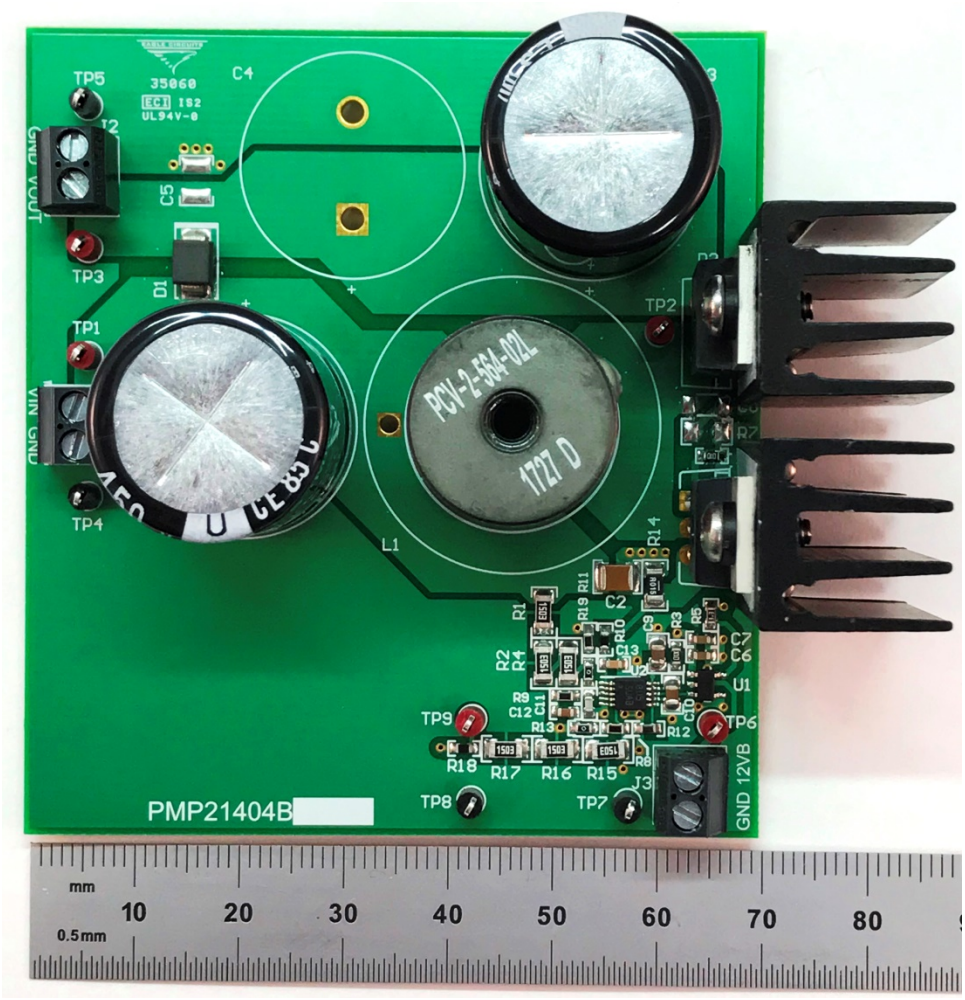
Test Report: PMP21404

High-Efficiency Boost Converter Power Supply Reference Design for Automotive DC/AC Inverter

TEXAS INSTRUMENTS

Description

This single-phase boost converter operates over an input voltage range of 120 V- 350 V and provides a non-isolated output of 221 V/0.87 A. Input voltages above 221 V are passed through to the output. With an efficiency of greater than 97%, component losses are reduced which result in lowers operating temperatures and minimal heat sink requirements.



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1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input voltage range	120 V – 350 V
Output voltage	221 V, for Vin < 221 V Vin, for Vin > 221 V
Output current	0.87 A
Switching frequency	125 kHz
External bias voltage	12 V

1.2 Required Equipment

- Power supply capable of 400 V and 3 A
- 12 V / 0.1 A bias power supply
- 250 Ohm/200 W resistive or 400 V/1 A active load
- Digital Multimeters
- 500 MHz oscilloscope and probes
- Stability measurement device (Venable or Bode)

