LINEAR TECHNOLOGY

DESIGN NOTES

New Micropower, Low Dropout Regulators Ease Battery Supply Designs – Design Note 121

Mitchell Lee and John Seago

Three new linear regulators simplify the design of battery-operated equipment. The LT®1521 is a 300mA, positive low dropout regulator with micropower quiescent current and shutdown. The LT1175 is a 500mA negative complement with adjustable current limit. A third product, the LT1118, has the unique capability of maintaining output regulation while sourcing or sinking load current.

The LT1521 contains all of the features associated with battery-operated applications. In designs where memory must be powered continuously, the LT1521's 12µA quiescent current eliminates the need for a separate micropower backup supply. In shutdown the quiescent current drops to 6µA. Figure 1 shows an example application using the LTC®1477 as a means of disconnecting all circuitry except for memory and ON/OFF control logic. The LTC1477 protected high side switch draws only 10nA in shutdown, eliminating itself as well as its load as a factor in battery shelf life.

In battery-backed memory applications, the output of the LT1521 can be held up by the backup battery while in shutdown or even with the input power removed. No series output diode is required as reverse current flow is internally limited to about 5µA.

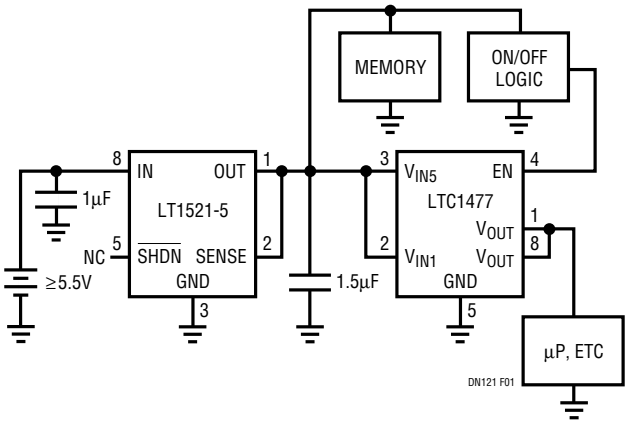

Figure 1. The LT1521's 12µA Standby Current Eliminates the Need for a Separate Memory Backup Supply

A common problem in portable equipment is the chance of installing the batteries backwards, thereby destroying the electronics contained within. The LT1521 needs no reverse protection diode to guard against this condition, as it is designed to withstand up to –20V input while also protecting the load. Low dropout is preserved.

Most important for battery applications is low dropout, a characteristic not neglected in the design of the LT1521. At 300mA the dropout is just 500mV, dropping to approximately 290mV at a 50mA load. This enables the LT1521 to maintain regulation while draining the last drop of power from the battery.

Like the LT1521, the LT1175 also features low dropout, running 500mV at 500mA load current. Quiescent current is 45µA dropping to 10µA in shutdown.

The LT1175 offers several unique features not available in other negative regulators. First, the current limit is adjustable by pin strapping to 200mA, 400mA, 600mA or 800mA. This allows the current limit to be tailored to suit normal load requirements while not exceeding the maximum safe current drain from the battery during a short-circuit fault.

Shutdown on a negative regulator could be a mixed blessing, particularly if positive logic was used to control a negative input. The LT1175 solves this problem by accepting either positive or negative shutdown signals. Holding the Shutdown pin within 0.8V of ground disables the LT1175. If pulled to 2.5V or more *positive or negative* with respect to ground, the regulator is enabled. If shutdown is not desired, either float or connect the Shutdown pin to V_{IN} and the regulator will be enabled whenever power is applied.

The LT1521 and LT1175 work well together as the basis for a split supply as shown in Figure 2. Low output capacitance requirements allow the use of ceramic units instead of larger, more expensive electrolytic or tantalum capacitors.

