

Digital Temperature Sensor IC

BH1900NUX

General Description

The BH1900NUX is a digital temperature sensor IC equipped with a two-wire serial interface. It's small package, so it can be placed near the component which temperature is measured. This device has 3 address pins and it allows to connect 8 devices on one bus.

Features

- Digital Output: Two-wire Serial Interface.
- 8 Addresses.
- Thermostat Mode.
- Small package.

Applications

- Smart phone, Tablet, LCD TV, notebook PC, portable game machine, and digital camera.

Key Specifications

- Supply Voltage Range: 2.7V to 3.6V
- Temperature Accuracy(-20°C to +85°C): ±3.0°C
- Operating Current: 75µA (Typ)
- Shutdown Current: 1µA (Typ)
- Operating Temperature Range: -30°C to +95°C

Package

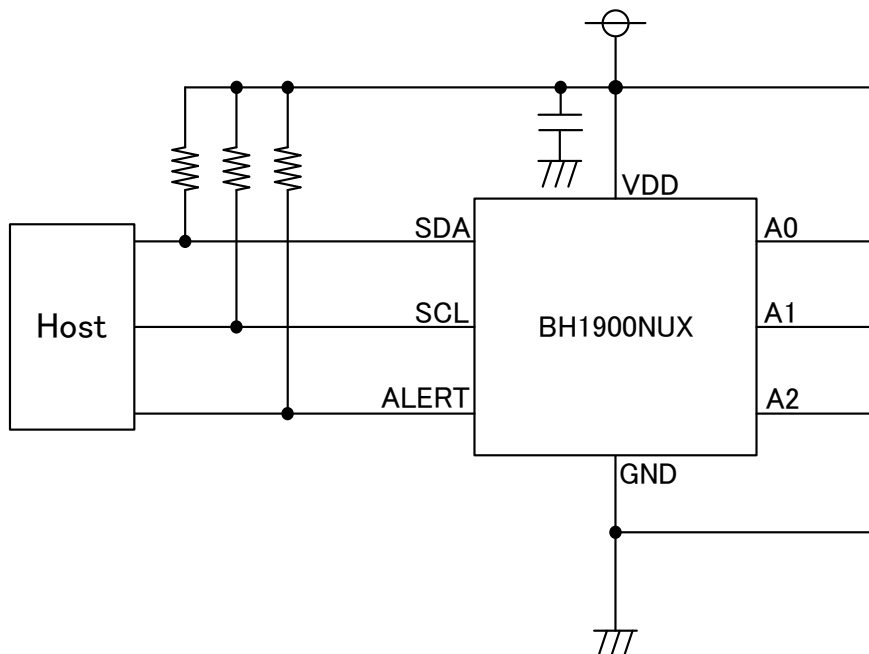
VSON008X2030

W(Typ) x D(Typ) x H(Max)

2.00mm x 3.00mm x 0.60mm



Typical Application Circuit

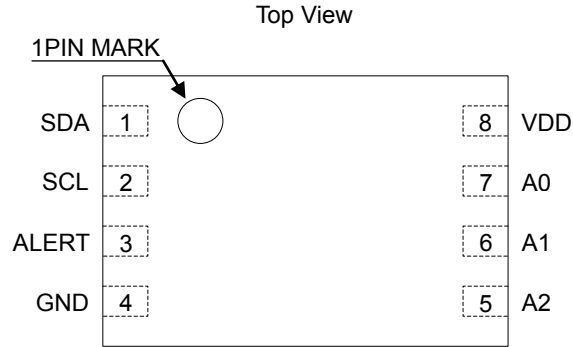


When address pins are A2=L, A1=L, A0=H.

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Pin Configuration

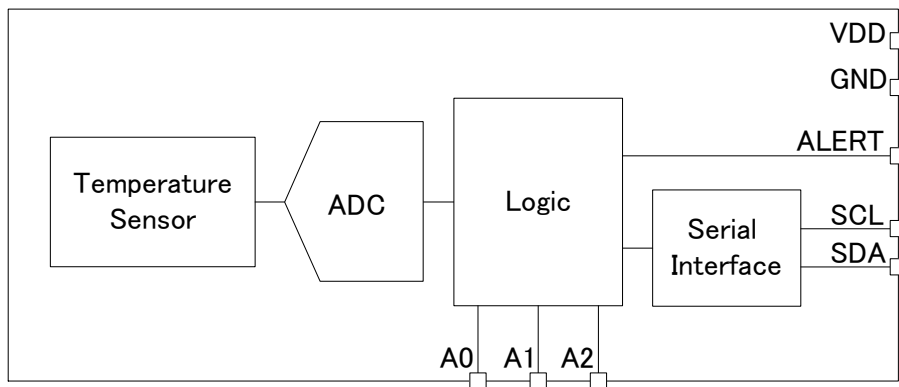


Pin Description

| Pin No. | Pin Name | Function |
|---------|----------|----------------------------------|
| 1 | SDA | Serial bus data |
| 2 | SCL | Serial bus clock |
| 3 | ALERT | Alert output |
| 4 | GND | Ground |
| 5 | A2 | Address2 |
| 6 | A1 | Address1 |
| 7 | A0 | Address0 |
| 8 | VDD | Power supply ^(Note 1) |

(Note 1) Dispose a bypass capacitor as close as possible to the IC.

