Test Report: PMP31261

Wide V_{IN} PSR Flyback Converter Dual-Output Reference Design

Description

The primary side regulated flyback provides dual outputs (B: 12 V at 170 mA, A: 18 V at 60 mA). The design has a small form factor with low component count. This design operates over an input voltage range of 8 V to 28 V to deliver two isolated outputs. Operating without an auxiliary winding or optocoupler, the LM5180 provides very tight output voltage regulation. The LM5180 offers several features that provide protection of the regulator during fault conditions.

Features

- Primary-side regulation eliminates optocoupler
- Integrated FET minimizes external components
- 8-V to 28-V input voltage range
- 12-V and 18-V output voltages

Applications

- Process analytics

Top Photo

Bottom Photo

Angled Photo

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage Range (DC)	8 V to 36 V
Output Voltage A	18 V
Maximum Output Current A	0.06 A
Output Voltage B	12 V
Maximum Output Current B	0.17 A
IC	LM5180
Topology	Isolated Flyback

1.2 Considerations

Unless otherwise mentioned, resistors were used as load and the input voltage was set to 24 V.

1.3 Dimensions

The size of the two-layer board is 58.4 mm × 41.9 mm. The copper thickness is 35 µm on each layer.

2 Testing and Results

2.1 Efficiency and Loss Graph

The measurements in Figure 2-1 and Figure 2-2 were performed with R9 = 3.01 kΩ and R10 = 6.49 kΩ pre-load resistors.

2.1.1 Efficiency

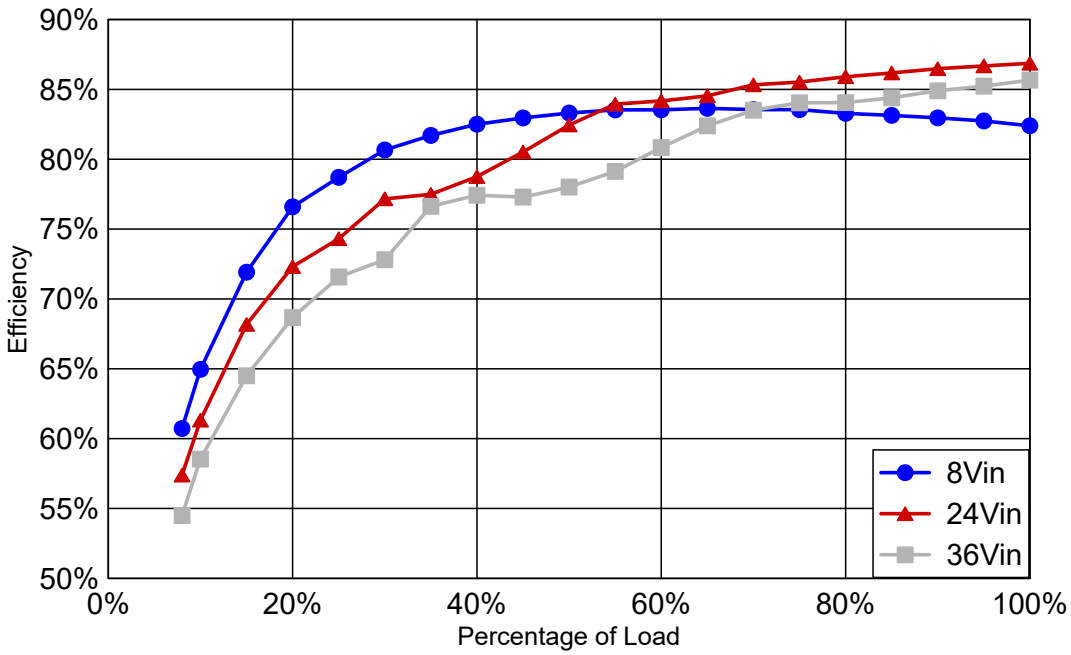

Figure 2-1. Efficiency vs Percentage of Load

2.1.2 Loss

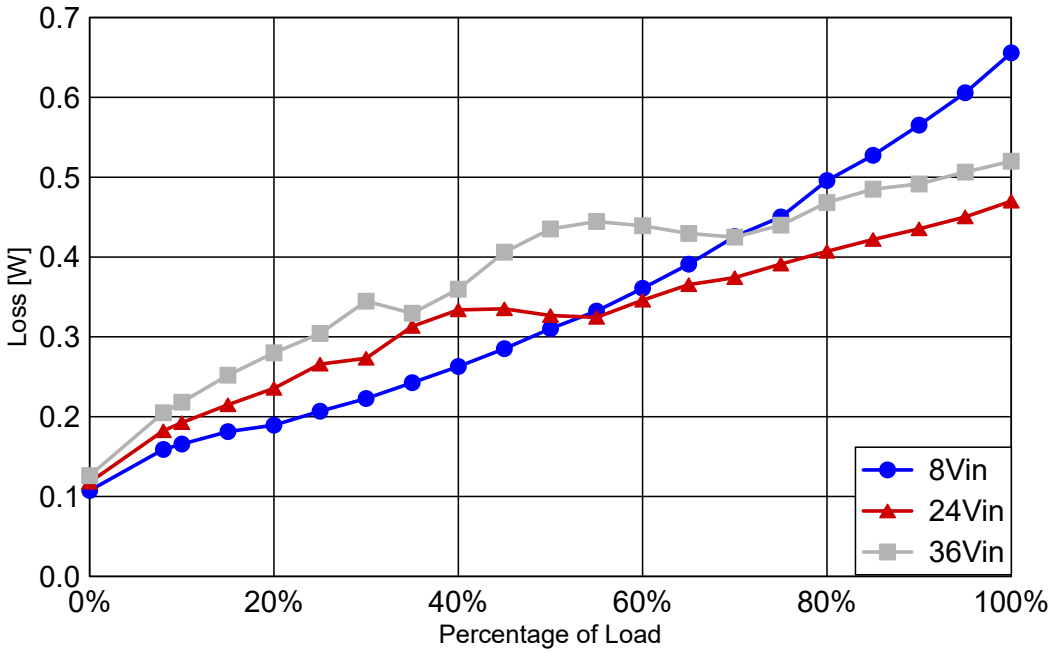

Figure 2-2. Loss vs Percentage of Load

2.2 Load Regulation

During the measurement for efficiency and loss, the values for load regulation were also obtained.

2.2.1 18-V Output Voltage (VOUT-A)

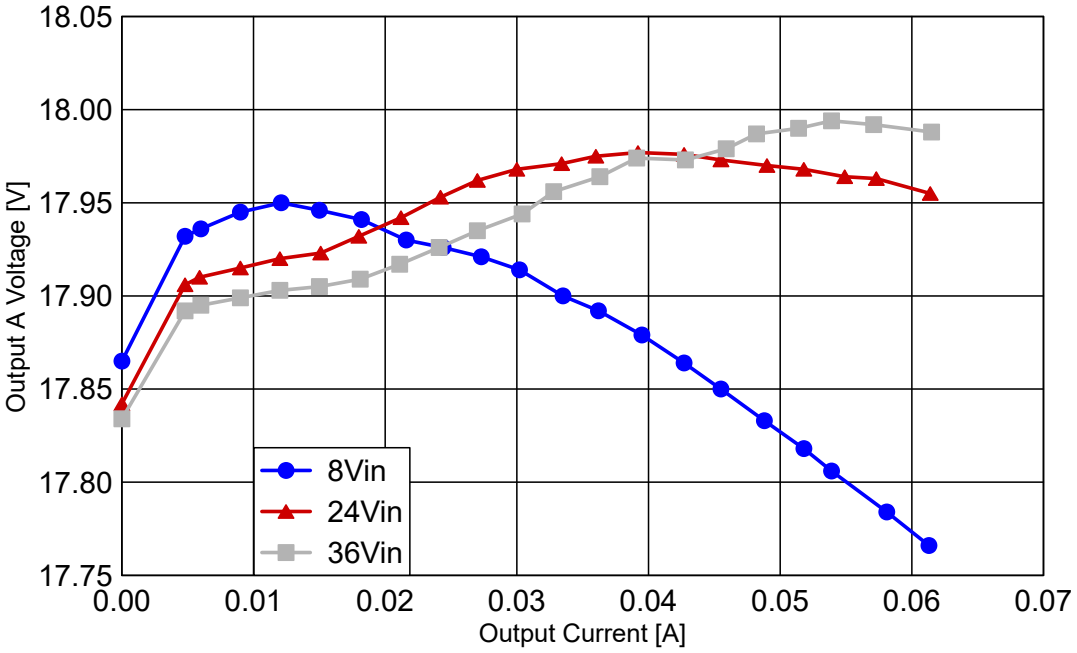

Figure 2-3. Load Regulation for 18-V Output Voltage

2.2.2 12-V Output Voltage (VOUT-B)

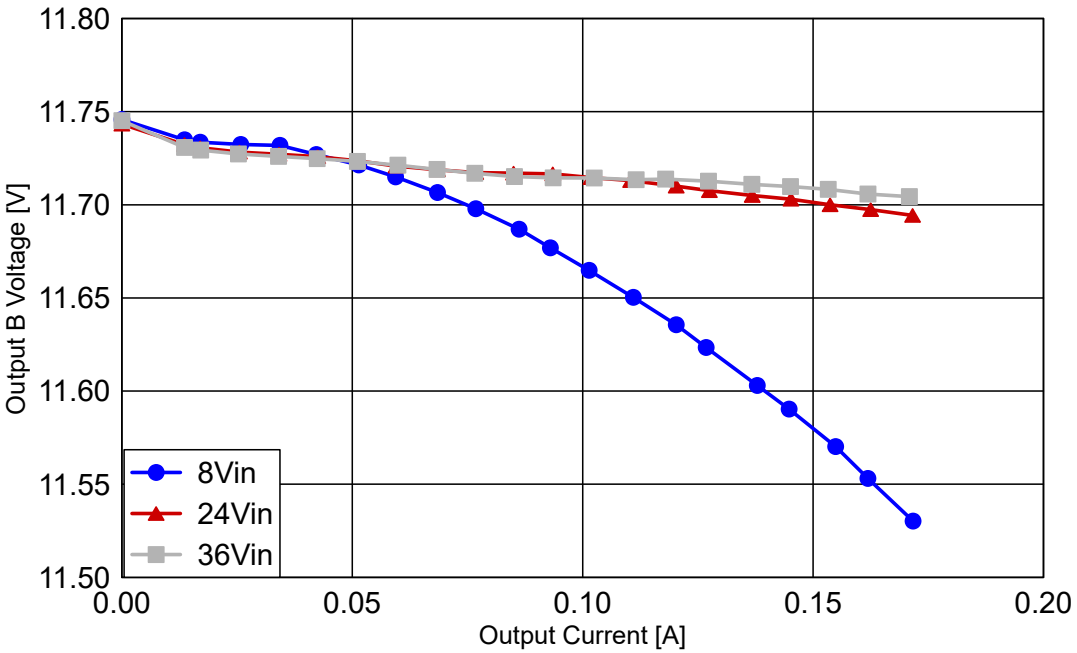

Figure 2-4. Load Regulation for 12-V Output Voltage

2.3 Line Regulation

The measurements for line regulation were done with the revision B circuit.

