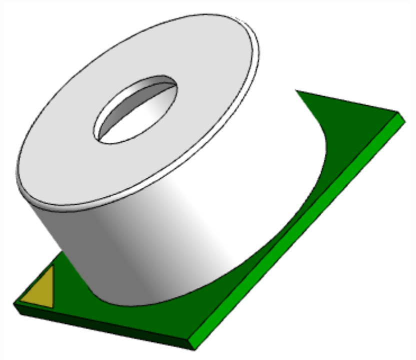
PRECISION BAROMETER AND ALTIMETER SENSOR



6.8×6.2×3.1mm

Features

- Supply voltage: 1.8V to 3.6V
- Pressure range: 300mbar ~ 2000mbar
- Support to read the compensated data directly
  – Pressure: 20-bit measurement (Pascal)
  – Altitude: 20-bit measurement (Meters)
  – Temperature: 20-bit measurement (Degree Celsius)
- Altitude resolution down to 0.2 meter
- Standby current: < 0.1µA
- Operation temperature: -40℃ to +85℃
- High-speed I²C digital interface
- Size: 6.8 x 6.2 x 3.1mm

Applications

- High Precision Mobile Barometer or Altimeter
- Industrial Pressure and Temperature Monitoring System
- Waterproof Consumer Electronics
- Outdoor Sports Equipment
- Weather Station
- Ventilation System

Descriptions

The HP206N 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 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 0.2 meter. Package is surface mount with a stainless-steel cap and is RoHS compliant.

1. Block Diagram

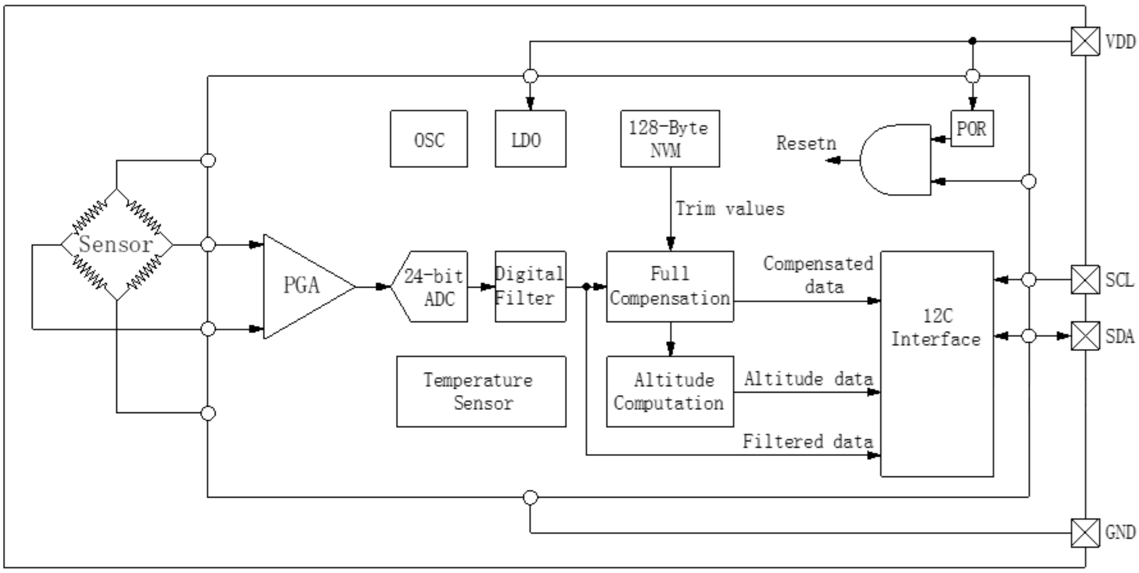


Figure 1: Functional Block Diagram

2. Mechanical and Electrical Specifications

2.1 Pressure and Temperature Characteristics

Table 1: 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		2000	mbar
Pressure Absolute Accuracy		300 to 1100 mbar from 0℃ to 50℃		±2.5		mbar
Pressure Relative Accuracy		300 to 1100 mbar from 0℃ to 50℃		±1.5		mbar
Max Error with Power Supply		Power supply from 1.8V to 3.6V	-2.5		+2.5	mbar
Pressure/Altitude Resolution		Pressure mode		0.02		mbar
		Altitude mode		0.20		m
Board Mount Drift		After reflow soldering		±0.5		mbar
Long Term Drift		After a period of 1 year		±2.0		mbar
Impact of Reflow Soldering		IPC/JEDEC J-STD-020C		±1.0		mbar

