Test Report: PMP31245

Discrete Power Tree Reference Design for Automotive MCU

Description

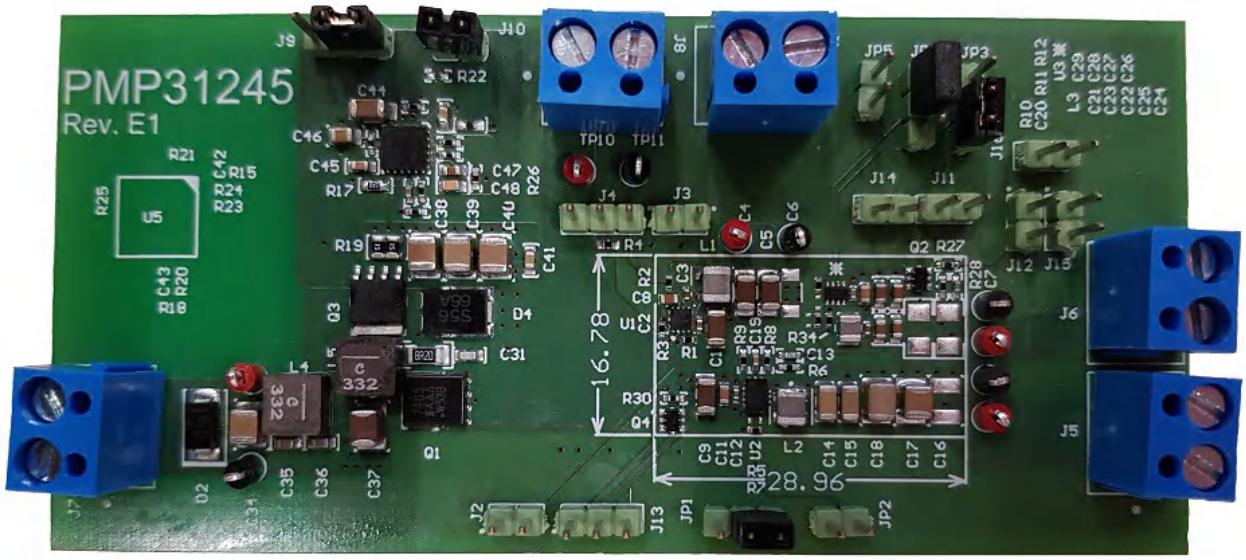
This reference design provides 5 V, 3.3 V and 1.0 V to power an automotive MCU using three buck converters together with a pre-boost converter. The pre-boost regulator can provide 1.25-A continuous output current at 8.5 V from a 3.2-V input voltage. The main goal of this design is to fit the buck architecture within a small board area, using mostly single-sided component placement.

Features

- Optimized for small PCB area
- Single-side population possible
- Design can easily be adapted for other voltage requirements
- Discrete power tree allows better board space utilization

Applications

- Automotive cluster display
- Infotainment and cluster
- ADAS domain controller



Top of Board

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltages and Currents

Device	Input Voltage	Output Voltage, Maximum Current
LM5150-Q1	3.2 – 16 V, 36-V peak	8.5 V, 1.25-A continuous, 2-A peak
LMR43620-Q1	8.5 – 16 V, 36-V peak	5 V, 2 A
TPS62810-Q1	5 V, ±10%	1.0 V, 4 A
TPS62850-Q1	5 V, ±10%	3.3 V, 1 A

1.2 PCB Properties

Figure 1-1 shows the PMP31245 PCB with the following features:

- Standard FR4
- 1.6-mm thickness
- 4 layers
- 1 oz copper on all layers

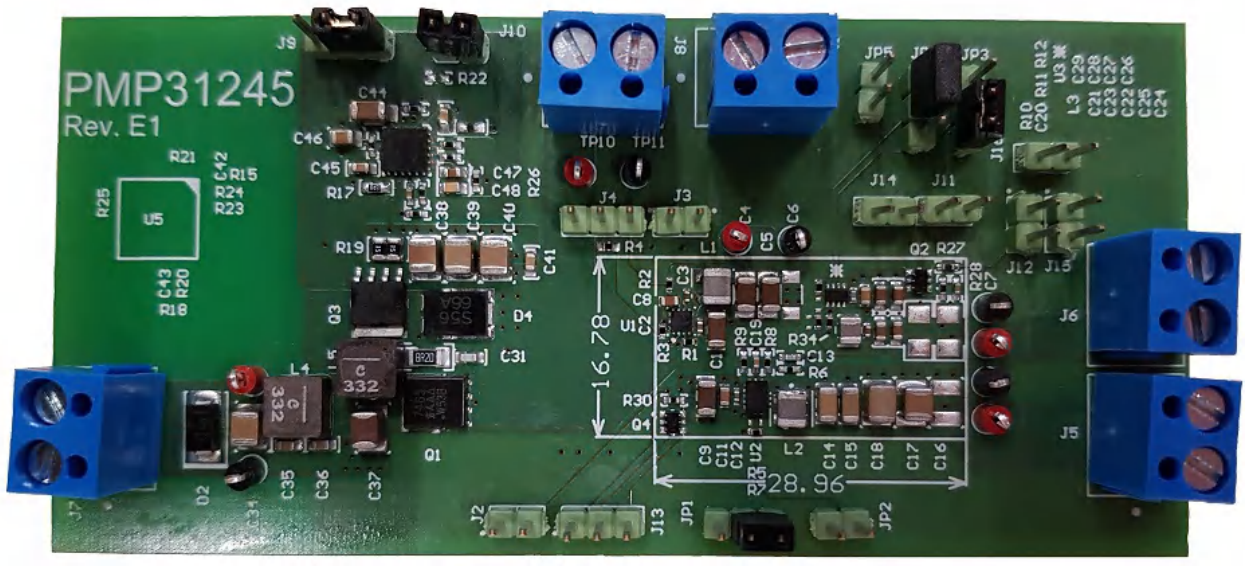


Figure 1-1. Top View of PMP31245 PCB

2 Testing and Results

For all tests, an additional electrolytic capacitor with 120 µF was placed on the input terminal to compensate for the length of the cable between power supply and the PCB.

All voltages were measured at the corresponding test points while all loads were applied to the corresponding screw terminals.

2.1 Efficiency and Thermals

Table 2-1 shows the results of the boost converter efficiency testing. The output voltage was set to 8.5 V for all tests. 4.7 R was used as gate resistor for the switching MOSFET.

Table 2-1. Testing Results

Input Voltage (V)	Output Current (A)	Efficiency (%)
3.2	0.3	88.5
3.2	0.6	88.5
3.2	1	85.9
3.2	1.25	83.6
5	0.3	90.0
5	0.6	90.9
5	1	90.5
5	1.25	89.9

Thermal testing was performed with 3.2-V input voltage, 1.25-A output current at 25°C ambient temperature, board placed flat on the table, no artificial air flow. Figure 2-1 was taken after thermal equilibrium was reached.

