Test Report: PMP31365

Industrial 24V to 5V Safe Power Supply Reference Design

Description

This reference design enables high-efficiency and low EMI. The design operates over a wide input voltage range reducing the need for external input surge protection. The design uses the LM686x5 buck converter which is intended for functional safety relevant applications. The design includes safety features such as redundant V_{in} and V_{out} monitoring with undervoltage lockout (UVLO) and overvoltage lockout (OVLO), feedback path failure detection and thermal shutdown.

Resources

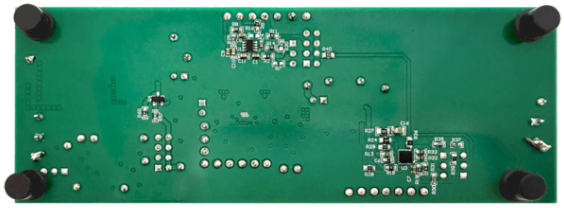
PMP31365	Design Folder
LM68645-Q1	Product Folder
LM7480	Product Folder
TPS3762-Q1	Product Folder

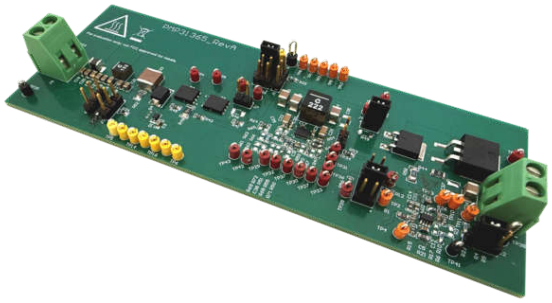
Features

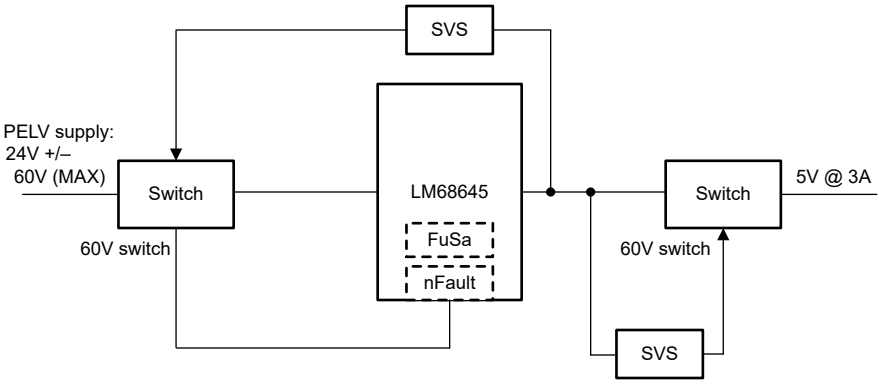
- LM686x5-Q1 integrated OVP and UVLO monitoring functions with nFLT and PG
- Industrial functional safety-compliant power supply
- Safe cost for external diagnostics, safe time-to-market
- Designed for low electromagnetic interference (EMI)
- Additional input and output window supervisors

Applications

- Robot safety module
- HMI panel







1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage Range	19.2V to 28.8V
Output Voltage	5V
Maximum Output Current	3A
Topology	Buck

1.2 Dimensions

The size of the four-layer board is 136.6mm × 49.5mm.

2 Testing and Results

2.1 Efficiency

Efficiency is shown in Figure 2-1.

