SINGLE PHASE SYNCHRONOUS BUCK PWM CONTROLLER WITH REFERENCE INPUT

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.

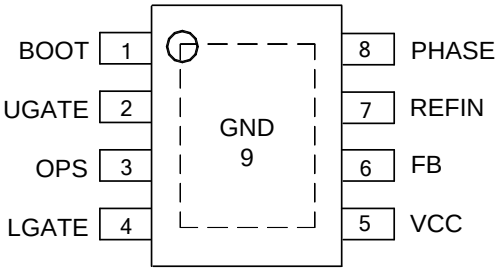
The AP3583/A is available in PSOP-8 package.

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
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Pin Assignments

(Top View)



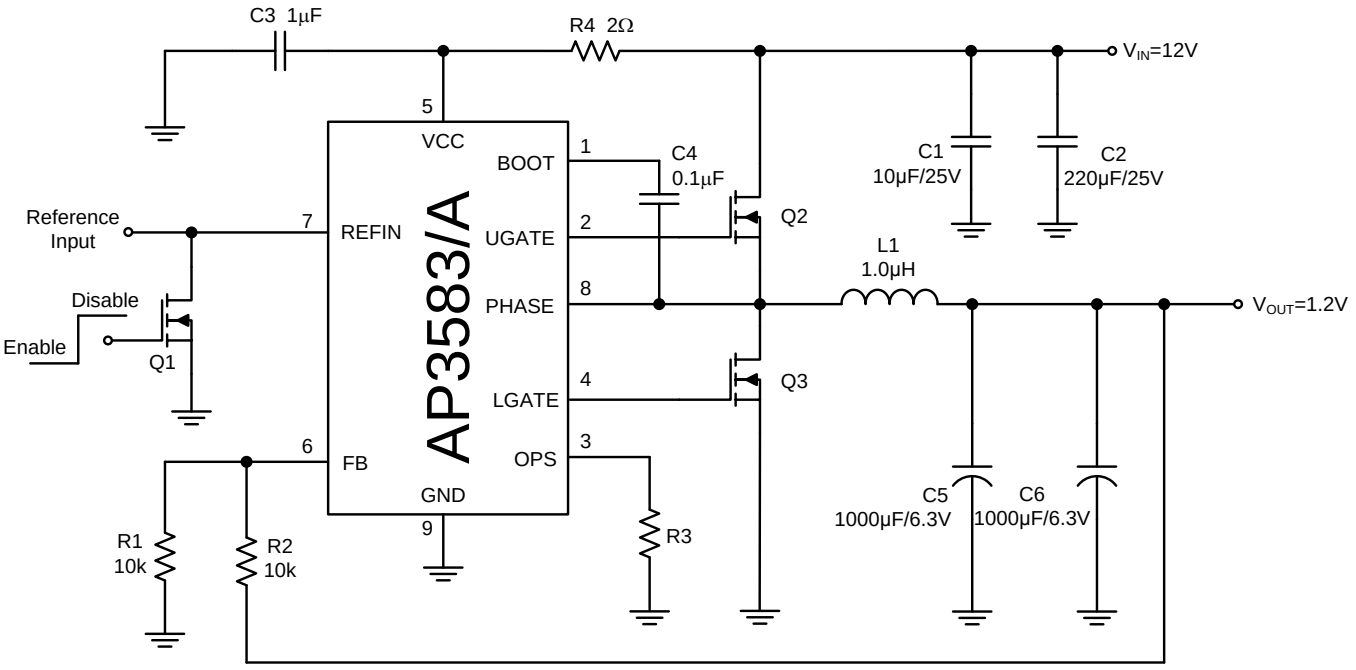
