Test Report: PMP31431

48V to 24V GaN Buck Converter Industrial Power Supply Reference Design

TEXAS INSTRUMENTS

Description

This reference design is designed for high efficiency and small form factor. The design showcases the LMG708B0 Gallium Nitride (GaN) synchronous buck converter and operates over an input voltage range of 44V to 52V to deliver a 24V at 9.5A output.
The design uses a printed circuit board with less than 34.6cm^2, which can be used to drive a 200W humanoid robot hand demo from a 48V battery.
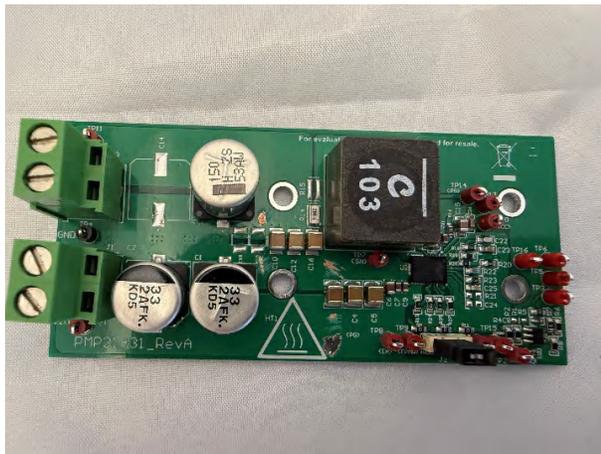
Resources

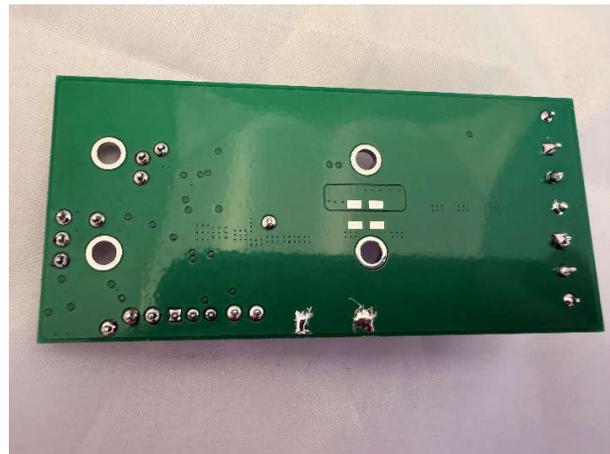|	
PMP31431	Design Folder
LMG708B0	Product Folder
TLV3401	Product Folder

Features

- Peak efficiency of 97.7%
- Adjustable current limit
- Forced pulse width modulation (PWM) or diode emulation
- Current monitoring
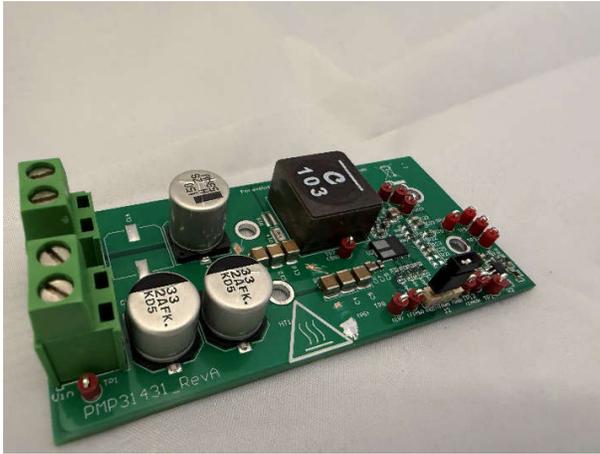- Integrated GaN field effect transistor (FET)

Applications

- Humanoid robot motor drive

Top View of Board

Bottom View of Board

Angled View 1 of Board

Angled View 2 of Board

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage Range	44V to 52V
Output Voltage	24V
Maximum Output Current	9.5A
Topology	Buck

1.2 Dimensions

The outline of the board is 86.5mm × 40mm with four copper layers. The copper thickness is 70µm on each layer.

