DATASHEET

AS60 SERIES

VERSION A

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

History of Revision

Datasheet Rev.	Date	Note
01	Oct/09/2022	Released

CONTENTS

1. Features

- Pressure ranges from -100KPa to700kPa
- Gage or Differential pressure type
- 24-bit digital, pressure calibrated and temperature compensated output
- I2C interface
- 1.8V to 5.5V power supply
- Low power consumption
- Package size is 7.0mm x10.3mm x10.0mm
- Humidity Limits(non condensing) 0~95%RH

2. Applications

- Medical Breathing
- Industrial Controls
- HVAC
- Environmental Controls
- Portable Equipment

3. Descriptions

The AS60 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 Package is surface mount with a plastic cap and is RoHS compliant.

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.

4. Standard Pressure Ranges

Differential Pressure Type Products			
Device	**Operating Range**	**Proof Pressure**	**Burst Pressure**
AS60-010KD	-10~10k Pa	50Kpa	100Kpa
AS60-015KD	-15~15k Pa	50Kpa	100Kpa
AS60-035KD	-35~35 kPa	70 kPa	105kPa
AS60-040KD	-40~40 kPa	80 kPa	120kPa
AS60-100KD	-100~100kPa	200 kPa	300kPa
Gage Pressure Type Products			
Device	**Operating Range**	**Proof Pressure**	**Burst Pressure**
AS60-010KG	0~10k Pa	50Kpa	100Kpa
AS60-015KG	0~15k Pa	50Kpa	100Kpa
AS60-035KG	0~35 kPa	70 kPa	105kPa
AS60-040KG	0~40 kPa	80 kPa	120kPa
AS60-100KG	0~100kPa	200 kPa	300kPa
AS60-200KG	0~200kPa	400 kPa	600kPa
AS60-350KG	0~350kPa	700 kPa	1100kPa
AS60-700KG	0~700kPa	1400 kPa	2100kPa

5. Performance Characteristics

Parameter	Min	Typ	Max	Units	Specification Notes
Accuracy	-1		1	%FSS	
Response time@ OSR=1024		3.0		ms	
Long term stability		±0.1		%FSS/yr	
Compensation Temperature	C: 0℃ to 50 ℃ S: -20℃ to 60 ℃ T:Customer customization				

Note:

1. Accuracy and temperature compensation range could be customized;
2. Anti static protection during welding;
3. Overload voltage (6.5Vdc) or current (5mA) may burn the circuit chip;
4. Please add 0.1uf capacitance between VDD and GND.

