

# D/A Converters

## Standard 8bit 4ch · 6ch Type

BH2227FV BH2228FV

### General Description

The BH2227FV and BH2228FV ICs are 8bit R-2R-type D/A converters with 4 and 6 channels, respectively. Optimized circuitry allows two output voltages to be supplied (3V/5V). Furthermore, the built-in RESET function ensures that the output voltage at all channels is LOW during power up. A broad power supply voltage range is available (2.7V to 5.5V), providing design flexibility.

### Features

- Suitable for 2 independent power sources (3V/5V)
- Built-in RESET function
- High speed output response characteristics
- 3-line serial interface

### Applications

DVCs, DSCs, DVDs, CD-Rs, CD-RWs

### Key Specifications

- Power Source Voltage Range: 2.7V to 5.5V
- Current Consumption: 0.8mA(Typ)
- Differential Non Linearity Error:  $\pm 1.0$ LSB
- Integral non Linearity Error:  $\pm 1.5$ LSB
- Output current Performance:  $\pm 1.0$ mA
- Settling Time: 100 $\mu$ s(Min)
- Data Transfer Frequency: 10MHz(Max)
- Action Temperature Range: -20°C to +85°C

### Package

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



### Lineup

Number of channels	Input method	Data latch method	Package		Orderable Part Number
4ch	CMOS	CSB method	SSOP-B14	Reel of 2500	BH2227FV-E2
			SSOP-B14K		BH2227FV-ZE2
SSOP-B14			BH2228FV-E2		

Pin Descriptions and Block Diagrams

(BH2227FV)

Terminal	Terminal Name	Function
1	AO1	Analog output terminal
2	AO2	
3	TESTMONI1	Test terminal (OPEN at normal use)
4	TESTMONI2	
5	AO3	Analog output terminal
6	AO4	
7	NC	Internally not connected yet
8	NC	
9	VDD	Power source terminal (AO3, 4 full scale voltage use in common)
10	CSB	Chip select signal input terminal
11	CLK	Serial clock input terminal
12	DI	Serial data input terminal
13	VFS	AO1,2 full scale Voltage setting terminal
14	VSS	Ground terminal

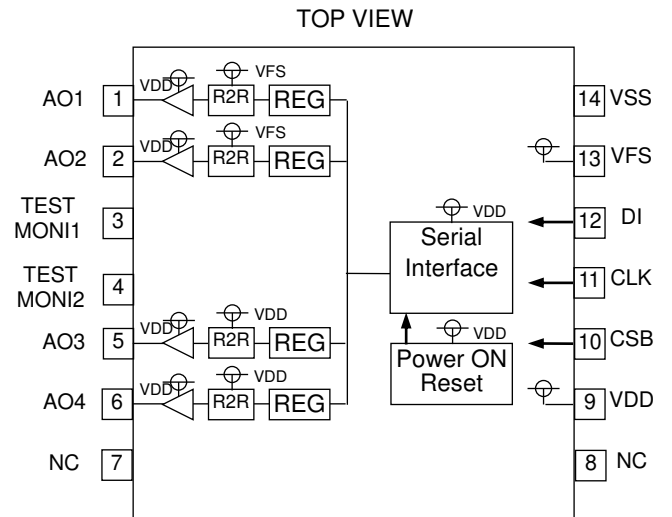


Figure 1. BH2227FV

(BH2228FV)

Terminal	Terminal Name	Function
1	AO1	Analog output terminal
2	AO2	
3	AO3	
4	AO4	
5	AO5	
6	AO6	
7	NC	Internally not connected yet
8	NC	
9	VDD	Power source terminal (AO4 to AO6 full scale voltage use in common)
10	CSB	Chip select signal input terminal
11	CLK	Serial clock input terminal
12	DI	Serial data input terminal
13	VFS	AO1,2,3 full scale Voltage setting terminal
14	VSS	Ground terminal

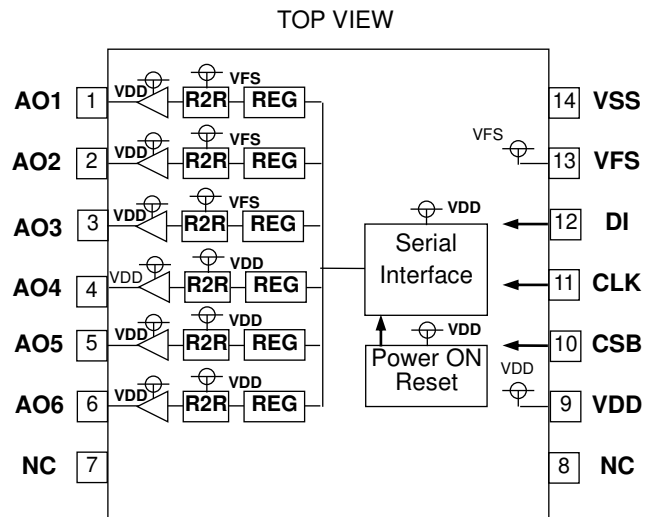


Figure 2. BH2228FV

## Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Limit	Unit	Remark
Power Source Voltage	V <sub>DD</sub>	-0.3 to +7.0	V	-
Terminal Voltage	V <sub>IN</sub>	-0.3 to V <sub>CC</sub>	V	-
Storage Temperature Range	T <sub>stg</sub>	-55 to +125	°C	-
Power Dissipation	P <sub>d</sub>	0.40 (Note 1)	W	-

