Test Report: PMP30831

Offline Valley Switching Flyback Reference Design With Multiple Outputs

Description

This 42W multiple output power reference design supports AC/DC industrial power supplies with an AC/DC input voltage range of $150V_{AC}$ to $253V_{AC}$. The design achieves a peak efficiency of 89% by using discontinuous conduction mode (DCM) valley-switching of TI's UCC28742 flyback controller.

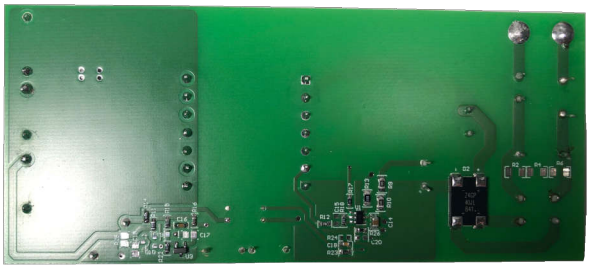
Features

- AC input voltage range $150V_{AC}$ to $253V_{AC}$
- Delivers 42W output power over the entire operating voltage range
- Three outputs: 8V, 18V, and 24V
- Peak power conversion efficiency of greater than 89%

Applications

- Residential water heater

Top of Board



Bottom of Board

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input	$150V_{AC}$ to $253V_{AC}$
Output 1	8V at 1A
Output 2	18V at 0.25A
Output 3	24V at 1.2A

1.2 Dimensions

The size of the board is 126mm × 55mm.

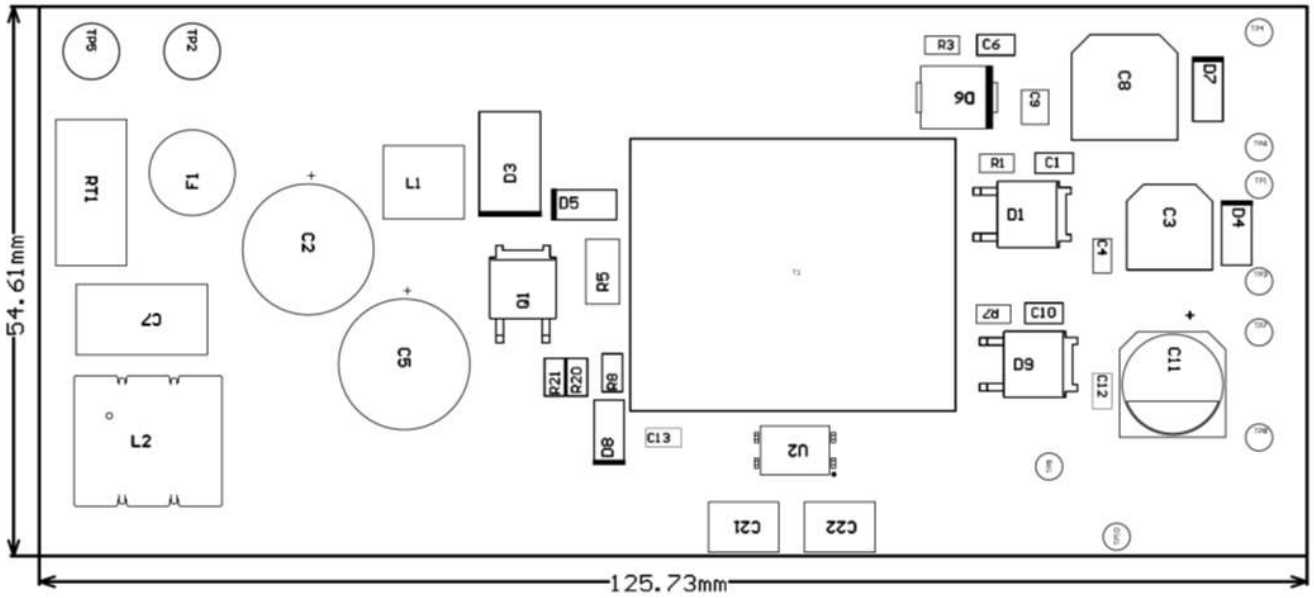


Image shown does not reflect actual size.

