Linear Technology Chronicle

November 1997 — A Showcase of Linear Technology's Focus Products — Vol. 6 No. 11

Product of the Month

Serial 16-bit Multiplying DACs Upgrade Industry Standard 12-Bit DACs

The **LTC®1595/LTC1596** are serial input, 16-bit multiplying current output DACs pin compatible with industry standard 12-bit devices. The LTC1595/LTC1596 offer guaranteed 16-bit accuracy over the industrial temperature range. DNL and INL are tested to be less than ±1LSB over temperature—ensuring a 16-bit monotonic response. They include an internal deglitching circuit that provides the industry's lowest glitch impulse: 1nV•s (typ). The LTC1595 is pin compatible with the 12-bit industry standard '8043 and is offered in 8-pin PDIP and SO packages. The LTC1596 is drop-in compatible with the '8143 or '7543 and comes in 16-pin PDIP and SO wide packages. Most applications with multiplying DACs require an external op amp which also influences system accuracy. The LTC1595/LTC1596 have reduced sensitivity to op amp V_{OS} which allows most systems to be easily upgraded to true 16-bit linearity without requiring more precise op amps. Figure 1 shows the INL performance of the LTC1595. The LTC1595/LTC1596 are ideal for industrial control, instrumentation, ATE and other high resolution applications.

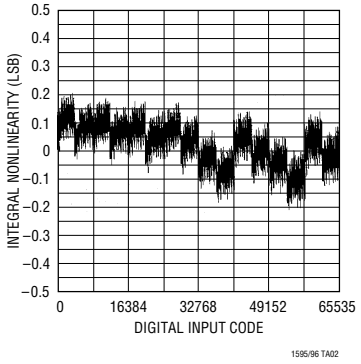

Figure 1. LTC1595 Has Typical INL of ±0.2LSB and Specified Max INL of ±1LSB

The LTC1595/LTC1596 have a 3-wire serial interface (LTC1595) or a full-duplex serial interface with strobe and clear inputs (LTC1596). The LTC1596 has a daisy-chain output that allows multiple DACs to be connected on the same serial port minimizing data I/O pins (see Figure 2). The asynchronous clear pin ($\overline{CLR}$) allows the user to quickly reset the output to zero-scale without writing data to the input.

The LTC1595 is offered in 8-lead PDIP and SO packages and the LTC1596 is offered in 16-lead PDIP and SO packages. Parts are screened to A, B and C electrical grades over the commercial and industrial temperature ranges and delivery is from stock. 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**.

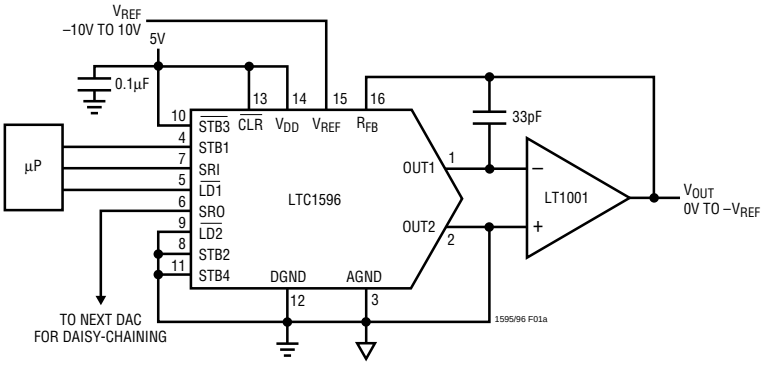

Figure 2. The 16-Pin LTC1596 Has Additional Pins for Flexibility (Compared to LTC1595), Four Clock Pins, Two Load Pins and a Data Output Pin for Daisy-Chaining Multiple DACs

Dual 12-bit Micropower DAC in SO-8 Has Max DNL Error of ±0.5LSB

The **LTC1448** is a dual 12-bit DAC in an SO-8 package that operates from a single 2.7V to 5V supply with maximum differential nonlinearity (DNL) of just ±0.5LSB. Its unity-gain configuration allows the reference input to be tied directly to V_{CC} for true rail-to-rail output swing. This dual DAC (Figure 1) consumes only 3.5mW maximum from a 5V supply. Power-on reset ensures that it will start in a known (zero-scale) state after power-up. These features make it well-suited for portable and battery-powered equipment, for general trimming and digital calibration applications and in industrial control systems and cellular phones.

