Features and Benefits

- **Cost effective and Compact Solution**
- **VDD range: 2.7V～3.3V**
- **Low power consumption: 3.7mA**
- **Small size: 5mmx5mmx1.2mm**
- **Operating temperature range:- 20℃ to 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**
  ±1350 º/s at ZOUT PIN
  ±300 º/s at Z4.5OUT PIN
- **On chip EPROM trimming**
- **On-chip 11 bits ADC**
- **Analog and digital output(I2C interface)**

Applications

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

General Description

The SZ030H is an integrated Z-Axis angular rate sensor (Gyroscope). A single QFN 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 provides on-chip temperature sensor, which outputs a voltage proportional to the temperature.

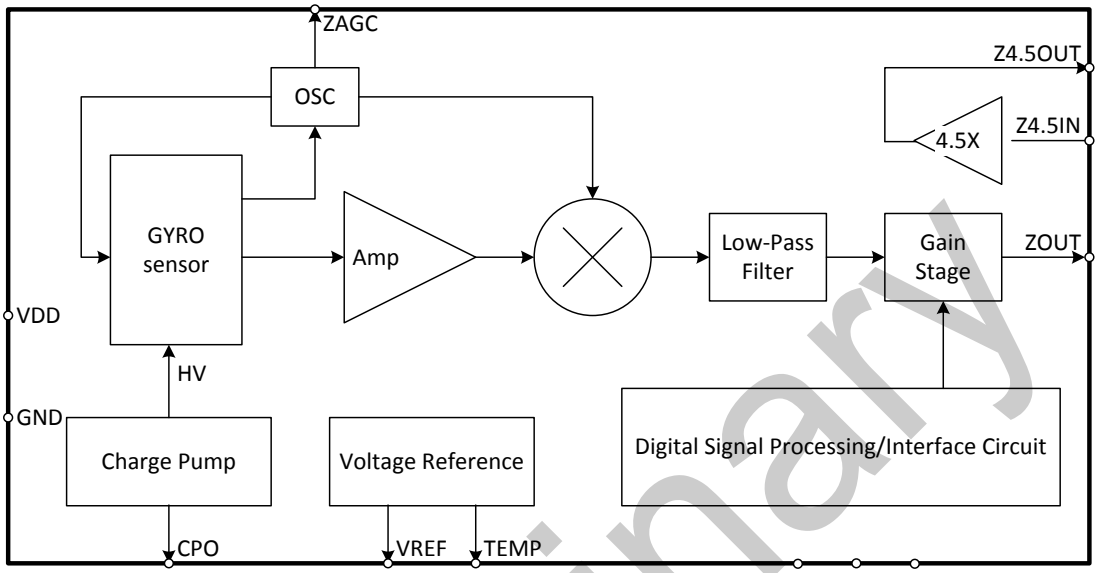
It has ±1350 °/s and ±300 °/s full scale selectable, and the signals of different full scale can be accessed by using different I2C commands conveniently. SZ030H is capable of detecting rates with -3dB bandwidth up to 100Hz.

The SZ030H delivers output signal proportional to angular rate perpendicular to the assembly surface. SZ030H 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 SZ030H is provided in Quad Flat No-lead (QFN) package.

1. Functional Diagram

Fig. 1. Function block diagram



2. SZ030H Gyroscope Sensor Specifications

DC Operating Parameters T=-20℃ to 85℃, Vdd=2.7V to 3.3V (unless otherwise specified)
All parameters specified are @ Vdd=3.0V and T=25℃

Parameter	Conditions	Min.	Typ.	Max.	Unit
Full Scale Range	Without 4.5X amplifier		±1350		º /s
	With 4.5X amplifier		±300		º /s
Non-Linearity	Best Fit Straight Line		±1		% of FS
Sensitivity/Scale Factor	Without 4.5X amplifier	0.46	0.5	0.55	mV/ º /s
	With 4.5X amplifier	2.07	2.25	2.43	mV/ º /s
Scale Factor Drift	-20℃~85℃		±10		%
VREF Reference			1.525		V
Zero Rate Temperature Drift	-20℃~85℃		±20		mV
Bandwidth(-3dB)	External selectable		100		Hz
Output Noise Density	With 4.5X amplifier		15		mVpp
Cross-sensitivity			±1		%
Zero Rate Output/ZRO		1.30	1.45	1.60	V
Reference Over Temperature	-20℃~85℃		±5		mV
Temperature Sensor	At 25℃		750		mV
Temperature Sensor TC	-20℃~85℃		2		mV/ ℃
Power on time	Settling to ±3 º /s，With 4.5X amplifier		200		ms

