

# D/A Converters Standard 8bit 10ch/12ch

BH2223FV BH2221FV

#### **General Description**

BH2223FV and BH2221FV are high performance 8bit R-2R-type D/A converters with 10 and 12 channel outputs, respectively.

A built-in RESET function ensures that the output voltage at all channels is LOW during power up and a broad power supply voltage range (2.7V - 5.5V) provides design flexibility.

#### **Features**

- Built-in RESET function
- High speed output response characteristics
- 3-line serial interface

#### **Applications**

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

#### **Key Specifications**

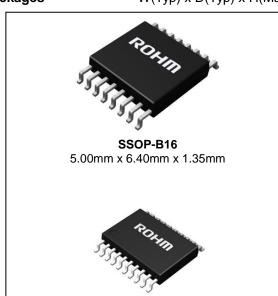
VCC Power Source Voltage Range: 2.7V to 5.5V
 VDD Power Source Voltage Range: 2.7V to V<sub>CC</sub>

Current Consumption:

BH2223FV: 1.1mA(Typ) BH2221FV: 1.6mA(Typ) Differential Non Linearity Error: ±1.0LSB Integral Non Linearity Error: ±1.5LSB Output Current Performance: ±1.0mA Settling Time: 100us(Min) Data Transfer Frequency: 10MHz(Max) Action Temperature Range: -20°C to +85°C

# **Packages**

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



**SSOP-B20** 6.50mm x 6.40mm x 1.45mm

#### Lineup

Number of channels	Input method	Data latch method	Package		Orderable Part Number
10ch	CMOS	I D mosth and	SSOP-B16	Reel of 2500	BH2223FV-E2
12ch	CMOS	LD method	SSOP-B20	Reel of 2500	BH2221FV-E2

## Pin Descriptions / Block Diagrams

(BH2223FV)

(DI 122231	,	
Terminal	Terminal name	Function
1	AO2	
2	AO3	
3	AO4	
4	AO5	Analog output torminal
5	AO6	Analog output terminal
6	AO7	
7	AO8	
8	AO9	
9	VCC	Power source terminal
10	AO10	Analog output terminal
11	NC	Not connected yet
12	LD	Serial data load input terminal
13	CLK	Serial clock input terminal
14	DI	Serial data input terminal
15	AO1	Analog output terminal
16	GND	Ground terminal

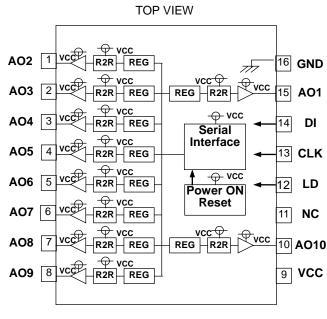


Figure 1. BH2223FV

(BH2221FV)

Terminal	Terminal name	Function		
1	NC	Not connected yet		
2	AO3			
3	AO4			
4	AO5			
5	AO6	Analog output terminal		
6	AO7	Analog output terminal		
7	AO8			
8	AO9			
9	AO10			
10	VDD	D/A converter standard power source terminal		
11	VCC	Power source terminal		
12	AO11	Analog output terminal		
13	AO12	Analog output terminal		
14	NC	Not connected yet		
15	LD	Serial data		
16	CLK	Serial clock input terminal		
17	DI	Serial data input terminal		
18	AO1	Analog output terminal		
19	AO2	Analog output terminal		
20	GND	Ground terminal		

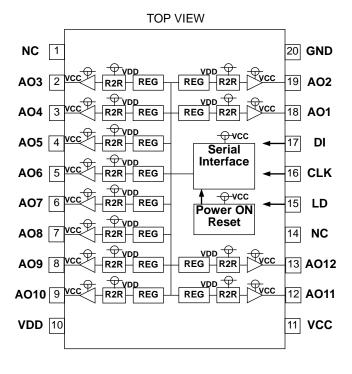


Figure 2. BH2221FV

Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit	Remark
Power Source Voltage	Vcc	-0.3 to +7.0	V	
Terminal Voltage	Vin	-0.3 to Vcc	V	
Storage Temperature Range	Tstg	-55 to +125	°C	
Device Discipation	Dd	0.65 (Note 1)	W	BH2221FV
Power Dissipation	Pd	0.45 (Note 2)	W	BH2223FV

