Test Report: PMP31406

Quasi-Resonant GaN Flyback Reference Design

Description

This reference design generates a 24V output with 2.5A load current from a 195V_{AC} to 265V_{AC} input. This design uses the self-biasing gallium nitride (GaN) flyback UCG28826. This design can deliver 60W output power. The design does not need an auxiliary transformer winding because this device has a self-bias and auxless sensing scheme integrated. The design operates at 130kHz switching frequency for full load and reduces switching frequency for medium or light load to keep efficiency high.

Features

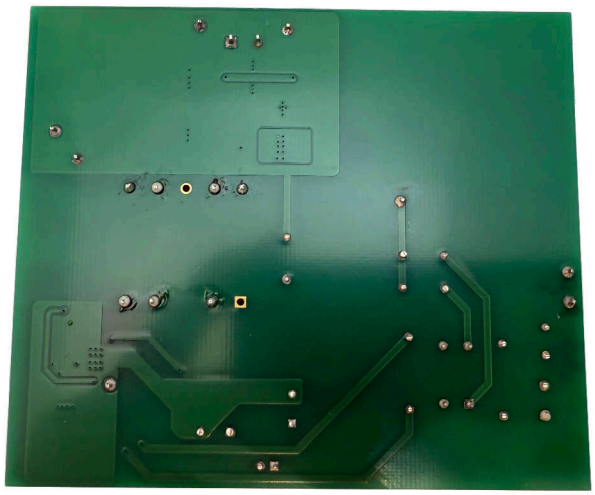
- Aux-less sensing eliminates the need for an auxiliary winding
- Switching frequency less than 130kHz
- Output: 24V at 2.5A
- Integrated GaN FET with quasi-resonant operation

Applications

- Dishwasher
- Washer and dryer

Resources

PMP31406	Design Folder
UCG28826	Product Folder
UCC24612	Product Folder
TL431	Product Folder



1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage Range	$195V_{AC}$ to $265V_{AC}$
Output Voltage	24V
Maximum Output Current	2.5A

1.2 Dimensions

The outline of the two-layer board is 101.25mm × 86.5mm.

