature Ranges Compensated 0°C to 70 °C • Operating -40°C to 85 °C • Storage -40°C to 125 °C • Humidity Limits (non-condensing) 0 to 95% RH

5. Equivalent Circuit



6. Pressure Ranges

Device	Operating Range		Proof Pressure		Burst Pressure	
ASM10-L01D	±1 inH2O	±250 Pa	200 inH2O	49.77 kPa	300 inH2O	74.65kPa
ASM10-125PD	±125Pa	0.5 inH2O	100 inH2O	24.88 kPa	300 inH2O	74.65kPa
ASM10-250PD	±250Pa	±1 inH2O	200 inH2O	49.77 kPa	300 inH2O	74.65kPa

7. Performance Characteristics

Parameter	Min	Typ	Max	Units	Notes
Output Span (FSS)					
LxxD	-	$\pm 0.4*2^{24}$	-	Dec Counts	1
0xxD	-	$\pm 0.4*2^{24}$	-	Dec Counts	1
Offset Output @ Zero Diff. Pressure (Osdig)					-
LxxD	-	$0.5 * 2^{24}$	-	Dec Counts	-
0xxPD	-	$0.5 * 2^{24}$	-	Dec Counts	-
Total Error Band					
L01D, 125PD, 250PD	-	-	±2.75	%FSS	2
L01D, 125PD, 250PD(afterAutozero)	-	-	±1.25	%FSS	2
Pressure Digital Resolution - No Missing Codes					
16-bit Option	15.3	15.5		bit	-
Supply Current Requirement					
During Active State (ICCActive)	-	2.0	2.5	mA	3, 4, 5
During Idle State (ICCIdle)	-	100	250	nA	3, 4, 5
Power On Delay	-	-	2.5	ms	3
Data Update time (tDU)		(see table below)		ms	3, 4

Calibrated Resolution	Measurement Command										Units
	Single		Average2		Average4		Average8		Average16		
	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	
16 bit	3.70	4.1	7.20	8.0	14.20	15.7	28.20	31.1	56.20	61.9	ms

Soldering Recommendations

1) Solder parts as a second operation only.

2) Post re-flow, wait for 48 hrs before performing any calibration operations.

3) Perform spot cleaning as necessary only by hand. DO NOT wash or submerge device in cleaning liquid.

8. Digital Interface Electrical Parameters

Parameter	Symbol	Min	Typ	Max	Units	Notes
Input High Level	-	80.0	-	100	% of Vs	5
Input Low Level	-	0	-	20.0	% of Vs	5
Output Low Level	-	-	-	10.0	% of Vs	5
I2C Pull-up Resistor	-	1000	-	-	Ω	5
I2C Load Capacitance on SDA, @ 400 kHz	CSDA	-	-	200	pF	5
I2C Input Capacitance (each pin)	CI2C_IN	-	-	10.0	pF	5
I2C Address			41		decimal	

Pressure Output Transfer Function:

$$\textbf{Pressure(inH2O)} = 1.25x\left(\frac{Poutdig - OSdig}{2\text{^}24}\right)\textbf{xFSS(inH2O)}$$

Where:

Poutdig Is the sensor 24-bit digital output.

OSdig Is the specified digital offset output.

(see Performance Characteristics Table)

FSS(inH2O） The sensor Full Scale Span in inches H2O

For Gage Operating Range sensors: Full Scale Pressure

For Differential Operating Range sensors: 2 x Full Scale Pressure.

Temperature Output Transfer Function:

$$\textbf{Temperature(℃)} = \left(\frac{Toutdig * 165}{2\text{^}24}\right)\textbf{-40}$$

Where:

Toutdig The sensor 24-bit digital temperature output.

(Note that only the upper 16 bits are significant)

Note 1: the span is the algebraic difference Between full scale decimal counts And the offset decimal counts. the full scale pressure is the maximum positive calibrated pressure.

Note 2: total error Band consists of offset and span temperature And calibration errors, linearity And pressure hysteresis errors, offset warm-up shift And offset position sensitivity errors.

Note 3: parameter is characterized And not 100% tested.

Note 4: data update time is exclusive of communications, from command received to end of Busy status. this can Be observed As EOC pin low- state duration.

