Application Report
SNVA741–July 2015

Maintaining Output Voltage Regulation During Automotive Cold-Crank with LM5118 Buck-Boost

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ABSTRACT

The standard 12 V automotive battery rail can vary from 9 V-16 V during normal operation depending on load and charge. Under transients conditions battery voltages can range from 3 V to nearly 65 V. One of these extreme conditions is cold-crank. Cold-crank happens when the battery is trying to energize the starter of the engine and the battery voltage plummets to 3 V. Previously a small number of functions were required to operate during this condition, however automotive manufactures are requiring more features to endure cold crank in order to improve vehicle performance and operator comfort. With this range of input voltage and new standards, dc-dc converter design can be challenging.

Cold-cranking conditions are out lined in ISO 7637-2 Pulse 4. Automotive manufactures tend to supply customized standards for cold-crank testing. Many manufacturer standards are very similar to the ISO standard, usually with varying time durations and voltage levels. Figure 1 shows an example of a cold-crank waveform.

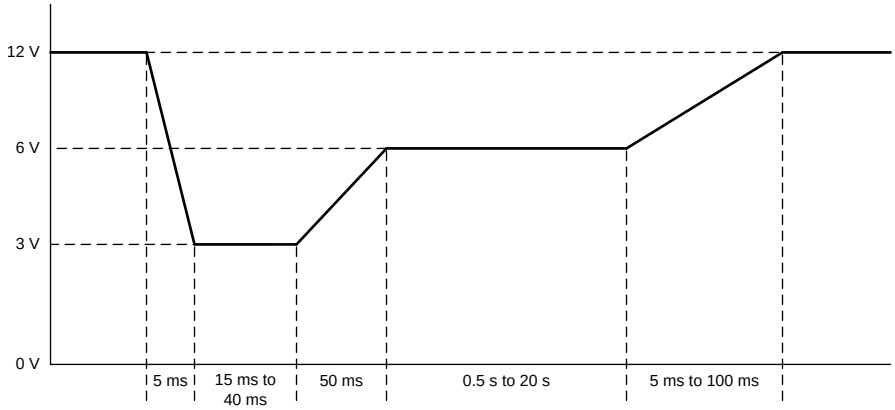
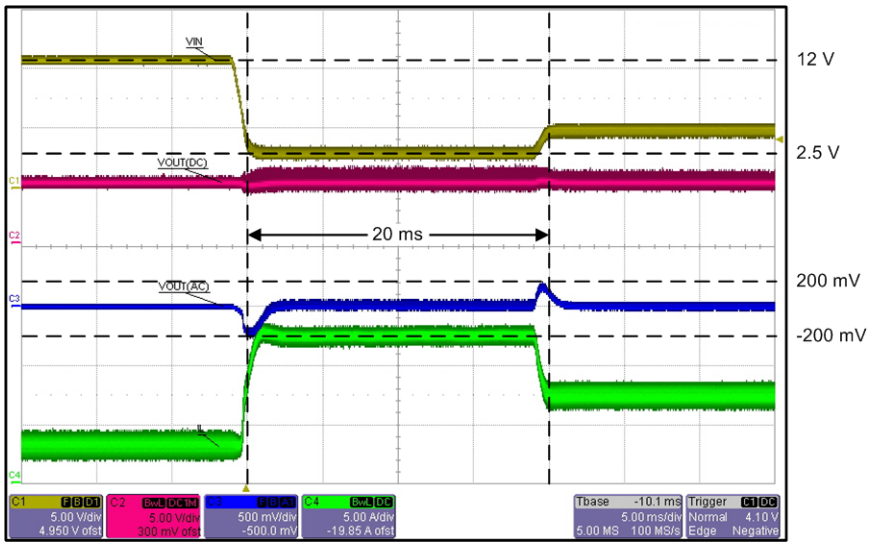


