Description

The AP3581A/B/C is a compact synchronous – rectified bulk controller specifically designed to operate from 5V/12V supply and deliver high-quality output voltage as low as 0.6V (AP3581A) or 0.8V (AP3581B/C). The AP3581A/B/C operates at fixed frequency of 300kHz (AP3581A/B) or 200kHz (AP3581C) and provides an optimal level of integration to reduce size and cost of the power supply.

This controller integrates internal MOSFET drivers that support 12V+12V bootstrapped voltage for high- efficiency power conversion. The bootstrap diode is built-in to simplify the circuit design and minimize external part count.

This controller provides single feedback loop, voltage-mode control with fast transient response. The error amplifier features a 10MHz gain-bandwidth product and 6V/μs slew rate which enables high converter bandwidth for fast transient performance.

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

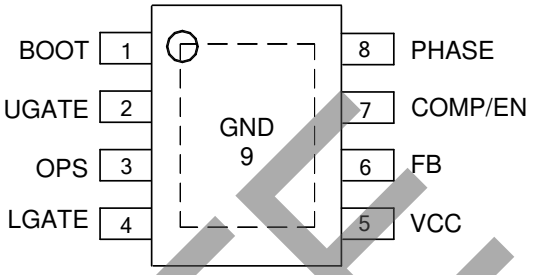
The AP3581A/B/C is available in PSOP-8 package.

Features

- Supply Voltage: 5V/12V
  V_{IN} Input Range: 3.0V to 13.2V
  0.6V/0.8V to 80% of V_{IN} Output Range
  Internal Reference: 0.6V/0.8V
- Simple Single-Loop Control
  Voltage-Mode PWM Control
  Duty Cycle: 0% to 80%
  Fast Transient Response
- 10MHz High-Bandwidth Error Amplifier with 6V/μs Slew Rate
- Fixed Oscillator Frequency: 300kHz/200kHz
- 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

Pin Assignments

(Top View)

