Programmable Output Voltage Single Synchronous Buck Controller

General Description

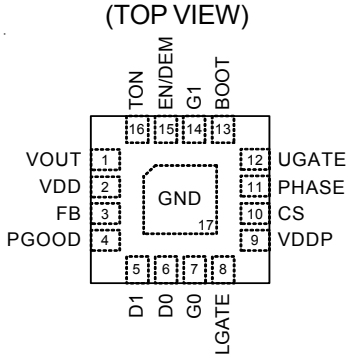
The RT8208A/B is a constant-on-time PWM controller which provides four resistor programmable DC output voltages by controlling the G0 and G1 digital input. The output voltage is programmable from 0.75V to 3.3V. The RT8208A/B offers the lowest total solution cost in systems where need output voltage slewing. The RT8208A/B provides an automatic masking power good output during output voltage transition.

The constant-on-time PWM control scheme handles wide input/output ratios with ease and provides 100ns "instant-on" response to load transient while maintaining a relatively constant frequency. It provides the high efficiency, excellent transient response, and DC output accuracy needed for stepping down high voltage batteries to generate low voltage CPU core, graphics, I/O and chipset RAM supplies in notebook computers.

The RT8208A/B achieves high efficiency at a reduced cost by eliminating the current sense resistor in traditional current mode PWMs. Efficiency is further enhanced by its ability to drive very large synchronous rectifier MOSFETs. The buck conversion allows this device to directly step down from high voltage batteries for the highest possible efficiency. Additional features include soft-start, under voltage protection, programmable over current protection and non-overlapping gate drive. The RT8208A/B is available in a WQFN-16L 3x3 package.

Pin Configurations

(TOP VIEW)



WQFN-16L 3x3

Features

- **Ultra-High Efficiency**
- **Resistor Programmable Output Voltage from 0.75V to 3.3V with Integrated Transition Support**
- **Quick Load Step Response within 100ns**
- **1% V_{FB} Accuracy over Line and Load**
- **4.5V to 26V Battery Input Range**
- **Resistor Programmable Frequency**
- **Integrated Bootstrap Switch**
- **Resistor Programmable Positive Current Limit by Low Side $R_{DS(ON)}$ Sense (Lossless Limit)**
- **Negative Current Limiter**
- **Voltage Transient Overshoot Eliminator***
- **Over Voltage Protection**
- **Under Voltage Protection**
- **4 Steps Current Limit During Soft-Start**
- **Power Good Indicator**
- **RoHS Compliant and Halogen Free**

* Paten Pending

Applications

- Notebook Computers
- System Power Supplies
- I/O Supplies
- Programmable-Output Power Supplies

Ordering Information

RT8208 □□□

- Package Type
  QW : WQFN-16L 3x3 (W-Type)
- Lead Plating System
  G : Green (Halogen Free and Pb Free)
  Z : ECO (Ecological Element with Halogen Free and Pb free)
- Turn-on D0/D1 MOSFET
  A : G0/G1 High
  B : G0/G1 Low

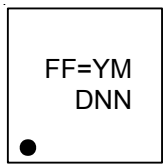
Note :

