Linear Technology Chronicle

April 1998 — A Showcase of Linear Technology's Focus Products — Vol. 7 No. 4

Product of the Month

Intelligent Backup Battery Controllers Operate from Single 1.2V NiCd Cell

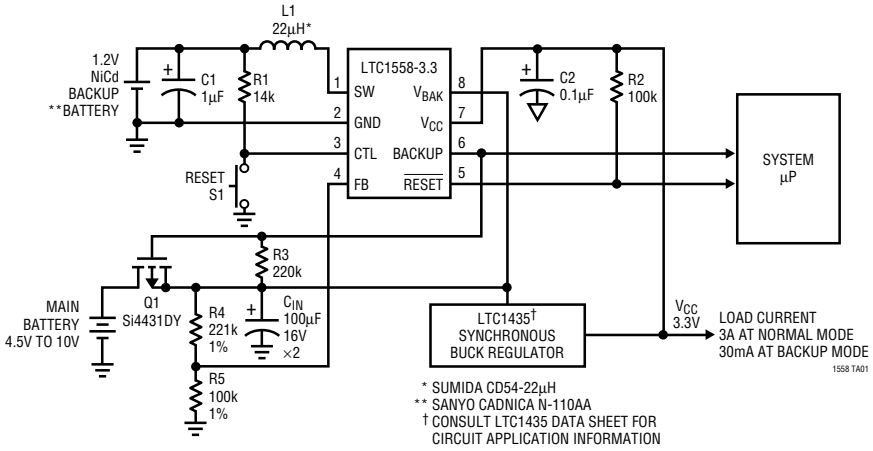

Figure 1. The LTC1558 Connects to the Front of the Main Buck Regulator and Generates Adjustable Backup Voltages from a NiCd Cell. It Allows the System DC/DC Converter to Seamlessly Supply Power to Critical Systems and Peripherals While the Main Battery Is Being Replaced

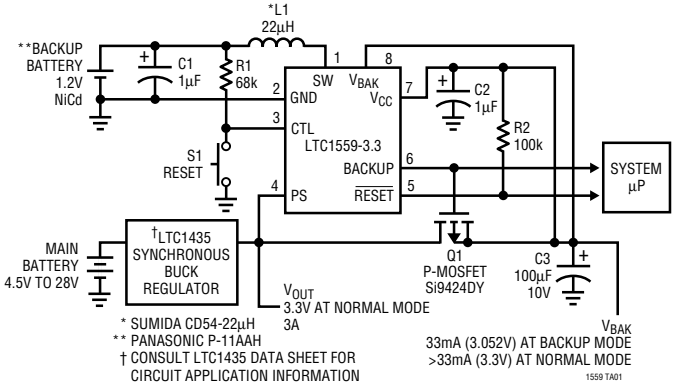

Figure 2. The LTC1559 Connects to the Back End of the Main Regulator and Generates a Fixed Backup Voltage of 3.3V or 5V Using a Single 1.2V NiCd Cell

The **LTC®1558** and **LTC1559** are backup battery (bridge battery) controller ICs for notebook computers, PDAs and other battery-powered systems. The LTC1558 uses a single rechargeable NiCd cell to produce an adjustable (3V to 10V) output which backs up the **input** of a system's DC/DC converter (see Figure 1). This is done in a seamless manner while the main power source is removed without losing any data or requiring a complete power-down sequence. The LTC1559 offers the same features as the LTC1558 except that it backs up the **output** of the DC/DC converter, supplying a single fixed 3.3V or 5V output voltage to sustain minimal system operation when the main power source is removed, as shown in Figure 2.

The LTC1558 and LTC1559 include a 1.2V boost converter, an intelligent 2-stage battery charger, automatic backup switching and a microprocessor reset generator. The charger includes programmable fast/trickle charge rates and termination to eliminate overcharging the battery. The boost converter uses a synchronous switching architecture to achieve a typical efficiency of 70%, ensuring maximum backup lifetime from an inexpensive NiCd cell. The internal V_{CC} fault detector and reset generator eliminate the need for a separate microprocessor supervisory chip in most applications. The LTC1558 and LTC1559 are available in either 8- or 16-lead versions with a 3.3V or 5V voltage monitor. Functions exclusive to the 16-pin package include a low-battery comparator, shutdown control, a main battery disconnect switch driver and an active HIGH reset generator.

The LTC1558 and LTC1559 are available in an SO-8 and 16-pin SO and SSOP packages. 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.