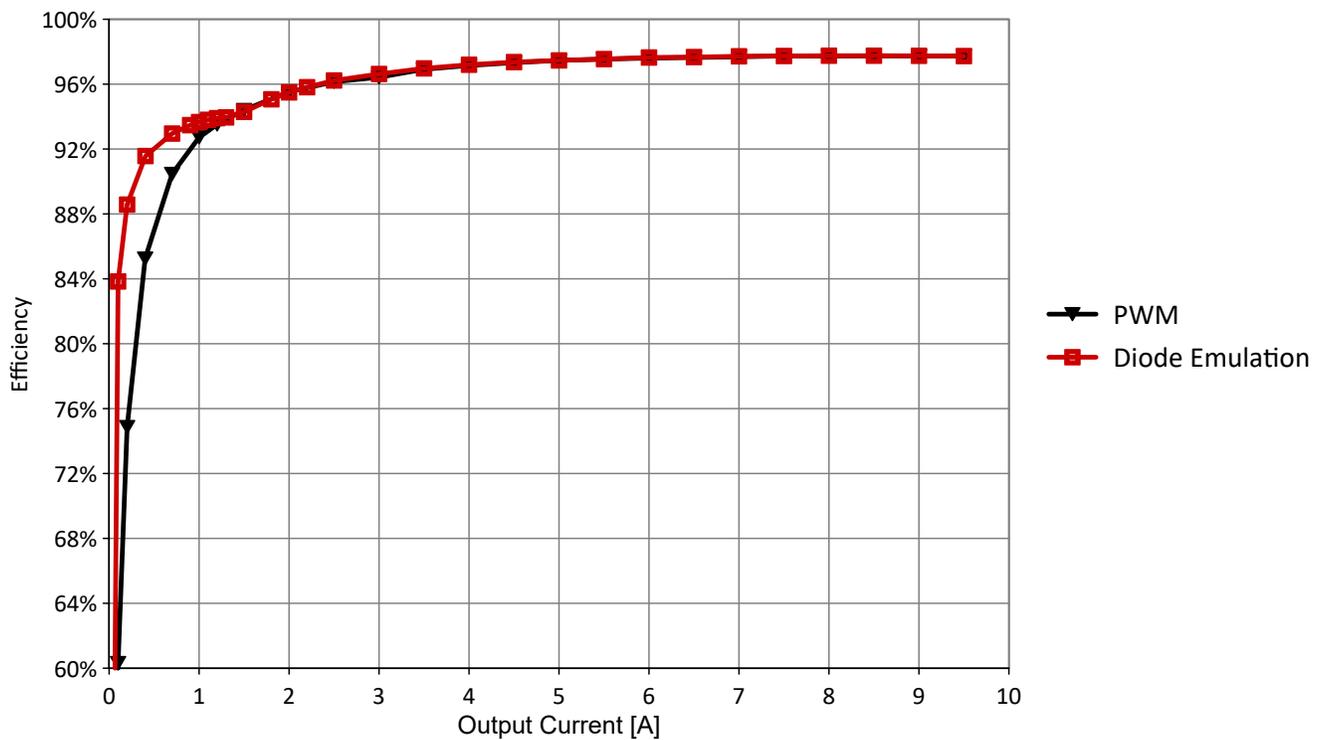# 2 Testing and Results

2.1 Efficiency Graphs
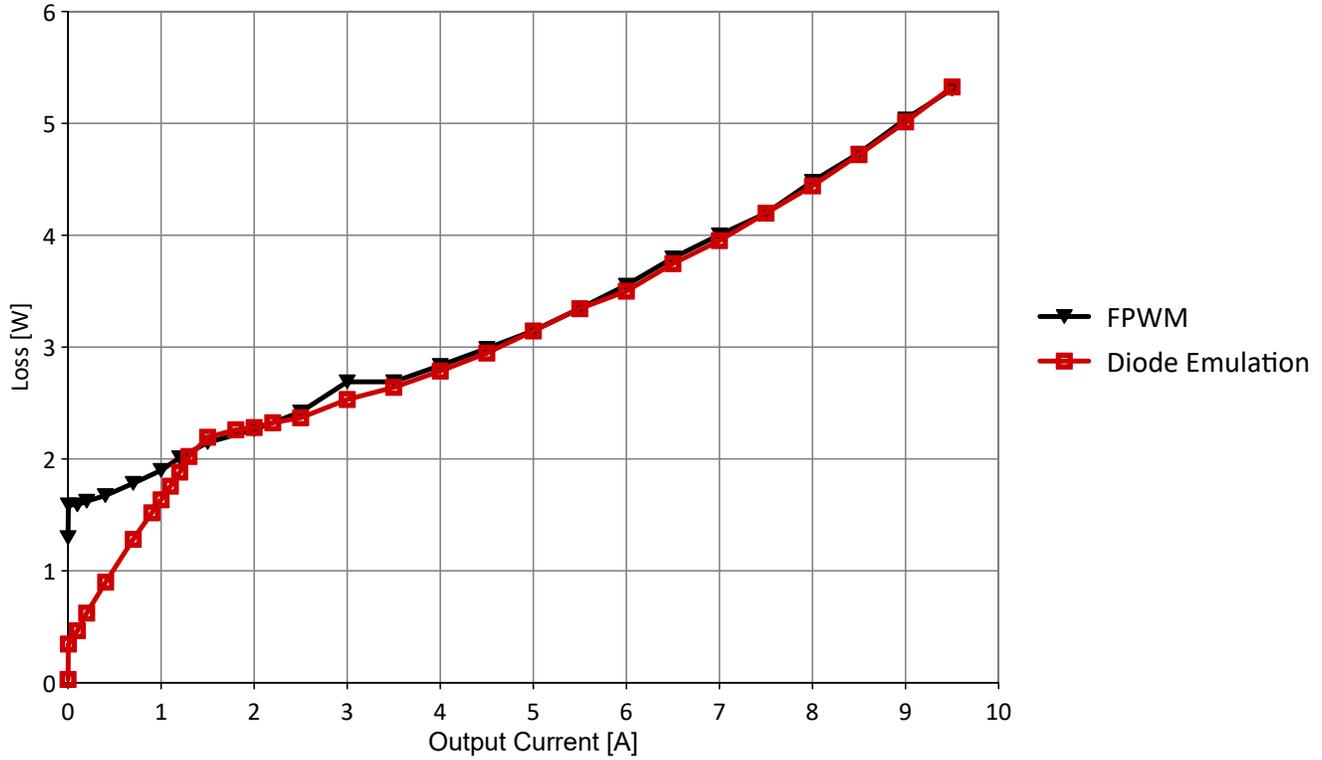

Figure 2-1. Efficiency versus Output Current

2.2 Loss Graph

Figure 2-2. Loss versus Output Current
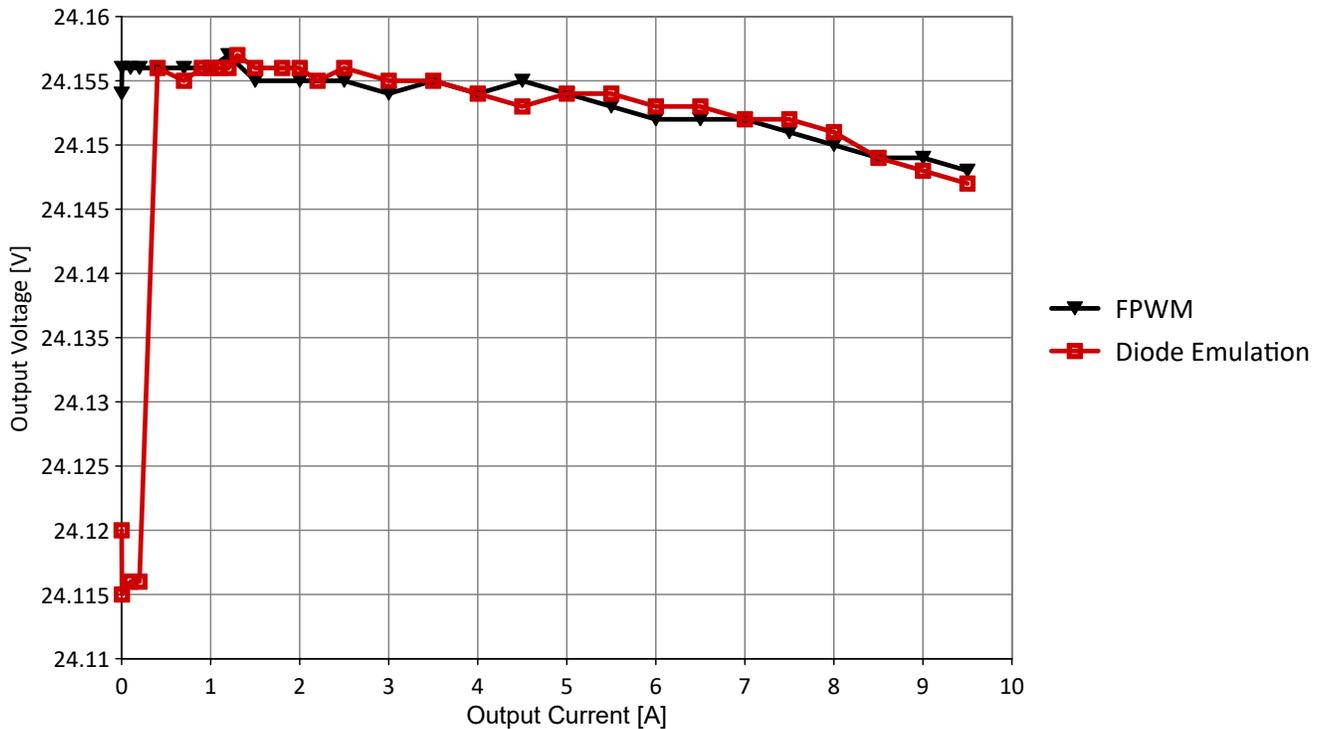
