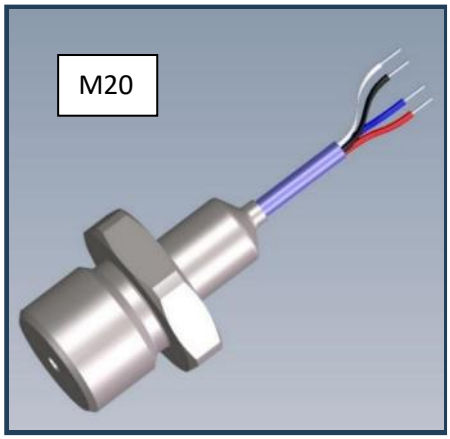
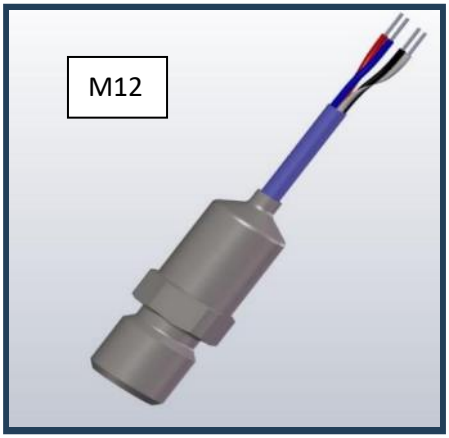
DATASHEET

ASP001 TRASDUSER SERIES





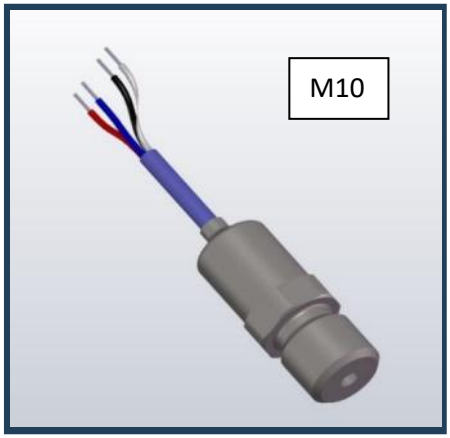


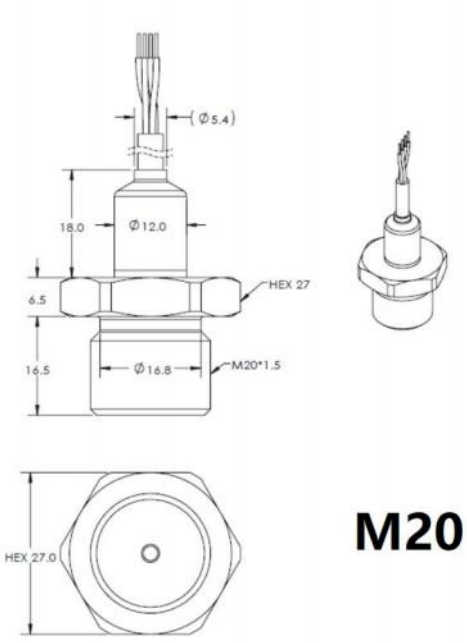
Figure 1

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

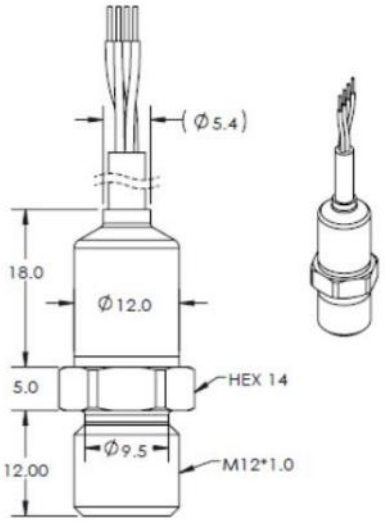
1. HISTORY OF REVISION

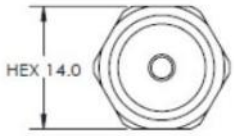
REV No.	DATE	REVISION NOTES
0.0	NOV-29/2022	Initial Release
0.1	JUL -15/2023 -	Added M10 and M12 product photos & dimension drawings Modified ASIC Data format information