Figure 1-1. Board Outline

2 Testing and Results

2.1 Efficiency Graphs

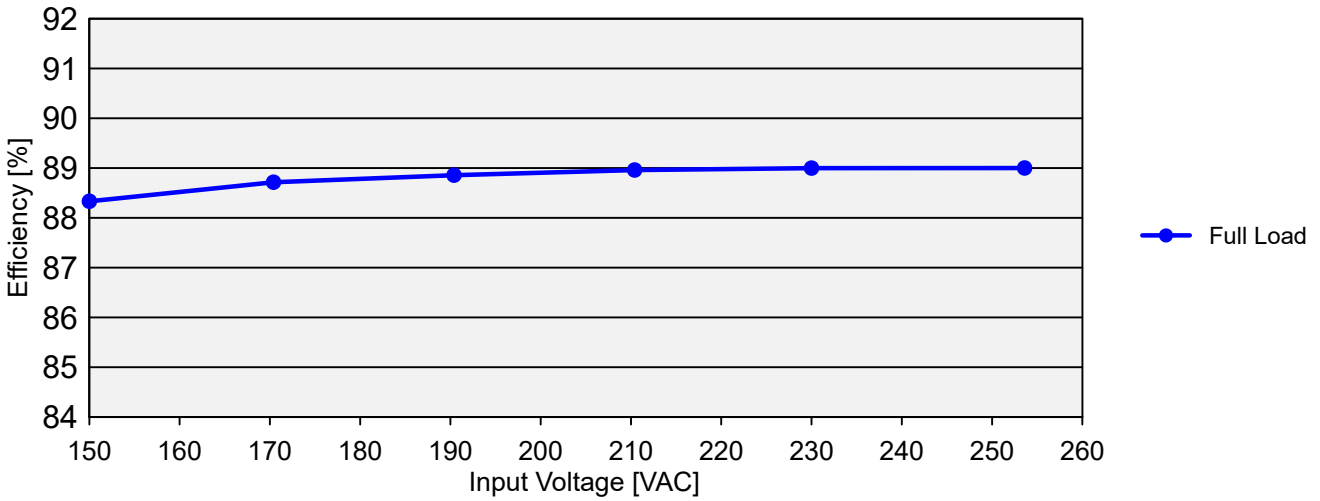


Figure 2-1. Efficiency vs Input Voltage

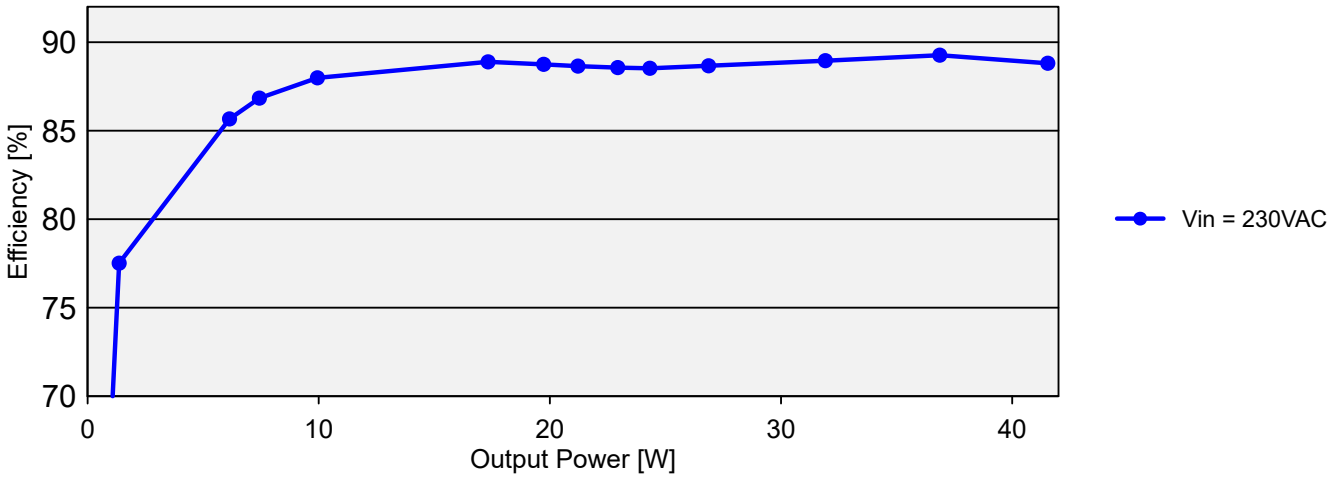


Figure 2-2. Efficiency vs Output Power

2.2 Thermal Images

The images below show the infrared images taken from the FlexCam after 10min.

Input voltage	= 150V_{AC}
Output 1	= 8V @ 1A
Output 2	= 18V @ 0.25A
Output 3	= 24V @ 1.2A

Top Side, 150V_{AC} Input Voltage

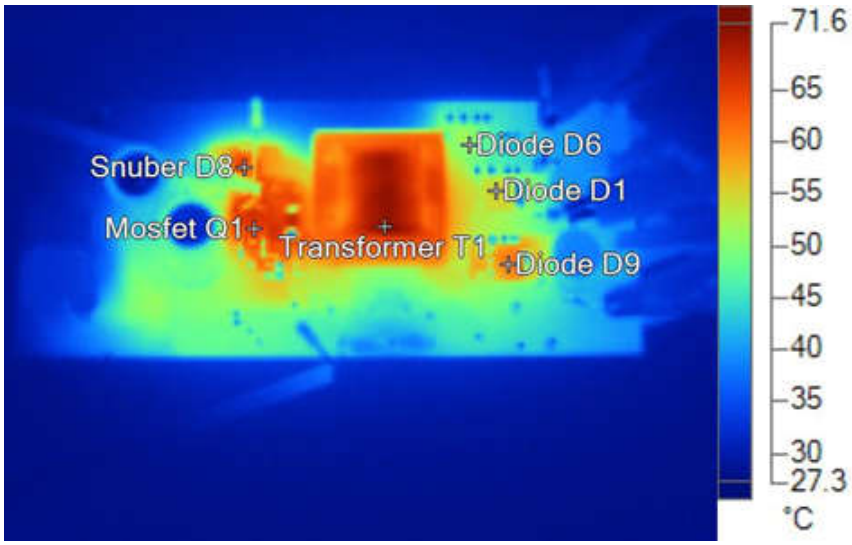


Figure 2-3. Top Side Thermal Image (150V_{AC})

Name	Temperature
Transformer T1	71.6°C
Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET) Q1	65.4°C
Snubber D8	65.3°C
Diode D9	60.4°C
Diode D1	55.3°C
Diode D6	50.9°C

Bottom Side, 150V_{AC} Input Voltage

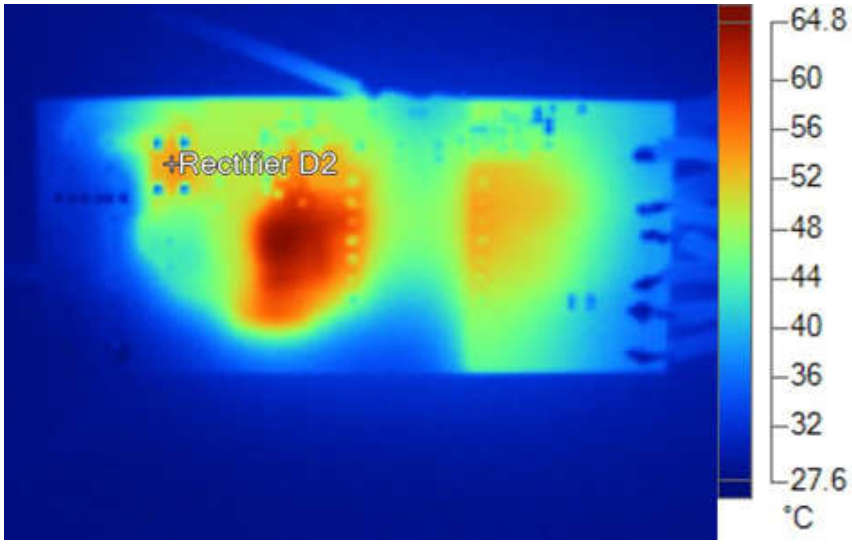


Figure 2-4. Bottom Side Thermal Image (150V_{AC})