Table 2: Temperature Output Characteristics @ VDD = 3.0V, T = 25°C unless otherwise noted

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operation Temperature Range	T_{OP}		-40		85	℃
Temperature Absolute		25℃		±2.0		℃
Max Error with Power		Power supply from 1.8V to 3.6V	-0.5		+0.5	℃
Temperature Resolution				0.01		℃

2.2 Electrical Characteristics

Table 3: DC Characteristics @ VDD = 3.0 V, T = 25℃ unless otherwise noted

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Operation Voltage	V_{DD}			1.8	3.0	3.6	V
Operation Temperature	T_{OP}			-40		85	℃
Average Operation Current (Pressure Measurement under One Conversion per Second)	I_{DDAVP}	OSR*	4096		85.2		μA
			2048		42.6		
			1024		21.3		
			512		10.7		
			256		5.3		
			128		2.7		
Average Operation Current (Temperature Measurement under One Conversion per Second)	I_{DDAVT}	OSR*	4096		68.8		μA
			2048		34.4		
			1024		17.2		
			512		8.6		
			256		4.3		
			128		2.2		
Conversion Time of Pressure or Temperature	t_{CONV}	OSR*	4096		65.6		ms
			2048		32.8		
			1024		16.4		
			512		8.2		
			256		4.1		
			128		2.1		
Peak Current	I_{PEAK}	During conversion			1.3		mA
Standby Current	I_{DDSTB}	At 25℃				0.1	μA
Serial Data Clock Frequency	f_{SCLK}	I^2C protocol, pull-up resistor of 10k		0	100	400	kHz
Digital Input High Voltage	V_{IH}			0.8			V
Digital Input Low Voltage	V_{IL}					0.2	V
Digital Output High Voltage	V_{OH}	IO = 0.5 mA		0.9			V
Digital Output Low Voltage	V_{OL}	IO = 0.5 mA				0.1	V
Input Capacitance	C_{IN}				4.7		pF

*OSR stands for over sampling rate

2.3 Absolute Maximum Ratings

Table 4: Absolute Maximum Ratings

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	VDD+0.3	V
Storage Temperature Range	T_{STG}		-40	125	℃
Maximum Soldering Temperature	T_{MS}	40 seconds maximum		250	℃
ESD Rating		Human Body Model	-2	+2	kV
Latch-up Current		At 85℃	-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 HP206N 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.

3.2 Factory Calibration

Every device is individually factory calibrated for sensitivity and offset for both 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 400us.

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 Altitude)
128	2.1	4.1
256	4.1	8.2
512	8.2	16.4
1024	16.4	32.8
2048	32.8	65.6
4096	65.6	131.1

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.

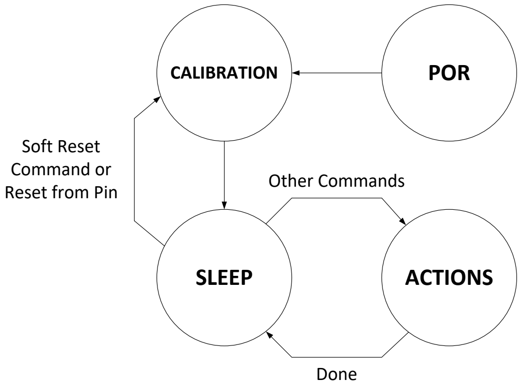
3.5 Altitude Computation

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 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 of 2-bit channel (CHNL) are shown below:

00: 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 2-bit CHNL bits to the value of 01 or 11, or the 3-bit OSR bits to the value of 110 or 111 will lead to failure of conversion.

4. 2.3 Read Temperature and Pressure Values

READ_PT (0x10)

The temperature data is arranged as 20-bit 2's complement format and the unit is in degree Celsius. Temperature value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the temperature value. The user shall convert this 20-bit 2's complement binary value into an integer, and then divide the integer by 100 to obtain the final result.

The pressure data is arranged as 20-bit 2's complement format and the unit is in Pascal. Pressure value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the pressure value. The user shall convert this 20-bit unsigned binary value into an integer, and then divide the integer by 100 to obtain the final result.