PSOP-8

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

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

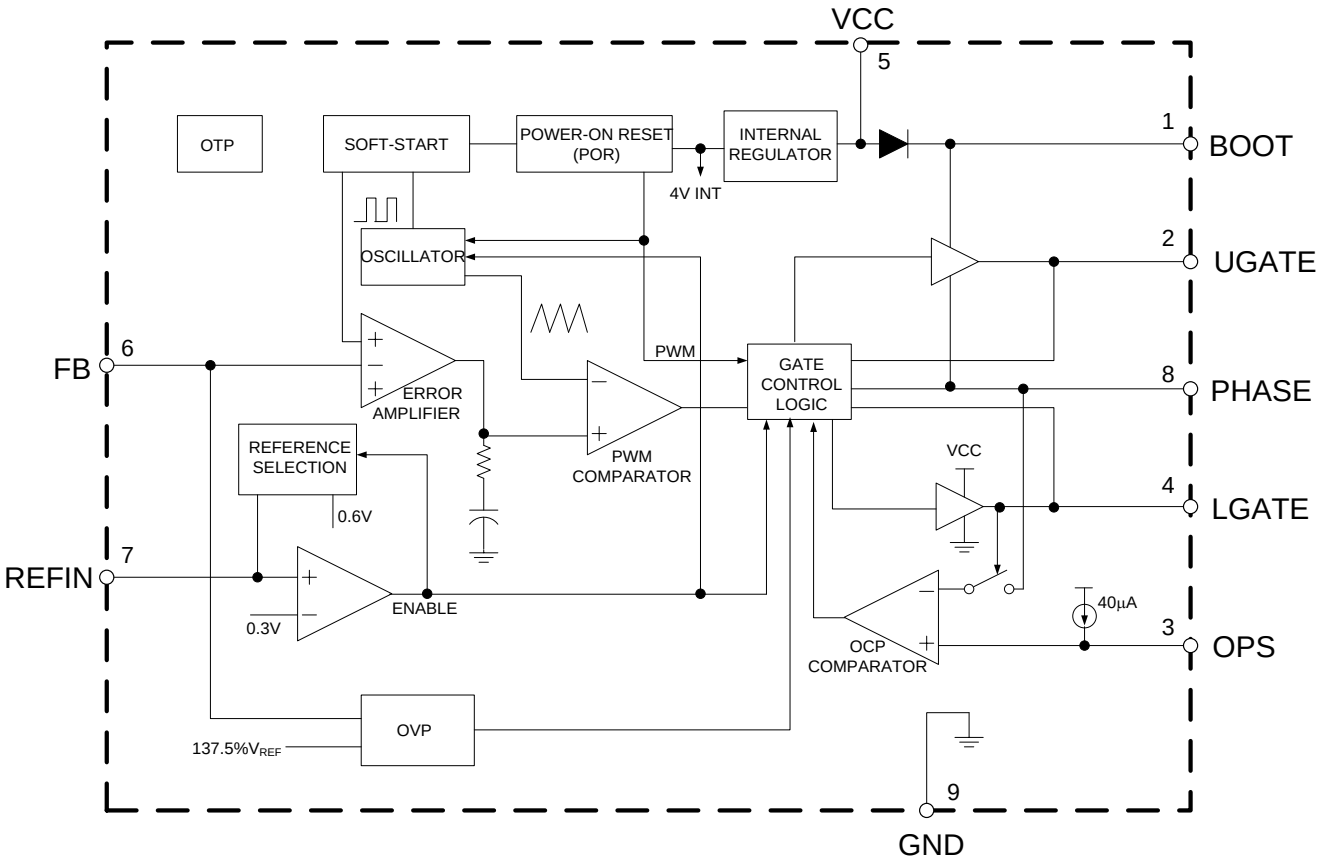
Typical Applications Circuit



Pin Descriptions

Pin Number	Pin Name	Function
1	BOOT	Bootstrap pin. Connect a bootstrap capacitor (Typically from 0.1 to 0.47μF) 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.