Name	Temperature
Rectifier D2	54.7°C

Top Side, 254V_{AC} Input Voltage

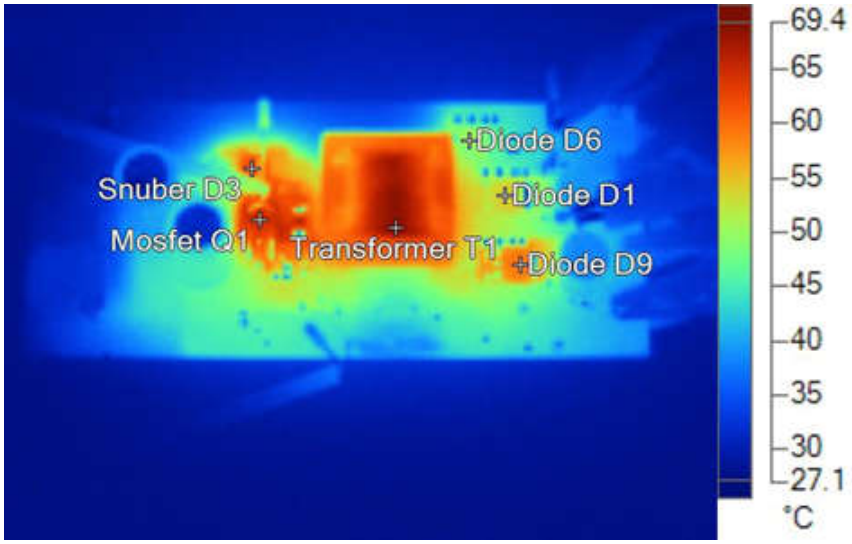


Figure 2-5. Top Side Thermal Image (254V_{AC})

Name	Temperature
Transformer T1	69.4°C
MOSFET Q1	65.1°C
Snubber D3	62.8°C
Diode D6	50.4°C
Diode D1	54.5°C
Diode D9	59.7°C

2.3 Bode Plot

The Bode plot is shown in the following figure.

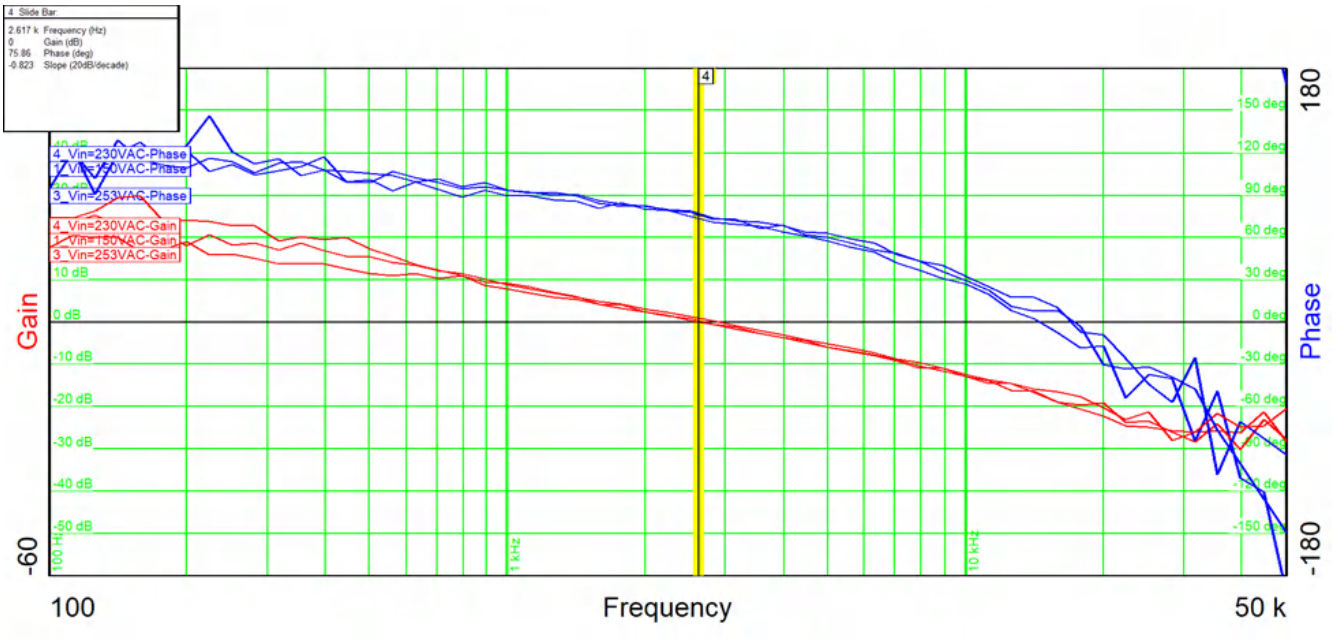


Figure 2-6. Bode Plot

Input Voltage	= 150V_{AC}
Load	= full load
Bandwidth	= 2.9kHz
Phase Margin	= 71°
Input Voltage	= 230V_{AC}
Load	= full load
Bandwidth	= 2.6kHz
Phase Margin	= 76°
Input Voltage	= 253V_{AC}
Load	= full load
Bandwidth	= 2.7kHz
Phase Margin	= 76°

2.4 Electromagnetic Interference (EMI) Measurement

The graph below shows the conducted emission EMI noise and the EN55022 Class-B Quasi-Peak limits (measurement from the worst-case line). The measurement is not certified. The board was connected to a line impedance stabilization network (LISN) and an isolation transformer; the loads were power resistors. The receiver was set to quasi-peak detector, 10kHz bandwidth. The negative terminal of the converter was connected to the ground of the LISN.

