## Voltage Detector IC Series

# Counter Timer Built-in CMOS Voltage Detector IC

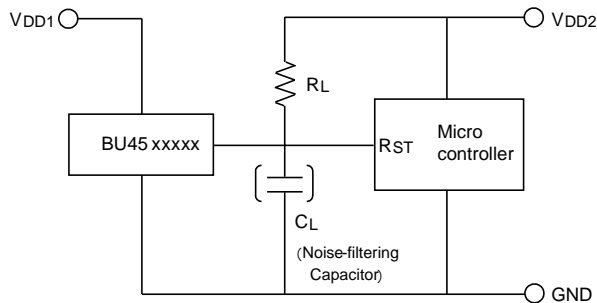## BU45Kxxxx, BU46Kxxxx, BU45Lxxxx series

● **General Description**

ROHM's BU45xxxxx and BU46xxxxx series are highly accurate, low current consumption voltage detector IC series. Because the counter timer delay circuit is built-in, an external capacitor for the delay time setting is unnecessary. Two output types are available (Nch open drain and CMOS output) and detection voltages are 2.3V, 2.4V, 2.6V, 2.9V, 3.0V, 3.3V, 3.6V, 4.0V, 4.2V with fixed delay time of 200ms and 400ms, that may be selected according to application.

● **Features**

■ Counter Timer Built-in
■ No delay time setting capacitor required
■ Low current consumption
■ Two output types (Nch open drain and CMOS output)
■ Package SSOP3 is similar to SOT-23-3 (JEDEC)

● **Key Specifications**

| | | |
|---|---|---|
| ■ Detection voltage: | | 2.3V, 2.4V, 2.6V, 2.9V, 3.0V, 3.3V, 3.6V, 4.0V, 4.2V (Typ.) |
| ■ High accuracy detection voltage: | | ±1.0% |
| ■ Low current consumption: | | 2.3µA (Typ.) |
| ■ Operating temperature range: | | -40°C to +105°C |
| ■ Two internal, fixed delay time: | | 200ms |
| | | 400ms |

● **Package**

SSOP3    2.92mm x 2.80mm x 1.25mm

● **Applications**

Circuits using microcontrollers or logic circuits that require a reset

● **Typical Application Circuit**



（Open Drain Output Type）
BU45xxxxx series
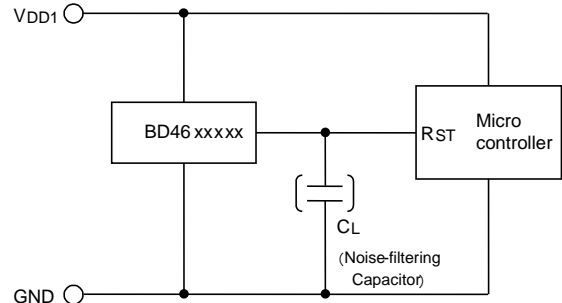


（CMOS Output Type）
BU46xxxxx series

● **Connection Diagram**

**SSOP3**



BU45KxxxG
BU46KxxxG
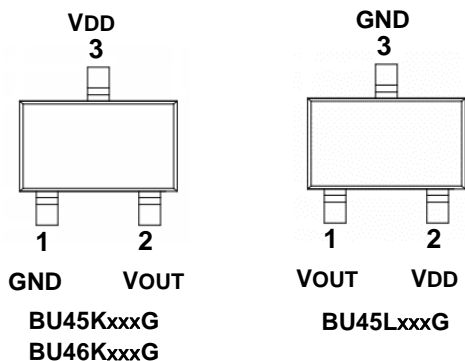
BU45LxxxG

● **Pin Descriptions**

**BU45KxxxG / BU46KxxxG**

| PIN No. | Symbol | Function |
|---|---|---|
| 1 | GND | GND |
| 2 | V$_{OUT}$ | Reset Output |
| 3 | V$_{DD}$ | Power Supply Voltage |

**BU45LxxxG**

| PIN No. | Symbol | Function |
|---|---|---|
| 1 | V$_{OUT}$ | Reset Output |
| 2 | V$_{DD}$ | Power Supply Voltage |
| 3 | GND | GND |

○Product structure：Silicon monolithic integrated circuit    ○This product is not designed for protection against radioactive rays.

●**Ordering Information**

| B | U | x | x | x | x | x | x | x | – | T | L |
|---|---|---|---|---|---|---|---|---|---|---|---|

- Part Number
- Output Type
  45 : Open Drain
  46 : CMOS
- Package 1
- Reset Voltage Value
  23 : 2.3V
  ⇓
  42 : 4.2V
- Counter Timer Delay Time Settings
  2 : 200ms
  4 : 400ms
- Package 2
- Packaging and forming specification
  TL : Embossed tape and reel

| Package 1 | Package 2 | Package name |
|---|---|---|
| K | G | SSOP3 (1pin GND) |
| L | G | SSOP3 (3pin GND) |

●**Lineup**

Table 1. Open Drain Output Type

| Detection Voltage | Counter Timer Delay Time Settings | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-Pin GND | | | | 3-Pin GND | | | |
| | 200ms | | 400ms | | 200ms | | 400ms | |
| | Marking | Part Number | Marking | Part Number | Marking | Part Number | Marking | Part Number |
| 4.2V | bB | BU45K422 | – | - | - | - | - | - |
| 3.6V | aS | BU45K362 | - | - | - | - | - | - |
| 3.3V | aN | BU45K332 | - | - | - | - | - | - |
| 3.0V | - | - | dF | BU45K304 | - | - | - | - |
| 2.9V | aG | BU45K292 | dE | BU45K294 | - | - | - | - |
| 2.6V | aD | BU45K262 | - | - | - | - | - | - |
| 2.4V | aB | BU45K242 | - | - | - | - | - | - |
| 2.3V | - | - | - | - | fT | BU45L232 | kR | BU45L234 |

