Linear Technology Chronicle

June 1996 — *A Showcase of Linear Technology's Focus Products* — Vol. 5 No. 6

Products of the Month

12-Bit Micropower Voltage Output Digital-to-Analog Converters in SSOP Package Have Excellent DNL

The **LTC®1450** and **LTC1450L** are complete single supply micropower voltage output 12-bit digital-to-analog converters (DACs) in 24-pin SSOP and PDIP packages. The 3V powered LTC1450L and 5V powered LTC1450 draw only 250µA and 400µA of supply current, respectively. Maximum Differential Nonlinearity error is only 0.5LSB. Figure 1 shows the highly accurate DNL of the LTC1450 and LTC1450L. These new DACs include a rail-to-rail output buffer amplifier, reference and a double buffered parallel digital interface. The parallel interface can be configured as a 12-bit or 8 + 4-bit digital I/O.

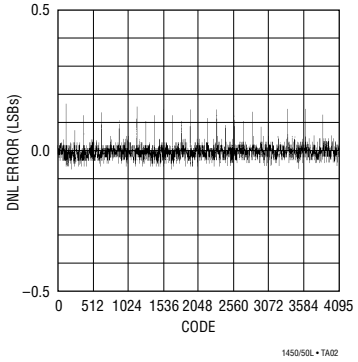

Figure 1. LTC1450/LTC1450L Have a Maximum ±0.5LSB DNL Error

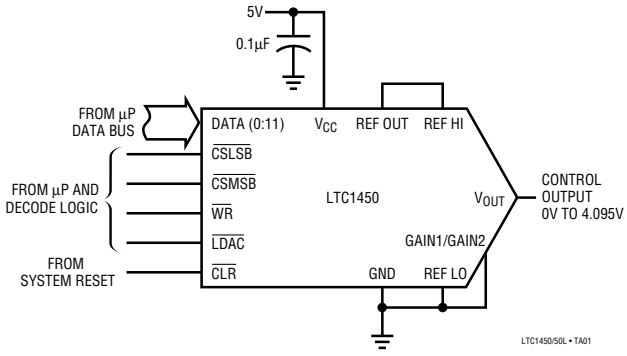

Figure 2. LTC1450 Simplified Circuit

The 5V powered LTC1450 contains a 2.048V internal reference and an output that can be pin selected for a 4.095V or 2.047V full-scale range. The 3V powered LTC1450L contains a 1.22V reference and the output can be configured for a 2.5V or 1.22V full-scale range. An external reference can be applied to convert the device to a true rail-to-rail output DAC. Internal power-on reset is also provided to assure a zero output at system start-up. Figure 2 shows a typical LTC1450 simplified circuit diagram. The reference output, high and low reference inputs and gain setting resistors are user accessible to provide maximum flexibility.

The LTC1450 and LTC1450L micropower DACs are ideal for use in industrial process control, automatic test equipment, function generators and portable battery-powered data acquisition and conversion products. The LTC1450 and LTC1450L are specified over 4.5V to 5.5V and 2.7V to 5.5V supply voltage ranges, respectively. These DACs are available specified for either the 0°C to 70°C range or the industrial –40°C to 85°C range. Contact your local Linear Technology sales office for a data sheet and free evaluation samples of the LTC1450 and LTC1450L.

Inside This Issue:

2A Battery Charger IC Has Automatic Buck-to-Boost and Boost-to-Buck Switchover

The **LT®1513** is a 500kHz current mode switching regulator specifically configured to create a constant-current/constant-voltage battery charger. This new charger IC automatically transfers from buck to boost mode, allowing the input voltage to range above or below the battery voltage. Also known as a SEPIC (Single-Ended Primary Inductance Converter) circuit, the LT1513 can be used

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LT1513 from page 1

for either voltage step-down (buck) or voltage boost mode with no component changes. This power IC charges any number of Li-Ion, NiMH and NiCd battery cells up to 20V. The LT1513 includes 1% output voltage accuracy as required by rechargeable lithium-ion batteries. The LT1513 is available in a surface mount 7-lead DD package and the switching frequency of 500kHz minimizes external component size.

