

DATASHEET
ASC31SERIES

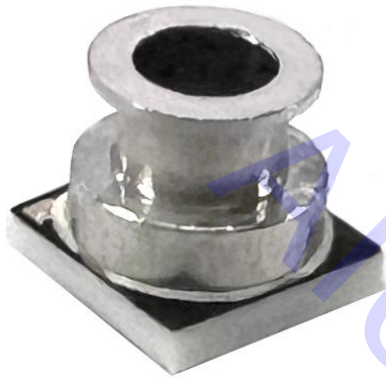
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History of Revision

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1. Features

- Pressure ranges from 0 to 20Bar
- Absolute 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 3.1mm x 3.1mm x 2.7mm
- Ceramic - metal Package

2. Applications

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

3. Descriptions

The ASC31series 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 stainless-steel 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

Absolute Pressure Type Products			
Device	Operating Range	Proof Pressure	Burst Pressure
ASC31-01BA	0~1BA	2XFSS	3XFSS
ASC31-02BA	0~2BA	2XFSS	3XFSS
ASC31-05BA	0~5BA	2XFSS	3XFSS
ASC31-07BA	0~7BA	2XFSS	3XFSS
ASC31-10BA	0~10BA	2XFSS	3XFSS
ASC31-14BA	0~14BA	2XFSS	3XFSS
ASC31-20BA	0~20BA	2XFSS	3XFSS

5. Performance Characteristics

5.1 Pressure

Parameter	Min	Typ	Max	Units	Specification Notes
Accuracy		±0.3		%FSS	@25°C
Total error band			±1.00	%FSS	TEB@(-25~60°C)
Response time@ OSR=1024		3.0*2		ms	
Long term stability		±0.1		%FSS/yr	

NOTE:

- 1.Accuracy:Include linearity , pressure hysteresis errors, and repeatability.
- 2.TEB : 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.

5.2Temperature

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Temperature Range	TOP		-40	25	85	°C
Temperature Absolute Accuracy		-20~60°C		±0.5		°C
Temperature Resolution				0.01		°C

6. Block Diagram

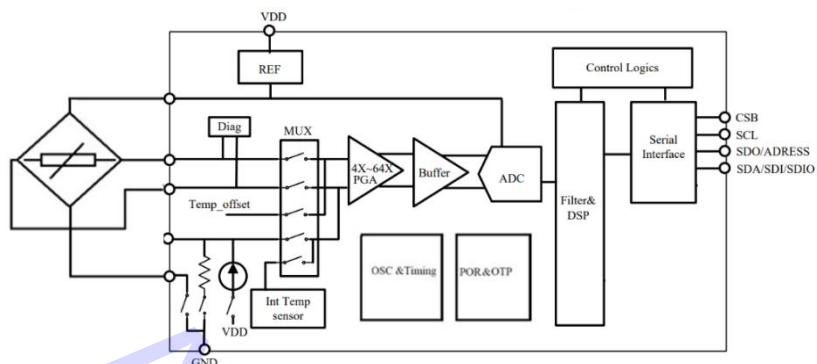


Figure 1: Functional Block Diagram

7. Electrical Specifications

7.1 Electrical Characteristics

Table 7.1: DC Characteristics @VDD=3.3V, T=25°C unless otherwise noted

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Supply Voltage	VDD			3.3		V
Operation Temperature	T _{OP}		-40		85	°C
Compensated Temperature	T _{CO}		-10		60	°C
Supply Current @25°C on during conversion	I _{BDD_pga on}	PGA on (Gain>=4)		1.8	2.5	mA
Conversion time	T _C	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.)	I _{DD}	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}	At 25°C		0.1	0.2	μA
Serial Data Clock Frequency	f _{SCLK}	I ² C protocol SPI protocol		100 10	400 MHz	kHz
Digital Input High Voltage	V _{IH}		0.8			V
Digital Input Low Voltage	V _{IL}				0.2	V
Digital Output High Voltage	V _{OH}	I _O =0.5mA	0.9			V
Digital Output Low Voltage	V _{OL}	I _O =0.5mA			0.1	V
Input Capacitance	C _{IN}			4.7		pF

