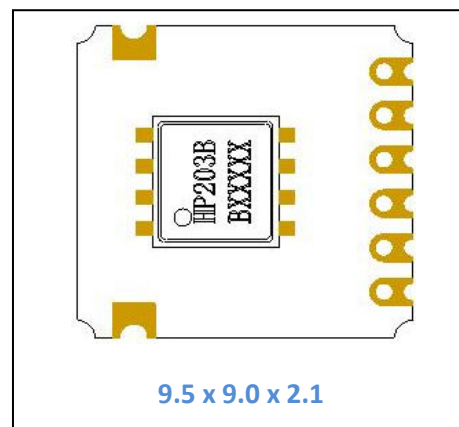


PRECISION BAROMETER AND ALTIMETER SENSOR

Features

Supply voltage: 1.8V to 3.6V
Pressure range: 300mbar~1200mbar
Programmable events and interrupt controls
Fully data compensated
Direct Reading, compensated:
-Pressure: 20-bit measurement (Pascals)
-Altitude: 20-bit measurement (Meters)
-Temperature: 20-bit measurement (Degrees Celsius)
Altitude Resolution down to 0.1 meter
Standby current: <0.1μA
Operation temperature: -40 to +85℃
High-speed I²C digital output interface
Size: 9.5 x 9.0 x 2.1 mm



Applications

Mobile altimeter / barometer
Smart phones / tablets
Industrial pressure and temperature sensor system
Adventure and sports watches
Weather station equipment
Indoor navigation and map assist
Data loggers for pressure, temperature and altitude
GPS enhancement for emergency services

Descriptions

The HPNSC02-203 employs a MEMS pressure sensor with an I²C interface to provide accurate temperature, pressure or altitude data. The sensor pressure and temperature outputs are digitized by a high resolution 24-bit ADC. The altitude value is calculated by a specific patented algorithm according to the pressure and temperature data. Data compensation is integrated internally to save the effort of the external host MCU system. Easy command-based data acquisition interface and programmable interrupt control is available. Typical active supply current is 5.3μA per measurement-second while the ADC output is filtered and decimated by 256. Pressure output can be resolved with output in fractions of a Pascal, and altitude can be resolved in 0.1 meter. Package is surface mount with a stainless steel cap and is RoHS compliant.

