500kHz Micropower DC/DC Converter for Flash Memory

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FOR INFORMATION PURPOSES ONLY
Contact Linear Technology for Potential Replacement

FEATURES

- **60mA Output Current at 12V from 3V or 5V Supply**
- **Shutdown to 9μA**
- $\overline{\text{VPP VALID}}$ Comparator
- **Up to 85% Efficiency**
- Switching Frequency: 500kHz (Typical)
- Quiescent Current: 650μA
- Low V_{CESAT} Switch: 300mV at 0.5A (Typical)
- Soft Start Reduces Supply Current Transients
- Uses Low Value, Small Size, Surface Mount Inductors
- Available in 8-Lead SO Package

APPLICATIONS

- Flash Memory VPP Generators
- Type II and III PCMCIA Card DC/DC Converters
- 3V to 12V, 5V to 12V Converters
- Portable Computers and Instruments
- Cellular Telephones
- DC/DC Converter Module Replacements

DESCRIPTION

The LT®1309 is a 500kHz micropower DC/DC converter for Flash Memory. The regulator features Burst Mode™ operation with a 0.5A, 300mV switch, enabling 85% efficiency at the fixed 12V output. High frequency operation permits the use of small value, and therefore small size, surface mount inductors and capacitors. The LT1309 comes in an 8-lead SO package allowing extremely compact PC board layouts. These features make the device attractive for PCMCIA cards, cellular phones and other applications where PC board space is limited.

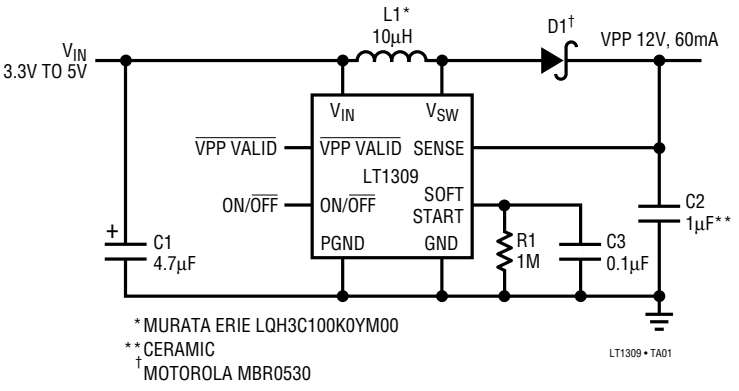
Quiescent current is 650μA decreasing to 9μA when the part shuts down. The device includes a soft start feature which limits supply current transients during turn-on.

The LT1309 contains a $\overline{\text{VPP VALID}}$ comparator with a logic output that goes low when the output voltage is ready to program 12V Flash Memory. This comparator simplifies the interface to external control logic.

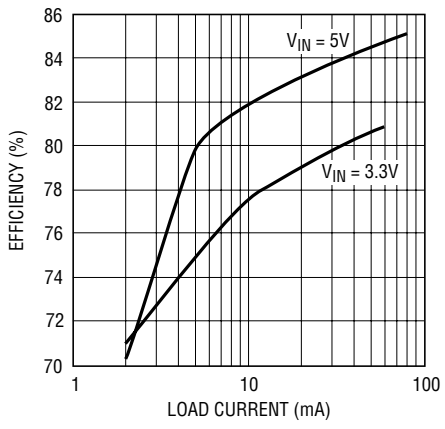
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Burst Mode is a trademark of Linear Technology Corporation.

TYPICAL APPLICATION

12V, 60mA Flash Memory Programming Supply



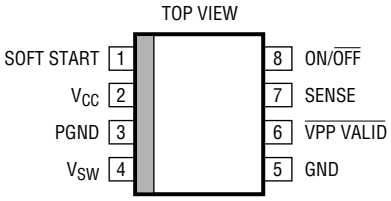
12V Output Efficiency



ABSOLUTE MAXIMUM RATINGS

V_{CC} Voltage 7V
V_{SW} Voltage 20V
V_{SENSE} Voltage 20V
$V_{ON/\overline{OFF}}$ Voltage 7V
V_{SEL} Voltage 7V
I_{LIM} Voltage 7V
Maximum Power Dissipation 500mW
Operating Temperature Range ..... 0°C to 70°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PACKAGE/ORDER INFORMATION



S8 PACKAGE
8-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 150°C/W

ORDER PART NUMBER
LT1309CS8
S8 PART MARKING
1309

Consult factory for Industrial and Military grade parts.