Note 5: Average current can Be estimated As : ICCIdle + ((tDU / reading interval) * ICCACTIVE)). Refer to figure 2

for active and idle conditions of the sensor (the active state is while EOC pin is low)

Note 6: The sensor is calibrated with a 3.3V supply, however, an internal regulator allows a supply voltage of 1.8V to 3.6V, to be used without affecting the overall specifications. This allows direct operation from a battery supply.

Note 7: Calibrated with continuous Reads.

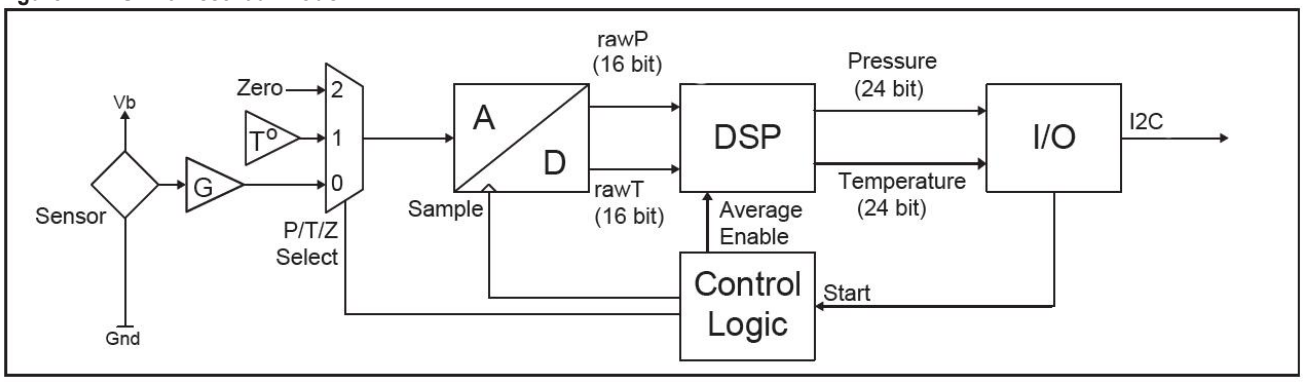
9. Device Ordering Options

Output Resolution
Calibrated output resolution of 16 bits.
See the Data Update Time in the Performance Characteristics table.

10. Operation Overview

The ASM10 is a digital sensor with a signal path that includes a sensing element, a variable- bit analog to digital converter, a DSP and an IO block that supports an I2C interface (see Figure 1 below). The sensor also includes an internal temperature reference and associated control logic to support the configured operating mode. Since there is a single ADC, there is also a multiplexer at the front end of the ADC that selects the signal source for the ADC.

Figure 1 - ASM10 Essential Model



The ADC performs conversions on the raw sensor signal (P), the temperature reference (T) and a zero reference (Z) during the ADC measurement cycle.

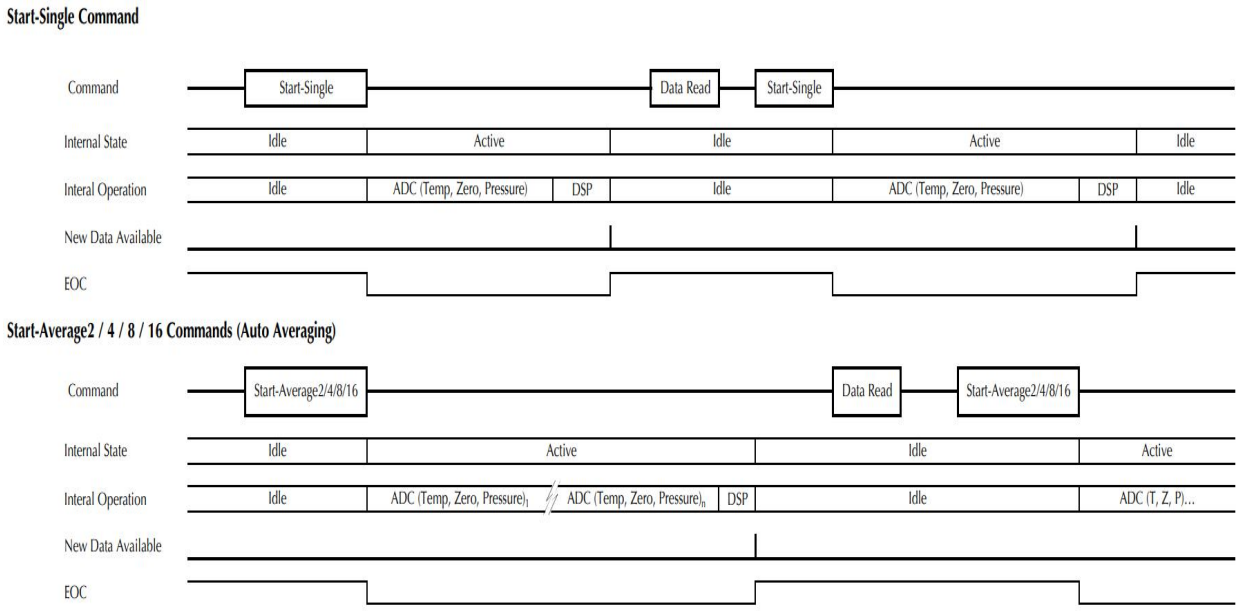
The DSP receives the converted pressure and temperature information and applies a multi-order transfer function to compensate the pressure output. This transfer function includes compensation for span, offset, temperature effects on span, temperature effects on offset and second order temperature effects on both span and offset. There is also linearity compensation for gage devices and front to back linearity compensation for differential devices.

