

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

General Description

The AP3583/A is a simple single-phase synchronous buck controller. It operates from 5V or 12V supply voltage and delivers high quality output voltage as low as 0.6V. This device operates at fixed 200kHz (AP3583) or 300kHz (AP3583A) frequency and provides an optimum compromise between efficiency, external component size and cost.

With integrated linear regulator bootstrap diode, and N-Channel MOSFET gate drives, the AP3583/A can reduce external component count and board space requirements.

The AP3583/A supports both tracking mode and stand-alone mode operation. The output voltage is tightly regulated to the external reference voltage from 0.4V to 3V at tracking mode or internal 0.6V reference at stand-alone mode.

Other features include internal soft-start, under voltage protection, over current protection and shutdown function. With aforementioned functions, this part provides customers a compact, high efficiency, well-protected and cost-effective solutions.

The AP3583/A is available in PSOP-8 package.

Features

- Supply Voltage: 5V/12V
V_{IN} Input Range: 3.0V to 13.2V
0.6V to 80% of V_{IN} Output Range
Internal Reference: 0.6V
- Support Tracking Mode and Stand-alone Mode
- Simple Single-loop Control
Voltage-mode PWM Control
Duty Cycle: 0% to 80%
- Fast Transient Response
- Fixed Oscillator Frequency: 200/300kHz
- Lossless, Programmable Over Current Protection (Uses Lower MOSFET R_{DS(ON)})
- Start-up into Pre-biased Output
- Built-in Thermal Shutdown
- Built-in Soft-start
- Over Current/Voltage Protection
- Under Voltage Protection
- Integrated Boot Diode

Applications

- Power Supplies for Microprocessors/Peripherals
PCs, Embedded Controllers, Memory Supplies
DSP and Core Communications Processor
Supplies
- Subsystem Power Supplies
PCI, AGP, Graphics Cards and Digital TV
SSTL-2 and DDR/2/3 SDRAM Bus Termination
Supply
- Cable Modems, Set Top Boxes, and DSL
Modems
- Industrial Power Supplies and General Purpose
Supplies
- 5V/12V Input DC-DC Regulators
- Low-voltage Distributed Power Supplies



Figure 1. Package Type of AP3583/A

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Pin Configuration

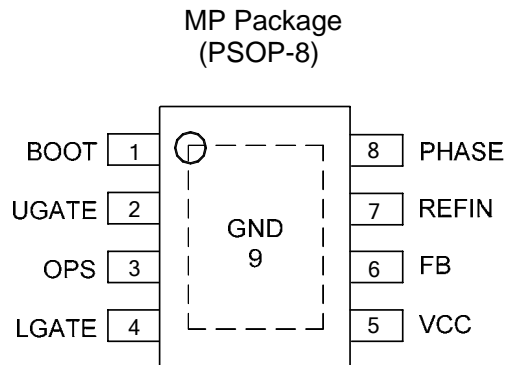


Figure 2. Pin Configuration of AP3583/A (Top View)

Pin Description

Pin Number	Pin Name	Function
1	BOOT	Bootstrap pin. Connect a bootstrap capacitor (Typically from 0.1 to 0.47 μ F) from this pin to PHASE pin to create a BOOT voltage suitable to drive a standard N-Channel MOSFET
2	UGATE	Upper-gate drive pin. Connect this pin to the upper MOSFET gate providing the gate drive. This pin is monitored by the adaptive shoot-through protection circuitry to determine when the upper MOSFET has been turned off
3	OPS	Over-current setting pin. Connecting a resistor (R_{OCSET}) between OPS and GND to set the over-current trigger point
4	LGATE	Lower-gate drive pin. Connect LGATE to the lower MOSFET gate providing the gate drive for the lower MOSFET. This pin is monitored by the adaptive shoot-through protection circuitry to determine when the lower MOSFET has been turned off
5	VCC	Bias supply pin. Provides a 5V or 12V bias supply for the chip from this pin. The pin should be bypassed with a capacitor to GND
6	FB	Feedback pin. This pin is the inverting input of the internal error amplifier. A resistor divider from output to GND is used to set the output voltage
7	REFIN	External reference input pin. This pin receives a voltage with range from 0.4V to 3.0V as the reference voltage at the non-inverting input of the error amplifier. Pull this pin lower than 0.3V to disable the controller, and the V_{UGATE} and V_{LGATE} will go low. Let this pin open for internal 0.6V reference use
8	PHASE	PHASE pin. This pin connects to the source of the upper MOSFET and the drain of the lower MOSFET. This pin is also monitored by the adaptive shoot-through protection circuitry to determine when the upper MOSFET is turned off
9	GND	Exposed pad as ground pin. Represents the signal and power ground for the IC. Tie this pin to ground island/plane through the lowest impedance connection available