1. Block Diagram

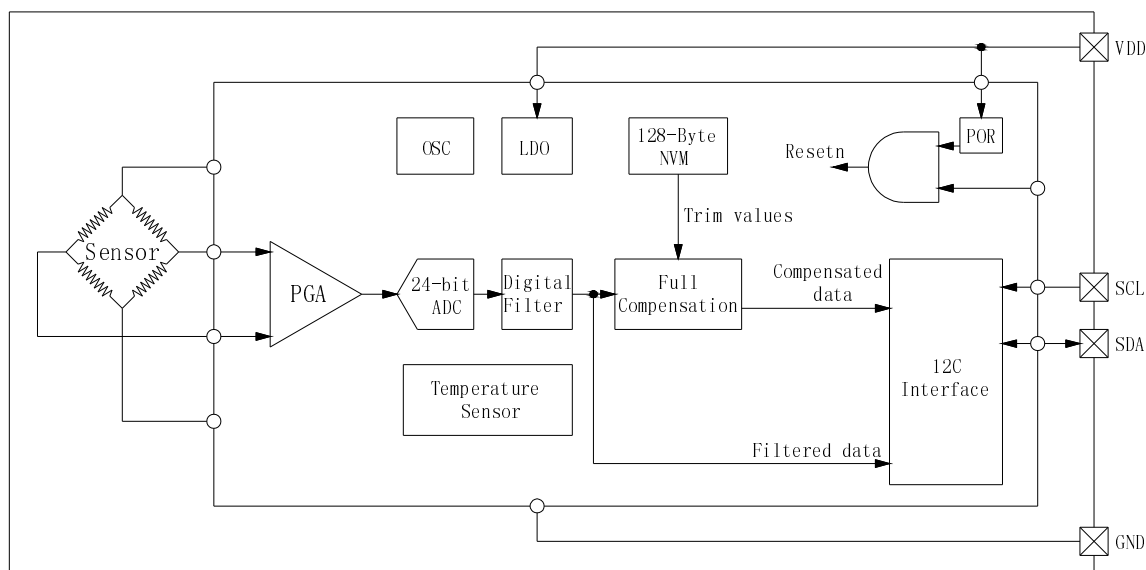


Figure 1: Functional block diagram

2. Mechanical and Electrical Specifications

2.1 Pressure and Temperature Characteristics

Table1: Pressure Output Characteristics @ VDD = 3.0V, T = 25°C unless otherwise noted

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Pressure Measurement Range	P _{FS}		300		1200	mbar
Pressure Absolute Accuracy		700 to 1100 mbar From 0°C to 50°C	-1.5		+1.5	mbar
		700 to 1100 mbar From -20°C to 70°C	-3		+3	mbar
Pressure Relative Accuracy		700 to 1100 mbar at 25°C		±1.0		mbar
		700 to 1100 mbar From 0°C to 50°C		±2.0		
Max Error with Power Supply		Power supply from 1.8V to 3.6V	-2.5		+2.5	mbar
Pressure/Altitude Resolution		Pressure Mode		0.01		mbar
		Altimeter Mode		10		cm
Long Term Drift		After a period of 1 year		±2.0		mbar

Table2: Temperature Output Characteristics @ VDD = 3.0V, T = 25°C unless otherwise note

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operation Temperature Range	T _{OP}		-40		85	°C
Temperature Absolute Accuracy		25°C		±0.5	±0.8	°C
		-10°C to +70°C		±1.0	±1.5	°C
		-40°C to +85°C		±1.5	±4.0	°C
Max Error with Power		Power supply from 1.8V to 3.6V			±0.5	°C
Temperature Resolution of Output Data				0.01		°C

2.2 Electrical Characteristics

Table3: DC Characteristics @V_{DD}=3 V, T=25°C unless otherwise note

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Operation Supply Voltage	V _{DD}			1.8	3.0	3.6	V
Operation Temperature	T _{OP}			-40		85	°C
Average Operation Current (Pressure Measurement under One Conversion per Second)	I _{DDAVP}	OSR*	4096		43.7		μA
			2048		21.9		
			1024		11.1		
			512		5.7		
			256		3.0		
			128		1.5		
Average Operation Current (Temperature measurement under One Conversion per Second)	I _{DDAVT}	OSR*	4096		34		μA
			2048		17		
			1024		8.6		
			512		4.4		
			256		2.3		
			128		1.1		
Conversion Time of Pressure or Temperature	t _{CONV}	OSR*	4096		16.2		ms
			2048		8.1		
			1024		4.1		
			512		2.1		
			256		1.1		
			128		0.53		
Peak Current	I _{PEAK}	During conversion			1.3		mA
Standby Supply Current	I _{DDSTB}	At 25°C				0.1	μA
Serial Data Clock Frequency	f _{SCLK}	I ² C protocol, pull-up resistor of 10k			100	400	kHz
Digital Input High Voltage	V _{IH}			0.8			V _{DD}
Digital Input Low Voltage	V _{IL}					0.2	V _{DD}
Digital Output High Voltage	V _{OH}	I _O = 0.5 mA		0.9			V _{DD}
Digital Output Low Voltage	V _{OL}	I _O = 0.5 mA				0.1	V _{DD}
Input Capacitance	C _{IN}					4.7	uF

*OSR stands for over sampling rate

2.3 Absolute Maximum Rating

Table 4

Parameter	Symbol	Conditions	Min	Max	Unit
Overpressure	P_{MAX}			3	bar
Supply Voltage	V_{DD}		-0.3	3.6	V
Interface Voltage	V_{IF}		-0.3	$V_{DD}+0.3$	V
Storage Temperature Range	T_{STG}		-50	150	°C
Maximum Soldering Temperature	T_{MS}	40 second maximum		250	°C
ESD Rating		Human body model	-2	+2	kV
Latch-up Current		At 85°C	-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.

