Features and Benefits

- **Cost effective and Compact Solution**
- **VDD range：2.2 V～5 V**
- **Low power consumption：2.7mA**
- **Small size：5.24mmx7.9mmx2.1mm**
- **Operating temperature range: -20℃ ～85℃**
- **High resolution and dynamic range**
- **Low zero rate output drift**
- **High-performance MEMS sensor in SOI yielding a superior long-term behavior reliability and dynamic range**
- **Factory set full scale range：ZOUT: ±1000 º/s**
- **On chip EPROM trimming**
- **On-chip 12 bits ADC**
- **Analog and digital output (I2C interface)**

Applications

- **Game Consoles**
- **GPS/DR Navigation**
- **Air Mouse**
- **Cell phones**
- **Handheld devices**

General Description

The SZ030HS is an integrated Z-Axis angular rate sensor (Gyroscope). A single SOP package contains a high performance silicon micro machined sensor with signal conditioning circuitry.

It provides excellent temperature stability and high resolution over the operating temperature range (-20℃ ~ 85℃)

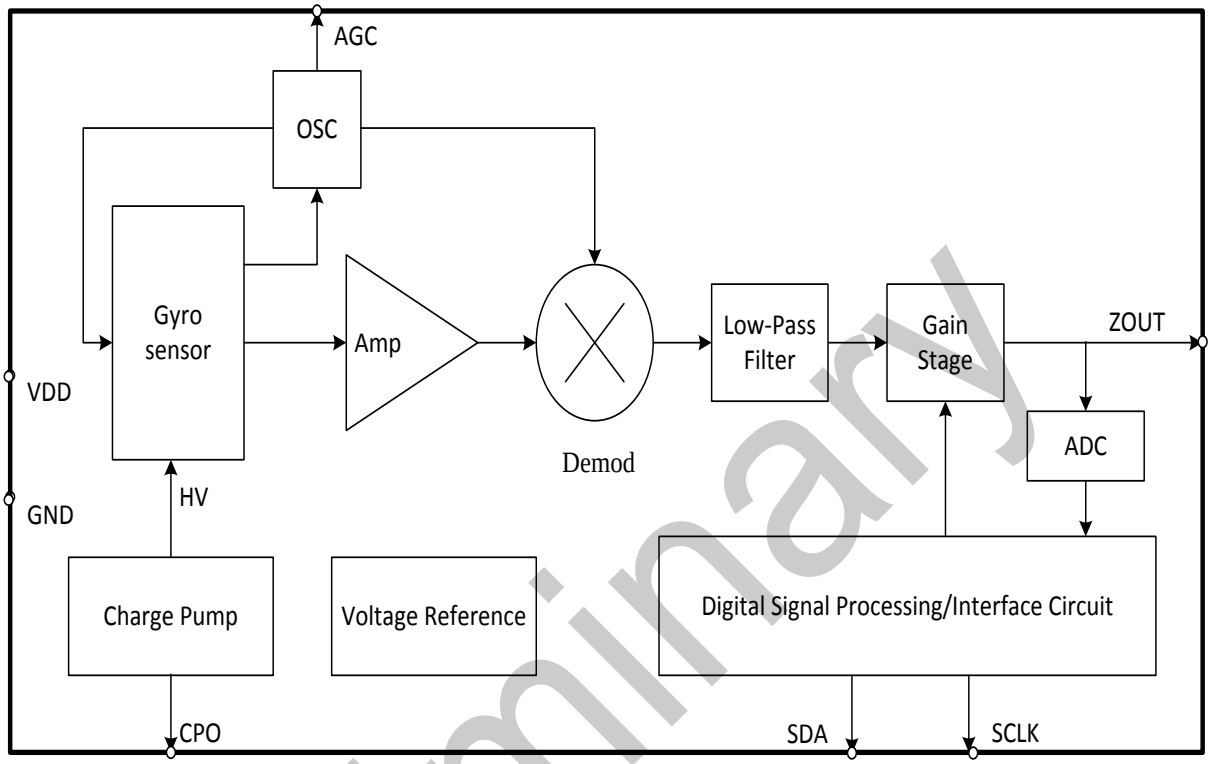
It's ±1000 º/s full scale can be accessed by using I2C commands conveniently. SZ030HS is capable of detecting rates with -3dB bandwidth up to 100Hz.