2 Testing and Results

2.1 Efficiency Graph

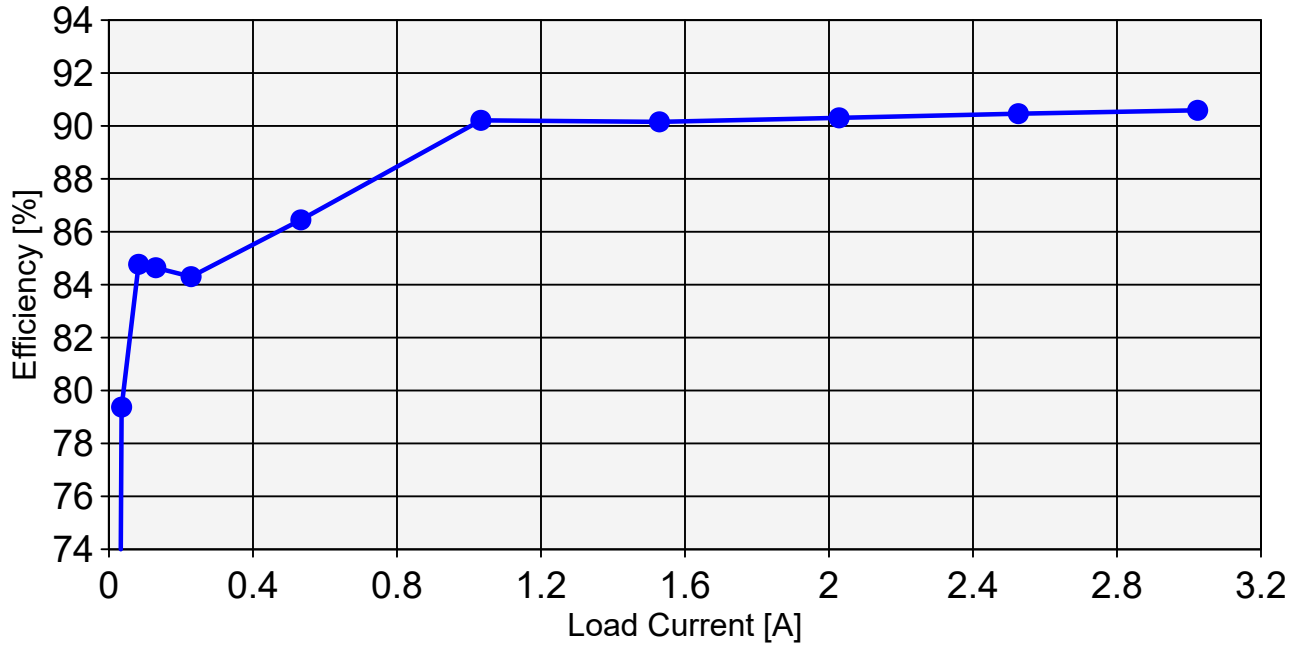


Figure 2-1. Efficiency versus Output Current for 230V_{AC} Input Voltage

2.2 Load Regulation

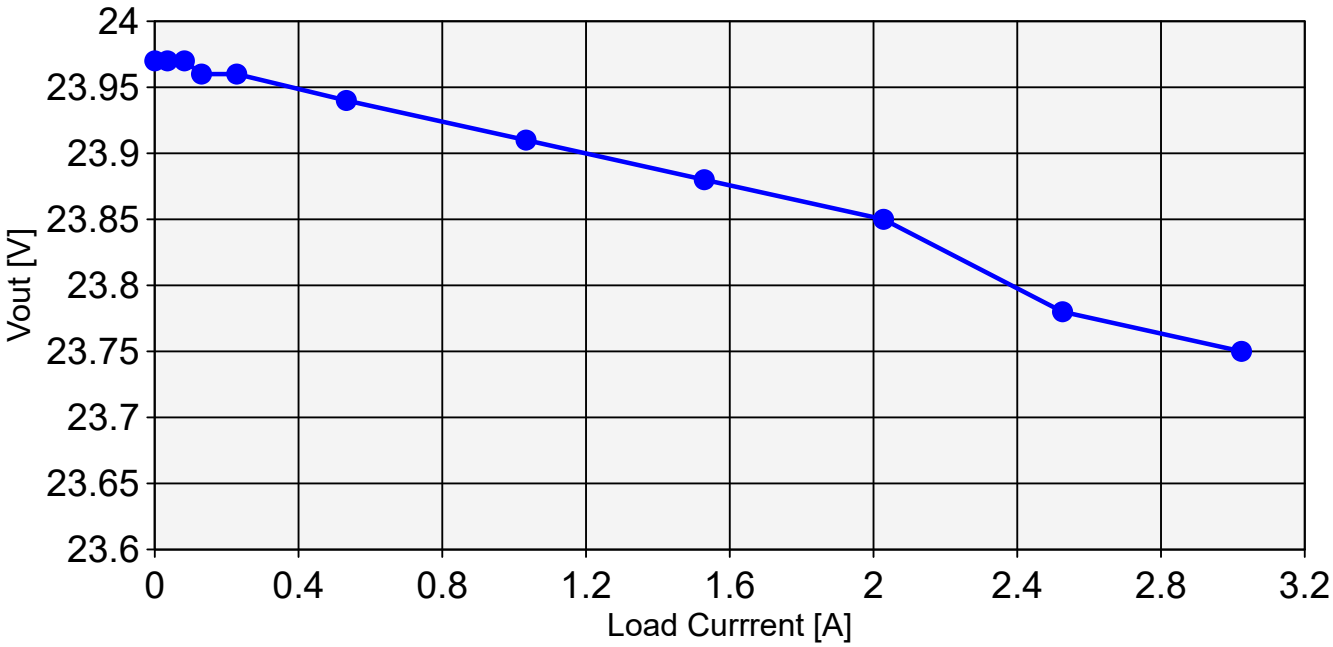


Figure 2-2. Load Regulation for 230V_{AC} Input Voltage

2.3 Thermal Images

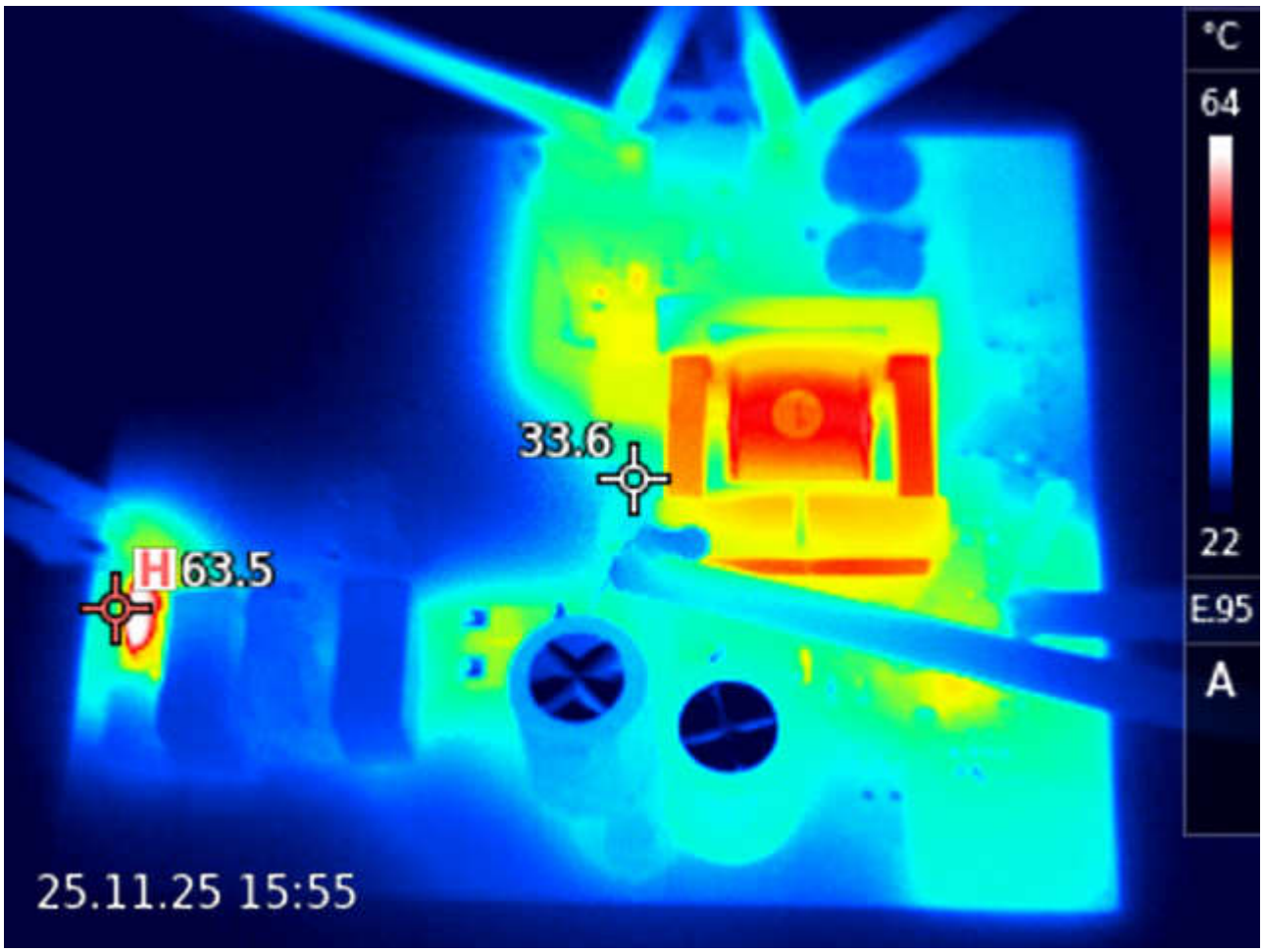


Figure 2-3. Thermal Image for 230V_{AC} Input Voltage and Full Load

2.4 Bode Plots

The bode plots were taken with 2.5A output current.

Table 2-1. Summery of the Bode Plots

Input Voltage	$195V_{AC}$	$230V_{AC}$	$265V_{AC}$
bandwidth (kHz)	1.03	1.08	1.05
phase margin	62.9°	63.3°	62.9
slope (20db / decade)	-1.34	-1.20	-1.09
gain margin (dB)	-26.5	-26.0	-26.4
slope (20db / decade)	-1.35	-1.73	-1.79
frequency	8.46	8.35	8.32