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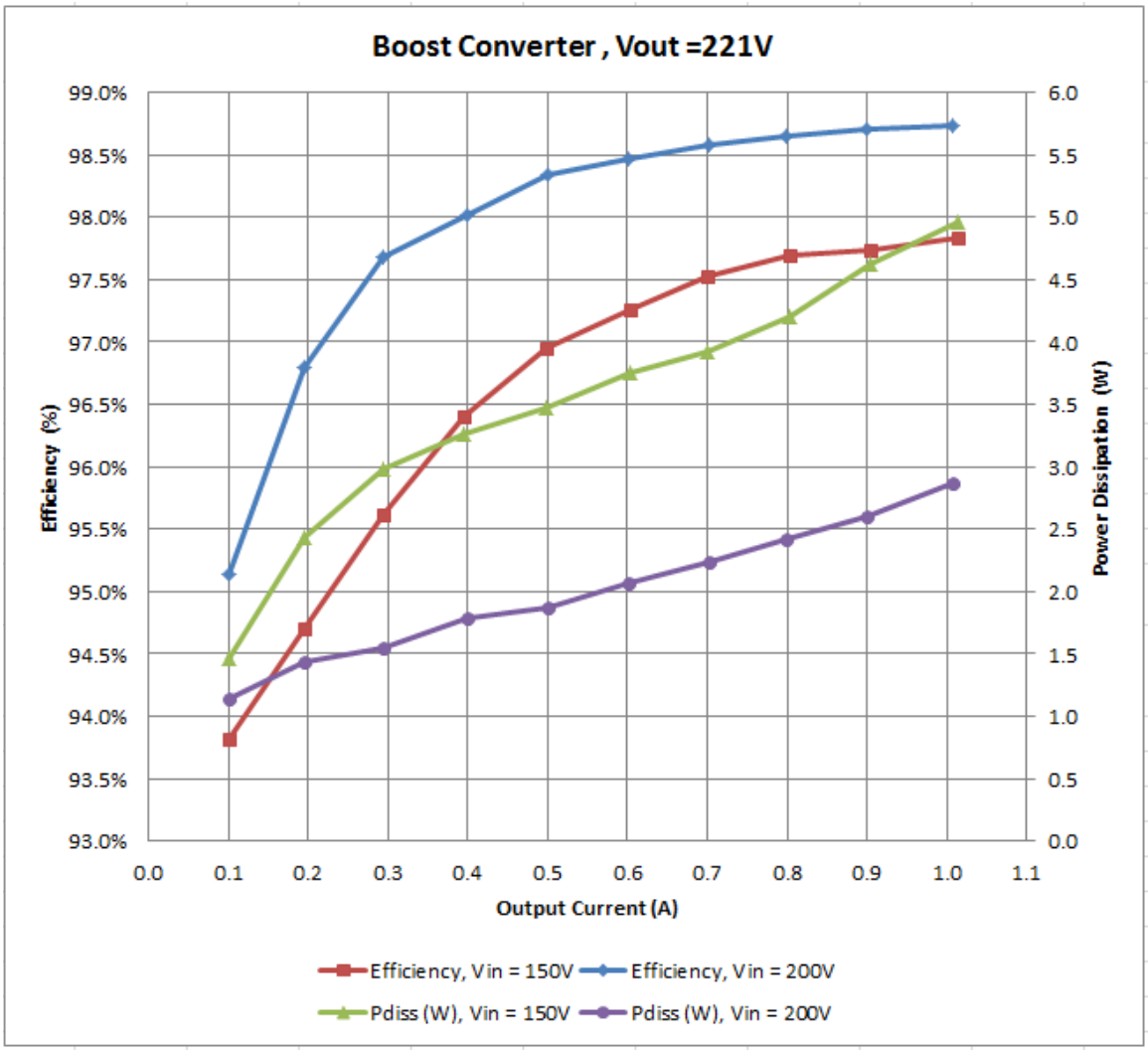
2 Testing and Results

2.1 Efficiency and Regulation Graphs

The boost converter efficiency is shown below with the input voltage set to 150 V and 200 V.



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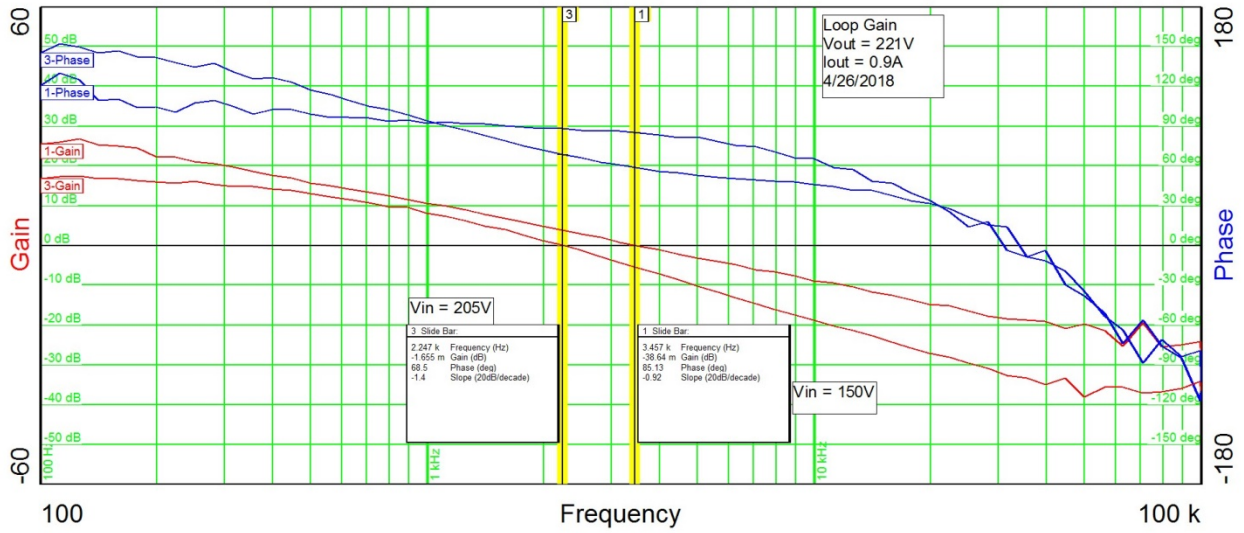
2.2 SEPIC Loop Gain

