Test Report: PMP31306

GaN-Based Dual-Phase Boost Converter Reference Design for Class H Audio Applications

Texas Instruments

Description

This design showcases a dual-phase automotive boost converter for Class-H audio applications using LMG2100R026 gallium nitride (GaN) half bridges and offering analog- or digital-output voltage tracking. The output power is 1000W at 11V input voltage (1250W peak at 12V). The converter area measures only 47mm × 48mm, not including the reverse polarity protection and bulk input capacitance.

This test report is based on the LM5125-Q1. The pin-compatible LM51251-Q1 variant offering additional I²C for diagnostics and control can also be used on this design.
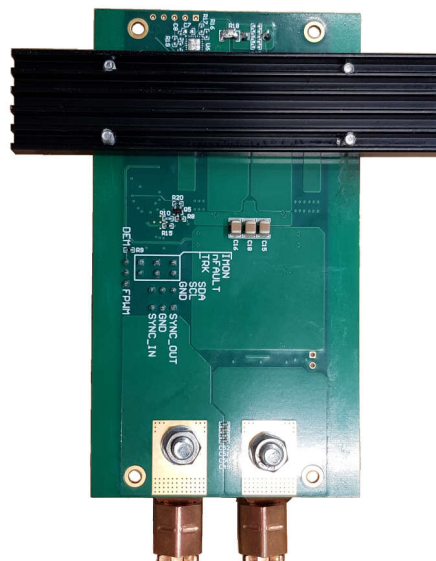
Features

- Very high power density
- Low switching losses due to GaN switches
- Digital and analog voltage tracking
- With I^{2}C control (IC variant dependent)
- High efficiency and high peak output power

Applications

- Premium audio
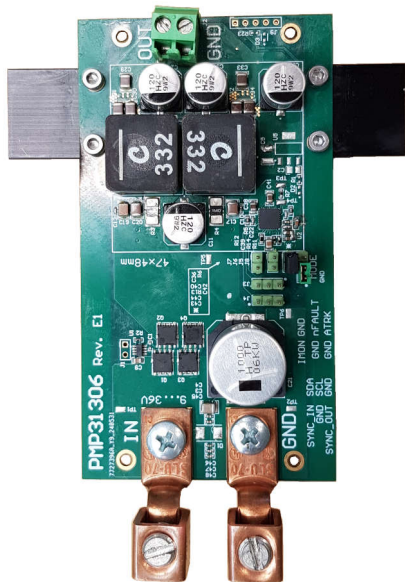
Top of Board

Bottom of Board

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	9V-18V, 36V peak, full output power at ≥11V
Output Voltage	40.5V
Output Current	31A peak at $12V_{IN}$, 26A at $11V_{IN}$
Switching Frequency	315kHz

1.2 Considerations

- Unless otherwise noted, the input voltage was set to 12V.
- A fan was used to blow air across the board with a heat sink mounted on the GaN switches on the bottom side.
- The 1250W peak output power test was done with 1kW base load and 250W dynamic load set to 2Hz, 20% duty cycle.

1.3 Dimensions

The dimensions of the four-layer board is 115.6mm × 63.6mm × 1.6mm. The thickness of the copper layer is 70μm for each layer.