ELECTRICAL CHARACTERISTICS

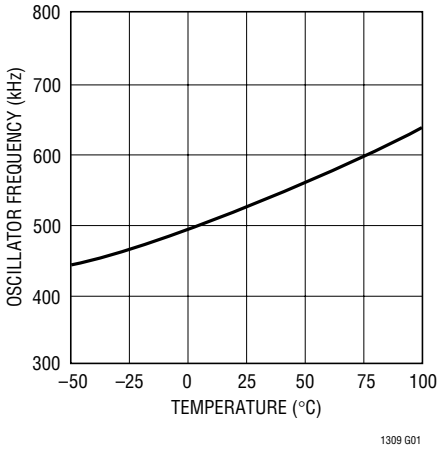
T_A = 25°C, V_{CC} = 5V, $V_{ON/\overline{OFF}}$ = 3V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_Q	Quiescent Current	V_{SENSE} = 12V			650	900	µA
	Quiescent Current, Shutdown	$V_{ON/\overline{OFF}}$ = 0.2V			9	15	µA
	Input Voltage Range			2		6	V
	Output Sense Voltage		●	11.5	12	12.6	V
	Output Referred Comparator Hysteresis				35		mV
f_{OSC}	Oscillator Frequency	Current Limit Not Asserted		400	500	700	kHz
DC	Maximum Duty Cycle		●	80	85	92	%
t_{ON}	Switch ON Time				1.7		µs
	Reference Line Regulation	2V < V_{IN} < 6V			0.06	0.15	%/V
V_{CESAT}	Switch Saturation Voltage	I_{SW} = 0.5A			230	350	mV
	Switch Leakage Current	V_{SW} = 12V, Switch Off			0.1	10	µA
	Switch Current Limit	V_{IN} = 5V, Soft Start Floating V_{IN} = 3V, Soft Start Floating		400 450	600 650	900 950	mA mA
	Soft Start Current	Soft Start Grounded			80	120	µA
	ON/$\overline{OFF}$ Input Voltage Low					0.8	V
	ON/$\overline{OFF}$ Input Voltage High			1.6			V
	ON/$\overline{OFF}$ Bias Current	$V_{ON/\overline{OFF}}$ = 5V $V_{ON/\overline{OFF}}$ = 3V $V_{ON/\overline{OFF}}$ = 0V			16.0 8.0 0.1	24.0 14.0 1.0	µA µA µA
	Sense Pin Input Current	 $V_{ON/\overline{OFF}}$ = 0.2V			50.0 0.1	90 1	µA µA
	$\overline{VPP\ VALID}$ Threshold	V_{SENSE} Rising (High to Low Transition)			V_{SENSE} – 200mV		
	$\overline{VPP\ VALID}$ Output Voltage Low	I_{SINK} = 100µA			0.13	0.3	V
	$\overline{VPP\ VALID}$ Output Voltage High	I_{SOURCE} = 2.5µA		4	4.5		V

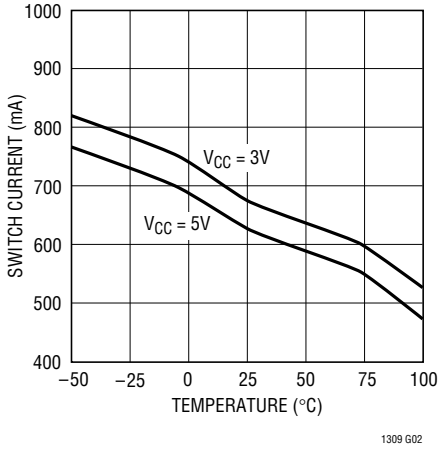
The ● denotes specifications which apply over the full operating temperature range.

