Test Report: PMP31345

Triple Output PSR Flyback Converter Reference Design

Description

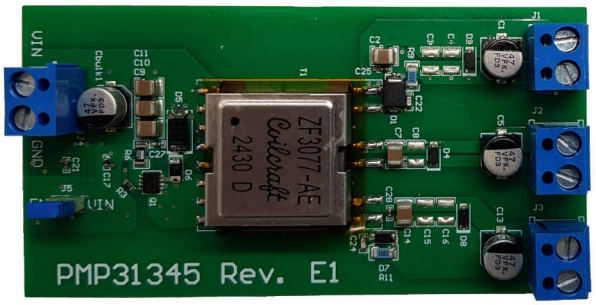
This reference design showcases a primary-side regulation (PSR) flyback converter based on the LM5185-Q1. The design offers three isolated output windings, delivering up to 19W in total from a 6V to 27V input voltage range.

Features

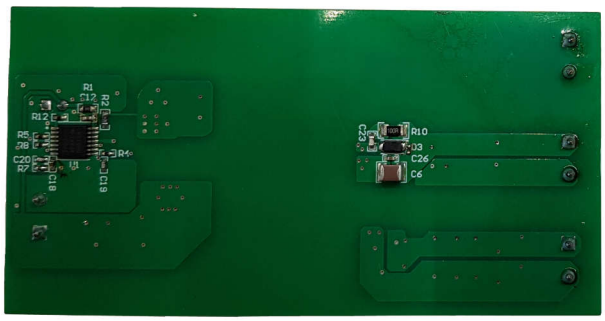
- Low component count due to primary side regulation
- No optocoupler required
- Good line and load regulation
- Good cross regulation
- High efficiency

Applications

- Onboard charger
- Traction inverter



Top Photo



Bottom Photo

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1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	6 - 27V, 12V nominal
Output Voltage	3 × 22V at 550mA, 160mA, 160mA
Switching Frequency	Up to 350kHz

1.2 Considerations

- Unless otherwise noted, the input voltage was set to 12V
- Input voltages below 10V are considered transients

1.3 Dimensions

Two layer printed circuit board (PCB), standard FR4 1.6mm thickness, 1oz copper on all layers, 47mm x 92mm (output one top, output two middle, output three bottom).

