NSPGS2 Series

Integrated Gauge Pressure Sensor

Datasheet (EN) 2.8

Product Overview

NSPGS2 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 Small Outline Package (SOP) with tube port. NSPGS2 series pressure sensor is target for consumer and medical application. 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 output. This eliminates the need for additional circuitry, such as a compensation network or micro-controller containing a custom correction algorithm. NSPGS2 series are designed for operating pressure ranges of -100kPa Gauge to 350kPa Gauge, very suitable for consumer electronics such as vacuum cleaner and medical applications.

Key Features

- High accuracy over the life

  better than ±1.5% from 0°C to 60°C；(analog)

  better than ±2.5% from -40°C to 70°C；(analog)

  better than ±1% from 0°C to 60°C；(digital)

  better than ±2% from -40°C to 70°C；(digital)
- Large temperature range -40°C ~70°C
- Ratio-metric/Absolute analog output
- 24bit I^2C
- SOP package with air nozzle, easy to assembly

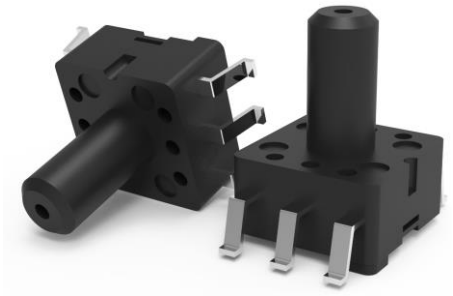
Applications

- Vacuum cleaner, vacuum juicer
- Air bed, massage chair
- Smart blood pressure monitoring, oxygen concentrators
- Industrial pressure sensor
- IoT pressure sensor

Device Information

Part Number	*Package*	*Body Size*
NSPGS2	SOP6	7mm*7mm

Outline



INDEX

1. Pin Configuration and Functions

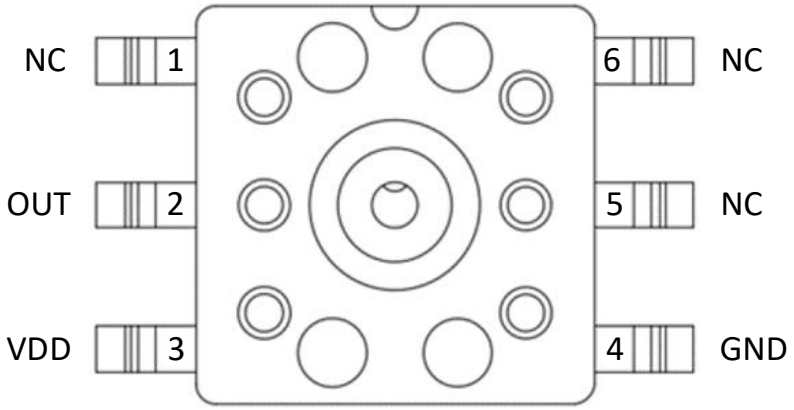


Fig 1.1 NSPGS2 series analog out pin definition (Top view)

Table 1.1 analog output pin description

Pin NO.	*Pin name*	*Description*
1	NC	No connect
2	OUT	Analog output
3	VDD	Power supply
4	GND	Ground
5	NC	No connect
6	NC	No connect

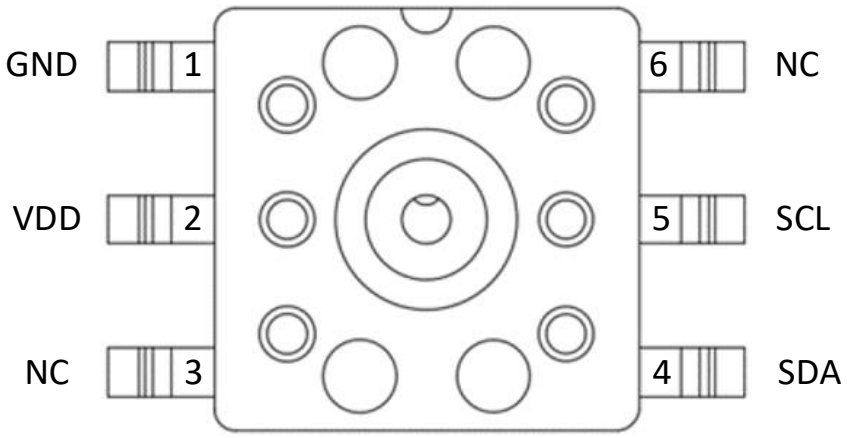


Fig 1.2 NSPGS2 series IIC out pin definition (Top view)

Table 1.2 digital output pin description

Pin NO.	*Pin name*	*Description*
1	GND	Ground
2	VDD	Power supply
3	NC	No connect
4	SDA	I^2C data signal
5	SCL	I^2C clock signal
6	NC	No connect

2. Absolute Maximum Ratings

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply voltage	VDD	-0.3		6.5	V	
Analog output current limit				25	mA	
Digital pin voltage		-0.3		VDD+0.3	V	25℃
Proof pressure	P_{proof}	300			kPaG	
Burst pressure	P_{burst}	500		1000	kPaG	
ESD susceptibility	HBM		2		kV	
Storage temperature	T_{stg}	-40		100	℃	

