Serial EEPROM Series Standard EEPROM
I²C BUS EEPROM (2-Wire)

BR24G64xxx-5 Series

General Description
BR24G64xxx-5 Series is a 64Kbit serial EEPROM of I²C BUS Interface.

Features
- All Controls Available by 2 Ports of Serial Clock (SCL) and Serial Data (SDA)
- 1.6V to 5.5V Wide Limit of Operating Voltage, Possible 1MHz Operation
- Page Write Mode 32Byte
- Bit Format 8K x 8bit
- Low Current Consumption
- Prevention of Miswriting
  - WP (Write Protect) Function Added
  - Prevention of Miswriting at Low Voltage
- Noise Filter Built-in SCL / SDA Pin
- Initial Delivery State FFh

Applications
Ordinary Electronic Equipment (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.).

Typical Application Circuit

```
* Connect A0, A1, A2 to VCC or GND. These pins have pull-down elements inside the IC.
  If pins are open, they are the same as when they are connected to GND.
```

Figure 1. Typical Application Circuit

Key Specifications
- Write Cycles: 4 Million Times (Ta=25°C)
- Data Retention: 200 Years (Ta=55°C)
- Write Cycle Time: 5ms (Max)
- Supply Voltage: 1.6V to 5.5V

Packages
- SOP8  W(Typ) x D(Typ) x H(Max)
  - 5.00mm x 6.20mm x 1.71mm
- SOP-J8
  - 4.90mm x 6.00mm x 1.65mm
- TSSOP-B8
  - 3.00mm x 6.40mm x 1.20mm
- MSOP8
  - 2.90mm x 4.00mm x 0.90mm
- VSON008X2030
  - 2.00mm x 3.00mm x 0.60mm

Figure 2

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©Product structure : Silicon monolithic integrated circuit  ○This product has no designed protection against radioactive rays
Contents

General Description ........................................................................................................... 1
Features .............................................................................................................................. 1
Applications ....................................................................................................................... 1
Typical Application Circuit ............................................................................................... 1
Key Specifications .............................................................................................................. 1
Packages ............................................................................................................................ 1
Contents ............................................................................................................................ 2
Pin Configuration .............................................................................................................. 3
Pin Description .................................................................................................................. 3
Block Diagram .................................................................................................................. 3
Absolute Maximum Ratings ............................................................................................. 4
Thermal Resistance .......................................................................................................... 4
Operating Conditions ....................................................................................................... 5
Input / Output Capacitance ............................................................................................... 5
Input Impedance .............................................................................................................. 5
Memory Cell Characteristics ............................................................................................ 5
Electrical Characteristics ................................................................................................. 6
AC Characteristics ........................................................................................................... 6
AC Characteristics Condition .......................................................................................... 6
Input / Output Timing ....................................................................................................... 7
Typical Performance Curves ............................................................................................. 8
I²C BUS Communication ................................................................................................... 17
Write Command ............................................................................................................... 18
Read Command ............................................................................................................... 19
Method of Reset ............................................................................................................... 20
Acknowledge Polling ........................................................................................................ 20
WP Valid Timing (Write Cancel) .................................................................................... 21
Command Cancel by Start Condition and Stop Condition ............................................. 21
Application Examples ...................................................................................................... 22
Caution on Power-Up Conditions .................................................................................... 24
Low Voltage Malfunction Prevention Function ............................................................. 24
I/O Equivalence Circuits ................................................................................................. 25
Operational Notes ............................................................................................................ 26
Ordering Information ........................................................................................................ 27
Lineup .............................................................................................................................. 27
Marking Diagrams ............................................................................................................ 28
Physical Dimension and Packing Information ................................................................. 29
Revision History ............................................................................................................... 34
Pin Configuration

(SOP8, SOP-J8, TSSOP-B8, MSOP8)

Figure 3-(a).

(TOP VIEW)

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin Name</th>
<th>Input / Output</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A0</td>
<td>Input</td>
<td>Slave address setting (Note 1)</td>
</tr>
<tr>
<td>2</td>
<td>A1</td>
<td>Input</td>
<td>Slave address setting (Note 1)</td>
</tr>
<tr>
<td>3</td>
<td>A2</td>
<td>Input</td>
<td>Slave address setting (Note 1)</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Input</td>
<td>Reference voltage of all input / output, 0V</td>
</tr>
<tr>
<td>5</td>
<td>SDA</td>
<td>Input / Output</td>
<td>Serial data input / serial data output (Note 2)</td>
</tr>
<tr>
<td>6</td>
<td>SCL</td>
<td>Input</td>
<td>Serial clock input</td>
</tr>
<tr>
<td>7</td>
<td>WP</td>
<td>Input</td>
<td>Write protect pin (Note 3)</td>
</tr>
<tr>
<td>8</td>
<td>VCC</td>
<td>Input</td>
<td>Connect the power source</td>
</tr>
</tbody>
</table>

(Note 1) Connect to VCC or GND. There are pull-down elements inside the IC. If pins are open, they are the same as when they are connected to GND.
(Note 2) SDA is NMOS open drain, so it requires a pull-up resistor.
(Note 3) Connect to VCC or GND, or control to 'HIGH' level or 'LOW' level. There are pull-down elements inside the IC. If this pin is open, this input is recognized as 'LOW'.

Pin Description

(SOP08X2030)

(TOP VIEW)

Figure 3-(b).

Block Diagram

Figure 4. Block Diagram
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>-0.3 to +6.5</td>
<td>V</td>
<td>Ta=25°C. The maximum value of input voltage/output voltage is not over 6.5 V. When the pulse width is 50ns or less, the minimum value of input voltage/output voltage is -1.0V.</td>
</tr>
<tr>
<td>Input Voltage / Output Voltage</td>
<td>-</td>
<td>-0.3 to V&lt;sub&gt;CC&lt;/sub&gt;+1.0</td>
<td>V</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td>Electro Static Discharge (Human Body Model)</td>
<td>V&lt;sub&gt;ESD&lt;/sub&gt;</td>
<td>-3000 to +3000</td>
<td>V</td>
<td>Ta=25°C. The maximum value of input voltage/output voltage is 6.5 V.</td>
</tr>
<tr>
<td>Maximum Output Low Current (SDA)</td>
<td>I&lt;sub&gt;OLMAX&lt;/sub&gt;</td>
<td>10</td>
<td>mA</td>
<td>Ta=25°C. When the pulse width is 50ns or less, the minimum value of input voltage/output voltage is -1.0V.</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>T&lt;sub&gt;jmax&lt;/sub&gt;</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
<td>-65 to +150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

**Caution 1:** 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.

**Caution 2:** 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, design a PCB boards with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.