3. Electrical Characteristics

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

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
Vdd	Supply voltage		2.7	3	3.3	V
Idd	Supply current	Vdd=3.0V		3.7		mA

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit
low level input voltage	VIL	SCLK, SDA, A0		0	30%VDD	V
high level input voltage	VIH	SCLK, SDA, A0	70%VDD	VDD	110%VDD	V
low level output voltage	VOL	SCLK, SDA, A0		0	20%VDD	V
high level output voltage	VOH	SCLK, SDA, A0	80%VDD	VDD		V

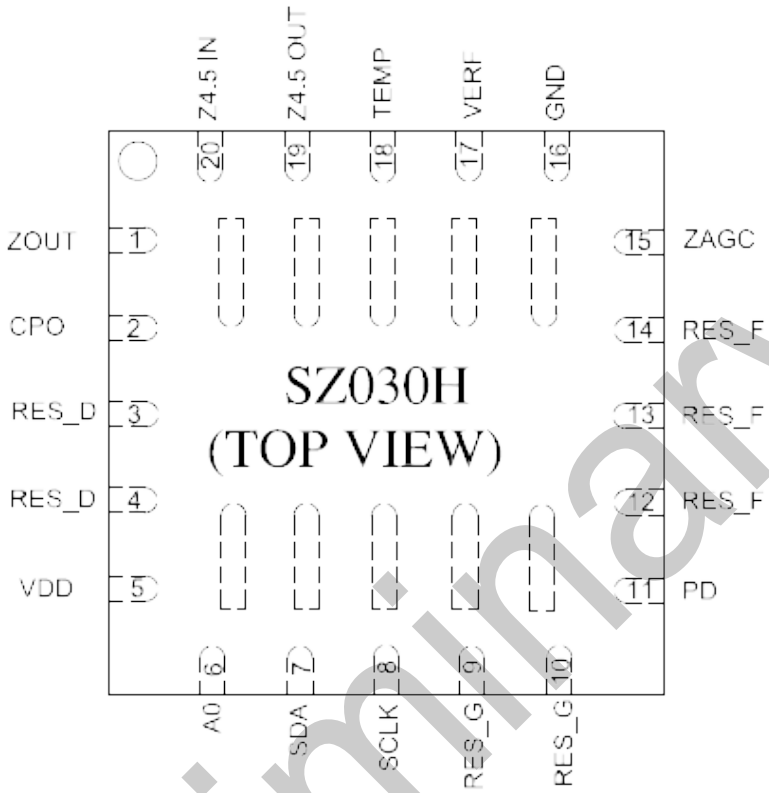
4. Absolute Maximum Ratings

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℃
ESD	2000V (HBM)

5. Pin Description

Fig. 2. PIN Description



(Top View)

Table PIN Description

PIN No.	PIN Name	PIN Function
1	ZOUT	Rate output signal
2	CPO	Charge pump filter(Need to connect a 10nF with 16V capacitance)
5	VDD	Power supply
6	A0	I2C least significant bit of the device address
7	SDA	I2C serial data
8	SCLK	I2C serial clock
11	PD	Power down control (high voltage: normal mode; low voltage: power down mode)
15	ZAGC	Amplitude control filter
16	GND	Power supply ground
17	VREF	Voltage of sensor reference
18	TEMP	Temperature sensor output
19	Z4.5OUT	4.5X buffer rate output
20	Z4.5IN	4.5X buffer rate input
3,4	RES_D	Reserved, Please connect to VDD
9,10	RES_G	Reserved, Please connect to GND

12,13,14	RES_F	Reserved, leave these pins unconnected

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 15 (ZAGC) are compensation capacitors for the amplitude control loops. Please place a 1uF capacitance as close as possible to Pin 15.