Input voltage	= 230V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

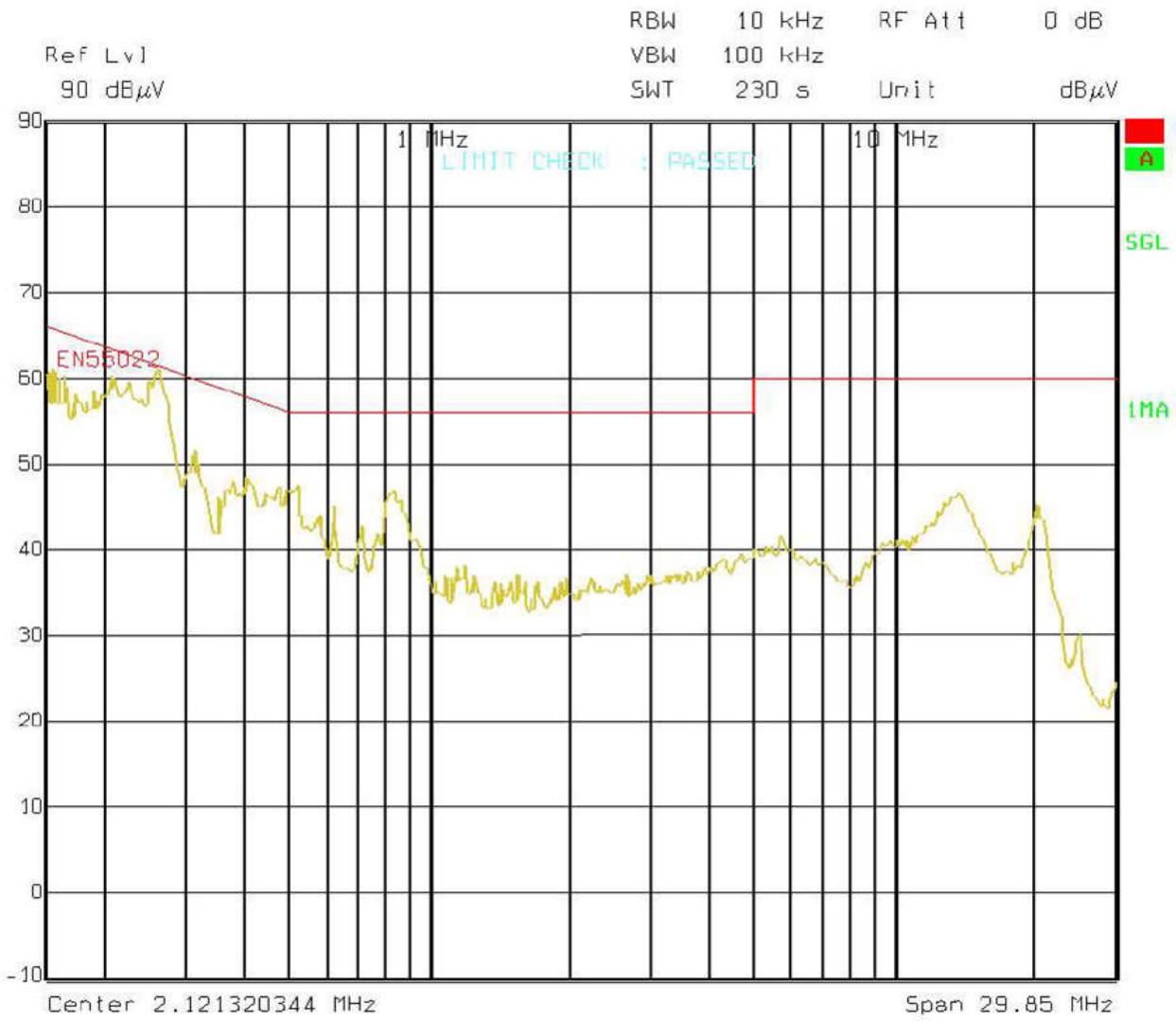


Figure 2-7. EMI

3 Waveforms

3.1 Switching

3.1.1 150V_{AC} Input Voltage

Input voltage	= 150V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

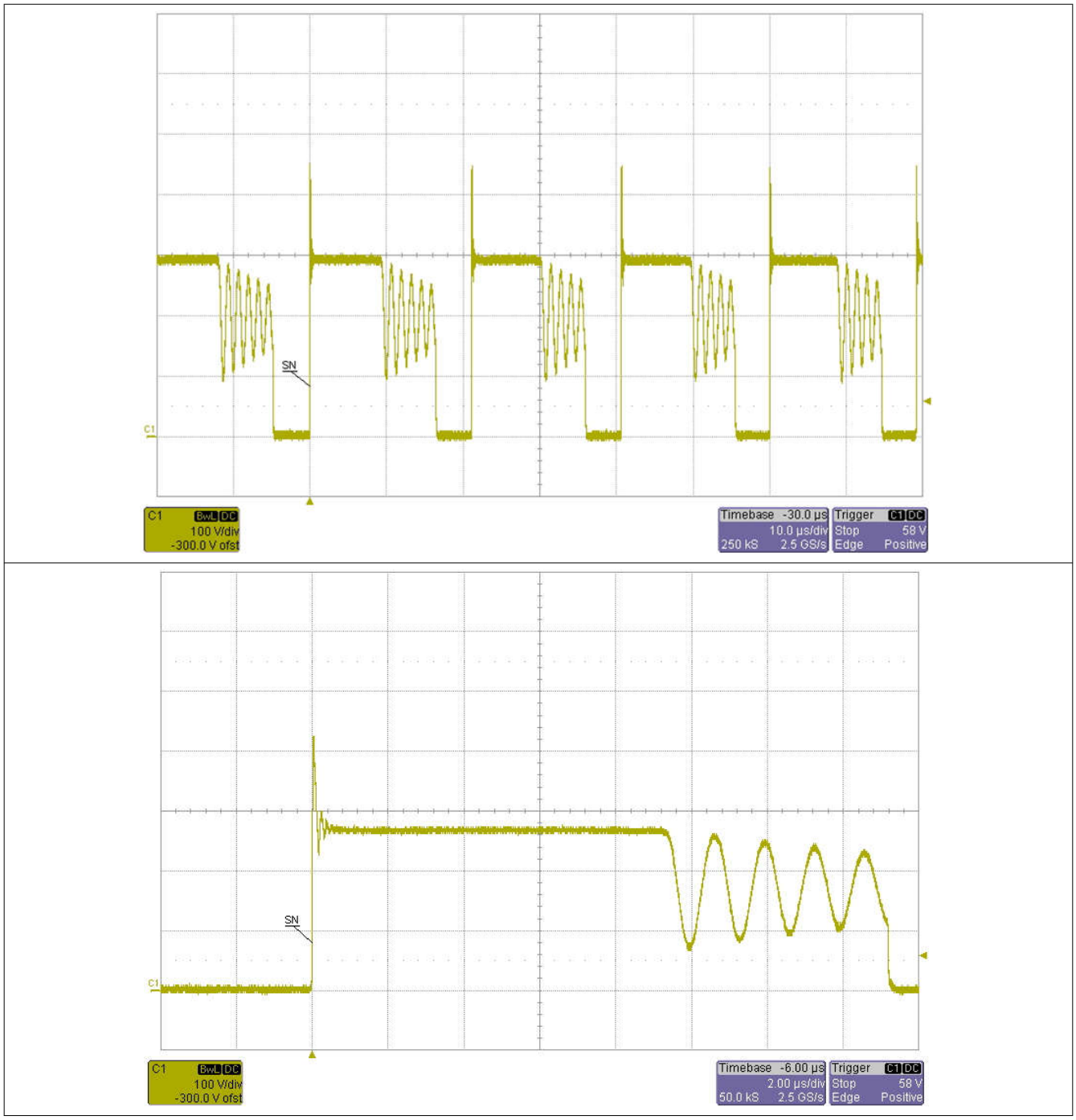


Figure 3-1. Switching at 150V_{AC} Input Voltage

3.1.2 254V_{AC} Input Voltage

