Test Report: PMP31333

Reinforced-Isolation LLC Converter Reference Design for SiC and GaN Driving Supply

Description

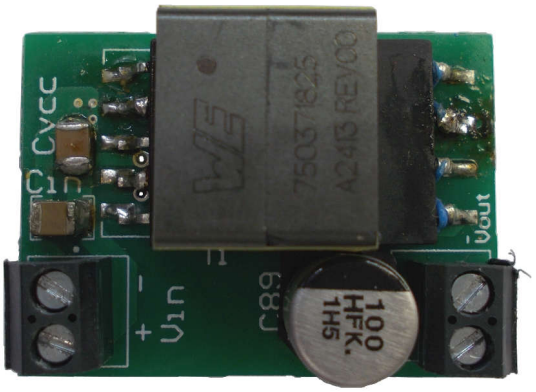
This small form factor power supply provides bias power to isolated silicon carbide (SiC) or gallium nitride (GaN) MOSFET gate drivers when extremely high dV/dT on the secondary side are expected, like in the case of wideband gap switches. The board accepts 24V input and supplies 12V at 200mA. The resonant inductor-inductor-capacitor (LLC) topology, combined to low primary to secondary winding capacitance, makes this converter an excellent choice for all low-noise and high CMTI (common mode transient immunity) applications, while significantly reducing common-mode current injection through the transformer. Even though this isolated LLC converter works in open-loop, the output voltage keeps tracking V_{IN} and has very low variation versus load current.

Features

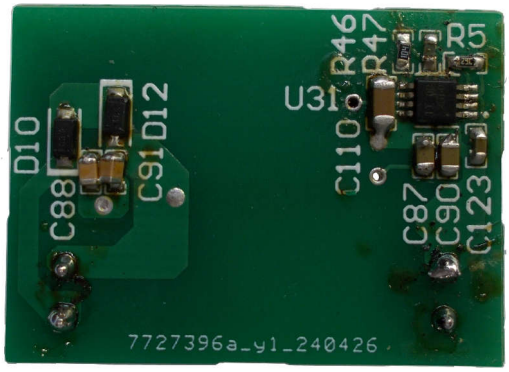
- Reinforced insulation
- Extreme low primary-secondary winding capacitance
- Regulated $24V_{IN}$ to $12V_{OUT}$
- Tested with 30µF switched output capacitance (first activation of high-side GaN or SiC-FET)
- Resonant (secondary side) LLC topology

Applications

- Onboard charger
- AC charging (pile) station
- Central inverter
- Mobile robot motor control



Top Photo



Bottom Photo

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1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	24V
Output Voltage	12V
Maximum Output Current	0.2A
IC	UCC25800-Q1

1.2 Considerations

Unless otherwise indicated, all test were done with 24V input voltage and 0.2A output current adjusted with a sliding resistor.

1.3 Dimensions

The size of the two-layer board is 35mm × 26mm.