2.3 Load Regulation

Figure 2-3. Output Voltage versus Output Current

2.4 Thermal Images

The thermal image in Figure 2-4 was done after 10 minutes with 48V input voltage and 9.5A output current.
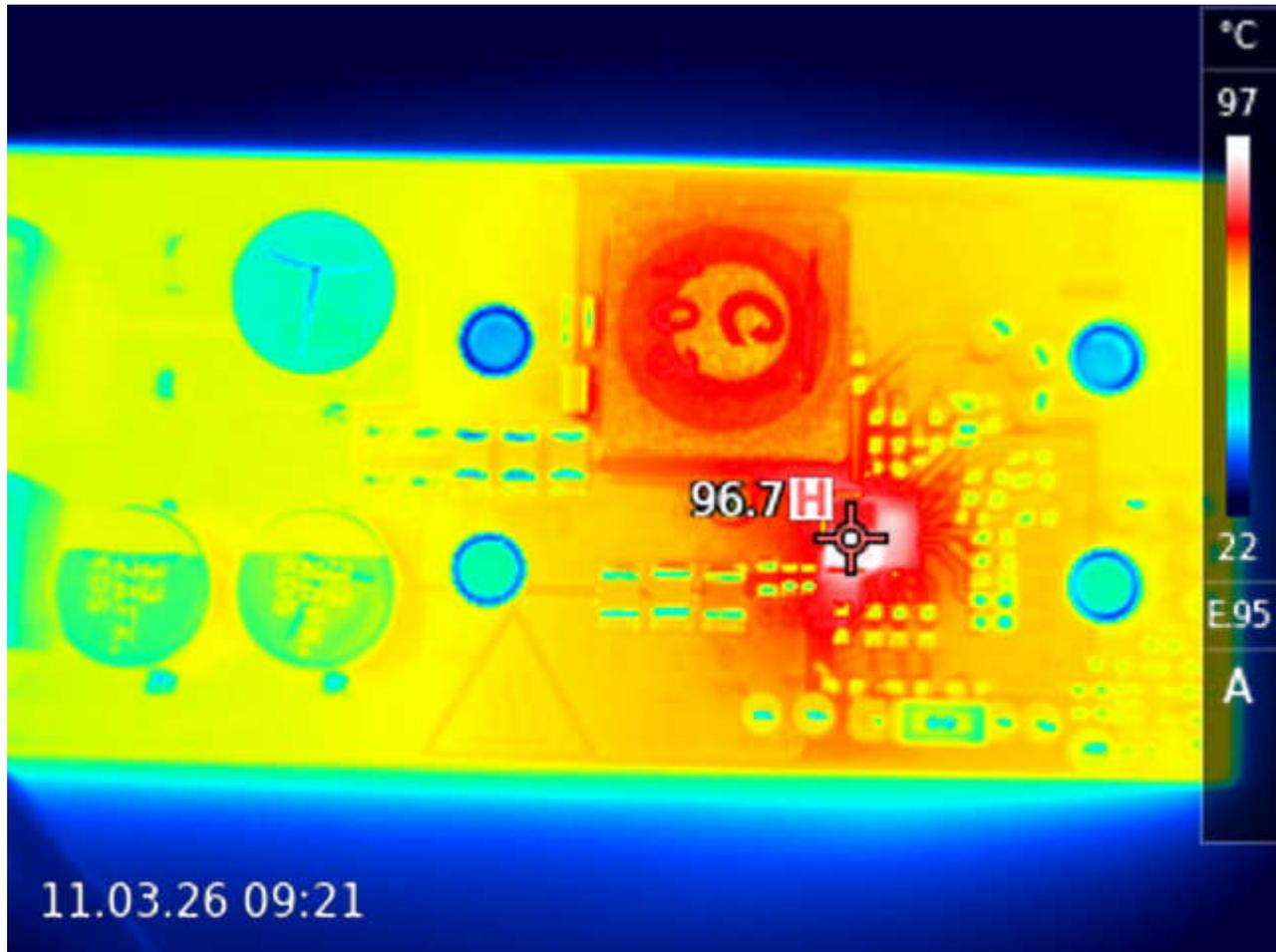