3. Recommended Operating Conditions

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply voltage	VDD	3	3.3	3.6	V	VDD=3.3V
		4.5	5	5.5	V	VDD=5V
Operating pressure	P_{amb}	-100		350	kPaG	
Operating pressure range	P_{range}	20		450	kPa	P_{max} - P_{min}
Operating temperature	T_{opr}	-40		70	℃	

4. Specifications

4.1. Electrical Characteristic

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Power on reset	VDD_{POR}		2		V	
Operating current	I_{avdd}		2.5		mA	Operation mode
			200		nA	Standby mode in digital output
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
Full life accuracy (analog output)[1,2]	ACC		1.5%		%FS	0°C ~ 60°C
			2.5%		%FS	-40°C ~ 70°C
Full life accuracy (I^2C output)[1,2]	ACC		1%		%FS	0°C ~ 60°C
			2%		%FS	-40°C ~ 70°C
Power up time	T_{UP}		100		ms	
EEPROM data retention	T_{live}	10			years	@125℃

1. Accuracy includes non-linearity, temperature, pressure hysteresis, temperature hysteresis;
2. Full life accuracy based on the 1000 hour of HTOL, LTOL, HTSL, THB and PCT testing;

4.2. I²C Electrical Characteristics

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

5. Function Description

5.1. Overview

NSPGS2 uses a MEMS piezoresistive absolute 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 voltage signal that is linear with the applied pressure.

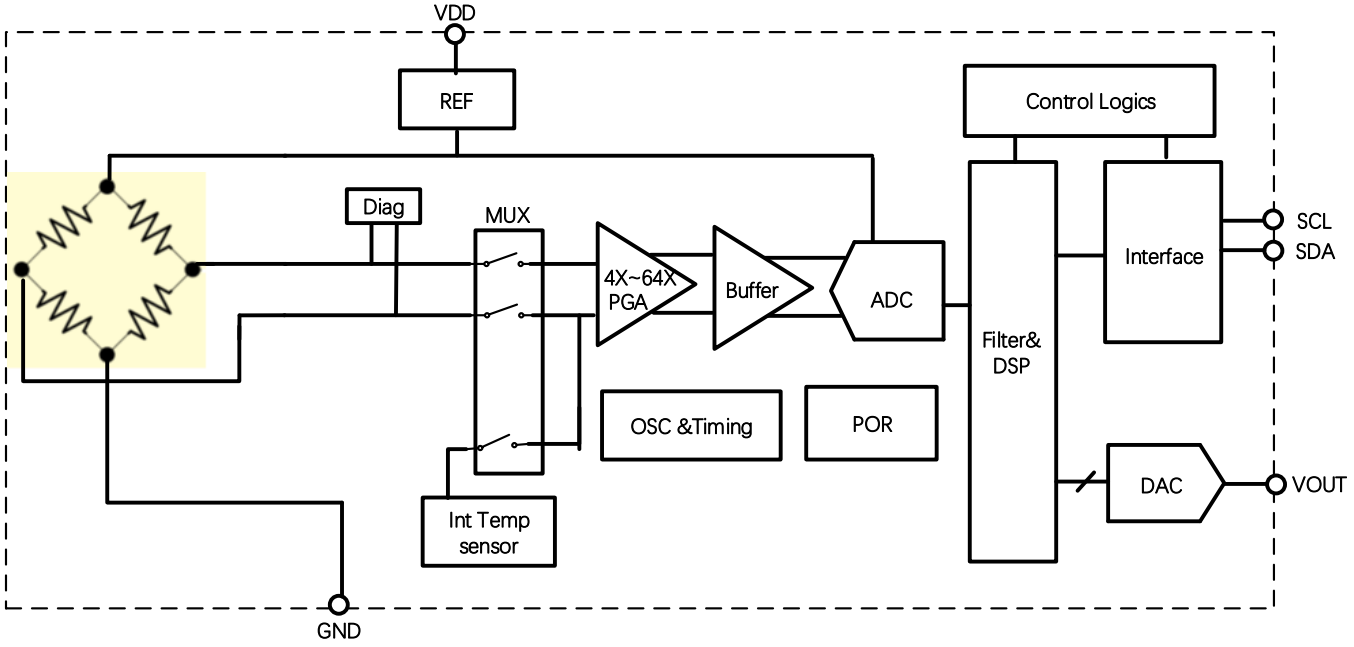


Fig 5.1 Product Function Block Diagram

5.2. Analog output transfer function

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

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

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

Note:

OUT is the analog output, unit is V;

P is the pressure value, gauge pressure, unit is kPa;

Table 5.1 Analog Output Transfer Function Coefficient

Product type	Pressure range		Output range		Gain and offset	
	P_L	P_H	O_L	O_H	A	B
NSPGS2F035RT01	0kPa	-35kPa	0.1*VDD	0.9*VDD	-0.02286	0.1