Sensor Commands: Five Measurement commands are supported, returning values of either a single pressure / temperature reading or an average of 2, 4, 8, or 16 readings. Each of these commands wakes the sensor from Idle state into Active state, and starts a measurement cycle. For the Start-Average commands, this cycle is repeated the appropriate number of times, while the Start-Single command performs a single iteration. When the DSP has completed calculations and the new values have been made available to the I/O block, the sensor returns to Idle state. The sensor remains in this low-power state until another Measurement command is received.

After completion of the measurement, the result may then be read using the Data Read command. The ADC and DSP remain in Idle state, and the I/O block returns the 7 bytes of status and measurement data. See Figure 2, following. At any time, the host may request current device status with the Status Read command.
See Table 1 for a summary of all commands.

For optimum sensor performance, All Sensors recommends that Measurement commands be issued at a fixed interval by the host system. Irregular request intervals may increase overall noise on the output.
Furthermore, if reading intervals are much slower than the Device Update Time, using the Averaging commands is suggested to reduce offset shift. This shift is constant with respect to time interval, and may be removed by the application. For longer fixed reading intervals, this shift may be removed by the factory on special request.

Figure 2 - ASM10 Communication Model



11.Command Formats

Sensor Measurement Commands				
Description	SPI(3bytes)			I2C (1byte)
Start-Single	0XAA	0X00	0X00	0XAA
Start-Average2	0XAC	0X00	0X00	0XAC
Start-Average4	0XAD	0X00	0X00	0XAD
Start-Average8	0XAE	0X00	0X00	0XAE
Start-Average16	0XAF	0X00	0X00	0XAF

Read Sensor Data	
I2C	Read of 7 bytes from sensor

Read Sensor Status	
I2C	Read of 1 byte from sensor

12.Output Data Format

For either type of digital interface, the format of data returned from the sensor is the same. The first byte consists of the Status Byte followed by a 24-bit unsigned pressure value. Unused bits beyond the calibrated bit width are undefined, and may have any value. See the Pressure Output Transfer Function and Temperature Output Transfer Function definitions on page 3 for converting to pressure and temperature. Refer to Table 2 for the overall data format of the sensor. Table 3 shows the Status Byte definition. Note that a completed reading without error will return status 0x40.