3. Function Descriptions

3.1 General Description

The HPNSC02-203 is a high precision barometer and altimeter that measures the pressure and the temperature by an internal 24-bit ADC and compensates them by a patented algorithm. The fully-compensated values can be read out via the I²C interface by external MCU. The uncompensated values can also be read out in case the user wants to perform their own data compensation. The devices can also compute the value of altitude according to the measured pressure and temperature. Furthermore, the device allows the user to setup the temperature, pressure and altitude threshold values for various events. Once the device detects that a certain event has happened, a corresponding interrupt will be generated and sent to the external MCU. Also, multiple useful interrupt options are available to be used by the user.

3.2 Factory Calibration

Every device is individually factory calibrated for sensitivity and offset for both of the temperature and pressure measurements. The trim values are stored in the on-chip 128-Byte Non-Volatile Memory (NVM). In normal situation, further calibrations are not necessary to be done by the user.

3.3 Automatic power on initialization

Once the device detects a valid VDD is externally supplied, an internal Power-On-Reset (POR) is generated and the device will automatically enter the power-up initialization sequence. After that the device will enter the sleep state. Normally the entire power-up sequence consumes about 400 us. The user can scan a DEV_RDY bit in the INT_SRC register in order to know whether the device has finished its power-up sequence. This bit appears to 1 when the sequence is done. The device stays in the sleep state unless it receives a proper command from the external MCU. This will help to achieve minimum power consumptions.

3.4 Sensor Output Conversion

For each pressure measurement, the temperature is always being measured prior to pressure measurement automatically, while the temperature measurement can be done individually. The conversion results are stored into the embedded memories that retain their contents when the device is in the sleep state.

The conversion time depends on the value of the OSR parameter sent to the device within the ADC_CVT command. Six options of the OSR can be chosen, range from 128, 256 ... to 4096. The below table shows the conversion time according to the different values of OSR:

Table 5: Conversion Time VS OSR

OSR	Conversion Time (ms)	
	Temperature	Temperature and Pressure (or Ititude)
128	0.53	1.1
256	1.1	2.1
512	2.1	4.1
1024	4.1	8.1
2048	8.1	16.2
4096	16.2	32.4

The higher OSR will normally achieve higher measuring precision, but consume more time and power.

The conversion results can be compensated or uncompensated. The user can enable/disable the compensation by setting the PARA register before performing the conversions.

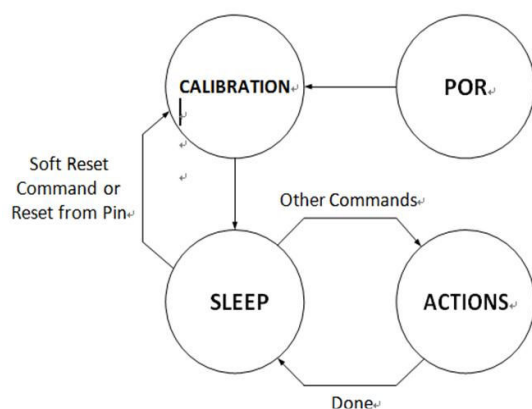
3.5 Altitude Computation

The device can compute the altitude according to the measured pressure and temperature. The altitude value is updated and available to read as soon as the temperature and pressure measurement is done.

4. Access Modes & Commands

4.1 Operation Flow

During each power-up/reset cycle, the device will only perform one calibration. After that it will enter the SLEEP state waiting for any incoming commands. It will take actions after receiving different proper commands, and re-enters the SLEEP state when it finishes the jobs.



4.2 Command

The Command Set (Table 6) allows the user to control the device to perform the measuring, results reading and the miscellaneous normal operations.

4.2.1 Soft Reset the Device

.SOFT_RST (0x06)

Once the user issues this command, the device will immediately be reset no matter what it is working on. Once the command is received and executed, all the memories (except the NVM) will be reset to their default values following by a complete power-up sequence to be automatically performed.

