NSPGD1M Series
Integrated Gauge Pressure Sensor
Datasheet (EN) 2.0

Product Overview

NSPGD1M series are calibrated gauge pressure sensor which combines state-of-art MEMS sensor technology and CMOS mix-signal processing technology to produce an amplified, fully conditioned, multi-order pressure and temperature compensated sensor in a Double In-line Package (DIP) with tube port. NSPGD1M series pressure sensor is target for household electric appliances and the small kitchen and bathroom home-appliances. Combining the pressure sensor with a signal conditioning ASIC in a single package simplifies the use of advanced silicon micromachined pressure sensors. The pressure sensor can be mounted directly to a standard printed circuit board and an amplified, high-level, calibrated pressure signal can be acquired from the digital interface or analog/frequency output. This eliminates the need for additional circuitry, such as a compensation network or micro-controller containing a custom correction algorithm. NSPGD1M series are designed for operating pressure ranges of -10kPa ~ 10kPa Gauge, very suitable for household electronics such as washing machine and dishwasher.

Key Features

- Custom range -10kPa~10kPa
- High accuracy

  Total error band initially better than ±1.5%F.S.

  Full life accuracy better than ±2.5%F.S.
- Temperature range 0~70°C
- Ratio-metric/Absolute analog output
- 24bit I^2C output
- Frequency output
- Front side of the chip enters the gas, not easing to block
- Waterproof and moisture-proof treatment inside
- RoHS & REACH Compliance

Applications

- Washing machine
- Dishwasher, water purifier
- Air bed, massage chair
- Smart sphygmomanometer, oxygen generator
- Industrial control
- IoT pressure detection

Device Information

Part Number	Package	Body Size
NSPGD1M	DIP8	10.4mm*10.4mm

Outline

INDEX

1. Pin Configuration and Functions

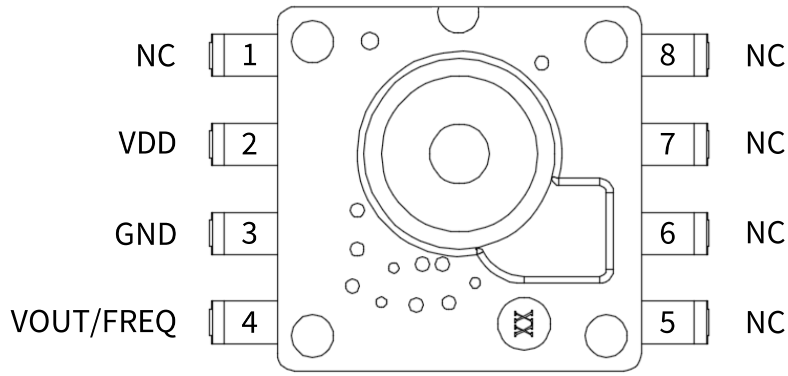


Figure 1.1 NSPGD1M Analog/ Frequency Output Pin Definition (top view)

Table 1.1 Analog/ Frequency Output Pin Description

Pin NO.	Pin Name	Description
1	NC	NC
2	VDD	Power supply
3	GND	Ground
4	VOUT / FREQ	Analog output / Frequency output
5	NC	NC
6	NC	NC
7	NC	NC
8	NC	NC

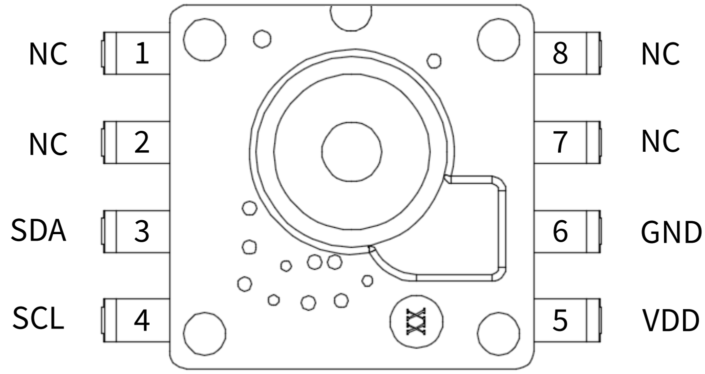


Figure 1.2 NSPGD1M Digital Output Pin Definition (top view)

Table 1.2 Digital Output Pin Description

Pin NO.	Pin Name	Description
1	NC	NC
2	NC	NC
3	SDA	I^2C data signal
4	SCL	I^2C clock signal
5	VDD	Power supply
6	GND	Ground
7	NC	NC
8	NC	NC

2. Absolute Maximum Ratings

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply voltage	VDD_{max}	-0.3		6.5	V	
Analog output current limit				25	mA	
Analog pin voltage		-0.3		VDD+0.3	V	
Proof pressure	P_{proof}	±30			kPa	
Burst pressure	P_{burst}	±50			kPa	
Storage temperature	T_{stg}	-40		105	°C	

3. ESD Ratings

Ratings		*Value*	*Unit*
Electrostatic discharge	Human body model (HBM), per AEC-Q100-002-RevE	±2	kV
	Charged device model (CDM), per AEC-Q100-011-RevD	±500	V
	Latch up (LU), per JESD78D	±100	mA

4. Recommended Operating Conditions

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply voltage	VDD	3	3.3	3.6	V	Analog output Digital output
		4.5	5	5.5		
		4.8	5	5.2		Frequency output
Operating pressure	P_{amb}	-10		10	kPa	
Operating pressure range	P_{range}	2		20	kPa	P_{max} - P_{min}
Operating temperature	T_{opr}	0		70	°C	

5. Specifications

5.1. Electrical Characteristics

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Operating current	I_{avdd}	1.8	2.5	3	mA	Analog/ Frequency output
			0.3	30	uA	Standby mode in digital output
Accuracy [1,2,3,4,5]	ACC	-1.5%		1.5%	%FS	Initially accuracy
		-2.5%		2.5%	%FS	Full life accuracy
ADC resolution	RES_{RAW}		24		Bits	
PSRR	PSRR	90	120		dB	
DAC resolution			12		Bits	
Output load resistance	R_{load}	1			kOhm	Analog output
Output load capacitance	C_{load}			15	nF	Analog output
Response time	T_{RESP}		4		ms	
EEPROM data retention	T_{live}	10			years	@125°C

1. Accuracy includes non-linearity, temperature, pressure hysteresis, temperature hysteresis.
2. Full life accuracy based on the part number NSPGD1M002RT02 500 hour HTOL, LTOL, HTSL, THB and TCT testing.
3. For pressure accuracy of different part number, please refer to complete part number list at chapter 9. Unless otherwise specified, the accuracy is based on typical operating voltage.
4. The ratiometric analog output also include ±0.5% ratiometric error. The ratiometric error is defined as the difference between the ratio that VDD changed and the ratio that VOUT changed. Ratiometric signal error is not included in the overall accuracy. Absolute analog output and I^2C output are not applicable.
5. The analog and frequency outputs have an output stabilization time of 1 minute after power-up. Initial accuracy and full-life accuracy calculations are based on output stabilization data.

