AC Voltage Zero Cross Detection IC

BM1Z001FJ

General Description

This IC outputs the AC voltage zero cross timing detection with high accuracy.
By eliminating the need for photocoupler and external components required in conventional applications, it is possible to reduce the number of parts drastically and realize compact and highly reliable power supply applications. In addition, this IC can reduce standby power largely in comparison with an existing photocoupler control.
Furthermore, this IC can handle both normal and double rectification by the original system.

Features

- AC Zero Cross Detection Function
  Eliminates Photocoupler
  600 V High Voltage Monitor
  Handle both Normal and Double Rectification
  n Channel Open Drain Output
- VCC Under Voltage Locked Out (VCC UVLO)

Key Specifications

- VCC Input Power Supply Voltage Range: -0.3 V to +29.0 V
- VH_AC1 and VH_AC2 Pins Operation Voltage: 600 V (Max)
- Circuit Current at Standby: 50 µA (Typ)
- Circuit Current at Operation: 160 µA (Typ)
- Operating Temperature Range: -40 °C to +105 °C

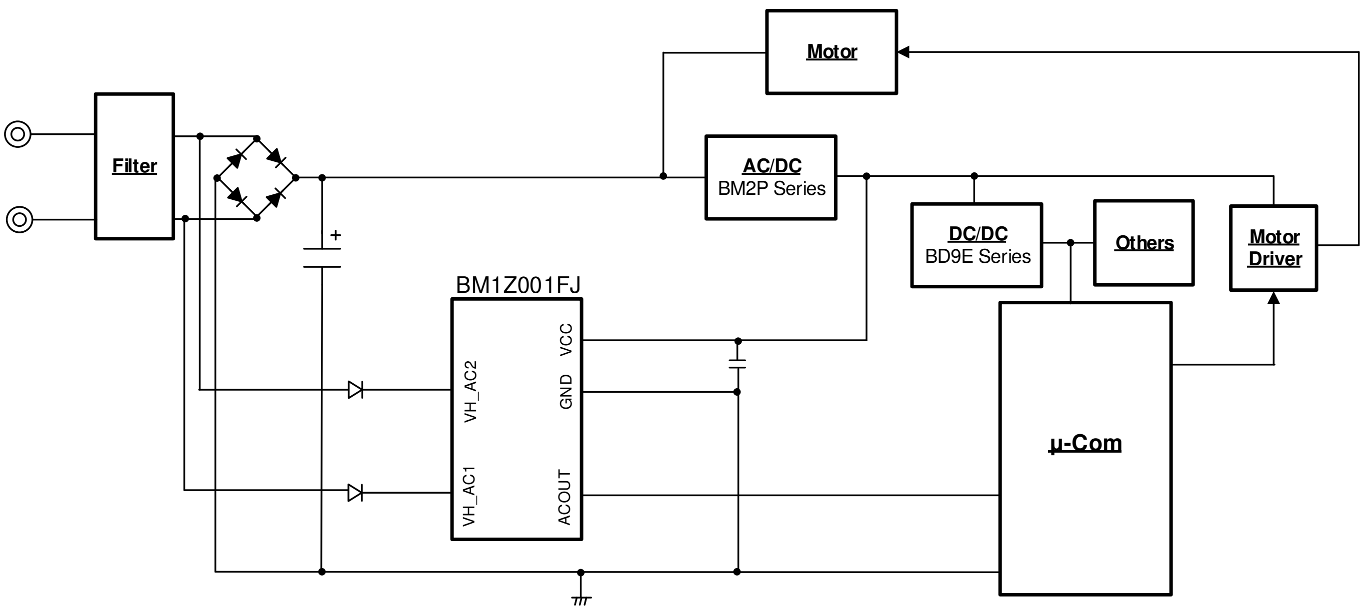
Package

Package	W (Typ) x D (Typ) x H (Max)
SOP-J7S	4.90 mm x 6.00 mm x 1.65 mm
	Pitch (Typ): 1.27 mm

Applications

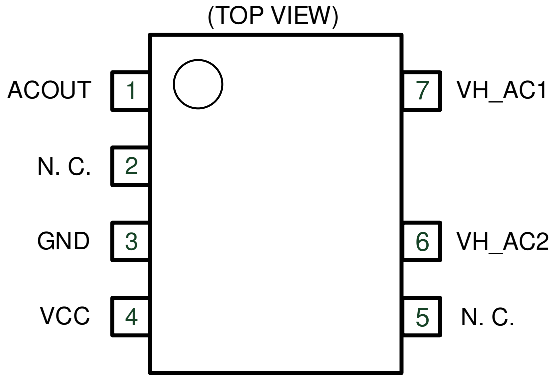
- Household Appliances such as Washing Machine, Air-conditioner

Typical Application Circuit



〇Product structure : Silicon integrated circuit 〇This product has no designed protection against radioactive rays