The SZ030HS delivers output signal proportional to angular rate perpendicular to the assembly surface. SZ030HS includes low-pass filters and EPROM for on-chip factory calibration for the sensor. Factory trimmed scale factors eliminates the need for external active components and end-user calibration.

The SZ030HS is provided in SOP8 package.

1. Functional Diagram

Fig 1. Function block diagram



2. SZ030HS Gyroscope Sensor Specifications

DC Operating Parameters： T=-20℃ to 85℃, Vdd=2.2V ～ 5V
unless otherwise specified, All parameters specified are： Vdd=3.0V ， T=25℃；

Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Full Scale Range			±1000		º/s
Non-Linearity	Best Fit Straight Line		±1		% of FS
Sensitivity /Scale Factor	Analog Output	0.46	0.5	0.55	mV/º/s
	Digital Output	1.024	1.138	1.252	lsb/º/s
Scale Factor Drift	-20℃~85℃		±10		%
Zero Rate Temperature Drift	-20℃~85℃		±20		mV
Bandwidth(-3dB)	External selectable		100		Hz
Output Noise			15		mVpp
Cross-sensitivity			±1		%
Zero Rate Output/ZRO		1.15	1.35	1.55	V
Power-on Time	Settling to ±3 º /s		200		ms

3. Electrical Characteristics

Electrical characteristics @ Vdd=3.0V ， T=25℃ unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Vdd	Supply voltage		2.2	3	5	V
Idd	Supply current	Vdd=3.0V		2.7		mA

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit
low level input voltage	VIL	SCLK, SDA,		0	30%VDD	V
high level input voltage	VIH	SCLK, SDA,	70%VDD	VDD	110%VDD	V
low level output voltage	VOL	SCLK, SDA,		0	20%VDD	V
high level output voltage	VOH	SCLK, SDA,	80%VDD	VDD		V

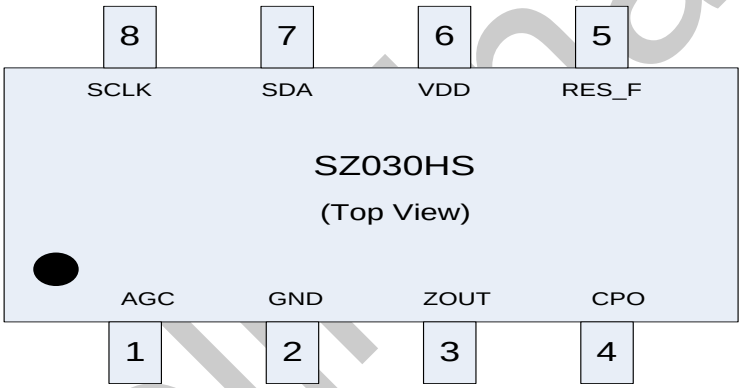
4. Absolute Maximum Ratings

Stress above those listed as “Absolute Maximum Ratings” may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Parameter	Rating
Operating supply voltage	-0.3V ~ 6V
Operating Temperature Range	-20℃ ~ 85℃
Storage Temperature Range	-40℃ ~ 105℃

5. Pin Description

Fig. 2. PIN Description



(Top view)

PIN Description Table:

PIN No.	PIN Name	PIN Function
1	AGC	Amplitude control filter
2	GND	Power supply ground
3	ZOUT	Rate output signal
4	CPO	Charge pump filter(Need to connect a 1uF with 25V capacitance)
5	RES_F	Reserved, leave these pins unconnected
6	VDD	Power supply
7	SDA	I2C serial data
8	SCLK	I2C serial clock

6. Design Notes

6.1 Angular Rate Sensor

A sensor that measures rotational velocity measured in degrees per second around its sensitive axis. Angular rate sensors are sometimes referred to as gyroscope.

6.2 Bandwidth

The input signal frequency range from DC up to the frequency where a -3dB amplitude decay is observed. In the case of the present device, the bandwidth is selectable by an external optional low pass filter.