Recommended Operating Conditions (Ta=25°C)

Parameter	Symbol	Rating			Unit	Remark
Farameter		Min	Тур	Max	Offic	Remark
VCC Power Source Voltage	V <sub>CC</sub>	2.7	-	5.5	V	(Note 3)
VDD Power Source Voltage	$V_{DD}$	2.7	-	Vcc	V	(Note 3)
Terminal Input Voltage Range	VIN	0	-	Vcc	V	-
Analog Output Current	Іоит	-1.0	0	+1.0	mA	-
Action Temperature Range	Topr	-20	-	+85	°C	-
Serial Clock Frequency	f <sub>SCLK</sub>	-	1.0	10.0	MHz	-
Limit Load Capacitance	CL	-	-	0.1	μF	-

<sup>(</sup>Note 3) Set the power source voltage so that  $V_{CC} \ge V_{DD}$ .

# **Electrical Characteristics**

(Unless otherwise specified, Vcc=3.0V, VDD=3.0V, RL=OPEN, CL=0pF, Ta=25°C)

Parameter	Symbol		Limit		Unit	Conditions			
Parameter	Symbol	Min	Тур	Max	Offic				
Current Consumption> CLK=1MHz, 80H Setting									
VCC System	Icc	-	0.6	1.5	mA	BH2221FV			
VDD System	I <sub>DD</sub>	-	1.0	2.0	mA	DHZZZ IF V			
VCC System	Icc	-	1.1	2.5	mA	BH2223FV			
<logic interface=""></logic>									
L input Voltage	VIL	GND	-	0.2Vcc	V				
H input Voltage	ViH	0.8Vcc	-	Vcc	V				
Input Current	I <sub>IN</sub>	-10	-	+10	μΑ				
<buffer amplifier=""></buffer>									
Output Zara Saala Valtaga	V <sub>ZS1</sub>	GND	-	0.1	V	00H setting, at no load			
Output Zero Scale Voltage	Vzs2	GND	-	0.3	V	00H setting, I <sub>OH</sub> =1.0mA			
Output Full Scale Voltage	V <sub>FS1</sub>	Vcc-0.1	-	Vcc	V	FFH setting, at no load			
Output Full Scale Voltage	$V_{FS2}$	V <sub>CC</sub> -0.3	-	Vcc	V	FFH Setting, I <sub>OL</sub> =1.0mA			
<d a="" converter="" precision=""></d>									
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			
VCC Power Source Voltage Rise Time	t <sub>rVCC</sub>	100	-	-	μs	V <sub>CC</sub> =0V to 2.7V			
Power ON Reset Release Voltage	$V_{POR}$	-	1.9	-	V				

<sup>(</sup>Note 1) Derated at 6.5mW/°C at Ta>25°C (Note 2) Derated at 4.5mW/°C at Ta>25°C (Soution: 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.

# **Timing Chart**

( $V_{CC}$  = 3.0V,  $V_{DD}$  = 3.0V,  $R_L$  = OPEN,  $C_L$  = 0pF, Ta = 25°C, unless otherwise specified.)