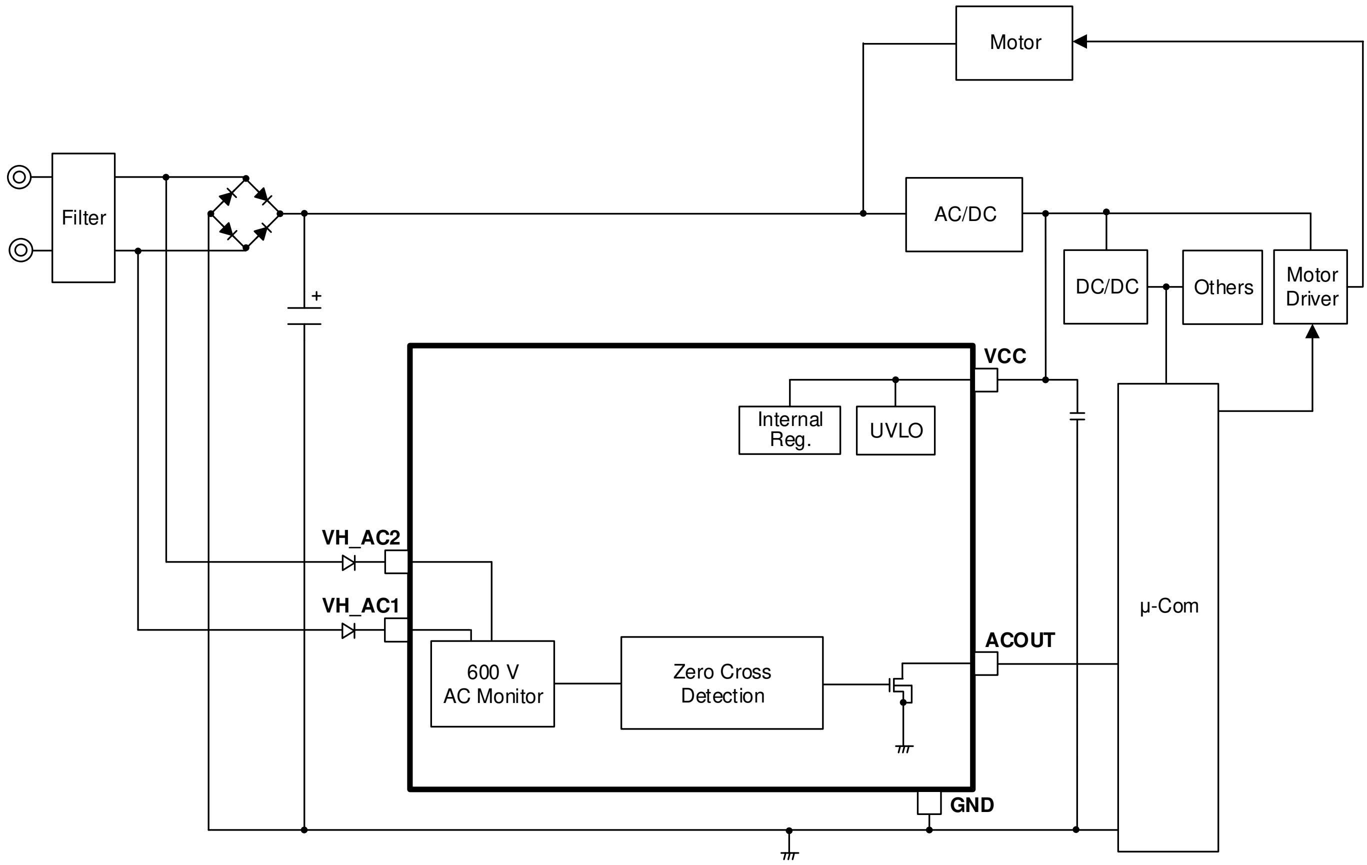
Pin Configuration



Pin Descriptions

Pin No.	Pin Name	Function
1	ACOUT	AC voltage zero cross timing output pin
2	N.C.	Non connection
3	GND	Ground pin
4	VCC	Power supply pin
5	N.C.	Non connection
6	VH_AC2	AC voltage input 2 pin
7	VH_AC1	AC voltage input 1 pin

Block Diagram



Description of Blocks

1. **AC Voltage Zero Cross Detection**
   By monitoring the voltage between the VH_AC1 and VH_AC2 pins, this IC outputs the zero cross point of AC voltage from the ACOUT pin. These pins have a built-in monitor circuit that tolerates 600 V and they realize high reliability and low power consumption.
   The ACOUT pin performs an n channel open drain output and this makes it possible to support various applications.
   During normal voltage rectification, it is necessary to connect the VH_AC1 and VH_AC2 pins to the point of N_GND and L_GND each.
   During double voltage rectification, it is necessary to connect the VH_AC2 pin to the midpoint of the VP voltage capacitor.