Block Diagram



Absolute Maximum Ratings (Ta = 25°C)

| Parameter | Symbol | Limits | Units |
|------------------------------|--------------------|---|-------|
| Supply Voltage | V _{DD_MR} | 4.5 | V |
| Input Voltage | V _{INMR} | -0.3 to (V _{DD} +0.3) or +4.5 Whichever is less | V |
| Operating Temperature Range | T _{opr} | -30 to +95 | °C |
| Storage Temperature | T _{stg} | -40 to +125 | °C |
| Maximum Junction Temperature | T _{jmax} | 125 | °C |

Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Thermal Resistance (Note 1)

| Parameter | Symbol | Thermal Resistance (Typ) | | Unit |
|--|---------------|--------------------------|--------------------------|------|
| | | 1s ^(Note 3) | 2s2p ^(Note 4) | |
| VSON008X2030 | | | | |
| Junction to Ambient | θ_{JA} | 308.3 | 69.9 | °C/W |
| Junction to Top Characterization Parameter ^(Note 2) | Ψ_{JT} | 43 | 10 | °C/W |

(Note 1)Based on JESD51-2A(Still-Air).

(Note 2)The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.

(Note 3)Using a PCB board based on JESD51-3.

| Layer Number of Measurement Board | Material | Board Size |
|-----------------------------------|----------|----------------------------|
| Single | FR-4 | 114.3mm x 76.2mm x 1.57mmt |

| Top | |
|-----------------------|-----------|
| Copper Pattern | Thickness |
| Footprints and Traces | 70μm |

(Note 4)Using a PCB board based on JESD51-7.

| Layer Number of Measurement Board | Material | Board Size |
|-----------------------------------|----------|---------------------------|
| 4 Layers | FR-4 | 114.3mm x 76.2mm x 1.6mmt |

| Top | | 2 Internal Layers | | Bottom | |
|-----------------------|-----------|-------------------|-----------|-----------------|-----------|
| Copper Pattern | Thickness | Copper Pattern | Thickness | Copper Pattern | Thickness |
| Footprints and Traces | 70μm | 74.2mm x 74.2mm | 35μm | 74.2mm x 74.2mm | 70μm |

Recommended Operating Conditions (Ta= -30°C to +95°C)

| Parameter | Symbol | Min | Typ | Max | Units |
|----------------------|-----------------|-----|-----|-----|-------|
| Power Supply Voltage | V _{DD} | 2.7 | 3.3 | 3.6 | V |

Electrical Characteristics (Unless otherwise specified V_{DD}=3.3V, Ta=25°C)

| Parameter | Symbol | Min | Typ | Max | Units | Conditions |
|-------------------------------------|------------------|---------------------|--------|---------------------|--------|----------------------|
| Temperature Accuracy | Et | -3.0 | - | +3.0 | °C | Ta=-20°C to +85°C |
| Resolution | R _{ES} | - | 0.0625 | - | °C/LSB | |
| Oscillator Frequency | F _{OSC} | 470 | 750 | - | kHz | |
| Conversion time | T _{AD} | - | 22 | 35 | ms | |
| Operating Current | I _{DD} | - | 75 | 150 | μA | In Non-communication |
| Shutdown Current | I _{SS} | - | 1 | 5 | μA | |
| L Input Voltage (SDA, SCL) | V _{IL} | - | - | 0.54 | V | |
| H Input Voltage (SDA, SCL) | V _{IH} | 1.26 | - | - | V | |
| L Input Voltage2 (A0, A1, A2) | V _{IL2} | - | - | 0.3*V _{DD} | V | |
| H Input Voltage2 (A0, A1, A2) | V _{IH2} | 0.7*V _{DD} | - | - | V | |
| Input Leakage Current | I _{IL} | -10 | - | +10 | μA | |
| Digital Output Voltage (SDA, ALERT) | V _{OL} | 0 | - | 0.4 | V | I _{OL} =3mA |

Caution: A characteristic of the IC might change heating during reflow soldering. When high temperature accuracy is required, correction should be done after assembly.

