

# Inverting 600kHz Switching Regulator

July 1998

## FEATURES

- Better Regulation Than a Charge Pump
- 0.1Ω Effective Output Impedance
- -5V at 200mA from a 5V Input
- 600kHz Fixed Frequency Operation
- Operates with  $V_{IN}$  as Low as 1V
- 1mA Quiescent Current
- Low Shutdown Current: 10μA
- Low-Battery Detector
- Low  $V_{CESAT}$  Switch: 295mV at 500mA

## APPLICATIONS

- MR Head Bias
- LCD Bias
- GaAs FET Bias
- Positive-to-Negative Conversion

## DESCRIPTION

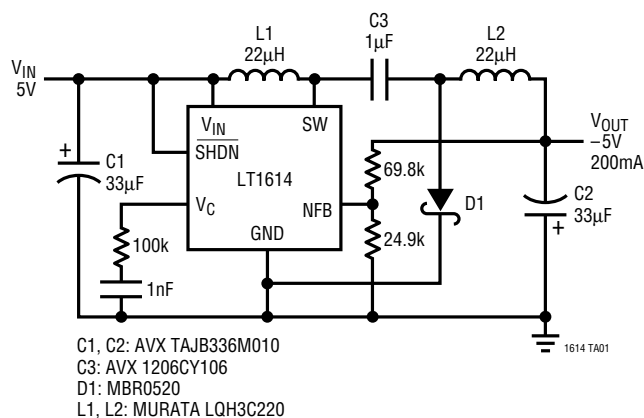
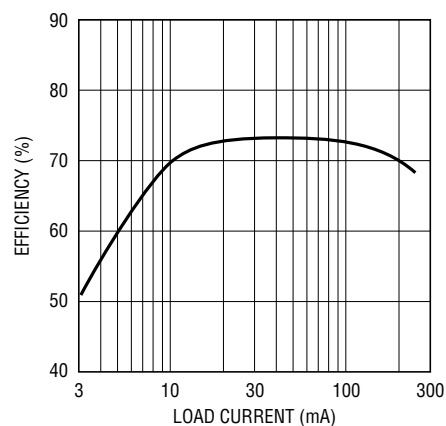
The LT<sup>®</sup>1614 is a fixed frequency, inverting mode switching regulator that operates from an input voltage as low as 1V. Utilizing a low noise topology, the LT1614 can generate a negative output down to -24V from a 1V to 5V input. Fixed frequency switching ensures a clean output free from low frequency noise. The device contains a low-battery detector with a 200mV reference and shuts down to less than 10μA. No load quiescent current of the LT1614 is 1mA and the internal NPN power switch handles a 500mA current with a voltage drop of just 295mV.

High frequency switching enables the use of small inductors and capacitors. Ceramic capacitors can be used in many applications, eliminating the need for bulky tantalum types.

The LT1614 is available in 8-lead MSOP or SO packages.

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## TYPICAL APPLICATION

**5V to -5V Converter**

**5V to -5V Converter Efficiency**


1614 TA02

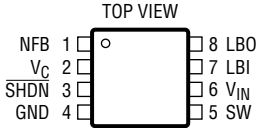
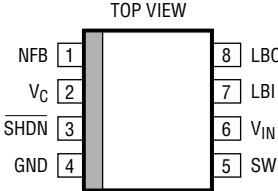
# LT1614

## ABSOLUTE MAXIMUM RATINGS

$V_{IN}$ , $\overline{SHDN}$ , LBO Voltage	12V
SW Voltage	-0.4V to 30V
NFB Voltage	-3V
$V_C$ Voltage	2V
LBI Voltage	$0V \leq V_{LBI} \leq 1V$
Current into FB Pin	$\pm 1mA$
Junction Temperature	125°C

Operating Temperature Range	
LT1614C	0°C to 70°C
LT1614I	-40°C to 85°C
Extended Commercial	
Temperature Range (Note 1)	-40°C to 85°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 sec)	300°C

## PACKAGE/ORDER INFORMATION

 <p>MS8 PACKAGE 8-LEAD PLASTIC MSOP <math>T_{JMAX} = 125^{\circ}C, \theta_{JA} = 160^{\circ}C/W</math></p>	ORDER PART NUMBER	 <p>S8 PACKAGE 8-LEAD PLASTIC SO <math>T_{JMAX} = 125^{\circ}C, \theta_{JA} = 120^{\circ}C/W</math></p>	ORDER PART NUMBER
	LT1614CMS8		LT1614CS8 LT1614IS8
	MS8 PART MARKING		S8 PART MARKING
	LTEJ		1614 1614I

Consult factory for Military grade parts.