TYPICAL PERFORMANCE CHARACTERISTICS

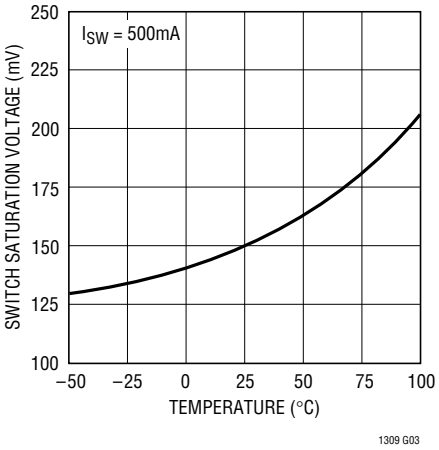
Oscillator Frequency



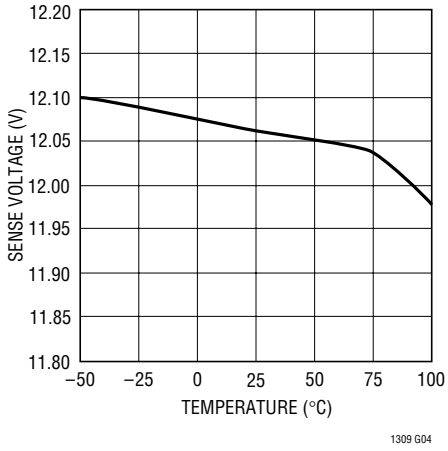
Switch Current Limit



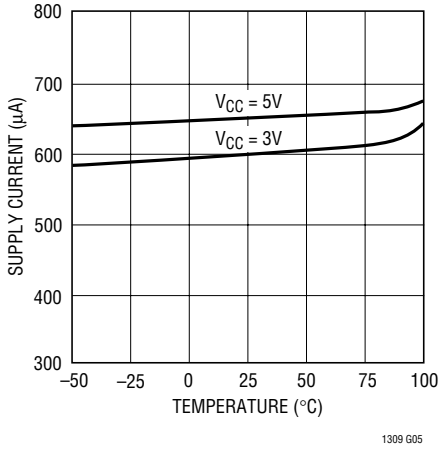
Switch Saturation Voltage



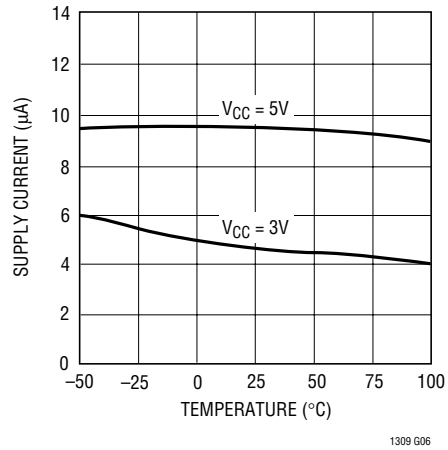
Sense Voltage



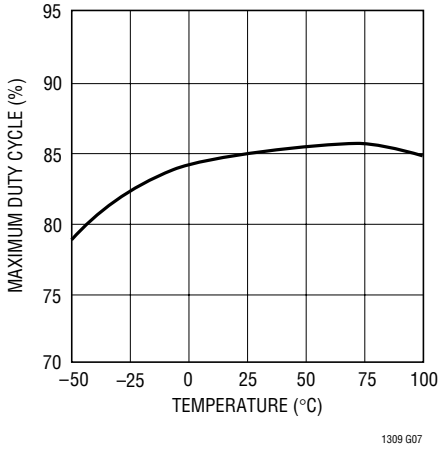
Supply Current



Supply Current in Shutdown

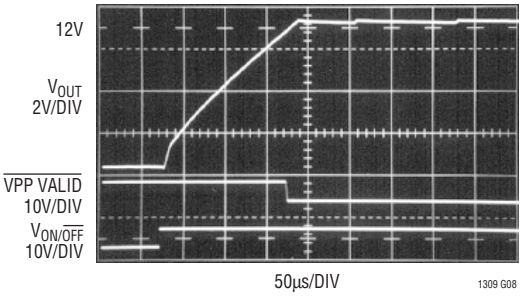


Maximum Duty Cycle

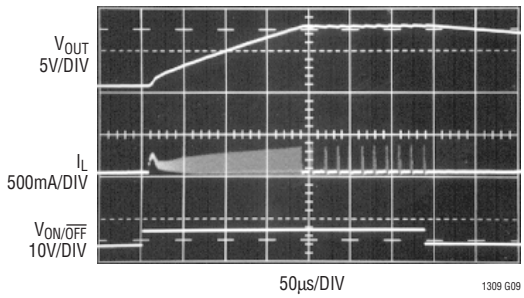


TYPICAL PERFORMANCE CHARACTERISTICS

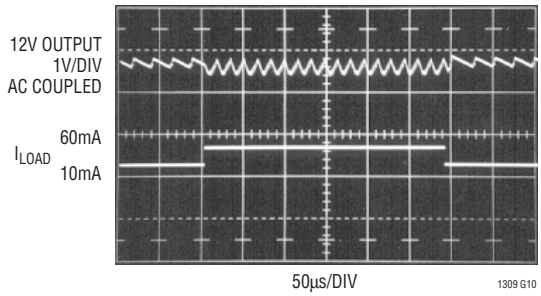
Start-Up Waveforms, I_{LOAD} = 1mA



Start-Up Waveforms, I_{LOAD} = 10mA



Load Transient Response, C_{OUT} = 1µF



PIN FUNCTIONS

