LT3461A

3MHz Step-Up DC/DC Converter in ThinSOT

November 2003

FEATURES

- **Integrated Schottky Rectifier**
- **3MHz Switching Frequency**
- **High Output Voltage: Up to 38V**
- **300mA Integrated Switch**
- 12V at 70mA from 5V Input
- 5V at 115mA from 3.3V Input
- Wide Input Range: 2.5V to 16V
- Uses Small Surface Mount Components
- Low Shutdown Current: <1μA
- Soft-Start
- Low Profile (1mm) SOT-23 (ThinSOT™) Package

APPLICATIONS

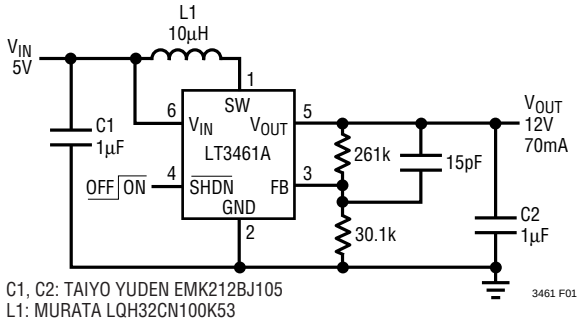
- Digital Cameras
- CCD Bias Supply
- XDSL Power Supply
- TFT-LCD Bias Supply
- Local 5V or 12V Supply
- Medical Diagnostic Equipment
- Battery Backup

DESCRIPTION

The LT®3461A is a general purpose step-up DC/DC converter. The device switches at 3MHz, allowing the use of tiny, low cost and low profile capacitors and inductors. An integrated Schottky rectifier results in lower parts cost and smaller converter footprint. The constant frequency results in low, predictable output noise that is easy to filter. The high voltage switch in the LT3461A is rated at 40V, making the device ideal for boost converters up to 38V. The LT3461A can generate 12V at up to 70mA from a 5V supply.

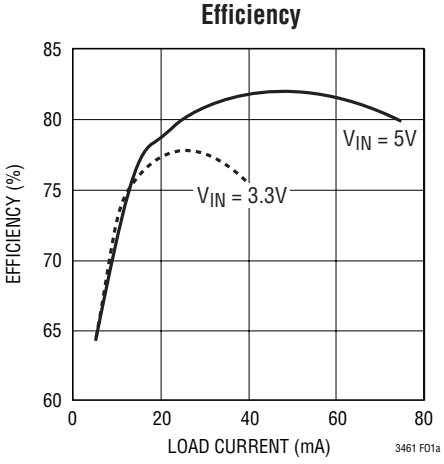
The LT3461A is available in a low profile (1mm) SOT-23 package.

TYPICAL APPLICATION



C1, C2: TAIYO YUDEN EMK212BJ105
L1: MURATA LQH32CN100K53

Figure 1. 5V to 12V, 70mA Step-Up DC/DC Converter

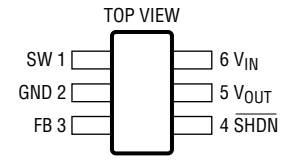


ABSOLUTE MAXIMUM RATINGS

(Note 1)

Input Voltage (V_{IN}) 16V
V_{OUT}, SW Voltage 40V
FB Voltage 5V
$\overline{SHDN}$ Voltage 16V
Operating Ambient
Temperature Range (Note 2) ..... –40°C to 85°C
Maximum Junction Temperature ..... 125°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec)..... 300°C

PACKAGE/ORDER INFORMATION



S6 PACKAGE
6-LEAD PLASTIC TSOT-23
T_{JMAX} = 125°C, θ_{JA} = 256°C/W IN FREE AIR
θ_{JC} = 120°C/W
θ_{JA} = 120°C ON BOARD OVER GROUND PLANE

ORDER PART NUMBER
LT3461AES6
S6 PART MARKING
LTAHG

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C, V_{IN} = 3V, $V_{\overline{SHDN}}$ = 3V, unless otherwise noted.