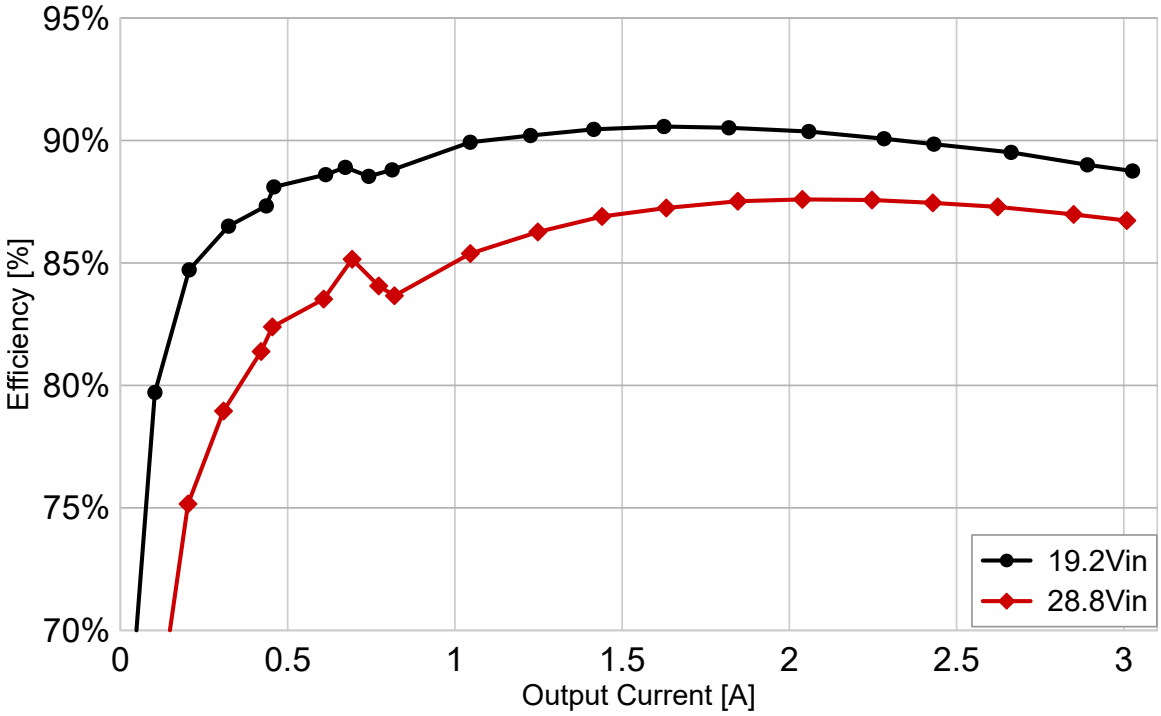


Figure 2-1. Efficiency versus Output Current

2.2 Loss

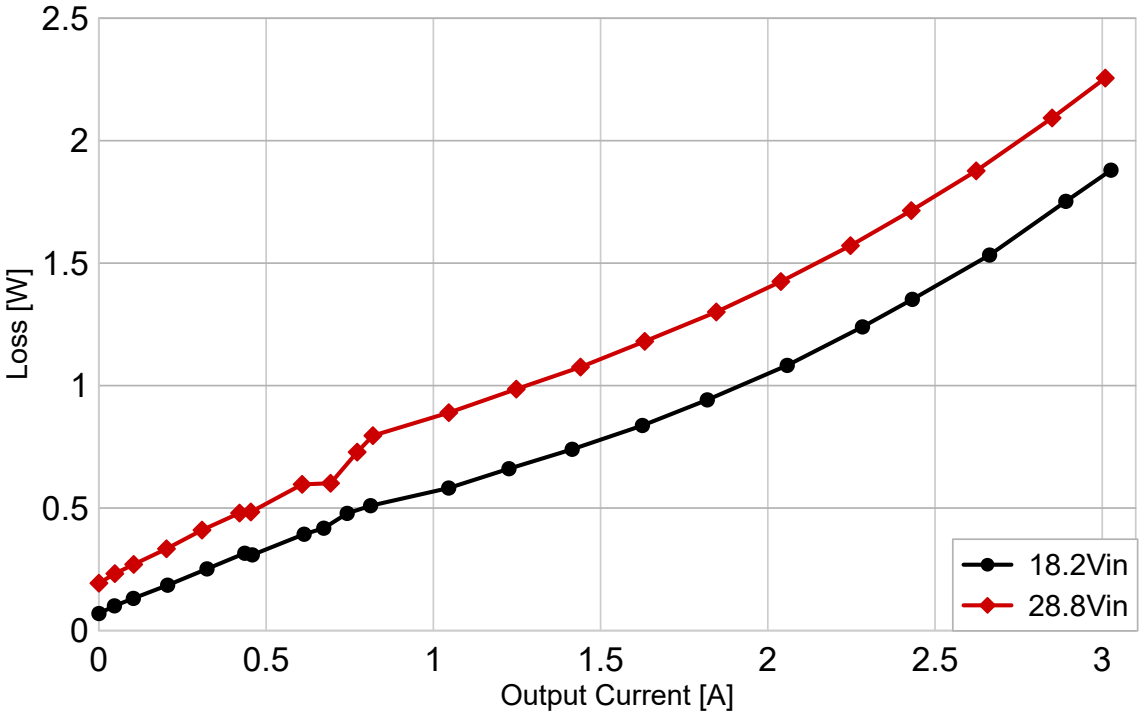


Figure 2-2. Loss versus Output Current

2.3 Load Regulation

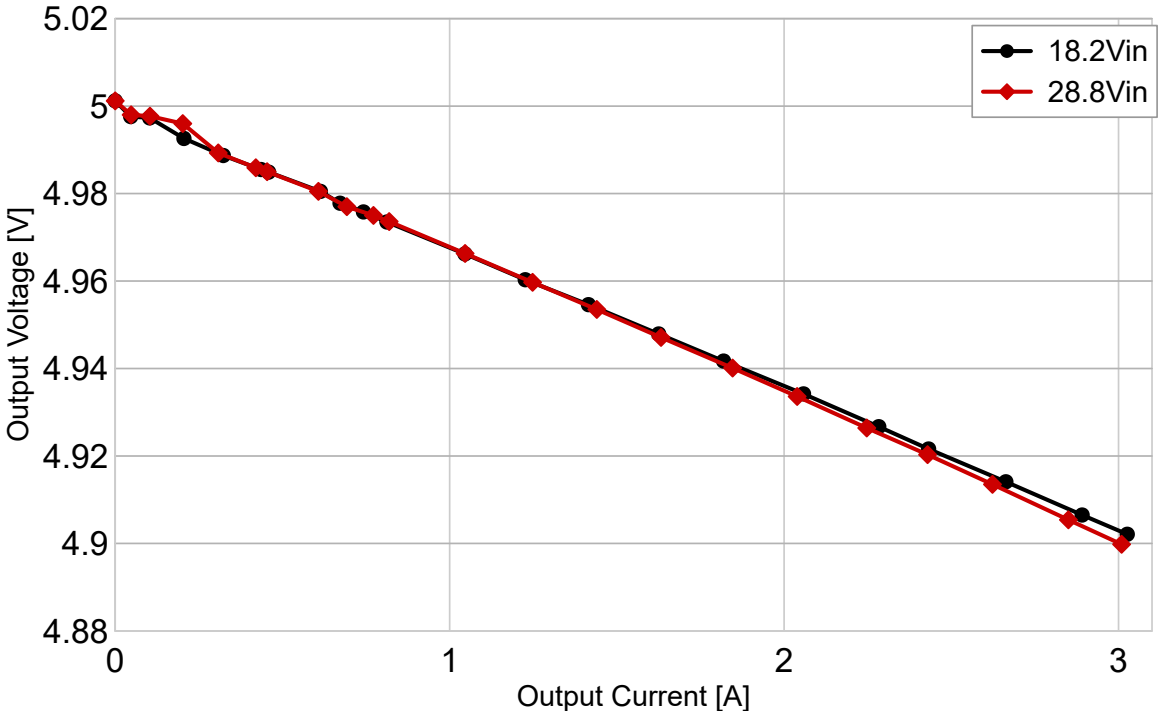


Figure 2-3. Output Voltage versus Output Current

2.4 Frequency Fold-Back Behavior

The measurement was taken at 28.8V input voltage.