4. 2.2 OSR and Channel Setting

.ADC_CVT (010, 3-bit OSR, 2-bit CHNL)

This command let the device to convert the sensor output to the digital values with or without compensation depends on the PARA register setting. The 2-bit channel (CHNL) parameter tells the device the data from which channel(s) shall be converted by the internal ADC. The options are shown below:

00: sensor pressure and temperature channel
10: temperature channel

The 3-bit OSR defines the decimation rate of the internal digital filter as shown below:

000: OSR = 4096 011: OSR = 512
001: OSR = 2048 100: OSR = 256
010: OSR = 1024 101: OSR = 128

Setting the CHNL bits to the value of 01 or 11, or the OSR bits to the values of 110 or 111 will lead to failure of conversion.

4. 2.3 Read the Temperature and Pressure Values

READ_PT (0x10)

This command allows the user to read out the 24-bit temperature conversion result and 24-bit pressure conversion result in sequence, starting from the MSB of the temperature data and ending with the LSB of the pressure data.

For Example :(Temperature)

Hex value	OUT_T_MSB	OUT_T_CSB	OUT_T_LSB	Dec value
0x000A5C	0x00	0x0A	0x5C	26.52
0xFFFC02	0xFF	0xFC	0x02	-10.22

For Example :(Unsigned data pressure)

Hex value	OUT_P_MSB	OUT_P_CSB	OUT_P_LSB	Dec value
0x018A9E	0x01	0x8A	0x9E	1010.22

4. 2.4 Read the Temperature and Altitude Values

.READ_AT (0x11)

This command allows the user to read out the 24-bit temperature conversion result and 24-bit altitude conversion result in sequence, starting from the MSB of the temperature data and ending with the LSB of the altitude data.

For Example :(Altitude)

Hex value	OUT_A_MSB	OUT_A_CSB	OUT_A_LSB	Dec value
0x001388	0x00	0x13	0x88	50.00
0xFFEC78	0xFF	0xEC	0x78	-50.00

4. 2.5 Read the Pressure Value

.READ_P (0x30)

This command allows the user to read out the 24-bit pressure conversion result, starting from the MSB.

4. 2.6 Read the Altitude Value

.READ_A (0x31)

This command allows the user to read out the 24-bit altitude conversion result, starting from the MSB.

4. 2.7 Read the Temperature Value

.READ_T (0x32)

This command allows the user to read out the 24-bit temperature conversion result, starting from the MSB.

4. 2.8 Re-calibrate the Internal analog Blocks

.ANA_CAL (0x28)

This command allows the user to re-calibrate the internal circuitries in a shorter time compare to soft resetting the device. It is designed for the applications where the device needs to work in a rapidly changed environment. In those environments, since the temperature and supply voltage may have changed significantly since the first power-up sequence during which the calibrations have been performed, the circuitries may not adept to the world as better as they were just calibrated. Therefore, in this case, re-calibrating the circuitries before performing any sensor conversions can give a more accurate result. Once the device received this command, it calibrates all the circuitries and enters the sleep state when it finishes. The user can simply send this command to the device before sending the ADC_CVT command. However, it is not necessary to use this command when the environment is stable.

4. 2.9 Read the Control Registers

. READ_REG (10, 6-bit register address)

This command allows the user to read out the control registers.

4. 2.10 Write the Control Registers

. WRITE_REG (11, 6-bit register address)

This command allows the user to write in the control register

Table6: The Command Set

Name	Hex Code	Binary Code	Descriptions
SOFT_RST	0x06	0000 0110	Soft reset the device
ADC_CVT	NA	010_dsr_chnl	Perform ADC conversion
READ_PT	0x10	0001 0000	Read the temperature and pressure values
READ_AT	0x11	0001 0001	Read the temperature and altitude values
READ_P	0x30	0011 0000	Read the pressure value only
READ_A	0x31	0011 0001	Read the altitude value only
READ_T	0x32	0011 0010	Read the temperature value only
ANA_CAL	0x28	0010 1000	Re-calibrate the internal analog blocks
READ_REG	NA	10_addr	Read out the control registers
WRITE_REG	NA	11_addr	Write in the control registers

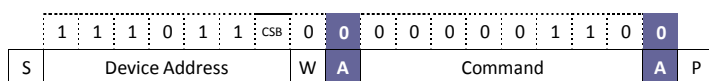
5. I²C Interface

The I²C interface is fully compatible to the official I²C protocol specification. All the data are sent starting from the MSB. Successful communication between the host and the device via the I²C bus can be done using the four types of protocol introduced below.

