Pressure Sensor HPSxxxGS Series

Features

- Compact size, MEMS technology
- Measuring range: ±10kPa, ±40kPa, ±100kPa, ±200kPa
- High-speed I^2C interface
- High-precision pressure monitor, wide temperature compensation
- SOP SMD package, easy to install and seal

Applications

- Intelligent electronic blood pressure monitors, oxygen concentrators, air wave therapy devices and other medical fields
- Massagers, massage chairs, air mattresses, sleep aid neck pillows and other sports and fitness equipment fields
- Smart vacuum cleaners, vacuum juicers and other small household appliances
- Beer machines, coffee machines, vacuum pumps, pressure instruments and other fields

Overview

HPSxxxGS series sensors are integrated, digital output pressure sensors with the characteristics of miniaturization, high precision, high sensitivity and high reliability.

HPSxxxGS series sensors integrate the pressure sensor MEMS chip and signal conditioning chip to digitally compensate the zero point, sensitivity, temperature drift and nonlinearity of the sensor, output a calibrated and temperature compensated measurement data, and provide standard I2C Communication Interface.

HPSxxxGS series sensors are packaged in SOP and comply with RoHS standards, making it convenient for customers to weld, install and use. They are widely used in medical electronics, automotive electronics, sports and fitness equipment and other fields.

Maximum Rated Parameters

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Max. Working Voltage	VDDmax	-0.3		+6.5	V	
Proof Pressure	Pproof		3X		FS	
Burst Pressure	Pburst		5X		FS	
ESD Protection	HBM		2		kV	
Storage Temperature	Tstg	-40		+100	℃	

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Operating Voltage	VDDop	3	3.3	3.6	V	VDD=3.3V
		4.5	5.0	5.5	V	VDD=5.0V
Operating Pressure	Pop	-200		+200	kPa	
Operating Temperature	Top	-20		+85	℃	

Electrical Parameters

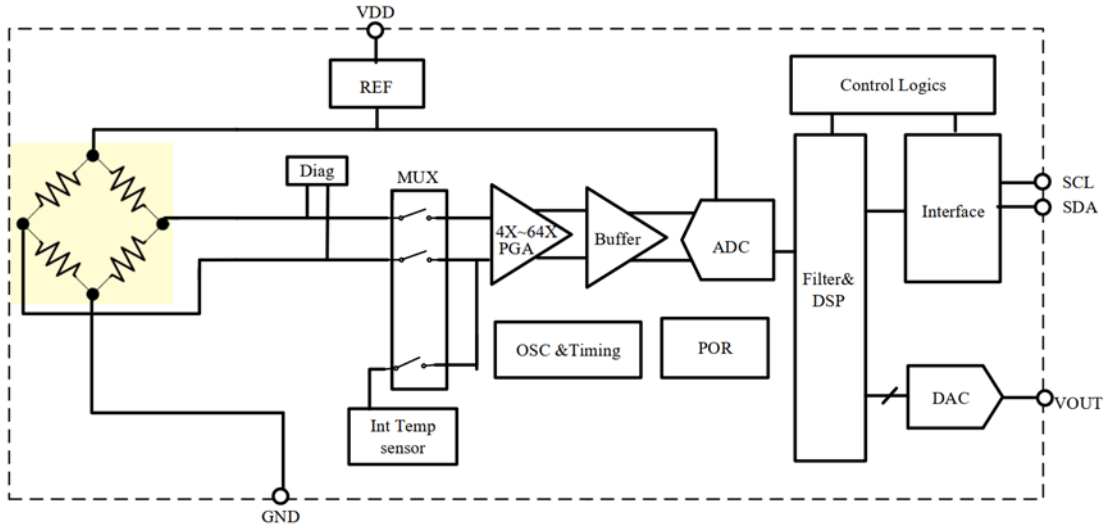
Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Power-on Reset	VDDpor		2.00		V	
Operating Current	Iaverage		1.60		mA	
	Istandby			200	nA	
ADC Resolution	RESraw		24		bits	
ADC Conversion Time	Tact		1.54		ms	@OSR=256X
			1.86		ms	@OSR=512X
			2.50		ms	@OSR=1024X
			3.78		ms	@OSR=2048X
			6.34		ms	@OSR=4096X
			11.46		ms	@OSR=8192X
			21.70		ms	@OSR=16384X
			42.18		ms	@OSR=32768X
Power Supply Rejection Ratio	PSRR	90	120		dB	
SCL/SDA Pull-up Resistor	Rpu		4.70		kOhm	
Compensation Temperature Range	Tcom	0		+85	℃	
Total Accuracy	ACC		1.50 %		@FS	-20℃ ~ +85℃

