LINEAR TECHNOLOGY

DESIGN NOTES

80V Linear Regulator Is Micropower

Design Note 314

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Introduction

Industrial, automotive and telecom applications pose tough design challenges due to harsh operating environments and large voltage transients on already high (12V to 48V) rails. Some switching power supplies are robust enough to provide localized low voltage/high current power from high voltage input rails, but switch-mode supplies are overly complex for low power keep-alive circuits that typically consume only a few milliamps of current. For most of these low power circuits, a wide input range linear regulator is an ideal solution.

Introducing the LT®3010 High Voltage LDO

The LT3010 is a high voltage, micropower, low dropout linear regulator in a thermally enhanced 8-lead MSOP package. It can provide up to 50mA of output current from input supplies ranging from 3V to 80V. At 50mA of output current, dropout voltage on the LT3010 is only 300mV. The LT3010 operates normally on only 30µA of quiescent current. It can also be put into a low power shutdown state by pulling the $\overline{SHDN}$ pin low, bringing quiescent current down to just 1µA. For standard operation, the $\overline{SHDN}$ pin can be pulled as high as 80V (regardless of input voltage) or left floating. The LT3010 is offered in both adjustable and fixed 5V output versions.

Figure 1 shows a typical application for the LT3010, illustrating how easy it is to design a low current supply running from a high voltage rail. The only external components required are input and output bypass capacitors, and the input bypass is not required if the device is located close enough to the main supply bypass capacitor. Internal frequency compensation on the LT3010 stabilizes the output for a wide range of capacitors. A minimum of 1µF output capacitance is required for stability, and almost any type of output capacitor can be used. Small ceramic capacitors with low ESR can be used without requiring extra series resistance as is sometimes required with other regulators.

Protection features are incorporated in the LT3010, safeguarding itself and sensitive load circuits. If the input voltage reverses—from a backwards battery or fault on the line—no current flows into the device and no negative voltage is seen at the load. No external protection diodes are necessary when using the LT3010. With a reverse voltage from output to input, the LT3010 acts as though it has a diode in series with its output and prevents reverse current flow. For dual supply applications where the regulator load is returned to a negative supply, the output can be pulled below ground by several volts while still allowing the device to start and operate. The LT3010 also provides current limiting and thermal limiting features.

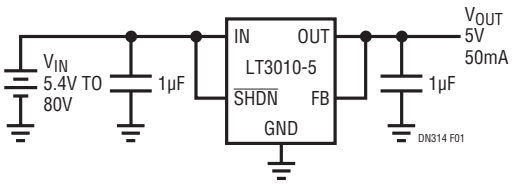

Figure 1. LT3010 Typical Application

A Versatile and Rugged Regulator

The LT3010 provides an optimum solution for harsh conditions. Long wire runs for high voltage rails can have transient voltage spikes as loads are switched on and off. Existing automotive applications run from 12V while some new systems are transitioning to 42V, but both can have transients greater than 60V. Telecom applications typically run from a 48V supply that may extend as high as 72V. Industrial applications can span even wider input voltage ranges. Reverse input or reverse voltages from output to input are also possible.

Figure 2 shows a typical automotive or telecom application for the LT3010 that takes advantage of its micropower quiescent current. In an automotive application, this might be an always-on circuit that runs whether the ignition is on or not—common for many modern automotive subsystems. The total current consumed by all always-on subsystems must be no more than several milliamps to prevent excessive battery drain. The LT3010 can also be placed into the shutdown state whenever the subsystem is not needed.

Other features of the LT3010 make it ideal for automotive applications. The small size of the LT3010 and its associated external components keep board space and height to a minimum. Power connections to the LT3010 can come directly from a battery because input transients will not damage the regulator or the load. Even reversed battery connections present no worry since the LT3010 prevents reverse current from flowing and damaging sensitive load circuits. Above all, the LT3010's input limit of 80V saves design time and costs by allowing subsystems to migrate directly from 12V to 42V (or anywhere in between) without redesign.

For telecom applications, the 48V rail powers a keep-alive circuit for monitoring or other purposes. The quiescent current is important, especially when battery back-up must kick in to keep the output alive when a fault occurs on the input. Should a fault on the 48V rail occur, the battery back-up takes over and the internal protection of the LT3010 prevents current flow from the output back to the input, removing the need for protection diodes. Component size can still be a concern, depending upon application constraints. The 48V input rail in telecom applications can have transient voltages as high as 72V. The LT3010 can handle these transients without the need for preregulation or protection devices. Finally, the thermally enhanced 8-lead MSOP package provides a very compact, thermally efficient solution footprint. With a θ_{JA} of only 40°C/W, it is able to dissipate heat from high power transients found in these applications.

Conclusion

The LT3010 offers exceptional performance in a small package. It can supply low power from high voltage rails in applications that previously required external pre-regulation schemes or complex switching supplies. Low quiescent current minimizes the power consumption that can be dropped even further by placing the part into shutdown. Stable output voltage is available with a wide range of output capacitors, including small ceramics. Internal protection circuitry in the LT3010 eliminates the need for external protection diodes. The thermally enhanced 8-lead MSOP package provides low thermal resistance making it easy to design the part into harsh environments.

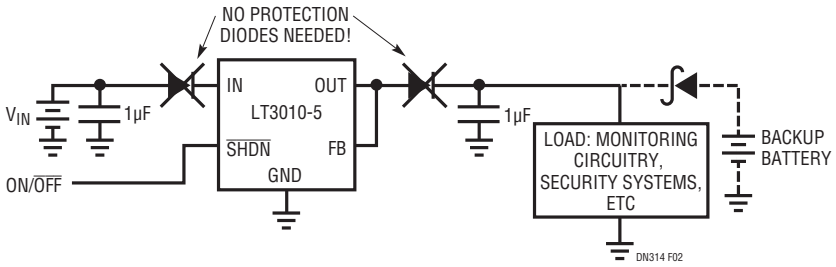

Figure 2. LT3010 Automotive or Telecom Application

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