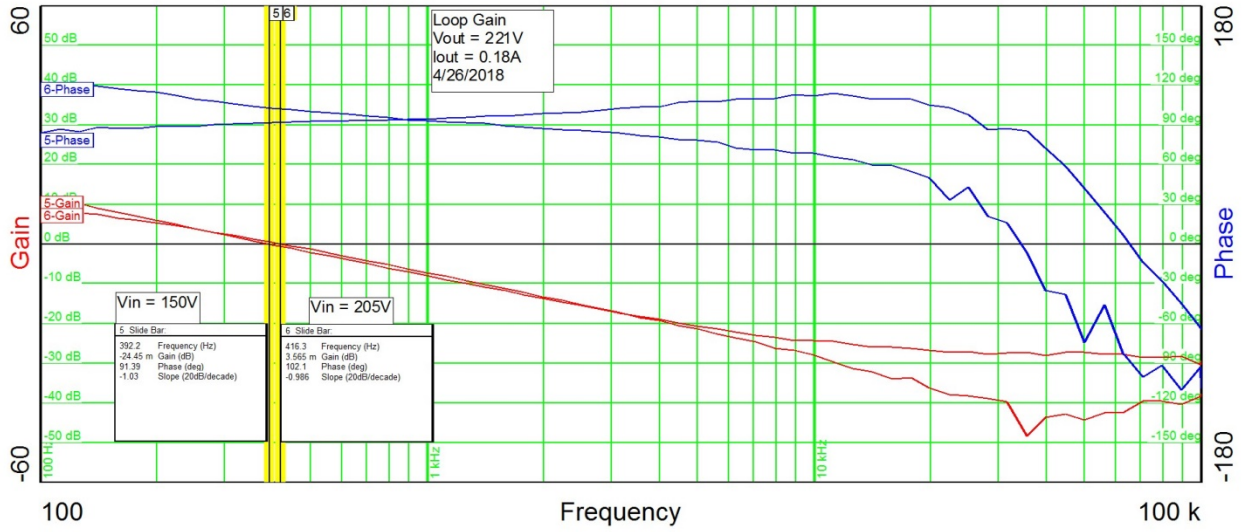
The plot below shows the boost converters loop gain with the input voltage set to 150 V and 205 V while loaded at 0.9 A.

Loop Gain (Vin = 150 V)	BW: 3.46 kHz	PM: 85 degrees
Loop Gain (Vin = 205 V)	BW: 2.25 kHz	PM: 69 degrees



The plot below shows the boost converters loop gain with the input voltage set to 150 V and 205 V while loaded at 0.18 A.

Loop Gain (Vin = 150 V)	BW: 392 Hz	PM: 91 degrees
Loop Gain (Vin = 205 V)	BW: 416 Hz	PM: 102 degrees



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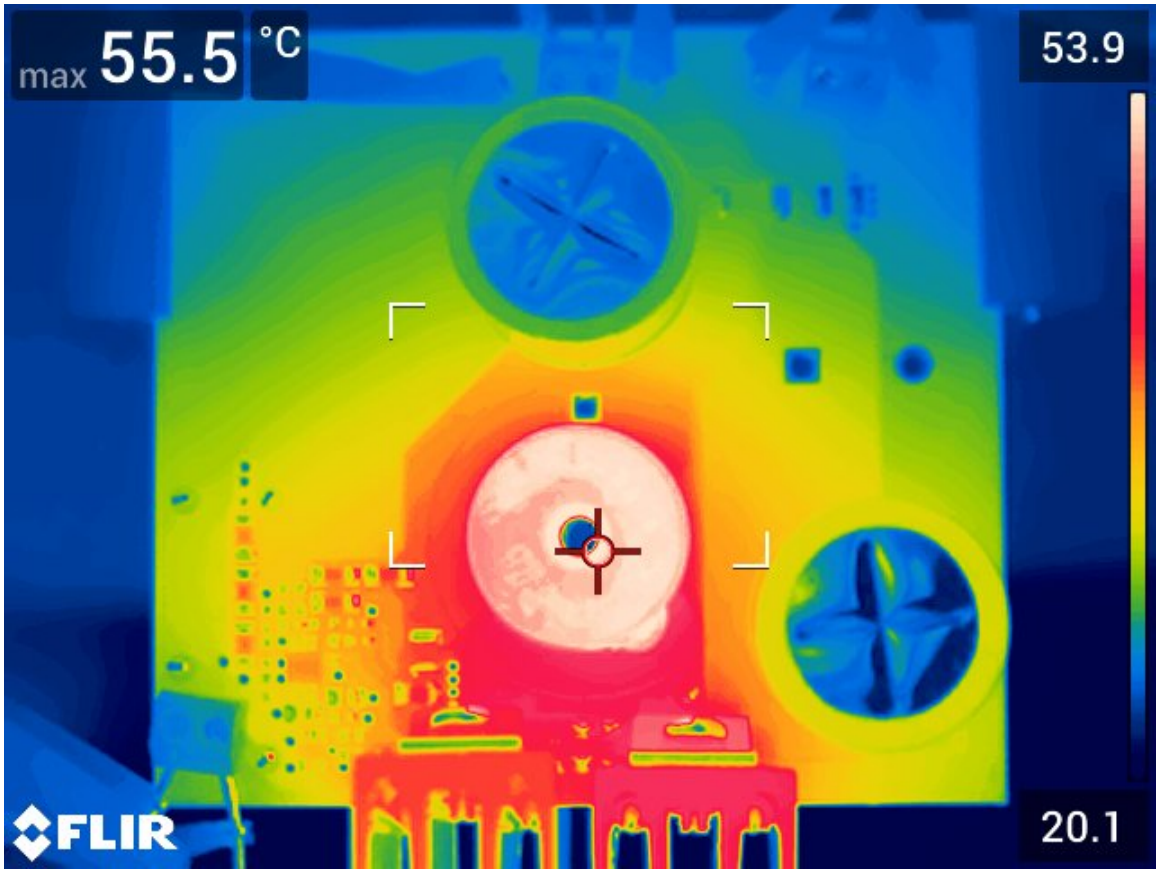
2.3 Thermal Image

A thermal image is shown below with the boost converter operating at 150 V input and 221 V/0.9 A output (room temp, no airflow).



