

# Dual Channel Synchronous-Rectified Buck MOSFET Driver

## General Description

The RT9602 is a, twin power channel MOSFET driver specifically designed to drive four power N-Channel MOSFETs in a synchronous-rectified buck converter topology. These drivers combined with a RT9237/RT9241 series of Multi-Phase Buck PWM controller provide a complete core voltage regulator solution for advanced microprocessors.

The RT9602 can provide flexible gate driving for both high side and low side drivers. This gives more flexibility of MOSFET selection.

The output drivers in the RT9602 have the capability to drive a 3000pF load with a 40ns propagation delay and 80ns transition time. This device implements bootstrapping on the upper gates with only a single external capacitor required for each power channel. This reduces implementation complexity and allows the use of higher performance, cost effective, N-Channel MOSFETs. Adaptive shoot-through protection is integrated to prevent both MOSFETs from conducting simultaneously.

The RT9602 can detect high side MOSFET drain-to-source electrical short at power on and pull the 12V power by low side MOS and cause power supply to go into over current shutdown to prevent damage of CPU.

## Ordering Information

RT9602□ □

- └─ Package type  
S : SOP-14
- └─ Operating temperature range  
C: Commercial standard

## Features

- **Drives Four N-Channel MOSFETs**
- **Adaptive Shoot-Through Protection**
- **Internal Bootstrap Devices**
- **Small 14-Lead SOIC Package**
- **5V to 12V Gate-Drive Voltages for Optimal Efficiency**
- **Tri-State Input for Bridge Shutdown**
- **Supply Under-Voltage Protection**
- **Power ON Over-Voltage Protection**

## Applications

- Core Voltage Supplies for Intel Pentium® 4 and AMD® Athlon™ Microprocessors
- High Frequency Low Profile DC-DC Converters
- High Current Low Voltage DC-DC Converters

