NOVOSENSE
纳芯微电子

NSPGS5 Series

Integrated Gauge Low Pressure Sensor

Datasheet (EN) 2.1

Product Overview

NSPGS5 is a calibrated gauge pressure sensor series product launched by NOVOSENSE for low pressure measurement market. This series use a high-performance ASIC to calibrate and compensate the MEMS sensor element. While ensuring the reliability of the product, the two chips are integrated and packaged, reduces the package size greatly, this series provide JEDEC standard SOIC-16 package with vertical porting. The pressure signal from -10kPa ~ 10kPa gauge can be converted into an analog output signal (0~5V) or I^2C output signal with a customizable output range. The pressure sensor can be directly mounted on a standard printed circuit board very suitable for ventilators, sleep apnea and IOT applications.

Key Features

- Custom range -10kPa to 10kPa
- Operating temperature range -20°C to 85°C
- High accuracy

  Total error band initially better than ±1%

  Full life accuracy better than ±2%
- 16bit analog output
- 24bit I^2C digital output
- Vertical port
- RoHS & REACH-compliant packages: SOIC-16

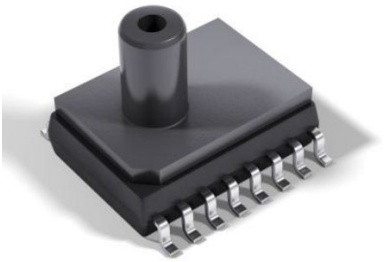
Applications

- CPAP/sleep apnea
- Fire pressure monitoring
- Ventilators
- HVAC/VAV
- Safety cabinets
- Pressure switches

Device Information

Part Number	*Package*	*Body Size*
NSPGS5	SOIC16	10.26mm*7.52mm

Outline



INDEX

1. PIN CONFIGURATION AND FUNCTIONS 3
2. ABSOLUTE MAXIMUM RATINGS 4
3. ESD RATINGS 4
4. RECOMMENDED OPERATING CONDITIONS 4
5. SPECIFICATIONS 5
5.1. ELECTRICAL CHARACTERISTIC 5
5.2. I²C TIMING DIAGRAM 5
5.3. I²C INTERFACE 6
6. FUNCTION DESCRIPTION 7
6.1. OVERVIEW 7
6.2. ANALOG OUTPUT TRANSFER FUNCTION 7
6.3. I²C OUTPUT TRANSFER FUNCTION 8
6.4. I²C INTERFACE 9
7. TYPICAL APPLICATION 11
7.1. APPLICATION CIRCUIT 11
8. PACKAGE INFORMATION 12
9. ORDER INFORMATION 13
10. SOLDERING PARAMETERS 14
10.1. REFLOW SOLDERING (SMD TERMINAL) 14
10.2. MANUAL SOLDERING 14
11. PACKING INFORMATION 15
12. REVISION HISTORY 16
NOTES： 17

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

1. Pin Configuration and Functions

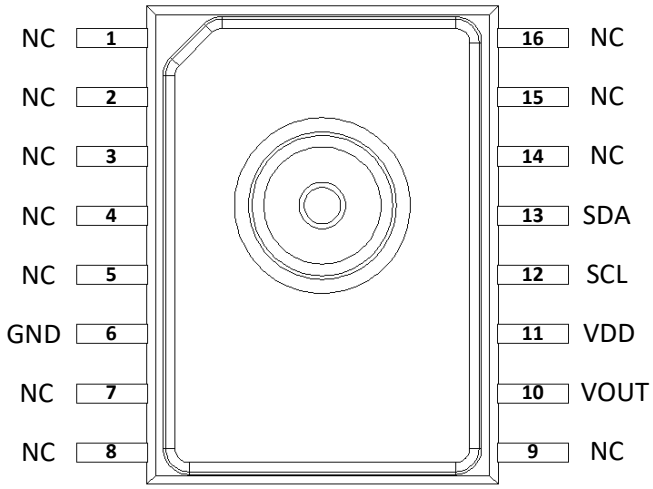


Figure 1.1 NSPGS5 series pin definition (Top view)

Table 1.1 NSPGS5 pin description

Pin No.	*Pin Name*	*Description*
1	NC	No connect
2	NC	No connect
3	NC	No connect
4	NC	No connect
5	NC	No connect
6	GND	Ground
7	NC	No connect
8	NC	No connect
9	NC	No connect
10	VOUT	Analog output
11	VDD	Power supply
12	SCL	I^2C clock signal
13	SDA	I^2C data signal
14	NC	No connect
15	NC	No connect
16	NC	No connect

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	VDD_{max}	-0.3		6.5	V	
Analog pin voltage	VOUT	-0.3		5.3	V	25°C, VDD>5V
Analog output current limit				25	mA	
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	±2.5	kV
	Charged device model (CDM), per AEC-Q100-011-RevB	±500	V
	Latch up (LU), per JESD78F	±100	mA