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 VREF

VREF is a temperature independent voltage reference that can be used as a reference for the system.

6.7 Temperature Sensor

Temperature sensor output, Temp, is a voltage proportional to the temperature.

6.8 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

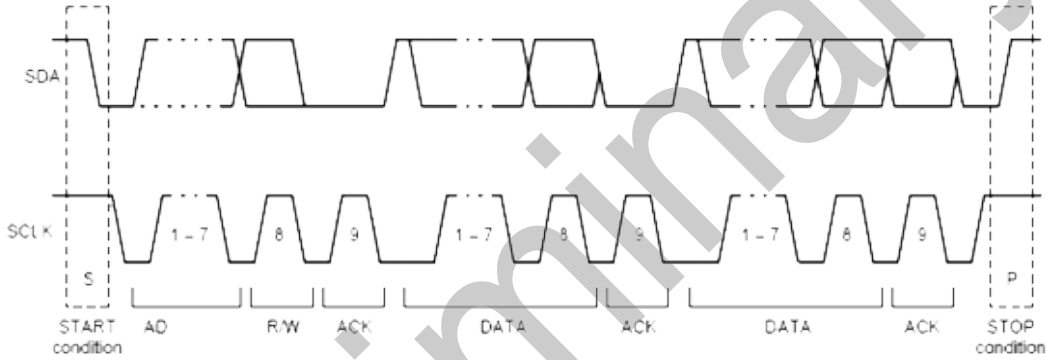
Pin Number	Pin Name	Pin Description

6	A0	I2C least significant bit of the device address
7	SDA	I2C serial data
8	SCLK	I2C serial clock

6.8.1 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
NA	Not-Acknowledge
P	STOP condition

The slave address of the chip is binary “101010X” which is 7 bits long. The LSB bit of the 7 bits address is determined by the logic level on pin A0. This allows two chips to be connected to the same I2C bus. When used in this configuration, the address of the device is listed as following:

Command	AD[6:1]	A0	R/W	AD+R/W
Read	101010	0	1	10101001B(A9H)
Write	101010	0	0	10101000B(A8H)
Read	101010	1	1	10101011B(ABH)

Write	101010	1	0	10101010B(AAH)

6.8.2 Command Sequence

To read the internal chip registers, the master first transmits the start condition(S), followed by the 7 bits I2C address and the write bit (0). At the 9th clock cycle (when the clock is high), the chip acknowledges the transfer. The master then writes the relative command (Rate read command/temperature read command). Upon receiving the ACK signal from the chip, the master transmits a repeat start signal followed by the slave address and read bit (1). As a result, the chip sends an ACK signal and three bytes data DB0, DB1, DB2. The DB1 [7:0] is the lower eight bits of the 11-bits ADC data, and the DB2 [2:0] is the higher three bits of the ADC data. The communication ends with a not acknowledge (NACK) signal. The command sequence is shown as the following:

Command sequence

M	S	AD+W		COM		S	AD+R			ACK		ACK		NA	P
S			ACK		ACK			ACK	DB0		DB1		DB2		

Signal	Description
S	Start Condition
AD	Slave I2C address
W	Write bit (0)
R	Read bit (1)
ACK	Acknowledge
NA	Not-Acknowledge
COM	Command
DB0/DB1/DB2	Received data
P	Stop condition

6.8.3 Rate Read Command

Command word: 0xH82

Usage: replace above command sequence COM with 0xH82, master then can receive the slave rate output data through the three bytes data, DB0, DB1, and DB2. And the 11bits ADC data is: DB2 [2:0] DB1 [7:0], with the higher bits in the left side, and the lower in the right side.

6.8.4 Temperature Read Command

Command word: 0xH83

Usage: replace above command sequence COM with 0xH83, master then can receive the slave rate output data through the three bytes data, DB0, DB1, and DB2. And the 11bits ADC data is: DB2 [2:0] DB1 [7:0], with the higher bits in the left side, and the lower in the right side.

6.8.5 Four times Rate Read Command

Command word: 0xH84

Usage: replace above command sequence COM with 0xH84, master then can receive the slave rate output data through the three bytes data, DB0, DB1, and DB2. And the 11bits ADC data is: DB2 [2:0] DB1 [7:0], with the higher bits in the left side, and the lower in the right side.