For Example : (Signed 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 Pressure)

Hex value	OUT_ P _MSB	OUT_ P_CSB	OUT_ P_LSB	Dec value
0x018A9E	0x01	0x8A	0x9E	1010.22

4. 2.4 Read Temperature and Altitude Values

.READ_AT (0x11)

The temperature data is arranged as 20-bit 2's complement format and the unit is in degree Celsius. Temperature value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the temperature value. The user shall convert this 20-bit 2's complement binary value into an integer, and then divide the integer by 100 to obtain the final result.

The altitude data is arranged as 20-bit 2's complement format and the unit is in meters. Altitude value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the altitude value. The user shall convert this 20-bit unsigned binary value into an integer, and then divide the integer by 100 to obtain the final result.

For Example : (Signed 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 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 Pressure Value

.READ_P (0x30)

The pressure data is arranged as 20-bit 2's complement format and the unit is in Pascal. Pressure value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the pressure value. The user shall convert this 20-bit unsigned binary value into an integer, and then divide the integer by 100 to obtain the final result.

4. 2.6 Read Altitude Value

.READ_A (0x31)

The altitude data is arranged as 20-bit 2's complement format and the unit is in meters. Altitude value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the altitude value. The user shall convert this 20-bit unsigned binary value into an integer, and then divide the integer by 100 to obtain the final result.

4. 2.7 Read Temperature Value

.READ_T (0x32)

The temperature data is arranged as 20-bit 2's complement format and the unit is in degree Celsius. Temperature value is stored in all 24 bits of OUT_T_MSB, OUT_T_CSB and OUT_T_LSB. The 4 most significant bits of the 24-bit data is useless, while the 20 least significant bits represent the temperature value. The user shall convert this 20-bit 2's complement binary value into an integer, and then divide the integer by 100 to obtain the final result.

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 adapt 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 (0x80+ register address)

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

4. 2.10 Write the Control Registers

.WRITE_REG (0xc0 + register address)

This command allows the user to write in the control registers.

Table 6: The Command Set

Name	Hex Code	Binary Code	Descriptions
SOFT_RST	0x06	0000 0110	Soft reset the device
ADC_CVT	NA	010_OSR_chnl	Perform ADC conversion
READ_PT	0x10	0001 0000	Read temperature and pressure values
READ_AT	0x11	0001 0001	Read temperature and altitude values
READ_P	0x30	0011 0000	Read pressure value only
READ_A	0x31	0011 0001	Read altitude value only
READ_T	0x32	0011 0010	Read 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

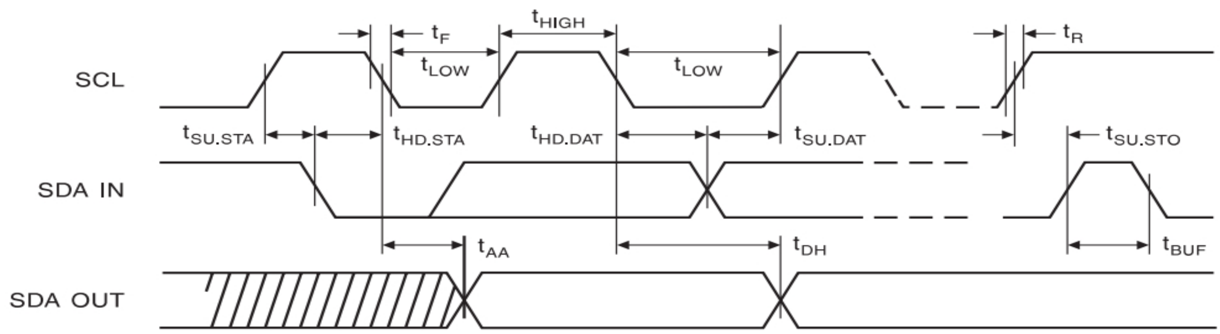
5. I²C Interface

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.