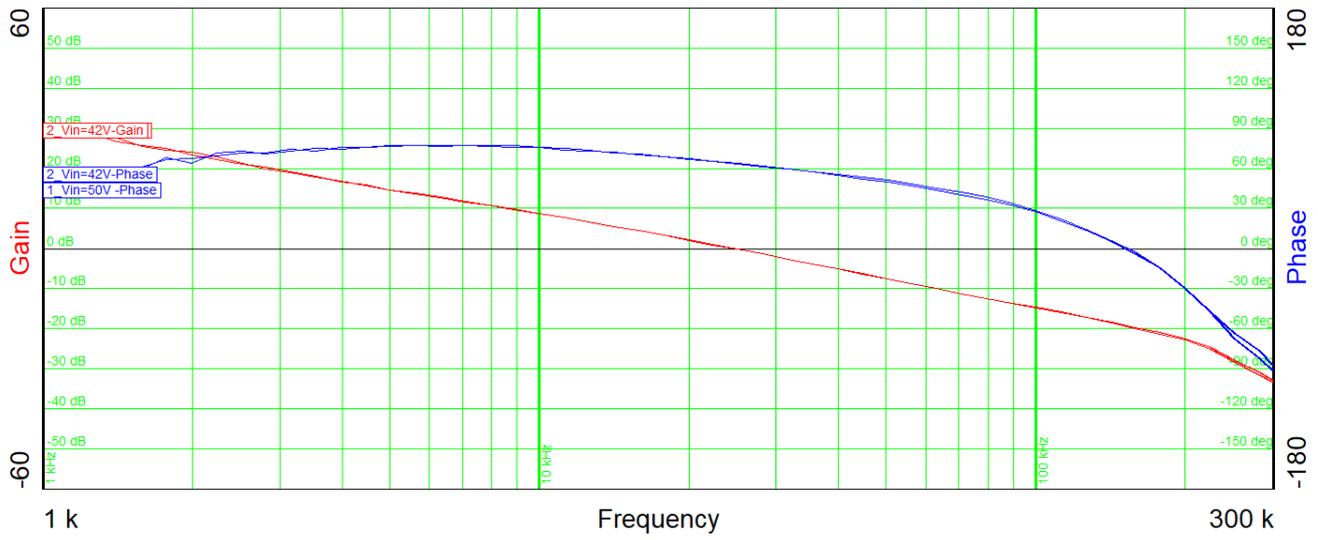**Figure 2-4. Thermal Image at 48V$_{IN}$ and 9.5A$_{OUT}$**

2.5 Bode Plots

Figure 2-5. Bode Plot with 9.5A$_{OUT}$

	42V$_{IN}$	50V$_{IN}$
Bandwidth (kHz)	24.5	24.4
Phase margin	64°	63.5°
Slope (20dB/decade)	-1.18	-1.17
Gain margin (dB)	-19.3	-19.5
Slope (20dB/decade)	-1.38	-1.44
Frequency (kHz)	152	151

3 Waveforms

All waveform images were captured with 48V input voltage.