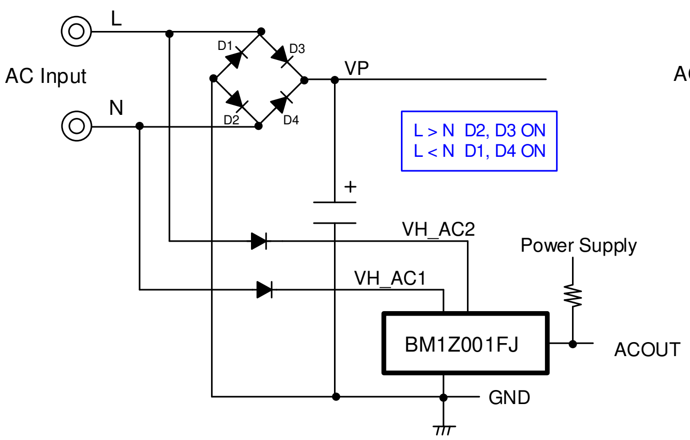


Figure 1. Normal Voltage Rectification Circuit

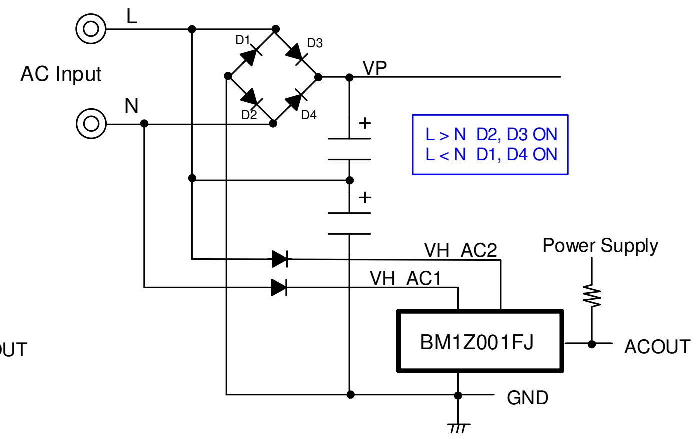


Figure 2. Double Voltage Rectification Circuit

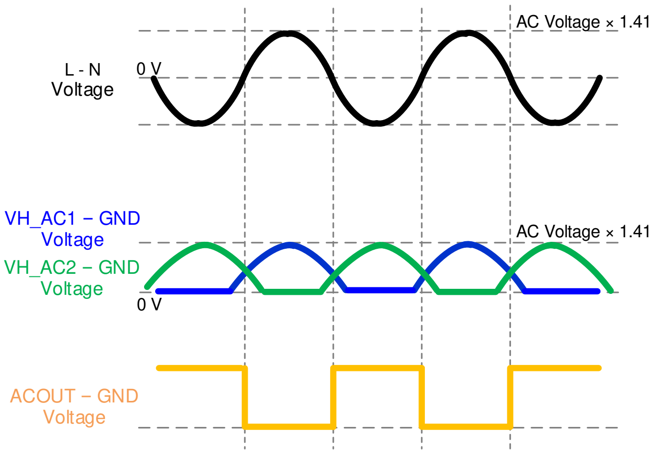


Figure 3. Normal Voltage Rectification Waveform

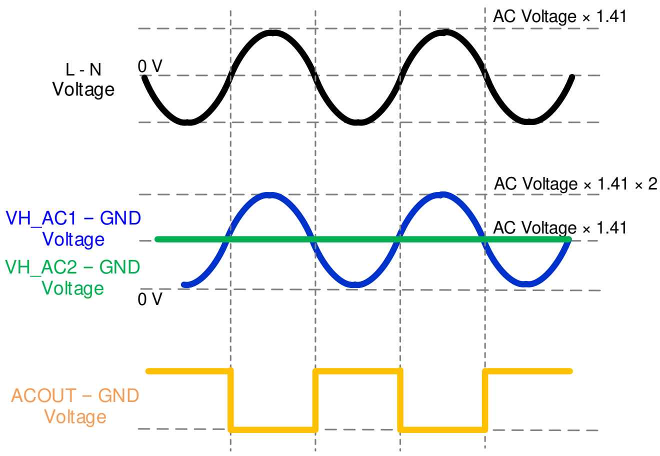


Figure 4. Double Voltage Rectification Waveform

1. AC Voltage Zero Cross Detection – continued

1.1 VH_AC1 Pin UVLO

In case that the peak voltage of the VH_AC1 pin is V_{ACUVLO} or less, the ACOUT pin voltage is defined as Hiz.

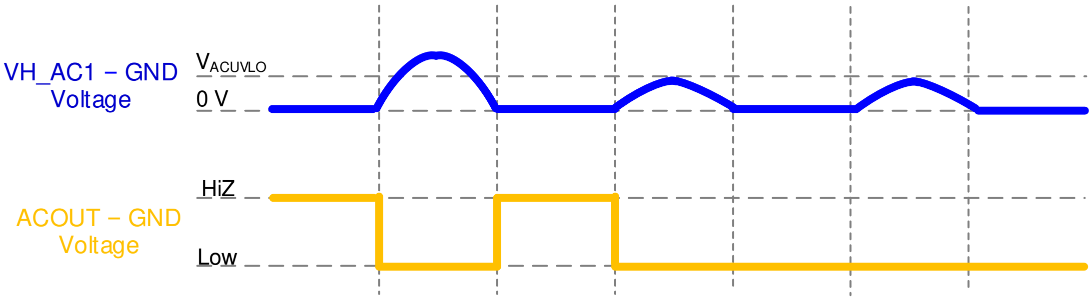


Figure 5. VH_AC1 Pin UVLO

1.2 VH_AC1 and VH_AC2 Pins Noise Filter

This IC has two noise filters.

Noise Filter 1 (t_{AC1}): In case of the ACOUT pin voltage = Hiz, signals of pulse width < t_{AC1} is not accepted.