7.2 Absolute Maximum Rating

Table 7.2: Absolute Maximum Rating

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	VDD		-0.3		5.5	V
Interface Voltage	VIF		-0.3		VDD+0.3	V
Storage Temperature Range	TSTG		-40		125	°C
ESD Rating		Human body model	-2		+2	kV
Latch-up Current		At 85°C	-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 ASC31series consists of a piezo-resistive sensor and a sensor interface I²C. The main function of the I²C 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 ASC31provides I²C 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	SPI_Ctrl	RW	SDO_active	LSB_first	Softreset			Softreset	LSB_first	SDO_active	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

SDO_active: 1: 4-wire SPI, 0: 3-wire SPI

LSB_first: 1: LSB first for SPI interface, 0: MSB first for SPI interface

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 $(1/2^{23}) \times (V_{EXT-PSW})$. 24 bits calibrated data when 'raw_data_on' = 1.

Reg0x09-Reg0x0a

Temp_out: Temperature output with an LSB equals to $(1/256) ^\circ\text{C}$

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	
0xa9		R	Range value n [7:0]								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	I ² C			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 _{BBUF}		1.3			μs

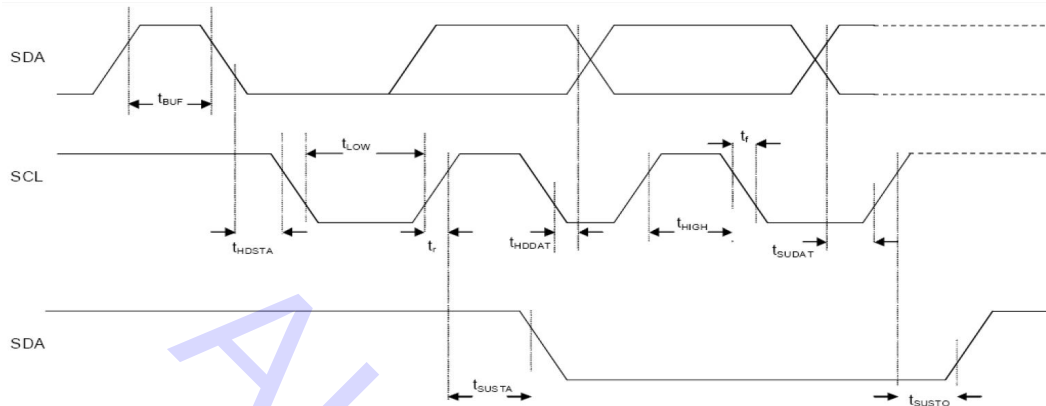


Figure 2: I²C Timing Diagram

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.