Table 2. CMOS Output Type

| Detection Voltage | Counter Timer Delay Time Settings | |
|---|---|---|
| | 1-Pin GND | |
| | 200ms | |
| | Marking | Part Number |
| 4.0V | cH | BU46K402 |
| 2.9V | bT | BU46K292 |

● **Absolute maximum ratings (Ta=25°C)**

| Parameter | | Symbol | Limit | Unit |
|---|---|---|---|---|
| Power Supply Voltage | | V$_{DD}$-G$_{ND}$ | -0.3 to +6.0 | V |
| Output Voltage | Nch Open Drain Output | V$_{OUT}$ | GND-0.3 to +6.0 | V |
| | CMOS Output | | GND-0.3 to VDD+0.3 | |
| Output Current | | Io | 70 | mA |
| Power Dissipation   (Note1, Note2) | | Pd | 700 | mW |
| Operating Temperature | | Topr | -40 to +105 | °C |
| Ambient Storage Temperature | | Tstg | -55 to +125 | °C |

(Note 1)   Use above Ta=25°C results in a 7.0mW loss per degree.
(Note 2)   When mounted on ROHM standard circuit board (70mmx70mmx1.6mm, glass epoxy board).
**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.

●**Electrical characteristics (Unless Otherwise Specified Ta=-40 to 105°C)**

| Parameter | Symbol | Condition | | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | Limit | | | |
| Operating Voltage Range | V$_{OPL}$ | V$_{OL}$≤0.4V, R$_L$=470kΩ, Ta=25~105°C | | | 0.6 | - | 6.0 | V |
| | | V$_{OL}$≤0.4V, R$_L$=470kΩ, Ta=-40~25°C | | | 0.9 | - | 6.0 | |
| Detection Voltage | V$_{DET}$ | V$_{DD}$=H→L, R$_L$=470kΩ (Note 1) | | | V$_{DET}$(T) ×0.99 | V$_{DET}$(T) | V$_{DET}$(T) ×1.01 | V |
| | | VDET=3.0V | | Ta=25°C | 2.970 | 3.0 | 3.030 | |
| | | | | Ta=-40°C to 85°C | 2.901 | - | 3.100 | |
| | | | | Ta=85°C to 105°C | 2.885 | - | 3.117 | |
| | | VDET=3.3V | | Ta=25°C | 3.267 | 3.3 | 3.333 | |
| | | | | Ta=-40°C to 85°C | 3.191 | - | 3.410 | |
| | | | | Ta=85°C to 105°C | 3.173 | - | 3.428 | |
| | | VDET=4.2V | | Ta=25°C | 4.158 | 4.2 | 4.242 | |
| | | | | Ta=-40°C to 85°C | 4.061 | - | 4.341 | |
| | | | | Ta=85°C to 105°C | 4.039 | - | 4.364 | |
| Detection Voltage Temperature coefficient | V$_{DET}$/ΔT | -40°C~105°C | | | - | ±50 | ±360 | ppm/°C |
| Hysteresis Voltage | ΔV$_{DET}$ | V$_{DD}$=L→H→L, R$_L$=470kΩ | | | V$_{DET}$(T) ×0.03 | V$_{DET}$(T) ×0.05 | V$_{DET}$(T) ×0.08 | V |
| 'High' Output Delay time | t$_{PLH}$ | C$_L$=100pF, R$_L$=100kΩ ( Note1, Note 2, Note 3 ) | BU4xxxx2G | Ta=25°C | 120 | 200 | 280 | ms |
| | | | | Ta=-40°C to 85°C | 95 | - | 460 | |
| | | | | Ta=85°C to 105°C | 85 | - | 235 | |
| | | | BU4xxxx4G | Ta=25°C | 240 | 400 | 560 | |
| | | | | Ta=-40°C to 85°C | 190 | - | 920 | |
| | | | | Ta=85°C to 105°C | 170 | - | 470 | |
| Circuit Current when ON | I$_{DD1}$ | V$_{DD}$=VDET-0.2V,   VDET=2.3V~4.2V | | | 0.60 | 2.30 | 7.00 | µA |
| Circuit Current when OFF | I$_{DD2}$ | V$_{DD}$=VDET+1.0V,   VDET=2.3V~4.2V | | | 1.10 | 2.80 | 8.00 | µA |
| 'Low'Output Voltage (Nch) | V$_{OL}$ | V$_{DD}$=1.2V, I$_{SINK}$ = 2.0mA | | | - | - | 0.3 | V |
| | | V$_{DD}$=2.4V, I$_{SINK}$ = 8.5mA, VDET(2.9V to 4.2V) | | | - | - | 0.3 | V |
| Leak Current when OFF | I$_{leak}$ | V$_{DD}$=V$_{DS}$=6.0V   (Note 1) | | | - | - | 1.0 | µA |

V$_{DET}$(T):Standard Detection Voltage (2.3V, 2.4V, 2.6V, 2.9V, 3.0V, 3.3V, 3.6V, 4.0V, 4.2V)

R$_L$ :Pull-up resistor to be connected between V$_{OUT}$ and power supply.

C$_L$ :Capacitor to be connected between V$_{OUT}$ and GND.

(Note 1)  Guarantee is Ta=25°C.
(Note 2)  t$_{PLH}$:V$_{DD}$=(VDET(T)-0.5V)→(VDET(T)+0.5V)
(Note 3)  t$_{PLH}$:V$_{DD}$=Please set up the rise up time between V$_{DD}$=V$_{OPL}$→VDET more than 10µs.

