

VRM 9.0 Synchronous PWM Buck Converter Controller and Output Voltage Monitor

General Description

The RT9224C is a high speed switching controller designed for use in Synchronous DC/DC buck converter for modern CPUs. The regulated output voltage is digitally programmable from 1.075V to 1.85V by a 5-bit DAC which provides initial accuracy of $\pm 1\%$. The RT9224C drives two external N-Channel MOSFETs, providing high efficiency and eliminating the need for high cost P-Channel devices. It senses the output current across the on-resistance of the N-Channel MOSFET and provides an adjustable current limit without external sense resistor.

The RT9224C monitors the output voltage and provides the output signal for power-good and over-voltage protections. The switching frequency is 200kHz. The high switching frequency cooperating with a high speed error amplifier maintains a fast response to the dynamic load of modern CPUs.

Ordering Information

RT9224C □ □

- Package Type
S : SOP-20
- Operating Temperature Range
C : Commercial Standard
P : Pb Free with Commercial Standard

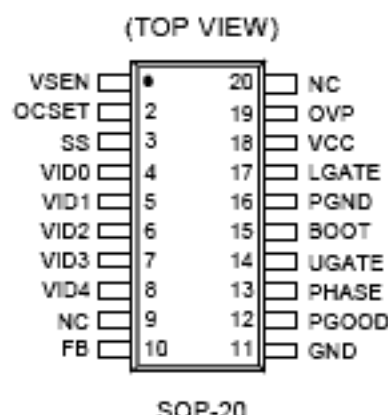
Features

- Simple Voltage-Mode PWM Control with Buck Rectification
- $\pm 1\%$ DAC Output Voltage Accuracy
- 5-Bit Digital-to-Analog Output Voltage Range from 1.075V to 1.85V
- Fast Transient Response and Excellent Output Voltage Regulation
- Fault Protection for Over-Voltage and Over-Current
- Power-Good Output Voltage Monitor