Input voltage	= 253V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

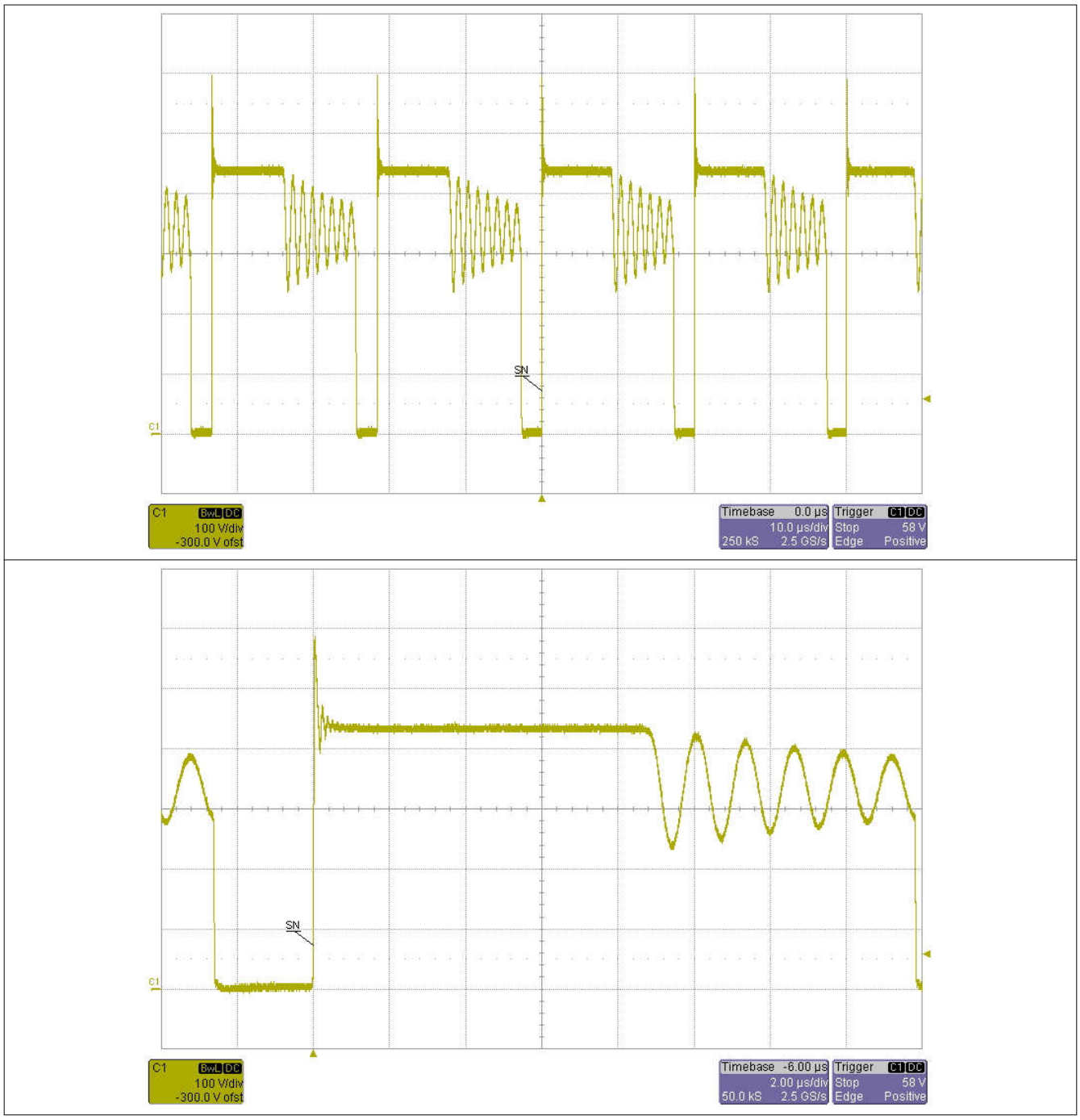


Figure 3-2. Switching at 253V_{AC} Input Voltage

3.2 Output Voltage Ripple

3.2.1 Output 1 (8V)

Input voltage	= $230V_{AC}$
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

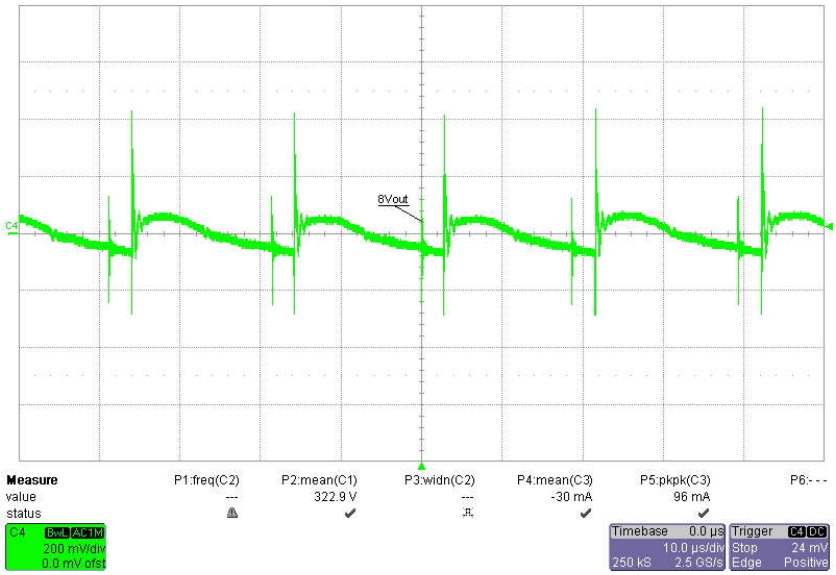


Figure 3-3. Output 1 Voltage Ripple

3.2.2 Output 2 (18V)

Input voltage	= $230V_{AC}$