6.3 Amplitude control

The scale factor of the sensor depends on the amplitude of the mechanical motion and the trim setting of the internal programmable gain stages. The oscillation circuit precisely controls the amplitude to maintain constant sensitivity over the temperature range. The capacitors connected to Pin 1 (AGC) are compensation capacitors for the amplitude control loops. Please place a 1uF capacitance as close as possible to Pin 1.

6.4 Zero Rate Output (ZRO) Drift

The bounds within which the circuit output signal may vary as the temperature varies across the operating temperature range with no applied angular rate. Such drift is present to some degree in all gyroscope systems, and must be addressed in the application.

6.5 External Low-Pass Filter

An external low-pass filter is recommended to attenuate high frequency noise. The cutoff frequency should be less than 2 kHz to attenuate tones above 10 kHz generated by the vibrating proof-masses.

6.6 I2C Serial Interface

The internal registers can be accessed using I2C at up to 400 Kbps.

Note: The I2C interface protocol please refers to "THE I2C-BUS SPECIFICATION VERSION2.1 JANUARY 2000".

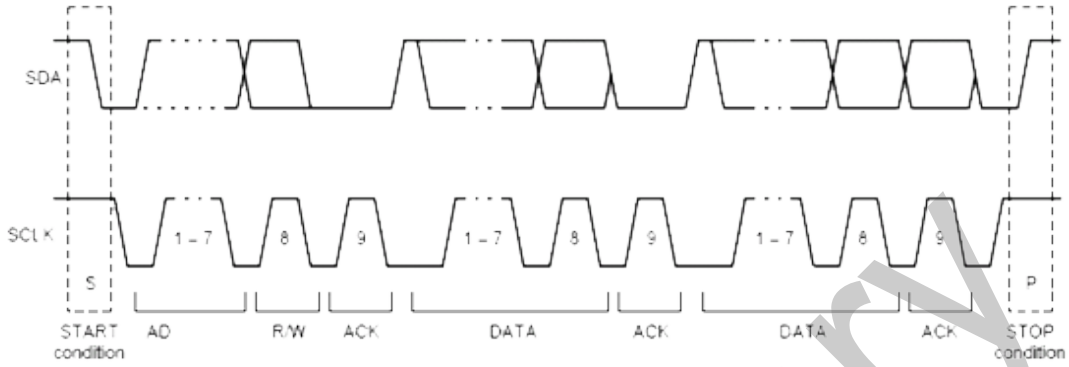
Serial Interface

Pin Number	Pin Name	Pin Description
7	SDA	I2C serial data
8	SCLK	I2C serial clock

6.6.1 I2C Interface Description

I2C is a two-wire interface comprised of the signals serial data (SDA) and serial clock (SCLK). In general, the lines are open-drain and bi-directional. In a generalized I2C interface implementation, attached devices can be a master or a slave, the master device puts the slave address on the bus, and the slave device with the matching address acknowledges to the master.

The chip always operates as a slave device when communicating to the system processor, which thus acts as the master. SDA and SCLK lines typically need pull-up resistors (1K ~ 10K) to VDD. The maximum bus speed is 400 Kbps. A preliminary timing diagram is shown as below:



Signal	Description
S	START condition
AD	Slave I2C address
W	Write (R\W=0)
R	Read (R\W=1)
ACK	Acknowledge
NACK	Not-Acknowledge
P	STOP condition

The slave address of the chip is binary “1010100” which is 7 bits.

6.6.2 Command sequence

To read the internal chip registers,

1. The master first transmits the start condition(S), followed by the 7 bits I2C address and the write bit (0).
2. At the 9th clock cycle (when the clock is high), the chip acknowledges the transfer.
3. The master then transmits the corresponding command (COM, for example, 0x40, Angular Rate low byte Read Command), the chip sends an ACK signal once receive the correct command word.
4. Upon receiving the ACK signal from the chip, the master transmits a repeat start signal followed by the slave address and read bit (1).
5. As a result, the chip sends an ACK signal and one byte data (for example, 0x40 corresponding Angular Rate low byte data).
6. The read operation ends with a not acknowledge (NACK) signal.
7. The master transmits the stop condition (P) to end the communication.