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2 Testing and Results

2.1 Efficiency Graphs

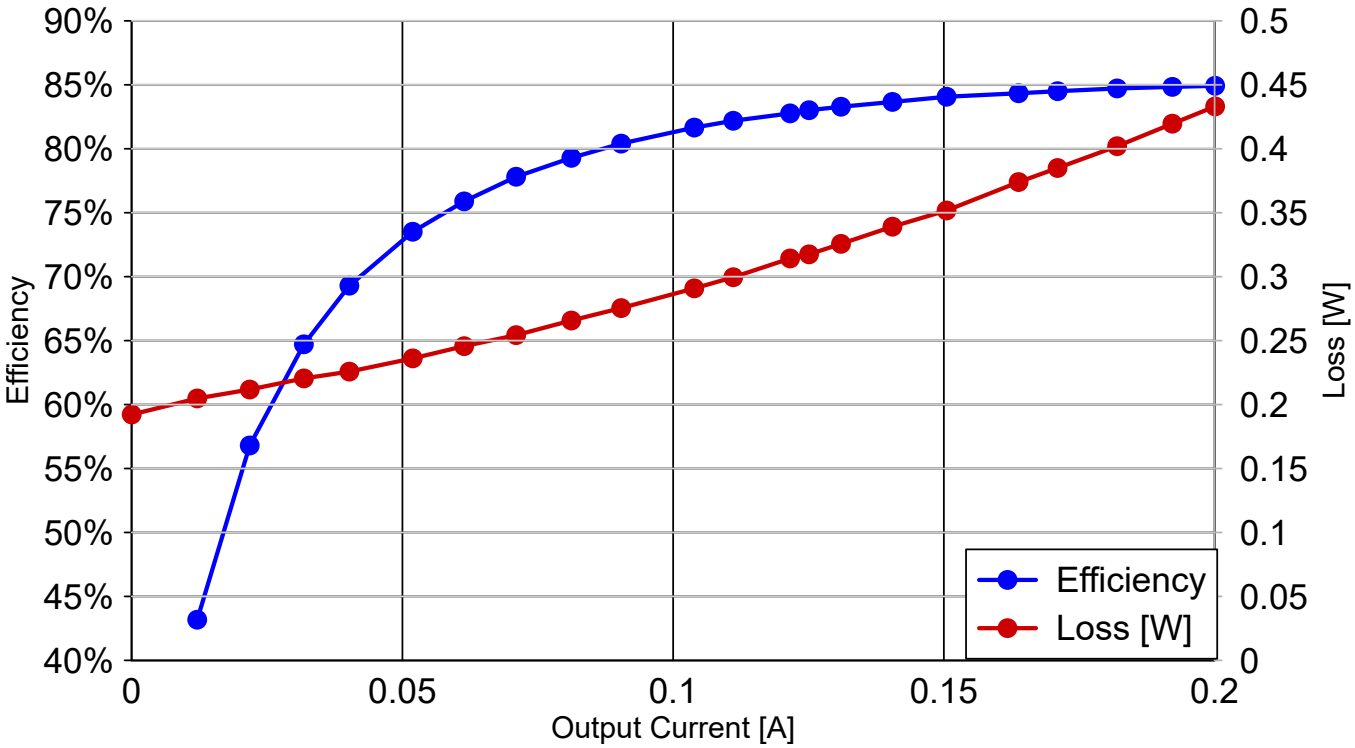

Figure 2-1. Efficiency and Loss Versus Output Current

2.2 Load Regulation

