Switching Regulator ICs with Built-in FET (5V)

BD9639MWV

General Description

BD9639MWV is a 6-channel system switching regulator IC with built-in FET and error amplifier phase compensation for DSC/DVC applications. The built-in regulators consisting of 2ch Buck-Boost, 2ch Buck and 2ch Boost circuits operate at high efficiency.

Features

- 6CH DC/DC converter
  - CH1 Boost FET embedded Start-up ch,Motor
  - CH2 Buck FET embedded Core
  - CH3 Buck-Boost FET embedded CMOS
  - CH4 Buck-Boost FET embedded Digital
  - CH5 Buck FET embedded CMOS, Memory
  - CH6 Boost FET embedded LED
- Low voltage operation 2.5[V]
- CH1 supply voltage output for internal circuit
- CH1 PWM / PFM selectable
- CH3-CH4 Boost-Buck auto switching
- CH6 integrated Boost output shutdown (Load switch embedded)
- Soft-start correspondence to each channel
- Built-in ground short protection function (CH2 to CH6)
- Built-in error amp phase compensation (CH1 to CH6)
- Operating frequency 1.5[MHz] (CH1 to CH6)

Applications

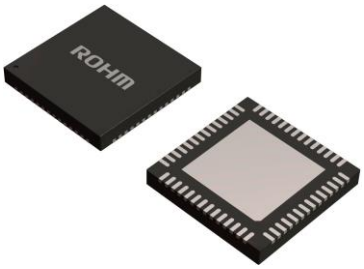
DSC/DVC

Key Specifications

- Input Supply Voltage Range: 2.5V to 5.5V
- Oscillating Frequency 1: 1.5 MHz(Typ)
- ON-Resistance: Refer to Electrical Characteristics
- Shutdown Current Consumption: 0μA(Typ)
- Operating Temperature Range: -20°C to +85°C

Package

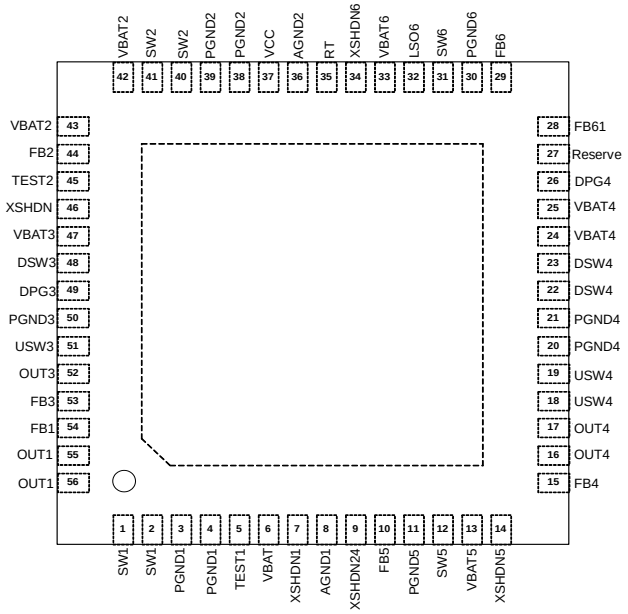
W(Typ) x D(Typ) x H(Max)



UQFN056V7070
7.00mm x 7.00mm x 1.00mm

Pin Configuration

TOP VIEW



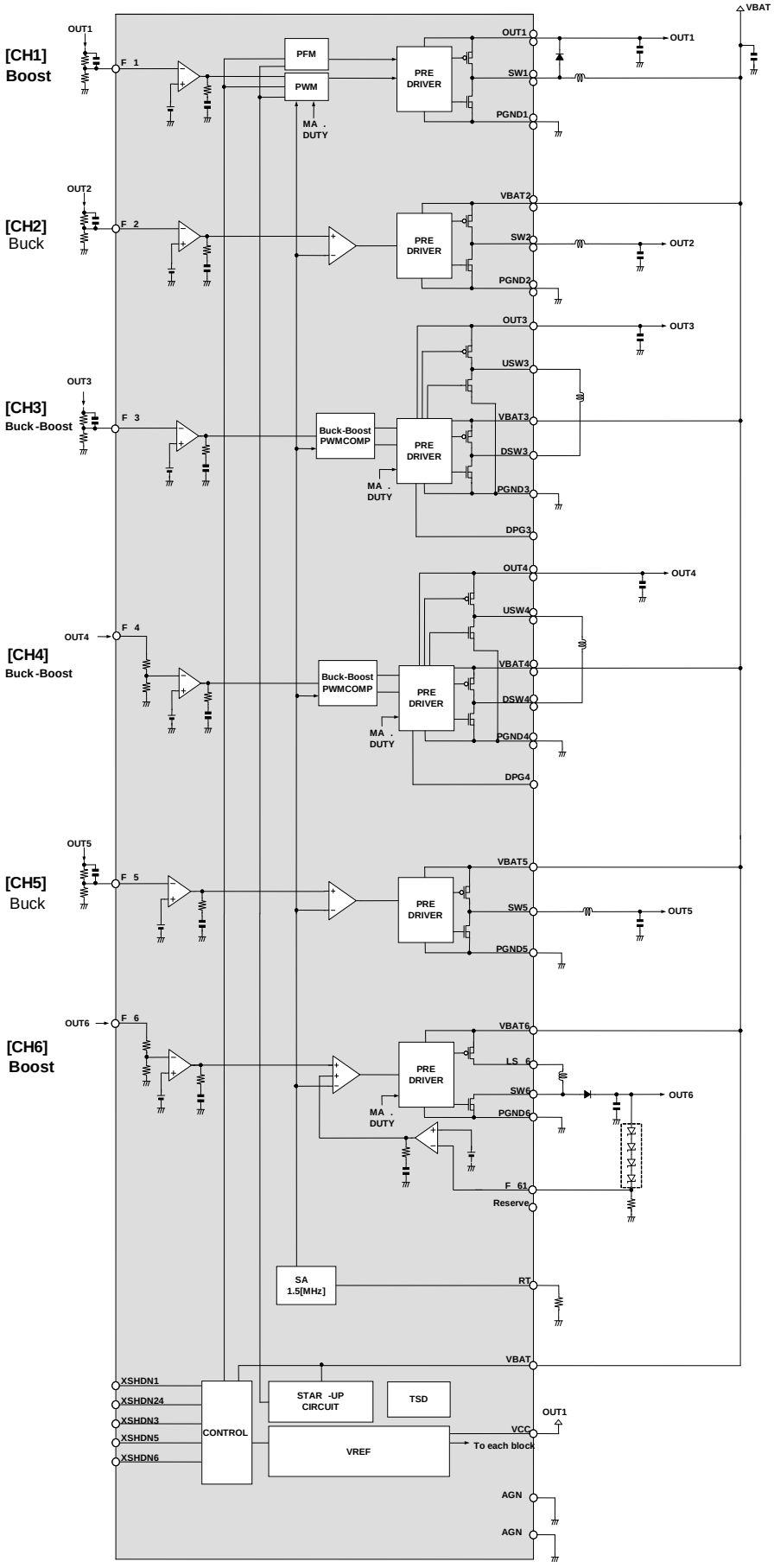
Pin Descriptions

Terminal No.	Name	Equivalent Circuit	
1	SW1	CH1 switching terminal	O
2	SW1	CH1 switching terminal	O
3	PGND1	CH1 DRIVER GND terminal	G
4	PGND1	CH1 DRIVER GND terminal	G
5	TEST1	Test terminal	O･G
6	VBAT	Battery input terminal	V
7	XSHDN1	CH1 shutdown terminal	G
8	AGND1	Analog GND terminal	G
9	XSHDN24	CH2･ 4 shutdown terminal	O･G
10	FB5	CH5 feed buck terminal	G
11	PGND5	CH5 DRIVER GND terminal	G
12	SW5	CH5 switching terminal	O
13	VBAT5	CH5 DRIVER power supply terminal	V
14	XSHDN5	CH5 shutdown terminal	O･G
15	FB4	CH4 feed buck terminal	G
16	OUT4	CH4 output terminal	O
17	OUT4	CH4 output terminal	O
18	USW4	CH4 Boost side switching terminal	O
19	USW4	CH4 Boost side switching terminal	O
20	PGND4	CH4 DRIVER GND terminal	G
21	PGND4	CH4 DRIVER GND terminal	G
22	DSW4	CH4 Buck side switching terminal	O
23	DSW4	CH4 Buck side switching terminal	O
24	VBAT4	CH4 DRIVER power supply terminal	V
25	VBAT4	CH4 DRIVER power supply terminal	V
26	DPG4	CH4 gate connecting terminal	O
27	Reserve	Reserve terminal	O･G
28	FB61	CH6 feed buck terminal (Constant current side)	G