## Thermal Resistance (Note 4)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Thermal Resistance (Typ)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1s&lt;sup&gt;(Note 6)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2s2p&lt;sup&gt;(Note 7)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>SOP8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction to Ambient</td>
<td>θ&lt;sub&gt;JA&lt;/sub&gt;</td>
<td>197.4</td>
<td>109.8</td>
</tr>
<tr>
<td>Junction to Top Characterization Parameter&lt;sup&gt;(Note 5)&lt;/sup&gt;</td>
<td>Ψ&lt;sub&gt;JT&lt;/sub&gt;</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>SOP-8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction to Ambient</td>
<td>θ&lt;sub&gt;JA&lt;/sub&gt;</td>
<td>149.3</td>
<td>76.9</td>
</tr>
<tr>
<td>Junction to Top Characterization Parameter&lt;sup&gt;(Note 5)&lt;/sup&gt;</td>
<td>Ψ&lt;sub&gt;JT&lt;/sub&gt;</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>TSSOP-B8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction to Ambient</td>
<td>θ&lt;sub&gt;JA&lt;/sub&gt;</td>
<td>251.9</td>
<td>152.1</td>
</tr>
<tr>
<td>Junction to Top Characterization Parameter&lt;sup&gt;(Note 5)&lt;/sup&gt;</td>
<td>Ψ&lt;sub&gt;JT&lt;/sub&gt;</td>
<td>31</td>
<td>20</td>
</tr>
<tr>
<td>MSOP8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction to Ambient</td>
<td>θ&lt;sub&gt;JA&lt;/sub&gt;</td>
<td>284.1</td>
<td>135.4</td>
</tr>
<tr>
<td>Junction to Top Characterization Parameter&lt;sup&gt;(Note 5)&lt;/sup&gt;</td>
<td>Ψ&lt;sub&gt;JT&lt;/sub&gt;</td>
<td>21</td>
<td>11</td>
</tr>
</tbody>
</table>

<sup>(Note 4)</sup> Based on JESD51-2A(Still-Air)

<sup>(Note 5)</sup> 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.

<sup>(Note 6)</sup> Using a PCB board based on JESD51-3.

### Layer Number of Measurement Board

<table>
<thead>
<tr>
<th>Material</th>
<th>Board Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>FR-4</td>
</tr>
<tr>
<td></td>
<td>114.3mm x 76.2mm x 1.57mm</td>
</tr>
</tbody>
</table>

### Layer Number of Measurement Board

<table>
<thead>
<tr>
<th>Material</th>
<th>Board Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Layers</td>
<td>FR-4</td>
</tr>
<tr>
<td></td>
<td>114.3mm x 76.2mm x 1.6mm</td>
</tr>
</tbody>
</table>

### Layer Number of Measurement Board

<table>
<thead>
<tr>
<th>Material</th>
<th>Top</th>
<th>Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Pattern</td>
<td>Thickness</td>
<td>Copper Pattern</td>
</tr>
<tr>
<td>70μm</td>
<td>74.2mm x 74.2mm</td>
<td>35μm</td>
</tr>
</tbody>
</table>

<sup>(Note 7)</sup> Using a PCB board based on JESD51-7.
Thermal Resistance (Note 8) - continued

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Thermal Resistance (Typ)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSON008X2030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction to Ambient</td>
<td>$\theta_{JA}$</td>
<td>308.3</td>
<td>69.6</td>
</tr>
<tr>
<td>Junction to Top Characterization Parameter (Note 8)</td>
<td>$\Psi_{JT}$</td>
<td>43</td>
<td>10</td>
</tr>
</tbody>
</table>

(Note 8) Based on JESD51-2A (Still Air)
(Note 9) 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 10) Using a PCB board based on JESD51-3.

<table>
<thead>
<tr>
<th>Layer Number of Measurement Board</th>
<th>Material</th>
<th>Board Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>FR-4</td>
<td>114.3mm x 76.2mm x 1.57mmt</td>
</tr>
<tr>
<td>Top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper Pattern</td>
<td>Thickness</td>
<td></td>
</tr>
<tr>
<td>Footprints and Traces</td>
<td>70µm</td>
<td></td>
</tr>
</tbody>
</table>

(Note 11) Using a PCB board based on JESD51-5, 7.

<table>
<thead>
<tr>
<th>Layer Number of Measurement Board</th>
<th>Material</th>
<th>Board Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Layers</td>
<td>FR-4</td>
<td>114.3mm x 76.2mm x 1.6mmt</td>
</tr>
<tr>
<td>Top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper Pattern</td>
<td>Thickness</td>
<td></td>
</tr>
<tr>
<td>Copper Pattern</td>
<td>Thickness</td>
<td></td>
</tr>
<tr>
<td>Footprints and Traces</td>
<td>70µm</td>
<td>74.2mm x 74.2mm</td>
</tr>
</tbody>
</table>

(Note 12) This thermal via connects with the copper pattern of all layers.

Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC}$</td>
<td>1.6</td>
<td>-</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Ambient Operating Temperature</td>
<td>$T_a$</td>
<td>-40</td>
<td>-</td>
<td>+85</td>
<td>°C</td>
</tr>
<tr>
<td>Bypass capacitor (Note 13)</td>
<td>C</td>
<td>0.1</td>
<td>-</td>
<td>-</td>
<td>µF</td>
</tr>
</tbody>
</table>

(Note 13) Connect a bypass capacitor between the IC’s VCC and GND pin.

Input / Output Capacitance (Ta=25°C, f=1MHz)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input / Output Capacitance (SDA) (Note 14)</td>
<td>$C_{IO}$</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>pF</td>
<td>$V_{IO}=GND$</td>
</tr>
<tr>
<td>Input Capacitance (SCL, A0, A1, A2, WP) (Note 14)</td>
<td>$C_{IN}$</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>pF</td>
<td>$V_{IN}=GND$</td>
</tr>
</tbody>
</table>

(Note 14) Not 100% TESTED.

