

STRUCTURE

Silicon Monolithic Integrated Circuit

PRODUCT SERIES

7-Channel Switching Regulator Controller for Digital Camera

TYPE

**BD9756AMW**

PIN ASSIGNMENT

Fig.1

BLOCK DIAGRAM

Fig.1

PACKAGE

Fig.2

Functions

- 1.5V minimum input operating
- Supplies power for the internal circuit by using charge-pump circuit which outputs a voltage twice bigger than VBAT voltage, or a equal voltage as VBAT + VIN.
- Contains step-up converter(1ch), step-down converter(2ch), cross converter(1ch), configurable for step-up/step-down converter(1ch), with PWM brightness controller for step-up converter(1ch).
- Contains 4FETs for the cross converter channel.
- 3channels contain transistor for synchronous rectifying action mode.
- 2channels contain FETs for the step-up converter.
- All channels contain internal compensation between inputs outputs of error amps.
- Contains sequence control circuit for ch1,2 and 4.
- Operating frequency 1.2MHz(CH1~4), 600kHz(CH5~7).
- Contains output interception circuit when over load.
- 2 channels have high side switches with soft start function, one channel has PMOS back gate control circuit.
- Thermally enhanced UQFN044V6060 package.(6mm x 6mm, 0.4mm pitch)

## ○ Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Limits	Units
Power Supply Voltage	VBAT	-03~7	V
	VHx1~4	-0.3~7	V
	HS67H	-0.3~7	V
	VLx6~7	-0.3~20	V
	VIN	-0.3~7	V
Output Current	ImaxLx1	±12	A
	ImaxHx2	±15	A
	ImaxHx3~4	±12	A
	ImaxHS6~7	±12	A
	ImaxLx6~7	±0.8	A
Power Dissipation	Pd	0.54 *1	W
Operating Temperature	Topr	-25~+85	°C
Storage Temperature	Tstg	-55~+150	°C
Junction Temperature	Tjmax	+150	°C

(\*1) Without external heat sink, the power dissipation reduces by 4.32mW/°C over 25°C.

## ○ Recommended operating conditions

Parameter	Symbol	Spec			Unit
		MIN	TYP	MAX	
Power Supply Voltage	VBAT	1.5	-	5.5	V
VREF Pin Connecting Capacitor	CVREF	0.47	1.0	4.7	μF
VREGA Pin Connecting Capacitor	CVREGA	0.47	1.0	4.7	μF
SCP Pin Connecting Capacitor	CSCP	-	-	0.47	μF
C <sub>H1</sub> to C <sub>H1</sub> connecting Capacitor	CF	1.0	-	-	μF
【Oscillator】					
Oscillator Frequency	fosc	0.6	1.2	1.5	MHz
OSC Timing Resistor	RT	47	62	120	kΩ

Status of this document

The Japanese version of this document is the official specification. Please use the translation version of this document as a reference to expedite understanding of the official version. If there are any uncertainty in translation version of this document, official version takes priority.

○Electrical characteristics (Ta=25°C, VBAT=3V, RT=62k, STB1~6=3V, PWM7=2.5V)