In addition to the usual voltage feedback mode, the LT1513 has a current sense feedback circuit for accurately controlling the output current of a flyback or SEPIC topology charger. These topologies allow the current sense circuit to be ground referred and completely separated from the battery itself, simplifying battery switching and eliminating ground loop errors. Figure 1 shows a typical LT1513 battery charger circuit.

Maximum switch current on the LT1513 is 3A. This allows battery charging currents up to 2A for a single lithium-ion cell. Charging current can be easily programmed for all battery types. Figure 2 shows the maximum charging current versus input voltage of the LT1513.

The LT1513 is designed for battery charging when the input voltage is above and below the charge voltage. Other LT1513 family members include the LT1510, LT1511 and LT1512. These other devices are optimized for various input/output conditions and different battery types as shown in Table 1. These power devices are available in various package types, including an 8-lead SO surface mount package. The LT1513 is available in a 7-lead TO-220 and a 7-lead surface mount DD package. Devices are specified for operation from 0°C to 70°C and –40°C to 85°C. For a data sheet and evaluation samples of the LT1513, contact your local Linear Technology sales office.

Table 1. Battery Charger Selection Guide

Characteristics	LT1510CS8	LT1510	LT1511	LT1512	LT1513
Maximum Charging Current	1.2A	1.5A	3A	1A	2A
Charges Li-Ion Cells		✓	✓	✓	✓
Charges NiCd and NiMH Cells	✓	✓	✓	✓	✓
Step-Up				✓	✓
Step-Down	✓	✓	✓	✓	✓
V_{BAT} Maximum	20V	20V	20V	20V	20V
Up to 24V Wall Adapter	✓	✓	✓	✓	✓
Packages	8-Lead SO	16-Lead SO	24-Lead SO, 16-Lead PDIP	8-Lead SO, 8-Lead PDIP	7-Lead DD

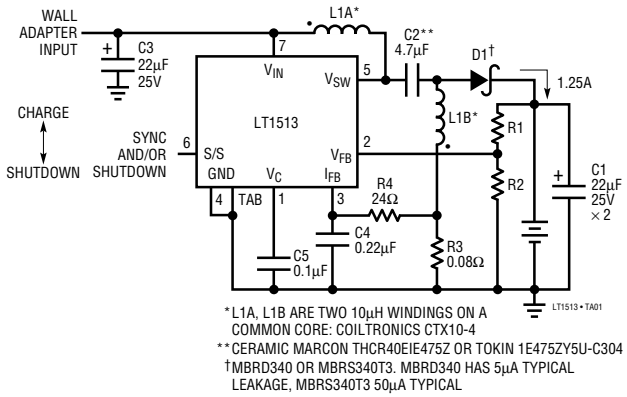

Figure 1. LT1513 Battery Charger with 1.25A Output Current

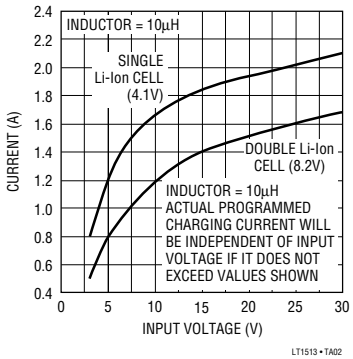

Figure 2. LT1513 Maximum Charging Current vs Li-Ion Cell Count and Input Voltage

Industrial Grade 3V, 8-Bit A/D Converters Are Micropower and Micro Sized

The **LTC1096L** and **LTC1098L** are 3V micropower, 8-bit successive approximation sampling A/D converters. They typically draw only 40µA of supply current when converting and automatically power down to a typical supply current of 1nA between conversions. They are available in 8-pin SO packages specified for both the commercial and industrial temperature range. These 8-bit, switched capacitor, successive approximation A/Ds include a sample-and-hold circuit. The LTC1096L has a single differential analog input. The LTC1098L offers a software selectable 2-channel multiplexed input. Figure 1 shows the LTC1096L running on a 3V battery.

On-chip serial ports allow efficient data transfer to a wide range of microprocessors and microcontrollers over three or four wires. The digital interfaces of these new A/D converters are SPI and MICROWIRE™ compatible. This, coupled with micropower consumption, makes remote location possible and facilitates transmitting data through isolation barriers.

These new A/D converters can be used in ratiometric applications or with an external reference. The high impedance analog inputs and the ability to operate with reduced spans (to 1V full scale) allow direct connection to sensors and transducers in many applications, eliminating the need for gain stages.