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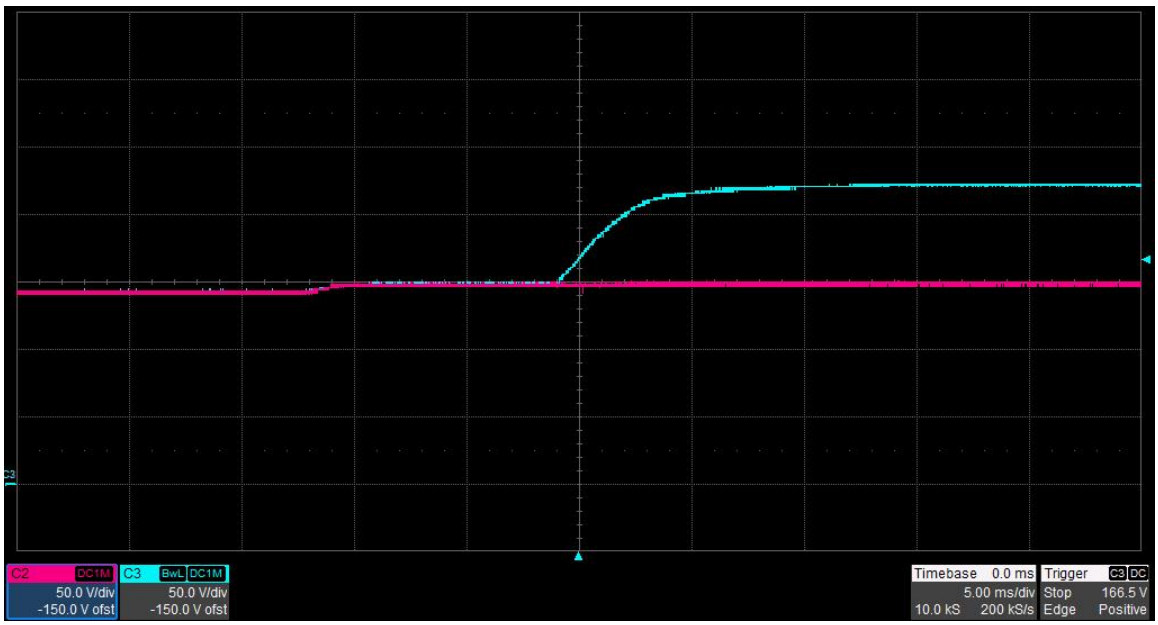
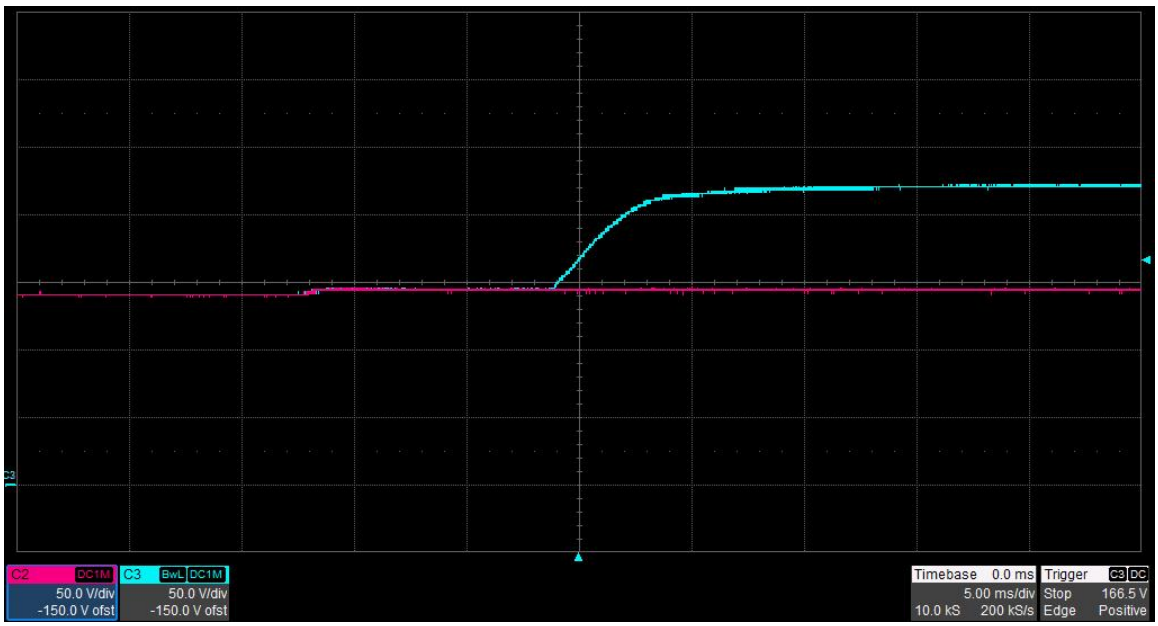
3 Waveforms