The 1st TYPE: the host issuing a single byte command to the device

The host shall issue the Device Address (ID) followed by a Write Bit before sending a Command byte. The device will reply an ACK after it received a correct SOFT_RST command.

The 1st TYPE: the host issuing a single byte command to the device



The 2nd TYPE: the host writing a register inside the device

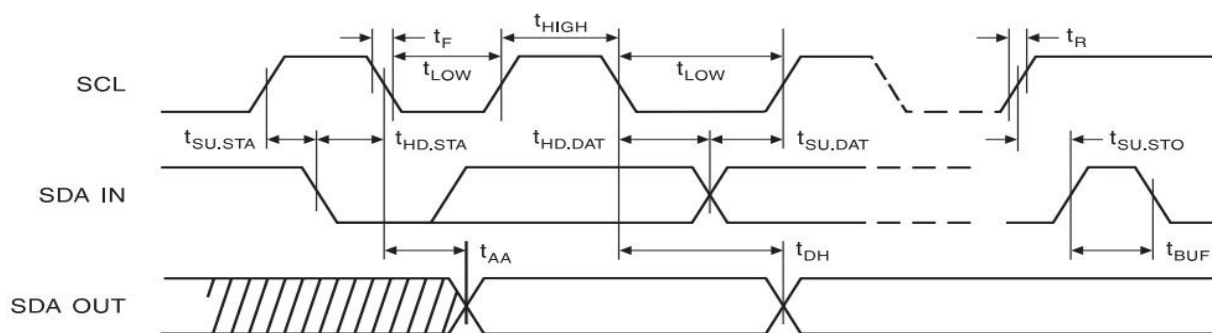
The host shall issue the Device Address (ID) followed by a Write Bit before sending a command byte and a data byte. This format only applies while the user wants to send the WRITE_REG command.

The 2nd TYPE: the host writing a register inside the device



The 3rd TYPE: the host reading a register from the device

In this activity there are two frames that are sent separately. The first frame is to send the READ_REG command which contains a 2-bit binary number of 10 followed by a 6-bit register address. The format of the first frame is identical to the 1st type activity. In the second frame, the device will send back the register data after receiving the correct Device Address followed by a Read Bit. This format only applies while the user wants to use the READ_REG command.



5.2 I²C Device and Register Address

The I²C device address is shown below. The LSB of the device address is determined by the status of the CSB pin:

CSB PIN=0: corresponding to address 0XEE (write) and 0XEF (read).

CSB PIN=1: corresponding to address 0XEC (write) and 0XED (read).

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

5.3 I²C Protocol

The 1st TYPE: the host issuing a single byte command to the device

The host shall issue the Device Address (ID) followed by a Write Bit before sending a Command byte. The device will reply an ACK after it received a correct SOFT_RST command.

	1	1	1	0	1	1	/CS B	0	0	0	0	0	0	0	1	1	0	0		
S	Device Address							W	A	Command									A	P

The 2nd TYPE: the host writing a register inside the device

The host shall issue the Device Address (ID) followed by a Write Bit before sending a command byte and a data byte. This format only applies while the user wants to send the WRITE_REG command.

	1	1	1	0	1	1	/CSB	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	1	1	0	0
S	Device Address							W	A	Command							A	Data						A	P	

The 3rd TYPE: the host reading a register from the device

In this activity there are two frames that are sent separately. The first frame is to send the READ_REG command which contains a 2-bit binary number of 10 followed by a 6-bit register address. The format of the first frame is identical to the 1st type activity. In the second frame, the device will send back the register data after receiving the correct device address followed by a read bit. This format only applies while the user wants to use the READ_REG command.