Note：Can support single byte read sequence only, can’t support multi-byte consecutively read sequence; to read multi-byte data it is needed to operate single byte twice.

The command sequence is shown as the following:

M	S	AD+W		COM		S	AD+R			NACK	P
S			ACK		ACK			ACK	DB0		

Signal	Description
S	START condition
AD	slave device I2C address
W	Write (R\W=0)
R	Read (R\W=1)
ACK	Acknowledge
NACK	Not-Acknowledge
COM	Command
DB0	Received data
P	STOP condition

6.6.3 Angular Rate Read Command

Angular Rate Read Command comprise low byte Read Command（0x40）and high byte Read Command（0x41），the sequence is reading low byte first then high byte.

Angular Rate low byte Read Command word:0x40

Note： replace COM in the above command sequence table with 0x40，thus can read SZ030HS Angular Rate low byte data（DBL）。

Angular Rate high byte Read Command word:0x41

Note： replace COM in the above command sequence table with 0x41, thus can read SZ030HS Angular Rate high byte data，get the lower 4 bits (DBH) as valid data，the highest bit of valid data is sign bit (bit11 in below combined data is sign bit)。

Bit[15:12]	Bit[11:8]	Bit[7:0]
0	DBH	DBL

6.6.4 SAR ADC Enable Control

Read Command word: 0x48

Read DB8[7:0]

Command word 0x48 can read DB8 initial value.

Write Command word: 0x28

Write DB8[7:0]

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	ADC（Default:1）

ADC: 0 - Enable； 1 - Disable;

Note：ADC needed to be enabled before read the angular rate data through I2C.
ADC enable command：
1. Read ADC control register data DB through the read command word 0x48;
2. Write data（DB & 0xFE）to ADC control register through the write command word 0x28；

6.7 Conversion Formula for Analog output and Digital output

We convert the readout 12bit 2's complement data with sign bit which is marked as hex, to decimal number with sign bit which is marked as Dec, we operate hex as unsigned number：

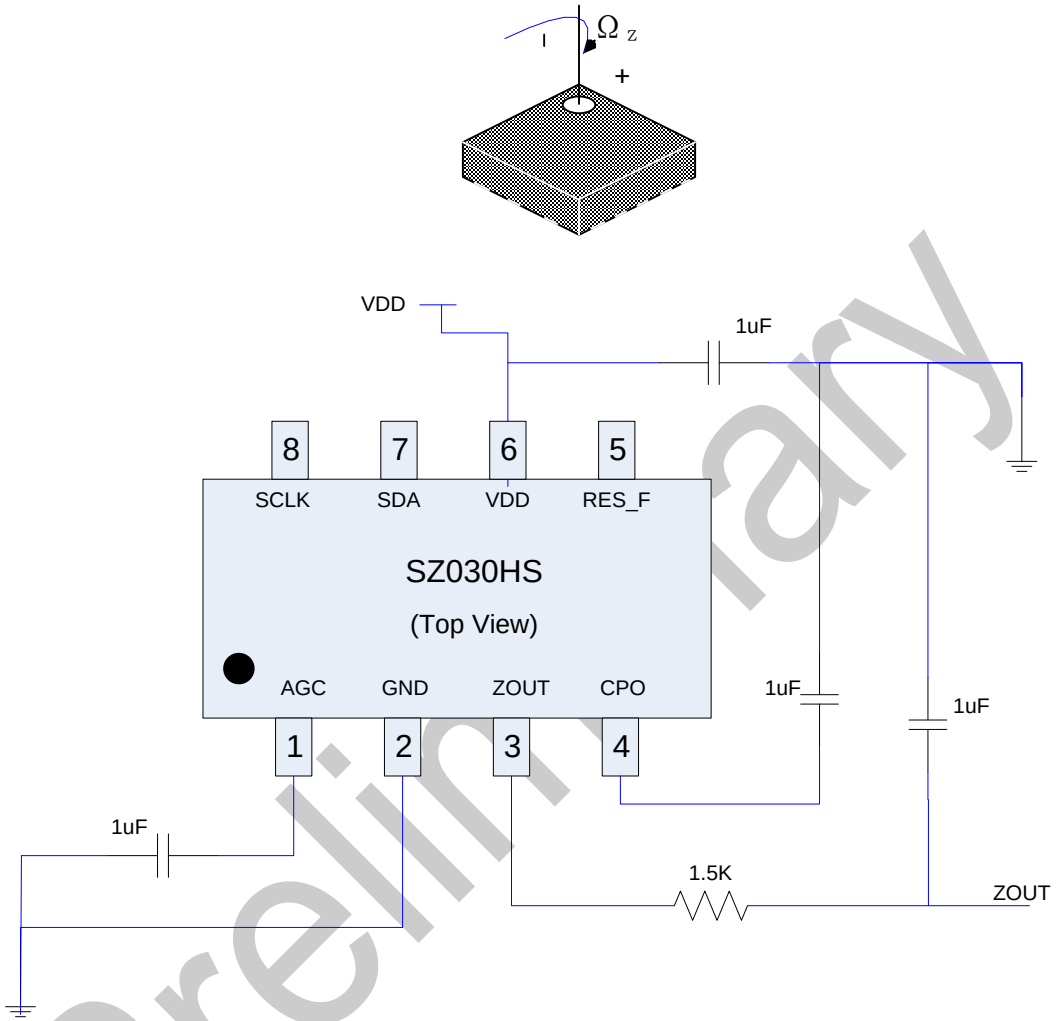
dec1 = hex2dec (hex);
If dec1 is greater or equal to 2048，then Dec = dec1 – 4096，
If dec1 is less than 2048，then Dec = dec1。