2.3.1 18-V Output Voltage (VOUT-A)

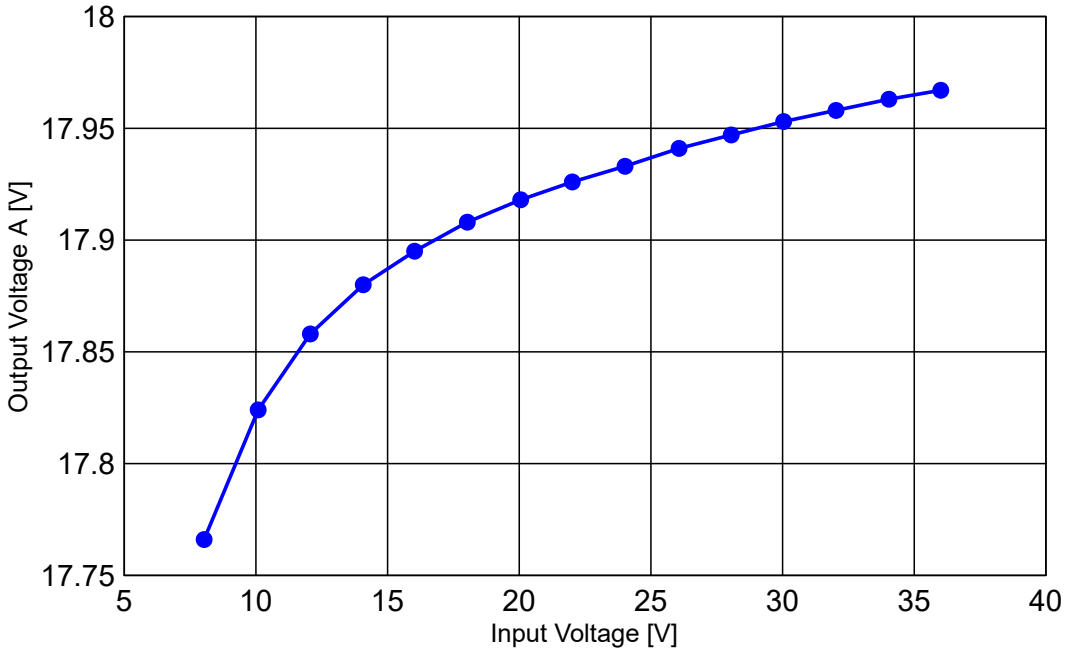

Figure 2-5. Line Regulation for 18-V Output Voltage

2.3.2 12-V Output Voltage (VOUT-B)

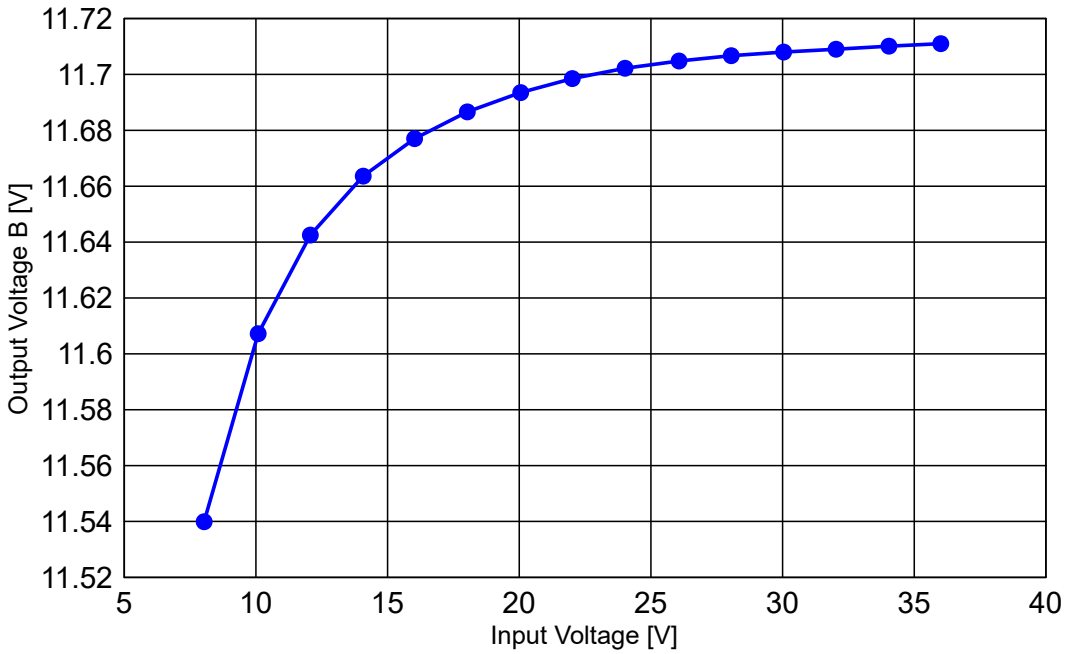

Figure 2-6. Line Regulation for 12-V Output Voltage

2.3.3 Efficiency and Loss vs Line Variation

The efficiencies were measured with R9 = 1.5-kΩ and R10 = 1-kΩ pre-load resistors.

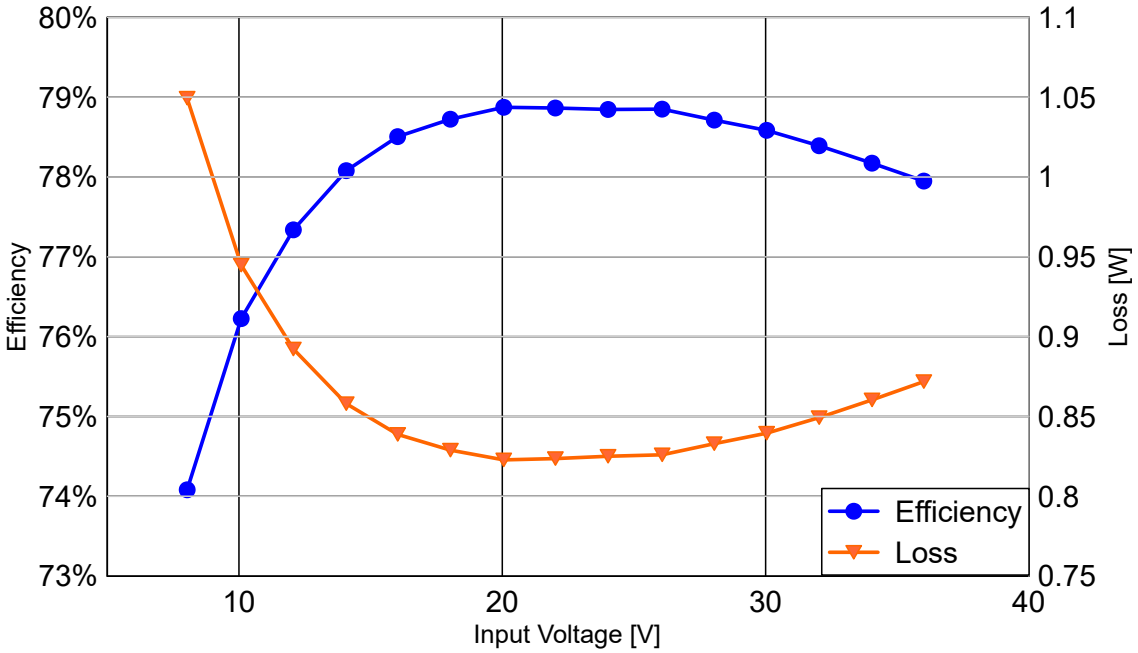

Figure 2-7. Efficiency and Loss vs Input Voltage

2.4 Cross Regulation

For the measurements in this section, the input voltage was set to 24 V.

2.4.1 12-V Output With No Load

2.4.1.1 Effects on the 18-V Output

Figure 2-8 displays:

- (blue curve) 18-V output voltage; during the output, current of the 18-V output was varied.
- (red curve) the according voltage values with symmetrically loaded outputs. (See also Figure 2-3).

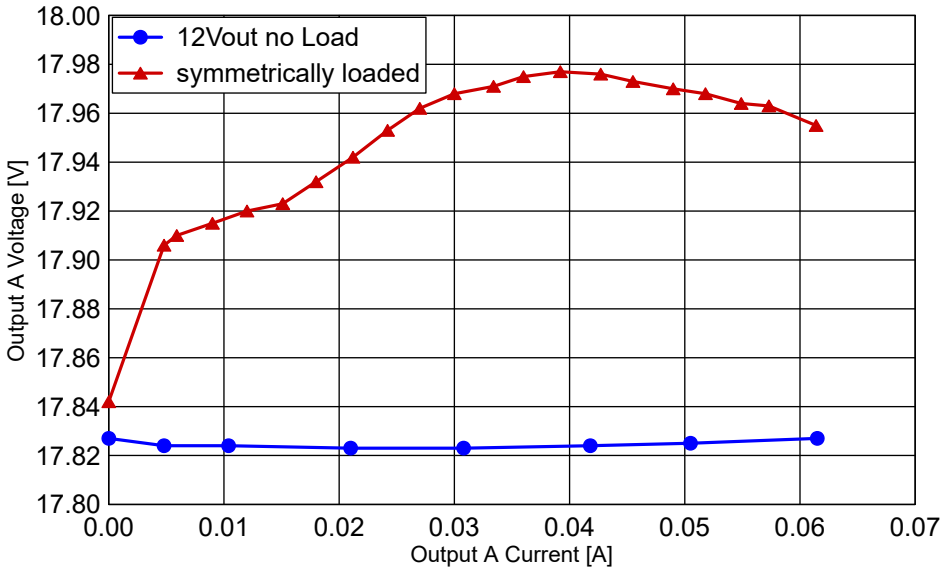

Figure 2-8. 18-V Output Voltage (VOUT-A) vs Output Current A

2.4.1.2 Effects on the 12-V Output

Figure 2-9 displays:

- (blue curve) 12-V output voltage during the output current of the 18-V output was varied.
- (red curve) the according voltage values with symmetrically loaded outputs. (See also Figure 2-4)

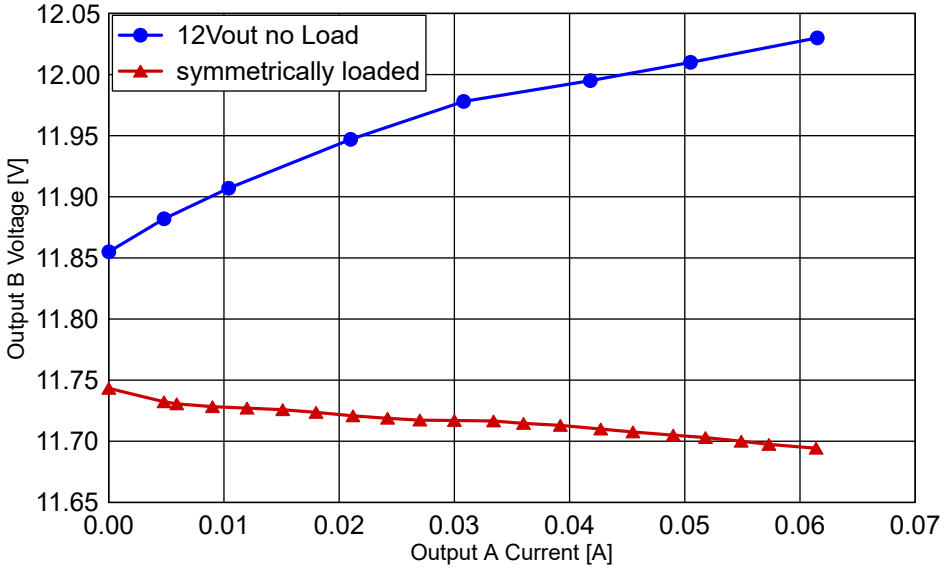

Figure 2-9. 12-V Output Voltage (VOUT-B) vs Output Current A

2.4.2 18-V Output With no Load

2.4.2.1 Effects on the 12-V Output Voltage

Figure 2-10 displays:

- (blue curve) 12-V output voltage during the output current of the 12-V output was varied.
- (red curve) the according voltage values with symmetrically loaded outputs. (See also Figure 2-4)

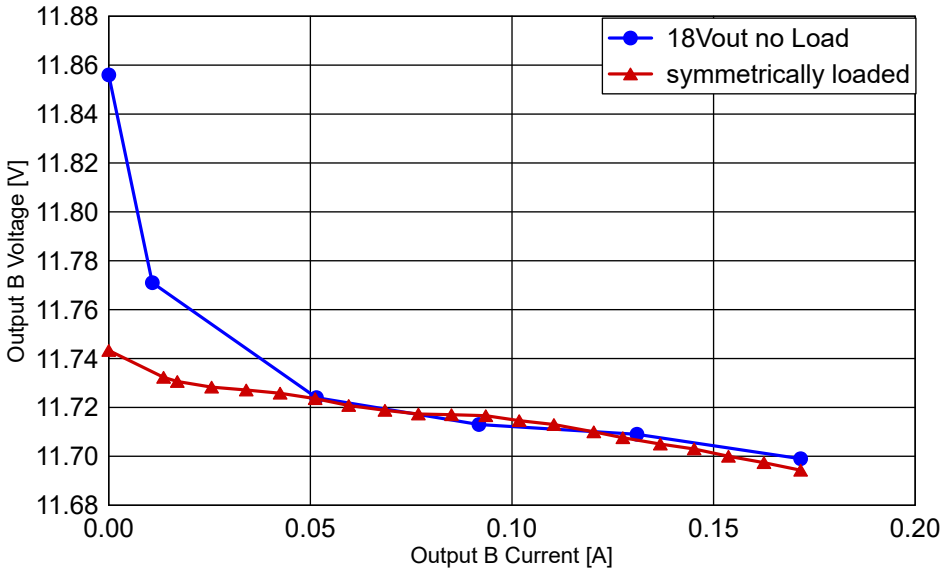

Figure 2-10. 18-V Output Voltage (VOUT-A) vs Output Current B

2.4.2.2 Effects on the 18-V Output Voltage

Figure 2-11 displays:

- (blue curve) 12-V output voltage during the output current of the 18-V output was varied.
- (red curve) the according voltage values with symmetrically loaded outputs. (See also Figure 2-3)