	1	1	1	0	1	1	/CSB	0	0	1	0	0	0	0	1	1	0	0	
S	Device Address							W	A	Command							A	P	

	1	1	1	0	1	1	/CS B	1	0	1	0	0	1	0	1	1	0	1	
S	Device Address						R	A	Data									N	P

The 4th type: the host reading the 3-byte or 6-byte ADC data from the device

In this activity there are two frames that are sent separately. The first frame is identical to sending a single command, which can be one of the conversion result reading commands. In the second frame, the device will send back the ADC data (either 3 bytes or 6 bytes depending on the commands) after receiving the correct Device Address followed by a Read Bit.

	1	1	1	0	1	1	/CS B	0	0	0	0	0	0	0	1	1	0	0	
S	Device Address						W	A	Command									A	P

	1	1	1	0	1	1	/CS B	1	0	0	1	0	0	0	1	1	0	0	
S	Device Address						R	A	Data Byte 6 or 3									A	

	0	1	1	0	1	0	0	1		
Data Byte 0									N	P

Bit Descriptions

<input type="checkbox"/>	From Host	<input checked="" type="checkbox"/>	From Chip
<input type="checkbox"/> S	Start Bit	<input type="checkbox"/> P	Stop Bit
<input type="checkbox"/> W	Write	<input type="checkbox"/> R	Read
<input type="checkbox"/> A	ACK	<input type="checkbox"/> N	NACK
<input type="checkbox"/> CSB	Sensor CSB PIN		