6. Block Diagram

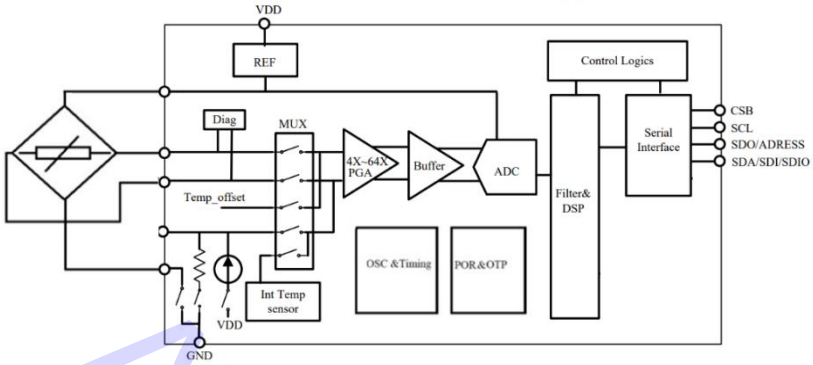


Figure 1: Functional Block Diagram

7. Electrical Specifications

7.1 Electrical Characteristics

Table7.1: DC Characteristics @VDD=3.3V, T=25℃ unless otherwise noted

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Supply Voltage	V_{DD}			3.3		V
Operation Temperature	T_{OP}		-40		85	℃
Supply Current @25°C on during conversion	I_{BDD}_pga on	PGA on (Gain>=4)		1.8	2.5	mA
Conversion time	Tc	OSR 32768 16384 8192 4096 2048 1024 512 256		43.0 35.0 12.0 7.0 4.0 3.0 2.0 2.0		ms
Supply current (1 sample per sec.)	Idd	OSR 32768 16384 8192 4096 2048 1024 512 256		77.4 63.0 21.6 12.6 7.2 5.4 3.6 3.6	107.5 87.5 30 17.5 10 7.5 5.0 5.0	uA
Power up reset time	PURT		15	30		ms
Standby Supply Current	I_{DDSTB}	At25℃		0.1	0.2	μA
Serial Data Clock Frequency	f_{SCLK}	I^2C protocol		100	400	kHz
		SPI protocol			10	MHz
Digital Input High Voltage	V_{IH}		0.8			V
Digital Input Low Voltage	V_{IL}				0.2	V
Digital Output High Voltage	V_{OH}	IO=0.5mA	0.9			V
Digital Output Low Voltage	V_{OL}	IO=0.5mA			0.1	V
Input Capacitance	C_{IN}			4.7		pF

7.2 Absolute Maximum Rating

Table7.2: Absolute Maximum Rating

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{DD}		-0.3		5.5	V
Interface Voltage	V_{IF}		-0.3		VDD+0.3	V
Storage Temperature Range	T_{STG}		-40		125	℃
ESD Rating		Human body model	-2		+2	kV
Latch-up Current		At 85℃	-100		100	mA

Stresses above those listed as "absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

8. Function Descriptions

8.1 General Description

The AS60 series consists of a piezo-resistive sensor and a sensor interface I^2C. The main function of the I^2C is to convert the uncompensated analogue output voltage from the piezo-resistive pressure sensor to a 24-bit digital value, as well as providing a 16-bit digital value for the temperature of the sensor, and compensates them by a patented algorithm. The fully-compensated values can be read out by external MCU.

8.2 Factory Calibration

Every sensor is individually factory calibrated for sensitivity and offset for both of the temperature and pressure measurements; further calibrations are not necessary to be done by the user. The OTP registers are used to store the configurations and calibration coefficients for the sensor.

8.3 Sensor Output Conversion

For each pressure measurement, customer used to send a conversion command to the sensor, read back the conversion data from the normal register to be stored from 0x06 to 0x0a, the pressure data is stored from 0x06 to 0x08, the highest bit is sign bit, the temperature data is stored from 0x09 to 0x0a, the highest bit is sign bit. All the data are sent starting from the MSB.

8.4 Serial Interface

The AS60 provides I^2C interface for serial communication.

9. Register

All the registers can be departed into normal registers and OTP registers. The normal registers are used to send a conversion command to the Sensor, read back the conversion data and perform the OTP blowing. The OTP registers are used to store the configurations and calibration coefficients for the Sensor, whose default values can be programmed by the inside OTP banks.

9.1. Normal Register

Table8.1 normal registers

Addr	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default
0x00		RW			Soft reset			Soft reset			0x00
0x01	Part_ID	R	PartID								0x00
0x02	Status	R	Error_code						1'b0	DRDY	
0x06	DATA_MSB	R	Data out[23:16]								0x00
0x07	DATA_CSB	R	Data out[15:8]								0x00
0x08	DATA_LSB	R	Data out[7:0]								0x00
0x09	TEMP_MSB	R	Temp out[15:8]								0x00
0x0A	TEMP_LSB	R	Temp out[7:0]								0x00
0x30	CMD	RW	Sleep_time[3:0]				Sco	Measurement_ctrl]2:0]			0x00

Reg0x00

Soft_reset: 1: Reset all the registers (except 'margin'), automatically come back to 0 after reset complete.

Reg0x01

PartID: OTP programmed 8 bits Part ID, corresponding to OTP register Reg0xA4. Read only from the address 0x01.

Reg0x02

DRDY： 1, indicates once conversion complete, and the output data is ready for reading.
Error_code: When diagnostic function enabled, These bits stores the error information.
Error_code[3]: VINP short to VDD
Error_code[2]: VINP short to GND
Error_code[1]: VINN short to VDD
Error_code[0]: VINN short to GND

Reg0x06-Reg0x08

Data_out: 24 bits ADC output data when 'raw_data_on' = 0 with an LSB equals to (1/2^23)*(VEXT-PSW). 24 bits calibrated data when 'raw_data_on' = 1.

