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

BD9634GU

General Description

BD9634GU is a system switching regulator IC for DSC/DVC applications to generate plural voltage high efficiently from battery. Component for Power FET and phase compensation are embedded so it is suitable for compact type DSC/DVC application.

Features

- 7ch DC/DC converter, 2ch LDO embedded

・CH1 Boost	―	Startup ch,Motor
・CH2 LDO	FET embedded	Analog
・CH3 Buck	FET embedded	Core
・CH4 Buck-Boost	FET embedded	Digital
・CH5 Boost/Buck	―	CMOS, Memory
・CH6 Boost	―	LED
・CH7 Boost	FET embedded	CCD
・CH8 Reverse	―	CCD
・CH9 LDO	FET embedded	Analog

- Low voltage operation 2.5[V]
- CH1 supply voltage output for internal circuit
- CH1 PWM / PFM selectable
- CH4 Boost-Buck auto switching
- CH5 Boost/Buck external switching
- CH6,CH7 integrated Boost output shutdown
  - ・CH7: Back Gate Control Function
  - ・CH6: Load Switch integrated
- Soft-start correspondence to each channel ch
  - ・CH3→CH4 Sequence Control integrated
  - ・CH7→CH8 2-types Sequence Control
- Output Current Limiter (CH2,CH9),
  Short Circuit Protection Function (CH3 to CH8)
  Error Amp Phase Compensation integrated
  (CH1,CH3,CH4,CH6 to CH8)
- Operating Frequency 1[MHz](CH1,CH3 to CH5）
  500[KHz](CH6 to CH8)

Key Specifications

VBAT Supply Voltage:		2.5V to 5.5V
Oscillating Frequency 1:		1.0 MHz(Typ)
Oscillating Frequency 2:		500kHz(Typ)
ON-Resistance		
CH2	PMOS	1.2Ω(Typ)
CH3	PMOS	0.45Ω(Typ)
CH3	NMOS	0.30Ω(Typ)
CH4	PMOS DOWN,UP side	0.45Ω(Typ)
CH4	NMOS DOWN,UP side	0.30Ω(Typ)
CH6	Load Switch	0.40Ω(Typ)
CH7	PMOS	4.00Ω(Typ)
CH7	NMOS	0.70Ω(Typ)
CH9	PMOS	0.90Ω(Typ)
Operating Temperature Range:		-20°C to +85°C

Package

	W (Typ) x D (Typ) x H (Max)
VCSP85H4	4.26mm x 4.26mm x 1.00mm

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays.

Pin Configuration

BOTTOM VIEW

H	H1	VOUT4	USW4	PGND4	PGND4	DSW4	VBAT4	H8
G	VBAT3	VOUT4	USW4	XSHDN1	XSHDN34	DSW4	VBAT4	VOUT7
F	SW3	XSHDN5	CTL4	XSHDN2	CONT78	XSHDN78	SEL5	SW7
E	PGND13	XSHDN9	FB1	FB4	FB3	FB5	FB7	PGND78
D	PGND13	PREV1	FB2	AGND	FB6	VREF8	FB8	RT
C	OUT1	VDCO1		PREV56	VCC	AMPOUT5	VBAT8	VOUT8
B	VOUT2	VBAT	FB6.1	PGND56	XSHDN6	RESERVE	PWM/PFM	OUT8
A	A1	VBAT6	LSO6	OUT6	OUT5	VOUT9	VDCO4	A8
	1	2	3	4	5	6	7	8

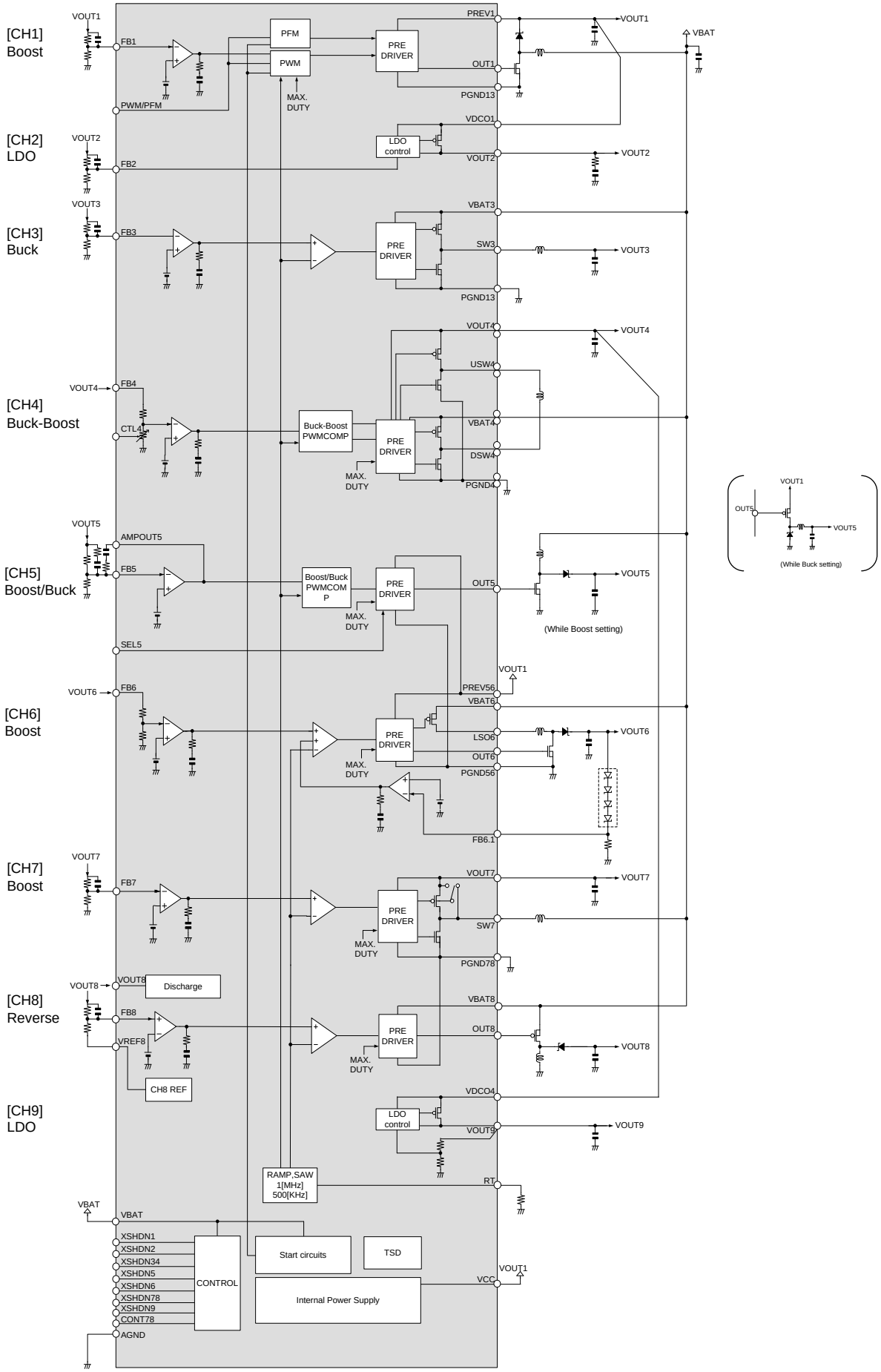
Pin Descriptions

Terminal No.	Name	Equivalent Circuit	
1-A	A1	TEST terminal	O･G
2-A	VBAT6	Load switch input terminal	V
3-A	LSO6	Load switch output terminal	O
4-A	OUT6	CH6 gate connecting terminal	O
5-A	OUT5	CH5 gate connecting terminal	O
6-A	VOUT9	CH9 output terminal	O
7-A	VDCO4	CH9 LDO power supply terminal	V
8-A	A8	TEST terminal	O･G
1-B	VOUT2	CH2 output terminal	O
2-B	VBAT	Battery input terminal	V
3-B	FB6.1	CH6 feedback terminal (Constant voltage side)	G
4-B	PGND56	CH5,CH6 DRIVER GND terminal	G
5-B	XSHDN6	CH6 shutdown terminal	O・G
6-B	RESERVE	Reserve terminal	O
7-B	PWM/PFM	CH1 PWM/PFM switching terminal	O・G
8-B	OUT8	CH8 gate connecting terminal	O
1-C	OUT1	CH1 gate connecting terminal	O
2-C	VDCO1	CH2 LDO power supply terminal	V
3-C	―	―	-
4-C	PREV56	CH5,CH6 DRIVER power supply terminal	V
5-C	VCC	Analog power supply terminal	V
6-C	AMPOUT5	CH5 error amp output terminal	O
7-C	VBAT8	CH8 DRIVER power supply terminal	V
8-C	VOUT8	CH8 output terminal (for Discharge)	G
1-D	PGND13	CH1,CH3 DRIVER GND terminal	G
2-D	PREV1	CH1 DRIVER power supply terminal	V
3-D	FB2	CH2 feedback terminal	G
4-D	AGND	Analog GND terminal	G
5-D	FB6	CH6 feedback terminal (Constant voltage side)	O・G
6-D	VREF8	CH8 reference voltage	O
7-D	FB8	CH8 feedback terminal	G
8-D	RT	Triangle wave setting resistance terminal	(Note 1)