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Functional Block Diagram

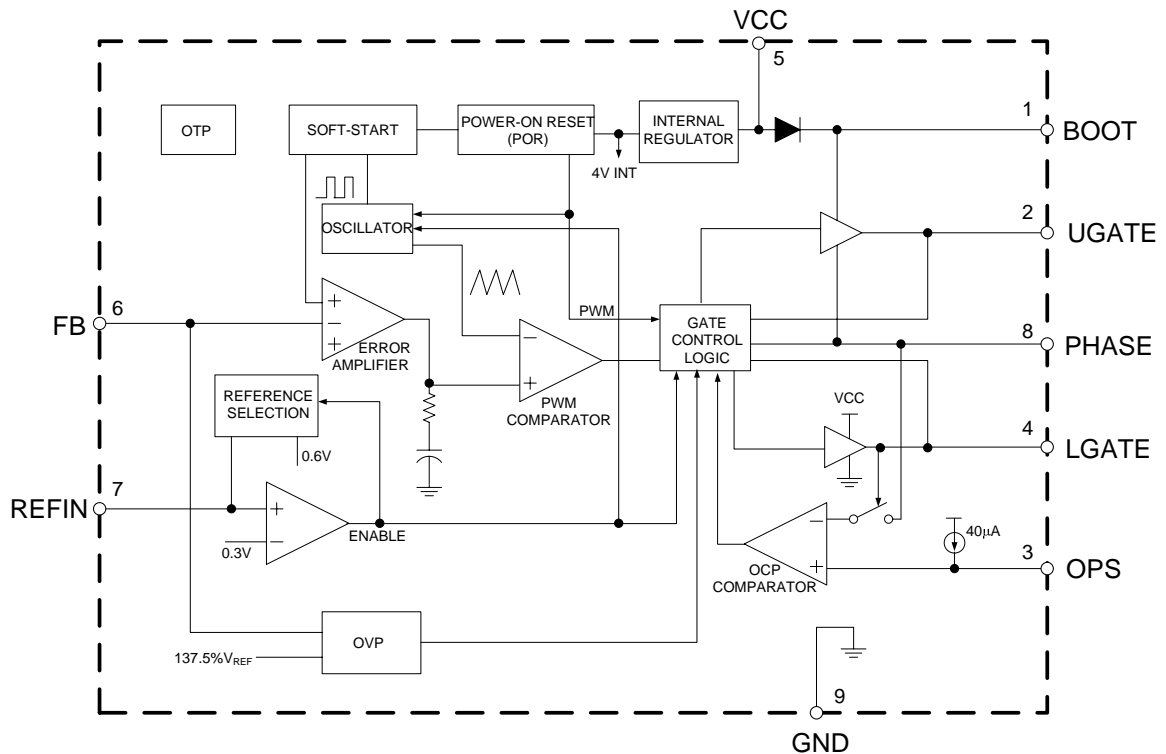
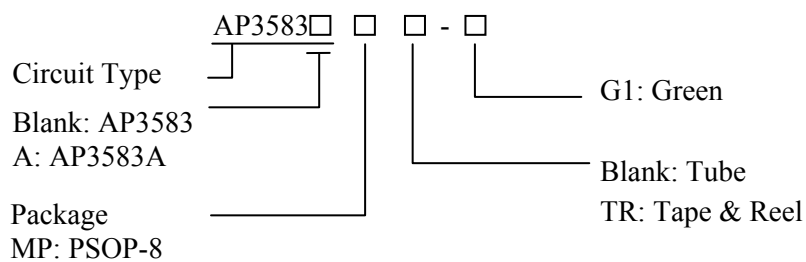