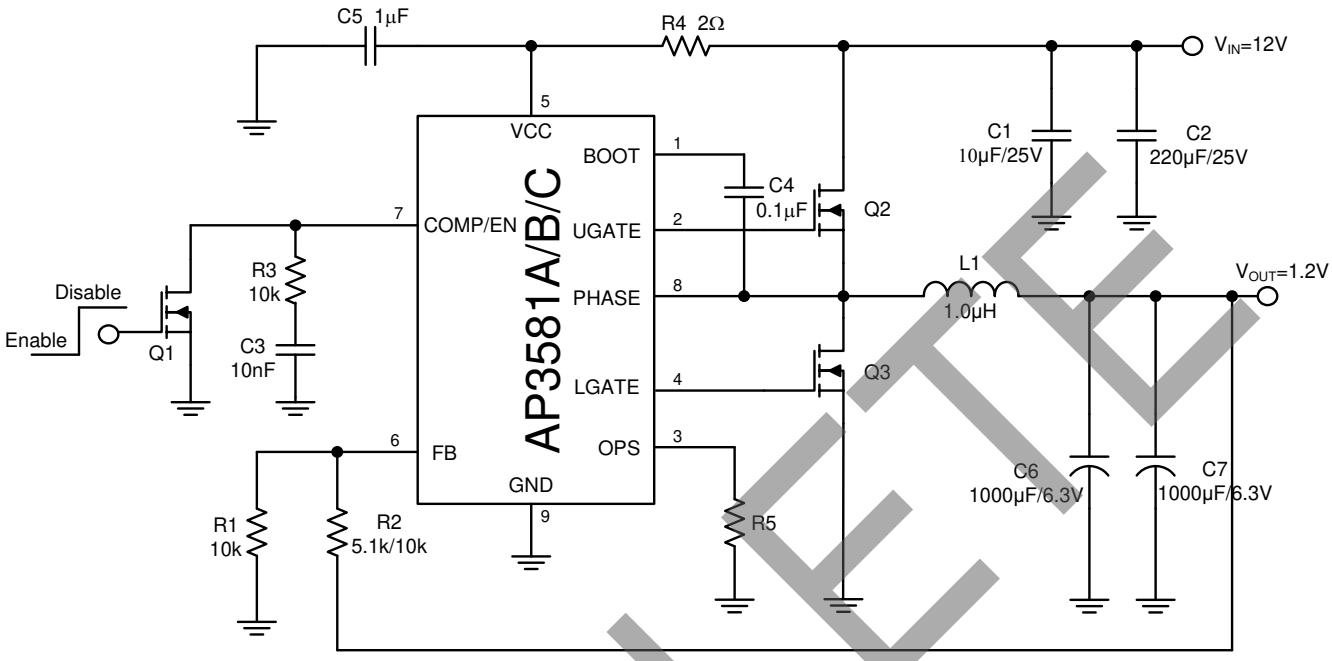


PSOP-8
(Top View)

Applications

- Power Supplies for Microprocessors/Peripherals
  PCs, Embedded Controllers, Memory Supplies
  DSP and Core Communications Processor Supplies
- Subsystem Power Supplies
  PCI, AGP, Graphics Cards, 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