The LTC1096L and LTC1098L are ideal for use in battery-operated data acquisition, remote or isolated data acquisition,

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Application of the Month

Constant Voltage Load Box for Battery Simulation

Linear Technology has developed many new switcher-based battery charger ICs. Testing accuracy, regulation and efficiency in the lab with a battery load is inconvenient because the terminal voltage of a battery constantly changes as it is being charged. If much testing is to be done, a large supply of dead batteries will be needed, since one set of cells can quickly become overcharged. This article describes an active load circuit that can be used to simulate a battery in any state of charge. The battery simulator provides a constant voltage load for a battery charging circuit, independent of applied charging current. The simulator's impedance is less than 0.5Ω at all reasonable input frequencies. Best of all, the simulator can never be overcharged, allowing long term testing and debugging of a charger system without the possibility of battery damage.

Circuit Operation

Figure 1 shows the schematic diagram of the battery simulator. The simulator uses an LT1211 high speed, single-supply op amp to drive the base of a high gain PNP transistor-stage active load. Power for the LT1211—a portion of the charging current—is supplied through a diode so the op amp and reference can survive brief periods of zero charging current. The op amp is configured for a DC gain of four, so the voltage on its noninverting input is one fourth of the voltage to which the load box is set. With S1 open, the load voltage adjust range will be from 10V to 20V and with S1 closed it will be approximately 3.5V to 10V. Low voltage operation could be improved by using an LT1004-1.2 volt reference, reducing the 10k bias resistor to 2k and changing D1 to a Schottky diode. The 510Ω and 1.1k resistors are required for high frequency stability; they suppress a 1MHz oscillation. The 1N5400 diode and 4A fuse protect the circuit from reverse voltages.

Results

The battery simulator circuit has been tested absorbing currents from 30mA to 3A with the output voltage essentially unchanged. When simulating a battery, the voltage adjust can be increased until the charger thinks the battery is fully charged and reduces the current into the simulator. Conversely, as the voltage is adjusted down, the battery charger may think the battery is becoming discharged and increase the current into the simulator.

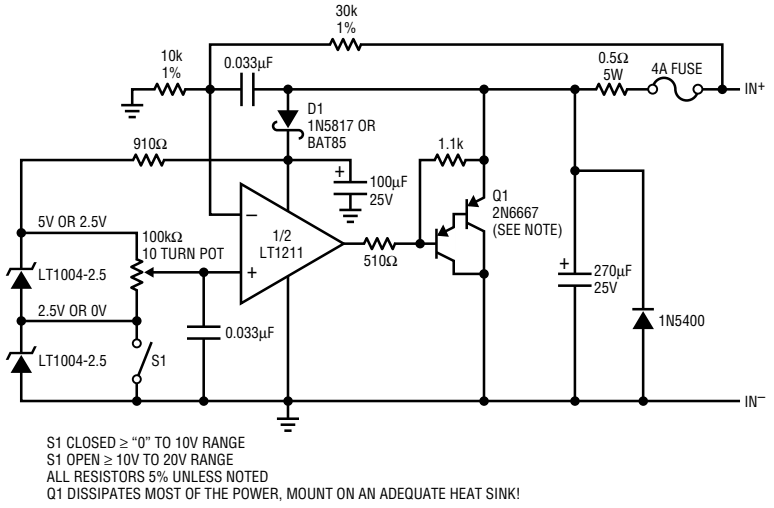

Figure 1. Schematic Diagram of Battery Simulator

LTC1096/LTC1098L from page 2

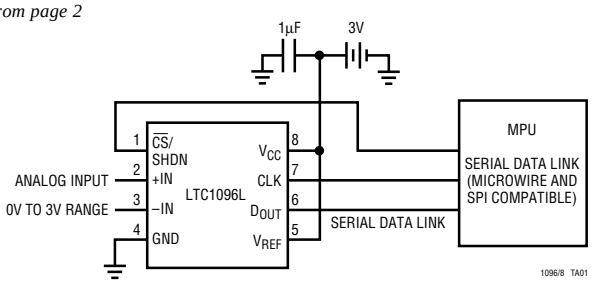

Figure 1. 10µW, SO-8 Package, 8-Bit A/D Converter Samples at 200Hz and Runs Off a 3V Battery

battery voltage monitoring and temperature monitoring applications. These new A/D converters are available in the 8-lead plastic SO package specified for operation from 0°C to 70°C. Industrial versions, LTC1096LIS8 and LTC1098LIS8, are available as standard products specified from –40°C to 85°C. Contact your local Linear Technology sales office for a data sheet and evaluation samples of these new micropower A/D converters.