Richtek products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

Marking Information

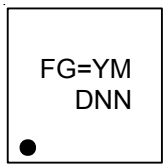
RT8208AGQW



FF= : Product Code

YMDNN : Date Code

RT8208BGQW



FG= : Product Code

YMDNN : Date Code

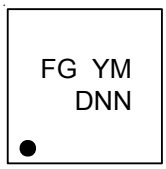
RT8208AZQW



FF : Product Code

YMDNN : Date Code

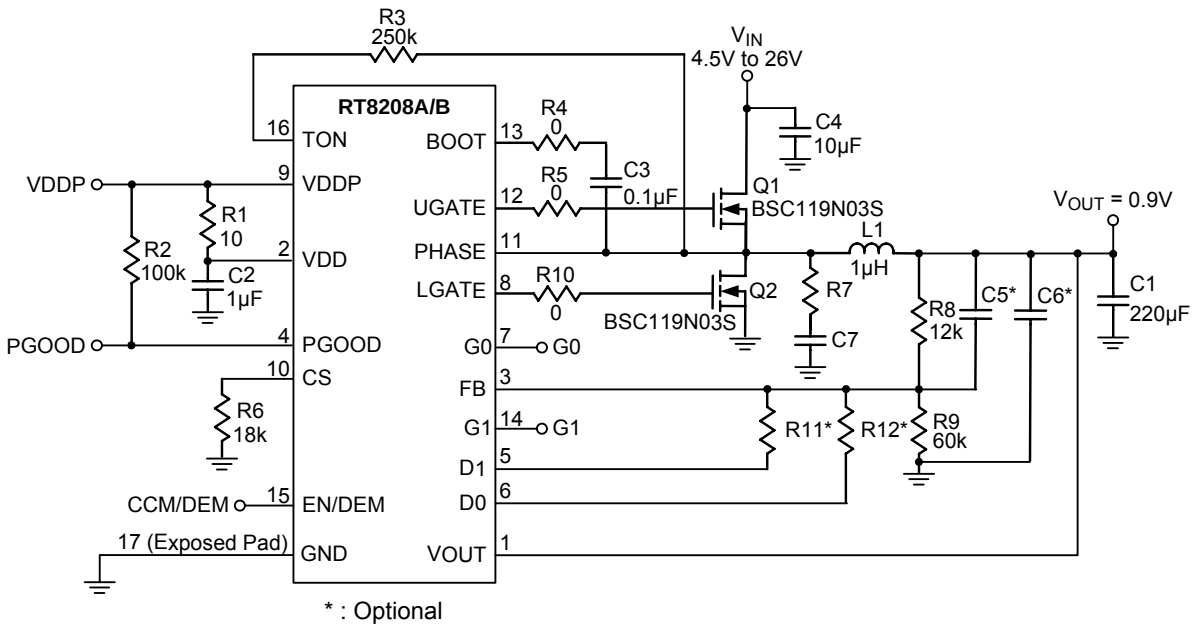
RT8208BZQW



FG : Product Code

YMDNN : Date Code

Typical Application Circuit



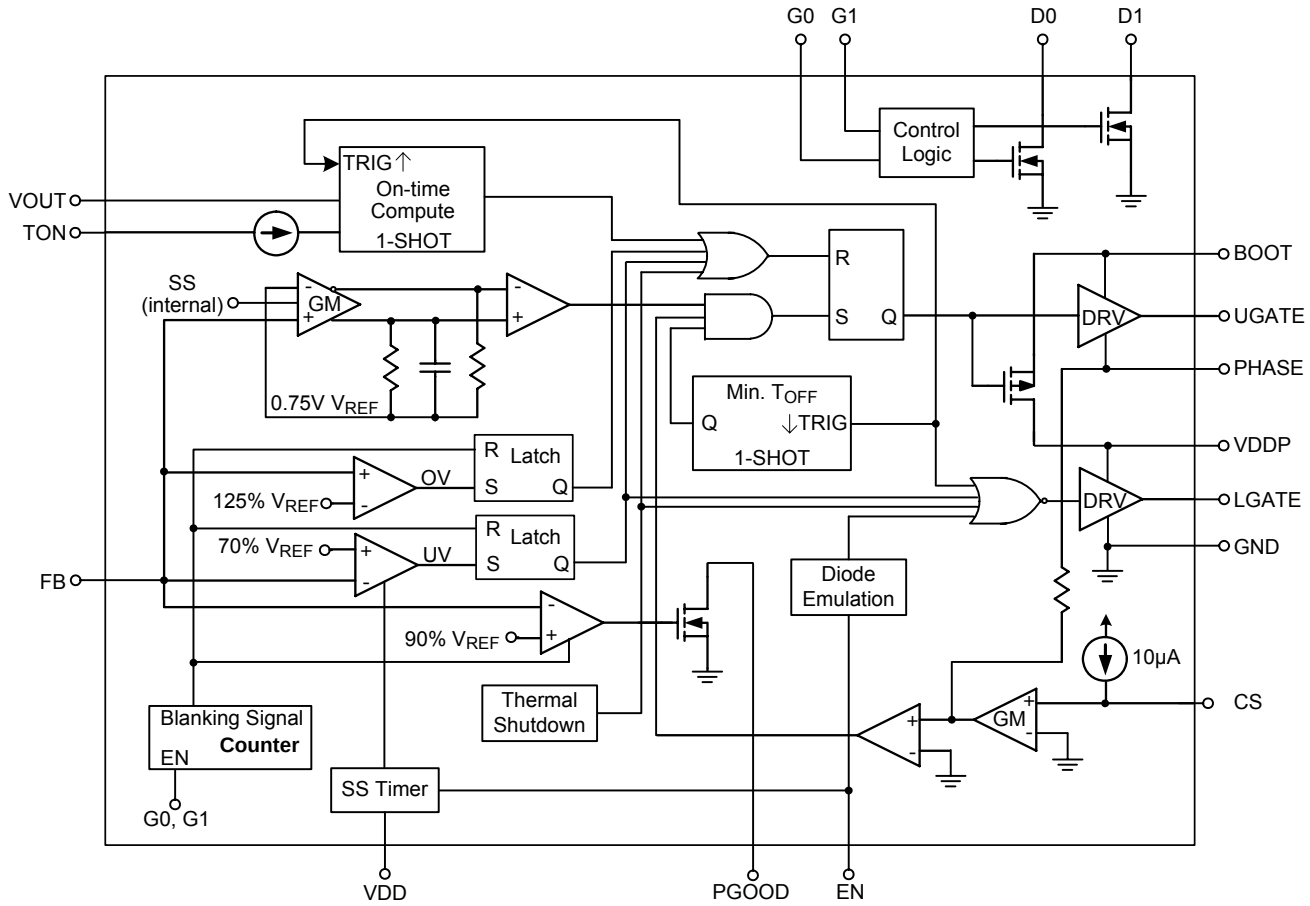
Functional Pin Description

Pin No.	Pin Name	Pin Function
1	VOUT	Output Voltage Pin. Connect to the output of PWM converter. VOUT is an input of the PWM controller.
2	VDD	Analog supply voltage input for the internal analog integrated circuit. Bypass to GND with a 1µF ceramic capacitor.
3	FB	Feedback Input Pin. Connect FB to a resistor voltage divider from VOUT to GND to adjust output voltage from 0.75V to 3.3V
4	PGOOD	Power good signal open-drain output of PWM converter. This pin will be pulled high when the output voltage is within the target range.
5	D1	Drain of the internal MOSFET which is controlled by G1.
6	D0	Drain of the internal MOSFET which is controlled by G0.

To be continued

Pin No.	Pin Name	Pin Function
7	G0	Control Input Pin for the D0 MOSFET. A logic high for RT8208A and low for RT8208B turn on the D0 MOSFET on, pulling D0 to the ground.
8	LGATE	Low side N-MOSFET gate driver output for PWM. This pin swings between GND and VDDP.
9	VDDP	VDDP is the gate driver supply for external MOSFETs. Bypass to GND with a 1μF ceramic capacitor.
10	CS	Over Current Trip Point Set Input. Connect a resistor from this pin to signal ground to set threshold for both over current and negative over current limit.