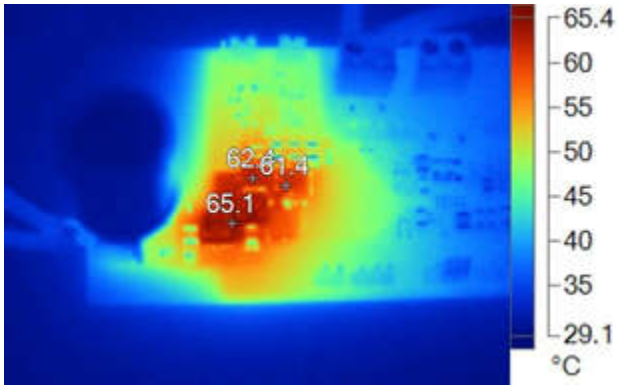
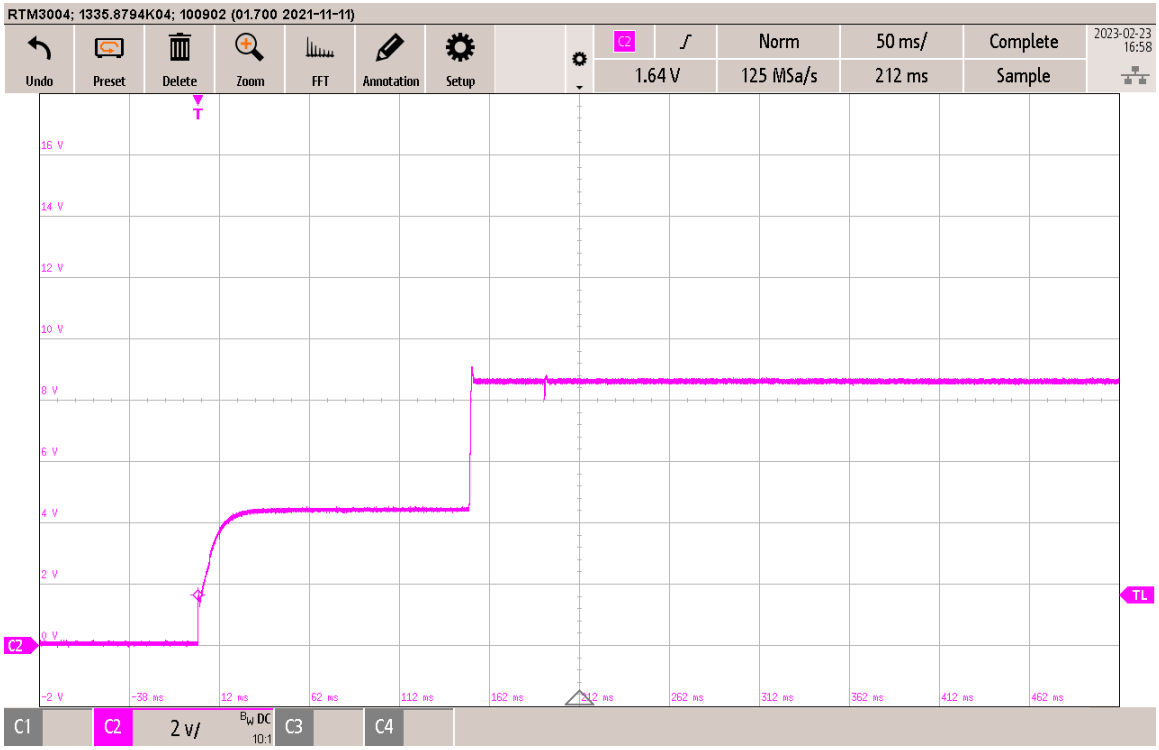


Figure 2-1. Thermal Image

3 Waveforms

3.1 Start-Up Sequence

Figure 3-1 shows the LM5150-Q1 start-up waveform into a 1.25-A load.