Table 2 - Output Data Format

S[7:0]	P[23:16]	P[15:8]	P[7:0]	T[23:16]	T[15:8]	T[7:0]
Status Byte	Pressure MSB	Pressure Byte 1	Pressure LSB	Temperature MSB	Temperature Byte 1	Temperature LSB

Table 3- Status Byte Definition

Bit	Description
Bit 7 [MSB]	[Always = 0]
6	Power: [1 = Power On]
5	Busy: [1 = Processing Command, 0 = Ready]
4:3	Mode: [00 = Normal Operation]
2	Memory Error [1 = EEPROM Checksum Fail]
1	Sensor Configuration [always = 0]
Bit 0 [LSB]	ALU Error [1 = Error]

13.I2C interface

I2C Command Sequence

The part enters Idle state after power-up, and waits for a command from the bus master. Any of the five Measurement commands may be sent, as shown in Table 1. Following receipt of one of these commands,

the EOC pin is set to Low level, and the sensor Busy bit is set in the Status Byte. After completion of

measurement and calculation in the Active state, compensated data is written to the output

registers, the EOC pin is set high, and the processing core goes back to Idle state. The host processor can then perform the Data Read operation, which for I2C is simply a 7-byte Device Read.

If the EOC pin is not monitored, the host can poll the Status Byte by repeating the Status Read command, which for I2C is a one-byte Device Read. When the Busy bit in the Status byte is zero, this indicate that valid data is ready, and a full Data Read of all 7 bytes may be performed.

I2C Interface (Cont'd)

I2C Bus Communications Overview

The I2C interface uses a set of signal sequences for communication. The following is a description of the sup- ported sequences and their associated mnemonics. Refer to Figure 3 for the associated usage of the following signal sequences.

Bus not Busy (I): During idle periods both data line (SDA) and clock line (SCL) remain HIGH.

START condition (ST): A HIGH to LOW transition of SDA line while the clock (SCL) is HIGH is interpreted as START condition. START conditions are always set by the master. Each initial request for a pressure value has to begin with a START condition.

Slave address (An): The I C-bus requires a unique address for each device. The ASM10 sensor has a preconfigured slave address (see specification table on Page 3). After setting a START condition the master sends the address byte containing the 7 bits sensor address followed by a data direction bit (R/W). A "0" indicates a transmission from master to slave (WRITE), a "1" indicates a device-to master request (READ).

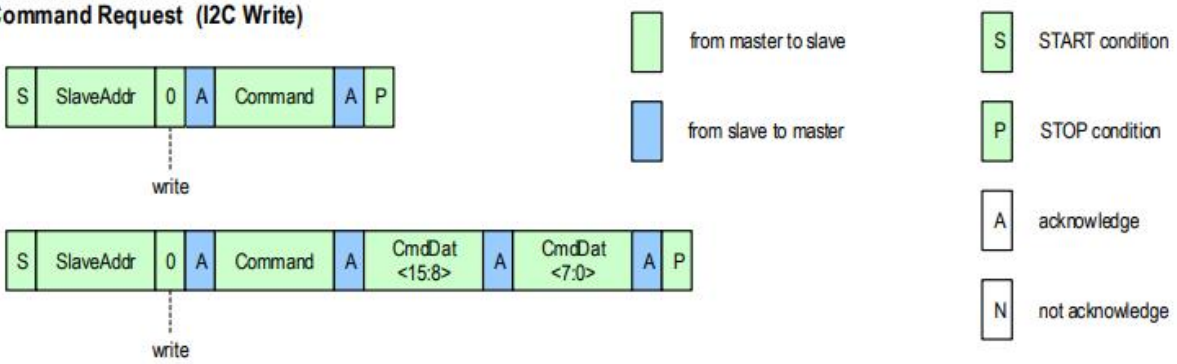
Acknowledge (A or N): Data is transferred in units of 8 bits (1 byte) at a time, MSB first. Each data-receiving device, whether master or slave, is required to pull the data line LOW to acknowledge receipt of the data. The Master must generate an extra clock pulse for this purpose. If the receiver does not pull the data line down, a NACK condition exists, and the slave transmitter becomes inactive. The master determines whether to send the last command again or to set the STOP condition, ending the transfer.

DATA valid (Dn): State of data line represents valid data when, after a START condition, data line is stable for duration of HIGH period of clock signal. Data on line must be changed during LOW period of clock signal. There is one clock pulse per data bit.

STOP condition (P): LOW to HIGH transition of the SDA line while clock (SCL) is HIGH indicates a STOP condition. STOP conditions are always generated by the master.