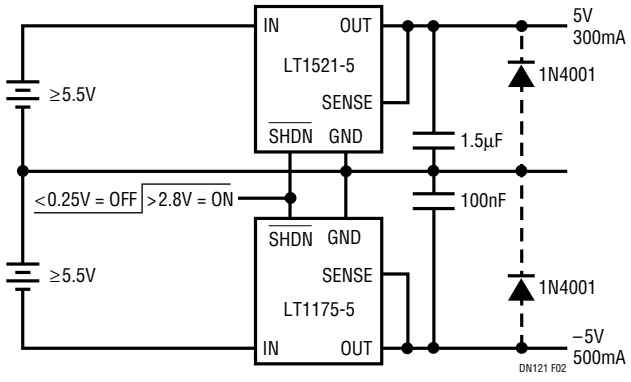

Figure 2. In a Split Supply Application the Shutdown Pins May Be Commanded in Parallel Using Positive Logic

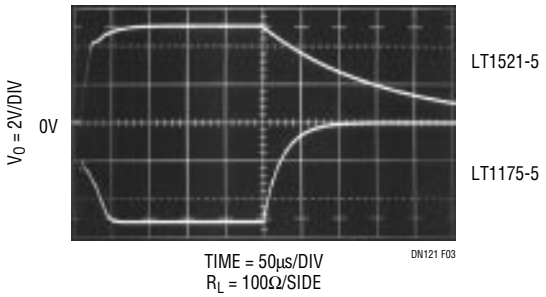

Figure 3. Clean Start-Up and Shutdown is Assured by Utilizing Ganged Shutdown Control of the LT1521 and LT1175.

Owing to the LT1175's unique Shutdown pin, the Shutdown pins of both devices can be joined together as shown and driven from a positive control logic signal. Behavior of the outputs relative to shutdown control is shown in Figure 3.

Although the LT1521-5 can tolerate up to –20V forced output potential with respect to its input, supply reversal diodes (1N4001) are often required to protect both linear and digital load circuitry from damage under transient start-up or fault conditions. The LT1175 is designed to withstand up to +2V forced output voltage. For both devices, start-up and recovery from short-circuit or thermal shutdown is guaranteed under these conditions.

As anyone who has designed and built a "single supply" op amp circuit can attest, few can be implemented without the use of a mid-supply bias point or resistive divider providing that same function. The LT1118 serves as a low power means of obtaining a regulated, low dropout bias point for critical applications. This device features the ability to both source and sink load current (+800mA, –400mA), and exhibits an output impedance of about 16µH across a wide range of frequencies. The output remains stable irrespective of any bypass capacitance of 220nF or more. An output impedance of less than 3Ω can be acheived across a 10MHz bandwidth with the addition of a 1µF bypass; less than 1Ω with a 10µF bypass.

The LT1118 is available in 5V, 2.85V and 2.5V versions. Where the 5V version might serve as a stand alone regulator, the 2.5V version is a good choice for splitting an existing 5V rail (see Figure 4). In addition to greatly reducing power consumption, the DC output impedance is less than 0.025Ω—unmatched by any resistive divider solution. A separate Enable pin shuts off the LT1118, reducing its supply current to 1µA. Figure 5 shows typical output impedance under a variety of operating conditions.

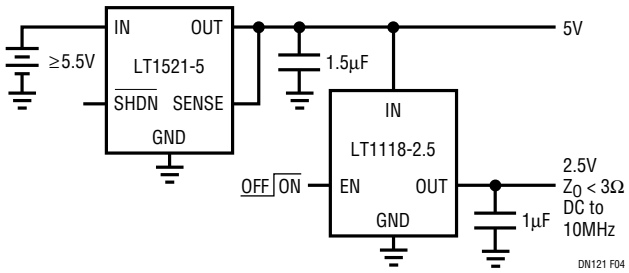

Figure 4. Splitting the Supply Saves Power and Holds Bias Point DC Resistance to Less Than 0.025Ω

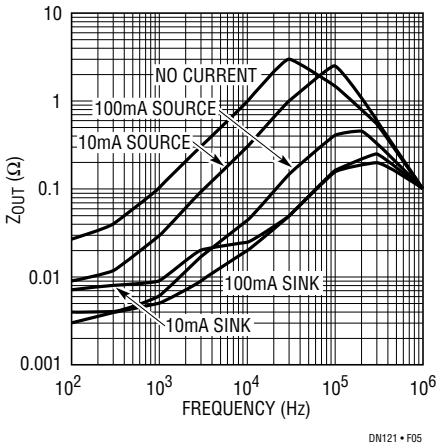

Figure 5. LT1118-2.5 Output Impedance vs Frequency

For literature on our Linear Regulators, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 361

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • TELEX: 499-3977

LT/GP 0196 155K • PRINTED IN THE USA