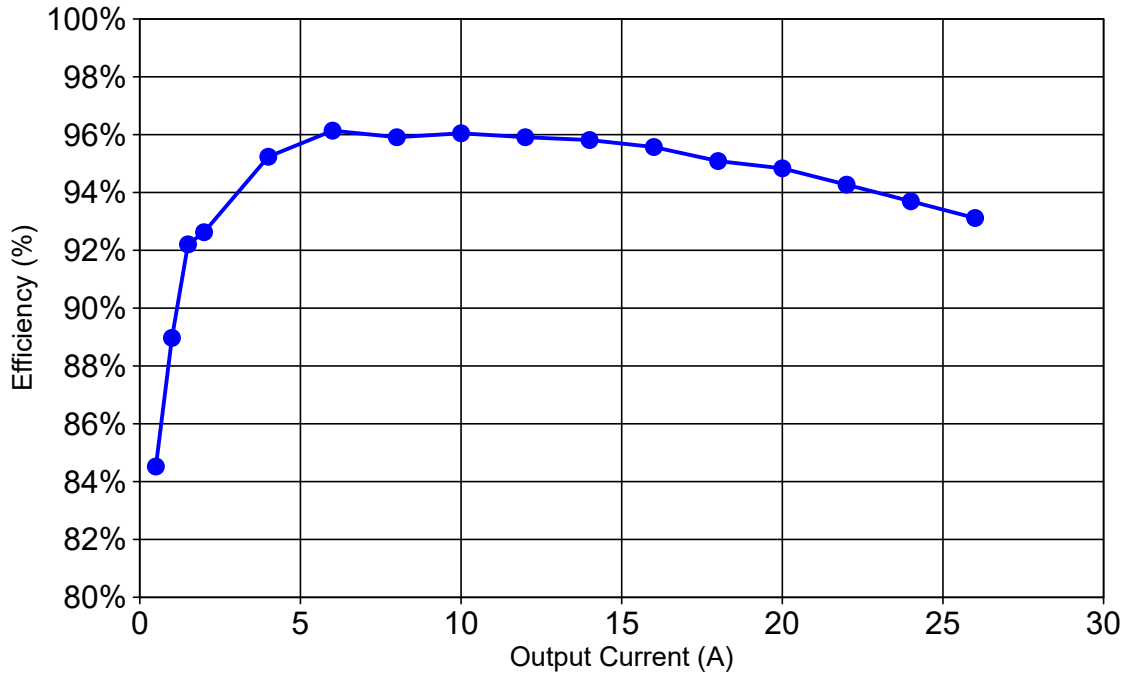# 2 Testing and Results

2.1 Efficiency Graph

Figure 2-1. Efficiency Graph at 12V Input Voltage

2.2 Efficiency Data

Table 2-1 shows the efficiency data.

Table 2-1. Efficiency Data

OUTPUT CURRENT (A)	EFFICIENCY (%)
0.5	84.5%
1	89.0%
1.5	92.2%
2	92.6%
4	95.2%
6	96.1%
8	95.9%
10	96.0%
12	95.9%
14	95.8%
16	95.6%
18	95.1%
20	94.8%
22	94.3%
24	93.7%
26	93.1%

