LinearTechnologyChronicle

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Product of the Month

Multiple Output Power Supply ICs for Portable Computers Have Wide Input Range and Constant Switching Frequency

The **LTC®1438** and **LTC1439** high efficiency power conversion ICs offer the industry's most highly integrated and flexible solution for maximum battery life in portable computers. These dual controllers are the first and most complete members of a new family of ultrahigh efficiency voltage conversion products. They are designed to satisfy the ever increasing need for maintaining long battery life in the face of increasing power demands of new high performance microprocessors. These highly integrated ICs operate from a wide input voltage range of 3.5V to 36V, operate at constant switching frequency, have high efficiency over a wide range of load current and drive low cost N-channel power MOSFETs.

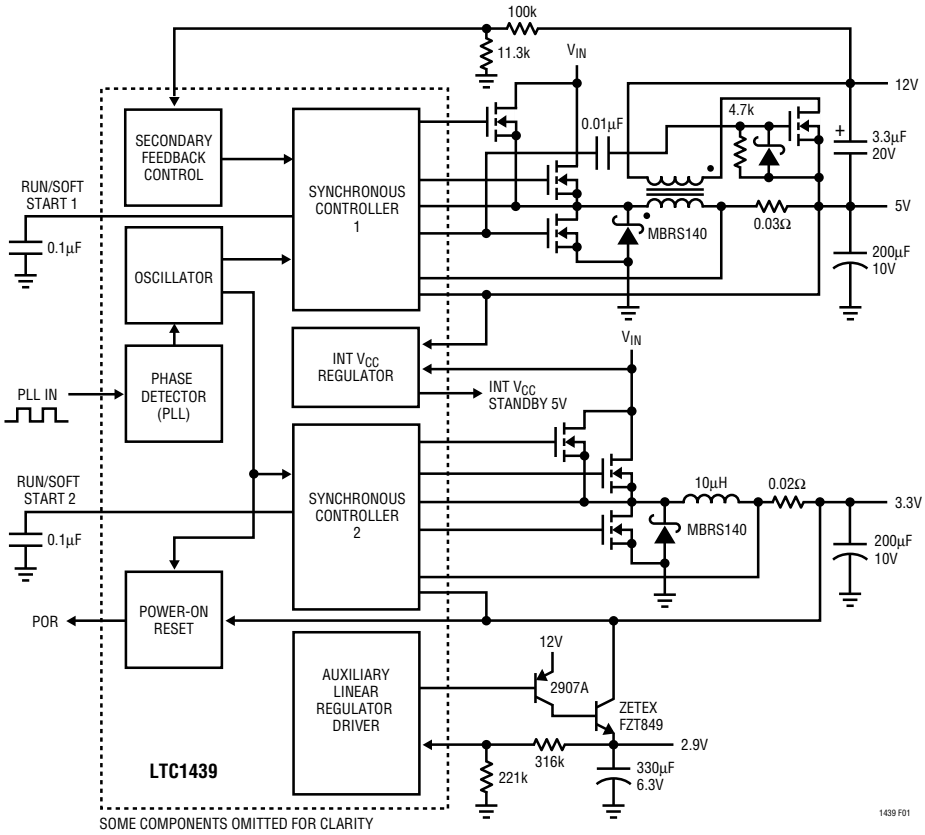

Figure 1. Complete Notebook Computer Power Supply

The LTC1439 contains all the control circuitry needed to implement up to a 4-output power supply with an overall efficiency of better than 90% over a wide range of load current while maintaining constant switching frequency of up to 400kHz. The LTC1439 was designed to provide all the necessary functions for battery power conversion without sacrificing flexibility or small size. The block diagram and simplified 4-output application pictured in Figure 1 illustrates the following key functional areas.

Synchronous controllers 1 and 2 provide an all N-channel MOSFET drive for highest efficiency with the excellent dynamic performance inherent with true current mode control. Gate drive of these controllers is sufficient to drive MOSFETs capable of supplying output currents in excess of 8A; 99% maximum switch duty cycle assures low dropout operation. A new Adaptive Power™ mode uses a small N-channel MOSFET which operates under low load conditions while maintaining constant switching frequency. This conserves power that would otherwise be consumed driving the larger main switches used during high load current conditions. If this third FET is not used, the device reverts to standard Burst Mode™ operation which maintains high efficiency at low loads with variable frequency.