Input Impedance (Unless otherwise specified, Ta=-40°C to +85°C, $V_{CC}$=1.6V to 5.5V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance 1</td>
<td>$Z_{IH}$</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>kΩ</td>
</tr>
<tr>
<td>Input Impedance 2</td>
<td>$Z_{IL}$</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>kΩ</td>
</tr>
</tbody>
</table>

Memory Cell Characteristics ($V_{CC}$=1.6V to 5.5V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write Cycles (Note 15, 16)</td>
<td>-</td>
<td>4,000,000</td>
<td>-</td>
<td>-</td>
<td>Times</td>
<td>Ta=25°C</td>
</tr>
<tr>
<td>Data Retention (Note 15)</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>Years</td>
<td>Ta=55°C</td>
</tr>
</tbody>
</table>

(Note 15) Not 100% TESTED.
(Note 16) The Write Cycles is defined for unit of 4 data bytes with the same address bits of WA12 to WA2.
### Electrical Characteristics (Unless otherwise specified, Ta=–40°C to +85°C, Vcc=1.6V to 5.5V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input High Voltage 1</td>
<td>VHI</td>
<td>0.7VCC</td>
<td>-</td>
<td>VCC+1.0</td>
<td>V</td>
<td>1.7VsVCC&lt;5.5V</td>
</tr>
<tr>
<td>Input Low Voltage 1</td>
<td>VIL</td>
<td>-0.3(Note 17)</td>
<td>-</td>
<td>+0.3VCC</td>
<td>V</td>
<td>1.7VsVCC&lt;5.5V</td>
</tr>
<tr>
<td>Input High Voltage 2</td>
<td>VHI2</td>
<td>0.8VCC</td>
<td>-</td>
<td>VCC+1.0</td>
<td>V</td>
<td>1.6VsVCC&lt;1.7V</td>
</tr>
<tr>
<td>Input Low Voltage 2</td>
<td>VIL2</td>
<td>-0.3(Note 17)</td>
<td>-</td>
<td>+0.2VCC</td>
<td>V</td>
<td>1.6VsVCC&lt;1.7V</td>
</tr>
<tr>
<td>Output Low Voltage 1</td>
<td>VOS1</td>
<td>-</td>
<td>-</td>
<td>0.4</td>
<td>V</td>
<td>IOL=3.2mA, 2.5VsVCC&lt;5.5V (SDA)</td>
</tr>
<tr>
<td>Output Low Voltage 2</td>
<td>VOS2</td>
<td>-</td>
<td>-</td>
<td>0.2</td>
<td>V</td>
<td>IOL=1mA, 1.6VsVCC&lt;2.5V (SDA)</td>
</tr>
<tr>
<td>Input Leakage Current 1</td>
<td>IL1</td>
<td>-1</td>
<td>-</td>
<td>+1</td>
<td>µA</td>
<td>VWP0 or Vcc (A0, A1, A2, WP) Standby Mode</td>
</tr>
<tr>
<td>Input Leakage Current 2</td>
<td>IL2</td>
<td>-1</td>
<td>-</td>
<td>+1</td>
<td>µA</td>
<td>VWP0 to Vcc (SCL)</td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>IOL</td>
<td>-1</td>
<td>-</td>
<td>+1</td>
<td>µA</td>
<td>VOUT=0 to Vcc (SDA)</td>
</tr>
<tr>
<td>Supply Current (Write)</td>
<td>ICC1</td>
<td>-</td>
<td>-</td>
<td>2.0</td>
<td>mA</td>
<td>VCC=5.5V, fSCL=1MHz, tWR=5ms, Byte Write, Page Write</td>
</tr>
<tr>
<td>Supply Current (Read)</td>
<td>ICC2</td>
<td>-</td>
<td>-</td>
<td>2.0</td>
<td>mA</td>
<td>VCC=5.5V, fSCL=1MHz Random Read, Current Read, Sequential Read</td>
</tr>
<tr>
<td>Standby Current</td>
<td>ISB</td>
<td>-</td>
<td>-</td>
<td>2.5</td>
<td>µA</td>
<td>VCC=5.5V, SDA, SCL=Vcc A0, A1, A2, WP=GND</td>
</tr>
</tbody>
</table>

(Note 17) When the pulse width is 50ns or less, it is -1.0V.

### AC Characteristics (Unless otherwise specified, Ta=–40°C to +85°C, Vcc=1.6V to 5.5V)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock Frequency</td>
<td>fSCL</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>MHz</td>
</tr>
<tr>
<td>Data Clock High Period</td>
<td>tHIGH</td>
<td>260</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Data Clock Low Period</td>
<td>tLOW</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>SDA, SCL (input) Rise Time</td>
<td>tR</td>
<td>-</td>
<td>-</td>
<td>120</td>
<td>ns</td>
</tr>
<tr>
<td>SDA, SCL (input) Fall Time</td>
<td>tF</td>
<td>-</td>
<td>-</td>
<td>120</td>
<td>ns</td>
</tr>
<tr>
<td>SDA (output) Fall Time</td>
<td>tF2</td>
<td>-</td>
<td>-</td>
<td>120</td>
<td>ns</td>
</tr>
<tr>
<td>Start Condition Hold Time</td>
<td>tHDSTA</td>
<td>250</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Start Condition Setup Time</td>
<td>tSUSTA</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Input Data Hold Time</td>
<td>tHDAT</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Input Data Setup Time</td>
<td>tSUAT</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Output Data Delay Time</td>
<td>tPD</td>
<td>50</td>
<td>-</td>
<td>450</td>
<td>ns</td>
</tr>
<tr>
<td>Output Data Hold Time</td>
<td>tDH</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Stop Condition Setup Time</td>
<td>tSUATO</td>
<td>250</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Bus Free Time</td>
<td>tBUF</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Write Cycle Time</td>
<td>tWR</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>ms</td>
</tr>
<tr>
<td>Noise Suppression Time (SCL, SDA)</td>
<td>t</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>ns</td>
</tr>
<tr>
<td>WP Hold Time</td>
<td>tHDWP</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>µs</td>
</tr>
<tr>
<td>WP Setup Time</td>
<td>tSUWP</td>
<td>0.1</td>
<td>-</td>
<td>-</td>
<td>µs</td>
</tr>
<tr>
<td>WP High Period</td>
<td>tHIGHWP</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>µs</td>
</tr>
</tbody>
</table>

(Note 18) Not 100% TESTED.