## ELECTRICAL CHARACTERISTICS

Commercial Grade 0°C to 70°C.  $V_{IN} = 1.5V$ ,  $V_{\overline{SHDN}} = V_{IN}$ ,  $T_A = 25^{\circ}C$  unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	$V_{\overline{SHDN}} = 0V$		1 5	2 10	mA μA
Feedback Voltage		● -1.21	-1.24	-1.27	V
NFB Pin Bias Current (Note 2)	$V_{NFB} = -1.24V$	● -2.5	-4.5	-7	μA
Reference Line Regulation	$1V \leq V_{IN} \leq 2V$ $2V \leq V_{IN} \leq 6V$		0.6 0.3	1.1 0.8	%/V %/V
Minimum Input Voltage			0.92	1	V
Maximum Input Voltage		●		6	V
Error Amp Transconductance	$\Delta I = 5\mu A$		16		μmhos
Error Amp Voltage Gain			100		V/V
Switching Frequency		● 500	600	750	kHz
Maximum Duty Cycle		● 73 70	80 80		% %
Switch Current Limit (Note 3)		0.75	1.2		A

## ELECTRICAL CHARACTERISTICS

Commercial Grade 0°C to 70°C.  $V_{IN} = 1.5V$ ,  $V_{SHDN} = V_{IN}$ ,  $T_A = 25^\circ C$  unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Switch $V_{CESAT}$	$I_{SW} = 500mA$ (25°C, 0°C) $I_{SW} = 500mA$ (70°C)		295	350 400	mV mV
Shutdown Pin Current	$V_{SHDN} = V_{IN}$ $V_{SHDN} = 0V$		10 -5	20 -10	$\mu A$ $\mu A$
LBI Threshold Voltage		190 185	200	210 215	mV mV
LBO Output Low	$I_{SINK} = 10\mu A$		0.1	0.25	V
LBO Leakage Current	$V_{LBI} = 250mV$ , $V_{LBO} = 5V$		0.01	0.1	$\mu A$
LBI Input Bias Current (Note 4)	$V_{LBI} = 150mV$		10	50	nA
Low-Battery Detector Gain	1M $\Omega$ Load		1000		V/V
Switch Leakage Current	$V_{SW} = 5V$		0.01	3	$\mu A$

Industrial Grade -40°C to 85°C.  $V_{IN} = 1.5V$ ,  $V_{SHDN} = V_{IN}$  unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	$V_{SHDN} = 0V$		1 5	2 10	mA $\mu A$
Feedback Voltage		● -1.21	-1.24	-1.27	V
NFB Pin Bias Current (Note 2)	$V_{NFB} = -1.24V$	● -2	-4.5	-7.5	$\mu A$
Reference Line Regulation	$1V \leq V_{IN} \leq 2V$ $2V \leq V_{IN} \leq 6V$		0.6 0.3	1.1 0.8	%/V %/V
Minimum Input Voltage	-40°C 85°C		1.1 0.8	1.25 1.0	V V
Maximum Input Voltage		●		6	V
Error Amp Transconductance	$\Delta I = 5\mu A$		16		$\mu mhos$
Error Amp Voltage Gain			100		V/V
Switching Frequency		● 500	600	750	kHz
Maximum Duty Cycle		● 70	80		%
Switch Current Limit (Note 3)		0.75	1.2		A
Switch $V_{CESAT}$	$I_{SW} = 500mA$ (-40°C) $I_{SW} = 500mA$ (85°C)		250 330	350 400	mV mV
Shutdown Pin Current	$V_{SHDN} = V_{IN}$ $V_{SHDN} = 0V$		10 -5	20 -10	$\mu A$ $\mu A$
LBI Threshold Voltage		● 180	200	220	mV
LBO Output Low	$I_{SINK} = 10\mu A$		0.1	0.25	V
LBO Leakage Current	$V_{LBI} = 250mV$ , $V_{LBO} = 5V$		0.1	0.3	$\mu A$
LBI Input Bias Current (Note 4)	$V_{LBI} = 150mV$		5	30	nA
Low-Battery Detector Gain	1M $\Omega$ Load		1000		V/V
Switch Leakage Current	$V_{SW} = 5V$		0.01	3	$\mu A$

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

**Note 1:** The LT1614C is guaranteed to meet specified performance from 0°C to 70°C and is designed, characterized and expected to meet these extended temperature limits, but is not tested at -40°C and 85°C. The LT1614I is guaranteed to meet the extended temperature limits.