4. Recommended Operating Conditions

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	VDD	3	3.3	3.6	V	
		4.5	5	5.5		
Operating pressure range	Prange	-10		10	kPaG	
High level voltage at digital I/O	VIH	2			V	
Low level voltage at digital I/O	VIL			0.8	V	
I2C clock frequency	Fsclk			400	kHz	
Operating temperature	Topr	-20		85	°C	

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

5. Specifications

5.1. Electrical Characteristic

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Output voltage range	VOUT	0.01		4.99	V	
Operating current	I_{avdd}	2.5	2.9	3.3	mA	@VDDHV=5V
Output RMS noise	V_{rms}		0.5		mV	
Output load resistance	R_{load}	1			kOhm	
Output load capacitance	C_{load}			150	nF	
Accuracy [1,2,3,4]	ACC	-1%		1%	%FS	Initially accuracy
		-2%		2%	%FS	Full life accuracy
Bandwidth	BW		500			Hz
Power up time	T_{UP}		100		ms	
Response time	T_{RESP}		1		ms	
I²C data update time	$T_{data\ updata}$		1		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 NSPGS5F004RT01 500 hour HTOL, LTOL, HTSL, TH(85°C /85%RH) ,TC and 3x reflow testing.
3. For pressure accuracy of different part number, please refer to complete part number list at chapter 8.
4. Unless otherwise specified, the accuracy is based on typical operating voltage.

5.2. I²C Timing Diagram

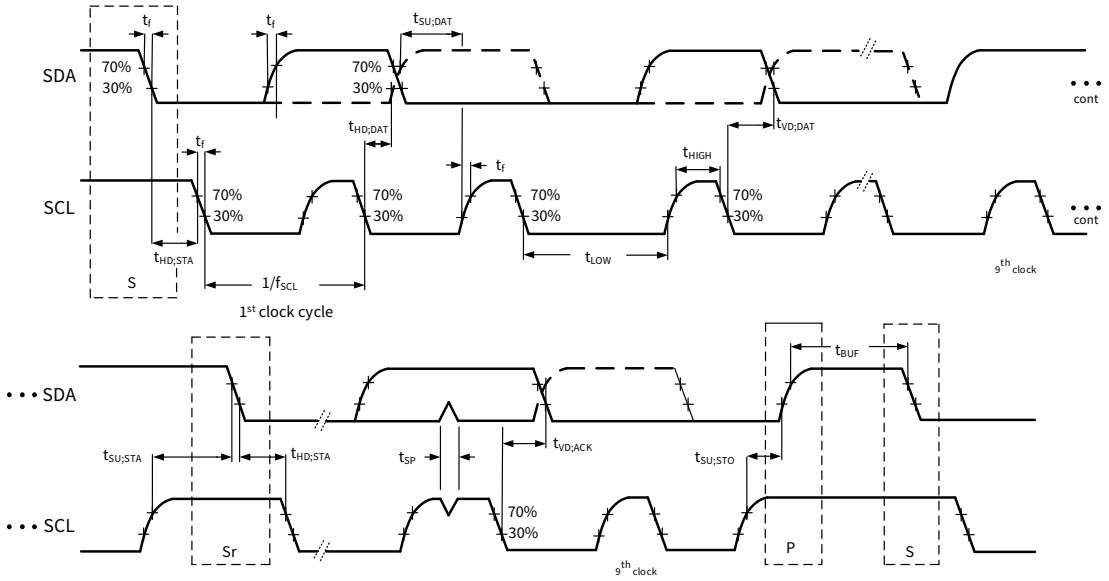


Figure 5.1 I²C Timing Diagram

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

5.3. I²C Interface

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	

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

6. Function Description

6.1. Overview

NSPGS5 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 voltage or I^2C signal that is linear with the applied pressure.