Parameter	Symbol	Standard value			Units	Conditions
		Min	Typ	Max		
【Charge Pump Circuit】						
Output Voltage (Regulated)	V <sub>out1</sub>	52	54	—	V	I <sub>o</sub> =1mA, INV1~7=1.2V NON5=−0.2V
Output Voltage (X2 Step up)	V <sub>out2</sub>	4.5	48	—	V	Only for internal Current VBAT=25V, INV1~7=1.2V NON5=−0.2V
Output Resistance	V <sub>pro</sub>	—	35	50	Ω	CF=1μF, VBAT=25V
Operating Frequency	f <sub>op</sub>	60	75	90	kHz	RT=62kΩ
Minimum VBAT Voltage	V <sub>st1</sub>	15	—	—	V	
【Internal Regulator VREGA】						
Output Voltage	V <sub>REGA</sub>	24	25	26	V	I <sub>o</sub> =5mA
【Prevention Circuit of Miss Operation by Low voltage Input】						
Threshold Voltage	V <sub>std1</sub>	—	2.15	2.30	V	VREGA Monitor
Hysteresis Width	ΔV <sub>std1</sub>	50	100	200	mA	
【Short Circuit Protection】						
Timer start threshold voltage	V <sub>tcinv</sub>	0.42	0.48	0.54	V	INV monitor CH4
SCP Stand by Voltage	V <sub>ssc</sub>	—	22	170	mV	
SCP Out Source Current	I <sub>scp</sub>	2	4	6	μA	V <sub>scp</sub> =0.1V
SCP Threshold Voltage	V <sub>scp</sub>	0.9	1.0	1.1	V	
【Oscillator】						
Frequency CH1~4	f <sub>osc1</sub>	1.0	1.2	1.4	MHz	RT=62kΩ
Frequency CH5~7	f <sub>osc2</sub>	0.5	0.6	0.7	MHz	RT=62kΩ
Max Duty 1.3.4(Step Down)	D <sub>max1d</sub>	—	—	100	%	V <sub>scp</sub> =0V (※1)
Max Duty 1.4(Step Up)	D <sub>max1u</sub>	86	92	96	%	
Max Duty 5.6.7	D <sub>max2</sub>	86	92	96	%	
Max Duty CH2 LX21	D <sub>max3</sub>	—	—	100	%	
Max Duty CH2 LX22	D <sub>max4</sub>	78	84	90	%	
【Error AMP】						
Input Bias Current	I <sub>INV</sub>	—	0	50	nA	INV1~7, NON5=3.0V
INV Threshold Voltage1	V <sub>INV1</sub>	0.79	0.80	0.81	V	CH1~4
INV Threshold Voltage2	V <sub>INV2</sub>	0.99	1.00	1.01	V	CH6,7V
INV Threshold Voltage3	V <sub>INV3</sub>	513	540	567	mV	CH7I
【Base Bias Voltage Vref for inverted Channel】						
CH5	V <sub>OUT5</sub>	−6.09	−6.00	−5.91	V	NON5 resistor 12kΩ, 72kΩ (※2)
Output Voltage	DVL <sub>i</sub>	—	4.0	125	mV	CPOUT=1.5~55V
Output Current When shorted	I <sub>os</sub>	0.2	1.0	—	mA	V <sub>ref</sub> =0V
【Soft Start】						
CH124 Soft Start Time	T <sub>ss124</sub>	1.5	2.5	3.5	msec	RT=62kΩ
CH3 Soft Start Time	T <sub>ss3</sub>	0.5	1.5	2.5	msec	RT=62kΩ
CH5 Soft Start Time	T <sub>ss5</sub>	1.5	2.5	3.5	msec	RT=62kΩ
CH6 Soft Start Time	T <sub>ss6</sub>	20	30	40	msec	RT=62kΩ
CH7 Soft Start Time	T <sub>ss7</sub>	4.7	5.7	6.7	msec	RT=62kΩ
【Output Driver】						
CH1 Highside SW ON Resistance	R <sub>ON1P</sub>	—	160	380	mΩ	HX1=3V, CPOUT=5.4V
CH1 Lowside SW ON Resistance	R <sub>ON1N</sub>	—	130	180	mΩ	CPOUT=5.4V
CH2 LX21Pin Highside SW ON Resistance	R <sub>ON21P</sub>	—	160	240	mΩ	HX2=3.0V, CPOUT=5.4V
CH2 LX21Pin Lowside SW ON Resistance	R <sub>ON21N</sub>	—	130	200	mΩ	CPOUT=5.4V
CH2 LX22Pin Highside SW ON Resistance	R <sub>ON22P</sub>	—	180	280	mΩ	V <sub>OUT2</sub> =50V
CH2 LX22Pin Lowside SW ON Resistance	R <sub>ON22N</sub>	—	130	200	mΩ	CPOUT=5.4V
CH3 Highside SW ON Resistance	R <sub>ON3P</sub>	—	160	260	mΩ	HX3=3.0V, CPOUT=5.4V
CH3 Lowside SW ON Resistance	R <sub>ON3N</sub>	—	130	200	mΩ	CPOUT=5.4V
CH4 Highside SW ON Resistance	R <sub>ON4P</sub>	—	280	380	mΩ	HX4=5.0V
CH4 Lowside SW ON Resistance	R <sub>ON4N</sub>	—	130	200	mΩ	CPOUT=5.4V
CH6 NMOS SW ON Resistance	R <sub>ON6N</sub>	—	500	800	mΩ	CPOUT=5.4V
CH6.7 Load SW ON Resistance	R <sub>ON67P</sub>	—	200	300	mΩ	HS67H=30V CPOUT=5.4V
CH5 Driver Output Voltage H	V <sub>out5H</sub>	P <sub>VCC5</sub> −15	P <sub>VCC5</sub> −10	—	V	I <sub>OUT5</sub> =50mA, NON5=0.2V, PVCC5=3V
CH5 Driver Output Voltage L	V <sub>out5L</sub>	—	0.5	1.0	V	I <sub>OUT5</sub> =50mA, NON5=−0.2V
【Switch to configure step up/down】						
UDSEL4 Control Voltage	Step down	V <sub>UDDO</sub>	CPOUT ×0.7	—	CPOUT	V
	Step up	V <sub>UDUP</sub>	0	—	CPOUT ×0.3	V
【STB1~6】						
STB control Voltage	Active	V <sub>STBH1</sub>	1.5	—	5.5	V
	Non Active	V <sub>STBL1</sub>	−0.3	—	0.3	V
Pull down Resistance	R <sub>STB1</sub>	250	400	700	kΩ	
【PWM7】						
PWM7 control Voltage	Active	V <sub>PWMH1</sub>	1.5	—	4.0	V
	Non Active	V <sub>PWML1</sub>	0	—	0.4	V
Pull down Resistance	R <sub>PWM1</sub>	30	50	80	kΩ	
【Circuit Current】						
Stand-by Current	V <sub>BAT</sub> terminal	I <sub>STB1</sub>	—	—	5	μA
	HX terminal	I <sub>STB2</sub>	—	—	5	μA
	LX terminal	I <sub>STB3</sub>	—	—	5	μA
	HS67H terminal	I <sub>STB4</sub>	—	—	5	μA
Circuit Current1 (V <sub>BAT</sub> current when voltage supplied for the terminal)	I <sub>cc1</sub>	—	7.0	11.0	mA	INV1~7=1.2V, NON5=−0.2V, V <sub>BAT</sub> =30V
Circuit Current2 (CPOUT current when voltage supplied for the terminal)	I <sub>cc2</sub>	—	3.0	5.0	mA	INV1~7=1.2V, NON5=−0.2V, CPOUT=5.4V C <sub>H</sub> , C <sub>L</sub> =OPEN