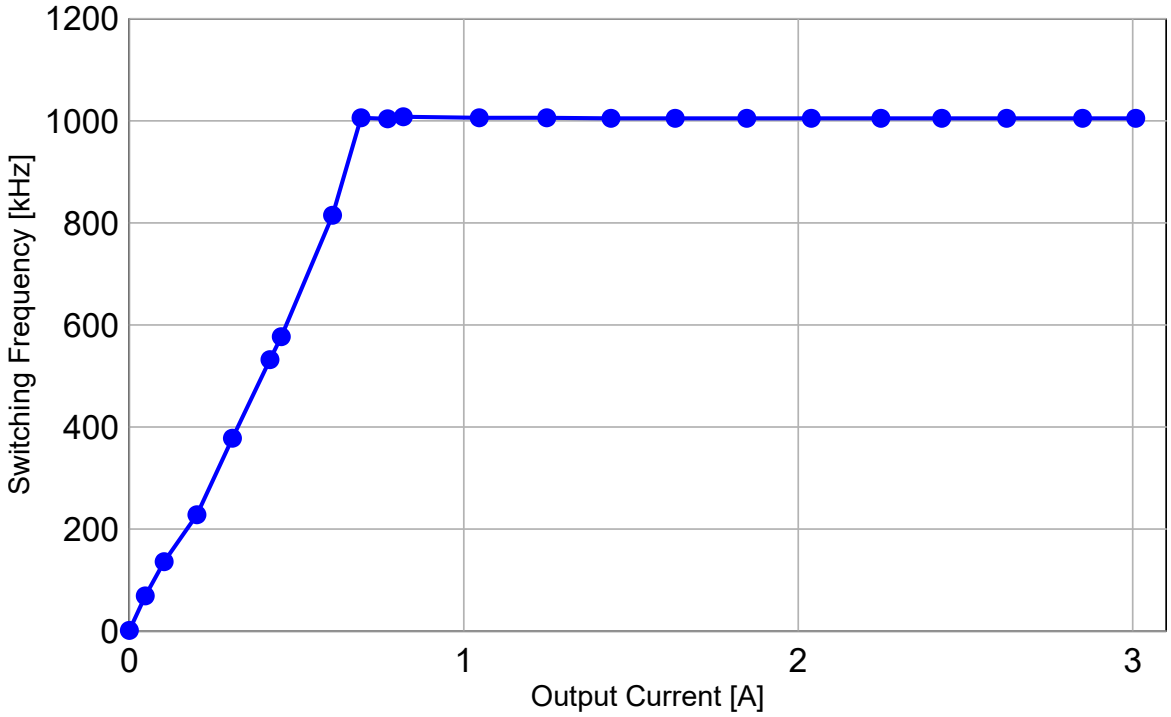


Figure 2-4. Switching Frequency versus Output Current

2.5 Line Regulation with 3A Output Current

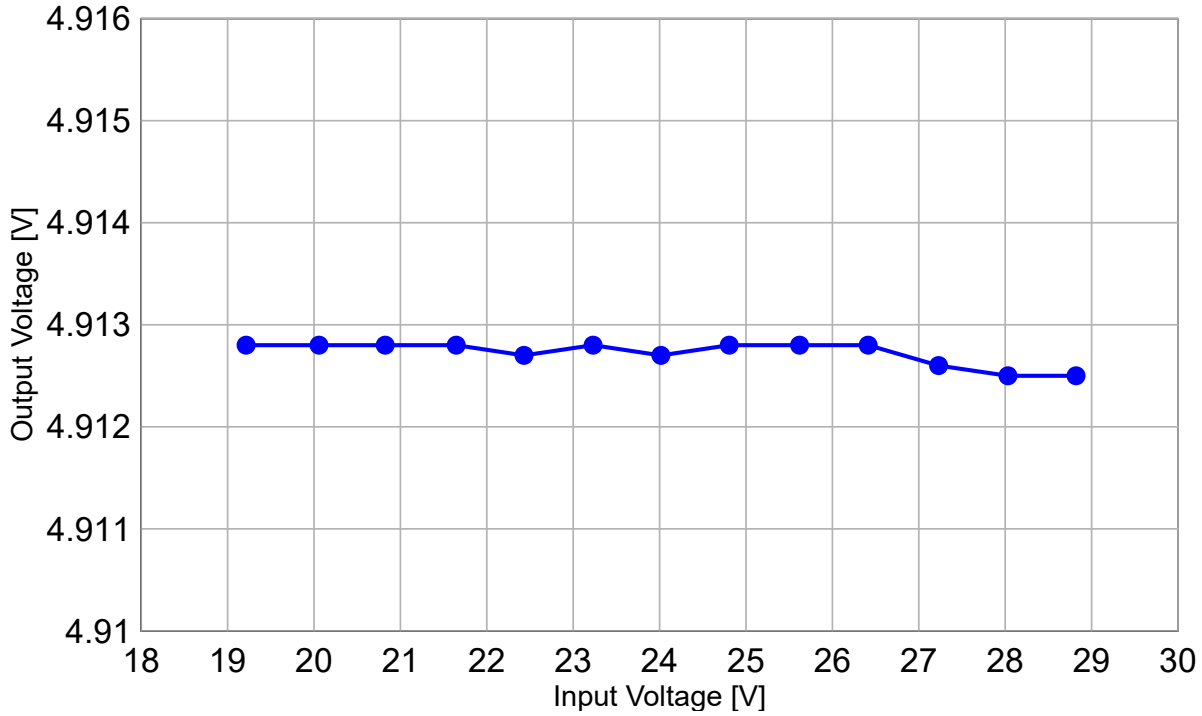


Figure 2-5. Output Voltage Versus Input Voltage

During the measurements for line regulation the values for efficiency and loss were also obtained and displayed in Figure 2-6.