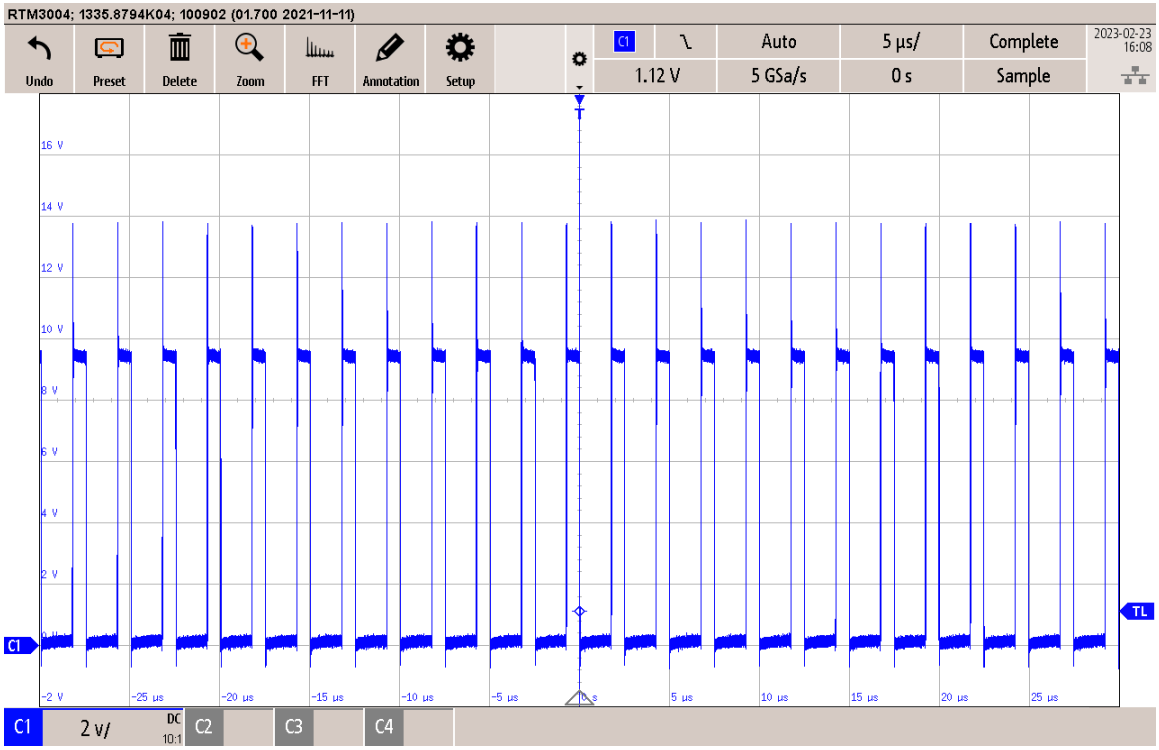


CH2: Output voltage, 2 V/div, 50 ms/div, 20-MHz bandwidth

Figure 3-1. LM5150-Q1 Start-Up 1.25-A Load

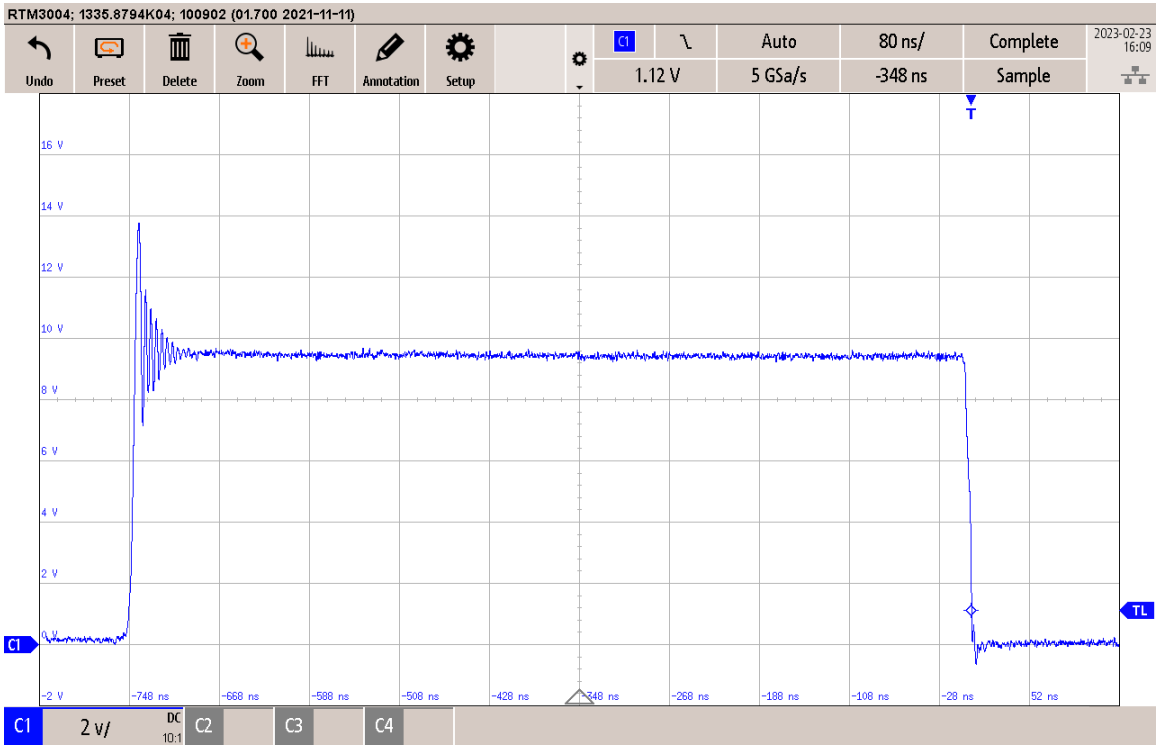
3.2 Switch Node