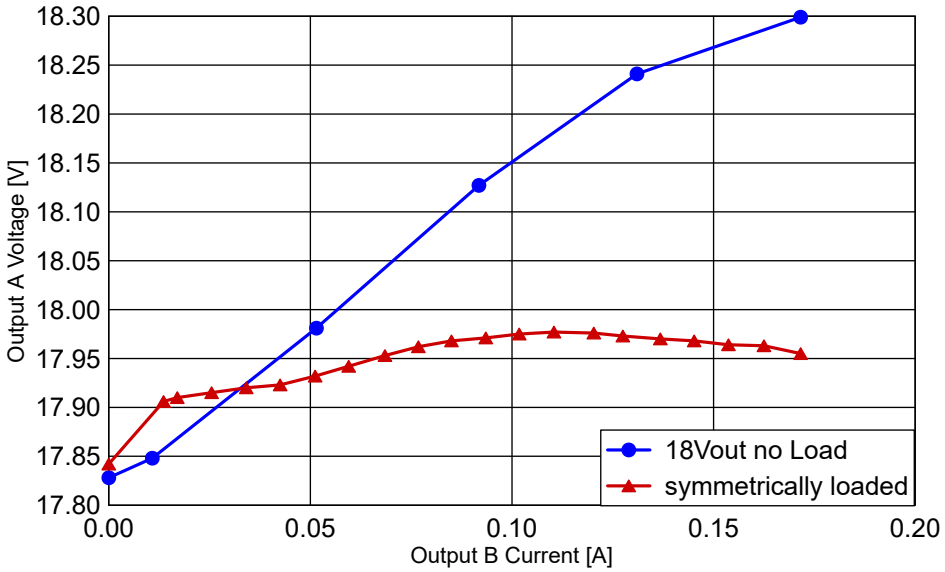

Figure 2-11. Output Voltage B vs Output Current B

2.5 Thermal Images

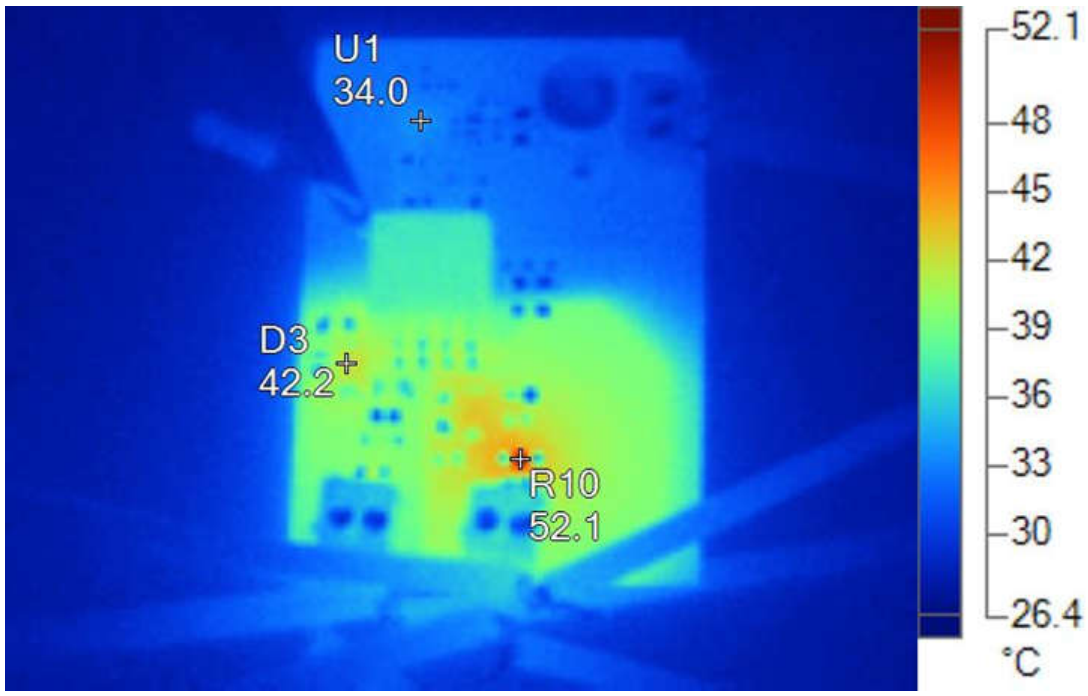

Figure 2-12. Infrared Image Full Load 24-V Input Voltage

Name	Temperature
R10	52.1°C
D3	42.2°C
U1	34.0°C

3 Waveforms

3.1 Switching

3.1.1 Primary Switching Node

3.1.1.1 8-V Input Voltage

3.1.1.1.1 Full Load

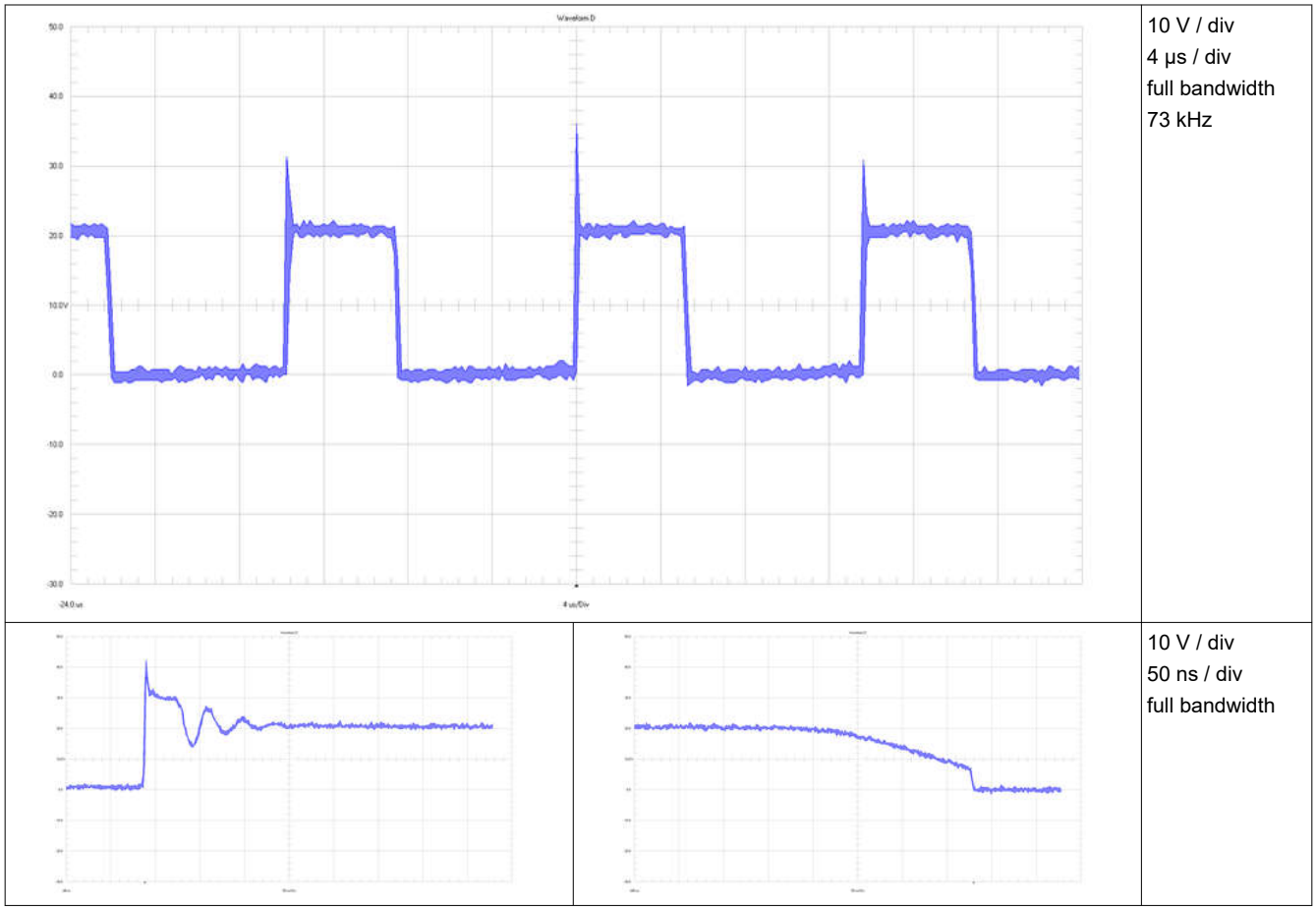

Figure 3-1. Primary Switch Node, 8 V_{IN}, Full Load

3.1.1.1.2 No Load

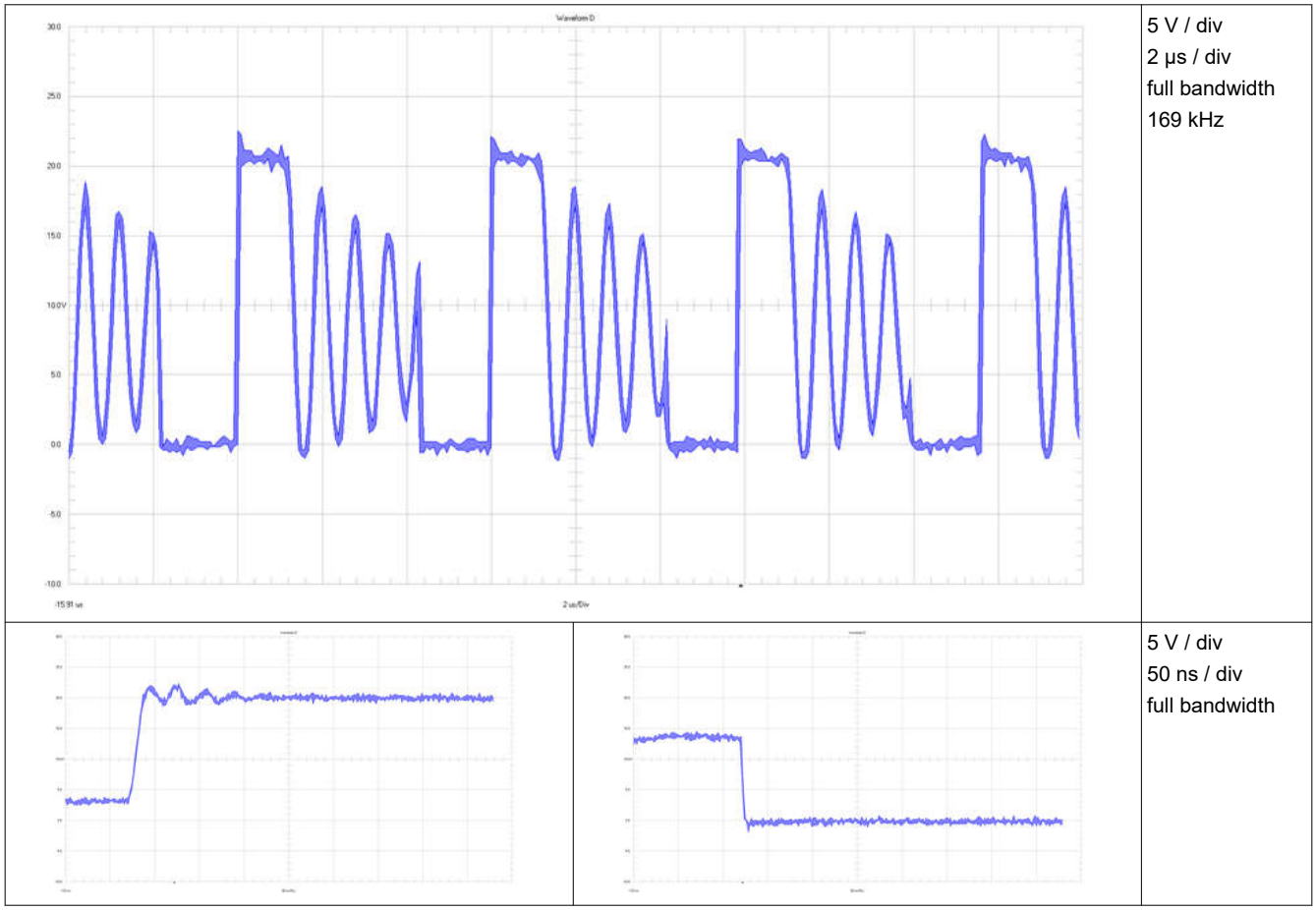

Figure 3-2. Primary Switch Node, 8 V_{IN}, No Load