11	PHASE	The UGATE High Side Gate Driver Return. Also serves as anode of over current comparator.
12	UGATE	High side N-MOSFET floating gate driver output for the PWM converter. This pin swings between PHASE and BOOT.
13	BOOT	Boost Capacitor Connection for PWM Converter. Connect to an external ceramic capacitor to PHASE.
14	G1	Control Input Pin for the D1 MOSFET. A logic high for RT8208A and low for RT8208B turn on the D1 MOSFET on, pulling D1 to the ground.
15	EN/DEM	Enable/Diode Emulation Mode Control Input. Connect to VDD for diode–emulation mode, connect to GND for shutdown and floating the pin for CCM mode.
16	TON	On Time/Frequency Adjustment Pin. Connect to PHASE through a resistor. TON is an input for the PWM controller.
17 (Exposed pad)	GND	The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- BOOT to GND ---------- –0.3V to 38V
- BOOT to PHASE ---------- –0.3V to 6V
- PHASE to GND
  - DC ---------- –0.3V to 32V
  - < 20ns ---------- –8V to 38V
- UGATE to PHASE
  - DC ---------- –0.3V to 6V
  - < 20ns ---------- –5V to 7.5V
- LGATE to GND
  - DC ---------- –0.3V to 6
  - < 20ns ---------- –2.5V to 7.5V
- VDD, VDDP, VOUT, EN/DEM, FB, PGOOD, TON to GND ---------- –0.3V to 6V
- CS to GND ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  - WQFN–16L 3x3 ---------- 1.471W
- Package Thermal Resistance (Note 2)
  - WQFN–16L 3x3, θ_{JA} ---------- 68°C/W
  - WQFN–16L 3x3, θ_{JC} ---------- 7.5°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  - HBM (Human Body Mode) ---------- 2kV
  - MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 4)