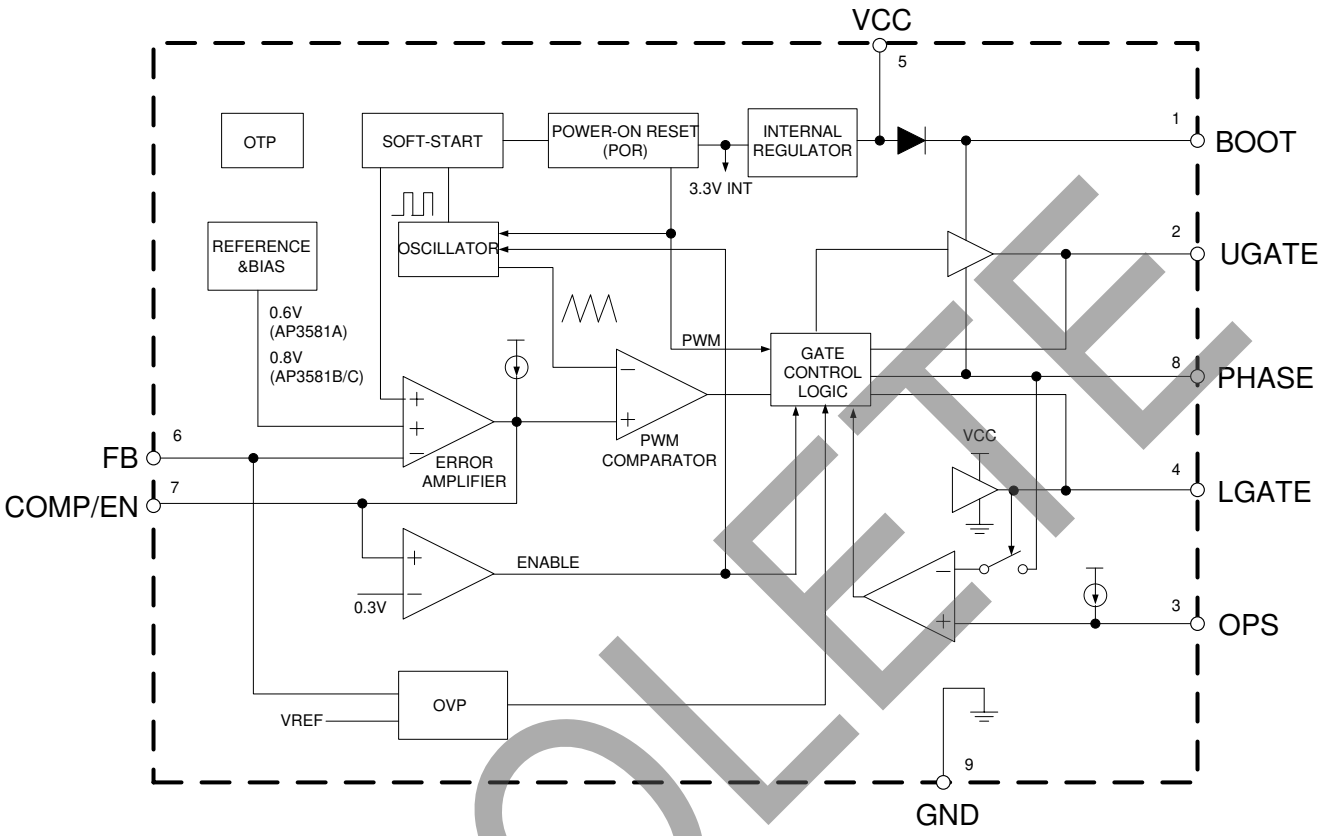
Typical Applications Circuit



Pin Descriptions

Pin Number	Pin Name	Function
1	BOOT	Bootstrap pin. Connect a bootstrap capacitor (Typically from 0.1µF 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 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. Use FB pin, in combination with the COMP pin, to compensate the voltage control feedback loop of the converter. A resistor divider from output to GND is used to set the output voltage
7	COMP/EN	Compensation and disable pin, this pin is the output of the error amplifier. Pull COMP pin low will shut down the IC
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 has turned off
9	GND	Exposed pad as ground pin. Represents the signal and power ground for the IC. Tie this pin to the ground island/plane through the lowest impedance connection available

Functional Block Diagram



Absolute Maximum Ratings (Note 1)

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 2)	2000	V
_	ESD (Machine Model) (Note 2)	200	V

Notes: 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.

2. 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 Range	-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 LGATE Pin Open; V_{CC}=12V, Switching	_	5	_	mA
I_{CC_Q}	Quiescent Supply Current	V_{FB}=V_{REF}+0.1V, No Switching	_	4	_	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	_	_	500	_	mV
OSCILLATOR						
f_{OSC}	Oscillator Frequency	AP3581A/B	270	300	330	kHz
		AP3581C	180	200	220	
ΔV_{OSC}	Ramp Amplitude	V_{CC}=12V	_	1.8	_	V
ERROR AMPLIFIER						
G_{DC_OL}	Open Loop DC Gain (Note 3)	_	55	70	_	dB
G_{BW}	Gain Bandwidth (Note 3)	_	_	10	_	MHz
SR	Slew Rate (Note 3)	_	3	6	_	V/μs
_	Transconductance	_	_	800	1100	μA/V
_	Output Source Current	V_{FB}<V_{REF}	80	120	_	μA
_	Output Sink Current	V_{FB}>V_{REF}	80	120	_	μA
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	50mA Sink Current, V_{CC}=12V	_	1	2	Ω
_	PHASE Falling to LGATE Rising Delay	V_{PHASE}<1.2V to V_{LGATE}>1.2V	_	50	_	ns

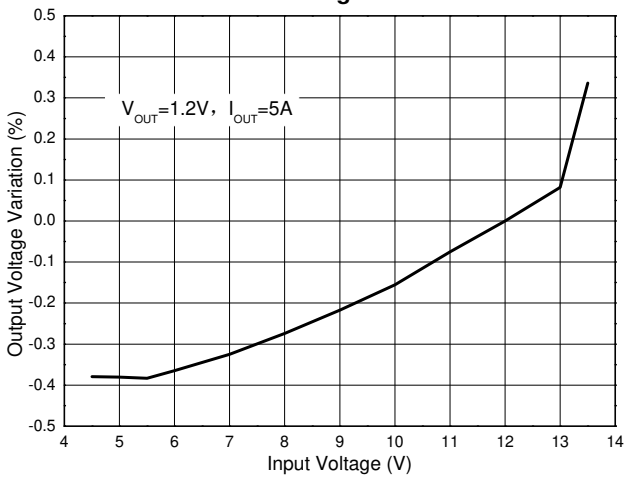
Note: 3. Not tested, guaranteed by design.

Electrical Characteristics (Cont.)