5.1 I²C Specifications

Table 7: I²C Slave Timing Values

Parameter	Symbol	I²C Conditions	Min.	Typ.	Max.	Unit
SCL Clock Frequency	S_{CL}	Pull-up = 10 kΩ	0		400	KHz
Bus Free Time between STOP and START	t_{BUF}		1.5			µs
Repeated START Hold Time	$t_{HD.STA}$		0.6			µs
Repeated START Setup Time	$t_{SU.STA}$		0.6			µs
STOP Setup Time	$t_{SU.STO}$		0.6			µs
SDA Data Hold Time	$t_{HD.DAT}$		100			ns
SDA Data Setup Time	$t_{SU.DAT}$		100			ns
SCL Clock Low Time	t_{LOW}		1.5			µs
SCL Clock High Time	t_{HIGH}		0.6			µs
SDA and SCL Rise Time	t_R		30		500	ns
SDA and SCL Fall Time	t_F		30		500	ns



5.2 I²C Device and Register Address

The I²C device address is shown below. The LSB of the device address is corresponding to address 0XEC (write) and 0XED (read).

A7	A6	A5	A4	A3	A2	A1	W/R
1	1	1	0	1	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 with an ACK after it received a correct SOFT_RST command.

	1	1	1	0	1	1	0	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	0	0	**0**	1	1	0	0	1	0	1	0	**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	0	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	0	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	0	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	0	1	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	0	
S	Device Address							R	**A**	**Data Byte 6 or 3**								A	

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

Bit Descriptions

	From Host		From Device
S	Start Bit	P	Stop Bit
W	Write	R	Read
A	ACK	N	NACK

6. Typical Application

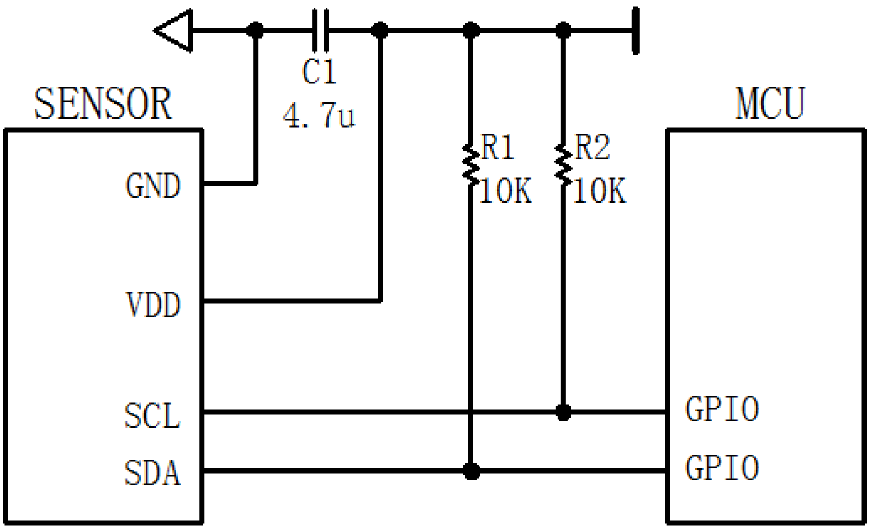
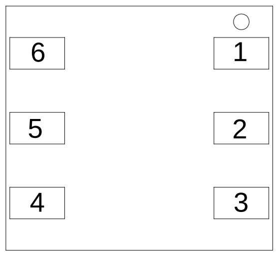


Figure 2: Typical Application

7. Pin Configuration

Table 8: Pin Descriptions

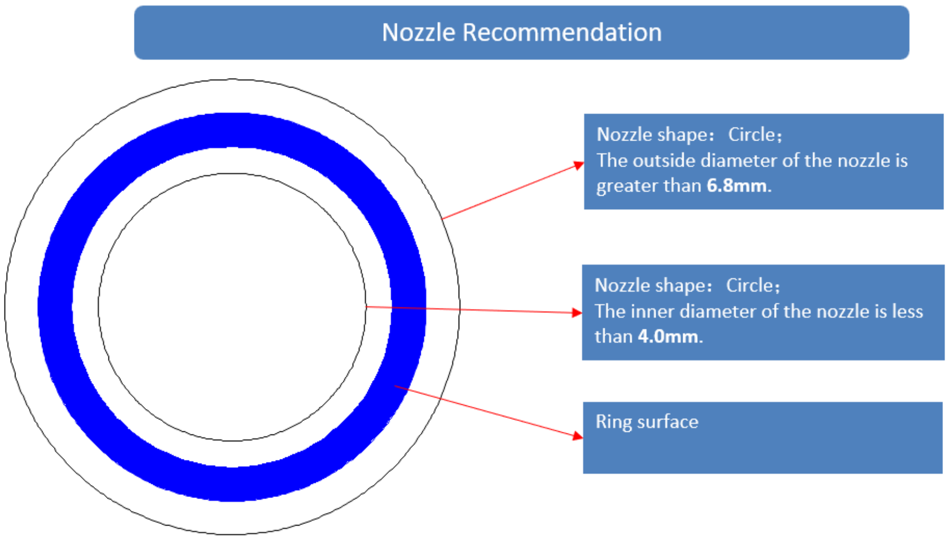
Pin	Name	I/O	Function
1	GND	I	Ground
2	VDD	I	Power Supply
3	NC	-	NO Connect
4	NC	-	NO Connect
5	SDA	IO	I²C Serial Data Pin
6	SCL	I	I²C Serial Clock Pin



