Application Report

SNVA818–April 2018

Automotive Cold Crank Operation with LP8860-Q1

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ABSTRACT

The LP8860-Q1 is an automotive high-efficiency, four-channel LED driver with a boost controller typically used in automotive backlight applications such as infotainment and instrument clusters. Today, automotive electronic components need to be extremely reliable and stable under severe weather conditions to ensure the safety of the driver and passengers. This application note will depict the impact of automotive cold and warm cranking on the LP8860-Q1 EVM under different load conditions and test parameters.

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Trademarks

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1 Introduction

Cold cranking occurs when the ambient temperature is too low causing a car’s battery voltage to fall during the cranking of the engine. Warm cranking occurs when the ambient temperature increases and causes a car's battery to drop as well. Automotive electronics tied to the battery supply must be able to operate without interruption in the case of a drop in input voltage during cold or warm cranking. It is very important to ensure that LED drivers do not shutdown due to this voltage drop and react quickly to keep the output steady.

The profiles for cold cranking waveforms are similar among many automotive manufacturers. Usually, variations are within specific voltage levels and timing. The tests performed on the LP8860-Q1 EVM used the profiles outlined below:

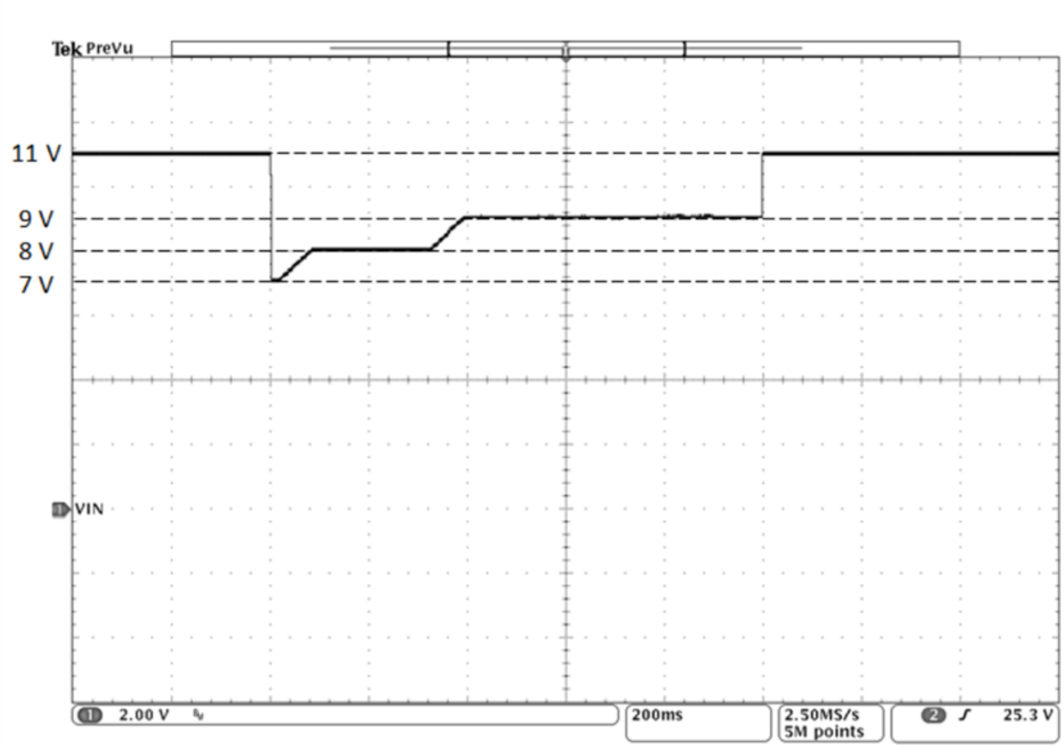

Figure 1. Example of Warm Crank Test Profile

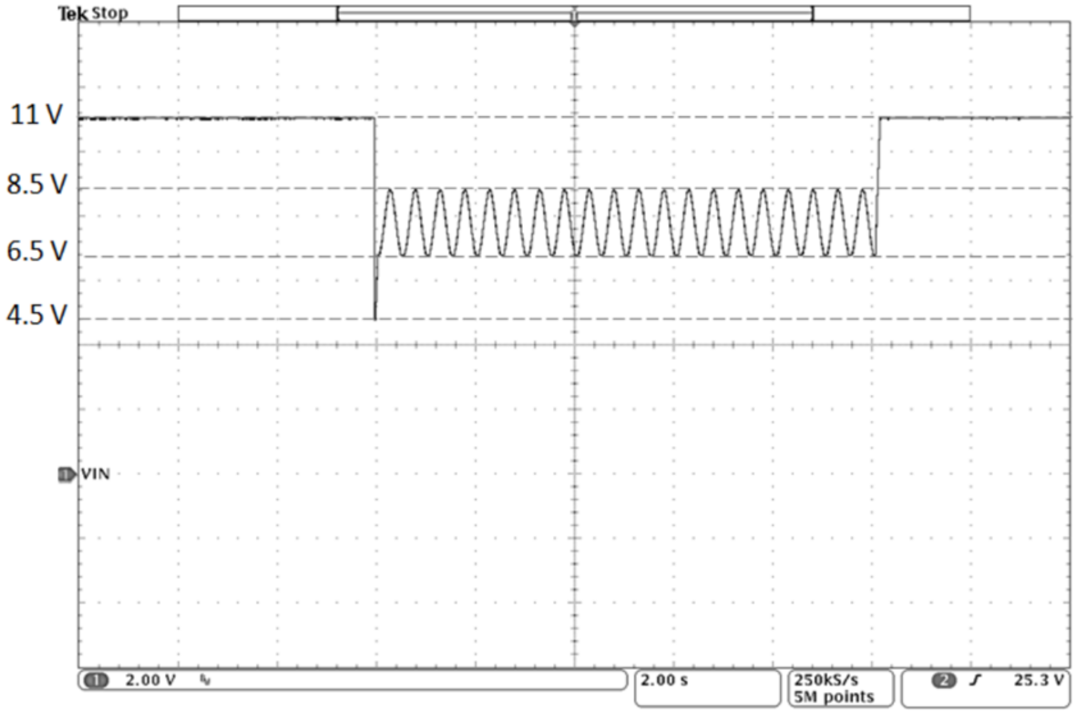

Figure 2. Example of Cold Crank Test Profile

2 Test Procedure

The Texas Instruments AutoCrankSIM EVM was used to perform the cold and warm cranking simulations. The EVM conveniently allows a user to configure three different cranking profiles that can be continuously pulsed for automotive testing. Along with the EVMs, a power supply with at least 24 V and 3 A must be used to perform these tests. The diagram and photo below show how to connect the AutoCrankSIM EVM to the LP8860-Q1 EVM and LED load board to conduct the cranking tests.