●**Block Diagrams**
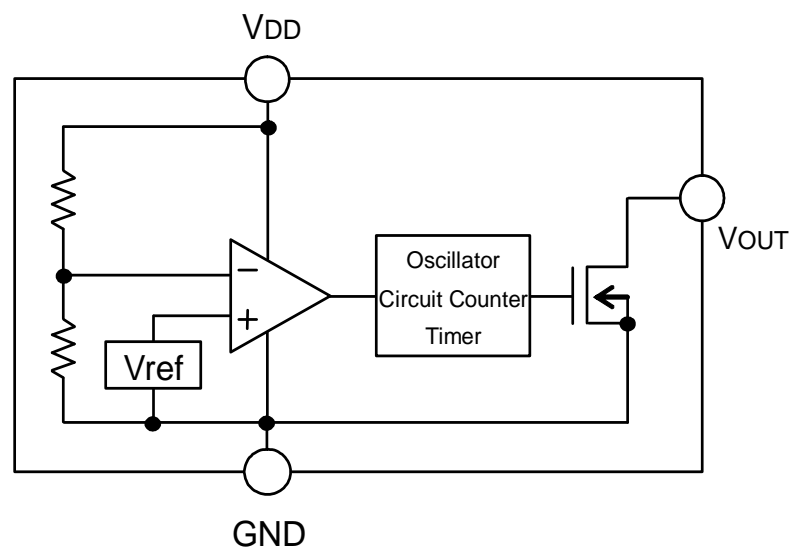


Fig.1   BU45xxxxx   Series
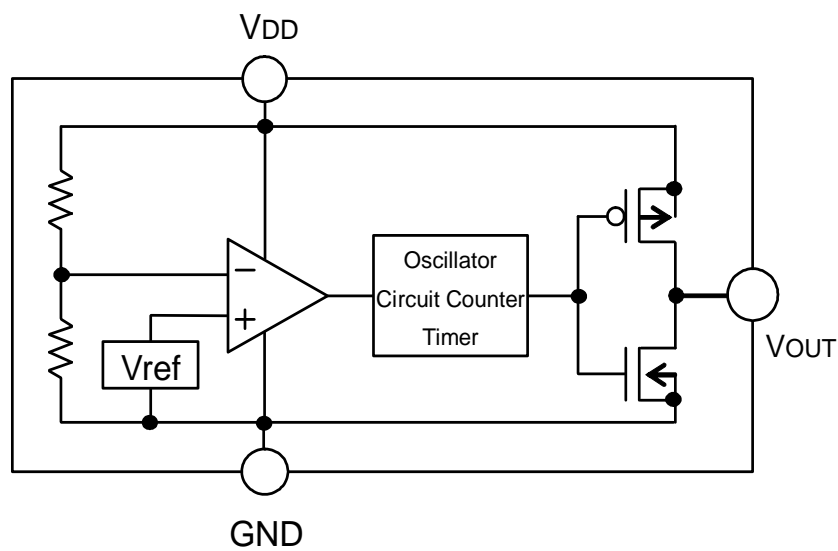


Fig.2   BU46xxxxx   Series

●**Typical Performance Curves**



Fig.3 Circuit Current



Fig.4 "LOW" Output Current
VDD=1.2V



Fig.5 "HIGH" Output Current
VDD=3.9V