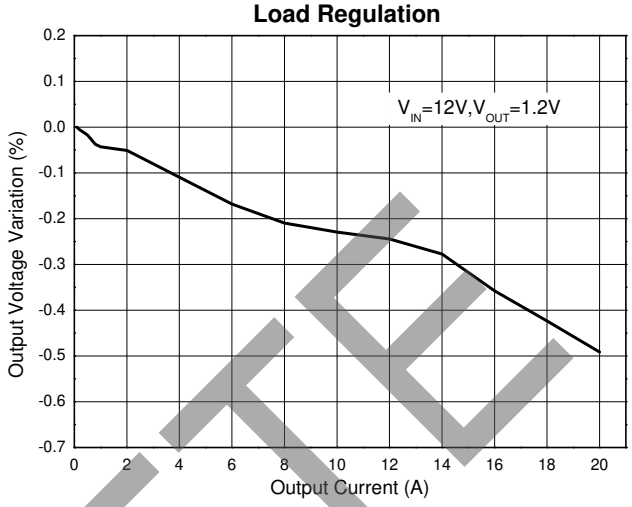
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
–	LGATE Falling to UGATE Rising Delay	V_{LGATE}<1.2V to (V_{UGATE}-V_{PHASE})>1.2V	–	50	–	ns
–	Minimum Duty Cycle	–	–	0	–	%
–	Maximum Duty Cycle	–	75	80	85	%
REFERENCE VOLTAGE						
V_{FB}	Feedback Voltage	AP3581A	0.591	0.6	0.609	V
		AP3581B/C	0.788	0.8	0.812	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	AP3581A	–	2.0	–	ms
		AP3581B	–	2.7	–	
		AP3581C	–	3.6	–	
$V_{COMP/EN}$	Enable Threshold	–	0.25	0.30	0.35	V
T_{OTSD}	Thermal Shutdown	–	–	+160	–	ºC
T_{HYS}	Thermal Shutdown Hysteresis	–	–	+20	–	ºC