### AC Characteristics Condition

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Capacitance</td>
<td>CL</td>
<td>100</td>
<td>pF</td>
</tr>
<tr>
<td>Input Rise Time</td>
<td>tR</td>
<td>20</td>
<td>ns</td>
</tr>
<tr>
<td>Input Fall Time</td>
<td>tF1</td>
<td>20</td>
<td>ns</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>VIL/VIH</td>
<td>0.2VCC/0.8VCC</td>
<td>V</td>
</tr>
<tr>
<td>Input / Output Data Timing Reference Level</td>
<td>-</td>
<td>0.3VCC/0.7VCC</td>
<td>V</td>
</tr>
</tbody>
</table>
Input / Output Timing

- Input read at the rise edge of SCL
- Data output in sync with the fall of SCL

Figure 5-(a). Input / Output Timing

Figure 5-(b). Start-Stop Condition Timing

Figure 5-(c). Write Cycle Timing

Figure 5-(d). WP Timing at Write Execution

Figure 5-(e). WP Timing at Write Cancel
Typical Performance Curves

Figure 6. Input High Voltage 1,2 vs Supply Voltage

Figure 7. Input Low Voltage 1,2 vs Supply Voltage

Figure 8. Output Low Voltage 1 vs Output Low Current
(V\textsubscript{CC}=2.5V)

Figure 9. Output Low Voltage 2 vs Output Low Current
(V\textsubscript{CC}=1.6V)
Typical Performance Curves - continued

Figure 10. Input Leakage Current 1 vs Input Voltage
   (Standby Mode)

Figure 11. Input Leakage Current 2 vs Input Voltage

Figure 12. Output Leakage Current vs Output Voltage

Figure 13. Supply Current (Write) vs Supply Voltage
Typical Performance Curves - continued

Figure 14. Supply Current (Read) vs Supply Voltage

Figure 15. Standby Current vs Supply Voltage

Figure 16. Clock Frequency vs Supply Voltage

Figure 17. Data Clock High Period vs Supply Voltage
Typical Performance Curves - continued

Figure 18. Data Clock Low Period vs Supply Voltage

Figure 19. SDA (OUTPUT) Fall Time vs Supply Voltage

Figure 20. Start Condition Hold Time vs Supply Voltage

Figure 21. Start Condition Setup Time vs Supply Voltage
Typical Performance Curves - continued

Figure 22. Input Data Hold Time vs Supply Voltage (SDA 'LOW' to 'HIGH')

Figure 23. Input Data Hold Time vs Supply Voltage (SDA 'HIGH' to 'LOW')

Figure 24. Input Data Setup Time vs Supply Voltage (SDA 'LOW' to 'HIGH')

Figure 25. Input Data Setup Time vs Supply Voltage (SDA 'HIGH' to 'LOW')
Typical Performance Curves - continued

Figure 26. Output Data Delay Time vs Supply Voltage (SDA 'LOW' to 'HIGH')

Figure 27. Output Data Delay Time vs Supply Voltage (SDA 'HIGH' to 'LOW')

Figure 28. Output Data Hold Time vs Supply Voltage (SDA 'LOW' to 'HIGH')

Figure 29. Output Data Hold Time vs Supply Voltage (SDA 'HIGH' to 'LOW')
Typical Performance Curves - continued

Figure 30. Stop Condition Setup Time vs Supply Voltage

Figure 31. Bus Free Time vs Supply Voltage

Figure 32. Write Cycle Time vs Supply Voltage

Figure 33. Noise Suppression Time vs Supply Voltage (SCL ‘HIGH’)

Supply Voltage : $V_{CC}$ [V]

Stop Condition Setup Time : $t_{SU:STO}$ [ns]

SPEC
Ta=-40°C
Ta=+25°C
Ta=+85°C

Bus Free Time : $t_{BUF}$ [ns]

SPEC
Ta=-40°C
Ta=+25°C
Ta=+85°C

Noise Suppression Time : $t_{I}$ [ns]

SPEC
Ta=-40°C
Ta=+25°C
Ta=+85°C

Write Cycle Time : $t_{WR}$ [ms]

SPEC
Ta=-40°C
Ta=+25°C
Ta=+85°C
Typical Performance Curves - continued

Figure 34. Noise Suppression Time vs Supply Voltage (SCL 'LOW')

Figure 35. Noise Suppression Time vs Supply Voltage (SDA 'HIGH')

Figure 36. Noise Suppression Time vs Supply Voltage (SDA 'LOW')

Figure 37. WP Hold Time vs Supply Voltage
Typical Performance Curves - continued

Figure 38. WP Setup Time vs Supply Voltage

Figure 39. WP High Period vs Supply Voltage
I²C BUS Communication

1. I²C BUS Data Communication
   (1) I²C BUS data communication begins with start condition input, and ends at the stop condition input.
   (2) The data is always 8bit long, and acknowledge is always required after each byte.
   (3) I²C BUS data communication with several devices connected to the BUS is possible by connecting with 2
       communication lines: serial data (SDA) and serial clock (SCL).
   (4) Among the devices, there is a “master” that generates clock and control communication start and end. The rest
       become “slave” which are controlled by an address peculiar to each device. EEPROM is a “slave”.
   (5) The device that outputs data to the bus during data communication is called “transmitter”, and the device that
       receives data is called “receiver”.

2. Start Condition (Start Bit Recognition)
   (1) Before executing each command, start condition (start bit) where SDA goes down from ‘HIGH’ to ‘LOW’ while SCL
       is ‘HIGH’ is necessary.
   (2) This IC always detects whether SDA and SCL are in start condition (start bit) or not, therefore, unless this condition
       is satisfied, any command cannot be executed.

3. Stop Condition (Stop Bit Recognition)
   Each command can be ended by a stop condition (stop bit) where SDA goes from ‘LOW’ to ‘HIGH’ while SCL is
   ‘HIGH’.