- Input Voltage, V_{IN} ---------- 4.5V to 26V
- Supply Voltage, V_{DD}, V_{DDP} ---------- 4.5V to 5.5V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = 15V, V_{DD} = V_{DDP} = 5V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
PWM Controller						
Quiescent Supply Current	I_Q	VDD + VDDP, V_{FB} = 0.8V	--	--	1250	μA
Shutdown Current	I_{SHDN}	V_{DD} + V_{DDP}	--	1	10	μA
		EN/DEM = GND	–10	–1	--	
FB Reference Voltage	V_{REF}	V_{DD} = 4.5V to 5.5V	0.742	0.750	0.758	V
FB Input Bias Current		V_{FB} = 0.75V	–1	0.1	1	μA
Output Voltage Range	V_{OUT}		0.75	--	3.3	V

To be continued

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
D0 Pull-Down Resistance		D0 to GND, G0 = 5V	--	10	--	Ω
D1 Pull-Down Resistance		D1 to GND, G1 = 5V	--	10	--	Ω
On-Time		V_{PHASE} = 12V, V_{OUT} = 2.5V, R_{TON} = 250kΩ	336	420	504	ns
Minimum Off-Time			250	400	550	ns
VOUT Shutdown Discharge Resistance		EN/DEM = GND	--	20	--	Ω
Current Sensing						
Current Limiter Source Current		CS to GND	9	10	11	μA
Current Comparator Offset			−10	--	10	mV
Zero Crossing Threshold		PHASE to GND, EN/DEM = 5V	−10	--	5	mV
Fault Protection						
Current Limit (Threshold)		GND to PHASE, V_{CS} = 50mV	40	50	60	mV
		GND to PHASE, V_{CS} = 200mV	190	200	210	
Current Limit Setting Range		CS to GND	50	--	200	mV
Output UV Threshold		UVP Detection	60	70	80	%
OVP Threshold	V_{FB_OVP}	OVP Detection	120	125	130	%
OV Fault Delay		FB forced above OV threshold	--	20	--	μs
VDD Under Voltage Lockout Threshold		Rising edge, PWM disabled below this level	4.1	4.3	4.5	V
		Hysteresis	--	80	--	mV
Current Limit Step Duration at Soft-Start		Each step	--	128	--	clks
UVP Blanking Time		From EN signal going high	--	512	--	clks
Thermal Shutdown	T_{SHDN}		--	155	--	°C
Thermal Shutdown Hysteresis			--	10	--	°C
Driver On-Resistance						
UGATE Drive Source	$R_{UGATEsr}$	BOOT to PHASE = 5V	--	2	5	Ω
UGATE Drive Sink	$R_{UGATEsk}$	BOOT to PHASE = 5V	--	1	5	Ω
LGATE Drive Source	$R_{LGATEsr}$	LGATE, High State	--	1	5	Ω
LGATE Drive Sink	$R_{LGATEsk}$	LGATE, Low State	--	0.5	2.5	Ω
UGATE Gate Driver Source/Sink Current		UGATE to PHASE = 2.5V, BOOT to PHASE = 5V	--	1	--	A
LGATE Gate Driver Source Current		LGATE forced to 2.5V	--	1	--	A
LGATE Gate Driver Sink Current		LGATE forced to 2.5V	--	3	--	A
Dead Time		LGATE Rising (Phase = 1.5V)	--	30	--	ns
		UGATE Rising	--	30	--	
Internal Boost Charging Switch On-Resistance		VDDP to BOOT, 10mA	--	--	80	Ω