Typical Performance Curves

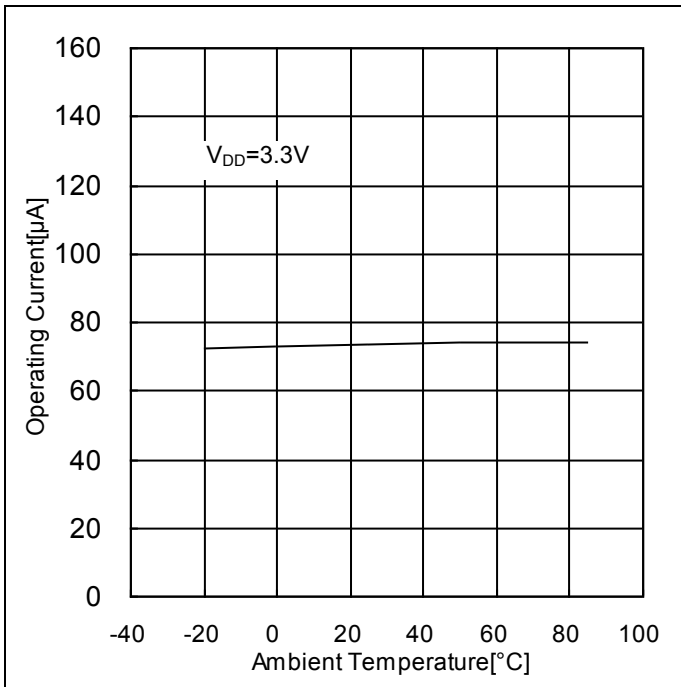


Figure 1. Operating Current vs Ambient Temperature

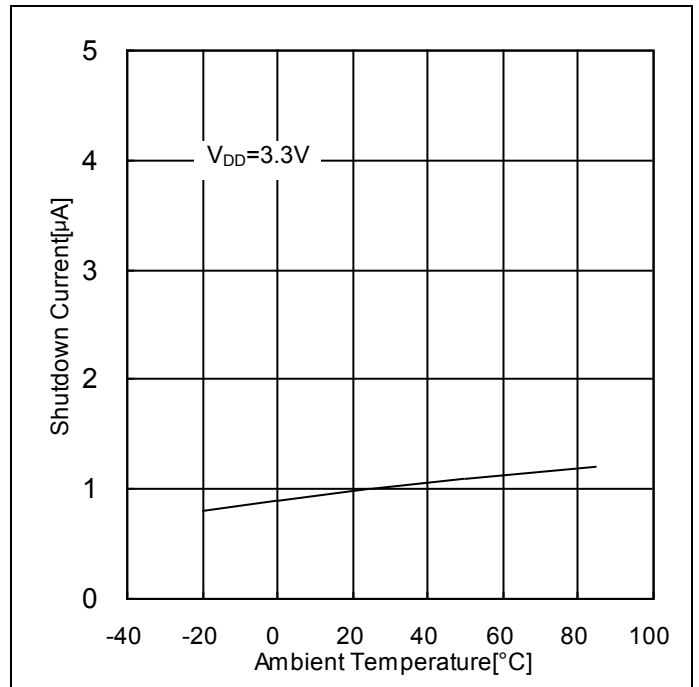


Figure 2. Shutdown Current vs Ambient Temperature

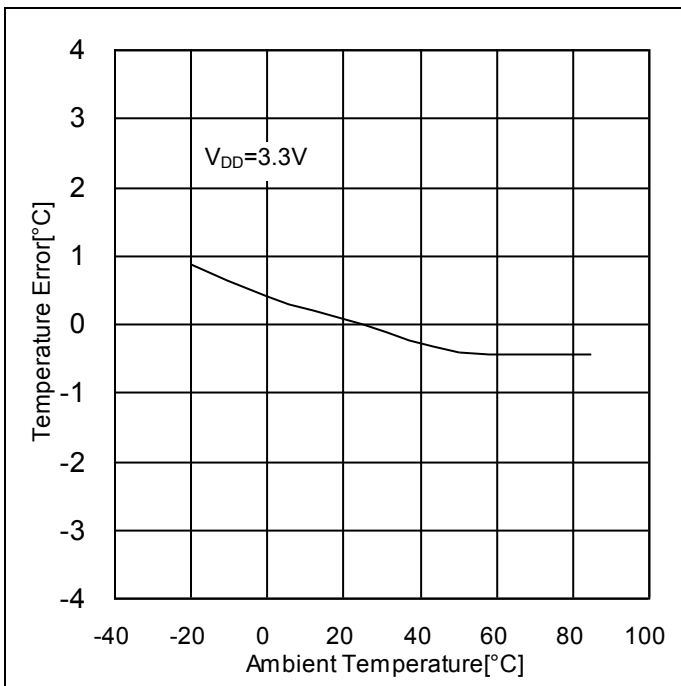
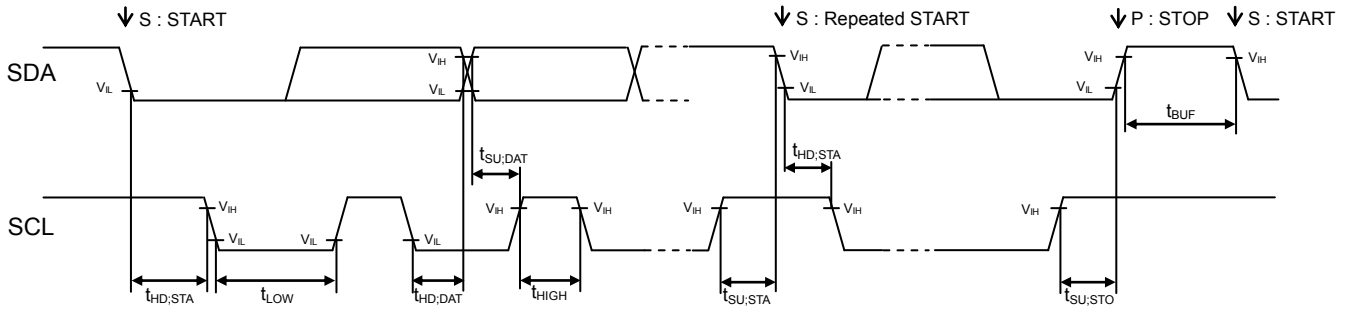