Functional Block Diagram



Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	-0.3 to 15	V
V_{BOOT}	BOOT Voltage	-0.3 to V_{PHASE} +15	V
V_{UGATE}	Voltage from UGATE to PHASE	-0.3 to 15	V
V_{PHASE}, V_{LGATE}	Voltage from PHASE, LGATE Pin to GND	-1 to 15	V
_	Voltage on Other Separate Pin	-0.3 to 6	V
θ_{JA}	Thermal Resistance	50	ºC/W
T_J	Operating Junction Temperature	-40 to +125	ºC
T_{STG}	Storage Temperature	-65 to +150	ºC
T_{LEAD}	Lead Temperature (Soldering, 10 sec)	+260	ºC
_	ESD (Human Body Model) (Note 5)	2000	V
_	ESD (Machine Model) (Note 5)	200	V

Notes 4: 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.

5: Devices are ESD sensitive. Handling precaution recommended.

Recommended Operating Conditions

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

Electrical Characteristics (V_{CC}=12V, T_A=+25℃, unless otherwise specified.)

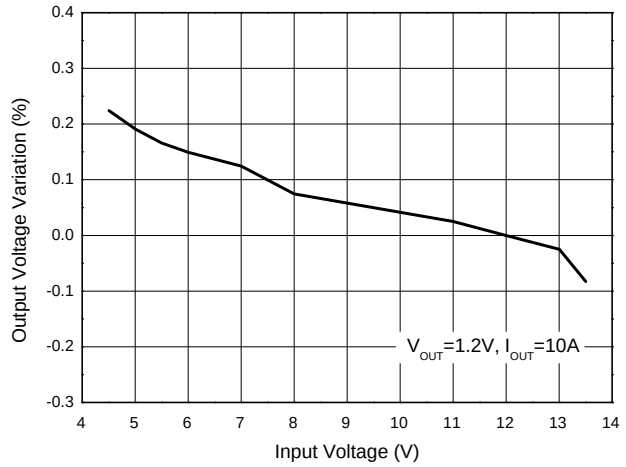
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
SUPPLY INPUT						
V_{CC}	Supply Voltage	_	4.5	_	13.2	V
I_{CC}	Supply Current	UGATE and LGATEPin Open; V_{CC}=12V, Switching	_	3	_	mA
I_{CC_Q}	Quiescent Supply Current	V_{FB}=V_{REF}+0.1V, No Switching	_	2	_	mA
V_{IN}	Power Input Voltage	_	3.0	_	13.2	V
POWER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

Electrical Characteristics (Cont. V_{CC}=12V, T_A=+25℃, unless otherwise specified.)

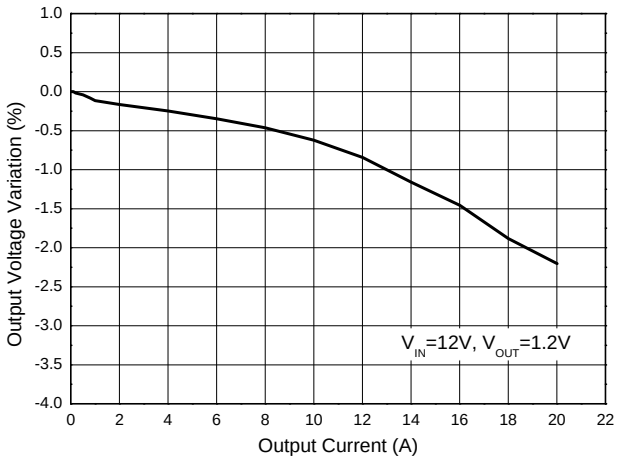
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
–	Output Voltage Accuracy	$\lvert V_{FB}-V_{REFIN}\rvert$, V_{REFIN}=0.4V to 1.0V, Tracking Mode	–	–	15	mV
–		$\lvert V_{FB}-V_{REFIN}\rvert/V_{REFIN}$, V_{REFIN}=1.0V to 3.0V, Tracking Mode	–	–	1.5	%
V_{REFIN}	REFIN Enable Threshold	–	–	0.3	0.35	V
PROTECTION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

