TIDA-00282 TI Design Test Data
Automotive Digitally-Controlled Boost Power Supply

1 Introduction

The following test data was collected using the TIDA-00282 hardware. Please refer to the TIDA-00282 Quick Start Guide for basic hardware setup and operation instructions.

2 TIDA-00282 Test Data

Figure 1 through Figure 31 present performance data for the TIDA-00282 hardware. Actual performance data can be affected by measurement techniques and environmental variables. Therefore, the following data is presented for reference and may differ from actual results obtained by some users.

2.1 Efficiency

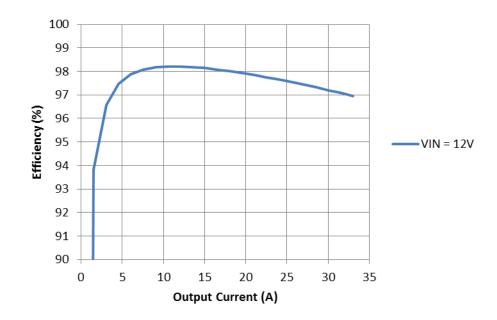Figure 1 and Figure 2 illustrate efficiency performance.

Figure 1. Efficiency vs Output Load Current (VIN = 12V, Bypass)
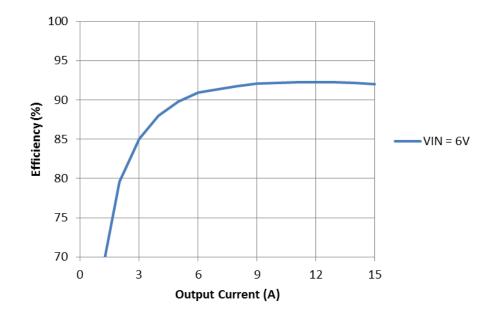
Figure 2. Efficiency vs Output Load Current (VIN = 6V, Boost)

2.2   Output Voltage Regulation

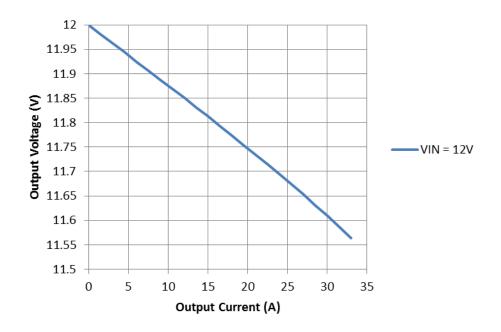Figure 3 and Figure 4 illustrate output voltage regulation.

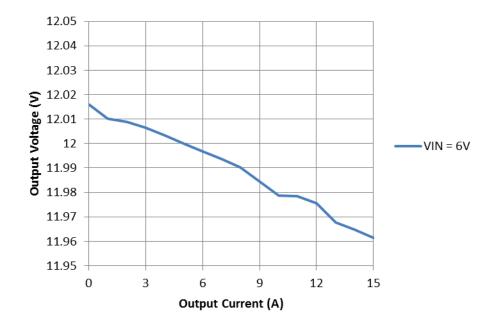**Figure 3. Output Voltage Regulation vs Output Load Current (VIN = 12V, Bypass)**

Figure 4. Output Voltage Regulation vs Output Load Current (VIN = 6V, Boost)

2.3   Bypass to Boost Transition

Figure 5 through Figure 18 illustrate the bypass mode to boost mode transition with a stable 12V output voltage for input voltages down to 6V.
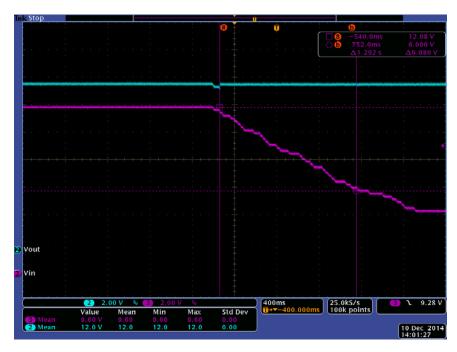

