Test Report: PMP31193

3-Phase Input Valley Switching Flyback With Two Outputs Reference Design

Description

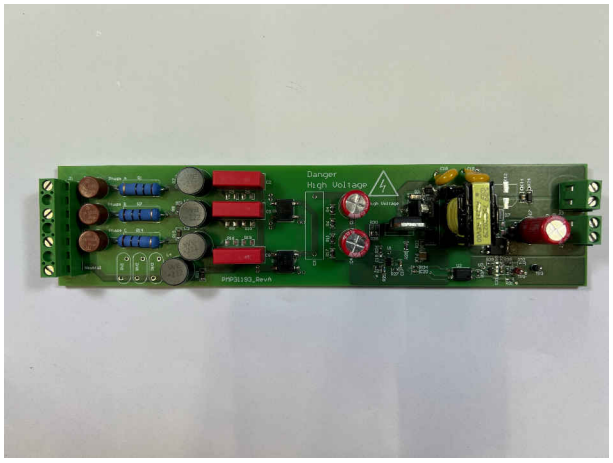
This reference design uses the UCC28742 flyback controller to generate two outputs (23 V at 1.0 A, 5.0 V at 0.15 A) from a 3-phase input. The UCC28742 uses an optical coupler to regulate the output and to improve transient response. The valley-switching technique reduces switching losses and keeps the efficiency high.

Features

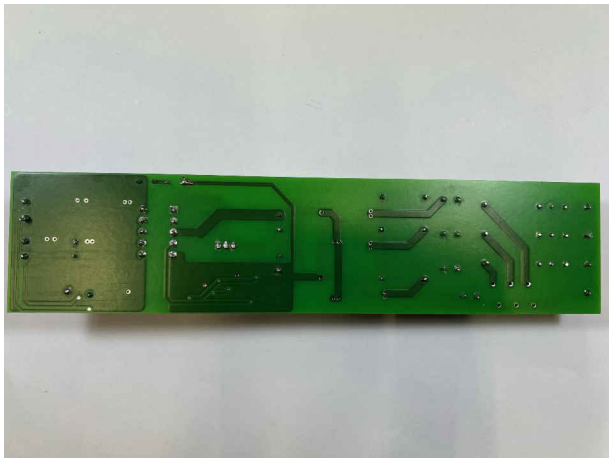
- Resonant-ring valley-switching operation
- Dual outputs: 23 V at 1.0 A and 5.0 V at 0.15 A
- 3-phase AC input voltage: 332 VAC–459 VAC
- Output overvoltage and overcurrent protection
- Completely tested design with available design files and test report

Applications

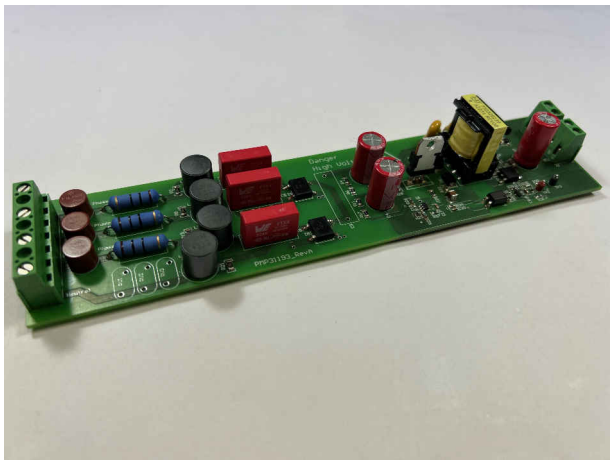
- Residential water heater and heating system



Top Photo



Bottom Photo



Top Photo 2

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input	332 VAC–459 VAC
Output 1	23 V at 1 A
Output 2	5 V at 150 mA

1.2 Required Equipment

- Oscilloscope: LeCroy WaveSurver 200 MHz
- Electronic load: Agilent 6060B
- Power supply: Lambda GEN600-2.6 (600 V, 2.6 A)
- AC power source: California Instruments Model 1251P

1.3 Dimensions

205 mm × 47 mm

2 Testing and Results

2.1 Efficiency and Load Regulation Graphs

Efficiency and load regulation is shown in the following figure.