To be continued

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Logic I/O						
EN/DEM Logic Input Voltage		EN/DEM Low	--	--	0.8	V
		EN/DEM High	2.9	--	--	
		EN/DEM Floating	--	2	--	
G0 Logic Input Voltage		G0 Low	--	--	0.8	V
		G0 High	2	--	--	
G1 Logic Input Voltage		G1 Low	--	--	0.8	V
		G1 High	2	--	--	
Logic Input Current		EN/DEM = VDD	--	1	5	μA
		EN/DEM = 0	–5	1	--	
		G0 = G1 = VDD or GND	–1	--	5	
PGOOD						
PGOOD Threshold		V_{FB} with respect to Reference, PGOOD from Low to High	87	90	93	%
		V_{FB} with respect to Reference, PGOOD from High to Low	--	125	--	
		Hysteresis	--	3	--	
Fault Propagation Delay		Falling edge, FB forced below PGOOD trip threshold	--	2.5	--	μs
Output Low Voltage		I_{SINK} = 1mA	--	--	0.4	V
Leakage Current		High state, forced to 5V	--	--	1	μA

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

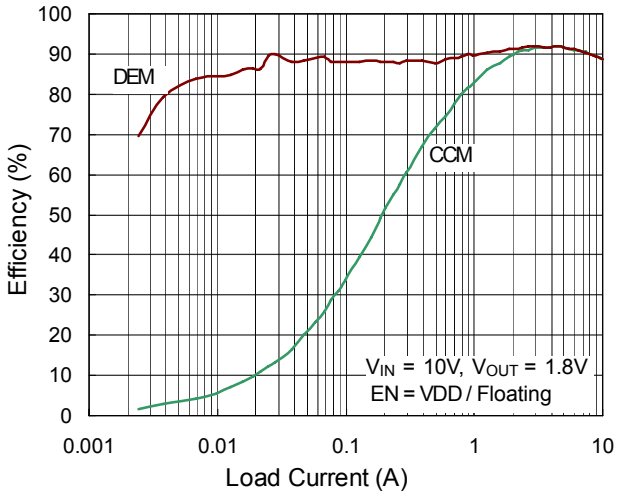
Note 2. θ_{JA} is measured in the natural convection at T_A = 25°C on a four layers high effective thermal conductivity test board of JEDEC 51-7 thermal measurement standard. The case point of θ_{JC} is on the expose pad for the package.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

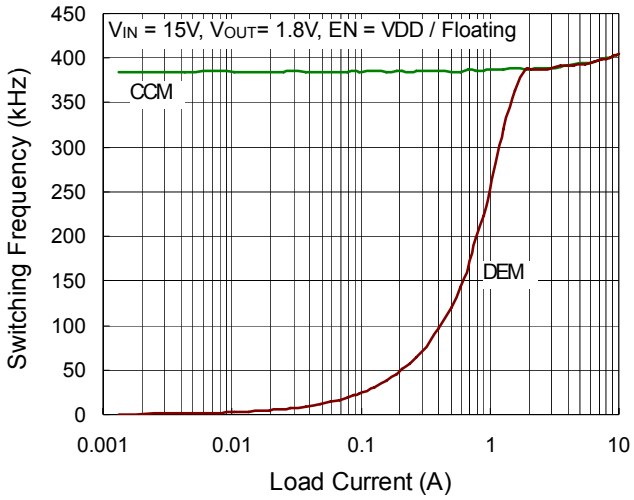
Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