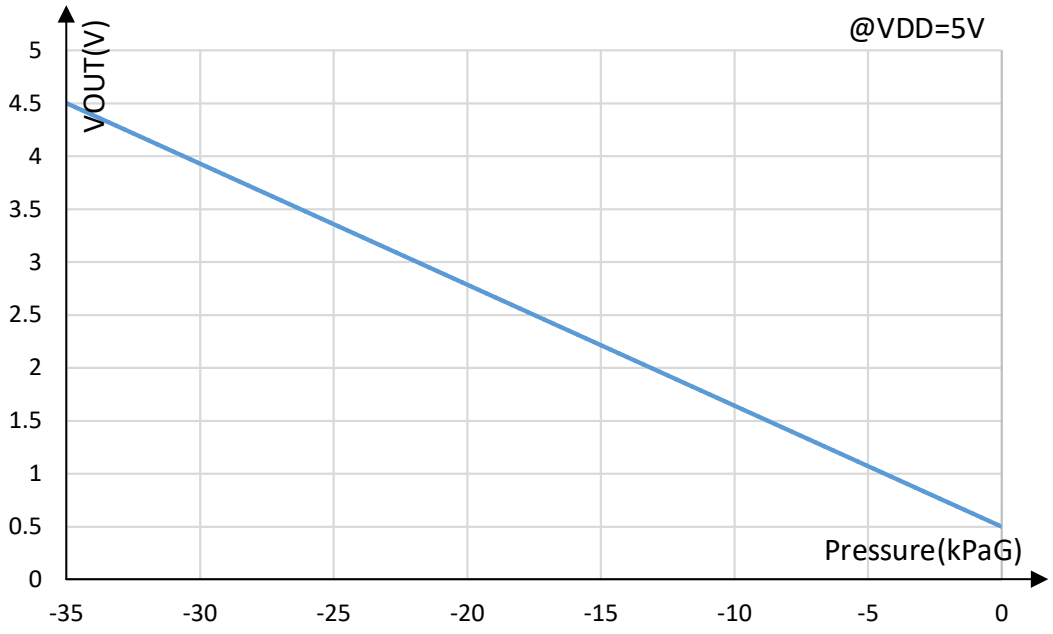


Fig 5.2 Analog Output Transfer Function

5.3. Digital output transfer function

$$Code = (A \text{ x } P + B) * 8388607$$

Code is the register 0x06~0x08 value;

P is the pressure value, gauge pressure, unit is kPa;

Table 5.2 Digital Output Transfer Function Coefficient

Product type	Pressure range		Output range		Gain and offset	
	P_L	P_H	O_L	O_H	A	B
NSPGS2F035DT09	0	-35	838861	7549746	-0.02286	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 NSPGS2F035DT09 transfer function, Code = 4194303, P(Pa) = (4194303/8388607-B)/A, and finally get the value of pressure about -17.5kPa.

5.4. 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 NSPGS2 is shown below.

Table 5.3 I²C address

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

The IIC 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.