Terminal No.	Name	Equivalent Circuit	
1- E	PGND13	CH1,CH3 DRIVER GND terminal	G
2- E	XSHDN9	CH9 shutdown terminal	O･G
3- E	FB1	CH1 feedback terminal	G
4- E	FB4	CH4 feedback terminal	O･G
5- E	FB3	CH3 feedback terminal	G
6- E	FB5	CH5 feedback terminal	G
7- E	FB7	CH7 feedback terminal	G
8- E	PGND78	CH7,CH8 DRIVER GND terminal	G
1- F	SW3	CH3 switching terminal	O
2- F	XSHDN5	CH5 shutdown terminal	O･G
3- F	CTL4	CH4 output voltage switching terminal	O･G
4- F	XSHDN2	CH2 shutdown terminal	O･G
5- F	CONT78	CH7,CH8 sequence control terminal	G
6- F	XSHDN78	CH7,CH8 shutdown terminal	O･G
7- F	SEL5	CH5 Boost/Buck switching terminal	G
8- F	SW7	CH7 switching terminal	O
1- G	VBAT3	CH3 DRIVER power supply terminal	V
2- G	VOUT4	CH4 output terminal	O
3- G	USW4	CH4 Boost side switching terminal	O
4- G	XSHDN1	CH1 shutdown terminal	G
5- G	XSHDN34	CH3,CH4 shutdown terminal	O･G
6- G	DSW4	CH4 Buck side switching terminal	O
7- G	VBAT4	CH4 DRIVER power supply terminal	V
8- G	VOUT7	CH7 output terminal	O
1- H	H1	TEST terminal	O･G
2- H	VOUT4	CH4 output terminal	O
3- H	USW4	CH4 Boost side switching terminal	O
4- H	PGND4	CH4 DRIVER GND terminal	G
5- H	PGND4	CH4 DRIVER GND terminal	G
6- H	DSW4	CH4 Buck side switching terminal	O
7- H	VBAT4	CH4 DRIVER power supply terminal	V
8- H	H8	TEST terminal	O･G

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)
(Note 1)・・・10[KΩ]Pull-down

Block Diagram



Absolute Maximum Ratings（Ta=25°C）

Parameter	Symbol	Rating	Unit
Supply Voltage Permissible Voltage	V_{VBAT} $V_{VBAT3,4,6,8}$	-0.3 to +7	V
VOUT7 Permissible Voltage	V_{VOUT7}	-0.3 to +15.5	V
SW7 Permissible Voltage	V_{SW7}	-0.3 to +15.5 -0.3 to +16 (Note 1)	V
VOUT2 Permissible Current Output	I_{VOUT2}	0.3	A
SW3 Permissible Current Output	I_{SW3}	0.5	A
VOUT4 Permissible Current Output	I_{VOUT4}	1.0	A
LSO6 Permissible Current Output	I_{LSO6}	0.5	A
VOUT7 Permissible Current Output	I_{VOUT7}	0.5	A
VOUT9 Permissible Current Output	I_{VOUT9}	0.3	A
Power Dissipation	Pd	1.4 (Note 2)	W
Operating Temperature Range	Topt	-20 to +85	°C
Storage Temperature Range	Tstg	-55 to +150	°C
Junction Temperature	Tjmax	+150	°C

(Note 1) 15.5[V] to 16[V] ： Pulse ≤40[ns] and Duty Cycle≤2[%]

(Note 2) Implemented on Glass epoxy board (ROHM standard board :50 x 58 x 1.75[mm^3] 8 layers）

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	Conditions
		MIN	TYP	MAX		
VBAT Supply Voltage	V_{VBAT}	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_{VBAT6}	2.5	3.7	5.5	V	
	V_{VBAT8}	2.5	3.7	5.5	V	

Electrical Characteristics

（Unless otherwise specified, V_{VBAT}=$V_{VBAT3,4,6,8}$=3.7[V], VOUT1 Input Voltage=3.7[V], Ta=25[°C]）

Parameter	Symbol	Limit			Unit	Conditions
		MIN	TYP	MAX		
Current Consumption (PFM)	I_{CC1}	-	90	180	μA	・XSHDN1=H, PWM/PFM=L, Other setting terminal=L ・Without load on each channel ・sum of VBAT terminal, and VOUT1 terminal
Current Consumption (PWM)	I_{CC2}	1.40	2.10	3.15	mA	・XSHDN1=H, PWM/PFM=H, Other setting terminal =L ・Without load on each channel ・sum of VBAT terminal, and VOUT1 terminal
Shutdown Current Consumption	I_{CC3}	-	0	10	μA	・All setting terminal =L ・Without load on each channel ・sum of VBAT terminal, and VOUT1 terminal
H Input Voltage1	V_{IH1}	V_{VBAT} -0.3	-	-	V	XSHDN1
L Input Voltage1	V_{IL1}	-	-	GND +0.3	V	
H Input Voltage2	V_{IH3}	2.5	-	-	V	Setting terminal except for XSHDN1, SEL5
L Input Voltage2	V_{IL3}	-	-	GND +0.3	V	
H Input Voltage3	V_{IH3}	V_{OUT1} -0.3	-	-	V	SEL5
L Input Voltage3	V_{IL3}	-	-	GND +0.3	V	
H Input Current1	I_{IH1}	4.63	9.25	18.5	μA	Input Voltage =3.7[V] XSHDN2,XSHDN34,XSHDN5,XSHDN6, XSHDN78,XSHDN9,PWM/PFM
H Input Current2	I_{IH2}	18.5	37	74	μA	Input Voltage =3.7[V]　CTL4
Oscillating Frequency 1	f_{OSC1}	0.8	1.0	1.2	MHz	R_{RT}=10[kΩ]
Oscillating Frequency 2	f_{OSC2}	400	500	600	KHz	R_{RT}=10[kΩ]
Reduced-voltage Detection Voltage	V_{UVLO1}	1.60	1.80	2.00	V	
Reduced-voltage Return Voltage	V_{UVLO2}	1.80	2.00	2.20	V	
【CH1】						
Error Amp Reference Voltage	V_{EREF1}	0.390	0.400	0.410	V	PWM/PFM=H
Soft-start Period 85%	t_{SS1}	0.44	1.08	1.72	ms	Soft-start period 100% 1.27[ms](TYP) PWM/PFM=L
Maximum Duty	DMAX1	76.5	85.0	93.5	%	PWM/PFM=H
【CH2】						
Reference Voltage	V_{REF2}	0.291	0.300	0.309	V	
Startup period 85%	t_{SS2}	0.73	1.45	2.17	ms	Startup Period 100%　1.7[ms]（TYP）
PMOS ON-Resistance	R_{ONP2}	-	1.20	1.95	Ω	Power Supply 3.7[V]

Electrical Characteristics –continued

（Unless otherwise specified, V_{VBAT}=$V_{VBAT3,4,6,8}$=3.7[V], VOUT1 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}	0.43	0.85	1.27	ms	Soft-start Period 100% 1.0[ms]（TYP）
PMOS ON-Resistance	R_{ONP3}	-	0.45	0.70	Ω	Power Supply 3.7[V]
NMOS ON-Resistance	R_{ONN3}	-	0.30	0.55	Ω	Power Supply 3.7[V]
【CH4】						
Error Amp Reference Voltage	V_{EREF4}	0.390	0.400	0.410	V	
Soft-start Period 85%	t_{SS4}	1.25	2.50	3.75	ms	Soft-start Period 100% 2.94[ms]（TYP）
PMOS ON-Resistance DOWN side	R_{ONPD4}	-	0.45	0.70	Ω	Power Supply 3.7[V]
NMOS ON-Resistance DOWN side	R_{ONND4}	-	0.30	0.55	Ω	Power Supply 3.7[V]
PMOS ON-Resistance UP side	R_{ONPU4}	-	0.45	0.70	Ω	Power Supply 3.7[V]
NMOS ON-Resistance UP side	R_{ONNU4}	-	0.30	0.55	Ω	Power Supply 3.7[V]
Maximum Duty	DMAX4	65	80	95	%	
【CH5】						
Error Amp Reference Voltage	V_{EREF5}	0.975	1.000	1.025	V	
Soft-start Period 85%	t_{SS5}	2.25	4.50	6.95	ms	Soft-start Period 100% 5.3[ms]（TYP）
Maximum Duty	DMAX5	76.5	85.0	93.5	%	SEL5=L
【CH6】						
Error Amp Reference Voltage 1	V_{EREF6}	0.386	0.400	0.414	V	Constant voltage control side
Error Amp Reference Voltage 2	$V_{EREF6.1}$	0.386	0.400	0.414	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 Switch ON-Resistance	R_{ONP6}	-	0.40	0.65	Ω	Power Supply 3.7[V]
Maximum Duty	DMAX6	87	-	-	%	
【CH7】						
Error Amp Reference Voltage	V_{EREF7}	0.983	1.000	1.017	V	
Soft-start Period 85%	t_{SS7}	3.40	6.80	10.20	ms	Soft-start Period 100% 8.0[ms]（TYP）
PMOS ON-Resistance	R_{ONP7}	-	4.00	6.40	Ω	Power Supply 3.7[V]
NMOS ON-Resistance	R_{ONN7}	-	0.70	1.12	Ω	Power Supply 3.7[V]
Maximum Duty	DMAX7	87	-	-	%	
【CH8】						
Error Amp Reference Voltage	V_{EREF8}	0.978	1.000	1.022	V	Refer to P.16 for Output Voltage accuracy
Soft-start Period 1 85%	t_{SS81}	2.55	5.10	7.65	ms	Soft-start Period 100% 6.0[ms]（TYP） CONT78=L
Soft-start Period 2 85%	t_{SS82}	3.40	6.80	10.20	ms	Soft-start Period 100% 8.0[ms]（TYP） CONT78=H
Maximum Duty	DMAX8	87	-	-	%	
CH8 Reference Voltage	V_{REF8}	2.44	2.50	2.56	V	
【CH9】						
Reference Voltage	V_{REF9}	0.2425	0.250	0.2575	V	
Startup period 85%	t_{SS9}	127	255	383	μs	Startup Period 100% 300[μs]（TYP）
PMOS ON-Resistance	R_{ONP9}	-	0.90	1.44	Ω	Power Supply 3.7[V]

Function Description

【Features Summary】

CH	Function	Output voltage (TYP)	Power output	Setting res.	USE
CH1	Boost converter	3.7[V] to 5.5[V]	External	External	Startup ch,Motor
CH2	LDO	I/O voltage differential over 0.2[V]	Embedded	External	Analog
CH3	Buck converter	1.05[V] to 1.8[V]	Embedded	External	Core
CH4	Buck-Boost converter	3.25[V]/3.3[V]	Embedded	Embedded	Digital
CH5	Boost/Buck converter	5.0[V]/1.8[V]	External	External	CMOS,Memory
CH6	Boost	6[V] to 16[V]	External	External	LED
CH7	Boost	12[V] to 14.5[V]	Embedded	External	CCD
CH8	Reverse	-7.5[V] to -6[V]	External	External	CCD
CH9	LDO	I/O voltage differential over 0.2[V]	Embedded	Embedded	Analog

【CONTROL】

・Stand-by function related terminals

Following table shows start-up condition of each block.