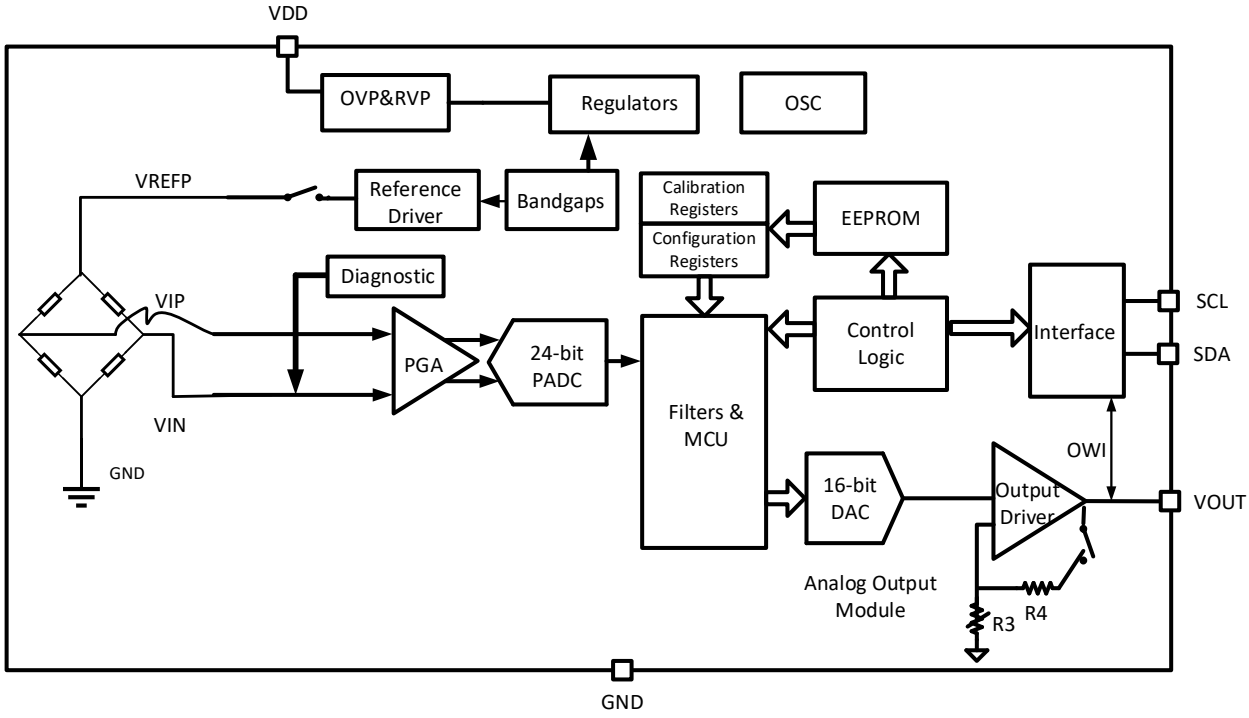


Figure 6.1 Product Function Block Diagram

6.2. Analog Output Transfer Function

NSPGS5 series device is fully calibrated on delivery. The sensor has a linear transfer function between the applied pressure and the output signal:

Ratiomatric : $VOUT=(A \times P + B) \times VDD$

Absolute: $VOUT=(A \times P + B) \times 5$ @VDD=5V

Absolute: $VOUT=(A \times P + B) \times 3.3$ @VDD=3.3V

VOUT is the analog output, unit is V.

VDD is the supply voltage, unit is V.

P is the pressure value, gauge pressure, unit is kPa/cmH_2O.

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
NSPGS5F004RT01	0cmH_2O	40cmH_2O	0.1*VDD	0.9*VDD	0.02	0.1

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

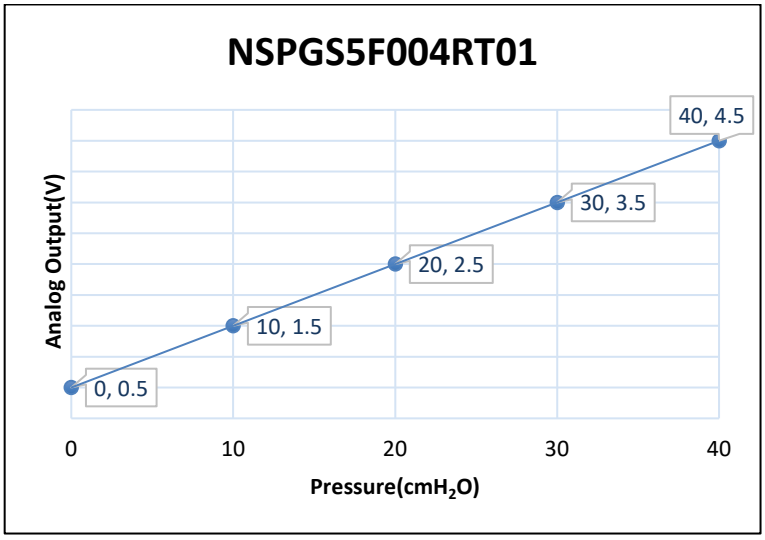


Figure 6.2 Analog Output Transfer Function

6.3. I²C 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/cmH_2O.

Table 6.2 I²C Output Transfer Function Coefficient

Product No.	*Pressure Range*		*Output Code Range*		*Gain and Offset*	
	P_L	P_H	O_L	O_H	A	B
NSPGS5F004DT05	0cmH_2O	40cmH_2O	838861	7549746	0.02	0.1

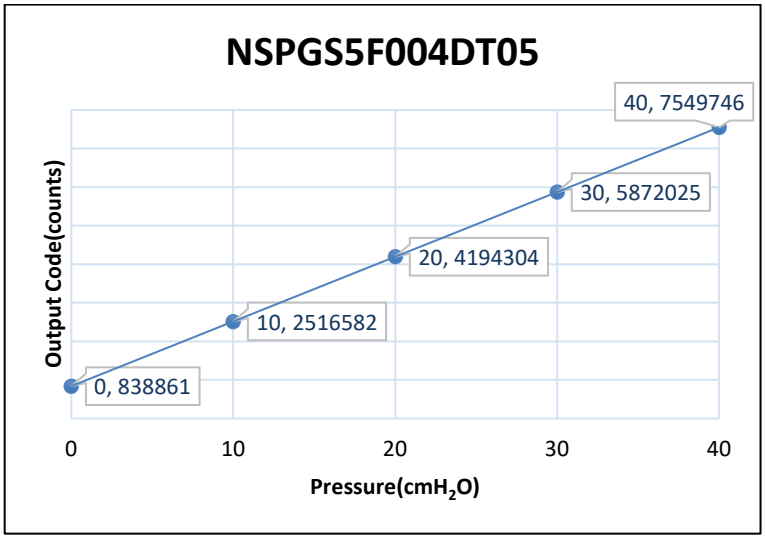


Figure 6.3 Digital Output Transfer Function

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

Register Map:

Addr	Bit Addr	Description	Default	Description
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 NSPGS5F004DT05 transfer function, Code = 4194303, P(cmH_2O) = (4194303/8388607-B)/A, and finally get the value of pressure about 20cmH_2O.

6.4. 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 NSPGS5 is shown below.

Table 6.3 I²C Address

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

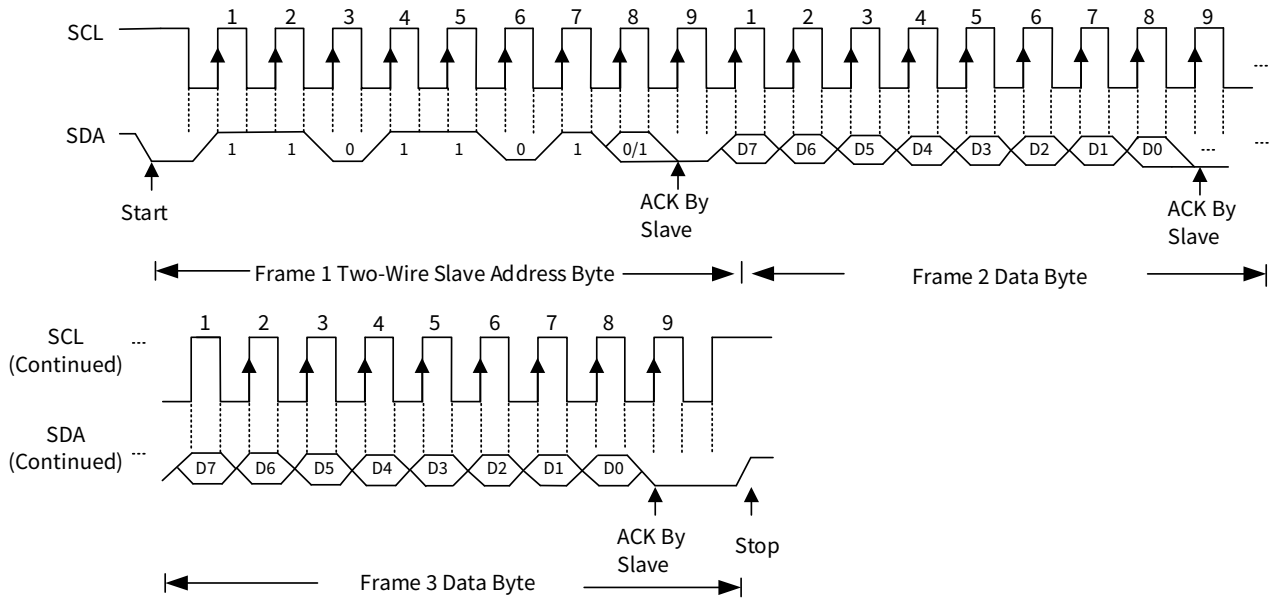


Figure 6.4 I²C Protocol