2.3 Thermal Images

2.3.1 20A Output Current

Figure 2-2 was taken at $12V_{IN}$, 20A output current, after 20 minutes with artificial air flow. The ambient temperature was 25°C. The board image in the *Applications* section shows the mounted heat sink.
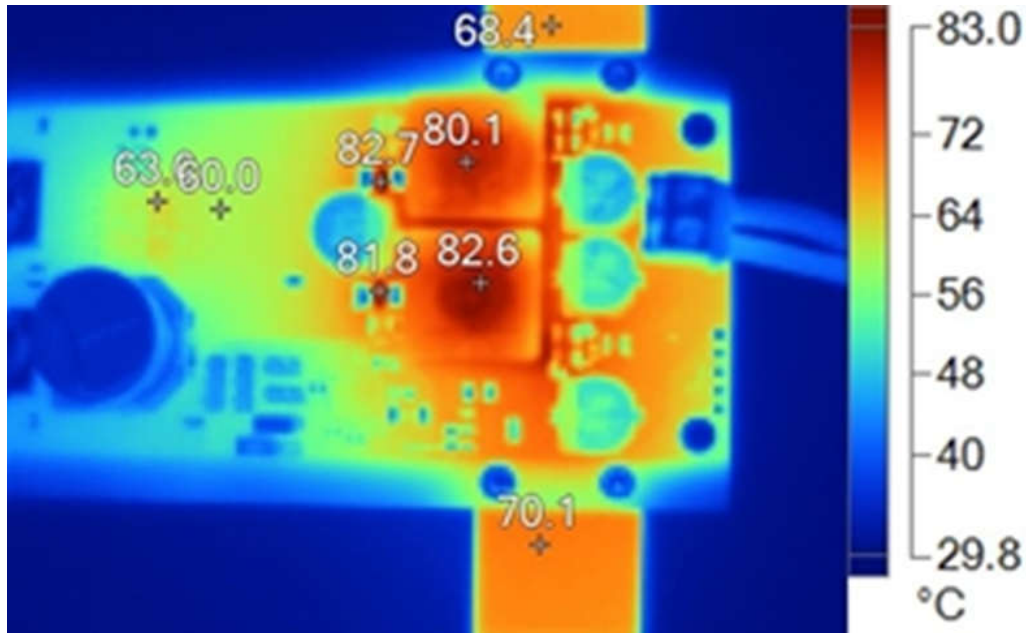
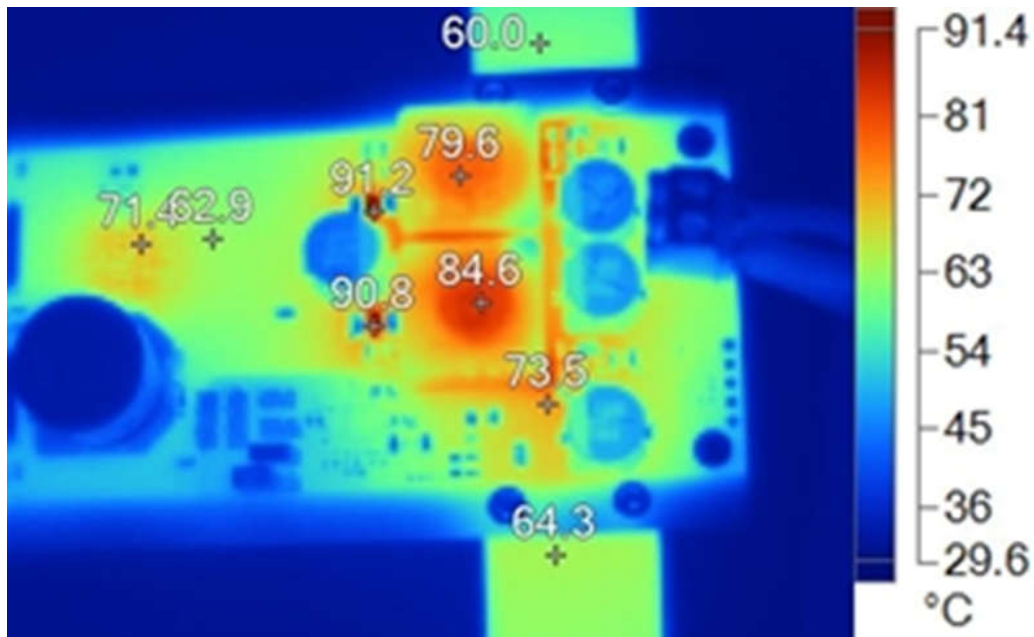**Figure 2-2. Thermal Image at 20A Output Current**

2.3.2 26A Output Current

Figure 2-3 was taken at $12V_{IN}$, 26A output current, after 20 minutes with increased artificial air flow. The ambient temperature was 25°C. The board image in the *Applications* section shows the mounted heat sink.