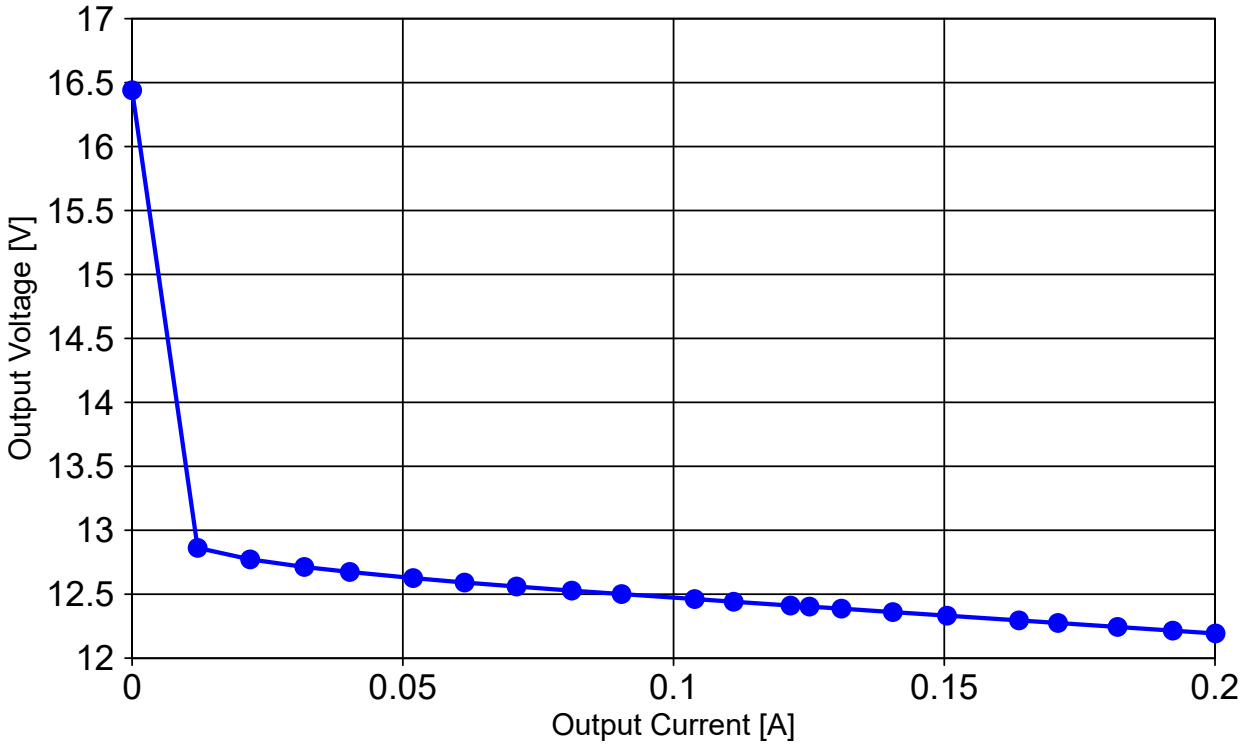

Figure 2-2. Output Voltage Versus Output Current

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2.3 Dependency of the Output Voltage to Input Voltage