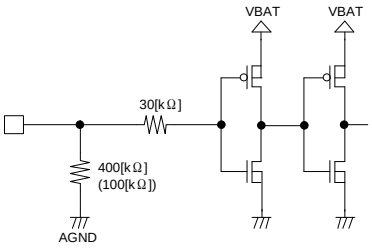
XSHDN 1	PWM /PFM	XSHDN 2	XSHDN 34	XSHDN 5	XSHDN 6	XSHDN 78	XSHDN 9	CH1	Internal supply	RAMP SAW	CH2	CH3 CH4	CH5	CH6	CH7 CH8	CH9
L	-	-	-	-	-	-	-	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
H	L	-	-	-	-	-	L	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
		-	-	-	-	-	H		ON	ON	OFF	OFF	OFF	OFF	OFF	ON
	H	L	L	L	L	L	L				OFF	OFF	OFF	OFF	OFF	OFF
		H	L	L	L	L	L				ON	OFF	OFF	OFF	OFF	OFF
		L	H	L	L	L	L				OFF	ON	OFF	OFF	OFF	OFF
		L	L	H	L	L	L				OFF	OFF	ON	OFF	OFF	OFF
		L	L	L	H	L	L				OFF	OFF	OFF	ON	OFF	OFF
		L	L	L	L	H	L				OFF	OFF	OFF	OFF	ON	OFF
		L	L	L	L	L	H				OFF	OFF	OFF	OFF	OFF	ON

(Note) PWM/PFM logic refer to the table below.
(Note) -symbol mean without conditions.

・Other setting terminals

Terminal	Function
PWM/PFM	H：PWM operation　L：PFM operation
CTL4	VOUT4 H　3.30[V] L　3.25[V] （Note）Latch logic at CH4 startup
SEL5	H：Buck setting　L：Boost setting　（Note）H input voltage is VOUT1 output voltage
CONT78	H：CH7,CH8 startup synchronous　L：CH7→CH8 startup　（Note）Logic after some [us] from rising edge of XSHDN78

・XSHDN2 to XSHDN9, PWM/PFM, CTL4 terminal equivalent circuit



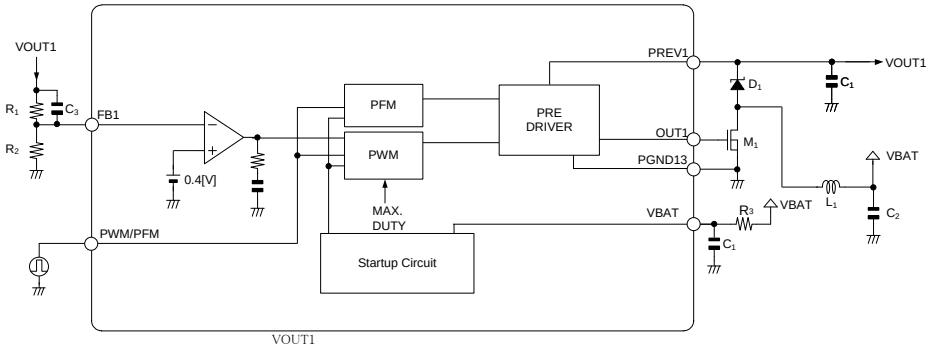
100[kΩ] is only for CTL4 terminal.

XSHDN1,SEL5,CONT7 terminal is not Pulled-down, so VBAT input and GND input is needed.

【CH1】

・Function

Selectable PWM/PFM boost DC/DC converter.
Output voltage is ranges from 3.7[V] to 5.5[V] (TYP) at PFM, 4.1[V] to 5.5[V] (TYP) at PWM.
Low voltage operation starts up from 2.5[V] and also provides supply voltage to VREF circuit.



VOUT1
Setting External Components

・Recommended External Components

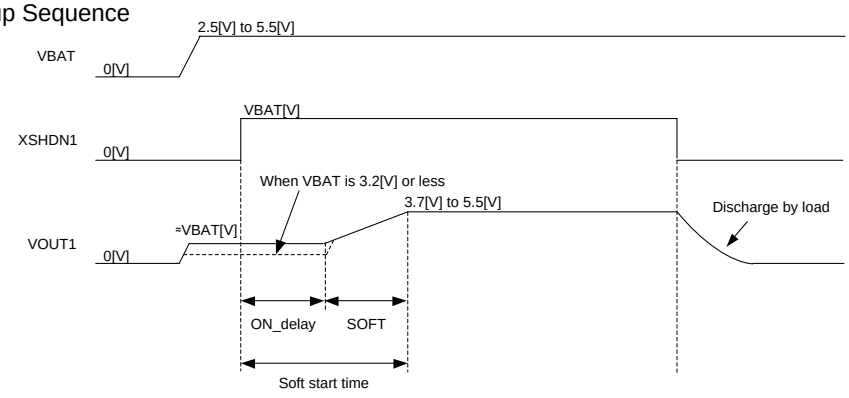
Parts Name	Value	Maker	Part Number
R_1	Refer to the right table	-	-
R_2	Refer to the right table	-	-
R_3	10[Ω]	-	-
C_1	22[μF] x 2	Taiyo Yuden	JMK212BJ226MG
C_2	10[μF]	Taiyo Yuden	JMK212BJ106KG
C_3	Refer to the right table	Taiyo Yuden	TMK063BJ101KP /TMK063BJ151KP
C_4	1[μF]	Taiyo Yuden	JMK105BJ105KV
L_1	1.0[μH]	TOKO	A997AS-1R0N
M_1 (Note)	-	ROHM	RTF015N03/RTR040N03
D_1	-	ROHM	RB060M-30

(Note) It depends on output load current

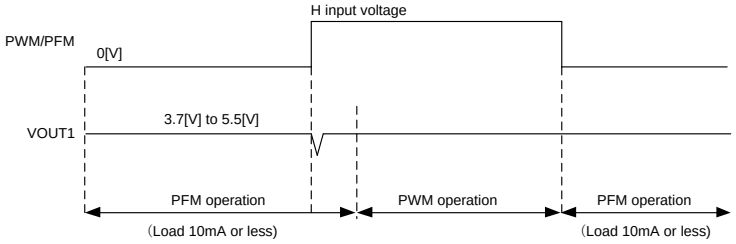
VOUT1 / Setting external	PFM	PFM/PWM	
	3.7[V]	4.2[V]	5.0[V]
R_1	620[KΩ]+24[KΩ]		620[KΩ]+24[KΩ]
R_2	56[KΩ]+22[KΩ]		56[KΩ]
C_3	100[pF]		100[pF]
R_1	510[KΩ]+22[KΩ]	510[KΩ]+22[KΩ]	
R_2	56[KΩ]+7.5[KΩ]+1[KΩ]	56[KΩ]	
C_3	150[pF]	150[pF]	

$$VOUT1 = \frac{R_1 + R_2}{R_2} \times 0.4[V]$$

・ Start-up Sequence



・PWM/PFM

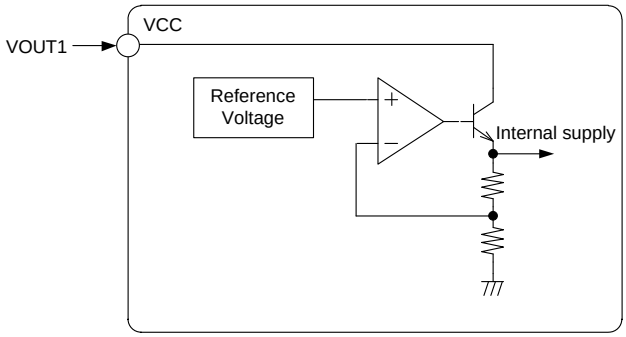


Select PWM/PFM with light load (10mA or less).

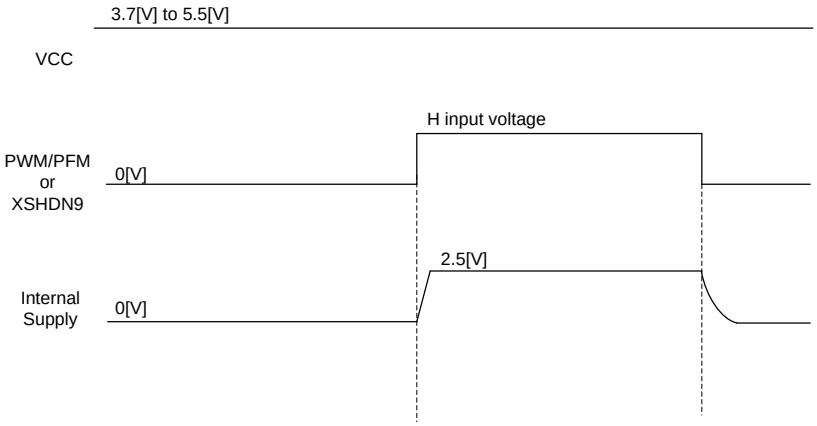
【Internal Supply Voltage】

・Function

Regulator input voltage is supplied by VOUT1.
Output voltage is 2.5[V]（TYP）.
No output terminal for internal power supply.
VREF voltage is used to power up internal circuit.
Internal supply rises up at PWM mode (PWM/PFM terminal=H) or CH9 turns ON (XSHDN9=H).