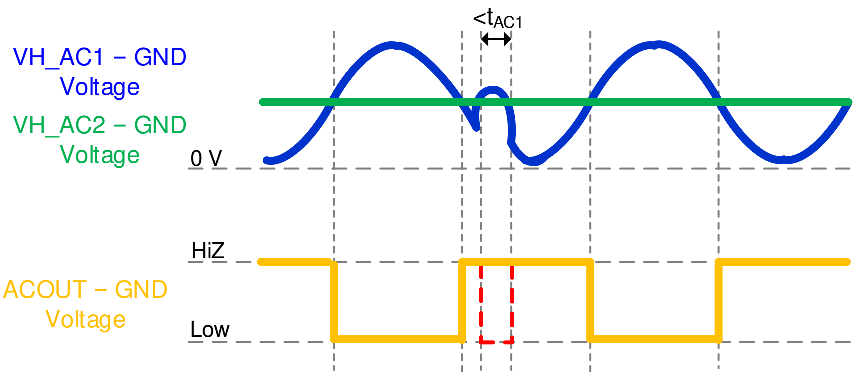


Figure 6. VH_AC1 and VH_AC2 Pins Noise Filter 1

Noise Filter 2 (t_{AC2}): In case of the ACOUT pin voltage = Low, signals of pulse width < t_{AC2} is not accepted.

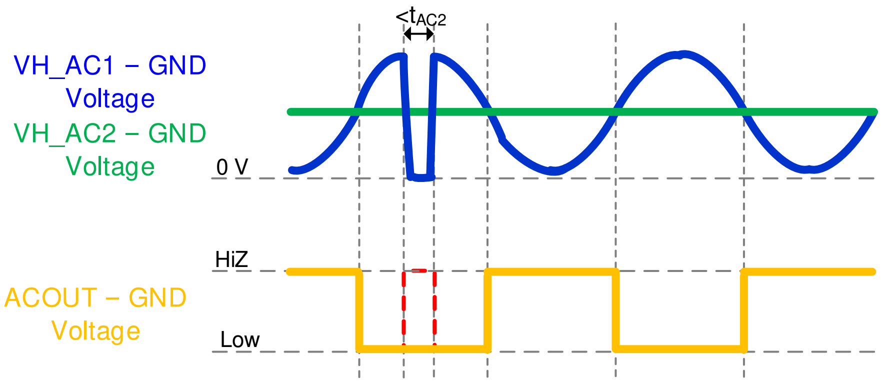


Figure 7. VH_AC1 and VH_AC2 Pins Noise Filter 2

Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Rating	Unit
VCC Input Power Supply Voltage	V_{CC}	-0.3 to +29	V
VH_AC1 Pin Voltage	V_{VH_AC1}	-0.3 to +600	V
VH_AC2 Pin Voltage	V_{VH_AC2}	-0.3 to +600	V
ACOUT Pin Voltage	V_{ACOUT}	-0.3 to +29	V
Allowable Dissipation (Note 1)	Pd	0.83	W
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	150	°C

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 with power dissipation taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

(Note 1) SOP-J7S: At mounted on a glass epoxy single layer PCB (114.3 mm x 76.2 mm x 1.6 mm). Derate by 6.64 mW/°C if the IC is used in the ambient temperature 25 °C or above.

Thermal Loss

Make the thermal design so that the IC operates in the following conditions.
(Because the following temperature is guarantee value, it is necessary to consider such as a margin.)

1. The ambient temperature must be 105 °C or less.
2. The IC's loss must be the allowable dissipation Pd or less.

The thermal abatement characteristics are as follows.
(At mounting on a glass epoxy single layer PCB which size is 114.3 mm x 76.2 mm x 1.6 mm.)

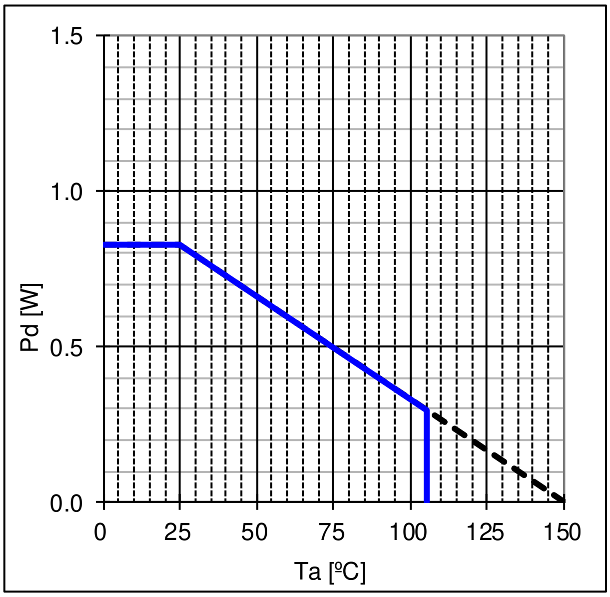


Figure 8. SOP-J7S Thermal Abatement Characteristic

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
VCC Input Power Supply Voltage	V_{CC}	10	15	28	V
VH_AC1 Pin Operation Voltage	V_{VH_AC1}	-	-	300 *(Note 2)*	V
VH_AC2 Pin Operation Voltage	V_{VH_AC2}	-	-	300 *(Note 2)*	V
VH_AC1 and VH_AC2 Pins Input Frequency	f_{VH_AC}	45	-	65	Hz
Operating Temperature	Topr	-40	-	+105	°C

(Note 2) The recommendation maximum operating voltage shows AC 300 V which is input AC voltage in the application.
During normal voltage rectification, apply the input AC voltage which is half-wave-rectified to the VH_AC1 and VH_AC2 pins.
During double voltage rectification, apply the input AC voltage which is half-wave-rectified to the VH_AC1 pin, and the divided voltage of the capacitor for VP voltage to the VH_AC2 pin.