SOFT START (Pin 1): A 0.1µF/1MΩ parallel RC from this pin to GND provides a Soft Start function upon device turn-on. Initially about 80µA will flow from the pin into the capacitor. When the voltage at the pin reaches approximately 0.4V, current ceases flowing out of the pin.

V_{CC} (Pin 2): Input Supply. At least 1µF input bypass capacitance is required. More capacitance reduces ringing on the supply line.

PGND (Pin 3): Power Ground. Connect to ground plane.

V_{SW} (Pin 4): Collector of Power Switch. High dV/dt present on this pin. To minimize radiated noise keep layout short and direct.

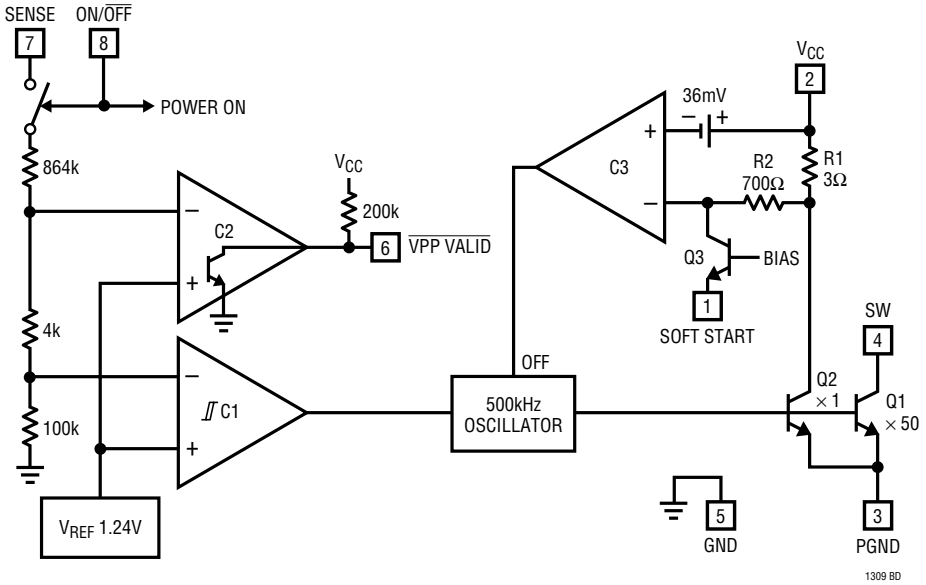
GND (Pin 5): Signal Ground. Connect to ground plane.