5.2. I²C Timing Diagram

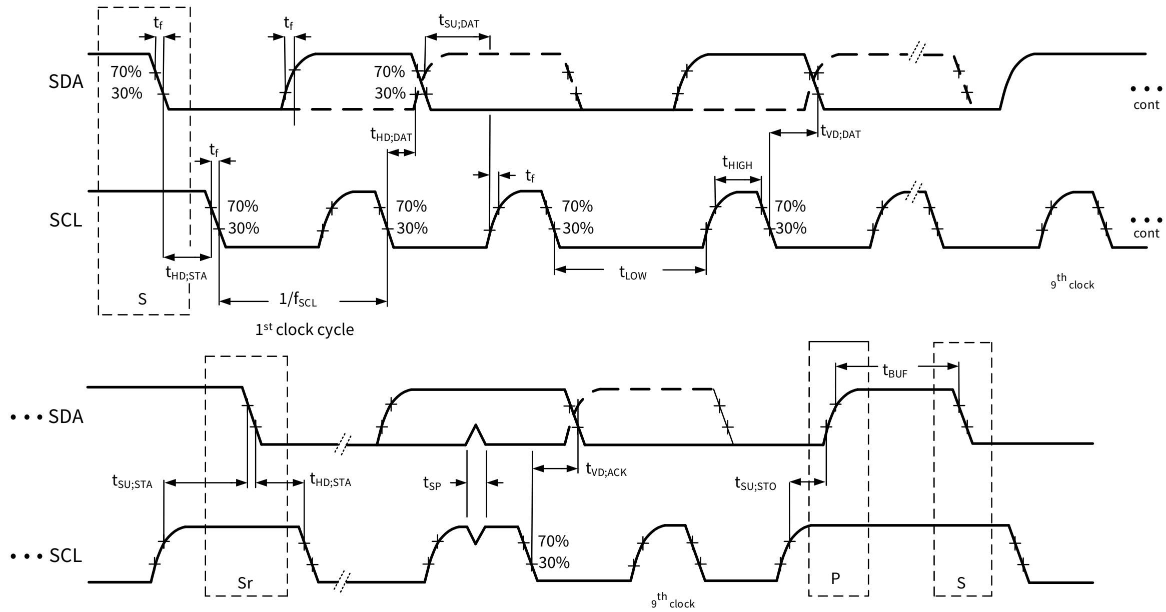


Figure 5.1 I²C Timing Diagram

5.3. I²C Electrical Characteristics

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Clock frequency	f_{scl}			400	kHz	
SCL low pulse	t_{LOW}	1.3			μs	
SCL high pulse	t_{HIGH}	0.6			μs	
SDA setup time	t_{SUDAT}	0.1			μs	
SDA hold time	t_{HDDAT}	0.0			μs	
Setup time for a repeated start condition	t_{SUSTA}	0.6			μs	
Hold time for a start condition	t_{HDSTA}	0.6			μs	
Setup time for a stop condition	t_{SUSTO}	0.6			μs	
Time before a new transmission can start	t_{BUF}	1.3			μs	

6. Function Description

6.1. Overview

NSPGD1M uses a MEMS piezoresistive differential pressure sensor element as a pressure sensitive component that provide an original signal output that is proportional to ambient pressure. The built-in conditioning IC drives the sensitive component and amplifies, temperature compensates, and linearizes the original signal to output a signal that is linear with the applied pressure.

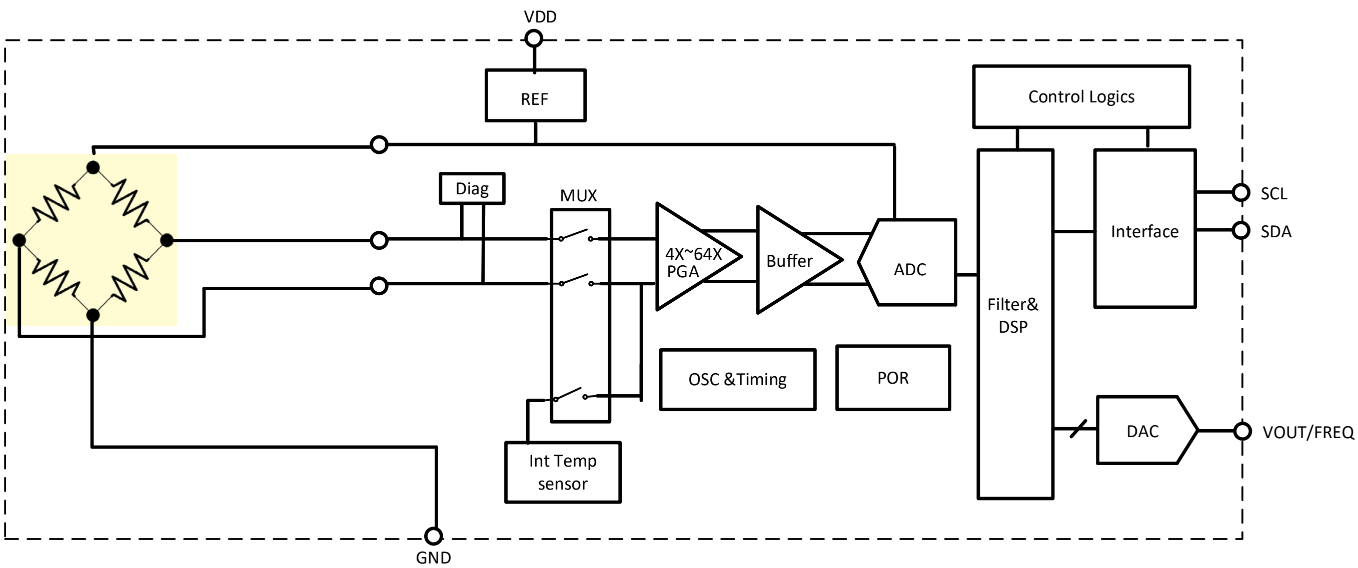


Figure 6.1 Product Function Block Diagram

6.2. Analog Output Transfer Function

$$VOUT = (A \times P + B) \times 5 \text{ @absolute analog output, VDD=5V}$$

$$VOUT = (A \times P + B) \times 3.3 \text{ @absolute analog output, VDD=3.3V}$$

$$VOUT = (A \times P + B) \times VDD \text{ @ratiometric analog output}$$

Note:

VOUT is the analog output, unit is V.

P is the pressure value, gauge pressure, unit is kPa/mmH2O.

Table 6.1 Analog Output Transfer Function Coefficient

Product NO.	Pressure Range		Output Range		Gain and offset	
	P_L	P_H	O_L	O_H	A	B
NSPGD1M002RT02	0kPa	2kPa	0.1*VDD	0.9*VDD	0.4	0.1

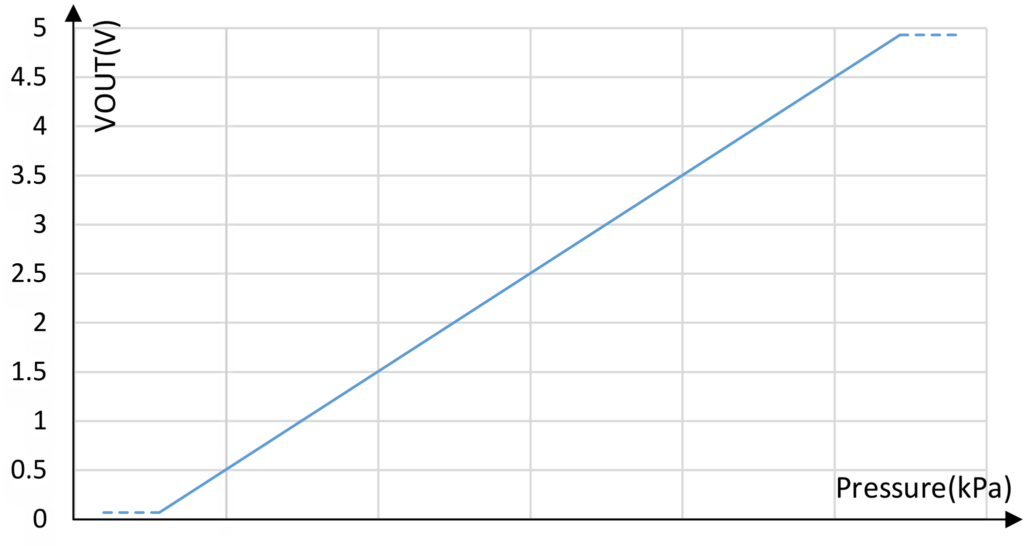


Figure 6.2 Analog Output Transfer Function

6.3. Digital Output Transfer Function

$$Code = (A \times P + B) \times 8388607$$

Code is the register 0x06~0x08 value.

P is the pressure value, gauge pressure, unit is kPa/mmH2O.

Table 6.2 Digital Output Transfer Function Coefficient

Product NO.	Pressure Range		Output Range		Gain and offset	
	P_L	P_H	O_L	O_H	A	B
NSPGD1M006DT04	0kPa	6kPa	838861	7549746	0.13333	0.1

Register Map:

Addr	Bit Addr	Description	Default	Description
0x30	7 – 4	Reserve	4’b0000	Write with 0x0A to start a conversion, automatically come back to 0x02 after conversion ends.
	3	Sco	1’b0	
	2 – 0	Measurement_ctrl<2:0>	3’b000	
0x06	7 – 0	PDATA<23:16>	0x00	Output Pressure Data. Code = Data0x06*2^{16}+ Data0x07*2^8+ Data0x08.
0x07	7 – 0	PDATA<15:8>	0x00	
0x08	7 – 0	PDATA<7:0>	0x00	

For example:

If the value of the registers 0x06、0x07、0x08 are 0x3F, 0xFF, 0xFF, according to NSPGD1M006DT04 transfer function, Code = 4194303, P(kPa) = (4194303/8388607-B)/A, and finally get the value of pressure about 3kPa.

6.4. Frequency Output Transfer Function

$$FREQ = (A \times P + B) \times F.S.$$

Note:

1) FREQ is the frequency output, unit is kHz.
2) P is the pressure value, gauge pressure, unit is kPa/mmH2O.
3) F.S. is the full scale of frequency output. The chip can be configured with four full-scale frequencies, which are 250kHz, 125kHz, 61.5kHz, and 31.25kHz.

Table 6.3 Frequency Output Transfer Function Coefficient

Product NO.	Pressure Range		Output Range		Gain and offset		Full Scale
	P_L	P_H	O_L	O_H	A	B	F.S.
NSPGD1M004FT12	0mmH2O	350mmH2O	3.125kHz	28.125kHz	0.002285714	0.1	31.25kHz