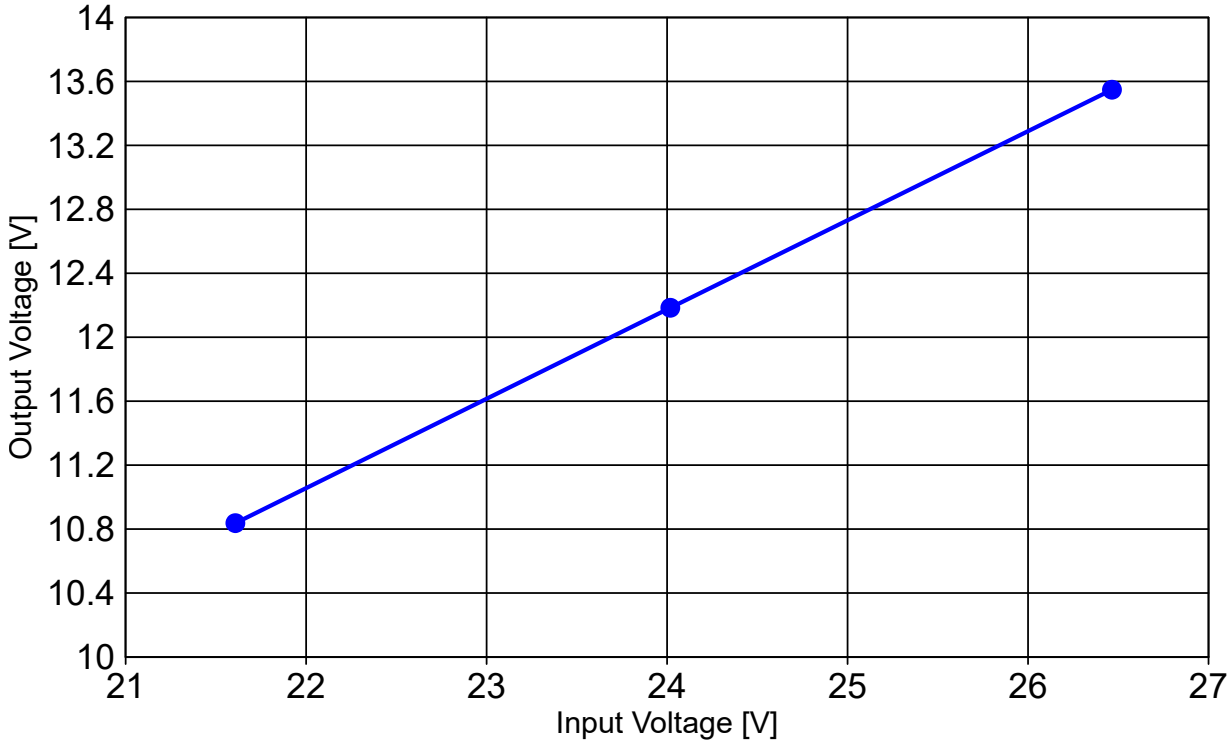

Figure 2-3. Output Voltage Versus Input Voltage

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3 Waveforms

3.1 Switching

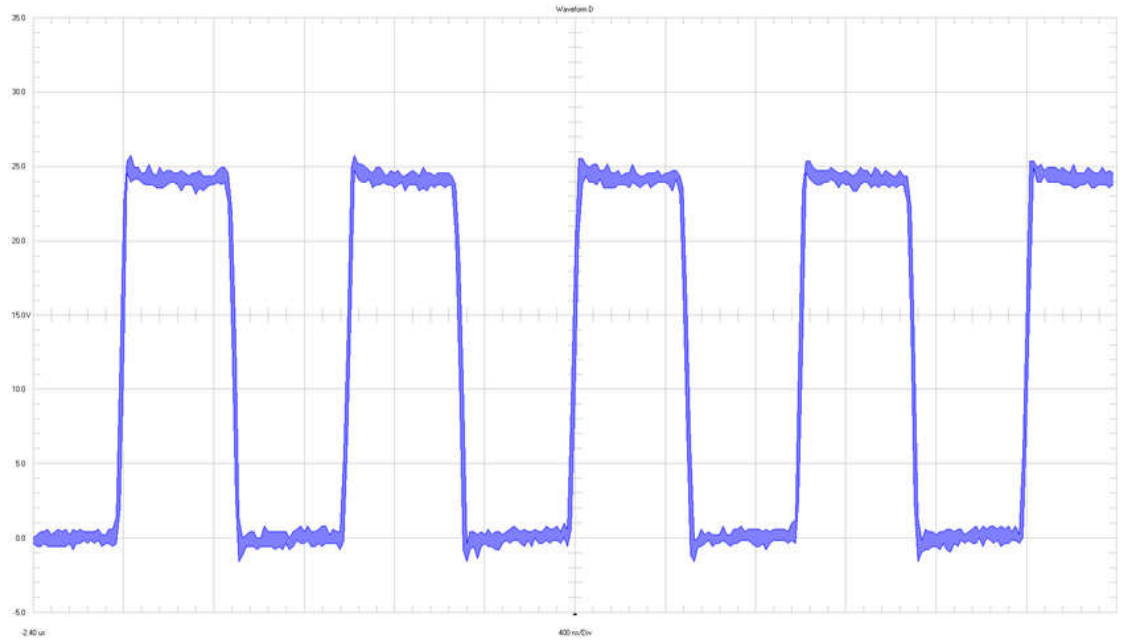

Figure 3-1. Switch-Node (Primary Side, 24V_{in}, 0.2A_{out}), 5V/div, 400nsec/div, Full Bandwidth