Performance Characteristics

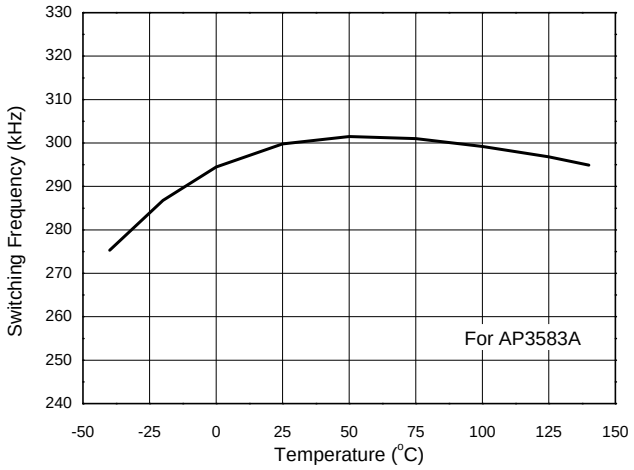
Line Regulation



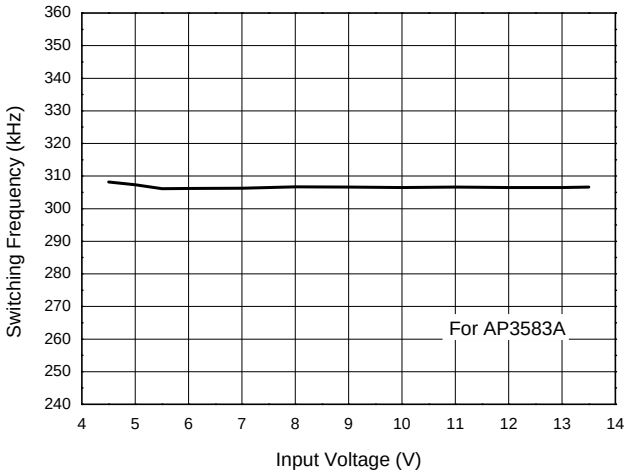
Load Regulation



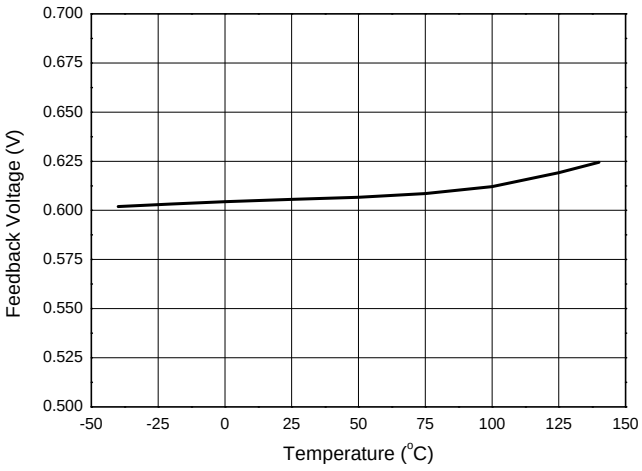
Switching Frequency vs. Temperature



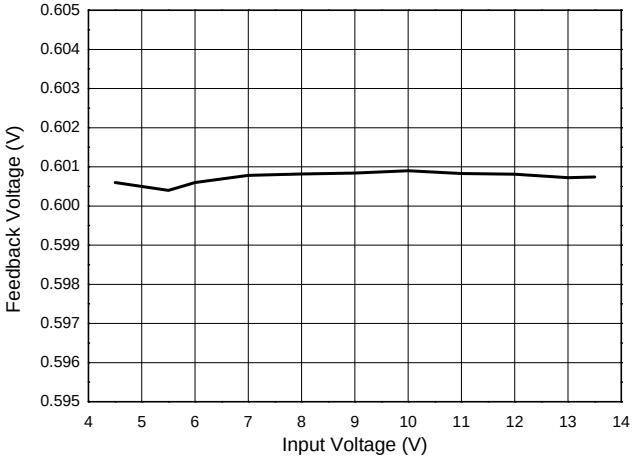
Switching Frequency vs. Input Voltage



Feedback Voltage vs. Temperature

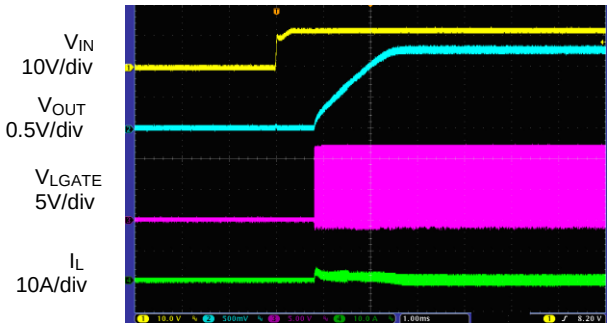


Feedback Voltage vs. Input Voltage



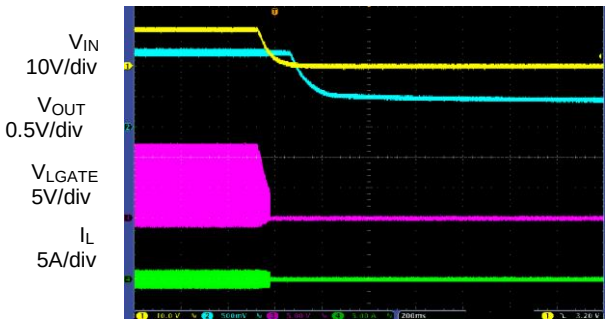
Performance Characteristics (Cont.)