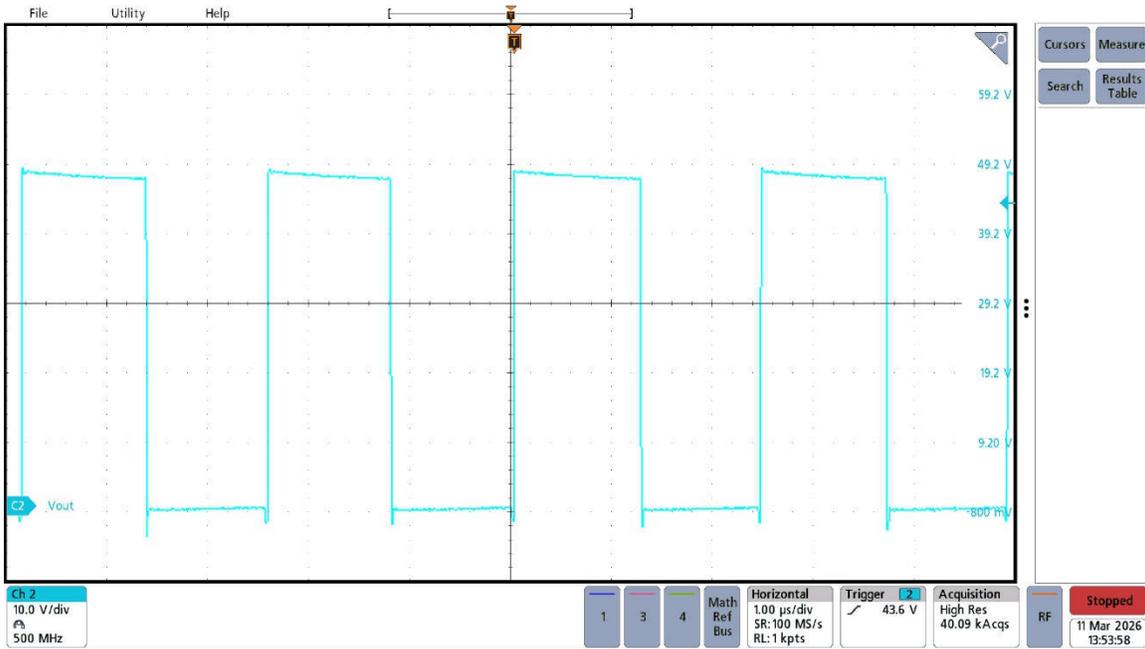## 3.1 Switching

3.1.1 9.5A Output Current

Figure 3-1. Switching With 1µs/div

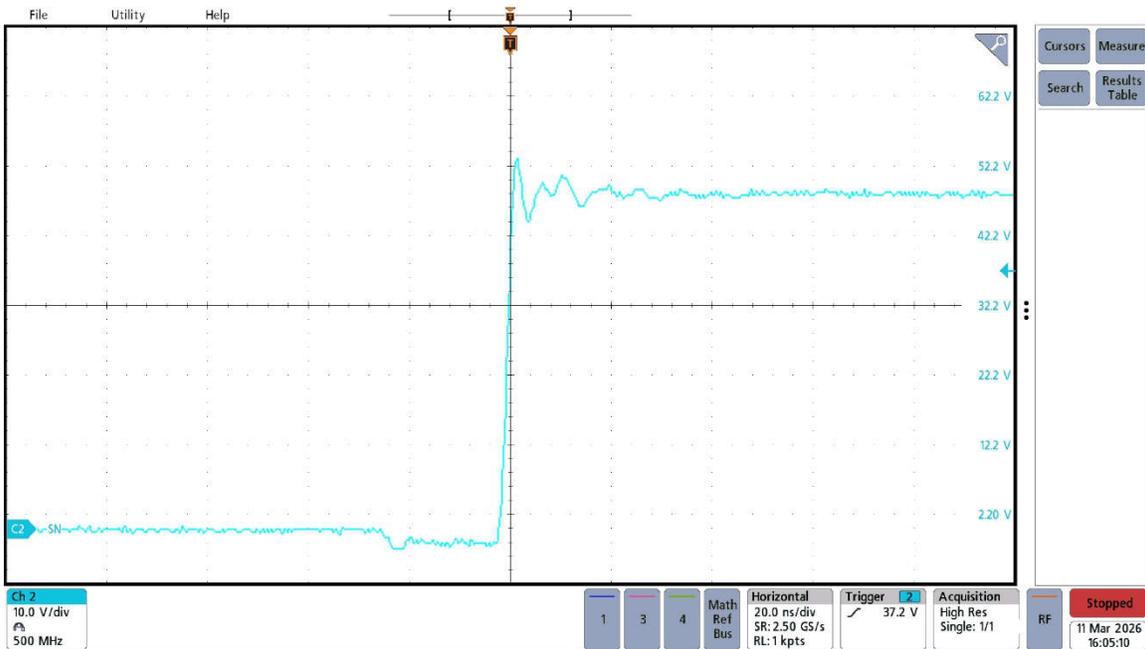Figure 3-2 displays the same measurement as in Figure 3-1 with a different time base.

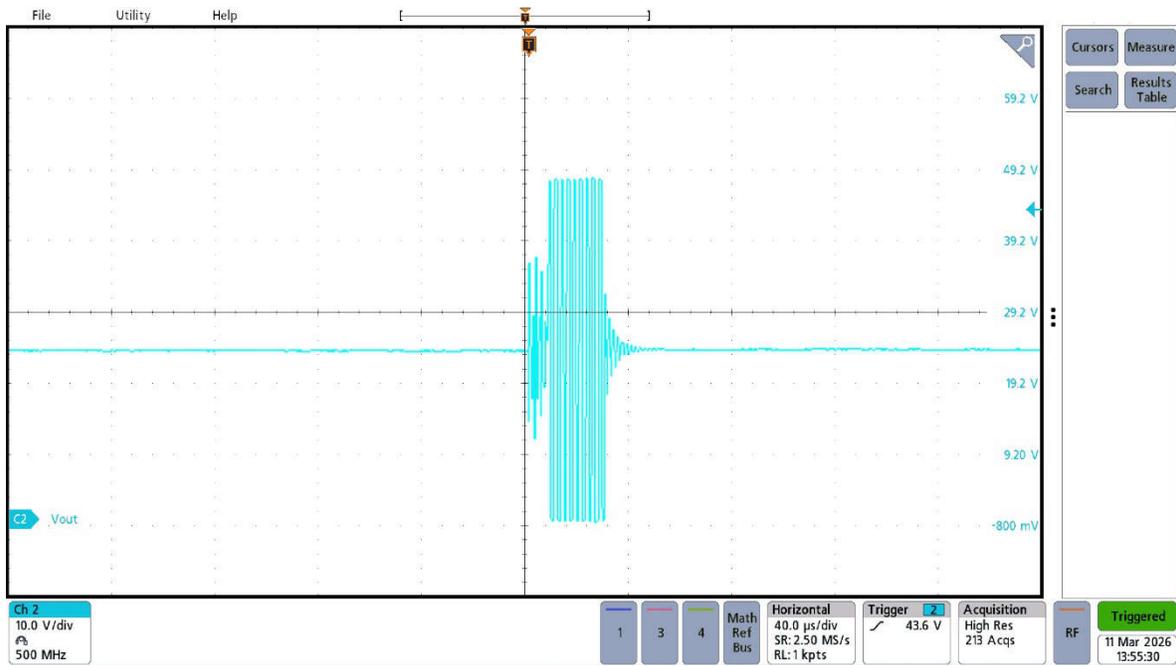**Figure 3-2. Switching with 20ns/div**

3.1.2 No Load

Figure 3-3. Switching without Load and 40μs/div
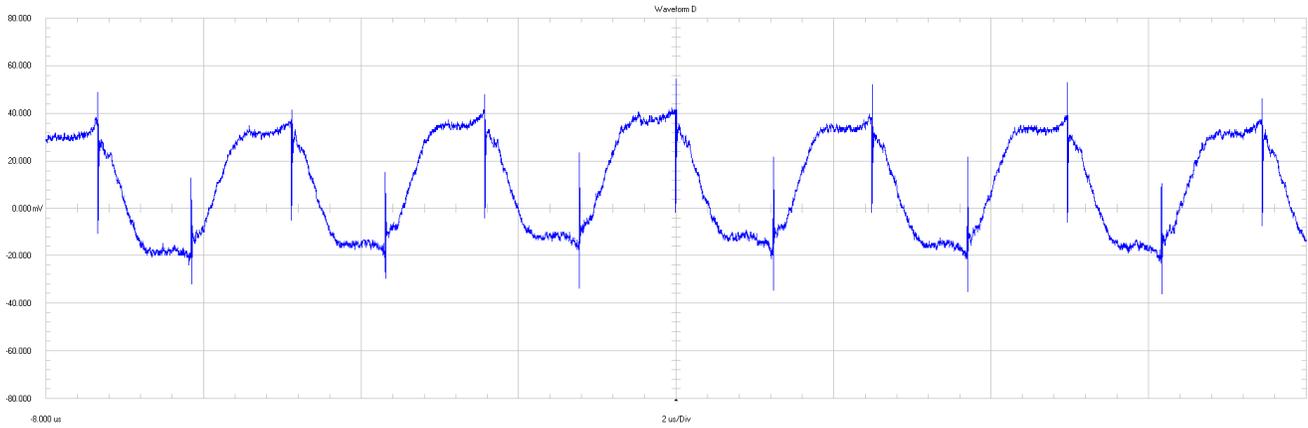
3.2 Output Voltage Ripple