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

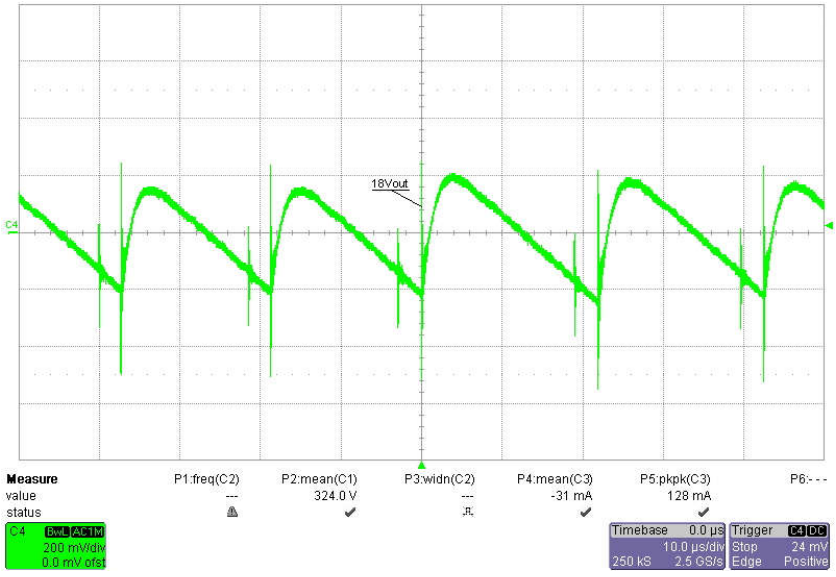


Figure 3-4. Output 2 Voltage Ripple

3.2.3 Output 3 (24V)

Input voltage	= $230V_{AC}$
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

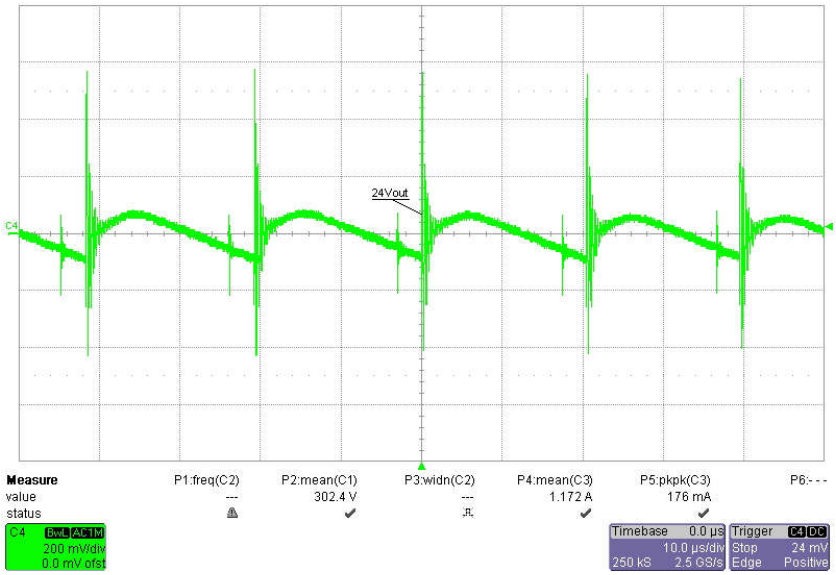


Figure 3-5. Output 3 Voltage Ripple

3.3 Input Voltage Ripple

Input voltage	= $150V_{AC}$
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