2.4.1 $195V_{AC}$ Input Voltage

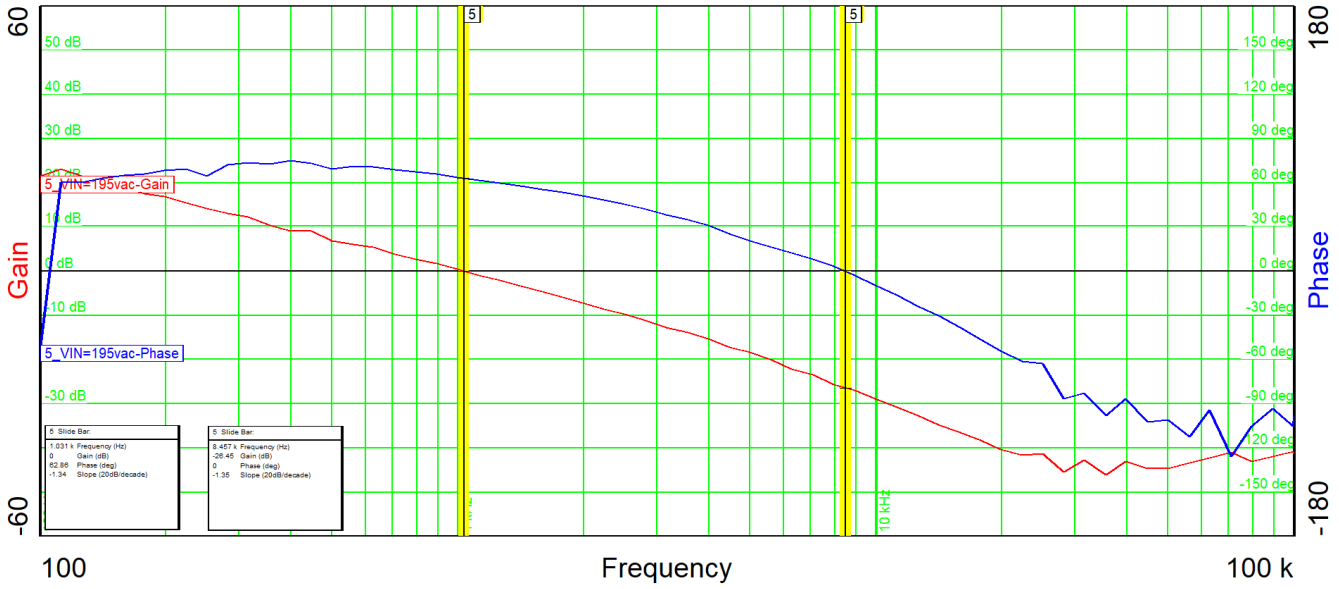


Figure 2-4. Bode Plot for $195V_{AC}$ Input Voltage and 2.5A Output Current

2.4.2 230V_{AC} Input Voltage

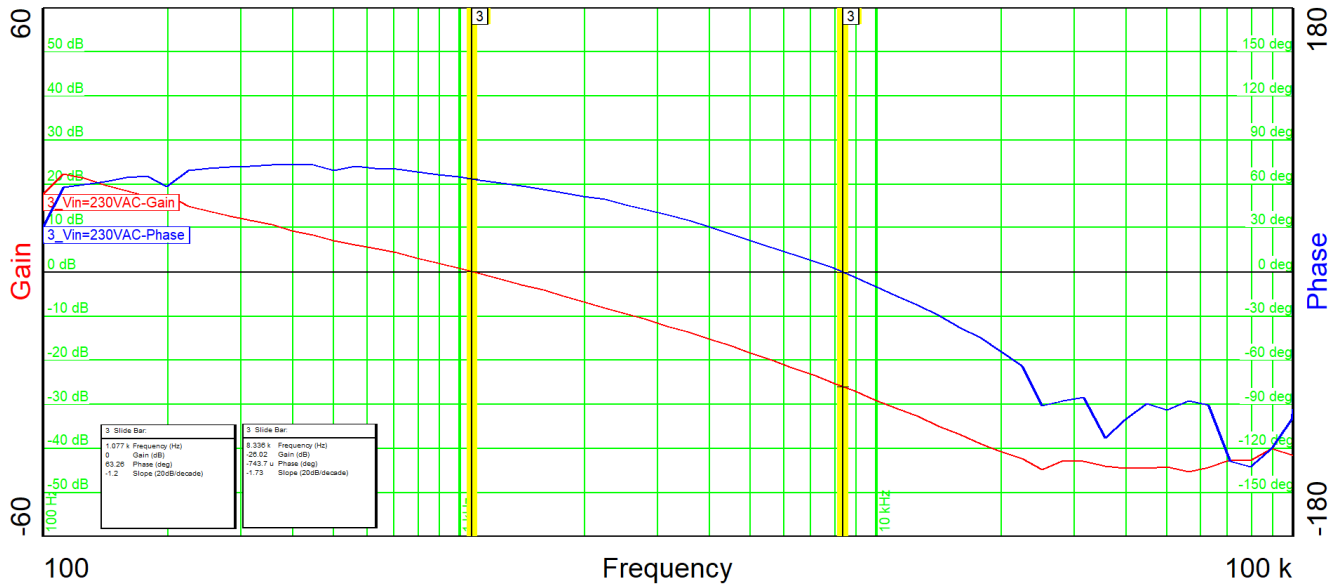


Figure 2-5. Bode Plot for 230V_{AC} Input Voltage and 2.5A Output Current

2.4.3 265V_{AC} Input Voltage

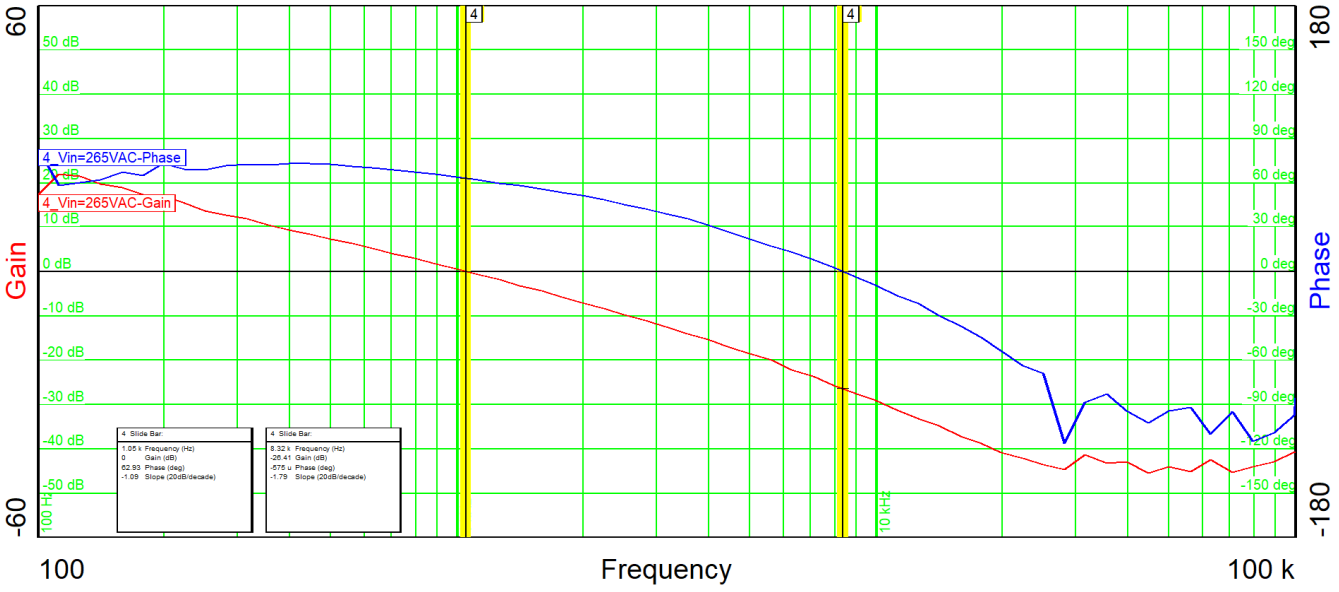


Figure 2-6. Bode Plot for 265V_{AC} Input Voltage and 2.5A Output Current

3 Waveforms

3.1 Switching

3.1.1 Primary Switch-node

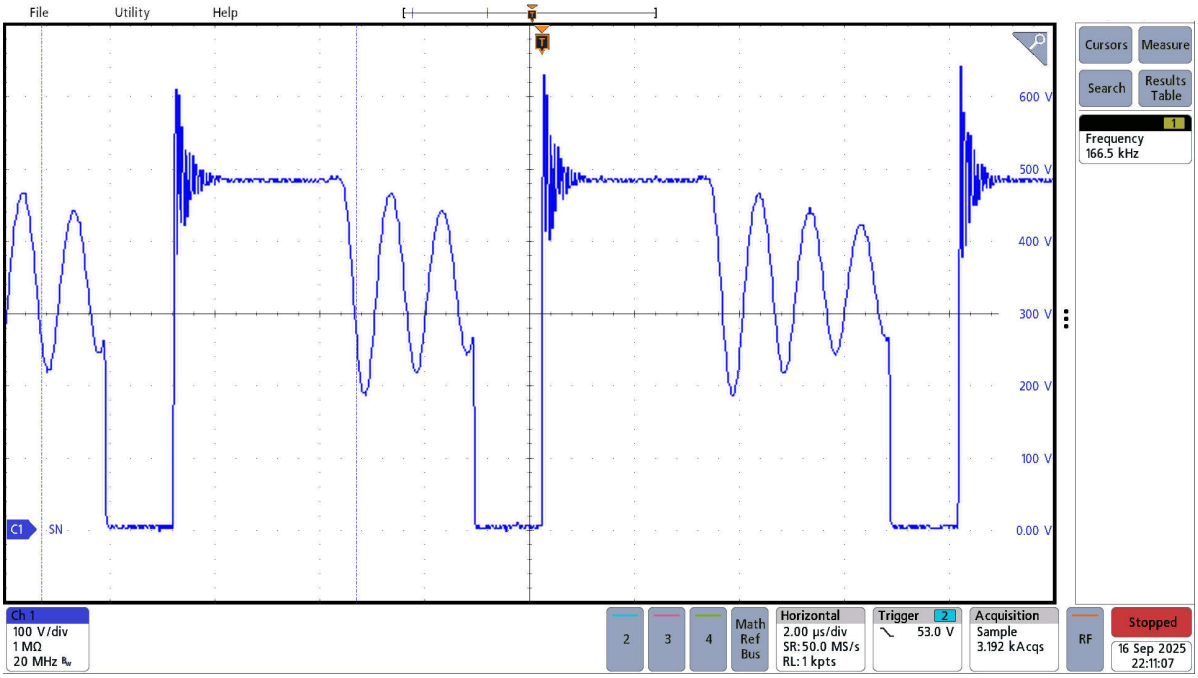


Figure 3-1. Primary Switch-node for 265V_{AC} Input Voltage and 2.5A Output Current, 2µs / div

The waveform in Figure 3-2 display the same waveform as in Figure 3-1 with a different time base.