Figure 3-2 through Figure 3-4 illustrate the LM5150-Q1 switch node waveforms at 1.25-A output current.



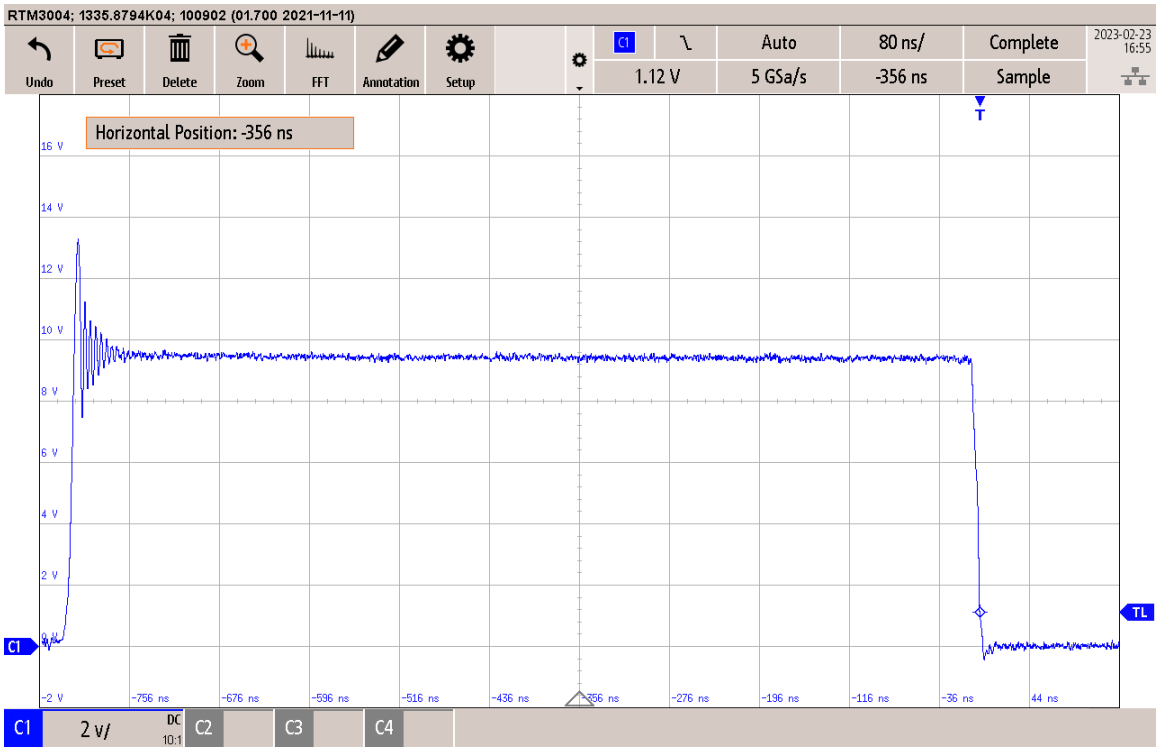
CH1: Switch node waveform, 2 V/div, 5 µs/div, 500-MHz bandwidth