4. Acknowledge (ACK) Signal
   (1) This acknowledge (ACK) signal is a software rule to indicate whether or not data transfer was performed normally.
       In both master and slave communication, the device at the transmitter (sending) side releases the bus after
       outputting 8-bit data. When a slave address of a write command or a read command is input, microcontroller is the
       device at the transmitter side. When data output for a read command, this IC is the device at the transmitter side.
   (2) The device on the receiver (receiving) side sets SDA ‘LOW’ during the 9th clock cycle, and outputs an ACK signal
       showing that the 8-bit data has been received. When a slave address of a write command or a read command is
       input, this IC is the device at the receiver side. When data output for a read command, microcontroller is the device
       at the receiver side.
   (3) This IC, after recognizing start condition and slave address (8bit), outputs ACK signal ‘LOW’.
   (4) Each write operation outputs ACK signal ‘LOW’ every 8bit data (a word address and write data) reception.
   (5) During read operation, this IC outputs 8bit data (read data) and detects the ACK signal ‘LOW’. When ACK signal is
       detected, and no stop condition is sent from the master (microcontroller) side, this IC will continue to output data. If
       the ACK signal is not detected, this IC stops data transfer, recognizes the stop condition (stop bit), and ends the
       read operation. Then this IC becomes ready for another transmission.

5. Device Addressing
   (1) From the master, input the slave address after the start condition.
   (2) The significant 4 bits of slave address are used for recognizing a device type.
       The device code of this IC is fixed to ‘1010’.
   (3) The next slave addresses (A2 A1 A0 --- device address) are for selecting devices, and multiple devices can be used
       on a same bus according to the number of device addresses. It is possible to select and operate only device whose
       ‘VCC’ ‘GND’ input conditions of the A0, A1, A2 pin match the ‘HIGH’ ‘LOW’ input conditions of slave address sent
       from the master.
   (4) The least significant bit (R/ W --- READ/ WRITE) of slave address is used for designating write or read operation,
       and is as shown below.

Setting R/ W to 0 ------- write (setting 0 to word address setting of random read)
Setting R/ W to 1 ------- read

<table>
<thead>
<tr>
<th>Slave address</th>
<th>Maximum number of Connected buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 0 1 0 A2 A1 A0 R/ W</td>
<td>8</td>
</tr>
</tbody>
</table>
Write Command

1. Write
   (1) Arbitrary data can be written to EEPROM. When writing only 1 byte, Byte Write is normally used, and when writing continuous data of 2 bytes or more, simultaneous write is possible by Page Write. Up to 32 arbitrary bytes can be written.

   ![Figure 41. Byte Write](image)

   ![Figure 42. Page Write](image)

   (2) During internal write execution, all input commands are ignored, therefore ACK is not returned.

   (3) Data is written to the address designated by word address (n-th address)

   (4) By issuing stop bit after 8bit data input, internal write to memory cell starts.

   (5) When internal write is started, command is not accepted for tWR (5ms at maximum).

   (6) Using page write, it is possible to write one lump sum up to 32 bytes. When data of more than 32 bytes is sent, the excess of the bytes is overwritten the data sent already from first byte. (Refer to "Internal Address Increment").

   (7) As for page write where 2 or more bytes of data is intended to be written, after the word address are designated arbitrarily, only the value of 5 least significant bits in the address is incremented internally, so that data up to 32 bytes of memory only can be written.

   (8) When VCC is turned off during tWR, data at the designated address is not guaranteed, please write it again.

   1 page=32bytes, but the write time of page write is 5ms at maximum for 32byte batch write. It is not equal to 5ms at maximum x 32byte=160ms(Max).

2. Internal Address Increment
   Page write mode

   ![Address Increment](image)

   For example, when starting from address 1Eh, then, 1Eh→1Fh→00h→01h⋯. Please take note that it will be incremented.

   *1Eh⋯1E in hexadecimal, therefore, 00011110 becomes a binary number.

3. Write Protect (WP) Function
   When WP pin is set at VCC ("HIGH" level), data rewrite of all addresses is prohibited. When it is set GND ("LOW" level), data rewrite of all address is enabled. Be sure to connect this pin to VCC or GND, or control it to 'HIGH' level or 'LOW' level. If WP pin is open, this input is recognized as 'LOW'.

   In case of using it as ROM, by connect it to pull-up or VCC, write error can be prevented.

   At extremely low voltage at power ON/OFF, by setting the WP pin 'HIGH', write error can be prevented.
4. ECC Function

This IC has ECC bits for Error Correction every 4 bytes with the same address bits of WA12 to WA2. In read operation, if 1 bit of error data exists in 4 bytes, this error data will be corrected by the ECC function and outputs the correct data. In write operation, only 1 byte of data is to be written, 4 bytes of data will be written as one group with the same address bits of WA12 to WA2 (the data to be written in the remaining 3 bytes will be the same as its previous stored data). Therefore, the number of write cycle times is guaranteed every 4 bytes with the same address bits of WA12 to WA2.

Initial Delivery State

<table>
<thead>
<tr>
<th>Address</th>
<th>Number of remaining write cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000h</td>
<td>400M times</td>
</tr>
<tr>
<td>0001h</td>
<td>400M times</td>
</tr>
<tr>
<td>0002h</td>
<td>400M times</td>
</tr>
<tr>
<td>0003h</td>
<td>400M times</td>
</tr>
<tr>
<td>0004h</td>
<td>400M times</td>
</tr>
<tr>
<td>0005h</td>
<td>400M times</td>
</tr>
</tbody>
</table>

After 100M times using byte write in address 0000h

<table>
<thead>
<tr>
<th>Address</th>
<th>Number of remaining write cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000h</td>
<td>300M times</td>
</tr>
<tr>
<td>0001h</td>
<td>300M times</td>
</tr>
<tr>
<td>0002h</td>
<td>300M times</td>
</tr>
<tr>
<td>0003h</td>
<td>300M times</td>
</tr>
<tr>
<td>0004h</td>
<td>400M times</td>
</tr>
<tr>
<td>0005h</td>
<td>400M times</td>
</tr>
</tbody>
</table>

Even if only 1 byte of data is to be written in address 0000h, the addresses 0000h to 0003h are written as one group. Therefore, the number of write cycle times at addresses 0001h to 0003h decreases.

Figure 43. Example of data write and number of remaining write cycles

Read Command

Read the EEPROM data. Read has a random read and a current read functions. Random read is commonly used in commands that specify addresses and read data. The current read is a command to read data of the internal address register without specifying an address. In both read functions, sequential read is possible where the next address data can be read in succession.