Inside This Issue:

Smallest Multiprotocol Serial Interface Port Is Complete with Switchable Termination

The **LTC1543/LTC1544** interface transceivers and LTC1344A cable terminator from Linear Technology Corporation form the smallest multiprotocol serial port for Local Area Networking (LAN) and Wide Area Networking (WAN) equipment with remote access ports. The 3-chip solution includes configurable transceivers for high speed data and clock signals, control signals and the cable terminator, all of which can be configured for RS232, RS449, EIA-530, EIA-530-A, V.35, V.36 and X.21 protocols. DTE or DCE configurations of any of the protocols can be selected simply with three mode selection pins—no external termination, no odd voltages and no DIP switches or relays are required.

The LTC1543 contains three configurable drivers and receivers for the data and clock signals as well as a charge pump to allow the entire chip set to operate from a single 5V supply. The LTC1544 contains four configurable drivers and receivers for the control signals including the optional local loopback test signal. The LTC1344A software-selectable cable connector uses the same mode selection logic to apply the appropriate termination resistors. It consists of six switchable resistive terminations and can configure a single DB-25 connector in up to eight different serial protocols. Figure 1 shows the chip set in a DTE or DCE multiprotocol serial interface with a DB-25 connector.

Every detail has been incorporated into this chip set, including certified compliance to the NET1 and NET2 tests of the European Telecommunications Standards Institute. Compliance reports were completed by Detecon, Inc. In anticipation of future requirements, Detecon has also certified this chip set for the more stringent TBR2 requirements.

The LTC1543 and LTC1544 are offered in the 28-lead SSOP package and the LTC1344A is offered in the 24-lead SSOP package, making the chip set the smallest overall solution for multiprotocol serial interface ports. 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.

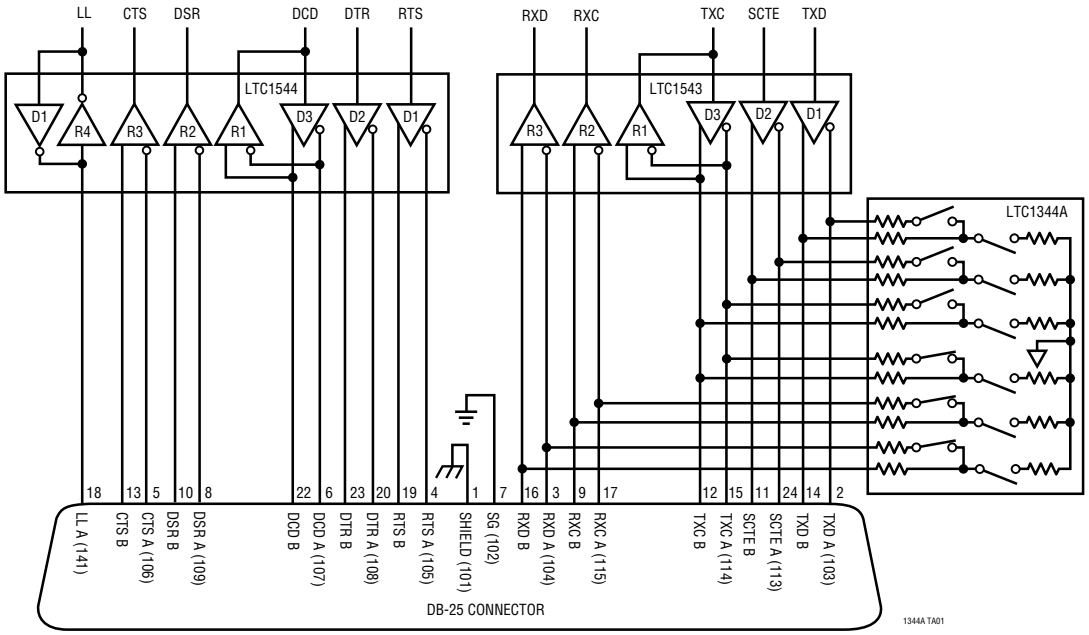

Figure 1. When Combined with the LTC1544 and LTC1543 Multiprotocol Transceivers, the LTC1344A Software-Selectable Cable Terminator Forms a Complete DTE or DCE Multiprotocol Serial Interface with a DB-25 Connector

Universal Filters Are Optimized for Low Noise, Low Power or High Frequency

Linear Technology Corporation introduces three new quad universal filter building blocks. One is optimized for high speed, another for single supply/low power and the third for very low frequency operation. The **LTC1068-25**, **LTC1068-50** and **LTC1068-200** have clock-to-center frequency ratios of 25:1, 50:1 and 200:1 respectively and compliment the LTC1068 (100:1) general purpose, low power quad filter building block introduced previously. Each consists of four identical, low noise 2nd order filter building blocks, housed in a 28-pin SSOP package. Together with three to five resistors, these switched capacitor filter building blocks can provide various 2nd order filter functions such as lowpass, highpass, bandpass or notch filters, optimized for specific performance requirements. The SSOP package combined with low supply voltage operation makes these three filters excellent choices in small, portable systems.