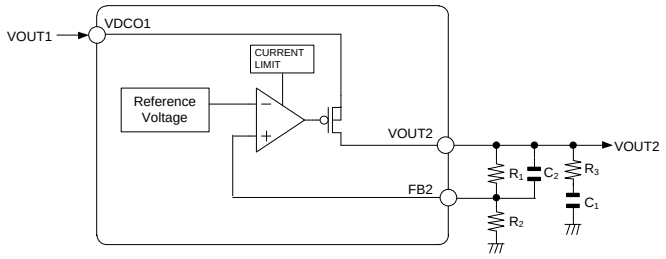
・Start-up Sequence



【CH2】

・Function

LDO for minimum I/O voltage differential is 0.2[V] or more.
Input voltage is VOUT1, output voltage is ranges from 1.8[V] to 3.5[V] (TYP).



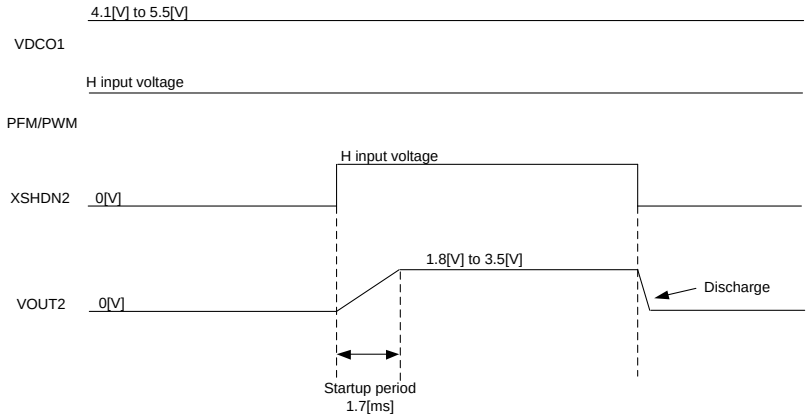
・Recommended External

Parts name	Value	Maker	Part number
R_1	Refer to the right table	-	-
R_2	Refer to the right table	-	-
R_3	200[mΩ]	-	-
C_1	2.2[μF]	Taiyo Yuden	JMK107BJ225KA
C_2	15[pF]	Taiyo Yuden	TMK063CH150JP

VOUT2	3.3[V]	2.5[V]
R_1	300[KΩ]	300[KΩ]
R_2	30[KΩ]	30[KΩ]+11[KΩ]

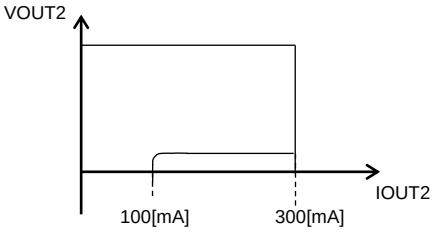
$$VOUT2 = \frac{R_1 + R_2}{R_2} \times 0.3[V]$$

・Start-up Sequence



・Over Current Protection

Characteristics of output voltage and output current shown below.

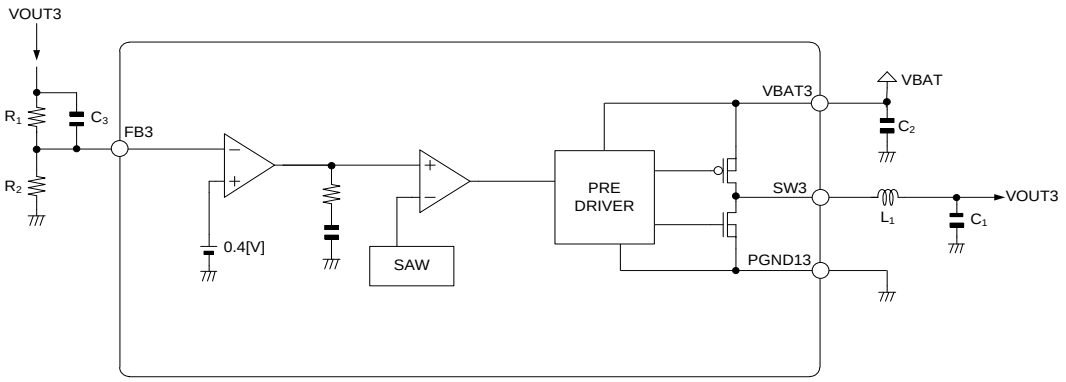


【CH3】

・Function

Synchronous rectification type buck DC/DC converter with built in power MOS output stage.

Output voltage ranges from 1.05[V] to 1.8[V]（TYP）.



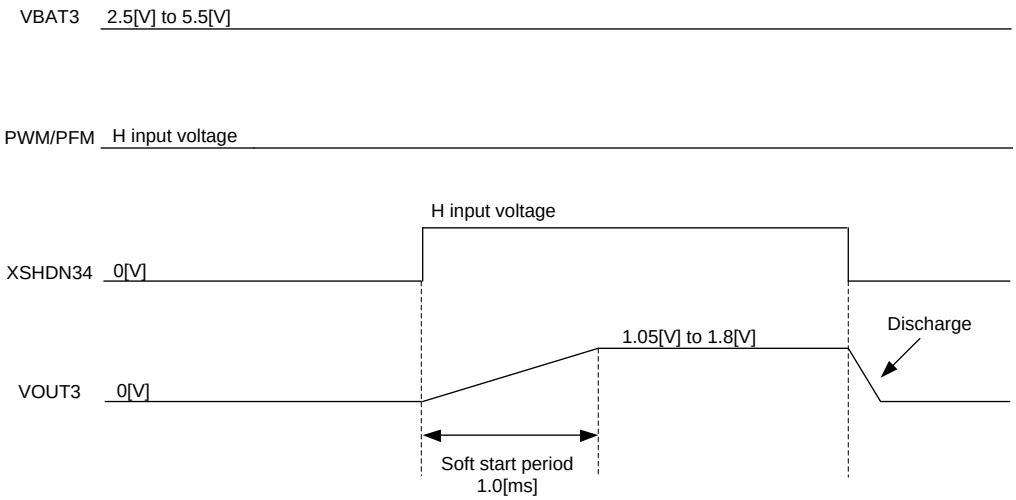
・Recommended External

Parts name	Value	Maker	Part number
R_1	Refer to the right table	-	-
R_2	Refer to the right table	-	-
C_1	10[μF]	Taiyo Yuden	JMK212BJ106KG
C_2	1[μF]	Taiyo Yuden	JMK105BJ105KV
C_3	10[pF]	Taiyo Yuden	TMK063CH100DT
L_1	4.7[μH]	sumida	CDRH2D14NP-4R7NC

VOUT3 / Setting external	1.05[V]	1.26[V]	1.8[V]
R_1	270[KΩ]	270[KΩ]	270[KΩ]
R_2	160[KΩ]+6.2[KΩ]	120[KΩ]+5.6[KΩ]	75[KΩ]+2.2[KΩ]

$$VOUT3 = \frac{R_1 + R_2}{R_2} \times 0.4[V]$$

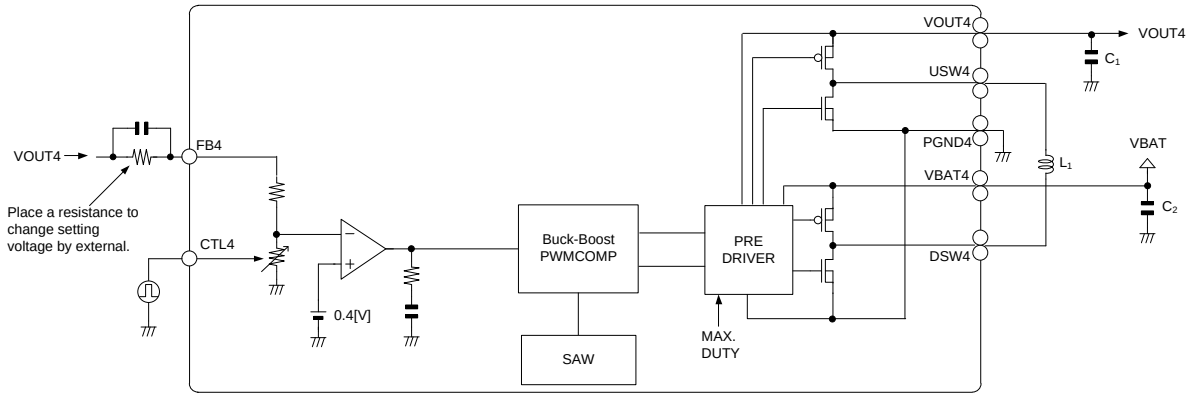
・Start-up Sequence



【CH4】

・Function

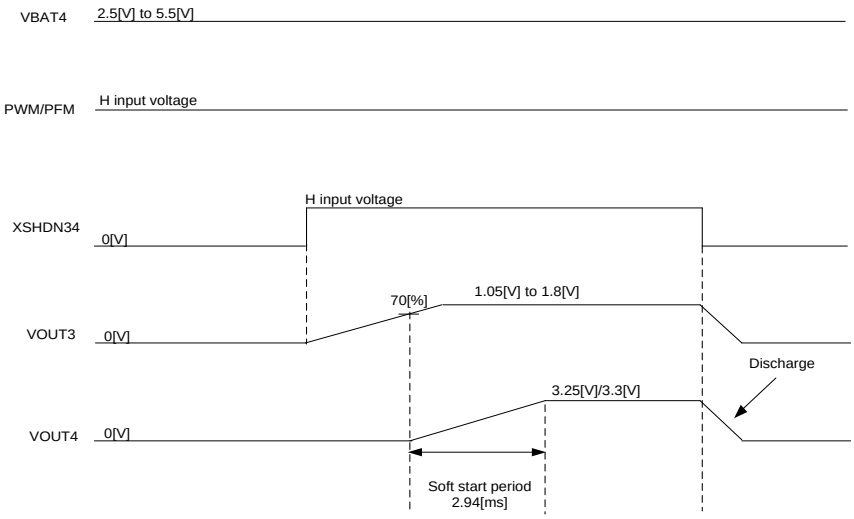
Synchronous rectification cross converter with built-in power MOS output stage.
Output voltage is selectable: 3.25[V]/3.3[V]（TYP）.