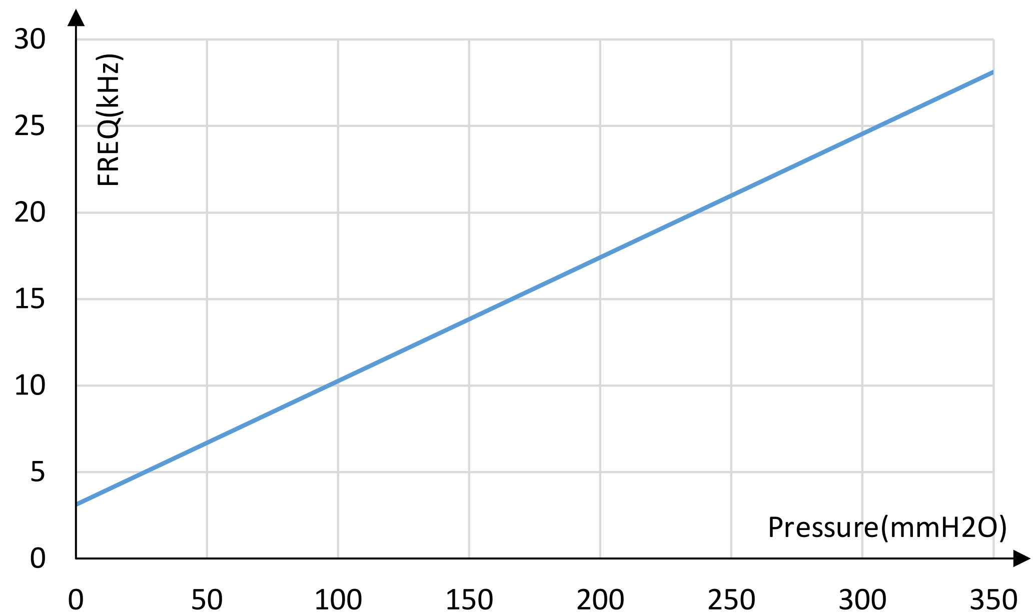


Figure 6.3 Frequency Output Transfer Function

6.5. I²C Interface

I²C bus uses SCL and SDA as signal lines. Both lines are connected to VDD externally via pull-up resistors so that they are pulled high when the bus is free. The I²C device address of NSPGD1M is shown below.

Table 6.4 I²C Address

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

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.

