

Eliminate the Voltage Drop and Save Power: An Ideal Diode

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Today, discrete diodes are commonly used in power system designs to protect against reverse current and reverse polarity events. In certain applications such as smart eMeters or thermostats, redundant power supplies or backup batteries are used to prevent system downtime. The system needs to prevent the main rail that is powering the downstream load from flowing back into the secondary supply and potentially damaging the system. A typical application with ideal diodes is shown in Figure 1. Using a discrete diode to block this unwanted reverse current may be a simple fix, however, discrete diodes have high reverse leakage current, which results in higher power dissipation. In addition, the forward voltage drop of a diode leads to a shortened battery life and lower system efficiency.

Texas Instruments' LM66100 Integrated Ideal Diode provides reverse current blocking and reverse polarity protection with a low forward voltage drop, leading to significant power dissipation savings. The key advantages of using the LM66100 ideal diode over discrete diode solutions, as shown in Table 1, are highlighted in this tech note.

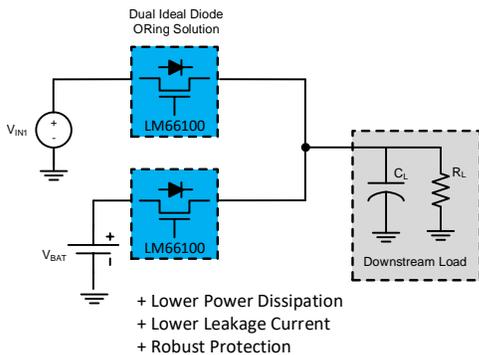


Figure 1. Typical ORing Application

Table 1. LM66100 Ideal Diode vs Discrete Diodes

Feature	Discrete Diode	LM66100	Advantages
Low Power Dissipation		✓	Reduced amount of heat in small form factor products
Low Reverse Leakage Current		✓	Lower reverse leakage current results in higher system efficiency
Reverse Polarity Protection	✓	✓	Prevent damage to downstream loads from miswiring input supply
Small Solution Size	✓	✓	Provides protection in a smaller integrated package

Power Dissipation Savings

The LM66100 device intelligently controls a P-channel MOSFET to behave as an ideal diode, removing the forward voltage drop found on discrete diode solutions. This integration into a single device results in a lower R_{on} and greater power dissipation savings as compared to a discrete diode. In a discrete diode, the normal 0.4 V–0.7 V forward voltage drop increases the power dissipation in conduction mode, which results in a shortened battery life and lower system efficiency. For example, if a battery system requires an input voltage above 2.5 V, the full capacity of the battery cannot be used due to the diode drop across the voltage rail. Figure 2 shows that the LM66100 results in a more than 90% power dissipation reduction as compared to discrete diodes. This reduction in heat can be advantageous in small form factor products.

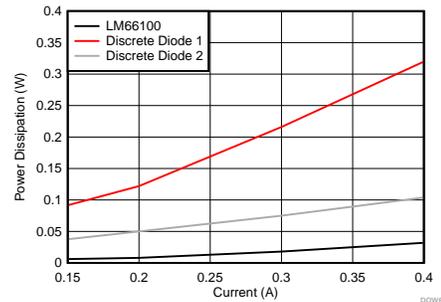


Figure 2. Power Dissipation vs. Load Current

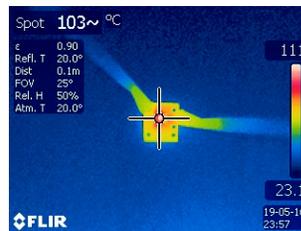


Figure 3. Discrete Diode 1 at 400 mA, Tj (111C)

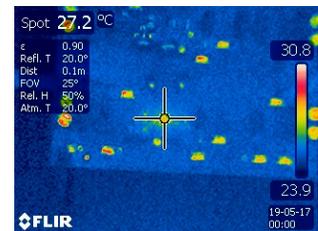


Figure 4. LM66100 at 400 mA, Tj (30C)

Reverse Current Blocking and Reverse Polarity Protection

The LM66100 integrates a fast comparator that disables the device in a reverse current scenario. When the output voltage is higher than the input voltage, the device turns off in 40 μ s as shown in Figure 5. Integrated reverse polarity protection

provides additional protection without the need for external components. When a negative voltage is seen at the input, such as when a battery is inserted backwards, the LM66100 responds by disabling the device within 4 μ s to prevent any damage to downstream loads. This behavior can be seen in [Figure 6](#).