・Recommended External

Parts name	Value	Maker	Part number
C_1	22[μF]	Taiyo Yuden	JMK212BJ226MG
C_2	10[μF]	Taiyo Yuden	JMK212BJ106KG
L_1	4.7[μH]	sumida	CDRH2D14NP-4R7NC

・Start-up Sequence



・Setting Voltage

It is possible to return in a set voltage by adding external resistance between VOUT4 and FB4.

CTL4=L, OPEN

$$VOUT4 = \frac{330.7[k\Omega] + ExternalR[k\Omega]}{40.7[k\Omega]} \times 0.4[V]$$

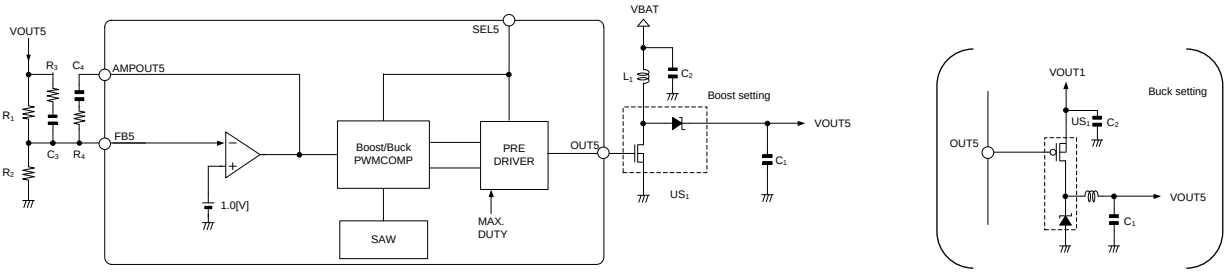
CTL4=H

$$VOUT4 = \frac{330[k\Omega] + ExternalR[k\Omega]}{40[k\Omega]} \times 0.4[V]$$

【CH5】

・Function

Boost/Buck selectable DC/DC converter.
Output voltage is selectable: 5.0[V] /1.8[V] (TYP).



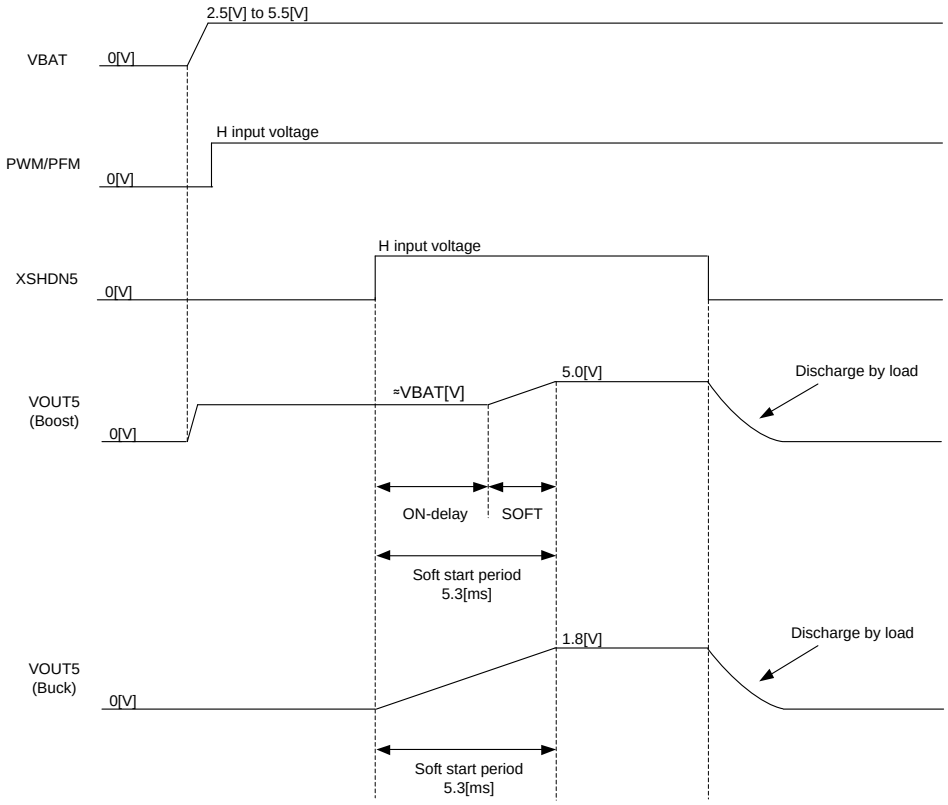
・Recommended External

Parts name	Value		Maker	Part number	
	Boost setting Output=4.8[V]	Buck setting Output=1.8[V]		Boost setting Output=4.8[V]	Buck setting Output=1.8[V]
R_1	91[KΩ]	24[KΩ]	-	-	-
R_2	24[KΩ]	30[KΩ]	-	-	-
R_3	2[KΩ]	1[KΩ]	-	-	-
R_4	10[KΩ]	62[KΩ]	-	-	-
C_1	22[μF]	22[μF]	Taiyo Yuden	JMK212BJ226MG	JMK212BJ226MG
C_2	1[μF]	10[μF]	Taiyo Yuden	JMK105BJ105KV	JMK212BJ106KG
C_3	100[pF]	100[pF]	Taiyo Yuden	TMK063CH101JP	TMK063CH101JP
C_4	2.2[nF]	10[nF]	Taiyo Yuden	LMK063BJ222KP	LMK063BJ103KP
L_1	1.5[μH]	1.8[μH]	sumida	CDRH2D14NP-1R5NC	CDRH2D14NP-1R8NC
US_1 (Note)	-	-	ROHM	US5U1/QS5U12	US5U29

(Note) Depends on output load current.

$$VOUT5 = \frac{R_1 + R_2}{R_2} \times 1.0[V]$$

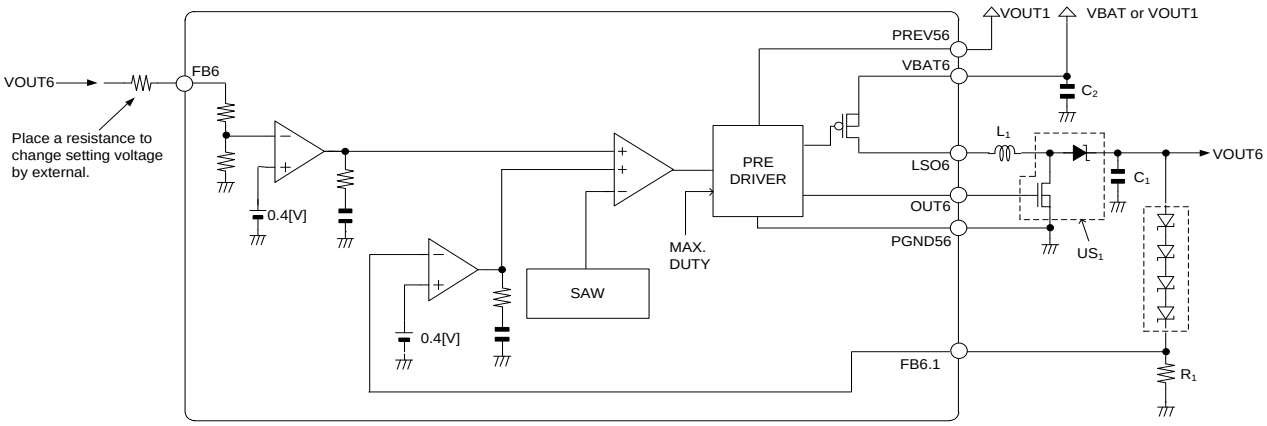
・Start-up Sequence



【CH6】

・Function

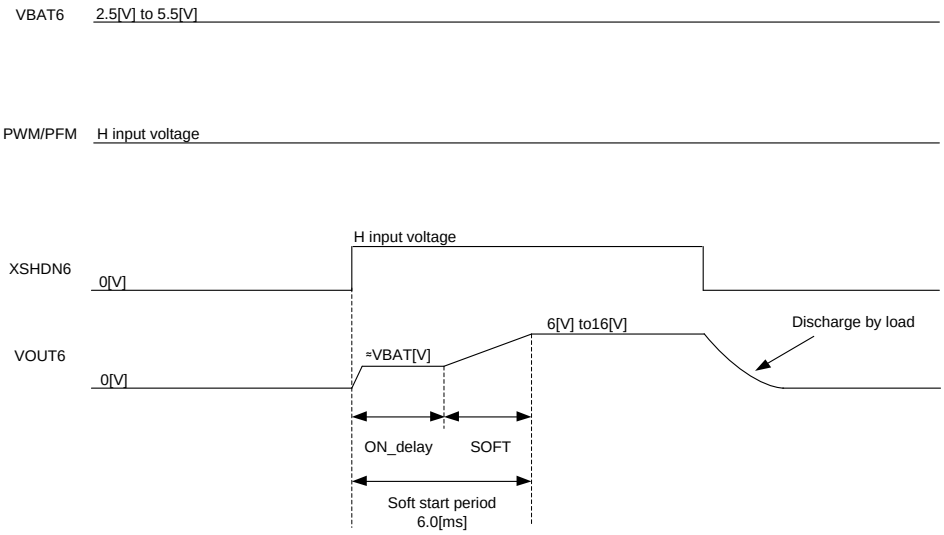
Boost DC/DC converter with built-in load switch.
This channel enables constant voltage operation and constant voltage operation for protection.
The constant voltage is available with output of 6[V] to 16[V] (TYP).
The load switch turns OFF when XSHDN6 goes LOW (CH6 shutdown) and the timer latch.