Figure 5. Bypass to Boost Transition with No Load (Channel 2 = VOUT, Channel 3 = VIN)
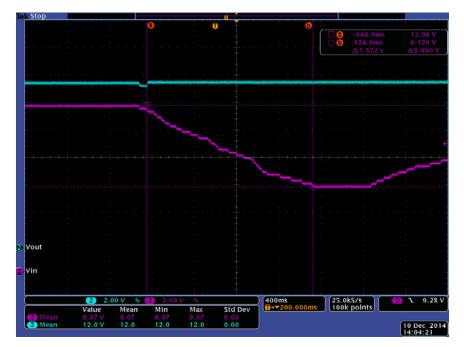
Figure 6. Bypass to Boost Transition with 2.5A Load
(Channel 2 = VOUT, Channel 3 = VIN)

Figure 7. Bypass to Boost Transition with 5A Load
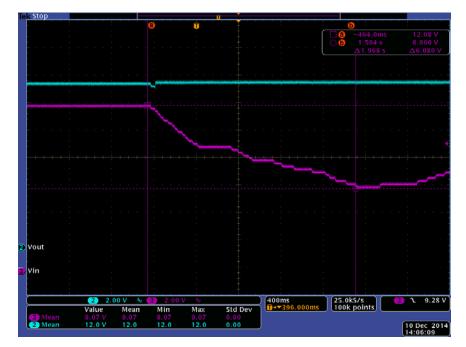**(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 8. Bypass to Boost Transition with 7.5A Load
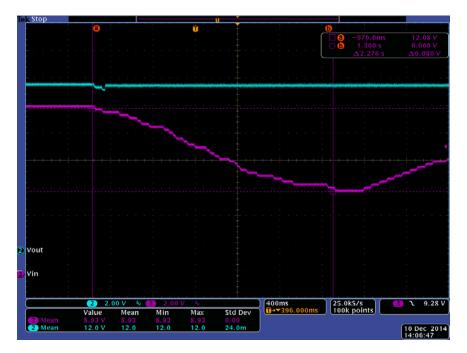(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 9. Bypass to Boost Transition with 10A Load
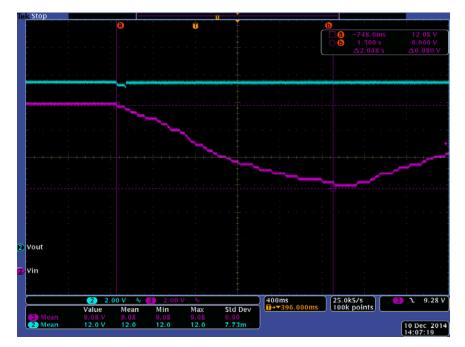(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 10. Bypass to Boost Transition with 12.5A Load
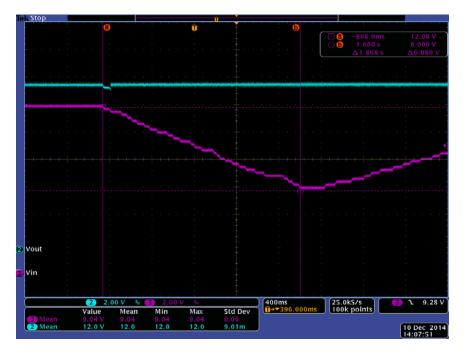(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 11. Bypass to Boost Transition with 15A Load
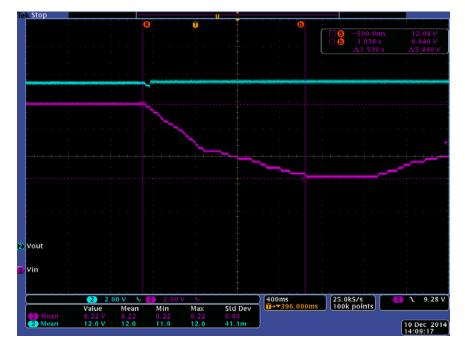(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 12. Bypass to Boost Transition with 17.5A Load
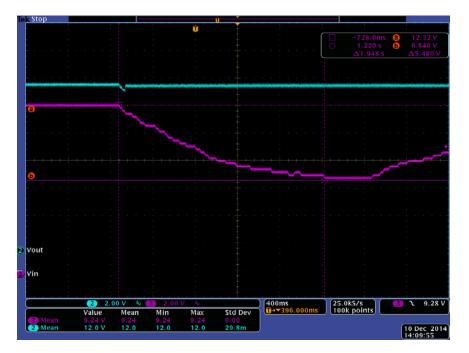(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 13. Bypass to Boost Transition with 20A Load
(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 14. Bypass to Boost Transition with 22.5A Load
(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 15. Bypass to Boost Transition with 25A Load
(Channel 2 = VOUT, Channel 3 = VIN)**