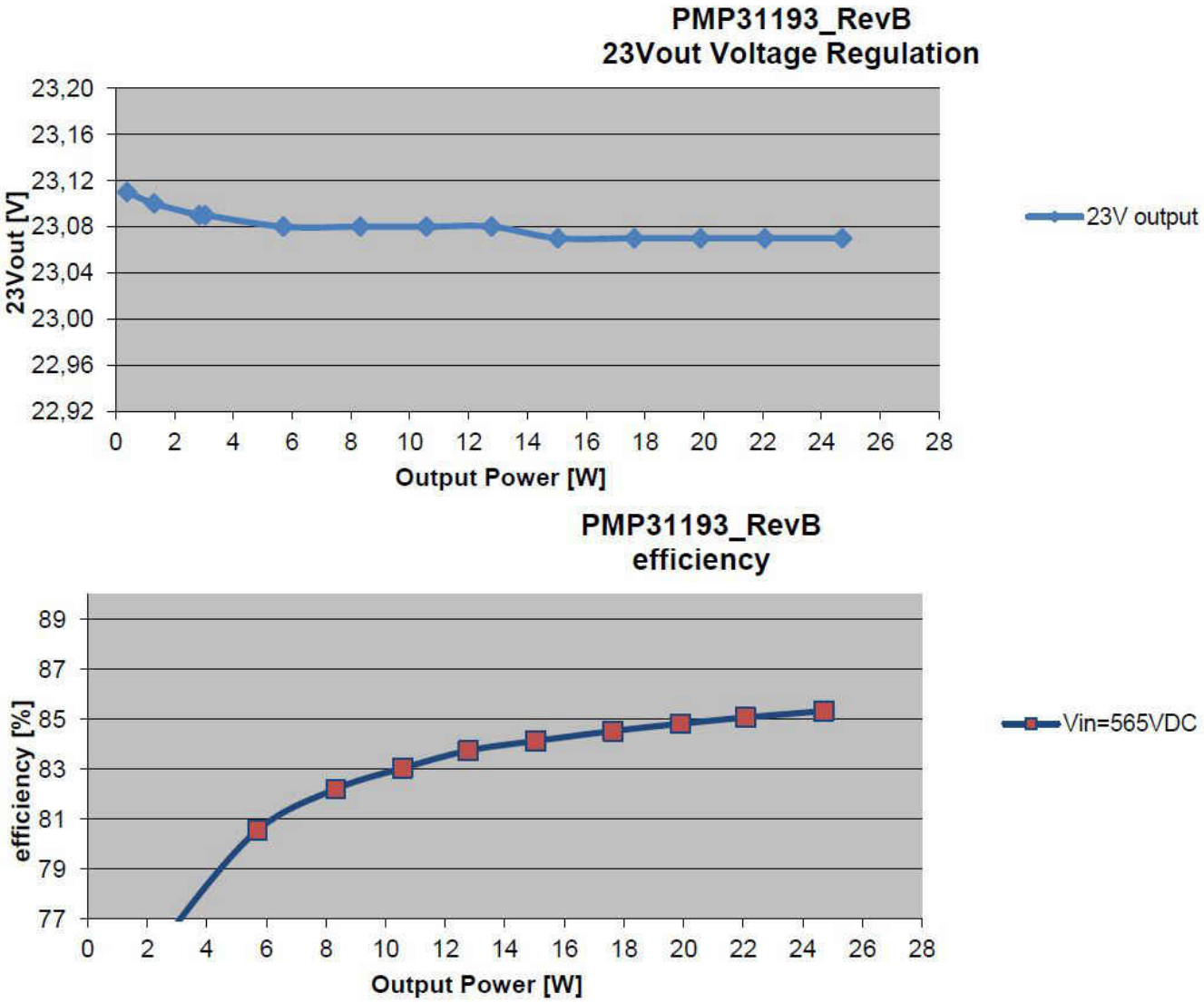
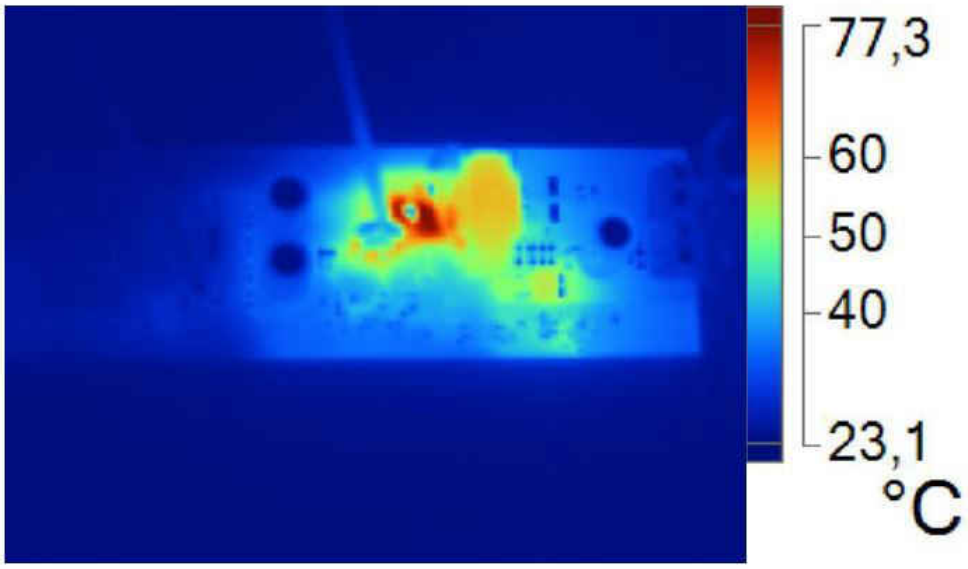


Figure 2-1. Voltage Regulation and Efficiency

2.2 Thermal Images

Figure 2-2 shows the thermal image after 10 minutes at full load.

Top:

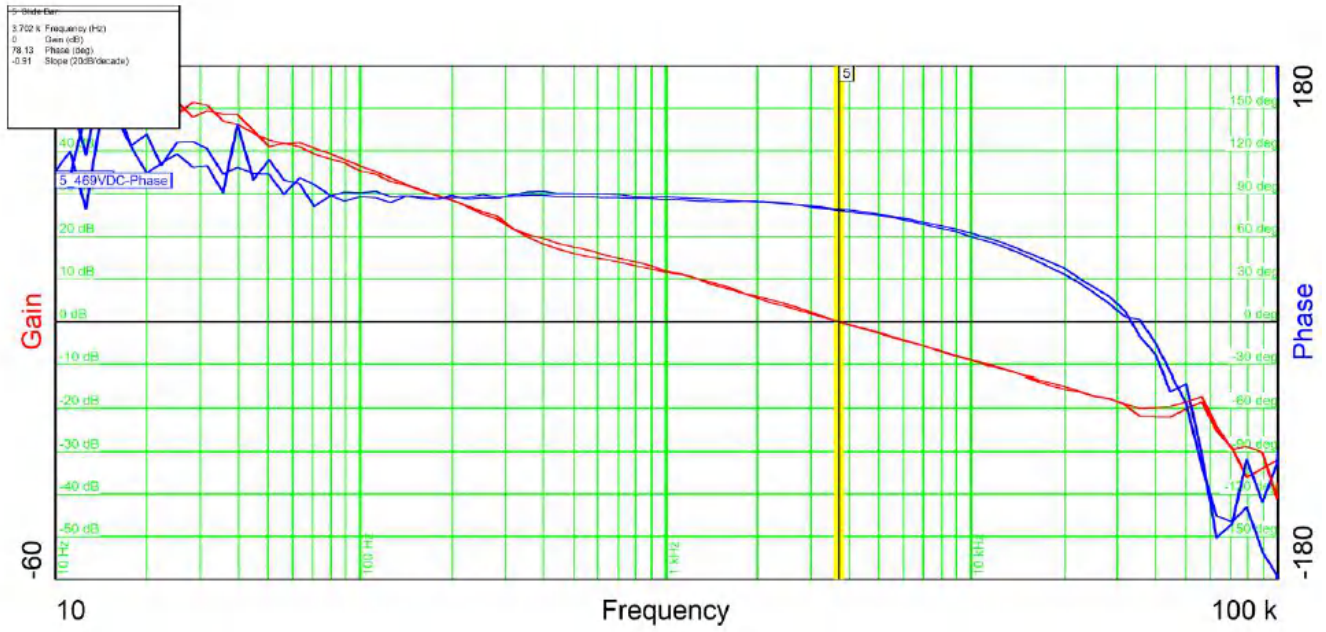


Name	Temperatur	
Transformer T1	59,1°C	
Snubber D2	77,3°C	
Mosfet Q1	47,2°C	
Diode D4	55,0°C	
Diode D7	45,7°C	

Figure 2-2. Thermal Image

2.3 Bode Plots

Figure 2-3 shows the bode plot.



Input voltage = 469 VDC
Phase margin = 78 (deg)
Slope = -0.91 (20dB/decade)
Bandwidth = 3.7 kHz
Gain margin > 10dB

Input voltage = 630 VDC
Phase margin = 79 (deg)
Slope = -1.06 (20dB/decade)
Bandwidth = 3.7 kHz
Gain margin > 10 dB

Figure 2-3. Bode Plot

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.

The waveform in Figure 3-1 was created using the following conditions: input voltage = 630 VDC; output power = full load.

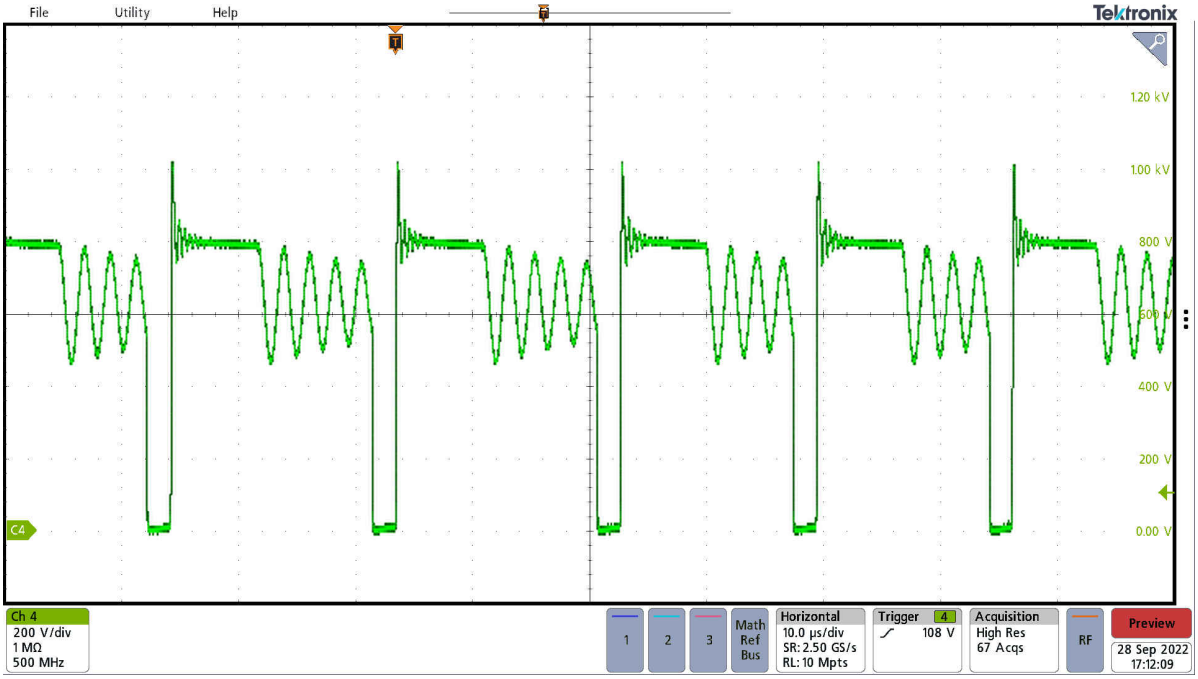


Figure 3-1. Switch Node

The waveform in Figure 3-2 was created using the following conditions: input voltage = 330 VDC; output power = full load.