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



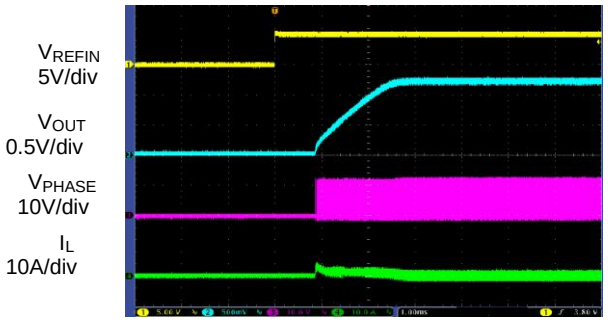
Time 1ms/div

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



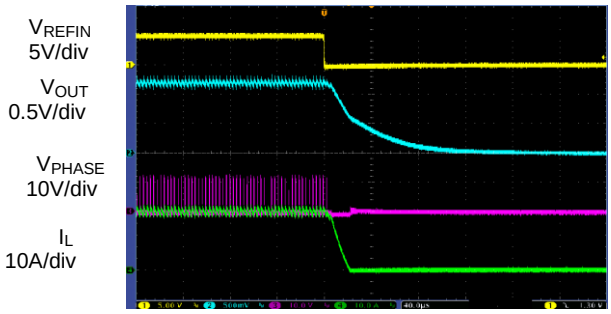
Time 200ms/div

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



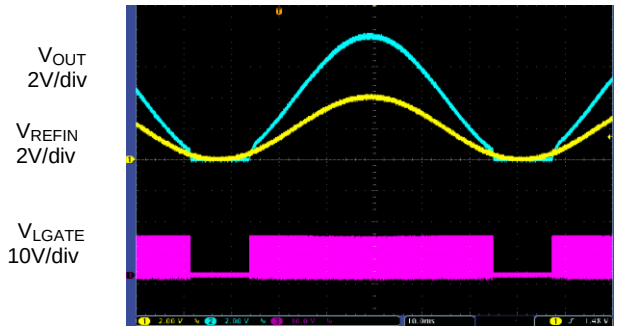
Time 1ms/div

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



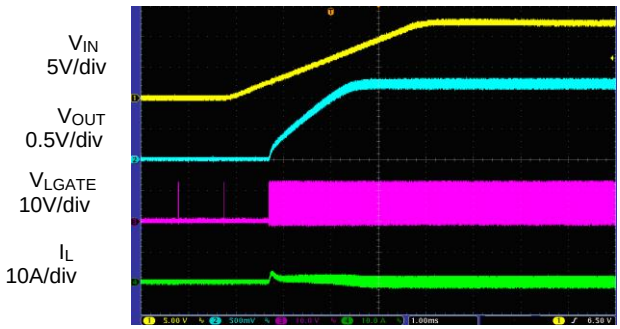
Time 40μs/div

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