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**Figure 16. Bypass to Boost Transition with 27.5A Load
(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 17. Bypass to Boost Transition with 30A Load
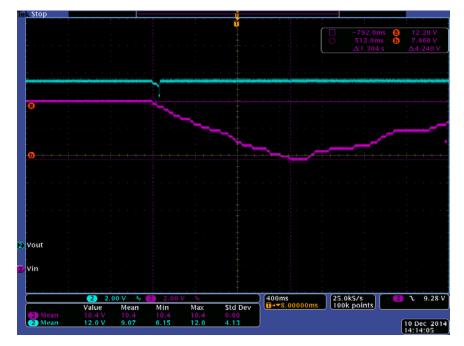(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 18. Bypass to Boost Transition with 33A Load
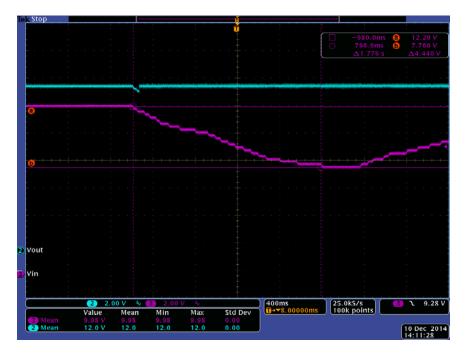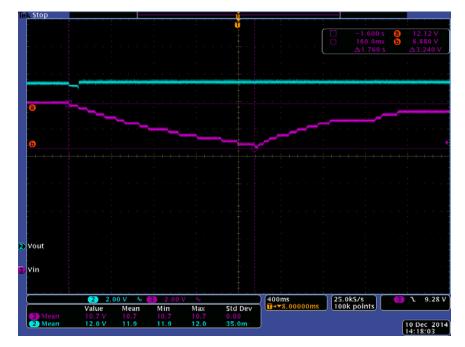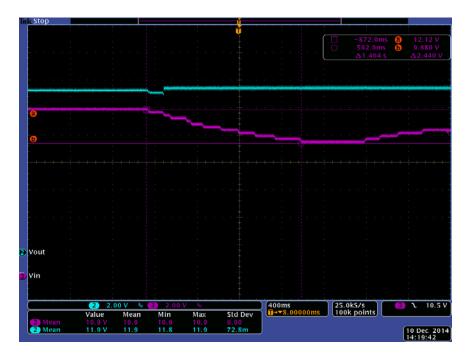(Channel 2 = VOUT, Channel 3 = VIN)**

2.4 Boost to Bypass Transition

Figure 19 through Figure 22 illustrate the boost mode to bypass mode transition.
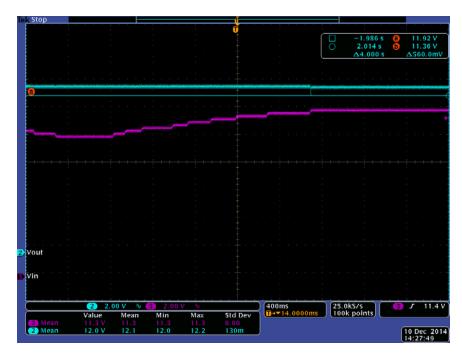
**Figure 19. Boost to Bypass Transition with No Load
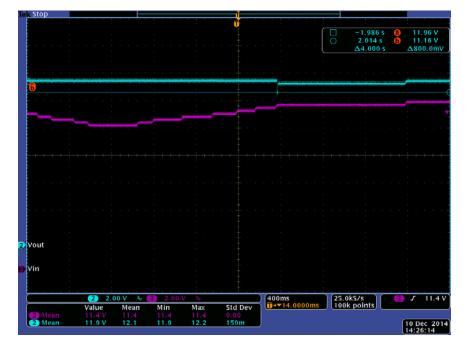(Channel 2 = VOUT, Channel 3 = VIN)**

Figure 20. Boost to Bypass Transition with 15A Load
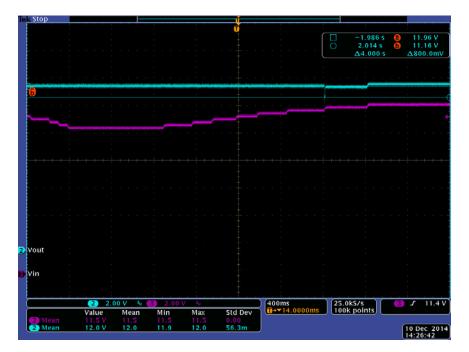**(Channel 2 = VOUT, Channel 3 = VIN)**

