

Product of the Month

600kHz Boost Switcher in SO-8 Delivers 5W from Single Li-Ion Cell

The **LT[®]1308** is a micropower 600kHz fixed frequency PWM switching regulator that incorporates a power switch capable of handling a 2A peak current with a voltage drop of only 300mV. It also contains a low-battery detector with a 200mV reference. The LT1308 can operate with an input voltage as low as 1V and delivers 5V at a load current of 1A (Figure 1) from a single Li-Ion cell or 3.3V at 300mA from a single NiCd cell. High efficiency is maintained over a load range of 1mA to 1A (Figure 2). The LT1308's no-load quiescent current is 100μA and it shuts down to less than 3μA. Constant frequency 600kHz operation keeps switching noise away from sensitive 455kHz IF frequencies, important for pager and other

wireless applications. It is well-suited for applications of a low duty cycle pulsed nature, such as two-way "answer-back" pagers, cell phones, camera flash units, latching relay energizers and handheld printers.

The LT1308 features Burst Mode[™] operation for improved efficiencies at light loads. Fixed 600kHz current mode operation allows the use of very small, surface mountable components. A 10μF ceramic bypass capacitor is the only input capacitance required when operating from a low impedance source such as a NiCd or NiMH battery. Inductor size and cost is also reduced by using standard 5μH surface mountable devices.

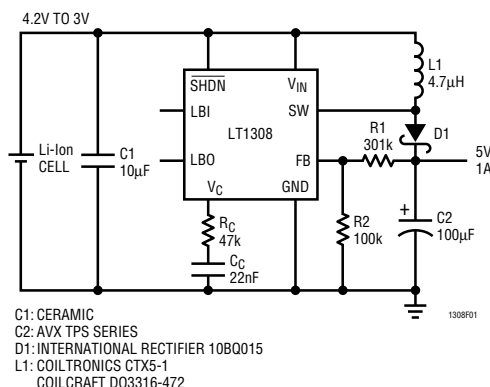


Figure 1. The LT1308 Boost Converter Contains a Low-Battery Detector with a 200mV Reference. It Delivers 5V at a Load Current of up to 1A from a Single Li-Ion Cell

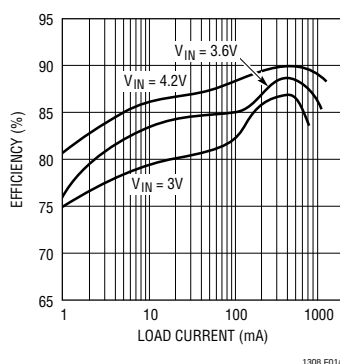


Figure 2. High Efficiency Is Maintained over a 1mA to 1A Load Range. The LT1308's Burst Mode Operation Maintains Efficiency at Light Loads

The LT1308's small size, operating frequency and low power consumption make this micropower switcher appropriate for many new portable products that require a high current capability using a single cell. The LT1308 is pin compatible with the LT1307 micropower PWM switching regulator which has a 600mA switching current capability. This permits the same basic design to support two different power levels without costly redesign.

The LT1308 is offered in an SO-8 package and is available in commercial and industrial versions from stock. A data sheet and evaluation samples are available by contacting your local Linear Technology sales office. For more information, visit our web site at www.linear-tech.com.

Low Dropout Linear Regulator in SO-8 Delivers Up to 700mA with Just 20μA Quiescent Current

The **LTC[®]1234** is a micropower CMOS low dropout linear regulator that is adjustable from 2.5V to 10V output for load currents up to 700mA. It has a typical dropout voltage of 250mV for a 5V output with a 500mA load and for a 3.3V output with 250mA output current, the dropout is only 150mV. Typical quiescent current is just 20μA because the LTC1234's internal 700mA P-channel pass transistor draws no base current. In fact, the device draws less than 30μA over an extended temperature range, independent of output load current. The adjustable output allows the LTC1234 in an SO-8 package to be used in a variety of battery-powered, space limited applications—such as notebook computers and portable instruments where extended battery life is crucial.

