STRUCTURE	Silicon Monolithic Integrate Circuit
TYPE	step down DC/DC converter controller for mobile PC
PRODUCT SERIES	**BD9560MUV**
FEATURES	・DC/DC converter controller. ・Build in MOS-FETs driver ・5-bit DAC for output voltage.

O ABSOLUTE MAXIMUM RATINGS (Ta=25℃)

Parameter	Symbol	Limits	Unit
Input voltage 1	VCC	7 *1*2	V
Input voltage 2	PVCC	7 *1*2	V
Input voltage 3	VIN	35 *1*2	V
BTS voltage	BTS	35 *1*2	V
BTS to SW voltage	BTS-SW	7 *1*2	V
HG to SW voltage	HG-SW	7 *1*2	V
Logic input voltage	LG	PVCC	V
VREF voltage	VREF	VCC	V
VRON input voltage	VRON	7 *1	V
Logic input voltage	CL/SCP/SS/TON/SLLM/VID4-0 PWRGD_C/DAC_C	VCC	V
Logic output voltage 1	PWRGD	7	V
Logic output voltage 2	SUS_OUT	VCC	V
Power dissipation 1	Pd1	0.38 *3	W
Power dissipation 2	Pd2	0.88 *4	W
Operating temperature range	Topr	-10～+100	℃
Storage temperature range	Tstg	-55～+150	℃
Junction temperature range	Tjmax	+150	℃

*1 Do not however exceed Pd.
*2 Instantaneous surge voltage, back electromotive force and voltage under less than 10% duty cycle.
*3 Reduced by 3.0mW for each increase in Ta of 1℃ over 25℃ (when don't mounted on a heat radiation board)
*4 Reduced by 7.0mW for increase in Ta of 1℃ over 25℃. (when mounted on a board 70.0mm×70mm×1.6mm Glass-epoxy PCB.))

O OPERATION SUPPLY VOLTAGE RANGE (Ta=25℃)

Parameter	Symbol	Minimum	Maximum	Unit
Input voltage 1	VCC	4.5	5.5	V
Input voltage 2	PVCC	4.5	5.5	V
Input voltage 3	VIN	4.5	25	V
BTS voltage	BTS	4.5	30	V
SW voltage	SW	-2	25	V
BTS to SW voltage	BTS-SW	4.5	5.5	V
VRON input voltage	VRON	-0.3	5.5	V
Logic input voltage	CL/SCP/SS/TON/SLLM/VID4-0 PWRGD_C/DAC_C	-0.3	VCC+0.3	V
Logic output voltage 1	PWRGD	-0.3	5.5	V
Logic output voltage 2	SUS_OUT	-0.3	VCC	V

★ This product is not designed for protection against radioactive rays.

Status of this document
The Japanese version of this document is the official specification.
This translated version is intended only as a reference, to aid in understanding the official version.
If there are any differences between the original and translated versions of this document, the official Japanese language version takes priority.

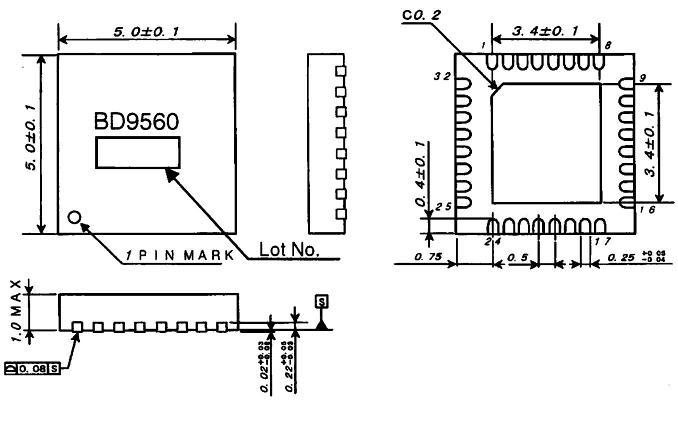
○ ELECTRICAL CHARACTERISTICS (Unless otherwise noted, Ta=25℃, VCC=5V,VIN=12V, VRON=5V,VDAC=1.2811V,SLLM=0V)