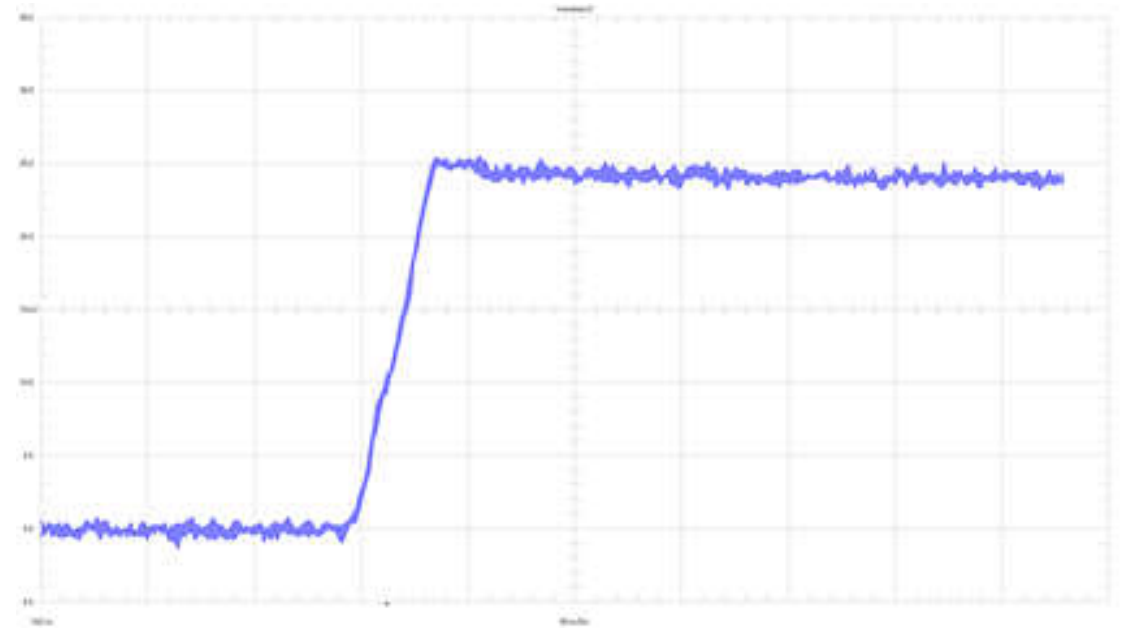

Figure 3-2. Switch-Node (Primary Side, 24V_{in}, 0.2A_{out}), 5V/div, 400nsec/div, Full Bandwidth

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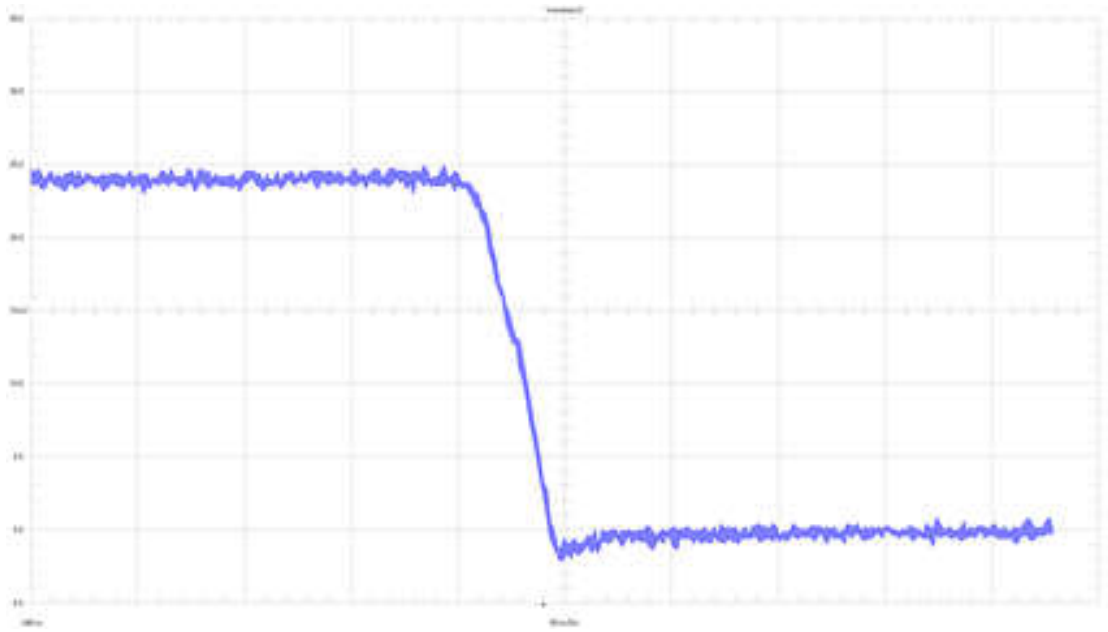