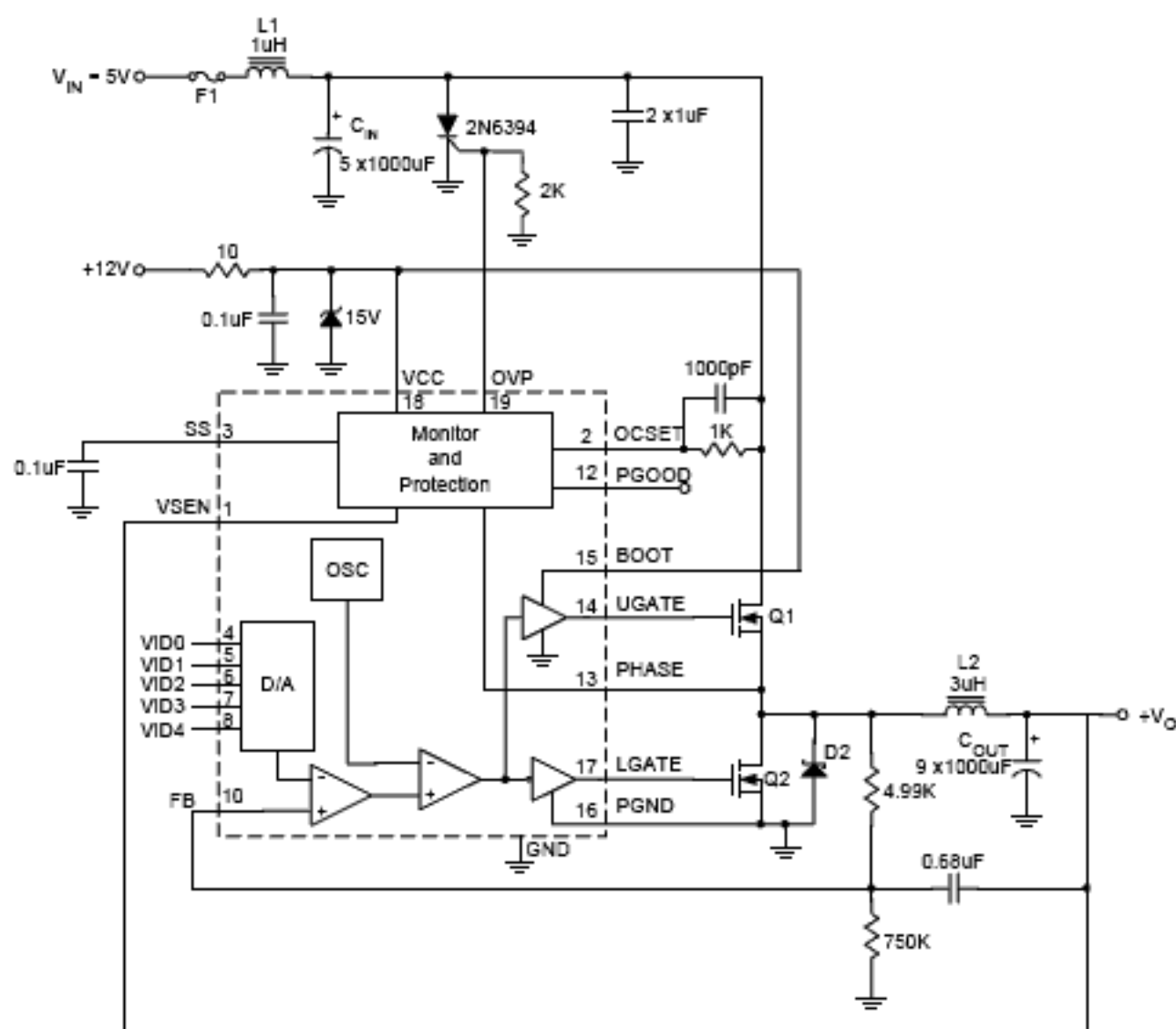
Applications

- Power Supply for VRM 9.0 Microprocessors
- Low-Voltage Distributed Power Supplies
- High Power 5V to 1.075V to 1.85V Switching Regulator

Pin Configurations



Typical Application Circuit



Component Selection Notes:

C_{OUT} , C_{IN} — Each 1000 μ F 6.3WV DC, Sanyo MV-GX or Equivalent.

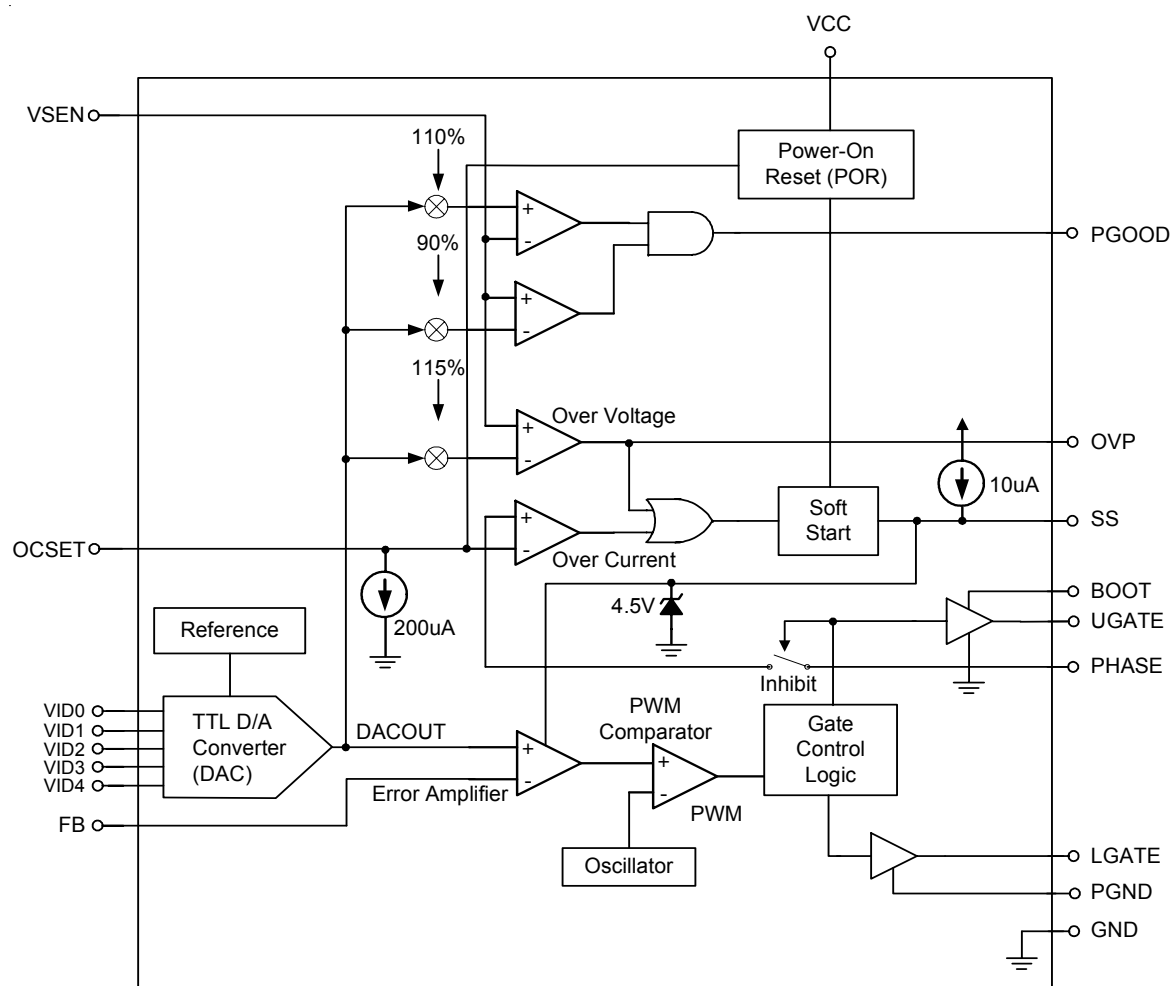
L2 — Core: Micrometals T50-52B; Winding: 10 Turns of 18AWG.