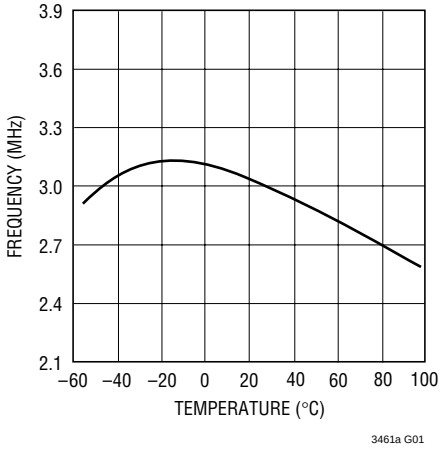
PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Minimum Operating Voltage			2.5			V
Maximum Operating Voltage					16	V
Feedback Voltage		 ●	1.235 1.225	1.255	1.275 1.280	V V
Feedback Line Regulation				0.005		%/V
FB Pin Bias Current		●		40	100	nA
Supply Current	FB = 1.3V, Not Switching $\overline{SHDN}$ = 0V			2.8 0.1	3.6 0.5	mA µA
Switching Frequency		●	2.1	3.0	3.9	MHz
Maximum Duty Cycle		●	82			%
Switch Current Limit			300	420	600	mA
Switch V_{CESAT}	I_{SW} = 250mA			260	350	mV
Switch Leakage Current	V_{SW} = 5V			0.01	1	µA
Schottky Forward Voltage	$I_{SCHOTTKY}$ = 250mA			800	1100	mV
Schottky Reverse Leakage	V_{OUT} – SW = 40V			0.03	4	µA
$\overline{SHDN}$ Voltage High			1.5			V
$\overline{SHDN}$ Voltage Low					0.4	V
$\overline{SHDN}$ Pin Bias Current				35	50	µA

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

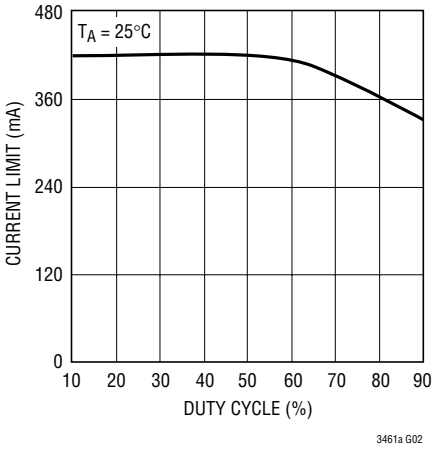
Note 2: The LT3461AE is guaranteed to meet specifications from 0°C to 70°C. Specifications over the –40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