I2C Communication Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Clock Frequency	Fclk			400	kHz	
Low Pulse Holding Time for Clock	Tlow	1.3			us	
High Pulse Holding Time for Clock	Thigh	0.6			us	
Set-up Time for SDA	Tsuda	0.1			us	
Holding Time for SDA	Thdda	0			us	
Set-up Time for Start Condition	Tsusta	0.6			us	
Holding Time for Start Condition	Thdsta	0.6			us	
Set-up Time for Stop Condition	Tsusto	0.6			us	
Interval Time between Two Communications	Tbuffer	1.3			us	

Product Description

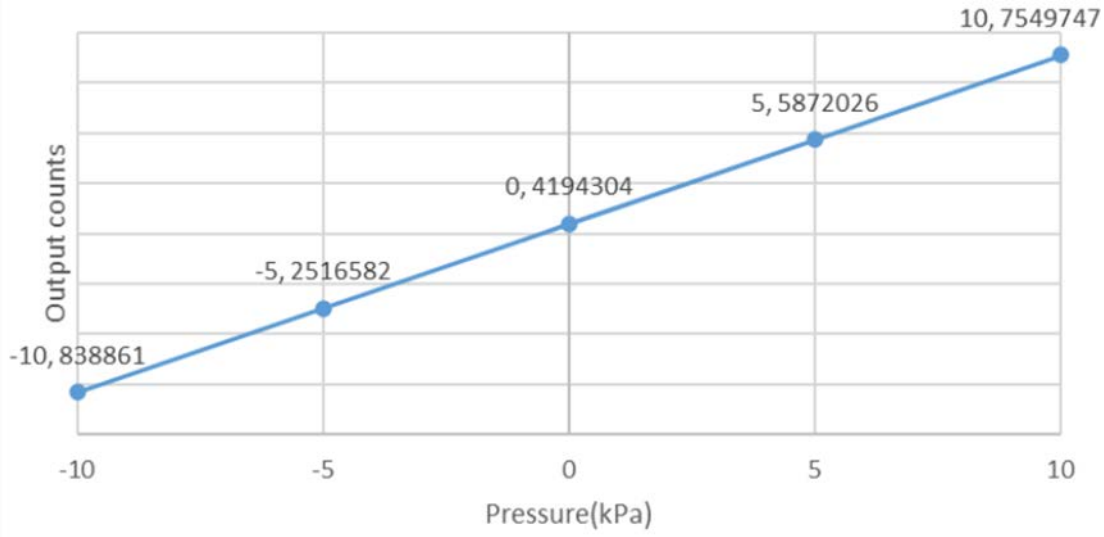
The HPSxxxGS series pressure sensor integrates a MEMS pressure chip and a signal conditioning chip. It digitally compensates the zero point, sensitivity, temperature drift and nonlinearity of the sensor through a 2 4 -bit ADC, and outputs a signal that is linear with the applied pressure. After calibration Digital signals are accessible through the digital I2C interface.