3.1 Startup

The photo below shows the startup of the 221 V output voltage (Blue) after the input voltage (RED) crosses the UVLO threshold of 142 V. Iout = 0 A. (50 V/DIV, 5 mS/DIV)



The photo below shows the startup of the 221 V output voltage (Blue) after the input voltage (RED) crosses the UVLO threshold of 142 V. Iout = 0.9 A. (50 V/DIV, 5 mS/DIV)



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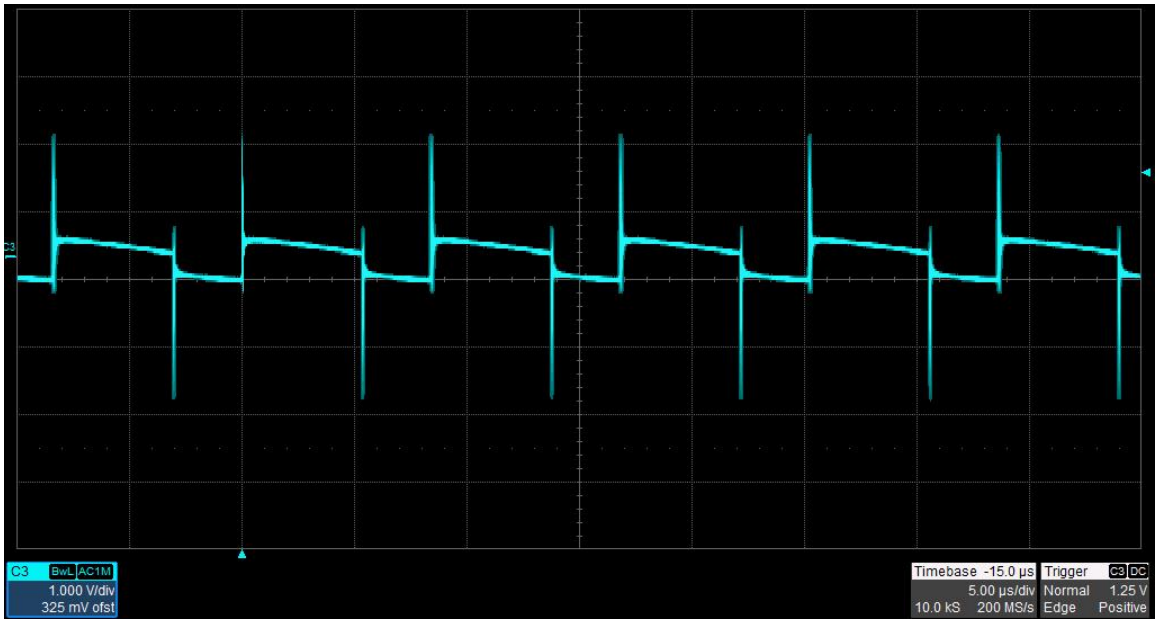
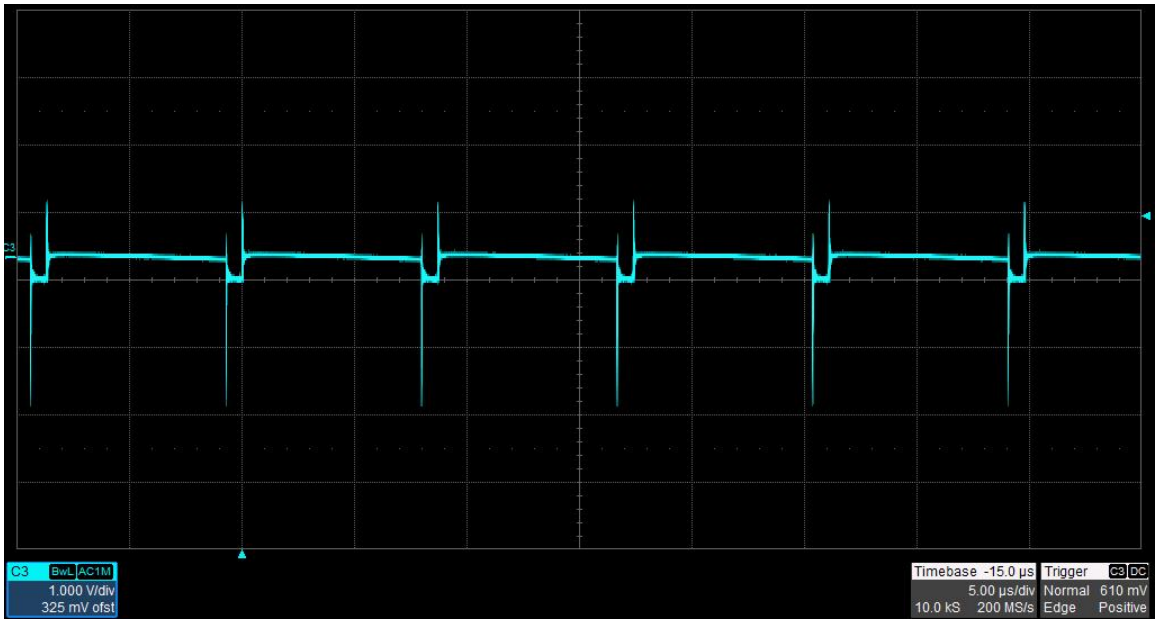
3.2 Output Ripple Voltage