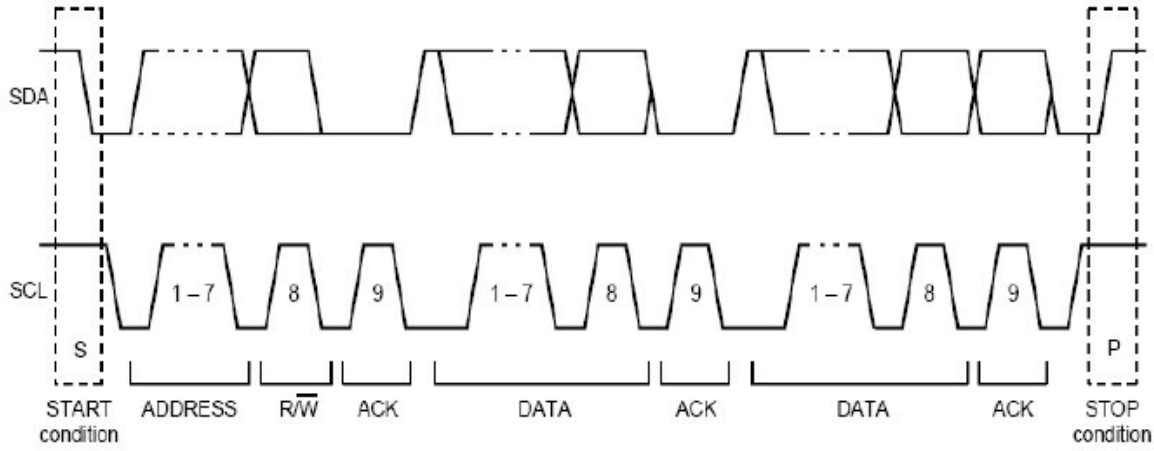


Fig 5.3 I²C Protocol

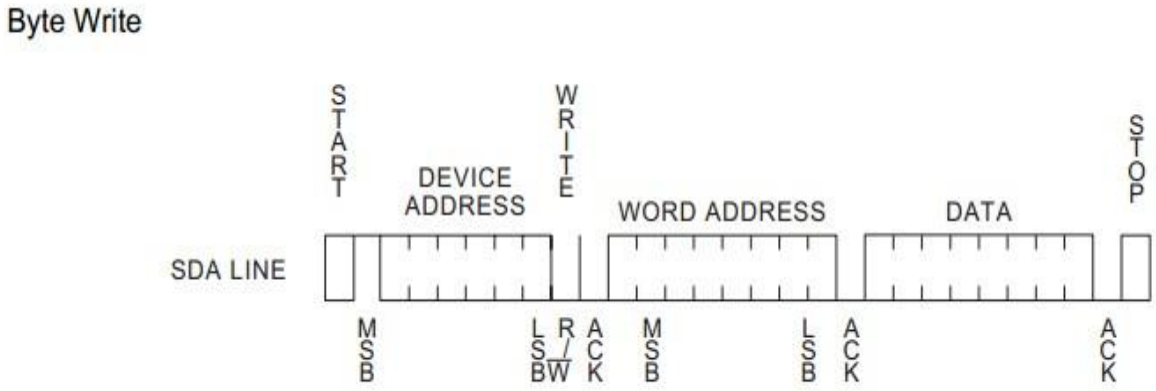


Fig 5.4 I²C Write Byte

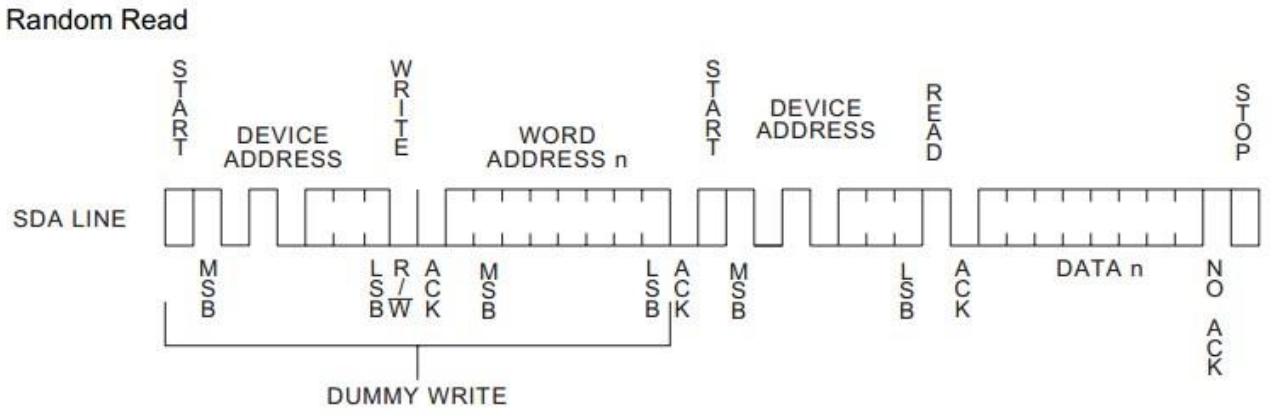


Fig 5.5 I²C Read Byte

6. Typical Application

6.1. Application circuit

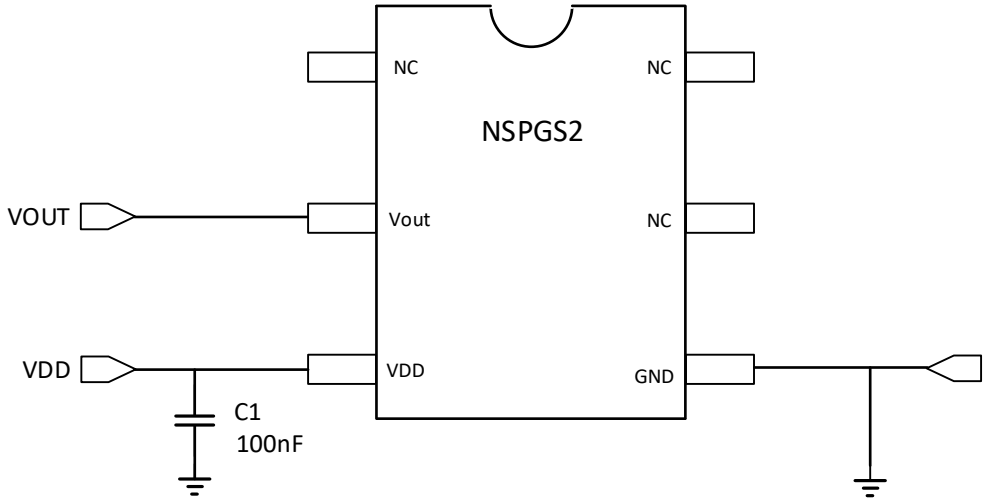


Fig 6.1 Analog Output Application Circuit

Note: For applications with higher ESD requirements, it is recommended that customers use the Fig 6.2 protection circuits.