Figure 3-4. Output Voltage Ripple with 9.5A Output Current (20mV/div; 20MHz Bandwidth)
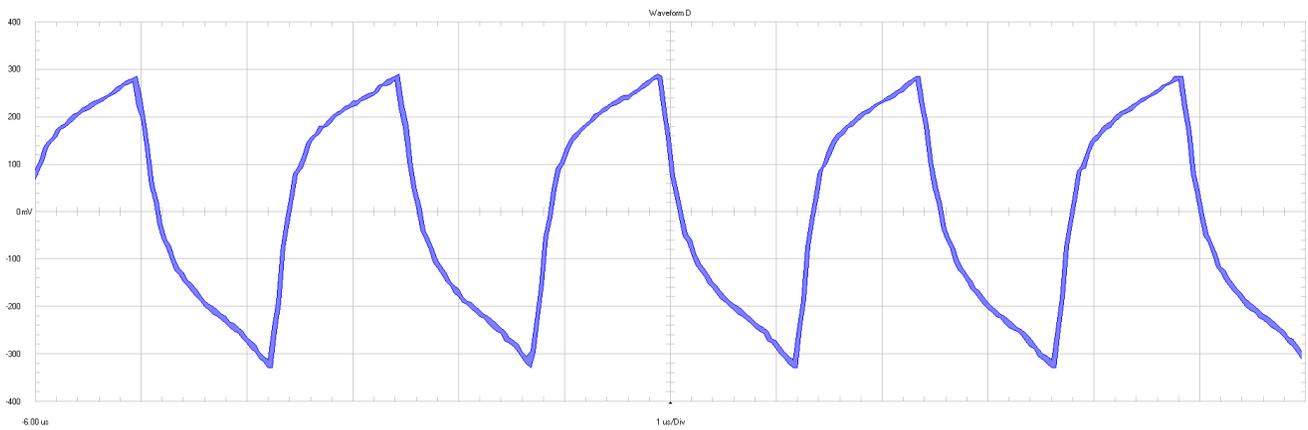
3.3 Input Ripple

Figure 3-5. Input Voltage Ripple with 9.5A Output Current (100mV/div; 20MHz Bandwidth)

3.4 Load Transients

3.4.1 4.5A to 9A Output Current

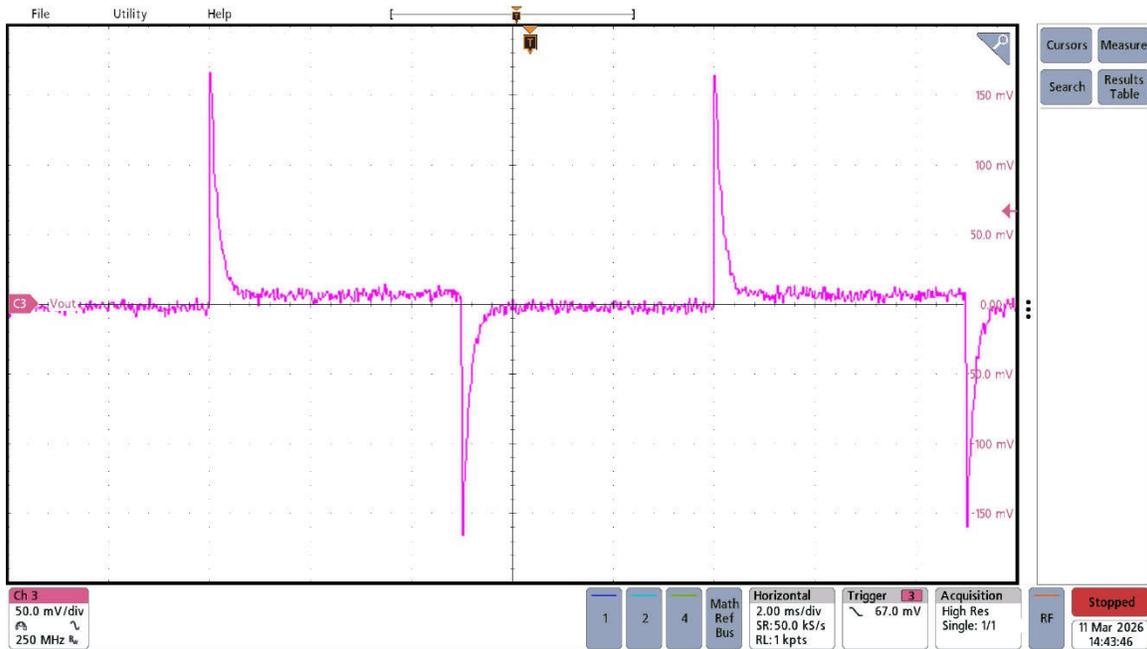**Figure 3-6. Load Transient 4.5A to 9A 50mV/div and 2ms/div**
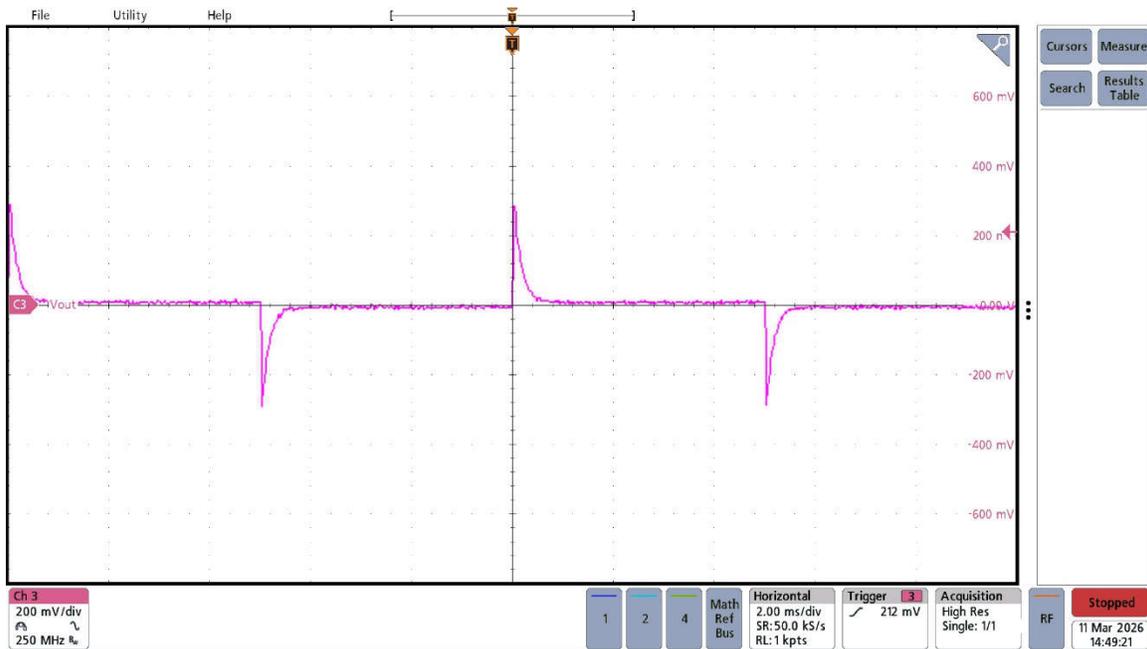
3.4.2 0A to 9A Output Current