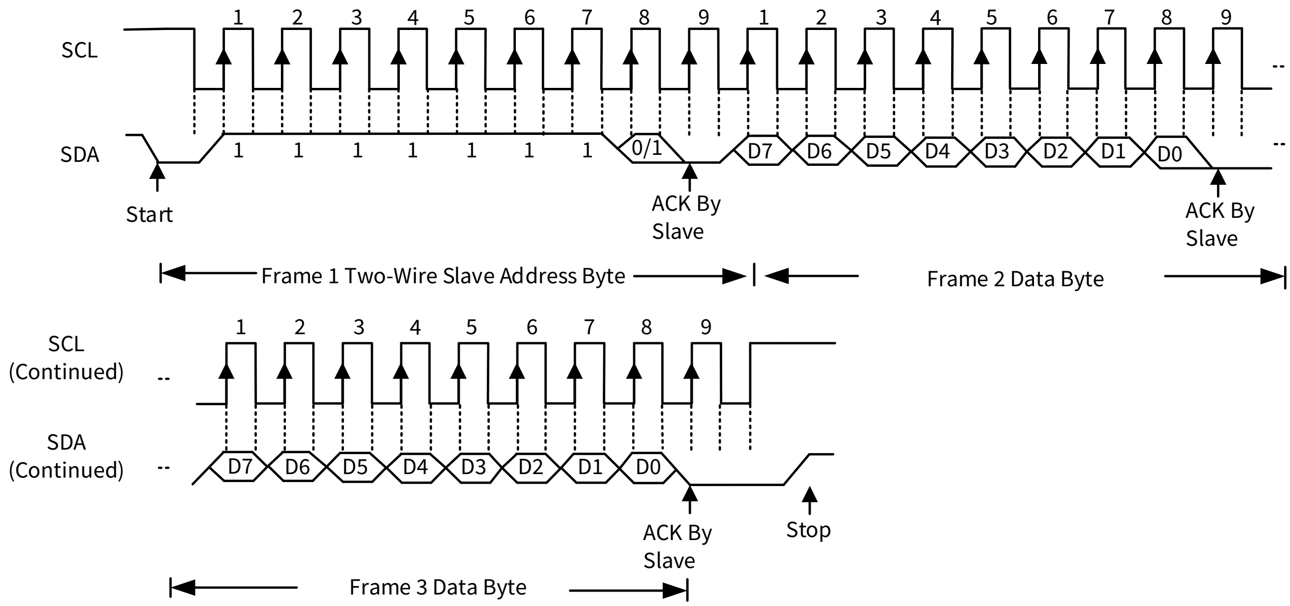


Figure 6.4 I^{2}C Protocol

Byte Write

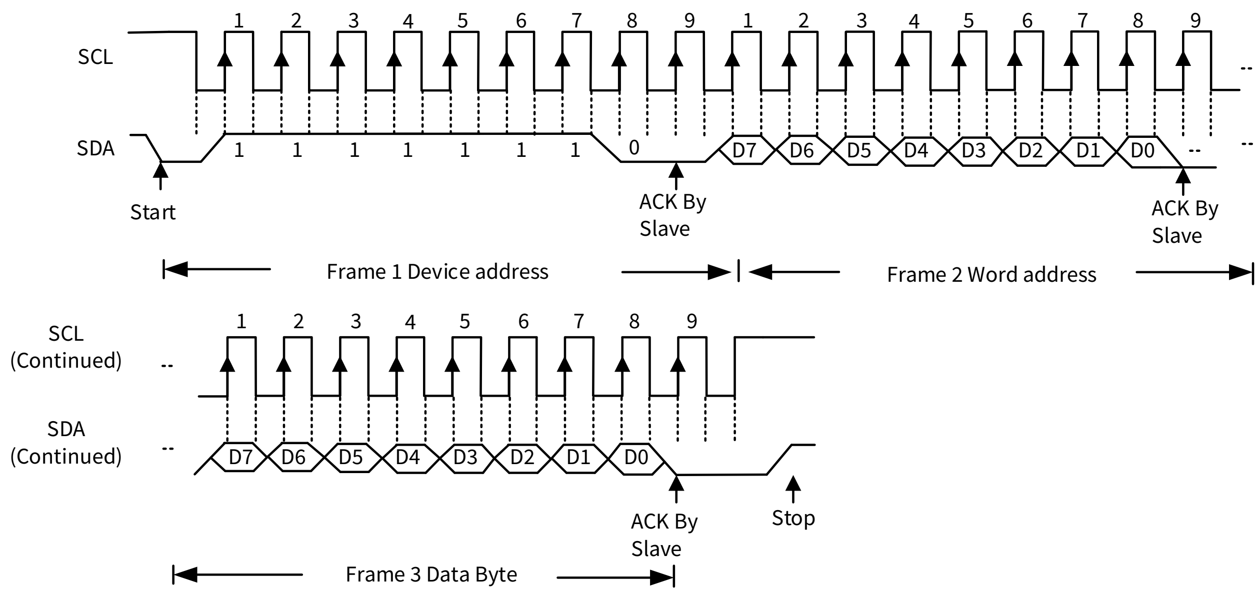


Figure 6.5 I^{2}C Write Byte

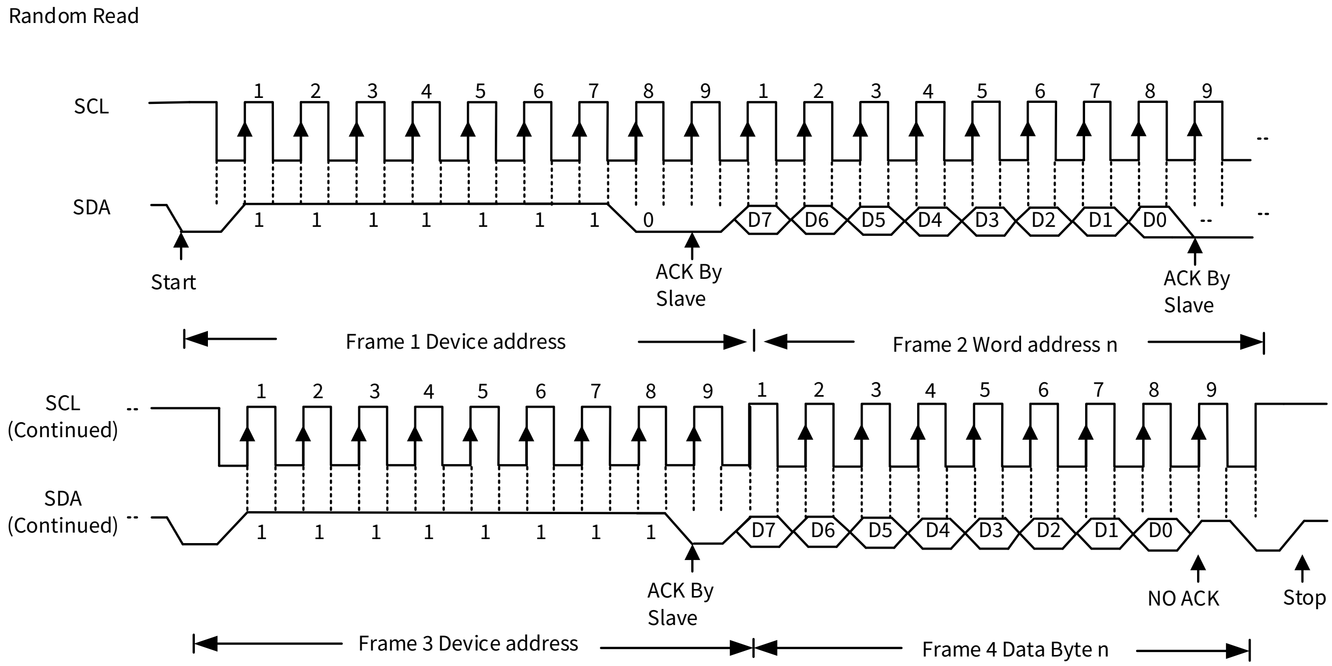


Figure 6.6 I²C Read Byte

7. Typical Application

7.1. Application Circuit

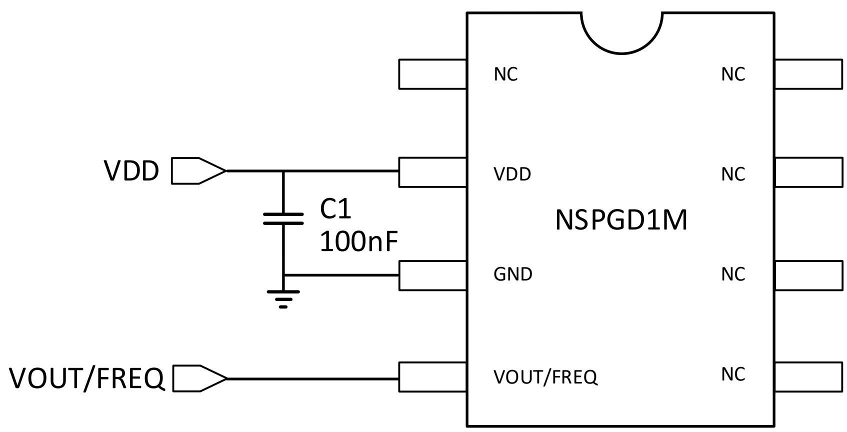


Figure 7.1 Analog/ Frequency Output Application Circuit

Note: For applications with higher ESD requirements, it is recommended that customers use the Figure 7.2 protection circuits.

