Ideal Diode Betters a Schottky by a Factor of Four in Power and Space Consumption

by Meilissa Lum

Introduction

High availability systems often use parallel power supplies or battery feeds to achieve redundancy and enhance system reliability. Traditionally, Schottky ORing diodes are used to connect these supplies at the point of load and prevent backfeeding into a faulty power supply. Unfortunately, the forward voltage drop of these diodes reduces the available supply voltage and dissipates significant power at high currents—costly heat sinks and elaborate layouts are needed to keep the diodes cool.

When power dissipation is a concern, the Schottky diode can be replaced with a MOSFET-based ideal diode. This reduces the voltage drop and power dissipation, thereby reducing the complexity, size and cost of the thermal layout and increasing system efficiency. The LTC4355, LTC4357 and LTC4358 enable MOSFET-based ideal diode solutions for various applications—the choice depends on the current and operating voltage of the application. Table 1 compares these devices.

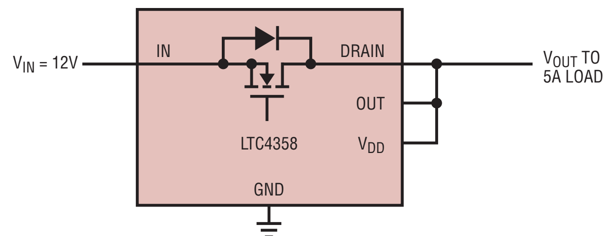

Figure 1. No external components are needed for a 12V/5A ideal diode.

With one-fourth the dissipated power, system efficiency is increased and PCB layout is simplified—no need for costly and bulky heat sinks.

Ideal Diode Easier to Use Than a Schottky

Of particular interest is the LTC4358, which includes an internal 20mΩ

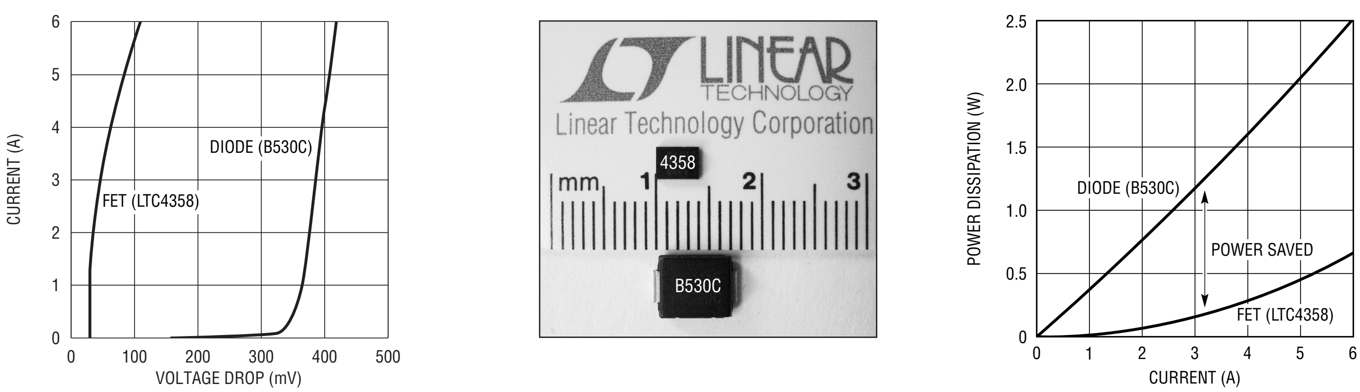

Figure 2. The LTC4358 ideal diode takes on a 5A B530C Schottky diode. The LTC4358 easily wins in voltage drop, power loss and package size.

Table 1. Comparison of ideal diode parts

Part Number	Description	Operating Voltage	Configuration	Package
LTC4355	Positive Voltage Diode-OR Controller and Monitor	9V–80V, 100V Abs Max	Dual, External MOSFETs	DFN14 (4mm × 3mm), SO16
LTC4357	Single Positive Voltage Ideal Diode Controller	9V–80V, 100V Abs Max	Single, External MOSFET	DFN6 (2mm × 3mm), MSOP8
LTC4358	Ideal Diode	9V–26.5V, 28V Abs Max	5A Internal MOSFET	DFN14 (4mm × 3mm), TSSOP16

MOSFET as the pass element. No external components are required. The IN pins are the source of the MOSFET and act like the anode of a diode, while the drain behaves as the cathode, as shown for a 12V/5A application in Figure 1. When power is first applied, the load current initially flows through the MOSFET's body diode. The MOSFET's gate is enhanced and turned on to maintain a 25mV forward voltage drop. If the load current causes more than 25mV of voltage drop, the MOSFET is driven fully on, and the forward drop equals $R_{DS(ON)} \cdot I_{LOAD}$. If the load current reverses, as may occur during an input short, the LTC4358 responds by turning off the internal MOSFET in less than 0.5µs.