Performance Characteristics

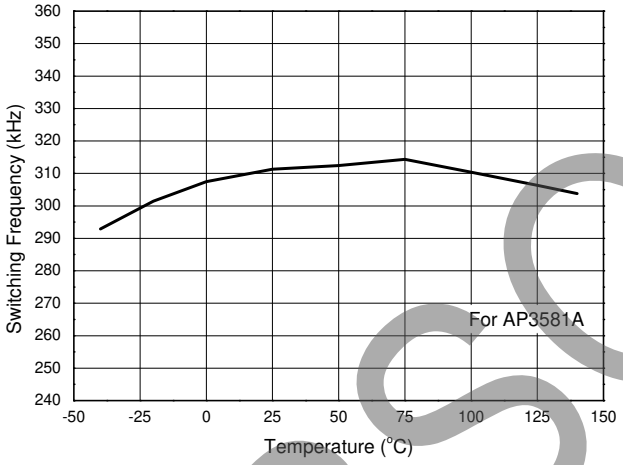
Line Regulation



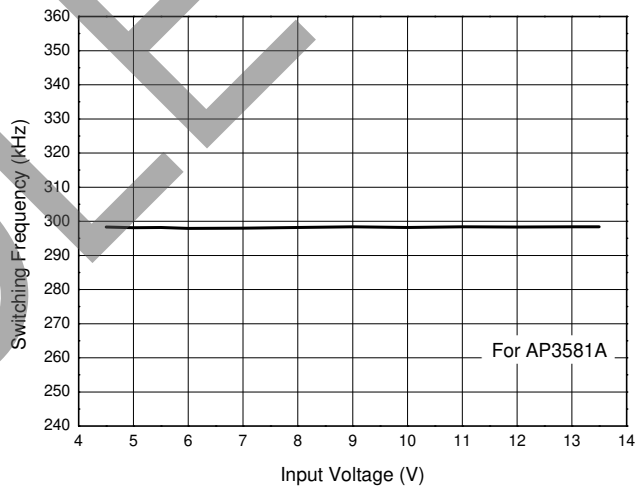
Load Regulation



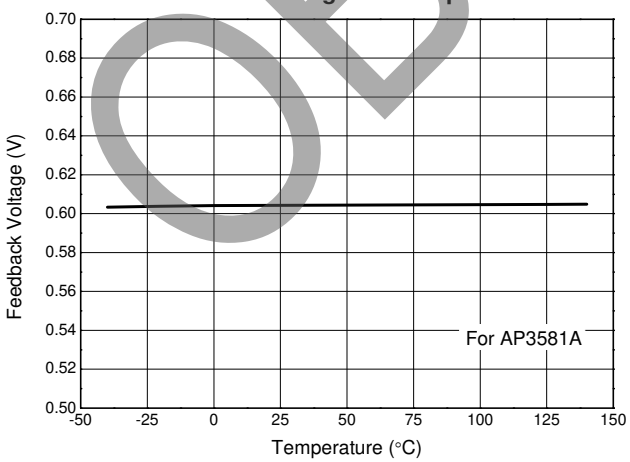
Switching Frequency vs. Temperature



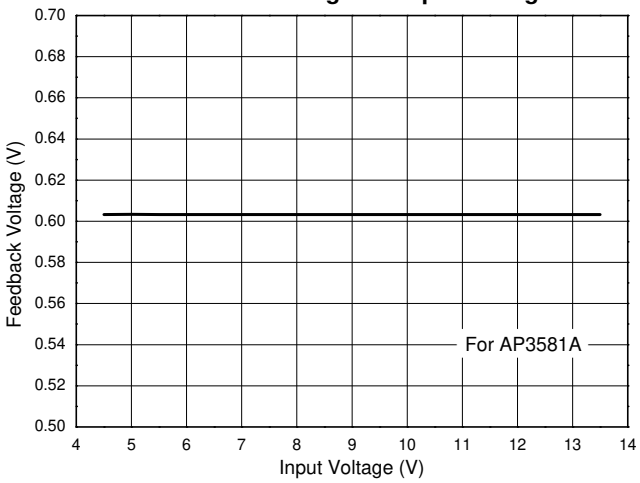
Switching Frequency vs. Input Voltage



Feedback Voltage vs. Temperature

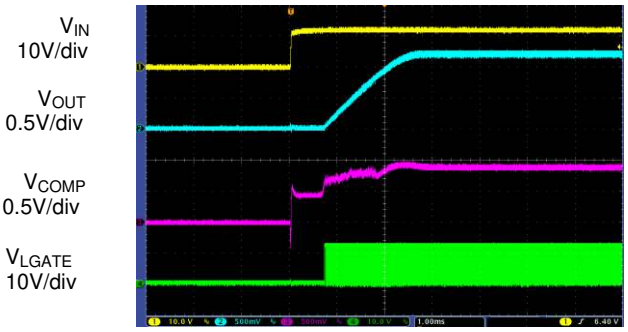


Feedback Voltage vs. Input Voltage



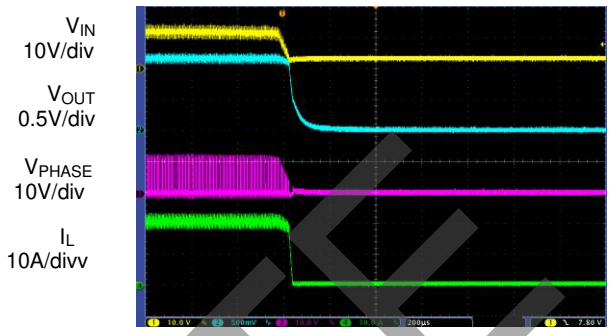
Performance Characteristics (Cont.)