An auxiliary linear regulator driver allows the use of an inexpensive external bipolar pass transistor to obtain up to 500mA at 12V for PCMCIA or low noise audio adjustable power supplies. For use with CPUs such as the Intel Pentium® processor for portable computers, the auxiliary driver can also be

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configured as shown in the block diagram to obtain the 2.9V core logic voltage at up to 3A regulated off of the main 3.3V output. When this is done, 12V for PCMCIA can be derived using an overwinding from the main 5V output. Secondary winding feedback control allows the 12V to remain in regulation even when the 5V power demand is low by forcing continuous operation of the section.

A phase-locked loop is provided which allows the LTC1439 to be synchronized to an external clock for applications such as communications and GPS systems. In these systems it is commonly desired to have switching frequencies positioned so as not to interfere with sensitive IF or RF sections of the system.

To round out the "system-on-a-chip" concept, power management functions are included in the LTC1439. A power-on reset with internal timer assures reliable processor operation and an internal comparator with reference can be used for low-battery detection. Soft start is independently programmable with a small capacitor on each section; thus, sequencing is under the control of the user. Quiescent current in shutdown is only 16µA.

The LTC1439 comes packaged in a 36-lead SSOP package while the LTC1438 contains a subset of the LTC1439 functions in a smaller 28-pin SSOP package. The LTC1438 contains the two main output controllers, the low-battery detector/comparator, secondary feedback control and power-on reset on output 2. Single output controllers which offer various combinations of the features described above are planned for release in the coming weeks. Future issues of *Linear Technology Chronicle* will detail these products as well as new versions of the dual output devices.

Both chips are specified for operation over the 0°C to 70°C commercial temperature range. Contact your local Linear Technology sales office for a data sheet and evaluation samples of the LTC1438 and LTC1439.

Zero Drift, 3V Op Amp Operates Rail-to-Rail

The **LTC1152** op amp features an input and output voltage range that extends all the way to both supply voltages, whether the device is operating on ±5V supplies or a single 3V or 5V supply. Typical input offset voltage is only 1µV and offset drift over temperature is only 0.01µV/°C, making it by far the most accurate rail-to-rail op amp on the market today. The LTC1152 is chopper stabilized to achieve accurate DC performance and requires no external components for normal operation. Figure 1 illustrates the use of the LTC1152 as a rail-to-rail buffer amplifier.

The LTC1152 also features other impressive DC specifications. Input bias current is 100pA, input offset current is 200pA maximum and the open-loop gain is 130dB. The 0.1Hz to 10Hz noise is only $2\mu V_{P-P}$. The LTC1152 has a gain bandwidth product of 1MHz and slew rate of 1V/µs while consuming only 2.2mA of supply current. The device also has a shutdown mode that reduces supply current to a maximum of 5µA.

This new op amp operates on supply voltages ranging from 2.7V to 14V (±7V). The CMRR and PSRR are 130dB and 120dB respectively.

The output stage of the LTC1152 can sink and source 10mA while maintaining a rail-to-rail output swing. The output swings to ground and within 500mV of the positive rail while driving a 1kΩ load. The LTC1152 can drive capacitive loads up to 1µF and can be configured (with only one external capacitor) to drive any capacitive load and remain stable.

The LTC1152 solves problems where a unity-gain buffer needs to handle 5V signals while running off a 5V supply. The LTC1152 is an ideal device for use in high resolution data acquisition systems, for use as a supply current sensor in a positive or negative supply rail, and can be used for amplification of low supply voltage transducer signals.

The LTC1152 is available in an 8-lead plastic dual-in-line and an 8-lead surface mount package. Device operating temperature is specified over the 0°C to 70°C voltage range. For a data sheet, samples or an extended temperature range version of this device, please contact your local LTC sales representative.

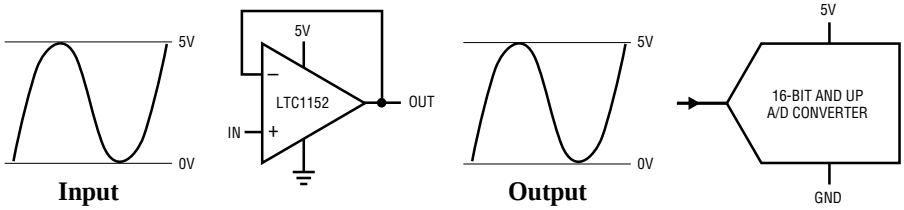

Figure 1. LTC1152: Rail-to-Rail Buffer Maintains Under 10µV Error Over Temperature and Needs No External Components

Application of the Month

500kHz Buck/Boost Converter Needs No Heat Sink

Thanks to an efficient 0.25Ω switch, the **LT®1371** SEPIC converter shown in Figure 1 operates at full power with no heat sink. Up to 9W at 5V output is available, and the circuit works over a wide range of input voltages extending from the LT1371's 2.7V minimum to 20V, limited by the rating of the capacitors.