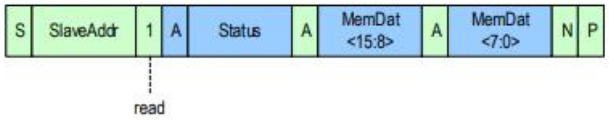
Figure 3 - I2C Communication Diagram

Command Request (I2C Write)

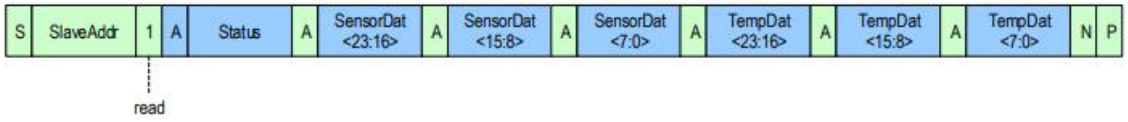


Read Data (I2C Read)

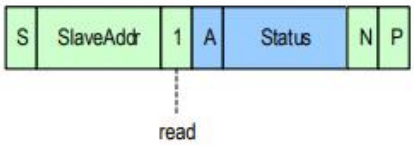
(a) Example: after the completion of a Memory Read command



(b) Example: after the completion of a Full Measurement command (AA_{HEX})

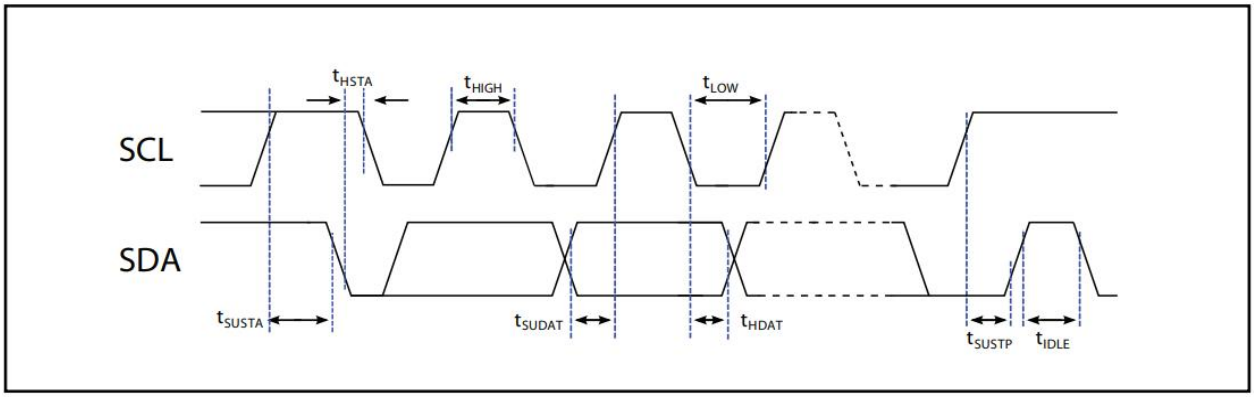


Read Status (I2C Read)