Figure 2-3. Thermal Image at 26A Output Current

2.4 Bode Plots

Figure 2-4 was measured with 11V input voltage and 26A load current.
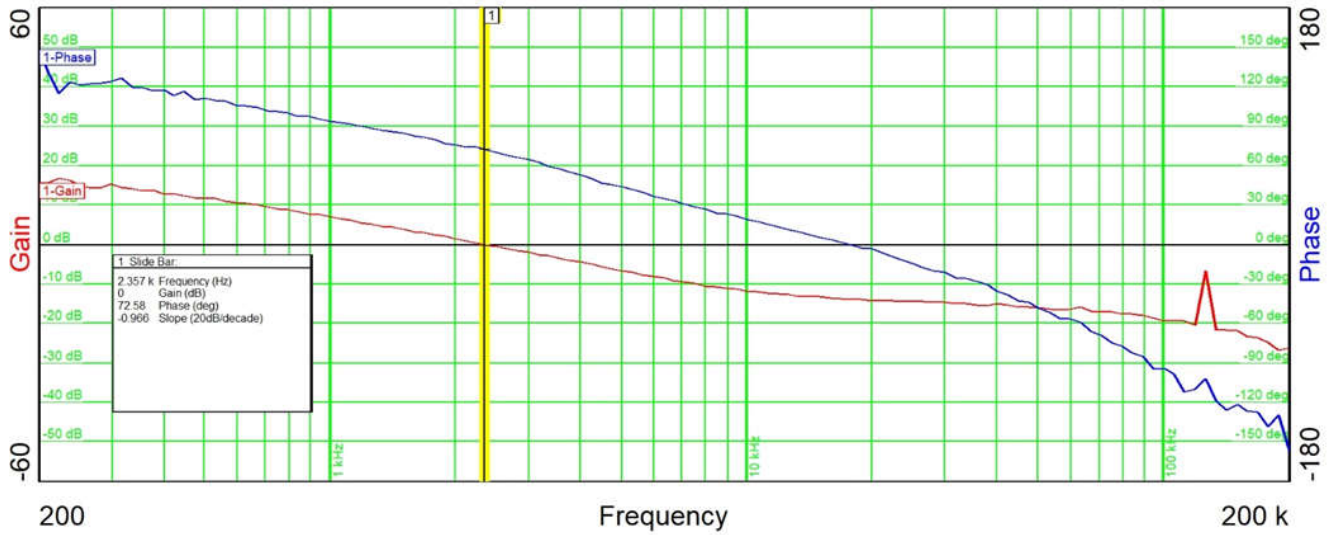
- Crossover frequency = 2.35kHz
- Phase margin = 72°
- Gain margin = 13.9dB

Figure 2-4. Bode Plot

3 Waveforms

3.1 Switching

3.1.1 26A Output Current
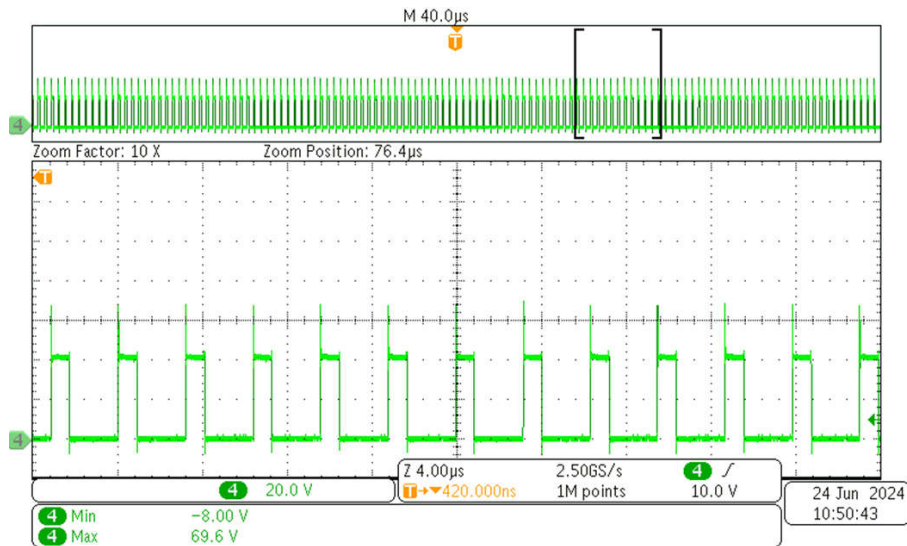
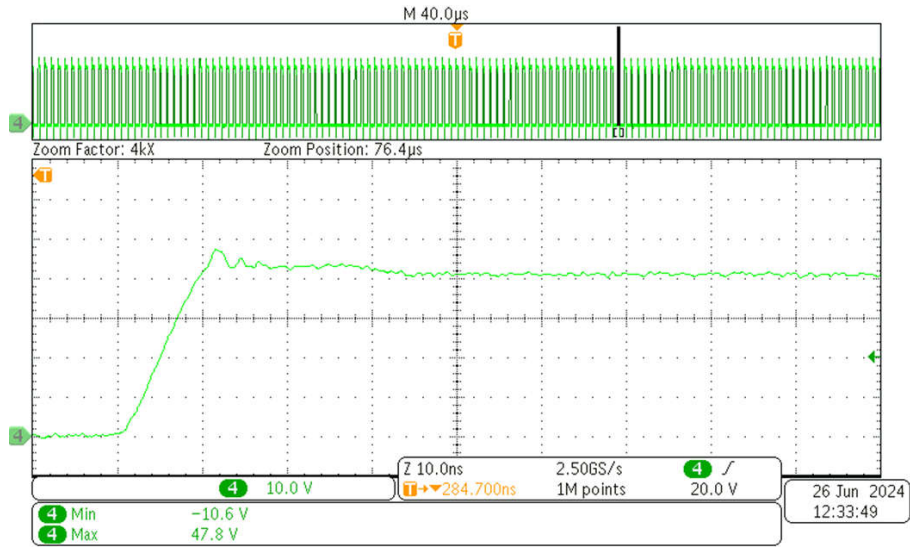CH4: DC-coupled switch node voltage (scale: 20V/div, 40µs/div, 500MHz bandwidth, 10× zoom)