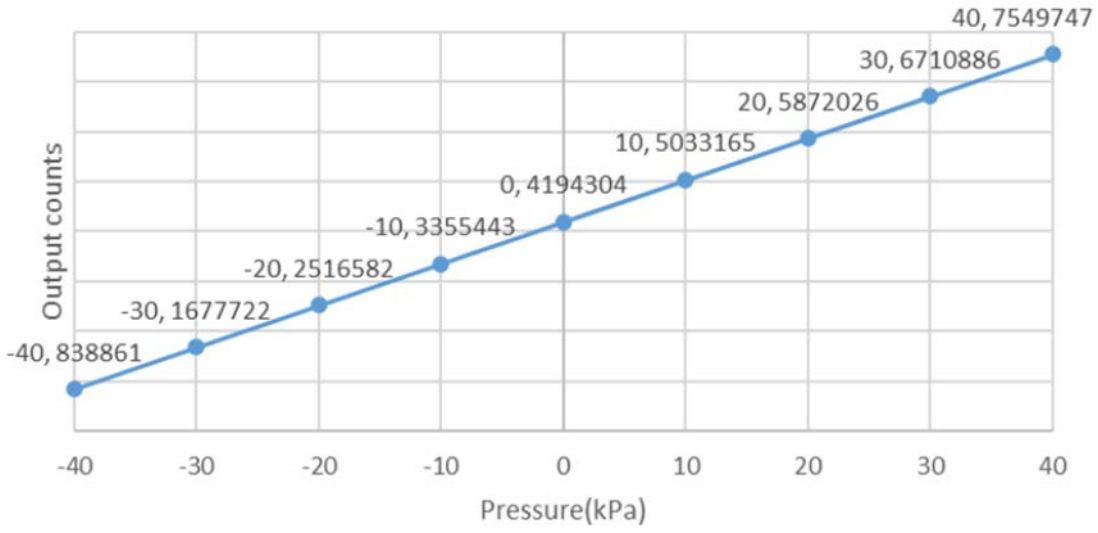
System functional block diagram

Digital Output Characteristic Curve

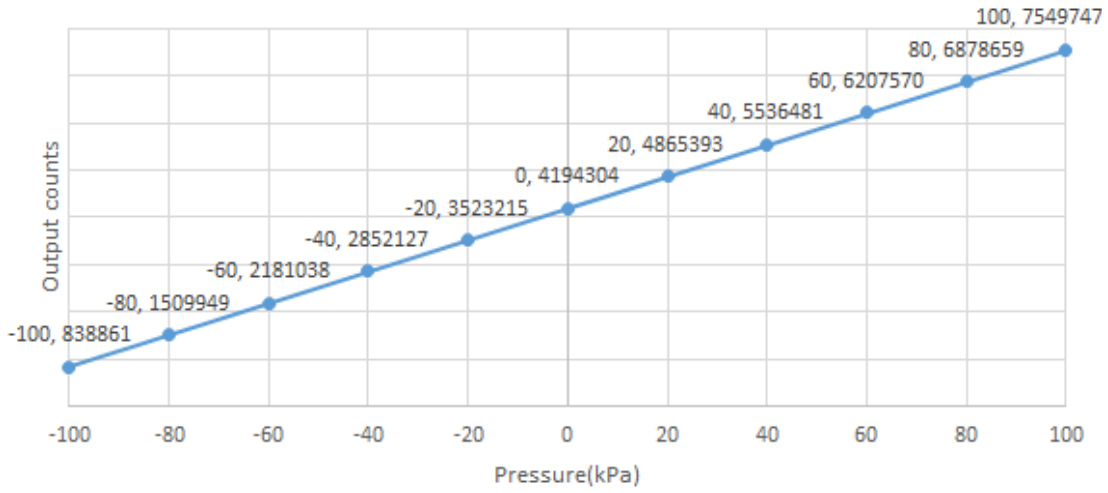
HPSxxxGS series pressure sensors are calibrated within the specified pressure range from Pmin to Pmax. The following figure shows the relationship curve between AD value and pressure value.