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2 Testing and Results

2.1 Efficiency Graphs

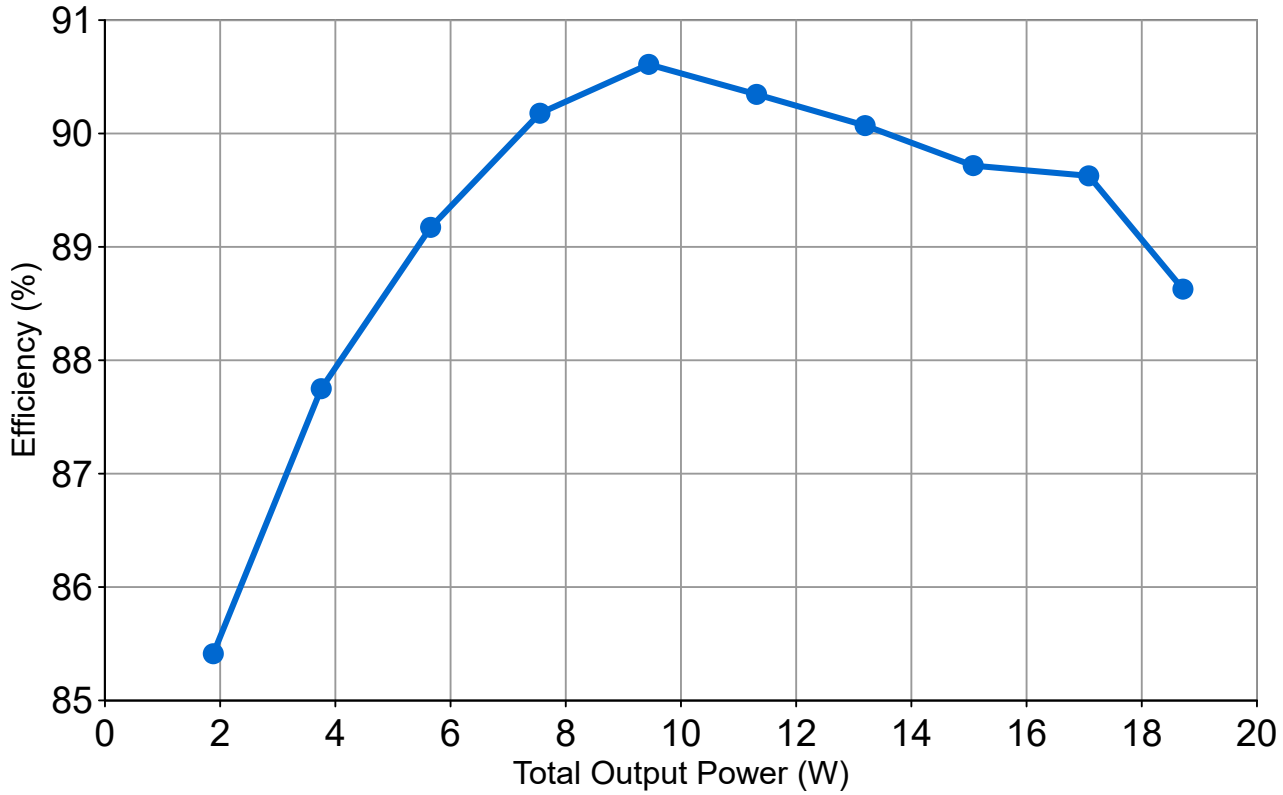

Figure 2-1. Efficiency Graph

2.2 Efficiency Data

Table 2-1. Efficiency Data

V_In (V)	I_In (A)	V_Out1 (V)	I_Out1 (A)	V_Out2 (V)	I_Out2 (A)	V_Out3 (V)	I_Out3 (A)	Eff_total (%)
12.08	0.1823	21.57	0.055	21.68	0.0157	21.73	0.0163	85.41
12.06	0.3548	21.59	0.11	21.69	0.0317	21.7	0.0319	87.75
12.04	0.5266	21.59	0.165	21.69	0.0485	21.7	0.0479	89.17
12.03	0.6961	21.56	0.22	21.67	0.0646	21.67	0.065	90.18
11.997	0.8684	21.59	0.275	21.71	0.0808	21.72	0.0805	90.61
11.98	1.0452	21.56	0.33	21.71	0.0967	21.7	0.0967	90.35
11.98	1.223	21.56	0.385	21.76	0.1133	21.76	0.1117	90.07
11.95	1.406	21.56	0.44	21.76	0.1284	21.74	0.1285	89.72
11.94	1.596	21.57	0.5	21.79	0.1448	21.77	0.1442	89.63
11.93	1.77	21.6	0.55	21.86	0.155	21.84	0.1578	88.63

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2.3 Thermal Images

Figure 2-2 was taken at 12V V_{IN}, maximum output current on all three outputs, after thermal equilibrium was reached, no artificial air flow, board lying flat on the table, and ambient temperature of 25°C.