Figure 21. Boost to Bypass Transition with 20A Load
(Channel 2 = VOUT, Channel 3 = VIN)

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**Figure 22. Boost to Bypass Transition with 30A Load
(Channel 2 = VOUT, Channel 3 = VIN)**

2.5   Bypass to Boost and Boost to Bypass Transitions

Figure 23 through Figure 25 illustrate the bypass mode to boost mode and boost mode to bypass mode transitions.
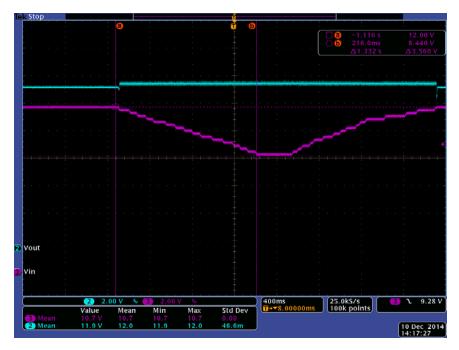

**Figure 23. Bypass to Boost and Boost to Bypass Transitions with 27.5A Load
(Channel 2 = VOUT, Channel 3 = VIN)**
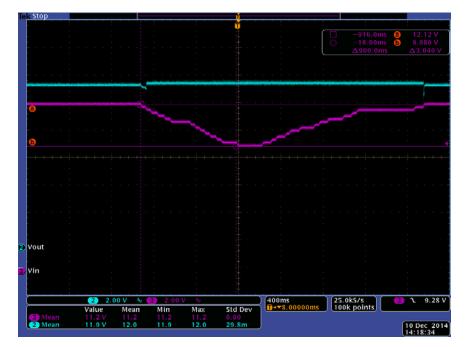
**Figure 24. Bypass to Boost and Boost to Bypass Transitions with 30A Load
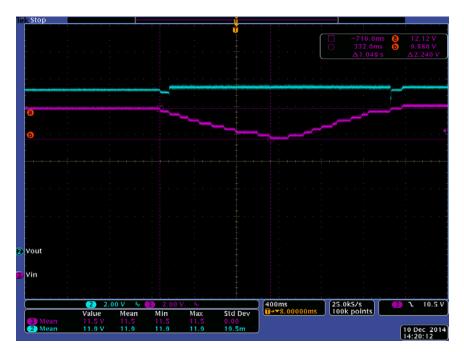(Channel 2 = VOUT, Channel 3 = VIN)**

**Figure 25. Bypass to Boost and Boost to Bypass Transitions with 33A Load
(Channel 2 = VOUT, Channel 3 = VIN)**

2.6   Output Voltage Ripple

Figure 26 through Figure 29 illustrate the output voltage ripple.

**Figure 26. AC Coupled Output Voltage Ripple with No Load
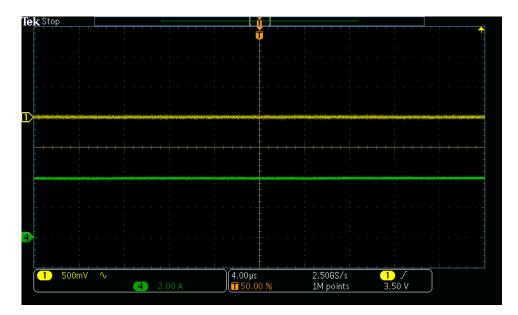(VIN = 12V, Channel 1 = VOUT, Channel 4 = IOUT)**

**Figure 27. AC Coupled Output Voltage Ripple with 3Ω Load
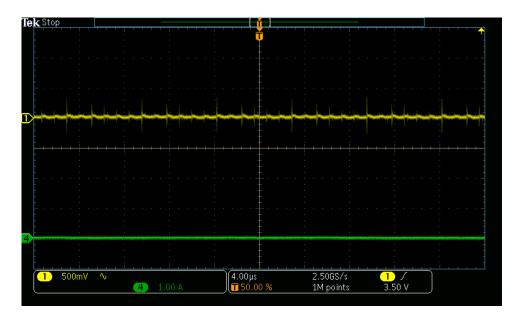(VIN = 12V, Channel 1 = VOUT, Channel 4 = IOUT)**