3.4.2.1 FPWM Mode

Figure 3-7. Load Transient 0A to 9.5A FPWM Mode (200mV/div, 2ms/div)

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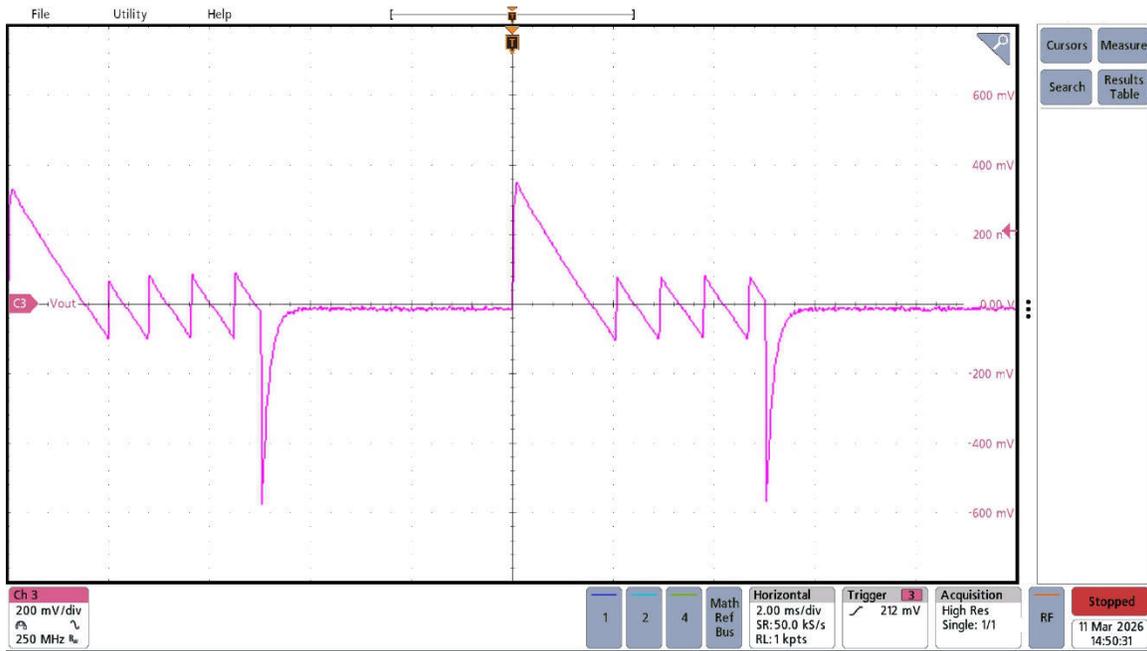
3.4.2.2 Diode Emulation Mode

Figure 3-8. Load Transient 0A to 9.5A Diode Emulation Mode (200mV/div, 2ms/div)

3.5 Start-up Sequence

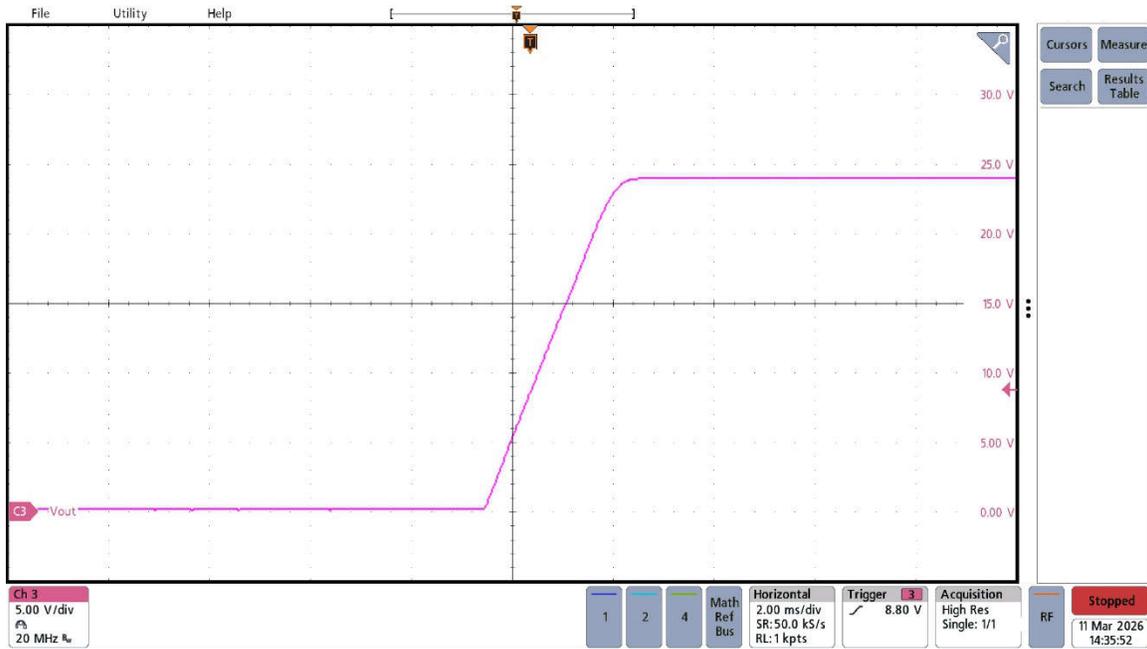### 3.5.1 Start-up into 9.5A Output Current