Corresponding digital voltage:
Sar_vout（v）= Dec * (1.8/4096)+0.9 ;

Corresponding analog Pin output:
Rate_pin_out（v）= Sar_vout+1.35-0.9

7. Typical Application

Fig. 3 Reference Application Circuitry



8. Package Information

8.1 Direction

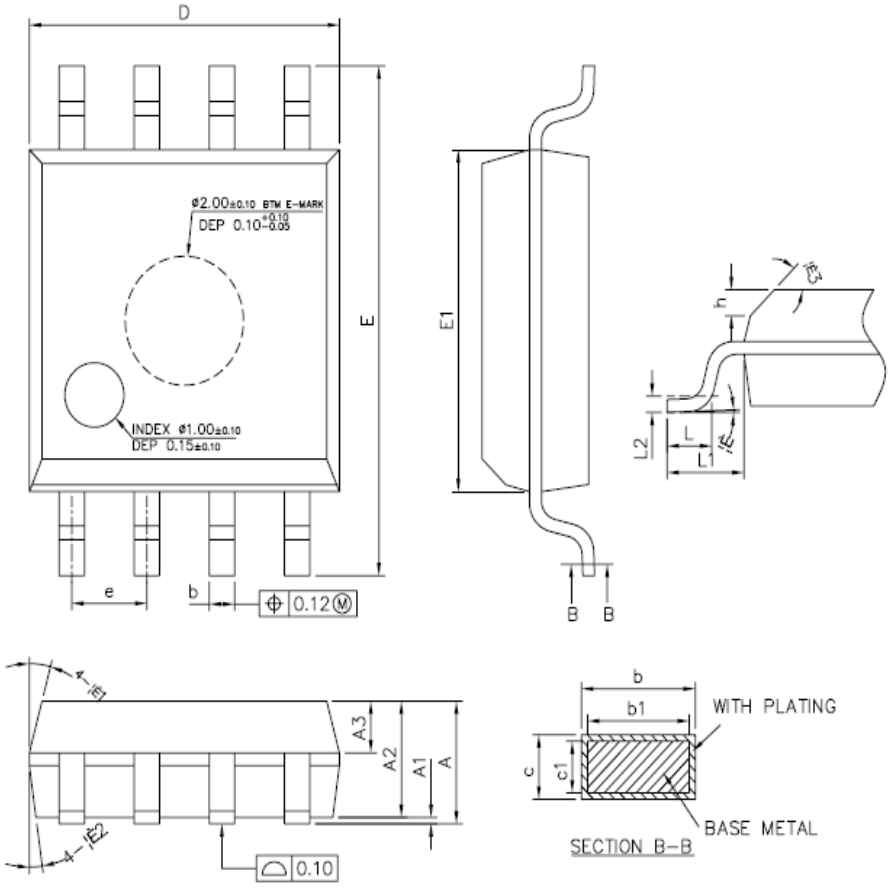
As shown in Fig 3.

