Maintaining Output Voltage Regulation During Automotive Cold-Crank with LM5175 Buck-Boost

Vijay Choudhary

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.

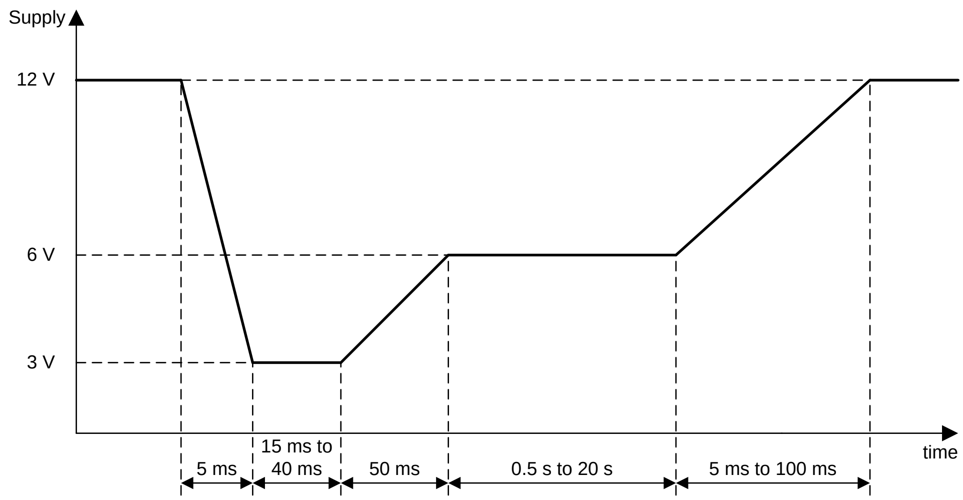

Figure 1. A Representative Startup (Cold-crank) Test Profile for Car Supply with 12-V Battery

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.

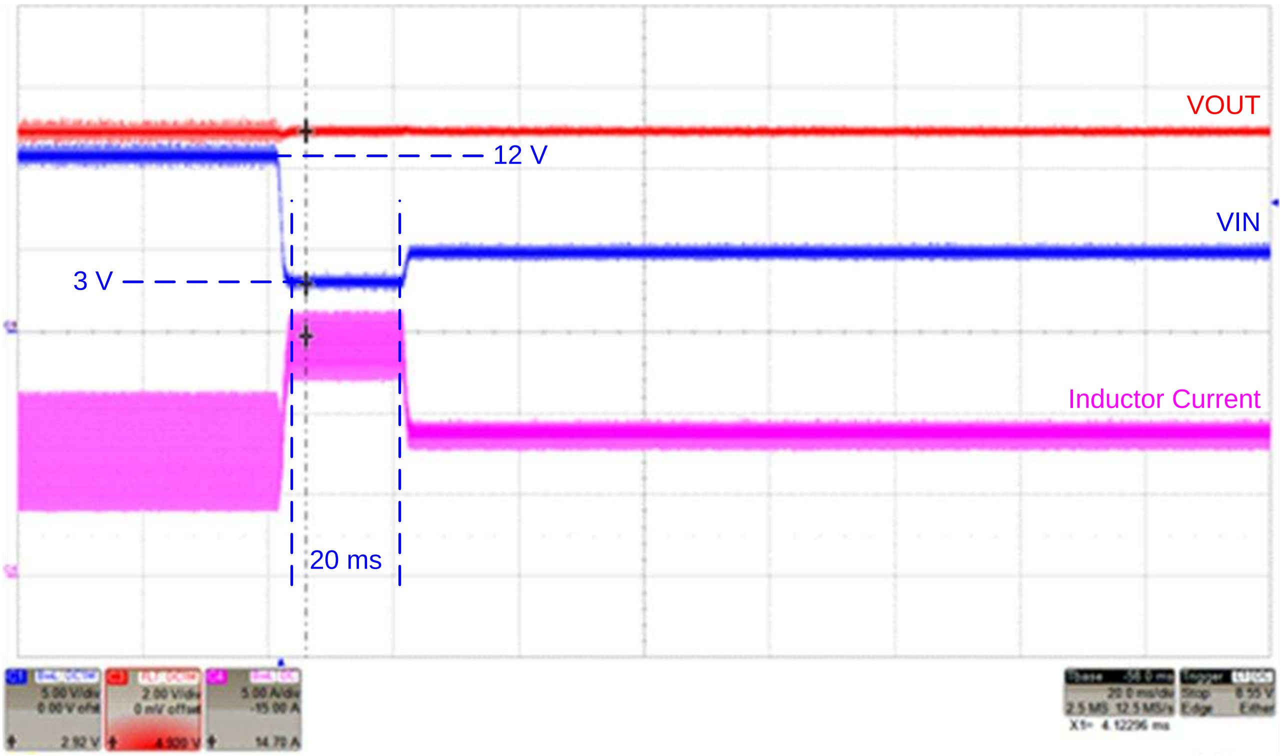

Figure 2. VOUT Regulated to 5 V as the Input Supply Voltage Drops Below 3 V for 20ms (Load=7.5 A)