Figure 3-1. Switching With 12V Input Voltage and 26A Load Current
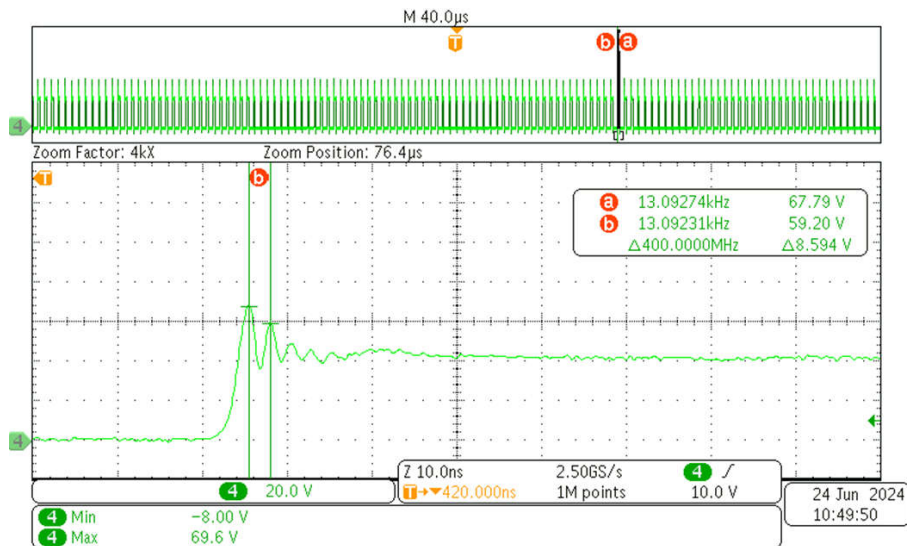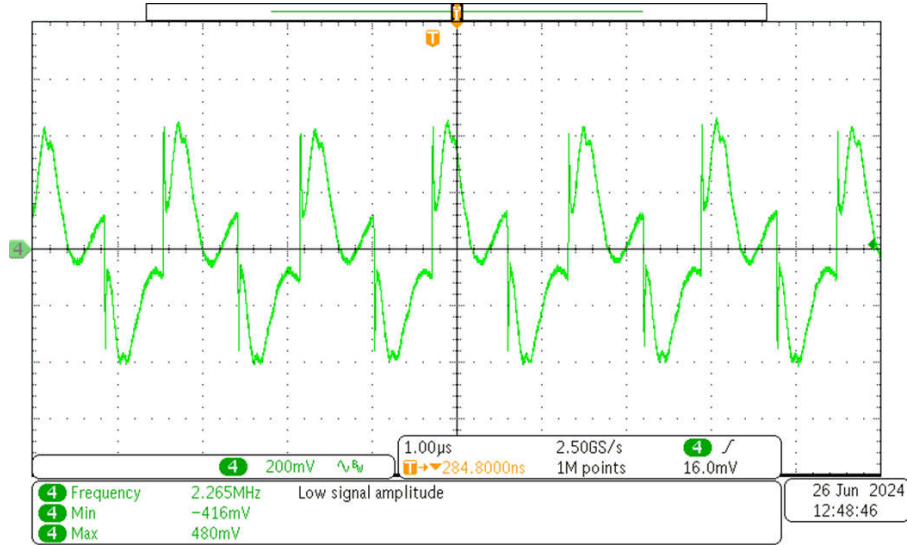

CH4: DC-coupled switch node voltage (scale: 20V/div, 40µs/div, 500MHz bandwidth, 4000× zoom)

