Test Report: PMP31252

150-W Dual-Phase Synchronous Buck Converter Reference Design for Automotive Applications

Description

This CISPR 25 Class 5 rated design showcases a dual-phase buck converter, which can also be used as a dual-output converter. As a dual-phase converter, the circuit can provide a continuous output current of 22 A with 30 A peak in a 12-V to 5-V configuration.

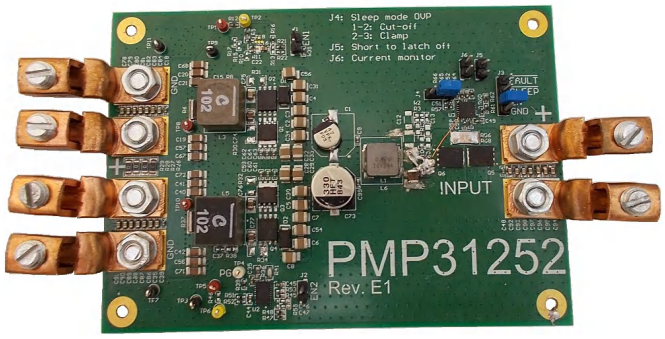
The main goal of this design is to provide good electromagnetic interference (EMI) performance to help the system integrator with EMI mitigation.

Features

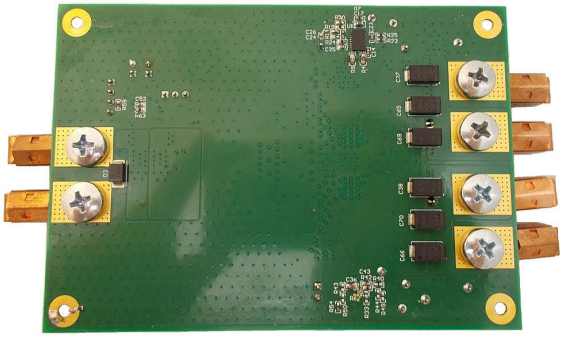
- 150-W peak output power (5-V single output configuration)
- 110-W continuous output power (5-V single output configuration)
- Circuit has an input protection
- Pre-compliance-tested to pass CISPR 25 Class 5

Applications

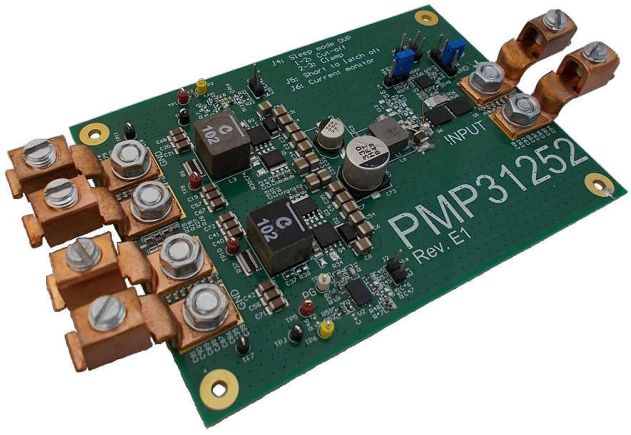
- Body electronics and lighting



Top Photo



Bottom Photo



Angled Photo

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Device	Input Voltage	Output Voltage, Maximum Current
LM5148-Q1	6 V to 16 V, 36-V peak	5 V, 22-A continuous, 30-A peak
LM74912-Q1	6 V to 16 V, 36-V peak	6 V to 16 V, 36-V peak

1.2 Considerations

Unless otherwise noted, the input voltage for testing was set to 12 V. The converter was configured to run in forced frequency pulse modulation (FPWM) operation during all tests.

1.3 Dimensions

The board has 6 layers with the dimensions of 115 mm × 81 mm. The inner 4 layers are with 70-µm copper thickness and the outer layers are with 35 µm.

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

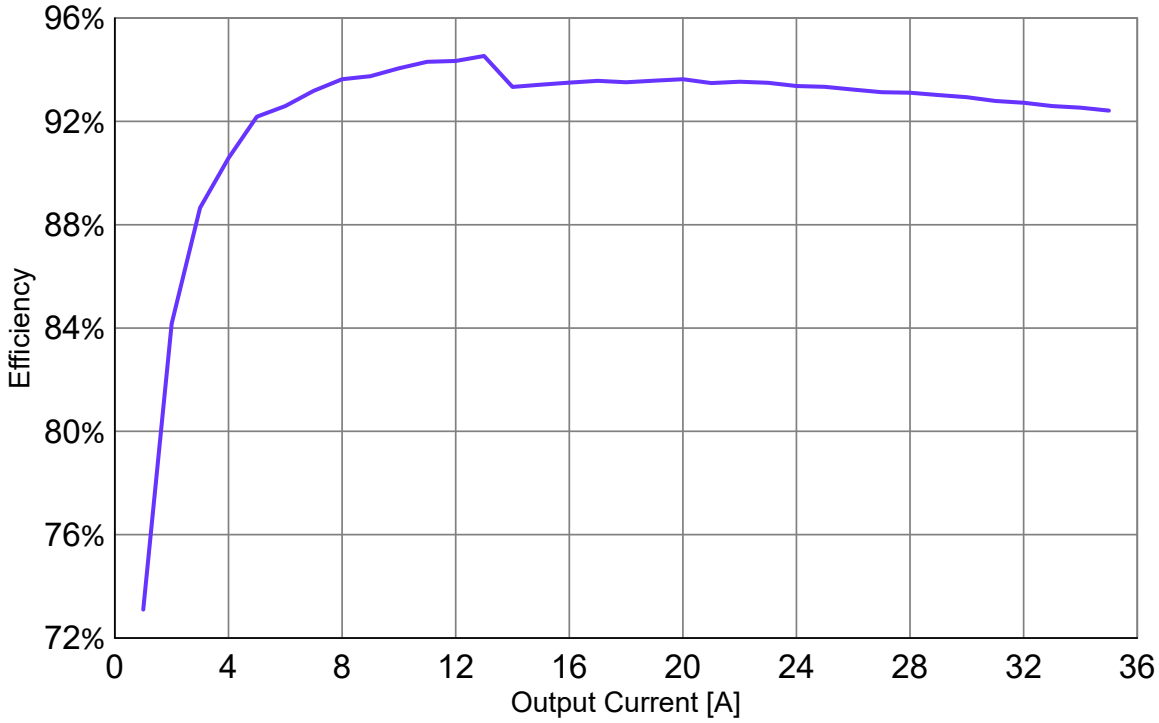


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

Efficiency data is shown in the following table.