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

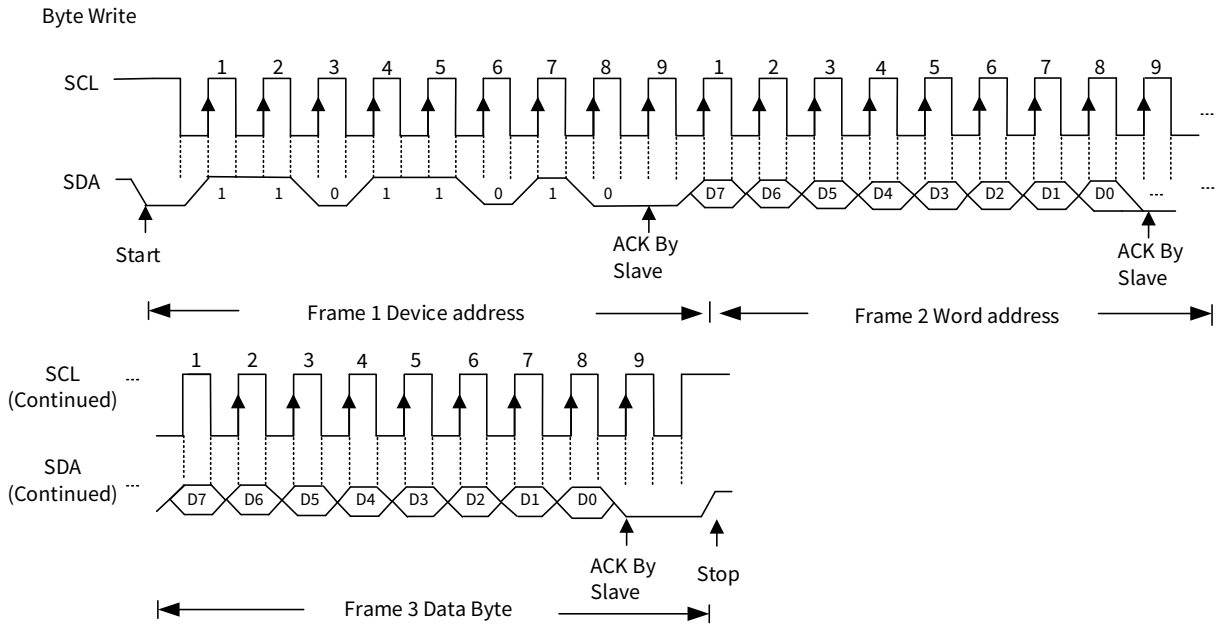


Figure 6.5 I²C Write Byte

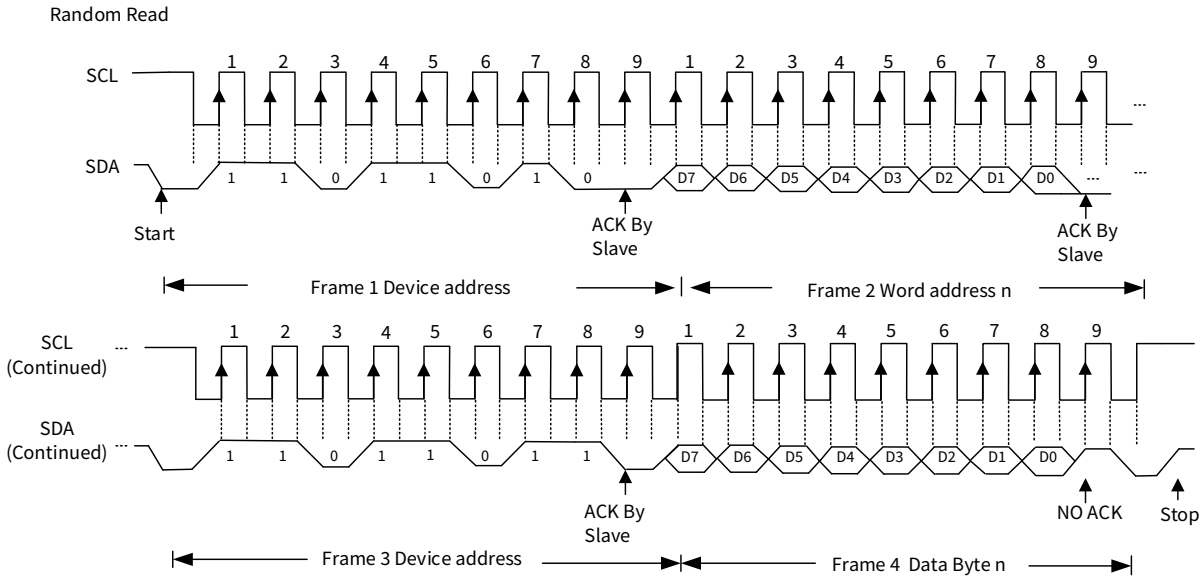


Figure 6.6 I²C Read Byte

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

7. Typical Application

7.1. Application Circuit

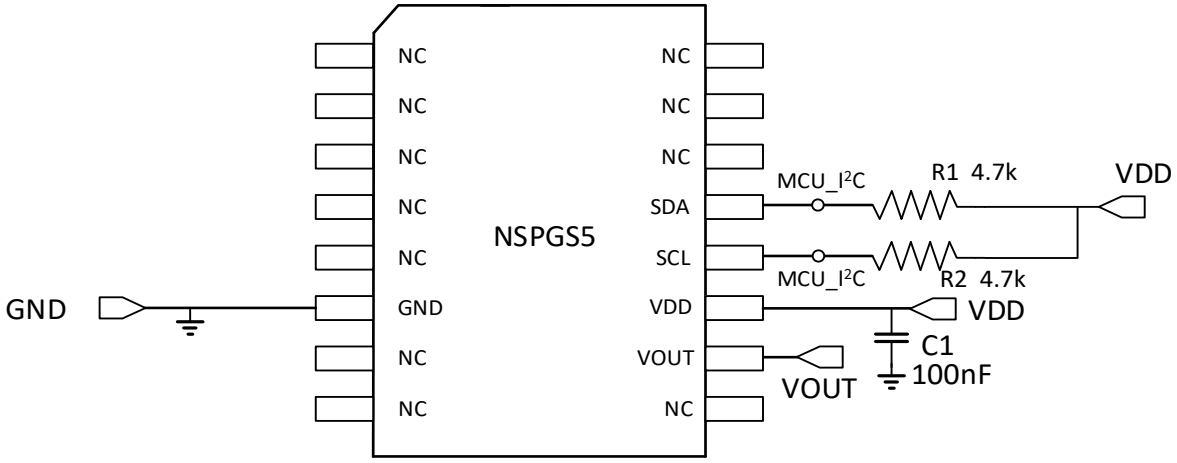


Figure 7.1 NSPGS5 Application Circuit

Note：

1）For applications with higher ESD requirements, can add TVS between VOUT and GND and between VDD and GND.