Reg0x09-Reg0x0a

Temp_out: Temperature output with an LSB equals to (1/256) °C

Reg0x30

Sleep_time[3:0]: 0000:0ms, 0001:62.5ms, 0010:125ms ... 1111: 1s, only active during sleep mode conversion.
Measurement_control: 000b, indicate a single shot temperature signal conversion. 001b, indicate a single shot sensor signal conversion. 010b: indicate a combined conversion (once temperature conversion immediately followed by once sensor signal conversion). 011b: indicate a sleep mode conversion (periodically perform once combined conversion with an interval time of 'sleep_time'), 100b: OTP programming mode, enter this mode to when programming OTP banks.

Sco: 1, Start of conversion, automatically come back to 0 after conversion ends (except sleep mode conversion).

9.2 OTP Registers

Table8.2 OTP registers

Addr	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default
0xa4	Part_ID	RW									OTP
0xa5	Sys_config	RW	System function,Prohibit modification							DIAG_on	OTP
0xa6	P_config	RW	System function,Prohibit modification					OSR_P[2:0]			OTP
0xa7	T_config	RW	System function,Prohibit modification					OSR_T[2:0]			OTP

Reg0xA4

PartID: OTP programmed 8 bits Part ID, also can be read from address 0x01.

Reg0xA5

Diag_on: 1, Enable diagnosis function.

Reg0xA6

OSR_P: set the over sampling ratio of the sensor signal conversion channel. 000:1024X, 001:2048X, 010:4096X, 011:8192X, 100:256X, 101:512X, 110:16384X, 111:32768X.

Reg0xA7

OSR_T: set the over sampling ratio of the temperature conversion channel. 000:1024X, 001:2048X, 010:4096X, 011:8192X, 100:256X, 101:512X, 110:16384X, 111:32768X.

10. High-Speed I²C Digital Output Interface

The I²C interface is fully compatible to the official I²C protocol specification.

10.1 I²C Specification

Table9.1: I²C Slave Timing Values

Parameter	Symbol	Conditions	I²C			Unit
			Min	Typ	Max	
Clock frequency	f_{BsclB}				400	kHz
SCL low pulse	t_{BLOWB}		1.3			µs
SCL high pulse	t_{BHIGHB}		0.6			µs
SDA setup time	$t_{BSUDATB}$		0.1			µs
SDA hold time	$t_{BHDDATB}$		0.0			µs
Setup Time for a repeated start condition	$t_{BSUSTAB}$		0.6			µs
Hold time for a start condition	$t_{BHDSTAB}$		0.6			µs
Setup Time for a stop condition	$t_{BSUSTOB}$		0.6			µs
Time before a new transmission can start	t_{BBUFB}		1.3			µs

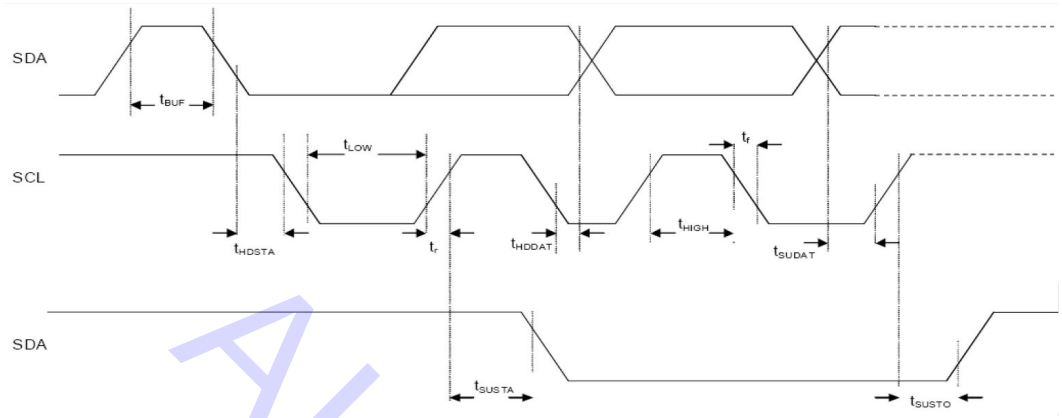


Figure 2: I²C Timing Diagram

The I²C interface protocol has special bus signal conditions. Start (S), stop (P) and binary data conditions are shown below. At start condition, SCL is high and SDA has a falling edge. Then the slave address is sent. After the 7 address bits, the direction control bit R/W selects the read or write operation. When a slave device recognizes that it is being addressed, it should acknowledge by pulling SDA low in the ninth SCL (ACK) cycle.

