

Product of the Month

3V Micropower 12-Bit A/D Converter with 4-Channel Input Multiplexer in Narrow 16-Lead Surface Mount Package

The LTC1594L is a 4-channel, 3V micropower, 12-bit sampling A/D converter. It typically draws only 160 μ A of supply current when converting and automatically powers down to 1nA between conversions. The LTC1594L has a guaranteed $\pm 3/4$ LSB max DNL. The LTC1594L is available in a 16-pin SO narrow package and operates on a 3V supply. The 12-bit switched capacitor successive approximation ADC includes a 4-channel MUX and a sample-and-hold. Figure 1 shows the LTC1594L's supply current over a sampling rate range of 0.1kHz to 10.5kHz.

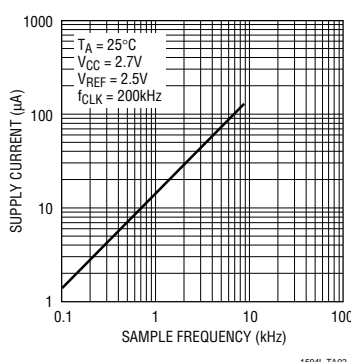


Figure 1. LTC1594L Supply Current vs Sample Rate

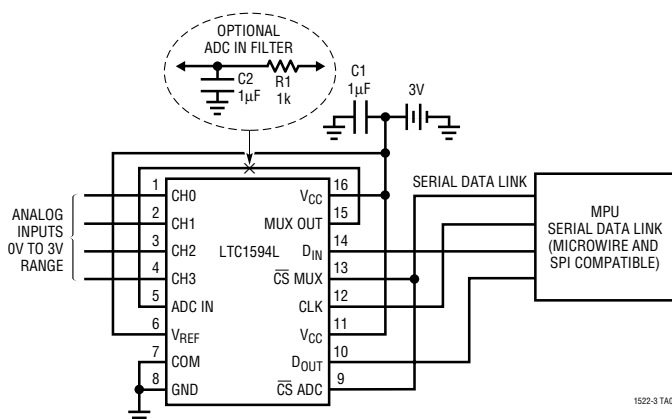


Figure 2. LTC1594L 12 μ W, 4-Channel, 12-Bit ADC Runs Off a 3V Battery

The LTC1594L's digital I/O is compatible with popular microprocessor interface schemes such as SPI and MICROWIRE™. The on-chip serial interface allows efficient data transfer to a wide range of microprocessors and microcontrollers over three or four wires. This, coupled with micropower consumption, makes remote location possible and facilitates transmitting data through isolation barriers. Figure 2 shows the LTC1594L interfacing to a microprocessor via a serial data link.

Separate MUX output and ADC input pins make it possible to reduce the number of filtering elements required by allowing one filter to be placed between the MUX output and ADC input pins and used for all channels of the MUX. Furthermore, the MUX and the ADC contain independent Chip Select pins which can be tied together or used to control the MUX and ADC independently. When a signal is applied to the MUX, the ADC power-up time can be delayed to allow for input settling prior to sampling. The high impedance analog inputs and the ability to operate with reduced spans (to 1.5V full scale) allow direct connection to sensors and transducers in many applications, eliminating the need for gain stages.

The LTC1594L is ideal for use in such applications as pen screen digitizing, battery-operated data acquisition, remote or isolated data acquisition, battery voltage monitoring and temperature monitoring. This new A/D converter is available in the 16-lead plastic narrow SO package specified for operation from 0°C to 70°C. An industrial version, the LTC1594LIS, is available as a standard product specified from -40°C to 85°C. Contact your local Linear Technology sales office for a data sheet and evaluation samples of the LTC1594L.

MICROWIRE is a trademark of National Semiconductor Corp.

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Regulated Inductorless DC/DC Converter Boosts 2V to 5V with Only 12 μ A Supply Current

The **LTC1516** is a micropower charge pump DC/DC converter in an 8-lead surface mount package. This new charge pump IC produces a regulated 5V output from a 2V to 5V supply. The LTC1516 features an extremely low 12 μ A supply current and draws only 1 μ A in shutdown mode. The low power combined with a low external parts count (two 0.22 μ F flying capacitors) make the LTC1516 ideal for small battery-powered applications. Typical efficiency

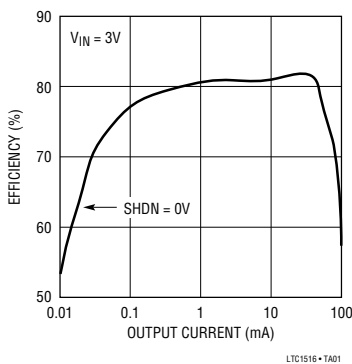


Figure 1. LTC1516 Efficiency vs Output Current

($V_{IN} = 3V$) exceeds 70% with load currents between 50 μA and 50mA. Modulating the Shutdown pin keeps the typical efficiency above 70% all the way down to 10 μA of output current. Figure 1 shows the efficiency of the LTC1516.