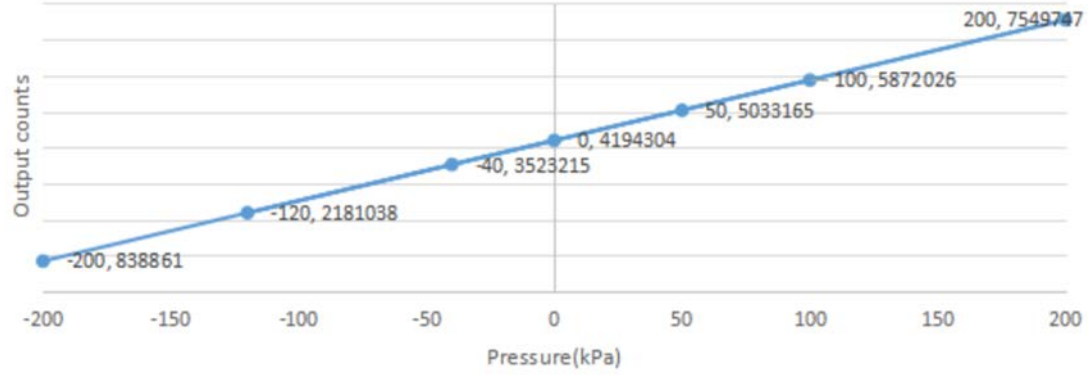
HPS010GS Counts VS Pressure (kPa)



HPS040GS Counts VS Pressure (kPa)



HPS100GS Counts VS Pressure (kPa)



HPS200GS Counts VS Pressure (kPa)

The data register value can be converted into a pressure value using the following equation:

$$\boldsymbol{P(kPa) = A \times code + B}$$

where $\boldsymbol{code}$is the normalized value of the data register P data /8388608; P is the actual pressure value, the unit is kPa;

Register Description

Address	Bit	Register	Default	Description
0x30	7-4	Reserve<7:4>	4'b 0000	
	3	Sco<3>	1'b 0	1：Data collection starts and automatically returns 0 at the end of collection
	2-0	Measurement_ctrl<2:0>	3'b 000	000b：Single-shot temperature acquisition mode 001b：Single-shot pressure acquisition mode 010b：Combined acquisition mode (one temperature acquisition followed by one pressure acquisition)
0x06	7-0	PDATA<23:16>	0x00	24-bit signed number, stores calibrated pressure data If the highest bit is 0， Pdata=$PDATA_{0x06}$*65536+$PDATA_{0x07}$*256+$PDATA_{0x08}$ If the highest bit is 1， Pdata=$PDATA_{0x06}$*65536+$PDATA_{0x07}$*256+$PDATA0_{x08}$-16777216
0x07	7-0	PDATA<15:8>	0x00	
0x08	7-0	PDATA<7:0>	0x00	
0x09	7-0	TEMP_MSB<7:0>	0x00	Stores calibrated temperature data，1 LSB = 1/256 ℃
0x0A	7-0	TEMP_LSB<7:0>	0x00	
0xA5	1	Raw_data_on<1>	1'b 0	1：Output ADC raw data (valid only in single-shot pressure acquisition mode and single-shot temperature acquisition mode) 0：Output calibrated data；
	0	Reserve<0>	1'b 0	
0xA6	2-0	OSR_P<2:0>	3'b 000	Oversampling rate when acquiring pressure signals 000：256X；001：512X；010：1024X；011：2048X； 100：4096X；101：8192X；110：16384X；111：32768X
0xA7	2-0	OSR_T<2:0>	3'b 000	Oversampling rate when acquiring temperature signals 000：256X；001：512X；010：1024X；011：2048X； 100：4096X；101：8192X；110：16384X；111：32768X