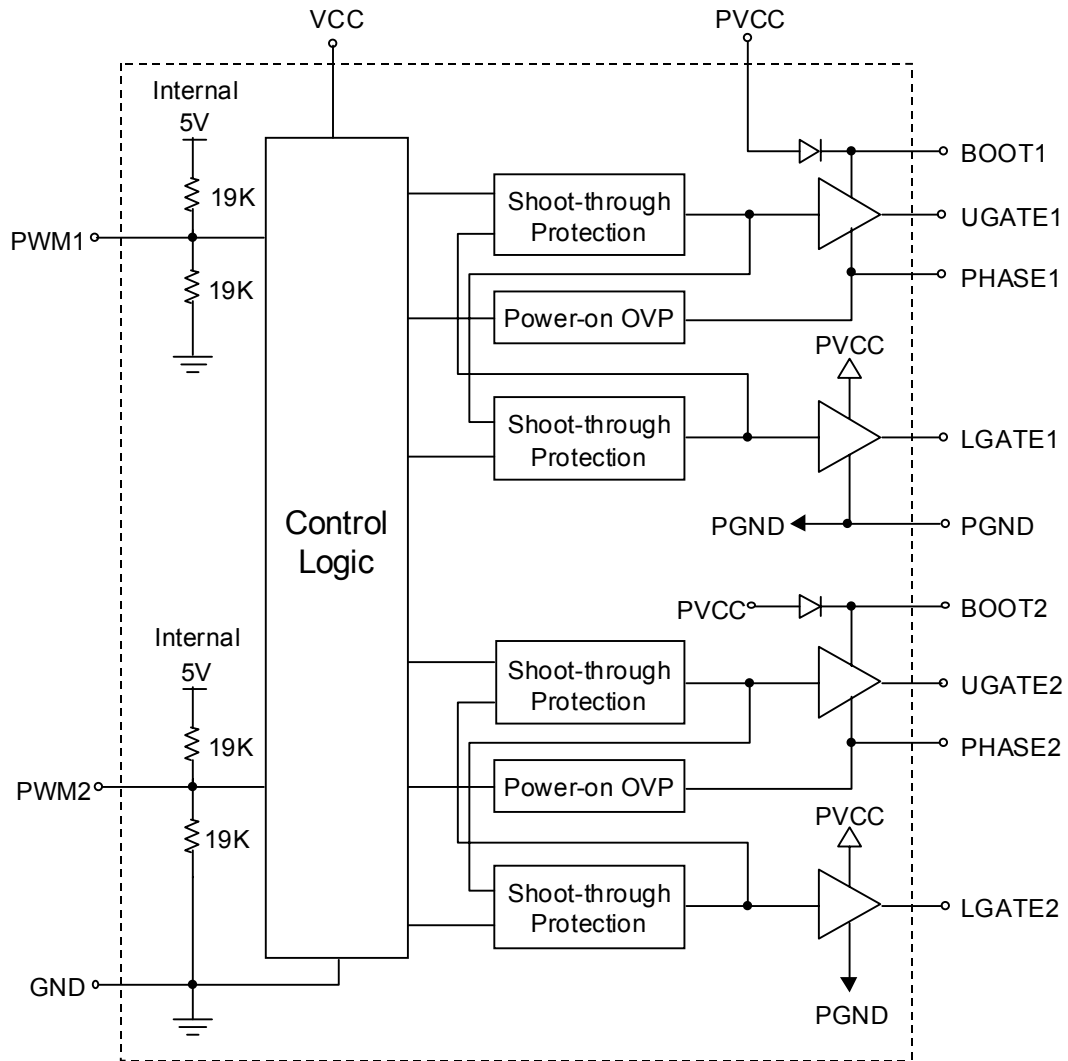
## Pin Configurations

Part Number	Pin Configurations
RT9602CS (Plastic SOP-14)	<p style="text-align: center;">TOP VIEW</p> <p>           PWM1 1      14 VCC            PWM2 2      13 PHASE1            GND 3        12 UGATE1            LGATE1 4     11 BOOT1            PVCC 5       10 BOOT2            PGND 6       9 UGATE2            LGATE2 7     8 PHASE2         </p>

**Pin Description**

Pin No.	Pin Name	Pin Function
1	PWM1	Channel 1 PWM Input
2	PWM2	Channel 2 PWM Input
3	GND	Ground Pin
4	LGATE1	Lower Gate Drive of Channel 1
5	PVCC	Upper and Lower Gate Driver Power Rail
6	PGND	Lower Gate Driver Ground Pin
7	LGATE2	Lower Gate Drive of Channel 2
8	PHASE2	Connect this pin to phase point of channel 2. Phase point is the connection point of high side MOSFET source and low side MOSFET drain
9	UGATE2	Upper Gate Drive of Channel 2
10	BOOT2	Floating Bootstrap Supply Pin of Channel 2
11	BOOT1	Floating Bootstrap Supply Pin of Channel 1
12	UGATE1	Upper Gate Drive of Channel 1
13	PHASE1	Connect this pin to phase point of channel 1. Phase point is the connection point of high side MOSFET source and low side MOSFET drain
14	VCC	Control Logic Power Supply

Function Block Diagram



**Absolute Maximum Ratings**

- Supply Voltage (VCC) ----- 15V
- Supply Voltage (PVCC) ----- VCC + 0.3V
- BOOT Voltage (V<sub>BOOT</sub>-V<sub>PHASE</sub>) ----- 15V
- Input Voltage (VPWM) ----- GND-0.3V to 7V
- UGATE ----- V<sub>PHASE</sub>-0.3V to V<sub>BOOT</sub>+0.3V
- LGATE ----- GND-0.3V to V<sub>PVCC</sub>+0.3V
- Package Thermal Resistance  
SOP-14,  $\theta_{JA}$  ----- 160°C /W
- Ambient Temperature ----- 0°C ~ 70°C
- Junction Temperature ----- 0°C ~ 125°C
- Storage Temperature Range ----- -40°C ~ 150°C
- Lead Temperature (Soldering, 10 sec.) ----- 260°C
- ESD Level  
HBM ----- 2KV  
MM ----- 200V