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



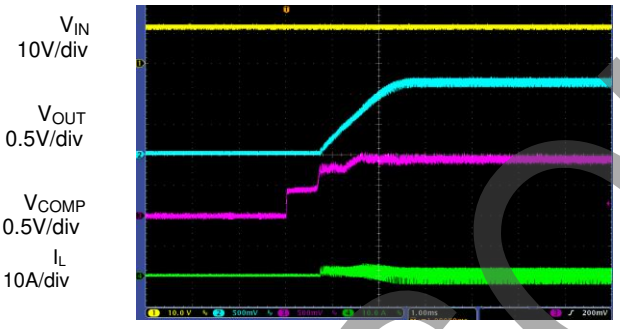
Time 1ms/div

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



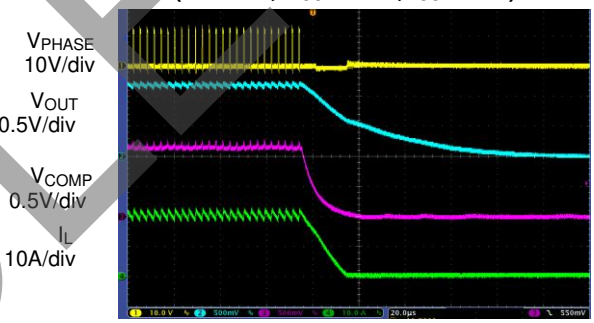
Time 200µs/div

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



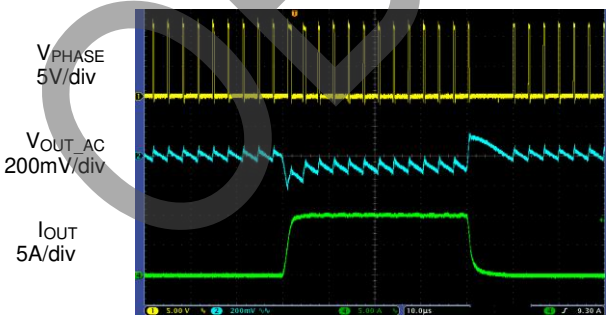
Time 1ms/div

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



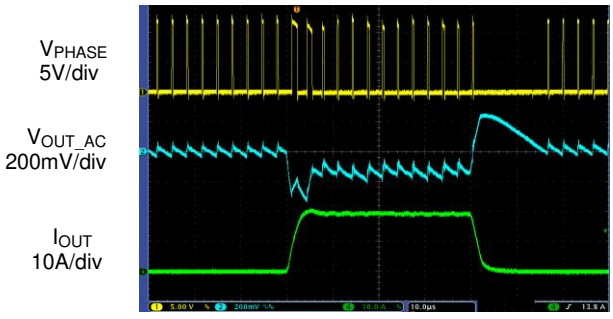
Time 20µs/div

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



Time 10µs/div

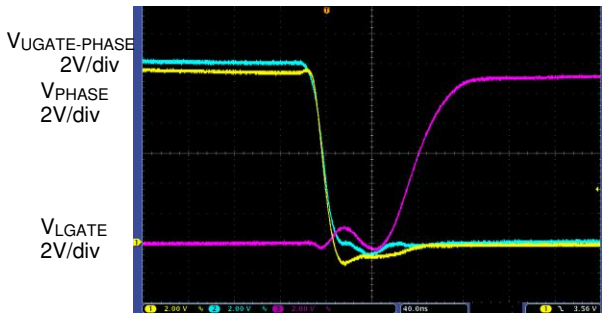
Load Transient Response
(V_{IN}=12V, V_{OUT}=1.2V, I_{OUT}=0A to 20A)



Time 10µs/div

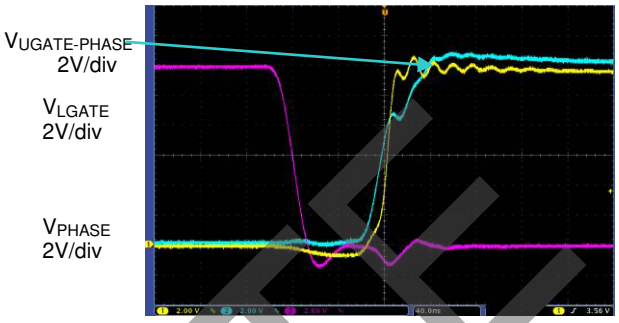
Performance Characteristics (Cont.)

