

Plug and Play Automotive Protection with Integrated FET Ideal Diode - LM76202-Q1

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Electronics in automobiles often need to operate in very harsh, stressful and noisy environments. Due to the nature of automobiles, in that they carry human lives, electronic systems need to comply with the highest standards of safety. This calls the need of a robust electronic system design which can operate in harsh automobile environments without compromising on safety.

Texas Instruments' LM76202-Q1 is the industry's first automotive qualified 60-V rated Ideal diode with integrated FETs. It can support load currents up to 2.2 A. It provides robust protection against reverse battery hookup, overvoltages, undervoltages, overcurrents, short circuit events, reverse current blocking and other features in a single integrated device.

This tech note highlights the various protection requirements in Automotive Systems (some shown in Figure 1) and how LM76202-Q1 simplifies the system design for these applications.

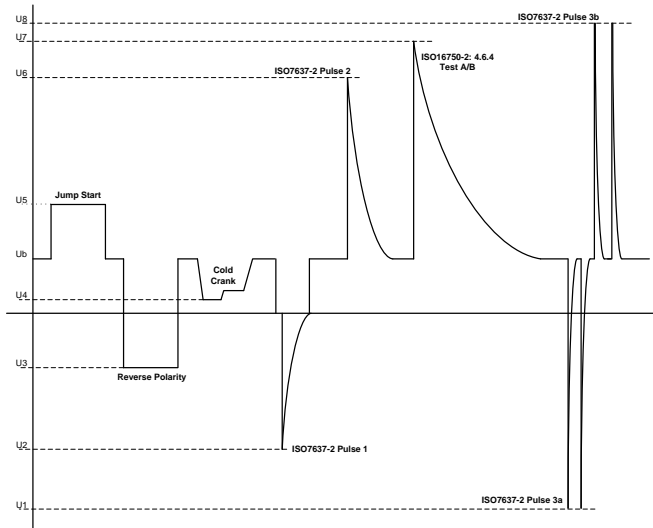


Figure 1. Transients in Automotive Systems

Reverse Battery Hookup Protection

In automotive systems, it is very common to mistakenly interchange the battery connections during some repair or service work. Thus, there is a need for a protection device which cuts off the output during negative input voltages. Though this can be achieved through a simple diode, it is not preferred, as it dissipates a lot of power which can result in heating up

of electronic boards. Other discrete PMOS-based solutions can provide reverse polarity protection, however they fail to provide reverse current blocking, which results in need for higher holdup capacitor for the load.

Overall, LM76202-Q1 provides a clean solution for reverse battery hookup protection without the need of any external components. Figure 2 shows the device behavior when a negative voltage is applied at the input.

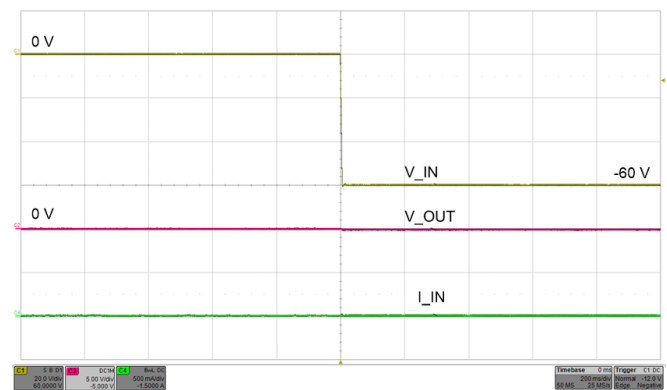


Figure 2. Reverse Input Polarity Protection at -60-V Supply

ISO7637-2 Pulse 1 Protection

ISO7637-2 Pulse 1 transient is caused due to sudden disconnection of supply powering an inductive load as shown in Figure 3. The ECUs, which remain connected directly in parallel with the inductive load, will see a negative kick back during supply disconnection. The negative kickback voltage can go as low as -150 V for a 12-V battery and -600 V for a 24-V battery, thus calling for a need of robust protection device to protect the ECU electronics.

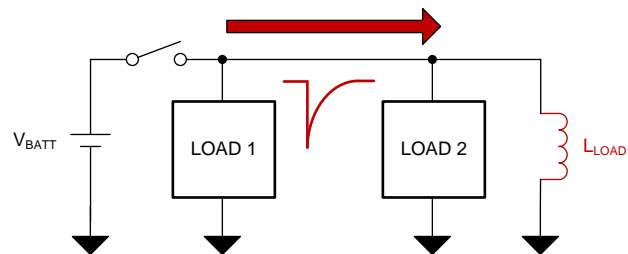


Figure 3. ISO7637-2 Pulse 1 Generation

The LM76202-Q1 along with a TVS diode help protect the downstream circuitry from seeing these transients. There is a reverse voltage comparator which monitors $V_{(IN)}$ and $V_{(OUT)}$ potentials. When $V_{(IN)}$ falls below $V_{(OUT)}$ by 10 mV, the comparator trips and turns off the current path.