**Figure 28. AC Coupled Output Voltage Ripple with No Load
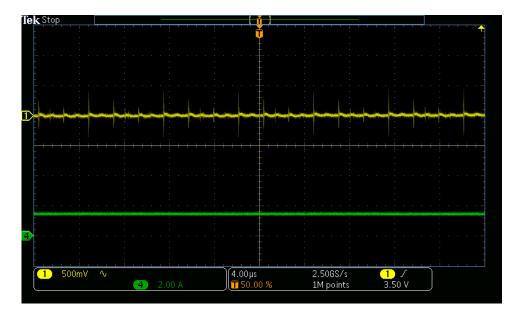(VIN = 6V, Channel 1 = VOUT, Channel 4 = IOUT)**

**Figure 29. AC Coupled Output Voltage Ripple with 8Ω Load
(VIN = 6V, Channel 1 = VOUT, Channel 4 = IOUT)**

2.7   Simulated Crank Waveform Transitions

Figure 30 shows the boost performance with a simulated automotive crank waveform applied to the input connector and a 25A electronic load applied to the output connector. In general the output voltage is maintained at a 12V level.

> Channel 1 (yellow) is the input voltage (12V battery nominal)
> Channel 2 (pink) is the output voltage

Note that due to the small voltage drop across the FETs in bypass mode, the output voltage is slightly lower in bypass mode than when the boost mode is operating. The boost control code is set to switch from bypass to boost mode when the input voltage drops below 11.7V. This set-point could be adjusted to fit the specific requirements of any particular application.

Figure 30 Performance with 25A load during simulated engine crank

2.8   In-Vehicle Crank Waveform Transitions

These series of tests show the input and output waveforms in an actual automotive 12V electrical system. In each crank event, the start motor was engaged, resulting in a step drop of the 12V battery voltage as shown by the gold trace of channel 1. The output voltage is shown in the pink trace of channel 2. Measurements below each plot indicate the maximum and minimum values during the sample time for both input and output voltage.

The tests represented by Figure 31 through Figure 36 were performed with no load on the output of the boost converter. The test shown in Figure 37 was performed with a 4 Ohm (nominal 36W load) on the output of the boost converter.
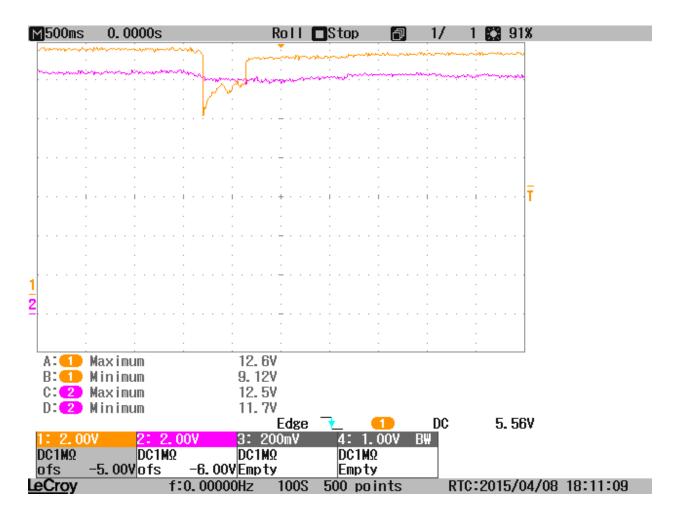

Figure 31.   In-vehicle crank event (no external load) – first example

The duration of the crank event is seen to be about half a second. The battery voltage in this case drops from a "resting" level of 12.6V to a low of about 9.1V. The increasing level and somewhat oscillatory nature of the battery voltage is typical of a crank event, as seen also in the crank emulator specifications.
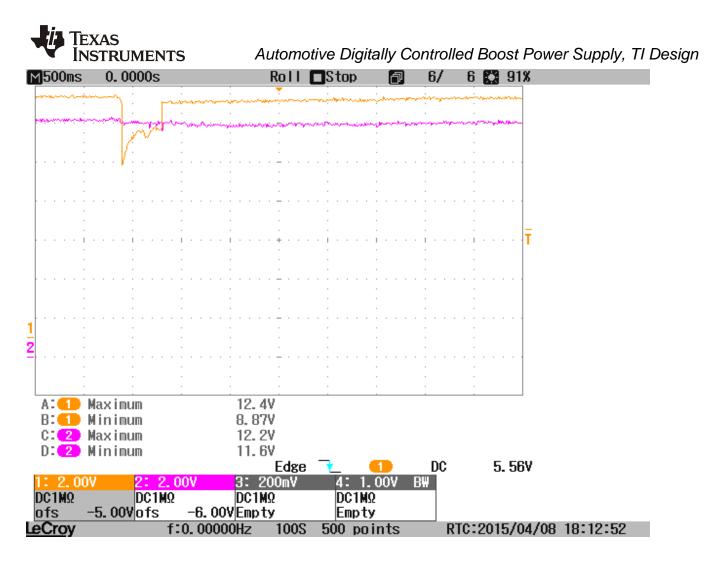
Figure 32.   In-vehicle crank event (no external load) – second example