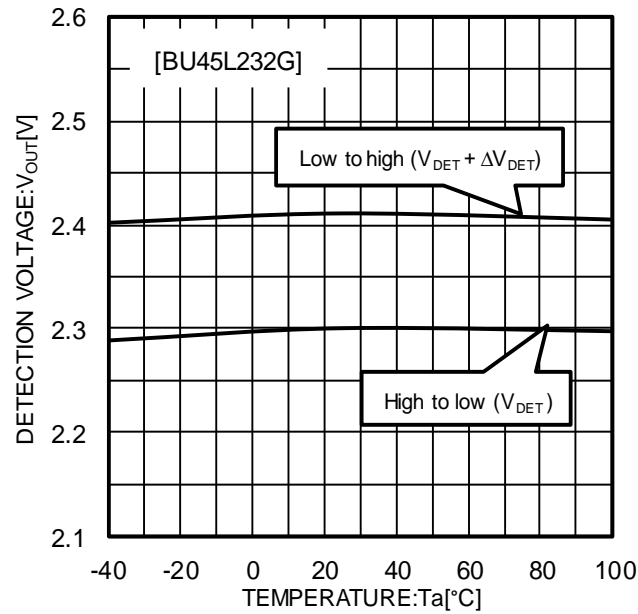Fig.6 I/O Characteristics
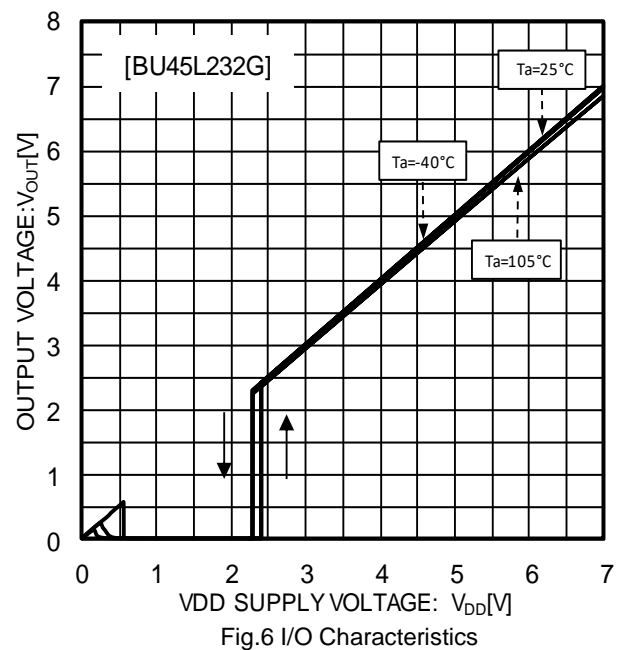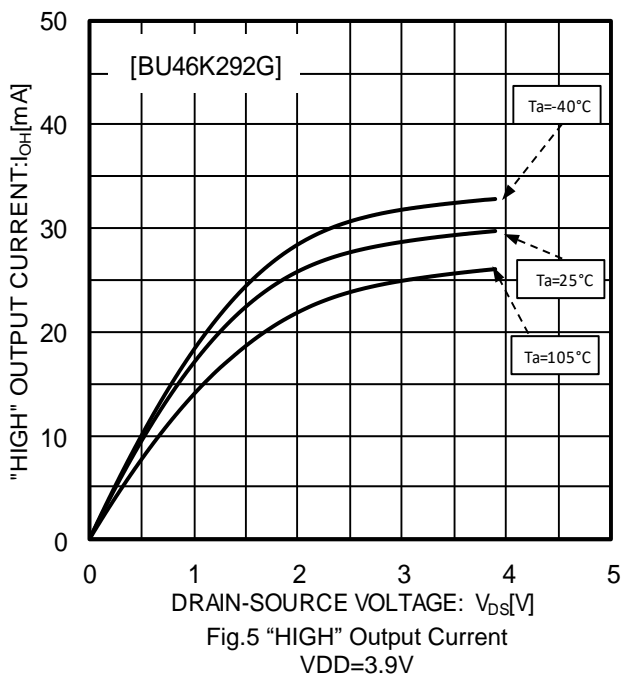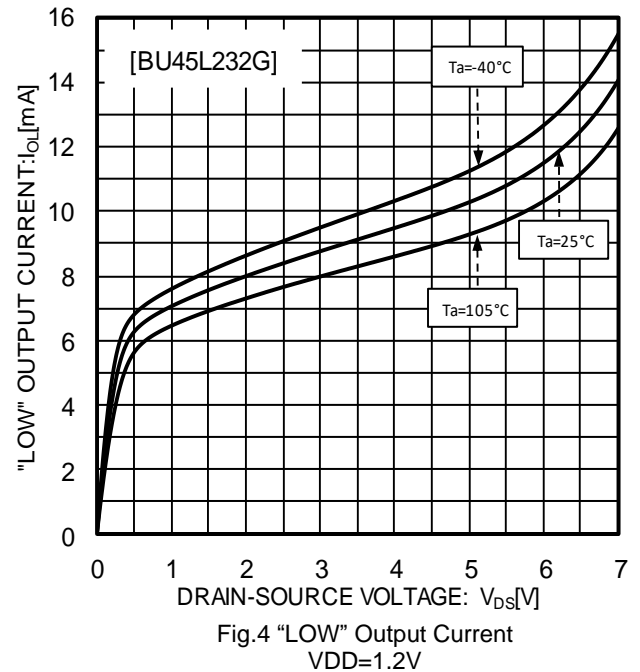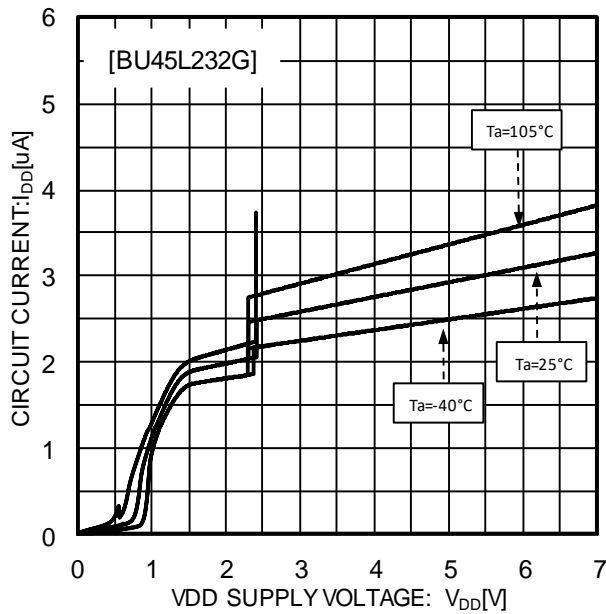
●**Typical Performance Curves - Continued**
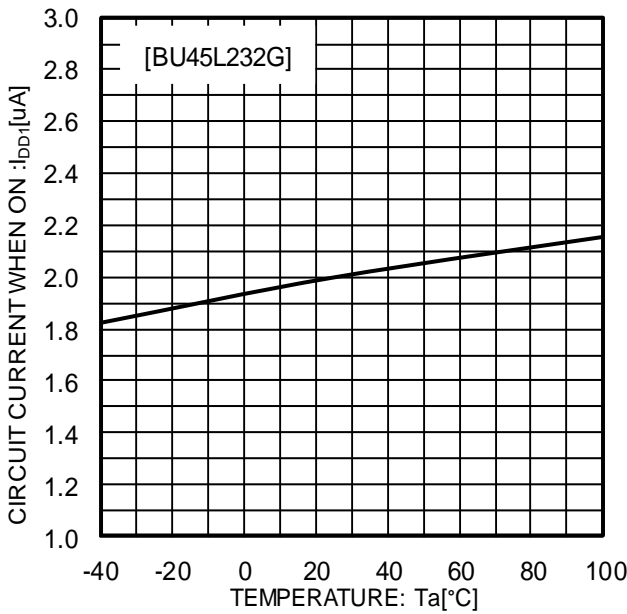