The output ripple voltage (AC coupled) is shown in the figure below. BWL = 20 MHz, Vin = 142 V, Vout = 221 V, Iout = 0.9 A (1 V/DIV, 5 uS/DIV)



The output ripple voltage (AC coupled) is shown in the figure below. BWL = 20 MHz, Vin = 205 V, Vout = 221 V, Iout = 0.9 A (1 V/DIV, 5 uS/DIV)



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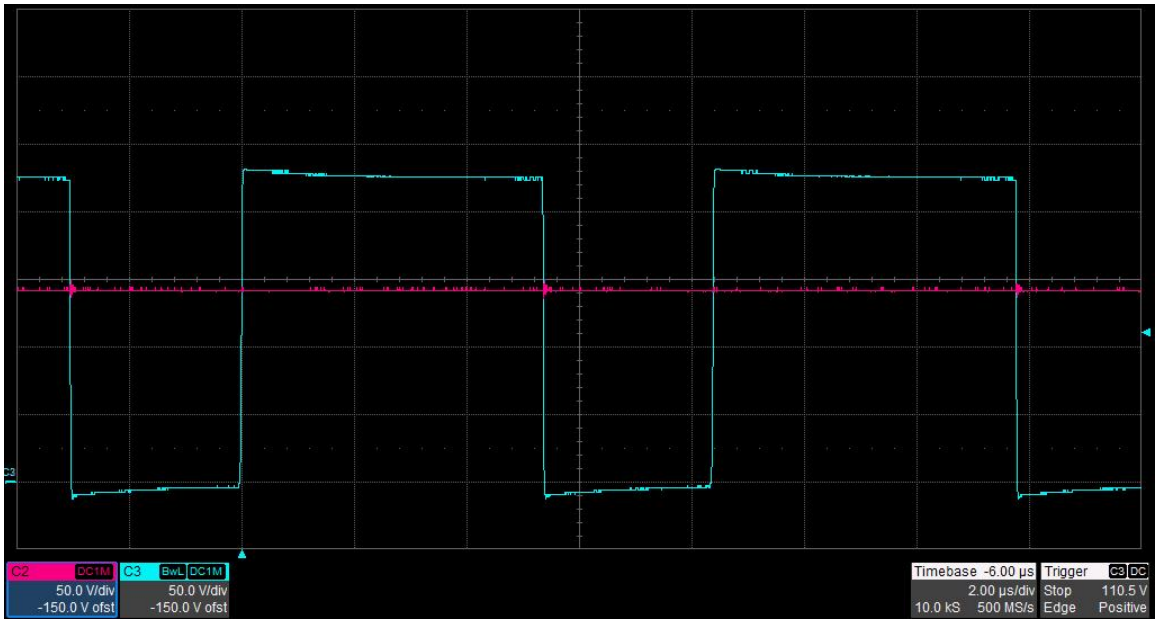
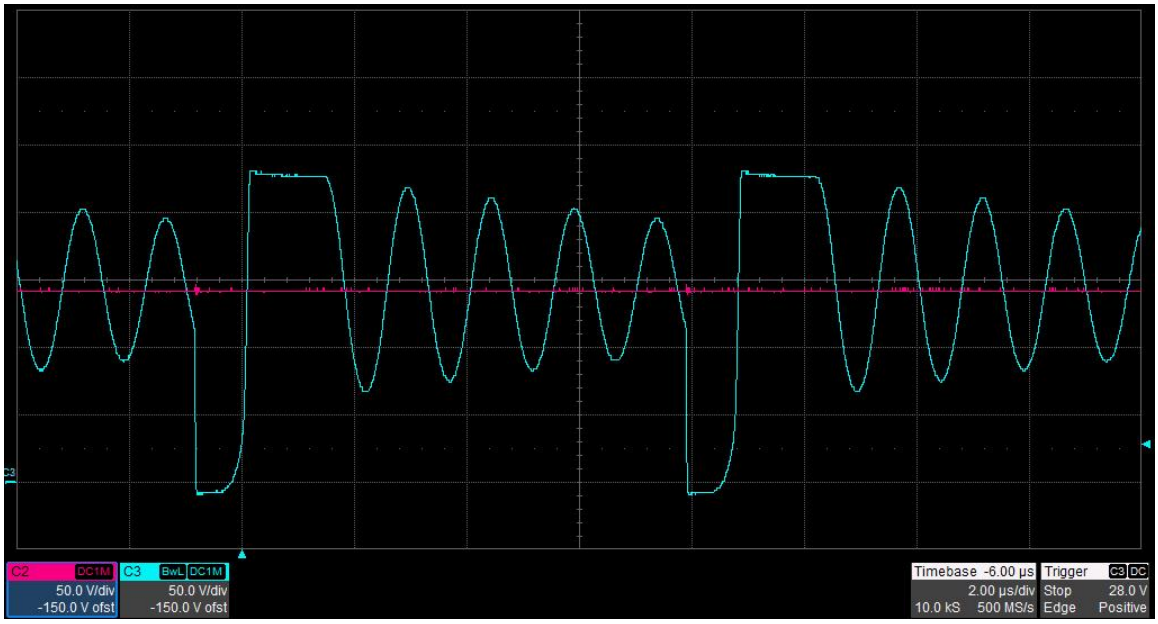
3.3 Switch Node Waveforms