**Electrical Characteristics**

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>VCC Supply Current</b>						
Bias Supply Current	I <sub>VCC</sub>	f <sub>PWM</sub> = 250KHz, V <sub>PVCC</sub> = 12V, C <sub>boot</sub> = 0.1μF, R <sub>phase</sub> = 20Ω	--	3	--	mA
Power Supply Current	I <sub>PVCC</sub>	f <sub>PWM</sub> = 250kHz, V <sub>PVCC</sub> = 12V, C <sub>boot</sub> = 0.1μF, R <sub>phase</sub> = 20Ω	--	8	--	mA
<b>Power-On Reset</b>						
VCC Rising Threshold			9.1	9.6	10	V
VCC Falling Threshold			7.5	8.1	8.5	V
<b>PWM Input</b>						
Maximum Input Current		V <sub>PWM</sub> = 0 or 5V	--	200	--	μA
PWM Floating Voltage		V <sub>CC</sub> =12V	--	1.9	--	V
PWM Rising Threshold			--	3.7	--	V
PWM Falling Threshold			--	1.1	--	V
UGATE Rise Time		V <sub>PVCC</sub> = V <sub>VCC</sub> = 12V, 3nF load	--	30	--	ns
LGATE Rise Time		V <sub>PVCC</sub> = V <sub>VCC</sub> = 12V, 3nF load	--	30	--	ns
UGATE Fall Time		V <sub>PVCC</sub> = V <sub>VCC</sub> = 12V, 3nF load	--	40	--	ns
LGATE Fall Time		V <sub>PVCC</sub> = V <sub>VCC</sub> = 12V, 3nF load	--	30	--	ns
UGATE Turn-Off Propagation Delay		V <sub>VCC</sub> = V <sub>PVCC</sub> = 12V, 3nF load	--	60	--	ns
LGATE Turn-Off Propagation Delay		V <sub>VCC</sub> = V <sub>PVCC</sub> = 12V, 3nF load	--	45	--	ns
Shutdown Window			1.1	--	3.7	V

*To be continued*

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>Output</b>						
Upper Drive Source	RUGATE	V <sub>VCC</sub> = 12V, V <sub>PVCC</sub> = 12V	--	1.5	--	Ω
Upper Drive Sink	RUGATE	V <sub>VCC</sub> = 12V, V <sub>PVCC</sub> = 12V	--	1.45	2	Ω
Lower Drive Source	RLGATE	V <sub>VCC</sub> = 12V, V <sub>PVCC</sub> = 12V	--	1.6	--	Ω
Lower Drive Sink	RLGATE	V <sub>VCC</sub> = V <sub>PVCC</sub> = 12V	--	0.75	1	Ω

## Operation Descriptions

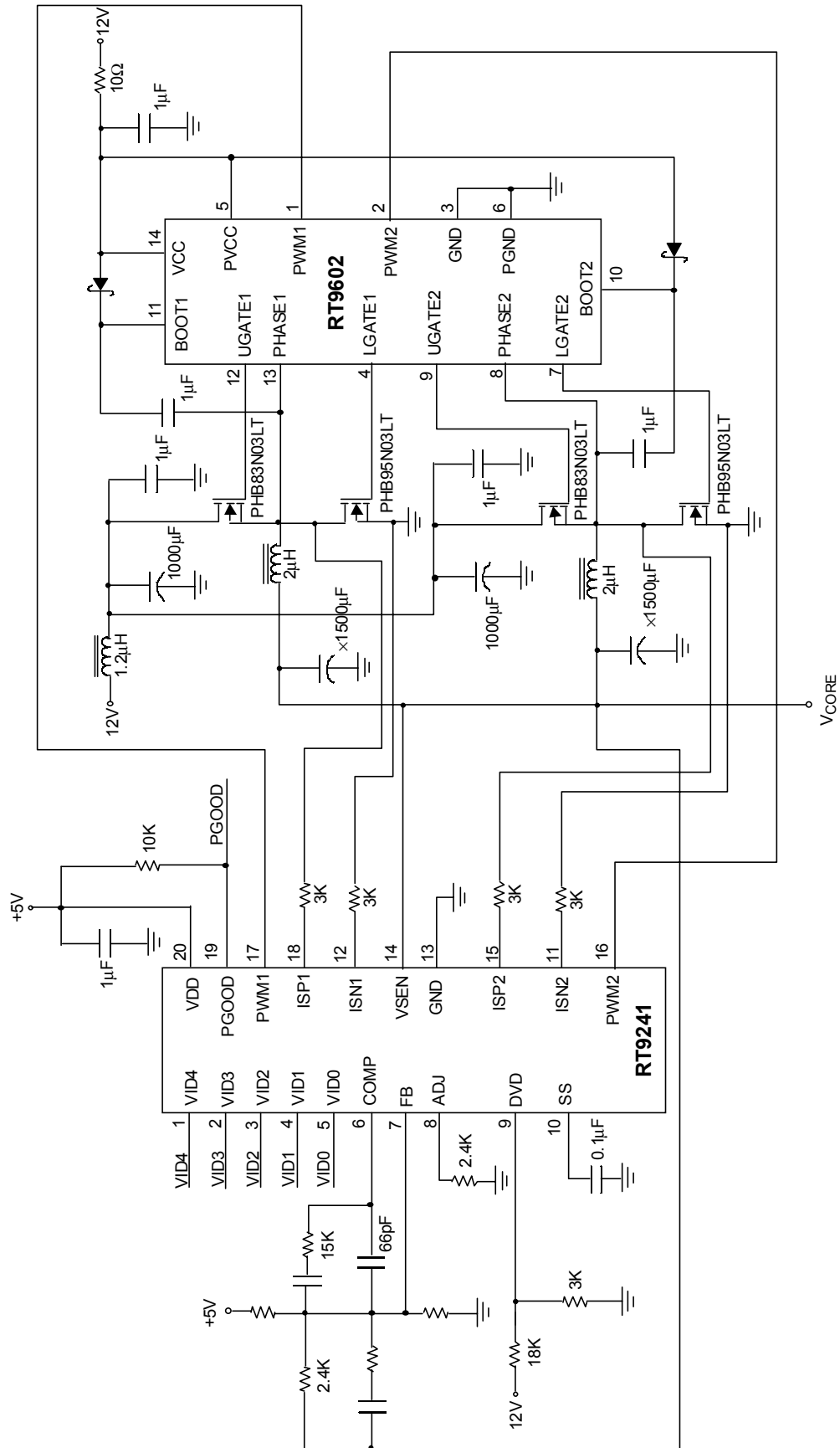
The RT9602 has power on protection function which held UGATE and LGATE low before V<sub>CC</sub> up across the rising threshold voltage. After the initialization, the PWM signal takes the control. The rising PWM signal first forces the LGATE signal turns low then UGATE signal is allowed to go high just after a non-overlapping time to avoid shoot-through current. The falling of PWM signal first forces UGATE to go low. When UGATE and PHASE signal reach a predetermined low level, LGATE signal is allowed to turn high. The non-overlapping function is also presented between UGATE and LGATE signal transient.