**Note 2:** Bias current flows out of NFB pin.

**Note 3:** Switch current limit guaranteed by design and/or correlation to static tests. Duty cycle affects current limit due to ramp generator.

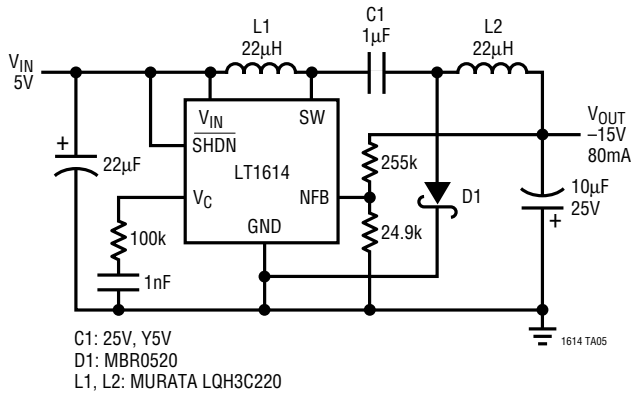
**Note 4:** Bias current flows out of LBI pin.



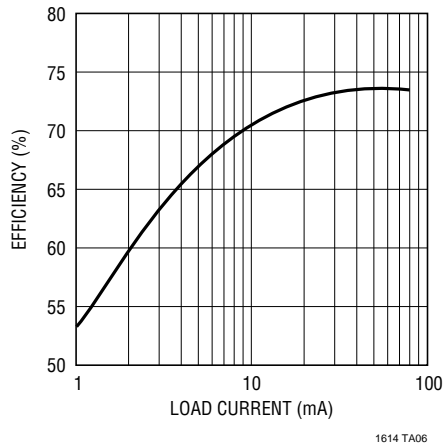


**TYPICAL APPLICATION**

**5V to -15V/80mA DC/DC Converter**

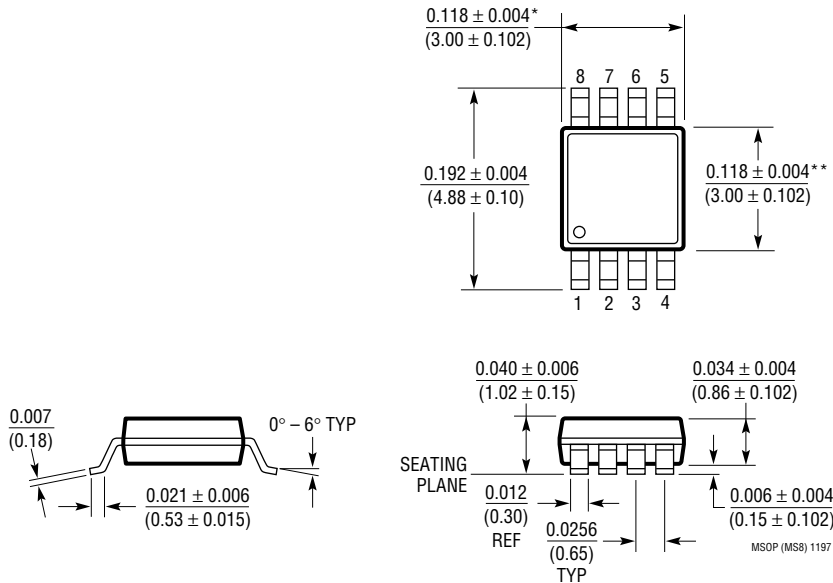


**5V to -15V Converter Efficiency**



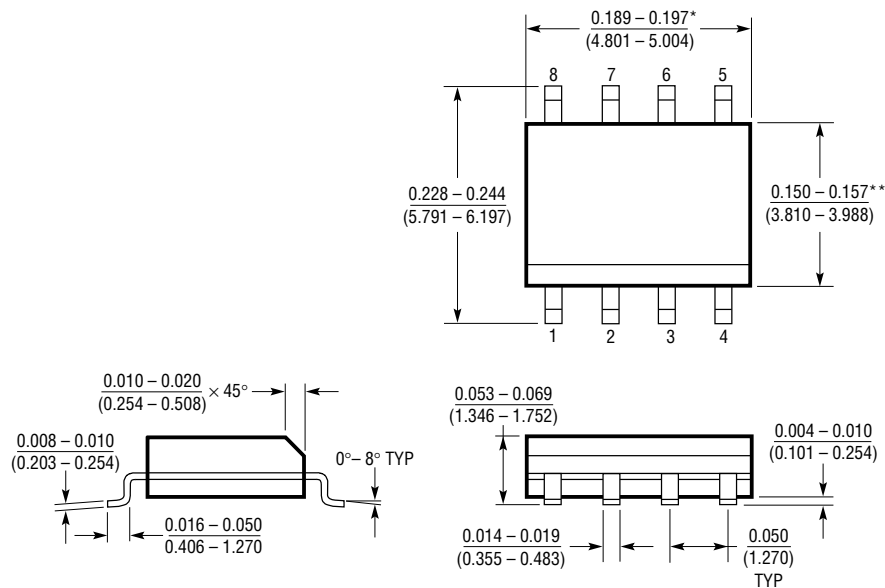
**PACKAGE DESCRIPTION** Dimensions in inches (millimeters) unless otherwise noted.

**MS8 Package**  
**8-Lead Plastic MSOP**  
 (LTC DWG # 05-08-1660)



\* DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.006\* (0.152mm) PER SIDE  
 \*\* DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006\* (0.152mm) PER SIDE

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

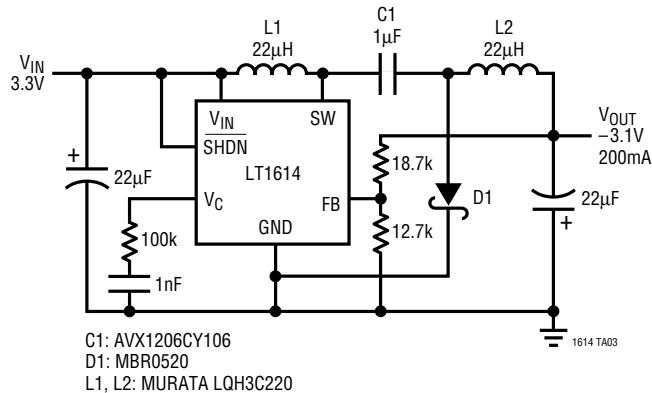


\* DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006\* (0.152mm) PER SIDE  