At stop condition, SCL is also high, but SDA has a rising edge. Data must be held stable at SDA when SCL is high. Data can change value at SDA only when SCL is low.

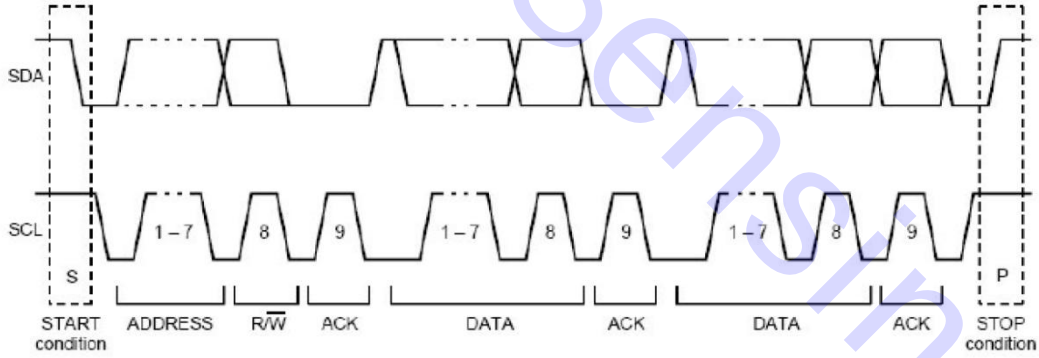


Figure 3: I²C Protocol

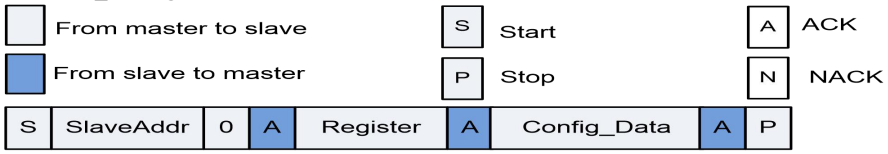
10.2 I²C Device Address

The I²C device address is shown below. The LSB of the device address is corresponding to address 0XDA (write) and 0XDB (read).

A7	A6	A5	A4	A3	A2	A1	W/R
1	1	0	1	1	0	1	0/1

10.3 I²CProtocol

10.3.1 P_Config

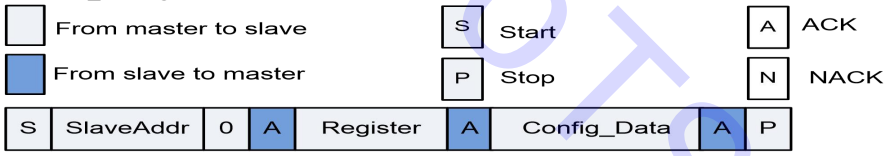


Register=0XA6
Config_Data:

Address	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	default
0xA6	P_CONFIG	RW		No change				OSR_P<2:0>			OTP

OSR_P: set the over sampling ratio of the sensor signal conversion channel. 000:1024X, 001:2048X, 010:4096X, 011:8192X, 100:256X, 101:512X, 110: 16384X, 111:32768X.

10.3.2 T_Config

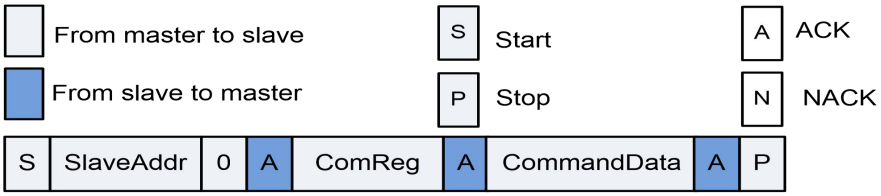


Register=0XA7
Config_Data:

Address	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	default
0xA7	T_CONFIG	RW		No change				OSR_T<2:0>			OTP

OSR_T: set the over sampling ratio of the sensor signal conversion channel. 000:1024X, 001:2048X, 010:4096X, 011:8192X, 100:256X, 101:512X, 110: 16384X, 111:32768X.