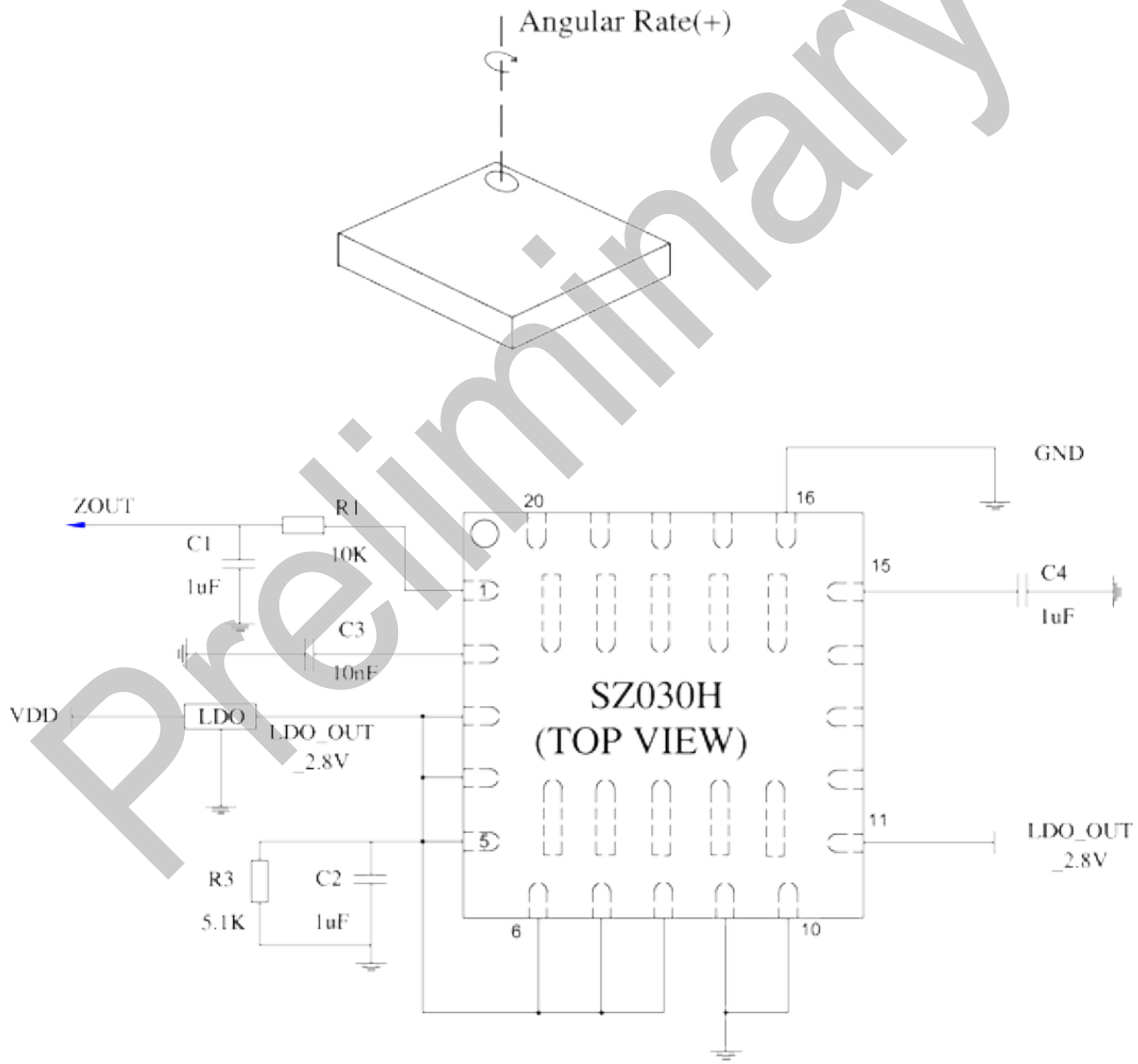
6.8.6 Conversion Formula for ADC

Let's convert the 11bits ADC data (DB2 [2:0] DB1 [7:0]) to Dec, then the analog value would be: 0.5+Dec/1024.