3.1.1.2 36-V Input Voltage

3.1.1.2.1 Full Load

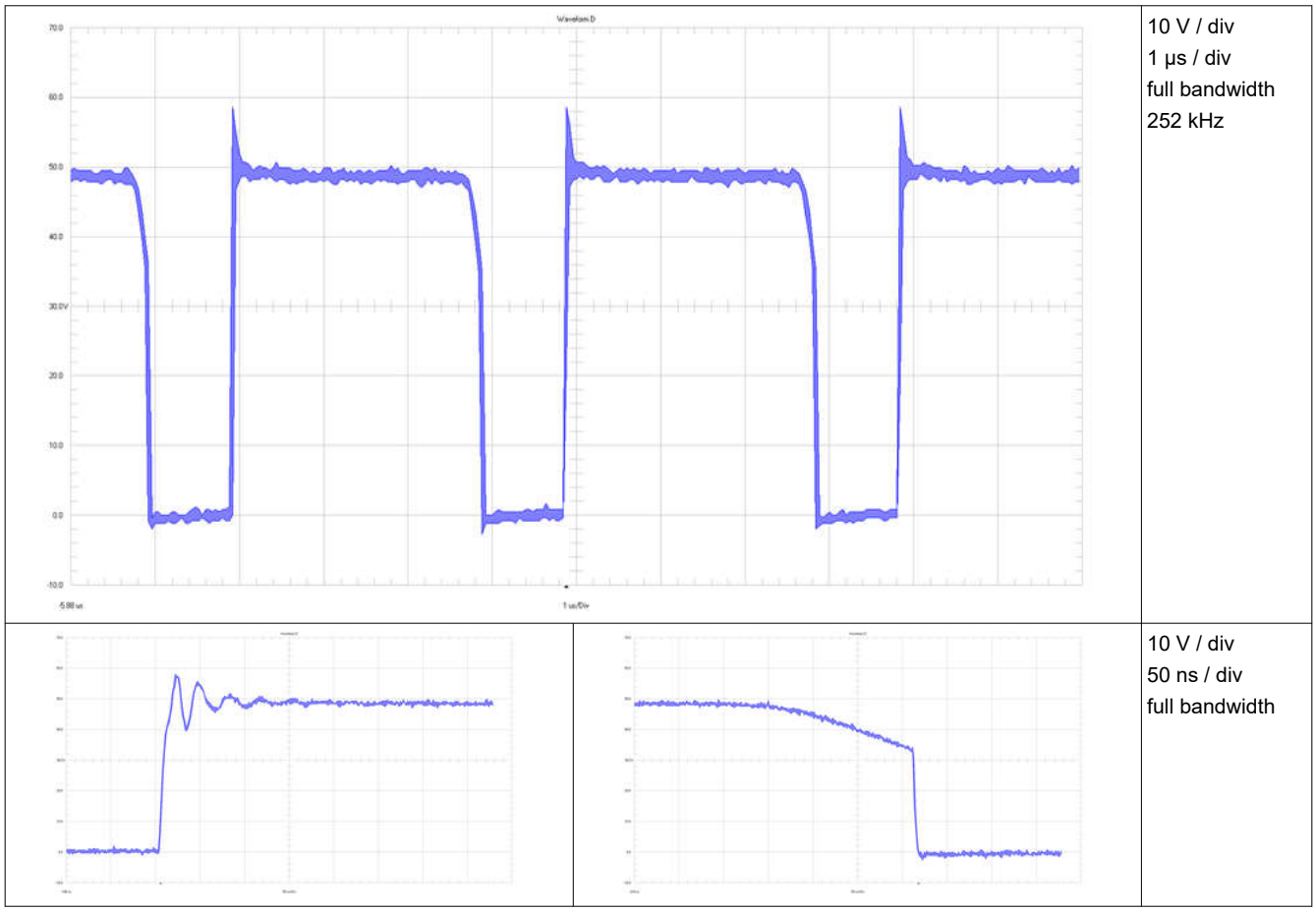

Figure 3-3. Primary Switch Node, 36 V_{IN}, Full Load

3.1.1.2.2 No Load

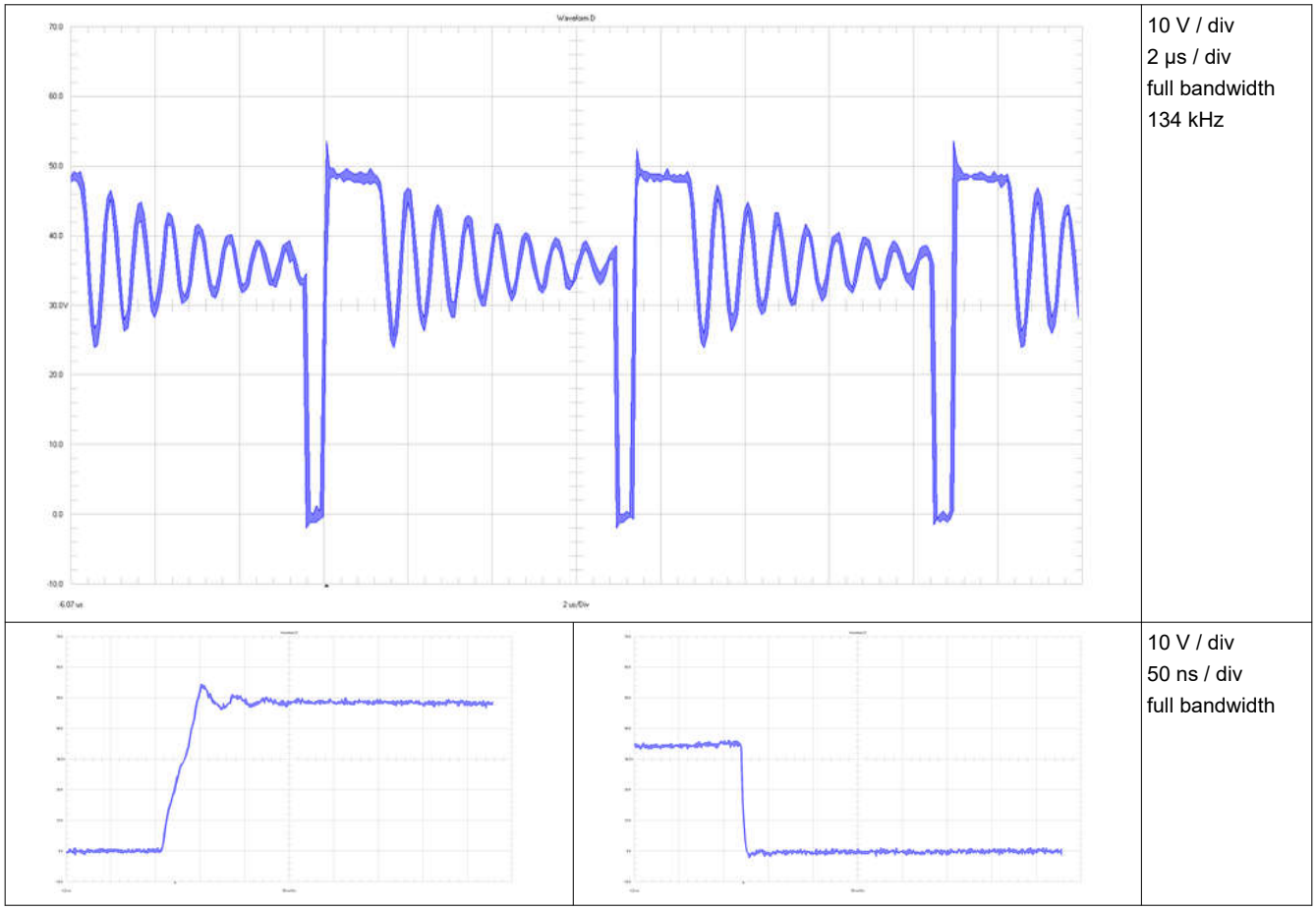

Figure 3-4. Primary Switch Node, 36 V_{IN}, No Load

3.1.2 Diode D3 Referenced to VOUT-B (12 V)

3.1.2.1 8-V Input Voltage

3.1.2.1.1 Full Load

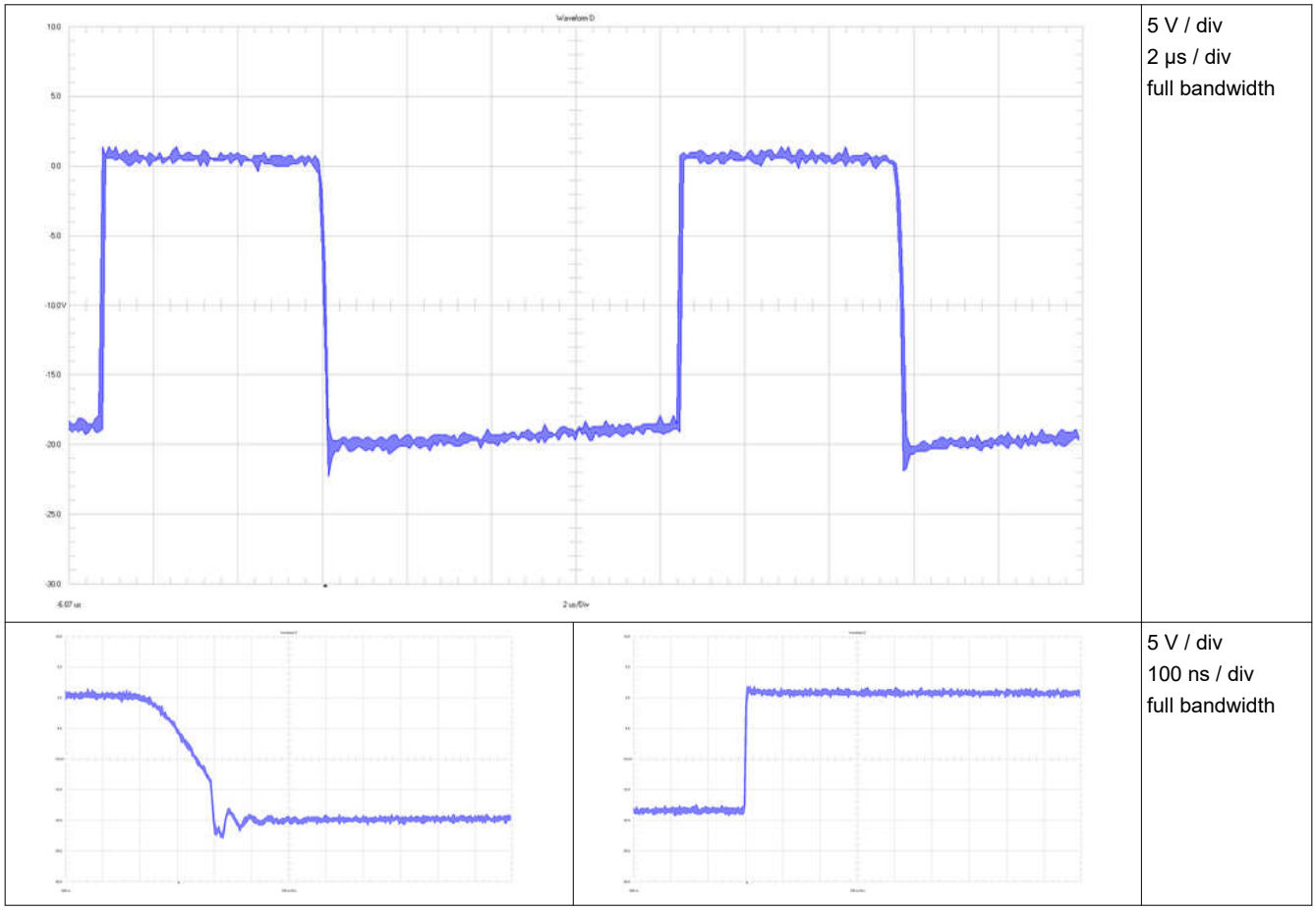

Figure 3-5. Diode D3, 8 V_{IN}, Full Load

3.1.2.1.2 No Load

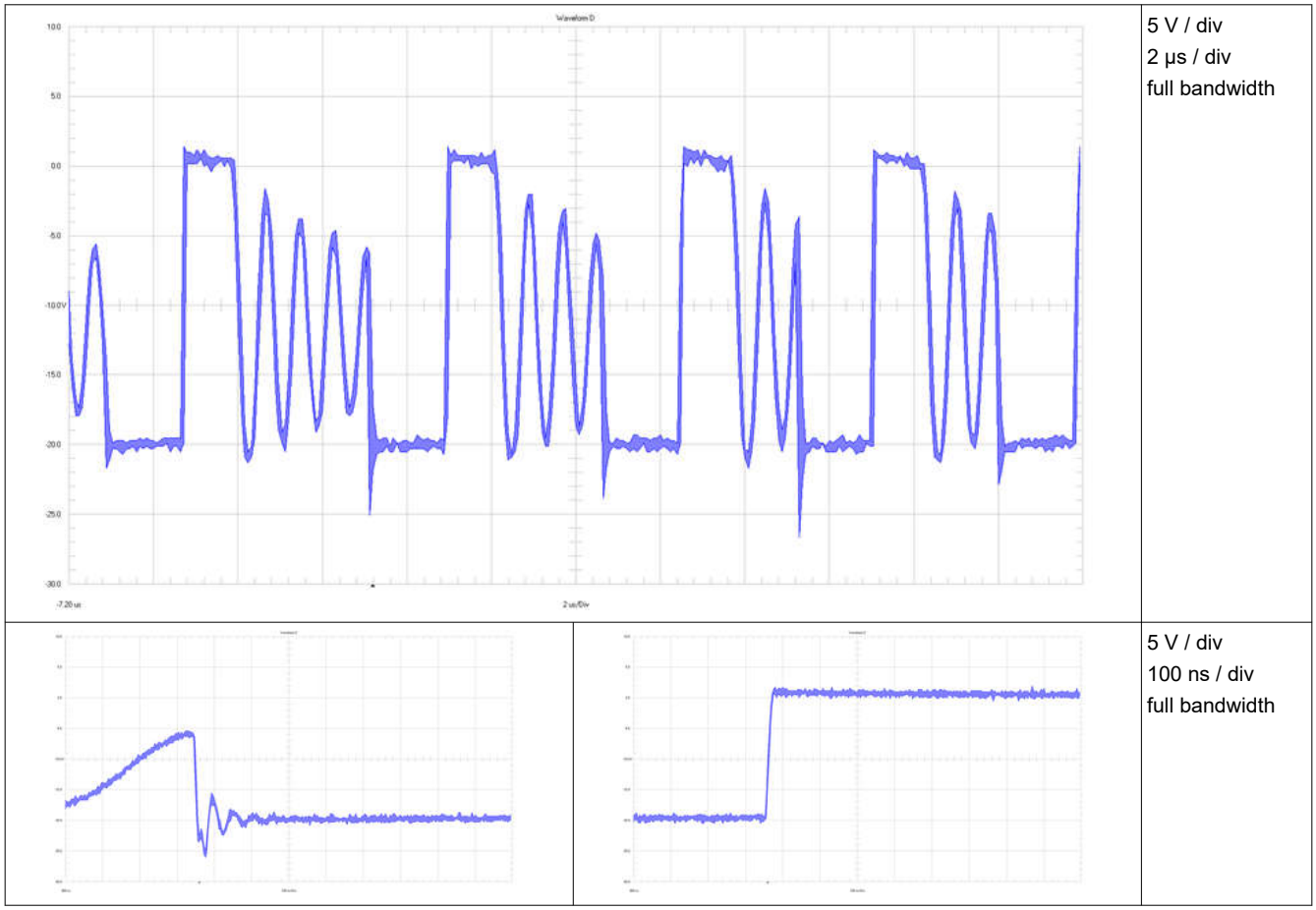

Figure 3-6. Diode D3, 8 V_{IN}, No Load