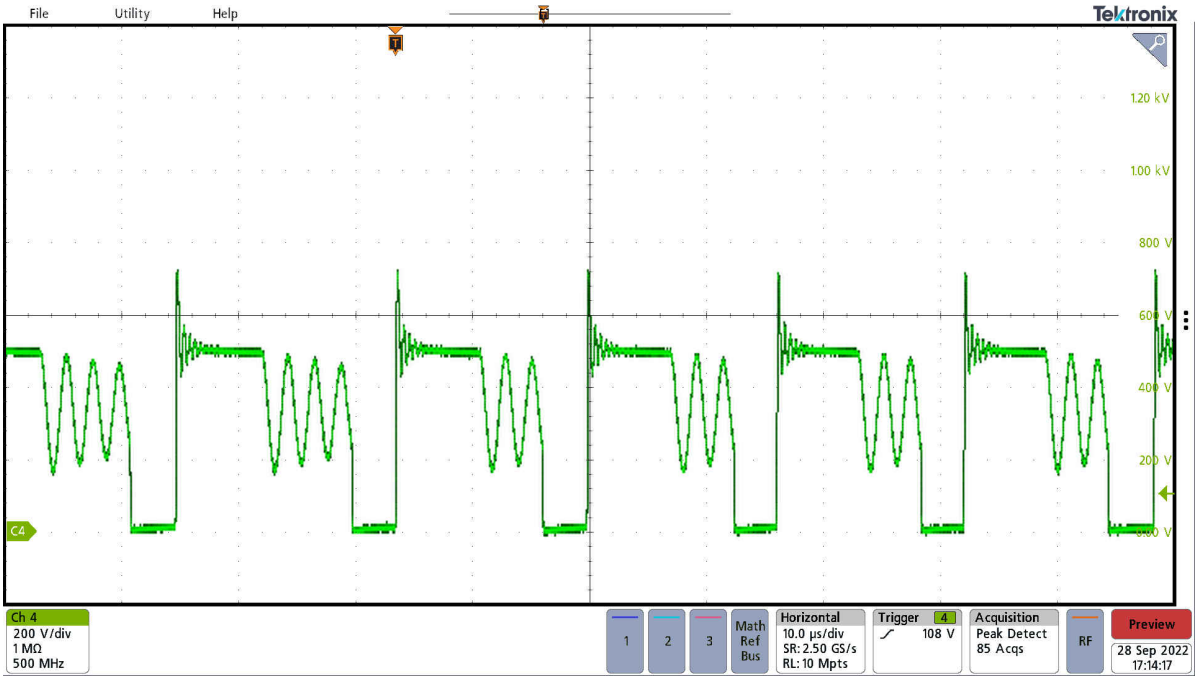


Figure 3-2. Switch Node

3.2 Output Voltage Ripple

Output voltage ripple is shown in the following figures.

The waveform in Figure 3-3 was created using the following conditions: input voltage = 565 VDC; output power = full load.

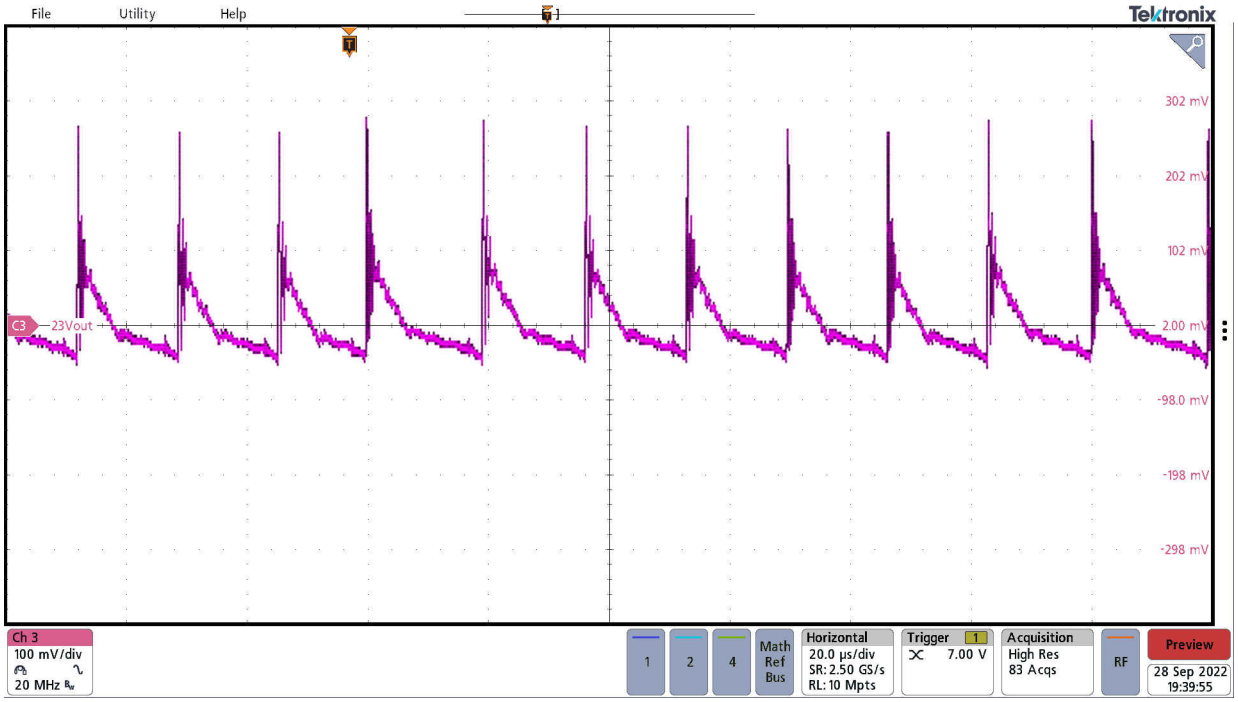


Figure 3-3. Output Voltage Ripple (23 V_{OUT})

The waveform in Figure 3-4 was created using the following conditions: input voltage = 565 VDC; output power = full load.