Figure 3. Temperature Error vs Ambient Temperature

Two-wire Serial Interface Timing Characteristics (Unless otherwise specified $V_{DD}=3.3V$, $T_a=25^{\circ}C$)

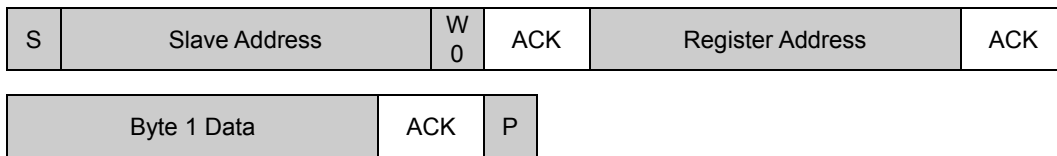


| Parameter | Symbol | Min | Typ | Max | Unit | Conditions |
|--------------------------------------|--------------|-----|-----|-----|---------|------------|
| SCL Clock frequency | f_{SCL} | 0 | - | 400 | kHz | |
| 'L' Period of the SCL Clock | t_{LOW} | 1.3 | - | - | μs | |
| 'H' Period of the SCL Clock | t_{HIGH} | 0.6 | - | - | μs | |
| Setup Time for Repeated START | $t_{SU,STA}$ | 0.6 | - | - | μs | |
| Hold Time for START | $t_{HD,STA}$ | 0.6 | - | - | μs | |
| Data Setup Time | $t_{SU,DAT}$ | 100 | - | - | ns | |
| Data Hold Time | $t_{HD,DAT}$ | 0 | - | - | μs | |
| Setup Time for STOP | $t_{SU,STO}$ | 0.6 | - | - | μs | |
| Bus Free Time between STOP and START | t_{BUF} | 1.3 | - | - | μs | |

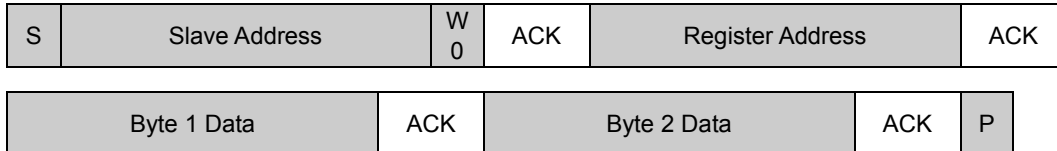
Two-wire Serial Communication

1. Write format

(1) Writing 1Byte data

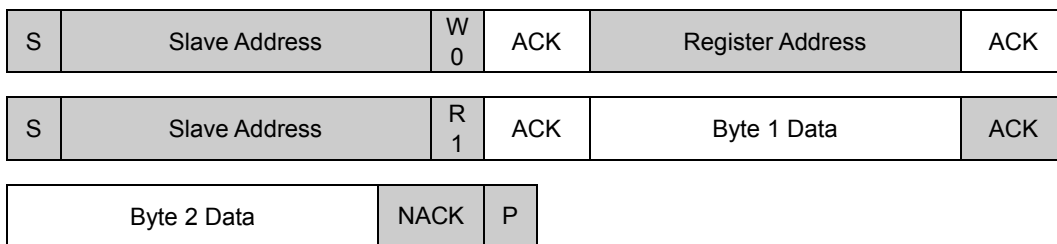


(2) Writing 2Byte data

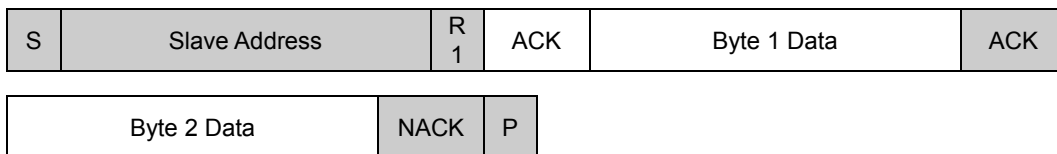


2. Read format

(1) Reading 2Byte data after setting register address



(2) Reading data of the addressed register



from master to slave



from slave to master

4. Slave Address

The slave address is selectable from 8 addresses by A0, A1, A2 pins.

