STRUCTURE Silicon Monolithic Integrated Circuit
PRODUCT SERIES 7-Channel Switching Regulator Controller for Digital Camera
TYPE **BD9353MWV**
PIN ASSIGNMENT Fig.1
BLOCK DIAGRAM Fig.1
PACKAGE Fig.2

Functions
- Power supply voltage 2.2～5.5V(at start-up), 2.05～5.5V(after start-up)
- CH1step-down converter, CH2cross converter, CH3 step-down converter, CH4 step-up converter CH5 inverting converter for CCD, CH6 boost converter for CCD, CH7 boost converter for LED
- All Internal Power MOSFETs
- Built-In MOSFETs for synchronous rectifying action mode on CH1～4
- Built-In feedback resistors on CH2
- All channels contain internal compensation between inputs outputs of error amps
- Contains sequence control circuit for CH1～4
- Operating frequency 1.5MHz(CH1,3,4)、750KHz（CH2,5,6,7）
- Built-In Short-circuit Protection (SCP)
- CH6 have high side switches with soft start function
- Built-In Over voltage Protection (OVP)
- Thermally enhanced UQFN036V5050 package（5mm×5mm, 0.4mm pitch）

○Absolute maximum ratings（Ta＝25℃）

Parameter	Symbol	Limit	Unit
Power Input Voltage	VCC,Hx13,Hx2, Hx4,Hx567,VO2,HS6L	−0.3～7	V
	STB1234,56	−0.3～7	V
	PWM7	−0.3～7	V
	Hx5 - Lx5	-0.3～15	V
	Lx6	−0.3～20	V
	Lx7,VO7	-0.3～21	V
Output current	IomaxLx1	±0.8	A
	IomaxHx2	±1.5	A
	IomaxHx3	±0.8	A
	IomaxHx4,Lx4	±2.2	A
	IomaxHx5	±1.5	A
	IomaxHS6L	±1.2	A
	IomaxLx6～7	±1.2	A
Power Dissipation	Pd	0.88 *1	W
Operating Temperature	Topr	−25～+85	℃
Storage Temperature	Tstg	−55～+150	℃
Junction Temperature	Tjmax	+150	℃

*1 Should be derated by 7.04mW/℃ at Ta=25℃ or more. When mounted on a glass epoxy PCB of 74.2mm×74.2 mm×1.6 mm

○Recommended operating conditions

Parameter	Symbol	Limit			Unit
		MIN	TYP	MAX	
Power Supply Voltage (at start-up)	VCC1	2.2	-	5.5	V
Power Supply Voltage (after start-up)	VCC2	2.05	-	5.5	V
VREF Pin Connecting Catacitor	CVREF	0.047	0.1	0.47	μF
VREGA Pin Connecting Capacitor	CVREGA	0.47	1.0	4.7	μF
PWM7 freqency	fpwm	20	-	100	kHz
【Oscillator】					
Oscillator (CH1,3,4)	fosc	0.8	1.5	1.8	MHz
OSC Timing Resistor	RT	47	62	120	kΩ

○Electrical characteristics（Ta=25℃, VCC=3V, RT=62kΩ, STB1～6=3V,PWM7=2.5V）

Parameter	Symbol	Standard Value			Unit	Condition
		MIN	TYP	MAX		
【Internal Regulator VREGA】						
Output Voltage	VREGA	2.125	2.2	2.275	V	Io=5mA
【Under Voltage Lockout】						
VCC startup voltage Threshold	Vuv1	–	1.95	2.05	V	
VCC minimum operating voltage after Turn-On	Vuv2	–	2.05	2.15	V	
VREGA startup voltage Threshold	Vuv3	–	–	2.025	V	VCC=2.2V
VREGA minimum operating voltage after Turn-On	Vuv4	–	–	2.15	V	VCC=2.2V
【Short Circuit Protection】						
Timer Startup Threshold	Vtcinv	0.42	0.48	0.54	V	INV pin monitor CH4
Delay time for SCP 1	Tscp	50	70	90	msec	CH1～3,5～7
Delay time for SCP 2	Tscp4	7	10	13	msec	CH4
【Oscillator】						
Frequency CH1,3,4	fosc1	1.3	1.5	1.7	MHz	RT=62kΩ
Rrequency CH2,5,6,7	fosc2	0.65	0.75	0.85	MHz	RT=62kΩ
Max duty 1,3	Dmax1d	–	–	100	%	Vscp=0V （※1）
Max duty 4	Dmax1u	86	92	96	%	
Max duty 5,6,7	Dmax2	86	92	96	%	
Max duty CH2 Lx21	Dmax3	–	–	100	%	
Max duty CH2 Lx22	Dmax4	86	92	96	%	
【Error AMP】						
Input Bias Current	IINV	–	0	50	nA	INV1,3～6=3.0V
INV Threshold	VINV	0.79	0.80	0.81	V	CH1,3～6
INV7 Threshold 1	VINV71	598	630	662	mV	PWM7 Duty=100%
INV7 Threshold 2	VINV72	449	473	497	mV	PWM7 Duty=75%
INV7 Threshold 3	VINV73	234	252	270	mV	PWM7 Duty=40%
INV7 Threshold 4	VINV74	17	32	47	mV	PWM7 Duty=5%
【CH2 Feedback】						
CH2 Output Voltage	VO2	3.332	3.4	3.468	V	
VO2S Input Current	IVO2S	4.7	6.7	8.7	uA	VO2S= 3.4V
【Reference Voltage Vref for CH5】						
CH5 Output Voltage	VOUT5	−6.09	−6.00	−5.91	V	INV5 1M//200kΩ, 1MΩ(※2)
Line Regulation	DVLi	–	4.0	12.5	mV	VCC= 2.2～5V
Output Current When shorted	Ios	0.2	1.0	–	mA	VREF5=0V