Ordering Information

Part Number	Interface	Range (kPa)		Number normalization		Transfer function coefficients		Voltage (V)
		P_L	P_H	O_L	O_H	A	B	
HPS010GS	I2C	-10	10	0.1	0.9	25	-12.5	3.3V
HPS040GS	I2C	-40	40	0.1	0.9	100	-50	3.3V
HPS100GS	I2C	-100	100	0.1	0.9	250	-125	3.3V
HPS200GS	I2C	-200	200	0.1	0.9	500	-250	3.3V

Pressure Value Calculation Process

Taking HPS010GS as an example, the conversion process of pressure value is as follows:

When the values of the 0x06, 0x07, and 0x08 registers are 0x4F, 0x5C, and 0x29 respectively,

Pdata = 79*65536+92*256+41 = 5200937,

The pressure value P (kPa) = 25 * Pdata / 8388608 - 12.5 = 3 kPa is obtained.

Data Reading

1) Set the value of the lower 3 bits of the 0xA6 and 0xA7 registers.
   Note: You cannot directly write an 8-bit value. You need to read the value of the 0xA6 and 0xA7 registers first, only modify the lower 3-bit value, and then write 0xA6, 0xA7 register!
2) Read 0xA5 the value of the register, "bitwise AND" the read value 0xFD After that, write 0xA5 register.
3) Send command 0x0A to register 0x30 to collect temperature data and pressure data.
4) Read the value of the 0x30 register. If the Sco bit is 0, it means that the acquisition is completed and the data can be read; otherwise, wait for 10 ms. (When the OSR configuration value is 1 024 X).

5) Read the values of the three registers 0x06, 0x07, and 0x08 to form the 24-bit pressure data AD value.
The 24-bit AD that will be read value, and calculate the final pressure output according to the transfer function characteristics:
$P(kPa) = A \times code + B.$

I²C Communication Protocol

The I²C bus uses SCL and SDA as signal lines. Both lines are connected to VDD through pull-up resistors and remain high when not communicating. The I²C device addresses of this series of products are as follows:

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

The I²C communication protocol has special start (S) and stop (P) conditions.

When SCL is high, the falling edge of SDA marks the start of data transfer.

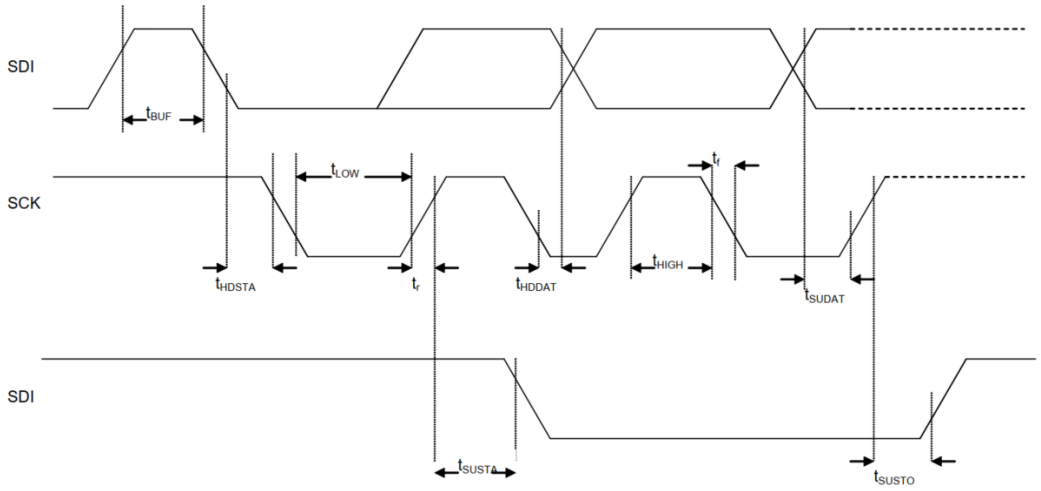
The I²C master device in turn sends the slave device's address (7 bits) and the read/write control bit (1 bit). When the slave device recognizes this address, it generates a response signal and pulls SDA low in the 9th cycle. After getting the response from the slave device, the master device continues to send the 8-bit register address. After getting the response from the slave device, the master device continues to send or read data.