Parameter	Symbol	Standard value			Unit	Conditions
		MIN.	TYP.	MAX.		
[Total block]						
VCC bias current	ICC_VCC	-	4	10	mA	VCC=5V
VIN bias current	ICC_VIN	-	20	50	uA	VIN=12V
VCC shut down mode current	IST_VCC	-	0	10	uA	VRON=0V
VIN shut down mode current	IST_VIN	-	0	10	uA	VRON=0V
VRON low voltage	VRON_L	GND	-	0.8	V	
VRON high voltage	VRON_H	2.3	-	5.5	V	
VRON bias current	IVRON	-	10	20	uA	VRON=5V
[Reference voltage block]						
Reference output voltage	VREF	2.475	2.500	2.525	V	IREF=0 to 100uA
Maximum source current	IREF_source	0.5	-	-	mA	
Line regulation	Reg.l	-	0.1	0.3	%/V	VCC=4.5 to 5.5V
Load regulation	Reg.L	-	5	20	mV	IREF=0 to 0.5mA
[Over voltage protection block]						
Threshold voltage	VOVPL	1.400	1.500	1.600	V	
Hysterisys voltage	VOVPH	50	150	250	mV	
[Under voltage lock-out block]						
VCC input threshold voltage	VCC_UVLO	4.0	4.1	4.2	V	VCC: Sweep up
VCC hysterics voltage	dVCC_UVLO	50	100	200	mV	VCC: Sweep down
[VID block]						
VID input high voltage	VVID_H	2.0	-	VCC	V	
VID input low voltage	VVID_L	GND	-	0.8	V	
VID bias current	IVID	-	0	1	uA	VVID=3.3V
DAC delay charge current	IDAC+	90	170	250	uA	
DAC output voltage	VDAC	1.2683	1.2811	1.2939	V	VID[0:4]=0V
[Error amplifier block]						
Output feed back voltage	VFB	VDAC-0.5%	VDAC	VDAC+0.5%	V	
[Current limit protection block]						
Current limit threshold	Ilim	22	30	38	mV	CL=0.48V
CL adjustment range	VCL	0.2	-	1.5	V	
CL bias current	ICL	-	0	1	uA	CL=5V
[Load slope setup block]						
Offset voltage	VLS	-6	0	6	mV	
[Soft start block]						
SS Delay charge current	ISS	1.5	2.0	2.5	uA	
[Short circuit Protection]						
SCP Delay charge current	ISCP	1.5	2.0	2.5	uA	
[SLLM block]						
Continuous mode threshold	Vthcon	GND	-	0.5	V	
SLLM threshold	$VthSL^2M$	VCC-0.5	-	VCC	V	
[On time pulse width]						
On time pulse width	Fosc	250	350	450	ns	TON=1V
TON adjustment voltage	VTON	0.2	-	2.0	V	
TON bias current	ITON	-	0	1	uA	TON=5V
[OFF time width]						
Min off time	MinOff	0.25	0.5	1.0	us	
[Driver block]						
HG high side ON resistor	RonHGH	-	1	2	Ohm	
HG low side ON resistor	RonHGL	-	1	2	Ohm	
LG high side ON resistor	RonLGH	-	1	2	Ohm	
LG high side ON resistor	RonLGL	-	0.5	1	Ohm	
[Power good block]						
PWRGD Low threshold voltage	PGDLow	VDAC -400mV	VDAC -300mV	VDAC -200mV	V	
PWRGD High threshold voltage	PGDHigh	VDAC +100mV	VDAC +200mV	VDAC +300mV	V	
PWRGD Output voltage	VPWRGD	-	-	0.4	V	IPRGD=4mA
PWRGD Output leakage current	PGDLeak	-	-	10	uA	PWRGD=3.6V
PWRGD_C Delay charge current	IPD	1.5	2.0	2.5	uA	