3.1.2.2 36-V Input Voltage

3.1.2.2.1 Full Load

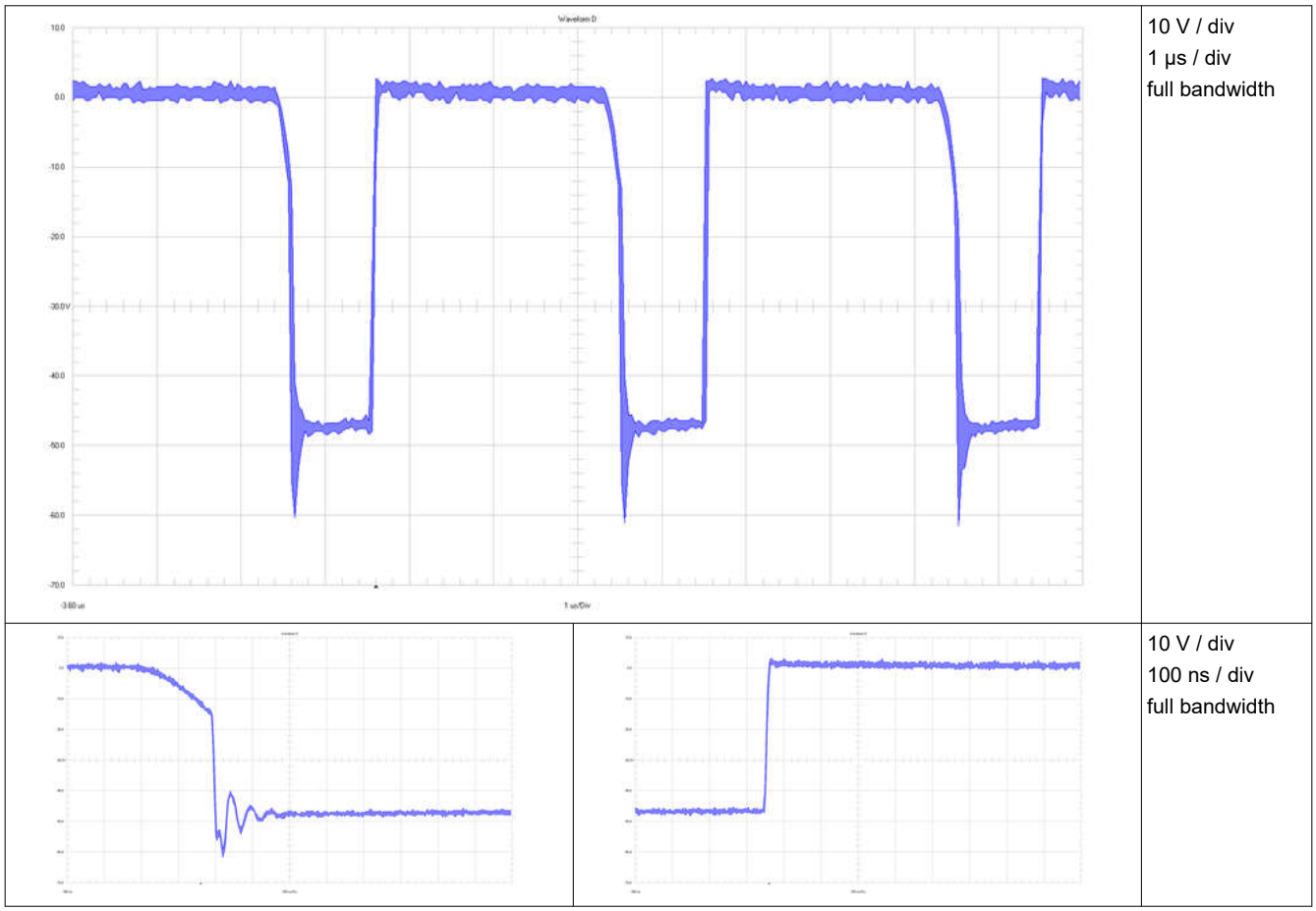

Figure 3-7. Diode D3, 36 V_{IN}, Full Load

3.1.2.2.2 No Load

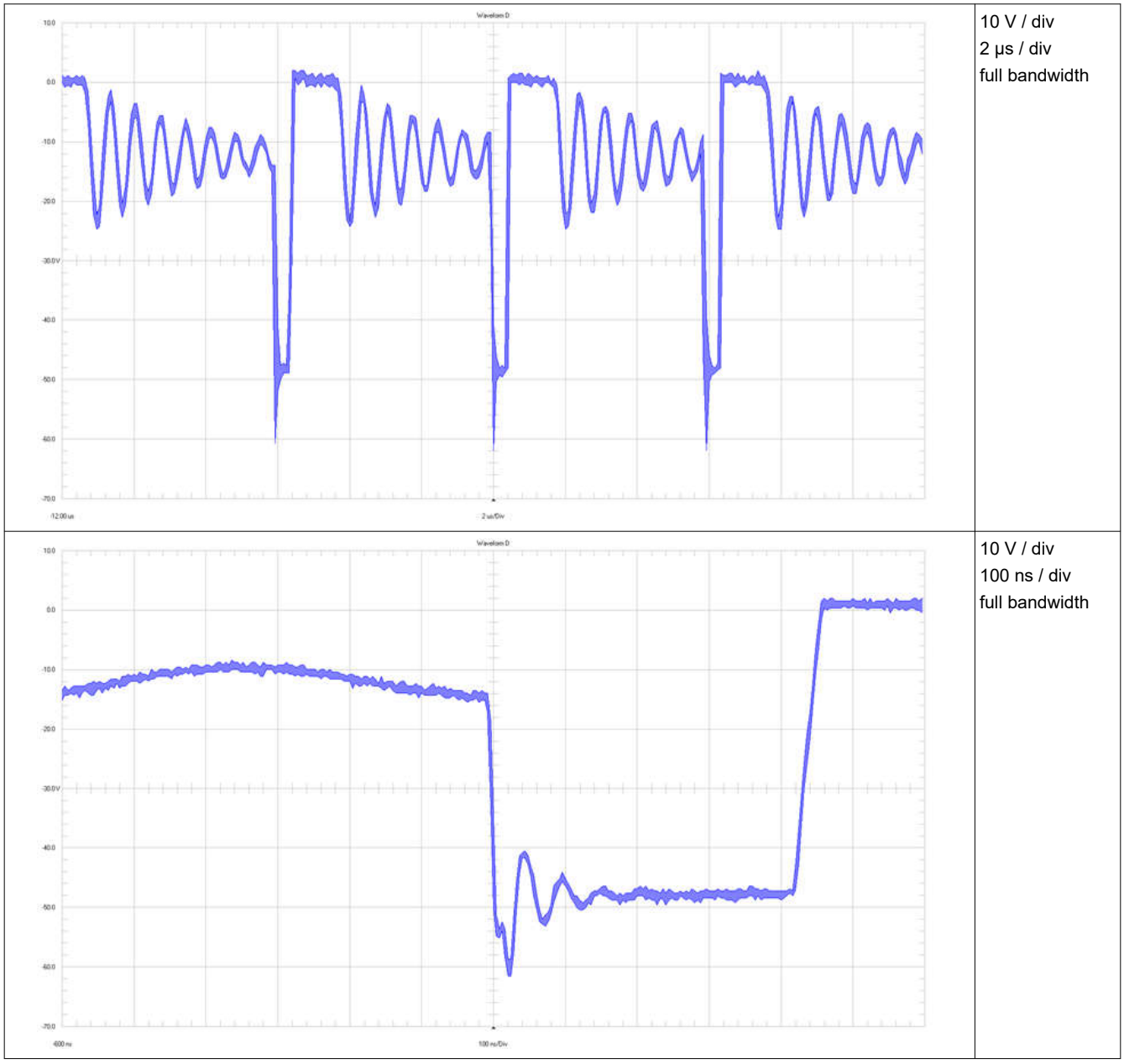

Figure 3-8. Diode D3, 36 V_{IN}, No Load

3.1.3 Diode D4 Referenced to VOUT-A (18 V)

3.1.3.1 8-V Input Voltage

3.1.3.1.1 Full Load

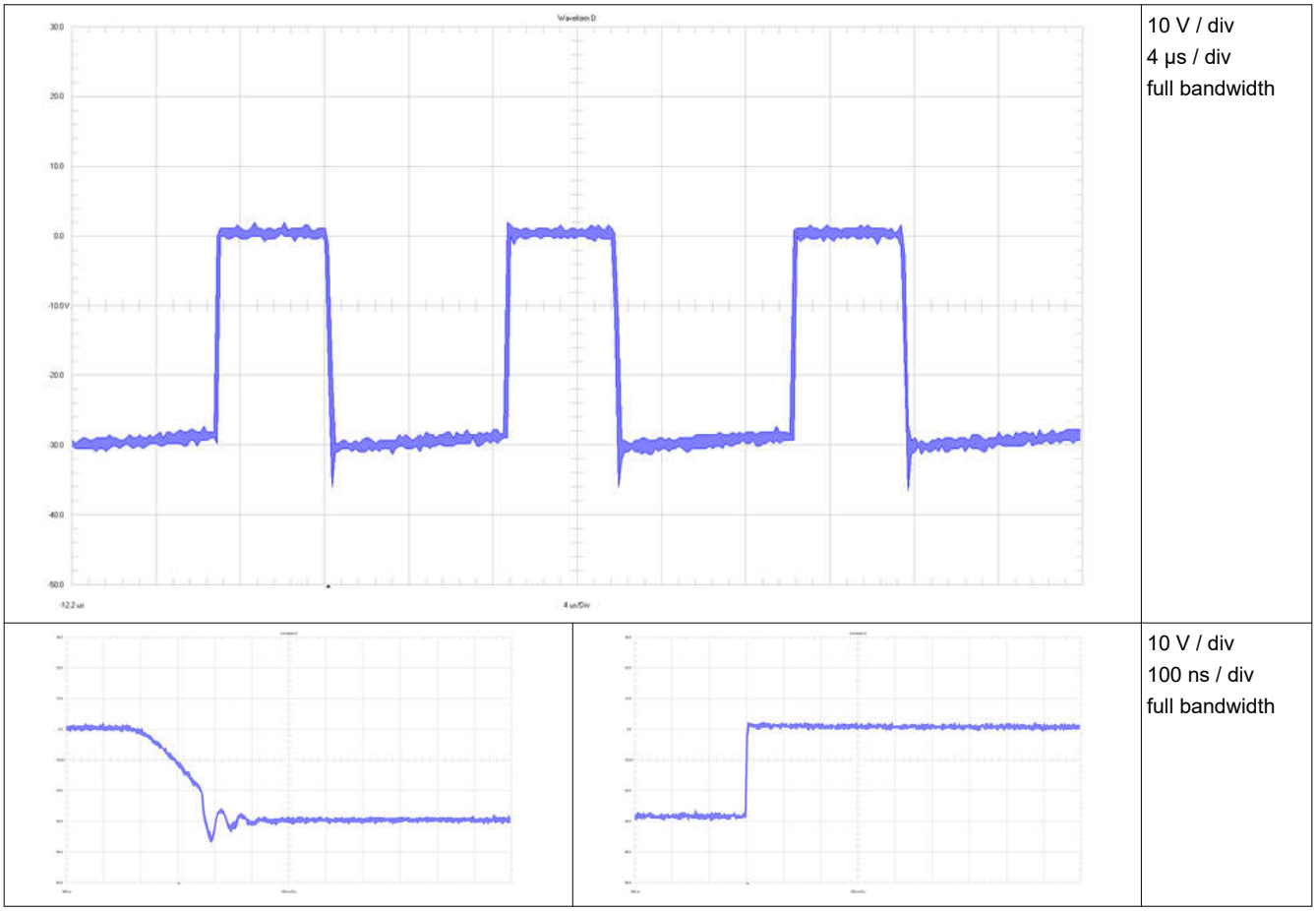

Figure 3-9. Diode D4, 8 V_{IN}, Full Load

3.1.3.1.2 No Load

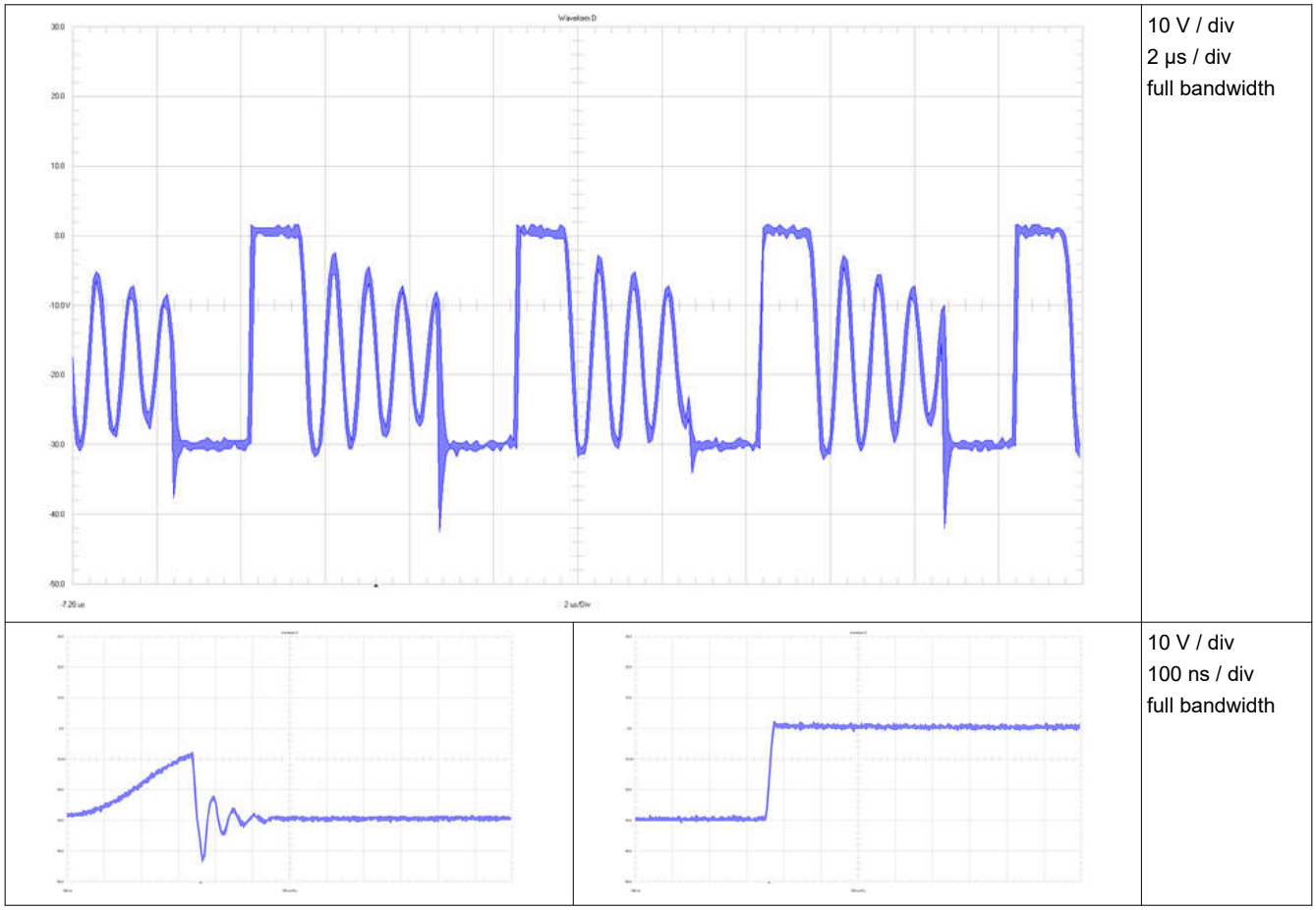

Figure 3-10. Diode D4, 8 V_{IN}, No Load

3.1.3.2 36-V Input Voltage