Load Current (A)	Efficiency (%)
5	92.18
10	94.06
15	93.42
20	93.63
25	93.34
30	92.94

2.3 Thermal Images

For thermal testing, the PCB was placed flat on the bench with no artificial air flow at 25°C ambient temperature. The image was taken after thermal equilibrium was reached.

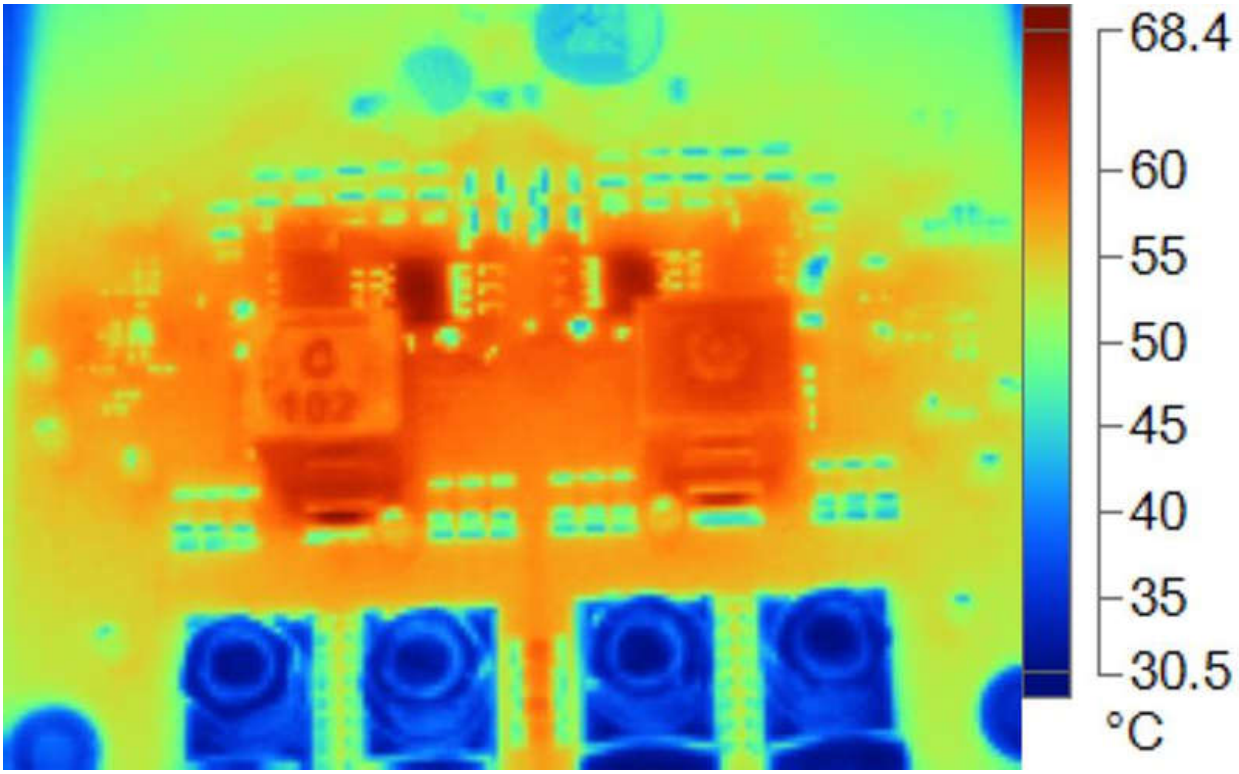


Figure 2-2. Thermal Image, 22-A Load Current

2.4 EMI

Conducted EMI tests were done in a shielded test chamber.

Radiated EMI tests were done in a CISPR25 conforming shielded test chamber.

For both types of tests, a freshly charged 12-V lead acid battery was used as a power source and a 220-mΩ resistor (Arcol HS100 R22 J) was used as a load, resulting in a load current of 23 A, which is above the targeted 22-A nominal output current. All EMI tests were done with dual random spread spectrum (DRSS) enabled.

The following measurements were done:

- Conducted Emissions
  - Noise floor
  - Conducted Emissions
- Radiated Emissions
  - Frequencies from 150 kHz to 30 MHz
    - Noise floor
    - Emissions
  - Frequencies from 30 MHz to 200 MHz
    - Horizontal Polarization
      - Noise Floor
      - Emissions
    - Vertical Polarization
      - Noise Floor
      - Emissions
  - Frequencies from 200 MHz to 1 GHz
    - Horizontal Polarization
      - Noise Floor
      - Emissions
    - Vertical Polarization
      - Noise Floor
      - Emissions

