Designing electronics to operate from a 12-V car supply is challenging. The 12-V battery supply voltage can range from 9-16V under normal operation depending on charge and load variation. However, the transient battery voltage range can be much wider. One of these conditions is cold-crank that happens when the battery is trying to energize the starter-motor circuits on the internal combustion engine. Traditionally, only a few critical functions were required to ride through the cold-crank. Increasing car manufacturers are making more features available through cold-cranks for better driver experience and safety.

The cold-crank profile is described by ISO 7637-2 (test pulse 4). Individual car manufacturers have similar cold-crank profiles with the supply rail dropping to 3 V or lower depending on the location of the load. An example cold-crank profile is shown in Figure 1. The actual voltage levels and time intervals are manufacturer specific.

To keep the safety and convenience functions such as navigation, entertainment, dashboard, LED break lights and headlights working through drops in the battery profile, the dc-dc converter supplying these loads must be able to maintain regulation even when the 12-V supply voltage drops below the required output voltage.

The LM5175, a 4-switch buck-boost controller, can maintain regulation even at supply voltages dropping below 3 V. With an absolute maximum voltage rating of 60 V, it can survive load dump transients with ease. In addition, the LM5175 uses a single inductor buck-boost topology to provide small solution size and higher efficiency compared to Flyback or SEPIC. The 4-switch buck-boost solution employs synchronous rectification for both buck and boost modes of operation which results in significant efficiency advantage for high power solutions compared to competing topologies.

A LM5175 based 5 V / 7.5 A buck-boost converter is shown in Figure 3 with an operating input voltage range of 3 V to 20 V with the ability to withstand load dump transients up to 42 V. Figure 2 shows a cold-crank test condition. The converter maintains the output voltage even when the input supply voltage drops below 3 V.
Figure 2. VOUT Regulated to 5 V as the Input Supply Voltage Drops Below 3 V for 20ms (Load=7.5 A)
Figure 3. Complete Application Schematic for an Automotive Design For Cold-crank

1 References

ISO 7637-2: Road vehicles - Electrical disturbances from conduction and coupling - Part 2: Electrical transient conduction along with supply lines only.

LM5175 42V Wide VIN 4-Switch Synchronous Buck-Boost Controller (LM5175)

Cranking Simulator Reference Design for Automotive Applications (PMP7233)
## Revision History

<table>
<thead>
<tr>
<th>DATE</th>
<th>REVISION</th>
<th>NOTES</th>
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