3.1.3.2.1 Full Load

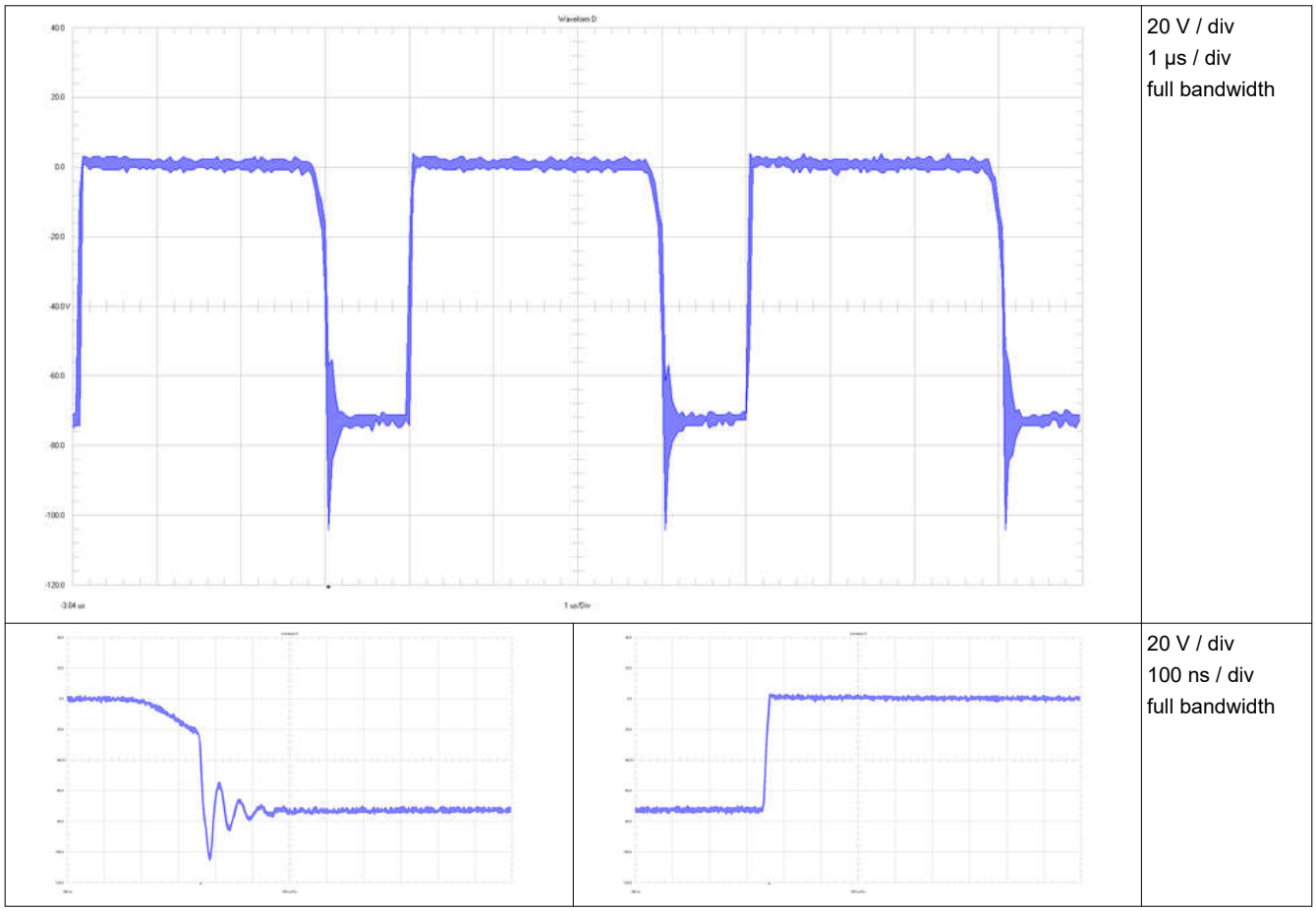

Figure 3-11. Diode D4, 36 V_{IN}, Full Load

3.1.3.2.2 No Load

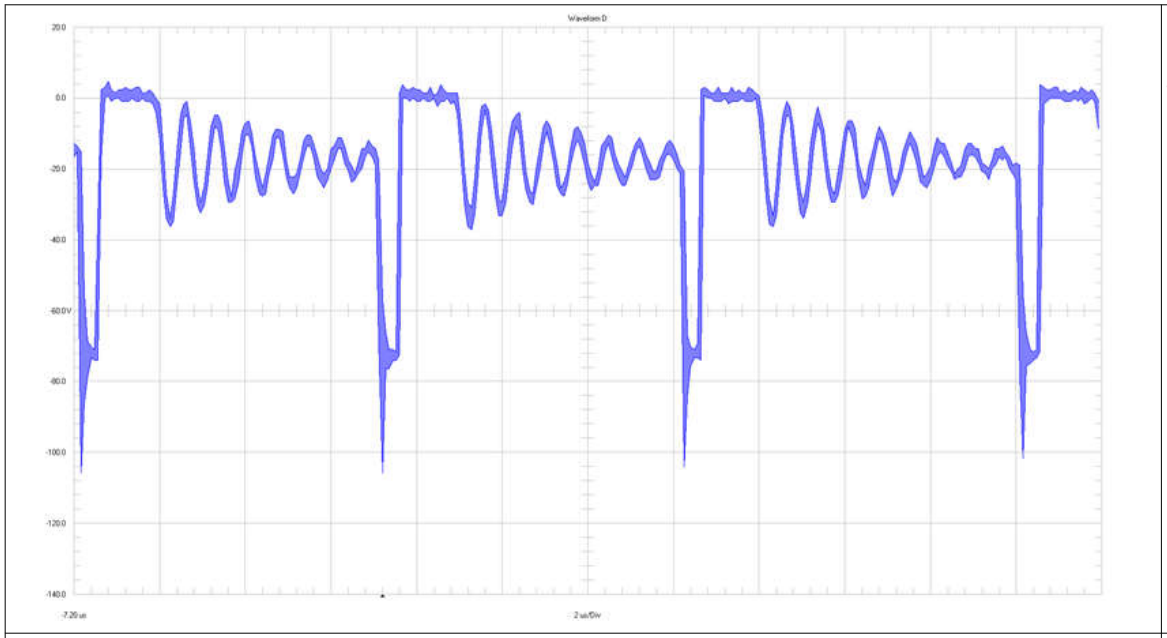

Figure 3-12. Diode D4, 36 V_{IN}, No Load

3.2 Input Voltage Ripple

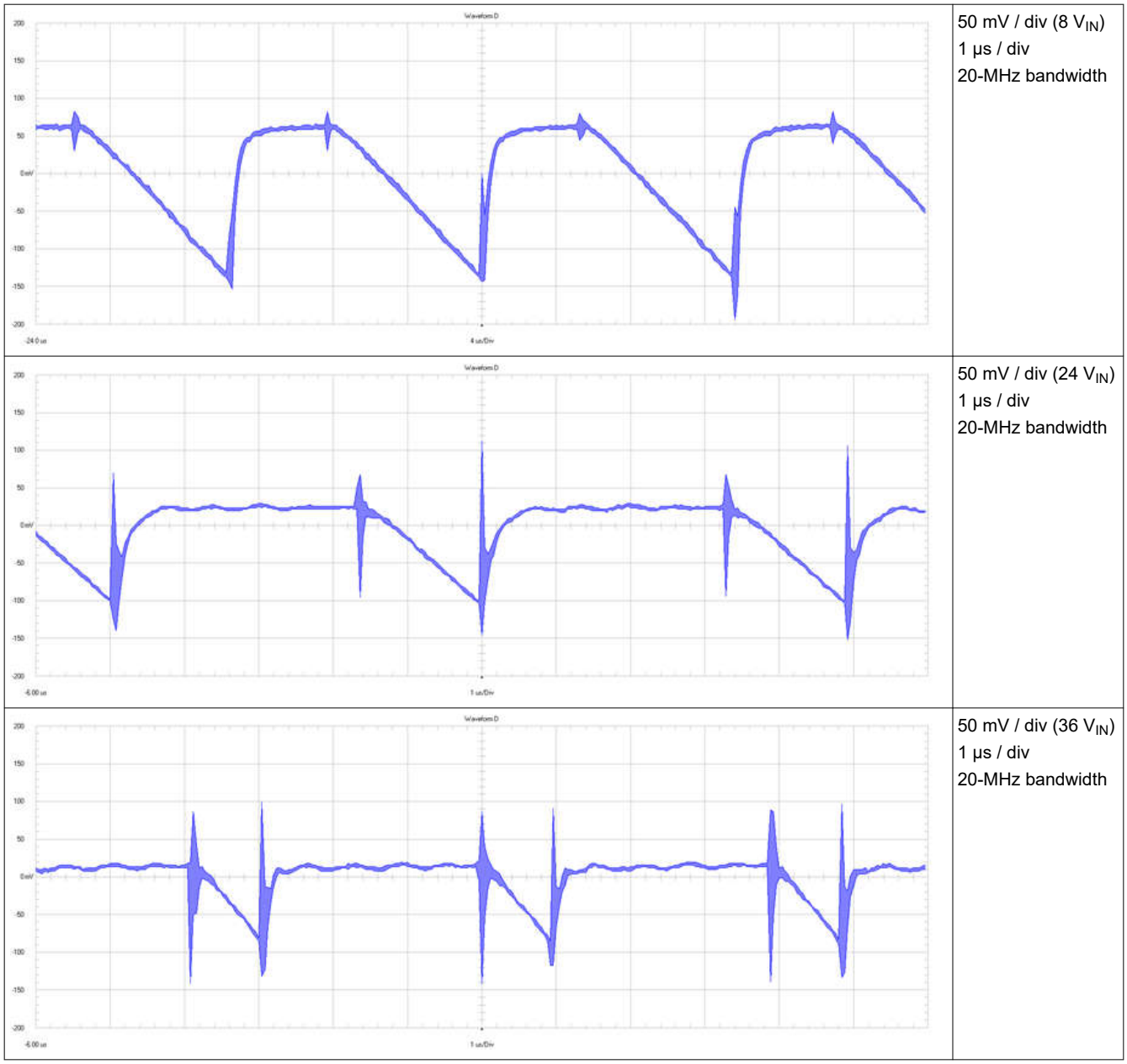

Figure 3-13. Input Voltage Ripple at Full Load

3.3 Output Voltage Ripple

The input voltage was set to 24 V. Both outputs were fully loaded.

3.3.1 VOUT-A (18 V)

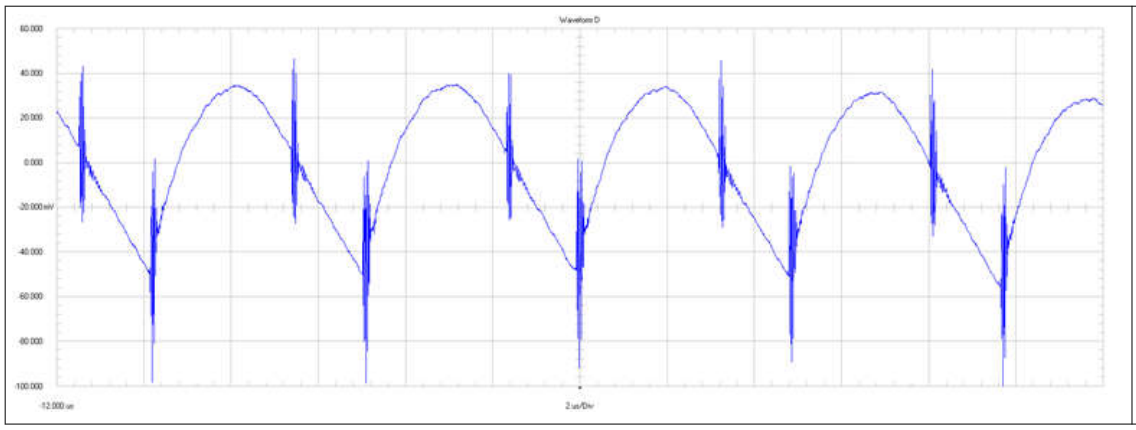

Figure 3-14. Output Voltage Ripple VOUT-A

3.3.2 VOUT-B (12 V)