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14-Bit 400ksps ADC Achieves 80dB SINAD at Nyquist, Consumes Only 75mW

The 400ksps **LTC1416** 14-bit analog-to-digital converter (ADC) delivers 80dB SINAD and -90dB total harmonic distortion (THD) at the Nyquist input frequency of 200kHz while drawing only 75mW from $\pm 5V$ supplies. The LTC1416's full-scale input range is $\pm 2.5V$. Maximum DC specifications include $\pm 1LSB$ DNL and $\pm 1.25LSB$ INL over temperature (see Figure 1). It offers a simple and cost-effective solution for upgrading performance of 12-bit data conversion systems wherever low power operation is essential.

At 100kHz, the LTC1416 delivers 80.5dB of SINAD, -93dB THD and -95dB spurious-free dynamic range. The LTC1416's differential input sample-and-hold can acquire single-ended or differential input signals up to its 15MHz bandwidth. The 60dB common mode rejection allows users to eliminate ground loops and common mode noise by measuring signals differentially from the source. Figure 2 shows a typical application for the LTC1416 as a low power, 400ksps sampling ADC. It is available in a 28-pin SSOP package.

The LTC1416 is capable of going into two power shutdown modes—nap and sleep, to save power during inactive periods. In nap

mode only the digital logic and reference is powered up so it can wake up and convert immediately. In sleep mode all bias currents are shut down and only leakage current remains. Wake-up time from sleep mode is slower since the reference circuit must power up and settle for full 14-bit accuracy. In sleep mode it consumes just $10\mu W$ and in nap mode only 4mW.

The internal 2.5V precision reference can be used for external circuitry or overrid-

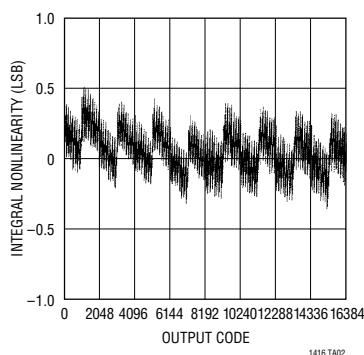


Figure 1. The LTC1416 ADC Guarantees $\pm 1.25LSB$ INL (Max) over Temperature but It's Typically Only $\pm 0.5LSB$

den by an external source to improve temperature or time stability. The LTC1416's three-state parallel interface easily connects to DSP and microprocessor parallel ports. It also has a separate convert start input pin and a data ready signal (BUSY) pin to facilitate these connections.

The LTC1416 14-bit ADC is available in a 28-pin SSOP package. Contact your local Linear Technology sales office for a data sheet and evaluation samples or visit our web site at www.linear-tech.com for more information. 

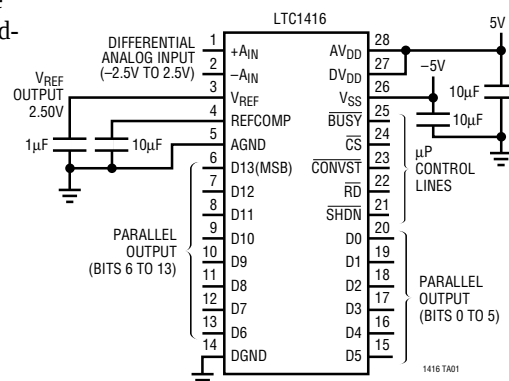


Figure 2. The LTC1416 14-Bit ADC Includes an Internal Reference and High Dynamic Range Sample-and-Hold. It Operates from $\pm 5V$ Supplies and Draws Only 75mW While Converting

Universal Dual Filter in SSOP Offers Rail-to-Rail Operation with 3V Supply

Linear Technology Corporation introduces an SSOP-16 version of its **LTC1067** rail-to-rail, low noise, universal dual filter building block. The smaller SSOP package occupies an area less than half that of an SO-16, the package in which the LTC1067 was originally introduced and 86% less area than a 16-pin DIP package. It operates from a single 3V to $\pm 5V$ supply with rail-to-rail input and output operation and draws only 2.5mA. The smaller SSOP package combined with its high performance at low supply voltages makes the LTC1067 an excellent choice for small, portable filters for data acquisition and telecommunications.