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



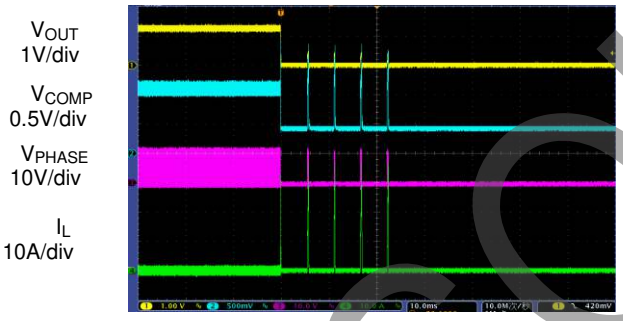
Time 40ns/div

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



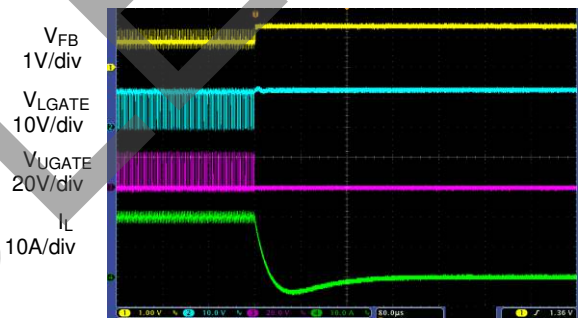
Time 40ns/div

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



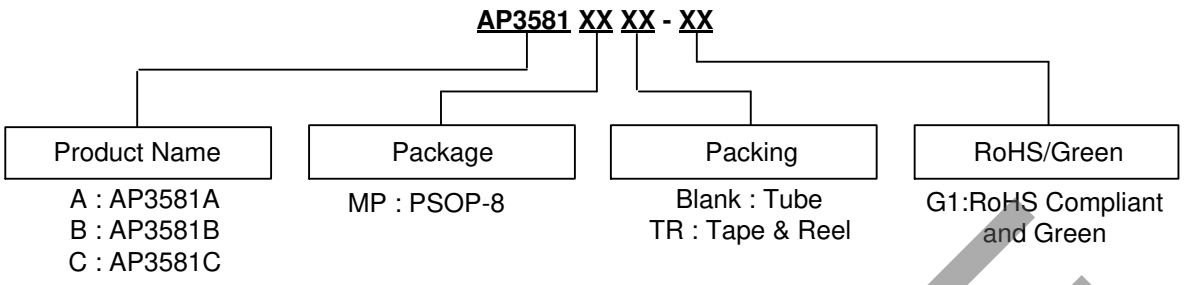
Time 10ms/div

Over Voltage Protection
(V_{IN}=12V, V_{OUT}=1.2V, I_{OUT}=20A)