Continued on page 4

Application of the Month

Zero-Bias RF Detector Yields High Sensitivity with Nanopower Consumption

RF ID tags, circuits that detect a "wake-up" call and return a burst of data, must operate on very low quiescent current for months or years, yet have enough battery power in reserve to answer an incoming call. For smallest size, most operate in the ultrahigh frequency range, where the design of a micropower receiver circuit is problematic. Familiar techniques, such as direct conversion, super regeneration or superhetrodyne, consume far too much supply current for long battery life. A better method involves a technique borrowed from simple field-strength meters: a tuned circuit and a diode detector.

Figure 1 shows the complete circuit, which was tested for proof-of-concept at 445MHz. This circuit contains a couple of improvements over the standard L/C-with-whip field-strength meter. Tuned circuits aren't easily constructed or controlled at UHF, so a transmission line is used to match the detector diode (1N5712) to a quarter-wave whip antenna. The 0.23λ transmission-line section transforms the 1pF (350Ω) diode junction capacitance to a virtual short at the base of the antenna. At the same time, it converts the received antenna current to a voltage loop at the diode, giving excellent sensitivity.

Biasing the detector diode can improve sensitivity,[1] but only when the diode is loaded by an external DC resistance. Careful curve-tracer examination of the 1N5712 at the origin reveals that it follows the ideal diode equation, with scales of millivolts and nanoamperes. To use a zero-bias diode at the origin, the external comparator circuitry must not load the rectified output.

The LTC1540 nanopower comparator and reference is a good choice for this application because it not only presents no load to the diode, but also draws only 300nA from the battery. This represents a 10-times improvement in battery life over biased detector schemes.[2] The input is CMOS, and input bias current consists of leakage in a small ESD-protection cell connected between the input and ground. The input leakage measures in the picoampere range, whereas the 1N5712 leaks hundreds of picoamperes. Any rectified output from the diode is loaded by the diode itself, not by the LTC1540, and the sensitivity can match that of a loaded, biased detector.

The rectified output is monitored by the LTC1540 comparator. The LTC1540's internal reference is used to set up a threshold of about 18mV at the inverting input. A rising edge at the comparator output triggers a one-shot, which temporarily enables answer-back and any other pulsed functions.

Total supply current is 400nA, consuming just 7mAH battery life over a period of five years. Monolithic one-shots draw significant load current, but the '4047 is about the best in this respect. A one-shot constructed from discrete NAND gates draws negligible power.

Sensitivity is excellent, and the circuit can detect about 200mW from a reference dipole at 100 feet. Range, of course, depends on operating frequency, antenna orientation and surrounding obstacles. Sensitivity is independent of supply voltage; this receiver will work just as well with a 9V battery as with a single lithium cell.

The length of the transmission line does not scale with frequency. Owing to a decrease in diode reactance, the electrical length will shorten as frequency increases. Adjust the line length for minimum feedpoint impedance at the operating frequency. If an impedance analyzer is used to measure the line, a 1pF capacitor can be substituted for the diode to avoid large signal effects in the diode itself. Consult the manufacturer's data sheet for accurate characterization of diode impedance at the frequency of interest.

Notes:

1. Eccles, W.H. Wireless Telegraphy and Telephony, Second Edition. Ben Brothers Limited, London, 1918, page 272.
2. Lee, Mitchell. "Biased Detector Yields High Sensitivity with Ultralow Power Consumption." *Linear Technology* VII:1(February 1997), page 21.

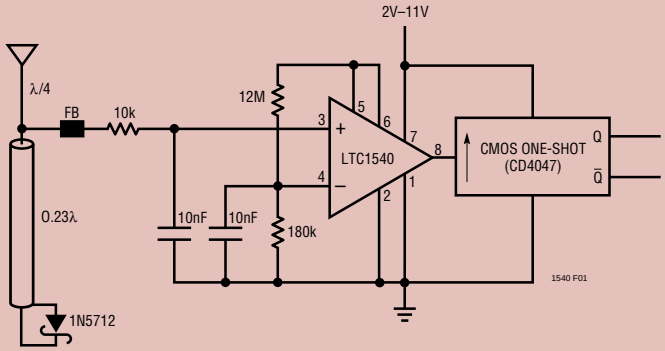

Figure 1. Nanopower Field Detector

LTC1068-25/LTC1068-50/LTC1068-200 from page 2

The LTC1068-25 is a high speed part designed for filter applications with a cutoff frequency up to 200kHz. It's ideally suited for high selectivity bandpass filter applications or elliptic lowpass filters. Figure 1 shows a LTC1068-25 as the main part of a 70kHz, 8th order, elliptic bandpass filter circuit and its frequency response is shown in Figure 2. The LTC1068-50 has a maximum center frequency of 50kHz and is optimized for low power, single supply operation. Power consumption is typically only 3mA with a 3.14V supply or 6mA with ±5V supplies.