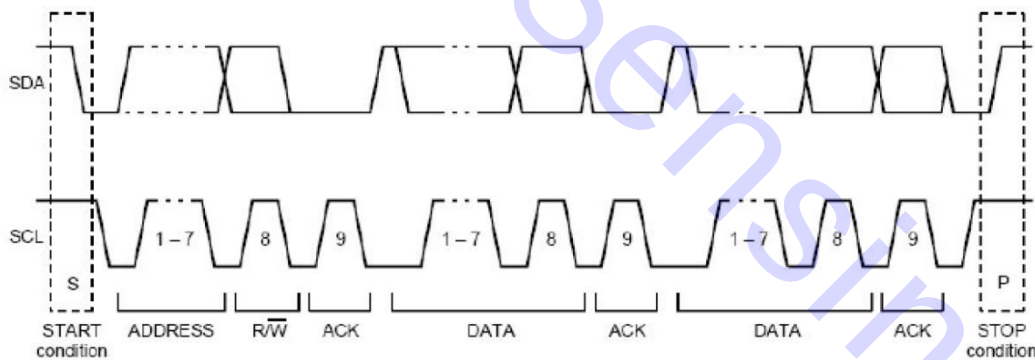


Figure 3: I²C Protocol

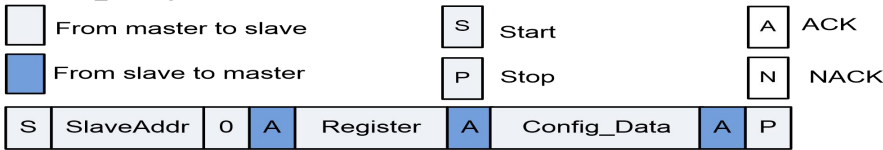
10.2 I²C Device Address

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 I²C Protocol

10.3.1 P_Config



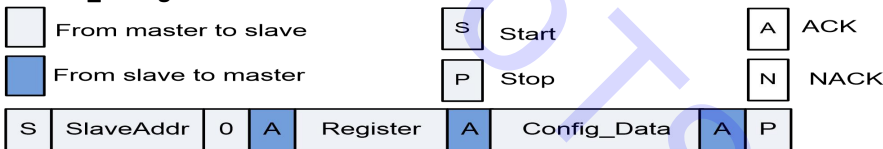
Register=0xA6

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



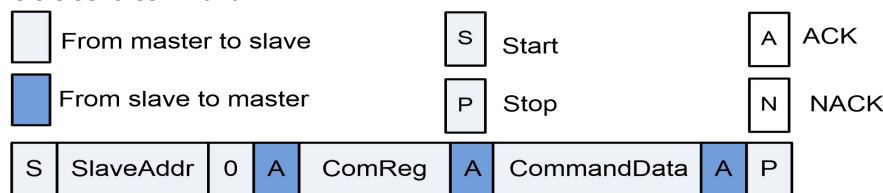
Register=0xA7

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:

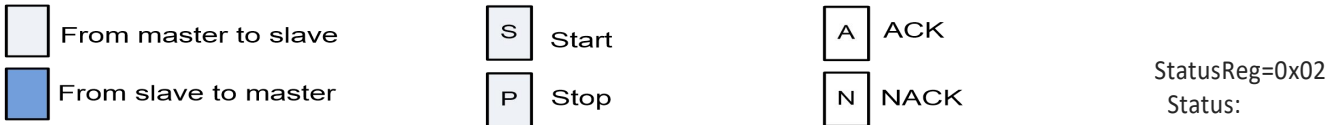
Address	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	default
0x30	CMD	RW	Sleep_time<3:0>				Sco	Measurement_ctrl<2:0>			OTP

Sleep_time<3:0>:0000:0ms, 0001:62.5ms,0010:125ms... 1111: 1s, 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).