L1 — Core: Micrometals T50-52; Winding: 5 Turns of 18AWG.

D2 — 3A, 40V Schottky, Motorola MBR340 or Equivalent.

Q1, Q2 — PHB83N03LT; PHB95N03LT

Function Block Diagram



Functional Pin Description

Pin No.	Pin Name	Pin Function
1	VSEN	Output voltage monitoring input for OVP & PGOOD
2	OCSET	Over current set pin, sinks 200μA through a resistor (R _{OCs}) from this pin to upper N-MOSFET to set the trip point: $I_{PEAK} = \frac{200\mu A \times R_{OCs}}{\text{MOSFET - on resistance}}$ An over-current trip cycles the soft-start function
3	SS	Soft start speed is set by internal 10μA current source and capacitor from this pin to GND
4	VID0	Switching regulator output voltage setting
5	VID1	Switching regulator output voltage setting
6	VID2	Switching regulator output voltage setting
7	VID3	Switching regulator output voltage setting
8	VID4	Switching regulator output voltage setting
9,20	NC	No connection
10	FB	Feedback input pin
11	GND	IC signal ground
12	PGOOD	Open drain logic output This pin is pulled low when the converter output is not within ±10% of the DACOUT reference voltage
13	PHASE	Current limit sense input
14	UGATE	High side driver output
15	BOOT	Driver power
16	PGND	Low side driver GND
17	LGATE	Low side driver output
18	VCC	Power supply input
19	OVP	Over voltage protection This pin is pulled high when the VSEN voltage is over 15% of the DACOUT reference voltage

Table 1 Output Voltage Program

Pin Name					Nominal Output Voltage DACOUT
VID4	VID3	VID2	VID1	VID0	
1	1	1	1	1	1.075V
1	1	1	1	0	1.100V
1	1	1	0	1	1.125V
1	1	1	0	0	1.150V
1	1	0	1	1	1.175V
1	1	0	1	0	1.200V
1	1	0	0	1	1.225V
1	1	0	0	0	1.250V
1	0	1	1	1	1.275V
1	0	1	1	0	1.300V
1	0	1	0	1	1.325V
1	0	1	0	0	1.350V
1	0	0	1	1	1.375V
1	0	0	1	0	1.400V
1	0	0	0	1	1.425V
1	0	0	0	0	1.450V
0	1	1	1	1	1.475V
0	1	1	1	0	1.500V
0	1	1	0	1	1.525V
0	1	1	0	0	1.550V
0	1	0	1	1	1.575V
0	1	0	1	0	1.600V
0	1	0	0	1	1.625V
0	1	0	0	0	1.650V
0	0	1	1	1	1.675V
0	0	1	1	0	1.700V
0	0	1	0	1	1.725V
0	0	1	0	0	1.750V
0	0	0	1	1	1.775V
0	0	0	1	0	1.800V
0	0	0	0	1	1.825V
0	0	0	0	0	1.850V