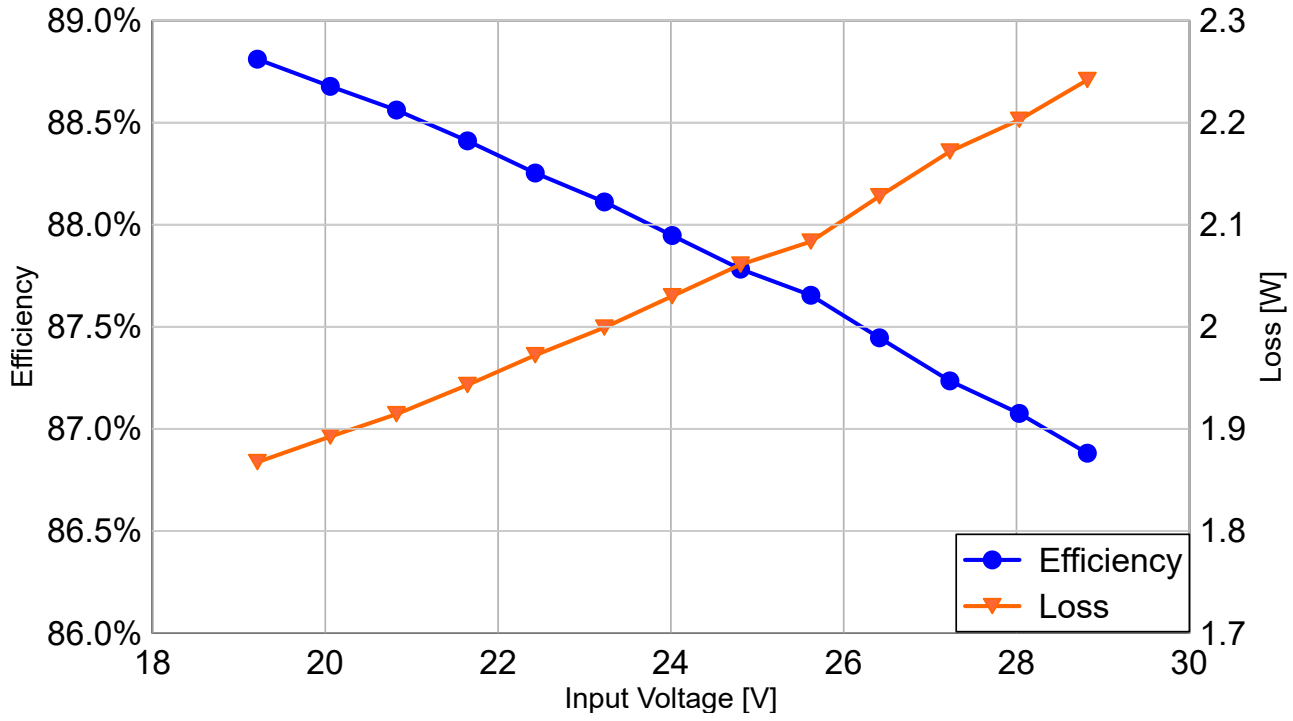


Figure 2-6. Efficiency and Loss versus Input Voltage

2.6 Thermal Images

Thermal images were done at 24V input voltage and 3A output current.