12-Bit, 1.25Msps Sampling A/D Converter Now Available in Industrial Grade

The **LTC1410** is a 650ns, 1.25Msps, sampling 12-bit A/D converter which draws only 160mW from ±5V supplies. The LTC1410 is now available as an industrial grade standard product, specified for operation over the –40°C to 85°C range. This easy-to-use device includes a high dynamic range sample-and-hold, a precision reference and a trimmed internal clock. Figure 1 shows the LTC1410IS pinout. The device operates with an internal 2.5V reference trimmed for 25ppm/°C that can easily be overridden by an external reference.

The LTC1410's internal clock is trimmed for 750ns maximum conversion time. The clock automatically synchronizes to each sample command. A separate convert start input and a data ready signal ease connections to FIFOs, DSPs and microprocessors.

The LTC1410's full-scale input range is ±2.5V. Maximum DC specs include ±1LSB INL, ±1LSB DNL and 45ppm/°C drift over temperature. Figure 2 shows the effective bits and signal-to-noise performance versus frequency of the LTC1410. Outstanding AC performance includes 71dB S/(N + D) and 82dB THD at the Nyquist input frequency of 625kHz.

The unique differential input sample-and-hold can acquire single-ended or differential input signals up to its 20MHz 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 the accuracy and quality of signal conversion achieved by the LTC1410 over a wide input frequency range.

Two digitally selectable power shutdown modes provide flexibility for low power systems. In the Nap mode, the LTC1410 dissipates 7mW. In the Sleep mode or full Shutdown mode the LTC1410 dissipates only 10µW. The Nap mode allows the LTC1410 to go into a power saving state while still being capable of instant wake-up. This allows for more frequent intermittent shutdowns than a full Sleep mode can provide, reducing overall power consumption in portable systems.

Applications for the LTC1410 include PC data acquisition, automatic test equipment, communications systems and industrial control systems. The LTC1410 is available in a 28-lead surface mount package. The standard commercial LTC1410CS is specified for operation from 0°C to 70°C. The industrial temperature range version, LTC1410IS, is also available for applications requiring –40°C to 85°C operation. Please contact your local LTC sales office for a data sheet and evaluation samples of the LTC1410.

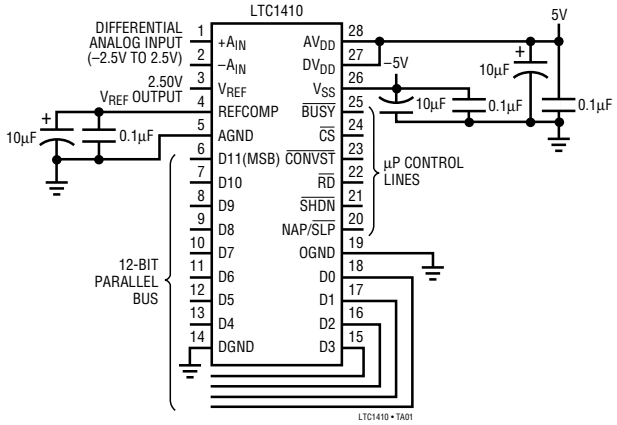

Figure 1. LTC1410 Industrial Grade 1.25MHz, 12-Bit Sampling A/D Converter

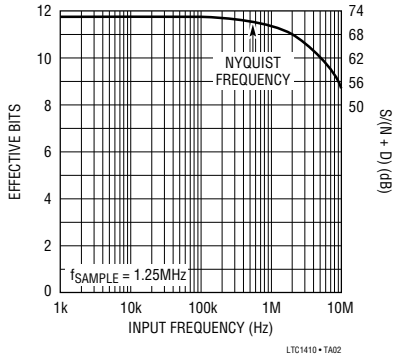

Figure 2. Effective Bits and Signal-to-(Noise + Distortion) vs Input Frequency