8.2 Package Information

8.2.1 Package dimensions

SZ030HS is provided in SOP8 package and RoHS compliant.

Figure 4. SZ030HS package dimensions

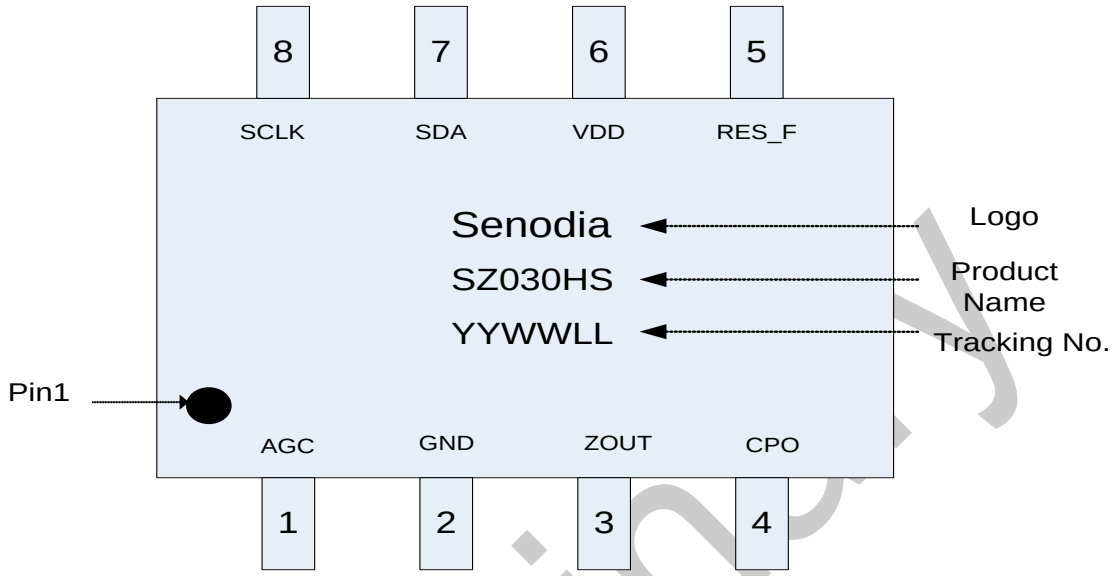


COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	–	–	2.10
A1	0.05	0.10	0.25
A2	1.70	1.80	1.90
A3	0.70	0.80	0.90
b	0.39	–	0.52
b1	0.38	0.43	0.48
c	0.20	–	0.25
c1	0.19	0.20	0.21
D	5.14	5.24	5.34
E	7.70	–	8.10
E1	5.20	5.30	5.40
e	1.17	1.27	1.37
h	0.30	0.40	0.50
L	0.55	0.75	0.85
L1	1.30REF		
L2	0.25BSC		
θ	0°	–	8°
θ1	13°	15°	17°
θ2	6°	8°	10°
θ3	43°	45°	47°