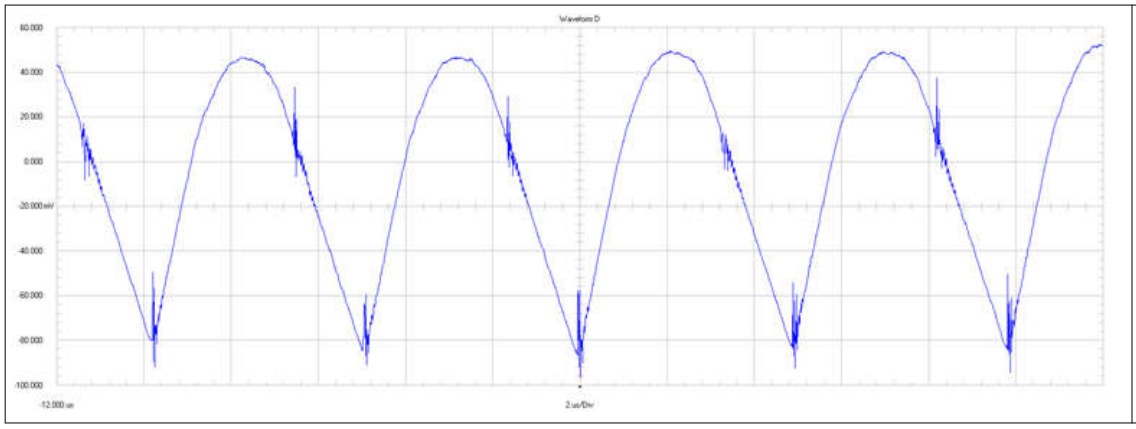

Figure 3-15. Output Voltage Ripple VOUT-B

3.4 Load Transients

3.4.1 Switching on VOUT-A (18 V)

The electronic load switches from 0.03 A to 0.06 A with a frequency of 200 Hz.

3.4.1.1 Effects on VOUT-A

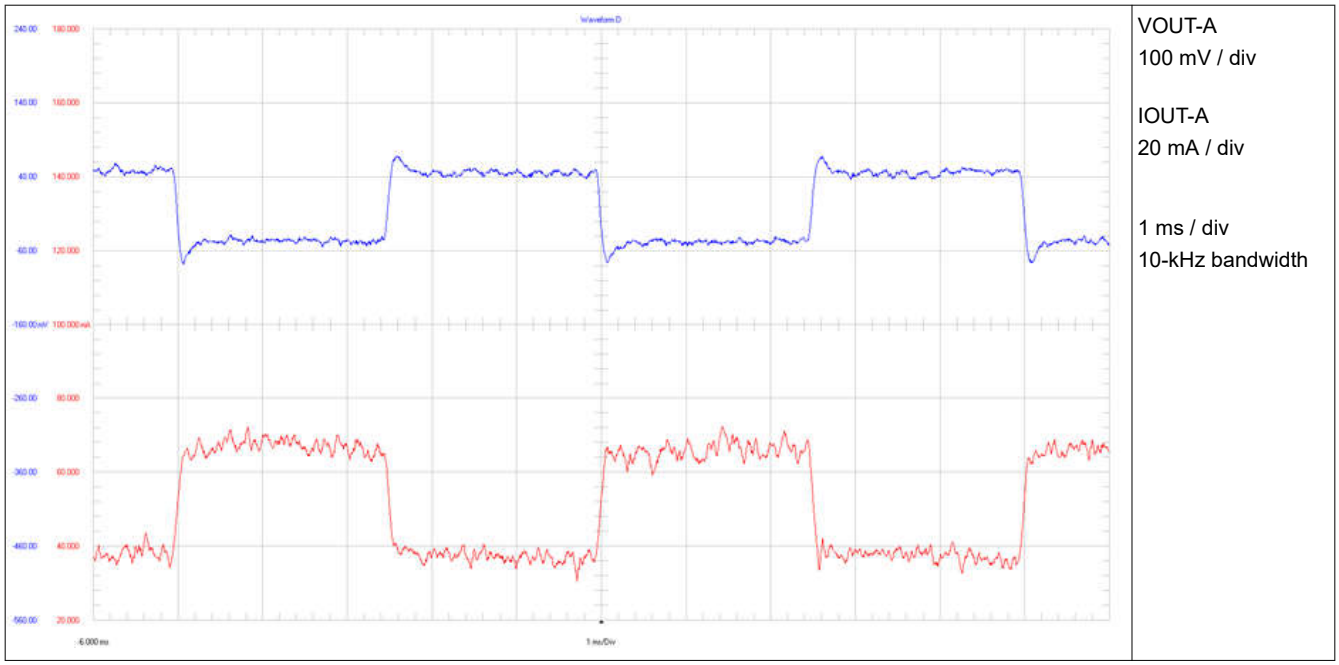

Figure 3-16. Transient on VOUT-A ⇒ VOUT-A

3.4.1.2 Effects on VOUT-B

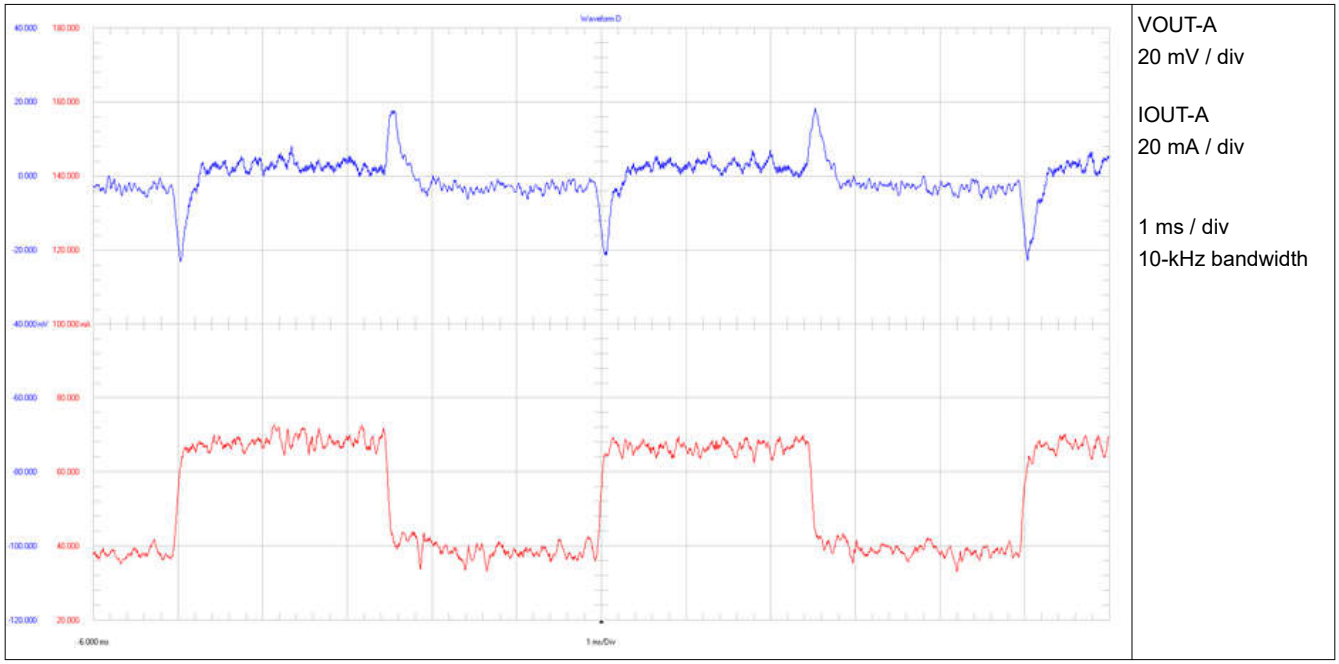

Figure 3-17. Transient on VOUT-A ⇒ VOUT-B

3.4.2 Switching on VOUT-B (12 V)

The electronic load switches from 0.05 A to 0.17 A with a frequency of 200 Hz.