Б	0 1 1	Limit				O EE
Parameter	Symbol	Min	Тур	Max	Unit	Conditions
CLK L Level Time	tclkl	50	-	-	ns	
CLK H Level Time	tclkh	50	-	-	ns	
DI Setup Time	t <sub>sDI</sub>	20	-	-	ns	
DI Hold Time	t <sub>hDI</sub>	40	-	-	ns	
LD Setup Time	t <sub>sLD</sub>	50	-	-	ns	
LD Hold Time	t <sub>hLD</sub>	50	-	-	ns	
LD H Level Time	t <sub>LDH</sub>	50	-	-	ns	
Output Settling Time	tоит	-	-	100	μs	$C_L=50pF, R_L=10k\Omega$

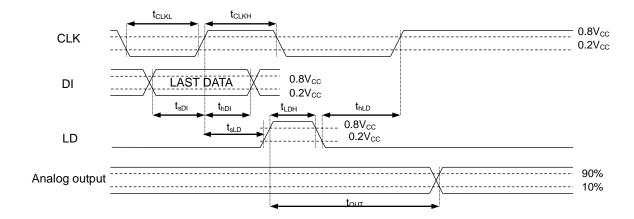


Figure 3

# **Typical Performance Curves**

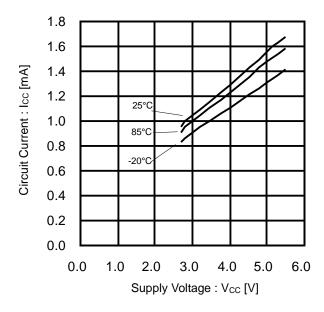


Figure 4. Circuit Current vs Supply Voltage (VCC Active Current Consumption)

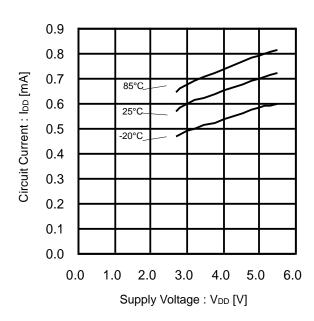


Figure 5. Circuit Current vs Supply Voltage (VDD Active Current Consumption)