Terminal No.	Name	Equivalent Circuit	
29	FB6	CH6 feed buck terminal (Constant voltage side)	G
30	PGND6	CH6 DRIVER GND terminal	G
31	SW6	CH6 switching terminal	O
32	LSO6	CH6 Load switch output terminal	O
33	VBAT6	CH6 Load switch input terminal	V
34	XSHDN6	CH6 shutdown terminal	O･G
35	RT	Triangle wave setting resistor terminal	
36	AGND2	Analog GND terminal	G
37	VCC	Analog power supply terminal	V
38	PGND2	CH2 DRIVER GND terminal	G
39	PGND2	CH2 DRIVER GND terminal	G
40	SW2	CH2 switching terminal	O
41	SW2	CH2 switching terminal	O
42	VBAT2	CH2 DRIVER power supply terminal	V
43	VBAT2	CH2 DRIVER power supply terminal	V
44	FB2	CH2 feed buck terminal	G
45	TEST2	Test terminal	O･G
46	XSHDN3	CH3 shutdown terminal	O･G
47	VBAT3	CH3 DRIVER power supply terminal	V
48	DSW3	CH3 Buck side switching terminal	O
49	DPG3	CH3 gate connecting terminal	O
50	PGND3	CH3 DRIVER GND terminal	G
51	USW3	CH3 Boost side switching terminal	O
52	OUT3	CH3 output terminal	O
53	FB3	CH3 feed buck terminal	G
54	FB1	CH1 feed buck terminal	G
55	OUT1	CH1 output terminal	O
56	OUT1	CH1 output terminal	O

The letter on the right side of each pin explanation indicates the reaction if the terminal are not used.
O・・・OPEN G・・・GND O･G・・・OPEN or GND V・・・Power supply (VBAT)

Block Diagram



Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply Voltage Permissible Voltage	V_{VBAT}	-0.3 to +7	V
	V_{VBAT2}		
	V_{VBAT3}		
	V_{VBAT4}		
	V_{VBAT5}		
	V_{VBAT6}		
SW6 Permissible Voltage	V_{SW6}	24.0	V
OUT1 Permissible Current Output	I_{OUT1}	1.0	A
SW1 Permissible Current Output	I_{SW1}	1.0	A
SW2 Permissible Current Output	I_{SW2}	2.0	A
OUT3 Permissible Current Output	I_{OUT3}	1.0	A
DSW3 Permissible Current Output	I_{DSW3}	1.0	A
USW3 Permissible Current Output	I_{USW3}	1.0	A
OUT4 Permissible Current Output	I_{OUT4}	1.0	A
DSW4 Permissible Current Output	I_{DSW4}	1.0	A
USW4 Permissible Current Output	I_{USW4}	1.0	A
SW5 Permissible Current Output	I_{SW5}	1.0	A
SW6 Permissible Current Output	I_{SW6}	0.2	A
Power Dissipation	Pd	4.83 (Note 1)	W
Operating Temperature Range	Topr	-20 to +85	°C
Storage Temperature Range	Tstg	-55 to +150	°C
Junction Temperature	Tjmax	+150	°C

(Note 1) Implemented on Glass epoxy board (ROHM standard board : 74.2 x 74.2 x 1.6[mm^3] 4 layers(Copper foil : 5502 m^2)
Power dissipation depends on the mounted wiring pattern.

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

Parameter	Symbol	Limit			Unit
		Min	Typ	Max	
VBAT Supply Voltage	V_{VBAT}	2.5	3.7	5.5	V
	V_{VBAT2}	2.5	3.7	5.5	V
	V_{VBAT3}	2.5	3.7	5.5	V
	V_{VBAT4}	2.5	3.7	5.5	V
	V_{VBAT5}	2.5	3.7	5.5	V
	V_{VBAT6}	2.5	3.7	5.5	V

Electrical Characteristics

(Unless otherwise specified, V_{VBAT}=$V_{VBAT2,3,4,5,6}$=3.7[V], VCC input terminal =3.7[V], Ta=25[°C])

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Current Consumption (PFM)	I_{CC1}	-	72	150	μA	・ XSHDN1=H, XSHDN24=L ・ Without load on each channel ・ V_{FB1}=0.5[V] ・ sum of VBAT terminal, and OUT1 terminal
Current Consumption (PWM)	I_{CC2}	1.57	2.35	3.53	mA	・ XSHDN1=H, XSHDN24=H, TEST1=H ・ V_{FB1}=0.5[V] ・ Sum of VBAT terminal, and OUT1 terminal
Shutdown Current Consumption	I_{CC3}	-	0	10	μA	・ All setting terminal=L ・ Sum of VBAT terminal, and OUT1 terminal
H Input Voltage 1	V_{IH1}	V_{VBAT} -0.3	-	-	V	XSHDN1
L Input Voltage 1	V_{IL1}	-	-	GND +0.3	V	
H Input Voltage 2	V_{IH3}	2.5	-	-	V	XSHDN24, XSHDN3, XSHDN5, XSHDN6
L Input Voltage 2	V_{IL3}	-	-	GND +0.3	V	
H Input Current 1	I_{IH1}	4.63	9.25	18.5	μA	Input voltage =3.7[V] XSHDN24, XSHDN3, XSHDN5, XSHDN6
Oscillating Frequency 1	f_{OSC1}	1.2	1.5	1.8	MHz	R_{RT}=10[kΩ]
Reduced-voltage Detection Voltage	V_{UVLO1}	1.75	1.95	2.15	V	
Reduced-voltage Return Voltage	V_{UVLO2}	1.95	2.15	2.35	V	
【CH1】						
Soft-start Period 85%	t_{SS1}	310	620	930	μs	Soft-start period 100% 730[μs](Typ) XSHDN24=L
Error Amp Reference Voltage	V_{EREF1}	0.388	0.400	0.412	V	XSHDN24=H
PMOS ON-Resistance	R_{ONP1}	-	0.24	0.38	Ω	Power supply 3.7[V]
NMOS ON-Resistance	R_{ONN1}	-	0.14	0.23	Ω	Power supply 3.7[V]
Maximum Duty	DMAX1	76.5	85.0	93.5	%	XSHDN24=H
【CH2】						
Error Amp Reference Voltage	V_{EREF2}	0.390	0.400	0.410	V	
Soft-start Period 85%	t_{SS2}	0.43	0.85	1.27	ms	Soft-start period 100% 1.0[ms](Typ)
PMOS ON-Resistance	R_{ONP2}	-	0.13	0.21	Ω	Power supply 3.7[V]
NMOS ON-Resistance	R_{ONN2}	-	0.08	0.14	Ω	Power supply 3.7[V]

Electrical Characteristics –continued

(Unless otherwise specified, V_{VBAT}=$V_{VBAT2,3,4,5,6}$=3.7[V], VCC input terminal =3.7[V], Ta=25[°C])

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
【CH3】						
Error Amp Reference Voltage	V_{EREF3}	0.390	0.400	0.410	V	
Soft-start Period 85%	t_{SS3}	0.85	1.70	2.55	ms	Soft-start period 100% 2.0[ms](Typ)
PMOS ON-Resistance DOWN Side	R_{ONPD3}	-	0.24	0.39	Ω	Power supply 3.7[V]
NMOS ON-Resistance DOWN Side	R_{ONND3}	-	0.25	0.40	Ω	Power supply 3.7[V]
PMOS ON-Resistance UP Side	R_{ONPU3}	-	0.26	0.42	Ω	Power supply 3.7[V]
NMOS ON-Resistance UP Side	R_{ONNU3}	-	0.16	0.27	Ω	Power supply 3.7[V]
Maximum Duty	DMAX3	65	80	95	%	
【CH4】						
Error Amp Reference Voltage	V_{EREF4}	0.390	0.400	0.410	V	
Soft-start Period 85%	t_{SS4}	1.28	2.55	3.83	ms	Soft-start period 100% 3.0[ms](Typ)
PMOS ON-Resistance DOWN Side	R_{ONPD4}	-	0.16	0.26	Ω	Power supply 3.7[V]
NMOS ON-Resistance DOWN Side	R_{ONND4}	-	0.21	0.33	Ω	Power supply 3.7[V]
PMOS ON-Resistance UP Side	R_{ONPU4}	-	0.24	0.38	Ω	Power supply 3.7[V]
NMOS ON-Resistance UP Side	R_{ONNU4}	-	0.16	0.26	Ω	Power supply 3.7[V]
Maximum Duty	DMAX4	65	80	95	%	
【CH5】						
Error Amp Reference Voltage	V_{EREF5}	0.390	0.400	0.410	V	
Soft-start Period 85%	t_{SS5}	0.85	1.70	2.55	ms	Soft-start period 100% 2.0[ms](Typ)
PMOS ON-Resistance	R_{ONP5}	-	0.26	0.42	Ω	Power supply 3.7[V]
NMOS ON-Resistance	R_{ONN5}	-	0.17	0.28	Ω	Power supply 3.7[V]
【CH6】						
Error Amp Reference Voltage 1	V_{EREF6}	0.380	0.400	0.420	V	Constant voltage control side
Error Amp Reference Voltage 2	$V_{EREF6.1}$	0.380	0.400	0.420	V	Constant current control side
Soft-start Period 85%	t_{SS6}	2.55	5.10	7.65	ms	Soft-start period 100% 6.0[ms](Typ)
Load Switching ON-Resistance	R_{ONP6}	-	0.23	0.37	Ω	Power supply 3.7[V]
NMOS ON-Resistance	R_{ONN6}	-	0.47	0.73	Ω	Power supply 3.7[V]
Maximum Duty	DMAX6	83	90	97	%	