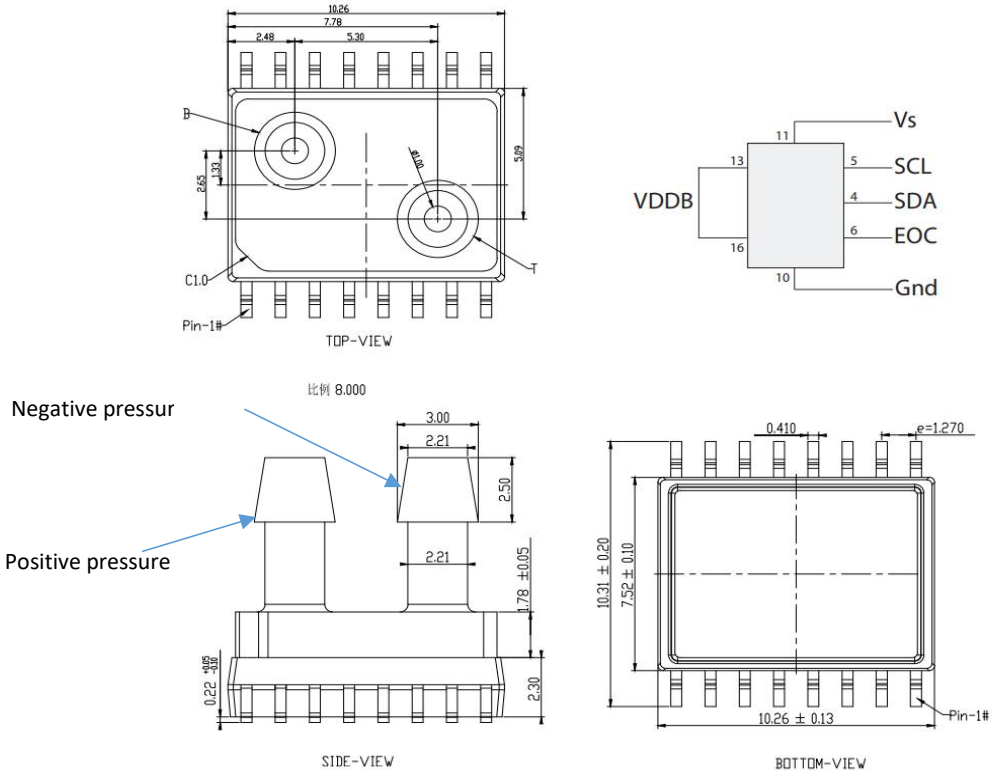
14.Interface Timing Diagram

Figure 4 - I2C Timing Diagram



PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
SCL frequency	fSCL	100	-	400	KHz
SCL low width	tLOW	1.3	-	-	us
SCL high width	tHIGH	0.6	-	-	us
Start condition setup	tSUSTA	0.6	-	-	us
Start condition hold	tHSTA	0.6	-	-	us
Data setup to clock	tSUDAT	0.1	-	-	us
Data hold to clock	tHDAT	0	-	-	us
Stop condition setup	tSUSTP	0.6	-	-	us
Bus idle time	tIDLE	2.0	-	-	us

15.Outline Drawings (SOIC 16mm)

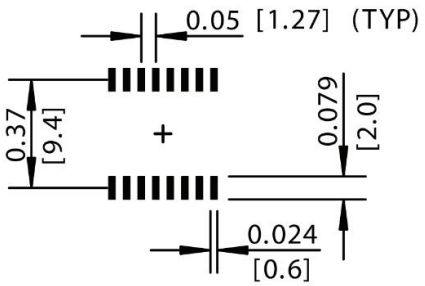


Pin	Definition
1	INP
2	N/C
3	VSSB
4	SDA
5	SCL
6	EOC
7	N/C
8	N/C
9	N/C
10	VSS
11	VDD
12	N/C
13	VDDB
14	INN
15	N/C
16	VDDB

Notes:

- All dimensions in units of [mm]
- Tolerance on all dimensions ±0.13 mm unless otherwise specified.
- [T] is tube connected to bottom side of sensor die, to be connected to the reference pressure.
- [B] is tube connected to top side of sensor die, to be connected to the detection pressure.
- An increase pressure in positive pressure port will result in an increase in sensor output

Suggested Pad Layouts (SOIC16 mm)



16.Marking and Package

All products are labeled via laser marking as the below Example.
AIoT is an abbreviation for AIoTSensing Inc.
Low pressure ranges from 1 to 60 inH2O are specified with code “L” and 5 to 150 psi high pressure products with code “H”.

Example: AIoT

ASM10-L01D

0-1A0BABB-165



17.Customer Use

17.1 Post Calibration Offset Correction

The process for applying a scalar offset correction is relatively straight forward：

Identify the offset error, which is [counts output] - (0.5*2^24) for differential sensors, or [counts output] - (0.1*2^24) for Gage calibrated sensors.

The adjustment is then the negative of the error, but expressed in binary as sign-magnitude, not 2’ s complement, in 24-bit format.

That is, value (-1) would be 0x800001, not 0xffffff.

This 24-bit value is then written into EEPROM location 0x17 (lower 2 bytes of adjustment), and 0x19 (high byte of adjustment).

This requires sending the following command sequence:

I2C communications (shown) is simplest:

Write 3 bytes: [0x57] [Middle Byte] [Low Byte]
Write 1 byte : [0x17]
Read 3 bytes: [0x40] [Middle Byte] [Low Byte]

Write 3 bytes: [0x59] [0x00] [High Byte]
Write 1 byte : [0x19]
Read 3 bytes: [0x40] [0x00] [High Byte]

Write 1 byte : [0x90]

Then turn power off.