2）Please contact NOVOSENSE for detailed peripheral recommended circuit.

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

8. Package Information

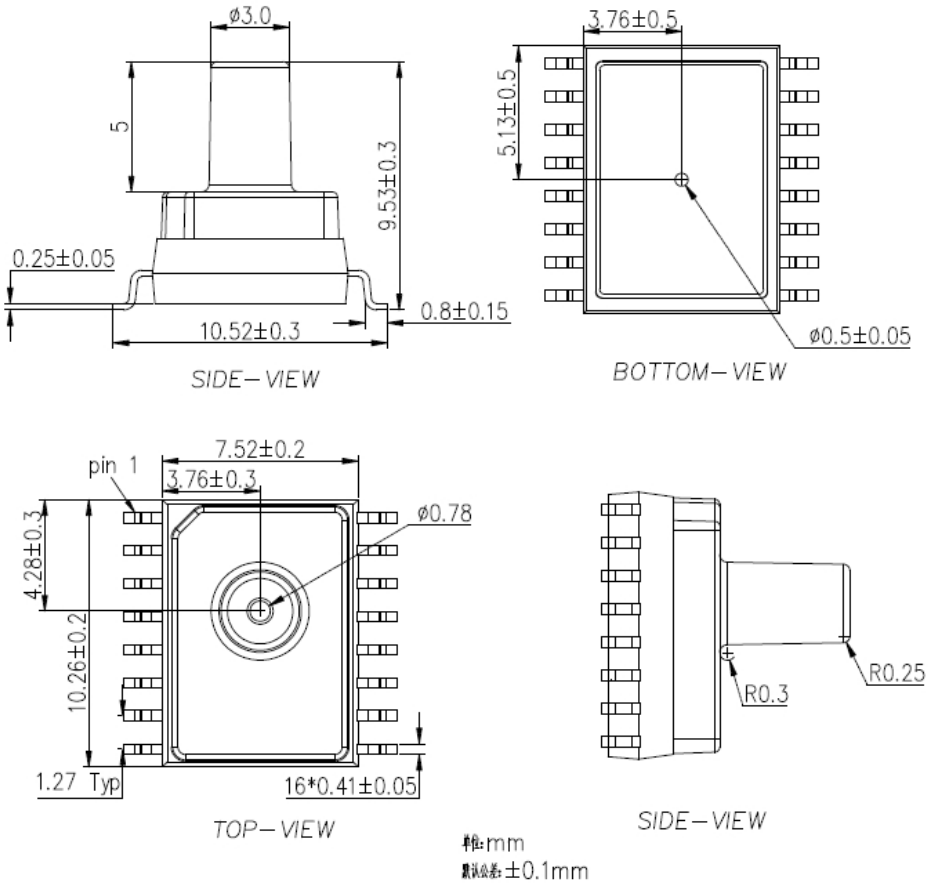


Figure 8.1 SOIC16 Package Outline mm

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

9. Order Information

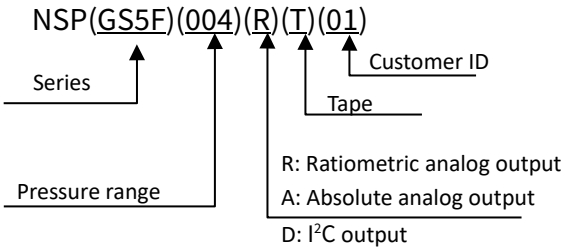
Product No.	Output Type	Pressure Range		Output Range		Gain and Offset		Supply Voltage	Accuracy	
		P_L	P_H	O_L	O_H	A	B		Initially	Full life
NSPGS5F004RT01	Ratiometric	0cmH_2O	40cmH_2O	0.50V	4.50V	0.020000	0.100000	5.00V	±1%	±2%
NSPGS5F004AT02	Absolute	0cmH_2O	40cmH_2O	0.33V	2.97V	0.020000	0.100000	3.30V	±1%	±2%
NSPGS5F007RT03	Ratiometric	0cmH_2O	70cmH_2O	0.50V	4.50V	0.011400	0.100000	5.00V	±1%	±2%
NSPGS5F010AT04	Absolute	0kPa	10kPa	0.33V	2.97V	0.080000	0.100000	3.30V	±1%	±2%
NSPGS5F004DT05	I^2C	0cmH_2O	40cmH_2O	838861	7549746	0.020000	0.100000	5.00V	±1%	±2%
NSPGS5F008AT06	Absolute	0kPa	8kPa	0.50V	4.50V	0.100000	0.100000	5.00V	±1%	±2%
NSPGS5F010DT07	I^2C	0kPa	10kPa	838861	7549746	0.080000	0.100000	3.30V	±1%	±2%