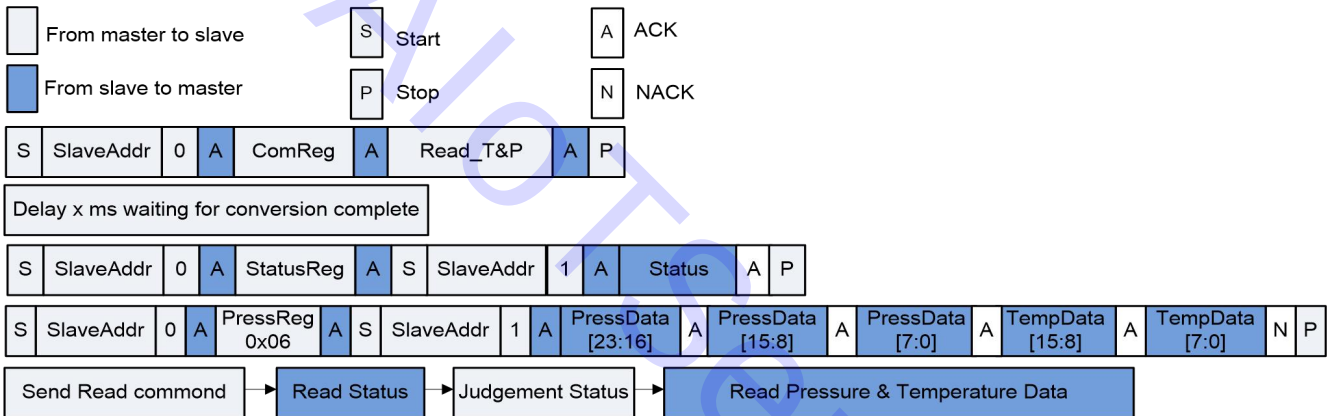
10.3.4 Read Status



S	SlaveAddr	0	A	StatusReg	A	S	SlaveAddr	1	A	Status	A	P
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/2ⁿ, the n value is stored in register 0xa9.

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

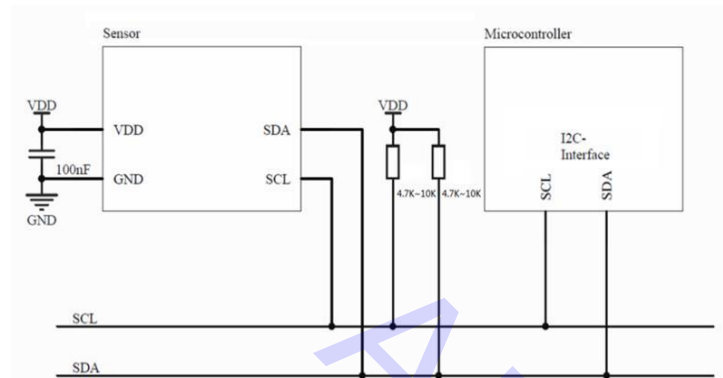
range	250Pa	500Pa	1kPa	2kPa	3~4kPa	5~8kPa	9~16kPa	17~32kPa
n	15	14	13	12	11	10	9	8
range	33~65kPa	66~100kPa	2Bar	3~5Bar	6~10Bar	11~20Bar	21~40Bar	45~86Bar
n	7	6	5	4	3	2	1	0

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.

$$\text{Temperature(°C)} = \left(\frac{\text{Read_TADC}[15:0]}{256} \right)$$

11. Application Circuit

11.1 I²C Interface



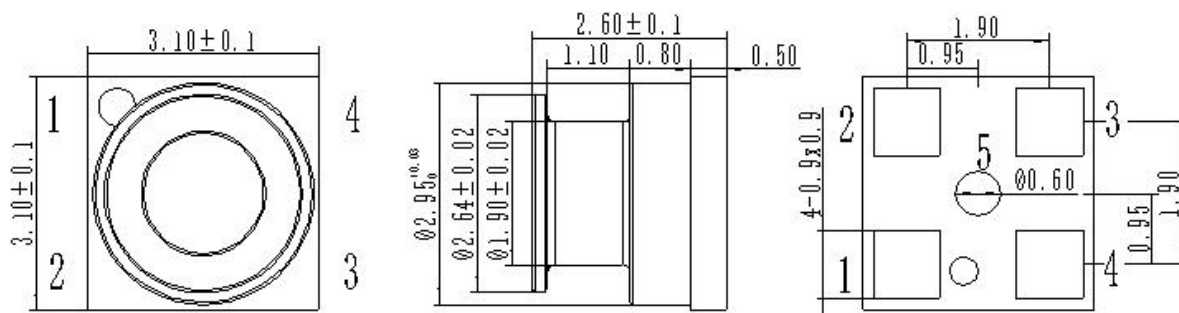
11.2 Pin Configuration and Description

Pin	Name	Type	Function
1	GND	G	Power Ground
2	VDD	P	Positive supply voltage
3	SCL	I	Serial data clock
4	SDA	I/O	Serial data input/output in I2C mode (SDA)
5	INT	O	Interrupt Output(Data ready)

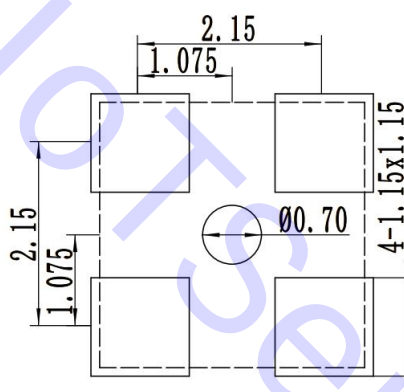
NOTE:

- Do not connect to NC pins.