Figure 3. Functional Block Diagram of AP3583/A

Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing Type
PSOP-8	-40 to 85°C	AP3583MP-G1	3583MP-G1	Tube
		AP3583MPTR-G1	3583MP-G1	Tape & Reel
		AP3583AMP-G1	3583AMP-G1	Tube
		AP3583AMPTR-G1	3583AMP-G1	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

**Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A****Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to 15	V
BOOT Voltage	V_{BOOT}	-0.3 to $V_{PHASE} +15$	V
Voltage from UGATE to PHASE	V_{UGATE}	-0.3 to 15	V
Voltage from PHASE, LGATE Pin to GND	V_{PHASE} , V_{LGATE}	-1 to 15	V
Voltage on Other Separate Pin		-0.3 to 6	V
Thermal Resistance	θ_{JA}	50	°C/W
Operating Junction Temperature	T_J	-40 to 125	°C
Storage Temperature	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering, 10 sec)	T_{LEAD}	260	°C
ESD (Human Body Model) (Note 2)		2000	V
ESD (Machine Model) (Note 2)		200	V

Note 1: Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

Note 2: Devices are ESD sensitive. Handling precaution recommended.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Supply Input Voltage	V_{CC}	4.5	13.2	V
Operating Junction Temperature	T_J	-40	125	°C
Operating Ambient Temperature	T_A	-40	85	°C



Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Electrical Characteristics

$V_{CC}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
SUPPLY INPUT						
Supply Voltage	V_{CC}		4.5		13.2	V
Supply Current	I_{CC}	UGATE and LGATE Pin Open; $V_{CC}=12V$, Switching		3		mA
Quiescent Supply Current	I_{CC_Q}	$V_{FB}=V_{REF}+0.1V$, No Switching		2		mA
Power Input Voltage	V_{IN}		3.0		13.2	V
POWER ON RESET						
V_{CC} Rising Threshold	V_{POR}	V_{CC} Rising	4.0	4.2	4.4	V
V_{CC} Threshold Hysteresis	V_{POR_HYS}			300		mV
OSCILLATOR						
Oscillator Frequency	f_{OSC}	AP3583	180	200	220	kHz
		AP3583A	270	300	330	
Ramp Amplitude	ΔV_{OSC}	$V_{CC}=12V$		1.0		V
PWM CONTROLLER GATE DRIVERS						
Upper Gate Source Current	I_{UG_SRC}	$V_{BOOT}-V_{PHASE}=12V$, $V_{BOOT}-V_{UGATE}=6V$		-1		A
Upper Gate Sink Current	I_{UG_SNK}	$V_{BOOT}-V_{PHASE}=12V$, $V_{BOOT}-V_{UGATE}=6V$		1.5		A
Upper Gate Sink Resistance	R_{UGATE}	50mA Sink Current $V_{BOOT}-V_{PHASE}=12V$		1.6	3.2	Ω
Lower Gate Source Current	I_{LG_SRC}	$V_{CC}-V_{LGATE}=6V$		-1		A
Lower Gate Sink Current	I_{LG_SNK}	$V_{LGATE}=6V$		1.5		A
Lower Gate Sink Resistance	R_{LGATE}	$V_{CC}=12V$, 50mA Source Current		1	2	Ω
PHASE Falling to LGATE Rising Delay		$V_{PHASE}<1.2V$ to $V_{LGATE}>1.2V$		50		ns
LGATE Falling to UGATE Rising Delay		$V_{LGATE}<1.2V$ to $(V_{UGATE}-V_{PHASE})>1.2V$		50		ns
Minimum Duty Cycle				0		%
Maximum Duty Cycle			75	80	85	%
REFERENCE VOLTAGE						
Feedback Voltage	V_{FB}	Stand-alone Mode	0.591	0.6	0.609	V

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Electrical Characteristics (Continued)