17.2 Interrupt Threshold

Register description (Customized according to order requirements, not be modified by user.)

MTP Address	Word / Bit Range	Default Setting	Description	Notes / Explanations
02HEX	6:0	000 0000BIN	Slave_Addr	I2C slave address; valid range: 00HEX to 7FHEX (default: 00HEX). Note: address codes 04HEX to 07HEX are reserved for entering the I2C High Speed Mode.

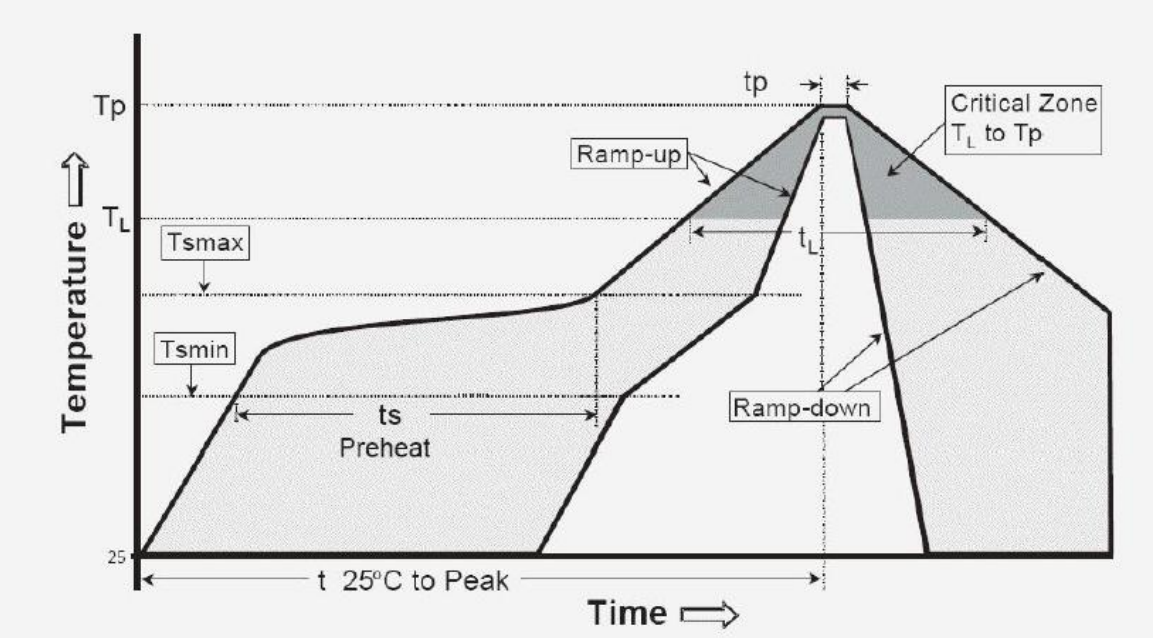
	8:7	00BIN	INT_setup	Interrupt configuration, EOC pin functionality “
				00 End-of-conversion signal
				01 0-1 transition on EOC/INT if conditioned measurement result (MEAS)
				exceeds threshold1 (TRSH1) and 1-0 transition if MEAS falls below threshold1 again
				10 0-1 transition if MEAS falls below threshold1 and 1-0 transition if MEAS rises above threshold1 again
				11 EOC is determined by threshold settings :
				If (TRSH1 > TRSH2) then EOC/INT (interrupt level) = 0 if (TRSH1 > MEAS ≥ TRSH2). Otherwise EOC/INT=1.
				If (TRSH1 ≤ TRSH2) then EOC/INT = 1 if (TRSH1 ≤ MEAS < TRSH2). Otherwise EOC/INT = 0.

