

Maintaining Output Voltage Regulation During Automotive Cold-Crank with LM5140 Dual Synchronous Buck Converter

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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. Cold-crank occurs 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 a 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.

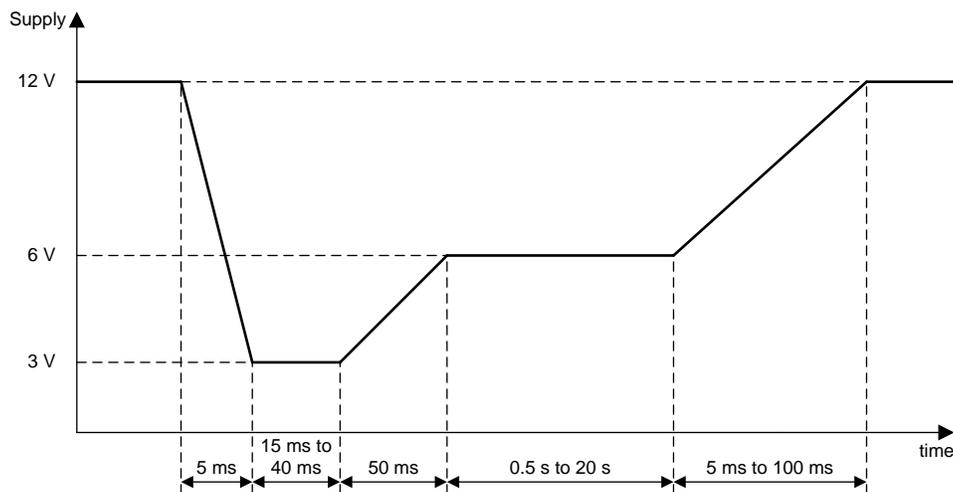


Figure 1. A Representative (Cold-Crank) Test Profile for Car Supply with 12V Battery

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 LM5140, a Dual Synchronous Buck controller, can maintain regulation on the 3.3V output even at supply voltages of 3.8 V, and on the 5.0 V output it can maintain output voltage regulation with the battery voltage dropping down to 5.5V. With an absolute maximum voltage rating of 60 V, it can survive load dump transients with ease. In addition, the LM5140's oscillator can switch at 2.2 MHz reducing to size of the output inductor and filter capacitor providing small solution size. The LM5140 incorporates features to simplify the compliance with the CISPR and Automotive EMI requirements. The LM5140 has two selectable switching frequencies, 2.2 MHz and 440 kHz, Gate Drivers with Adaptive Slew Rate Control, and Interleaved (180 degree output of phase) operation of the two outputs.

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The LM5140 Dual Synchronous Buck converter schematic is shown in [Figure 3](#) with an operating input voltage range of 3.8 V to 42 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 3.8 V.

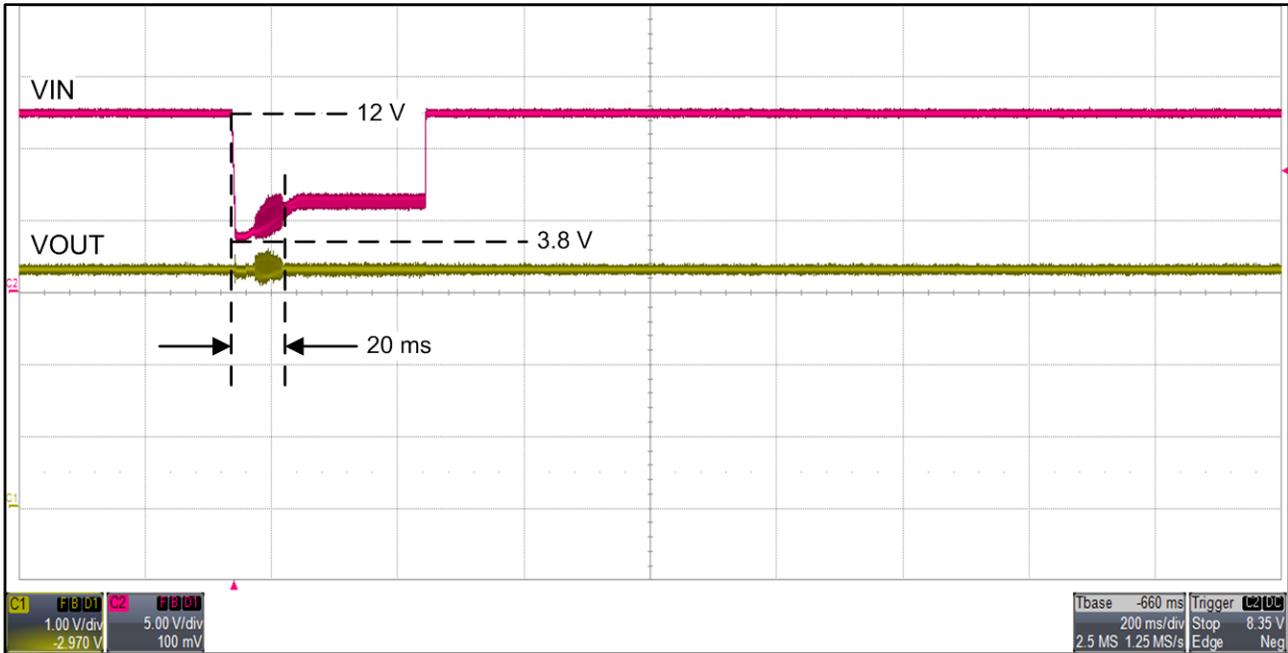


Figure 2. VOUT Regulated at 3.3V with VIN 3.8V for 20ms (Load 4A)