2.4.1 Conducted Emissions

2.4.1.1 Noise Floor

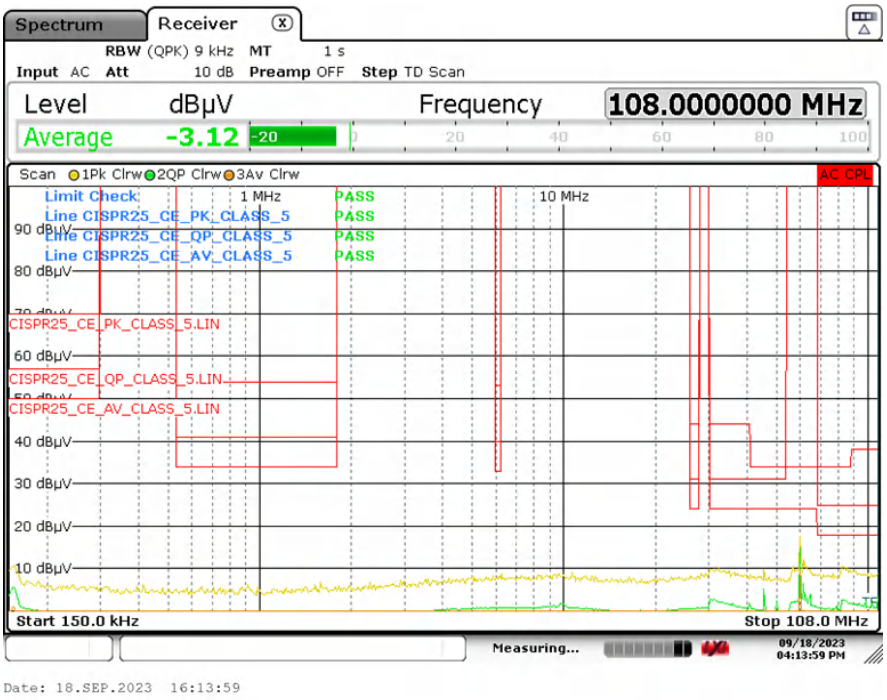


Figure 2-3. Noise Floor of the Conducted Measurement Setup

2.4.1.2 Conducted Emissions Measurement

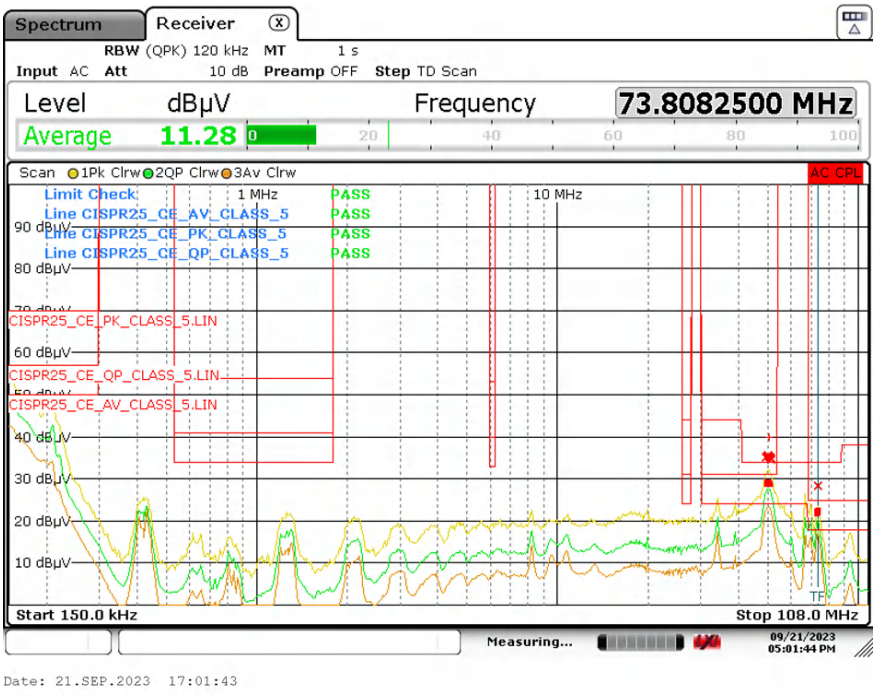


Figure 2-4. Results of Conducted Emissions

2.4.2 Radiated Emissions

2.4.2.1 Frequencies of 150 kHz to 30 MHz

2.4.2.1.1 Noise Floor

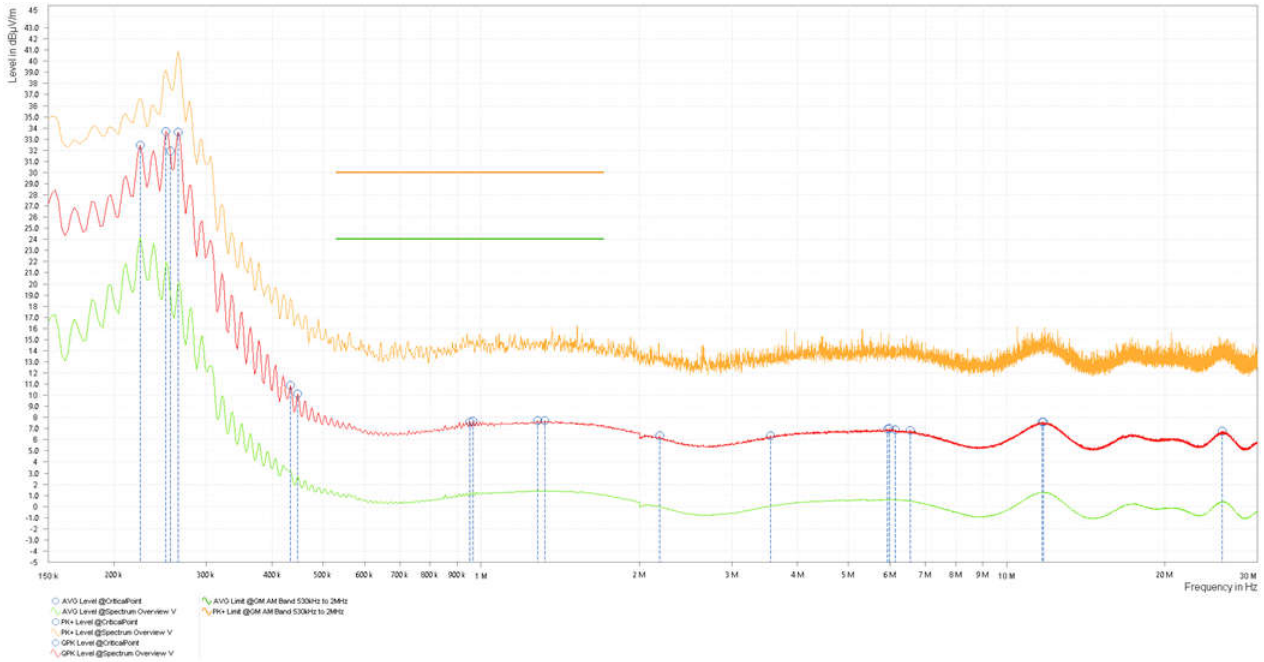