Please scan the following QR code or visit the download link for complete part number list.

https://www.novosns.com/Public/Uploads/uploadfile4/nspgs5-series.pdf

NSPGS5 Series

Naming Convention:



Copyright © 2024, NOVOSENSE

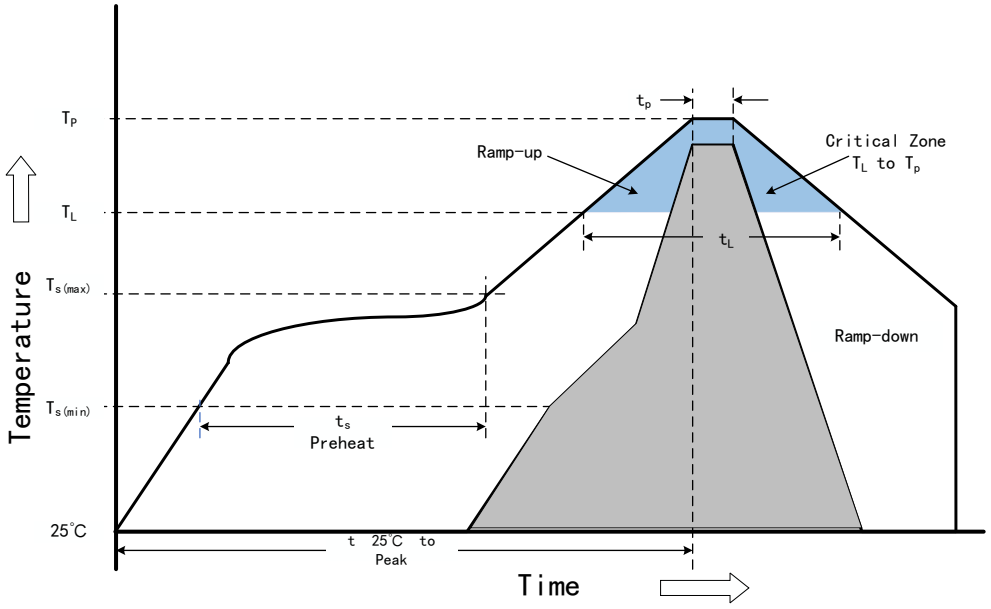
深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

10. Soldering Parameters

10.1. Reflow Soldering (SMD Terminal)

Table 10.1 Soldering Parameters

Reflow Condition		*Lead-free assembly*
Pre Heat	Temperature Min (T_s(min))	150°C
	Temperature Max (T_s(max)	180°C
	Time (min to max) (t_s)	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 (t_p)		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



10.2. Manual Soldering

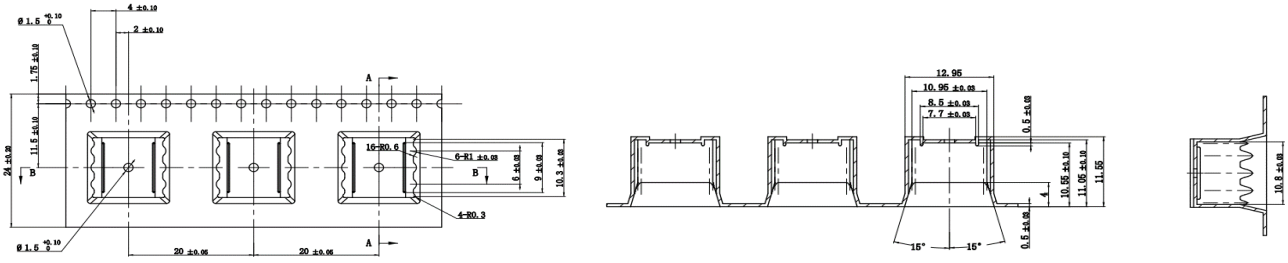
- Raise the temperature of the soldering tip between 260 °C and 300 °C and solder within 5 seconds.
- Use a flattened soldering tip when performing rework on the solder bridge.
- Complete rework in one time

Copyright © 2024, NOVOSENSE

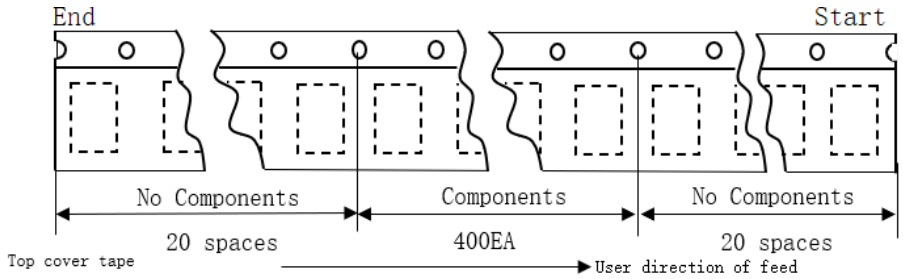
深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