Figure 44. Random Read

Figure 45. Current Read

Figure 46. Sequential Read (in the Case of Current Read)

(1) In random read, data of designated word address can be read.
(2) When the command just before current read is random read or current read (each including sequential read), if last read address is (n)-th, data of the incremented address (n+1)-th is outputted.
(3) When ACK signal 'LOW' after D0 is detected, and stop condition is not sent from master (microcontroller) side, the next address data can be read in succession.
(4) Read is ended by stop condition where 'HIGH' is input to ACK signal after D0 and SDA signal goes from 'LOW' to 'HIGH' while at SCL signal is 'HIGH'.
(5) When 'LOW' is input at ACK signal after D0 without 'HIGH' input, sequential read gets in, and the next data is outputted. Therefore, read command cannot be ended. To end read command, be sure to input 'HIGH' to ACK signal after D0, and the stop condition where SDA goes from 'LOW' to 'HIGH' while SCL signal is 'HIGH'.
(6) Sequential read is ended by stop condition where 'HIGH' is input to ACK signal after arbitrary D0 and SDA goes from 'LOW' to 'HIGH' while SCL signal is 'HIGH'.
Method of Reset

This IC can be reset by sending the stop condition after executing the start condition. Please execute it when it is necessary to reset after power-up, or during command input timing. However, the start condition and stop condition could not be applied because "HIGH" input of microcontroller and "LOW" output of EEPROM collide when EEPROM is "LOW" in ACK output section and data reading. In that case, input SCL clock until SDA bus is released ("HIGH" by pull-up). After confirming that SDA is released, send the stop condition after executing the start condition. If SDA bus could not be confirmed whether released or not in microcontroller, input the software reset. If software reset is run, EEPROM can be reset without confirming the SDA state because SDA bus is always released in either of the two start conditions. The method of reset is shown in the table below.

<table>
<thead>
<tr>
<th>Status of SDA</th>
<th>Method of reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDA bus released (&quot;HIGH&quot; by pull-up)</td>
<td>Send the stop condition after executing the start condition.</td>
</tr>
<tr>
<td>'LOW'</td>
<td>Input SCL clock until SDA bus is released, confirm that SDA bus is released, and send the stop condition after inputting start condition.</td>
</tr>
<tr>
<td>Microcontroller cannot confirm SDA bus is released or not</td>
<td>Using the software reset shown in the figure below, the start condition can be always executed. Within the dummy clock input area, the SDA bus is needed to be released (&quot;HIGH&quot; by pull-up). For normal commands, start with the start condition input.</td>
</tr>
</tbody>
</table>

Figure 47. Input timing of software reset

Acknowledgement Polling

During internal write execution, all input commands are ignored, therefore ACK is not returned. During internal automatic write execution after write input, next command (slave address) is sent. If the first ACK signal sends back 'LOW', then it means end of write operation, else 'HIGH' is returned, which means writing is still in progress. By the use of acknowledge polling, next command can be executed without waiting for 

\[ T_{WR} = 5 \text{ms} \]

To write continuously, slave address with \( R/W = 0 \), then to carry out current read after write, slave address with \( R/W = 1 \) is sent. If ACK signal sends back 'LOW', then execute word address input and data output and so forth.

Figure 48. The Case of Continuous Write by Acknowledge Polling
WP Valid Timing (Write Cancel)

WP is usually fixed to ‘HIGH’ or ‘LOW’, but when WP is controlled and used for write cancel and so on, pay attention to the following WP valid timing. Write can be cancelled by setting WP=‘HIGH’ while it is executed and in WP valid area. In both byte write and page write, the area from the first start condition of command to the rise of clock which take in D0 data (in page write, the first byte data) is the WP invalid area. WP input in this area becomes ‘Don’t care’. The area from the rise of clock to take in D0 to the stop condition input is the WP valid area. Furthermore, after the execution of forced end by WP, the IC enters standby status.

Command Cancel by Start Condition and Stop Condition

During command input, by continuously inputting start condition and stop condition, command can be cancelled. However, within ACK output area and during data read, SDA bus may output ‘LOW’. In this case, start condition and stop condition cannot be inputted, so reset is not available. Therefore, execution of reset is needed referring ‘Method of Reset’. When command is cancelled by start-stop condition during random read, sequential read, or current read, internal setting address is not determined. Therefore, it is not possible to carry out current read in succession. To carry out read in succession, carry out random read.
Application Examples

1. I/O Peripheral Circuit

(1) Pull-up Resistance of SDA Pin
SDA is NMOS open drain, so it requires a pull-up resistor. As for this resistor value (R_{PU}), select an appropriate value from microcontroller V_{IL}, I_{L}, and V_{OL}-I_{OL} characteristics of this IC. If R_{PU} is large, operating frequency is limited. The smaller the R_{PU} increases the supply current.

(2) Maximum Value of R_{PU}
The maximum value of R_{PU} is determined by the following factors.
(a) SDA rise time determined by the capacitance (C_{BUS}) of bus line of SDA and R_{PU} should be t_{R} or lower. Furthermore, AC timing should be satisfied even when SDA rise time is slow.
(b) The bus electric potential A to be determined by input current leak total (I_{L}) of the device connected to bus at output of 'HIGH' to SDA line and R_{PU} should sufficiently secure the input 'HIGH' level (V_{IH}) of microcontroller and EEPROM including recommended noise margin of 0.2V_{CC}.

\[ V_{CC} - I_{L}R_{PU} - 0.2V_{CC} \geq V_{IH} \]
\[ \therefore R_{PU} \leq \frac{0.8V_{CC} - V_{IH}}{I_{L}} \]
Ex.) V_{CC}=3V, I_{L}=10\mu A, V_{IH}=0.7V_{CC}
\[ \therefore R_{PU} \leq \frac{0.8 \times 3 - 0.7 \times 3}{10 \times 10^{-6}} \]
\[ \leq 30 \text{ [ k\Omega ]} \]

(3) Minimum Value of R_{PU}
The minimum value of R_{PU} is determined by the following factors.
(a) When IC outputs 'LOW', the bus electric potential A should be equal to or less than output 'LOW' level (V_{OL}) of EEPROM.

\[ \frac{V_{CC} - V_{OL}}{R_{PU}} \leq I_{OL} \]
\[ \therefore R_{PU} \geq \frac{V_{CC} - V_{OL}}{I_{OL}} \]
Ex.) V_{CC}=3V, V_{OL}=0.4V, I_{OL}=3.2mA, microcontroller, EEPROM V_{IL}=0.3V_{CC}
\[ \therefore R_{PU} \geq \frac{3 - 0.4}{3.2 \times 10^{-3}} \]
\[ \geq 812.5 \text{ [ \Omega ]} \]