Usually, the 11bits ADC data is 0x41A for ZRO.

7. Typical Application

Fig. 3.1 Reference Application Circuitry



8. Package Information

8.1 Direction

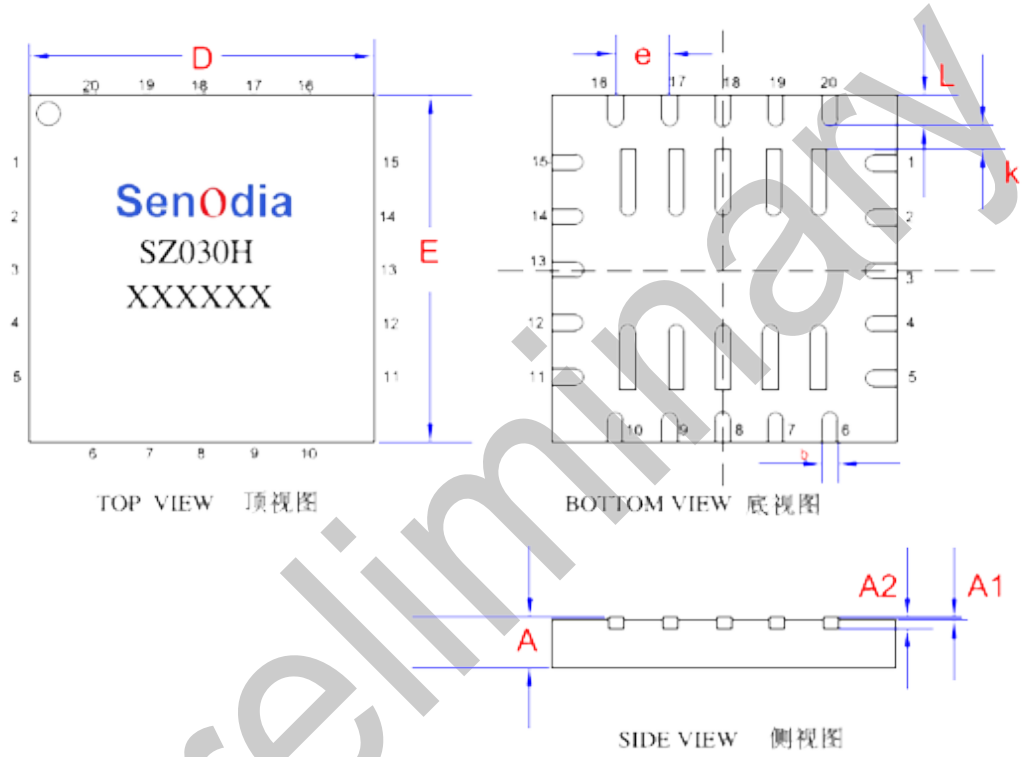
As shown in Fig 3.1.

8.2 Package Information

8.2.1 Package dimensions

SZ030H is provided in Quad Flat No-lead (QFN) package and RoHS compliant.

Figure 4. SZ030H package dimensions



DIMENSIONS TABLE			
REF.	MINIMUM	NOMINAL	MAXIMUM
A	1.10	1.20	1.30
A1	0.00	0.02	0.05
A2	0.203 REF	0.203 REF	0.203 REF
D	4.95	5.00	5.05
E	4.95	5.00	5.05
b	0.25	0.30	0.35
e	0.80 TYP	0.80 TYP	0.80 TYP
k	0.20 MIN	0.20 MIN	0.20 MIN
L	0.30	0.40	0.50