Electrical Characteristics

(Unless otherwise specified V_{CC} = 15 V, Ta = 25 °C)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
VCC Block						
Circuit Current at Standby	I_{STBY}	20	50	90	µA	V_{CC} = 5 V
Circuit Current at Operation	I_{CC}	100	160	500	µA	V_{CC} = 15 V
VCC Pin UVLO Detected Voltage	V_{UVLO1}	5.0	6.0	7.0	V	at VCC pin voltage falling
VCC Pin UVLO Released Voltage	V_{UVLO2}	6.0	7.0	8.0	V	at VCC pin voltage rising
VCC Pin UVLO Hysteresis Voltage	V_{UVLO_HYS}	0.5	1.0	1.5	V	
AC Voltage Zero Cross Detection Block						
VH_AC1 Pin Consumption Current	I_{VH_AC1}	15	30	45	µA	V_{VH_AC1} = 300 V
VH_AC2 Pin Consumption Current	I_{VH_AC2}	15	30	45	µA	V_{VH_AC2} = 300 V
VH_AC1 Pin UVLO Detection Voltage	V_{ACUVLO}	10	20	30	V	
VH_AC1 and VH_AC2 Pins Noise Filter 1	t_{AC1}	1.00	1.27	1.54	ms	
VH_AC1 and VH_AC2 Pins Noise Filter 2	t_{AC2}	1.38	1.73	2.08	ms	
ACOUT Pin Leak Current	I_{ACOUT}	-	0.0	1.0	µA	V_{ACOUT} = 5 V
ACOUT Pin On Resistance	R_{ACOUT}	-	50	100	Ω	

Typical Performance Curves
(Reference data)