$V_{CC}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Voltage Accuracy		$ V_{FB}-V_{REFIN} $, V_{REFIN} =0.4V to 1.0V, Tracking Mode			15	mV
		$ V_{FB}-V_{REFIN} /V_{REFIN}$, $V_{REFIN}=1.0V$ to 3.0V, Tracking Mode			1.5	%
REFIN Enable Threshold	V_{REFIN}			0.3	0.35	V
PROTECTION						
Under Voltage Protection	V_{FB_UVP}		0.3	0.4	0.5	V
Over Current Source	I_{OPS}		30	40	50	μA
Soft-start Interval	t_{SS}	AP3583, Stand-alone Mode		2.6		ms
		AP3583A, Stand-alone Mode		2.0		
Thermal Shutdown	T_{OTSD}			160		$^{\circ}C$
Thermal Shutdown Hysteresis	T_{HYS}			20		$^{\circ}C$

Typical Performance Characteristics

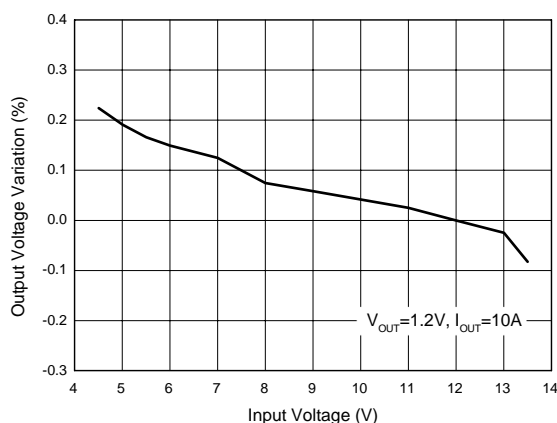


Figure 4. Line Regulation

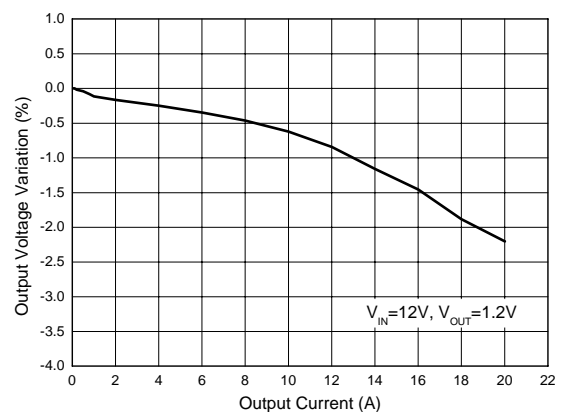


Figure 5. Load Regulation

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Typical Performance Characteristics (Continued)