(Note 1) Derated at 4.0mW/°C at Ta&gt;25°C

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

## Recommended Operating Conditions (Ta=25°C)

Parameter	Symbol	Limit			Unit	Remark
		Min	Typ	Max		
VDD Power Source Voltage	V <sub>DD</sub>	2.7	-	5.5	V	(Note 2)
VFS Voltage to be Impressed	V <sub>FS</sub>	2.7	-	V <sub>DD</sub>	V	(Note 2)
Terminal Input Voltage Range	V <sub>IN</sub>	0	-	V <sub>DD</sub>	V	-
Analog Output Current	I <sub>OUT</sub>	-1.0	-	+1.0	mA	-
Action Temperature Range	T <sub>opr</sub>	-20	-	+85	°C	-
Serial Clock Frequency	f <sub>CLK</sub>	-	1.0	10.0	MHz	-
Limit Load Capacitance	C <sub>L</sub>	-	-	0.1	μF	-

(Note 2) Set the power source voltage so that V<sub>DD</sub> ≥ V<sub>FS</sub>.

## Electrical Characteristics

(Unless otherwise specified, V<sub>DD</sub>=V<sub>FS</sub>=3.0V, R<sub>L</sub>=OPEN, C<sub>L</sub>=0pF, Ta=25°C)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
<Current Consumption>						
VDD System	I <sub>DD</sub>	-	0.5	1.5	mA	V <sub>DD</sub> =5V, CLK=1MHz
VFS System	I <sub>FS</sub>	-	0.3	0.9	mA	
<Logic Interface>						
L Input Voltage	V <sub>IL</sub>	V <sub>SS</sub>	-	0.6	V	V <sub>DD</sub> =5.0V
H Input Voltage	V <sub>IH</sub>	2.4	-	V <sub>DD</sub>	V	V <sub>DD</sub> =5.0V
Input Current	I <sub>IN</sub>	-10	-	+10	μA	
<Buffer Amplifier>						
Output Zero Scale Voltage	V <sub>ZS1</sub>	V <sub>SS</sub>	-	0.1	V	00h setting, at no load
	V <sub>ZS2</sub>	V <sub>SS</sub>	-	0.3	V	00H setting, I <sub>OL</sub> =1.0mA
Output Full Scale Voltage	V <sub>FS1</sub>	V <sub>DD</sub> -0.1	-	V <sub>DD</sub>	V	FFH setting, at no load
	V <sub>FS2</sub>	V <sub>DD</sub> -0.3	-	V <sub>DD</sub>	V	FFH setting, I <sub>OH</sub> =1.0mA
	V <sub>FS3</sub>	V <sub>FS</sub> -0.1	-	V <sub>FS</sub>	V	FFH setting, at no load
	V <sub>FS4</sub>	V <sub>FS</sub> -0.3	-	V <sub>FS</sub>	V	FFH setting, I <sub>OH</sub> =1.0mA
<D/A Converter Precision>						
Differential Non Linearity Error	DNL	-1.0	-	+1.0	LSB	Input code 02H to FDH
Integral Non Linearity Error	INL	-1.5	-	+1.5	LSB	Input code 02H to FDH
VDD Power Source Voltage Rise Time	t <sub>rVDD</sub>	100	-	-	μs	V <sub>DD</sub> =0V to 2.7V
Power ON Reset Release Voltage	V <sub>POR</sub>	-	1.9	-	V	

Timing Chart

(Unless otherwise specified,  $V_{DD} = V_{FS} = 3.0V$ ,  $R_L = OPEN$ ,  $C_L = 0pF$ ,  $T_a = 25^\circ C$ )

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
CLK L Level Time	$t_{CLKL}$	50	-	-	ns	
CLK H Level Time	$t_{CLKH}$	50	-	-	ns	
DI Setup Time	$t_{sDI}$	20	-	-	ns	
DI Hold Time	$t_{hDI}$	40	-	-	ns	
CSB Setup Time	$t_{sCSB}$	50	-	-	ns	
CSB Hold Time	$t_{hCSB}$	50	-	-	ns	
CSB H Level Time	$t_{CSBH}$	50	-	-	ns	
D/A Output Settling Time	$t_{OUT}$	-	-	100	$\mu s$	$C_L=50pF, R_L=10k\Omega$