 \*\* DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010\* (0.254mm) PER SIDE

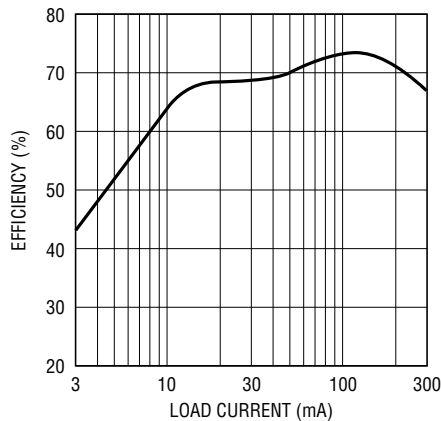
S08 0996

## TYPICAL APPLICATION

### 3.3V to -3.1V/200mA DC/DC Converter



### 3.3V to -3.1V Converter Efficiency



## RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC <sup>®</sup> 1174	High Efficiency Step-Down and Inverting DC/DC Converter	Selectable I <sub>PEAK</sub> = 300mA or 600mA
LT1307	Single Cell Micropower 600kHz PWM DC/DC Converter	3.3V at 75mA from 1 Cell, MSOP Package
LT1308	Single Cell High Current Micropower 600kHz Boost Converter	5V at 1A from a Single Li-Ion Cell, SO-8 Package
LT1316	Micropower Boost DC/DC Converter	Programmable Peak Current Limit, MSOP Package
LT1317	Micropower 600kHz PWM DC/DC Converter	2 Cells to 3.3V at 200mA, MSOP Package
LTC1474	Low Quiescent Current High Efficiency DC/DC Converter	I <sub>Q</sub> = 10µA, Programmable Peak Current Limit, MSOP
LT1610	1.7MHz Single Cell Micropower DC/DC Converter	5V at 200mA from 3.3V, MSOP Package