When SCL is at high level, the rising edge of SDA marks the end of data transfer.

In addition to the start and end flags, data transferred by SDA must remain stable when SCL is high. When SCL is low, the data transmitted by SDA can change.

All data transmission in I²C communication is based on 8 bits, and every 8 bits After a bit of data is transmitted, an acknowledge signal is required to keep the transmission going.

I²C Communication Timing



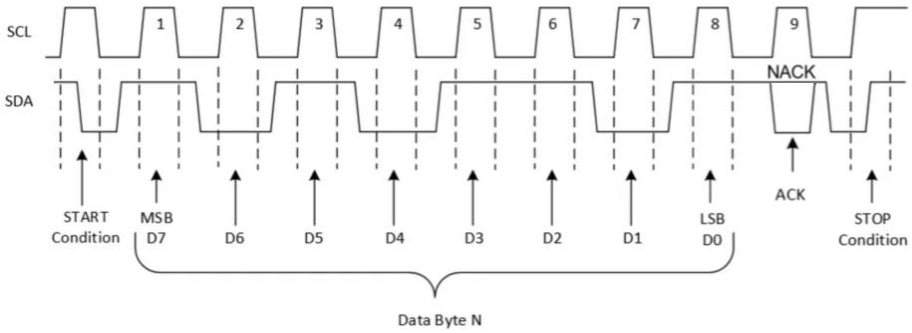
I²C Read and Write Timing

The I²C interface protocol has special bus signal conditions. I²C communication begins with a START condition sent by the master and ends with a STOP condition sent by the master.

START condition: When SCL is high level, the level on SDA changes from high to low.

STOP condition: When SCL is high, the level on SDA changes from low to high.

When the slave is addressed, the master should release SDA in the 9th clock cycle, and the slave should pull the SDA level low as a response signal. When SDA remains high in the 9th clock cycle, it is regarded as a non-acknowledge signal.



I²C communication protocol

I²C Write Timing

The write operation is accomplished by sending the slave address in write mode (read and write bits are 0), resulting in the slave write address 11111110b. The host then sends pairs of register addresses and corresponding values. The write operation is terminated with a STOP condition.

The graphic table is written with 0x30 Register as an example:

									Control byte									Data byte									
Start	Slave Address							RW	ACKS	Register Address(30h)								ACKS	Register Data								ACKS	Stop
S	1	1	1	1	1	1	1	0		0	0	1	1	0	0	0	0		bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0		P