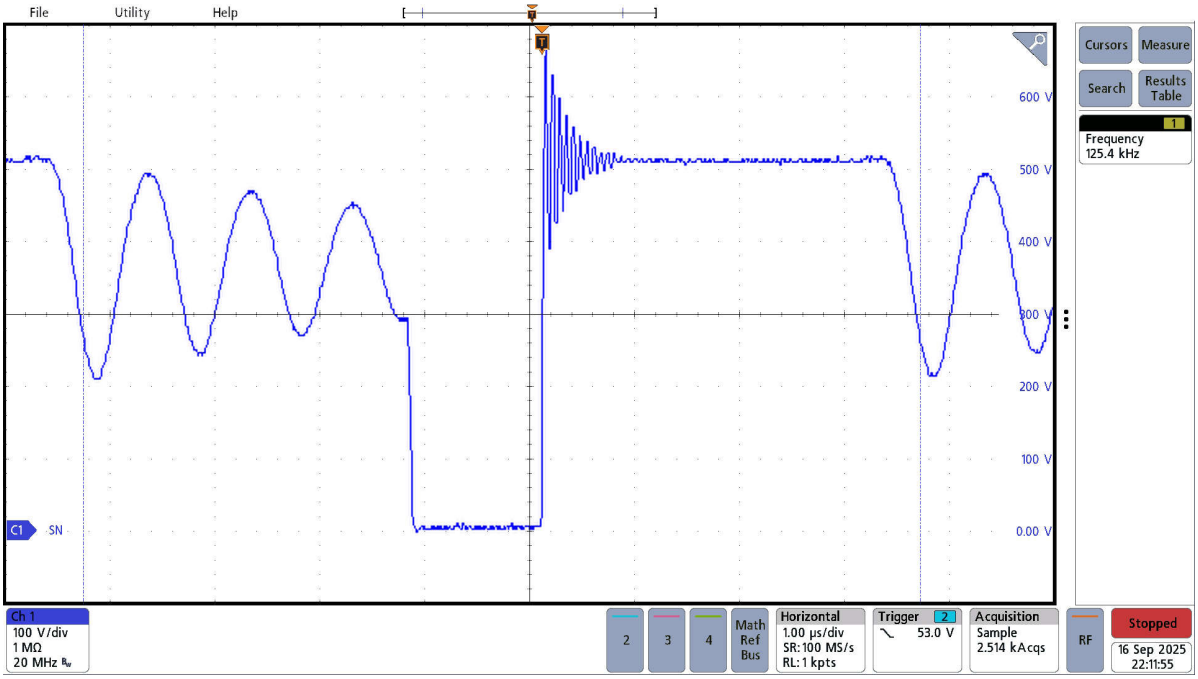


Figure 3-2. Primary Switch-node for 265V_{AC} Input Voltage and 2.5A Output Current, 1µs / div

3.1.2 Secondary Switch-node

3.1.2.1 195V_{AC} Input Voltage

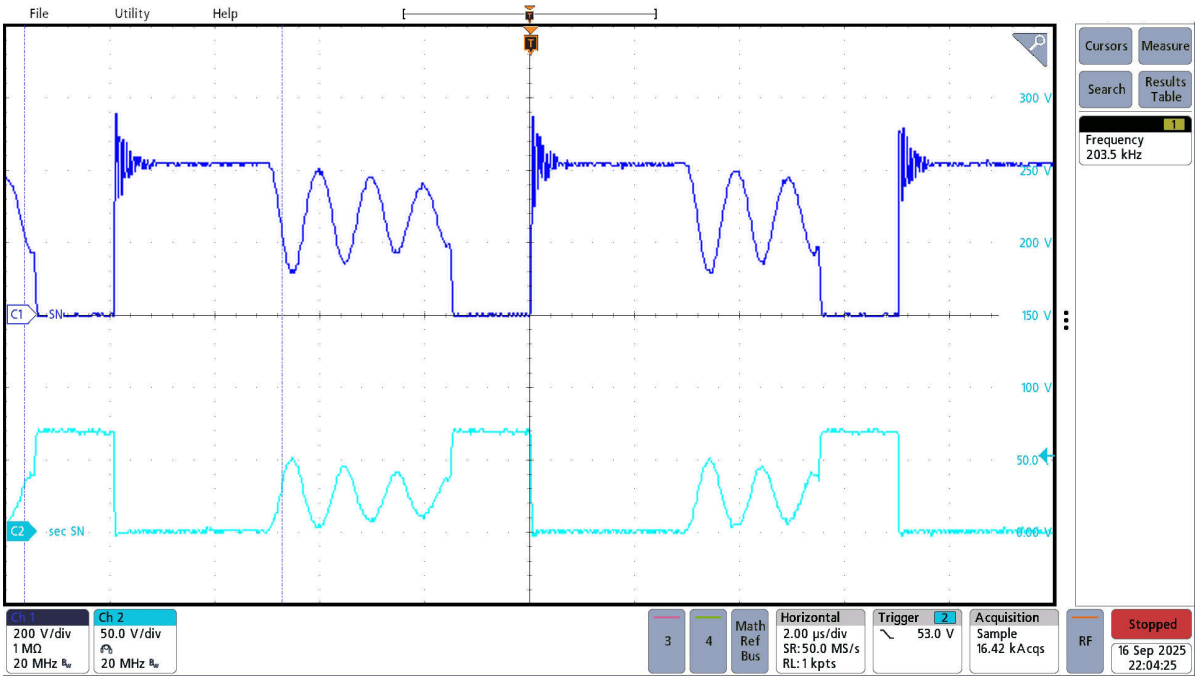


Figure 3-3. Secondary Switch-node for 195V_{AC} Input Voltage and 2.5A Output Current

3.1.2.2 230V_{AC} Input Voltage

3.1.2.2.1 30mA Output Current

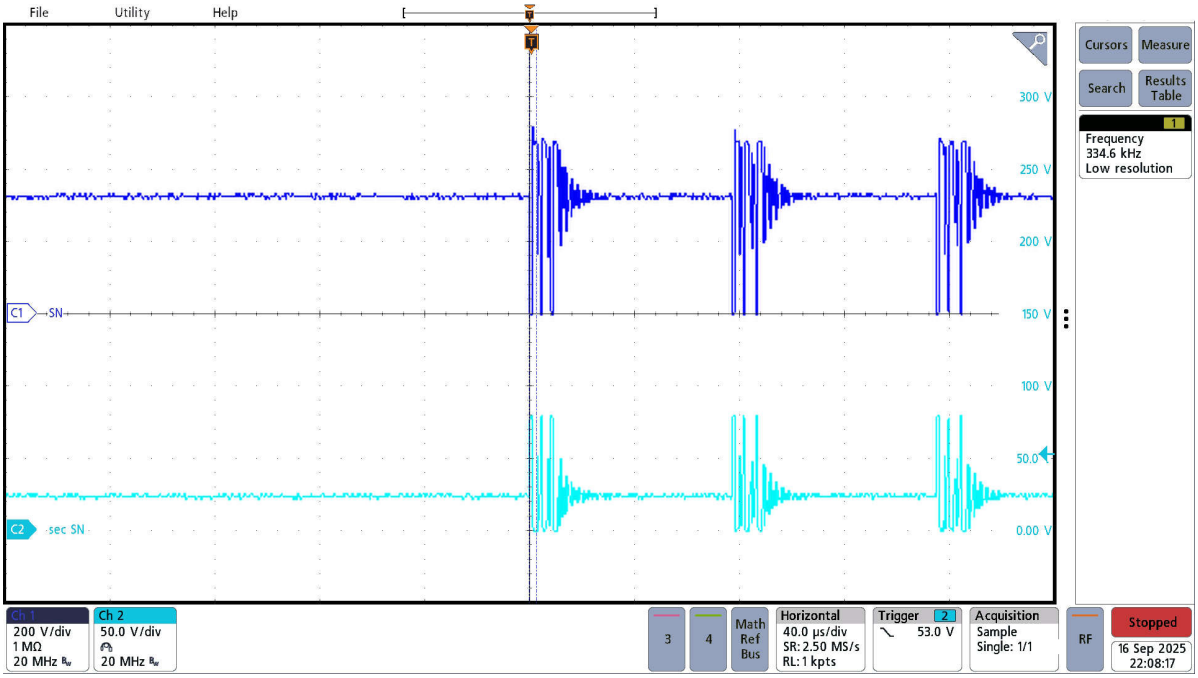


Figure 3-4. Secondary Switch-node for 230V_{AC} Input Voltage and 30mA Output Current