The photo below shows the FET switching voltage at TP2 and the input voltage.
Vin = 142 V, Vout = 221 V, Iout = 0.9 A. (50 V/DIV, 2 uS/DIV)



The photo below shows the FET switching voltage at TP2 and the input voltage.
Vin = 142 V, Vout = 221 V, Iout = 0.019 A. (50 V/DIV, 2 uS/DIV)



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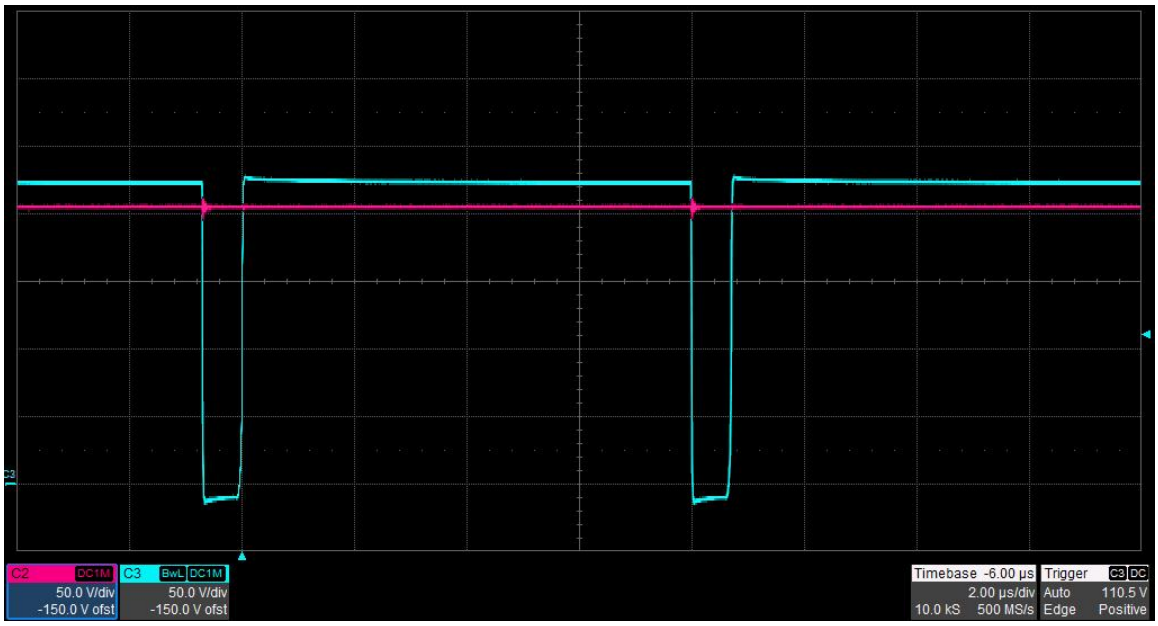
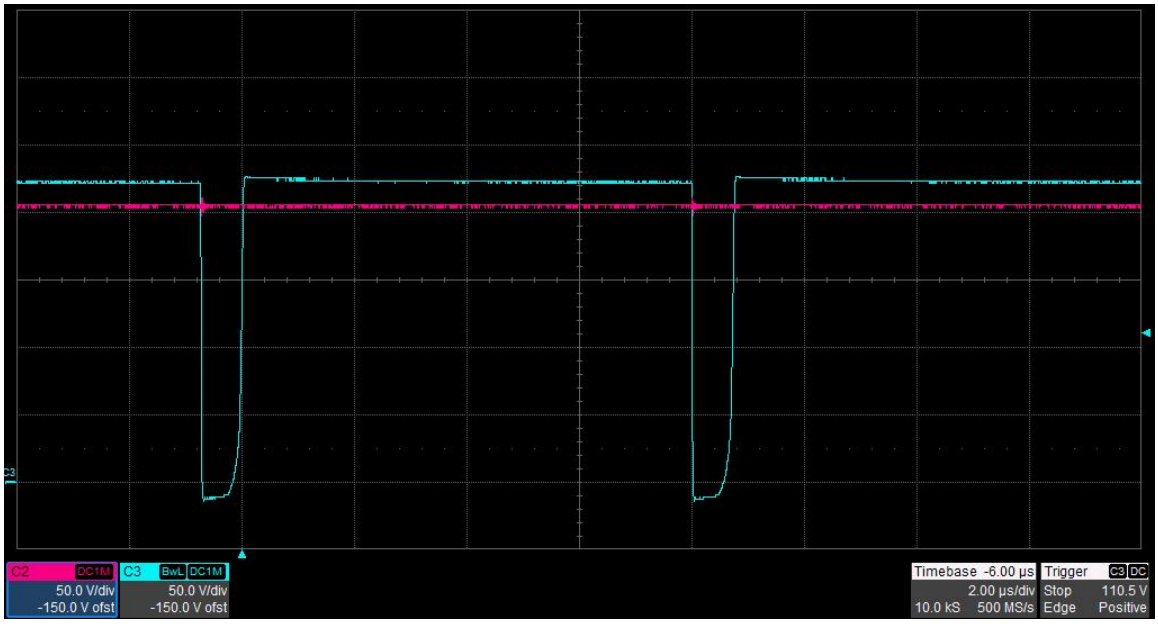
The photo below shows the FET switching voltage at TP2 and the input voltage.
Vin = 205 V, Vout = 221 V, Iout = 0.9 A. (50 V/DIV, 2 uS/DIV)