| A2 | A1 | A0 | Slave Address |
|----|----|----|---------------|
| L | L | L | 1001000 |
| L | L | H | 1001001 |
| L | H | L | 1001010 |
| L | H | H | 1001011 |
| H | L | L | 1001100 |
| H | L | H | 1001101 |
| H | H | L | 1001110 |
| H | H | H | 1001111 |

Register Map (Note 1)

| Register Address | Register Name | R/W | Byte | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|------------------|----------------------------|-----|------|-------------------------------|-------|----|------------------|----|-----|---------|--------|
| 0x00 | Temperature Register | R | 1 | Temperature Data[11:4] | | | | | | | |
| | | | 2 | Temperature Data[3:0] | | | | 0 | 0 | 0 | 0 |
| 0x01 | Configuration Register | RW | 1 | OS | ALERT | 0 | FAULT QUEUE[1:0] | | POL | 0 | SD |
| | | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | WT[1:0] | |
| 0x02 | T _{LOW} Register | RW | 1 | T _{LOW} Limit[11:4] | | | | | | | |
| | | | 2 | T _{LOW} Limit[3:0] | | | | 0 | 0 | 0 | 0 |
| 0x03 | T _{HIGH} Register | RW | 1 | T _{HIGH} Limit[11:4] | | | | | | | |
| | | | 2 | T _{HIGH} Limit[3:0] | | | | 0 | 0 | 0 | 0 |
| 0x04 | Software Reset | RW | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | SW_RST |

(Note 1) Do not write any commands to other addresses except above. Do not write '1' to the fields in which value is '0' in above table.

(0x00) Temperature Register

| Fields | Function |
|------------------------|---|
| Temperature Data[11:0] | <p>Measurement Temperature Data Output Register. Negative numbers are represented in binary two's complement format. The Temperature Register is 0x0000 until the first conversion complete after a software reset or power-on. Conversion to temperature value is like below.</p> <p>Measurement Temperature Value [°C] = Temperature Data [11:0] x 0.0625</p> |

default value 0x0000

(0x01) Configuration Register

| Fields | Function |
|------------------|--|
| OS | <p>When the device is in shutdown mode, writing '1' to the OS bit starts a single temperature measurement. The device returns to the shutdown state at the completion of the single measurement. 0 : Continuous Measurement 1 : Single Measurement When reading '0' is read.</p> |
| ALERT | <p>The ALERT bit is a read-only register, it provides information of interrupt state. The ALERT bit becomes '0', when Temperature Data or ALERT is read. 0 : Interrupt is not active 1 : Interrupt is active</p> |
| FAULT QUEUE[1:0] | <p>The FAULT QUEUE is number of consecutive times. When consecutive measurement values are out of range, the ALERT pin state changes. 00 : Single 01 : 2times 10 : 4times 11 : 6times</p> |
| POL | <p>The POL bit selects the polarity of the ALERT pin output. 0 : Active Low 1 : Active High</p> |
| SD | <p>When '1' is written in SD field, it becomes shut down mode after the measurement temperature. 0 : Active 1 : Shut Down</p> |

(0x01) Configuration Register - continued

| Fields | Function |
|---------|--|
| WT[1:0] | <p>This device operating intermittently, wait time can be selected.</p> <p>00 : (186240 x 16) / F_{OSC} [sec] 01 : (186240 x 4) / F_{OSC} [sec] 10 : (186240 x 1) / F_{OSC} [sec] 11 : (186240 x 0.5) / F_{OSC} [sec]</p> |

default value 0x0002

(0x02) T_{LOW} Register

| Fields | Function |
|-------------------------------|--|
| T _{LOW} Limit [11:0] | <p>Lower Temperature Limit Setting Register. Negative numbers are represented in binary twos complement format. It has to be set as T_{LOW} Limit < T_{HIGH} Limit. Conversion to T_{LOW} temperature value is like below.</p> <p>Lower Temperature Limit [°C] = T_{LOW} Limit [11:0] x 0.0625</p> |

default value 0x4B00

(0x03) T_{HIGH} Register

| Fields | Function |
|--------------------------------|--|
| T _{HIGH} Limit [11:0] | <p>Upper Temperature Limit Setting Register. Negative numbers are represented in binary twos complement format. It has to be set as T_{HIGH} Limit > T_{LOW} Limit. Conversion to T_{HIGH} temperature value is like below.</p> <p>Upper Temperature Limit [°C] = T_{HIGH} Limit [11:0] x 0.0625</p> |

default value 0x5000

(0x04) Software Reset

| Fields | Function |
|--------|--|
| SW_RST | <p>Reset process is performed when writing SW_RST='1'. '1' is not written in register SW_RST.</p> |

default value 0xFF

Caution: Read value of Software Reset Register is always 0xFF.