Figure 3-2. Switching with 12V Input Voltage and 26A Load Current

3.1.2 4A Output Current

CH4: DC-coupled switch node voltage (scale: 20V/div, 40µs/div, 500MHz bandwidth, 4000× zoom)

Figure 3-3. Switching at 12V Input Voltage and 4A Load Current

3.2 Output Voltage Ripple

CH4: AC-coupled output voltage (scale: 200mV/div, 1μs/div, 20MHz bandwidth)

Figure 3-4. Output Voltage Ripple at 11V Input and 26A Load Current

3.3 Input Voltage Ripple
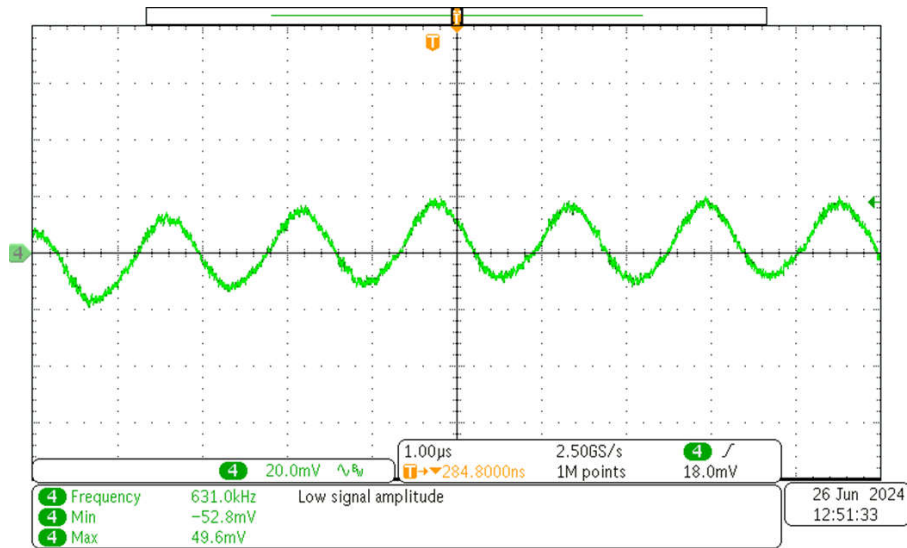
CH4: AC-coupled input voltage (scale: 200mV/div, 1μs/div, 20MHz bandwidth)

Figure 3-5. Input Voltage Ripple at 11V Input Voltage and 26A Load Current

3.4 Load Transients

Figure 3-6 shows the transient behavior with an 8A load step added on top of a 10A DC load (10A DC current not shown).
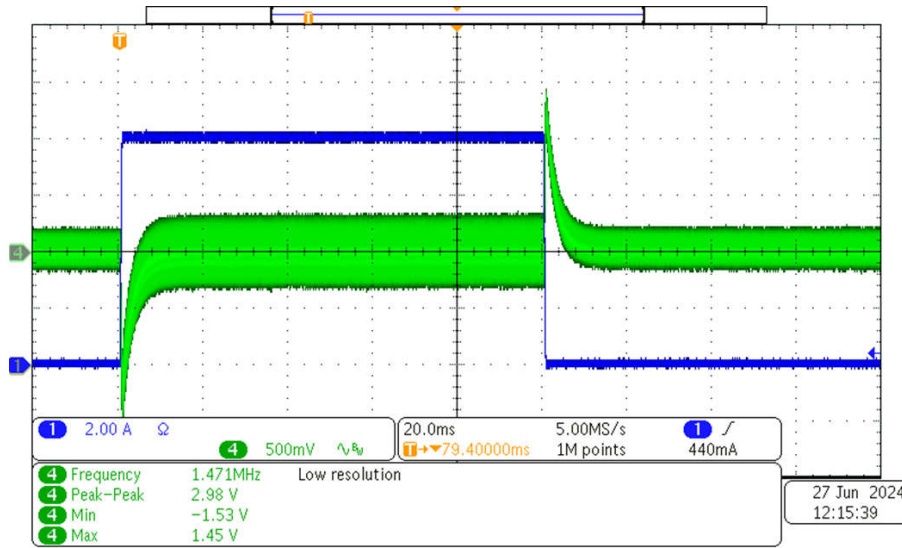
- CH1: Output transient current (scale: 2A/div, 20ms/div)
- CH4: AC coupled output voltage (scale: 500mV/div, 20ms/div, 20MHz bandwidth)