○ DAC code table

State	Enable	VID4	VID3	VID2	VID1	VID0	VCCGFX	VDAC	SUS OUT
Render Performance States	1	0	0	0	0	0	1.28750V	1.2811V	0
	1	0	0	0	0	1	1.26175V	1.2554V	0
	1	0	0	0	1	0	1.23600V	1.2298V	0
	1	0	0	0	1	1	1.21025V	1.2042V	0
	1	0	0	1	0	0	1.18450V	1.1786V	0
	1	0	0	1	0	1	1.15875V	1.1530V	0
	1	0	0	1	1	0	1.13300V	1.1273V	0
	1	0	0	1	1	1	1.10725V	1.1017V	0
	1	0	1	0	0	0	1.08150V	1.0761V	0
	1	0	1	0	0	1	1.05575V	1.0505V	0
	1	0	1	0	1	0	1.03000V	1.0249V	0
	1	0	1	0	1	1	1.00425V	0.9992V	0
	1	0	1	1	0	0	0.97850V	0.9736V	0
	1	0	1	1	0	1	0.95275V	0.9480V	0
	1	0	1	1	1	0	0.92700V	0.9224V	0
	1	0	1	1	1	1	0.90125V	0.8967V	0
	1	1	0	0	0	0	0.87550V	0.8711V	0
	1	1	0	0	0	1	0.84975V	0.8455V	0
Render Sleep States	1	1	0	0	1	0	0.82400V	0.8199V	1
	1	1	0	0	1	1	0.79825V	0.7943V	1
	1	1	0	1	0	0	0.77250V	0.7686V	1
	1	1	0	1	0	1	0.74675V	0.7430V	1
	1	1	0	1	1	0	0.72100V	0.7174V	1
	1	1	0	1	1	1	0.69525V	0.6918V	1
	1	1	1	0	0	0	0.66950V	0.6662V	1
	1	1	1	0	0	1	0.64375V	0.6405V	1
	1	1	1	0	1	0	0.61800V	0.6149V	1
	1	1	1	0	1	1	0.59225V	0.5893V	1
	1	1	1	1	0	0	0.56650V	0.5637V	1
	1	1	1	1	0	1	0.54075V	0.5380V	1
	1	1	1	1	1	0	0.51500V	0.5124V	1
	1	1	1	1	1	1	0.41200V	0.4099V	1
	0	×	×	×	×	×	0.000V	×	1