6. Typical Application Circuit

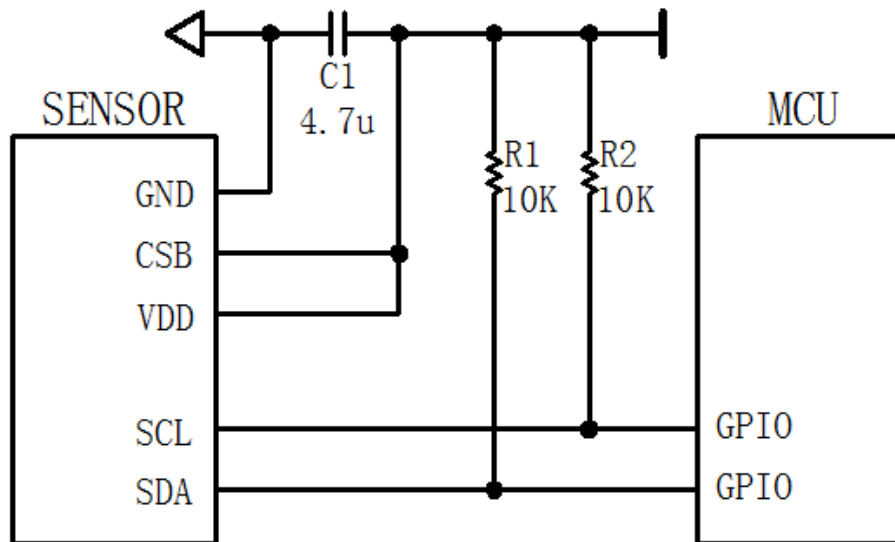


Figure2: Typical application circuit

7. Package Information

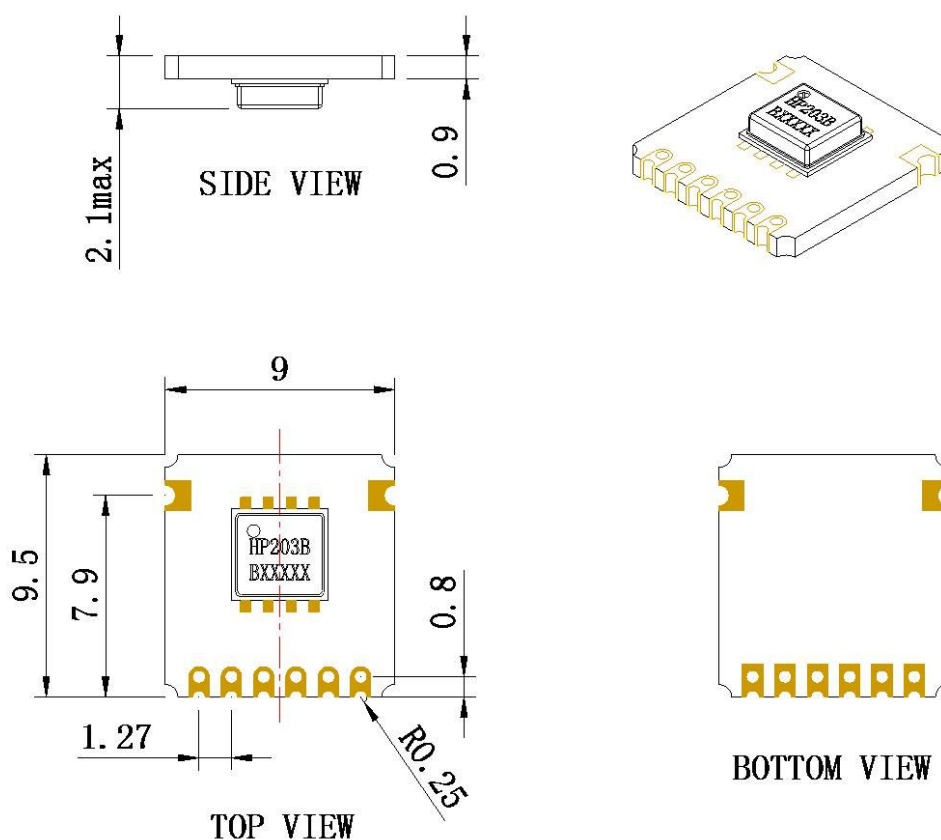


Figure5: HPNSC02-203 package outline

Notes:

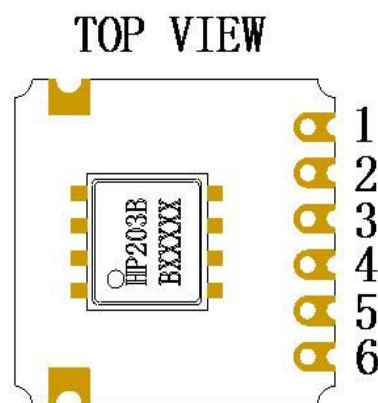
Mechanical dimension is mm

General tolerance ± 0.1

8. Pin Configuration

Table.8 – Pin Descriptions

脚位	名字	方向	功能
1	GND	输入	供电电源地
2	VDD	输入	供电电源正
3	NC	-	无连接
4	NC	-	无连接
5	SDA	输出/入	I ² C 串行双向数据
6	SCL	输入	I ² C 串行时钟输入



9. Tape and Reel Specifications

<p>HOPE MICROELECTRONICS CO.,LTD Add: 2/F, Building 3, Pingshan Private Enterprise Science and Technology Park, Lishan Road, XiLi Town, Nanshan District, Shenzhen, Guangdong, China Tel: +86 755 82973805 Fax: +86 755 82973550 Email: sales@hoperf.com Website: http://www.hoperf.com http://www.hoperf.cn</p>	<p>This document may contain preliminary information and is subject to change by Hope Microelectronics without notice. Hope Microelectronics assumes no responsibility or liability for any use of the information contained herein. Nothing in this document shall operate as an express or implied license or indemnity under the intellectual property rights of Hope Microelectronics or third parties. The products described in this document are not intended for use in implantation or other direct life support applications where malfunction may result in the direct physical harm or injury to persons. NO WARRANTIES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MECHANICAL FITNESS OR FITNESS FOR A PARTICULAR PURPOSE, ARE OFFERED IN THIS DOCUMENT.</p> <p>©2013, HOPE MICROELECTRONICS CO.,LTD. All rights reserved. Rev:HP206C_DataSheet_EN_V2.0</p>
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