Figure 1. Example Cold-Crank Waveform

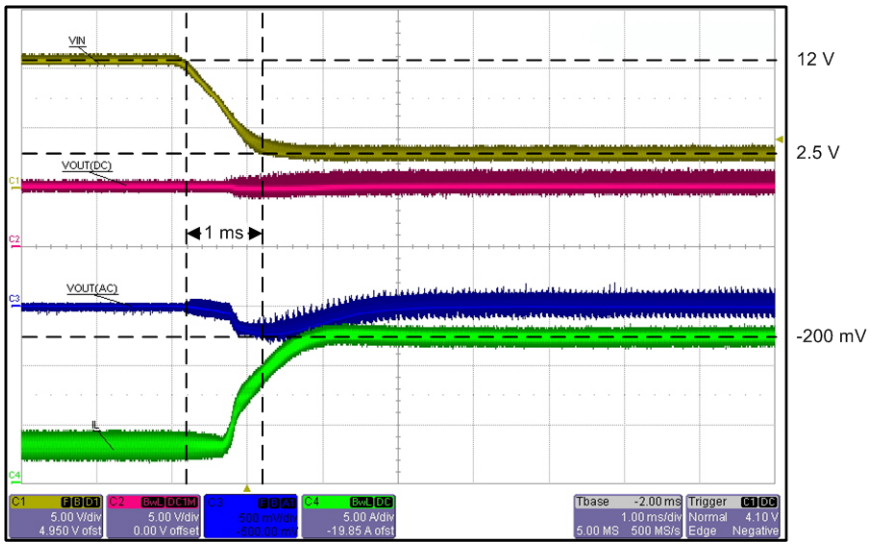
The LM5118 can maintain output regulation during a cold-crank event of input voltages down to 2.5 V. It can also endure events such as load dump where the voltage may exceed 65 V, being rated for VIN max of 75 V. Also as it uses a single inductor the solution size is smaller than that of a SEPIC or cascaded buck-boost topology.

Figure 2 shows a LM5118 design that regulates the output at 5V and delivers 3A through a cold-crank event. This design also has the ability to withstand a load dump transient up to 42 V. The design can be found under reference ID PMP10681. The reference design is a modified LM5118 orderable evaluation module. Figure 3 shows that even with a transition time of 1ms from 12 V to 2.5 V the output regulation is maintained.



CH1: VIN 5V/div | CH2: VOUT(DC) 5V/div | CH3: VOUT(AC) 500mV/div | CH4: IL 5A/div

Figure 2. Cold Crank Waveform: ($\Delta VOUT_{MAX}$ = 200 mV)



CH1: VIN 5V/div | CH2: VOUT(DC) 5V/div | CH3: VOUT(AC) 500mV/div | CH4: IL 5A/div

Figure 3. Cold Crank Transition VIN 12 V to 3 V in 1ms ($\Delta VOUT_{MAX}$ = 200 mV)

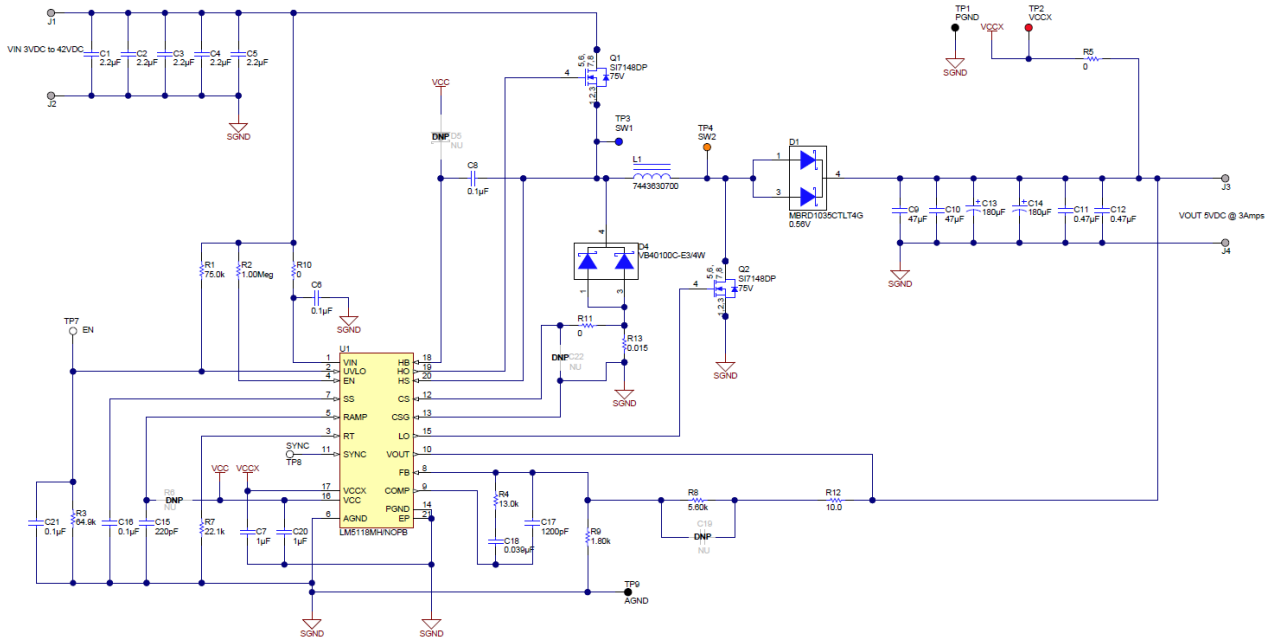


Figure 4. Test Board Schematic: Reference Design PMP 10681

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