Note: (1) 0:Connected to GND (2) 1:Open

Absolute Maximum Ratings

- Supply Voltage ----- +15V
- Boot Voltage ----- +15V
- Input, Output or I/O Voltage ----- GND –0.3V to $V_{CC} + 0.3V$
- Storage Temperature Range ----- –65°C to 150°C
- Package Thermal Resistance
SOP-20, θ_{JA} ----- 87°C/W

Recommended Operating Conditions

- Supply Voltage ----- +12V $\pm 10\%$
- Ambient Temperature Range ----- 0°C to 70°C
- Junction Temperature Range ----- 0°C to 125°C

Electrical Characteristics

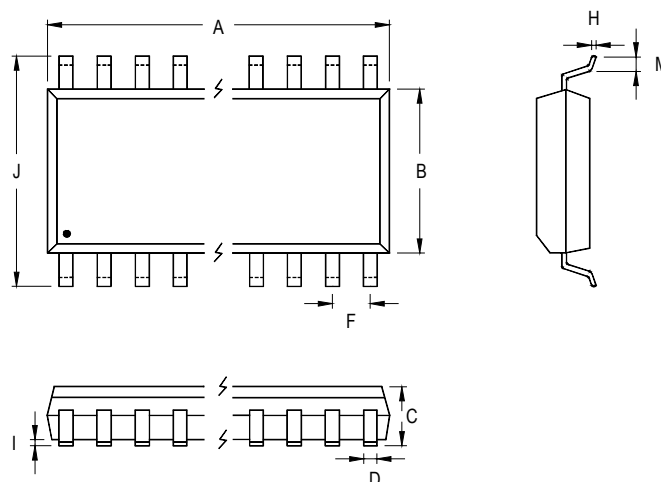
($T_A = 25^\circ\text{C}$, recommended operating conditions, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
VCC Supply Current						
Nominal Supply	I_{CC}	UGATE and LGATE Open	--	3	--	mA
Power-On Reset						
VCC Rising Threshold		$V_{OCSET} = 4.5V$	--	9.5	--	V
VCC Falling Threshold		$V_{OCSET} = 4.5V$	--	7.5	--	V
Rising V_{OCSET} Threshold			--	1.6	--	V
Oscillator						
Free Running Frequency			170	200	230	kHz
Ramp Amplitude	ΔV_{OSC}		--	1.9	--	V_{P-P}
Reference and DAC						
DAC (VID0 – VID4) Input Low Voltage			--	--	0.8	V
DAC (VID0 – VID4) Input High Voltage			2.0	--	--	V
DACOUT Voltage Accuracy			-1.0	--	+1.0	%
Error Amplifier						
DC Gain			--	65	--	dB
Gate Drivers						
UGATE Source	R_{UGATE}	$V_{BOOT} - V_{PHASE} = 12V$	--	8	--	Ω
UGATE Sink	R_{UGATE}	$V_{UGATE} - V_{PHASE} = 1V$	--	5	--	Ω
LGATE Source	I_{LGATE}	$V_{CC} = 12V, V_{LGATE} = 6V$	--	500	--	mA
LGATE Sink	R_{LGATE}	$V_{LGATE} = 1V$	--	5	--	Ω

To be continued

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Protection						
Over-voltage Trip (VSEN/DACOUT)			--	115	120	%
OCSET Current Source	I _{OCSET}	V _{OCSET} = 4.5V	167	200	233	μA
OVP Sourcing Current	I _{OVP}	V _{SEN} = 5.5V, V _{OVP} = 0V	60	--	--	mA
Soft-Start Current	I _{SS}	V _{SS} = 1.5V	--	10	--	μA
Power Good						
Upper Threshold (VSEN/DACOUT)		VSEN Rising	106	--	114	%
Lower Threshold (VSEN/DACOUT)		VSEN Falling	89	--	96	%
Hysteresis (VSEN/DACOUT)		Upper and Lower Threshold	--	2	--	%
PGOOD Voltage Low	V _{PGOOD}	I _{PGOOD} = -5mA	--	0.5	--	V

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	12.598	13.005	0.496	0.512
B	7.391	7.595	0.291	0.299
C	2.362	2.642	0.093	0.104
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.229	0.330	0.009	0.013
I	0.102	0.305	0.004	0.012
J	10.008	10.643	0.394	0.419
M	0.381	1.270	0.015	0.050

20-Lead SOP Plastic Package

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