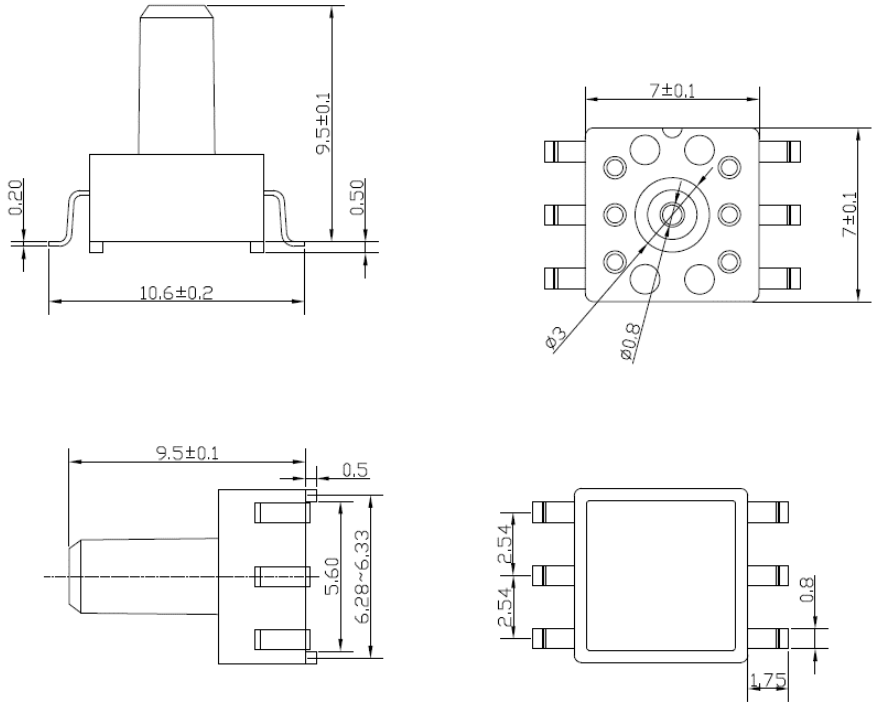
I²C Read Timing

Before starting the read operation, the register address is first sent in write mode (slave address 11111110b), then the start signal is regenerated, and then the slave is addressed in read mode with the I2C address (11111111b). The slave starts sending the register value from the register address until a NOACK signal and a stop condition are generated, and the read operation ends.

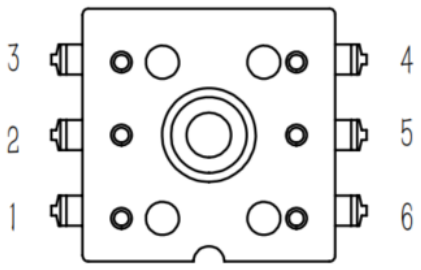
The table in the figure takes reading 0x06, 0x07, and 0x08 registers as an example:

										Control byte																	
Start	Slave Address							RW	ACKS	Register Address(06h)								ACKS									
S	1	1	1	1	1	1	1	0		0	0	0	0	0	1	1	0										
										Data byte																	
Start	Slave Address							RW	ACKS	Register Data(06h)								ACKM									
S	1	1	1	1	1	1	1	1		bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0										
										Data byte																	
										Register Data(07h)								ACKM									
										bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0										
										Data byte																	
										Register Data(08h)								NOACKM									Stop
										bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0										P

Dimensions



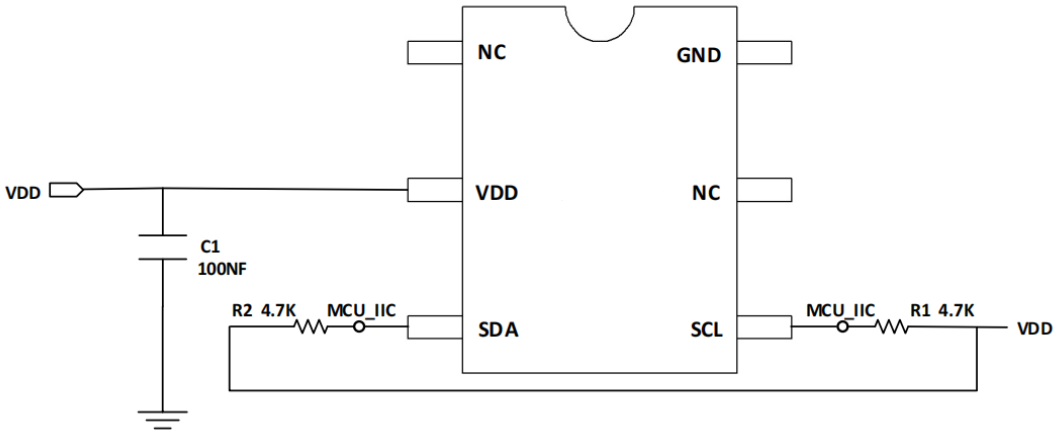
Pin Definition (Top View)



管脚标号
(俯视图，从气孔方向)

Pin	Name	I/O Type	Description
1	GND	Supply	land
2	NC	- -	- -
3	SCL	In	clock
4	SDA	In/Out	data
5	VDD	Supply	power supply
6	NC	- -	- -

Application Circuit



Note:

Recommended value of C filter capacitor is 100 nF

R_p pull-up resistor recommended value is 4.7 KΩ

Selection Guide

Code	HPS	xxx	G	S	x
Description	HOPE Pressure Sensor	Range	Type	Package	Packaging
Specification		010: ±10 kPa 040: ±40 kPa 100: ±100 kPa 200: ±200 kPa	A: Absolute G: Gauge D: Differential	S: SMT	T: Tube R: Reel & Tape

Item	Part Number	Range	Type	Package	Packaging
1	HPS010GSR	±10 kPa	Gauge	SOP6	Reel & Tape
2	HPS010GST	±10 kPa	Gauge	SOP6	Tube
3	HPS040GSR	±40 kPa	Gauge	SOP6	Reel & Tape
4	HPS040GST	±40 kPa	Gauge	SOP6	Tube
5	HPS100GSR	±100 kPa	Gauge	SOP6	Reel & Tape
6	HPS100GST	±100 kPa	Gauge	SOP6	Tube
7	HPS200GSR	±200 kPa	Gauge	SOP6	Reel & Tape
8	HPS200GST	±200 kPa	Gauge	SOP6	Tube

Product Packaging

Tube packaging, each tube is 70EA, 20 tubes per box, minimum order quantity (MOQ) 1400EA.

Reel & Tape packaging, each reel is 400EA, 2 reels per box, minimum order quantity (MOQ) 1600EA.

Precautions for Use

- Install

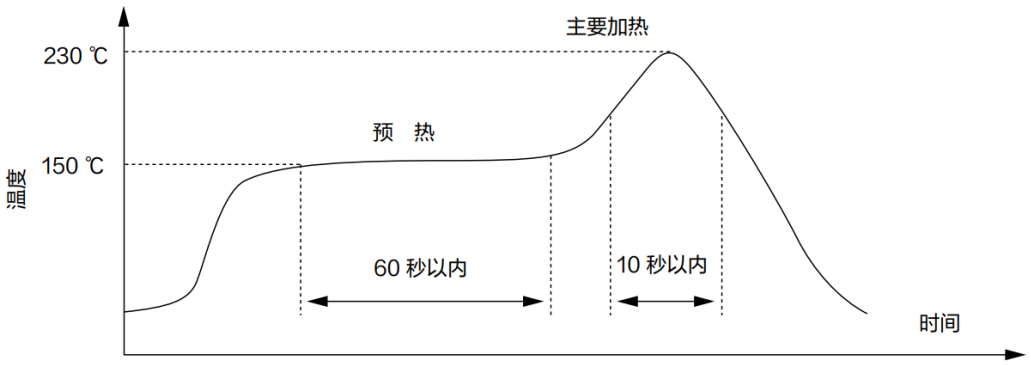
  Please use printed board pads so that the product can be adequately fixed.

- Welding

  Since this sensor has a small structure with a small heat capacity, please try to reduce the influence of heat from the outside. Otherwise, it may cause damage due to thermal deformation and affect the characteristics; please use non-corrosive rosin-type flux, and pay attention Do not allow flux to enter the inside of this sensor.

  1) Soldering iron welding
     - ✧ Please use a soldering iron with a temperature of 260 ~ 300 ℃ to complete the work within 5 seconds.
     - ✧ Soldering on the pins, it should be left for a while before use.
     - ✧ Clean the soldering iron tip regularly to keep it clean.
  2) Reflow soldering

     The recommended setting conditions for reflow soldering are as follows:



  3) Applying excessive external force to the pins can cause deformation and impair solderability, so please avoid dropping the sensor or performing complicated use.
  4) Try to keep the curvature of the PCB board relative to the entire sensor. Below 0.05mm.

Update Record

Version	Content	Date
1.0	Officially released	2019.08.13
1.1	Revised edition	2019.10.24
1.2	Add customized range	2022.03.12
1.22	Add packaging description	2023.03.20