The complete LTC1516 circuit fits in a 0.1 square inch space. The device provides up to 50mA with a 5V input and 20mA with an input as low as 2V. Figure 2 shows the LTC1516 as a 5V regulator. The LTC1516 operates as either a doubler or a tripler, depending on V_{IN} and output load conditions to improve overall efficiency. The part has

thermal shutdown and can survive a continuous short from V_{OUT} to GND. In shutdown, the load is disconnected from V_{IN} .

The LTC1516 is an ideal device for use as a 2-cell to 5V regulator, a Li-Ion battery backup supply, local 3V to 5V converter, 5V flash memory programmer or a smart card reader power supply. The LTC1516 is available in the 8-lead plastic surface mount package specified for operation from 0°C to 70°C or -40°C to 85°C. For a data sheet and free evaluation samples of the LTC1516, call your local Linear Technology sales office.

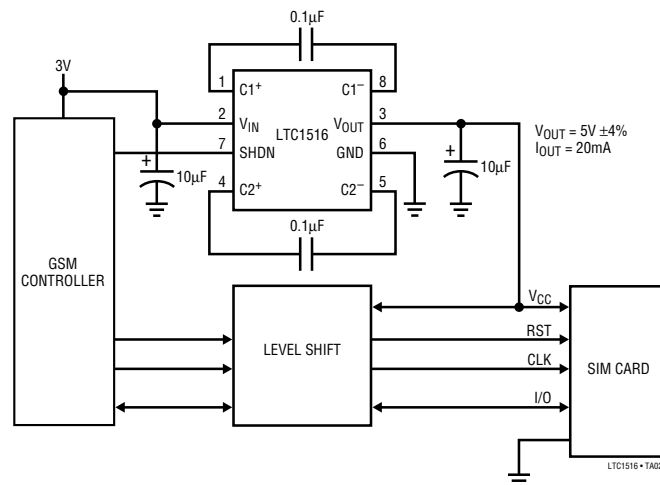


Figure 2. LTC1516 Provides a Regulated 5V Output from a 2V to 5V Input for GSM Phone SIM Cards

All Surface Mount Li-Ion Battery Charger Allows Input Voltage to be Higher or Lower Than Battery Voltage

The **LT[®]1512** is a 500kHz constant-current/constant-voltage battery charger in an 8-lead surface mount package. The LT1512 charges any number of NiCd (nickel-cadmium), NiMH (nickel-metal-hydride) or Li-Ion (lithium-ion) cells up to 20V. The LT1512 has a current sense feedback circuit that provides accurate output current control of a flyback or SEPIC topology charger. The input voltage can be higher or lower than the output voltage. This topology is also useful where different battery packs with battery voltage above and below

a fixed input voltage need charging. The flyback or SEPIC topology allows the current sense circuit to be ground referred and completely separated from the battery, simplifying battery switching and eliminating ground loop errors. Figure 1 shows an all

surface mount LT1512 0.5A battery charger circuit. Note that the two small inductors shown in the schematic are actually a single standard off-the-shelf double wound inductor in a surface mount package.

Continued on page 3

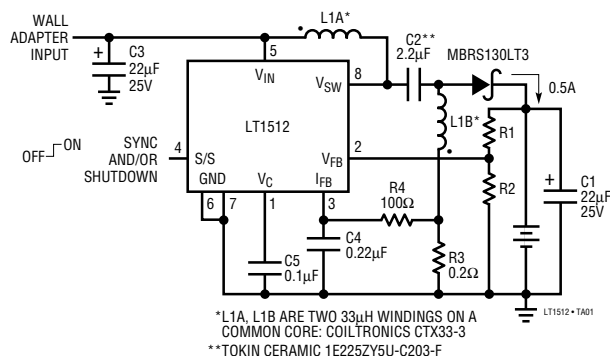


Figure 1. LT1512 500mA Output, All Surface Mount Battery Charger Allows Input Voltage to be Higher or Lower Than Battery Voltage