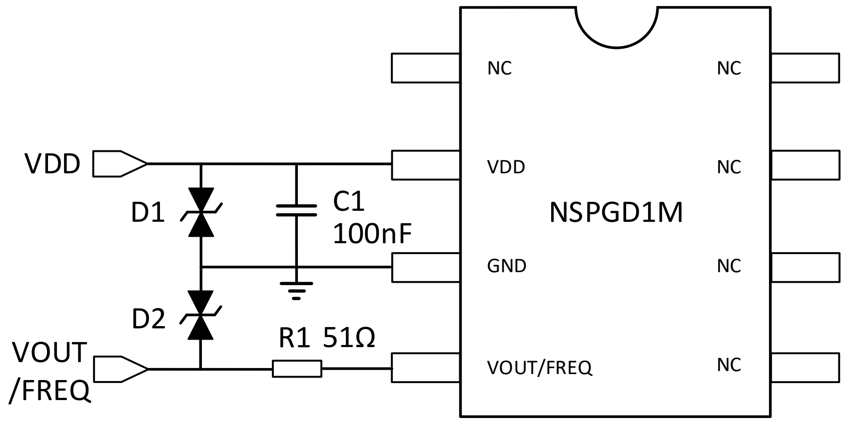


Figure 7.2 Analog/ Frequency Output Protection Circuit

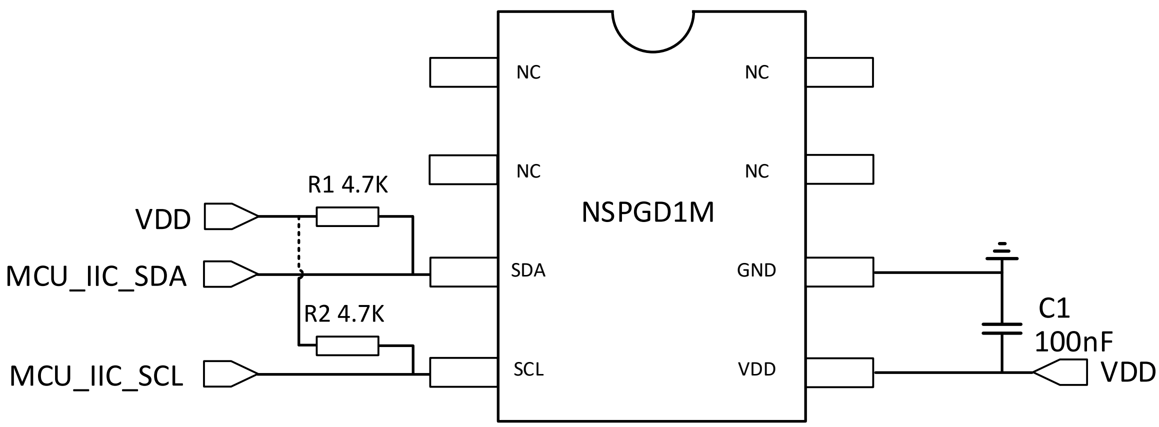


Figure 7.3 I^2C Output Application Circuit

8. Package Information

8.1. Package Size

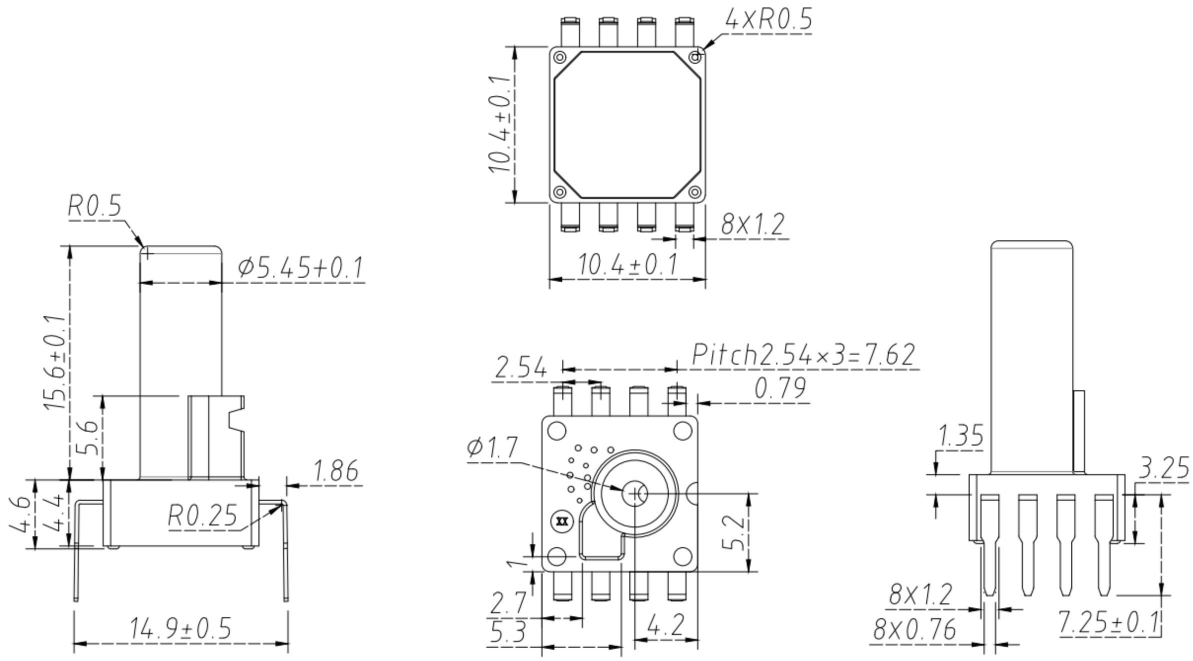


Figure 8.1 Package Outline mm

8.2. Recommended Footprint

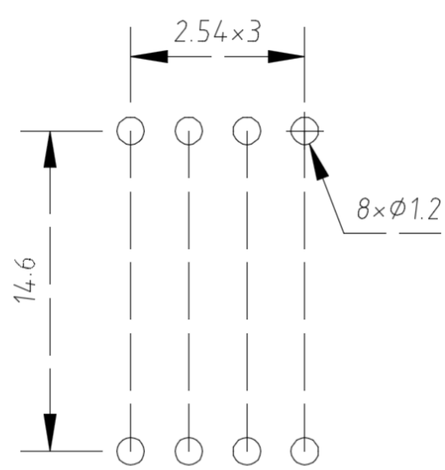


Figure 8.2 Footprint mm

9. Order Information

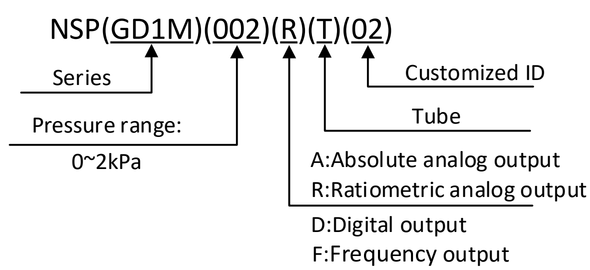
Product Type	Output Type	Pressure Range		Output Range		Clamp Level		Gain and Offset		Supply Voltage	Accuracy@0~70℃	
		P_L	P_H	O_L	O_H	V_{CL}	V_{CH}	A	B		Initially	Full Life
NSPGD1M002RT02	Ratiometric	0kPa	2kPa	0.50V	4.50V	4.76%	94%	0.40000	0.10000	5.0V	±1.5%	±2.5%
NSPGD1M004RT03	Ratiometric	0kPa	3.92kPa	1.00V	4.92V	0%	100%	0.20000	0.20000	5.0V	±1.5%	±2.5%
NSPGD1M006DT04	I^{2}C	0kPa	6kPa	838861	7549746	NA	NA	0.13333	0.10000	5.0V	±1%	±2%
NSPGD1M003AT05	Absolute	0mmH2O	325mmH2O	0.50V	4.50V	0%	100%	0.00246	0.10000	5.0V	±1.5%	±2.5%
NSPGD1M005AT06	Absolute	0mmH2O	450mmH2O	0.50V	4.50V	0%	100%	0.00178	0.10000	5.0V	±1.5%	±2.5%
NSPGD1M010RT07	Ratiometric	0kPa	10kPa	0.50V	4.50V	0%	100%	0.08000	0.10000	5.0V	±1.5%	±2.5%
NSPGD1M010DT10	I^{2}C	0kPa	10kPa	838861	7549746	NA	NA	0.08000	0.10000	3.3V	±1%	±2%
NSPGD1M004FT12	Frequency	0mmH2O	350mmH2O	3.125kHz	28.125kHz	NA	NA	0.002286	0.10000	5.0V	±1.5%	±2.5%
NSPGD1M005AT14	Absolute	0kPa	5kPa	0.50V	4.50V	0%	100%	0.16000	0.10000	5.0V	±1.5%	±2.5%
NSPGD1M010AT16	Absolute	0kPa	10kPa	0.33V	2.97V	0%	100%	0.08000	0.10000	3.3V	±1.5%	±2.5%

Please scan the following QR code for complete part number list.