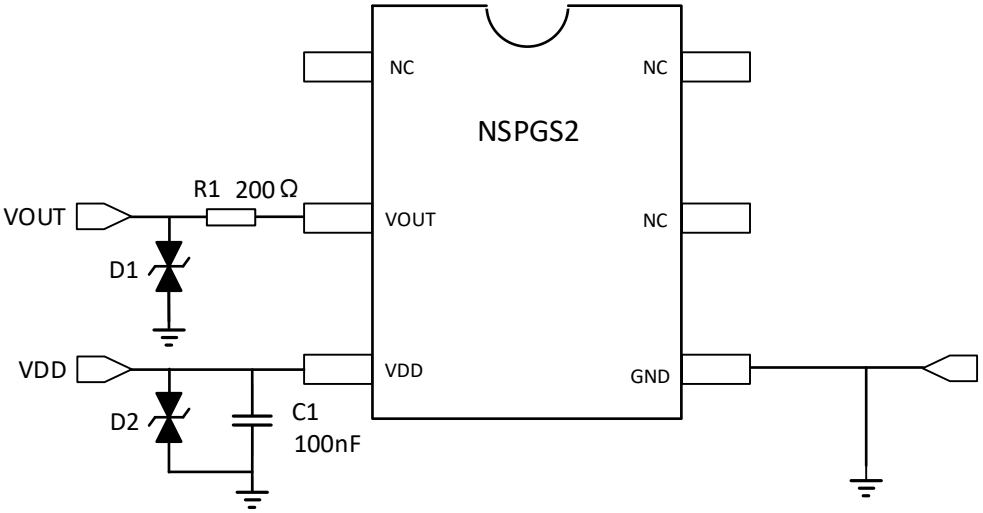


Fig 6.2 Analog Output Protection Circuit

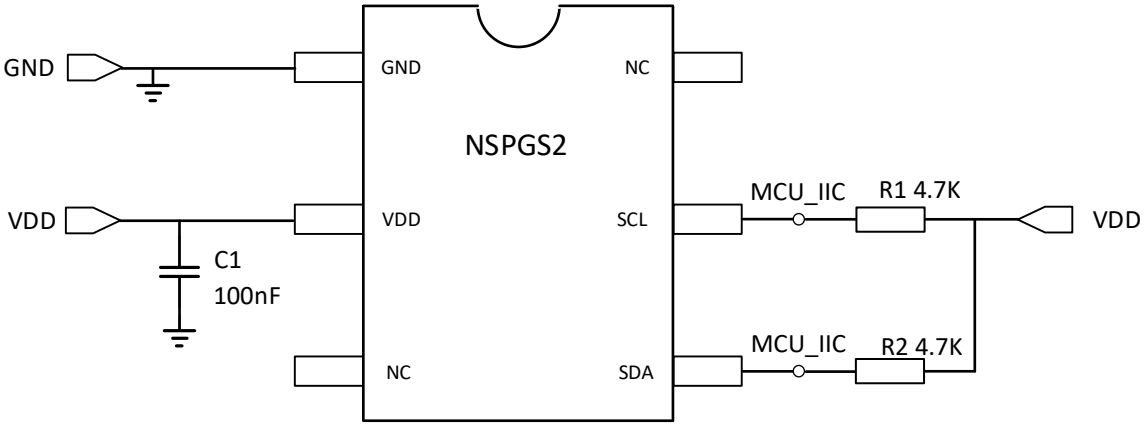


Fig 6.3 I²C Output Application Circuit

7. Package Information

7.1. Package size

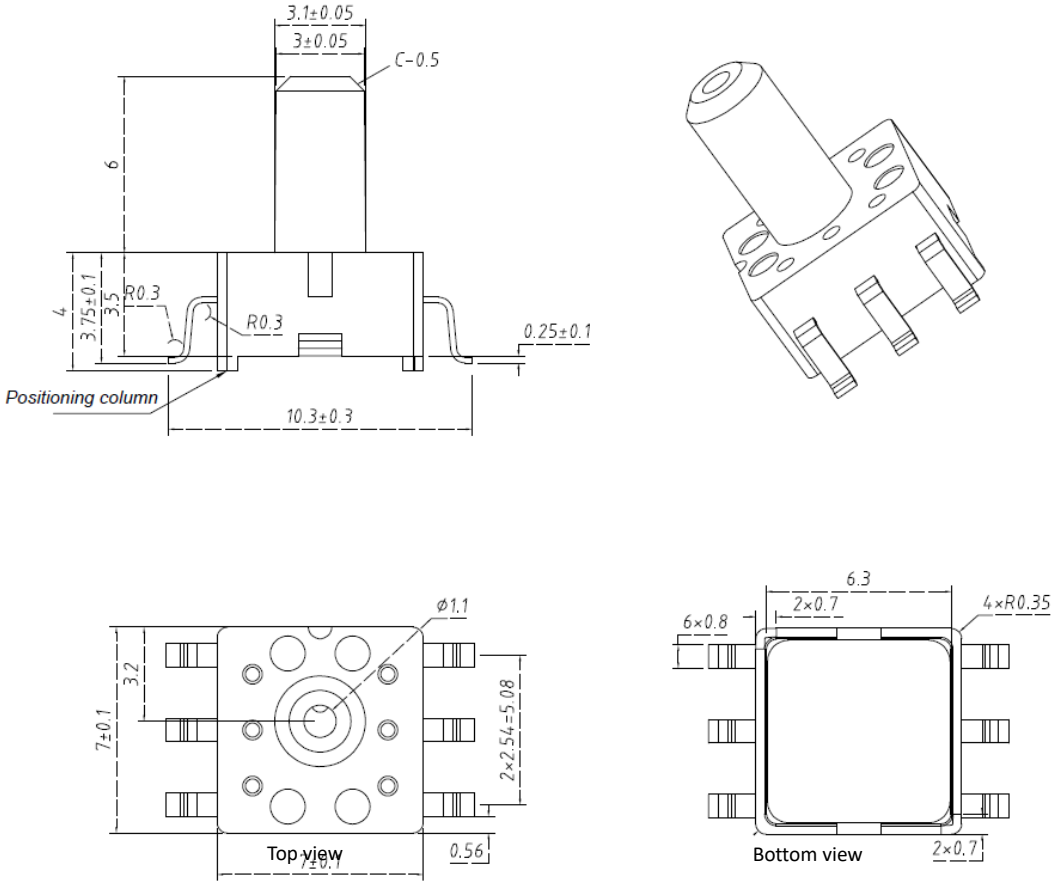


Fig 7.1 Package Outline mm

7.2. Recommended footprint

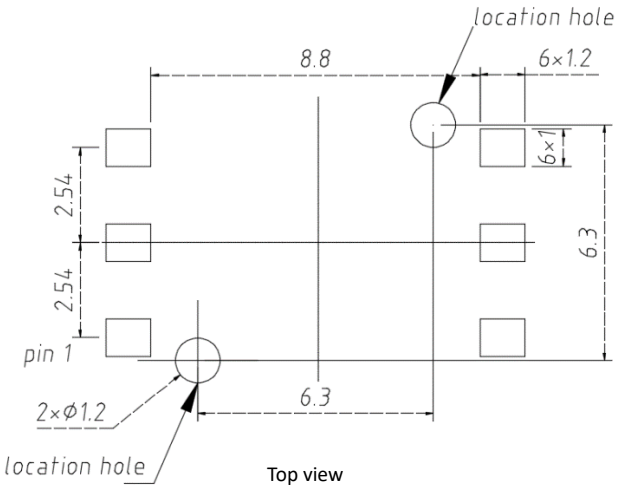
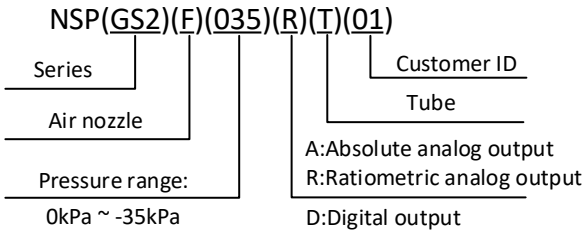


Fig 7.2 Footprint mm

8. Order Information

Product Type	Output type	Pressure range kPaG		Output range		Clamp level		Gain and offset		Supply voltage
		P_L	P_H	O_L	O_H	V_{CL}	V_{CH}	A	B	
NSPGS2F035RT01	Ratiometric	0kPa	-35kPa	0.50V	4.50V	4.76%	94%	-0.02286	0.10000	5.0V
NSPGS2F100RT02	Ratiometric	0kPa	-100kPa	0.50V	4.50V	4.76%	94%	-0.00800	0.10000	5.0V
NSPGS2F100RT03	Ratiometric	0 kPa	100kPa	0.50V	4.50V	4.76%	94%	0.00800	0.10000	5.0V
NSPGS2F200AT04	Absolute	-100 kPa	100kPa	0.20V	4.70V	0%	100%	0.00450	0.49000	5.0V
NSPGS2F020RT05	Ratiometric	0 kPa	-20kPa	0.50V	4.50V	0%	100%	-0.04000	0.10000	5.0V
NSPGS2F100AT06	Absolute	0 kPa	-100kPa	0.77V	4.60V	4.76%	94%	-0.00766	0.15400	5.0V
NSPGS2F020RT07	Ratiometric	0 kPa	-20kPa	0.50V	4.50V	4.76%	94%	-0.04000	0.10000	5.0V
NSPGS2F100AT08	Absolute	0 kPa	-100kPa	0.50V	4.50V	4.76%	94%	-0.00800	0.10000	5.0V