Figure 3-2. LM5150-Q1 Switch Node Waveform



CH1: Switch node waveform, 2 V/div, 80 ns/div, 500-MHz bandwidth

Figure 3-3. LM5150-Q1 Switch Node Waveform With 4.7 R Gate Resistor

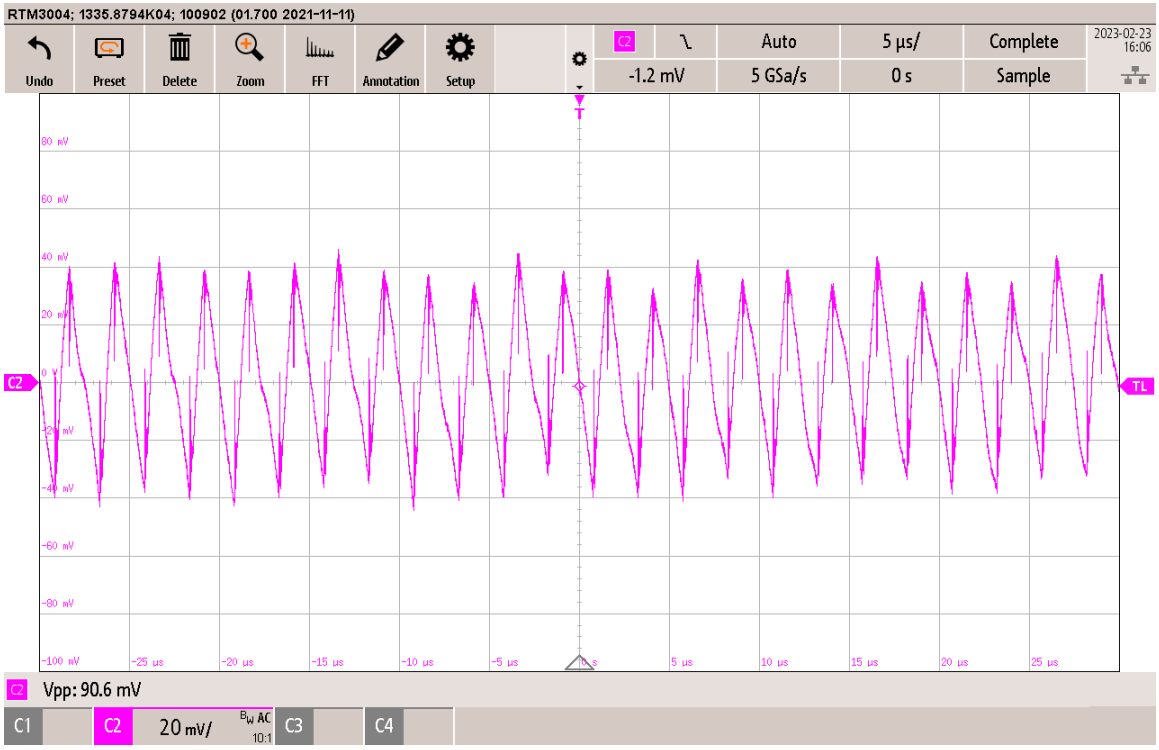


CH1: Switch node waveform, 2 V/div, 80 ns/div, 500-MHz bandwidth

Figure 3-4. LM5150-Q1 Switch Node Waveform With 6.8 R Gate Resistor

3.3 Output Voltage Ripple

Figure 3-5 shows the LM5150-Q1 output ripple waveform 3.2-V input voltage, 1.25-A load current.