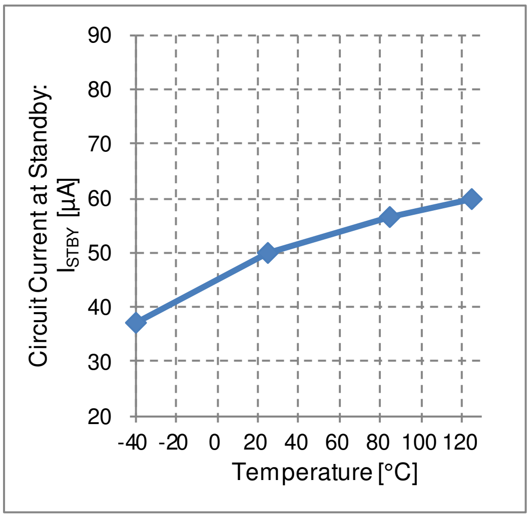


Figure 9. Circuit Current at Standby vs Temperature

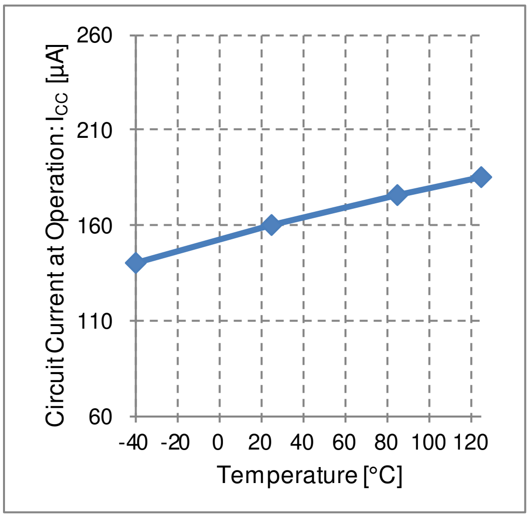


Figure 10. Circuit Current at Operation vs Temperature

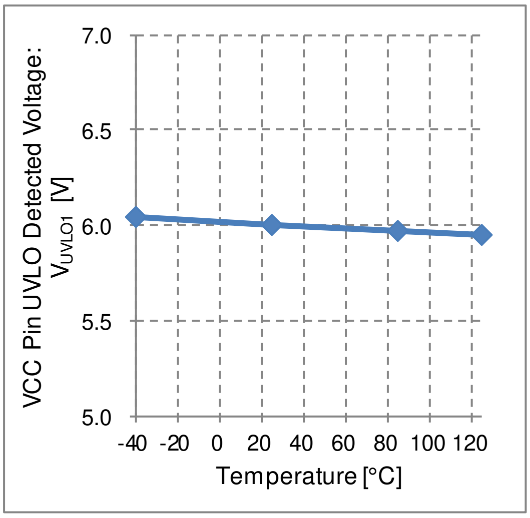


Figure 11. VCC Pin UVLO Detected Voltage vs Temperature

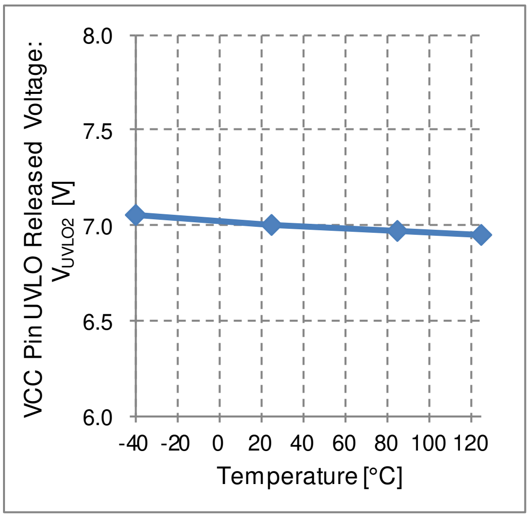


Figure 12. VCC Pin UVLO Released Voltage vs Temperature

Typical Performance Curves – continued
(Reference data)

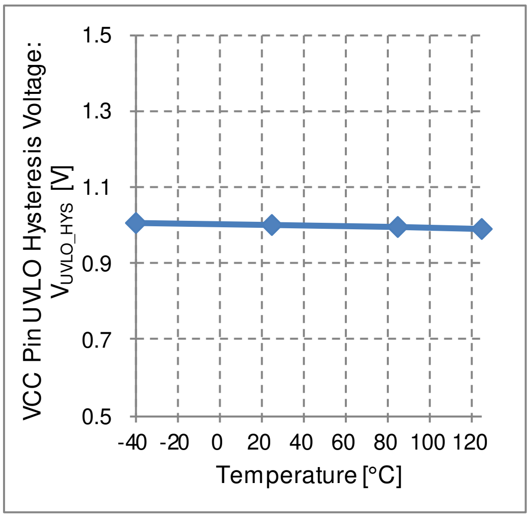


Figure 13. VCC Pin UVLO Hysteresis Voltage vs Temperature

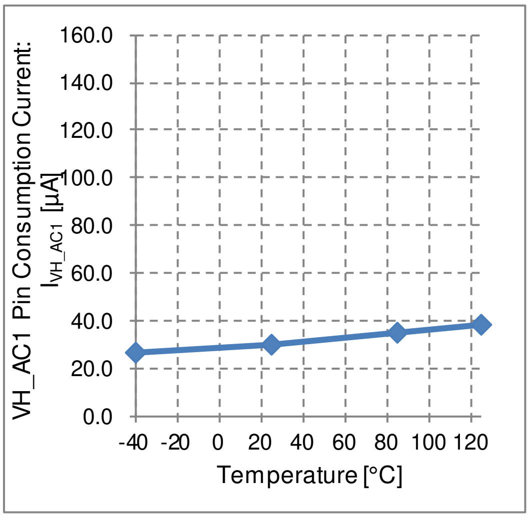


Figure 14. VH_AC1 Pin Consumption Current vs Temperature

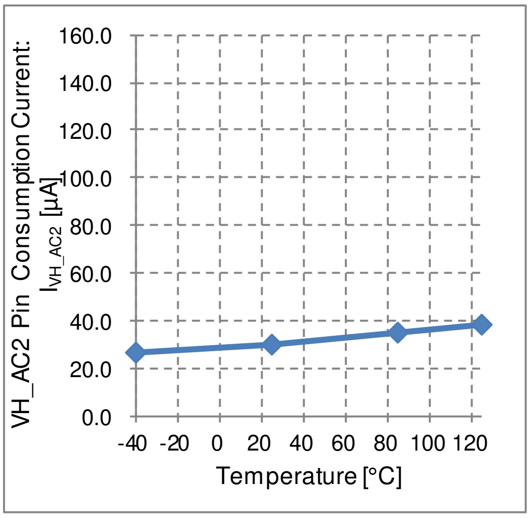


Figure 15. VH_AC2 Pin Consumption Current vs Temperature

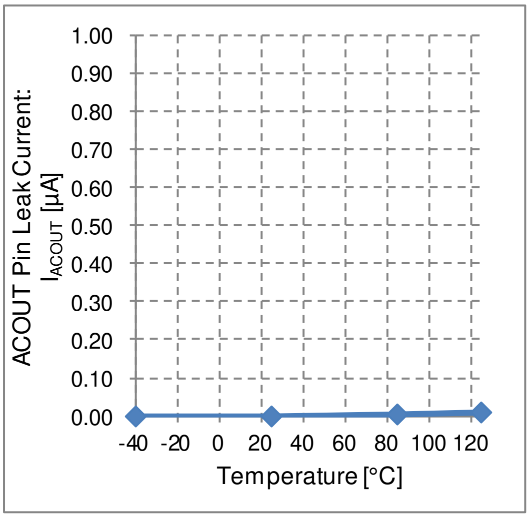


Figure 16. ACOUT Pin Leak Current vs Temperature

Typical Performance Curves – continued

(Reference data)