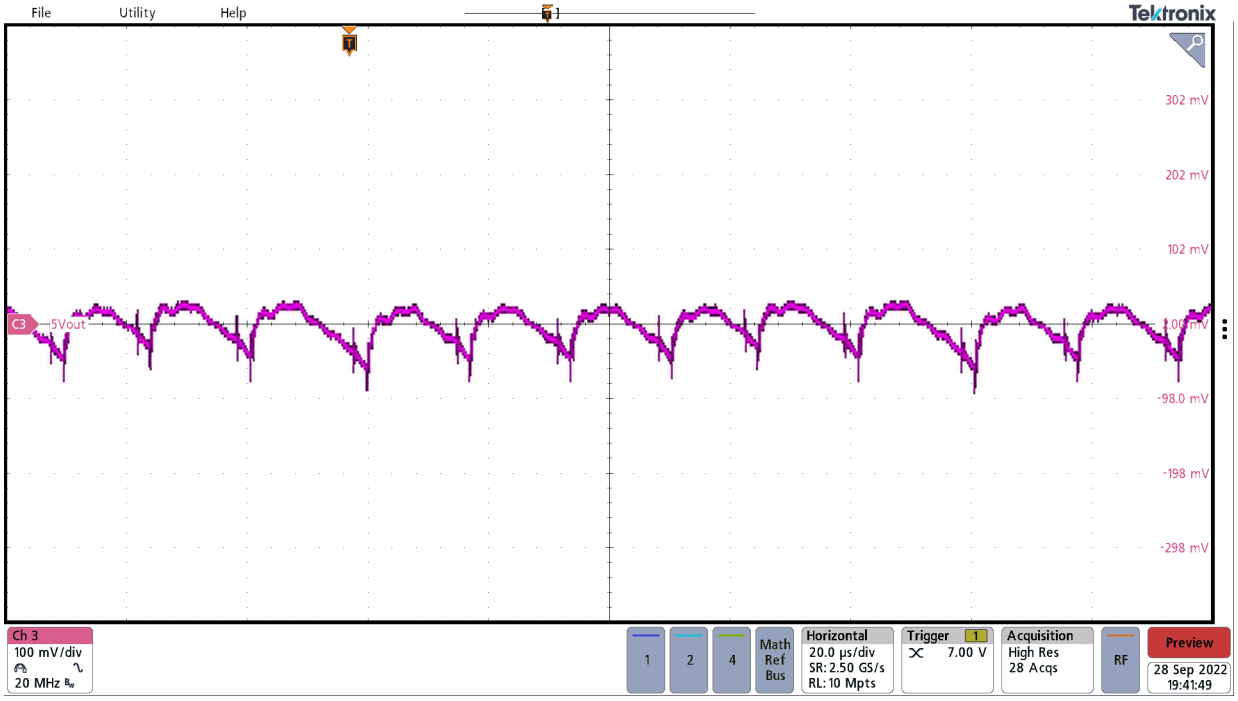


Figure 3-4. Output Voltage Ripple (5 V_{OUT})

3.3 Load Transients

Load transient response is shown in the following figures.

The waveform in Figure 3-5 was created using the following conditions: input voltage = 565 VDC; load transient = 200 mA to 1 A.

