# ROHM
**SEMICONDUCTOR**

| | |
|---|---|
| STRUCTURE | Silicon Monolithic Integrated Circuit |
| PRODUCT SERIES | 7-Channel Switching Regulator Controller for Digital Camera |

## TYPE **BD9354MWV**

| | |
|---|---|
| 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- down 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 | ±1.0 | 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 |

REV. A

○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 | CH1～7 |
| 【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 | – | – | 100 | % | |
| 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 | – | 190 | 290 | mΩ | Hx4=3.6V |
| 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 CH1,3 and CH4, 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..
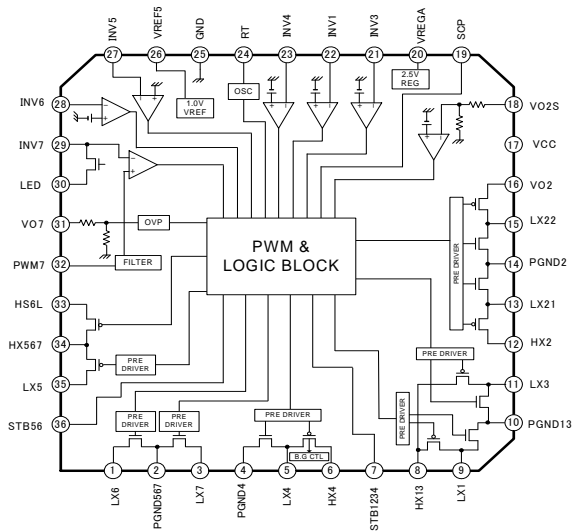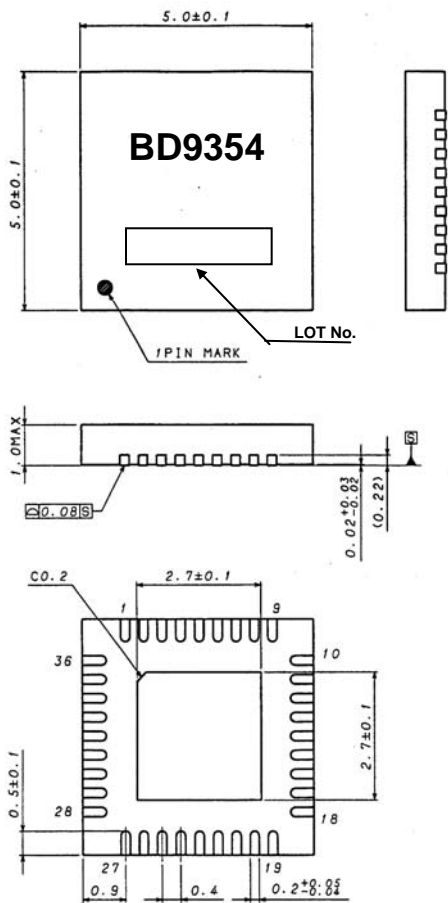
REV. A

## ○PIN Assignment ・Block Diagram



Fig .1

## ○Package



BD9354

1PIN MARK

LOT No.

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 |
| Hx13,2,4,567 | CH1～3,5,6 Pch FET Source Terminal , FET Driver Power Supply |
| 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 |

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## ○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.
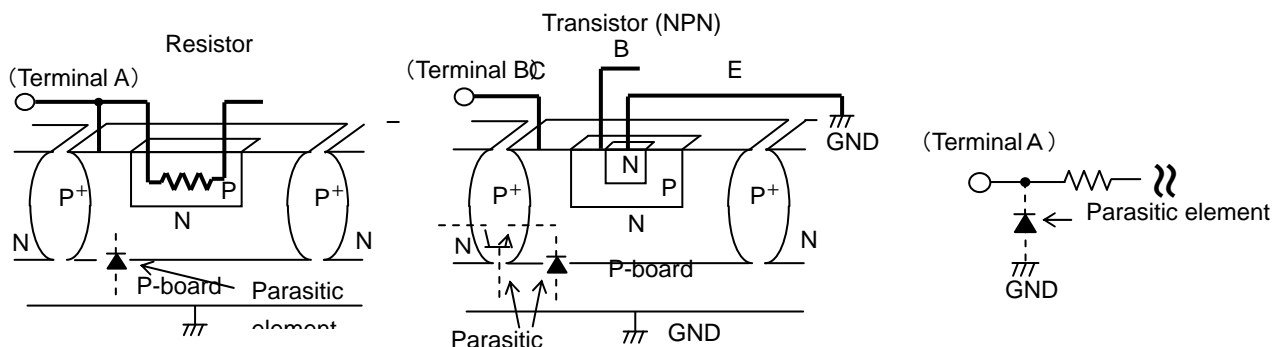


Fig - 3 Simplified structure of a Bipolar IC

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