10.3.3 Send Command



ComReg=0x30
CommandData:

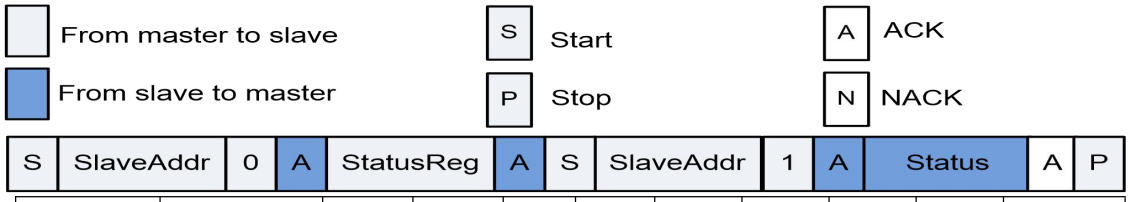
Address	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	default
0x30	CMD	RW	Sleep_time<3:0>				Sco	Measurement_ctrl<2:0>			OTP

Sleep_time<3:0>:0000:0ms, 0001:62.5ms,0010:125ms... 1111: 937.5ms, only active during sleep mode conversion.

Measurement_control<1:0>: 010b: indicate a combined conversion (once temperature conversion immediately followed by once sensor signal conversion).

Sco: 1, Start of conversion, automatically come back to 0 after conversion ends (except sleep mode conversion).

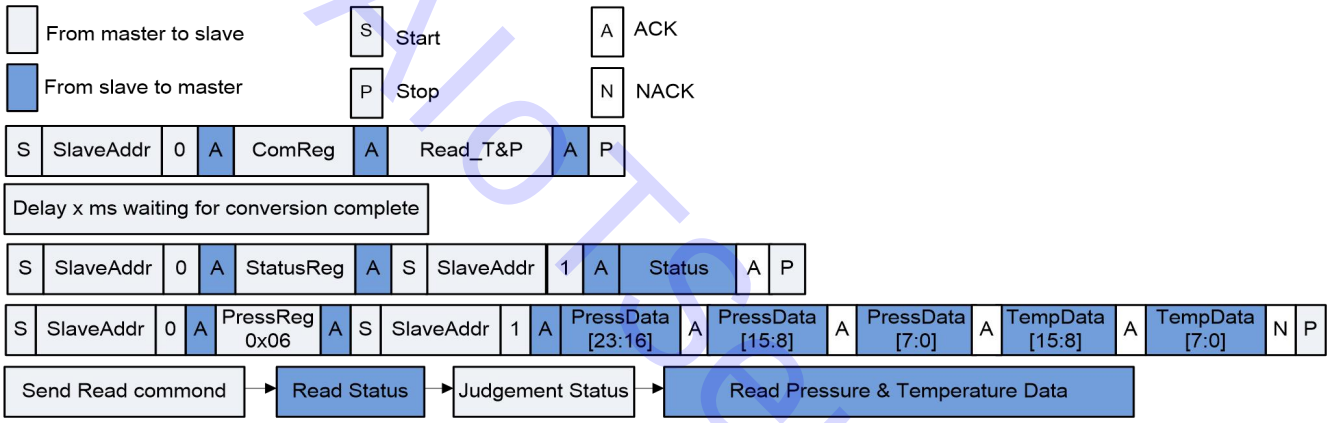
10.3.4 Read Status



Address	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0x02	Status	R					1'b0			RDY

DRDY: 1, indicates once conversion complete, and the output data is ready for reading.

10.3.5 Read the Pressure & Temperature



10.3.6 Calculate Pressure and Temperature

Pressure ADC bits are 24 bits 2's complement. Data format: the highest bit is the sign bit (0 is a positive number, 1 is a negative number), 23 data bits. In the 23-bit data bits, there are high N integer bits, and the low n bits are decimal bit, read the ADC number and convert it to Pa. The formula is:Pressure = Read_ADC value/2^n,the value of n as below:

range	250Pa	500Pa	1kPa	2kPa	3~4kPa	5~8kPa	9~16kPa	17~32kPa
n	15	14	13	12	11	10	9	8
range	33~65kPa	66~100kPa	2Bar	3~5Bar	6~10Bar	11~20Bar	21~40Bar	45~86Bar
n	7	6	5	4	3	2	1	0