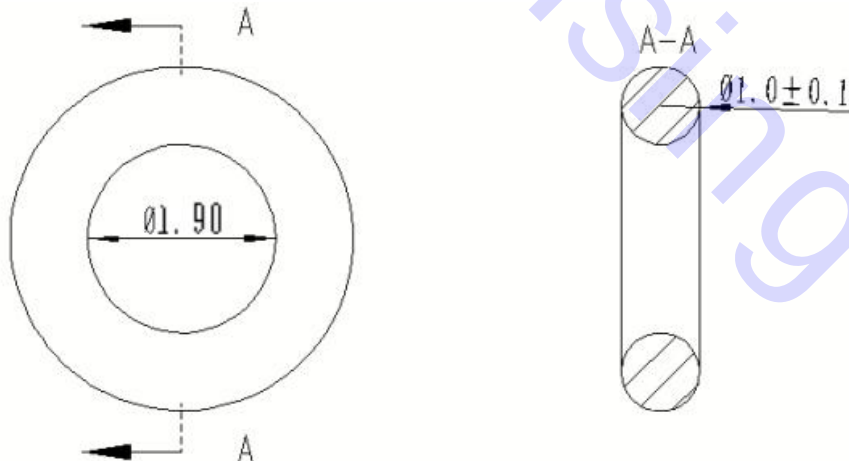
12. ASC31Package Outline (mm)



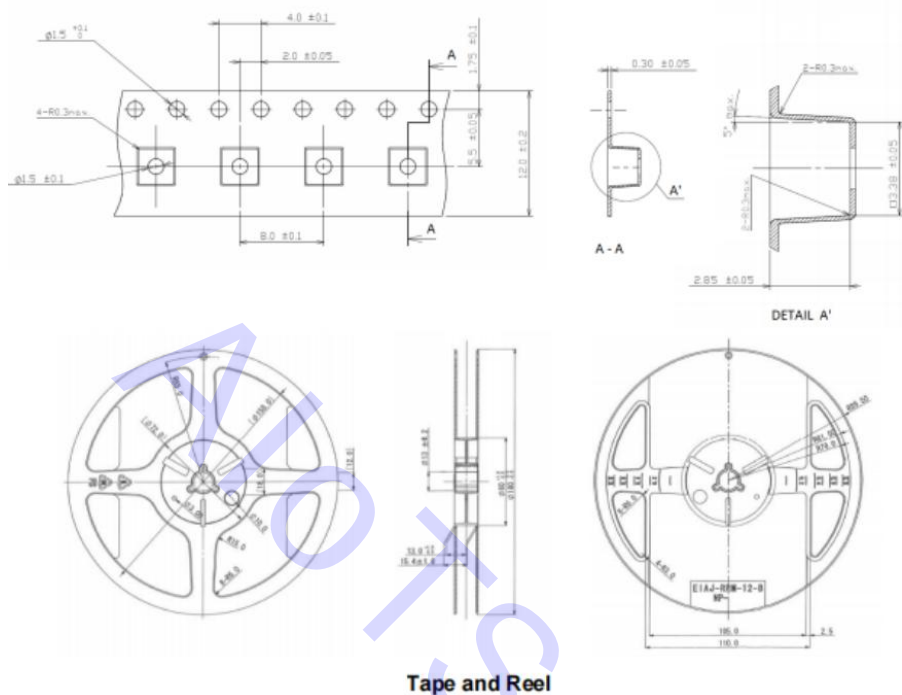
13. Recommended PCB Foot Print Layout (mm)