The LTC1448 includes two 12-bit D/A converters, two rail-to-rail voltage output amplifiers and a 3-wire serial interface. Its DNL of 0.5LSB (Figure 2) guarantees 12-bit

Continued on page 2

Inside This Issue:

Step-Up/Step-Down Charge Pump Provides 5V from 3V to 10V Input

The **LTC1514/LTC1515** are a family of micropower switched-capacitor DC/DC converters that produce a regulated 3.3V, 5V or adjustable output voltage from an input supply that can range from 2V to 10V. They are well-suited for battery-powered applications where the input battery voltage may begin above the output voltage and then decrease below the output voltage as the battery drains. An example of this would be a 4-cell alkaline cell battery (6V new, 3.6V dead) used to generate a 5V output or a 3-cell alkaline battery (4.5V new, 2.7V dead) to generate a 3.3V output. These charge pump step-up/step-down converters require only three capacitors and no inductors—making them particularly attractive in space-limited applications.

The LTC1514-3.3/LTC1514-5 incorporate a low-battery detector and produce a regulated fixed 3.3V or 5V output voltage, respectively, using an internal resistor divider (Figure 1). In shutdown, the LTC1514 draws just 10µA of supply current (the low-battery detector is active in shutdown) while the LTC1515, which disconnects the load from V_{IN}, needs less than 1µA of shutdown current. Controlled switch current limit makes them gentle on batteries and lowers the output voltage ripple.

The LTC1515 series devices have both adjustable and fixed output voltage versions and incorporate a POR (power-on reset) circuit that provides reliable system wake-up after power is applied. The LTC1515 has an adjustable output from 1.3V to 11V using an external resistor divider, while the LTC1515-3/LTC1515-5 and LTC1515-3.3/LTC1515-5 fixed output versions are pin selectable between 3V and 5V or 3.3V and 5V. Up to 50mA of output current is available from all of these converters. Figure 2 shows the output voltage vs input voltage for the LTC1515.

The LTC1514/LTC1515 are available in an SO-8 package and are screened to the commercial and industrial temperature ranges. 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.

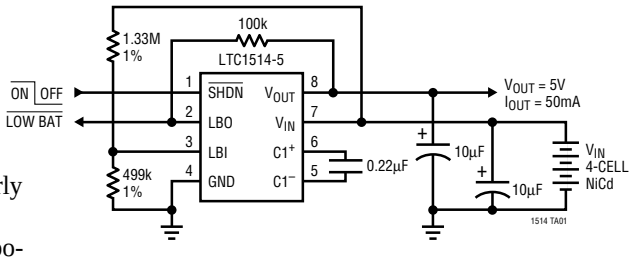

Figure 1. The LTC1514 Incorporates a Low-Battery Detector and Produces a Fixed 3.3V or 5V Output Voltage. It Can Either Boost or Buck the Input Voltage to Maintain a Regulated Output Voltage

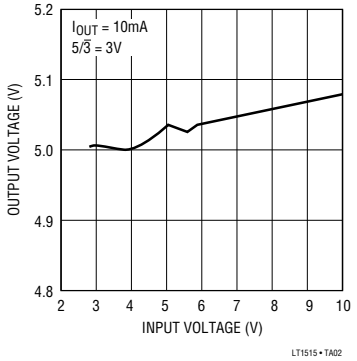

Figure 2. The LTC1515 Series Has Both Adjustable and Fixed Output Voltage Versions. Voltage Regulation Is ±4% over a 2V to 10V Input Range

LTC1448 from page 1

monotonic performance, critical in control loop applications. The rail-to-rail amplifiers have improved capacitive load handling over competing devices, even when driving a 5mA load from a 4.5V power supply.

The LTC1448's 3-wire cascadable serial interface is compatible with SPI and MICROWIRE™ serial protocols. This eases the connection to the serial interface of most microprocessors and microcontrollers and simplifies transmitting through isolation barriers or to remote locations.

The LTC1448 is immediately available in volume from stock in an SO-8 package. Commercial and industrial temperature versions are available. Contact your local Linear Technology sales office for a data sheet and evaluation samples. Visit our web site at **www.linear-tech.com** for more information.