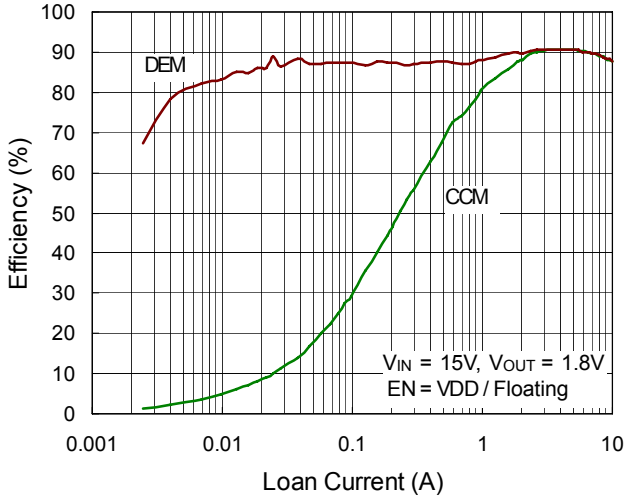
1.8V Efficiency vs. Load Current



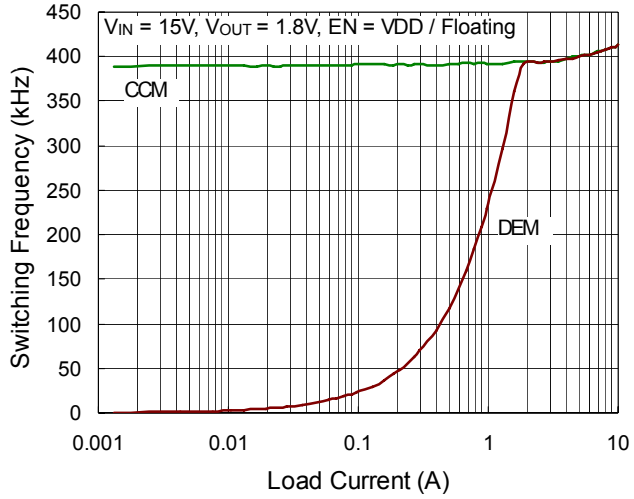
Switching Frequency vs. Output Current



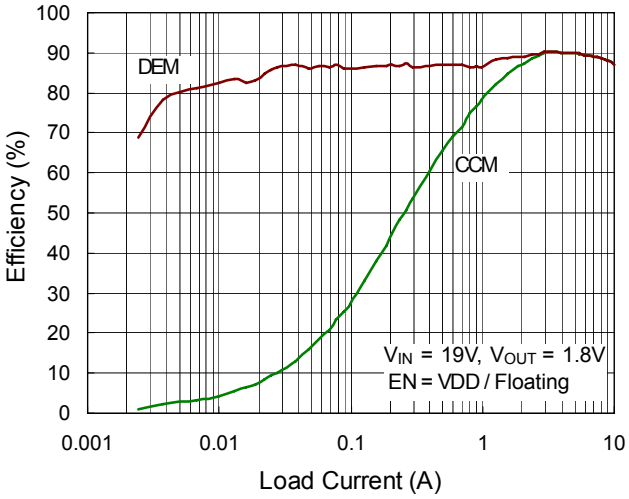
1.8V Efficiency vs. Load Current



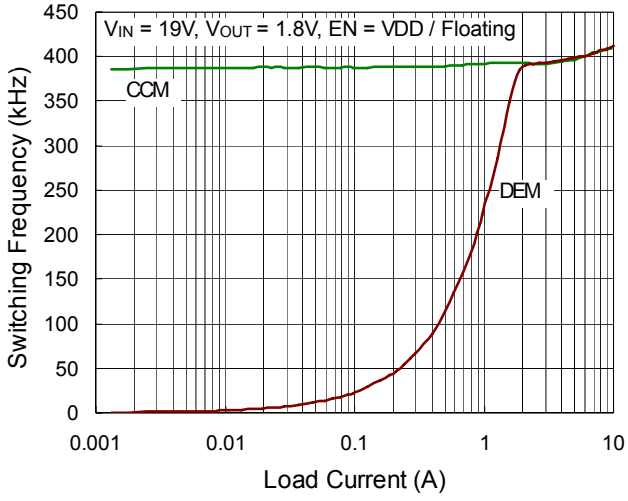
Switching Frequency vs. Output Current



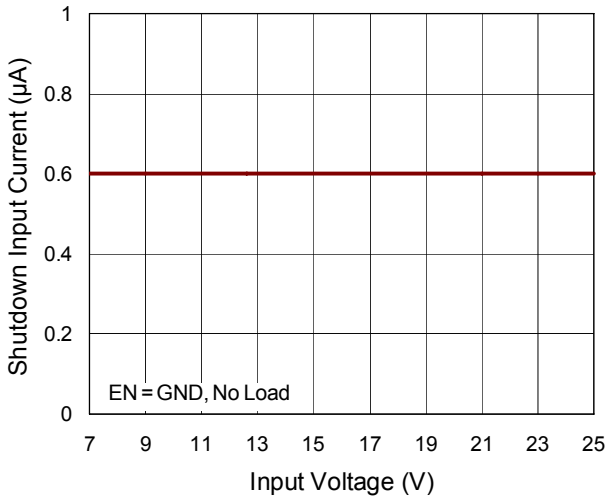