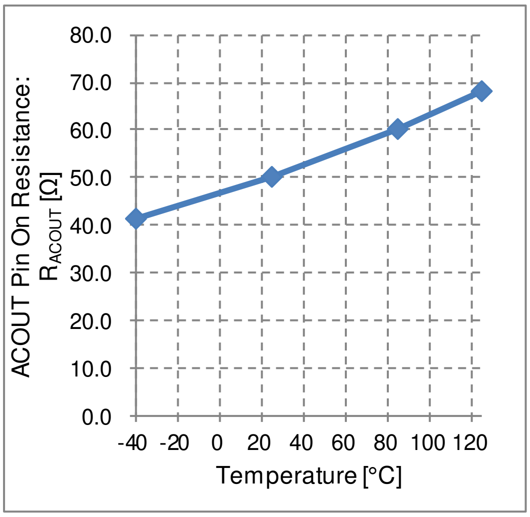


Figure 17. ACOUT Pin On Resistance vs Temperature

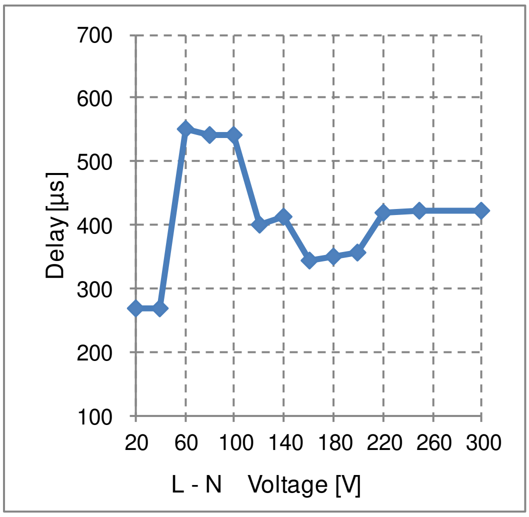
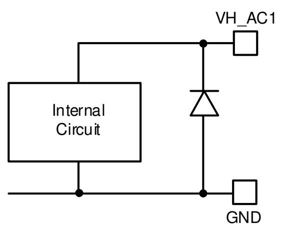
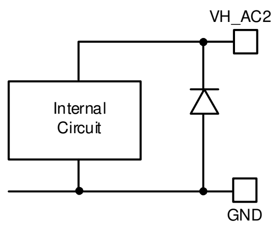
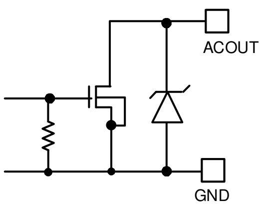
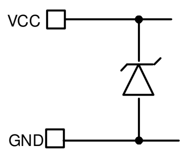
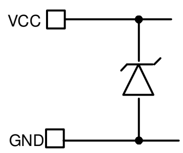


Figure 18. Delay vs L – N Voltage
(The reference data at the normal voltage rectification)

I/O Equivalence Circuit

7	VH_AC1	–	–	6	VH_AC2	5	N. C.
		–				Non Connetion	
1	ACOUT	2	N. C.	3	GND	4	VCC
		Non Connetion					

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. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended 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. **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.

8. **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.

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

Operational Notes – continued

10. Regarding the Input Pin of the IC

This 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.

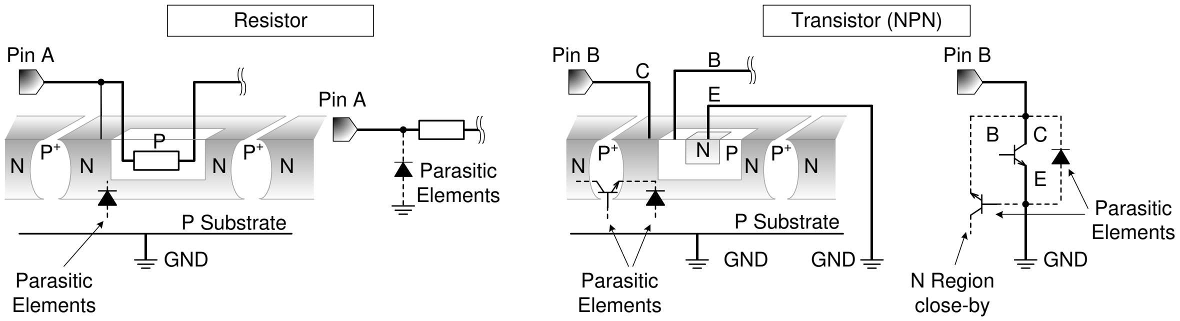


Figure 19. Example of IC Structure

11. 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.

12. Thermal Shutdown Circuit (TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

13. Over Current Protection Circuit (OCP)

This IC incorporates an integrated overcurrent protection circuit that is activated when the load is shorted. This protection circuit is effective in preventing damage due to sudden and unexpected incidents. However, the IC should not be used in applications characterized by continuous operation or transitioning of the protection circuit.