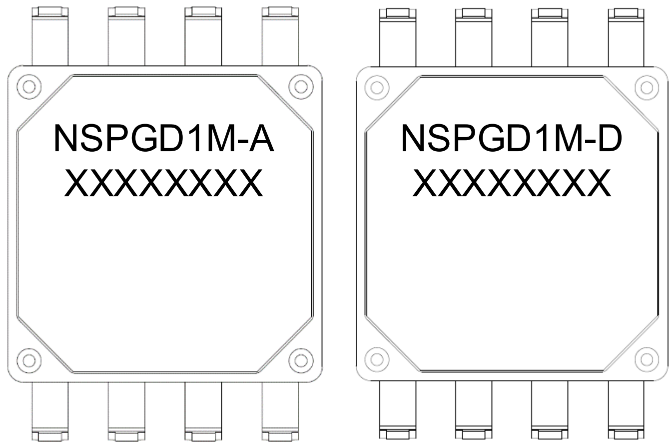
https://www.novosns.com/Public/Uploads/uploadfile4/nspgd1m.pdf

NSPGD1M

Naming Convention:



10. Identification Code



NSPGD1M: series name.

A: analog output.

D: digital output.

xxxxxxxx: package date code.

11. Soldering Parameters

(1) Manual soldering

- Please use an electric soldering iron with a tip temperature of 300~350°C to complete the soldering within 5 seconds.
- If a load is applied to the terminal during soldering, the sensor output may change.
- Please keep the solder tip clean and avoid using corrosive flux.

(2) Wave soldering

- Please keep the wave solder tank temperature below 255 °C and complete the soldering within 5 seconds.
- Since the MEMS pressure sensor is sensitive to temperature, it is recommended to verify the parameters of the wave soldering equipment in small batches, and then produce in large quantities after confirming the product performance.

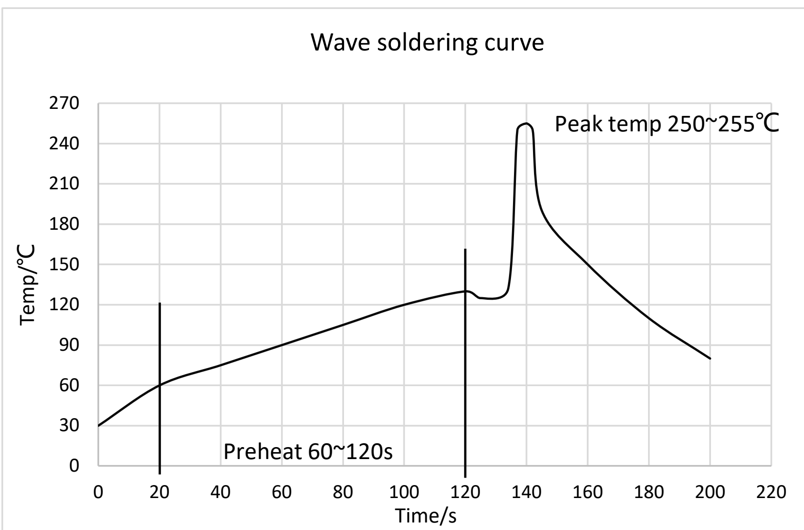


Figure 11.1 Wave Soldering Curve

Table 11.1 Wave Soldering Parameter

Wave Soldering Condition		Lead–free assembly
Preheat	Temperature Min	110°C
	Temperature Max	130°C
	Time (min to max)	60~120s
Preheat average ramp up rate		1~3 °C/sec
Wave soldering Peak Temperature		250~255°C
Time of peak Temperature		<5sec
Chain speed		1000~1300mm/min

(3) Circuit board protective paint

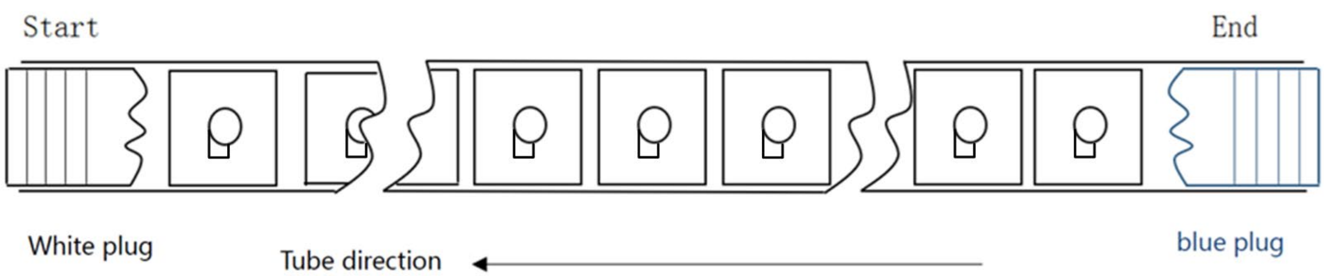
・ When applying circuit board protective paint after soldering, avoid blocking the atmospheric reference port next to the sensor air nozzle, otherwise the sensor output will be abnormal.