Note that while the measured input voltage drops to 9V or lower, the minimum output voltage is measured within a few hundred millivolts of the Begin_Boost set-point of 11.7V. Depending on the specific requirements of the application, the Begin_Boost set-point can be adjusted to an optimum value.
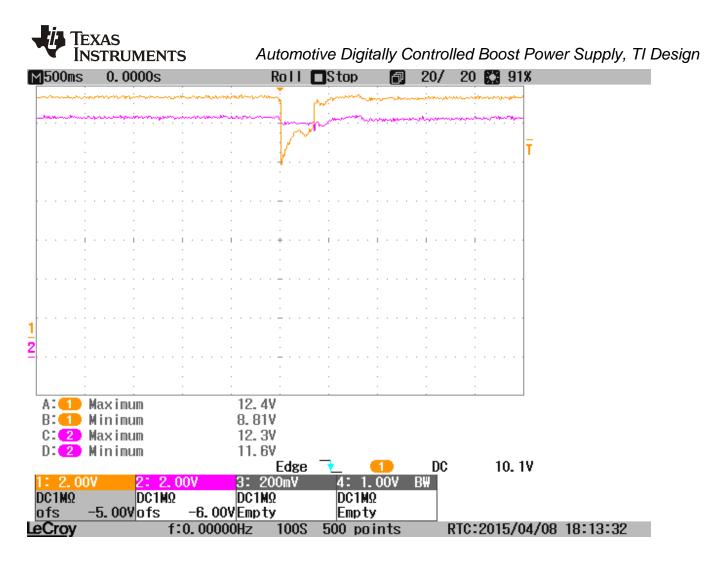
Figure 33.   In-vehicle crank event (no external load) – third example

Note that in Figure 33, the input voltage exhibits some relatively low-frequency variation after the crank event. This same variation is seen on the output voltage, because the input voltage at that point is above the Begin_Boost set-point threshold, so the output is tied to the input, bypassing the boost circuitry.
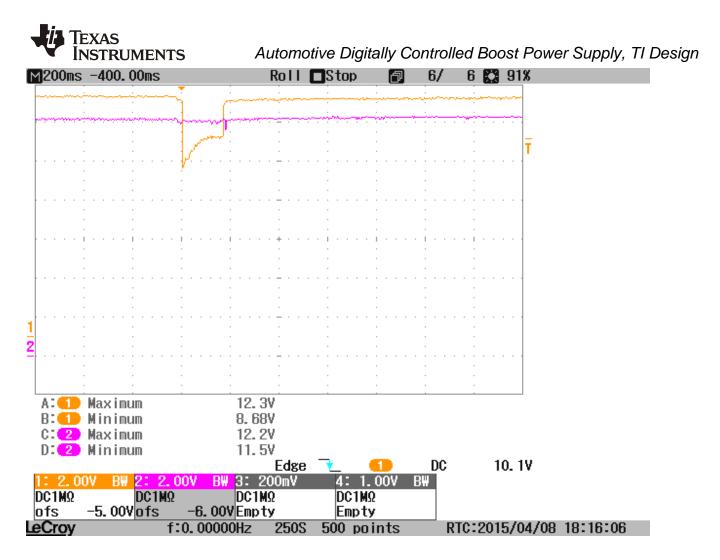
Figure 34.   In-vehicle crank event (no external load) – fourth example – starter "bump"