Thermostat mode

When the consecutive measurement temperature value exceeds the value in T_{HIGH} Limit, the device becomes interrupt and the ALERT pin becomes active. The number of consecutive times is set in FAULT QUEUE.

Interrupt is released when any of below action is taken.

- The device becomes shut down mode.
- Temperature Data or ALERT is read.
- Measurement temperature value falls below the value in T_{LOW} Limit consecutively over same times as FAULT QUEUE.

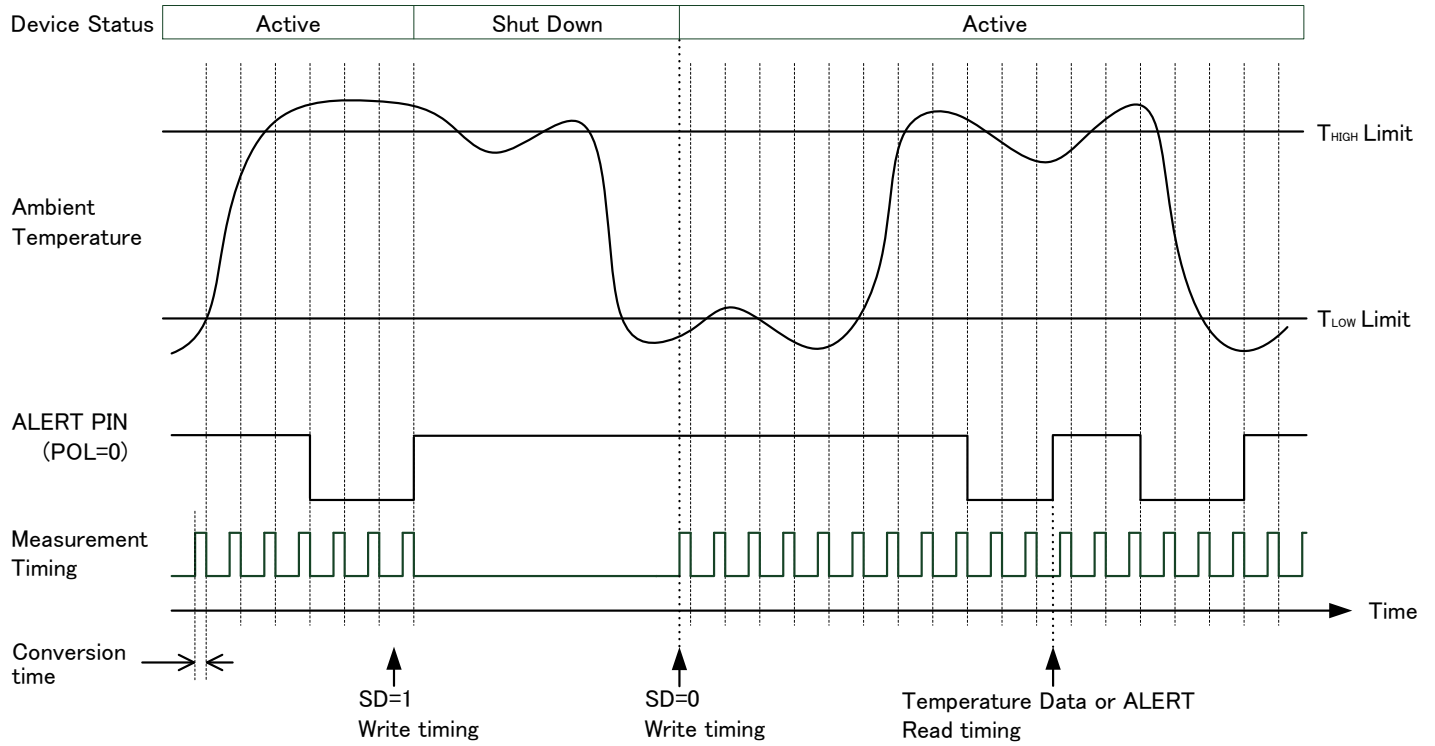
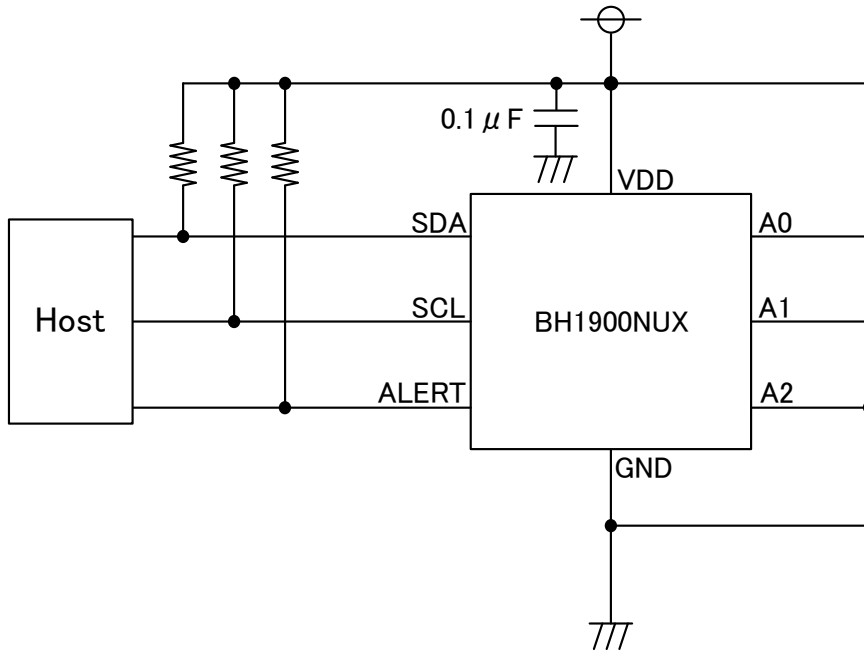