Figure 3-6. Load Transient at 11V Input Voltage

3.5 Start-up Sequence

Figure 3-7 shows the start-up behavior waveform.
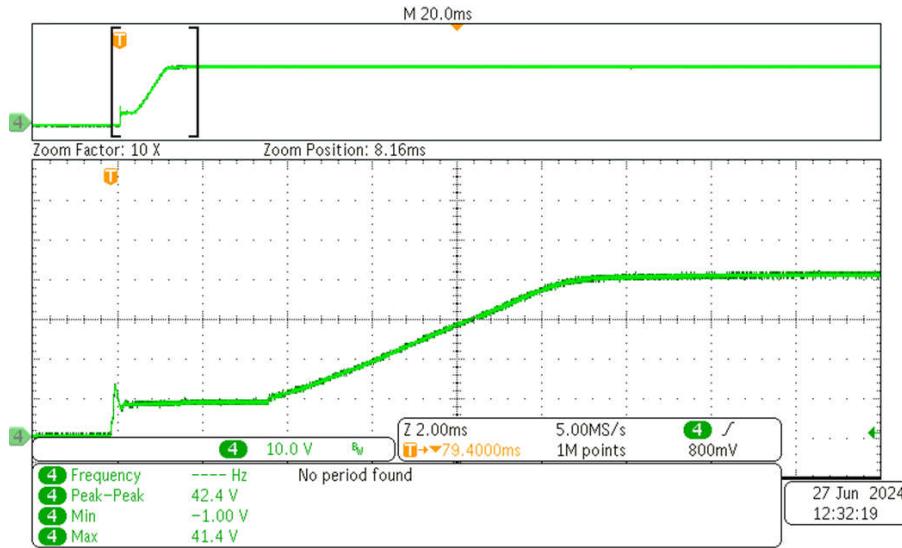
CH4: DC-coupled output voltage (scale: 10V/div, 20ms/div, 20MHz bandwidth, 10× zoom)

Figure 3-7. Start-Up at 11V Input Voltage Into 26A Load Current

3.6 Shutdown Sequence
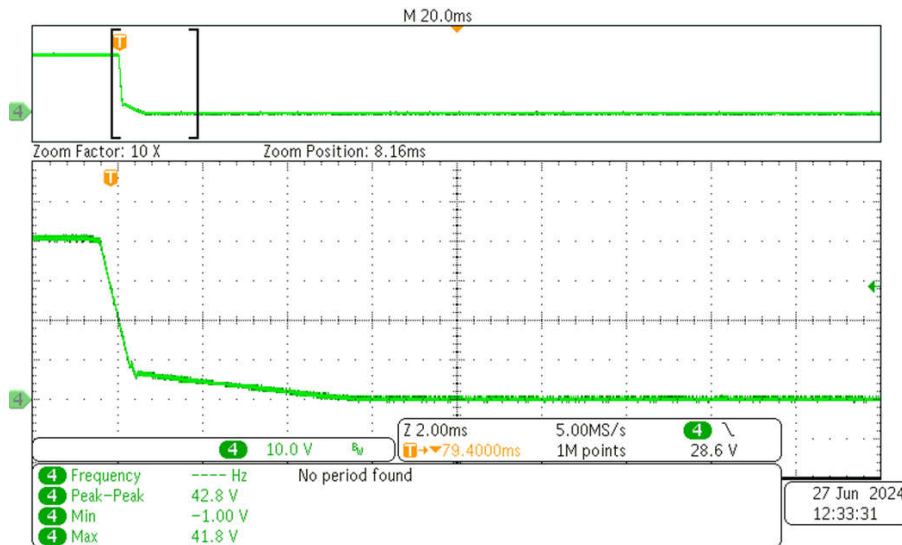
CH4: DC-coupled output voltage (scale: 10V/div, 20ms/div, 20MHz bandwidth, 10× zoom)

Figure 3-8. Shutdown Sequence at 11V Input Voltage with 26A Load Current

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