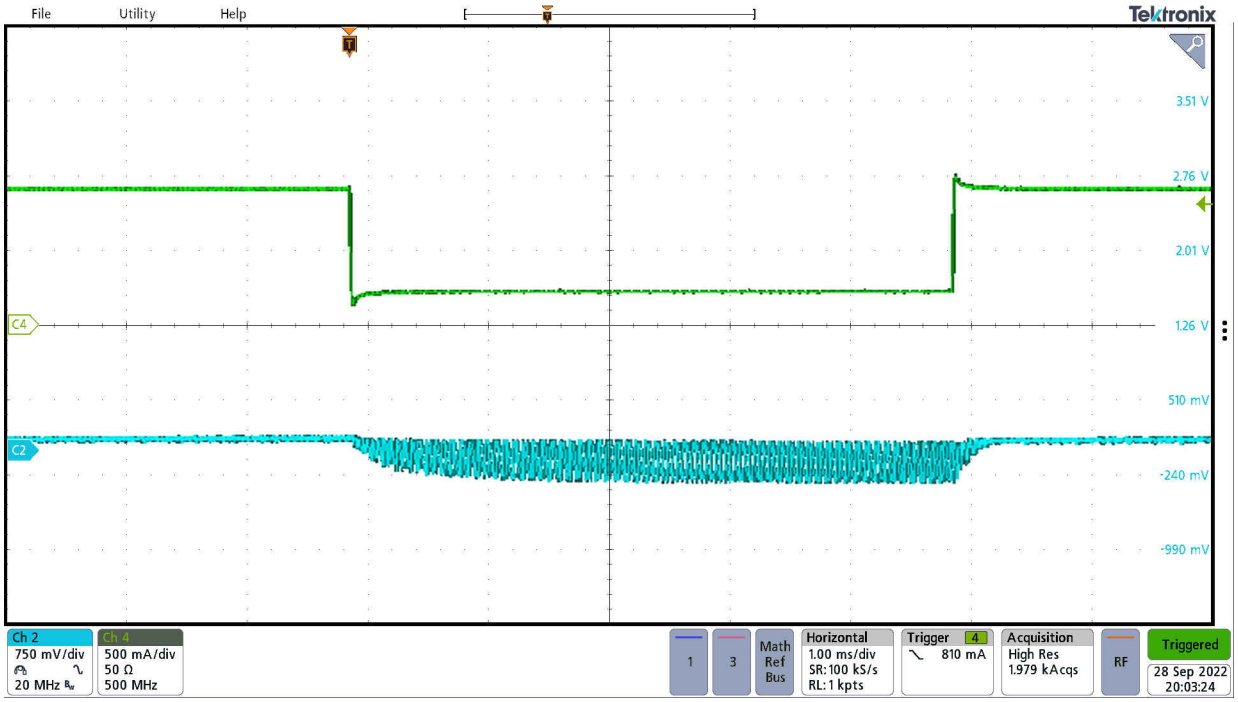


Figure 3-5. Load Transient 23-V Output

The waveform in Figure 3-6 was created using the following conditions: input voltage = 565 VDC; load transient = 500 mA to 1 A.

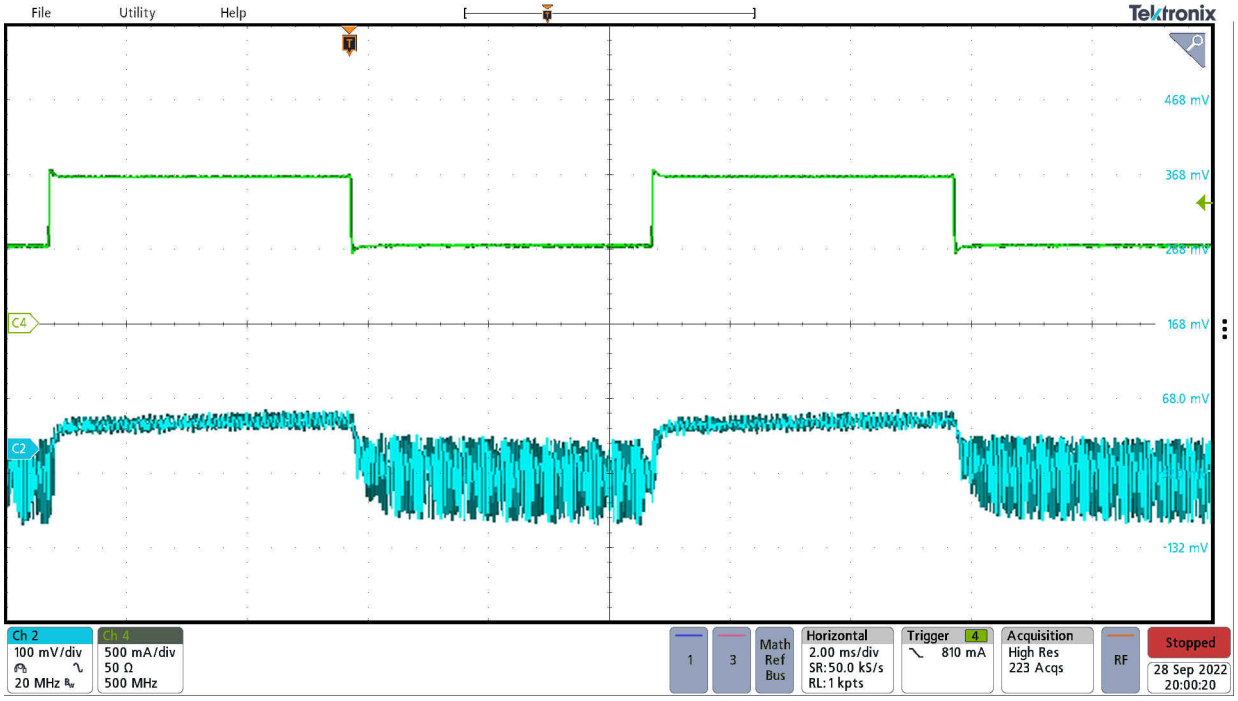


Figure 3-6. Load Transient 23-V Output

3.4 Start-Up Sequence

Start-up behavior is shown in the following figures.

The waveform in Figure 3-7 was created at input voltage = 420 VDC.