Time 10ms/div

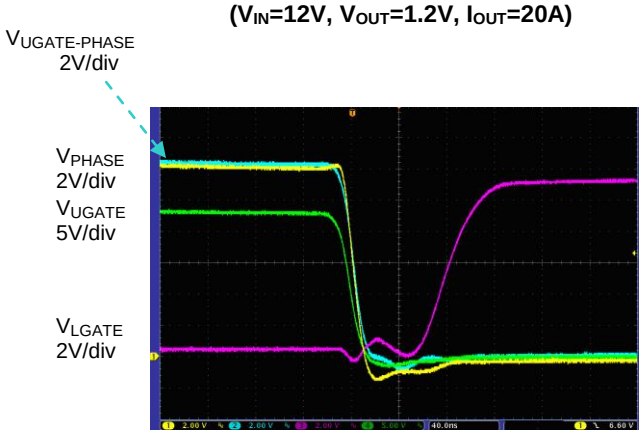
Power Input Detection
(V_{IN}=12V, V_{OUT}=1.2V, I_{OUT}=0A)



Time 1ms/div

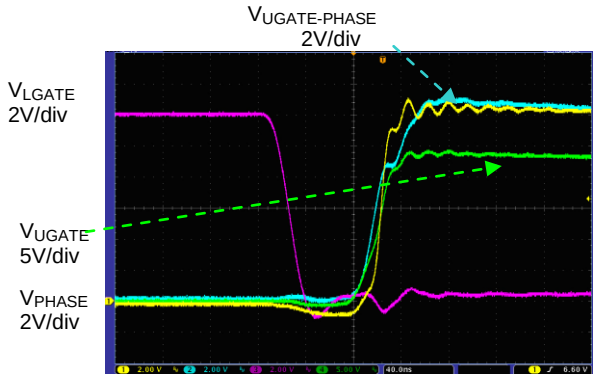
Performance Characteristics (Cont.)

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

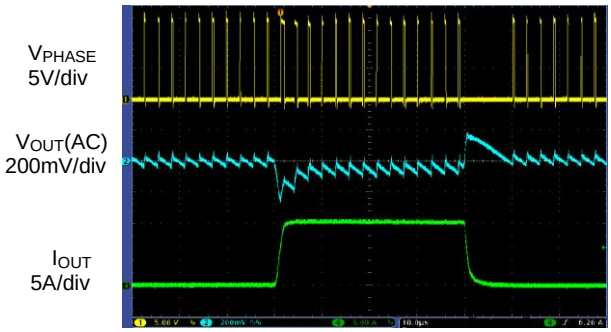


Time 40ns/div

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

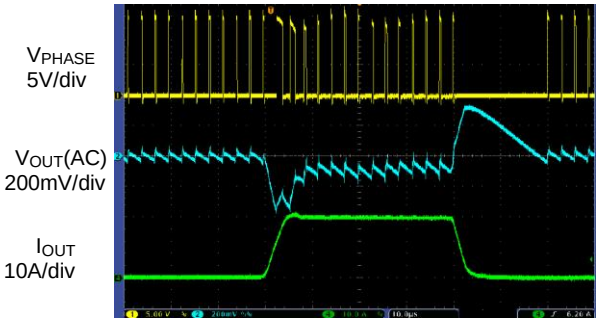


Load Transient Response
(V_{IN}=12V, V_{OUT}=1.2V, I_{OUT}=0 to 10A; 4A/µs)