Figure 2-5. Noise Floor, 150 kHz to 30 MHz

2.4.2.1.2 Emissions

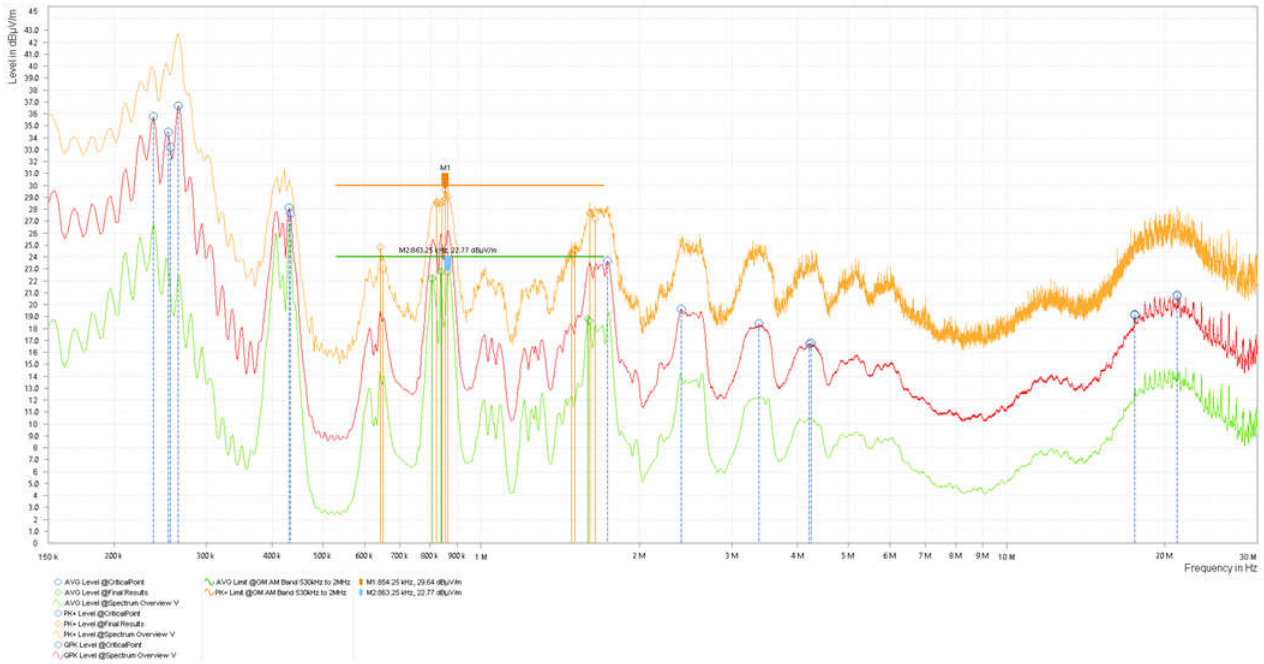


Figure 2-6. Radiated Emissions, 150 kHz to 30 MHz

2.4.2.2 Frequencies of 30 MHz to 200 MHz

2.4.2.2.1 Horizontal Polarization

2.4.2.2.1.1 Noise Floor

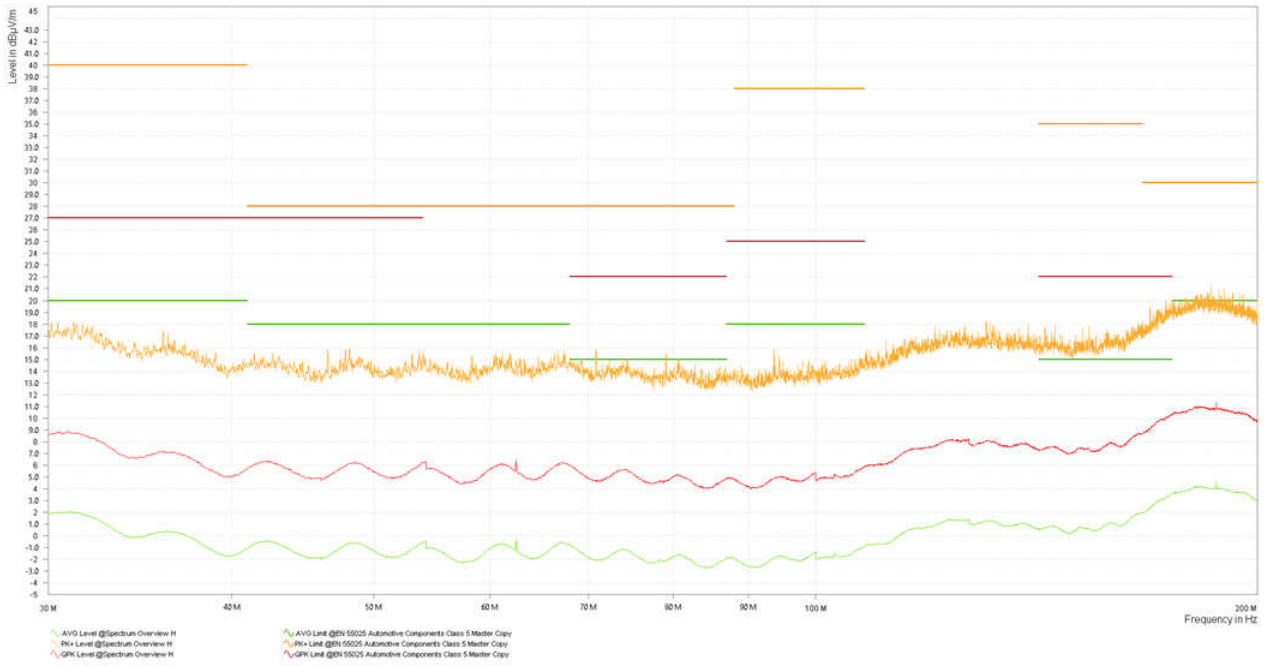


Figure 2-7. Noise Floor, 30 MHz to 200 MHz, Horizontal Polarization