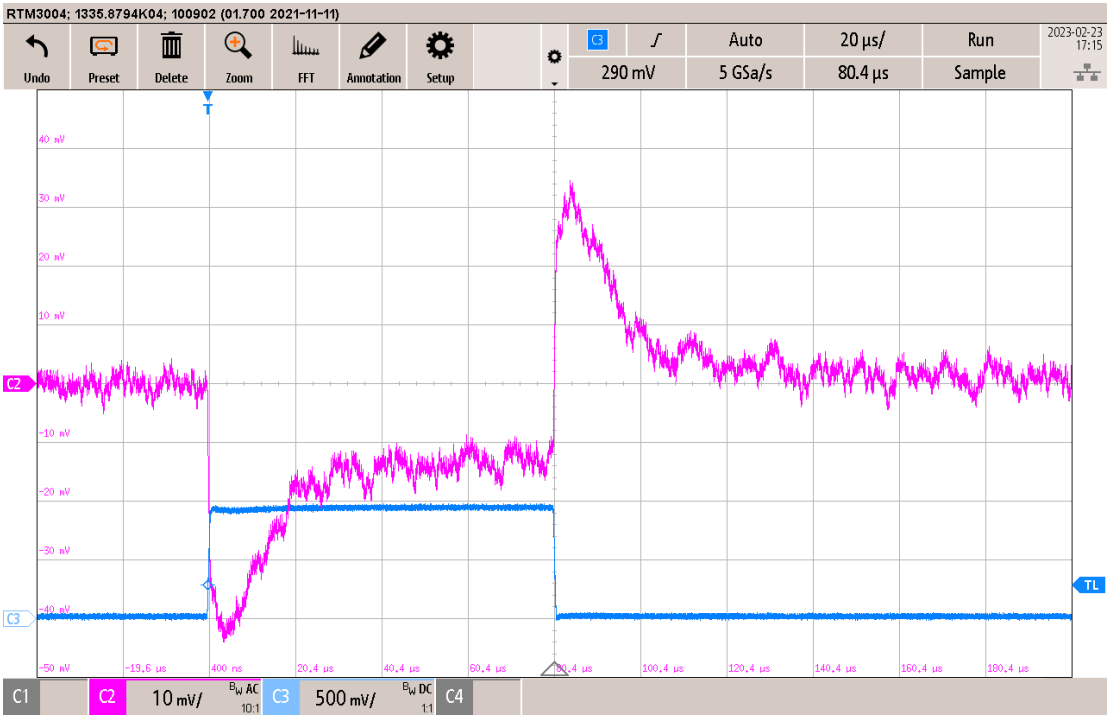


CH2: AC coupled output voltage, 20 mV/div, 5 µs/div, 20-MHz bandwidth

Figure 3-5. LM5150-Q1 Output Voltage Ripple, AC Coupled, V_{IN} = 3.2 V, 1.25-A Load

3.4 Load Step

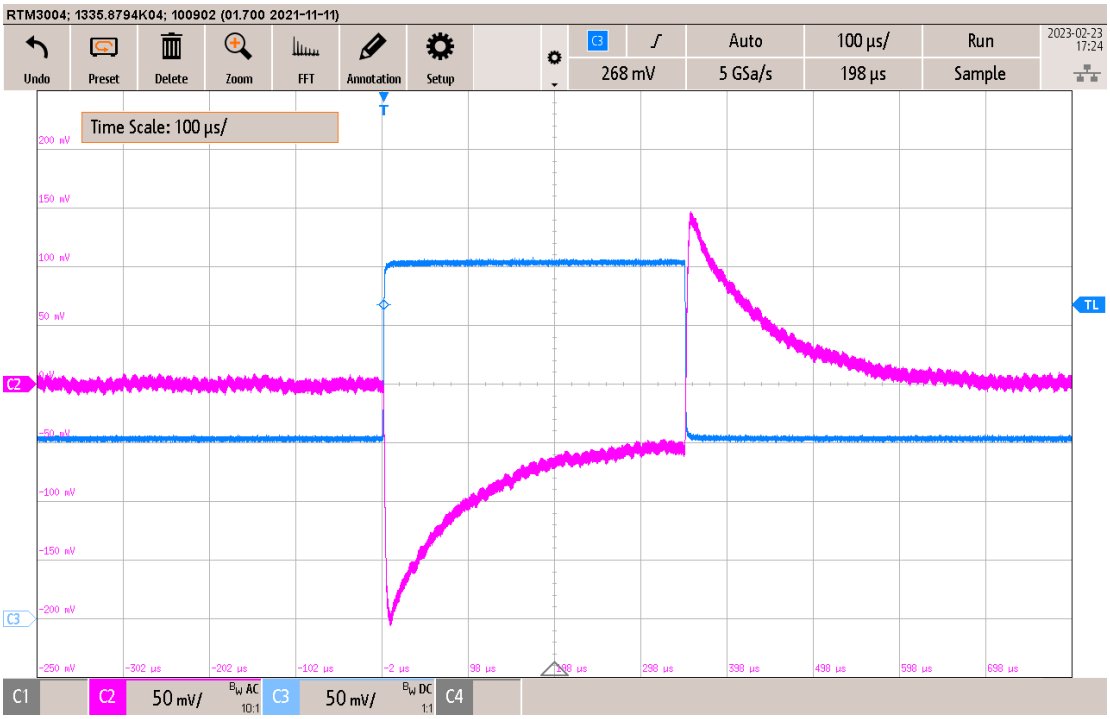
Figure 3-6 through Figure 3-8 show the load step behavior waveforms of various devices.