・Recommended External

Parts name	Value	Maker	Part number
R_1	20[Ω]	-	-
C_1	4.7[μF]	Taiyo Yuden	EMK212BJ475KG
C_2	1[μF]	Taiyo Yuden	JMK105BJ105KV
L_1	10[μF]	sumida	CDRH2D14NP-100NC
US_1	-	ROHM	US5U1

・Start-up Sequence



・Set Voltage when Fixed Voltage is Driven

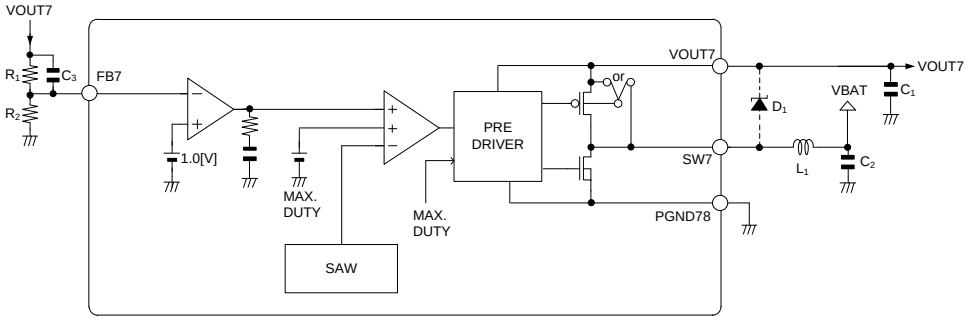
When a fixed voltage is driven by internal resistance, it is set to 16V.
It is possible to return in a set voltage by adding external resistance between VOUT6 and FB6.
However, note the resisting pressure of the capacitance of C_1 when stepping up the voltage applying external resistance.

$$VOUT6 = \frac{ExternalR + 400[k\Omega]}{10[k\Omega]} \times 0.4[V]$$

【CH7】

・Function

Synchronous rectification Boost DC/DC converter with integrated output stage power MOS.
Output voltage ranges from 12.0[V] to 14.5[V] (TYP).
Output can shut by back gate control function.
Back gate control function is a function to shut the output by placing back gate of PMOS to SW7 side when in XSHDN78=L (CH7 shut down) time and a timer latch.



・Recommended External

Parts name	Value	Maker	Part number
R_1	Refer to the right table	-	-
R_2	Refer to the right table	-	-
C_1	10[μF]	Taiyo Yuden	EMK212BJ106KG
C_2	10[μF]	Taiyo Yuden	JMK212BJ106KG
C_3	150[pF]	Taiyo Yuden	TMK063BJ151KP
L_1 (Note)	22[μH]	sumida	CDRH2D14B/LDNP-220M
D_1 (Note)	-	ROHM	RB551V-30

(Note) If output voltage ranges from 13[V] to 14[V], place D_1.

Setting external \ VOUT7	12[V]	13[V]
R_1	820[KΩ]	820[KΩ]
R_2	75[KΩ]	68[KΩ]

$$VOUT7 = \frac{R_1 + R_2}{R_2} \times 1.0[V]$$

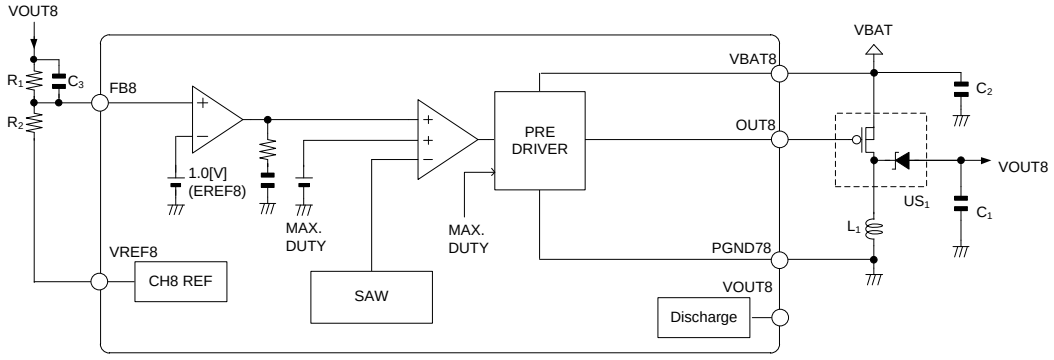
・Start-up Sequence

Refer to [CH8] Start-up Sequence in Page 16.

【CH8】

・Function

Reverse DC/DC Converter.
Output voltage ranges from -7.5[V] to -6.0[V] (TYP).



・Recommended External

Parts name	Value	Maker	Part number
R_1	Refer to the right table	-	-
R_2	Refer to the right table	-	-
C_1	10[μF] x 2	Taiyo Yuden	LMK212BJ106KG
C_2	1[μF]	Taiyo Yuden	JMK105BJ105KV
C_3	100[pF]	Taiyo Yuden	TMK063CH101JP
L_1	2.2[μH]	sumida	CDRH2D14NP-2R2NC
US_1	-	ROHM	QS5U21

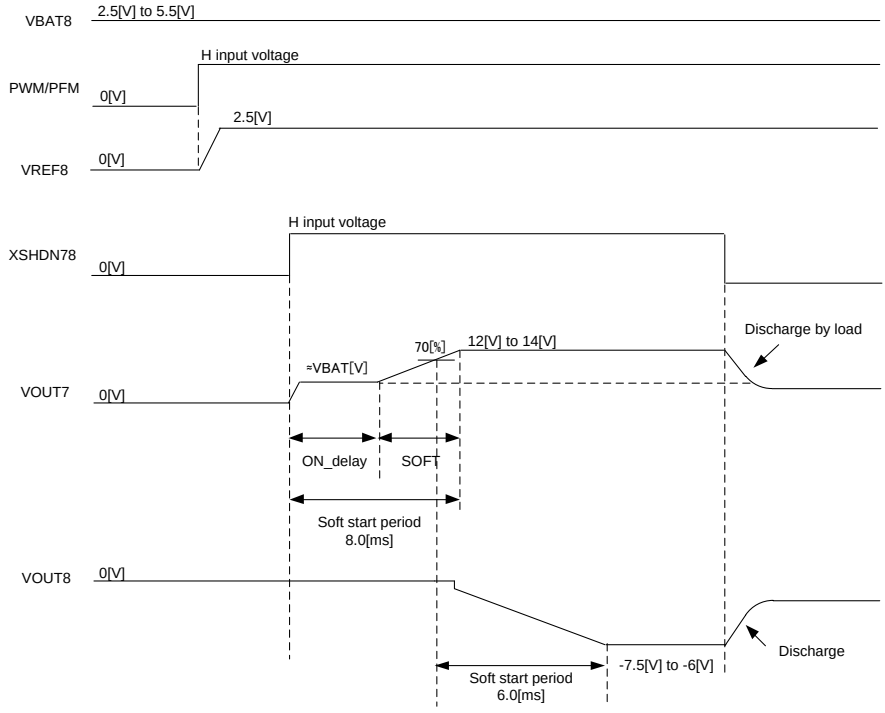
Setting external \ VOUT8	-7.5[V]	-6[V]
R_1	680[KΩ]	560[KΩ]
R_2	120[KΩ]	120[KΩ]

$$VOUT8 = -\frac{R_1}{R_2}VREF8 + \frac{R_1+R_2}{R_2}EREF8$$

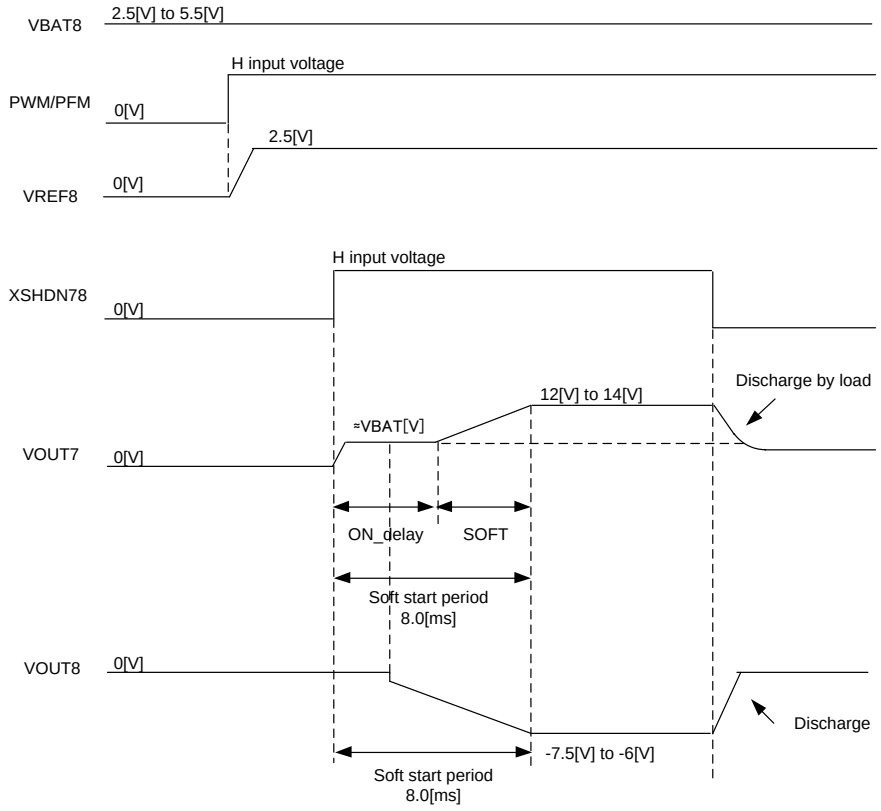
Output voltage accuracy is calculated by the above formula.

・Start-up Sequence

＜CONT78=L＞



＜CONT78=H＞



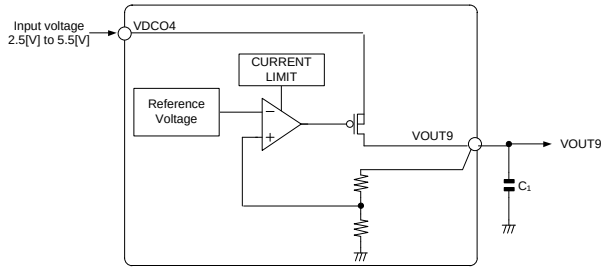
【CH9】

・Function

LDO with the minimum I/O voltage differential is 0.2[V] or more.