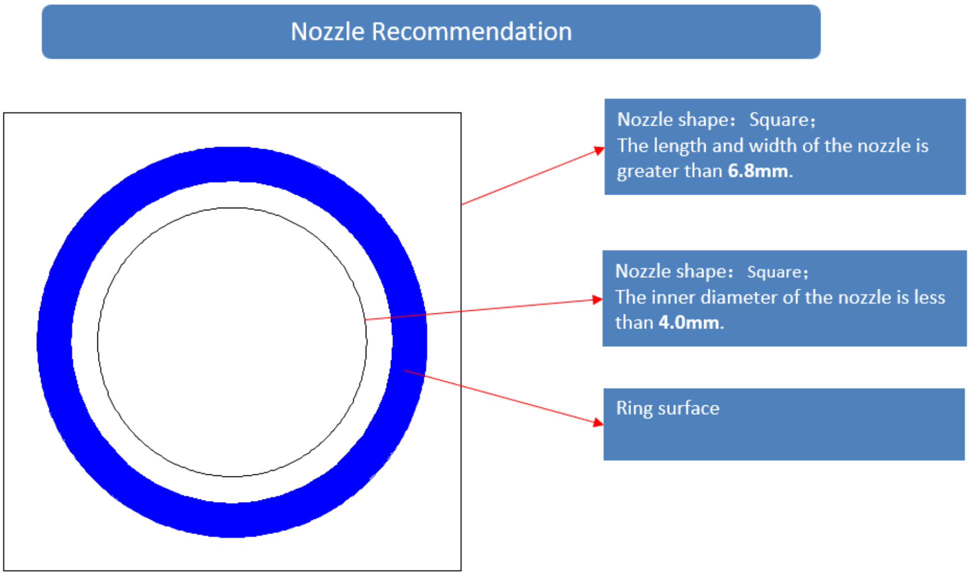
BOTTOM VIEW

8. Cautions

- Operating Temperature Range：-40°C～+85°C
- Storage Temperature Range：-40°C～+125°C
- The sensor is a highly sensitive component that must be stored in vacuum packaging. If the sensor is directly exposed to the external environment (Remove product from vacuum packaging) for more than 48 hours, the sensor needs to be baked at 150°C for 2 hours before reflow soldering. Care needs to be taken to ensure that the plastic housing (tray, tape) can withstand the corresponding baking temperature.
- Keep in warehouse with less than 75% humidity and without sudden temperature change, acid air, any other harmful air or strong magnetic field.
- The sensor with vacuum packaging can be transported by ordinary conveyances. Please protect products against moist, shock, sunburn and pressure during transportation.
- Because the high temperature of reflow soldering will produce thermal shock to the sensor, the sensor will have a certain pressure drift in the initial stage after reflow soldering, which is a normal phenomenon. It is recommended that customers leave the sensor for 48 hours after reflow soldering, and then test it again. Under normal circumstances, the pressure drift will automatically disappear.
- The inner area of the steel ring is a jelly-like waterproof glue covering the sensing element, and it is strictly forbidden to cause physical damage to it due to all external forces and sharp objects, otherwise it will affect the measurement accuracy of the sensing element or directly damage the sensing element.
- It is strictly prohibited to carry out ultrasonic cleaning or ultrasonic welding on the sensor, otherwise it will directly damage the sensor.
- The recommended SMT nozzle sizes for reflow soldering are as follows.