Application Information

1. Function Description

(1) Features Summary

CH	Function	Output voltage	Power output	Setting res.	USE
CH1	Boost converter	3.70[V] to 5.50[V]	Embedded	External	Start-up CH, Motor
CH2	Buck converter	1.05[V] to 1.80[V]	Embedded	External	Core
CH3	H-BRIDGE converter	1.80[V] to 3.30[V]	Embedded	External	CMOS
CH4	H-BRIDGE converter	3.25[V]	Embedded	Embedded	Digital
CH5	Buck converter	1.50[V] to 1.80[V]	Embedded	External	CMOS, Memory
CH6	Boost converter	2 LED to 6 LED	Embedded	External	LED

(2) CONTROL

(a) Stand-by function related terminals

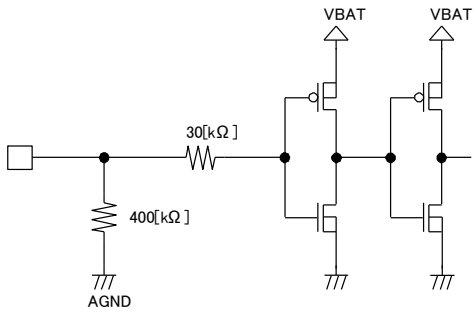
Following table shows start-up condition of each block.

XSHDN1	XSHDN24	XSHDN3	XSHDN5	XSHDN6	CH1 PFM	CH1 PWM	Internal supply	CH2 CH4	CH3	CH5	CH6
L	-	-	-	-	OFF	OFF	OFF	OFF	OFF	OFF	OFF
H	L				ON						
	H	L	L	L	OFF	ON	ON	ON			
		H	L	L					ON		
		L	H						OFF	ON	
			L	H						OFF	ON

(Note) - symbol mean without conditions.

(b) Other setting terminals

(c) XSHDN24 to XSHDN6 terminal equivalent circuit



XSHDN1 terminal does not have a pull down.
it is necessary to process the VBAT input and the GND input.

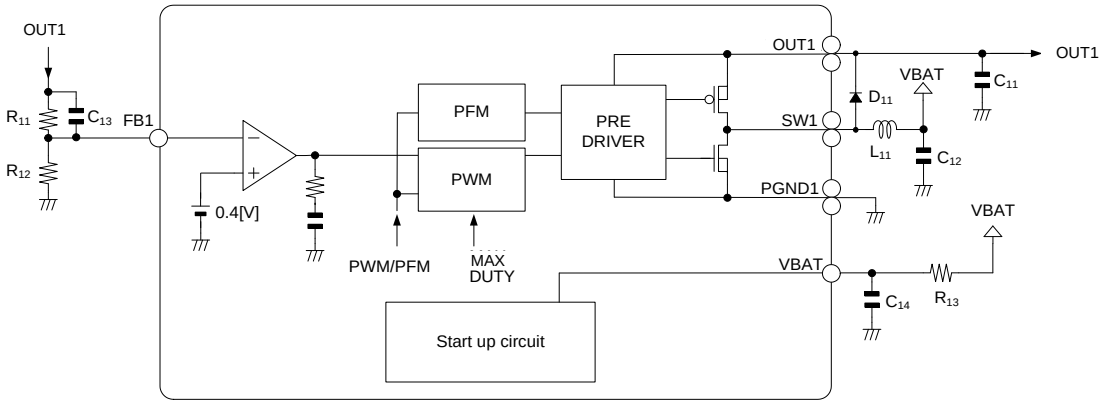
(3) Start-up Circuit

CH1 begins operating using PFM when XSHDN1 goes “HIGH”.
Afterwards, when XSHDN24 goes “HIGH” an internal power supply turns ON and CH1 starts operating using PWM. From the time XSHDN24 goes “HIGH”, CH2 to CH6 enters standby mode for about 5 ms after which CH2 and CH4 begin a soft start. Similarly, when XSHDN24 to XSHDN6 goes High synchronously, CH2 to CH6 starts soft-start after the normal wait time.

(4) CH1

(a) Function

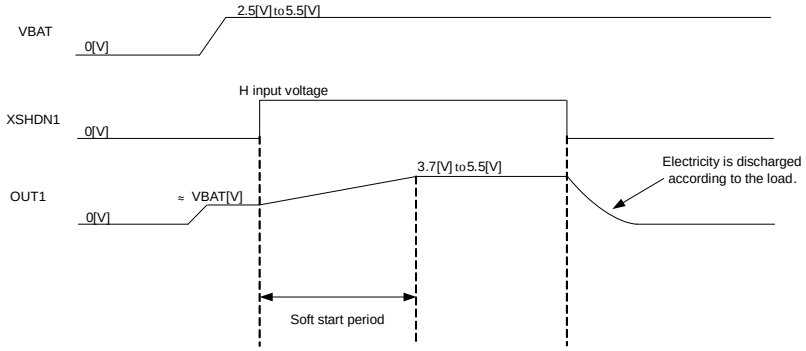
Selectable PWM/PFM boost DC/DC converter.
Output voltage is ranges from 3.7[V] to 5.5[V].
Low voltage operation starts up from 2.5[V] and also provides supply voltage to VREF circuit.



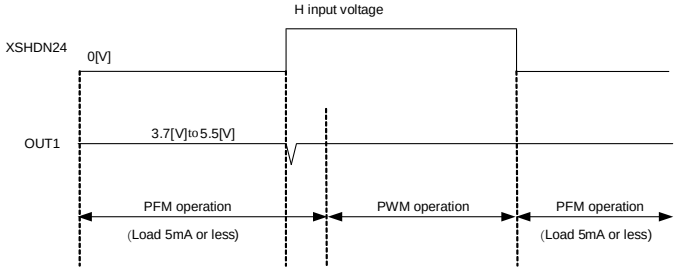
(b) Recommended External Components (At the time of setting when V_{OUT1}=5.0V)

Parts Name	Value	Maker	Part Number
R_{11}	620[kΩ] +24[kΩ]	-	-
R_{12}	56[kΩ]	-	-
R_{13}	10[Ω]	-	-
C_{11}	22[µF] (x2)	Taiyo Yuden	JMK212BJ226MG
C_{12}	10[µF]	Taiyo Yuden	JMK212BJ106KG
C_{13}	100[pF]	Taiyo Yuden	UMK1005CH101JV
C_{14}	1[µF]	Taiyo Yuden	JMK105BJ105KV
L_{11}	2.2[µH]	Taiyo Yuden	NR4018T2R2N
D_{11}	-	ROHM	RB060M-30

(c) Start-up Sequence



(d) PWM/PFM

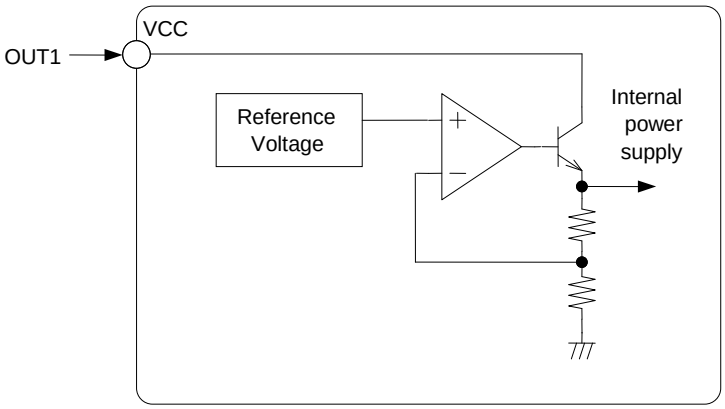


Select PWM/PFM (operation of XSHDN=HIGH and XSHDN24) with light load (10mA or less).