(※1)The protective circuit start working when circuit is operated by 100% duty.

So it is possible to use only for transition time shorter than charge time for SCP.

(※2) Recommend resistor value over 20k $\Omega$  between VREF to NON5, because VREF current is under 100 $\mu$ A.

◎This product is not designed for normal operation with in a radioactive environment

OPin Assignment • Block Diagram

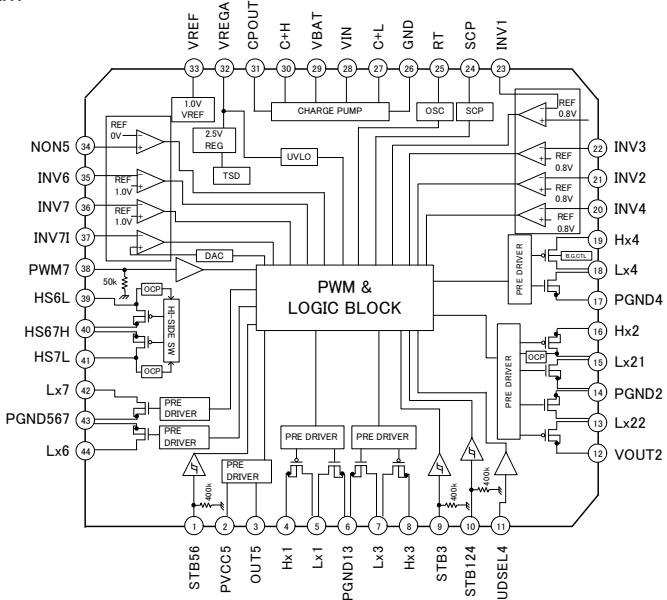


Fig. 1

OPin Description

Pin Name	Description
VBAT	Input for battery voltage
VIN	Returning voltage from output terminal
CPOUT	Output terminal for Charge Pump
GND	Ground terminal
C+H	Terminal for connecting flying capacitor for Charge Pump(H side)
C+L	Terminal for connecting flying capacitor for Charge Pump(L side)
PGND13,24,567	Ground terminal for internal FET
VREGA	VREGA output
VREF	CH5 base bias voltage
PVCC5	CH5 PMOS VCC input for driver