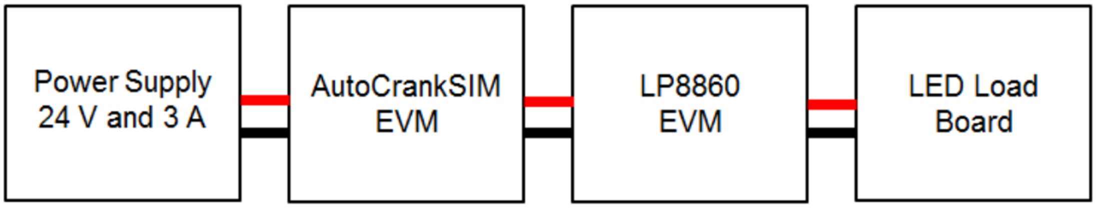

Figure 3. Cold Crank Test Connection Diagram

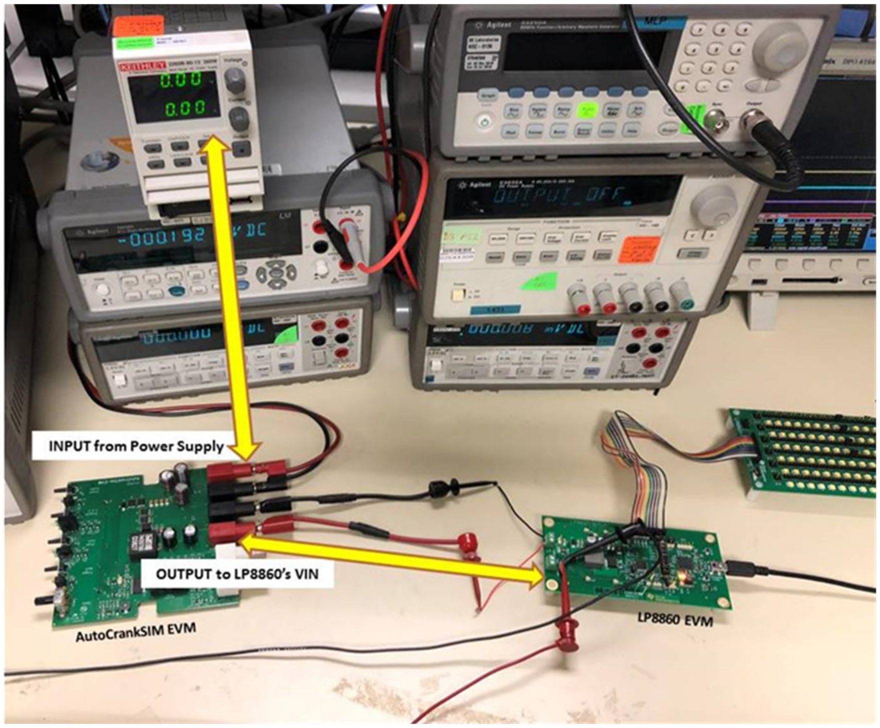

Figure 4. Cold Crank Test Connection

The AutoCrankSIM EVM also requires the use of the software Code Composer Studio if the user wants to create a customized cranking profile. If not, the AutoCrankSIM EVM comes equipped with 3 built in standard waveforms. For the cold and warm crank tests performed in this application note, a customized code was used for the specific voltage and time changes outlined in Section 1. For more information on how to create your own customized cold crank profile and how to use the AutoCrankSim EVM refer to the Automotive Cranking Simulator User's Guide.

2.1 Testing Conditions and Parameters

All tests were performed on the LP8860-Q1 EVM which is available for purchase. Please follow datasheet requirements and recommended components for specific test conditions.

Cold Crank Baseline Testing Parameters

- V_{DD} = 5V
- V_{OUT} = 26V, 8 LEDs
- Switching Frequency: f_{SW} = 300 kHz
- Number of LED Channels: 4
- Led Current per String: I_{LED} = 100mA

Below is the table of varying conditions tested for cold and warm cranking. The parameters listed above were used to compare a baseline test with a test that includes one of the detailed variations in the table.

Table 1. Testing Condition Variations

VARIATIONS	DETAILS
Switching Frequency	300 kHz (Baseline) or 2.2 MHz
Number of LEDs per String	8 LEDs (Baseline) or 10 LEDs

3 Test Results

3.1 Warm Crank

In the tests below, the LP8860-Q1 EVM undergoes warm cranking operations under different load conditions and settings. The baseline test parameters were tested against a variation in LEDs and then a variation in switching frequency.

3.1.1 Number of LEDs Per String

The number of LEDs on the load test board was increased from 8 to 10 LEDs. The results below revealed that the LP8860-Q1 EVM was able to keep a stable output voltage at the boost.