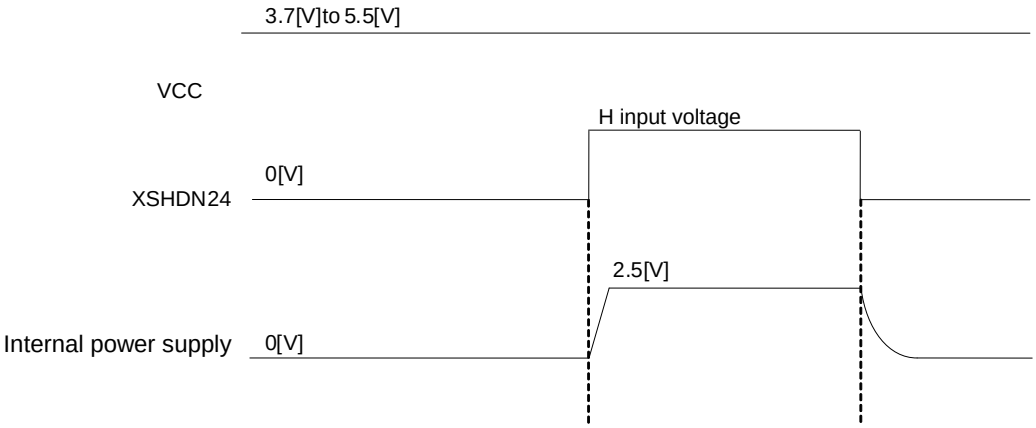
(5) Internal Supply Voltage

(a) Function

Regulator input voltage is supplied by OUT1.
Output voltage is 2.5[V] is not available outside the chip and is used only to power up internal circuit.
This internal supply is used during PWM mode when both XSHDN1 and XSHDN24 are “HIGH”.



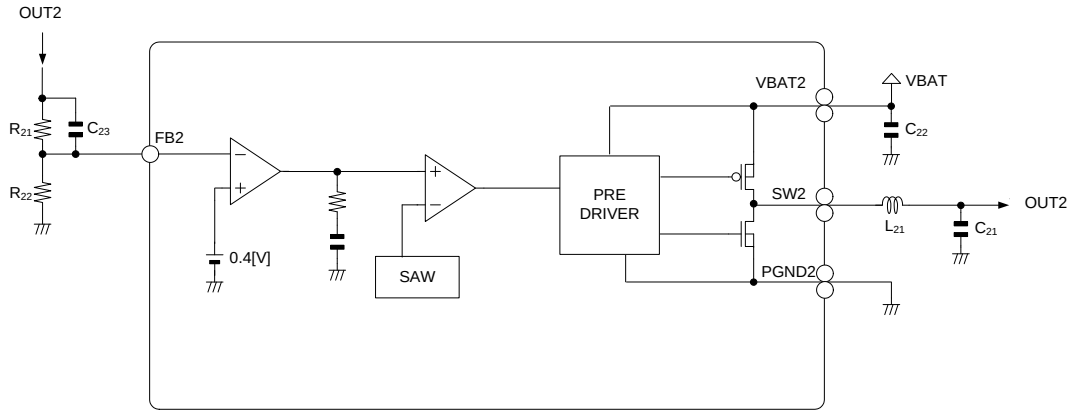
(b) Start-up Sequence



(6) CH2

(a) Function

Synchronous rectification buck DC/DC converter with built in power MOS output stage.
Output voltage ranges from 1.05[V] to 1.80[V].

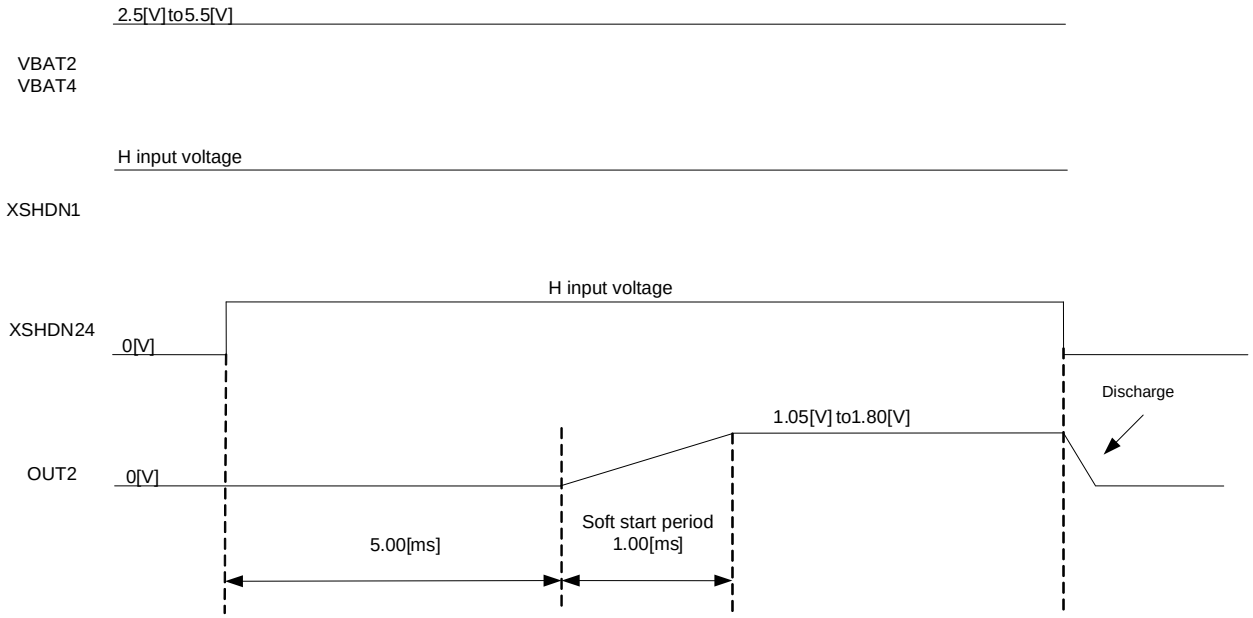


(b) Recommended External Components

Parts name	Value	Maker	Part number
R_{21}	Refer to right table	-	-
R_{22}	Refer to right table	-	-
C_{21}	22[µF]	Taiyo Yuden	JMK212BJ226MG
C_{22}	10[µF]	Taiyo Yuden	JMK212BJ106KG
C_{23}	33[pF]	Taiyo Yuden	UMK105CH330JV
L_{21}	2.0[µH]	TOKO	A915AY-2R0M

OUT2 / Set external	1.1[V]	1.2[V]
R_{21}	100[kΩ]	100[kΩ]
R_{22}	56[kΩ] + 1.1[kΩ]	20[kΩ] + 30[kΩ]

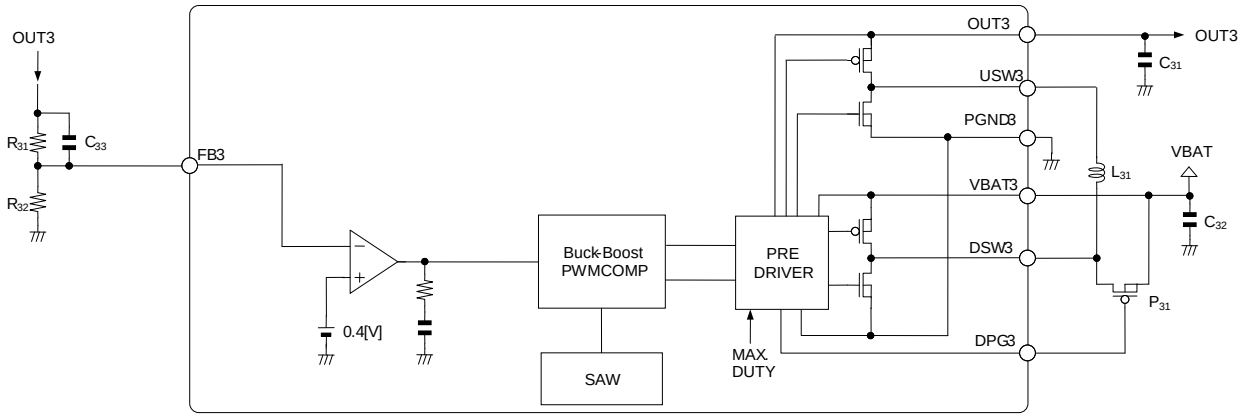
(c) Start-up Sequence



(7) CH3

(a) Function

Synchronous rectification cross converter with built-in power MOS output stage.
Output voltage ranges from 1.80[V] to 2.80[V].