$\overline{\text{VPP VALID}}$ (Pin 6): This pin provides a logic signal indicating that output voltage has reached 12V. Active low with internal 200k pull-up resistor.

SENSE (Pin 7): Output Sense Pin. This pin connects to a resistive divider that sets the output voltage. In shutdown, the resistor string is disconnected and current into this pin reduces to < 1µA.

ON/$\overline{\text{OFF}}$ (Pin 8): Shutdown Control. When pulled below 1.5V, this pin disables the LT1309 and reduces supply current to 9µA. All circuitry is disabled in shutdown. The part is enabled when ON/$\overline{\text{OFF}}$ is greater than 1.5V.

BLOCK DIAGRAM



OPERATION

The LT1309 is a current limited, Burst Mode (gated oscillator) type switching regulator that produces a 12V output from a 3.3V or 5V input. Operation can best be understood by referring to the Block Diagram. When the voltage at the Sense pin (Pin 7) is less than 12V, comparator C1 enables the oscillator, turning switches Q1 and Q2 on. The switch turns off when current limit is reached or when the oscillator maximum on-time is reached. When Q2 turns off, current built up in the inductor flows into the output capacitor and load. This action occurs until the output voltage reaches 12V. During start-up, the Sense pin voltage is either 3.3V or 5V, depending on the input. The $\overline{\text{VPP VALID}}$ signal remains high until the output voltage reaches 12V, signaling correct voltage level to program flash memory. Connecting a 1µF/0.1µF parallel RC to the Soft Start pin limits inrush current during start-up.

APPLICATIONS INFORMATION

Inductor Selection

The low inductance value required with the LT1309 (10µH) allows the use of very small units such as the Murata-Erie LQH3C100. Requirements for the inductor include low DCR, ability to perform efficiently at 500kHz and a saturation current rating of 700mA to 900mA. Often inductor manufacturers rate maximum current for a small inductor based on self-heating considerations. For use in switching regulators where the inductor current is not constant the maximum specified DC current can be safely exceeded.

Capacitor Selection

The LT1309 needs very little input and output capacitance to function. Output capacitance should be 1µF or 2µF for acceptable output ripple voltage. Flash memory tolerates higher ripple voltage than might be suitable for a low noise system. The capacitor can be either a single high capacitance ceramic unit such as Tokin 1E105ZY5U-203 or Murata-Erie GRM230Y5V105Z016, or can be distributed as 10 to 20 0.1µF ceramic units. Lower ripple can be obtained by increasing the capacitance to the 5µF to 10µF level. 2µF to 5µF of tantalum (low-Q) capacitance is recommended on the input side to reduce resonance effects which can otherwise cause hundreds of millivolts of ripple voltage at the input.

Diode Selection

The LT1309's high switching speed demands a high speed rectifier. Schottky diodes are preferred for their low forward drop and fast recovery. A suitable choice is the Motorola MBR0520. This is a 0.5A, 20V Schottky in a very small package that is 1.35mm high.

PC Board Layout

The component placement shown in Figure 1 is recommended for PC board layouts. The high speed current paths are kept to a minimum distance and the switch node copper is minimized to keep radiated noise low. Notice the placement of the input decoupling capacitor next to the IC. This is necessary for best performance.