Figure 3-3. Switch-Node Fall Time (Primary Side, 24V_{in}, 0.2A_{out}), 5V/div, 50nsec/div, Full Bandwidth

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3.2 Input Voltage Ripple

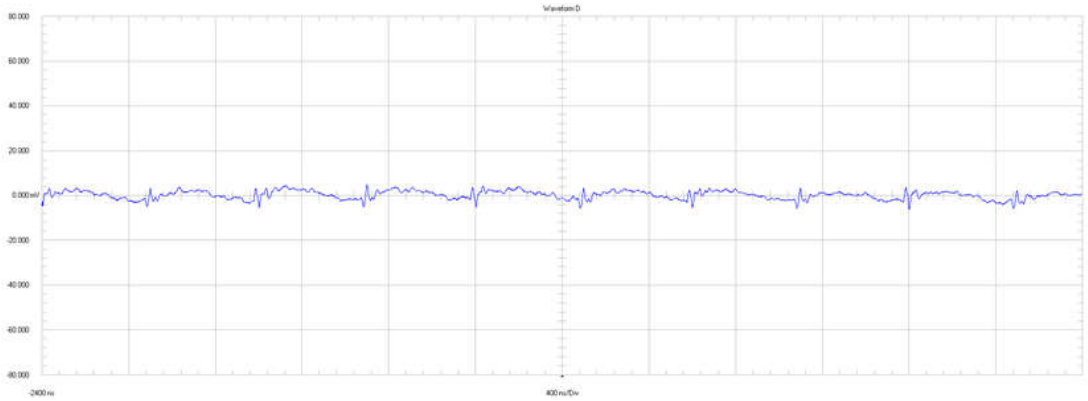

Figure 3-4. Input Voltage Ripple ($24V_{IN}$, $0.2A_{OUT}$) 20mV/div, 400ns/div, 20MHz Bandwidth

3.3 Output Voltage Ripple

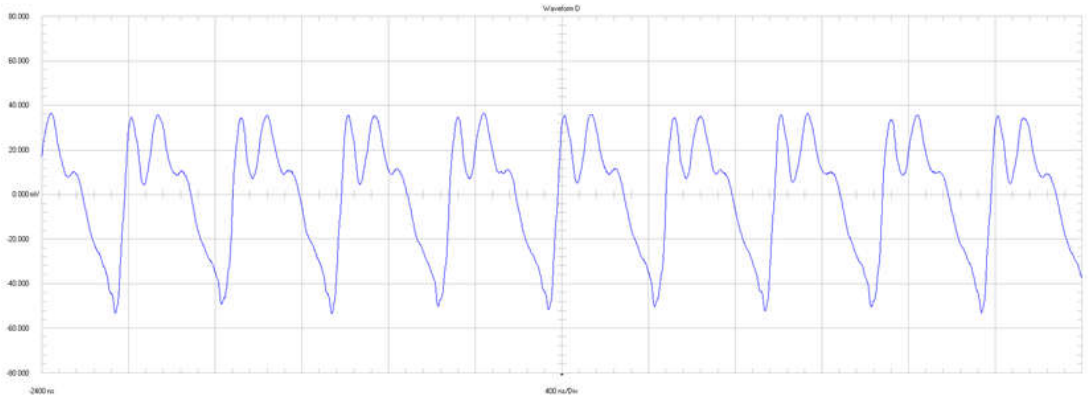

Figure 3-5. 20mV/div, 400ns/div, 20MHz Bandwidth

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3.4 Load Transients

The electronic load switches between 0.1A and 0.2A with a frequency of 100Hz.