TYPICAL PERFORMANCE CHARACTERISTICS

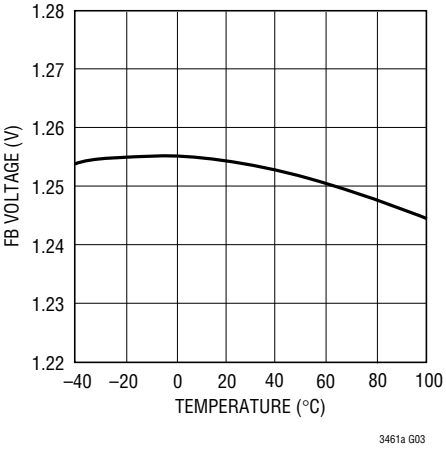
Oscillator Frequency



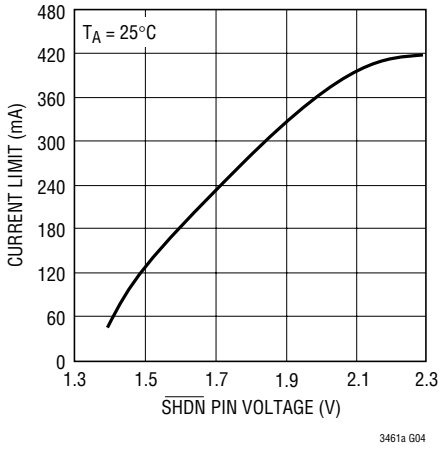
Current Limit



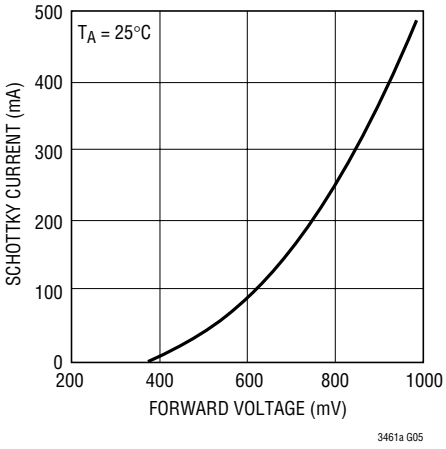
FB Pin Voltage



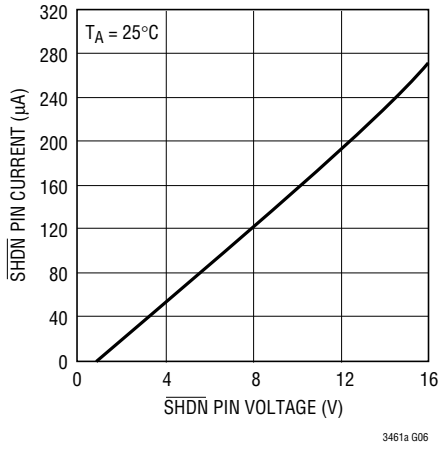
Current Limit in Soft Start Mode



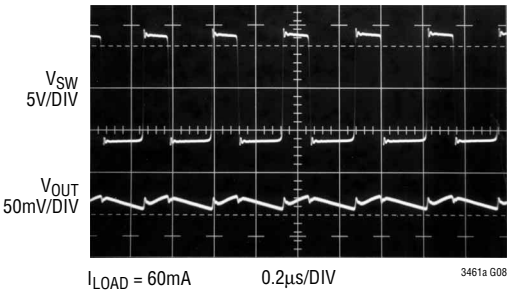
Schottky Forward Voltage



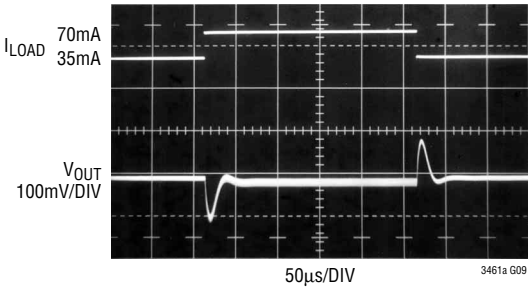
$\overline{SHDN}$ Pin Current



Switching Waveform
Circuit of Figure 1



Load Transient Response
Circuit of Figure 1



PIN FUNCTIONS

SW (Pin 1): Switch Pin. Connect inductor here. Minimize trace at this pin to reduce EMI.

GND (Pin 2): Ground Pin. Tie directly to local ground plane.

FB (Pin 3): Feedback Pin. Reference voltage is 1.255V. Connect resistor divider tap here. Minimize trace area at FB. Set V_{OUT} according to V_{OUT} = 1.255V (1 + R1/R2).

$\overline{SHDN}$ (Pin 4): Shutdown Pin. Tie to 1.5V or higher to enable device; 0.4V or less to disable device. Also functions as soft-start. Use RC filter (47k, 47nF typ) as shown in Figure 2.

V_{OUT} (Pin 5): Output Pin. Connect to resistor divider. Put capacitor close to pin and close to GND plane.

V_{IN} (Pin 6): Input Supply Pin. Must be locally bypassed.