The LTC1067 is the evolutionary descendant of the MF10 and the LTC1060 4th order filter but with greatly improved specifications. Each of the LTC1067's two

rail-to-rail 2nd order filter sections, together with three to five resistors, allows various filter functions to be quickly designed—such as bandpass, lowpass, notch and allpass filter responses. Like all switched-capacitor filters, the LTC1067's corner or center frequency is adjustable with the clock frequency. The LTC1067's internal clock-to-center frequency ratio is 100:1 with center

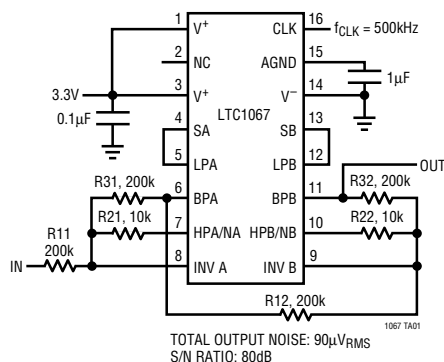


Figure 1. The LTC1067 Configured as a Single 3.3V Supply Rail-to-Rail 4th Order 5kHz Bandpass Filter

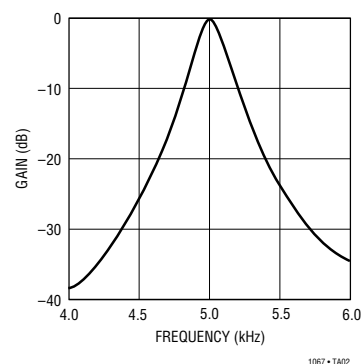


Figure 2. Frequency Response of Filter in Figure 1 Has a Center Frequency Error of Less Than $\pm 0.2\%$

frequency error typically less than $\pm 0.2\%$. The LTC1067-50 has a ratio of 50:1 and consumes just 1mA—less than half the current of the LTC1067.

Using a double-sampled architecture, which places aliasing and imaging components at twice the clock frequency, the LTC1067's dynamic range on a single 3.3V supply is over 80dB and noise is less than

Continued on page 4

Application of the Month

12V Wall Cube to 5V/400mA DC/DC Converter Is 85% Efficient

The ubiquitous 12V wall cube, power source of countless electronic products, generates an unregulated DC voltage between 8V and 18V, depending on line voltage and load. If you use a linear regula-

tor to drop the voltage to 5V, a 400mA load means the linear regulator must dissipate 5W under worst-case conditions. To deal with this heat, you must provide adequate heat sinking, increasing your product's size

and weight. Additionally, the heat is sometimes objectionable to customers. These factors can negate the cost advantage of a linear regulator. Figure 1's circuit, a negative buck converter, delivers 5V at loads up to 400mA from a 7V to 25V input with peak efficiency of 85%, eliminating the need for a heat sink. Since the LT1307B (U1) is intended for use with a low input voltage, Q1 and Q2 are used to make a simple preregulator, providing 1.9V for U1's V_{IN} pin. The IC switches at 600kHz, allowing a low cost 22 μ H inductor and 10 μ F ceramic output capacitor to be used. Q3 is needed to level shift the output voltage because U1's feedback pin is referenced to the negative input. Output ripple measures 10mV_{p-p} at a load of 400mA. The circuit's efficiency is detailed in Figure 2 and response to a load step from 150mA to 300mA is shown in Figure 3. Input bypass capacitor C1 sees worst-case RMS ripple current equal to one-half the output current and should have an ESR of less than 0.5 Ω . Take care during construction to keep R1-R3 and Q3 close to U1's FB pin and away from the SW pin to prevent unwanted coupling. Use a ground plane and keep traces for the power components short and direct.

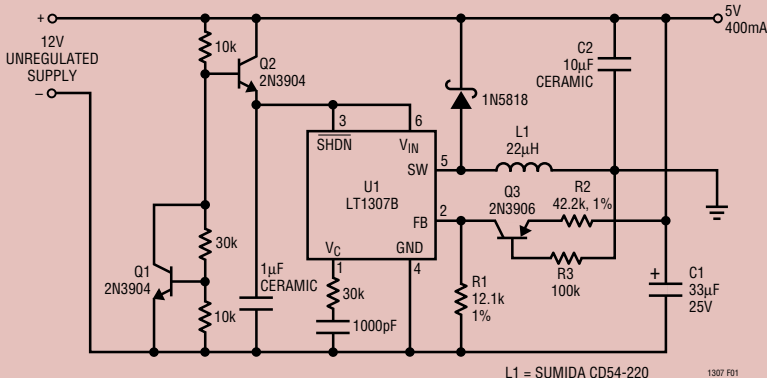


Figure 1. This Negative Buck Converter Delivers 5V at 400mA from a 7V to 25V Input