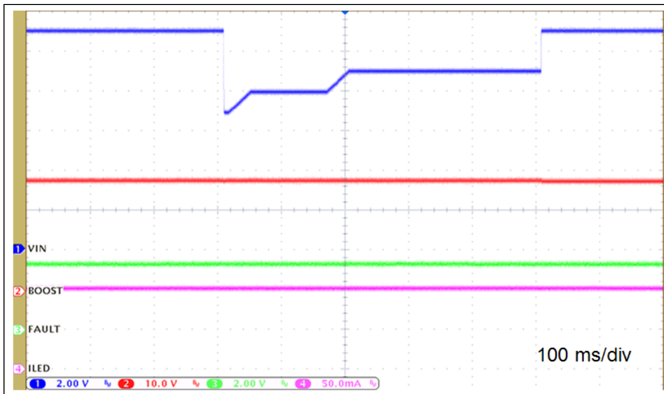

Figure 5. Warm Crank Baseline Test: 8 LEDs

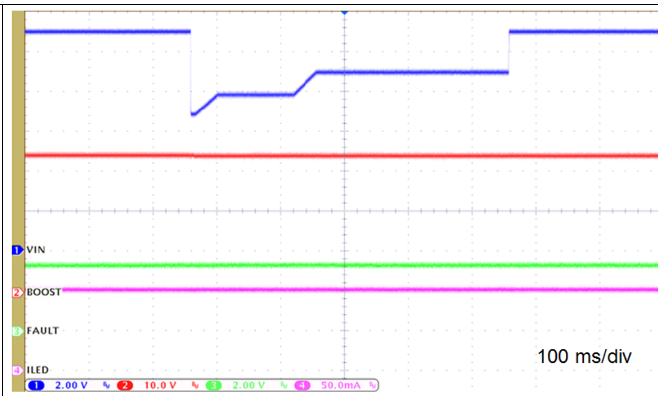

Figure 6. Warm Crank Variation Test: 10 LEDs

3.1.2 Switching Frequency

The switching frequency was changed from 300 kHz to 2.2 MHz. The inductor, input capacitor and output capacitor selections were based on datasheet recommendations. The results showed that changing the switching frequency did not affect the output voltage of the boost on the LP8860-Q1 EVM with 8 LEDs and 100mA current per string.

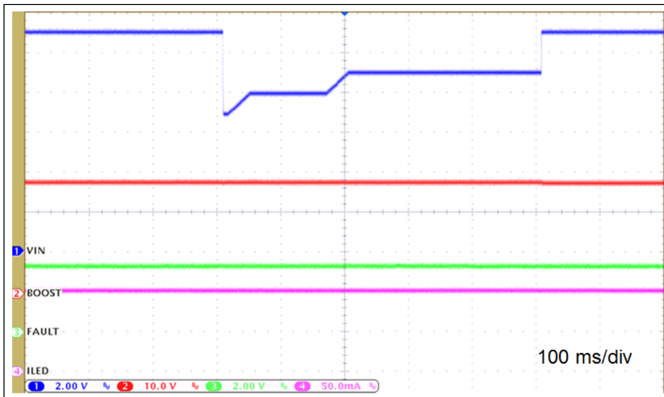

Figure 7. Warm Crank Baseline Test: f_{SW}= 300 kHz

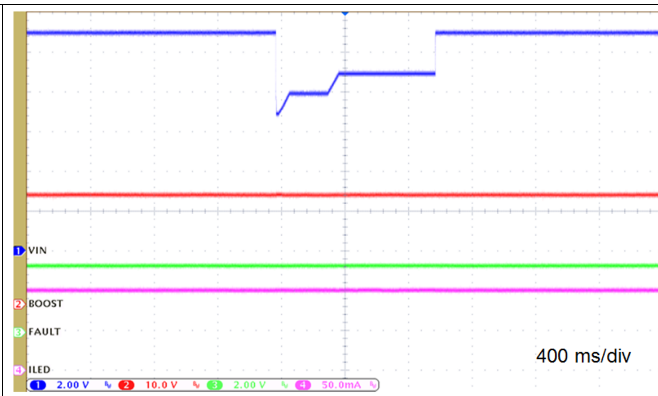

Figure 8. Warm Crank Variation Test: f_{SW}= 2.2 MHz

3.2 Cold Crank

The following results show the LP8860-Q1 cold crank performance using the test conditions as described in Section 2.1. The baseline test parameters were tested against a variation in LEDs and then a variation in switching frequency.

3.2.1 Number of LEDs Per String

The number of LEDs on the load test board was increased from 8 to 10 LEDs. The results below revealed that the LP8860-Q1 EVM was able to keep a stable output voltage at the boost.