Application of the Month


Multichannel A/D Uses a Single Antialiasing Filter

The circuit in Figure 1 demonstrates how the LTC1594's independent analog multiplexer can simplify the design of a 12-bit data acquisition system. All four channels are MUXed into a single 1kHz, fourth order Sallen-Key antialiasing filter, which is designed for single supply operation. Since the LTC1594's data converter accepts inputs from ground to the positive supply, rail-to-rail op amps were chosen for the filter to maximize dynamic range. The LT1368 dual rail-to-rail op amp is compensated for the 0.1 μ F load capacitors

(C1 and C2) that help reduce the amplifier's output impedance and improve supply rejection at high frequencies. The filter contributes less than 1LSB of error due to offsets and bias currents. The filter's noise and distortion are less than -72dB for a 100Hz, 2V_{P-P} offset sine input.

The combined MUX and A/D errors result in an integral nonlinearity error of ± 3 LSB (maximum) and a differential nonlinearity error of $\pm 3/4$ LSB (maximum). The typical signal-to-noise plus distortion ratio is 68dB, with approximately -78dB of total

harmonic distortion. The LTC1594 is programmed through a 4-wire serial interface that allows efficient data transfer to a wide variety of microprocessors and microcontrollers. Maximum serial clock speed is 200kHz, which corresponds to a 10.5kHz sampling rate.

The complete circuit consumes approximately 800 μ A from a single 5V supply. For ratiometric measurements, the A/D's reference can also be taken from the 5V supply. Otherwise, an external reference should be used. 

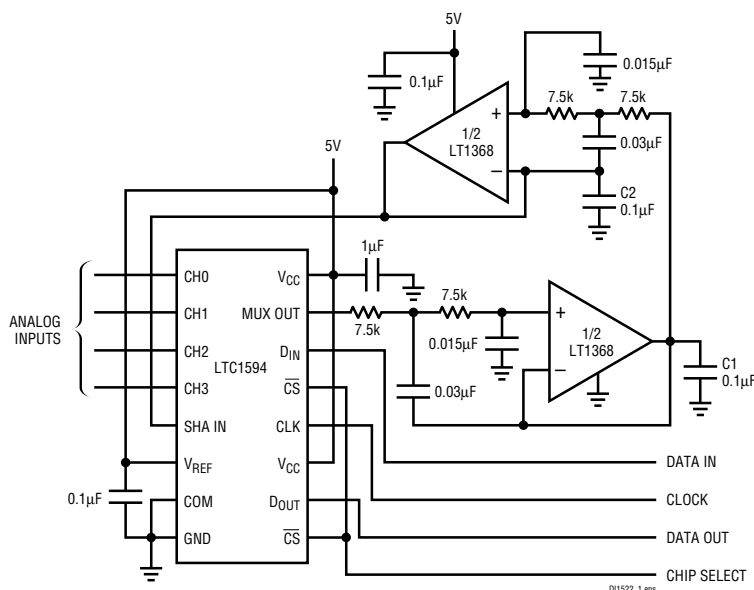


Figure 1. Simple Data Acquisition System Takes Advantage of the LTC1594's MUX OUT/SHA IN Loop to Filter Analog Signals Prior to A/D Conversion

LT1512 from page 2

Output charging voltage accuracy of 1% in constant voltage mode meets the charging requirements of lithium batteries. The LT1512 operates with input voltages as high as 30V and provides charging currents from 400mA to over 750mA, as illustrated in Figure 2. The charge current is easily programmed and a shutdown mode is also provided. The overall size of the surface mount charger circuit is typically less than 0.7 square inches.

The LT1512 is an ideal device for charging NiMH, Li-Ion and NiCd batteries

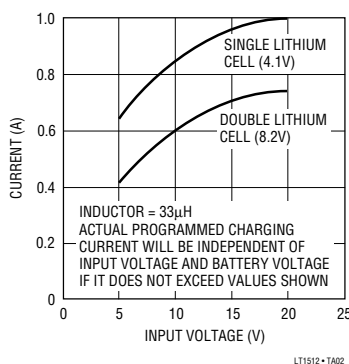



Figure 2. LT1512 Provides User Programmable Charging Current for Li-Ion Cells

where the input voltage can be higher or lower than the battery voltage. The device can also be used as a precision current limited power supply, a constant-voltage/constant-current power supply or used for a precision power supply for transducer excitation. The LT1512 is available in an 8-lead plastic dual-in-line and 8-lead plastic surface mount package. Operating junction temperature range is 0°C to 125°C. For a higher current step-down battery charger device, see the LT1510 and LT1511. Contact your local LTC sales office for a data sheet and free evaluation samples of the LT1512. 