Pin Name	Description
OUT5	Terminal for connecting gate of CH5 PMOS
Hx1,3,4	Input terminal for synchronous High side switch, Power supply for Pch Driver
Lx1,3,4,6,7	Terminal for connecting inductors
Hx2	Power supply for channel 2
Lx21	Terminal for connecting inductor for CH2 input
Lx22	Terminal for connecting inductor for CH2 output
VOUT2	CH2 output voltage
HS67H	Power supply for internal load switch
HS6L,HS7L	Output terminal for internal load switch
INV1,2,3,4,6,7	Error AMP inverted input
NON5	Error AMP non-inverted input

Pin Name	Description
INV7I	Error AMP inverted input
RT	For connecting a resistor to set the OSC frequency
SCP	For connecting a capacitor to set up the delay time of the SCP
UDSEL4	Step-up/down switching mode selection(H: step-down, L: step-up)
STB124,3,56	ON/OFF switch H: operating over 1.5V
PWM7	ON/OFF switch Duty input for PWM brightness control

OPackage

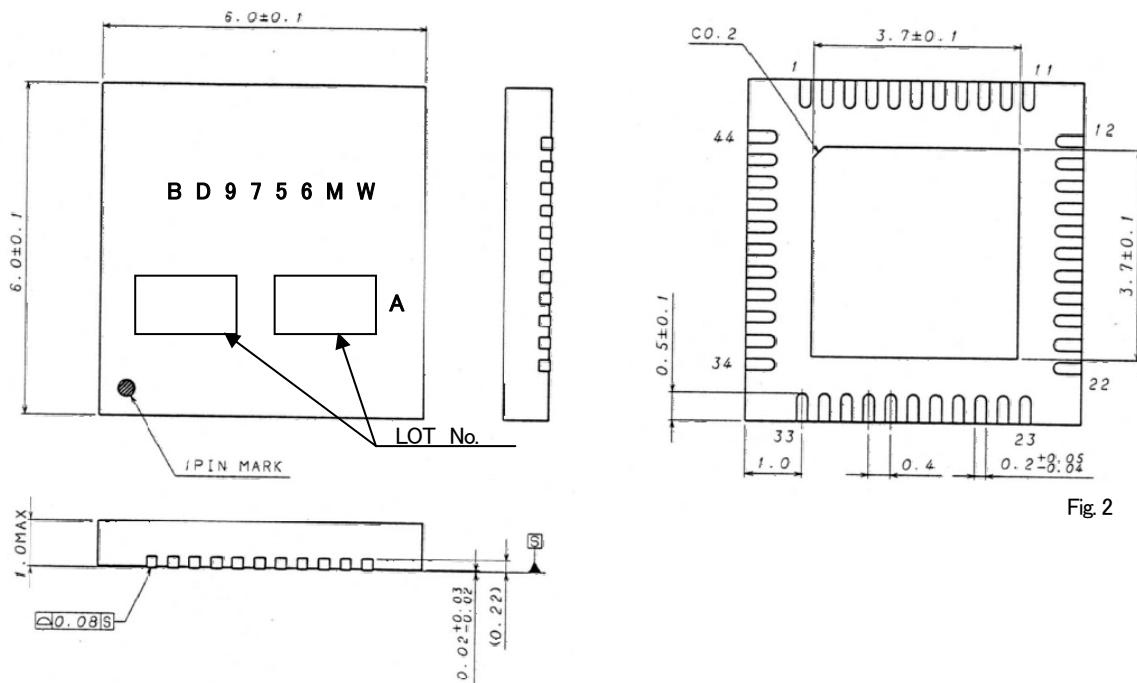


Fig. 2

Operation Notes

1.) Absolute maximum ratings

This product is produced with strict quality control. However, the IC may be destroyed if operated beyond its absolute maximum ratings. If the device is destroyed by exceeding the recommended maximum ratings, the failure mode will be difficult to determine. (E.g. short mode, open mode) Therefore, physical protection counter-measures (like fuse) should be implemented when operating conditions beyond the absolute maximum ratings anticipated.