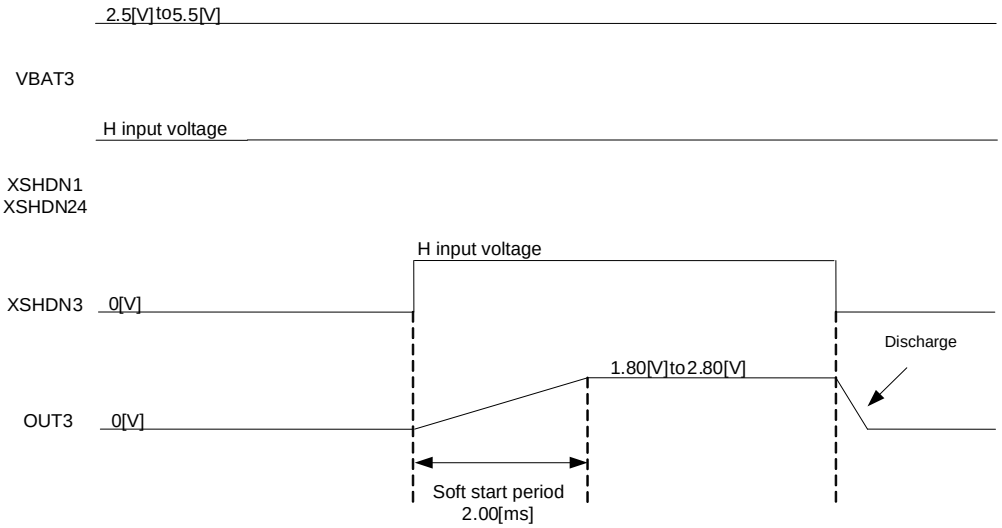


(b) Recommended External Components

Parts Name	Value	Maker	Part Number
R_{31}	Refer to right table	-	-
R_{32}	Refer to right table	-	-
C_{31}	22[µF]	Taiyo Yuden	JMK212BJ226MG
C_{32}	10[µF]	Taiyo Yuden	JMK212BJ106KG
C_{33}	100[pF]	Taiyo Yuden	UMK105CH101JV
L_{31}	4.7[µH]	Taiyo Yuden	NR3015T4R7M
P_{31}	-	ROHM	RW1A020ZP

OUT3 / Set external	1.80[V]	2.80[V]
R_{31}	100[kΩ]	100[kΩ]
R_{32}	27[kΩ] + 1.6[kΩ]	12[kΩ] + 4.7[kΩ]

(c) Start-up Sequence



(Note) When V_{OUT}=1.8[V], if OUT3・USW3 are not used (These terminals are only for Buck condition), Discharge function is not activated.

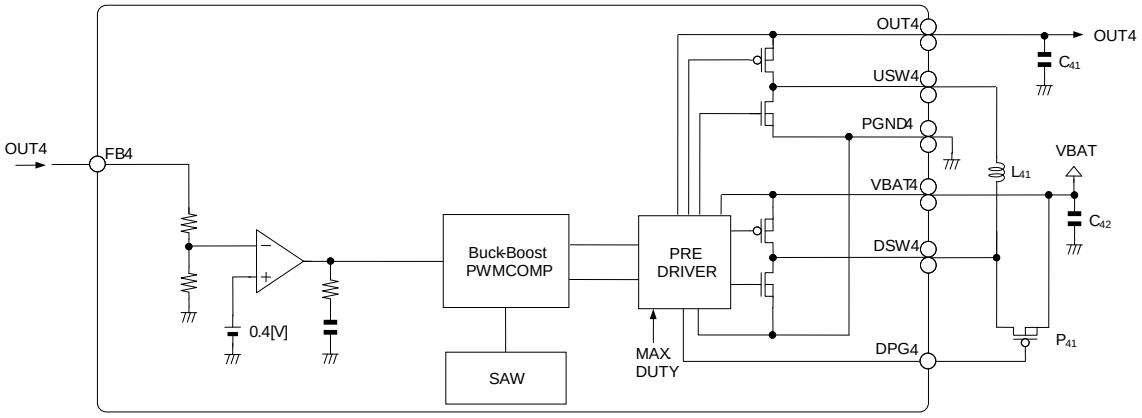
(d) DPG3

The DPG3 output terminal is a gating signal to an external PMOS inserted between VBAT3 and DSW3.
If the V_{VBAT} voltage becomes lower than 2.85[V], DPG3 becomes Low and an external PMOS turns ON.
The over-current can still electrify even if the voltage descend.

(8) CH4

(a) Function

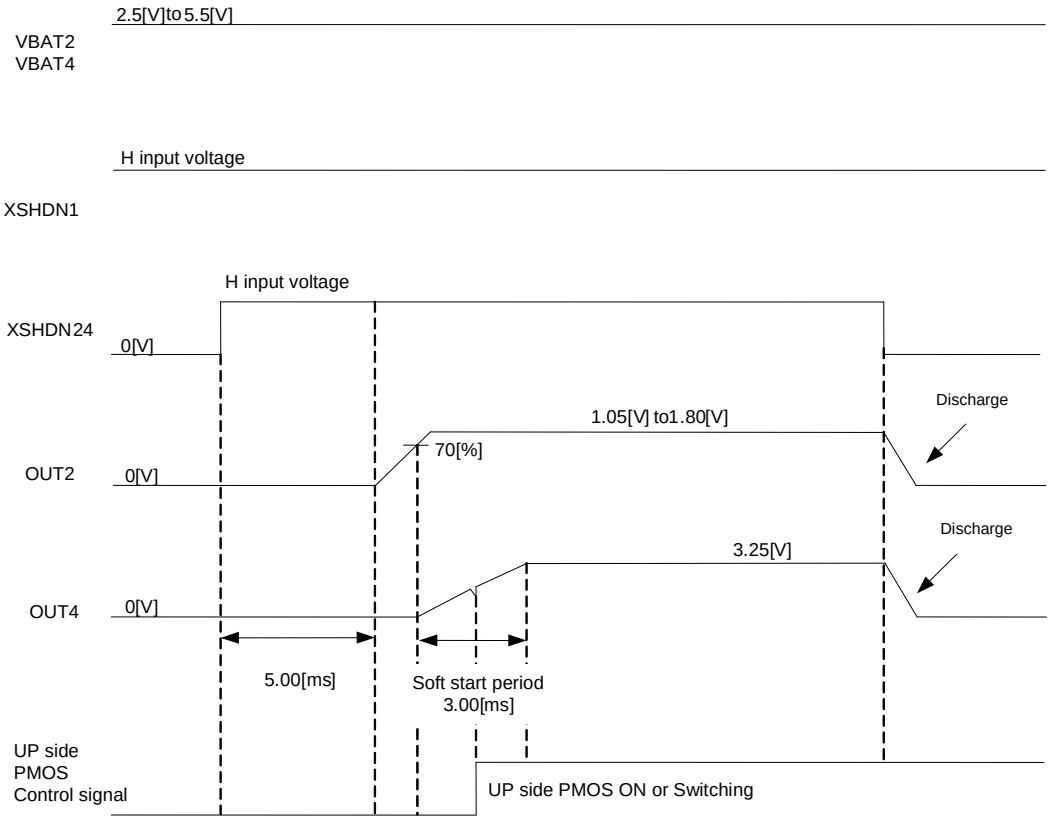
Synchronous rectification cross converter with built-in power MOS output stage.
The output voltage is fixed at 3.25V.