The photo below shows the FET switching voltage at TP2 and the input voltage.
Vin = 205 V, Vout = 221 V, Iout = 0.18 A. (50 V/DIV, 2 uS/DIV)



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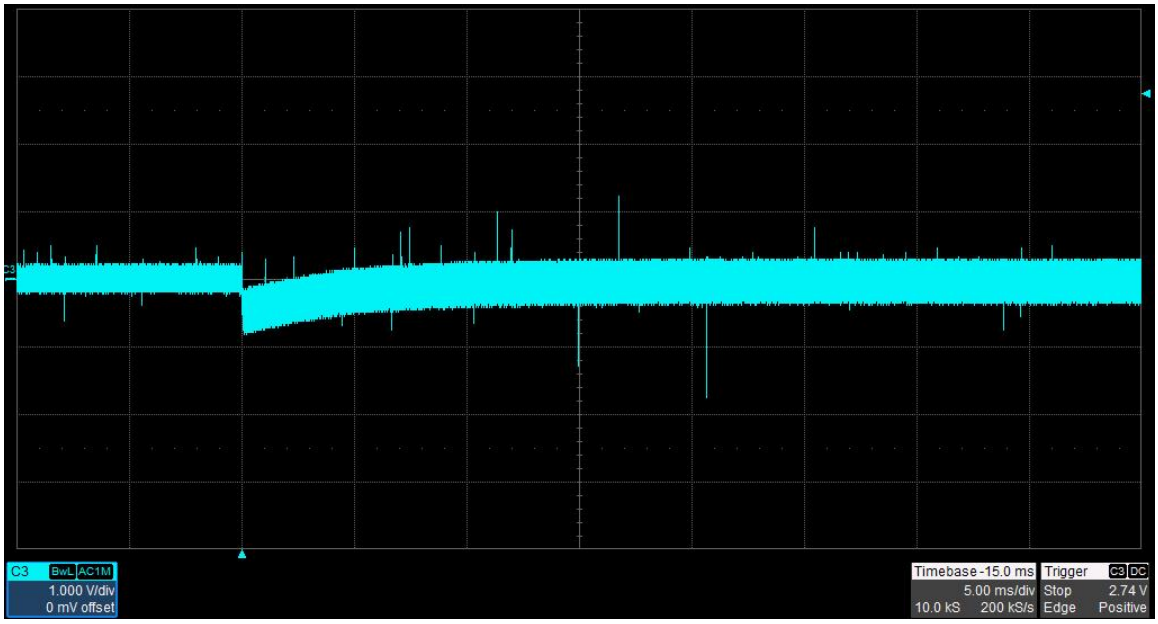
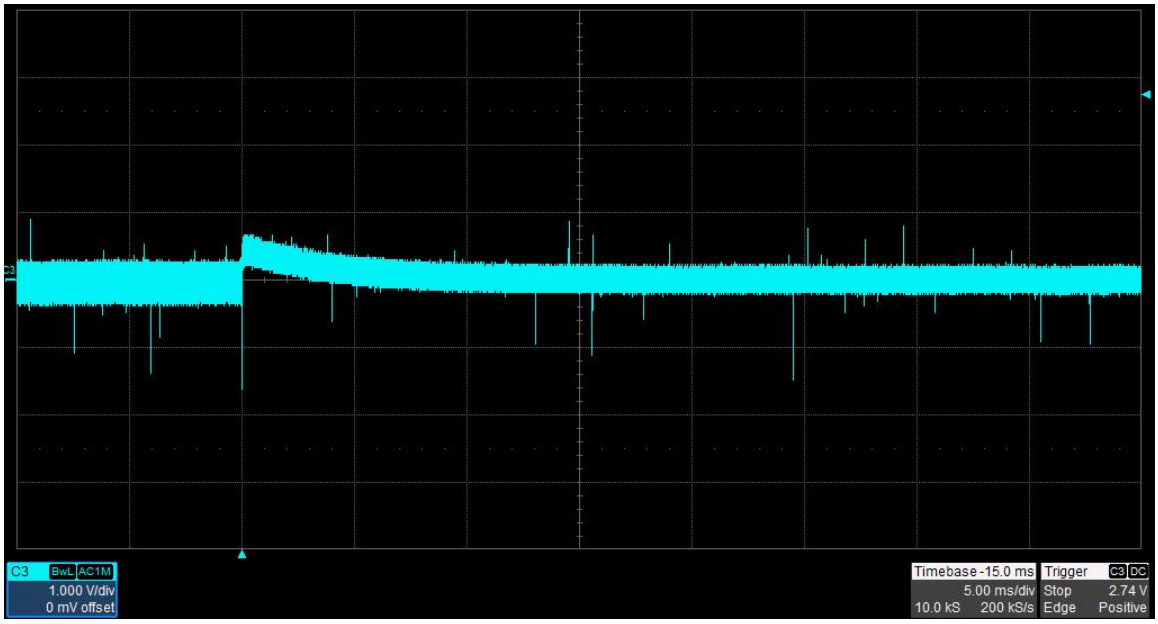
3.4 Load Transient

The photo below shows the 221 V output voltage (ac coupled) when the load current is stepped from 0.45 A to 0.9 A. Vin = 150 V. (1 V/DIV, 5 mS/DIV)



The photo below shows the 221 V output voltage (ac coupled) when the load current is stepped from 0.9 A to 0.45 A. Vin = 150 V. (1 V/DIV, 5 mS/DIV)



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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
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