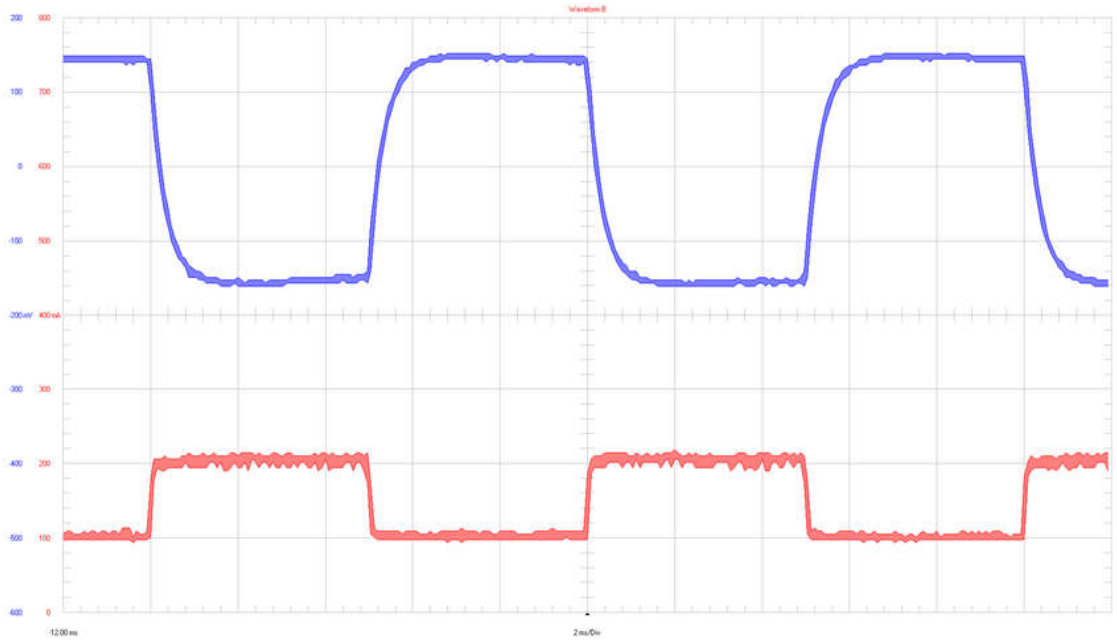

Figure 3-6. Load Transient (24V_{IN}) V_{out} (100mV/div), I_{out} (100mA/div), 2ms/div, 10kHz Bandwidth