2.4.2.2.1.2 Emissions

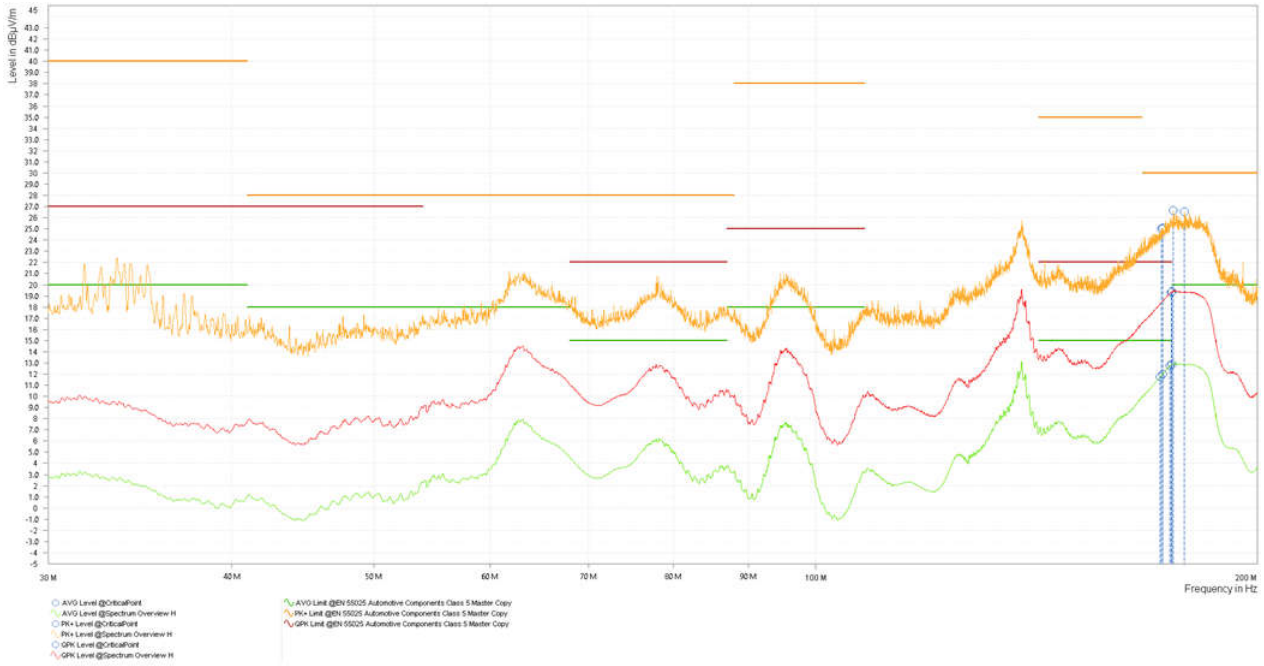


Figure 2-8. Radiated Emissions, 30 MHz to 200 MHz, Horizontal Polarization

2.4.2.2.2 Vertical Polarizations

2.4.2.2.2.1 Noise Floor

Figure 2-9. Noise Floor, 30 MHz to 200 MHz, Vertical Polarization

2.4.2.2.2.2 Emissions

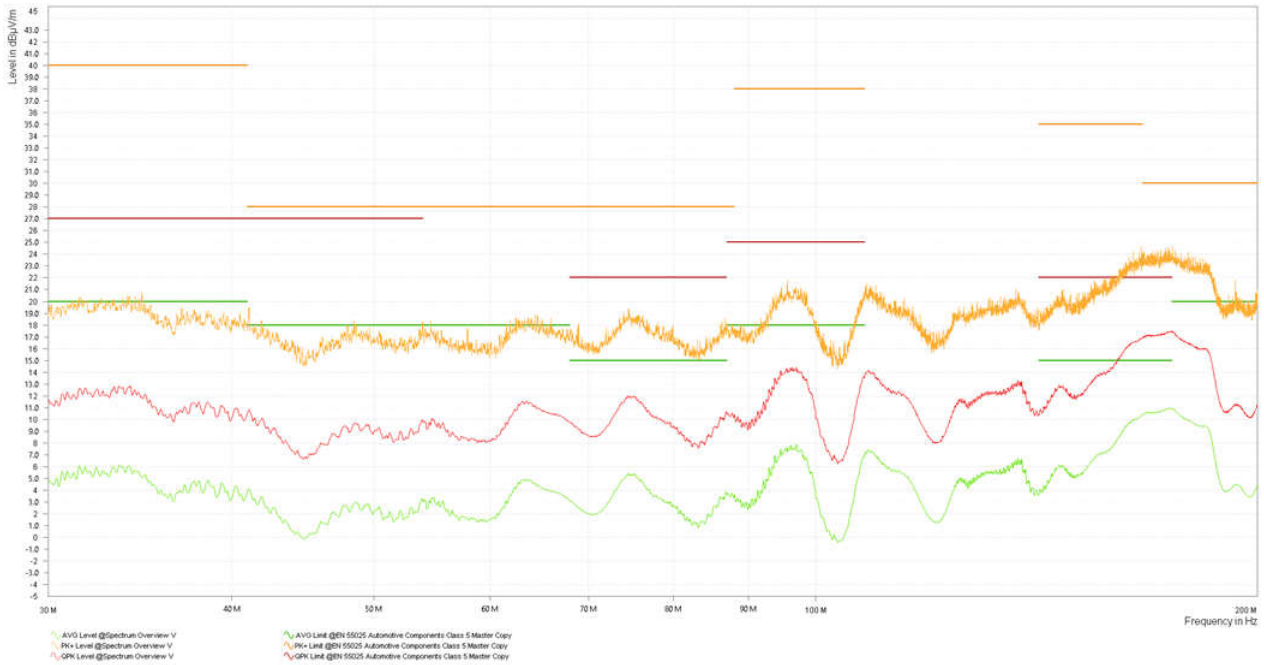


Figure 2-10. Radiated Emissions, 30 MHz to 200 MHz, Vertical Polarization