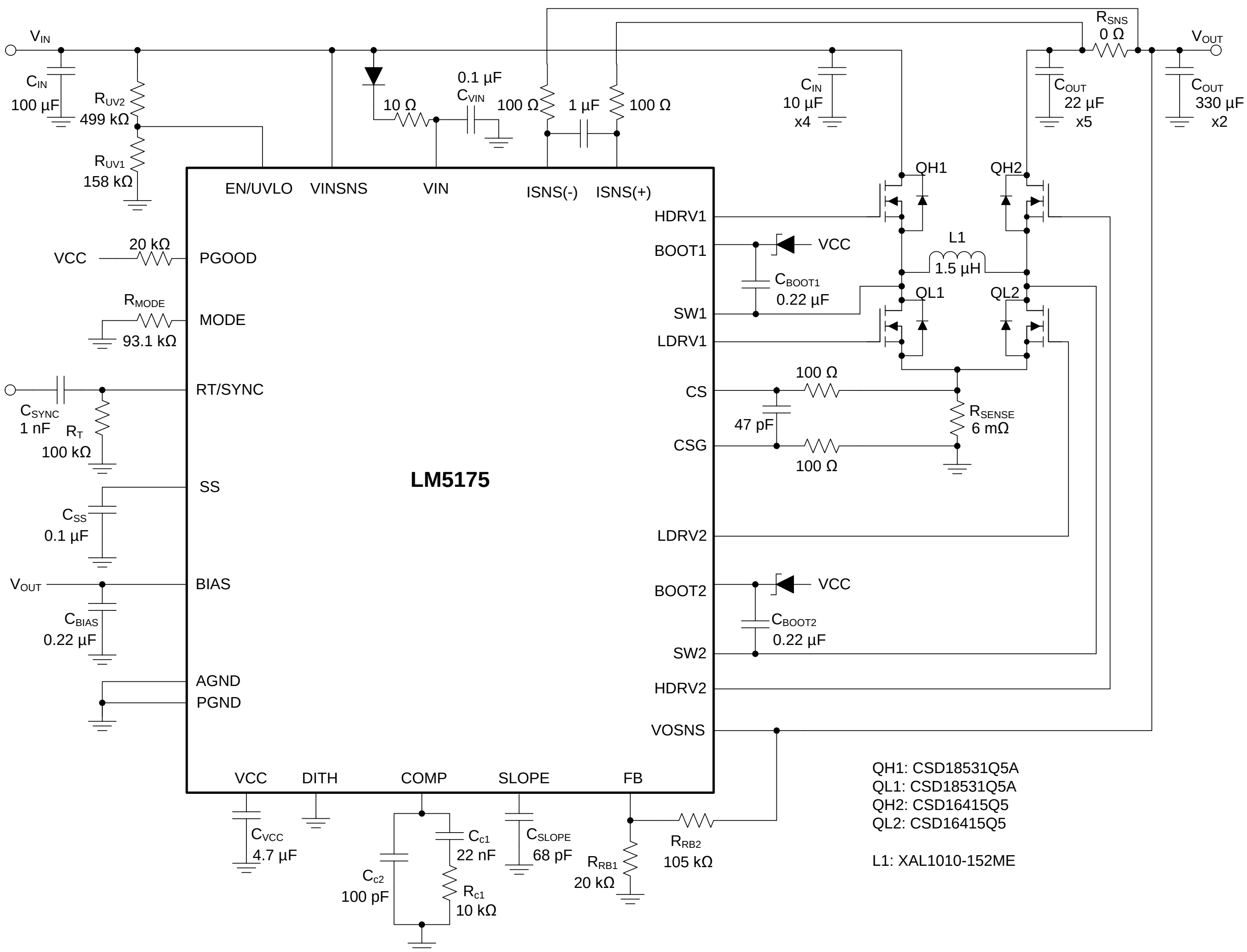

Figure 3. Complete Application Schematic for an Automotive Design For Cold-crank

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

DATE	REVISION	NOTES
May 2015	*	Initial release.