Fig.7 Detection Voltage
Release Voltage



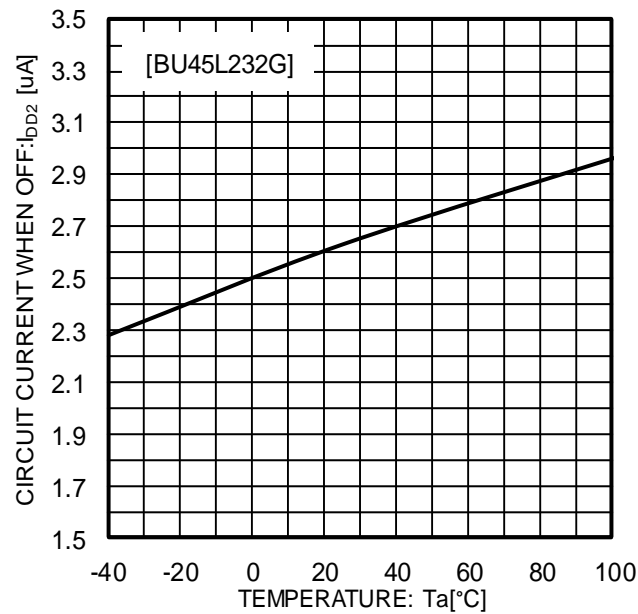Fig.8 Circuit Current when ON
(VDD=$V_{DET}$-0.2V)
VDD=2.1V



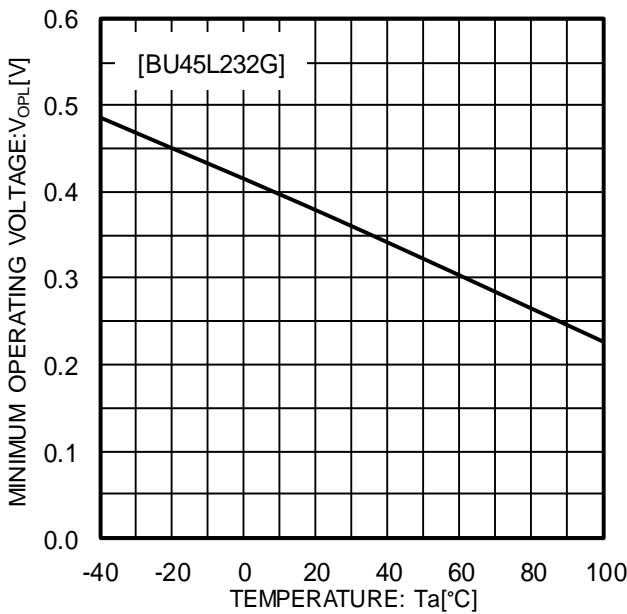Fig.9 Circuit Current when OFF
(VDD=$V_{DET}$+1V)
VDD=3.3 V



Fig.10 Operating Limit Voltage
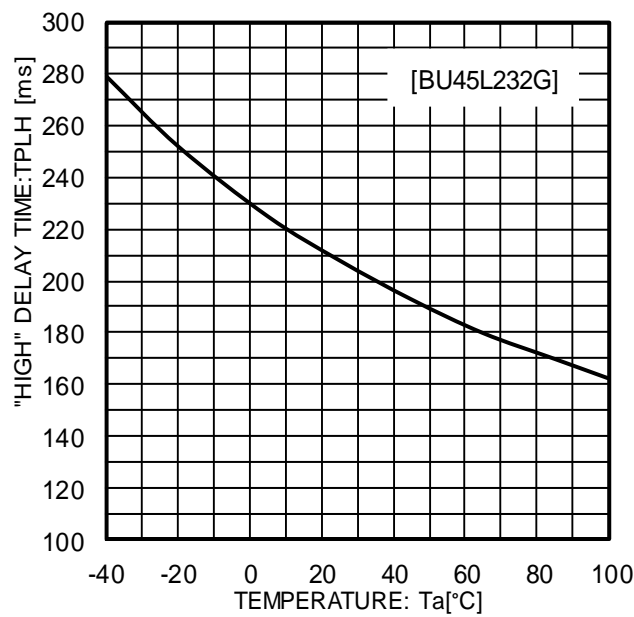
●**Typical Performance Curves - Continued**
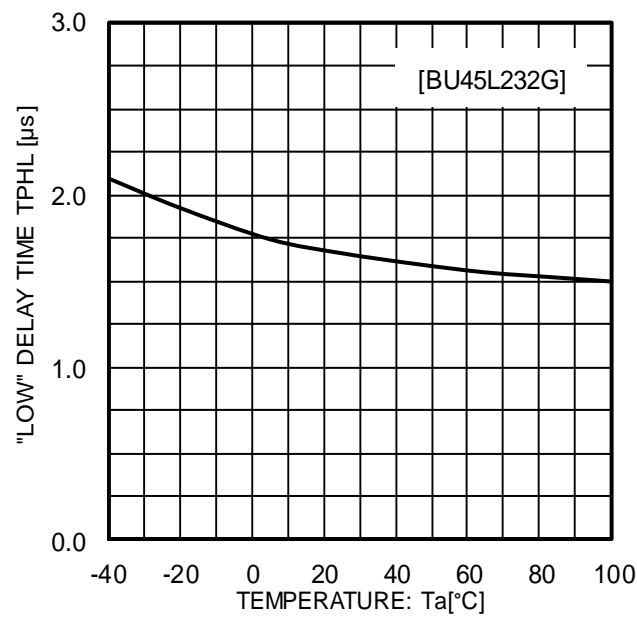


Fig.11 Output Delay Time
"Low" → "High"

Fig.11 Output Delay Time
"High" → "Low"