CH2: AC coupled output voltage, scale: 10 mV/div, 20 µs/div, 20-MHz bandwidth

CH3: Output current, scale: 1 A/div, 20 µs/div, 20-MHz bandwidth, 2 A offset: 0 V = 2 A

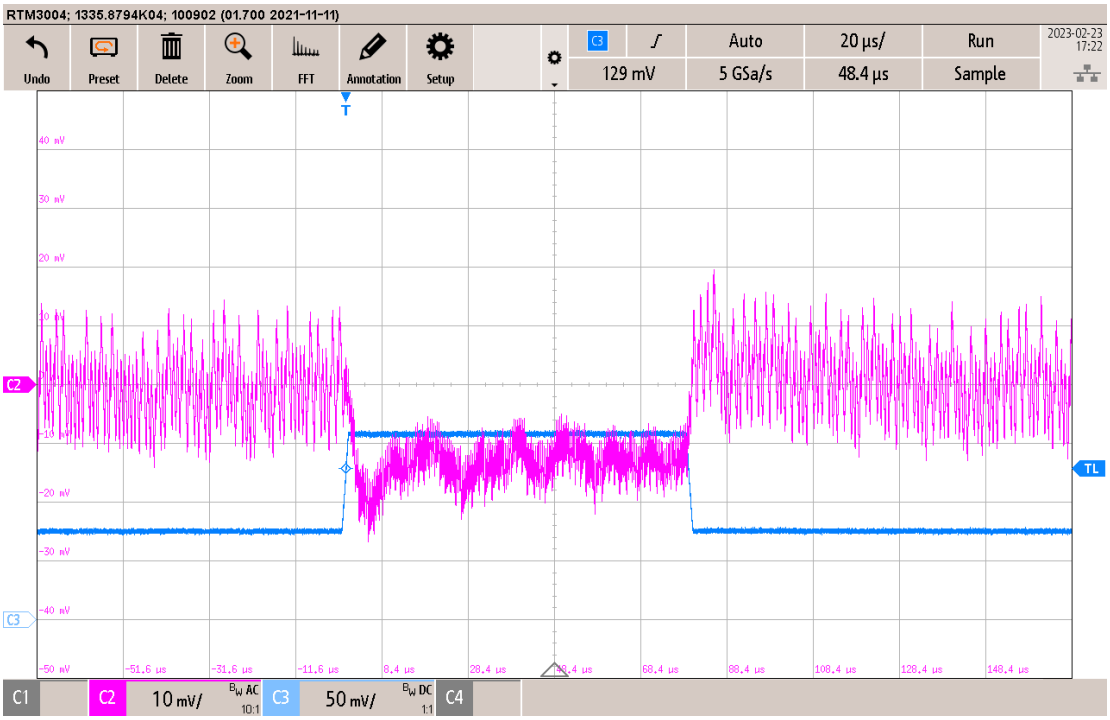
Figure 3-6. TPS62810-Q1 Load Step Behavior, 2 A to 4 A



CH2: AC coupled output voltage, scale: 50 mV/div, 100 µs/div, 20-MHz bandwidth

CH3: Output current, scale: 300 mA/div, 100 µs/div, 200-MHz bandwidth

Figure 3-7. LMR43620-Q1 Load Step Behavior, 300 mA to 600 mA



CH2: AC coupled output voltage, scale: 10 mV/div, 20 µs/div, 20-MHz bandwidth
CH3: Output current, scale: 100 mA/div, 20 µs/div, 20-MHz bandwidth

Figure 3-8. TPS62850-Q1 Load Step Behavior, 150 mA to 300 mA

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