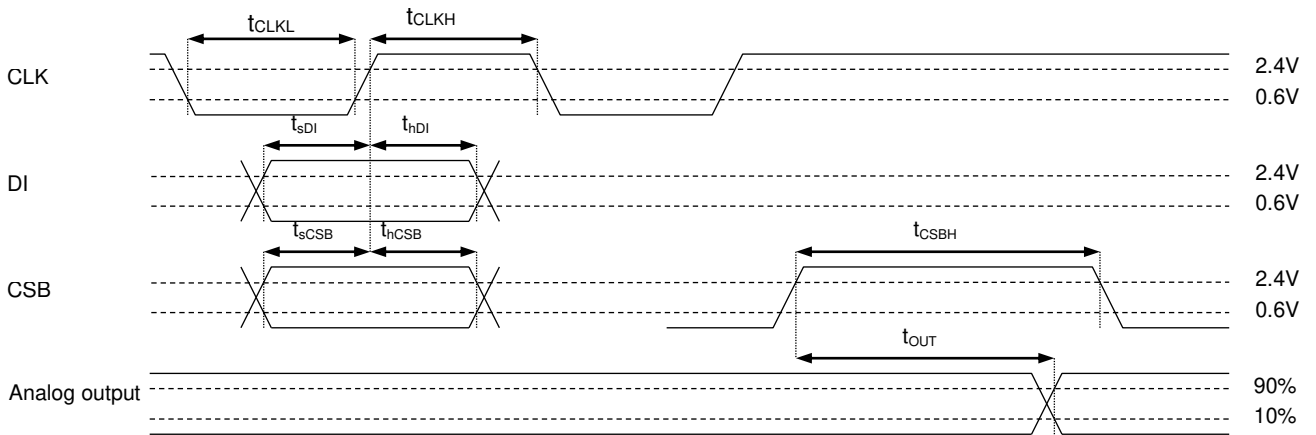


Figure 3

Typical Performance Curves

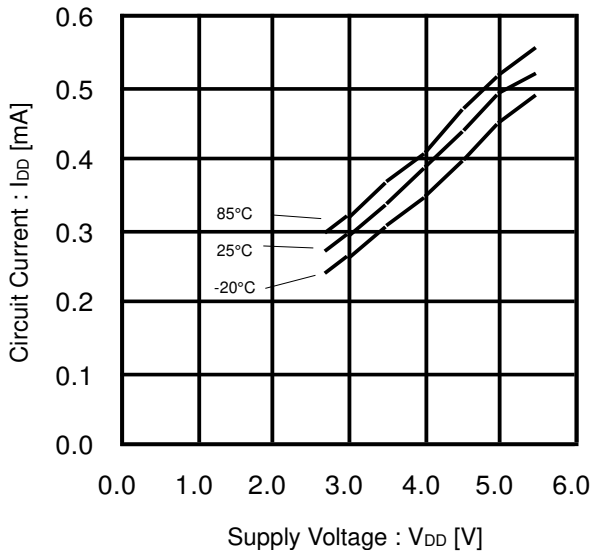


Figure 4. Circuit Current vs Supply Voltage (VDD Current Consumption)

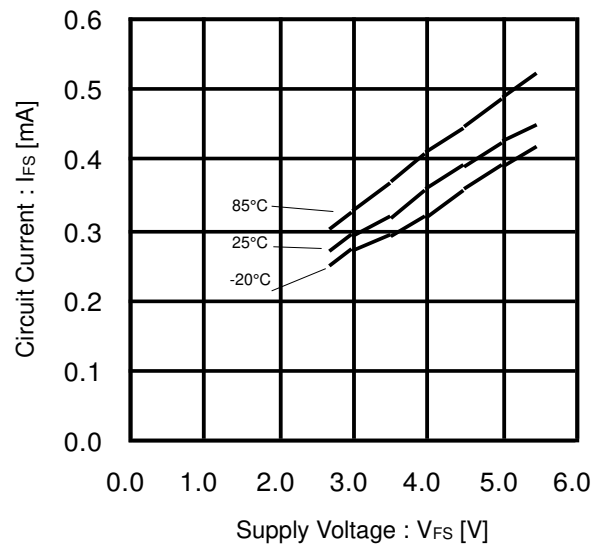


Figure 5. Circuit Current vs Supply Voltage (VFS Current Consumption)