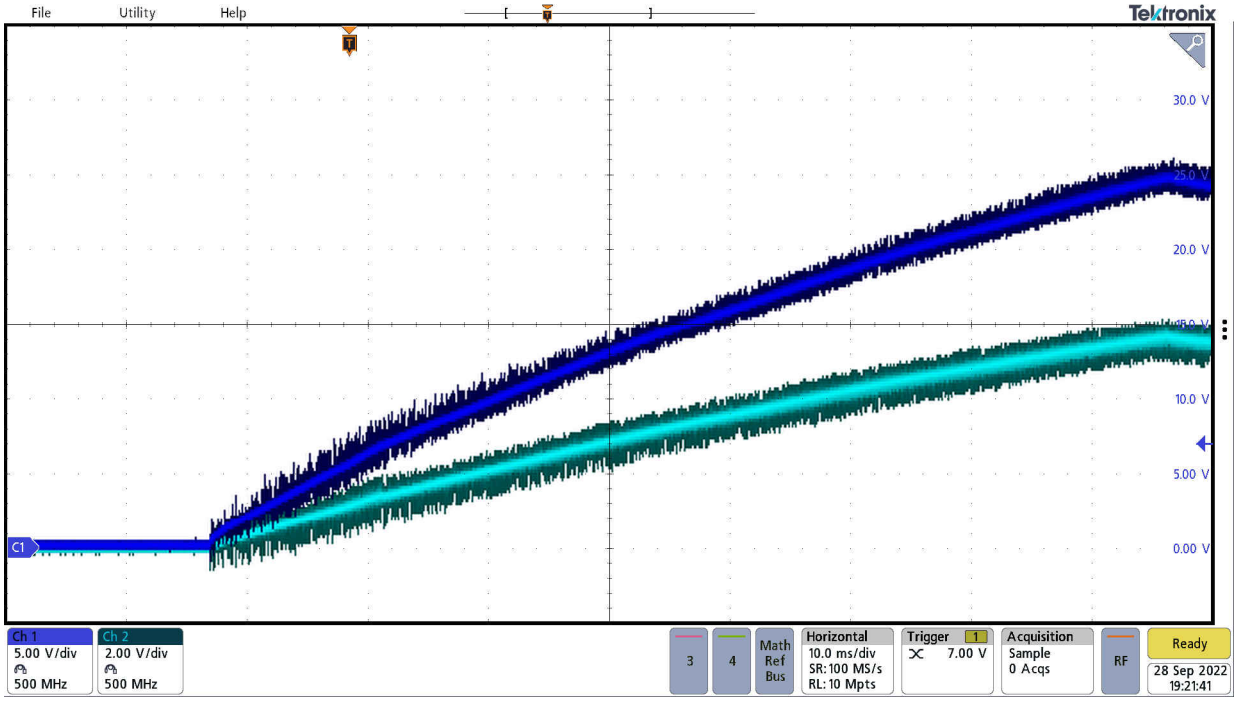


Figure 3-7. Start-Up Full Load

The waveform in Figure 3-8 was created at input voltage = 630 VDC.

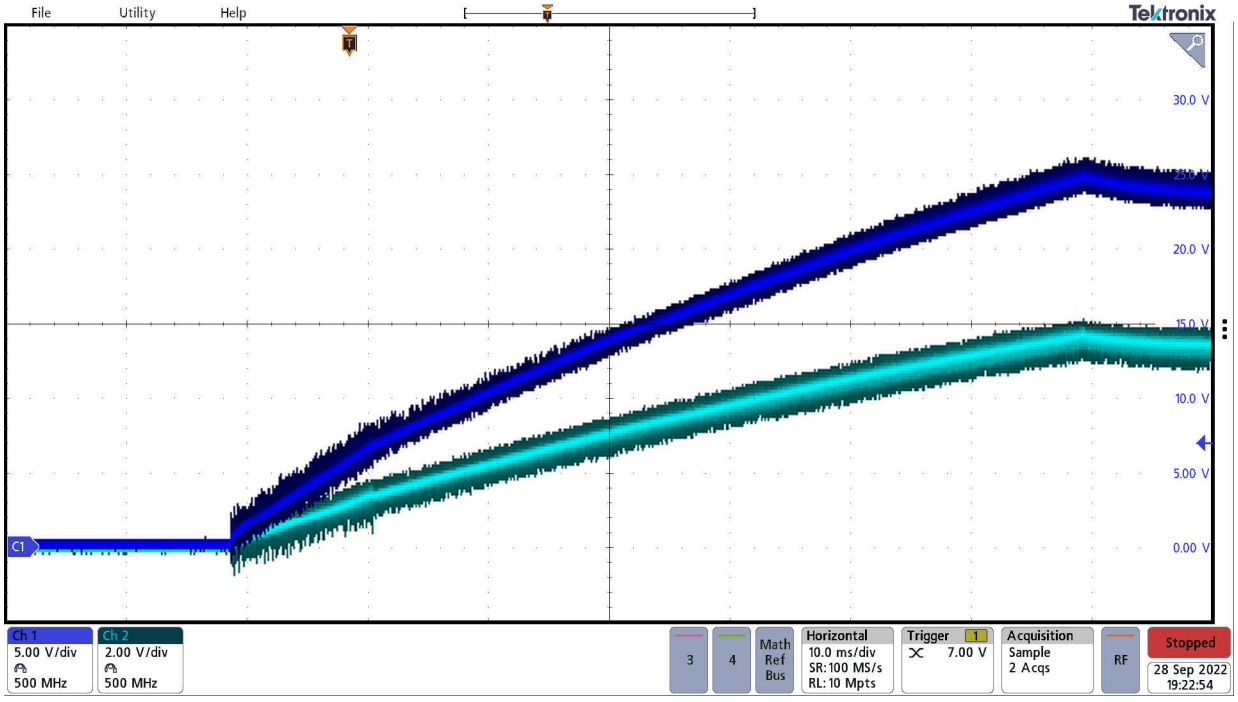


Figure 3-8. Start-Up Full Load

3.5 Other Waveforms

Other behavior is shown in the following figures.

Figure 3-9 and Figure 3-10 have input voltage = 630 VDC and output power = full load.