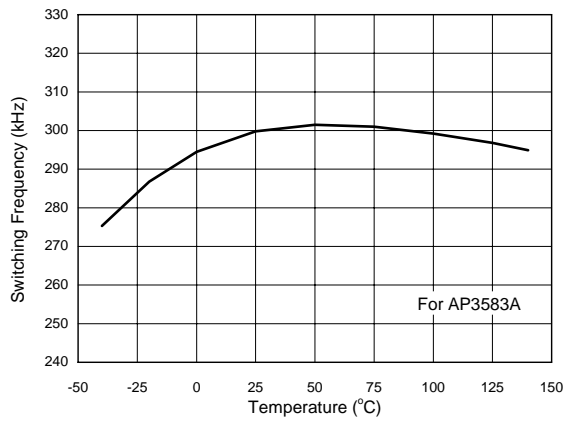


Figure 6. Switching Frequency vs. Temperature

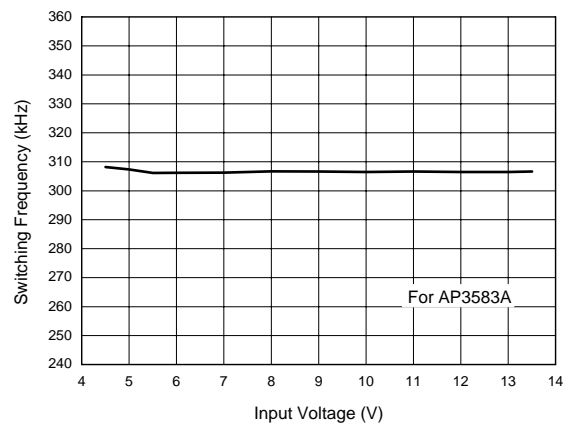


Figure 7. Switching Frequency vs. Input Voltage

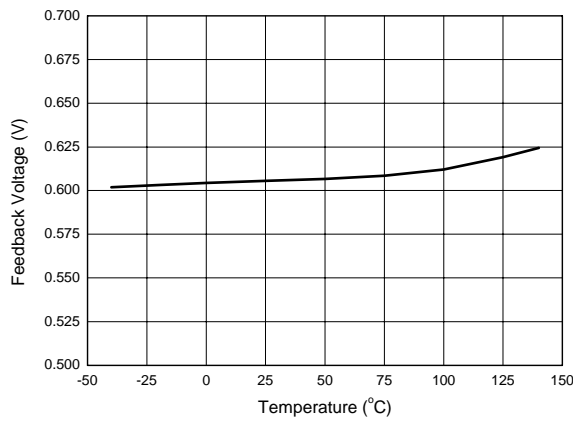


Figure 8. Feedback Voltage vs. Temperature

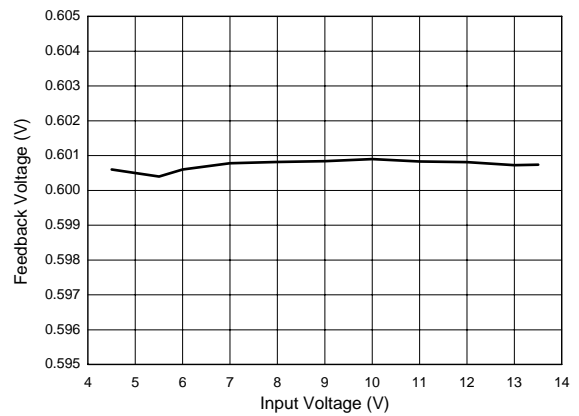


Figure 9. Feedback Voltage vs. Input Voltage

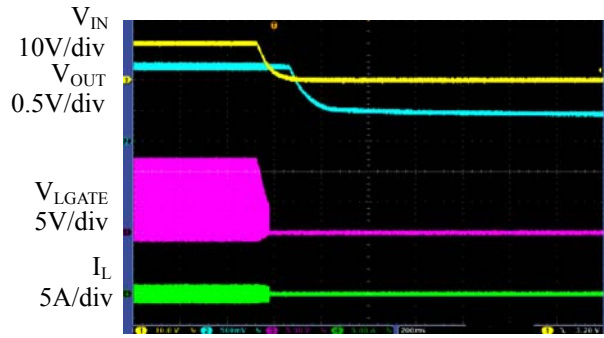
Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Typical Performance Characteristics (Continued)



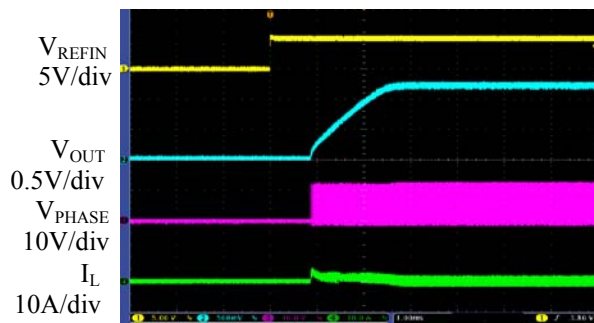
Time 1ms/div

Figure 10. Power-on Waveform
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0A$)



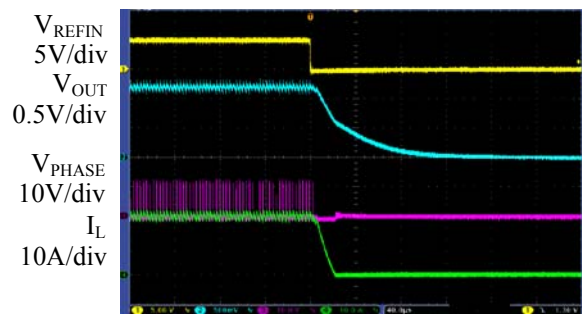
Time 200ms/div

Figure 11. Power-off Waveform
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0A$)