2. Dimension Drawing

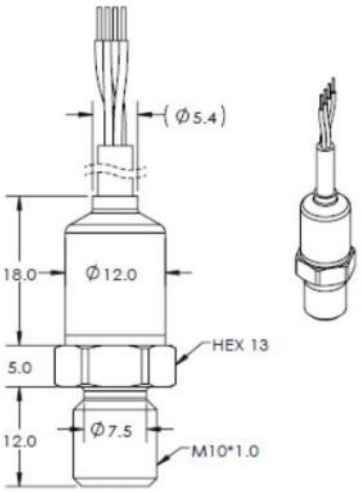


M20





M12



M10

3. Standard Pressure Range

Gage Pressure Type Products			
Device	**Operating Range**	**Proof Pressure**	**Burst Pressure**
ASP001-100-	0~1.0MPa	2.0MPa	3.0MPa
ASP001-160-	0~1.6MPa	3.0MPa	4.0MPa
ASP001-250	0~2.5MPa	4.0MPa	5.0MPa
ASP001-XXX	Custom built pressure ranges		

4. Performance Characteristics（Compensation Temperature , from 0℃ to 60 ℃）

Parameter	Min	Typ	Max	Units	Specification Notes
Accuracy			±1.0	%FSS	@(0~60)°C
Total error band			±2.0	%FSS	TEB@(-20~85)°C
Response time@ OSR=1024		3.0*2		ms	
Long term stability		±0.1		%FSS/yr	
Operating Temperature Range	-20		85	° C	

NOTE:

1.Accurcay: Includes- linearity, pressure hysteresis errors, and repeatability.

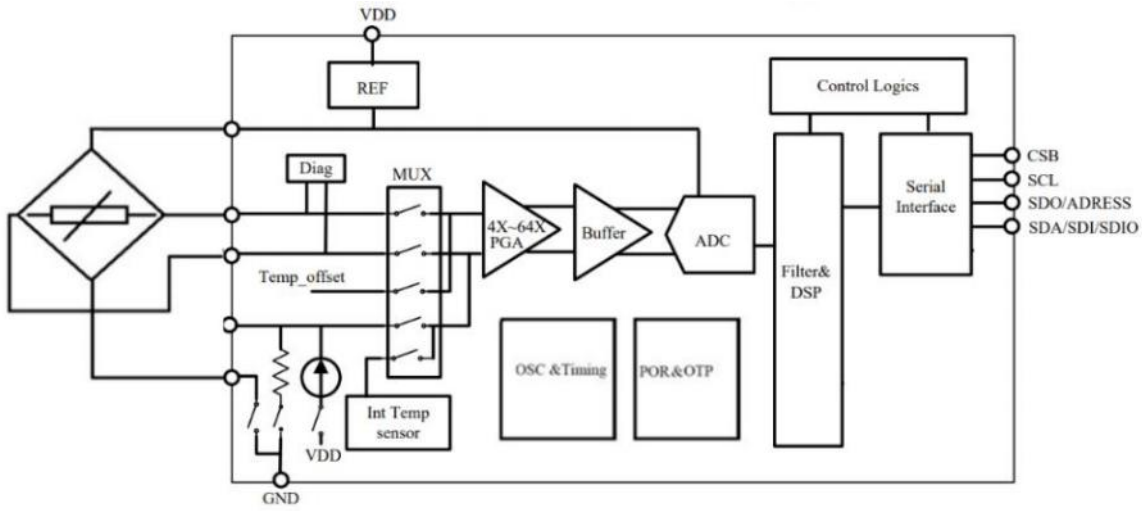
2.TEB: Total error band consists of offset and span temperature and calibration errors, linearity and pressure hysteresis errors, offset warm-up shift and offset position sensitivity errors.

5. Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{DD}		2.5		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.

6. Block Diagram



7. Electrical Specifications

DC Characteristics @VDD=3.3V, T=25℃ unless otherwise noted

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Supply Voltage	V_{DD}		2.5	3.3	5.0	V
Operation Temperature	T_{OP}		-20		85	℃
Compensated Temperature	Tco		0		60	℃
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

8. Function Descriptions

8.1 General Description

The ASP005 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 ASP005 Provide I^2C interface.

9. Registers

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 Registers

Addr	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default
0x00	SPI _Ctrl	RW			Softreset			Soft reset			0x00
0x01	Part_ID	R	PartID								0x00
0x02	Status	R							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.
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