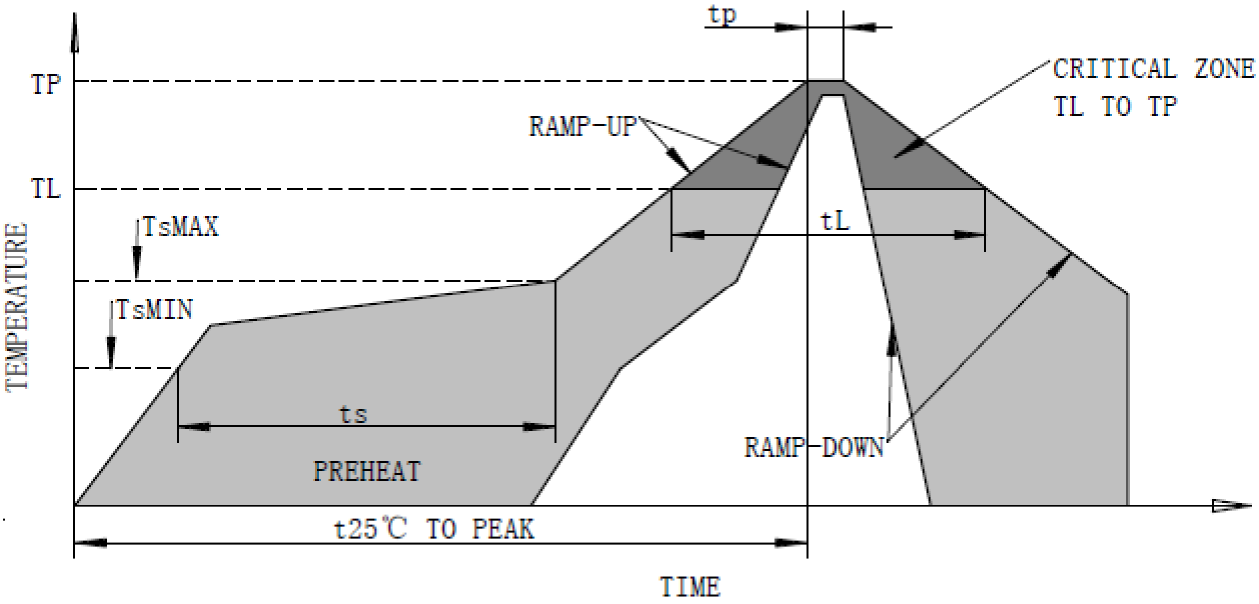
Circle Nozzle



Square Nozzle

9. Soldering Recommendation

Recommend solder reflow.



Profile Feature	Pb-Free Assembly
Average ramp-up rate (TsMAX to TP)	2°C/seconds max
Preheat -Temperature Min. (TsMIN) - Temperature Max. (TsMAX) - Time (TsMIN to TsMAX) (Ts)	 130°C 200°C 90~110 seconds
Time maintained above: -Temperature(TL) -Time(tL)	 217°C 50~60 seconds
Ramp time of Ts to TL	15-25 seconds
Time 25°C to peak temperature	300 seconds max
Peak temperature (TP)	235~240°C
Ramp-down rate (peak to 217°C)	2~4°C/seconds