2.6.1 Top Side

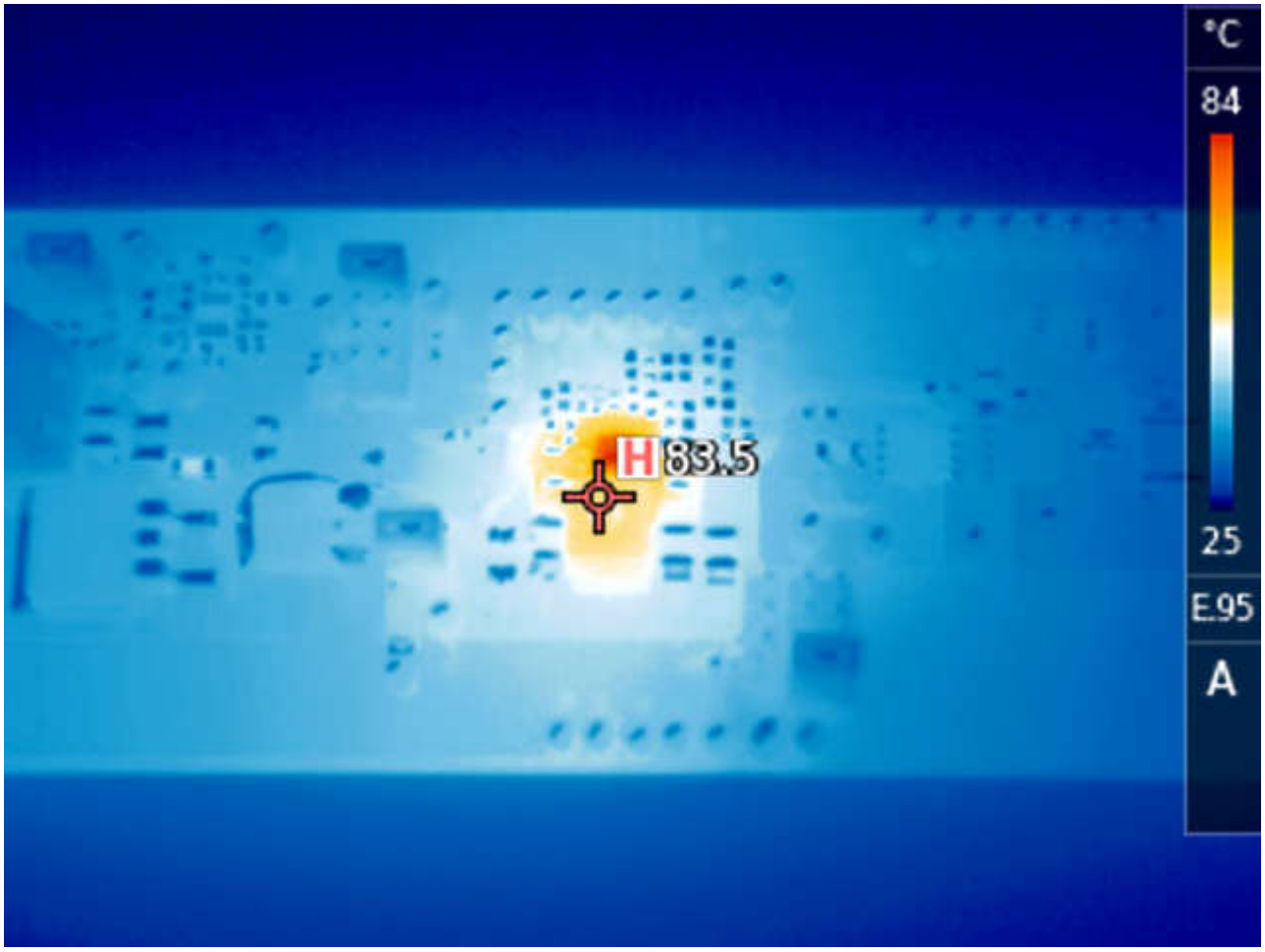


Figure 2-7. Thermal Image Top Side

2.6.2 Bottom Side

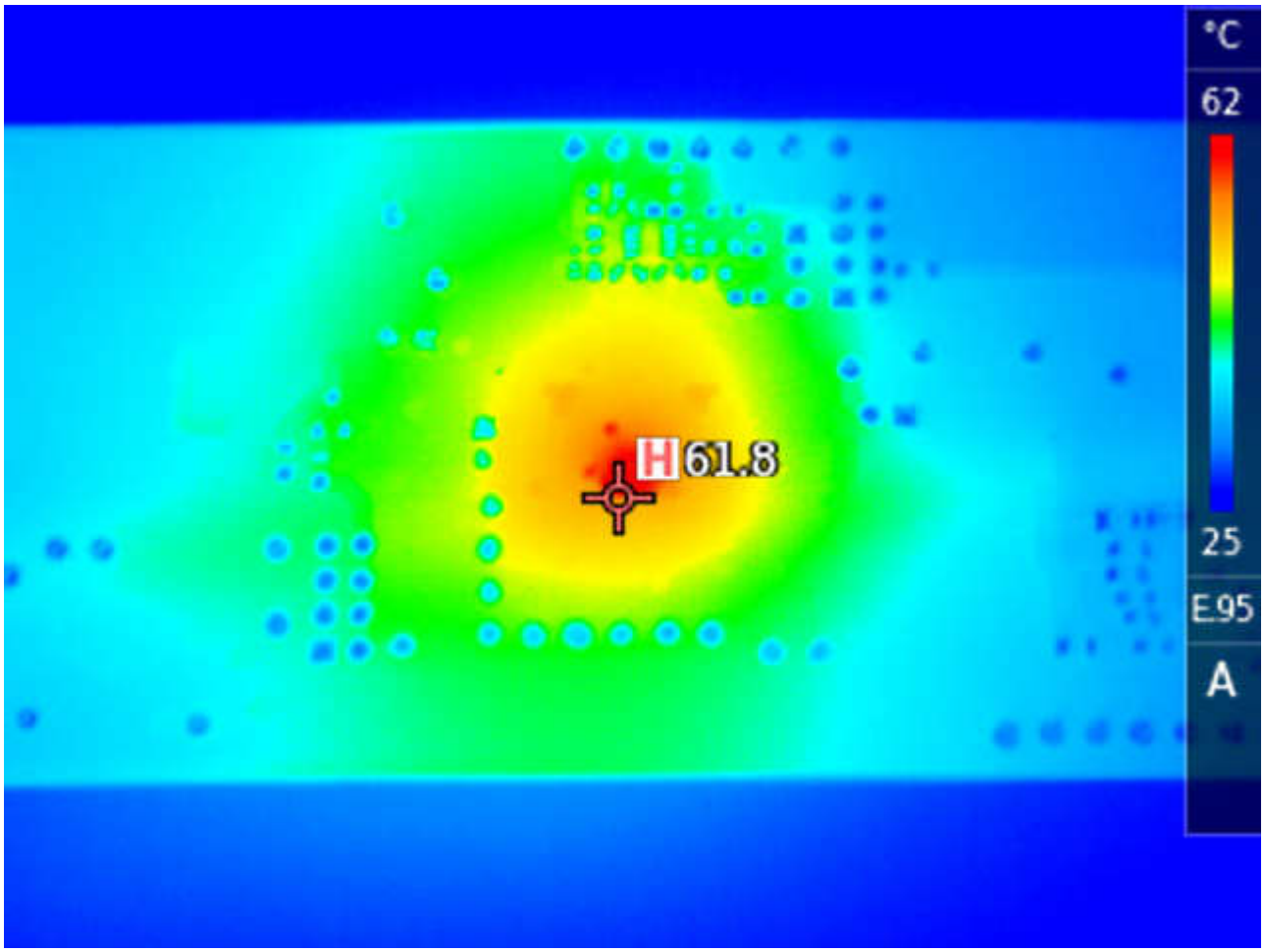


Figure 2-8. Thermal Image Bottom Side

2.7 Bode Plots

Bode plots are shown in Figure 2-9.

Input voltage = 24V

Load current = 3A

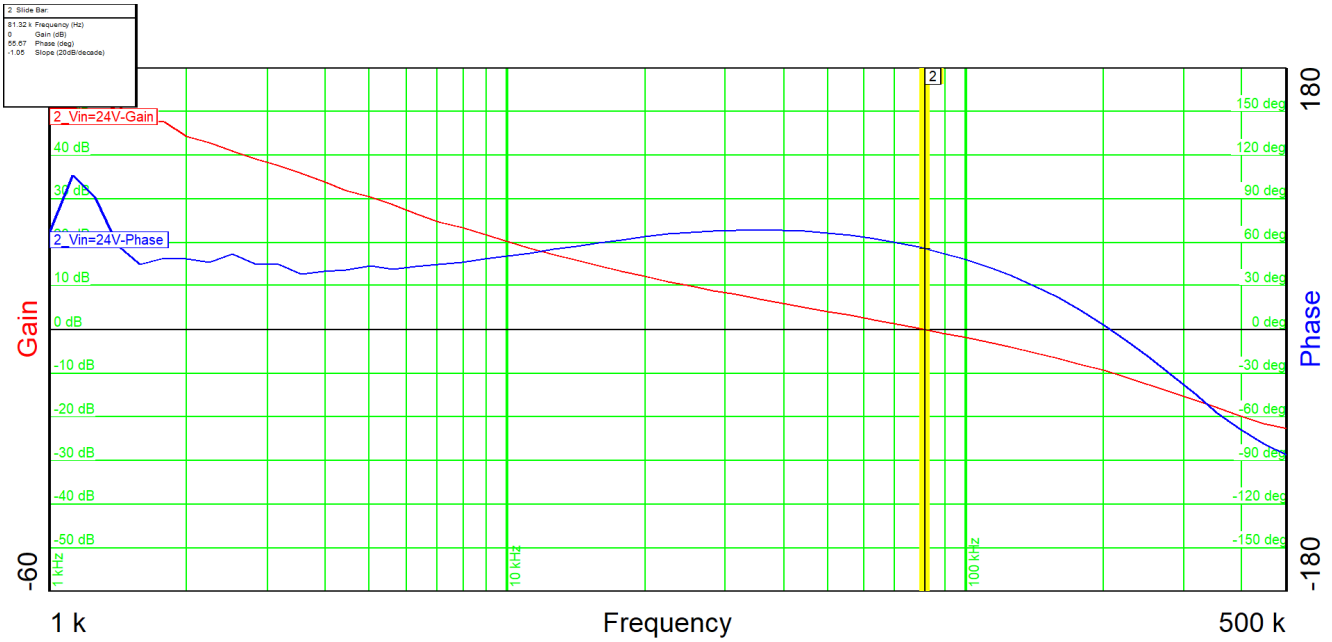


Figure 2-9. Bode Plots

3 Waveforms

All measurements unless otherwise indicated were done at 24V input voltage and 3A output current.