8.3 Package laser label

Fig. 5: example for laser label



（Top View）

8.4 Packing of the Chips

Fig. 6 packing direction

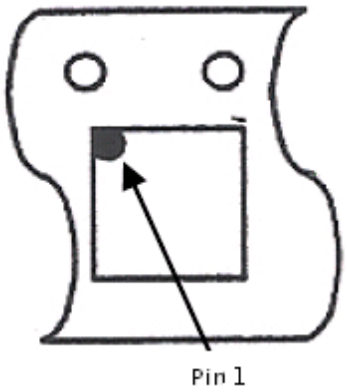
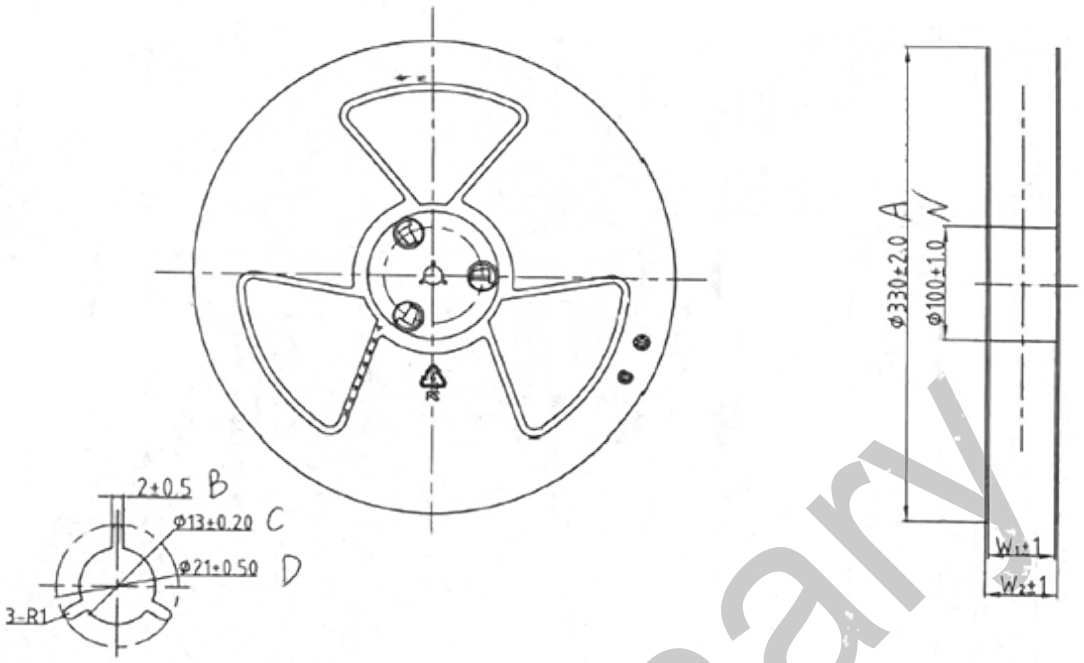


Fig. 7: tape reel size

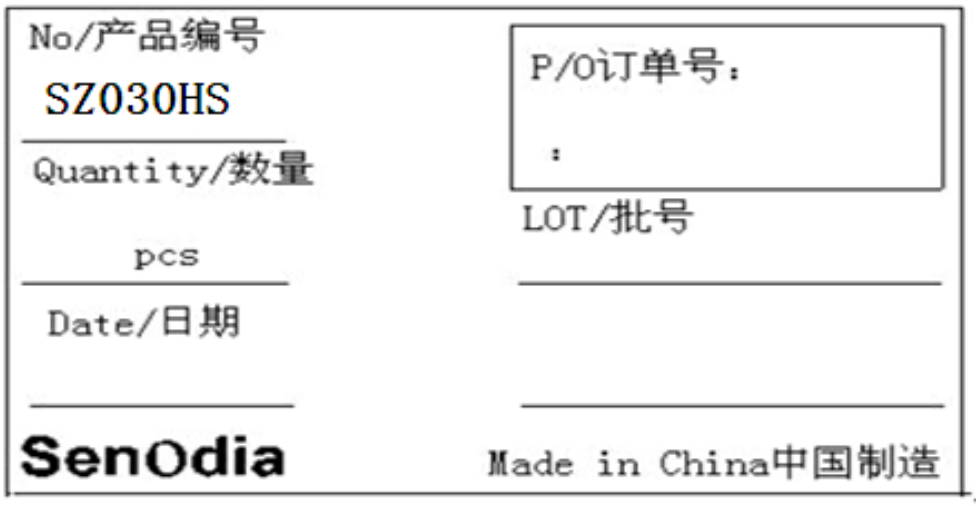


MATERIAL : PS COLOR :BLUE

Blank	12mm	16mm	24mm	32mm	44mm	56mm	72mm	88mm
W1	13.5	17.5	25.5	33.5	45.5	57.5	74.0	90
W2	17.5	21.5	29.5	37.5	49.5	61.5	78.0	94