NSPGS2F035DT09	I^2C	0 kPa	-35kPa	838861	7549746	NA	NA	-0.02286	0.10000	5.0V
NSPGS2F020AT10	Absolute	0 kPa	-20kPa	0.50V	4.50V	0%	100%	-0.04000	0.10000	5.0V
NSPGS2F200AT11	Absolute	0 kPa	200kPa	0.55V	3.47V	0%	100%	0.00292	0.11000	5.0V
NSPGS2F020AT12	Absolute	0kPa	20kPa	0.33V	2.97V	0%	100%	0.04000	0.10000	3.3V
NSPGS2F200RT13	Ratiometric	0 kPa	200kPa	0.33V	2.97V	0%	100%	0.00400	0.10000	3.3V
NSPGS2F040AT14	Absolute	0kPa	40kPa	0.33V	2.97V	0%	100%	0.02000	0.10000	3.3V
NSPGS2F350ATK1	Absolute	0kPa	350kPa	0.20V	4.70V	0%	100%	0.002571	0.040000	5.0V
NSPGS2F020DT15	I^2C	0kPa	-20kPa	838861	7549746	NA	NA	-0.04000	0.10000	5.0V
NSPGS2F200DT16	I^2C	-100kPa	100kPa	838861	7549746	NA	NA	0.00400	0.50000	3.3V
NSPGS2F350DT17	I^2C	0kPa	350kPa	838861	7549746	NA	NA	0.002286	0.10000	5.0V
NSPGS2F050DT18	I^2C	0kPa	50kPa	838861	7549746	NA	NA	0.01600	0.10000	3.3V
NSPGS2F010DT19	I^2C	0kPa	10kPa	838861	7549746	NA	NA	0.08000	0.10000	5.0V
NSPGS2F050RT20	Ratiometric	0kPa	50kPa	0.20V	4.70V	0%	100%	0.01800	0.04000	5.0V
NSPGS2F100AT21	Absolute	0kPa	100kPa	0.50V	4.50V	4.76%	94%	0.00800	0.10000	5.0V
NSPGS2F050AT22	Absolute	0kPa	50kPa	0.33V	2.97V	0%	100%	0.01600	0.10000	3.3V
NSPGS2F100DT23	I^2C	-50	50kPa	838861	7549746	NA	NA	0.00800	0.50000	3.3V
NSPGS2F300RT24	Ratiometric	0kPa	300kPa	0.33V	2.97V	0%	100%	0.00267	0.10000	3.3V