BLOCK DIAGRAM

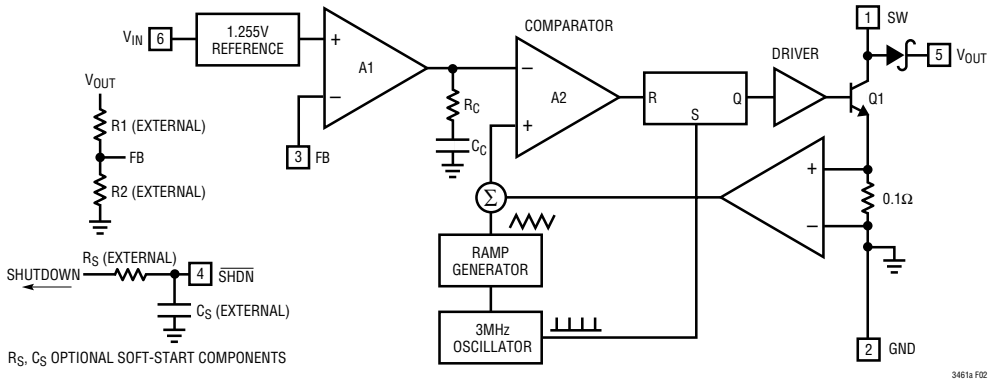


Figure 2. Block Diagram

OPERATION

The LT3461A uses a constant frequency, current mode control scheme to provide excellent line and load regulation. Operation can be best understood by referring to the block diagram in Figure 2. At the start of each oscillator cycle, the SR latch is set, which turns on the power switch Q1. A voltage proportional to the switch current is added to a stabilizing ramp and the resulting sum is fed into the positive terminal of the PWM comparator A2. When this voltage exceeds the level at the negative input of A2, the SR latch is reset turning off the power switch. The level at the negative input of A2 is set by the error amplifier A1, and is simply an amplified version of the difference between the feedback voltage and the reference voltage of 1.255V. In this manner, the error amplifier sets the correct peak current level to keep the output in regulation. If the error amplifier's output increases, more current is delivered to the output; if it decreases, less current is delivered.

Layout Hints

The high speed operation of the LT3461A demands careful attention to board layout. You will not get advertised performance with careless layout. Figure 3 shows the recommended component placement.

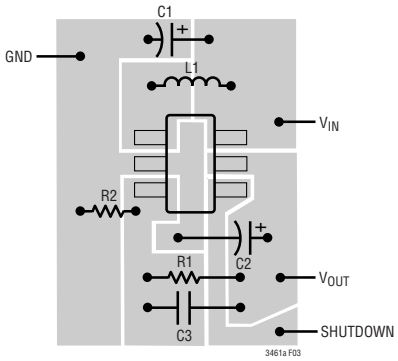


Figure 3. Suggested Layout

APPLICATIONS INFORMATION

Inrush Current

The LT3461A has a built-in Schottky diode. When supply voltage is applied to the V_{IN} pin, the voltage difference between V_{IN} and V_{OUT} generates inrush current flowing from input through the inductor and the Schottky diode to charge the output capacitor. The maximum nonrepetitive surge current the Schottky diode in the LT3461A can sustain is 1.5A. The selection of inductor and capacitor value should ensure the peak of the inrush current to be below 1.5A. In addition, turn-on of the LT3461A should be delayed until the inrush current is less than the maximum current limit. The peak inrush current can be calculated as follows:

$$I_P = \frac{V_{IN} - 0.6}{L \bullet \omega} \bullet \exp\left[-\frac{\alpha}{\omega} \bullet \tan^{-1}\left(\frac{\omega}{\alpha}\right)\right] \bullet \sin\left[\tan^{-1}\left(\frac{\omega}{\alpha}\right)\right]$$

$$\alpha = \frac{r + 1.5}{2 \bullet L}$$

$$\omega = \sqrt{\frac{1}{L \bullet C} - \frac{(r + 1.5)^2}{4 \bullet L^2}}$$

where L is the inductance, r is the resistance of the inductor and C is the output capacitance. For low DCR inductors, which is usually the case for this application, the peak inrush current can be simplified as follows:

$$I_P = \frac{V_{IN} - 0.6}{L \bullet \omega} \bullet \exp\left(-\frac{\alpha}{\omega} \bullet \frac{\pi}{2}\right)$$

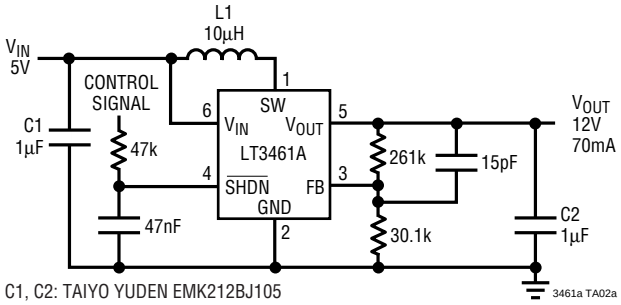
Table 3 gives inrush peak currents for some component selections.