3.1.2.2.2 200mA Output Current

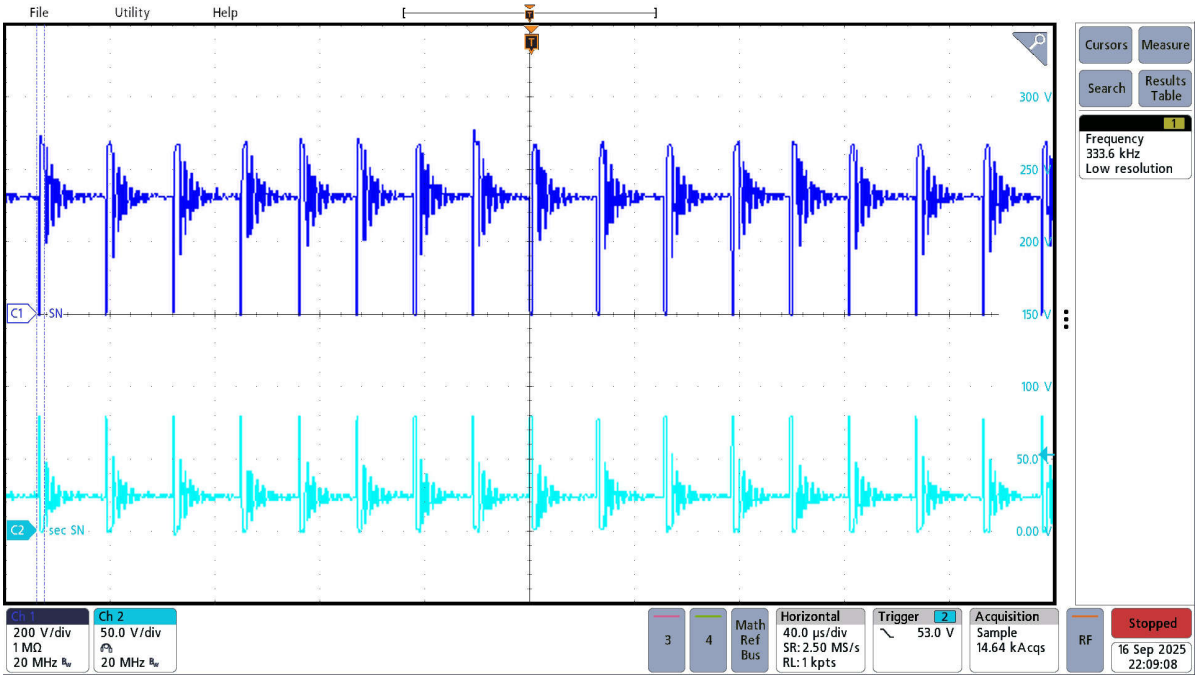


Figure 3-5. Secondary Switch-node for 195V_{AC} Input Voltage and 200mA Output Current, 40µs / div

The waveform in Figure 3-6 displays the waveform in Figure 3-5 with a different time base.

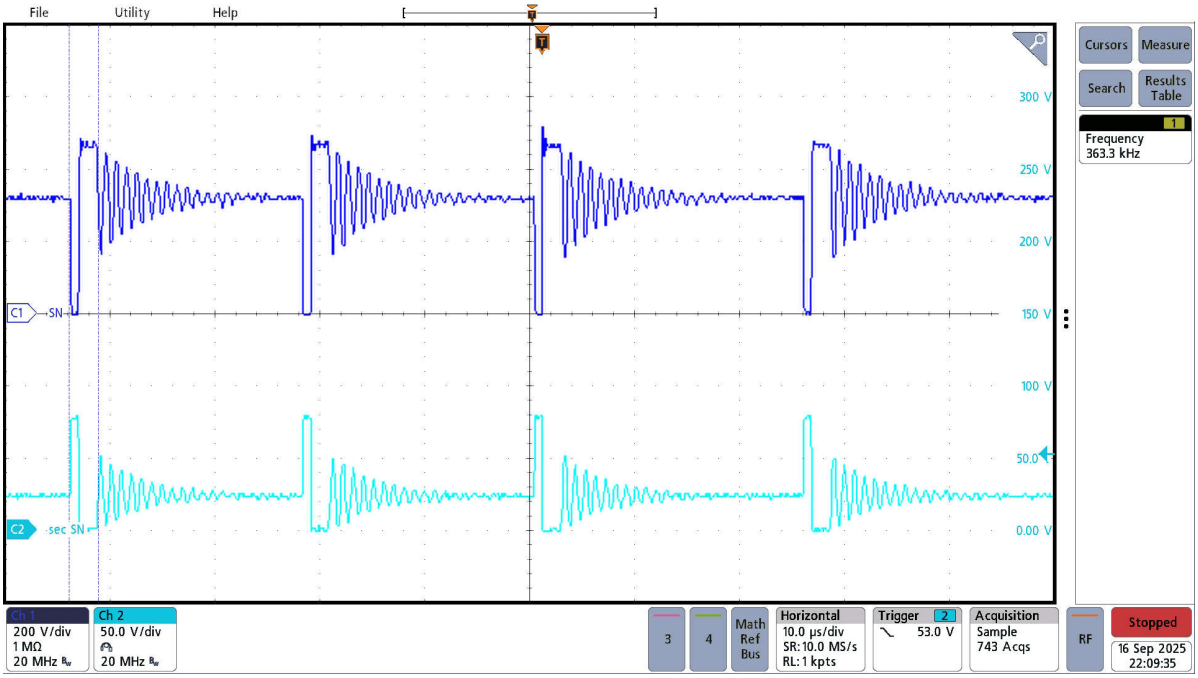


Figure 3-6. Secondary Switch-node for 195V_{AC} Input Voltage and 200mA Output Current, 10µs / div

3.1.2.2.3 2.5A Output Current

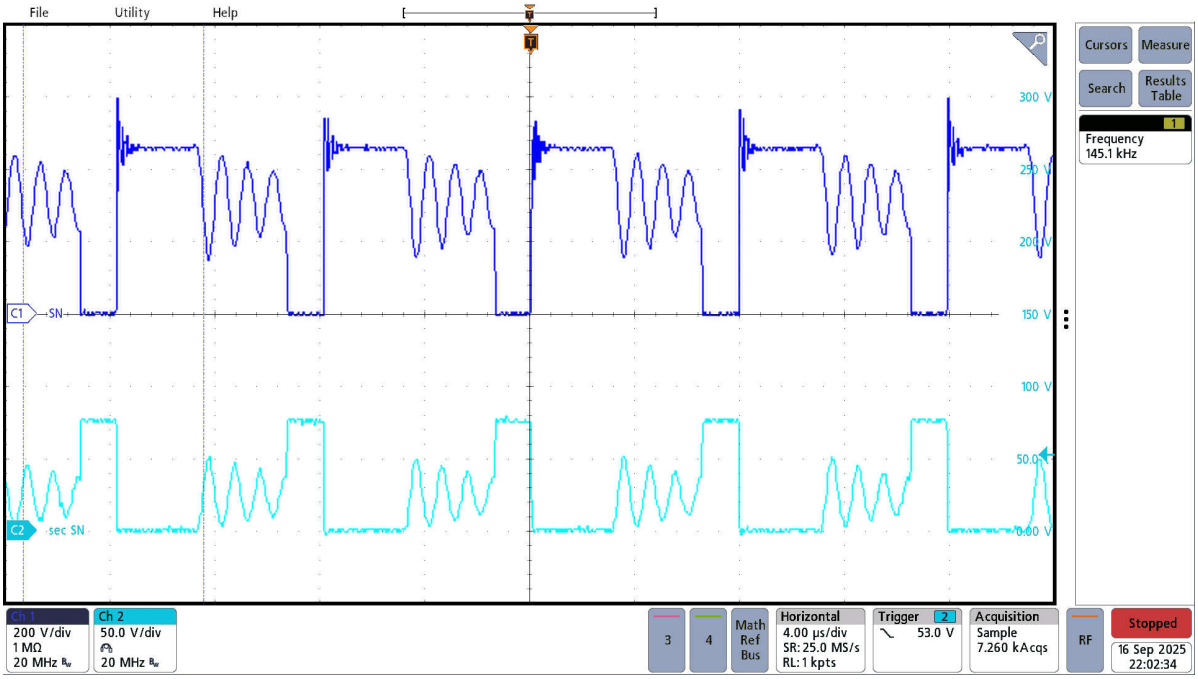


Figure 3-7. Secondary Switch-node for 230V_{AC} Input Voltage and 2.5A Output Current, 4µs /div

The waveform inFigure 3-8 display the waveform in Figure 3-7 with a different time base.