Figure 3-9. Start-up into 9.5A Output Current

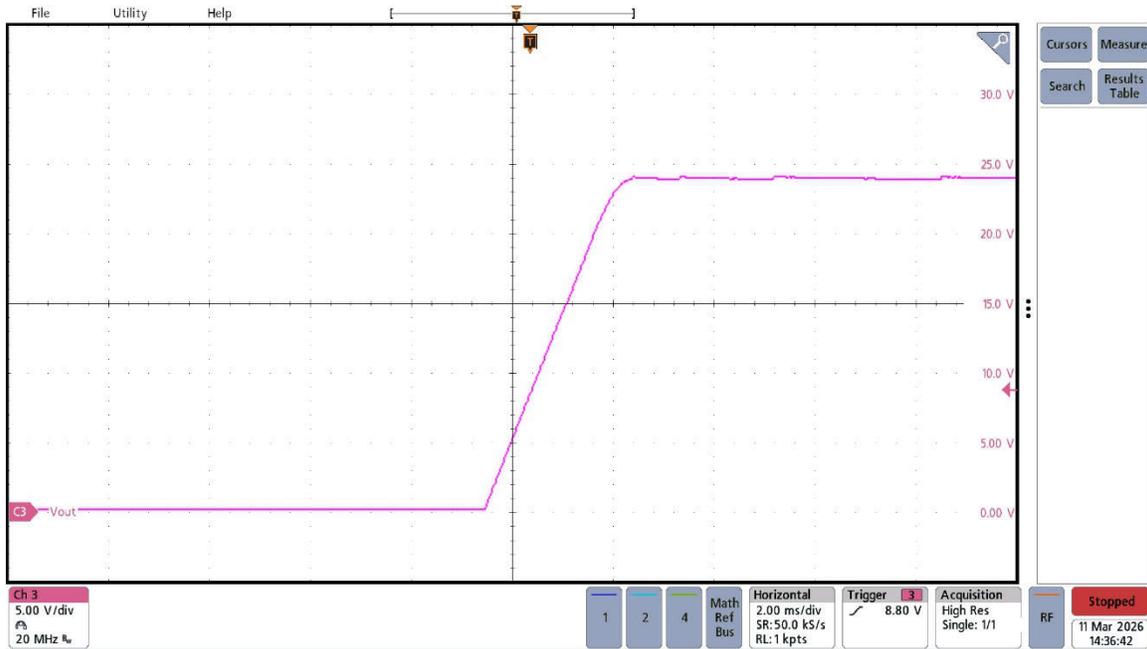### 3.5.2 Start-up without Load

Figure 3-10. Start-up without Load
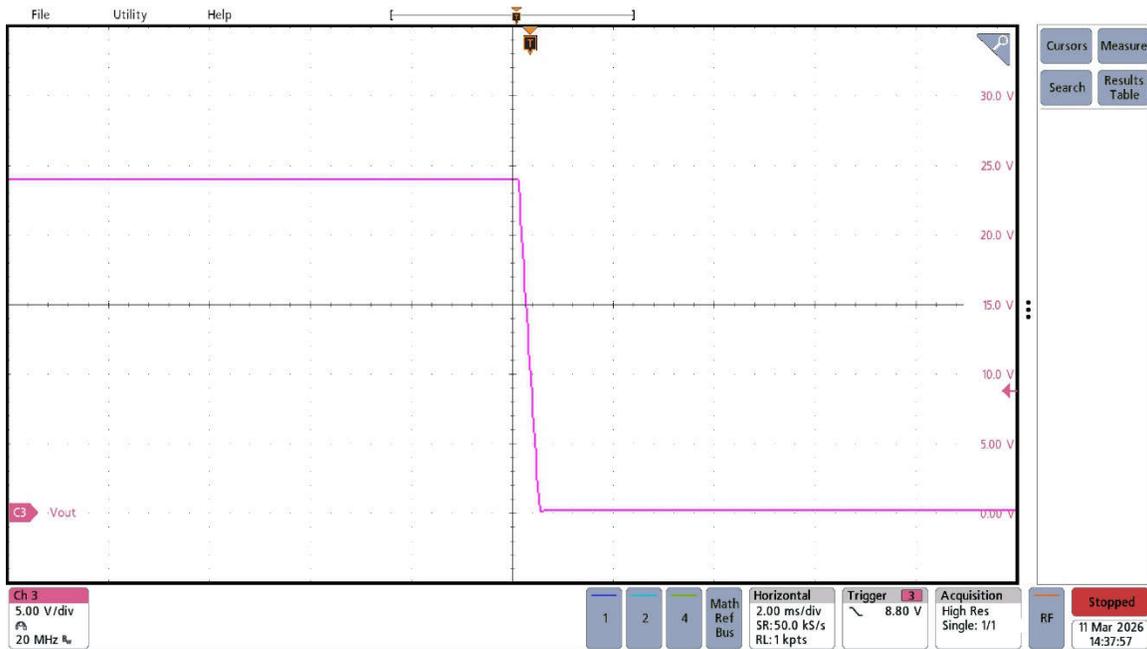
3.6 Shutdown Sequence

Figure 3-11. Shutdown from 9.5A Output Current

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