Table 3. Inrush Peak Current

V_{IN} (V)	r (Ω)	L (µH)	C (µF)	I_P (A)
5	0.5	4.7	1	1.1
5	0.5	10	1	0.9

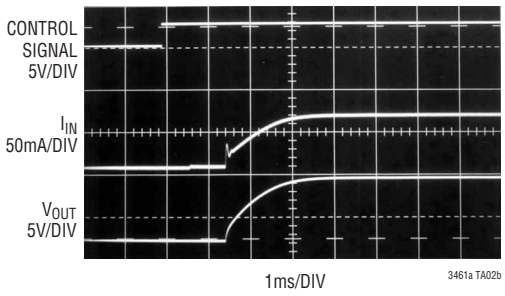
TYPICAL APPLICATIONS

5V to 12V with Soft-Start Circuit

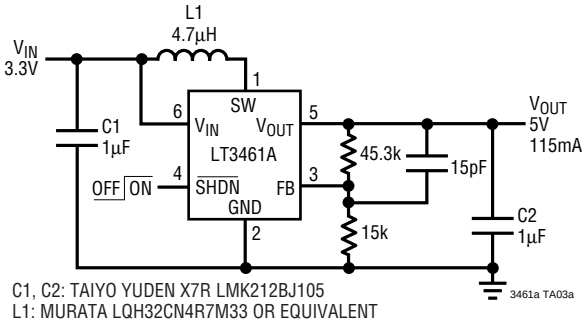


C1, C2: TAIYO YUDEN EMK212BJ105
L1: MURATA LQH32CN100K53

Input Current and Output Voltage

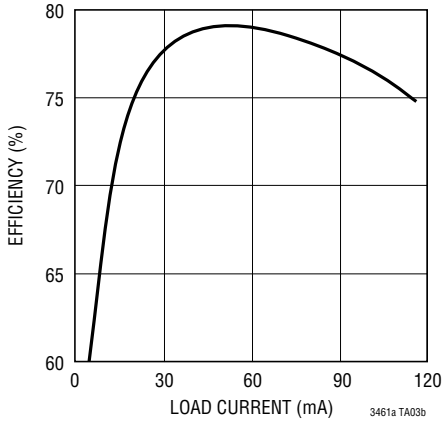


3.3V to 5V Step-Up Converter



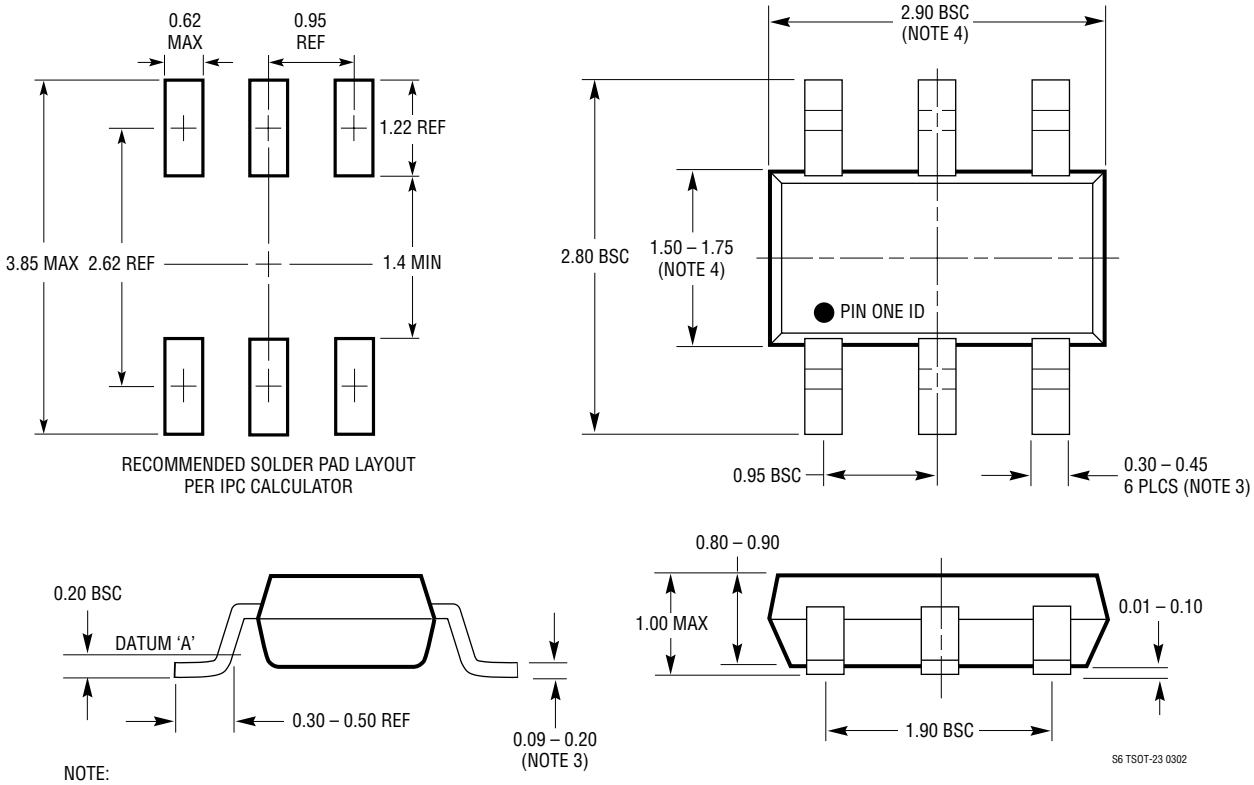
C1, C2: TAIYO YUDEN X7R LMK212BJ105
L1: MURATA LQH32CN4R7M33 OR EQUIVALENT

3.3V to 5V Step-Up Converter Efficiency