(4) Pull-up Resistance of SCL Pin
When SCL control is made at the CMOS output port, there is no need for a pull-up resistor. But when there is a time where SCL becomes 'Hi-Z', add a pull-up resistor. As for the pull-up resistor value, decide with the balance with drive performance of output port of microcontroller.
2. Cautions on Microcontroller Connection

(1) $R_S$
In FC BUS, it is recommended that SDA port is of open drain input/output. However, when using CMOS input/output of tri state to SDA port, insert a series resistance $R_S$ between the pull-up resistor $R_{PU}$ and the SDA pin of EEPROM. This is to control over current that may occur when PMOS of the microcontroller and NMOS of EEPROM are turned ON simultaneously. $R_S$ also plays the role of protecting the SDA pin against surge. Therefore, even when SDA port is open drain input/output, $R_S$ can be used.

\[
(V_{CC} - V_{OL}) \times R_S + V_{OL} + 0.1V_{CC} \leq V_{IL}
\]

\[
R_S \leq \frac{V_{IL} - V_{OL} - 0.1V_{CC}}{1.1V_{CC} - V_{IL}} \times R_{PU}
\]

Ex.) $V_{CC}=3V$, $V_{IL}=0.3V_{CC}$, $V_{OL}=0.4V$, $R_{PU}=20k\Omega$

\[
R_S \leq \frac{0.3 \times 3 - 0.4 - 0.1 \times 3}{1.1 \times 3 - 0.3 \times 3} \times 20 \times 10^3
\]

\[
 \leq 1.67 \text{ [kΩ]}
\]

(2) Maximum Value of $R_S$
The maximum value of $R_S$ is determined by the following relations.
(a) SDA rise time to be determined by the capacitance ($C_{BUS}$) of bus line of SDA and $R_{PU}$ should be $\leq 3\Omega$ or lower. Furthermore, AC timing should be satisfied even when SDA rise time is slow.
(b) The bus electric potential $\overline{V}$ to be determined by $R_{PU}$ and $R_S$ when EEPROM outputs 'LOW' to SDA bus should sufficiently secure the input 'LOW' level ($V_{IL}$) of microcontroller including recommended noise margin of $0.1V_{CC}$.

\[
\begin{align*}
(V_{CC} - V_{OL}) \times R_S + V_{OL} + 0.1V_{CC} & \leq V_{IL} \\
R_S & \leq \frac{V_{IL} - V_{OL} - 0.1V_{CC}}{1.1V_{CC} - V_{IL}} \times R_{PU}
\end{align*}
\]

Ex.) $V_{CC}=3V$, $V_{IL}=0.3V_{CC}$, $V_{OL}=0.4V$, $R_{PU}=20k\Omega$

\[
R_S \leq \frac{0.3 \times 3 - 0.4 - 0.1 \times 3}{1.1 \times 3 - 0.3 \times 3} \times 20 \times 10^3
\]

\[
 \leq 1.67 \text{ [kΩ]}
\]

(3) Minimum Value of $R_S$
The minimum value of $R_S$ is determined by over current at bus collision. When over current flows, noises in power source line and instantaneous power failure of power source may occur. When allowable over current is defined as $I$, the following relation must be satisfied. Determine the allowable current in consideration of the impedance of power source line in set and so forth.

\[
\frac{V_{CC}}{R_S} \leq I
\]

\[
\therefore R_S \geq \frac{V_{CC}}{I}
\]

Ex.) $V_{CC}=3V$, $I=10mA$

\[
R_S \geq \frac{3}{10 \times 10^{-3}}
\]

\[
\geq 300 \text{ [Ω]}
\]
Caution on Power-Up Conditions

At power-up, as the V\text{CC} rises, the IC’s internal circuits may go through unstable low voltage area, making the IC’s internal circuit not completely reset, hence, malfunction may occur. To prevent it, this IC is equipped with Power-on Reset (P.O.R.) circuit and LVCC circuit. In order to ensure its operation, observe the following three conditions at power-up.

1. Set SDA = 'HIGH' and SCL = 'LOW' or 'HIGH'.
2. In order to operate the P.O.R. function, please turn on the power supply so as to satisfy the power-up conditions below.
   In order to start its normal operation, set the power supply rise so that the supply voltage constantly increases from V\text{bot} to V\text{CC} level. Also, do not input commands during t\text{INIT} from power supply stabilized.

   \begin{figure}[h]
   \centering
   \includegraphics[width=0.5\textwidth]{rise_waveform.png}
   \caption{Rise Waveform Diagram}
   \end{figure}

   \begin{table}[h]
   \centering
   \begin{tabular}{|l|c|c|c|c|}
   \hline
   Parameter & Symbol & Min & Typ & Max & Unit \\
   \hline
   Supply Voltage at Power OFF & V\text{bot} & - & - & 0.3 & V \\
   Power OFF Time\textsuperscript{(Note 19)} & t\text{POFF} & 1 & - & - & ms \\
   Initialize Time\textsuperscript{(Note 19)} & t\text{INIT} & 0.1 & - & - & ms \\
   Supply Voltage Rising Time\textsuperscript{(Note 19)} & t\text{R:VCC} & 0.001 & - & 100 & ms \\
   \hline
   \end{tabular}
   \textsuperscript{(Note 19)} Not 100\% TESTED
   \end{table}

3. Set SDA and SCL so as not to be 'Hi-Z'.

   When the above conditions 1 and 2 cannot be observed, please take the following measures.
   Be sure to observe condition 3.

   (1) When the above condition 1 cannot be observed and SDA becomes 'LOW' at power-up.
       \rightarrow Control SCL and SDA as shown below, and set both SCL and SDA to 'HIGH'.

   \begin{figure}[h]
   \centering
   \includegraphics[width=0.5\textwidth]{low_vcc_conditions.png}
   \caption{When SCL='HIGH' and SDA='LOW'}
   \end{figure}

   (2) In the case when the above condition 2 cannot be observed.
       \rightarrow Set WP = 'HIGH' at power-up and then execute reset.

   (3) In the case when the above conditions 1 and 2 cannot be observed.
       \rightarrow Set WP = 'HIGH' at power-up, perform (1) and then (2).