Figure 34 and Figure 35 show the difference between a short crank event ("bumping" the starter) and a standard full crank which starts the internal combustion engine. The short crank event shown in Figure 34 has a duration of only about 200 milliseconds. This does, however, have the same downward step due to the acceleration-from-zero of the electrical starter motor.
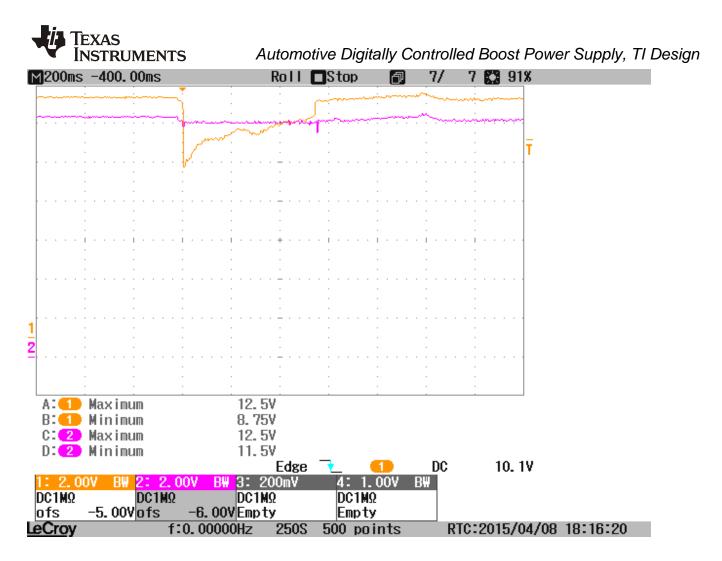
Figure 35.   In-vehicle crank event (no external load) – fifth example – full start crank

Figure3 5 shows a standard full crank which starts the internal combustion engine. The standard crank event has a duration of about 500 milliseconds. This includes the downward step due to the acceleration-from-zero of the electrical starter motor, as well as the rising oscillations as the electric motor and gas engine begin to turn during starting.
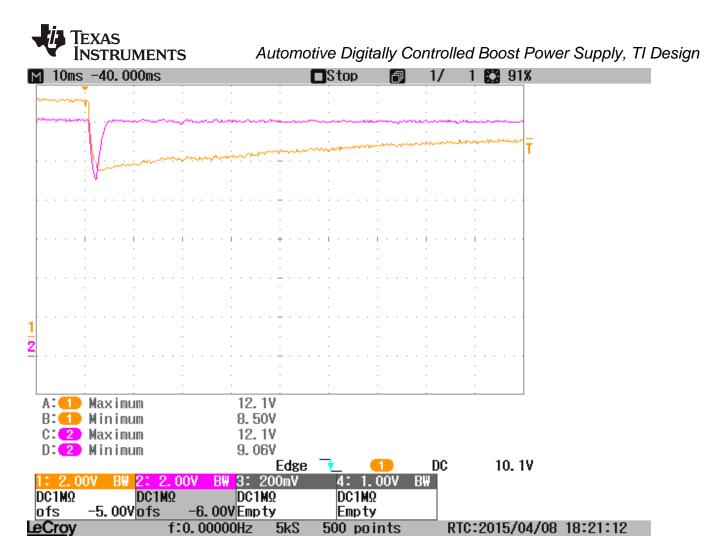
Figure 36.   In-vehicle drank event with no external load (expanded time scale)

Figure 36 shows that at an expanded (zoomed) time scale, there is a brief drop in the output voltage when the input voltage makes a step drop. While the input voltage is well below 12V for about 500 milliseconds, the boost circuitry quickly regulates the output voltage, recovering to 12V in about 5 milliseconds.

Figure 37.   In-vehicle drank event with 4 Ohm load (expanded time scale)

In Figure 37, a resistive 4-Ohm load is connected to the output voltage. At 12V, the load current is 3 Amps, and load power is 36 Watts, or about 10% of the rated power for the design. Note that the brief drop in output voltage is reduced due to the pre-existing load current flowing through the circuit. As before, the boost circuit regulates the output voltage to approximately 12V within about 5 milliseconds.

Note also that due to the 3A load current and losses in the test cable for this test, the input voltage drops below the 11.7V threshold before the negative step associated with the crank event. At that point, the boost circuit is active and provides a 12v output starting a few milliseconds before the crank event causes a significant drop in the input voltage.

2.9 Thermal Images

Figure 38 and Figure 39 illustrate thermal images taken at room temperature.

Figure 38.   Thermal Image with 3Ω Load (VIN = 12V, Bypass)

Figure 39.   Thermal Image with 8Ω Load (VIN = 6V, Boost)

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