3.4.2.1 Effects on VOUT-B

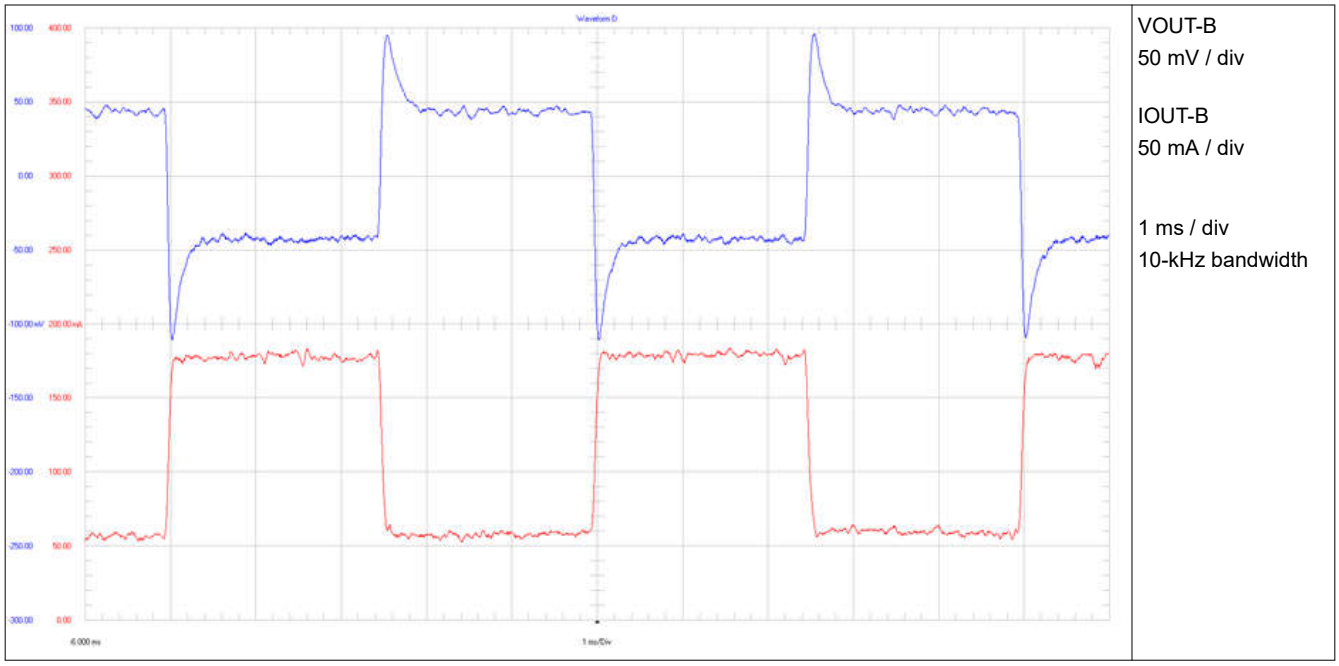

Figure 3-18. Transient on VOUT-B ⇒ VOUT-B

3.4.2.2 Effects on VOUT-A

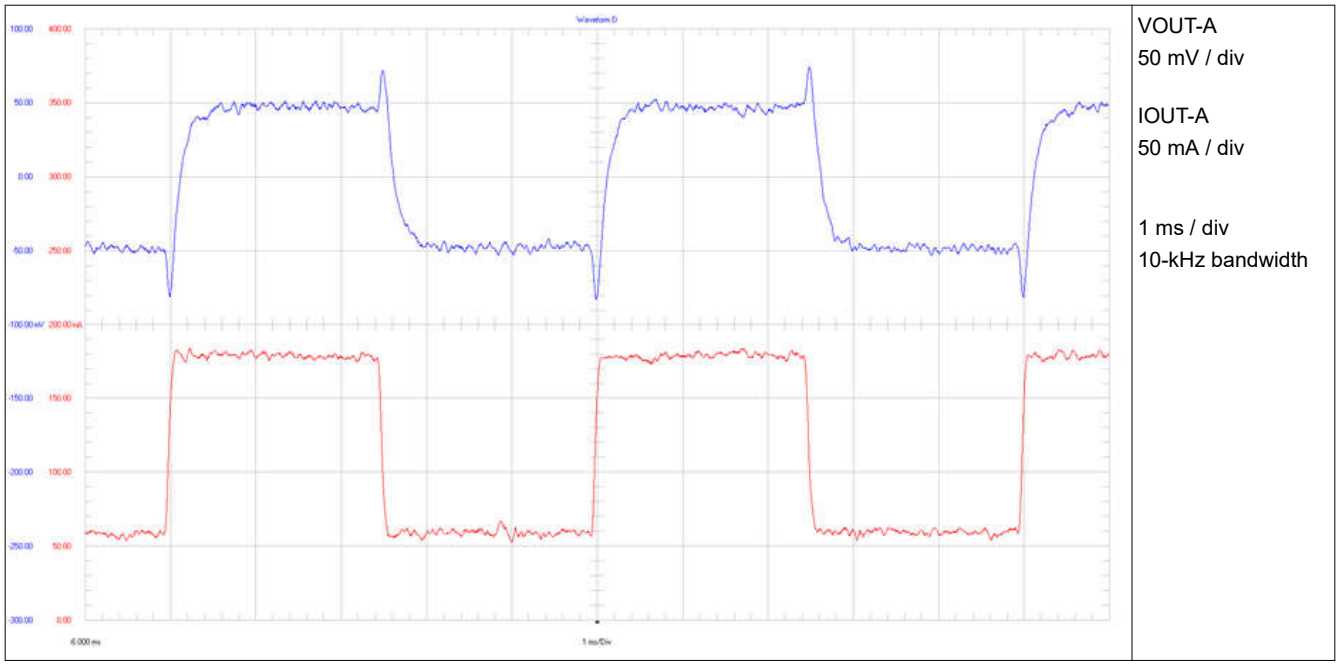

Figure 3-19. Transient on VOUT-B ⇒ VOUT-A

3.5 Start-Up Sequence

3.5.1 Full Load

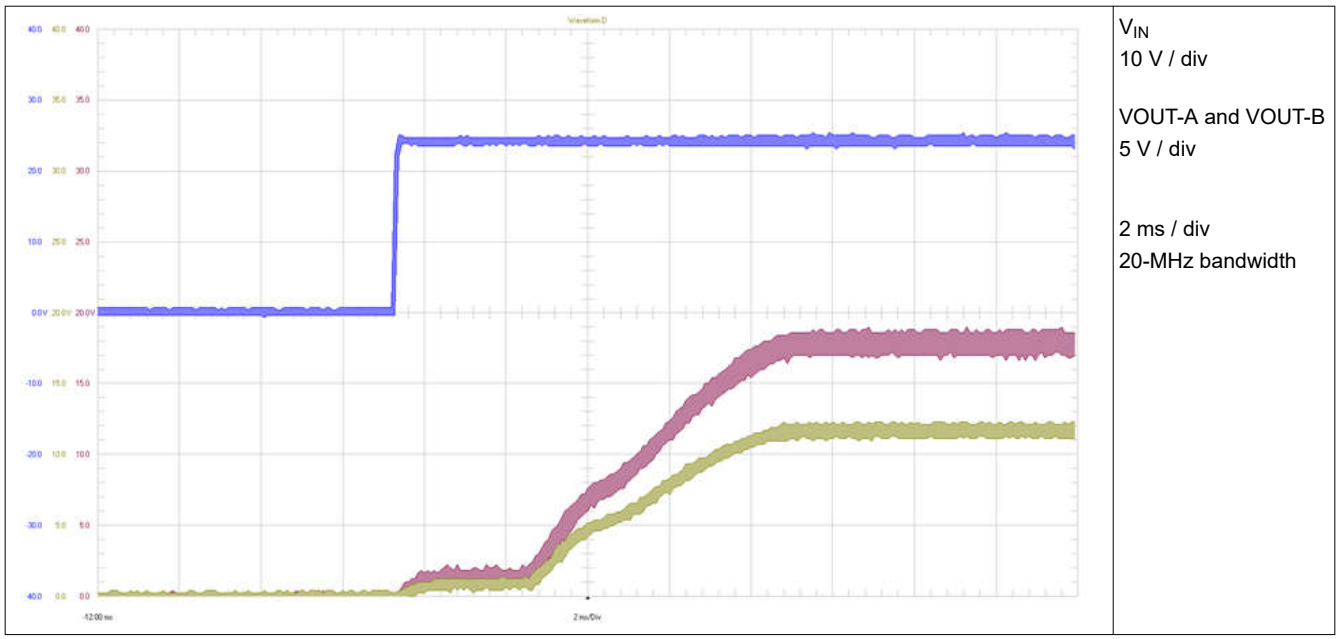

Figure 3-20. Start-Up With Full Load

3.5.2 No Load

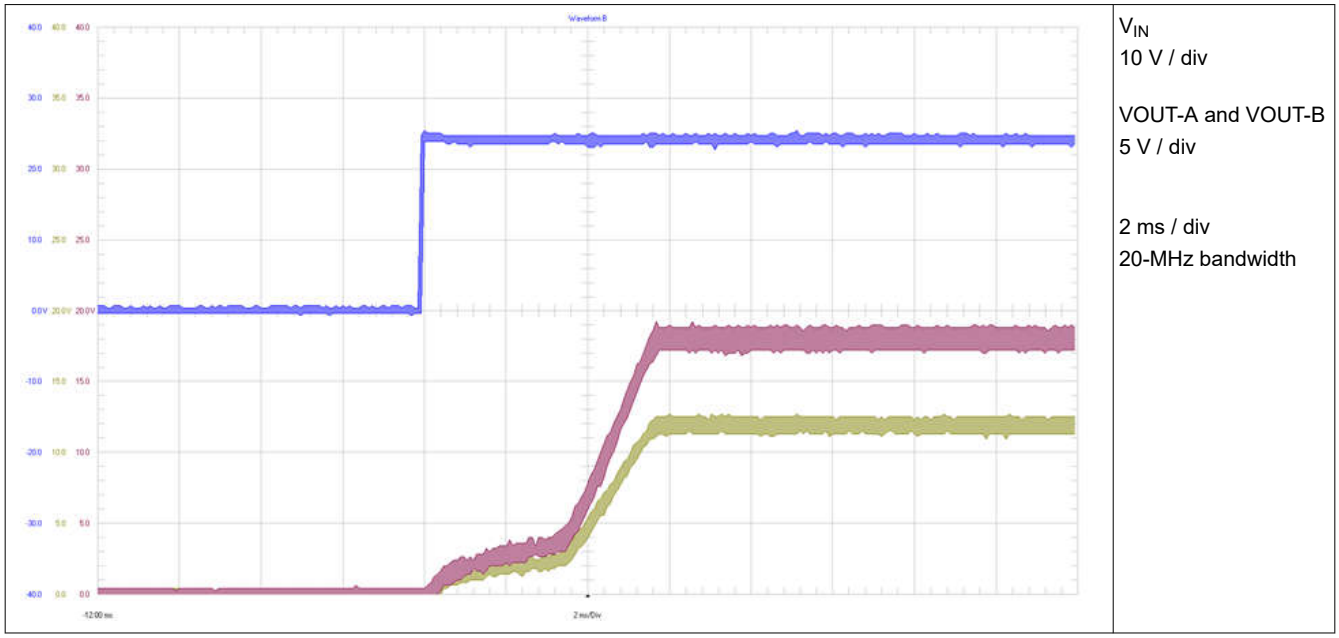

Figure 3-21. Start-Up With No Load

3.6 Shutdown Sequence

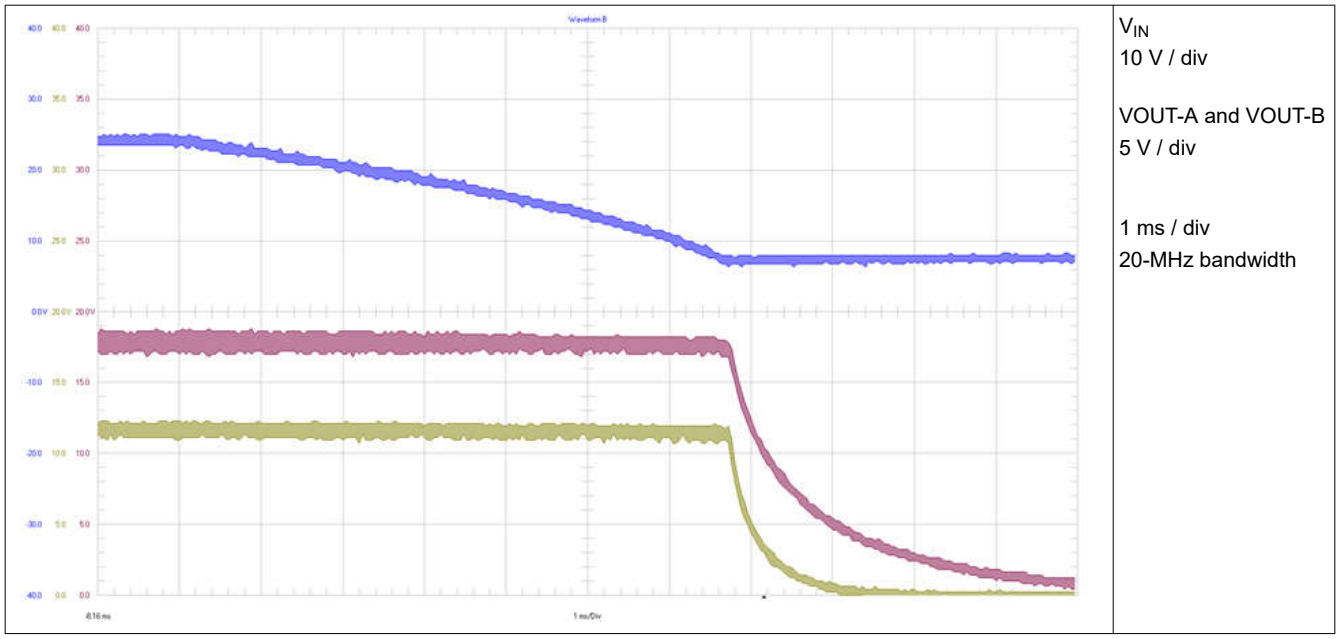

Figure 3-22. Shutdown With Full Load

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