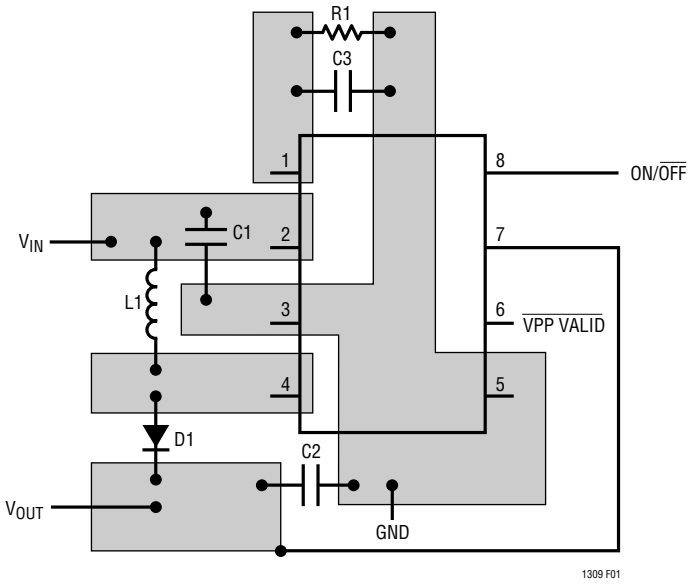
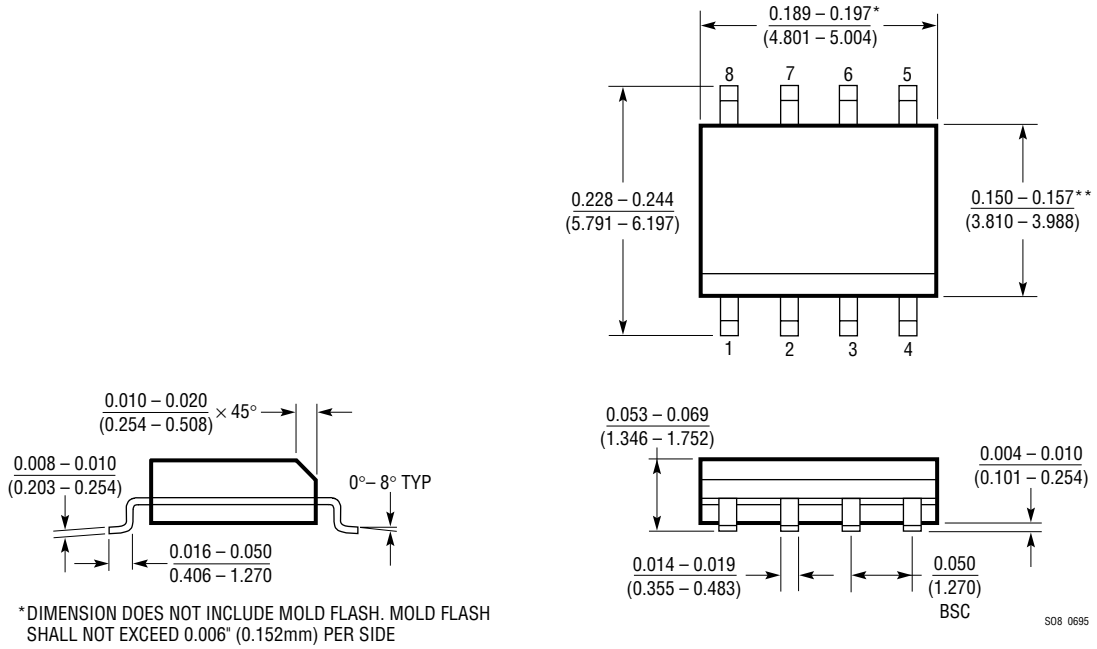


Figure 1. LT1309 Recommended Layout

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

S8 Package
8-Lead Plastic Small Outline (Narrow 0.150)
(LTC DWG # 05-08-1610)



*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

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RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1106	Micropower Step-Up DC/DC Converter, 12V at 60mA	Thin TSSOP Package for Type I PCMCIA Card
LT1109-12	Micropower Step-Up DC/DC Converter, 12V at 60mA	Flash Memory VPP Generator, Adjustable Also
LT1109A-12	Micropower Step-Up DC/DC Converter, 12V at 120mA	VPP Generator, Adjustable Also
LTC®1262	Inductorless Flash Memory Programming Supply, 12V at 30mA	Switched Capacitor Converter, No Inductor
LT1303	Micropower High Efficiency DC/DC Converter with Low-Battery Detector	Adjustable and Fixed 5V, I_{OUT} up to 200mA

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