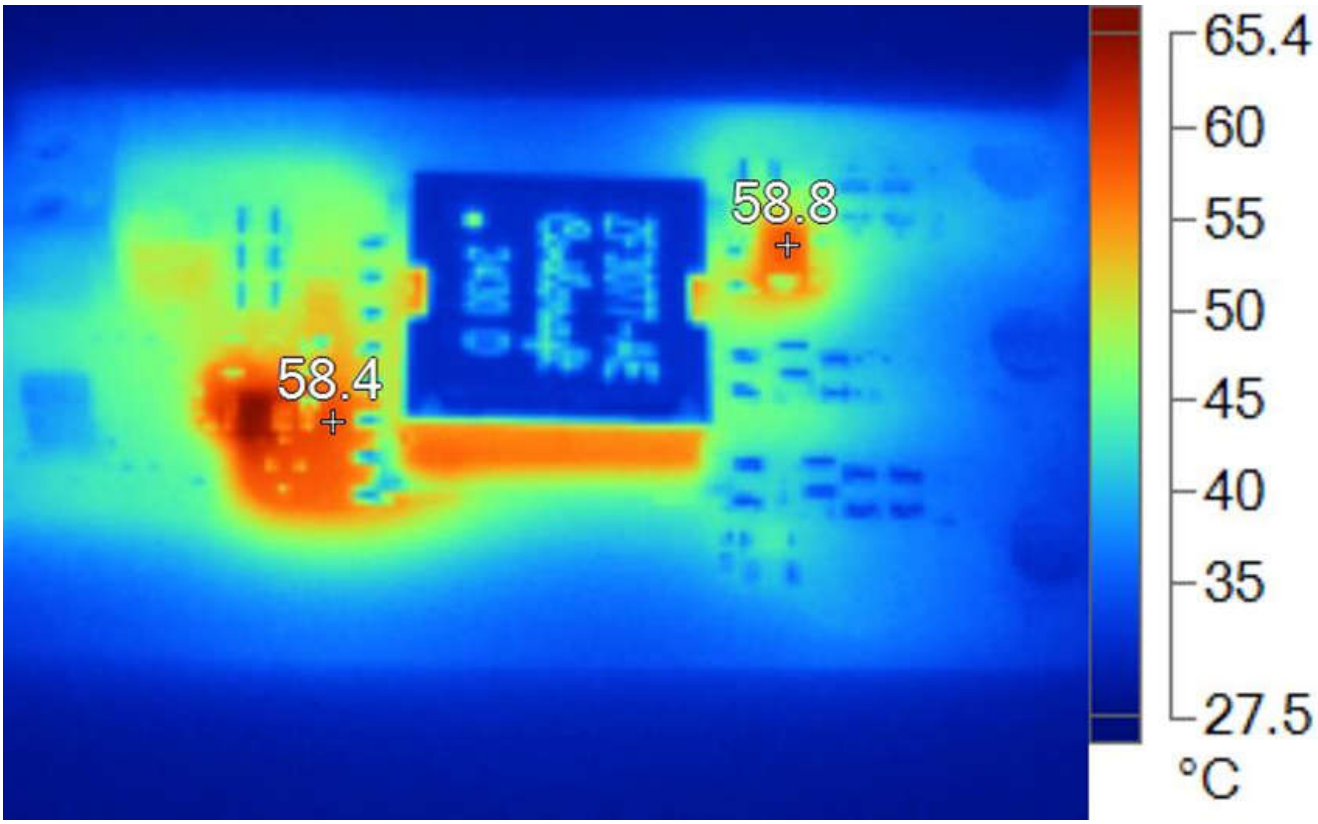

Figure 2-2. Thermal Image

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3 Waveforms

3.1 Switching

Unless otherwise noted, the following tests were done with 12V input voltage at full output current on all outputs.