Time 80µs/div

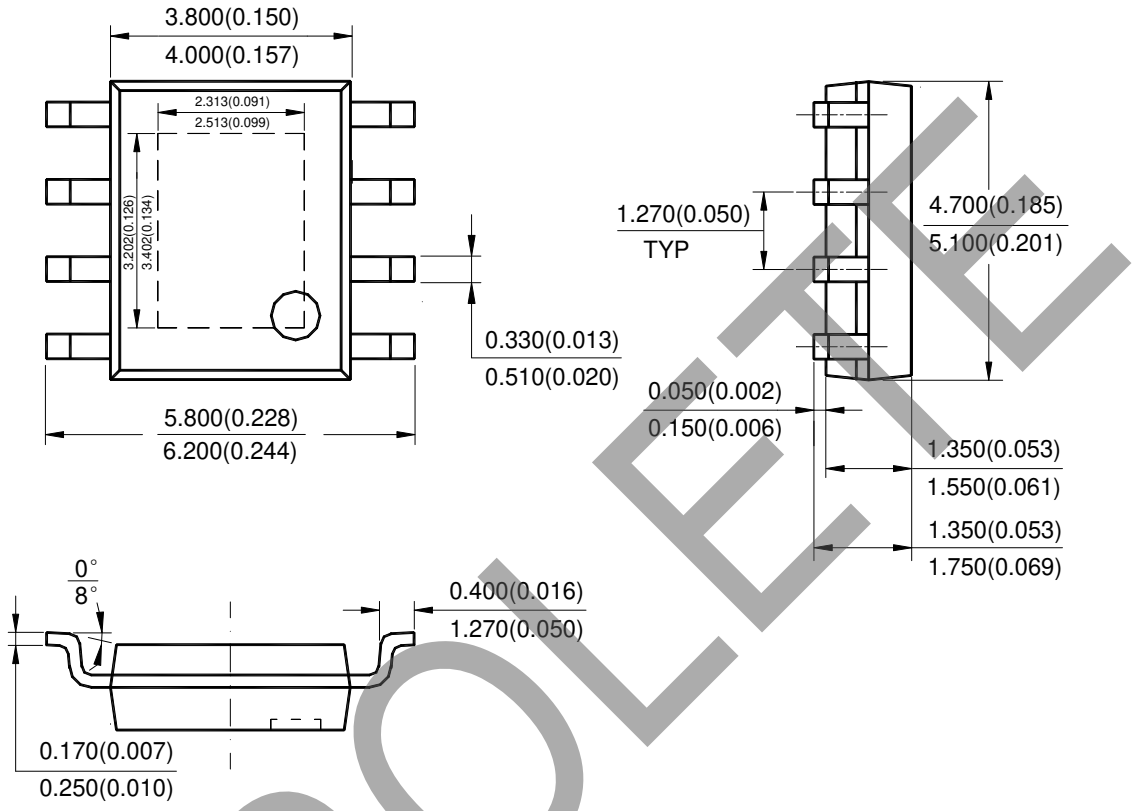
Ordering Information



Package	Temperature Range	Part Number	Marking ID	Packing Type
PSOP-8	-40 to +85°C	AP3581AMP-G1	3581AMP-G1	Tube
		AP3581AMPTR-G1	3581AMP-G1	Tape and Reel
		AP3581BMP-G1	3581BMP-G1	Tube
		AP3581BMPTR-G1	3581BMP-G1	Tape and Reel
		AP3581CMP-G1	3581CMP-G1	Tube
		AP3581CMPTR-G1	3581CMP-G1	Tape and Reel

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

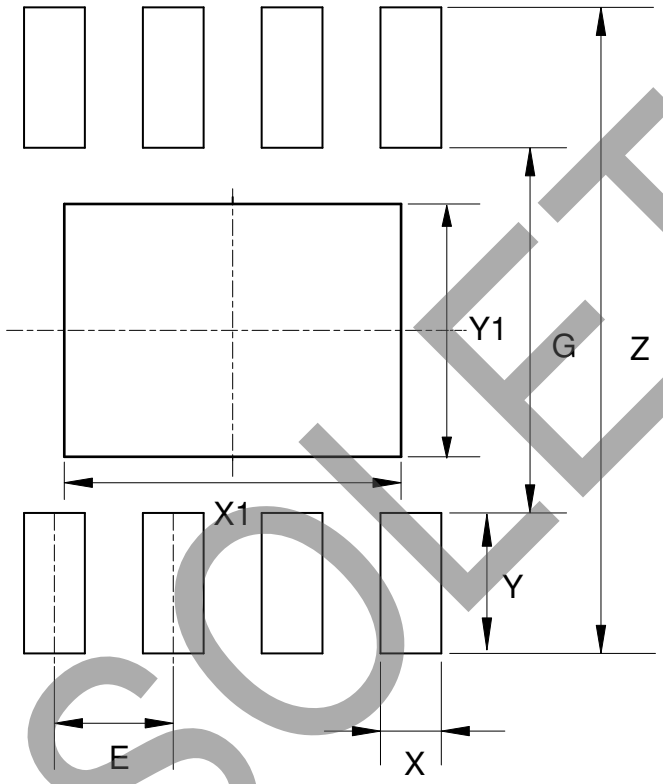
(1) Package Type: PSOP-8



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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