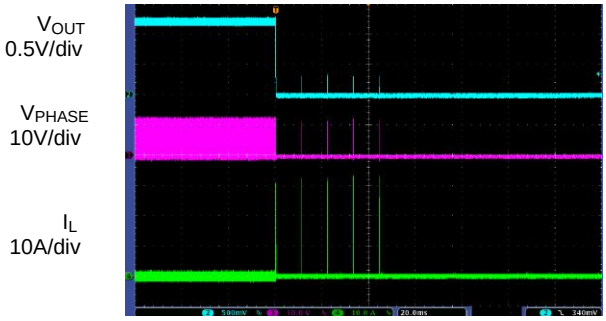
Time 10µs/div

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



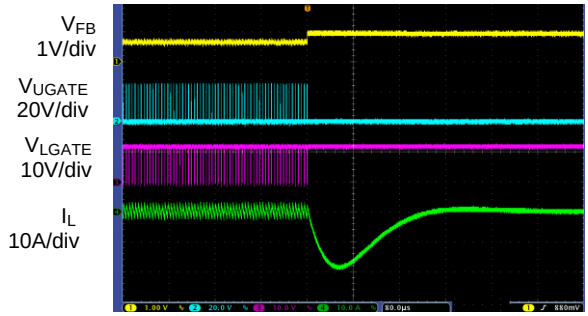
Time 10µs/div

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



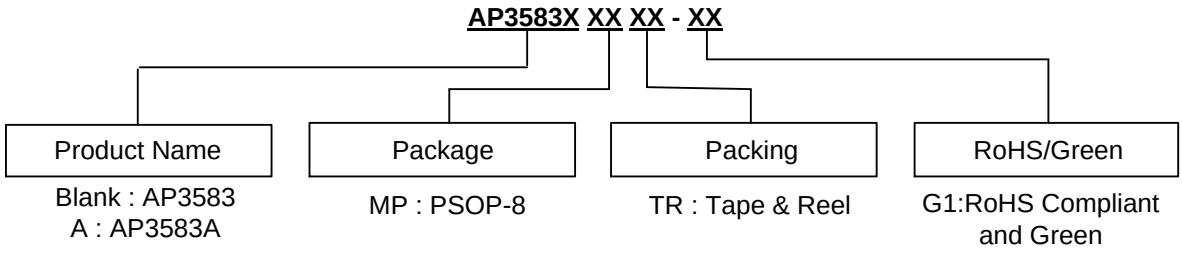
Time 20ms/div

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



Time 80µs/div

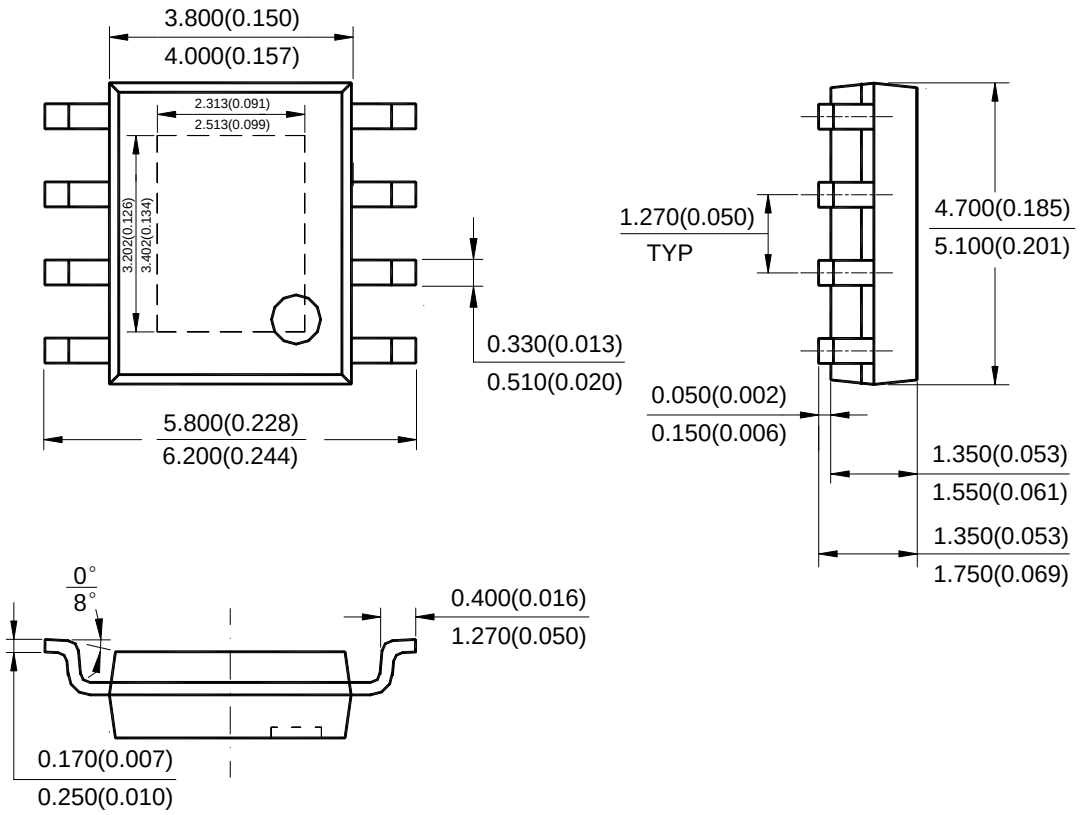
Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing
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

Package Outline Dimensions (All dimensions in mm(inch).)