●**Application Information**

**Explanation of Operation**

For both the open drain type (Fig.13) and the CMOS output type (Fig.14), the detection and release voltages are used as threshold voltages. When the voltage applied to the $V_{DD}$ pins reaches the applicable threshold voltage, the $V_{OUT}$ terminal voltage switches from either "High" to "Low" or from "Low" to "High". Because the BU45xxxxx series uses an open drain output type, it is necessary to connect a pull-up resistor to $V_{DD}$ or another power supply if needed [The output "High" voltage ($V_{OUT}$) in this case becomes $V_{DD}$ or the voltage of the other power supply].
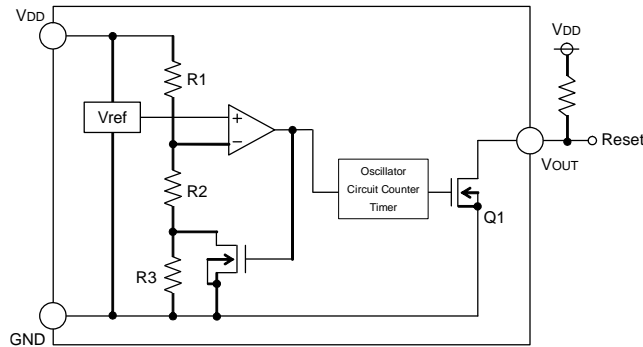


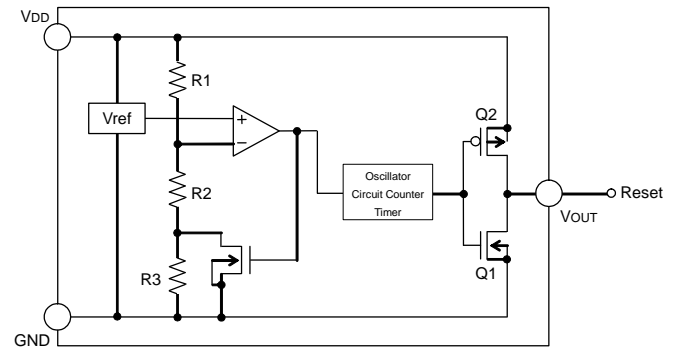Fig.13 (BU45xxxxx Type Internal Block Diagram)          Fig.14 (BU46xxxxx Type Internal Block Diagram)

**Reference Data**

Examples of Leading ($t_{PLH}$) and Falling ($t_{PHL}$) Output

| Part Number | $t_{PLH}$[ms] | $t_{PHL}$[µs] |
|---|---|---|
| BU45L232G | 208 | 1.4 |
| | $V_{DD}$=1.8V→2.8V | $V_{DD}$=2.8V→1.8V |

*This data is for reference only.

The figures will vary with the application, so please confirm actual operating conditions before use.

**Timing Waveform**

Example: The following shows the relationship between the input voltages $V_{DD}$ and the output voltage $V_{OUT}$ when the input power supply voltage $V_{DD}$ is made to sweep up and sweep down (the circuits are those in Fig. 13 and 14).
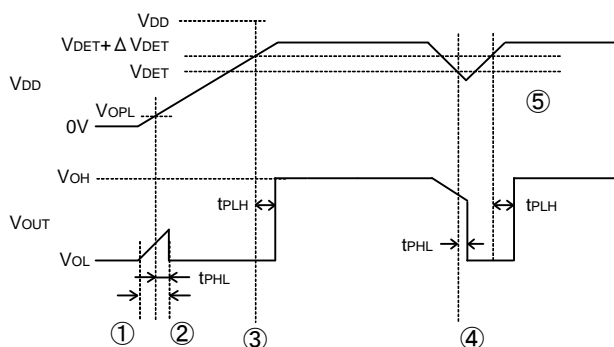


Fig.15   Timing Waveform

① When the power supply is turned on, the output is unstable from after over the operating limit voltage ($V_{OPL}$) until $t_{PHL}$. Therefore it is possible that the reset signal is not outputted when the rise time of $V_{DD}$ is faster than $t_{PHL}$.

② When $V_{DD}$ is greater than $V_{OPL}$ but less than the reset release voltage ($V_{DET} + \Delta V_{DET}$), the output voltages will switch to Low.

③ If $V_{DD}$ exceeds the reset release voltage ($V_{DET} + \Delta V_{DET}$), the counter timer start and $V_{OUT}$ switches from L to H.

④ If $V_{DD}$ drops below the detection voltage ($V_{DET}$) when the power supply is powered down or when there is a power supply fluctuation, $V_{OUT}$ switches to L (with a delay of $t_{PHL}$).

⑤ The potential difference between the detection voltage and the release voltage is known as the hysteresis width ($\Delta V_{DET}$). The system is designed such that the output does not toggle with power supply fluctuations within this hysteresis width, thus, preventing malfunctions due to noise.

Timing may change depending on application and use. Please verify and confirm using practical applications.

●**Circuit Applications**

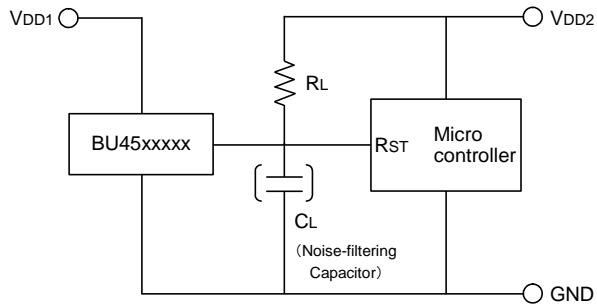1. Examples of a common power supply detection reset circuit.
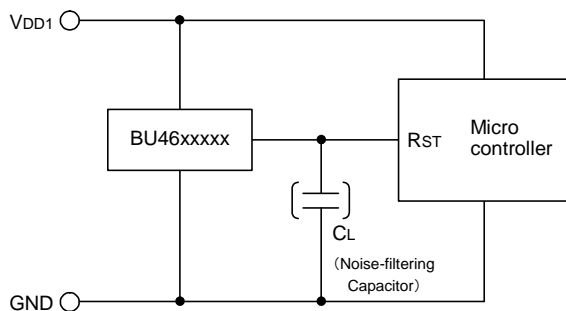


Fig.16 Open Drain Output Type



Fig.17 CMOS Output Type

Application examples of BU45xxxxx series (Open Drain output type) and BU46xxxxx series (CMOS output type) are shown below.