Time 1ms/div

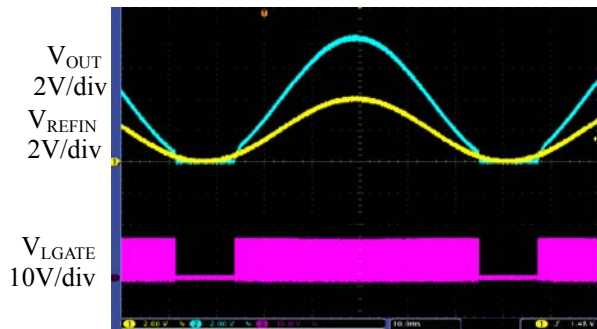
Figure 12. Enable Waveform
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0A$)



Time 40µs/div

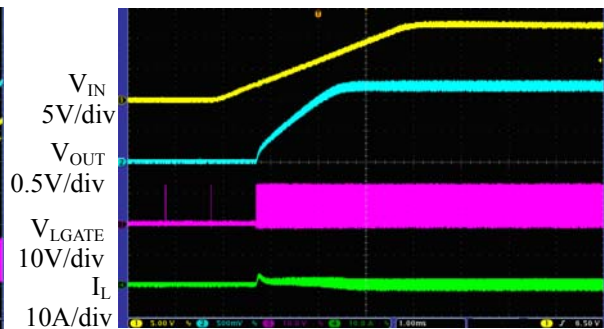
Figure 13. Disable Waveform
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=20A$)

Typical Performance Characteristics (Continued)



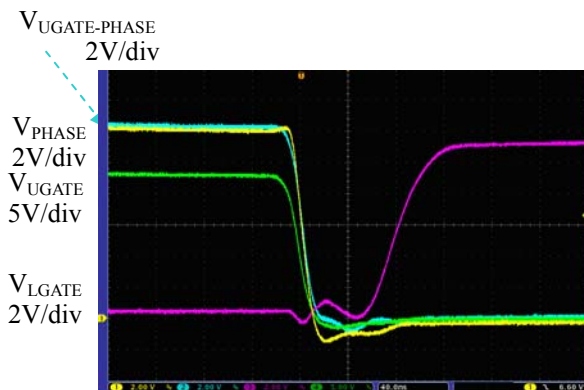
Time 10ms/div

Figure 14. REFIN Operation
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=5A$)



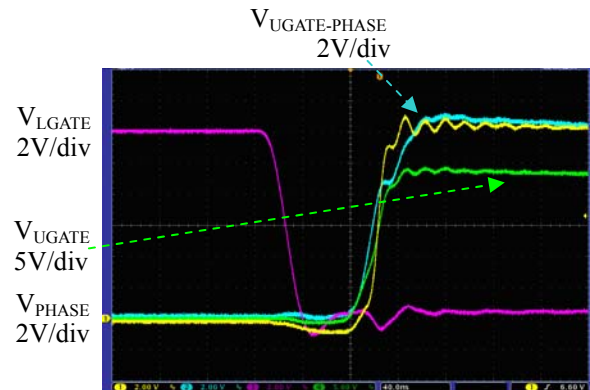
Time 1ms/div

Figure 15. Power Input Detection
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0A$)



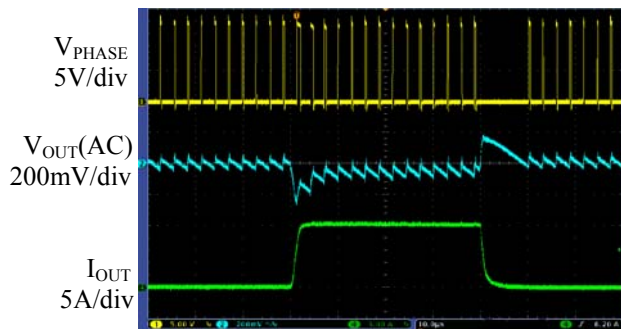
Time 40ns/div

Figure 16. UGATE Turn-off Waveforms
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=20A$)