Low Voltage Malfunction Prevention Function

LVCC circuit prevents data rewrite operation at low power, and prevents write error. At LVCC voltage (Typ =1.2V) or below, data rewrite is prevented.
I/O Equivalence Circuits

1. Input (A0, A1, A2, WP)

![Diagram of input (A0, A1, A2, WP)](image1)

Figure 59. Input Pin Circuit Diagram (A0, A1, A2, WP)

2. Input (SCL)

![Diagram of input (SCL)](image2)

Figure 60. Input Pin Circuit Diagram (SCL)

3. Input / Output (SDA)

![Diagram of input / output (SDA)](image3)

Figure 61. Input / Output Pin Circuit Diagram (SDA)
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. **Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **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.

7. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

8. **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.

9. **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.

10. **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.

11. **Regarding the Input Pin of the IC**
    In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input pins have voltages within the values specified in the electrical characteristics of this IC.

12. **Ceramic Capacitor**
    When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.
Ordering Information

<table>
<thead>
<tr>
<th>B</th>
<th>R</th>
<th>2</th>
<th>4</th>
<th>G</th>
<th>6</th>
<th>4</th>
<th>x</th>
<th>x</th>
<th>x</th>
<th>-</th>
<th>5</th>
<th>x</th>
<th>x</th>
</tr>
</thead>
</table>

**BUS Type**
24 : 1C

**Ambient Operating Temperature / Supply Voltage**
-40°C~+85°C
/ 1.6V~5.5V

**Capacity**
64=64Kbit

**Package**
F : SOP8
FJ : SOP-J8
FVT : TSSOP-B8
FVM : MSOP8
NUX : VSON008X2030

**Process Code**

**Packaging and Forming Specification**
E2 : Embossed tape and reel (SOP8, SOP-J8, TSSOP-B8)
TR : Embossed tape and reel (MSOP8, VSON008X2030)

**Lineup**

<table>
<thead>
<tr>
<th>Package</th>
<th>Orderable Part Number</th>
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</thead>
<tbody>
<tr>
<td>Type</td>
<td>Quantity</td>
</tr>
<tr>
<td>SOP8</td>
<td>Reel of 2500</td>
</tr>
<tr>
<td>SOP-J8</td>
<td>Reel of 2500</td>
</tr>
<tr>
<td>TSSOP-B8</td>
<td>Reel of 3000</td>
</tr>
<tr>
<td>MSOP8</td>
<td>Reel of 3000</td>
</tr>
<tr>
<td>VSON008X2030</td>
<td>Reel of 4000</td>
</tr>
</tbody>
</table>
Marking Diagrams

SOP8 (TOP VIEW)

Part Number Marking
LOT Number
Pin 1 Mark

MSOP8 (TOP VIEW)

Part Number Marking
LOT Number
Pin 1 Mark

SOP-J8 (TOP VIEW)

Part Number Marking
LOT Number
Pin 1 Mark

VSON008X2030 (TOP VIEW)

Part Number Marking
LOT Number
Pin 1 Mark

TSSOP-B8 (TOP VIEW)

Part Number Marking
LOT Number
Pin 1 Mark
Physical Dimension and Packing Information

<table>
<thead>
<tr>
<th>Package Name</th>
<th>SOP8</th>
</tr>
</thead>
</table>

![Diagram of package dimensions](image)

**Unit: mm**

PKG: SOP8

Drawing No.: EX112-5001-1

---

**Tape and Reel Information**

<table>
<thead>
<tr>
<th>Tape</th>
<th>Embossed carrier tape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Quantity**: 2500 pcs

**Direction of feed**: E2

The direction is the 1pin of product is at the upper left when you hold the reel on the left hand and you pull out the tape on the right hand.
<table>
<thead>
<tr>
<th>Package Name</th>
<th>SOP-J8</th>
</tr>
</thead>
</table>

<Physical Dimension and Packing Information - continued>

- **Package Name**: SOP-J8

![Diagram of SOP-J8 Package]

**Tape and Reel Information**

<table>
<thead>
<tr>
<th>Type</th>
<th>Embossed carrier tape</th>
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</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>2500pcs</td>
</tr>
</tbody>
</table>

**Direction of feed**

- The direction is the 1st pin of product is at the upper left when you hold the reel on the left hand and you pull out the tape on the right hand.

![Diagram of Tape and Reel Information]

---

**UNIT: mm**

PKG: SOP-J8

Drawing No. EX111-5002
### Physical Dimension and Packing Information - continued

<table>
<thead>
<tr>
<th>Package Name</th>
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![Diagram](image)

**<Tape and Reel Information>**

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<tr>
<th>Tape</th>
<th>Embossed carrier tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>3000pcs</td>
</tr>
<tr>
<td>Direction of feed</td>
<td>E2</td>
</tr>
</tbody>
</table>

**E2** The direction is the 1pin of product is at the upper left when you hold the reel on the left hand and you pull out the tape on the right hand.
### Physical Dimension and Packing Information - continued

<table>
<thead>
<tr>
<th>Package Name</th>
<th>MSOP8</th>
</tr>
</thead>
</table>

#### Tape and Reel Information

<table>
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<tr>
<th>Tape</th>
<th>Embossed carrier tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>3000pcs</td>
</tr>
</tbody>
</table>

**Direction of feed**

- **TR**: The direction in the tape of product is at the upper right when you hold the reel on the left hand and you pull out the tape on the right hand.
Physical Dimension and Packing Information – continued

<table>
<thead>
<tr>
<th>Package Name</th>
<th>VSON008X2030</th>
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</table>

<Details on Physical Dimensions and Packing Information>

<table>
<thead>
<tr>
<th>Tape Type</th>
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</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>4000pcs</td>
</tr>
<tr>
<td>Direction of feed</td>
<td>TR</td>
</tr>
<tr>
<td></td>
<td>The direction is the 1pin of product is at the upper right when you hold (rest on the left hand and you pull out the tape on the right hand)</td>
</tr>
</tbody>
</table>

<Diagram of Packaging Details>
## Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
</table>
Notice

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1. Our Products are designed and manufactured for application in ordinary electronic equipment (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 \(^{(Note1)}\), 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

<table>
<thead>
<tr>
<th>JAPAN</th>
<th>USA</th>
<th>EU</th>
<th>CHINA</th>
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<tr>
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<td>CLASS III</td>
<td>CLASS II b</td>
<td>CLASS III</td>
</tr>
</tbody>
</table>

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[c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂

[d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves

[e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items

[f] Sealing or coating our Products with resin or other coating materials

[g] 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

[h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. 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.

7. 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.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. 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

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. 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
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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:
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   [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.

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Precaution for Disposition
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