Quad Micropower Op Amp Provides Superior Speed and Accuracy

The **LT1353** is a quad, very low power, high speed operational amplifier. This new quad op amp features much lower supply current and higher slew rate than devices with comparable bandwidth. The LT1353 features a 3MHz gain bandwidth and a 200V/ μ s slew rate while consuming only 250 μ A per amplifier. The DC precision is also enhanced. The LT1353 features a maximum input offset voltage of 600 μ V, input bias current of 50nA and input offset current of 15nA. The device is fully specified with ± 2.5 V, ± 5 V, and ± 15 V supplies. Minimum gain is 30V/mV with a 2k Ω load. The AC performance of the LT1353 is excellent for a micropower op amp. The output of the LT1353 settles to 0.1% in 700ns and 0.01%

in 1.25 μ s with a 10V step. The high slew rate of the LT1353 ensures that the large-signal response is not degraded. Figure 1 shows the large-signal response of the LT1353.

The LT1353 is a C-Load™ op amp. The C-Load architecture of the LT1353 allows the device to drive any capacitive load while maintaining stability. The output of the

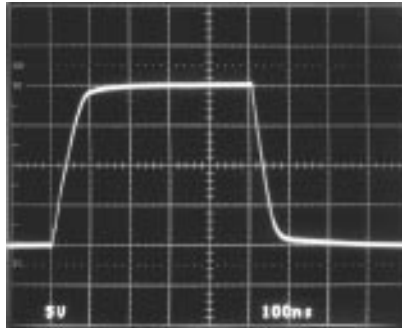



Figure 1. LT1353 Micropower High Speed Op Amp Large-Signal Response

LT1353 op amp is capable of driving a 1k Ω load to ± 13 V with ± 15 V supplies and a 500 Ω load to ± 3.4 V on ± 5 V supplies. Other high speed low power op amps from LTC include the LT1354 through LT1365. These devices feature bandwidths of 12MHz, 25MHz, 50MHz and 70MHz with only 1mA, 2mA, 4mA and 6mA of supply current respectively, per amplifier. Singles, duals and quads of each amplifier are available.

The low power, high speed and superior accuracy of the LT1353 make it an ideal amplifier for use as an active filter, photodiode amplifier, instrumentation amplifier and data acquisition buffer op amp. The LT1353 is available in the 14-lead SO package specified for operation from 0°C to 70°C and guaranteed to operate from -40°C to 85°C. For a data sheet and free evaluation samples of the LT1353, please contact your local Linear Technology sales office. 

C-Load is a trademark of Linear Technology Corporation.

New Micropower Comparator in 8-Lead Surface Mount Package Includes 1% Reference

The **LTC1440** is an ultralow power single comparator IC with a built-in 1.182V $\pm 1\%$ reference in an 8-lead surface mount package. This new device features a low 2.8 μ A quiescent current over temperature with guaranteed operation down to 2V. A special HYST pin on the LTC1440 allows the user to set hysteresis levels with only two resistors. The TTL/CMOS outputs of the LTC1440 are capable of continuously sinking up to 5mA and sourcing up to 40mA while still maintaining microampere quiescent currents. Figure 1 shows the LTC1440 supply current over temperature.

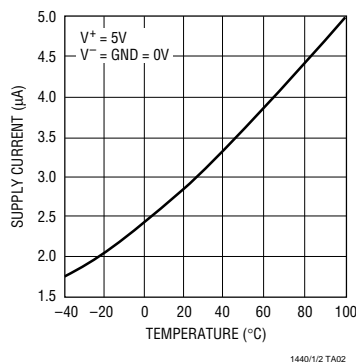



Figure 1. LTC1440 Supply Current vs Temperature

The internal bandgap reference on the LTC1440 maintains 1.5% accuracy from -40°C to 85°C. It can source up to 200 μ A and sink up to 20 μ A with a 5V supply. The reference can drive a bypass capacitor of up to 0.01 μ F without oscillation. By inserting a

series resistor, capacitance values up to 100 μ F can be used.

The LTC1440 is just one member of a complete single/dual/quad (LTC1440/1441/1442) micropower comparator family that provides many of the same features. The LTC1440 family is ideal for use as a battery voltage monitor, threshold detector, oscillator or as a window comparator building block. The LTC1440 is available in the 8-lead plastic surface mount package with specified operation from 0°C to 70°C or -40°C to 85°C. Contact your local Linear Technology sales office for a data sheet and free evaluation samples of the LTC1440. 

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