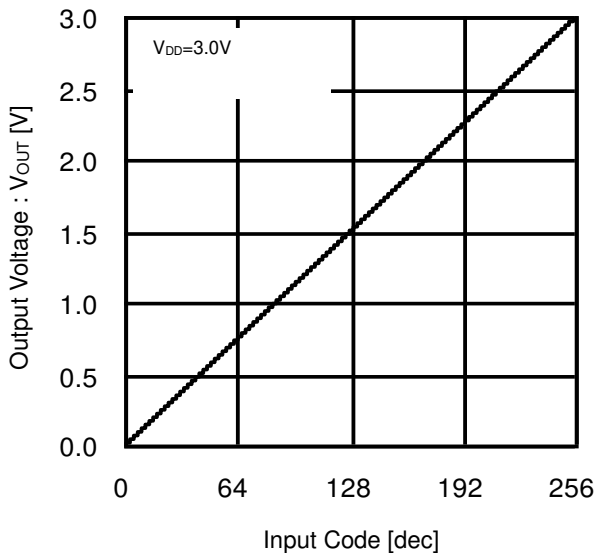


Figure 6. Output Voltage vs Input Code

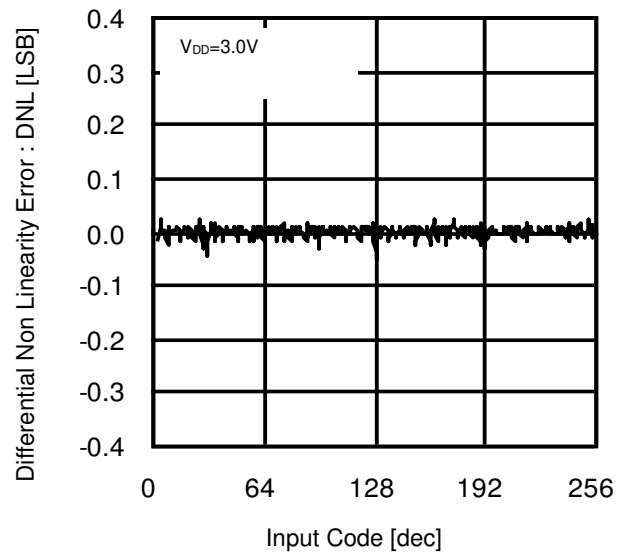


Figure 7. Differential Non Linearity Error vs Input Code

Typical Performance Curves – continued

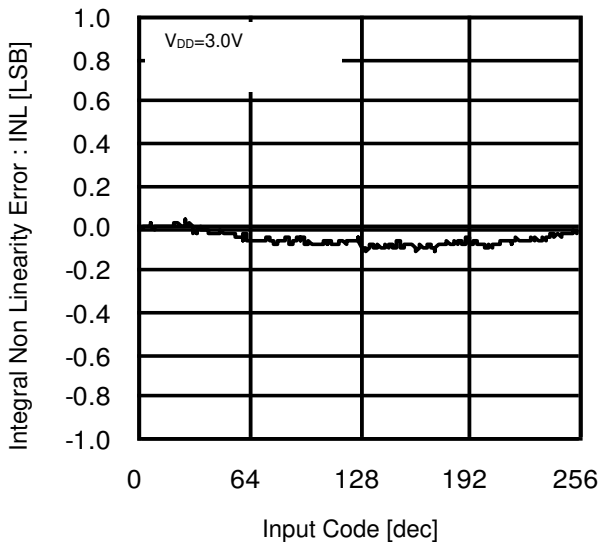


Figure 8. Integral Non Linearity Error vs Input Code

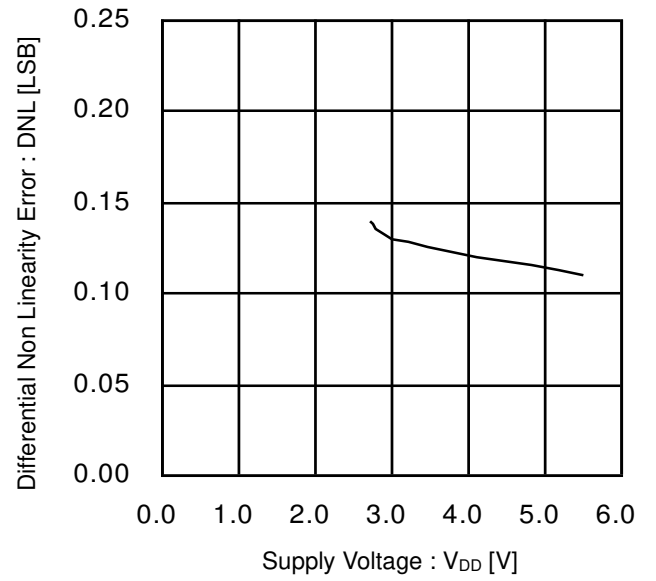


Figure 9. Differential Non Linearity Error vs Supply Voltage

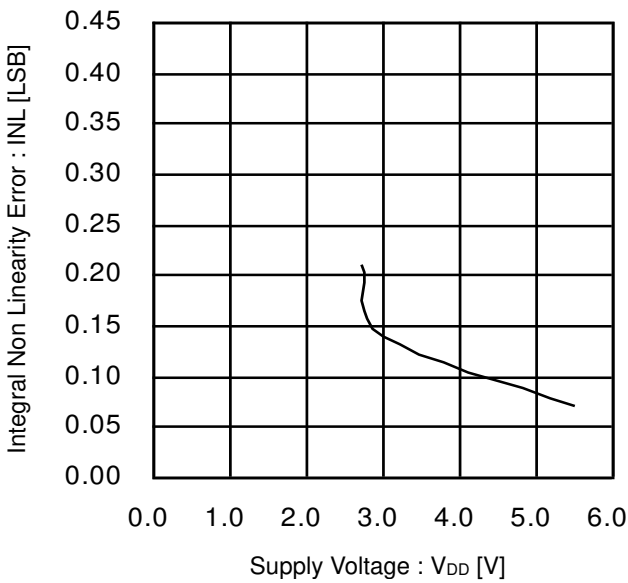


Figure 10. Integral Non Linearity Error vs Supply Voltage

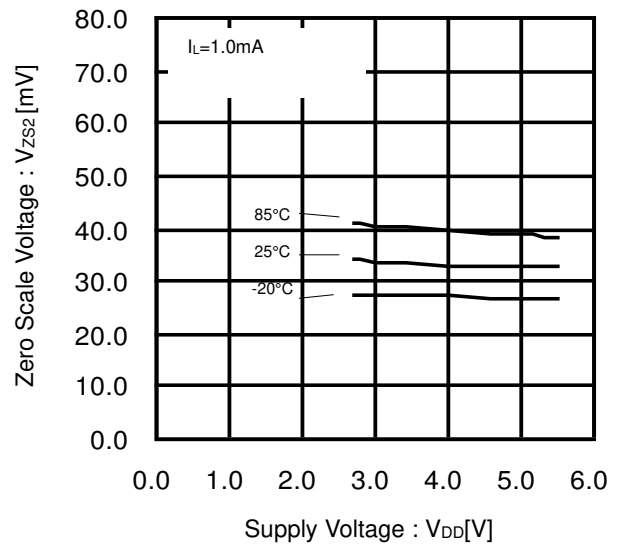


Figure 11. Output Zero Scale Voltage vs Supply Voltage

Typical Performance Curves – continued

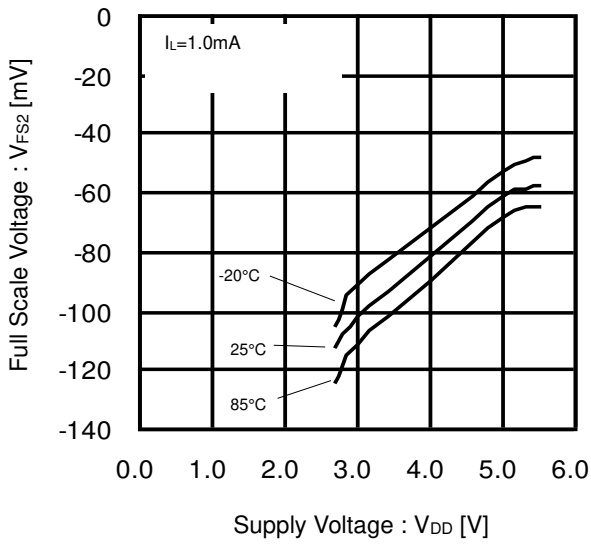


Figure 12. Output Full Scale Voltage vs Supply Voltage

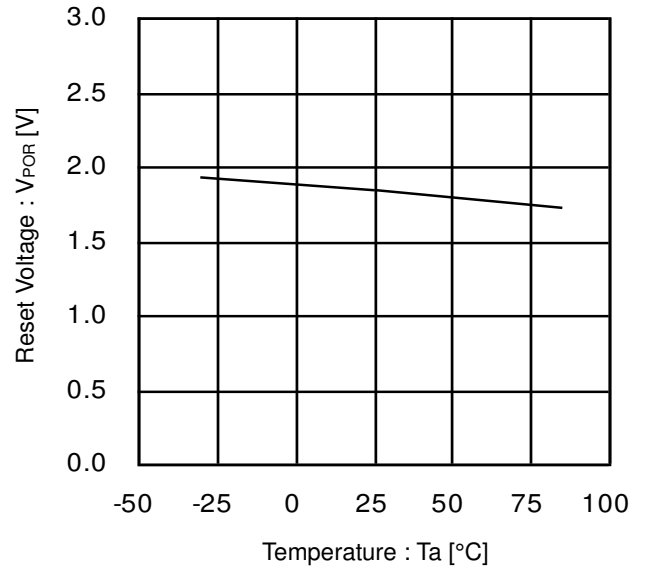


Figure 13. Reset Release Voltage vs Temperature

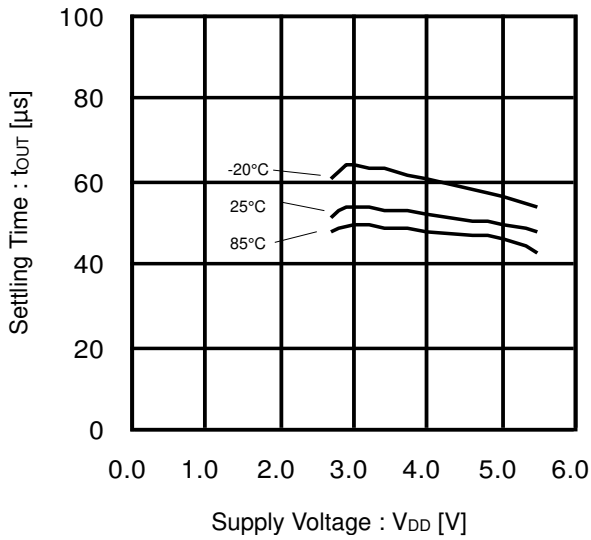


Figure 14. Settling Time vs Supply Voltage