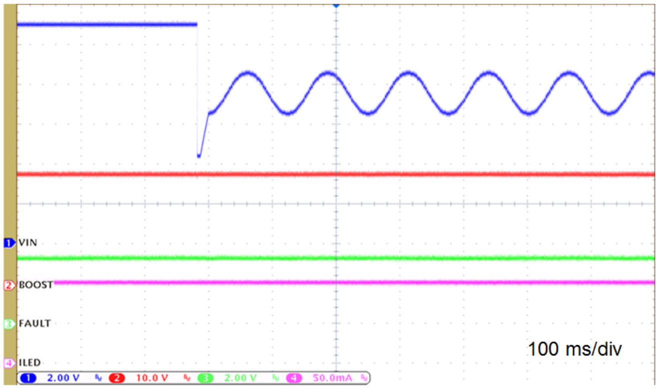

Figure 9. Cold Crank Baseline Test: 8 LEDs

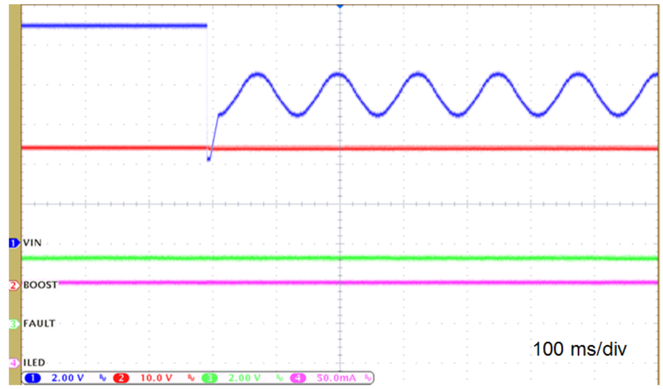

Figure 10. Cold Crank Variation Test: 10 LEDs

3.2.2 Switching Frequency

The switching frequency was changed from 300 kHz to 2.2 MHz. The inductor, input capacitor and output capacitor selections were based on datasheet recommendations. The results showed that changing the switching frequency did not affect the output voltage of the boost on the LP8860-Q1 EVM with 8 LEDs and 100 mA current per string.

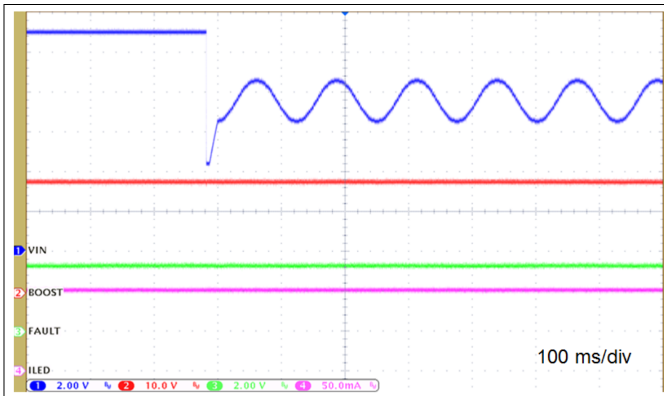

Figure 11. Cold Crank Baseline Test: f_{SW} = 300 kHz

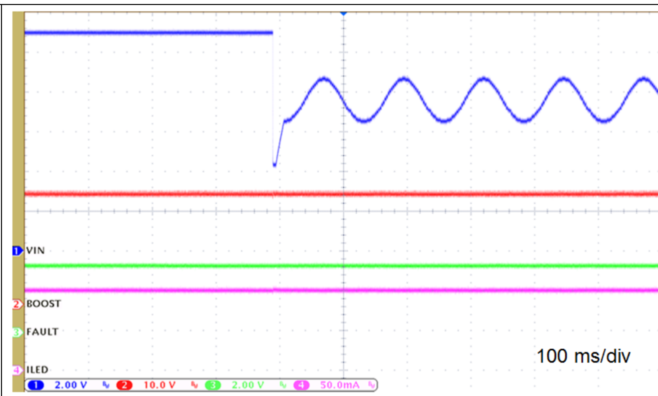

Figure 12. Cold Crank Variation Test: f_{SW} = 2.2 MHz

4 Summary

Testing cold crank operation can involve different test parameters and load variations. This application note is used to give insight on some of these changes when testing the LP8860-Q1 and to highlight its reliability in operation during cold and warm cranking. For more information please refer to www.ti.com

5 References

- LP8860-Q1 Automotive Low-EMI High-Performance 4-Channel LED Driver LP8860.
- LP8860-Q1EVM User's Guide SNVU382.
- AutoCrankSim-EVM: Simulator for Automotive Cranking Pulses Evaluation Module Board HVL068A.

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