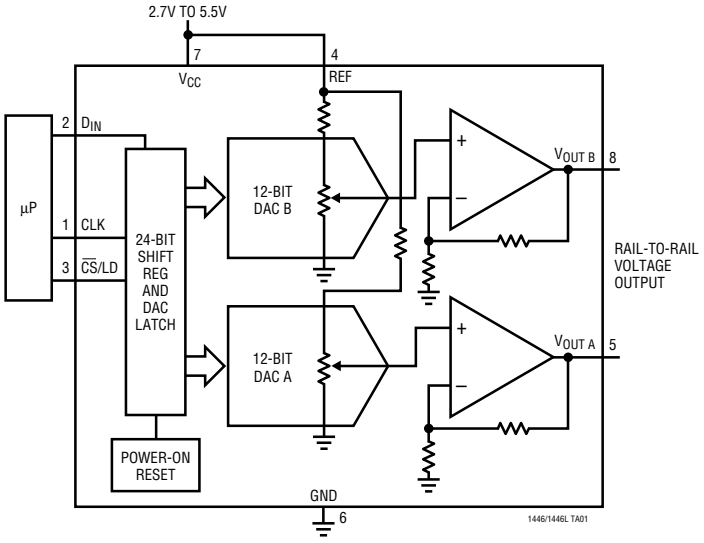

Figure 1. LTC1448 Dual DAC Includes a Rail-to-Rail Output Buffer Amplifier and an Easy-to-Use 3-Wire Serial Interface

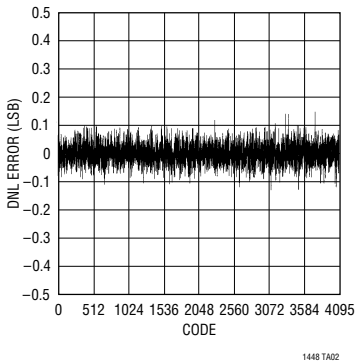

Figure 2. LTC1448 Has a Typical DNL of Only ±0.2LSB

MICROWIRE is a trademark of National Semiconductor Corp.

Application of the Month

A 1A Shunt Battery Charger

Most battery chargers comprise nothing more than a series-pass regulator with current limit. In solar-powered systems, you can't count on sufficient headroom to keep a series regulator alive, so a shunt method is preferred. A simple shunt battery charger is shown in Figure 1. It consists of an op amp driving a shunt transistor and ballast resistor, and is built around an LT1635. This device contains both an op amp and a reference, making it perfectly suited for regulator and charger applications.

Operation is straightforward: the battery voltage is sensed by a feedback divider composed of two 1M resistors. The internal 200mV reference is amplified to 7.05V and compared against the feedback. RT1 introduces a TC that accurately tracks the battery's correct charging voltage over a wide temperature range. Because RT1 is designed to compensate for changes in battery temperature, it should be located close to the battery and as far as possible from the shunt elements. When the battery charges to 14.1V, the op amp output begins to rise, turning on the Darlington shunt and resisting further increases in voltage. Full panel power is divided equally between the transistor and 7.5Ω resistor when the battery is completely charged. Don't forget to provide adequate heat sinking and airflow for up to 15W dissipation.

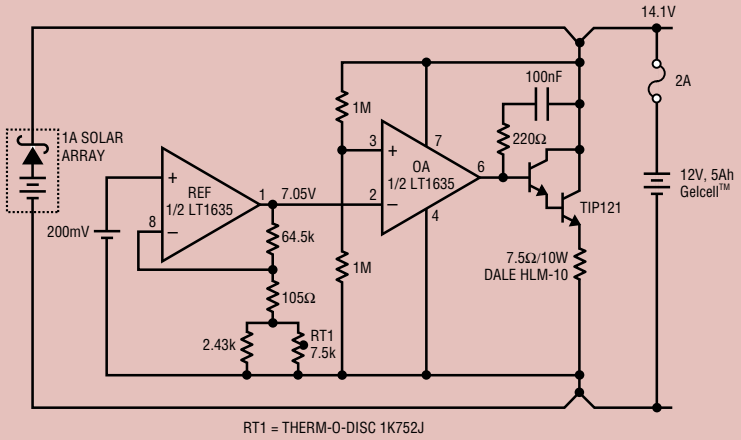

Figure 1. 1A Shunt Battery Charger (I_{DARK} = 230mA, V_{FLOAT} = 14.1V)

The charger is designed to handle 1A continuous, which is compatible with a "20W" panel. There is no need to disconnect or diode isolate the charger during periods of darkness, because the standby current is only 230µA—less than 10% of the self-discharge of even a small battery.