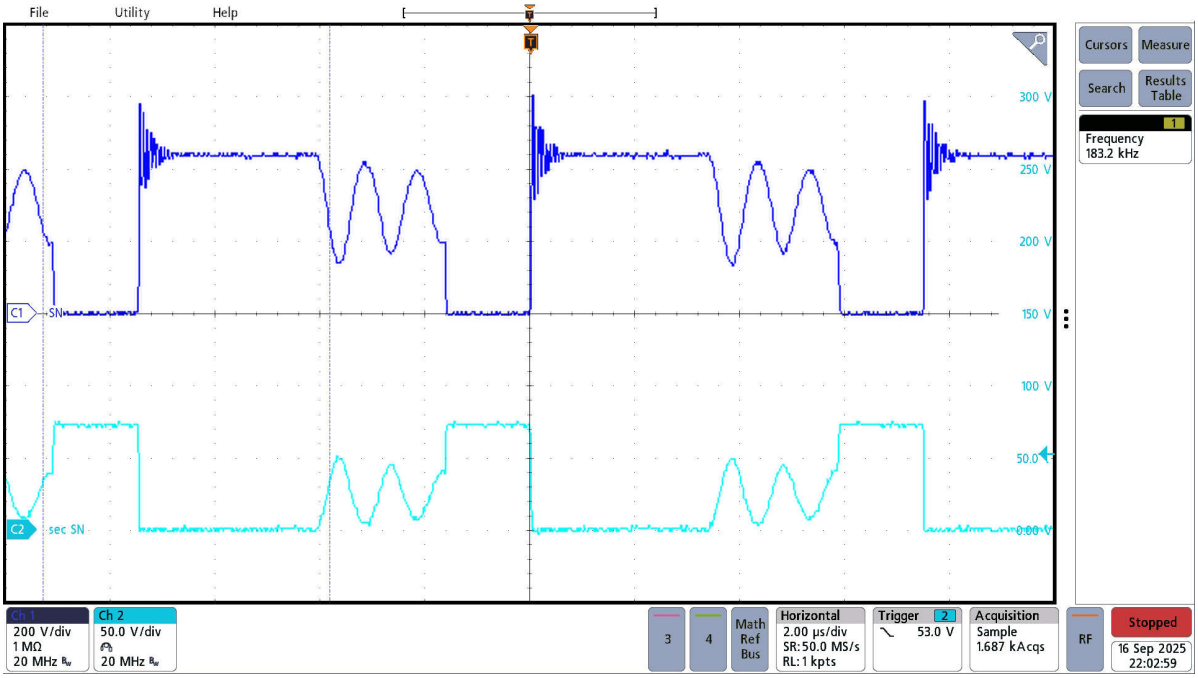


Figure 3-8. Secondary Switchnode for 230V_{AC} Input Voltage and 2.5A Output Current, 2µs / div

3.1.2.3 265V Input Voltage

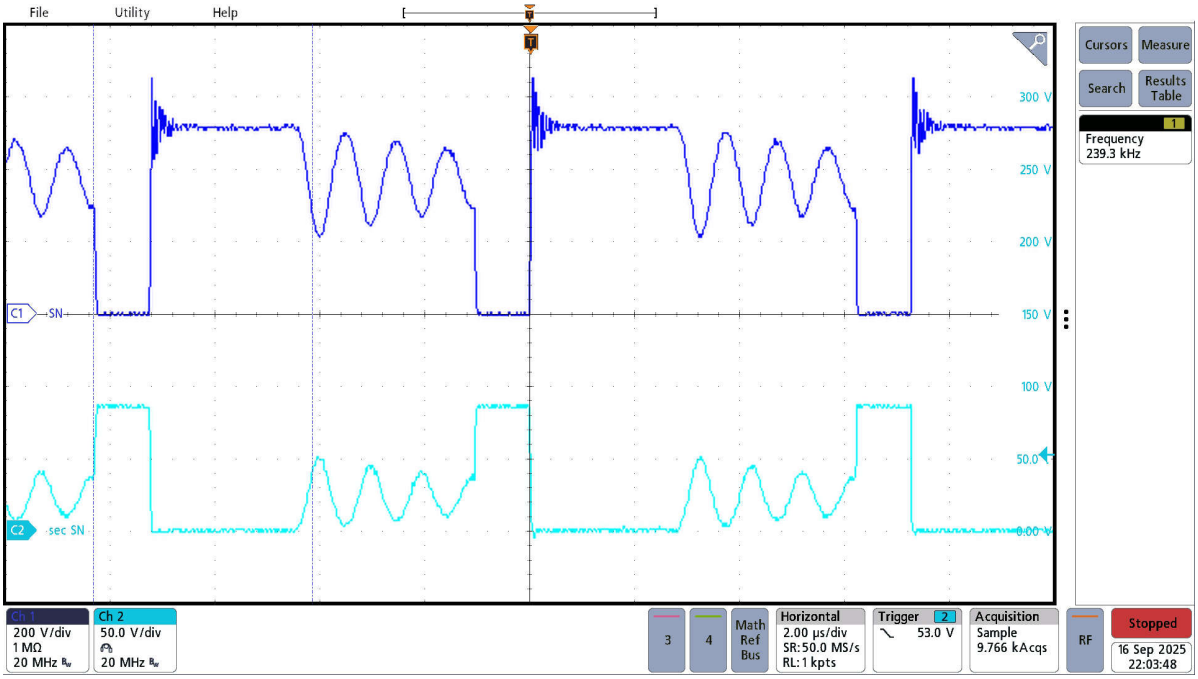


Figure 3-9. Secondary Switch-node for 265V_{AC} Input Voltage and 2.5A Output Voltage

3.2 Output Voltage Ripple

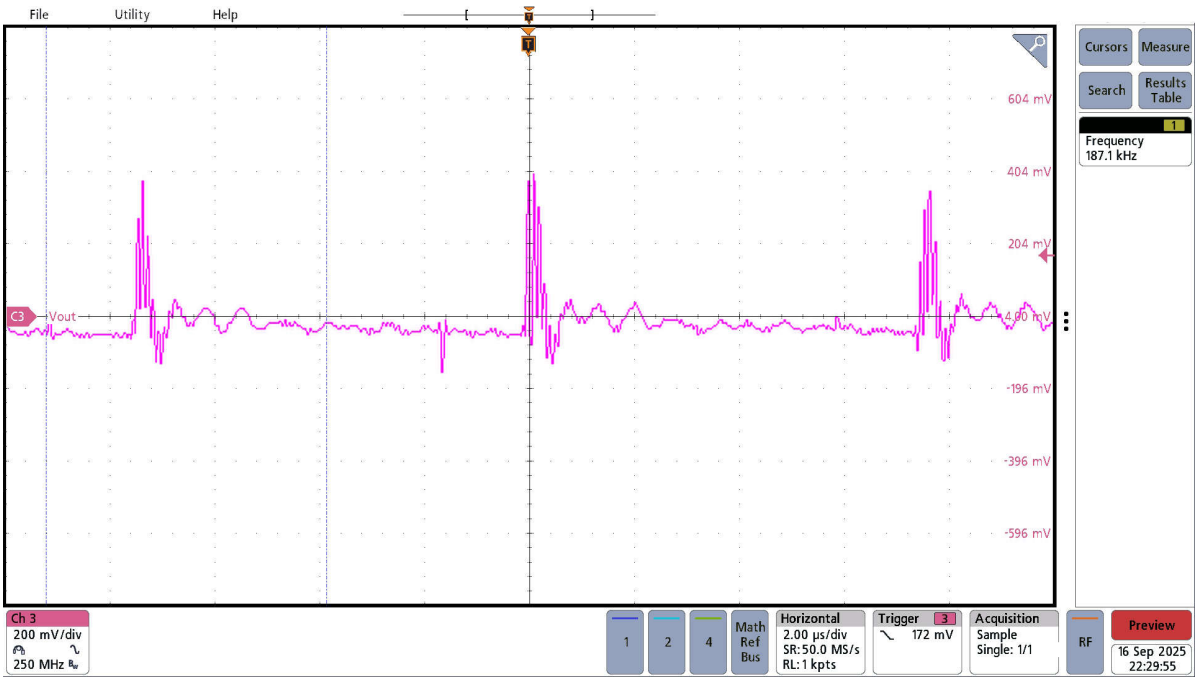


Figure 3-10. Output Voltage Ripple for 230V_{AC} Input Voltage and 2.5A Output Current (AC-coupled)