PACKAGE DESCRIPTION

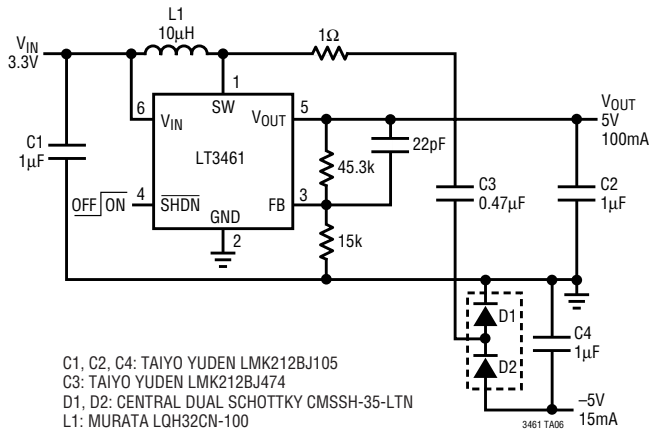
S6 Package
6-Lead Plastic TSOT-23
(Reference LTC DWG # 05-08-1636)



NOTE:
1. DIMENSIONS ARE IN MILLIMETERS
2. DRAWING NOT TO SCALE
3. DIMENSIONS ARE INCLUSIVE OF PLATING
4. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
5. MOLD FLASH SHALL NOT EXCEED 0.254mm
6. JEDEC PACKAGE REFERENCE IS MO-193

TYPICAL APPLICATION

±5V Dual Output Converter



C1, C2, C4: TAIYO YUDEN LMK212BJ105
C3: TAIYO YUDEN LMK212BJ474
D1, D2: CENTRAL DUAL SCHOTTKY CMSSH-35-LTN
L1: MURATA LQH32CN-100