3.1 Switching

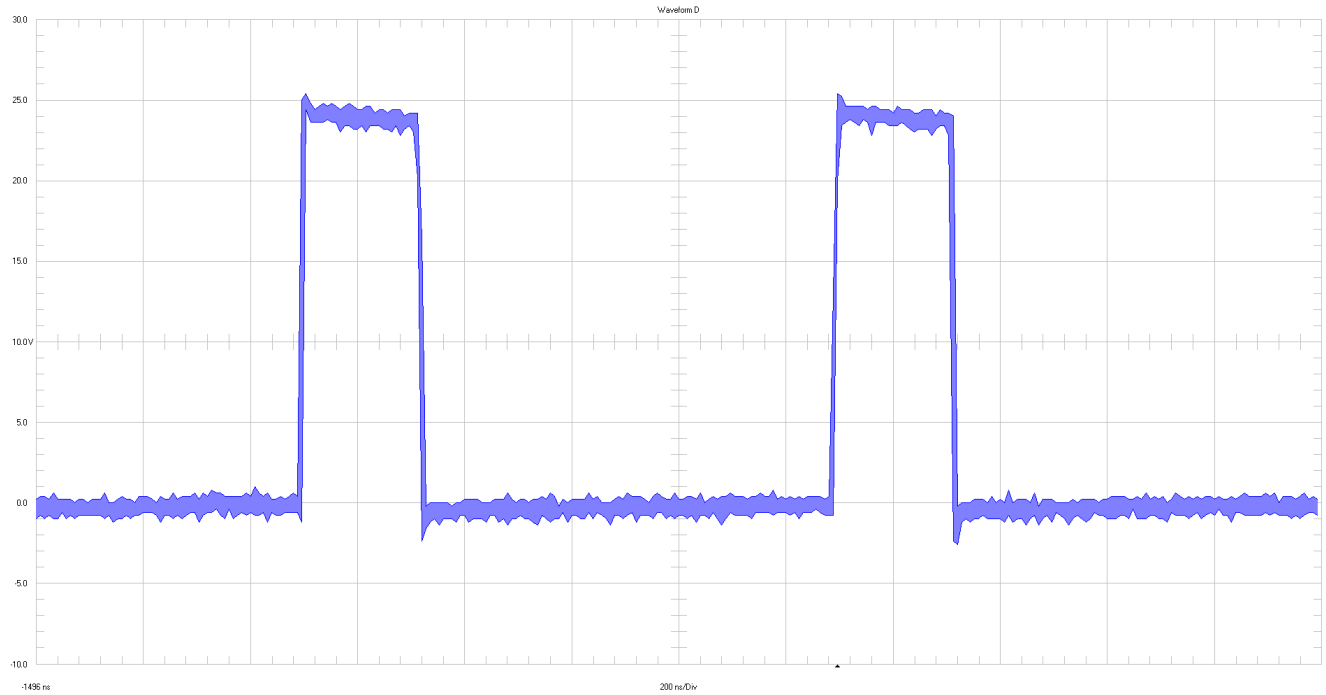


Figure 3-1. Switching Measured (5V / div; 200ns / div; Full Bandwidth)

3.2 Output Voltage Ripple

Output voltage ripple was measured on J10.

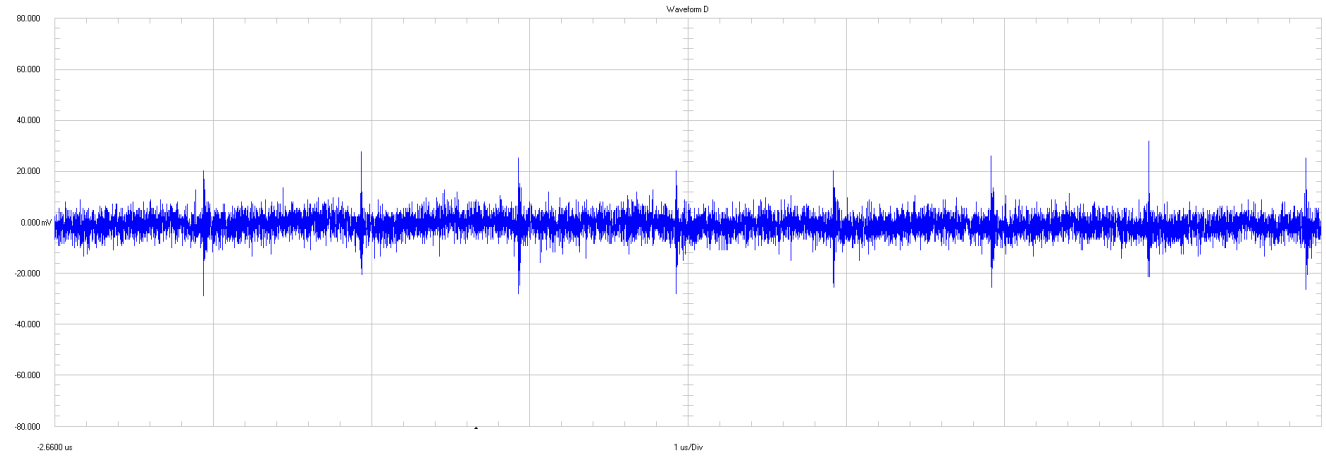


Figure 3-2. Output Voltage Ripple (20mV / div; 1µs /div; Full Bandwidth)

3.3 Input Voltage Ripple

3.3.1 Measured on J9

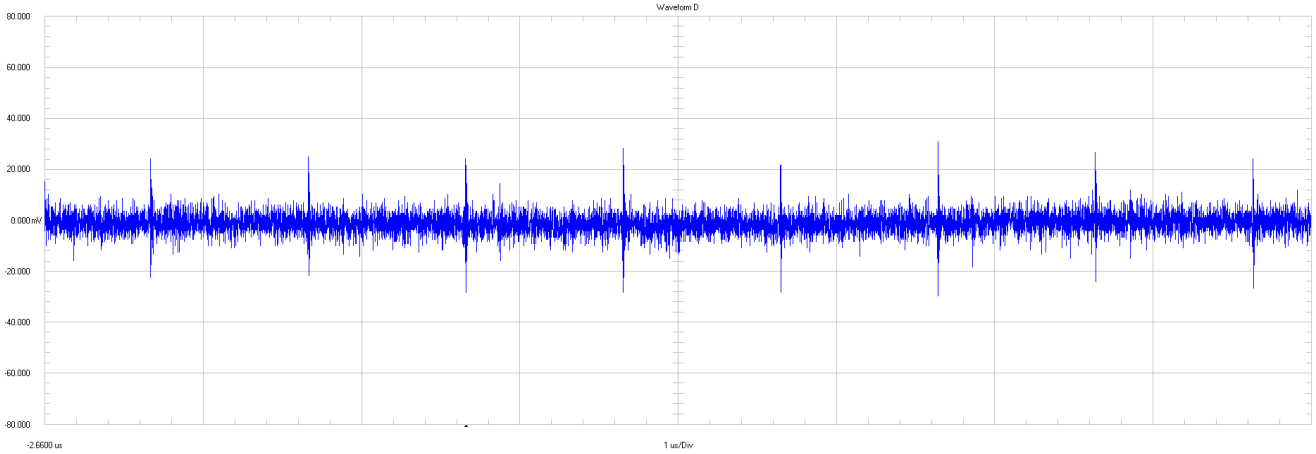


Figure 3-3. Input Voltage Ripple J9 (20mV / div; 1µs /div; Full Bandwidth)