3.3 Input Voltage Ripple

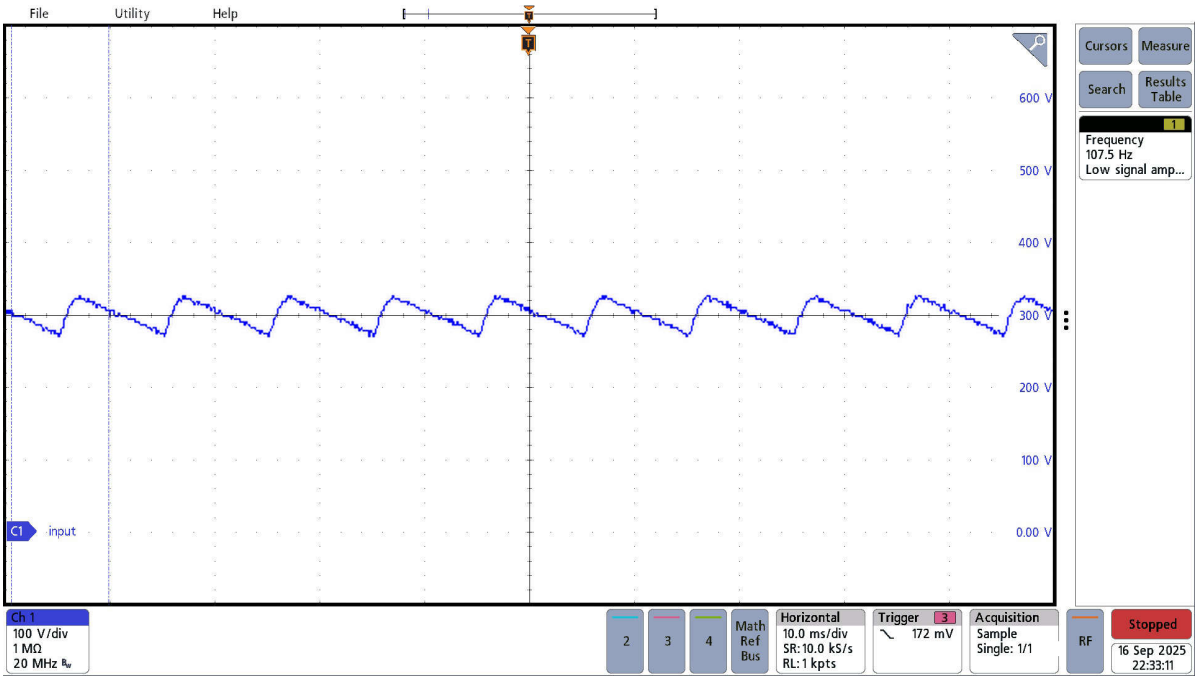


Figure 3-11. Input Voltage Ripple for 230V_{AC} Input Voltage and 2.5A Output Current (AC-coupled)

3.4 Load Transients

3.4.1 1.25A to 2.5A Load Steps

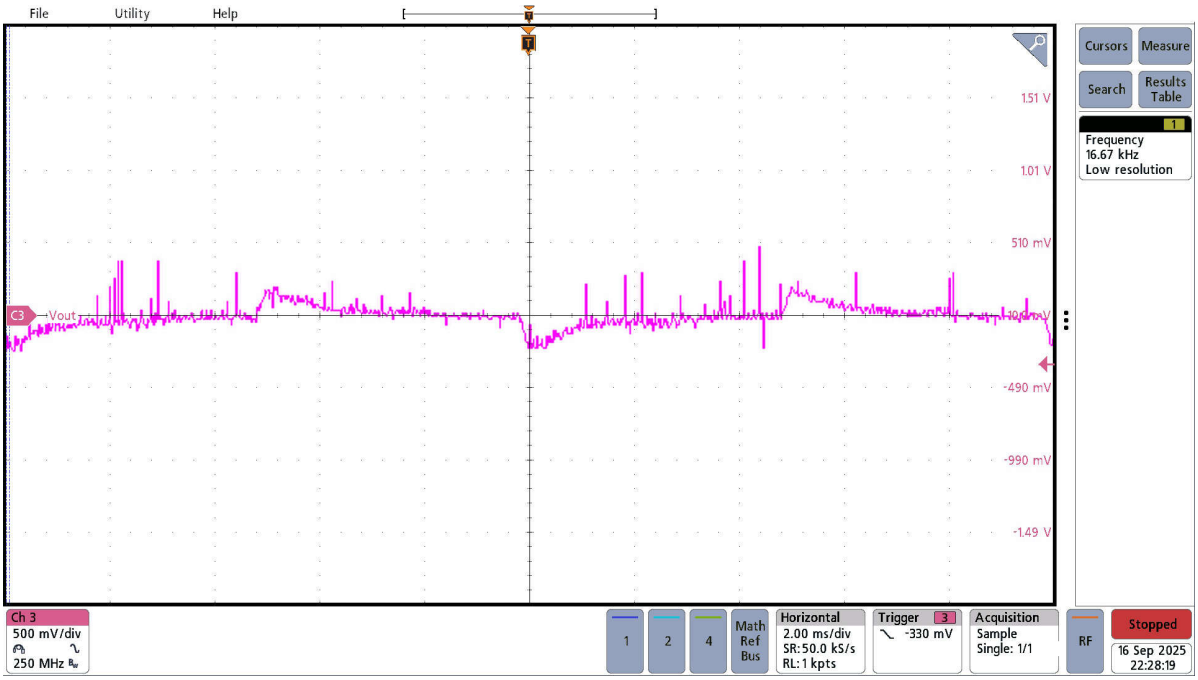


Figure 3-12. AC-Coupled Output Voltage During Load Steps from 1.25A to 2.5A for 230V_{AC} Input Voltage

3.4.2 0.4A to 2.5A Load Steps

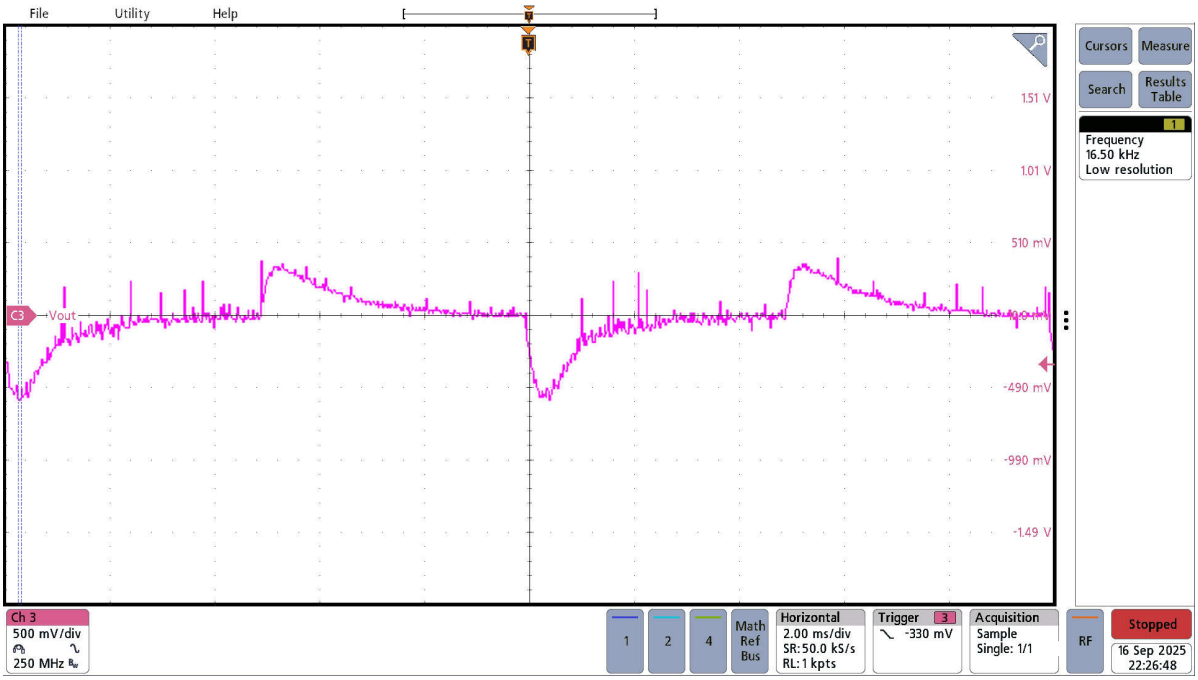


Figure 3-13. AC-Coupled Output Voltage During Load Steps from 0.4A to 2.5A for 230V_{AC} Input Voltage