2.) GND potential

Make sure GND is connected at lowest potential. All pins except NON5, must not have voltage below GND. Also, NON5 pin must not have voltage below - 0.3V on start up.

3.) Setting of heat

Make sure that power dissipation does not exceed maximum ratings.

4.) Pin short and mistake fitting

Avoid placing the IC near hot part of the PCB. This may cause damage to IC. Also make sure that the output-to-output and output to GND condition will not happen because this may damage the IC.

5.) Actions in strong magnetic field

Exposing the IC within a strong magnetic field area may cause malfunction.

6.) Mutual impedance

Use short and wide wiring tracks for the main supply and ground to keep the mutual impedance as small as possible. Use inductor and capacitor network to keep the ripple voltage minimum.

7.) Voltage of STB pin

The threshold voltages of STB pin are 0.3V and 1.5V. STB state is set below 0.3V while action state is set beyond 1.5V.

The region between 0.3V and 1.5V is not recommended and may cause improper operation.

The rise and fall time must be under 10msec. In case to put capacitor to STB pin, it is recommended to use under 0.01  $\mu$ F.

8.) Thermal shutdown circuit (TSD circuit)

The IC incorporates a built-in thermal shutdown circuit (TSD circuit). The thermal shutdown circuit (TSD circuit) is designed only to shut the IC off to prevent runaway thermal operation. It is not designed to protect the IC or guarantee its operation. Do not continue to use the IC after operating this circuit or use the IC in an environment where the operation of this circuit is assumed.

9.) Rush current at the time of power supply injection.

An IC which has plural power supplies, or CMOS IC could have momentary rush current at the time of power supply injection.

Please take care about power supply coupling capacity and width of power Supply and GND pattern wiring.

10.) IC Terminal Input

This IC is a monolithic IC that has a P- board and P+ isolation for the purpose of keeping distance between elements. A P-N junction is formed between the P-layer and the N-layer of each element, and various types of parasitic elements are then formed.

For example, an application where a resistor and a transistor are connected to a terminal (shown in Fig.15):

○When GND > (terminal A) at the resistor and GND > (terminal B) at the transistor (NPN), the P-N junction operates as a parasitic diode.

○When GND > (terminal B) at the transistor (NPN), a parasitic NPN transistor operates as a result of the NHayers of other elements in the proximity of the aforementioned parasitic diode.

Parasitic elements are structurally inevitable in the IC due to electric potential relationships. The operation of parasitic elements induces the interference of circuit operations, causing malfunctions and possibly the destruction of the IC. Please be careful not to use the IC in a way that would cause parasitic elements to operate. For example, by applying a voltage that is lower than the GND (P-board) to the input terminal.

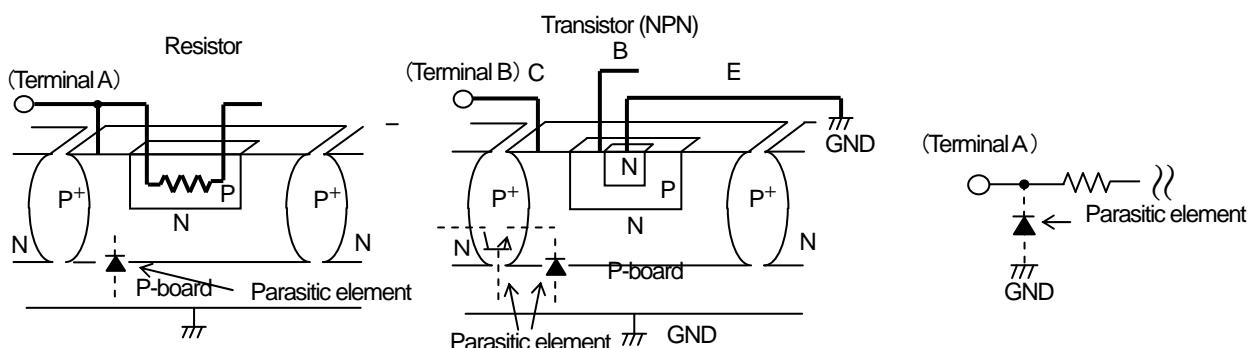


Fig - 3 Simplified structure of a Bipolar IC

## Notes

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