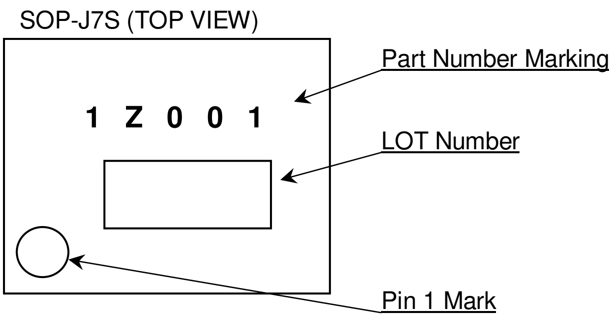
Ordering Information

B M 1 Z 0 0 1 F J - E 2

Package
FJ: SOP-J7S

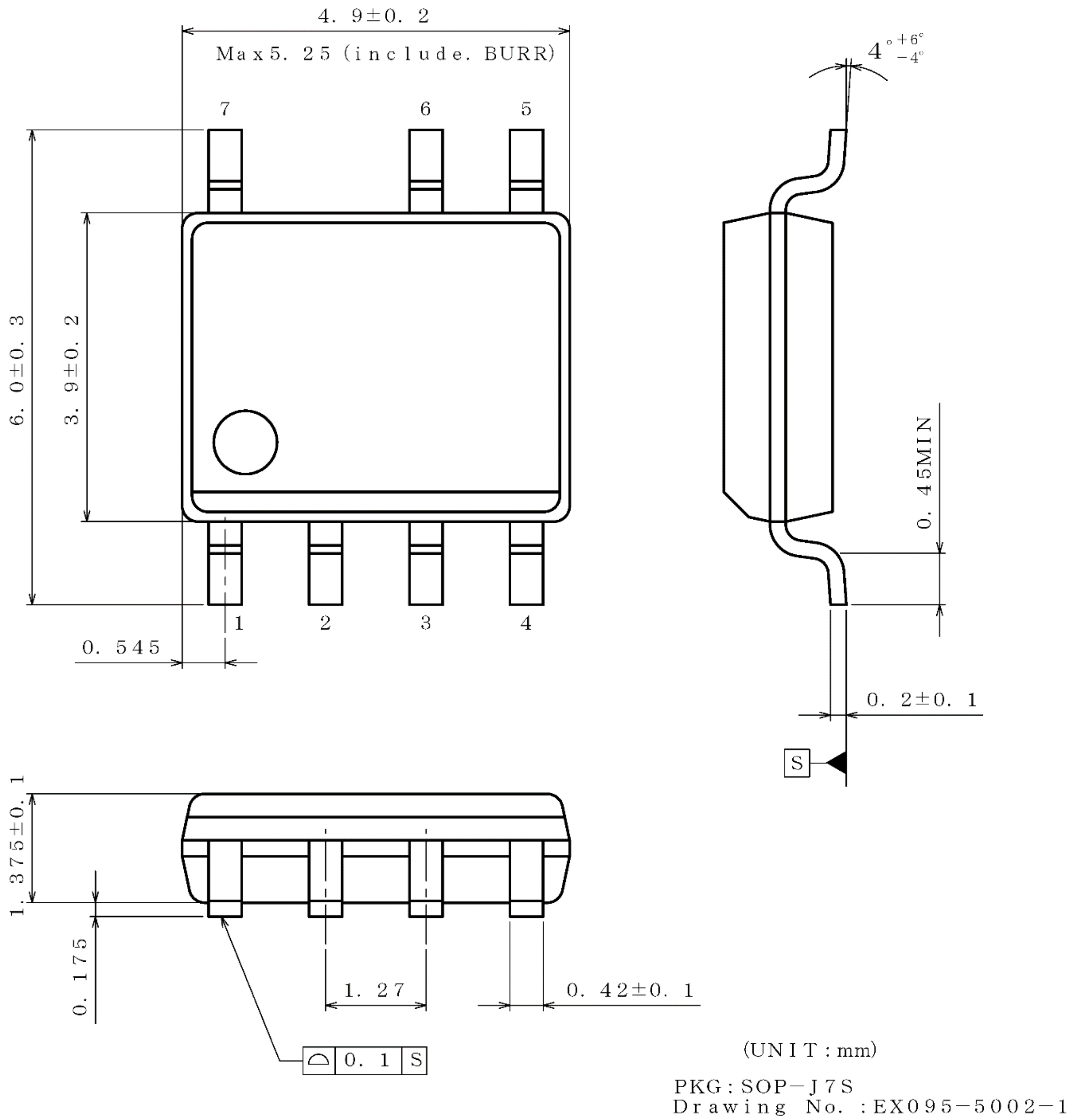
Packaging and forming specification
E2: Embossed tape and reel

Marking Diagram



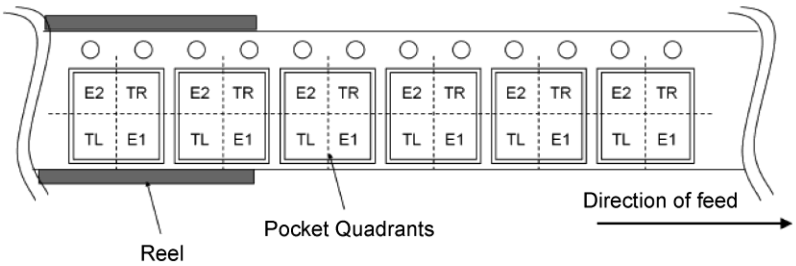
Physical Dimension and Packing Information

Package Name	SOP-J7S



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 The direction is the pin 1 of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand



Revision History

Date	Revision	Changes
15.Mar.2019	001	New Release

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

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

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General Precaution

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