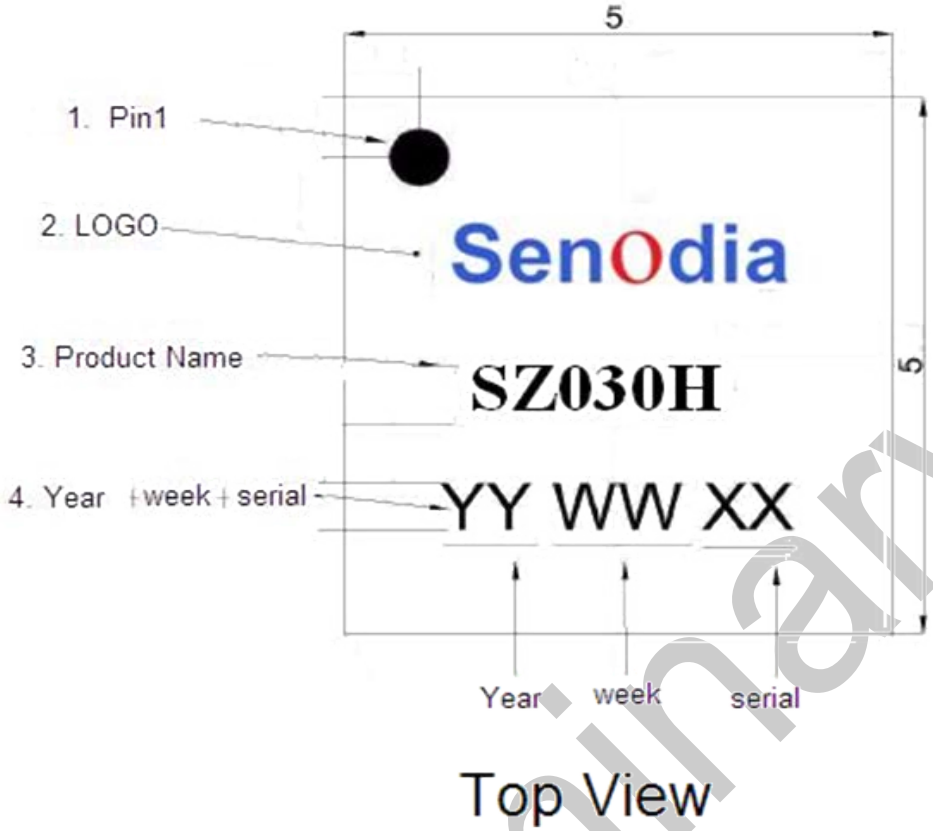
Mchanical Specification 外观尺寸

8.2.2 Assembly Precautions

The 2 rows 10 comb shaped exposed pads from bottom side view are non-functional pads, There is no electrical connection between these 10 pads and the internal IC. They are not required to connect to GND, and should not be soldered to the PCB, and should be isolated from PCB with solder mask.

8.3 Package laser label

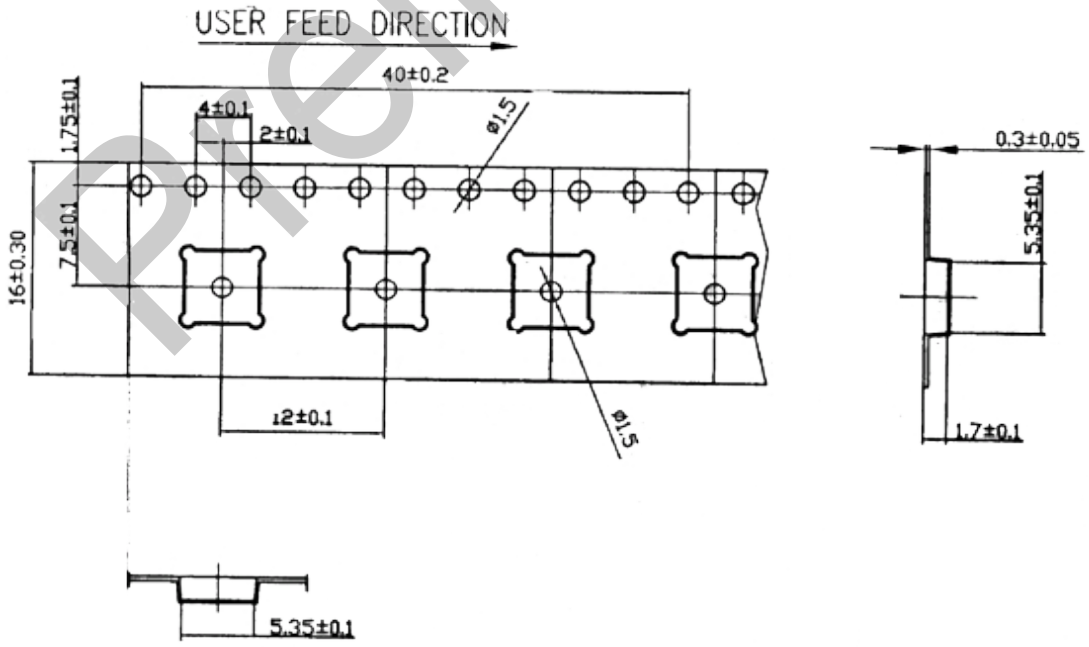
Fig. 5: example for laser label



Top View

8.4 Packing of the Chips

Fig. 6 tape size and packing direction



Packing direction:

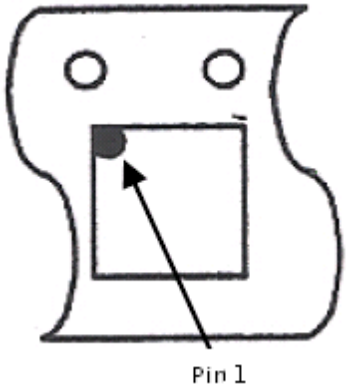
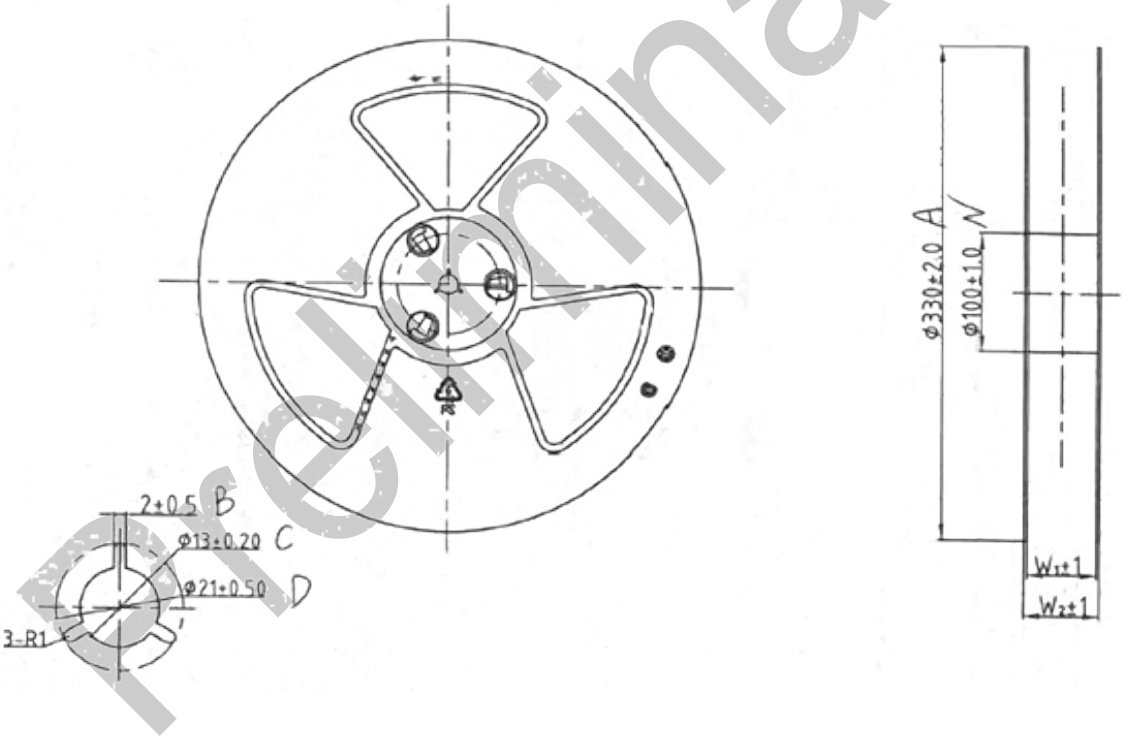