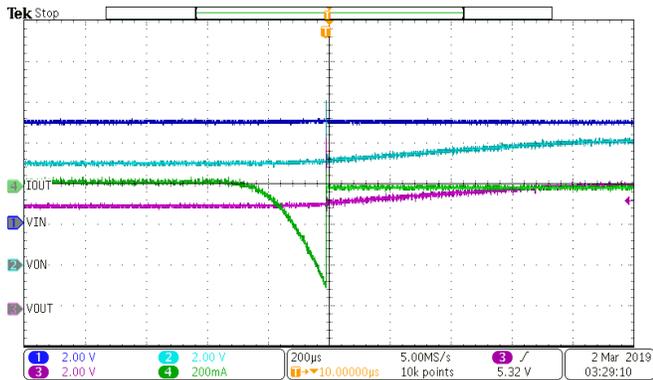


Figure 5. Reverse Current Blocking

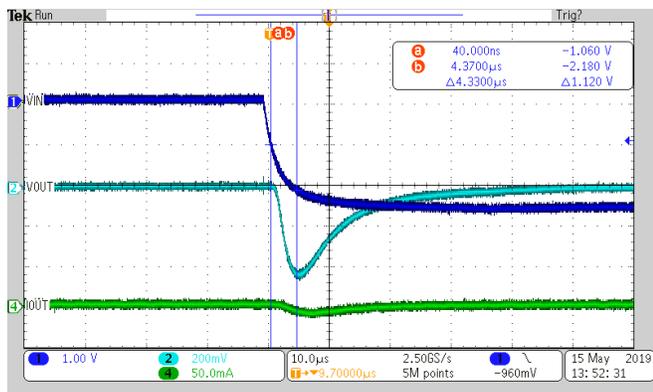


Figure 6. Reverse Polarity Protection

Low Reverse Leakage

Along with the advantages of low power dissipation, the LM66100 has low reverse current leakage when compared to a discrete diode. Reverse current can damage a nonrechargeable battery. Therefore, in an ORing scenario, it is important to reduce reverse leakage to prevent damaging the battery. This reverse current can damage a nonrechargeable battery. [Table 2](#) shows that compared to the discrete diode solutions, the LM66100 has a 65% reduction in leakage current, therefore, preventing excessive charge from flowing back to the battery. The leakage values below were taken at 85°C and only increase as temperature rises, adding to the lost efficiency.

Table 2. LM66100 Reverse Leakage Current Comparison

Vin	Discrete Diode 1	Discrete Diode 2	LM66100	Unit
1.5 V	0.91	100	0.082	μ A
3 V	1.05	120	0.214	μ A
5 V	1.30	150	0.339	μ A
5.5 V	1.50	180	0.423	μ A

ORing Power Supplies

There are applications which rely on some form of backup power via a battery or supercap to provide alternate power to the system. A traditional solution is a simple dual diode configuration as shown in [Figure 1](#), allowing the highest voltage supply to provide power to the system while the other diode is reverse biased. When used in an ORing configuration, the LM66100 provides a fast switchover response and includes a status pin to notify which power supply is providing power. This switchover response can be seen in [Figure 7](#).

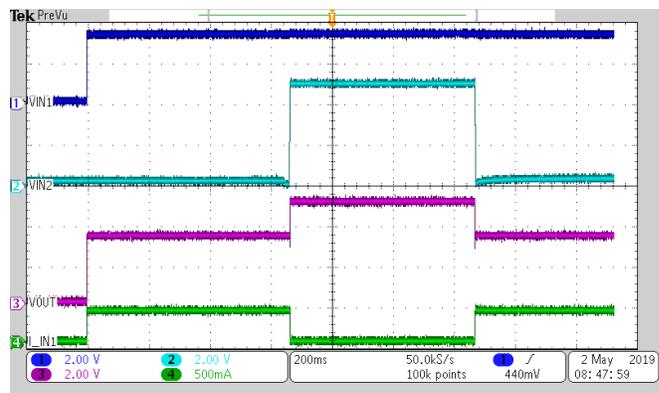


Figure 7. LM66100 Switchover from IN1 to IN2

Conclusion

Input power protection such as reverse polarity protection and reverse current blocking, are crucial in many systems. Traditional discrete diodes are a simple solution but lead to undesirable power dissipation and reduced system efficiency due to their non-ideal characteristics. TI's LM66100 Ideal Diode with an integrated P-Channel MOSFET provides protection against reverse battery, reverse current, and other fault events without the drawbacks of a discrete diode. The LM66100 also has a status pin that can be used to notify when the power sources have switched adding optional diagnostics to a system. Key features such as low forward conduction loss, fast reverse voltage recovery, and reduced leakage current of the LM66100 result in an efficient, robust solution as compared to discrete diodes.

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