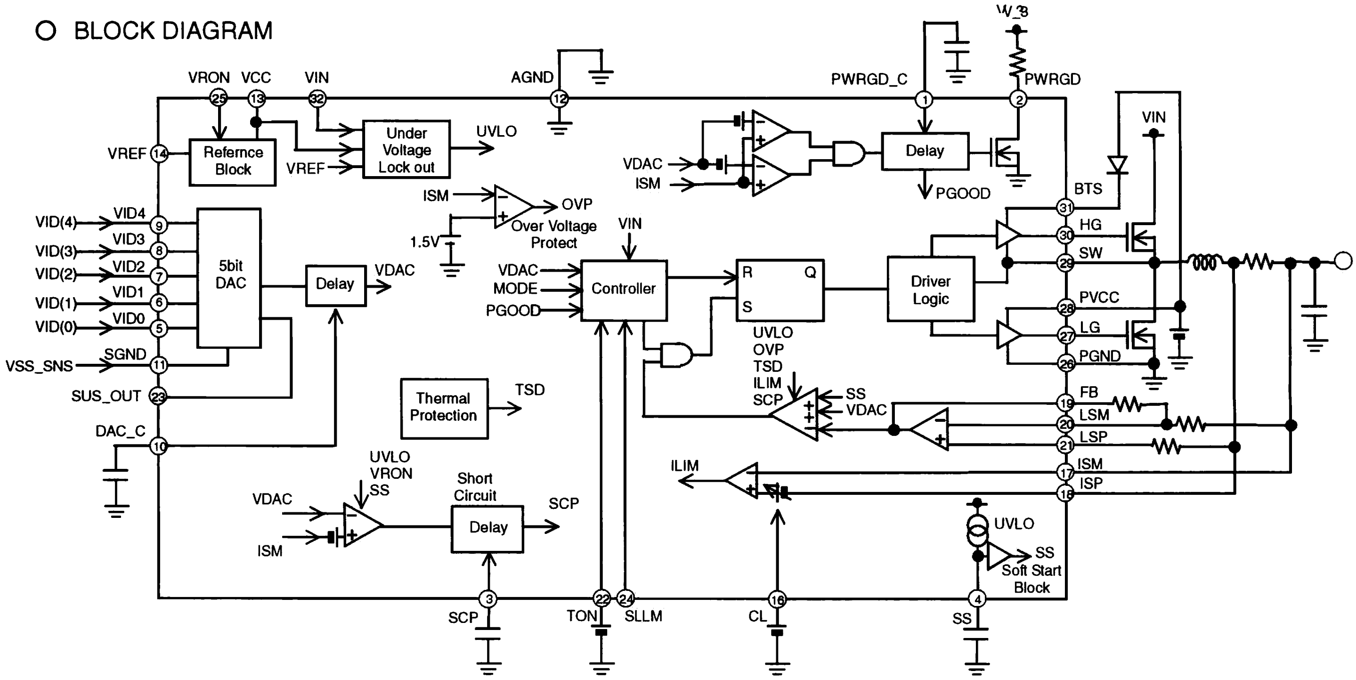
○ PHYSICAL DIMENSIONS



VQFN032V5050 (Unit:mm)

Pin No.	Pin name	Pin No.	Pin name
1	PWRGD_C	17	ISP
2	PWRGD	18	ISM
3	SCP	19	LSM
4	SS	20	LSP
5	VID0	21	FB
6	VID1	22	TON
7	VID2	23	SUS_OUT
8	VID3	24	SLLM
9	VID4	25	VRON
10	DAC_C	26	PGND
11	SGND	27	LG
12	GND	28	PVCC
13	VCC	29	SW
14	VREF	30	HG
15	NC	31	BTS
16	CL	32	VIN

○ BLOCK DIAGRAM



BD9560MUV BLOCK DIAGRAM

○ NOTE FOR USE

(1) Absolute maximum rating

The device may be destroyed when applied voltage or operating temperature exceeds its absolute maximum rating. Because the source, such as short mode or open mode, cannot be identified if the device is destroyed, it is important to take physical safety measures (such as fusing) if a special mode in excess of absolute rating limits is to be implemented.

(2) Supply line

Since the motor's reverse electromotive force gives rise to the return of regenerative current, measures should be taken to establish a channel for the current, such as adding a capacitor between the power supply and GND. In determining the approach to take, make sure that no problems will be posed by the various characteristics involved, such as capacitance loss at low temperatures with an electrolytic capacitor.

(3) GND potential

Make sure the potential for the GND pin is always kept lower than the potentials of all other pins, regardless of the operating mode.

(4) Thermal design

Be sure to factor in allowable power dissipation (Pd) in actual operation, and to build sufficient margin into the thermal design to accommodate this power loss.

(5) Operation in strong magnetic fields

Use in strong electromagnetic fields may cause malfunctions. Exercise caution with respect to electromagnetic fields.

(6) ASO

Set the parameters so that output Tr will not exceed the absolute maximum rating or ASO value when the IC is used.

(7) Thermal shutdown circuit

This IC is provided with a built-in thermal shutdown (TSD) circuit, which is activated when the chip temperature reaches the threshold value listed below. When TSD is on, the device goes to high impedance mode. Note that the TSD circuit is provided for the exclusive purpose shutting down the IC in the presence of extreme heat, and is not designed to protect the IC per se or guarantee performance when or after extreme heat conditions occur. Therefore, do not operate the IC with the expectation of continued use or subsequent operation once the TSD is activated.

TSD ON temperature [℃] (typ.)	Hysteresis temperature[℃] (typ.)
175	15

(8) Ground wiring pattern

When both a small-signal GND and high current GND are present, single-point grounding (at the set standard point) is recommended, in order to separate the small-signal and high current patterns, and to be sure the voltage change stemming from the wiring resistance and high current does not cause any voltage change in the small-signal GND. In the same way, care must be taken to avoid wiring pattern fluctuations in any connected external component GND.

(9) Heat sink (FIN)

Since the heat sink (FIN) is connected with the Sub, short it to the GND.

(10) Short-circuits between pins and and mounting errors

When mounting the IC onto a set substrate or circuit board, be careful to avoid incorrect orientation or mis-positioning of the IC, as such mounting errors may cause device malfunctions. Similar damage may occur when the power supply connection is reversed. Also, note that the introduction of foreign material between pins and the GND, or between the pins themselves may cause shorts and destroy the IC.

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As of 18th. April 2005