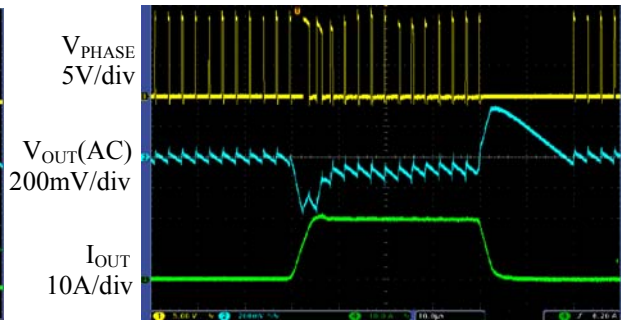


Time 40ns/div

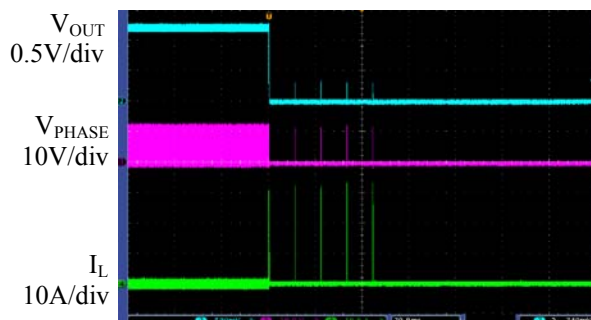
Figure 17. UGATE Turn-on Waveforms
($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=20A$)

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A
Typical Performance Characteristics (Continued)


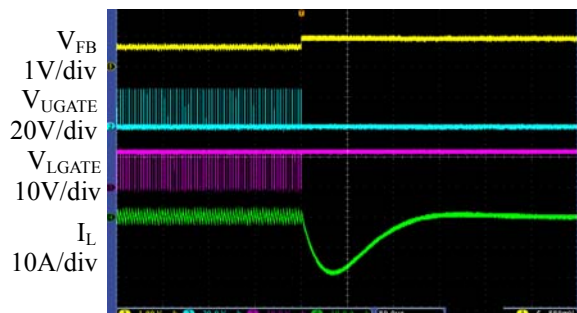
Time 10µs/div

 Figure 18. Load Transient Response
 ($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0$ to 10A; 4A/µs)


Time 10µs/div

 Figure 19. Load Transient Response
 ($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0$ to 20A; 4A/µs)


Time 20ms/div

 Figure 20. Over Current Protection
 ($V_{IN}=12V$, $V_{OUT}=1.2V$ to 0V, $I_{OUT}=0A$)


Time 80µs/div

 Figure 21. Over Voltage Protection
 ($V_{IN}=12V$, $V_{OUT}=1.2V$, $I_{OUT}=0A$)