2.4.2.3 Frequencies from 200 MHz to 1 GHz

2.4.2.3.1 Horizontal Polarization

2.4.2.3.1.1 Noise Floor

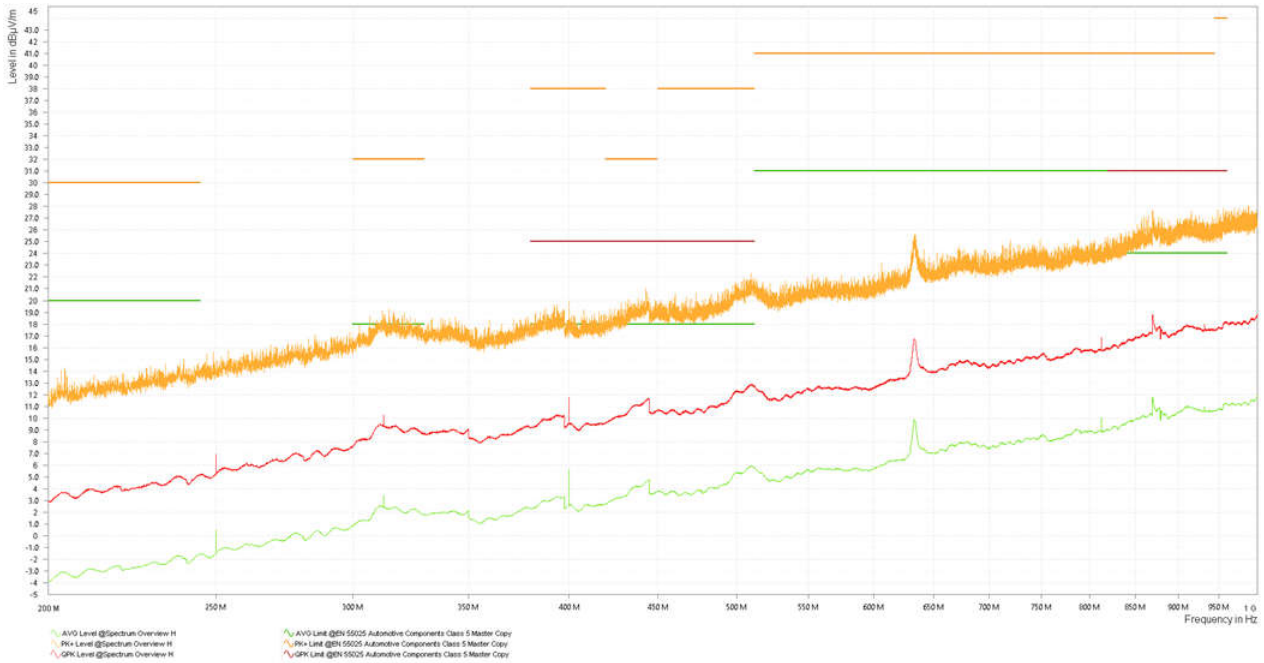


Figure 2-11. Noise Floor, 200 MHz to 1 GHz, Horizontal Polarization

2.4.2.3.1.2 Emissions

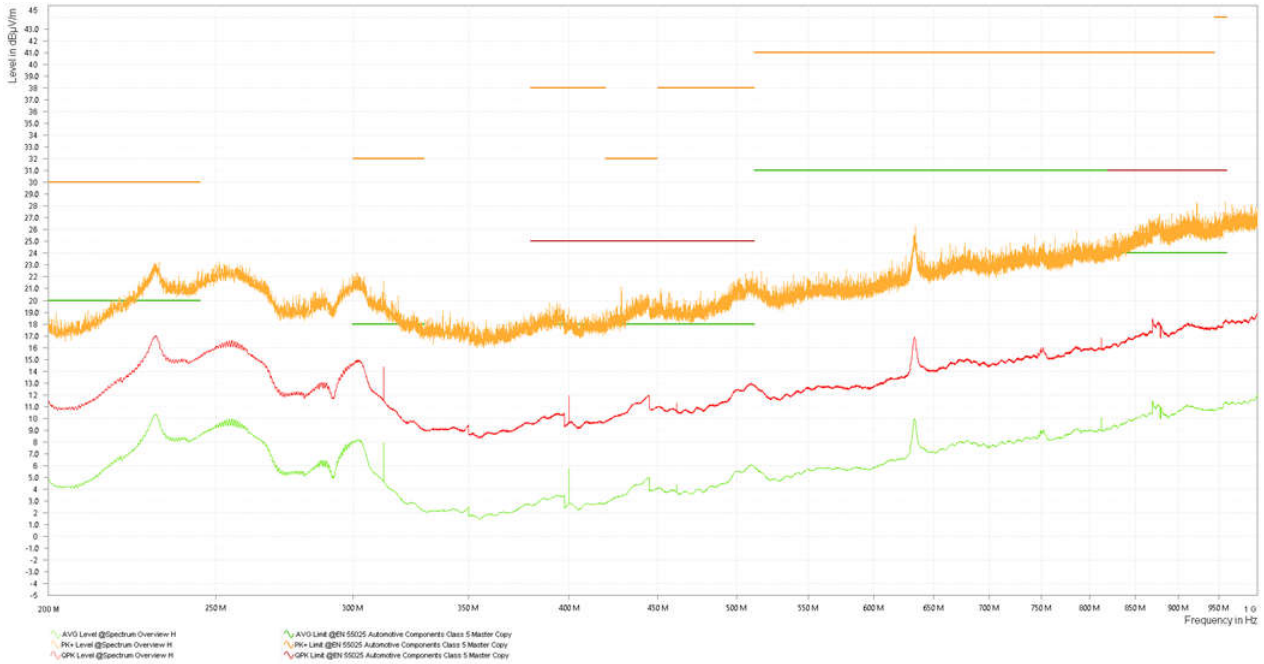


Figure 2-12. Radiated Emissions, 200 MHz to 1 GHz, Horizontal Polarization