Power Saved Versus Schottky Diode

Compared to a B530C Schottky diode in the SMC package, not only is the LTC4358's DE14 (4mm × 3mm) package one-fourth the size, the voltage drop and power dissipation are also considerably less as shown in Figure 2. The reduced voltage drop of the ideal diode also increases the voltage at the load, which reduces the capacitance required to hold up the output during supply disruptions. The power dissipated at 5A in the Schottky is 2W versus 0.5W for the LTC4358. With one-fourth the power dissipated, system efficiency is increased and PCB layout is simplified—no need for costly and bulky heat sinks.

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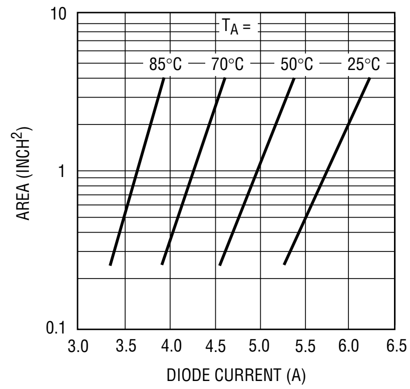

Figure 4. Maximum diode current vs PCB area

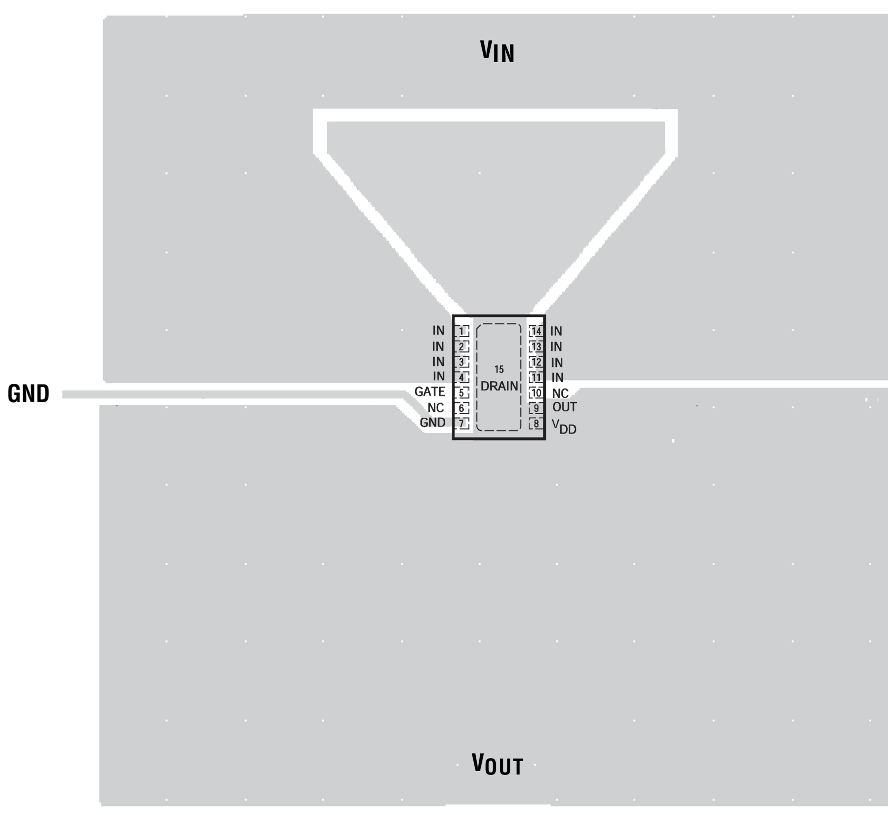

Figure 3. DFN layout considerations for 1" × 1" single sided PCB

PCB Layout

As described above, with only one-fourth as much power dissipation as a Schottky, thermal layout with the LTC4358 is much easier. Most of the heat escapes the part through the DRAIN/exposed pad, while some exits through the IN pins. Maximizing the copper of these connections increases the allowable maximum current. Figure 3 shows an optimal layout for a 1" × 1" single sided PCB with the DFN package. Copper connected to the exposed pad above and below the LTC4358 helps remove heat from the package. If you are using a two-sided PCB, use vias under the LTC4358 to transfer heat to copper on the bottom of the PCB, thus increasing the maximum current by 10%. Use Figure 4 to determine the amount of copper area needed for a specified current and ambient temperature.

Conclusion

The LTC4358 is a MOSFET-based ideal diode that can directly replace a 5A Schottky diode in 9V to 26.5V applications. The LTC4358 betters a Schottky by a factor of four on voltage drop, power loss and package size, thus significantly shrinking the thermal layout and improving overall performance. Also, simple optimization the PCB layout increases the maximum current—no heat sinks required.

Authors can be contacted at (408) 432-1900