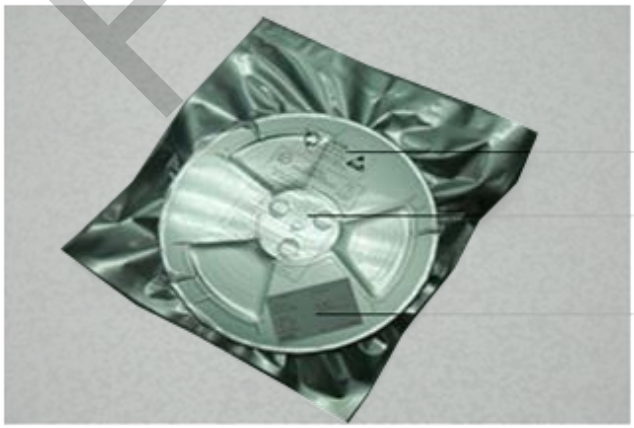
8.5 labels

Fig. 8: label for the product



8.6 Packing

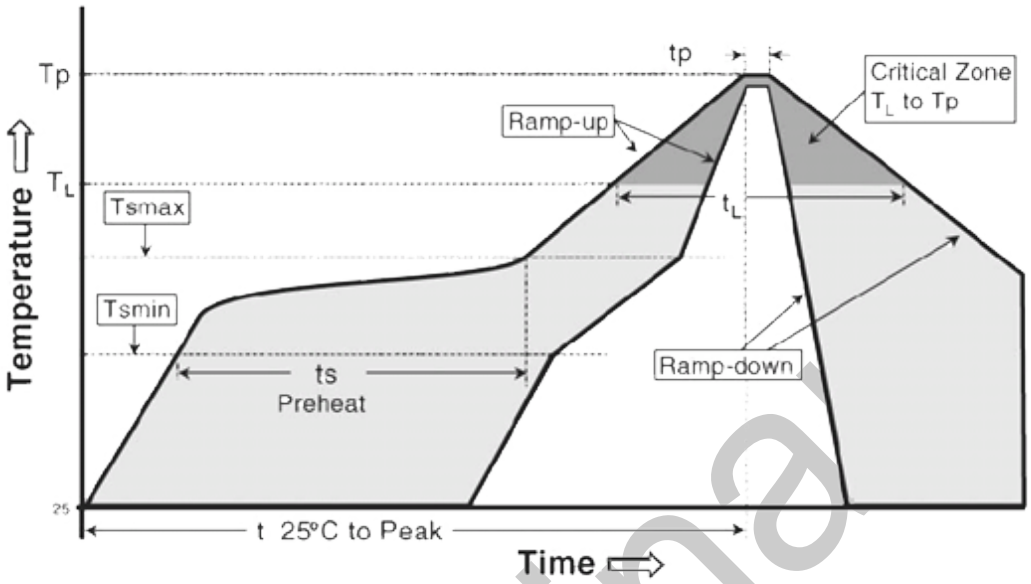
Fig. 9: packing of product



8.7 Solder Reflow Curve

Solder Reflow curve follows IPC/JEDEC J-STD-020 Pb-free standards.

Fig. 10: Solder Reflow curve



Profile Feature	Pb-Free Assembly
Average ramp-up rate (Tsmax to Tp)	3° C/second max.
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (Ts_{min} to Ts_{max}) (ts)	 150 °C 200 °C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	 217 °C 60-150 seconds
Peak Temperature (Tp)	260 °C
Time within 5°C of actual Peak Temperature (tp)	20-40 seconds
Ramp-down Rate	6 °C/second max.
Time 25°C to Peak Temperature	8 minutes max.

8.8 Storage condition

The storage condition follows JEDEC J-STD-020, MSL 3.

9 Reliability

9.1 Reliability standard:

SZ030HS reliability test plan follows JEDEC 47I standards, “Stress-Test-Driven Qualification of Integrated Circuits”.

10. Revision History

Date	Revision	Changes
2015-9-8	1.0	Preliminary version
2015-12-8	1.1	Update Features and Benefits
2016-6-29	1.2	Update 6.8，add 6.8.4
2016-11-15	1.3	Update 8.7 & 8.8 reference doc version

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