2.4.2.3.2 Vertical Polarization

2.4.2.3.2.1 Noise Floor

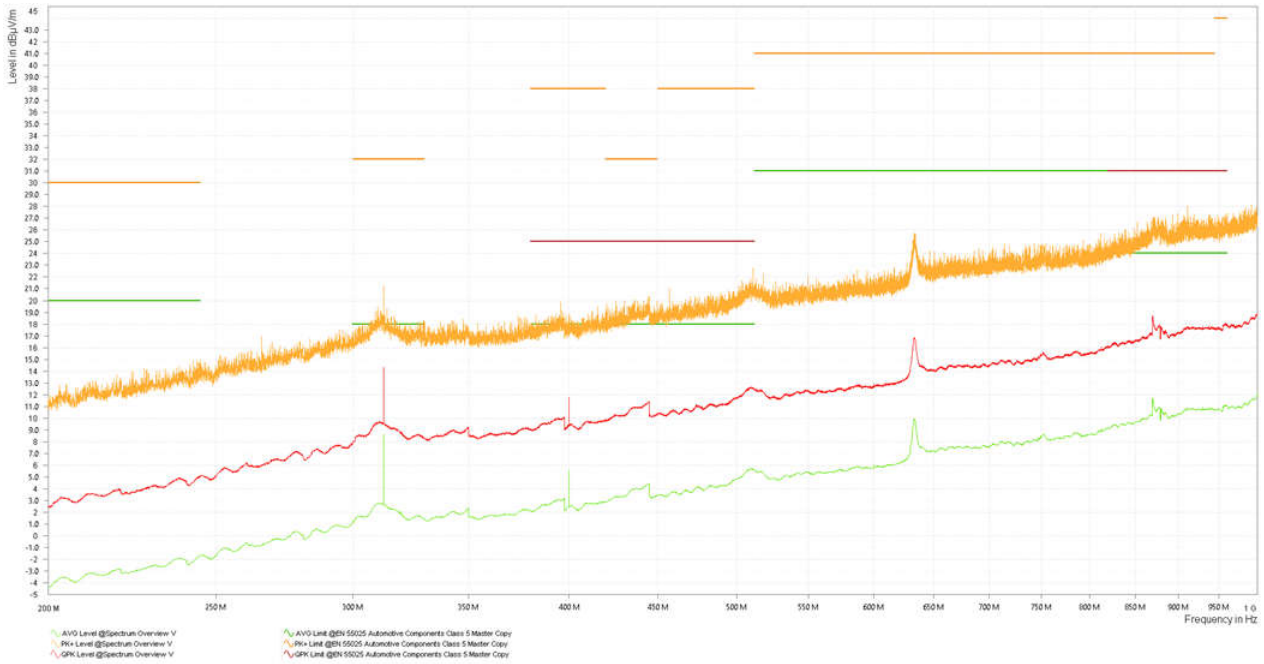


Figure 2-13. Noise Floor, 200 MHz to 1 GHz, Vertical Polarization

2.4.2.3.2.2 Emissions

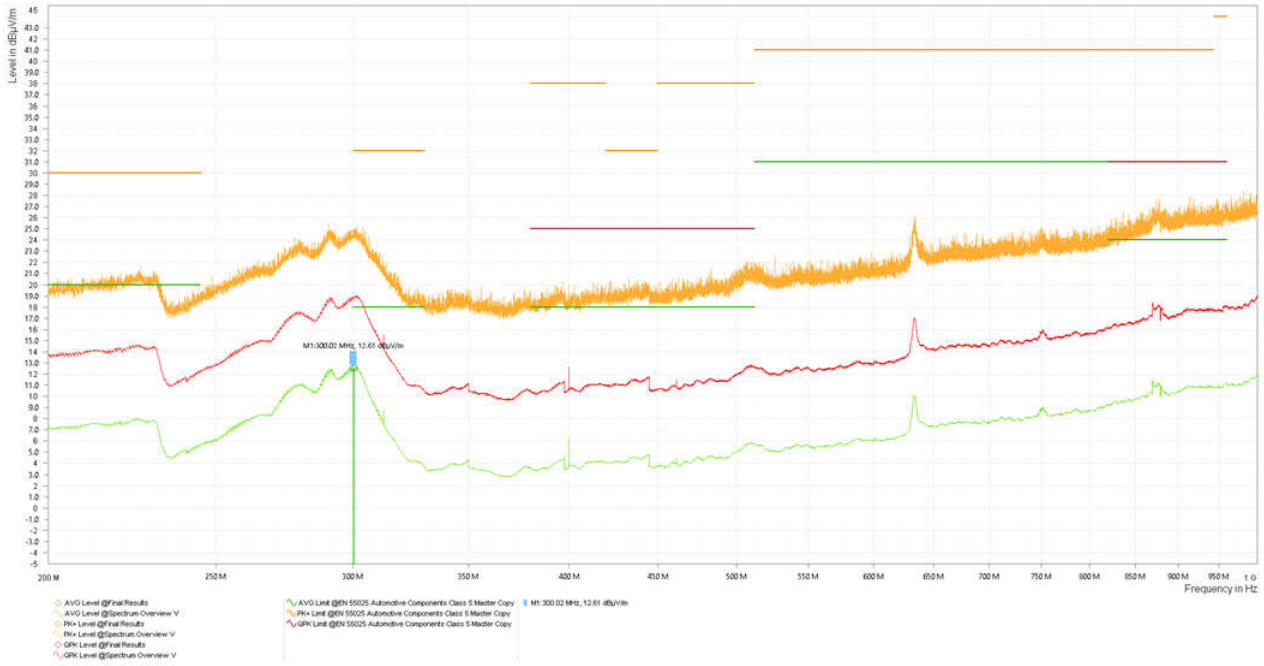
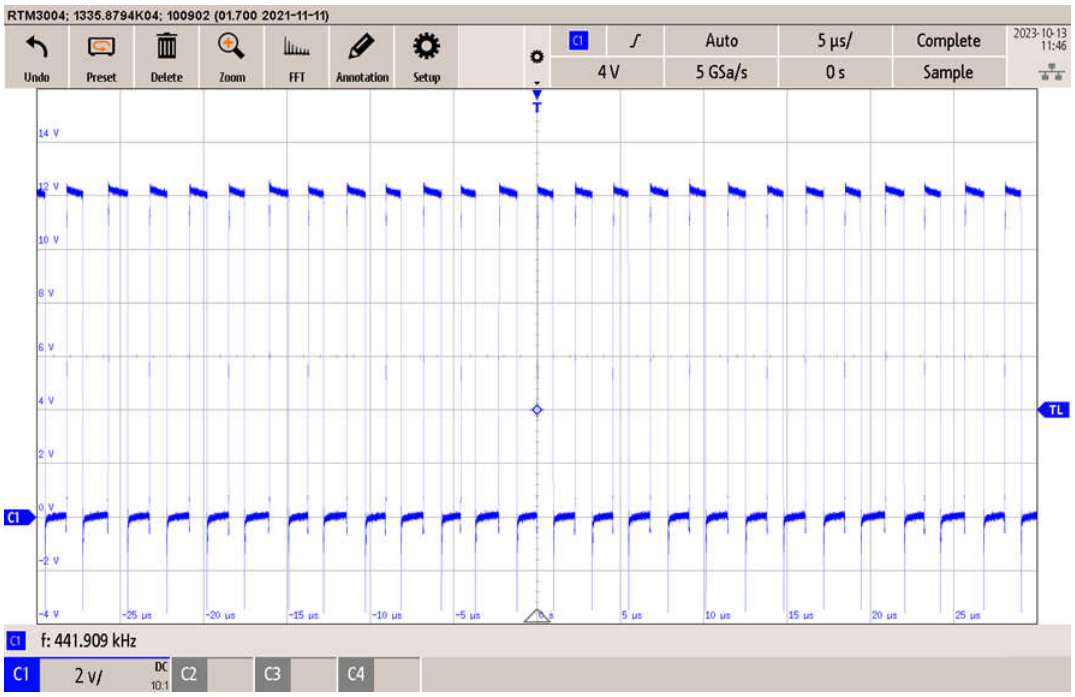


Figure 2-14. Radiated Emissions, 200 MHz to 1 GHz, Vertical Polarization

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.