With its 400:1 sampling rate to center frequency ratio, the LTC1068-200's operation closely approximates continuous time RC active filters. It is well-suited as a high-pass filter ($f_C \leq 25$kHz), as a notch filter with 60dB or more of rejection or in various 1Hz to 10Hz lowpass filter applications.

The center frequency of each 2nd order section is tuned by an external clock (f_0 error is typically less than ± 0.3%). This ratio may also be altered with external resistors. Using a double sampling technique, the maximum input frequency can approach twice the clock frequency before aliasing occurs. With LTC's FilterCAD™ 2.0 software, a user can easily implement a quad 2nd order filter or a dual 4th order filter just by entering the desired filter characteristics, such as cutoff frequency, ripple and stopband attenuation.

The LTC1068-25, LTC1068-50 and LTC1068-200 have an input noise of less than 40μV_{RMS} per 2nd order section for a $Q \leq 5$. Dynamic range (THD + noise) is less than 0.01% for the LTC1068-50 and LTC1068-200 and is less than 0.05% for the LTC1068-25, even with the supply voltage as low as 3.14V. Factory mask programmable versions of the LTC1068-25, LTC1068-50 and LTC1068-200 with on-chip thin film resistors and custom clock-to-cutoff frequency ratios are available in a 16-pin SO package to realize application specific monolithic filters. Contact Product Marketing for more information.

The LTC1068-25, LTC1068-50 and LTC1068-200 are immediately available in volume from stock and are offered in a 28-pin SSOP surface mount package. Both commercial and industrial temperature versions are available. They are supported by FilterCAD 2.0 filter design software — available on the new FilterCAD CD-ROM and on LTC's web site: **www.linear-tech.com**. Contact your local Linear Technology sales office for a data sheet and evaluation samples or visit our web site for more information.

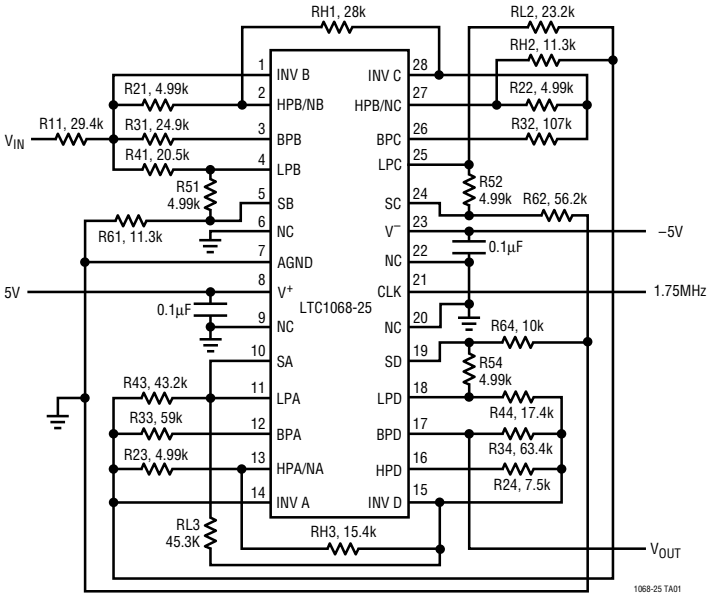

Figure 1. LTC1068-25 Configured as a 70kHz Bandpass Filter. It Replaces up to 12 Discrete Op Amps and 8 Integrator Capacitors Normally Used in a Discrete Implementation of This 8th Order Filter

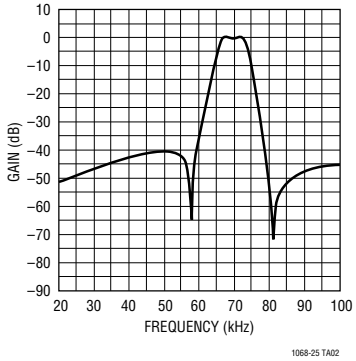

Figure 2. Frequency Response of the Bandpass Filter in Figure 1

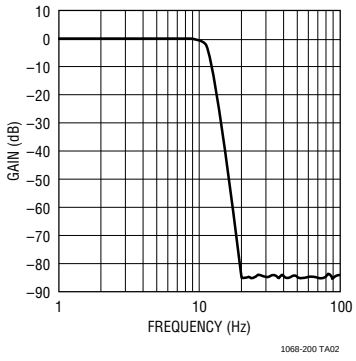

Figure 3. Frequency Response of a 10Hz, Elliptic Lowpass Filter Using the LTC1068-200

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