(b) Recommended External Components

Parts name	Value	Maker	Part number
C_{41}	22[µF]	Taiyo Yuden	JMK212BJ226MG
C_{42}	10[µF]	Taiyo Yuden	JMK212BJ106KG
L_{41}	3.3[µH]	Taiyo Yuden	NR4018T3R3M
P_{41}	-	ROHM	RW1A20ZP

(c) Start-up Sequence



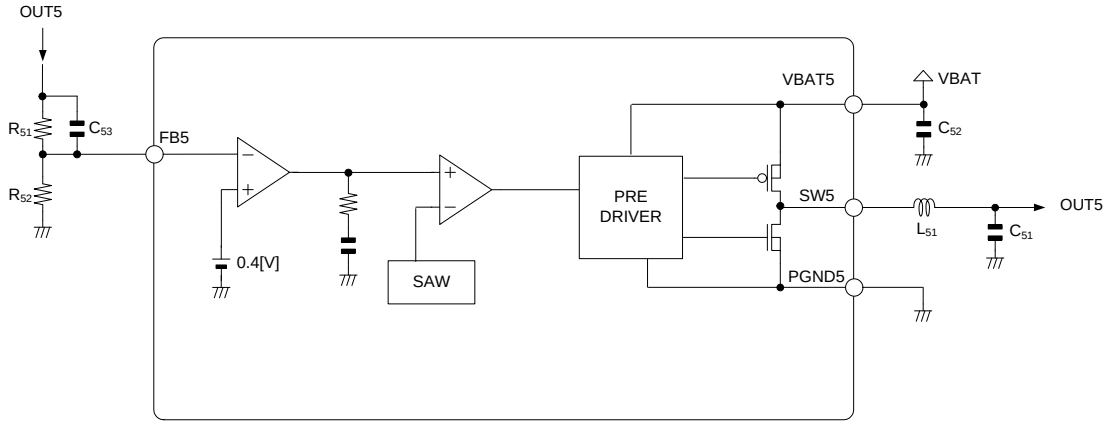
(d) DPG4

The DPG4 output terminal is a gating signal to an external PMOS inserted between VBAT4 and DSW4.
If the V_{VBAT} voltage becomes lower than 2.85[V], DPG4 becomes Low and an external PMOS turns ON.
The over-current can still electrify even if the voltage descend.

(9) CH5

(a) Function

Synchronous rectification Buck DC/DC converter with integrated output stage power MOS.
Output voltage ranges from 1.50[V] to 1.80[V].

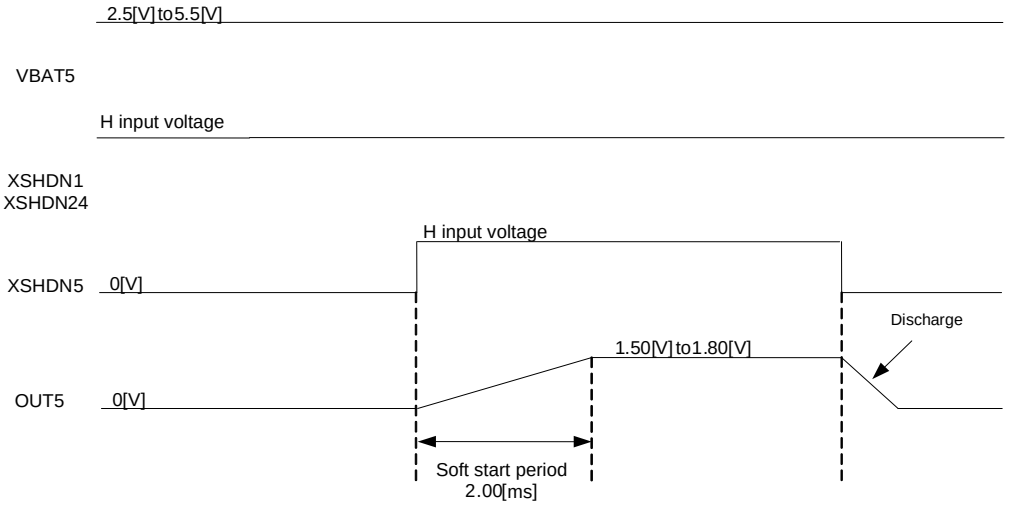


(b) Recommended External Components

Parts name	Value	Maker	Part number
R_{51}	Refer to right table	-	-
R_{52}	Refer to right table	-	-
C_{51}	10[µF]	Taiyo Yuden	JMK212BJ106KG
C_{52}	1[µF]	Taiyo Yuden	JMK105BJ105KV
C_{53}	100[pF]	Taiyo Yuden	UMK105CH101JV
L_{51}	6.8[µH]	Taiyo Yuden	NR3015T6R8M

OUT5 / Set external	1.5[V]	1.8[V]
R_{51}	100[kΩ]	100[kΩ]
R_{52}	33[kΩ] + 3.3[kΩ]	27[kΩ] + 1.6[kΩ]

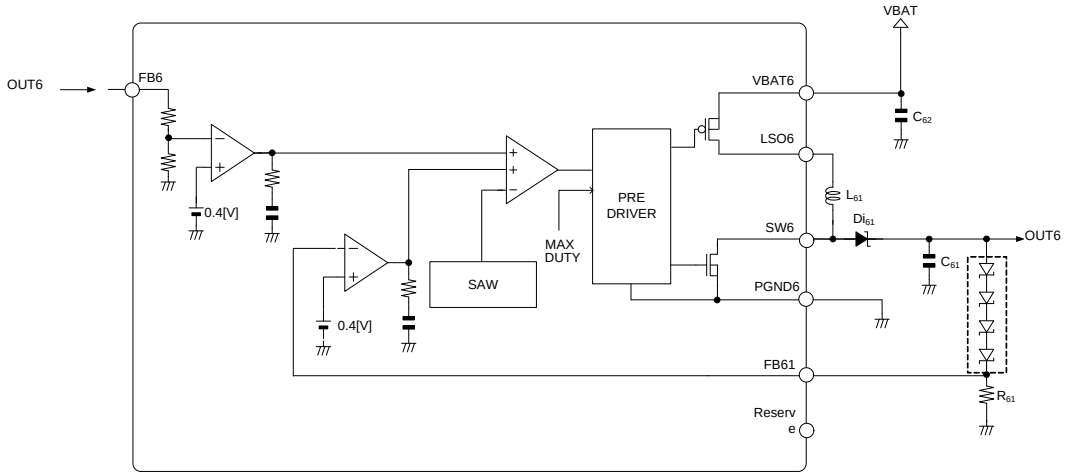
(c) Start-up Sequence



(10) CH6

(a) Function

Boost DC/DC converter with built-in load switch.
This channel enables constant voltage operation and constant voltage operation for protection.
The constant voltage is available with output of 2 to 6 LEDs (typ).
The load switch turns OFF when XSHDN6 goes LOW (CH6 shutdown) and the timer latch.



(b) Recommended External Components

Parts name	Value	Maker	Part number
R_{61}	20[Ω]	-	-
C_{61}	4.7[µF]	Taiyo Yuden	EMK212BJ475KG
C_{62}	1[µF]	Taiyo Yuden	JMK105BJ105KV
L_{61}	10[µH]	Taiyo Yuden	NR3015T100M
Di_{61}	-	ROHM	RB551V-30

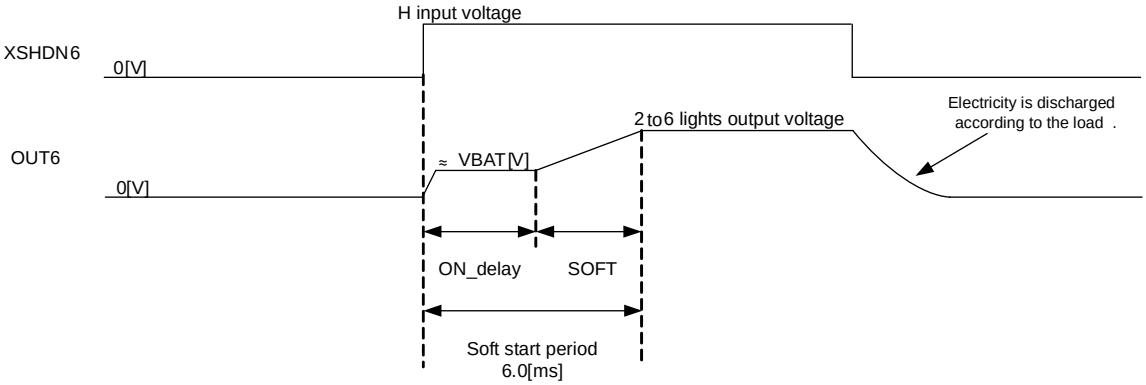
(c) Start-up Sequence

2.5[V] to 5.5[V]