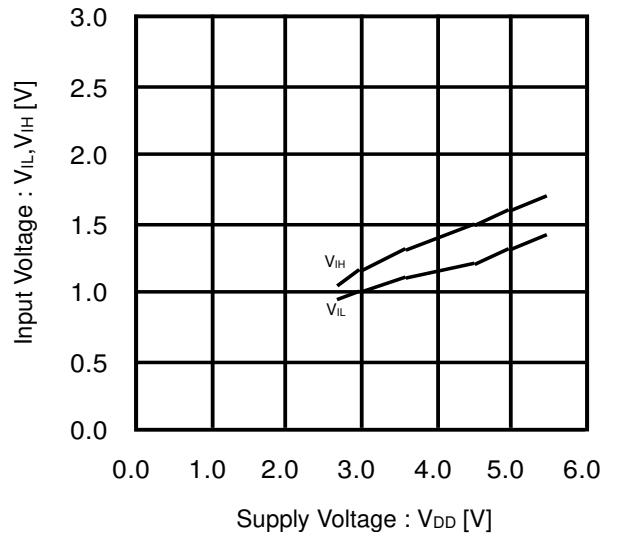


Figure 15. Input Voltage vs Supply Voltage

Application Information

Operation Description

The Serial Control Interface is 3-line serial interface 1) CSB, 2) CLK and 3) DI.  
 Every command is composed of 12 bits data sent through DI line (MSB first).  
 DI data is read every rising edge of the CLK while CSB is LOW.  
 Last 12 bits of data are latched when CSB goes HIGH.

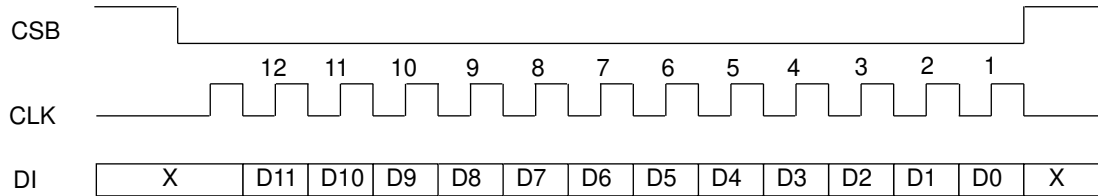


Figure 16

Data Settings

D0	D1	D2	D3	D4	D5	D6	D7	Setting
0	0	0	0	0	0	0	0	GND
1	0	0	0	0	0	0	0	(V <sub>DD</sub> or V <sub>FS-GND</sub> )/256x1
0	1	0	0	0	0	0	0	(V <sub>DD</sub> or V <sub>FS-GND</sub> )/256x2
1	1	0	0	0	0	0	0	(V <sub>DD</sub> or V <sub>FS-GND</sub> )/256x3
0	0	1	0	0	0	0	0	(V <sub>DD</sub> or V <sub>FS-GND</sub> )/256x4
⋮								
0	1	1	1	1	1	1	1	(V <sub>DD</sub> or V <sub>FS-GND</sub> )/256x254
1	1	1	1	1	1	1	1	(V <sub>DD</sub> or V <sub>FS-GND</sub> )/256x255