Figure 4. Comparator Mode Action Sequence
(Consecutive times = 2times)

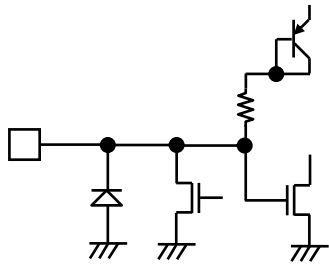
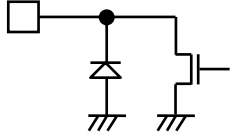
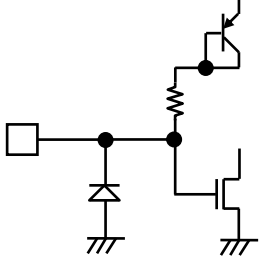
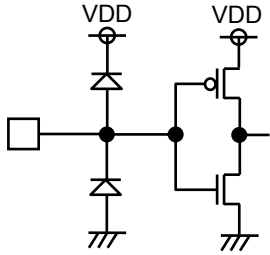
Application Example



When address pins are A2=L, A1=L, A0=H.

Caution: Adjust the bypass capacitor value as necessary, according to voltage noise conditions, etc. It is recommended to place bypass capacitance as near the IC as possible.

I/O equivalence circuit

| Pin Name | Equivalent Circuit | Pin Name | Equivalent Circuit |
|----------|---|----------------|---|
| SDA |  | ALERT |  |
| SCL |  | A0 A1 A2 |  |

Operational Notes

1. Reverse Connection of Power Supply

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. Power Supply Lines

Design the PCB layout pattern to provide low impedance supply lines. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. Ground Voltage

Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. Ground Wiring Pattern

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. Thermal Consideration

Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the maximum junction temperature rating.

6. Recommended Operating Conditions

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. Inrush Current

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. Operation Under Strong Electromagnetic Field

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. Testing on Application Boards

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. Inter-pin Short and Mounting Errors

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

11. Unused Input Pins

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

Operational Notes – continued

12. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When $GND > Pin A$ and $GND > Pin B$, the P-N junction operates as a parasitic diode.