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

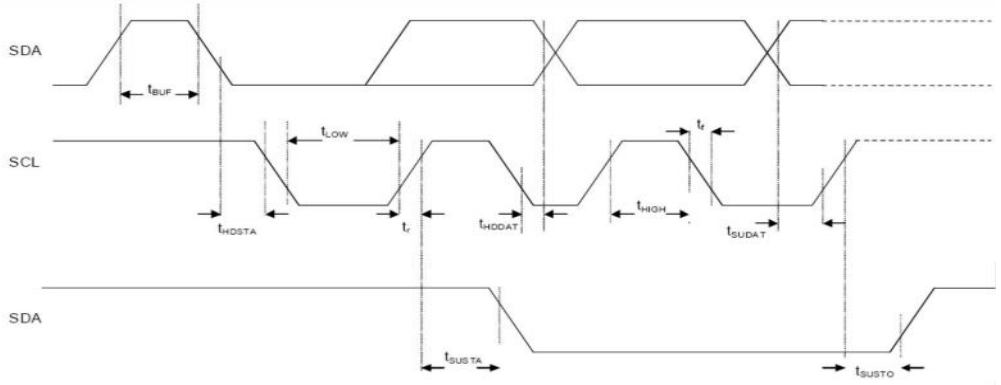
10. High-Speed I²C Digital Output Interface

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



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.

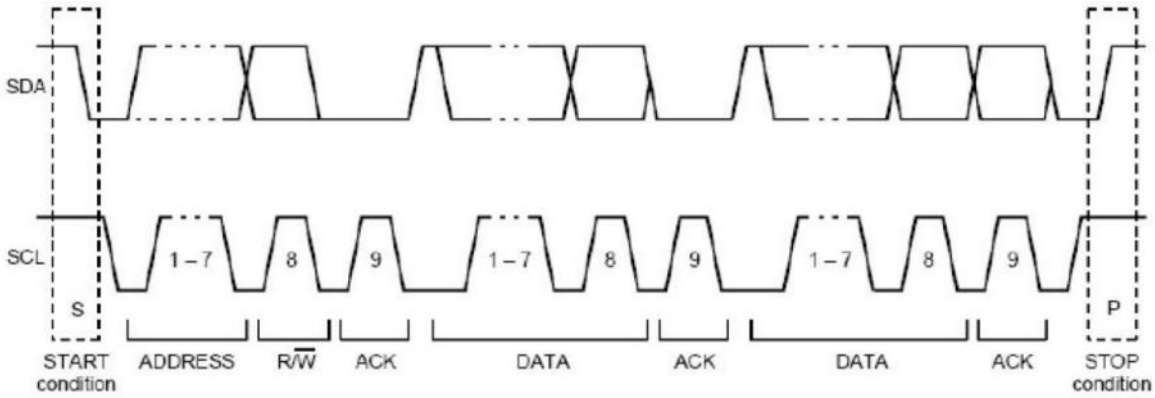


Figure 3: I²C Protocol

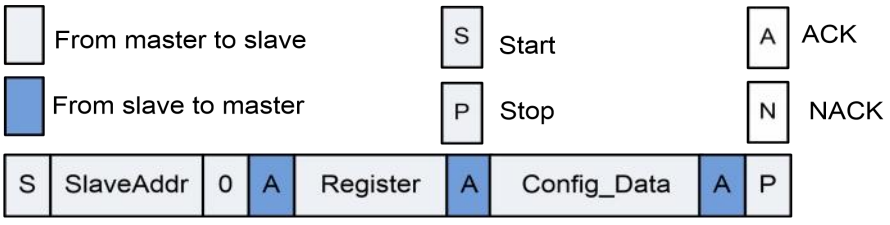
10.2 I²C Device Address

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 Device Protocol

10.3.1 P_Config

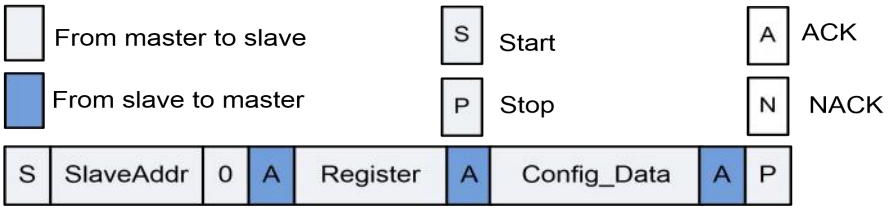


Register=0XA6
Config_Data:

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

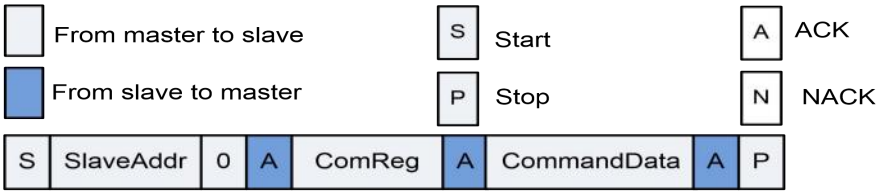


Register=0XA7
Config_Data:

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



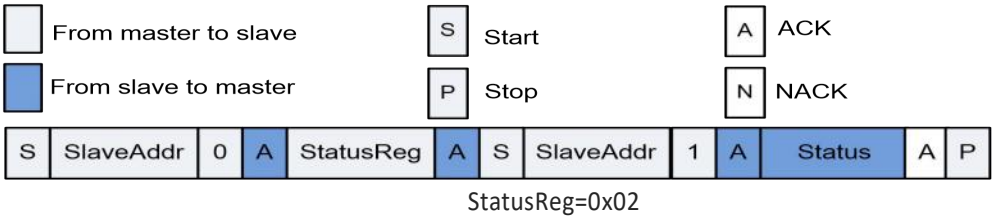
ComReg=0x30
CommandData:

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



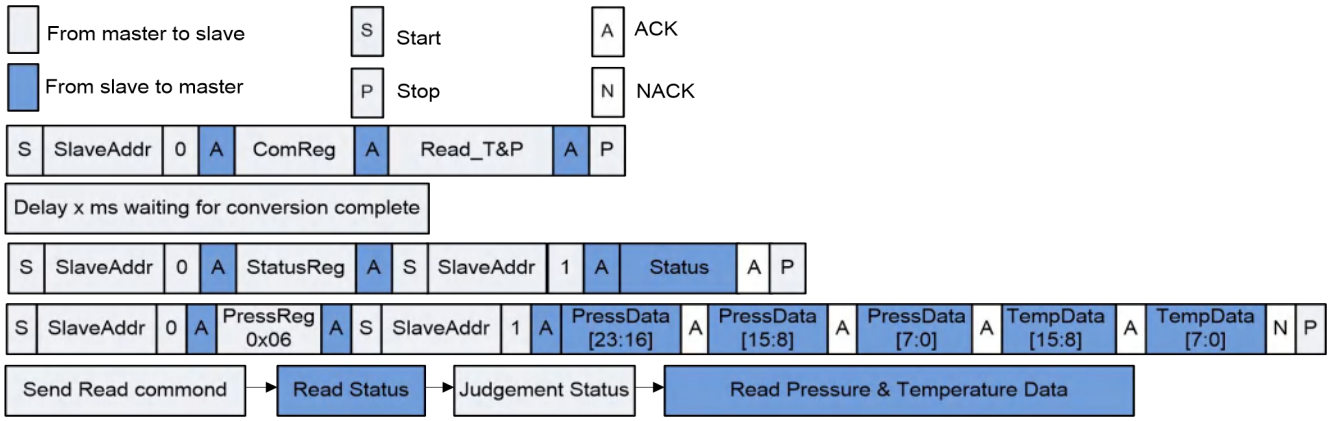
StatusReg=0x02

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:

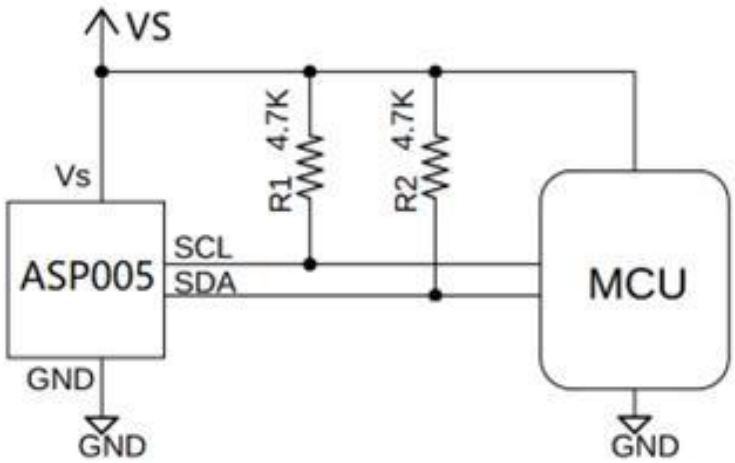
$$\text{Pressure(Pa)} = \left(\frac{\text{Read\_PADC[23:0]}}{2\text{^}n}\right)$$

RANGE	6-10bar	11-20bar	21-40bar	41-86bar
n	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.

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

11. Recommended Circuit



12. **How to order**

ASP001	X	X	XXX	X	X	X	X
PN series	Output	PORT	Range	Unit	Type	PORT material	Port material
ASP001	K: SPI L: I² C	L: E-M10*1.0 M: E-M12*1.5 N: M20*1.5	100 = 1 160 = 1.6 250 = 2.5 350 = 3.5	J: MPa	G: Gage S: Seal Gage	A: Wire Output B: Packard	V: 304

13. **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];
        }
}
```

14. **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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