VBAT6

H input voltage

XSHDN1
XSHDN24

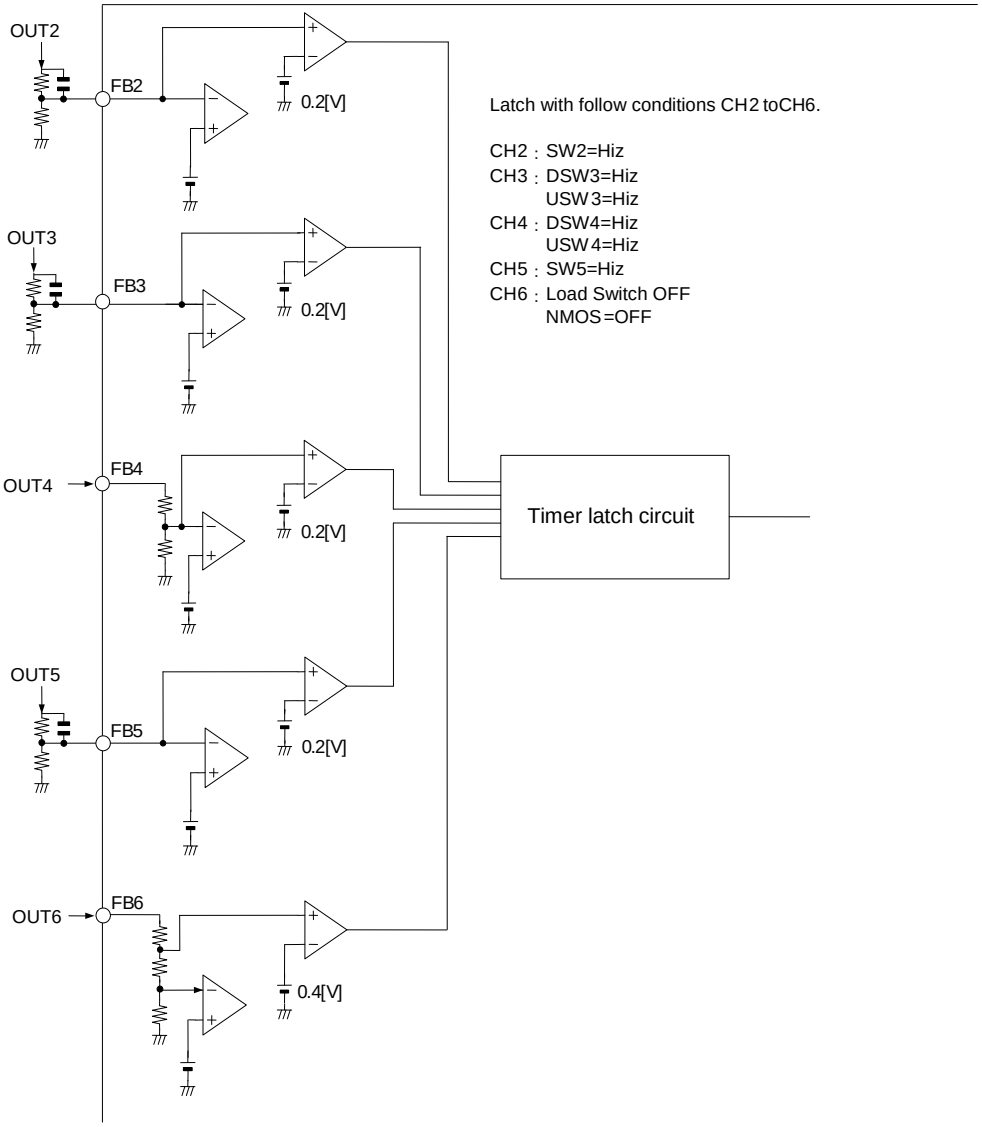


(d) Set Voltage when Fixed Voltage is Driven

When a fixed voltage is driven by internal resistance, it is set to 16V.
It is possible to return in a set voltage by adding external resistance between OUT6 and FB6.
When a fixed voltage is driven, it becomes 20.1V if 82kΩ is added.
When a fixed voltage is driven, it becomes 22.0V if 120kΩ is added.
However, note the resisting pressure of the capacitance of C_{61} when stepping up the voltage applying external resistance.

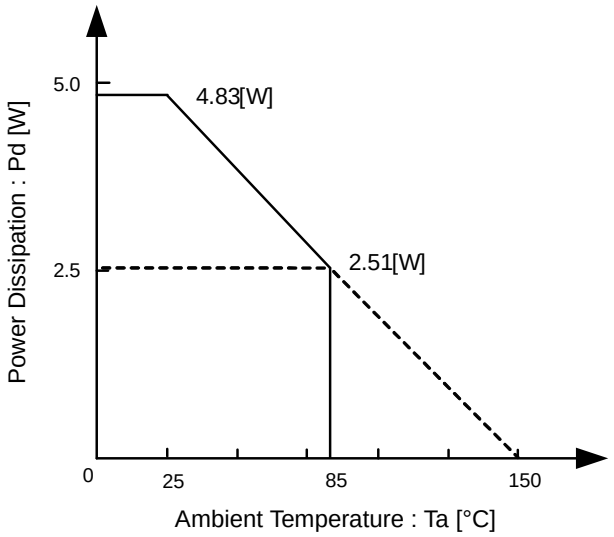
(11) Ground Short Protection Function

(a) CH2 to CH6 are monitoring error amp input voltage fed backed from output and enable timer circuit with falling below the detection voltage of short protection circuit. Timer latch circuit will latch power MOS to OFF status of CH2 to CH6 if such condition remained for 1.0[ms].
(b) All channel except CH1 will be latched with any other channels to be over-current and/or shorted.
(c) Latch will be released either setting XSHDN1=GND, XSHDN24=GND or restarting the device.
(d) Short detection comparator will be disabled by soft start.
(e) The timer latch circuit doesn't operate when an internal power supply is OFF.

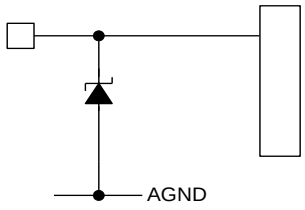


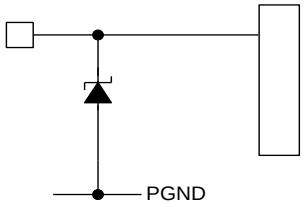
(12) Thermal shutdown function
Thermal shutdown function is built in to prevent IC from heat distraction.
Thermal circuit will be disabled by PFM.

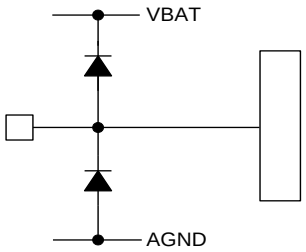
Power Dissipation

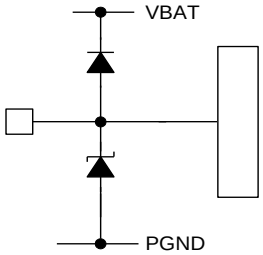


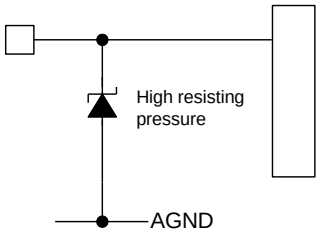
I/O Equivalent Circuits

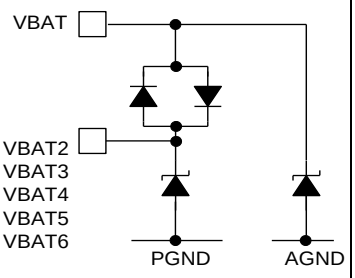
Terminal No.	Terminal Name	Equivalent Circuit
7 9 14 15 34 37 46	XSHDN1 XSHDN24 XSHDN5 FB4 XSHDN6 VCC XSHDN3	

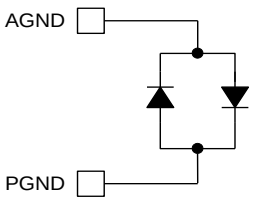
Terminal No.	Terminal Name	Equivalent Circuit
1 2 16 17 18 19 51 52 55 56	SW1 SW1 OUT4 OUT4 USW4 USW4 USW3 OUT3 OUT1 OUT1	

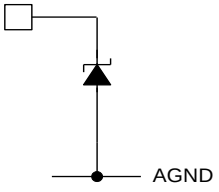
Terminal No.	Terminal Name	Equivalent Circuit
5 10 28 35 44 45 53 54	TEST1 FB5 FB61 RT FB2 TEST2 FB3 FB1	

Terminal No.	Terminal Name	Equivalent Circuit
12 22 23 26 32 40 41 48 49	SW5 DSW4 DSW4 DPG4 LSO6 SW2 SW2 DSW3 DPG3	

Terminal No.	Terminal Name	Equivalent Circuit
29 31	FB6 SW6	

Terminal No.	Terminal Name	Equivalent Circuit
6 13 24 25 33 42 43 47	VBAT VBAT5 VBAT4 VBAT4 VBAT6 VBAT2 VBAT2 VBAT3	

Terminal No.	Terminal Name	Equivalent Circuit
3 4 8 11 20 21 30 36 38 39 50	PGND1 PGND1 AGND1 PGND5 PGND4 PGND4 PGND6 AGND2 PGND2 PGND2 PGND3	

Terminal No.	Terminal Name	Equivalent Circuit
27	Reserve	

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. (Refer page 16)

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.