(4) Applicable pressure medium

・Not recommended for acidic and alkaline air and liquid measurements.

12. Packing Information

This Series product using tube package, each tube contains 50ea devices. Each tube has a blue plug as the bottom and a white plug as the top. The schematic diagram of tube is as follows:



Minimum ordering quantity (MOQ): 1000EA.
Standard pack quantity (SPQ): 500EA.

13. Revision History

Revision	Description	Date
1.0	Initial version.	2024/1/25
2.0	Update package size.	2025/1/22

Notes：

1. I^2C code

```
#define ACK      1
#define NACK    0
uchar REG06=0,REG07=0,REG08=0;
uchar number=1;
uchar Reg30[1];
int PCode=0, Pdata=0;
float Pressure=0.0;
void IIC_Start(void)           //Start the IIC, SDA High-to-low when SCL is high
{
    IIC_SCL(1);                //SCL output high level
    SDA_OUT(1);                //SDA output high level
    Delay_us(2);               //Delay 2us
    SDA_OUT(0);                //SDA output low level
    Delay_us(2);
}

void IIC_Stop(void)            //Stop the IIC, SDA Low-to-high when SCL is high
{
    IIC_SCL(0);
    Delay_us(2);
    IIC_SCL(1);
    SDA_OUT(0);
    Delay_us(2);
    SDA_OUT(1);
    Delay_us(2);
}

void IIC_ACK(void)             //Send ACK (LOW)
{
    SDA_OUT(0);
    IIC_SCL(1);
    Delay_us(2);
    IIC_SCL(0);
}

void IIC_NACK(void)            //Send No ACK (High)
{
    SDA_OUT(1);
    IIC_SCL(1);
    Delay_us(2);
    IIC_SCL(0);
}

uchar IIC_Wait_ACK(void)       //Check ACK, if return 0, then right, if return 1, then error
{
    int ErrTime=0;
    SDA_IN();                          //SDA set as input
    IIC_SCL(1);
    Delay_us(2);
```



```
    while(Read_SDA)
    {
        ErrTime++;
        if(ErrTime>200)
        {
            IIC_Stop();
            return 1;
        }
    }
    IIC_SCL(0);
    SDA_OUT(0);
    Delay_us(2);
    return 0;
}

void IIC_Send(uchar IIC_Data)                //Send a byte to IIC
{
    uchar i;
    IIC_SCL(0);
    Delay_us(2);
    for(i=0;i<8;i++)
    {
        if((IIC_Data&0x80)>>7)
            SDA_OUT(1);
        else
            SDA_OUT(0);
        IIC_Data<<=1;
        IIC_SCL(1);
        Delay_us(2);
        IIC_SCL(0);
        Delay_us(2);
    }
}

uchar IIC_Receive(uchar ACK)                 //Receive a byte from IIC
{
    uchar i,Receive_Data=0;
    SDA_IN();
    for(i=0;i<8;i++)
    {
        IIC_SCL(0);
        Delay_us(2);
        IIC_SCL(1);
        Receive_Data<<=1;
        if(Read_SDA==1)
            Receive_Data++;
        Delay_us(2);
    }
    IIC_SCL(0);
    Delay_us(2);
    if(ACK==0x01)
        IIC_ACK();
    else
```

```
            IIC_NACK();
    return Receive_Data;
}

void NSPGD1M006DT04_Write_Byte(uchar WriteAddr,uchar WriteData)
{
    IIC_Start();
    IIC_Send(0xFE|0x00);
    IIC_Wait_ACK();
    IIC_Send(WriteAddr);
    IIC_Wait_ACK();
    IIC_Send(WriteData);
    IIC_Wait_ACK();
    IIC_Stop();
}

void NSPGD1M006DT04_Read_Byte(uchar ReadAddr, uchar *pBuffer)
{
    IIC_Start();
    IIC_Send(0xFE|0x00);
    IIC_Wait_ACK();
    IIC_Send(ReadAddr);
    IIC_Wait_ACK();
    IIC_Start();
    IIC_Send(0xFE|0x01);
    IIC_Wait_ACK();
    pBuffer[0]=IIC_Receive(0);
    IIC_Stop();
}

void NSPGD1M006DT04_Read_3Byte(uchar ReadAddr,uchar *pBuffer)
{
    IIC_Start();
    IIC_Send(0xFE|0x00);
    IIC_Wait_ACK();
    IIC_Send(ReadAddr);
    IIC_Wait_ACK();
    IIC_Start();
    IIC_Send(0xFE|0x01);
    IIC_Wait_ACK();
    pBuffer[0]=IIC_Receive(ACK);
    pBuffer[1]=IIC_Receive(ACK);
    pBuffer[2]=IIC_Receive(NACK);
    IIC_Stop();
}

void main()
{
        uchar PData[3]={0,0,0};
        while(1)
        {
                NSPGD1M006DT04_Write_Byte(0x30,0x0A);
                while(1)                                    //Check whether the conversion ends
```

```
		{
			if(number<=50)
			{
				number++;
				delay_ms(1);
				NSPGD1M006DT04_Read_Byte(0x30,Reg30);
				if(0x02==Reg30[0])
				{
					number=1;
					break;
				}
			}
			if(number>50)
			{
				number=1;
				//User can add his own error handler function
				break;
			}
		}
		NSPGD1M006DT04_Read_3Byte(0x06,PData);
		REG06 = PData [0];                          //Register 0x06
		REG07 = PData [1];                          //Register 0x07
		REG08 = PData [2];                          //Register 0x08
		PCode=(REG06*65536+REG07*256+REG08);        //PCode = Data0x06*2^16+ Data0x07*2^8+
Data0x08
		if (PCode >8388607)
			Pdata= PCode-16777216;                          //Symbol processing
		else
			Pdata= PCode;
		Pressure =((float)Pdata/8388607-0.1)/(0.13333);      //PCode=(AxP+B)*8388607
P=(PCode/8388607-B)/A
                                                    //A=0.13333, B=0.1
                                                    //PNormalized=PCode/8388607
	}
}
```

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