(Note) Initial status D[7:0]=00h

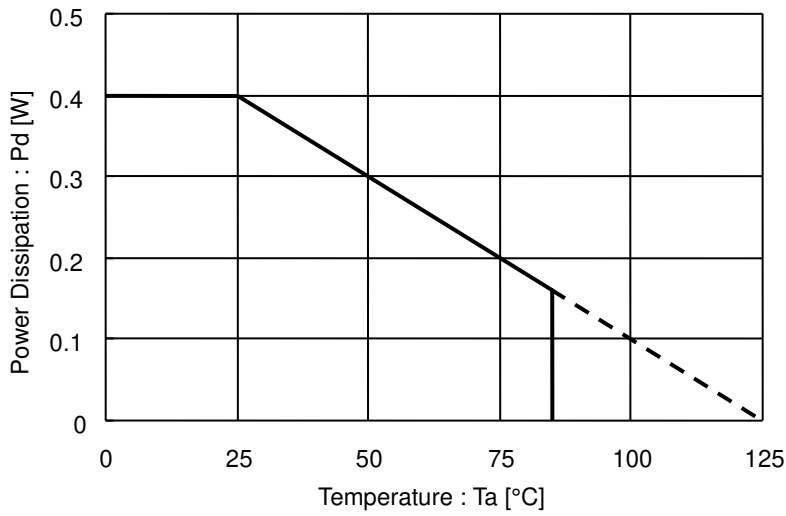
Channel Settings

D8	D9	D10	D11	BH2227FV	BH2228FV
0	0	0	0	Not used	Not used
0	0	0	1	AO1	AO1
0	0	1	0	AO2	AO2
0	0	1	1	Not used	AO3
0	1	0	0	Not used	AO4
0	1	0	1	AO3	AO5
0	1	1	0	AO4	AO6
0	1	1	1	Not used	Not used
1	0	0	0	Not used	Not used
1	0	0	1	Not used	Not used
1	0	1	0	Not used	Not used
1	0	1	1	Not used	Not used
1	1	0	0	Not used	Not used
1	1	0	1	Not used	Not used
1	1	1	0	Not used	Not used
1	1	1	1	Not used	Not used



**Power Dissipation**

• SSOP-B14



Board size : 70mm x 70mm x 1.6mm Material : FR4 glass epoxy board (copper foil area less than 3%)

**I/O Equivalent Circuit**

Terminal	Equivalent Circuit	Terminal	Equivalent Circuit
AO1 AO2 AO3 AO4 AO5 AO6		DI CLK CSB	

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

### 5. Thermal Consideration

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

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

### 8. Operation Under Strong Electromagnetic Field

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

### 9. Testing on Application Boards

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

### 10. Inter-pin Short and Mounting Errors

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

### 11. Unused Input Pins

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

Operational Notes – continued

12. Regarding the Input Pin of the IC

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

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

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

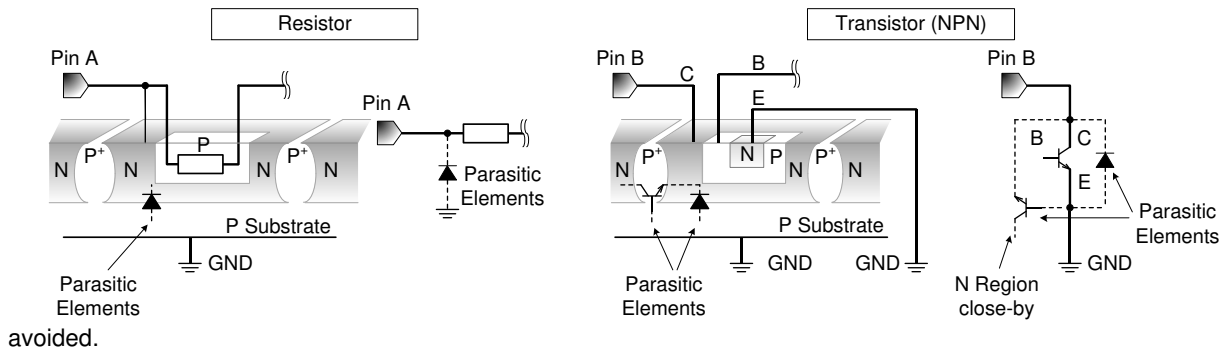
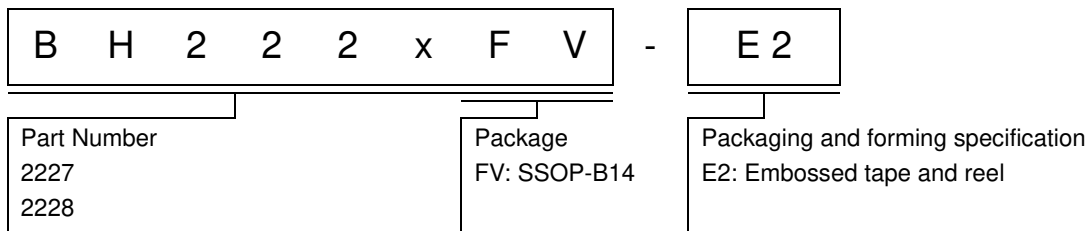


Figure 17. Example of monolithic IC structure

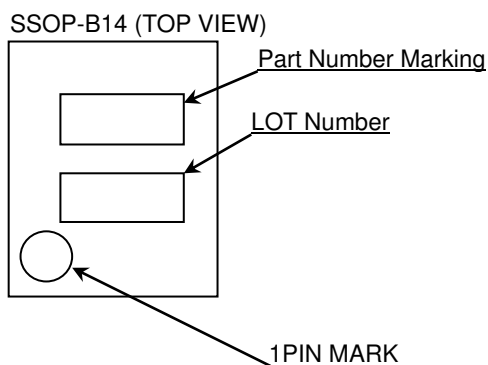
13. Reset Function

The power on reset circuit, which initializes internal settings, may malfunction during abrupt power ons. Therefore, set the time constant so as to satisfy the power source rise time.