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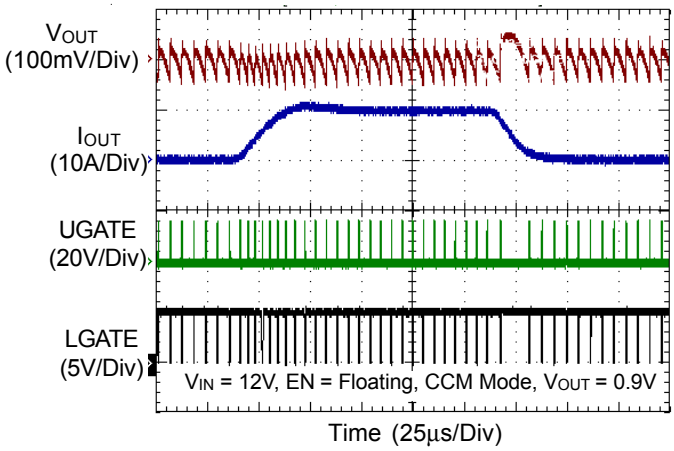
Switching Frequency vs. Output Current



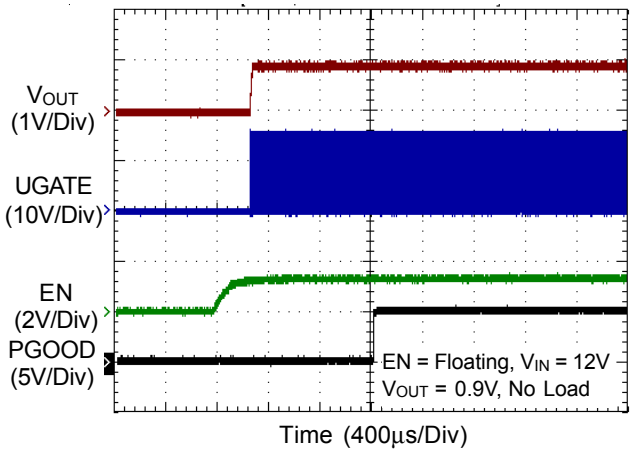
Shutdown Input Current vs. Input Voltage



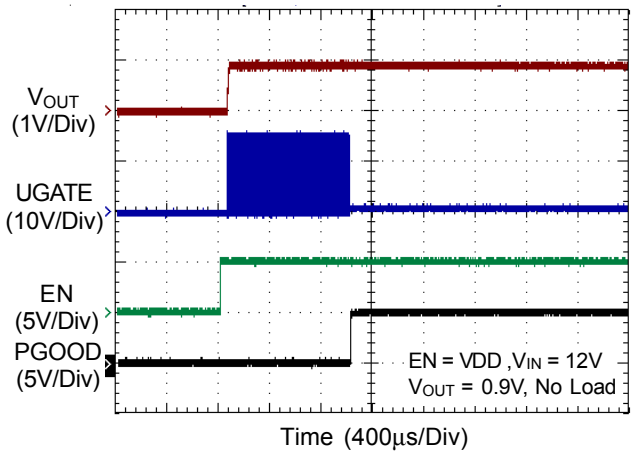
0.9V Load Transient Response



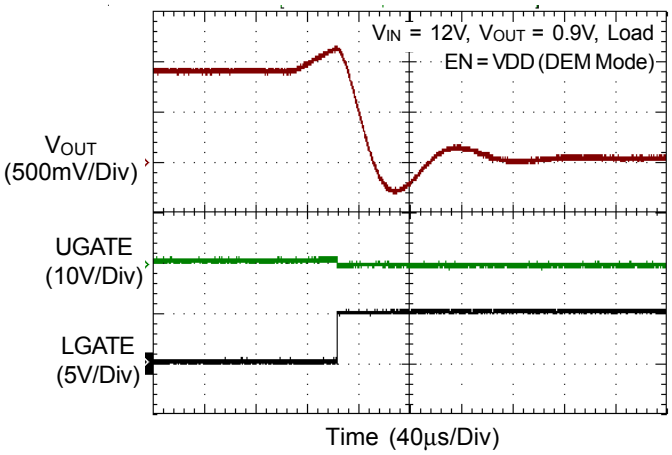
Power On From EN (CCM)



Power On From EN (DEM)



OVP Waveforms



UVP Waveforms