11. Packing Information

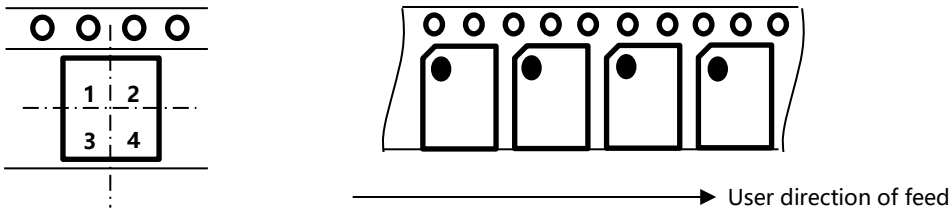
User direction of feed



There is no component at the head and tail of each tape, with a spacing of 20 spaces, as shown in the following figure.



Pin1 is located at the first quadrant, as shown in the following figure.



Minimum ordering quantity (MOQ): 400EA.
Standard pack quantity (SPQ): 400EA.

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

12. Revision History

Revision	*Description*	*Date*
0.1	Initial Version.	2020/12/19
1.0	Update Operating temperature range, package outline, delete the description of accuracy.	2022/11/16
2.0	Update order information and add barcode, I^2C Timing Diagram, I^2C code, electrical characteristic and order information and packing information.	2023/12/04
2.1	Update I^2C Timing Diagram.	2024/05/21

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

Notes：

1. I²C 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
{
```

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

```
    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 I2C
{
    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)
```

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

```
                Receive_Data++;
            Delay_us(2);
        }
        IIC_SCL(0);
        Delay_us(2);
        if(ACK==0x01)
            IIC_ACK();
        else
            IIC_NACK();
        return Receive_Data;
}

void NSPGS5F004DT05_Write_Byte(uchar WriteAddr,uchar WriteData)
{
        IIC_Start();
        IIC_Send(0xDA|0x00);
        IIC_Wait_ACK();
        IIC_Send(WriteAddr);
        IIC_Wait_ACK();
        IIC_Send(WriteData);
        IIC_Wait_ACK();
        IIC_Stop();
}

void NSPGS5F004DT05_Read_Byte(uchar ReadAddr, uchar *pBuffer)
{
        IIC_Start();
        IIC_Send(0xDA|0x00);
        IIC_Wait_ACK();
        IIC_Send(ReadAddr);
        IIC_Wait_ACK();
        IIC_Start();
        IIC_Send(0xDA|0x01);
        IIC_Wait_ACK();
        pBuffer[0]=IIC_Receive(0);
        IIC_Stop();
}

void NSPGS5F004DT05_Read_3Byte(uchar ReadAddr,uchar *pBuffer)
{
        IIC_Start();
        IIC_Send(0xDA|0x00);
        IIC_Wait_ACK();
        IIC_Send(ReadAddr);
        IIC_Wait_ACK();
        IIC_Start();
        IIC_Send(0xDA|0x01);
        IIC_Wait_ACK();
        pBuffer[0]=IIC_Receive(ACK);
```

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

```
    pBuffer[1]=IIC_Receive(ACK);
    pBuffer[2]=IIC_Receive(NACK);
    IIC_Stop();
}

void main()
{
     uchar PData[3]={0,0,0};
     delay_ms(7);
     NSPGS5F004DT05_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)/( 0.02);      //PCode=(AxP+B)∗8388607     P=(PCode/8388607-B)/A
                                                         //PNormalized=PCode/8388607
     }
}
```

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com

IMPORTANT NOTICE

The information given in this document (the “Document”) shall in no event be regarded as any warranty or authorization of, express or implied, including but not limited to accuracy, completeness, merchantability, fitness for a particular purpose or infringement of any third party’s intellectual property rights.

Users of this Document shall be solely responsible for the use of NOVOSENSE’s products and applications, and for the safety thereof. Users shall comply with all laws, regulations and requirements related to NOVOSENSE’s products and applications, although information or support related to any application may still be provided by NOVOSENSE.

This Document is provided on an “AS IS” basis, and is intended only for skilled developers designing with NOVOSENSE’s products. NOVOSENSE reserves the rights to make corrections, modifications, enhancements, improvements or other changes to the products and services provided without notice. NOVOSENSE authorizes users to use this Document exclusively for the development of relevant applications or systems designed to integrate NOVOSENSE’s products. No license to any intellectual property rights of NOVOSENSE is granted by implication or otherwise. Using this Document for any other purpose, or any unauthorized reproduction or display of this Document is strictly prohibited. In no event shall NOVOSENSE be liable for any claims, damages, costs, losses or liabilities arising out of or in connection with this Document or the use of this Document.

For further information on applications, products and technologies, please contact NOVOSENSE (www.novosns.com).

Suzhou NOVOSENSE Microelectronics Co., Ltd

Copyright © 2024, NOVOSENSE

深圳市满度科技有限公司
Web:www.manduic.com
Tel:150-1290-5940
Email:sales@manduic.com