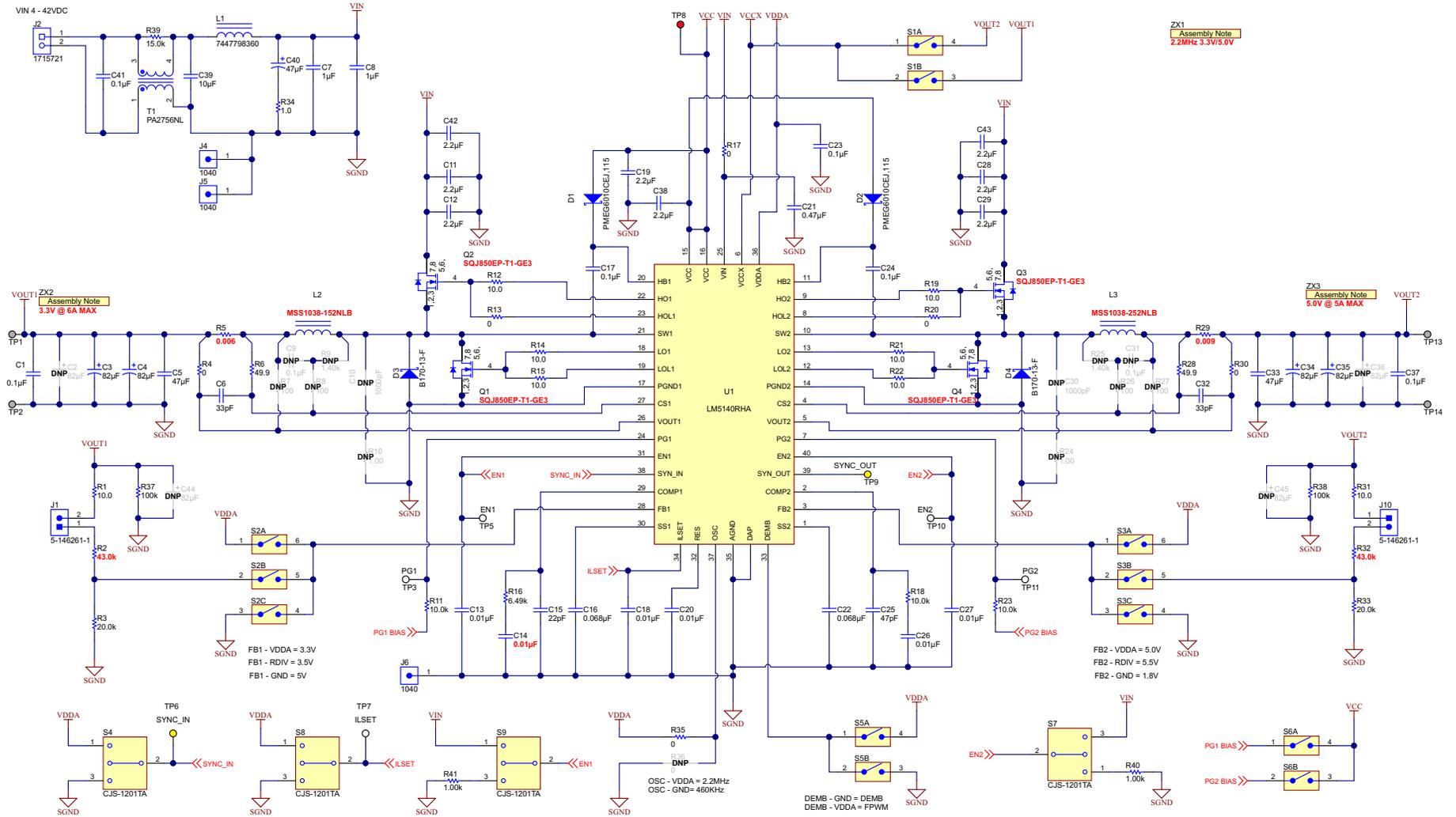


Figure 3. LM5140 2.2MHz EVM Schematic

References

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

LM5140 Wide Input Range Dual Synchronous Buck Controller

Cranking Simulator Reference Design for Automotive Applications (PMP7233)

Revision History

DATE	REVISION	NOTES
January 2016	*	Initial release.

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