When $GND > Pin B$, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

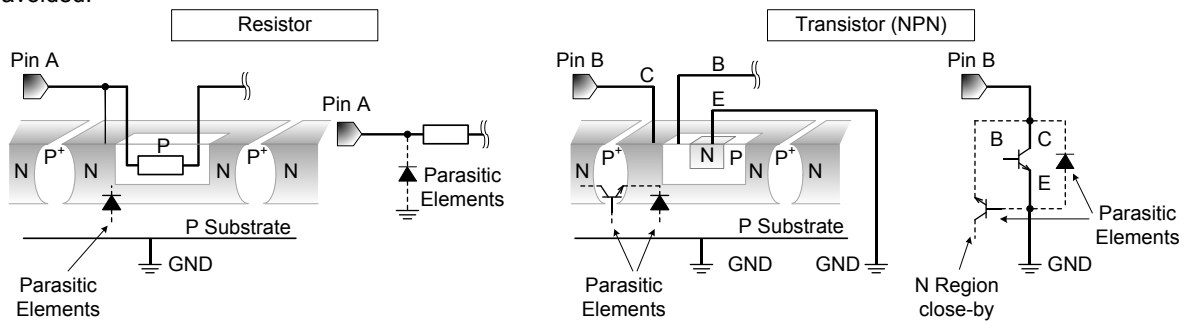


Figure 5. Example of monolithic IC structure

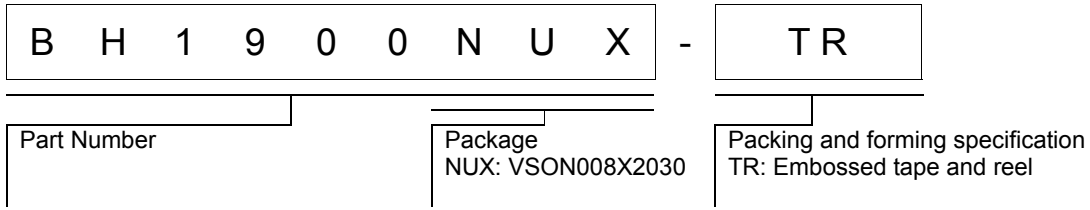
13. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

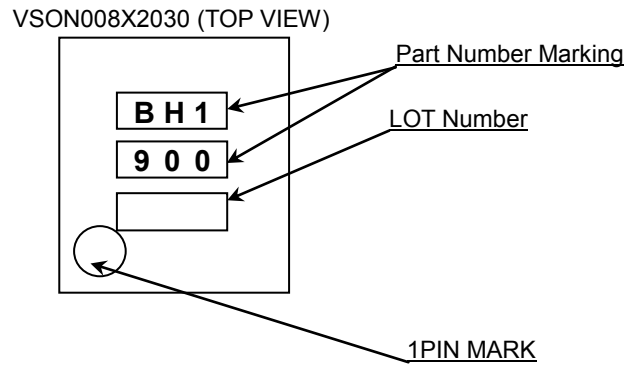
14. Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and the maximum junction temperature rating are all within the Area of Safe Operation (ASO).

Ordering Information

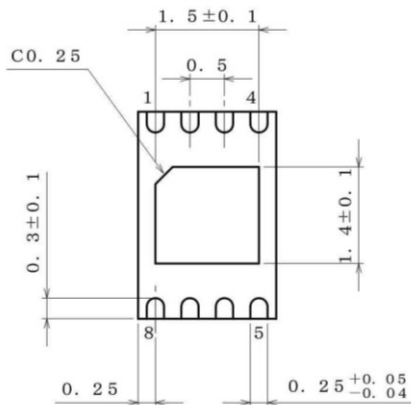
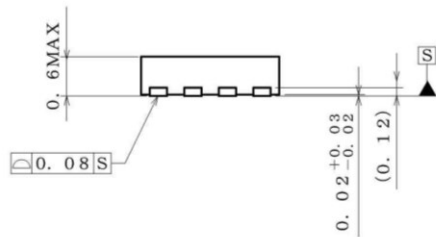
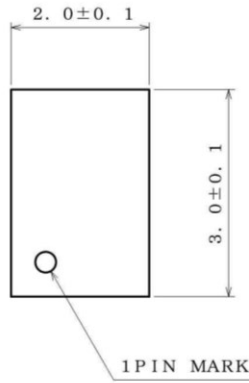


Marking Diagrams



Physical Dimension, Tape and Reel Information

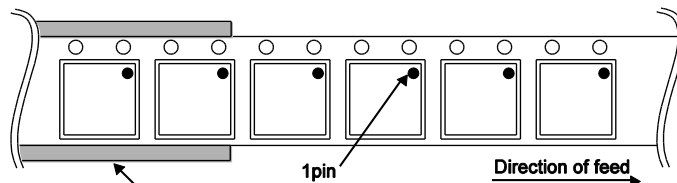
| | |
|--------------|--------------|
| Package Name | VSON008X2030 |
|--------------|--------------|



(UNIT : mm)
 PKG : VSON008X2030
 Drawing No. EX187-5001

<Tape and Reel information>

| | |
|-------------------|--|
| Tape | Embossed carrier tape |
| Quantity | 4000pcs |
| Direction of feed | TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand) |



*Order quantity needs to be multiple of the minimum quantity.

Revision History

| Date | Revision | Changes |
|-------------|----------|-------------|
| 26.Apr.2016 | 001 | New Release |

Notice

Precaution on using ROHM Products

- Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment ^(Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN | USA | EU | CHINA |
|-----------|-----------|------------|-----------|
| CLASS III | CLASS III | CLASS II b | CLASS III |
| CLASS IV | | CLASS III | |

- ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
 - Installation of protection circuits or other protective devices to improve system safety
 - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc. prior to use, must be necessary:
 - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
 - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
 - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
 - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
 - Sealing or coating our Products with resin or other coating materials
 - Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
 - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
 - [a] the Products are exposed to sea winds or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [b] the temperature or humidity exceeds those recommended by ROHM
 - [c] the Products are exposed to direct sunshine or condensation
 - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

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General Precaution

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