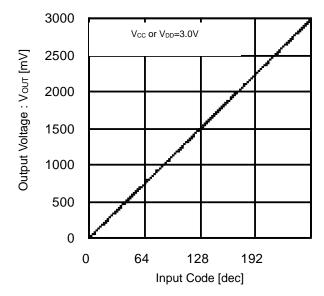


Figure 6. Output Voltage vs Input Code

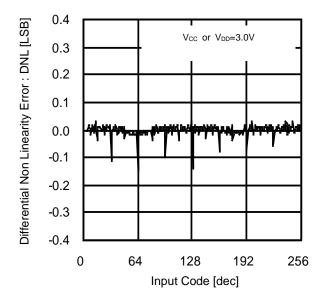


Figure 7. Differential Non Linearity Error vs Input Code

## Typical Performance Curves - continued

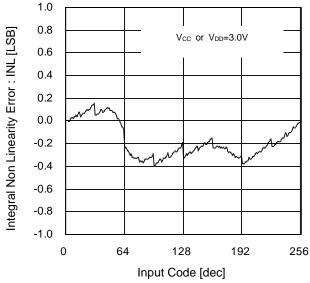


Figure 8. Integral Non Linearity Error vs Input Code

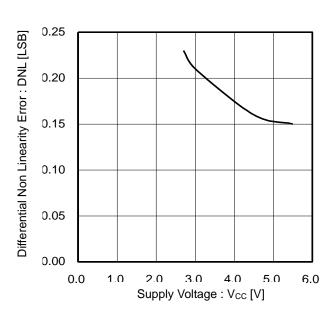


Figure 9. Differential Non Linearity Error vs Supply Voltage

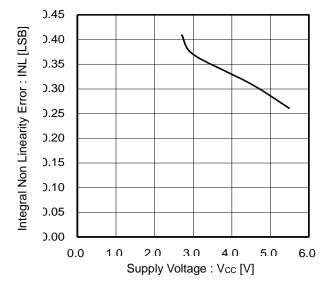


Figure 10. Integral Non Linearity Error vs Supply Voltage

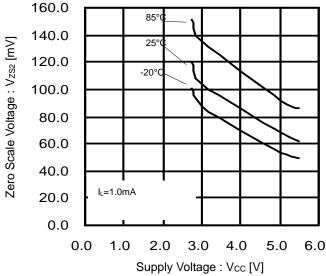


Figure 11. Output Zero Scale Voltage vs Supply Voltage

# Typical Performance Curves - continued

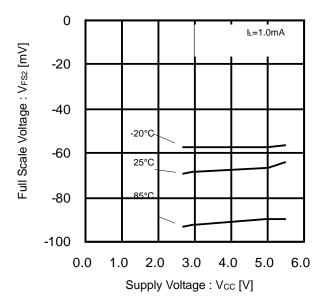


Figure 12. Output Full Scale Voltage vs Supply Voltage

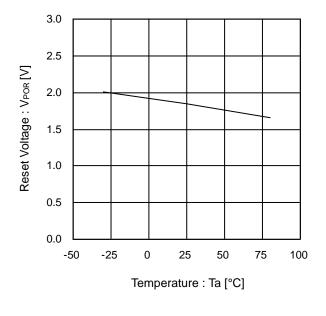


Figure 13. Reset Release Voltage vs Temperature

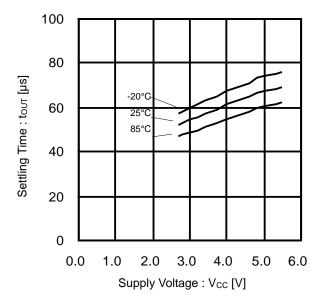


Figure 14. Settling Time vs Supply Voltage

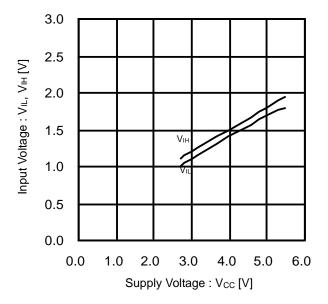


Figure 15. Input Voltage vs Supply Voltage

# **Application Information**

#### **Operation Description**

The Serial Control Interface is 3-line serial interface 1) LD, 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. That should be while LD is LOW. Last 12 bits of data are latched while LD is HIGH.

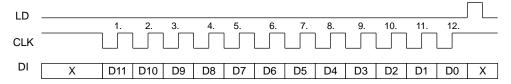


Figure 16

**Data Settings** 

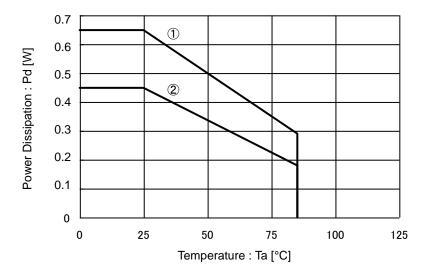
D0	D1	D3	D3	D4	D5	D6	D7	Setting
0	0	0	0	0	0	0	0	GND
1	0	0	0	0	0	0	0	(Vcc or V <sub>DD</sub> -GND)/256x1
0	1	0	0	0	0	0	0	(Vcc or V <sub>DD</sub> -GND)/256x2
1	1	0	0	0	0	0	0	(Vcc or V <sub>DD</sub> -GND)/256x3
0	0	1	0	0	0	0	0	(V <sub>CC</sub> or V <sub>DD</sub> -GND)/256x4
0	1	1	1	1	1	1	1	(V <sub>CC</sub>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

**Channel Settings** 

D8	D9	D10	D11	BH2223FV	BH2221FV
0	0	0	0	Not used	Not used
0	0	0	1	AO1	AO1
0	0	1	0	AO2	AO2
0	0	1	1	AO3	AO3
0	1	0	0	AO4	AO4
0	1	0	1	AO5	AO5
0	1	1	0	AO6	AO6
0	1	1	1	AO7	AO7
1	0	0	0	AO8	AO8
1	0	0	1	AO9	AO9
1	0	1	0	AO10	AO10
1	0	1	1	Not used	AO11
1	1	0	0	Not used	AO12
1	1	0	1	Not used	Not used
1	1	1	0	Not used	Not used
1	1	1	1	Not used	Not used