Figure 4 shows LM76202-Q1 response to a 12-V battery system pulse.

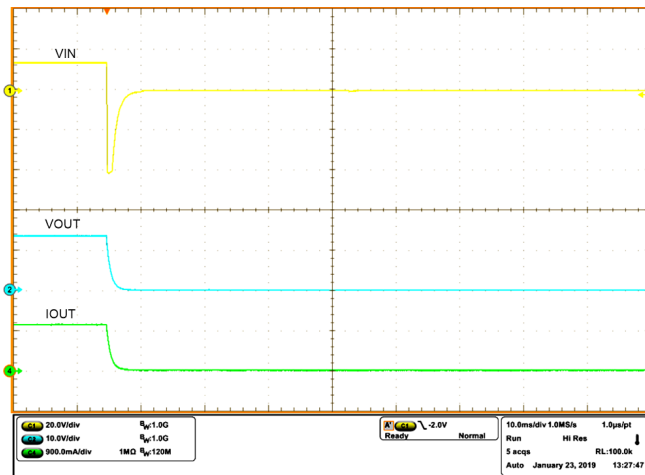


Figure 4. ISO7637-2 Pulse 1 Performance

ISO16750-2 : 4.6.4 Test B - Suppressed Load Dump

Load dump occurs when the battery terminal is suddenly disconnected while the alternator is providing charging current to the battery with other loads remaining on the alternator net as shown in Figure 5. This results in voltage rising on the alternator net. The voltage can rise up to 35 V for 12-V battery systems and up to 65 V for 24-V battery systems. This can last for up to 400 ms.

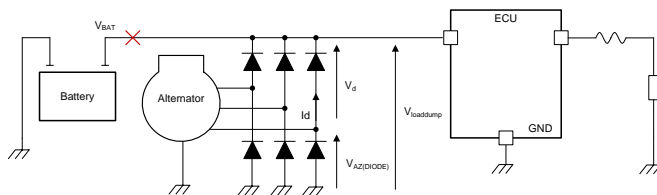


Figure 5. Load Dump Generation in Automotive Systems

It is important that during load dump all safety critical ECUs stay functional without turning off. Hence, without LM76202-Q1 the electronics directly connected to the alternator net must be rated to temporarily withstand the load dump voltage which increases risk of reliability of the components as well increase the

system cost. LM76202-Q1 helps designing such a system which neither turns off nor expose downstream electronics to high voltages during load dump, thus increasing system reliability and reducing costs. The output voltage of LM76202-Q1 can be clamped to a programmable level by connecting appropriate resistor ladder from OUT to OVP to RTN as shown in Figure 6. LM76202-Q1 performance during load dump for a 24-V system is shown in Figure 7.

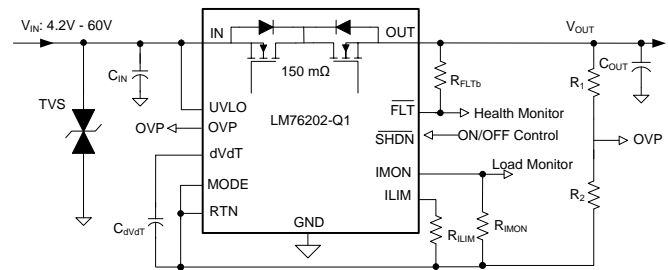


Figure 6. Typical Schematic With Programmable Over Voltage Clamp

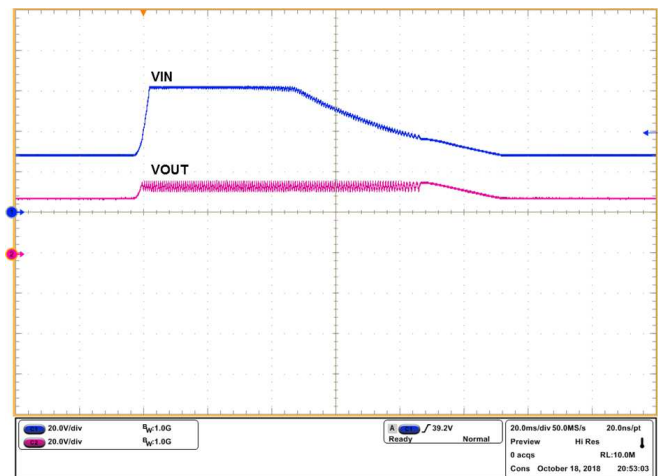


Figure 7. Suppressed Load Dump Performance with LM76202-Q1

Conclusion

LM76202-Q1 enables plug and play solutions for automotive protection needs. Apart from the few transients discussed in detail in this tech note, LM76202-Q1 also provides robust protection against other automotive transients like the ISO7637-2 Pulse 2, Pulse 3a and 3b. It works down to low voltages supporting cranking conditions during startup of the car as well as protects the downstream electronics during jump start.

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