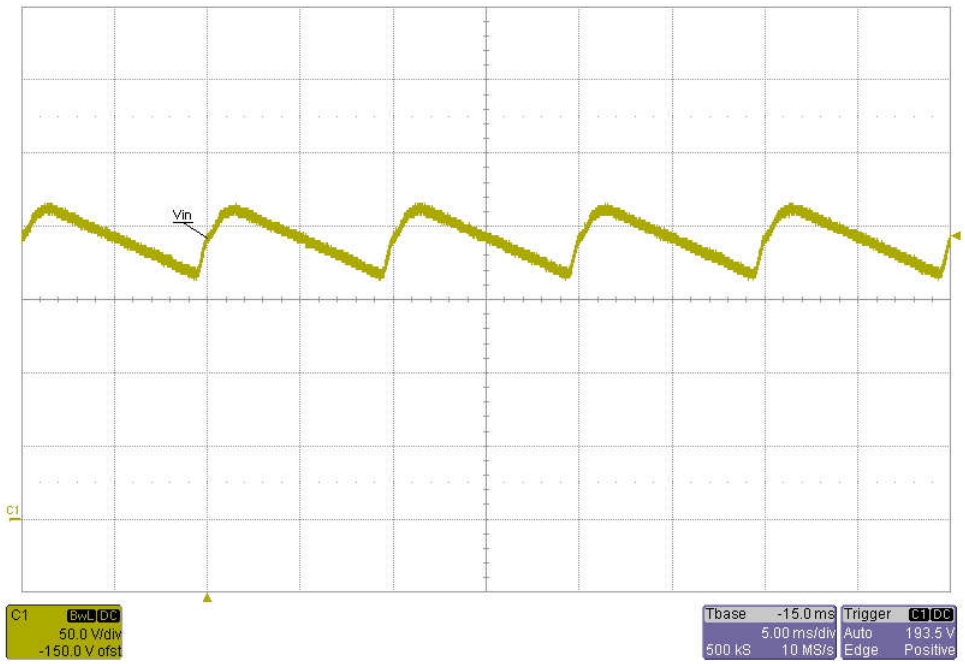


Figure 3-6. Input Voltage Ripple

3.4 Load Transient Output 3 (24V)

Input voltage	= $230V_{AC}$
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Load step Output 3	= 0.6A to 1.2A