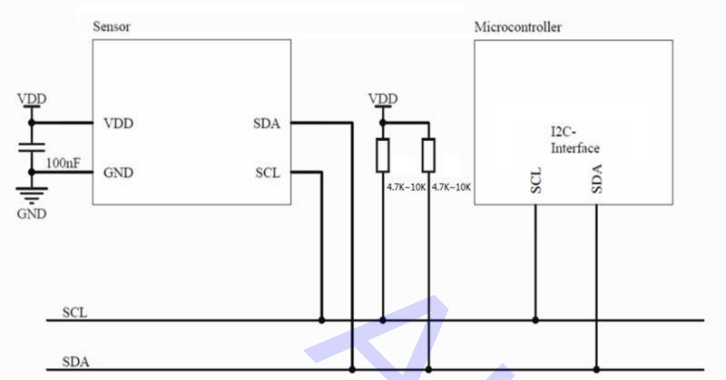
Temperature ADC bits are 16 bits 2's complement.Data format: the highest bit is the sign bit (0 is a positive number, 1 is a negative number),15 data bits. The high 7 bits are integer bits,the low 8 bits are decimal bits,equals to (1/256) °C.

$$\text{Pressure(Pa)} = \left(\frac{\text{Read\_PADC[23:0]}}{2\text{^}n}\right)$$

$$\text{Temperature(℃)} = \left(\frac{\text{Read\_TADC[15:0]}}{256}\right)$$

11. Application Circuit

11.1 I²C Interface



11.2 Pin Configuration and Description

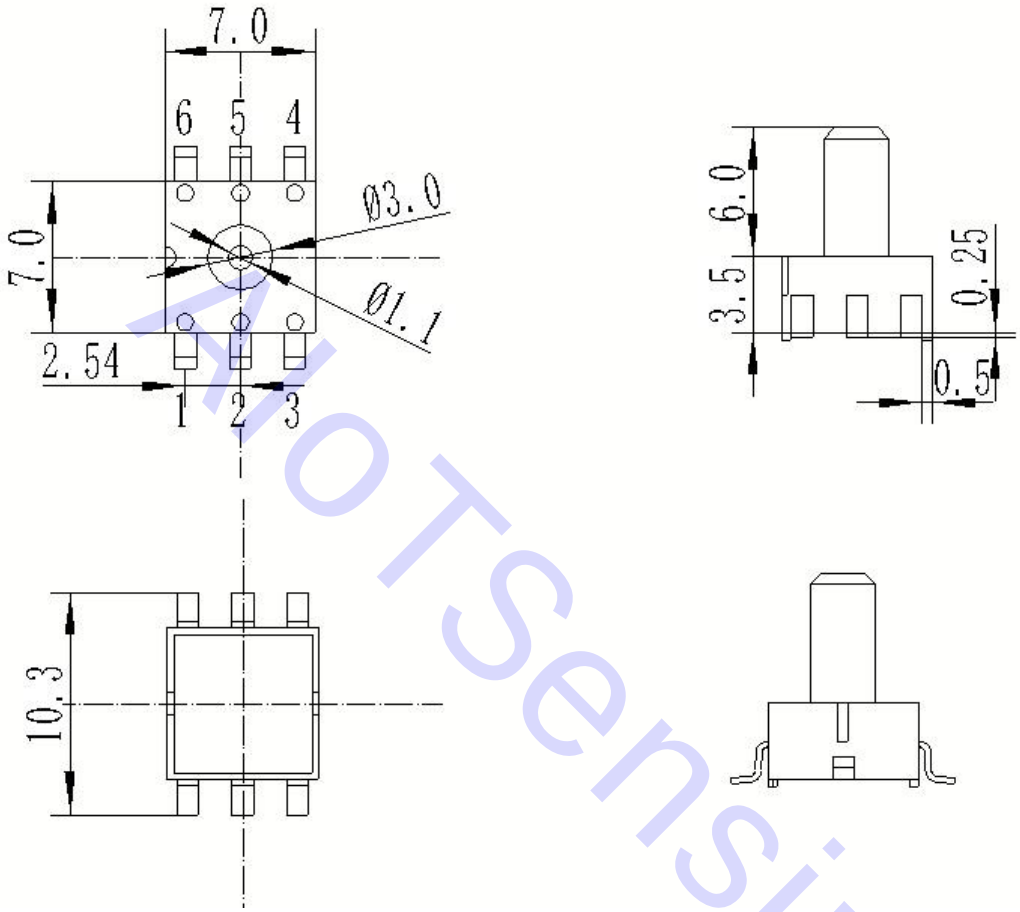
Pin	Name	Type	Function
1	GND	G	Power Ground
2	VDD	P	Positive supply voltage
3	NC	NC	Not Connect
4	SDA	I/O	Serial data input/output in I2C mode (SDA)
5	SCL	I	Serial data clock
6	GND	G	Power Ground