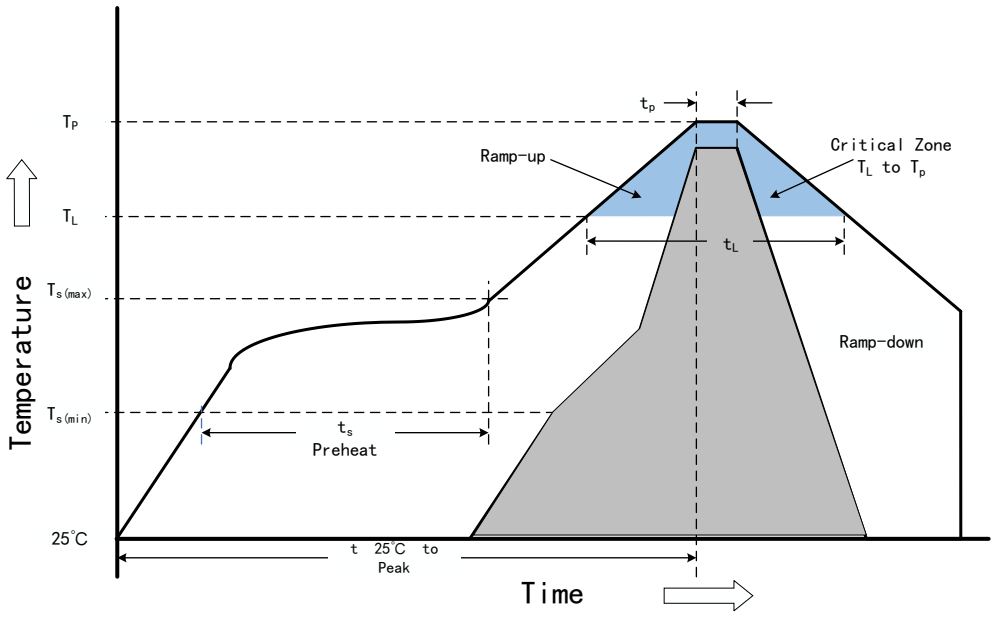
Naming Convention:



9. Soldering Parameters

9.1. Reflow soldering (SMD Terminal)

Reflow Condition		Lead-free assembly
Pre Heat	Temperature Min (Ts(min))	150°C
	Temperature Max (Ts(max)	180°C
	Time (min to max) (ts)	60 – 150 secs
Average ramp up rate (Liquidus Temp (T_L) to peak		2°C/second max
T_S(max)to T_L - Ramp-up Rate		2°C/second max
Reflow	Temperature (T_L) (Liquidus)	210°C
	Time (min to max) (t_L)	60 – 220 seconds
Peak Temperature (T_P)		240°C
Time within 5°C of actual peak Temperature (tp)		12 – 30 seconds
Ramp-down Rate		6°C/second max
Time 25°C to peak Temperature (T_P)		230 seconds Max.
Do not exceed		240°C

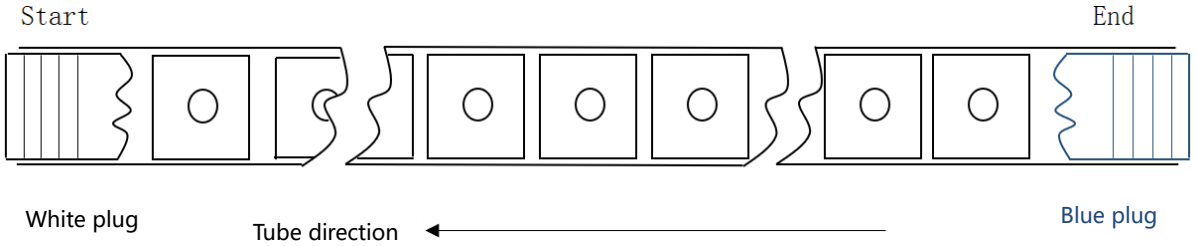


9.2. Manual soldering

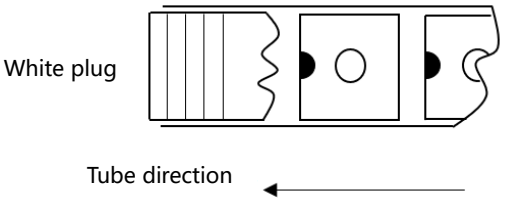
- Raise the temperature of the soldering tip between 260 °C and 300 °C and solder within 5 seconds.
- Use a flattened soldering tip when performing rework on the solder bridge.
- Complete rework in one time

10. Tube Information

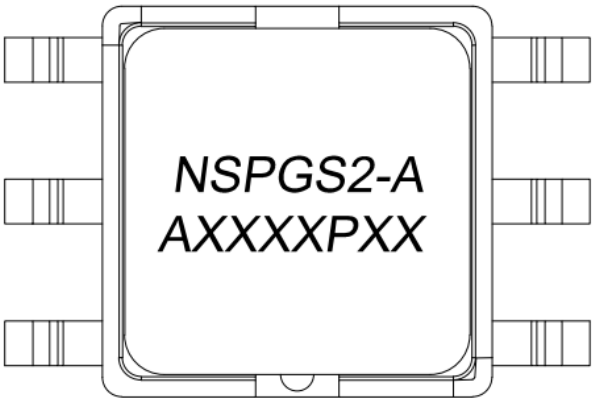
This series product using tube package, each tube contains 70ea devices. There are 10 tubes per box, and the minimum order quantity is 1400ea. Each tube has a blue plug at the bottom and a white plug at the top, as follows:

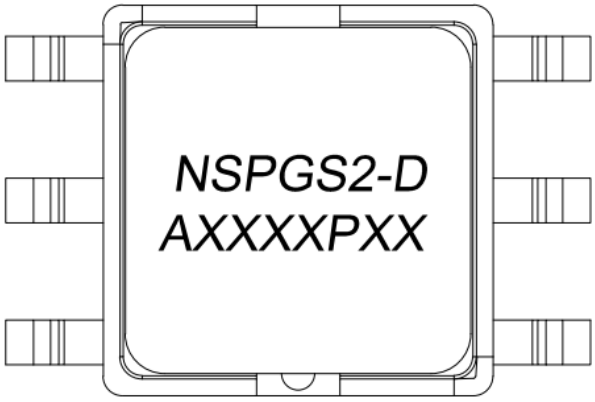


Pin1 point faces to the white plug at the top:



11. Identification Code





NSPGS2: series name;

A: analog output;

D: I^2C digital output;

AxxxxPxx: package date code;

12. Revision History

Revision	Description	Date
0.1	Initial version.	2018/4/23
1.0	Formal release.	2018/12/8
1.1	Add packing type description.	2019/8/12
1.2	Update footprint size.	2019/9/11
1.3	Add digital and frequency output description; I2C pin definition; I2C protocol description.	2019/11/25
2.0	Part number update.	2020/5/17
2.1	Add part number NSPGS2F020RT05, NSPGS2F100AT08, NSPGS2F035DT09, NSPGS2F020AT10, delete NSPGS2F040DT05; Difference description ratiometric & absolute output;	2020/11/16
2.2	Add part number NSPGS2F020AT10.	2020/12/3
2.3	Update identification code.	2020/12/23
2.4	Update format, font.	2020/1/8
2.5	Update logo, format.	2020/2/25
2.7	Add P_{range}, update I^2C pin definition, package information, add part number NSPGS2F200RT13.	2021/6/15
2.8	Add Soldering Parameters, update order Information, add important notice.	2022/6/1

Notes：

1. I²C code

```
void IIC_Init(void)
{
    SCL_H;
    SDA_H;
    SCL_W;
    SDA_W;
}

void IIC_Start(void)
{
    SDA_W;
    SCL_H;
    SDA_H;
    delay10us();
    SDA_L;
    delay10us();
}

void IIC_Stop(void)
{
    SCL_L;
    delay10us();
    SCL_H;
    SDA_W;
    SDA_L;
    delay10us();
    SDA_H;
    delay10us();
}

void IIC_ACK(void)
{
    SDA_W;
    SDA_L;
    SCL_H;
    delay10us();
    SCL_L;
}

void IIC_NACK(void)
{
    SDA_W;
    SDA_H;
    SCL_H;
    delay10us();
```

```
    SCL_L;
}

uchar IIC_Wait_ACK(void)
{
    int ErrTime=0;
    SDA_R;
    SCL_H;
    delay10us();
    while(Read_SDA)
    {
        ErrTime++;
        if(ErrTime>200)
        {
            IIC_Stop();
            return 1;
        }
    }
    SCL_L;
    SDA_W;
    SDA_L;
    delay10us();
    return 0;
}

void IIC_Send(uchar IIC_Data)
{
    uchar i;
    SDA_W;
    SCL_L;
    delay10us();
    for(i=0;i<8;i++)
    {
        if((IIC_Data&0x80)>>7)
            SDA_H;
        else
            SDA_L;
        IIC_Data<<=1;
        SCL_H;
        delay10us();
        SCL_L;
        delay10us();
    }
}

uchar IIC_Receive(uchar ACK)
{
    uchar i,Receive_Data=0x00;
    SDA_R;
```

```
    for(i=0;i<8;i++)
    {
        SCL_L;
        delay10us();
        SCL_H;
        Receive_Data<<=1;
        if(Read_SDA==1)
            Receive_Data++;
        else
            ;
        delay10us();
    }
    SCL_L;
    delay10us();
    if(ACK==0x01)
        IIC_ACK();
    else
        IIC_NACK();
    return Receive_Data;
}

void NSPGS2F020AT12_Write_Byte(uchar WriteAddr,uchar WriteData)
{
    uchar flag;
    IIC_Start();
    IIC_Send(0xFE|0x00);
    IIC_Wait_ACK();
    IIC_Send(WriteAddr);
    IIC_Wait_ACK();
    IIC_Send(WriteData);
    IIC_Wait_ACK();
    IIC_Stop();
}

void NSPGS2F020AT12_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 NSPGS2F020AT12_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(1);
    pBuffer[1]=IIC_Receive(1);
    pBuffer[2]=IIC_Receive(0);
    IIC_Stop();
}

Void Main()
{
      uChar PData[3]={0,0,0};
      IIC_Init();
    NSPGS2F020AT12_Write_Byte(0x30,0x0A);
    Delay_3ms();
    NSPGS2F020AT12_Read_3Byte(0x06,PData);
}
```

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