10. Package Information

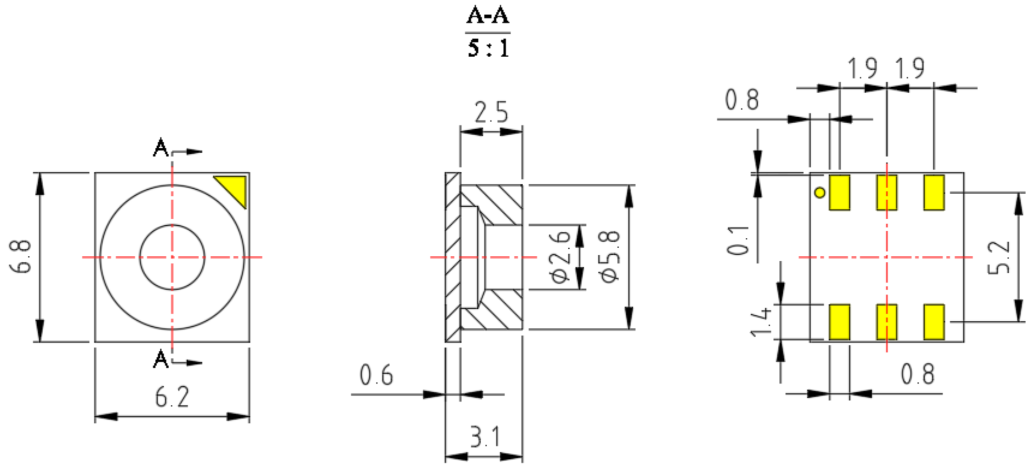
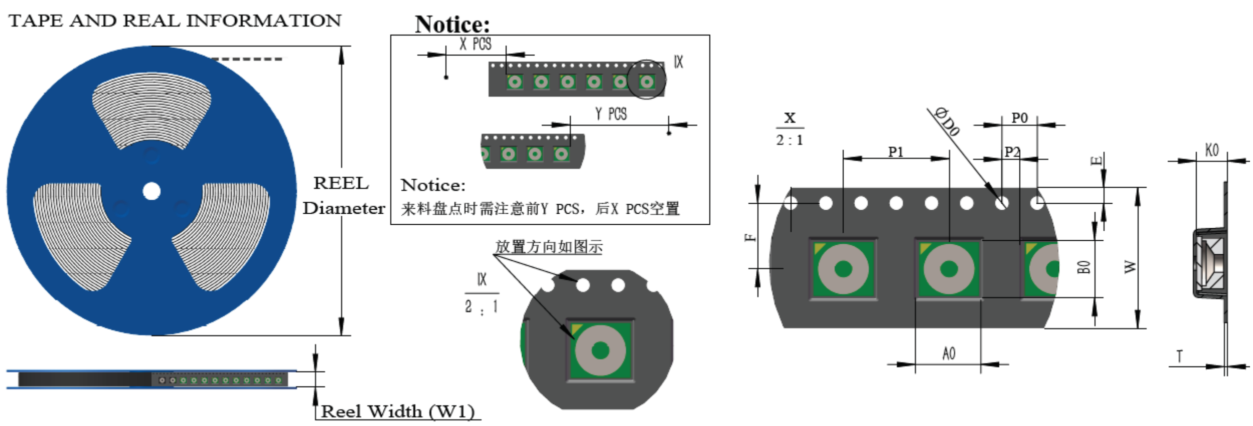


Figure 3: Package Information (Unit: mm)

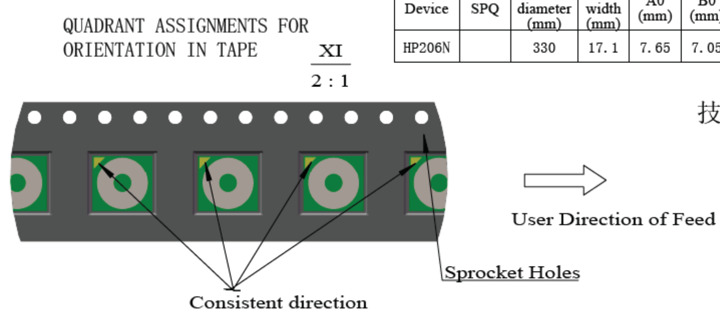
Notes: General Tolerance: ±0.10mm

11. Tape & Reel Specification

Carrier Tape Dimension (Unit：mm).
Quantity per Reel: 1000 pcs.



Device	SPQ	Reel diameter (mm)	Reel width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	D0 (mm)	F (mm)	T (mm)	E (mm)	P0 (mm)	P2 (mm)	Pin1 Quad
HP206N		330	17. 1	7. 65	7. 05	3. 5	12	16	1.5	7.5	0.35	1.75	4	2	



技术要求:

1. 每10个型腔间距的累积公差为±0. 2mm;
2. 表面摩擦电压<100V，10*10ˆ4欧姆<表面电阻<1*10ˆ9欧姆;
3. 所有尺寸符合EIA-481-3国际标准;
4. 每13寸盘载带长度20. 8M;
5. 材料：黑色;
6. 未注公差为±0. 2mm;
7. 载带弯曲每100mm不超过1mm;
8. A0，B0测量以型腔上表面为基准，其公差为±0. 3mm；K0值测量为型腔内底部为基准至载带上表面测量值。

Figure 4: Tape & Reel Specification

12. Publication History

Version	Date	Description
V1.0	2020.7.6	New release
V1.1	2024.2.6	1. Update package information and tape & reel specification 2. Add the caution information