NOTE:

• Do not connect to NC pins.

12. Package Outline (SOIC16 mm)

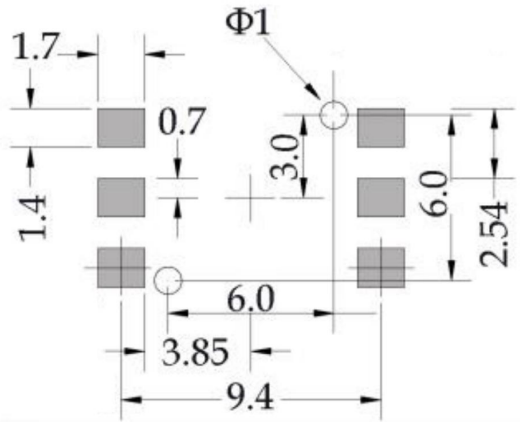
12.1 AS60



NOTES:

• All dimensions in units of [mm]

12.2Recommended Pad Layout (unit: mm)



13.Packing Options

TUBE

Real

14.How to Order

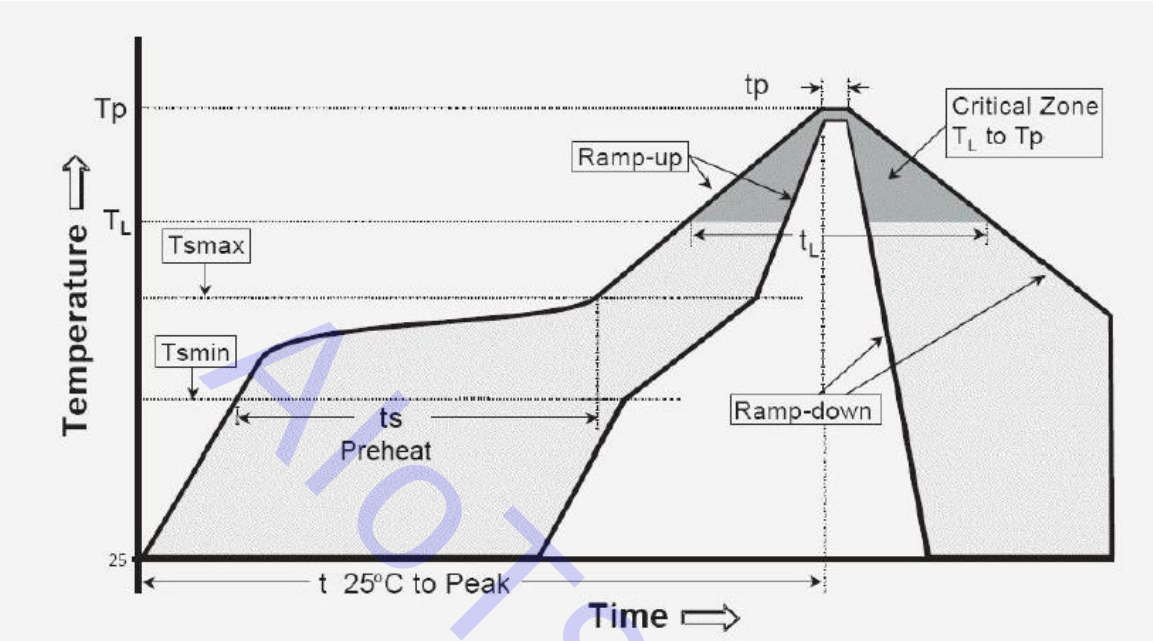
Refer to Table 5 for standard part numbers offered which includes the pressure range and package.
Example P/N with options: AS60-010KG-C00