Output voltage is 1.8[V] (TYP).

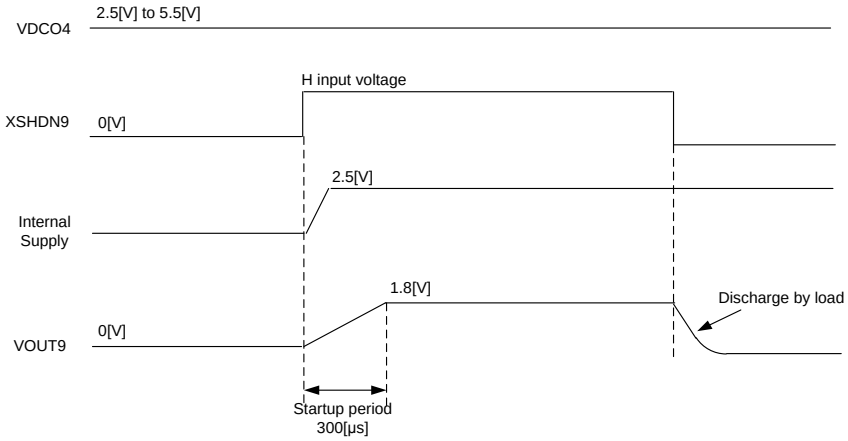
Input voltage (2.5[V] to 5.5[V]) is input to VDCO4 even in PFM mode and output 1.8[V] (TYP) if it becomes XSHDN9=H



・Recommended External

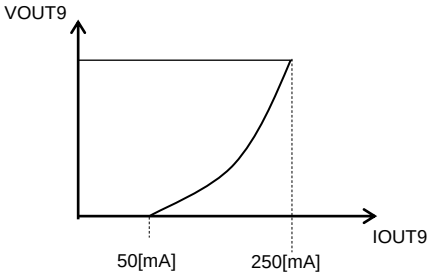
Parts name	Value	Maker	Part number
C_1	2.2[μF]	Taiyo Yuden	JMK107BJ225

・Start-up Sequence



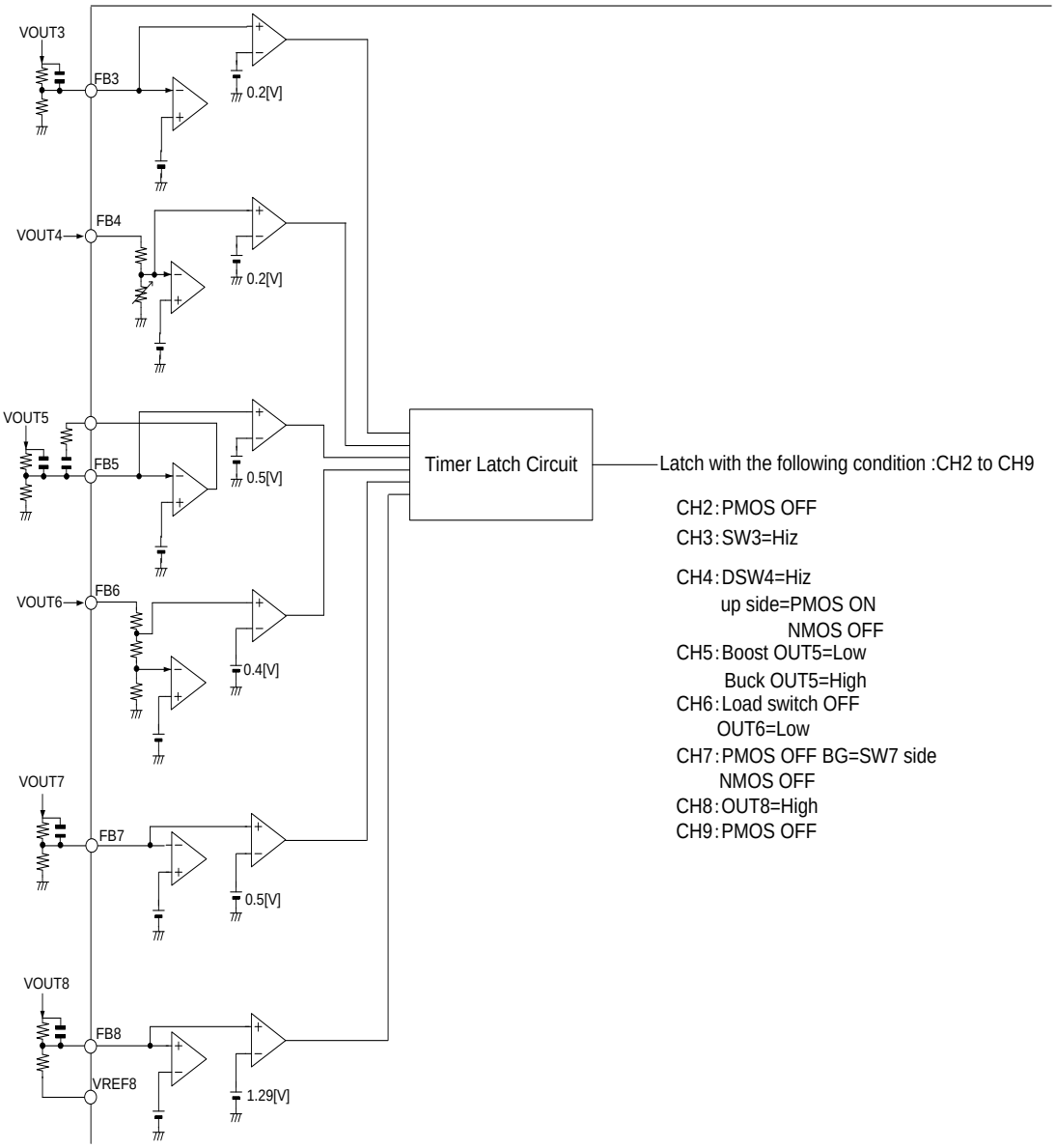
・Over Current Protection

Characteristics of output voltage and output current shown below.



【Short Protection Function】

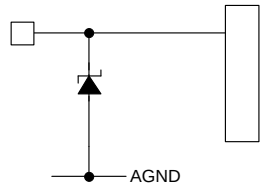
- CH3 to CH8 are monitoring error amp input voltage fed backed from output and enable timer circuit with falling below the detection voltage of short protection circuit. Timer latch circuit will latch power MOS to OFF status of CH2 to CH9 if such condition remained for 1.0[ms]. If VOUT5 is shorted during CH5 Boost setting, Short Protection Circuit will be disabled with falling below the detection voltage of input voltage.
- All channel except CH1 will be latched with any other channels to be over-current and/or shorted.
- Latch will be released either setting XSHDN1=GND, PWM/PFM=GND, XSHDN9=GND or restarting the device.
- Short detection comparator will be disabled by soft start.
- The timer latch circuit doesn't operate in PFM mode.

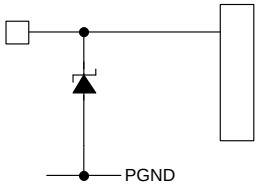


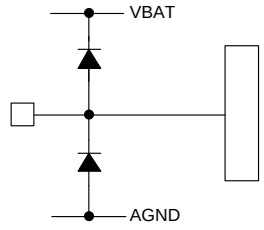
【Thermal shutdown function】

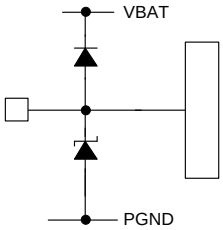
Thermal shutdown function is built in to prevent IC from heat distraction.
Thermal circuit will be disabled by PFM.

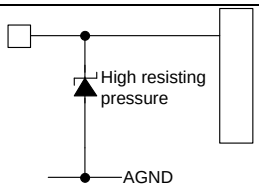
I/O Equivalent Circuits

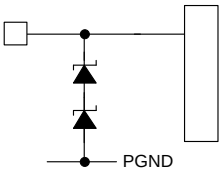
Terminal No.	Terminal Name	Equivalent Circuit
4-G 7-B 4-F 5-G 3-F 2-F 7-F 5-B 6-F 5-F 2-E 4-E 2-C 1-B 7-A 6-A 5-C	XSHDN1 PWM/PFM XSHDN2 XSHDN34 CTL4 XSHDN5 SEL5 XSHDN6 XSHDN78 CONT78 XSHDN9 FB4 VDCO1 VOUT2 VDCO4 VOUT9 VCC	

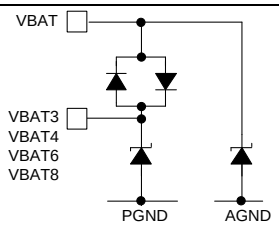
Terminal No.	Terminal Name	Equivalent Circuit
2-D 1-C 2-G, 2-H 3-G, 3-H 4-C 5-A 4-A	PREV1 OUT1 VOUT4 USW4 PREV56 OUT5 OUT6	

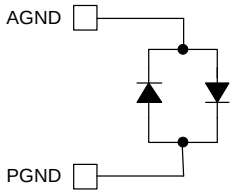
Terminal No.	Terminal Name	Equivalent Circuit
3-E 3-D 5-E 6-E 3-B 7-E 7-D 6-B 8-D 1-A 8-A 1-H 8-H	FB1 FB2 FB3 FB5 FB6.1 FB7 FB8 RESERVE RT A1 A8 H1 H8	

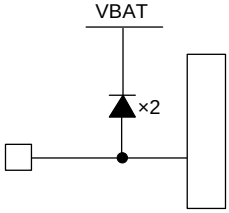
Terminal No.	Terminal Name	Equivalent Circuit
1-F 6-G, 6-H 3-A 8-B	SW3 DSW4 LSO6 OUT8	