Single Phase Synchronous Buck PWM Controller With Reference Input AP3583/A

Typical Application

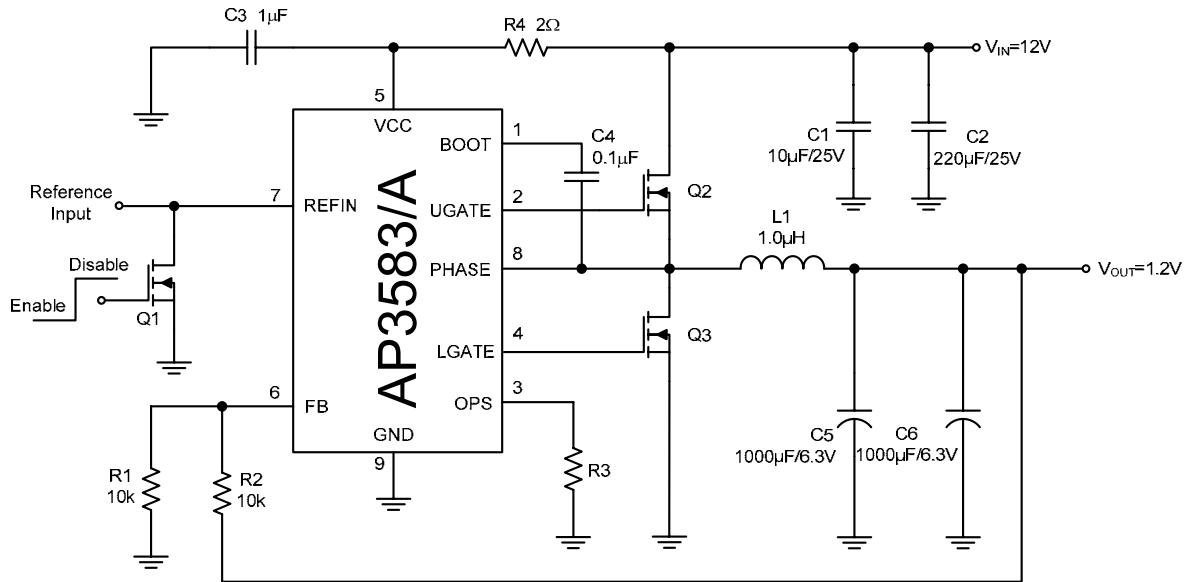
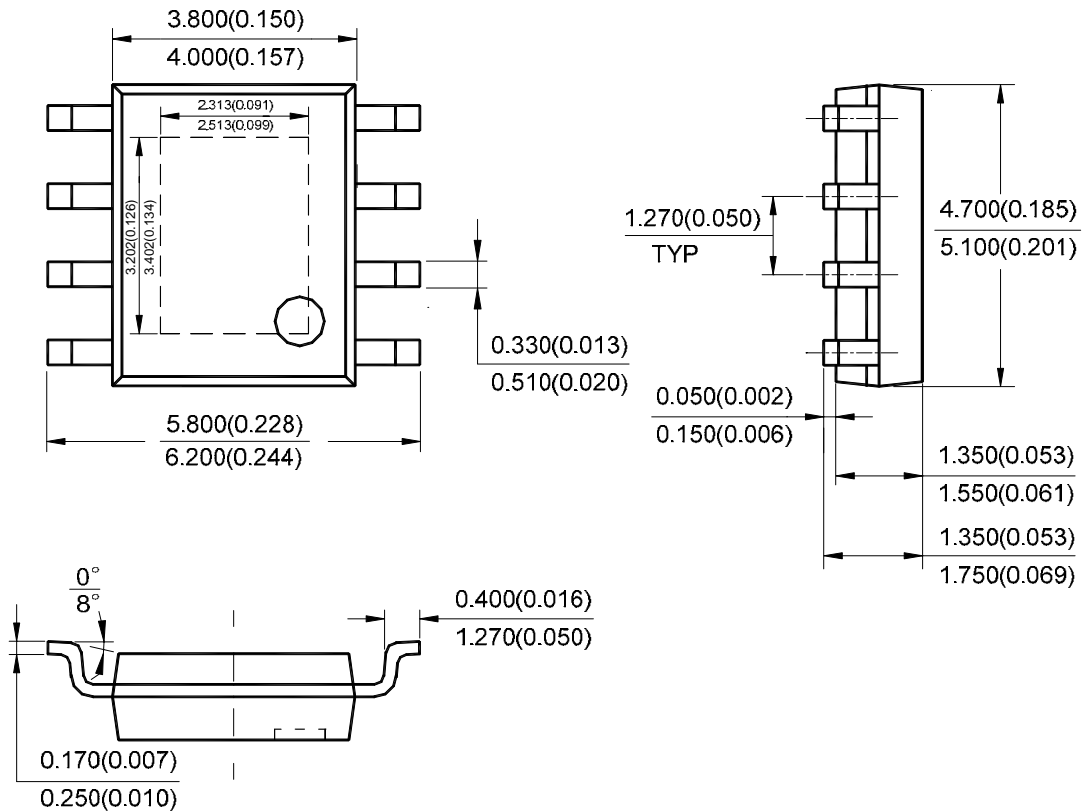


Figure 22. Typical Application Circuit of AP3583/A

Mechanical Dimensions

PSOP-8

Unit: mm(inch)



Note: Eject hole, oriented hole and mold mark is optional.



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