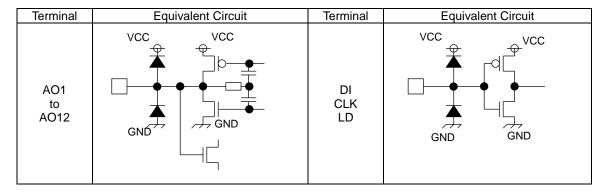
# **Power Dissipation**

- ① SSOP-B20(BH2221FV)
- ② SSOP-B16(BH2223FV)



Mounted on a 70mm x 70mm x 1.6mm FR4 glass epoxy board (copper foil area 3% or below)

# I/O Equivalent Circuit



#### **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.

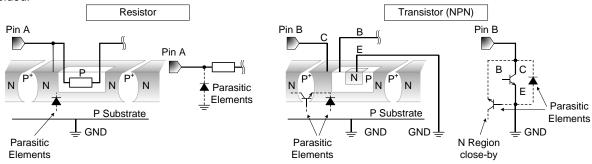
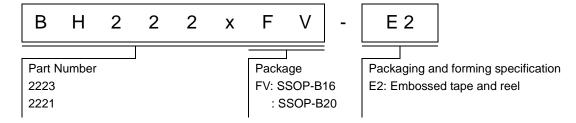


Figure 17. Example of monolithic IC structure

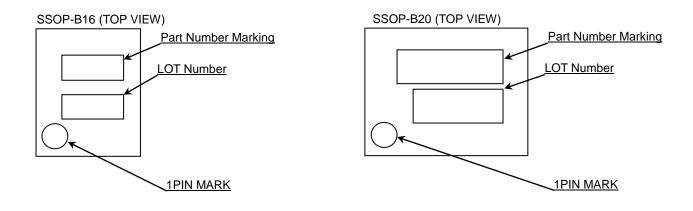
#### 13. Reset Function

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.