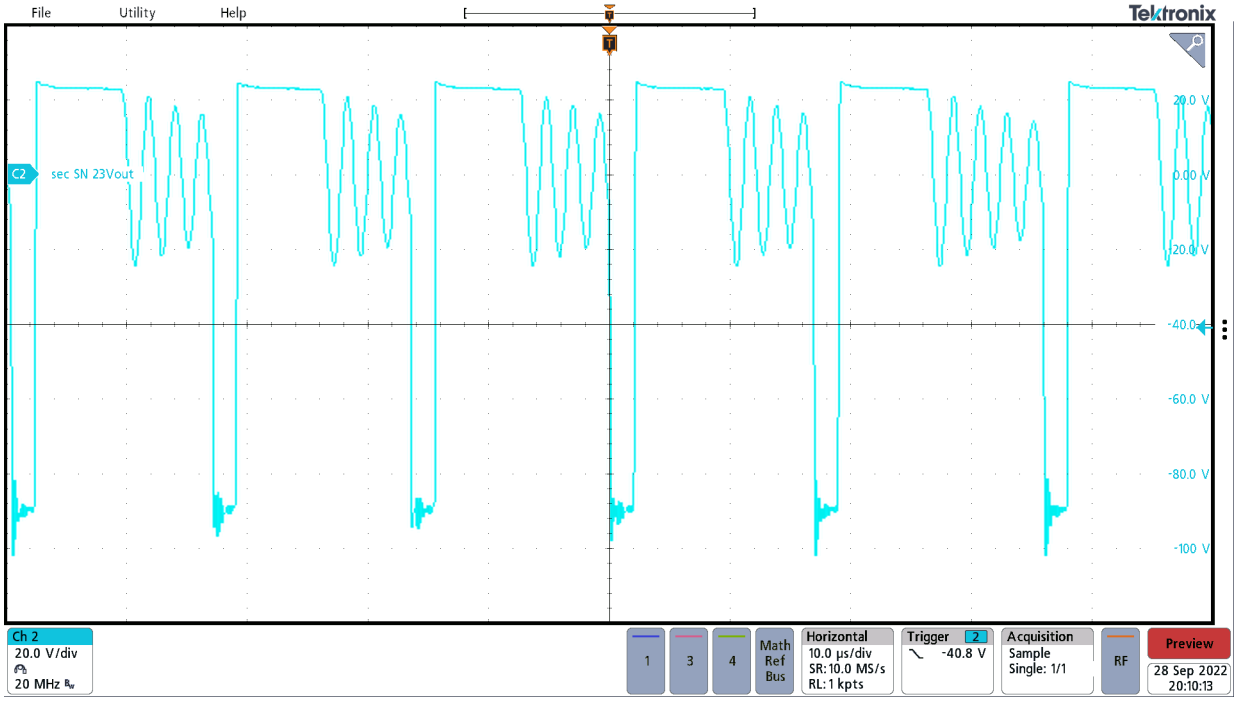


Figure 3-9. Secondary Side Switch Node 23-V Output

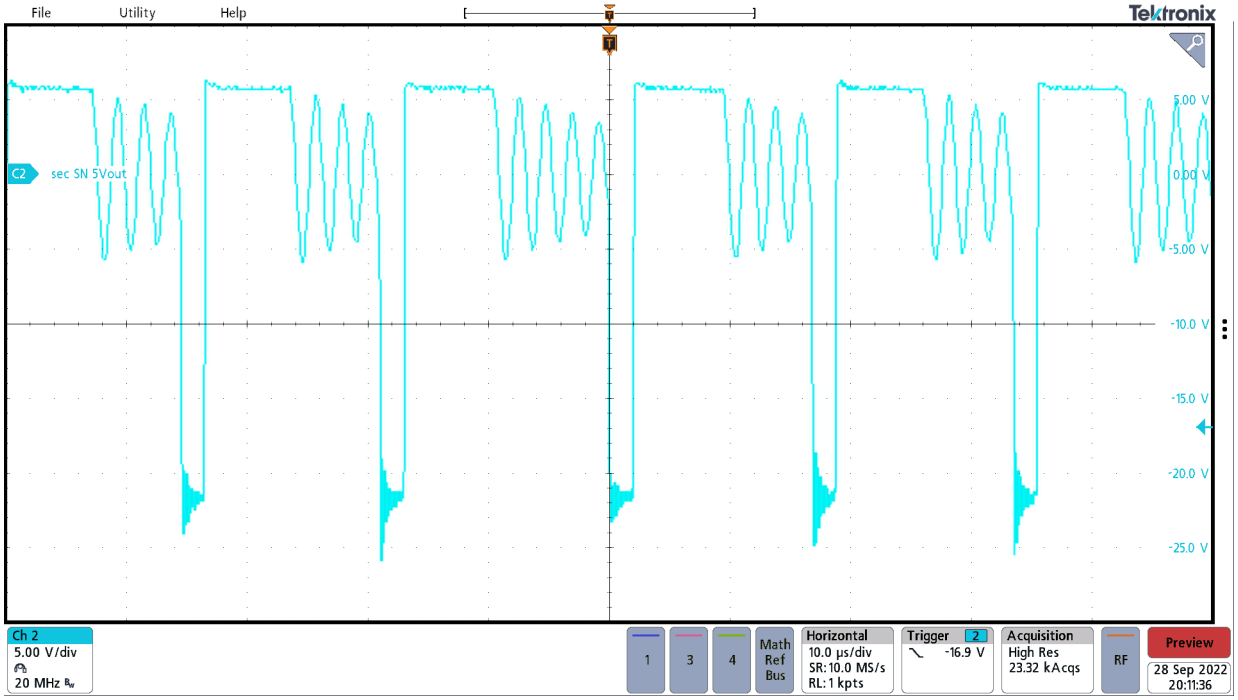


Figure 3-10. Secondary Side Switch Node 5-V Output

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