	15:9			Other function,not be modified by user.
13HEX	15:0	0000HEX	TRSH1[15:0]	Bits [15:0] of the 24-bit interrupt threshold1, *TRSH1*. (The MSB bits for this threshold are *TRSH1*[23:16], which is bits [7:0] of register 15HEX.)
14HEX	15:0	0000HEX	TRSH2[15:0]	Bits [15:0] of the 24-bit interrupt threshold2, *TRSH2*. (The MSB bits for this threshold are *TRSH2[*23:16], which is bits [15:8] of register 15HEX.)
15HEX	7:0	00HEX	TRSH1[23:16]	Bits [23:16] of the 24-bit interrupt threshold1, *TRSH1*. (The LSB bits for this threshold are *TRSH1*[15:0], which is bits [15:0] of register 13HEX.)
	15:8	00HEX	TRSH2[23:16]	Bits [23:16] of the 24-bit interrupt threshold2, TRSH2. (The LSB bits for this threshold are TRSH2[15:0], which is bits [15:0] of register 14HEX.)

18.Read C Code

```
void Read_ASM10_Sensor(void)
{
      u32 PressData;
      u32 TempData;
      u8 Read_Data[7] = {0x00};
    u8 Status = 0x00;
    u8 I2c_Address = 0x29;
    u8 Read_Commond = 0xAC;//
    IIC_Init();
    delay_ms(50);
    IIC_Start();
    IIC_Send_Byte((I2c_Address)<<1|0);//write
    IIC_Wait_Ack();
    IIC_Send_Byte(Read_Commond);//1mps
    IIC_Wait_Ack();
    IIC_Stop();
    delay_ms(100);
    IIC_Start();
    IIC_Send_Byte((I2c_Address)<<1|1);//read
    IIC_Wait_Ack();
    Read_Data[0] = IIC_Read_Byte(1);//STATUS[7:0]
    Read_Data[1] = IIC_Read_Byte(1);//PRESSURE[23:16]
    Read_Data[2] = IIC_Read_Byte(1);//PRESSURE[15:8]
    Read_Data[3] = IIC_Read_Byte(1);//PRESSURE[7:0]
    Read_Data[4] = IIC_Read_Byte(1);//TEMPERATURE[23:16]
    Read_Data[5] = IIC_Read_Byte(1);//TEMPERATURE[15:8]
    Read_Data[6] = IIC_Read_Byte(0);//TEMPERATURE[7:0]
    IIC_Stop();
    Status = Read_Data[0];
    PressData = (Read_Data[1]<<16)|(Read_Data[2]<<8)|Read_Data[3];
    TempData  = (Read_Data[4]<<16)|(Read_Data[5]<<8)|Read_Data[6];
}
```

19.Soldering Recommendation (IPC/JEDEC J-STD-020D)



IPC/JEDEC J-STD-020D	Pb-Free Assembly
Average Ramp-up rate（TL-Tp）	1~3℃/s（Max.）
Preheat –Temperature Min. (Tsmin) –Temperature Max. (Tsmax) –Time (Min. to Max.) (ts)	 140℃ 170℃ 60-90 seconds
Tsmax to TL –Tp	3℃/s（Max.）
Time maintained above: –Temperature (TL) –Time (tL)	 200℃ above 40-90 seconds
Peak temperature (Tp)	200~220℃
Time of Real peak temperature within 5℃ (tp)	60 seconds
Average Ramp-down rate（Tp-TL）	2~4℃/s（Max.）
Time 25℃ to peak temperature	4min.（Max.）

Note：

1) It is recommended that only one time reflow soldering, no more than two times.
2) After reflow soldering or other high temperature processes, wait for at least 48 hours (or as required by the data sheet) before data reading and processing.
3) Spot cleaning by hand if necessary, DO NOT wash or submerge sensor in cleaning liquid.
4) It is recommended to use the medium temperature solder paste.

20. How to order

Refer to 6 for standard part numbers offered which includes the pressure range and package. Example P/N with options: ASM10-125PD

Table 4 - Part Numbering Scheme:

ASM10 – 125P D



Product Series Code	Pressure Range	Output Mode D-Differential

21. Legal Disclaimer

1)For the export of products which are controlled items subject to foreign and domestic export laws and regulations, you must obtain approval and/or follow the formalities of such laws and regulations.

2)Products must not be used for military and/or antisocial purposes such as terrorism, and shall not be supplied to any party intending to use the products for such purposes.

3)Unless provided otherwise, the products have been designed and manufactured for application to equipment and devices which are sold to end-users in the market.

4)Before using products, which were not specifically designed for use in automotive applications, please contact an AIOT sales representative.

5)This specification is subject to change without notice.

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