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1613	550mA (I_{SW}), 1.4MHz, High Efficiency Step-Up DC/DC Converter	V_{IN}: 0.9V to 10V, $V_{OUT(MAX)}$: 34V, I_Q: 3mA, I_{SD}: <1µA, ThinSOT Package
LT1615/LT1615-1	300mA/80mA (I_{SW}) Constant Off-Time, High Efficiency Step-Up DC/DC Converter	V_{IN}: 1.2V to 15V, $V_{OUT(MAX)}$: 34V, I_Q: 20µA, I_{SD}: <1µA, ThinSOT Package
LT1934/LT1934-1	300mA (I_{OUT}), Constant Off-Time, High Efficiency Step-Down DC/DC Converter	90% Efficiency, V_{IN}: 3.2V to 34V, $V_{OUT(MIN)}$: 1.25V I_Q: 14µA, I_{SD}: <1µA, ThinSOT Package
LT1944/LT1944-1	Dual Output 350mA/100mA (I_{SW}), Constant Off-Time, High Efficiency Step-Up DC/DC Converter	V_{IN}: 1.2V to 15V, $V_{OUT(MAX)}$: 34V, I_Q: 20µA, I_{SD}: <1µA, MS Package
LT1945	Dual Output, Pos/Neg, 350mA (I_{SW}), Constant Off-Time, High Efficiency Step-Up DC/DC Converter	V_{IN}: 1.2V to 15V, $V_{OUT(MAX)}$: ±34V, I_Q: 20µA, I_{SD}: <1µA, MS Package
LT1961	1.5A (I_{SW}), 1.25MHz, High Efficiency Step-Up DC/DC Converter	V_{IN}: 3V to 25V, $V_{OUT(MAX)}$: 35V, I_Q: 0.9mA, I_{SD}: 6µA, MS8E Package
LTC3400/LTC3400B	600mA (I_{SW}), 1.2MHz, Synchronous Step-Up DC/DC Converter	V_{IN}: 0.85V to 5V, $V_{OUT(MAX)}$: 5V, I_Q: 19µA/300µA, I_{SD}: <1µA, ThinSOT
LTC3401	1A (I_{SW}), 3MHz, Synchronous Step-Up DC/DC Converter	V_{IN}: 0.5V to 5V, $V_{OUT(MAX)}$: 6V, I_Q: 38µA, I_{SD}: <1µA, MS Package
LTC3405/LTC3405A	300mA (I_{OUT}), 1.5MHz, Synchronous Step-Down DC/DC Converter	95% Efficiency, V_{IN}: 2.5V to 5.5V, $V_{OUT(MIN)}$: 0.8V I_Q: 20µA, I_{SD}: <1µA, ThinSOT Package
LTC3406/LTC3406B	600mA (I_{OUT}), 1.5MHz, Synchronous Step-Down DC/DC Converter	96% Efficiency, V_{IN}: 2.5V to 5.5V, $V_{OUT(MIN)}$: 0.6V I_Q: 20µA, I_{SD}: <1µA, ThinSOT Package
LTC3407	Dual 600mA (I_{OUT}), 1.5MHz, Synchronous Step-Down DC/DC Converter	95% Efficiency, V_{IN}: 2.5V to 5.5V, $V_{OUT(MIN)}$: 0.6V I_Q: 40µA, I_{SD}: <1µA, MSE Package
LT3460	0.32A (I_{SW}), 1.3MHz, High Efficiency Step-Up DC/DC Converter	V_{IN}: 2.5V to 16V, $V_{OUT(MAX)}$: 36V, I_Q: 2mA, I_{SD}: <1µA, SC70, ThinSOT Packages
LT3464	0.08A (I_{SW}), High Efficiency Step-Up DC/DC Converter with Integrated Schottky, Output Disconnect	V_{IN}: 2.3V to 10V, $V_{OUT(MAX)}$: 34V, I_Q: 25µA, I_{SD}: <1µA, ThinSOT Package
LT3465/LT3465A	Constant Current, 1.2MHz/2.7MHz, High Efficiency White LED Boost Regulator with Integrated Schottky Diode	V_{IN}: 2.7V to 16V, $V_{OUT(MAX)}$: 34V, I_Q: 1.9mA, I_{SD}: <1µA, ThinSOT Package

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