3.3.2 Measured on D4

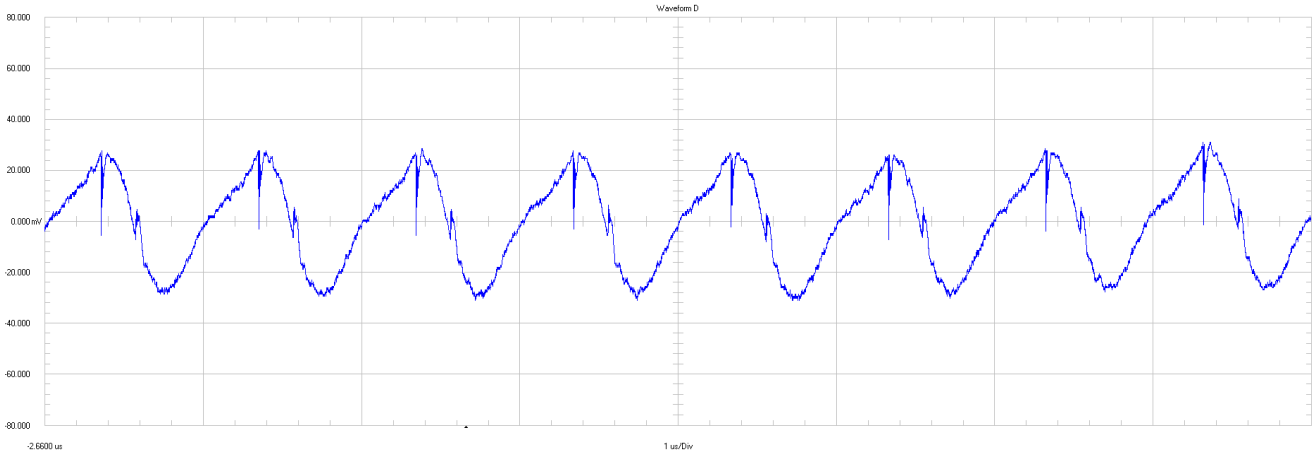


Figure 3-4. Input Voltage Ripple D4 (20mV / div; 1µs /div; 20MHz Bandwidth)

3.4 Load Transients

The electronic load switches from 1.5A to 3A with a frequency of 600Hz.

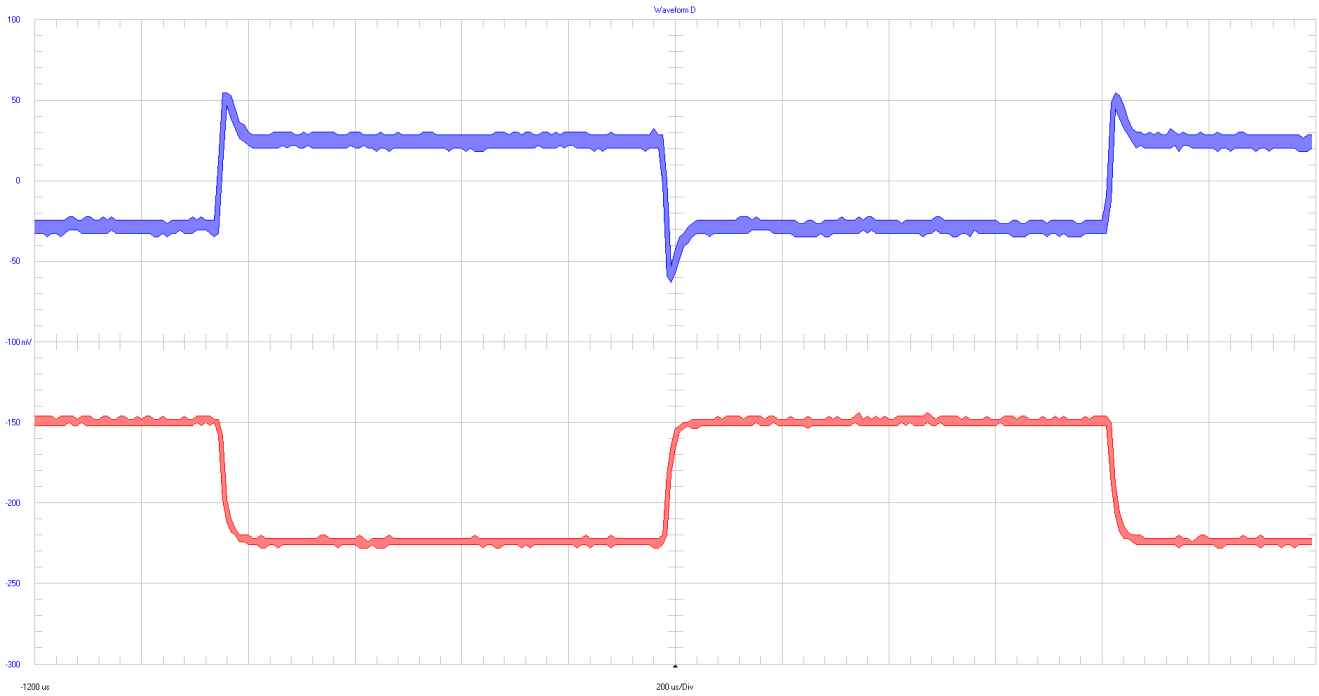


Figure 3-5. Load Transient

- Upper waveform: Output voltage [scale: 50mV / div; 200µs / div; 20MHz bandwidth]
- Lower waveform: Output Current [scale: 1A / div; 200µs / div; 20MHz bandwidth]