Ordering Information



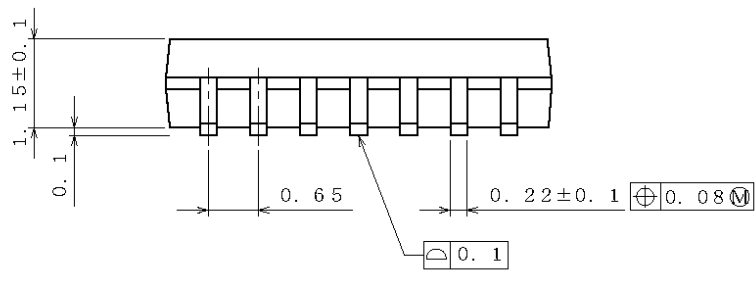
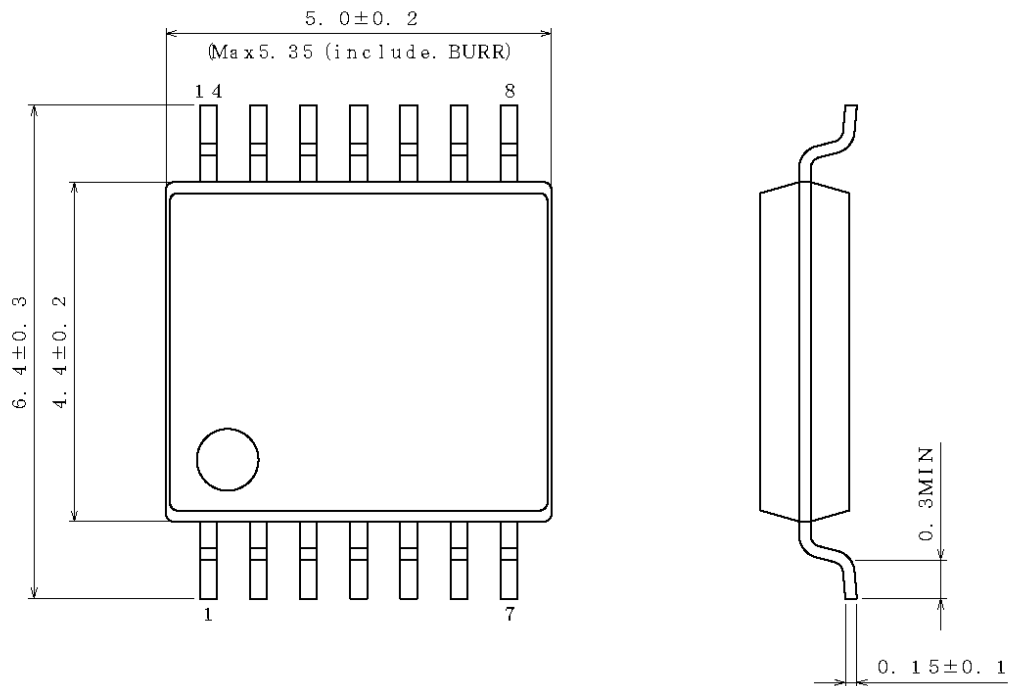
Marking Diagram



Part Number	Part Number Marking
BH2227FV-E2	H2227
BH2228FV-E2	H2228

Physical Dimension, Tape and Reel Information

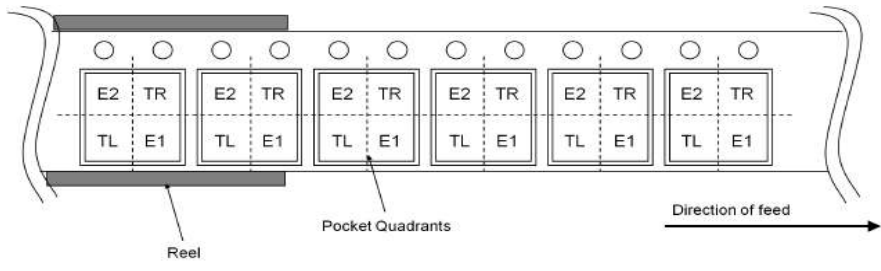
Package Name	SSOP-B14
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(UNIT : mm)  
 PKG : SSOP-B14  
 Drawing No. EX152-5002

< Tape and Reel Information >

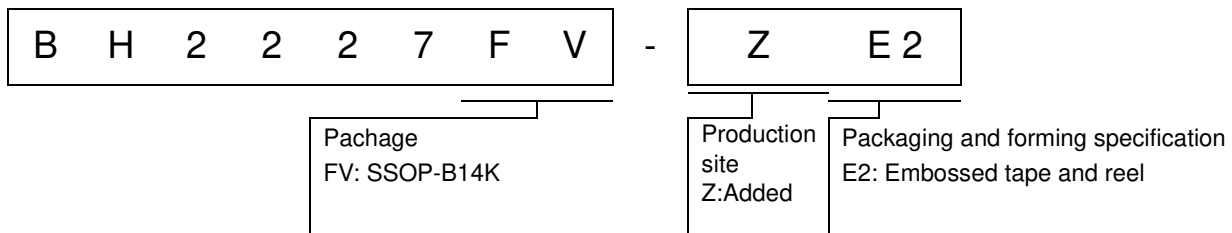
Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 The direction is the pin 1 of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand



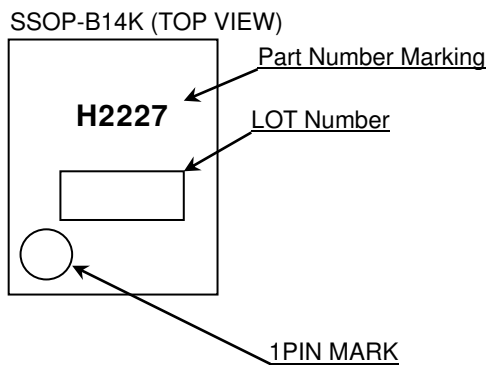
**Revision History**

Date	Revision	Changes
06.Nov.2015	001	New Release
26.May.2021	002	Updated packages and part numbers P.1, P.14-2, P.14-3

Ordering Information

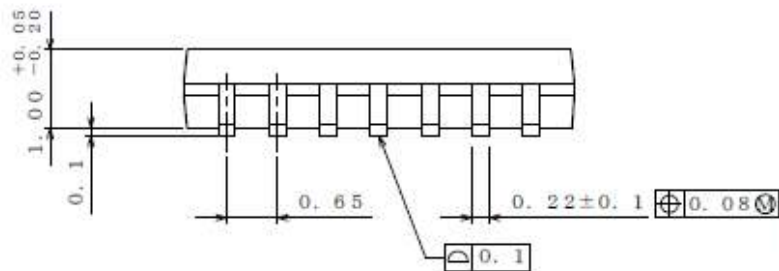
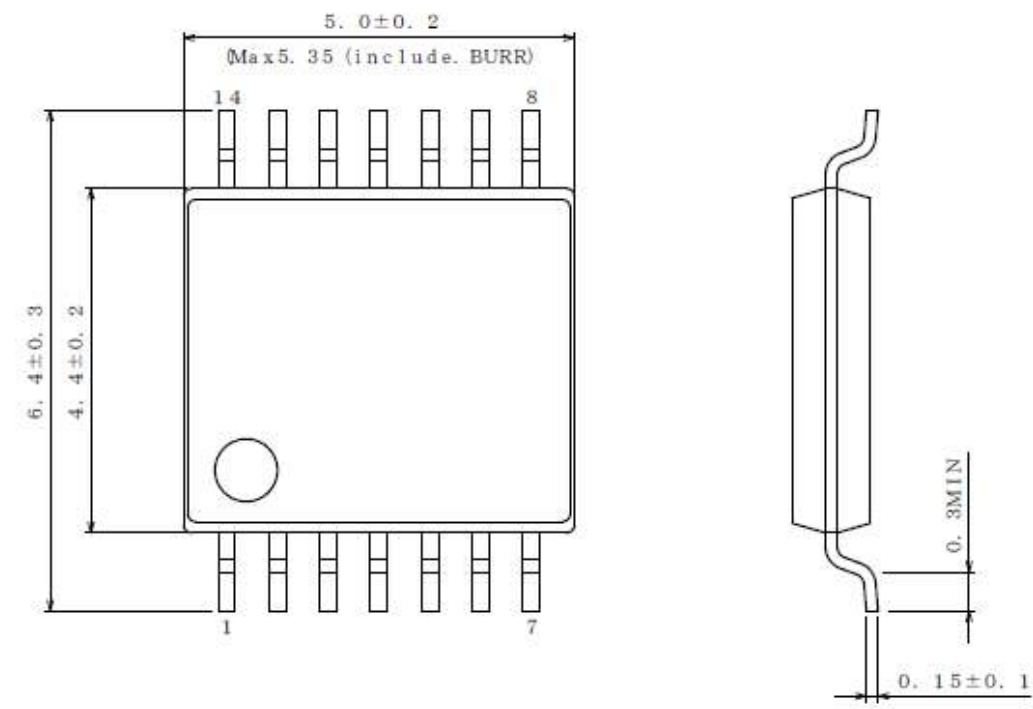


Marking Diagram



Physical Dimension, Tape and Reel Information

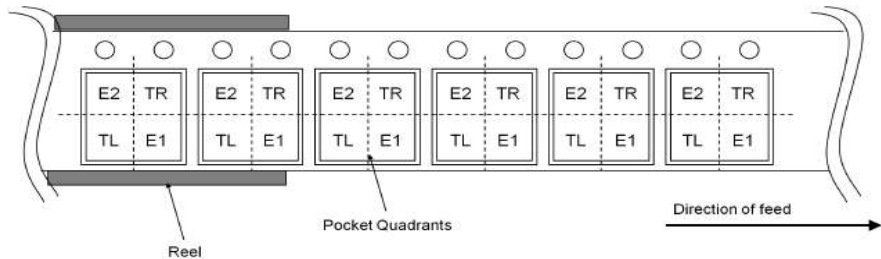
Package Name	SSOP-B14K
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(UNIT : mm)  
 PKG : SSOP-B14K  
 Drawing No. EX001-0104

< 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





# Notice

## Precaution on using ROHM Products

- 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 <sup>(Note 1)</sup>, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

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

- ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
  - Installation of protection circuits or other protective devices to improve system safety
  - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc. prior to use, must be necessary:
  - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - Sealing or coating our Products with resin or other coating materials
  - Use of our Products without cleaning residue of flux (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
  - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

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

For details, please refer to ROHM Mounting specification

### Precautions Regarding Application Examples and External Circuits

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

### Precaution for Electrostatic

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

### Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [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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### Other Precaution

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### 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.
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