Fig. 7: tape reel size

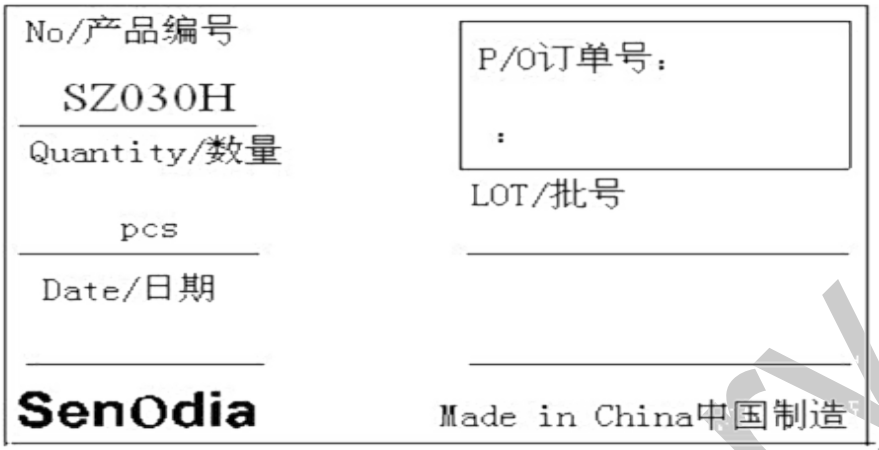


MATERIAL : PS COLOR :BLUE

	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



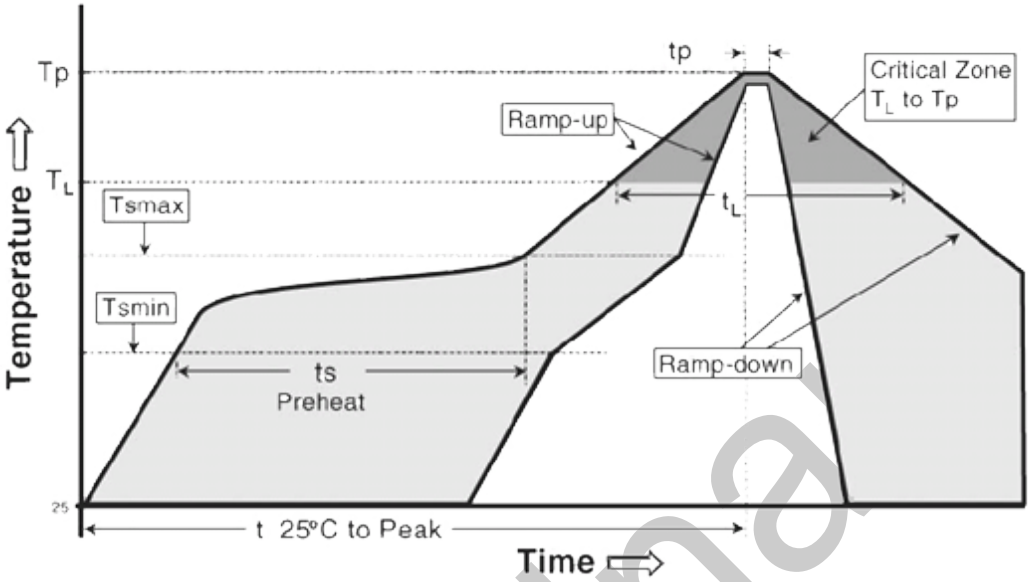
8.6 Packing

Fig. 9: packing of product

8.7 Solder Reflow Curve

Solder Reflow curve follows IPC/JEDEC J-STD-020C 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-020C, MSL 3.

9. Reliability

9.1 Reliability standard:

SZ030H reliability test plan follows JEDEC 47D standards, "Stress-Test-Driven Qualification of Integrated Circuits".

10. Environment Compliant

SZ030H pass SGS certification， compliant with RoHS standards.

11. Revision History

Date	Revision	Changes
2010-10-27	1.0	Preliminary version.
2013-5-13	2.0	update package information; update specification of Zero Rate Output/ZRO
2013-12-5	2.1	Fig. 3.1 Reference Application Circuitry Pin16 connect to GND
2013-12-30	2.2	Update Typical Application and add 6.8.1 I2C Interface Description till 6.8.6 Conversion Formula for ADC
2014-3-26	2.3	5：Pin Description pin10 update to connect to GND；update 8.5 label
2015-7-15	2.4	8.2：add assembly precautions

12. Disclaimer

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