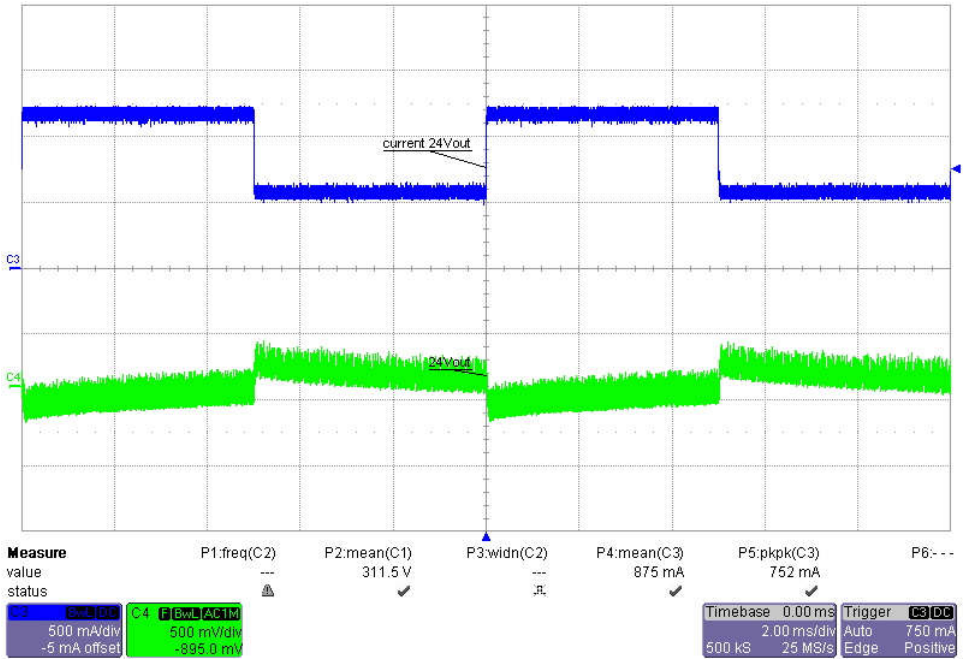


Figure 3-7. Load Transient Output 3

3.5 Start-Up

3.5.1 150V_{AC} Input Voltage

Input voltage	= 150V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

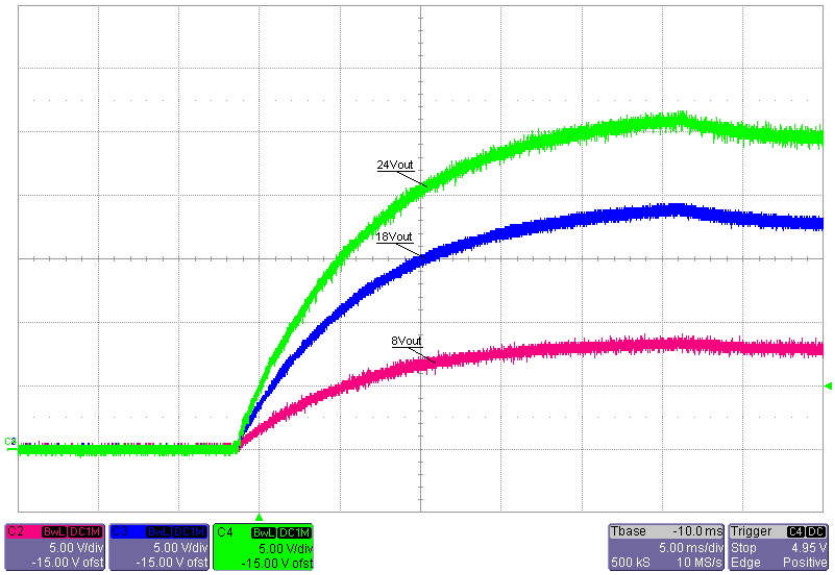


Figure 3-8. Start-Up 150V_{AC} Input Voltage

3.5.2 253V_{AC} Input Voltage

Input voltage	= 253V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

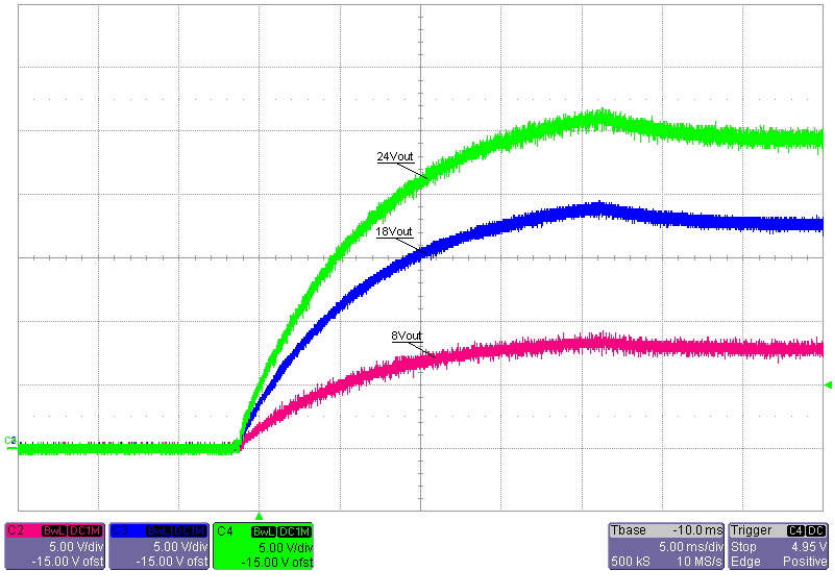


Figure 3-9. Start-Up 253V_{AC} Input Voltage

3.6 Shutdown

3.6.1 150V_{AC} Input Voltage

Input voltage	= 150V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

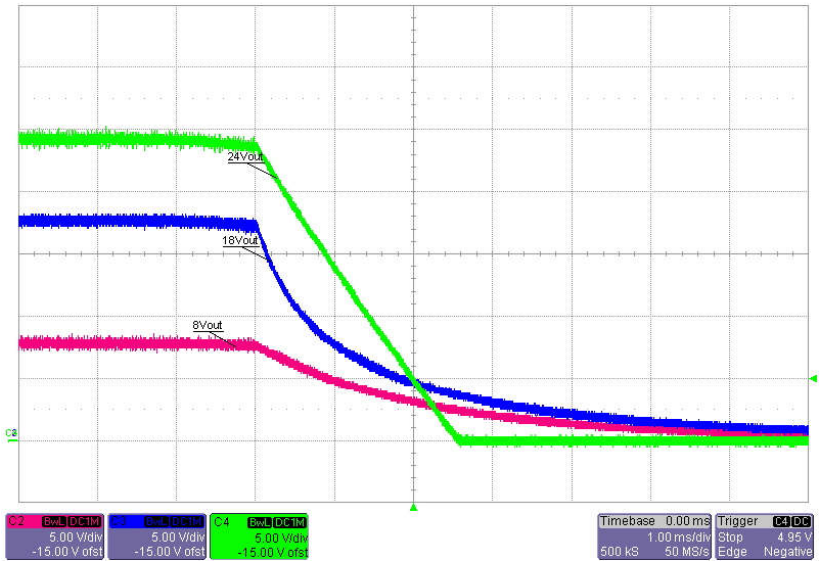


Figure 3-10. Shutdown 150V_{AC} Input Voltage

3.6.2 253V_{AC} Input Voltage

Input voltage	= 253V_{AC}
Output 1	= 8V at 1A
Output 2	= 18V at 0.25A
Output 3	= 24V at 1.2A

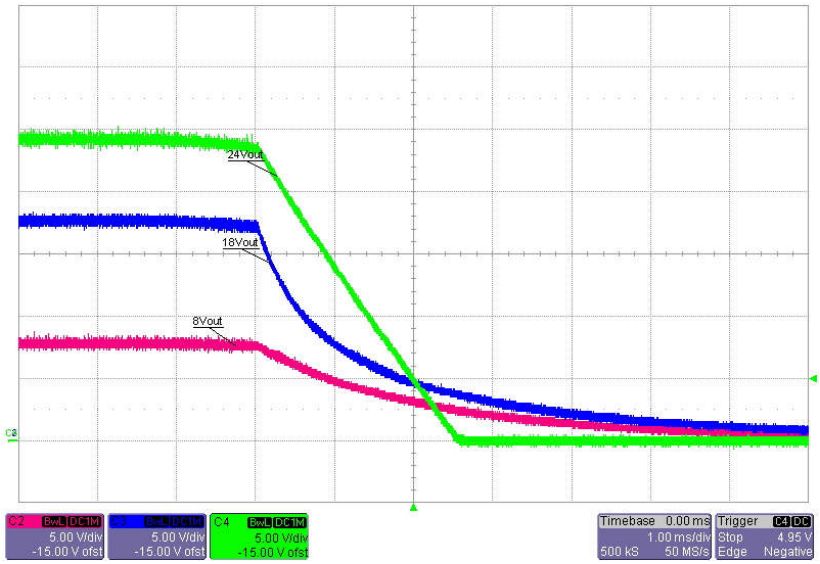


Figure 3-11. Shutdown 253V_{AC} Input Voltage

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