3.5 Start-Up Sequence (3A Output Current)

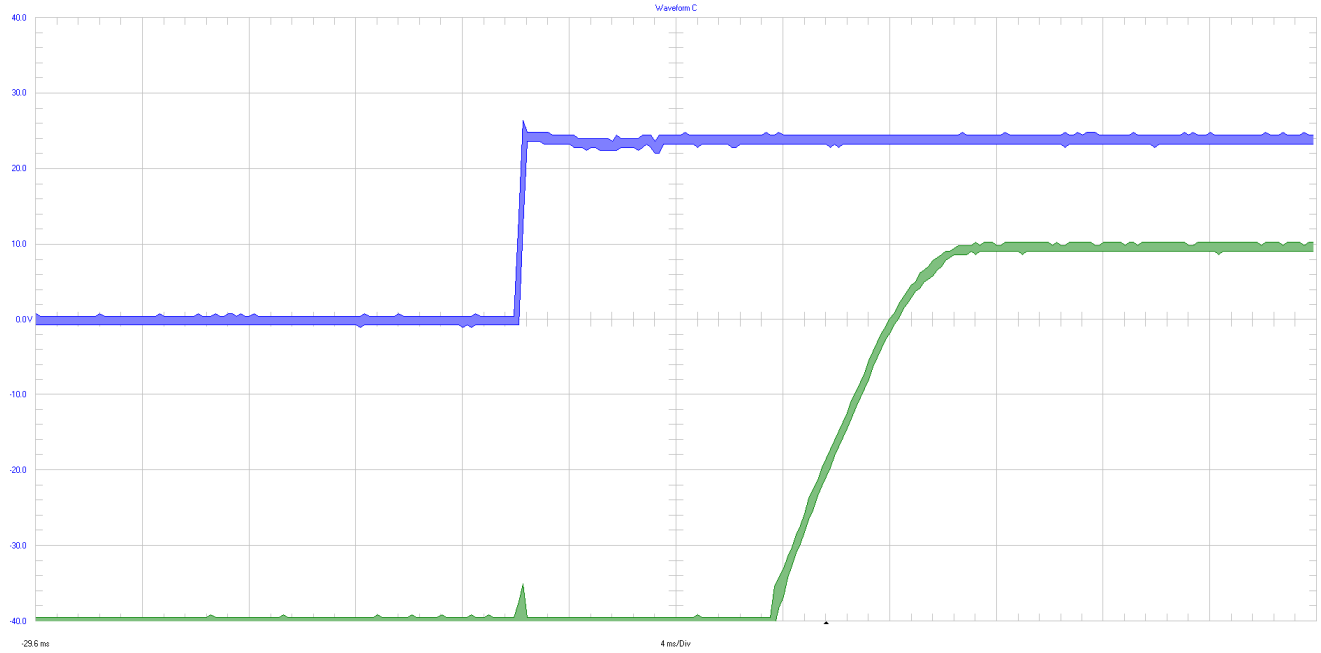


Figure 3-6. Start-Up

Upper waveform: Input Voltage (10V / div; 4ms / div; 20MHz bandwidth)

Lower waveform: Output Voltage (1V / div; 4ms /div; 20MHz bandwidth)

3.6 Shutdown Sequence (3A Output Current)

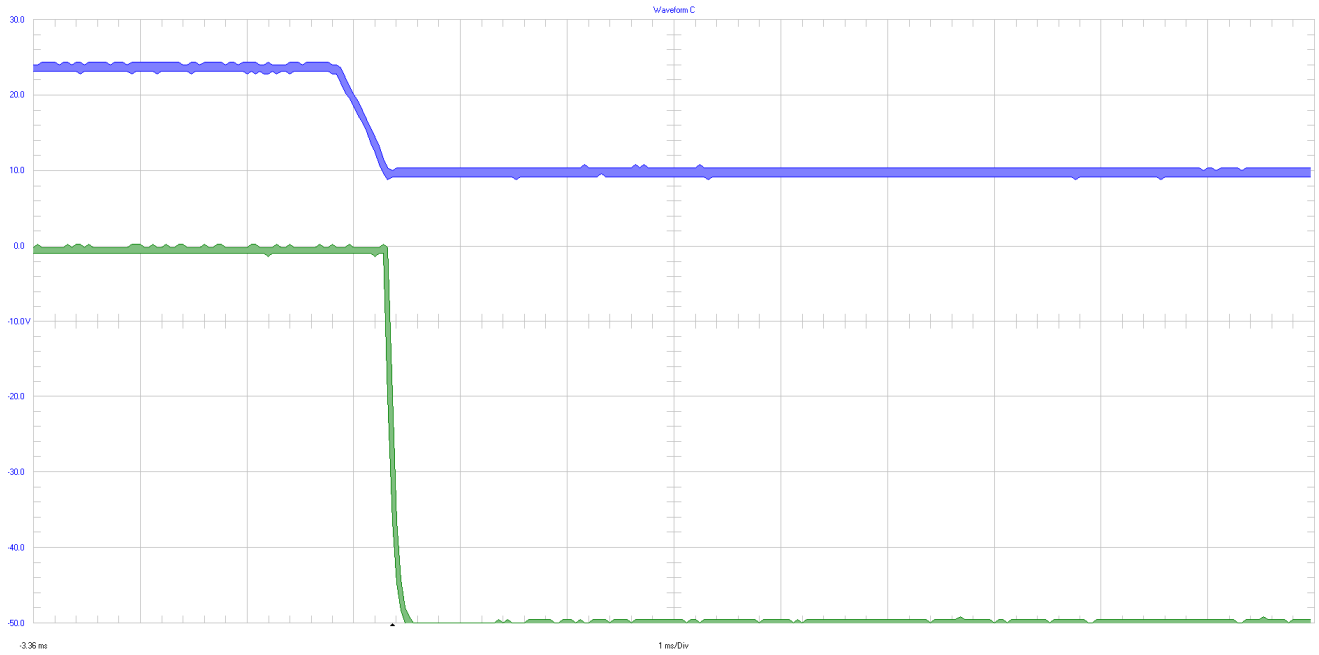


Figure 3-7. Shutdown

Upper waveform: Input Voltage (10V / div; 1ms / div; 20MHz bandwidth)

Lower waveform: Output Voltage (1V / div; 1ms /div; 20MHz bandwidth)

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