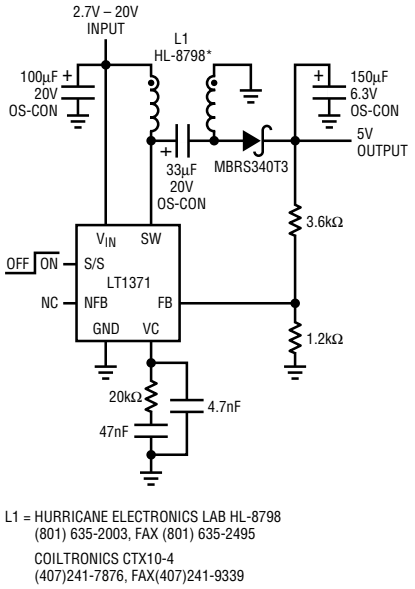

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Figure 1. 5V, 9W Converter Operates Over Wide Input Range with Good Efficiency

A 1:1 bifilar-wound toroid is used as the magnetic element. A careful analysis showed that, in spite of the 500kHz operating frequency, a high permeability (μ_r = 125) Magnetics Inc. Kool Mμ® core exhibited the best efficiency when compared to powdered iron materials. Copper loss is minimized by the use of the high-perm Kool Mμ material, with only a slight core-loss penalty.

Maximum available output current varies with input voltage, and is shown (for 3A peak switch current) in Figure 2. Efficiencies for several input voltages are shown in Figure 3. At a 2.7V input, most of the loss is tied up in the LT1371 switch, whereas the output diode is the dominant source of loss with high inputs. Because these losses are small, surface mount construction provides adequate dissipation, eliminating the need for heat sinks.

In this application, the synchronization feature of the LT1371 is not used. When driven with an external clock signal at the Shutdown/Sync pin (S/S), the chip can be synchronized to any frequency between 600kHz and 800kHz.

Kool Mμ is a registered trademark of Magnetics, Inc.

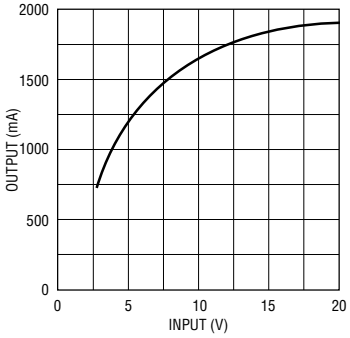


Figure 2. Maximum Available Output Current

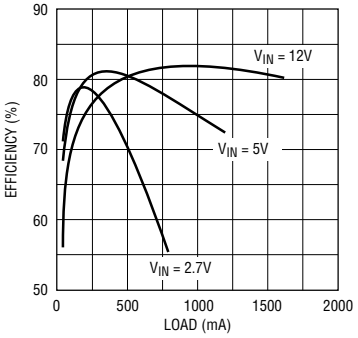


Figure 3. Efficiency of Figure 1's Circuit

50Mbps Quad Differential Receiver Offers Guaranteed 3ns Skew

The **LTC1520** precision differential line or backplane receiver IC supports data rates up to 50Mbps with tightly controlled propagation delays and rail-to-rail input range. Offered in the industry standard 26LS32/75173 pin configuration, the device meets the critical timing requirements of high speed parallel data buses found in backplanes of high speed digital switching systems such as telecom data routers, network servers and data multiplexers.

Receiver propagation delays are 18ns with ±3ns guaranteed tolerance over temperature and skew is only 1.5ns maximum. These specifications hold for input levels as low as 200mV, far lower than typical RS422/485 receivers. The receiver inputs maintain high (>18k) input resistance when the chip is disabled or unpowered. This makes it possible to use the LTC1520 for "hot-swap" applications where bus glitches when inserting or removing cards cannot be tolerated. Inputs can be forced to ±10V without harm to the device. Receiver outputs are high impedance when disabled. Protection features such as thermal shutdown and controlled maximum short circuit of 50mA assure reliable operation in high performance systems.