14. Recommend to the "O" ring (mm)



15.Packing Options



16.How to Order

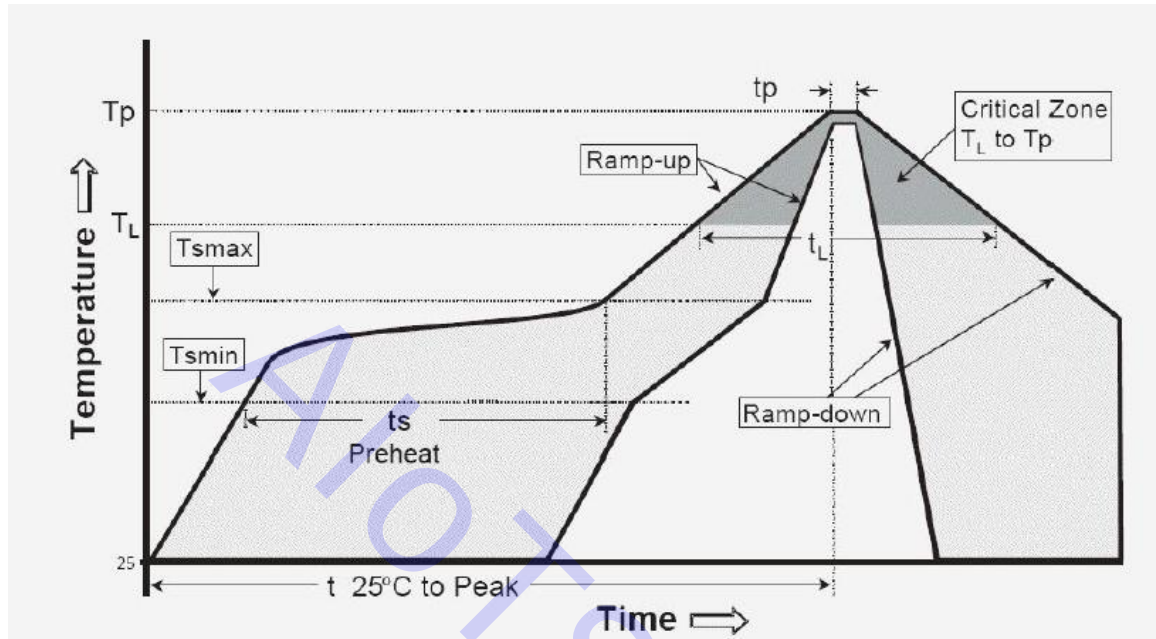
Refer to Table 5 for standard part numbers offered which includes the pressure range and package.

Example P/N with options: ASC31-01BA-W10

Table 5 - Part Numbering Scheme:

ASC31	-	01	B	A-	W	10	C
Product Series		Pressure Range	Pressure Unit	Pressure Type		Customer code	Temp.
			B bar	A Absolute	G Gas		C: 0~50°C
	-				W Water proof		S: -20~60°C
					C Corrosion Proof		T:TBD

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



IPC/JEDEC J-STD-020D	Pb-Free Assembly
Average Ramp-up rate (TL-Tp)	3°C/s (Max.)
Preheat	
–Temperature Min. (Tsmín)	140°C
–Temperature Max. (Tsmáx)	170°C
–Time (Min. to Max.) (ts)	60-180 seconds
Tsmáx to TL –Tp	3°C/s (Max.)
Time maintained above:	
–Temperature (TL)	200°C above
–Time (tL)	60-150 seconds
Peak temperature (Tp)	200~220°C
Time of Real peak temperature within 5°C (tp)	40 seconds
Average Ramp-down rate (Tp-TL)	6°C/s (Max.)
Time 25°C to peak temperature	8min. (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.

18.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(0);
    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); // TEMPERATURE[15:8]
        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];
    }
}
```

19.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 A:Recommended communication level conversion circuit.