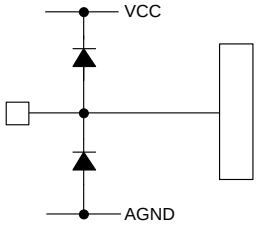
Terminal No.	Terminal Name	Equivalent Circuit
5-D	FB6	

Terminal No.	Terminal Name	Equivalent Circuit
8-G 8-F	VOUT7 SW7	

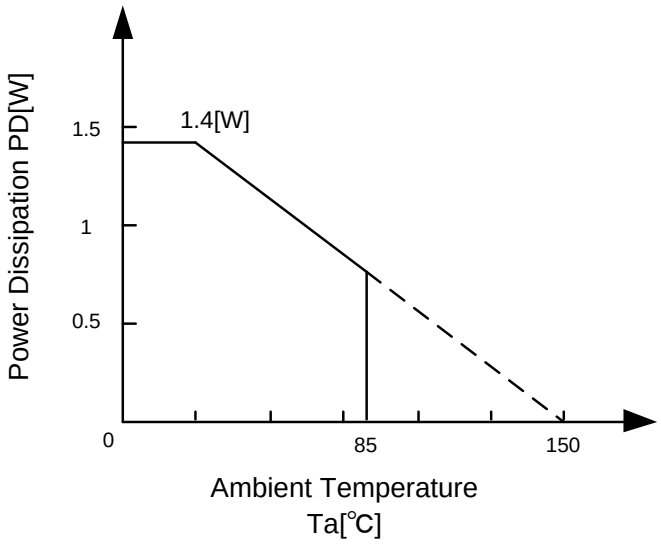
Terminal No.	Terminal Name	Equivalent Circuit
2-B 1-G 7-G, 7-H 2-A 7-C	VBAT VBAT3 VBAT4 VBAT6 VBAT8	

Terminal No.	Terminal Name	Equivalent Circuit
4-D 1-D,1-E 4-H,5-H 4-B 8-E	AGND PGND13 PGND4 PGND56 PGND78	

Terminal No.	Terminal Name	Equivalent Circuit
8-C	VOUT8	

Terminal No.	Terminal Name	Equivalent Circuit
6-C 6-D	AMPOUT5 VREF8	

Power Dissipation



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 20)

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.

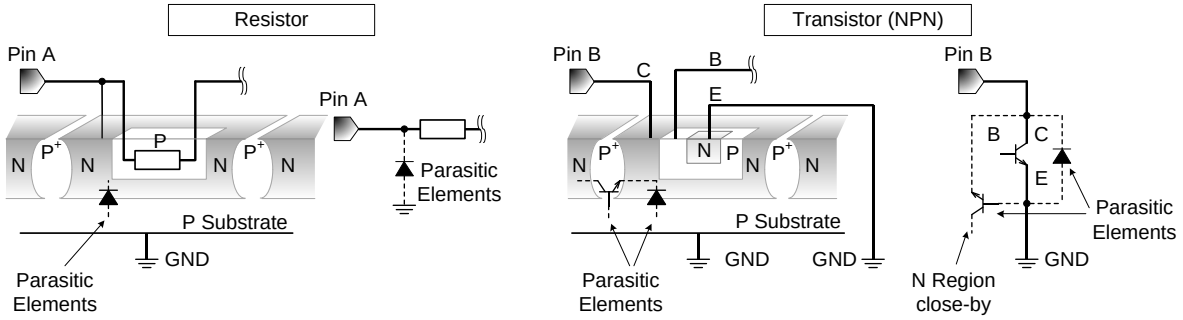


Figure 1. Example of monolithic IC structure

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. Disturbance light

In a device where a portion of silicon is exposed to light such as in a WL-CSP, IC characteristics may be affected due to photoelectric effect. For this reason, it is recommended to come up with countermeasures that will prevent the chip from being exposed to light.

15. Board Patterning

- VBAT,VBAT3,VBAT4,VBAT6,VBAT8 must be connected to the power supply on the board.
- VCC must be connected to VOUT1 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.

16. 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, CH5(Boost) 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.

17. Start-up

- Keep light load condition when starting up the device.
- Switch to PWM mode after CH1 has started up in PFM mode, and the VOUT1 output voltage is stable. CH2 to CH8 should starts after or simultaneously with PWM mode.

18. 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

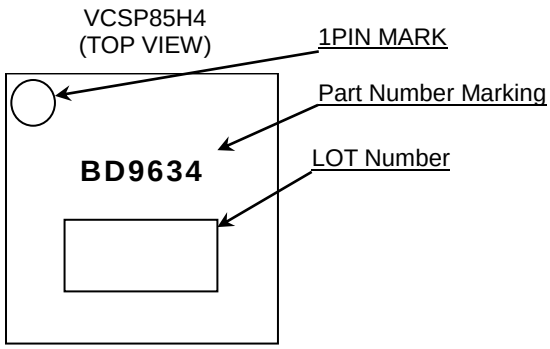
B D 9 6 3 4 G U	-	E 2

Package Name

Package
GU: VCSP85H4

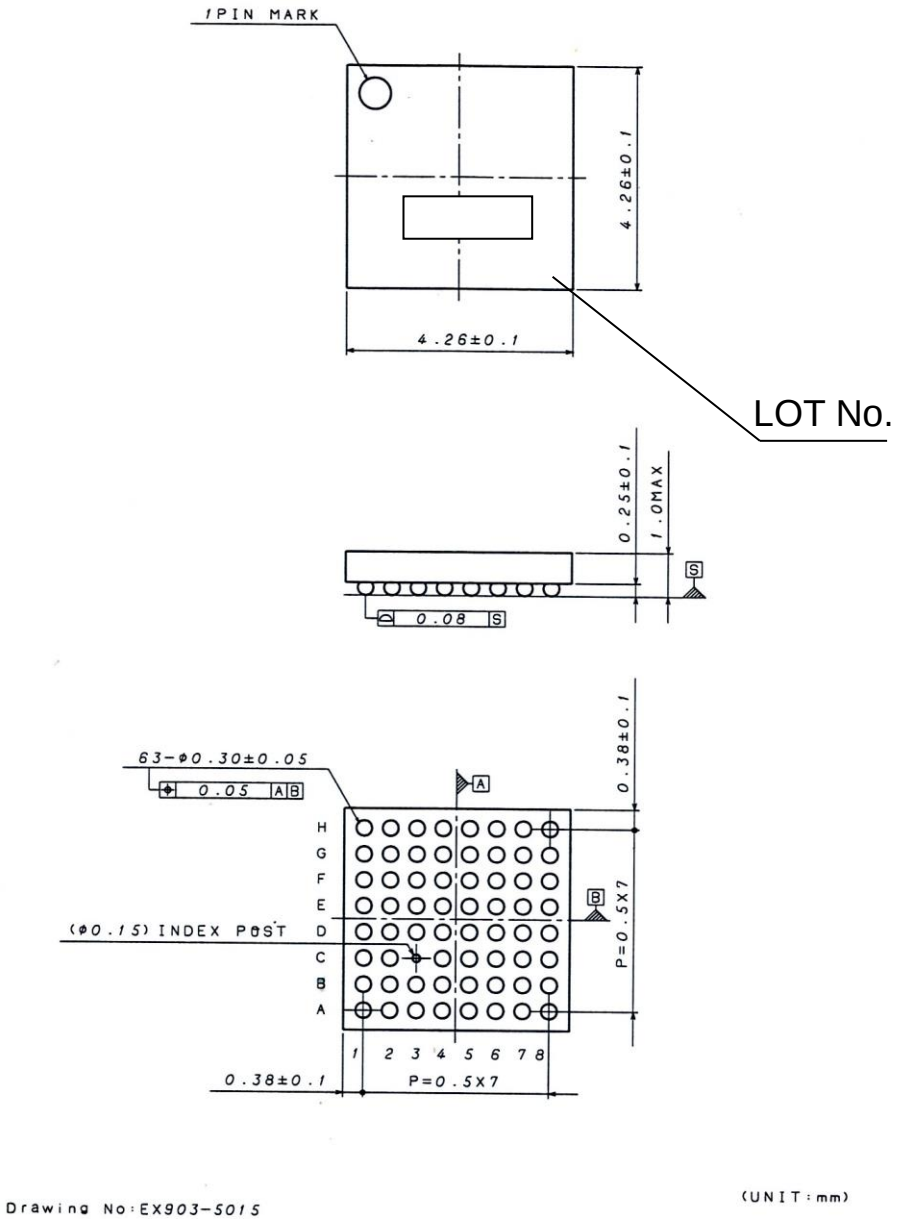
Packaging and forming specification
E2: Embossed tape and reel

Marking Diagram



Physical Dimension, Tape and Reel Information

Package Name	VCSP85H4(BD9634GU)

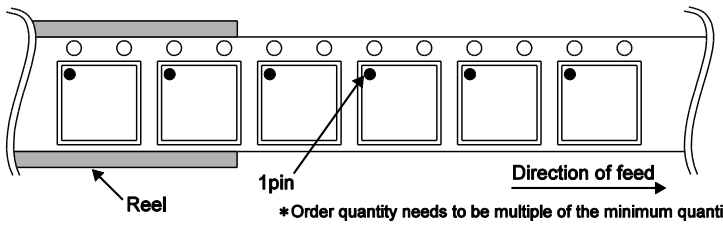


Drawing No: EX903-5015

(UNIT: mm)

<Tape and Reel information>

Tape	Embossed carrier tape (Heat sealed)
Quantity	2500pcs
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
26.Apr.2016	001	New Release

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipments (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 (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:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [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.

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BD9634GU - Web Page

Part Number	BD9634GU
Package	VCSP85H4
Unit Quantity	2500
Minimum Package Quantity	2500
Packing Type	Taping
Constitution Materials List	inquiry
RoHS	Yes