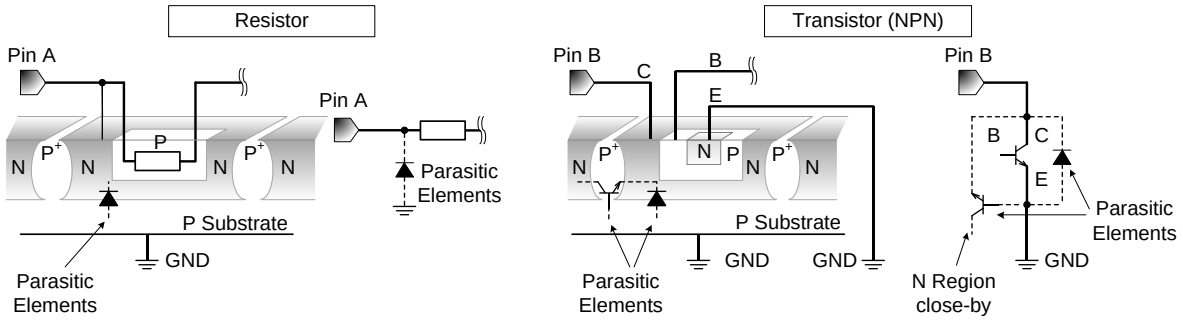


Figure 1. Example of monolithic IC structure

13. 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 power dissipation 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 all 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.

14. Board Patterning

- VBAT,VBAT2,VBAT3,VBAT4,VBAT5, VBAT6 must be connected to the power supply on the board.
- VCC must be connected to OUT1 output on the board.
- ALL PGND and AGND must be connected to GND on the board.
- ALL power supply line and GND terminals must be wired with wide/short pattern in order to achieve the lowest impedance possible.

15. Peripheral Circuitry

- Use low ESR ceramic capacitor for bypass capacitor and place them as close as possible between power supply and GND terminals.
- Place external components such as L and C by IC using wide and short PCB trace patterns.
- Draw output voltage from each end of capacitor.
- Causing short circuit at CH1 output will overload the external diode and may breakdown the component.
- Prepare physical countermeasures by adding poli-switches and fuses to avoid excess current flow.

16. Start-up

- Keep light load condition when starting up the device.
- Switch to PWM mode (XSHDN24=L to H) after CH1 has started up in PFM mode (XSHDN1=L to H), and the OUT1 output voltage is stable.
  CH3・CH5・CH6 should starts after or simultaneously with PWM mode.

17. Usage of this Product

This IC is designed to be used in DSC/DVD application. When using in other applications, please be sure to consult with our sales representative in advance.

Ordering Information

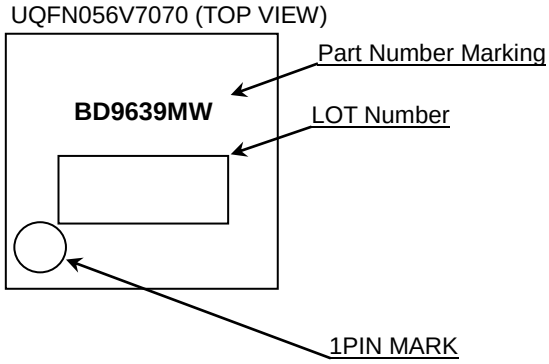
B D 9 6 3 9 M W V	-	E 2

Package Name

Package
MWV : UQFN056V7070

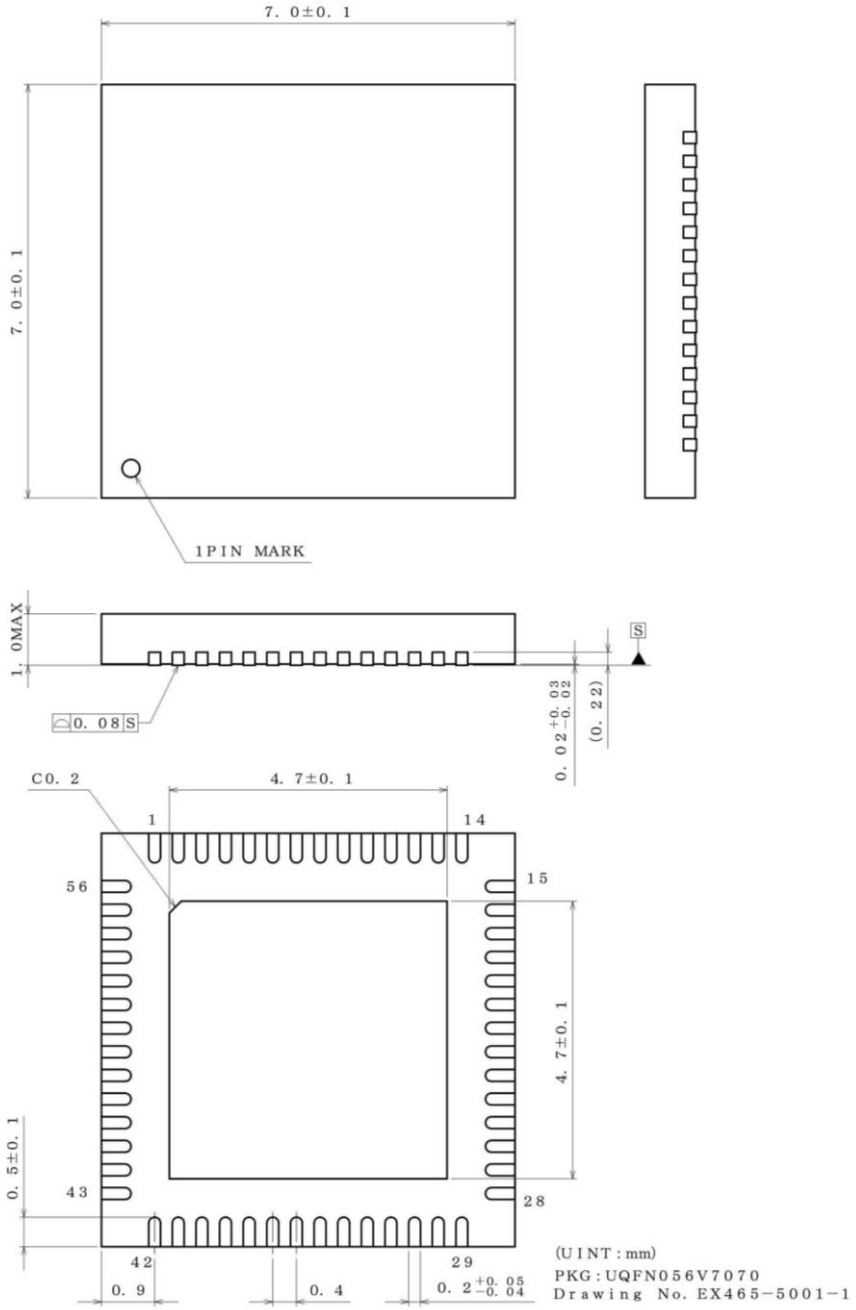
Packaging and forming specification
E2: Embossed tape and reel

Marking Diagram



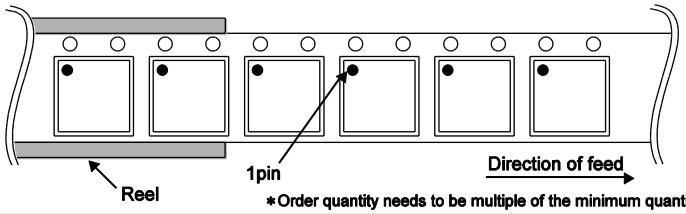
Physical Dimension, Tape and Reel Information

Package Name	UQFN056V7070



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin 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)



∗Order quantity needs to be multiple of the minimum quantity.

Revision History

Date	Revision	Changes
09.Feb.2016	001	New Release

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		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_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 (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.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

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

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
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   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

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Precaution for Disposition

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