Parameter		Symbol	Standard Value			Unit	Condition
			MIN	TYP	MAX		
【Soft Start】							
CH1,2,4 Soft Start time		Tss1,2,4	1.5	2.5	3.5	msec	RT=62kΩ
CH3 Soft Start time		Tss3	0.5	1.5	2.5	msec	RT=62kΩ
CH5 Soft Start time		Tss5	1.8	2.8	3.8	msec	RT=62kΩ
CH6 Soft Start time		Tss6	2.5	3.5	4.5	msec	RT=62kΩ
CH7 Soft Start time		TDTC	1.3	2.6	5.2	msec	L=6.4μH, Co=4.7μF LED 3pcs (※3)
CH1～4 Delay time for Soft Start		Td1	9	15	21	msec	RT=62kΩ
CH 5,6 Delay time for Soft Start		Td56	0.23	0.42	0.61	msec	RT=62kΩ, STB1234=H
【Output Driver】							
CH1 Highside SW ON resisitance		RON1P	–	300	450	mΩ	Hx1=3.6V
CH1 Lowside SW ON resistance		RON1N	–	230	350	mΩ	Hx1=3.6V
CH2 Lx21 Highside SW ON resistance		RON21P	–	120	180	mΩ	Hx2=3.6V
CH2 Lx21 Lowside SW ON resisitance		RON21N	–	120	180	mΩ	Hx2=3.6V,
CH2 Lx22 Highside SW ON resistance		RON22P	–	150	230	mΩ	VO2=3.4V
CH2 Lx22 Lowside SW ON resistance		RON22N	–	120	180	mΩ	Hx2=3.6V
CH3 Highside SW ON resistance		RON3P	–	300	450	mΩ	Hx3=3.6V
CH3 Lowside SW ON resistace		RON3N	–	230	350	mΩ	Hx3=3.6V
CH4 Highside SW ON resistace		RON4P	–	150	230	mΩ	Hx4=5V
CH4 Lowside SW ON resistance		RON4N	–	110	170	mΩ	Hx4=5V
CH5 PMOS SW ON resistace		RON5P	–	600	900	mΩ	Hx56=3.6V
CH6,7 NMOS SW ON resistance		RON6N	–	500	800	mΩ	Hx56=3.6V
CH6 Load SW ON resistace		RON67P	–	200	300	mΩ	Hx56=3.6V
【STB1～6】							
STB Control Voltage	Active	VSTBH1	1.5	–	5.5	V	
	Non Active	VSTBL1	−0.3	–	0.3	V	
Pull Down Resistance		RSTB1	250	400	700	kΩ	STB1234, STB56
【PWM7】							
PWM7 Control Voltage	H Level	VPWMH	2.05	–	4.00	V	
	L Level	VPWML	0	–	0.40	V	
Pull Down Resistance		RPWM	250	400	700	kΩ	
CH7 Delay time for shutdown		Toff7	200	300	–	μsec	RT=62kΩ
【LEDSW】							
LED PIN SW ON resistance		RLED	–	2	3	Ω	VCC=3.6V
【OVP】							
OVP Threshold		VOVP7	18	19	20	V	VO7 monitor
【Circuit Current】							
Stand-by Current	VCC terminal	ISTB1	–	–	5	μA	
	Hx terminal	ISTB2	–	–	5	μA	
	Lx terminal	ISTB3	–	–	5	μA	
Circuit Current (VCC PIN Current)		Icc	–	5.0	11.0	mA	INV1-7=1.2V INV5=-0.2V VCC= 3.0V

（※1） When circuit is operated by 100% duty at CH1 and CH3, SCP timer start.
So it is possible to use only for transition time shorter than Tscp.

（※2） Recommend resistor value over 20kΩ between VREF to INV5, because VREF current is under 100uA.
And, Please set resistor value considered phase compensation for coil and output capacitor.

（※3） Related to LED quantity , LED forward voltage and Input voltage.