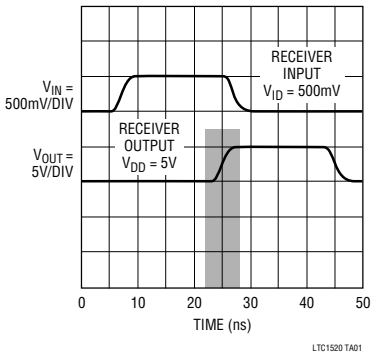


Figure 1. Propagation Delay Guaranteed to Fall Within Shaded Area (±3ns)

The LTC1520 is available in the 16-pin SO package and is specified for operation over the 0°C to 70°C commercial temperature range. Contact your local Linear Technology sales office for a data sheet and free evaluation samples.

Five Improved Industry Standard DACs Now Available from Linear Technology

The **LTC7541A**, **LTC7543, LTC7545A**, **LTC8043** and **LTC8143** are improved pin-for-pin replacements for industry standard multiplying 12-bit digital-to-analog converters. All devices are 100% pin compatible with competitive units and offer improved accuracy, better temperature stability, reduced sensitivity to output amplifier accuracy and lower cost.

The LTC7541A has a 12-bit wide unlatched parallel interface, the LTC7545A has a latched parallel interface and the other devices have serial interfaces. The LTC8043 is packaged in a small SO-8 package; the LTC8143 and LTC7543 are in 16-lead packages and have more flexible interfaces that include an asynchronous Clear pin. The LTC8143 has an added Data Output pin which allows the user to daisy chain multiple DACs on a common 3-wire serial bus. Table 1 summarizes the features of each device and the packages available for each.

The five devices all have excellent accuracy and stability with Integral Nonlinearity and Differential Nonlinearity of 1/2LSB maximum, 1/8LSB typical over temperature. Gain error is 1LSB maximum making adjustments unnecessary in most applications. The INL plot of the LTC7543/LTC8143 shows the superior performance of the device over the full industrial temperature range. All members of this family exhibit similar excellent performance.

Contact your local Linear Technology sales office for a data sheet and free evaluation samples of any of these devices.

Table 1

Device Type	Interface	Latched Data	Package	Temperature Range*
LTC7541A	Parallel		18-Pin PDIP, SW	Commercial, Industrial
LTC7543	Serial	✓	16-Pin PDIP, SW	Commercial, Industrial
LTC7545A	Parallel	✓	20-Pin PDIP, SW	Commercial, Industrial
LTC8043	Serial	✓	8-Pin PDIP, SO	Commercial, Industrial
LTC8143	Serial	✓	16-Pin PDIP, SW	Commercial, Industrial

*Commercial = 0°C to 70°C; Industrial = –40°C to 85°C

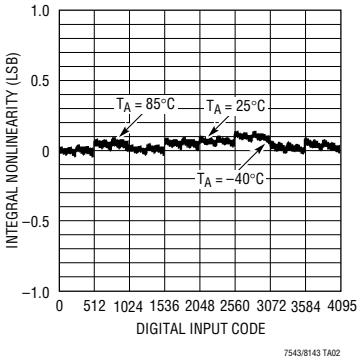
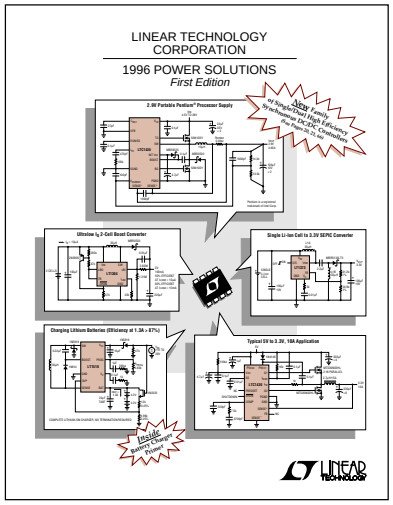


Figure 1. Integral Nonlinearity Over Temperature

1996 Power Solutions Brochure Now Available

The *1996 Power Solutions* brochure contains a wealth of applications and product information on LTC's ICs for power conversion and battery charging. This free 80 page booklet contains advanced information on our new LTC143x series multiple output DC/DC converters for portable computers, a battery charging primer and data on the industry's most efficient and easy-to-use charger ICs for all types of rechargeable batteries. New developments in ultrahigh efficiency DC/DC converters, inductorless DC/DC converters, DC power management and off-line power conversion are also presented. A section is devoted to supplying power to the latest high performance microprocessors using switching and linear approaches.

For a free copy of the *1996 Power Solutions* brochure, please call your local Linear Technology sales office.



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