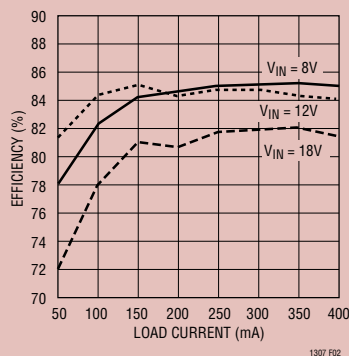


Figure 2. Efficiency Peaks at 85%; It Is Above 80% over an Input Range of 8V to 18V

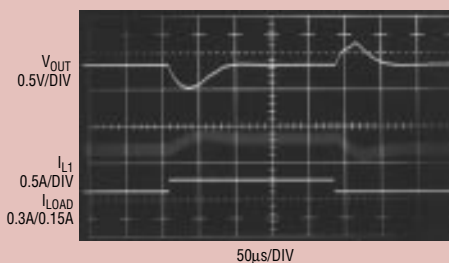


Figure 3. Load-Step Response; the Load Changes from 150mA to 300mA

Although it might seem unsettling that the negative side of the wall cube is not grounded, remember that the wall cube output floats. The circuit merely regulates the negative side, rather than the more conventional positive side. 

LTC1234 from page 1

The LTC1234 has internal thermal limiting designed to protect the device during overload conditions. Its $\overline{\text{SHDN}}$ pin (see Figure 1) allows the regulator to be shut down to a 5 μ A quiescent current while the comparator and reference remain alive. It also has an internal micropower comparator with an open-drain output—useful for system or battery monitoring.

The LTC1234 is offered in an SO-8 package and is available from stock. For a data sheet and evaluation samples, contact your local Linear Technology sales office or visit our web site at www.linear-tech.com for more information. 

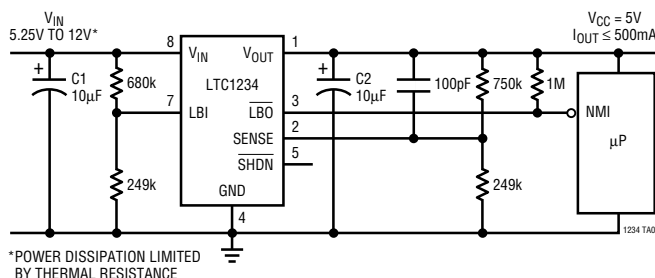


Figure 1. LTC1234 Regulator Offers a Very Low Dropout Combined with a Constant Low Quiescent Current. It Provides an Adjustable 2.5V to 10V Output Voltage Which is Maintained by the Sense Pin Reference, Held at 1.226V to Ground

Latest *New Products Catalog and Selection Guides* Now Available

The Fall/Winter 1997 *New Products Catalog and Selection Guides* has just arrived, hot off the press, available on request at no charge. It provides an excellent overview of all new products introduced during the past six months as well as selection guides for Linear Technology's entire product line. Section 1 contains data sheet summaries for 37 new products, complete with a brief product summary, key features, schematics of typical applications and package pinouts. The selection guides provide overviews of the products by performance and application. You'll also find a complete section on Design Tools, listing hundreds of currently available application and design notes, all catalogs and technical publications, as well as the latest versions of our design software. Much of this material is also available on our web page: www.linear-tech.com for immediate viewing. Contact your local Linear Technology sales office for a copy of the new *Fall/Winter 1997 New Products Catalog*. 



LTC1067 from page 2

40 μ V_{RMS}. Figure 1 shows the LTC1067 as a 3.3V 4th order bandpass filter and Figure 2 shows its frequency response. With LTC's FilterCAD™ software (Version 1.956 or later), a user can easily implement a dual 2nd order filter or a single 4th order filter just by entering the desired filter characteristics, such as cutoff frequency, ripple and stopband attenuation. The latest version of FilterCAD is available on the LinearView™ CD-ROM (Version 2.0, 4/97) and on our web site, www.linear-tech.com.

Factory mask programmable versions of the LTC1067 with on-chip thin film resistors and custom clock-to-cutoff frequency ratios

are available in an SO-8 package to realize application specific monolithic filters. Contact the Factory for more information.

The LTC1067 and LTC1067-50 in SO-16 and SSOP-16 packages are immediately available in volume in both commercial and industrial temperature versions. Contact your local Linear Technology sales office for a data sheet and evaluation samples. For more information, visit our web site at www.linear-tech.com. 

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