3.4.3 0A to 2.5A Load Steps

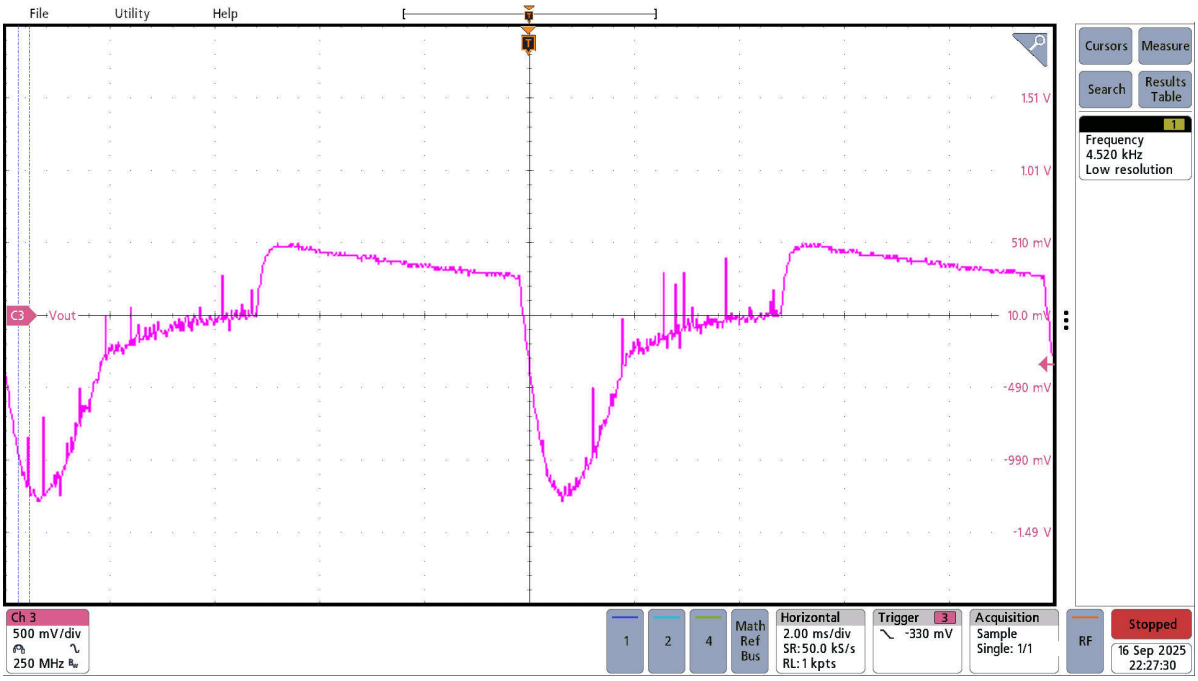


Figure 3-14. AC-Coupled Output Voltage during Load Steps from 0A to 2.5A for 230V_{AC} Input Voltage

3.5 Start-up Sequence

3.5.1 195V_{AC} Input Voltage

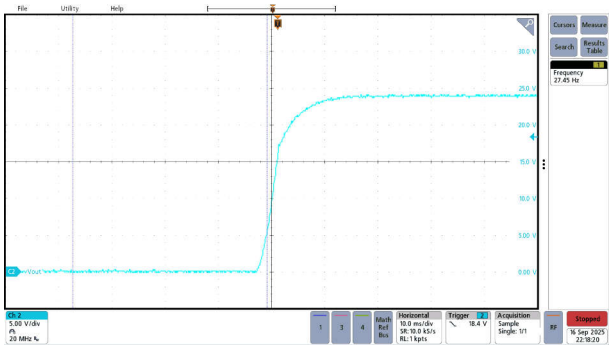


Figure 3-15. Start-up with No Load

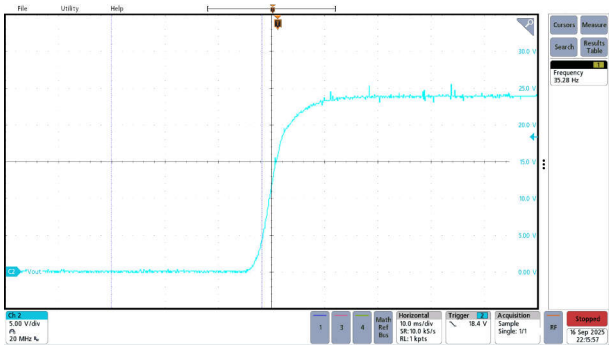


Figure 3-16. Start-up with 2.5A Load Current Setting

3.5.2 265V_{AC} Input Voltage

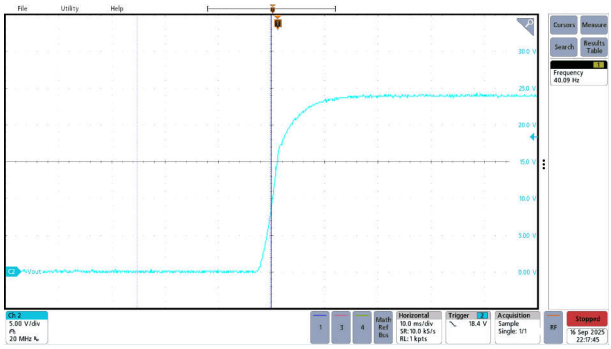


Figure 3-17. Start-up with No Load

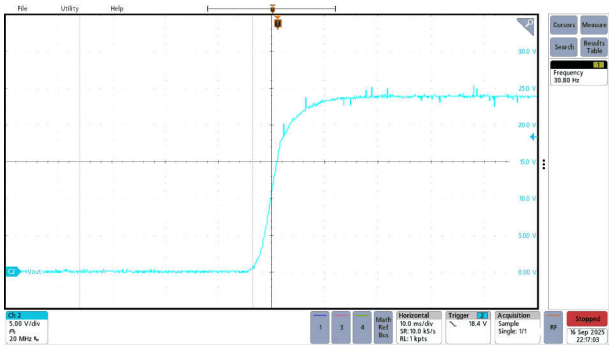


Figure 3-18. Start-up with 2.5A Load Current Setting

3.6 Shutdown Sequence

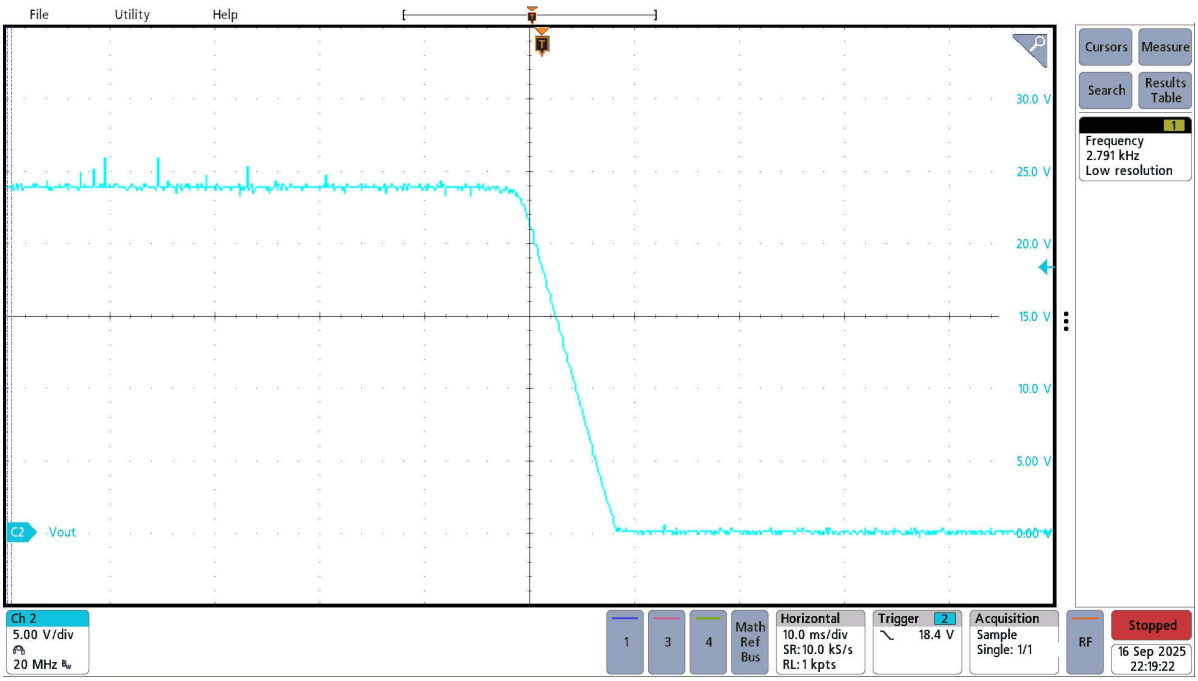


Figure 3-19. Shutdown Sequence for 230V_{AC} Input Voltage and 2.5A Output Current

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Last updated 10/2025