The PWM signal is recognized as high if above rising threshold and as low if below falling threshold. Any signal level in this window is considered as tri-state, which causes turn-off of both high side and low-side MOSFET. When PWM input is floating (not connected), internal divider will pull the PWM to 1.9V to give the controller a recognizable level. The maximum sink/source capability of internal PWM reference is 60μA.

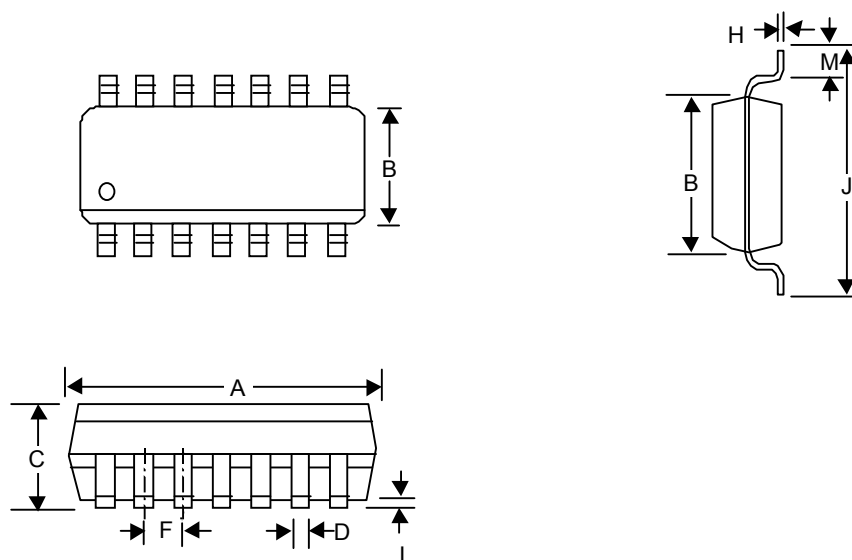
The PVCC pin provides flexibility of both high side and low side MOSFET gate drive voltages. If 8V, for example, is applied to PVCC, then high side MOSFET gate drive is 8V-1.5V(approximately, internal diode plus series resistance voltage drop). The low side gate drive voltage is exactly 8V.

The RT9602 implements a power on over-voltage protection function. If the PHASE voltage exceeds 1.5V at power on, the LGATE would be turn on to pull the PHASE low until the PHASE voltage goes below 1.5V. Such function can protect the CPU from damage by some short condition happened before power on, which is sometimes encountered in the M/B manufacturing line.

Typical Application Circuit



**Package Information**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	8.534	8.738	0.336	0.344
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.178	0.254	0.007	0.010
I	0.102	0.254	0.004	0.010
J	5.791	6.198	0.228	0.244
M	0.406	1.270	0.016	0.050

**14-Lead SOP Plastic Package**

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