If a different or adjustable output is desired, the feedback ratio can be easily modified at the 1M divider. 14.1V is a compromise between an aggressive charge voltage and a conservative float voltage. Given the cyclic nature of insolation, allowing periodic charging at 14.1V is not detrimental to Gelcell™ batteries. The circuit in Figure 1 will work with larger or smaller batteries than that shown. As a rule of thumb, the panel should be sized from 1W per 10Ah battery capacity (a float charge under good conditions with a good battery) to 5W per 1Ah battery capacity (1-day recharge of a completely discharged battery under favorable conditions of insolation).

Gelcell is a trademark of Johnson Controls, Inc.

Regulated 5V/20mA Charge Pump in SOT-23 Draws Just 6µA I_Q

The **LTC1517-5** is the first micropower boost charge pump DC/DC converter in a 5-lead SOT-23 package. It provides a regulated 5V output from a 2.7V to 5V input supply with a maximum output current of 20mA. It operates at 800kHz and draws only 6µA (typ) of supply current with no load. Its low external parts count—three external capacitors and *no* inductors—and the tiny SOT-23 package (33% of an SO-8 footprint) result in a total PCB area that's just 0.045 square inches (0.29cm^2). The LTC1517-5 is excellent for use in products powered by 3-cell alkaline batteries, 3- and 4-cell NiCd/NiMH batteries or a single Li-Ion cell. It's ideal for cellular telephones, PCMCIA supplies or any local generation of 5V from a 3.3V system supply where an extremely compact solution is essential.

As shown in Figure 1, the LTC1517-5 requires only a single 0.1µF flying capacitor and two small tantalum or ceramic bypass capacitors at V_{IN} and V_{OUT}. The LTC1517-5's 5V input voltage range allows it to operate with a 3-cell rechargeable NiCd battery system, even when charging. Figure 2 shows typical output voltage and current for V_{IN} operation at 2.7V, 3.0V and 3.3V.

For a data sheet and evaluation samples, contact your local Linear Technology sales office. For more information, visit our web site at **www.linear-tech.com.**

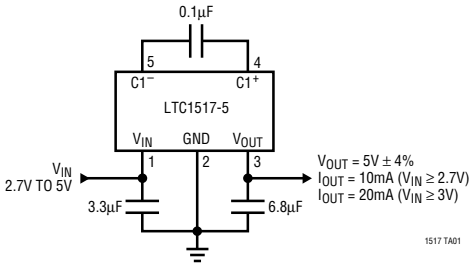

Figure 1. The LTC1517-5 as a Step-Up Converter Requires Only 0.45in^2 (0.29cm^2) of Board Space

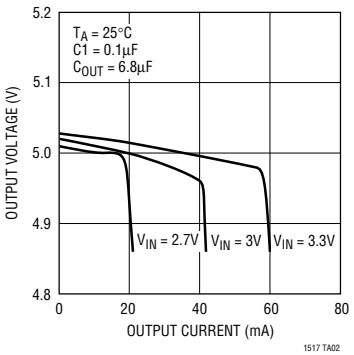

Figure 2. The LTC1517-5 Charge Pump Delivers a Regulated 5V Output with ±4% Regulation

Regulated 5V Charge Pump in MSOP Operates on 6µA

The **LTC1522** is a micropower boost charge pump DC/DC converter in an MSOP package that produces a regulated 5V ±4% output from a single 2.7V to 5V supply. It delivers an output current of 20mA for $V_{IN} \geq 3V$, 10mA for $V_{IN} \geq 2.7V$ and features a quiescent current of just 6µA (typ). Quiescent current drops to less than 1µA in shutdown. The LTC1522 has an internal 700kHz oscillator and requires only a single 0.22µF flying capacitor and two small 10µF tantalum or ceramic bypass capacitors at V_{IN} and V_{OUT}. The LTC1522 in a tiny 8-lead MSOP package has a PCB footprint that's two-thirds the size of an SO-8 and its low external parts count (just 3 external capacitors as shown in Figure 1), results in a total PCB solution area that's as small as 0.1 square inch (0.65cm^2). The LTC1522 is ideally suited for light load battery-powered applications, such as products powered by 3-cell alkaline batteries, 3- and 4-cell NiCd/NiMH batteries or a single Li-Ion cell. It is also useful in local generation of 5V from a 3.3V system supply.