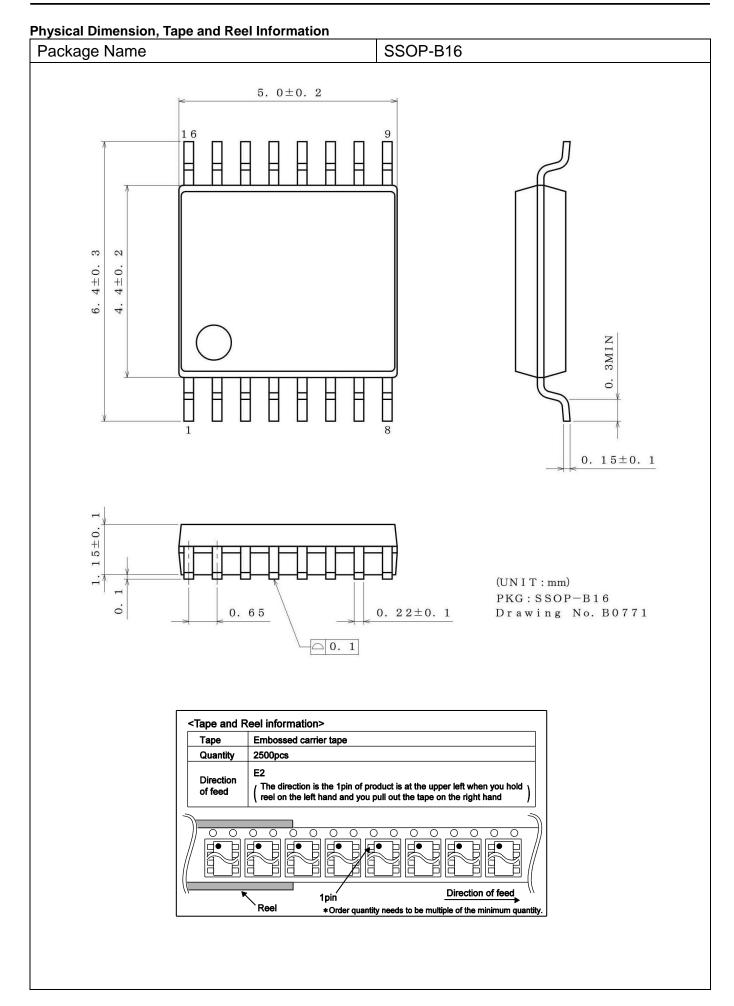
# **Ordering Information**

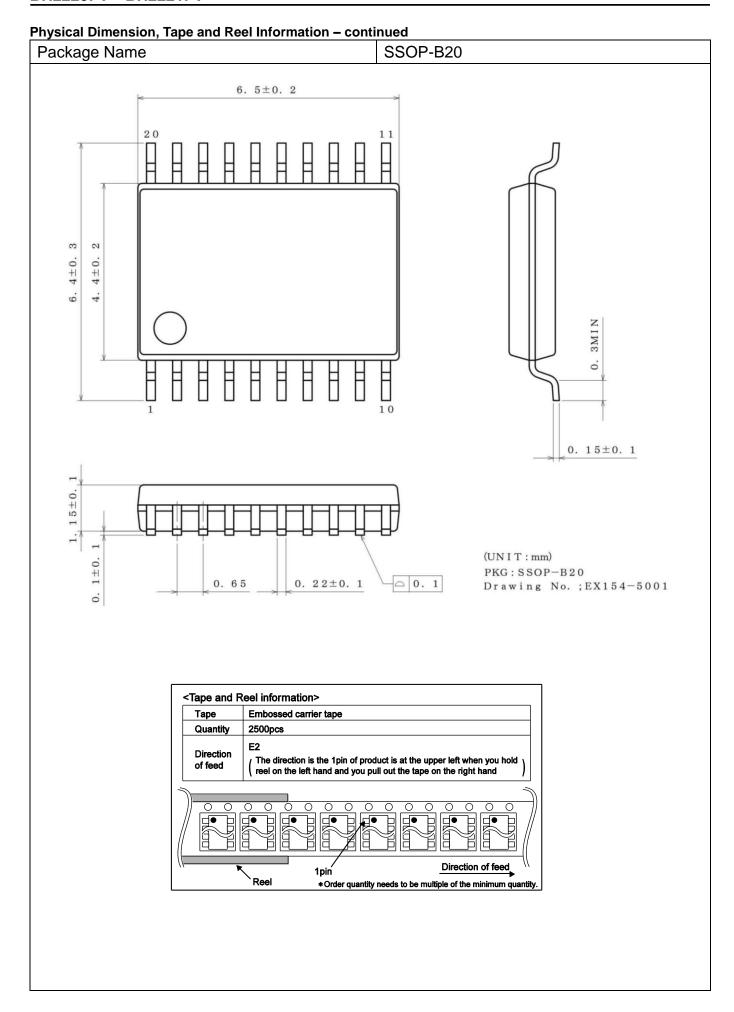


# **Marking Diagrams**



Part Number	Part Number Marking		
BH2223FV-E2	H2223		
BH2221FV-E2	H2221FV		





# **Revision History**

Date	Revision	Changes
06.Nov.2015	001	New Release

# **Notice**

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JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASS II b	CL A C C TT
CLASSIV	CLASSIII	CLASSⅢ	CLASSIII

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  - [c] 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>
  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [h] Use of the Products in places subject to dew condensation
- 4. The Products are not subject to radiation-proof design.
- 5. Please verify and confirm characteristics of the final or mounted products in using the Products.
- 6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- 7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
- 8. Confirm that operation temperature is within the specified range described in the product specification.
- 9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

#### Precaution for Mounting / Circuit board design

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

For details, please refer to ROHM Mounting specification

#### **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.
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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 lonizer, friction prevention and temperature / humidity control).

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  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
- 2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
- 3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
- 4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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