	2 V / div 5 µs / div 500-MHz bandwidth
	2 V / div 20 ns / div 500-MHz bandwidth

Figure 3-1. Switch Node at 32-A Load Current

3.2 Load Transients

Load transient response is shown in the following figure.

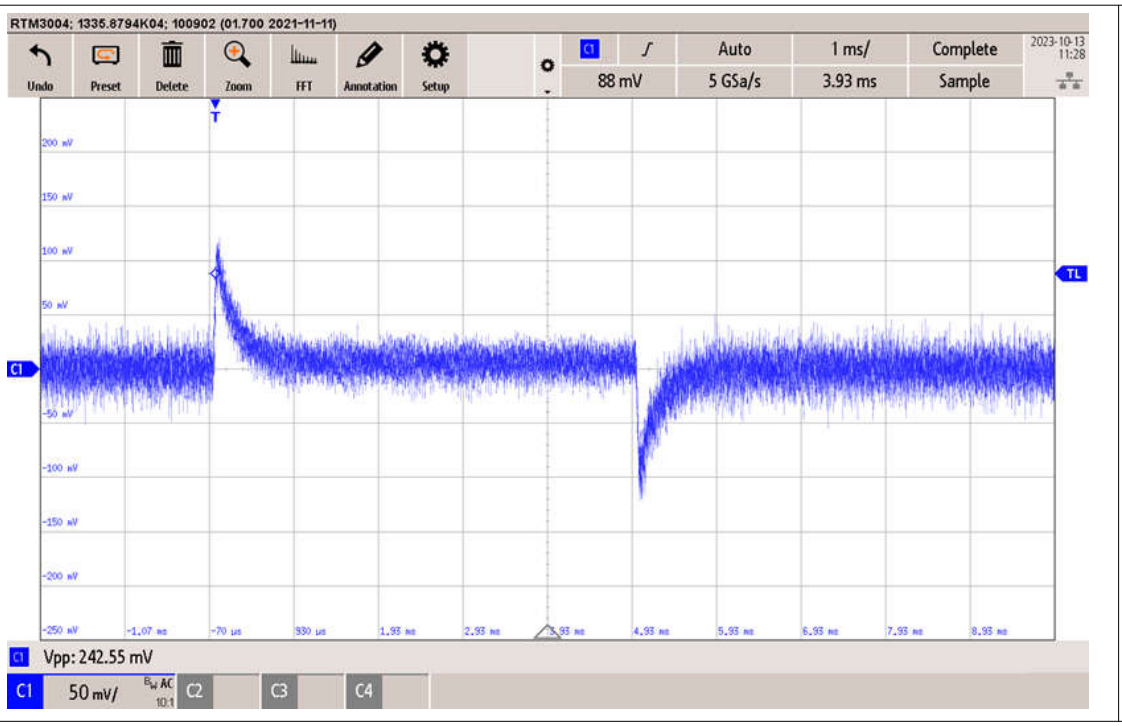


Figure 3-2. Load Step 5 A to 32 A to 5 A

3.3 Start-Up

Start-up behavior is shown in the following figure.

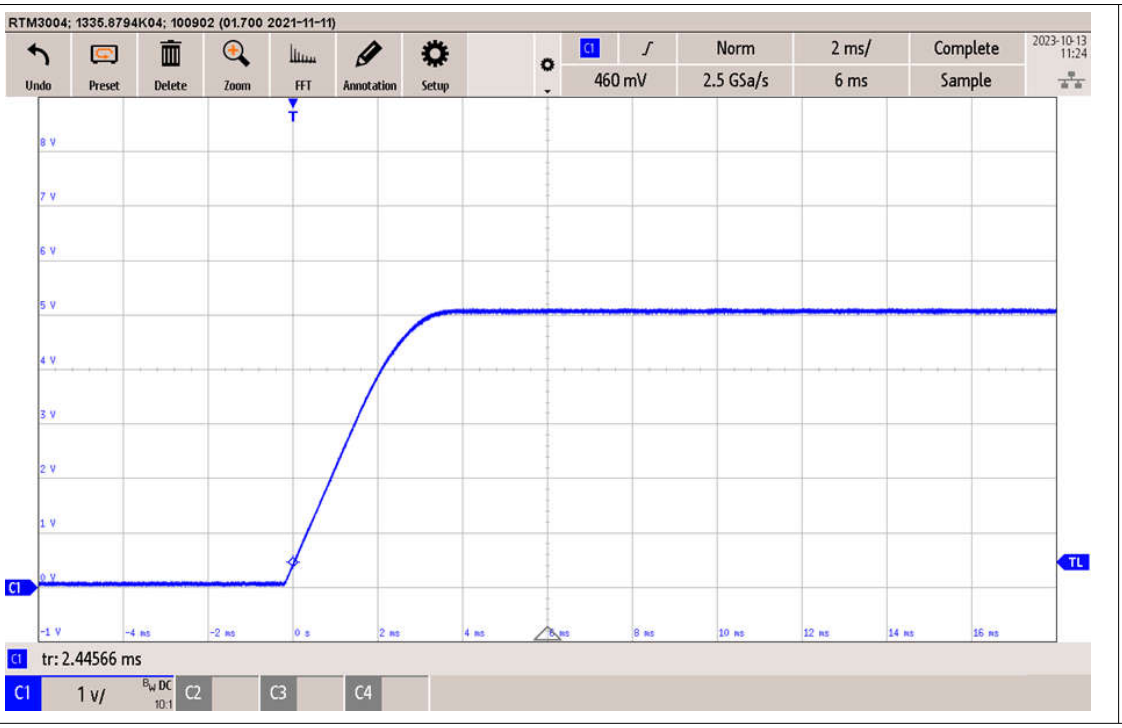


Figure 3-3. Start-Up Into 32-A Load

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