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3.5 Start-up Sequence

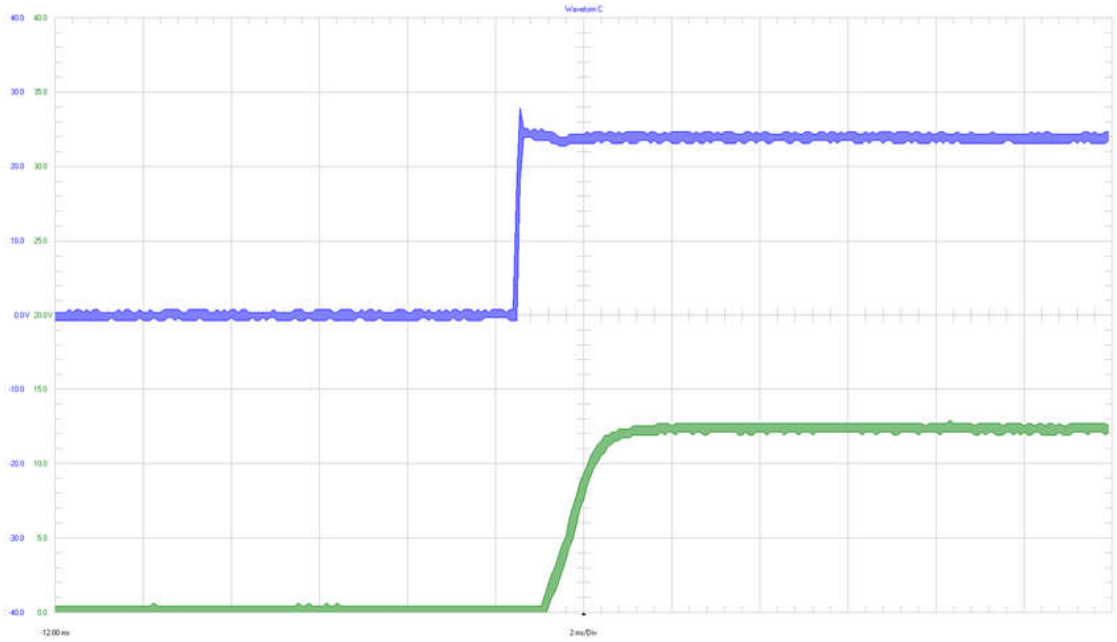

Figure 3-7. Start-up with Electronic Load (24V_{IN}, 0.2A_{OUT}) V_{in} (10V/div), V_{out} (5V/div), 2ms/div, 20MHz Bandwidth

3.6 Shutdown Sequence

The power supply was disconnected.

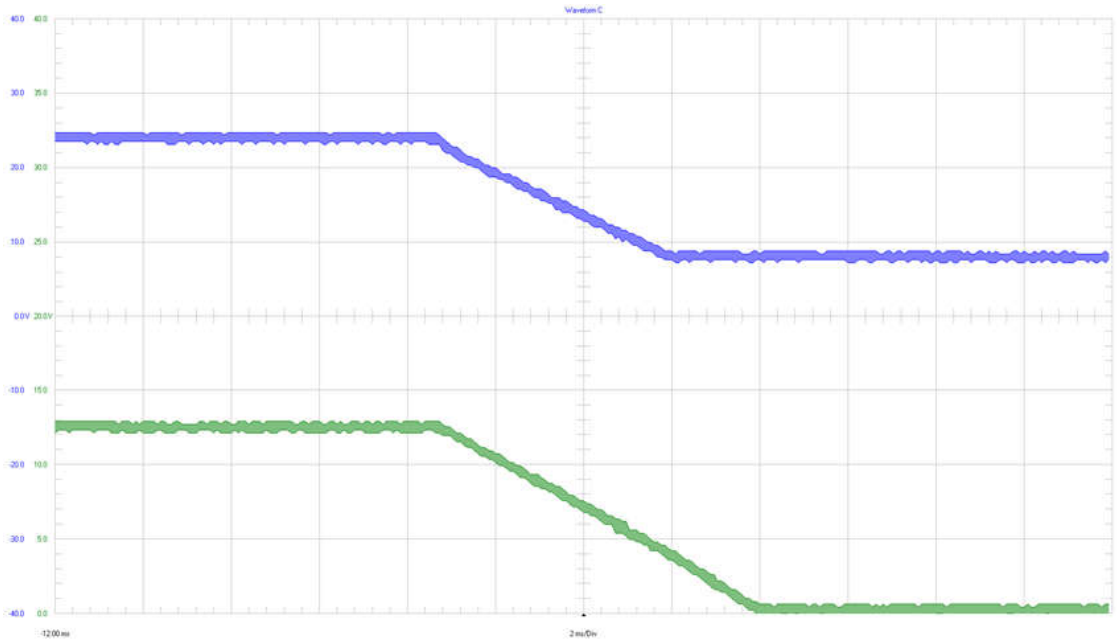

Figure 3-8. Shutdown with Electronic Load (24V_{IN}, 0.2A_{OUT}) V_{in} (10V/div), V_{out} (5V/div), 2ms/div, 20MHz Bandwidth

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