CASE1: Power supply of microcontroller ($V_{DD2}$) differs from the power supply of the reset detection ($V_{DD1}$).
Use an open drain output Type (BU45xxxxx series) device with a load resistance $R_L$ as shown Fig.16.

CASE2: Power supply of the microcontroller ($V_{DD1}$) is same as the power supply of the reset detection ($V_{DD1}$).
Use a CMOS output type (BU46xxxxx) device or an open drain output type (BU45xxxxx) with pull up resistor between the output and $V_{DD1}$. (As shown Fig.17)

When a capacitance $C_L$ for noise filtering is connected to the $V_{OUT}$ pin (the reset signal input terminal of the microcontroller), please take into account the waveform of the rise and fall of the output voltage ($V_{OUT}$).

2. The following is an example of a circuit application in which an OR connection between two types of detection voltage resets the microcontroller.
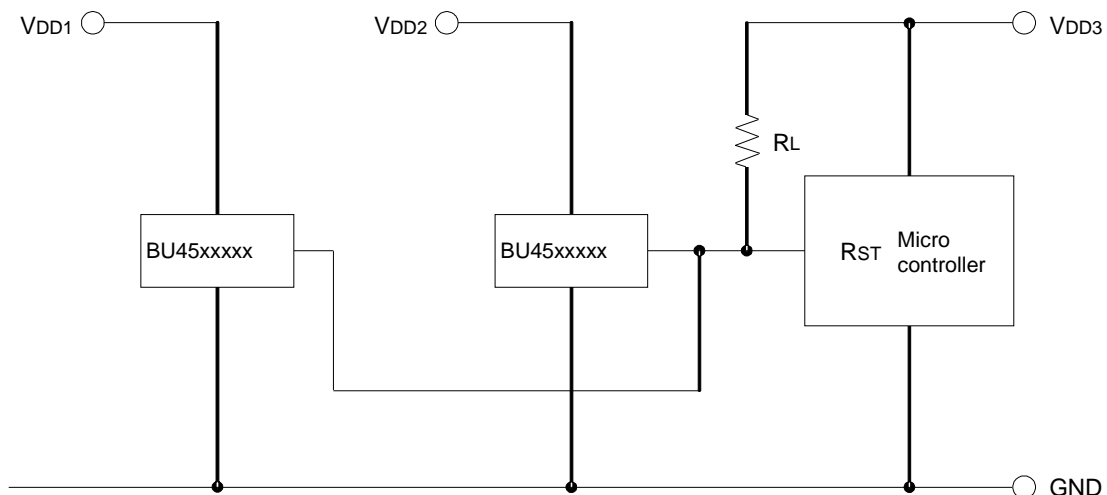


Fig. 18

To reset the microcontroller when many independent power supplies are used in the system, OR connect an open drain output type (BU45xxxxx series) to the microcontroller's input with pull-up resistor to the supply voltage of the microcontroller ($V_{DD3}$) as shown in Fig. 18. By pulling-up to $V_{DD3}$, output "High" voltage of micro-controller power supply is possible.

Examples of the power supply with resistor dividers.

In applications wherein the power supply voltage of an IC comes from a resistor divider circuit, an in-rush current will flow into the circuit when the output level switches from "High" to "Low" or vice versa. In-rush current is a sudden surge of current that flows from the power supply (VDD) to ground (GND) as the output logic changes its state. This current flow may cause malfunction in the systems operation such as output oscillations, etc.
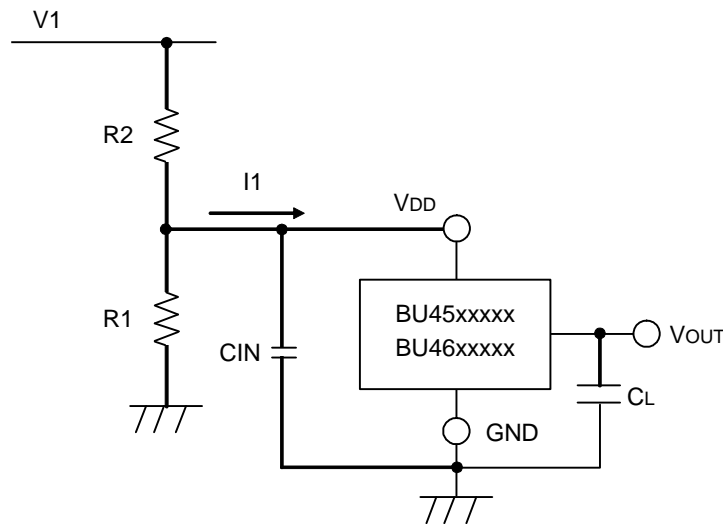


Fig. 19

When an in-rush current (I1) flows into the circuit (Refer to Fig. 19) at the time when output switches from "Low" to "High", a voltage drop of I1×R2 (input resistor) will occur in the circuit causing the VDD supply voltage to decrease. When the VDD voltage drops below the detection voltage, the output will switch from "High" to "Low". While the output voltage is at "Low" condition, in-rush current will stop flowing and the voltage drop will be reduced. As a result, the output voltage will switches again from "Low" to "High" which causes an in-rush current and a voltage drop. This operation repeats and will result to oscillation.