Table 5 - Part Numbering Scheme:

AS60	-	001	B	D	C

Product Series		Pressure Range	Pressure Unit	Pressure Type	Compensation Temperature
			B bar	D Negative & Positive pressure	C:0~50
			K kPa	G Gage	S:-20~60
				N Negative pressure	T:Customer customization

15. 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.
5) If partial lots are used, the remaining sensors must be resealed or placed in safe storage within 1 hour of bag opening. If 1 hour is exceeded, the taped parts should be removed from the reel and baked at 60'C for 2 hours.

16.Sensor Reading

```
void Read_AIOT_Sensor(void)
{
        u32 PressData;
        u32 TempData;
        u8 Status = 0x00;
        u8 Read_Data[7] = {0x00};
        IIC_Init();
       delay_ms(50);
       IIC_Start();
       IIC_Send_Byte(0xda);//0xda//0xd8
       IIC_Wait_Ack();
       IIC_Send_Byte(0x30);
       IIC_Wait_Ack();
       IIC_Send_Byte(0x0A);//PT_Read
       IIC_Wait_Ack();
       delay_ms(100);
      IIC_Stop();//
       IIC_Start();
       IIC_Send_Byte(0xda);
       IIC_Wait_Ack();
       IIC_Send_Byte(0x02);
       IIC_Wait_Ack();
       IIC_Start();
       IIC_Send_Byte(0xdb);//0xdb//0xd9
       IIC_Wait_Ack();
       Read_Data[0]=IIC_Read_Byte(1);
       IIC_Wait_Ack();
       IIC_Stop();
       Status = Read_Data[0];
       if(Status & 0x01)
       {
                IIC_Start();
                IIC_Send_Byte(0xda);
                IIC_Wait_Ack();
                IIC_Send_Byte(0x06);
                IIC_Wait_Ack();
                IIC_Start();
                IIC_Send_Byte(0xdb);
                IIC_Wait_Ack();
                 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);//TEMPERATURE15:8]
               Read_Data[5] = IIC_Read_Byte(1);//TEMPERATURE[7:0]
                IIC_Stop();
                PressData = (Read_Data[1]<<16)|(Read_Data[2]<<8)|Read_Data[3];
                TempData  = (Read_Data[4]<<8)|Read_Data[5];
        }
}
```

17.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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Appendix

1.Environment requirement

1) Please avoid places where there are corrosive gases (organic solvent gas, sulfurous acid gas, hydrogen sulfide gas, etc.) that have adverse effects on the product It shall be used in and kept.
2) This product is not drip proof, so please do not use it in places where it may be splashed with water.
3) Do not use in the environment that produces condensation. In addition, when the moisture attached to the sensor chip freezes, the sensor output may change move or destroy.
4) When the chip of the pressure sensor is exposed to light in structure, the output will change. Especially when applying pressure through transparent sleeve, please avoid the light touches the chip of the sensor.
5) Please avoid using methods such as ultrasonic wave to impose high-frequency vibration.

2.Attention

1) If the pressure range and installation method are wrong, accidents may occur, so please pay attention.
2) The only pressure medium that can be used directly is dry air. Other media, especially in corrosive gas (organic solvent gas, sulfurous acid gas, hydrogen sulfide gas, etc.) and media containing water and foreign matters will cause failure and damage when used, so please avoid the above environment use.
3) The pressure sensor chip is arranged inside the pressure inlet. Inserting foreign matters such as needles from the pressure inlet will cause chip damage and inlet blockage plug, so please absolutely avoid the above operation. In addition, avoid blocking the air inlet when using.
4) For the working pressure, please use it within the range of rated pressure. Damage may occur when used outside the scope.
5) Due to the damage caused by static electricity, please pay attention to the following items when using.

- During storage, please use conductive materials to short circuit terminals, or use aluminum foil to cover them as a whole. Because plastic containers are easily charged,therefore, do not use it during storage and transportation.
- When using, please ground the live objects on the table and the operators to make the surrounding static electricity discharge safely.

6) According to the pressure used, please pay full attention to the fixation and casing of the product, and the fixation and selection of the inlet pipe. In addition, if you have any questions, please contact us.