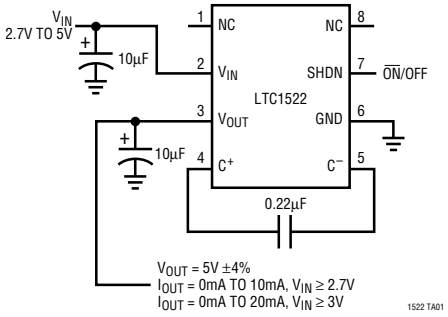

Figure 1. The LTC1522 Charge Pump in MSOP Package Requires Only Three External Capacitors to Produce a Regulated 5V from a 2.7V to 5V Input. Entire Circuit Occupies Less Than 0.65cm^2 of Board Space

The LTC1522 is short-circuit and thermal protected and can withstand a continuous dead short from V_{OUT} to ground. In shutdown, the load is disconnected from V_{IN}. Typical efficiency when V_{IN} is 3V exceeds 75% for load currents between 50µA and 20mA. Modulating the LTC1522's shutdown pin keeps the typical efficiency above 75% with load currents all the way down to 10µA.

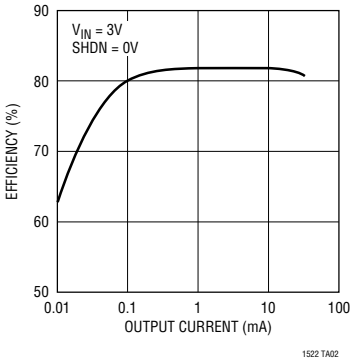

Figure 2. Efficiency Is over 80% for Load Currents from 100µA to 20mA. Modulating the LTC1522's SHDN Pin Keeps the Typical Efficiency Above 75% with Load Currents All the Way Down to 10µA

The LTC1522 is offered in 8-lead MSOP and SO packages. Contact your local Linear Technology sales office for a data sheet and evaluation samples. Visit our web site at **www.linear-tech.com** for more information.

Pentium® Processor Regulator Controller Delivers Low Cost, Low Dropout Solution

The **LT1573** is a regulator driver IC with an extremely fast transient response that provides a low cost solution to applications requiring high current, low (≤0.2V) dropout operation. When combined with an external PNP transistor, the LT1573 can supply load currents up to 5A with dropout voltages under 0.75V. Its fast response greatly reduces the amount of bulk storage capacitance required when used in applications with fast load transients. It's ideal in space constrained Pentium® processor VRE applications requiring a 5V to 3.3V ±100mV output with dynamic load conditions. It also is well-suited as a power supply for low voltage, low power DSPs and embedded processors, as a 3.3V to 2.5V regulator for low voltage logic and memory and as a high power post regulator for switching supplies.

To minimize cost and complexity in consumer designs, the LT1573 uses a unique time-delayed latching current protection technique that requires no external current sense resistor. Base drive is limited for instantaneous protection and a time-delayed latch protects the regulator from continuous short circuits. The LT1573 is available as an adjustable regulator with an output range of 1.2V to 15V and with fixed 3.3V, 2.8V and 2.5V outputs. Output accuracy is better than 1% (±2% fixed outputs over line, load and temperature) to meet the critical regulation requirements of fast microprocessors.

The LT1573 comes in a special fused-lead SO-8 package for improved heat sinking. 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.

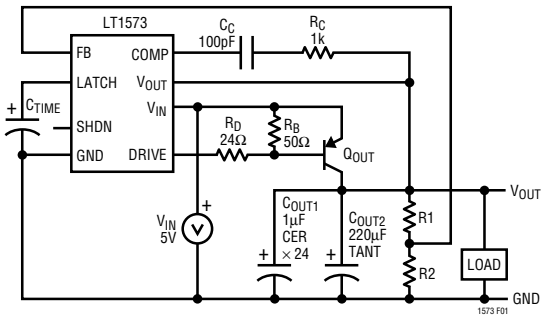

Figure 1. The LT1573's Fast Transient Response Permits Use of Just a Single 220µF Output Capacitor. It Can Provide a 2.5V Output from a 3.3V Supply, Which Reduces the Power (Heat) Dissipation and Allows a Smaller Heat Sink Than a 5V to 2.5V Regulator

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