Fig. 20 Current Consumption vs. Power Supply Voltage

●**Operational Notes**

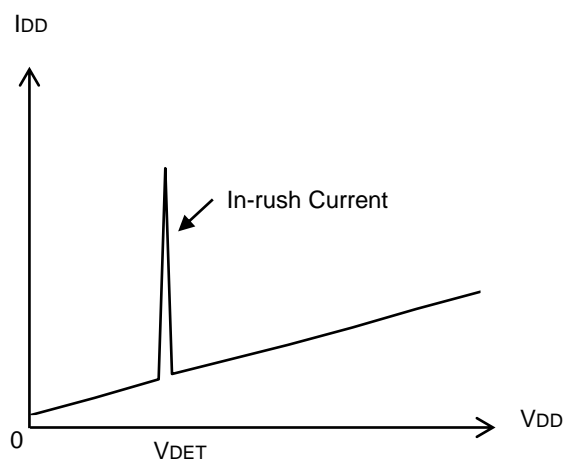1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply terminals.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance ground and supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. 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 GND 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 GND traces of external components do not cause variations on the GND voltage. The power supply and ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded, the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd 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. **Rush 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 GND 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. 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 Terminals**
    Input terminals 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 terminals should be connected to the power supply or ground line.

**12. Regarding Input Pins 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.
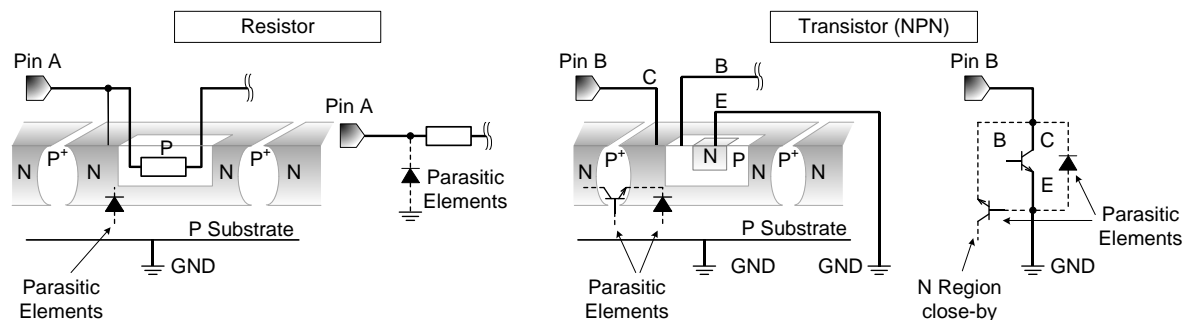


Figure 21. Example of monolithic IC structure

**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. Bypass Capacitor for Noise Rejection**
To help reject noise, put a 1µF capacitor between VDD pin and GND and 1000pF capacitor between VOUT pin and GND. Be careful when using extremely big capacitor as transient response will be affected.

**15.** The VDD line impedance might cause oscillation because of the detection current.

**16.** A VDD to GND capacitor (as close connection as possible) should be used in high VDD line impedance condition.

**17. External Parameters**
The recommended parameter range for RL is 50kΩ to 470kΩ. There are many factors (board layout, etc) that can affect characteristics. Please verify and confirm using practical applications.

**18.** Lower than the mininum input voltage puts the $V_{OUT}$ in high impedance state, and it must be $V_{DD}$ in pull up ($V_{DD}$) condition.

**19. Power-on Reset Operation**
Please note that the power on reset output varies with the $V_{DD}$ rise time. Please verify the behavior in the actual operation.

**20.** This IC has extremely high impedance terminals. Small leak current due to the uncleanness of PCB surface might cause unexpected operations. Application values in these conditions should be selected carefully.

**Physical Dimension, Tape and Reel Information**

| Package Name | SSOP3 |
|---|---|

2. 9±0. 1

3

4°$^{+6°}_{-4°}$

2. 8±0. 1

1. 6±0. 1

0. 2MIN

1

2

0. 95

1. 9

0. 13$^{+0.06}_{-0.03}$

S

1. 25MAX

1. 1±0. 05

0. 05

0. 075±0. 075

0. 1 S

0. 42$^{+0.05}_{-0.04}$

(UNIT : mm)

PKG : SSOP3
Drawing No. EX099−5001

< Tape and Reel Information >

| Tape | Embossed carrier tape |
|---|---|
| Quantity | 3000pcs |
| Direction of feed | TL<br>The direction is the pin 1 of product is at the lower left when you hold reel on the left hand and you pull out the tape on the right hand |

Reel

Pin 1

Direction of feed

●**Revision History**

| Date | Revision | Changes |
|---|---|---|
| 03.Feb.2014 | 004 | New Release |
| 03.July.2014 | 005 | Updated Fig.5 VDD condition<br>Updated Operational Notes and Notice |
| 02.Sep.2021 | 006 | Deleted Not Recommended New Designs product |

# Notice

**Precaution on using ROHM Products**

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 [(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 |
|-------|-----|------|-------|
| CLASSⅢ | CLASSⅢ | CLASSⅡb | CLASSⅢ |
| CLASSⅣ | | CLASSⅢ | |

2. 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:
    [a] Installation of protection circuits or other protective devices to improve system safety
    [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. 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:
    [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
    [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
    [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
    [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 (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; 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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## 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 $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
    - [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

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.

2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).

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## Other Precaution

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2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

**General Precaution**

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

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