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

○PIN Assignment ・Block Diagram

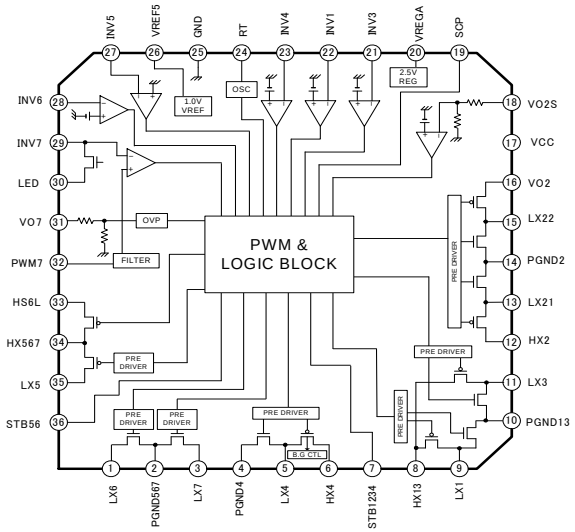

Fig .1

○Package

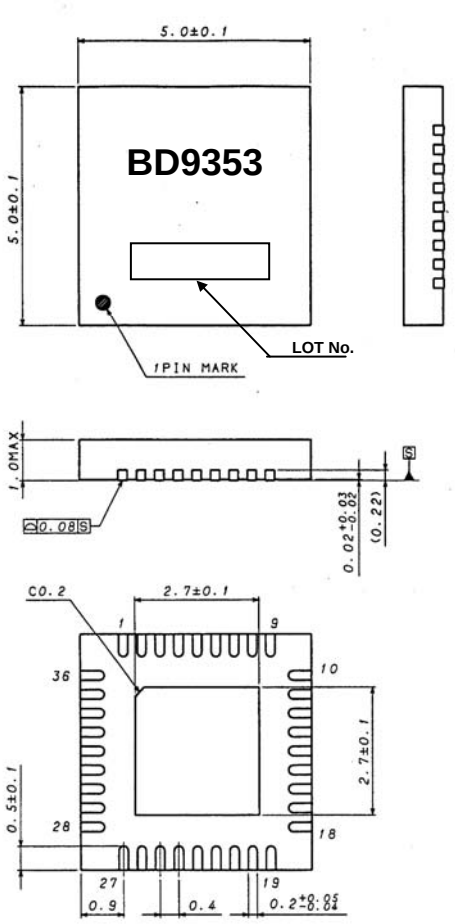

図-2

○PIN Description

端 子 名	機　　能
VCC	IC Power Supply Input
GND	Ground
PGND13,2,4,567	Ground for Internal FET
VREGA	VREGA Output
VREF5	CH5 Reference Output
Hx13,2,567	CH1～3,5,6 Pch FET Source Terminal , FET Driver Power Supply
Hx4	CH4 DC/DC Output
Lx1,3,4,5,6,7	Terminal for Connecting Inductor
Lx21	Terminal for Connecting Inductor For CH2 Input
Lx22	Terminal for Connecting Inductor For CH2 Output
VO2	CH2 DC/DC Output
HS6L	Output Terminal for Internal Load Switch
INV1,3,4,5,6,7	Error Amp Inverted Input
VO2S	CH2 Output Feedback Terminal
RT	Terminal for Connecting a Resister To Set the OSC Frequency
SCP	SCP Timer Flag Terminal
STB1234,56	CH1～CH6 ON/OFF Control Terminal
PWM7	CH7 ON/OFF Control, PWM Dimming Input
LED	Terminal for connecting LED Cathode
VO7	CH7 DC/DC Output

○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.) 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.

8.) 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.

9.) 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.

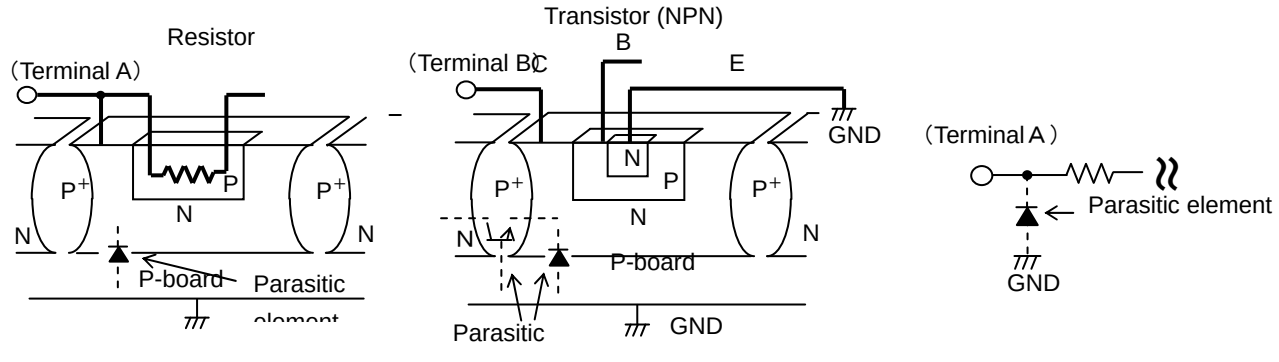

Fig - 3 Simplified structure of a Bipolar IC

Notes

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