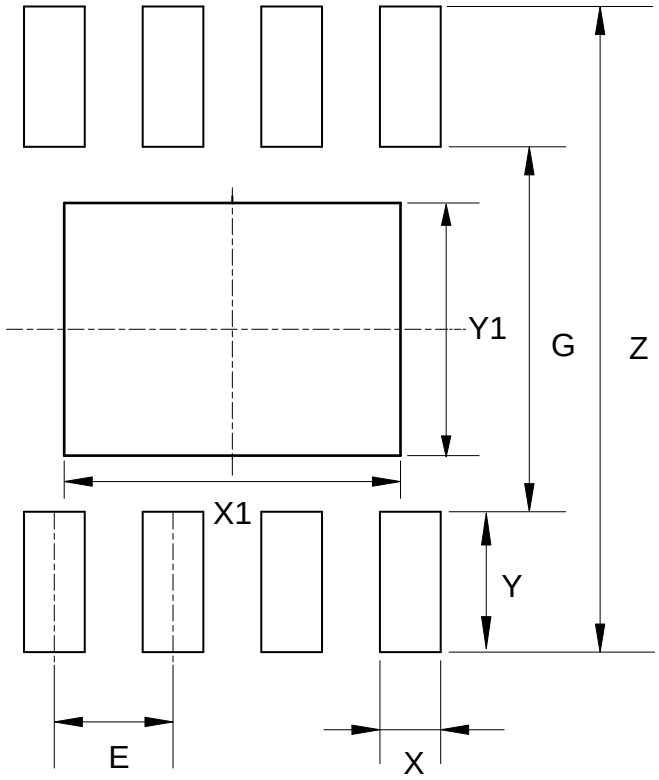
(1) Package Type: PSOP-8



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

Suggested Pad Layout

(1) Package Type: PSOP-8



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059
Dimensions	X1 (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)	---
Value	3.600/0.142	2.700/0.106	1.270/0.050	---

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2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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