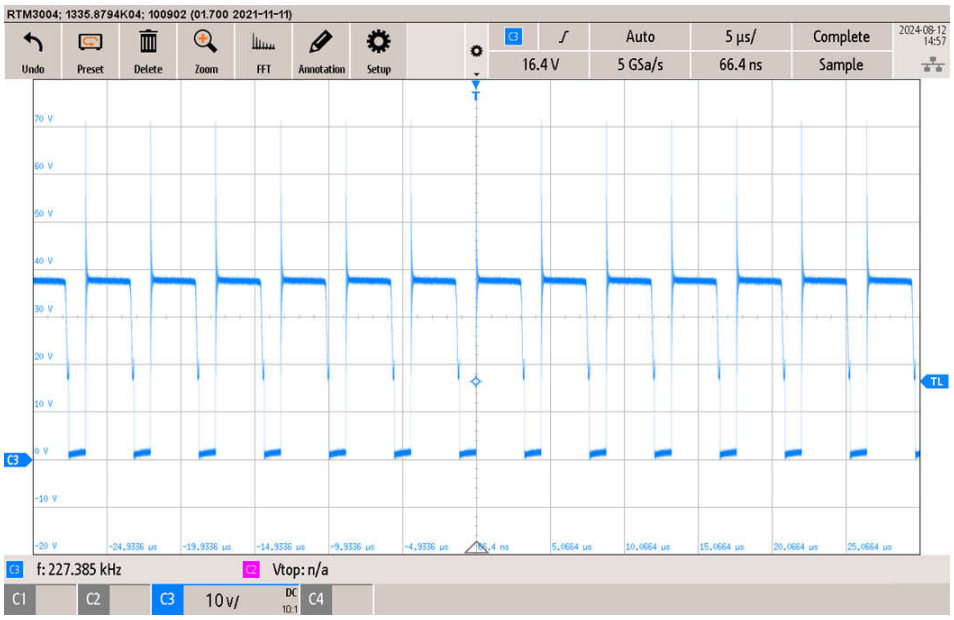

Figure 3-1. DC-Coupled Switch Node Voltage (Scale: 10V-div, 5µs-div)

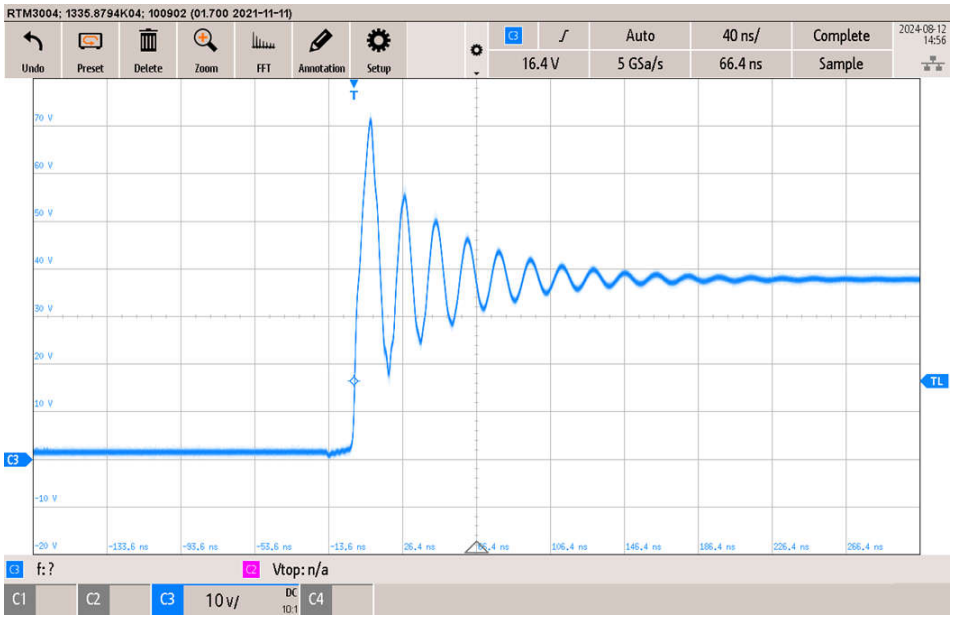

Figure 3-2. DC-Coupled Switch Node Voltage (Scale: 10V-div, 40ns-div)

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3.2 Load Transients

3.2.1 Output Volage 1

Figure 3-3 shows the load step behavior of the 550mA output winding during a 50% load step (550mA to 275mA to 550mA). The other outputs were loaded with 160mA each.

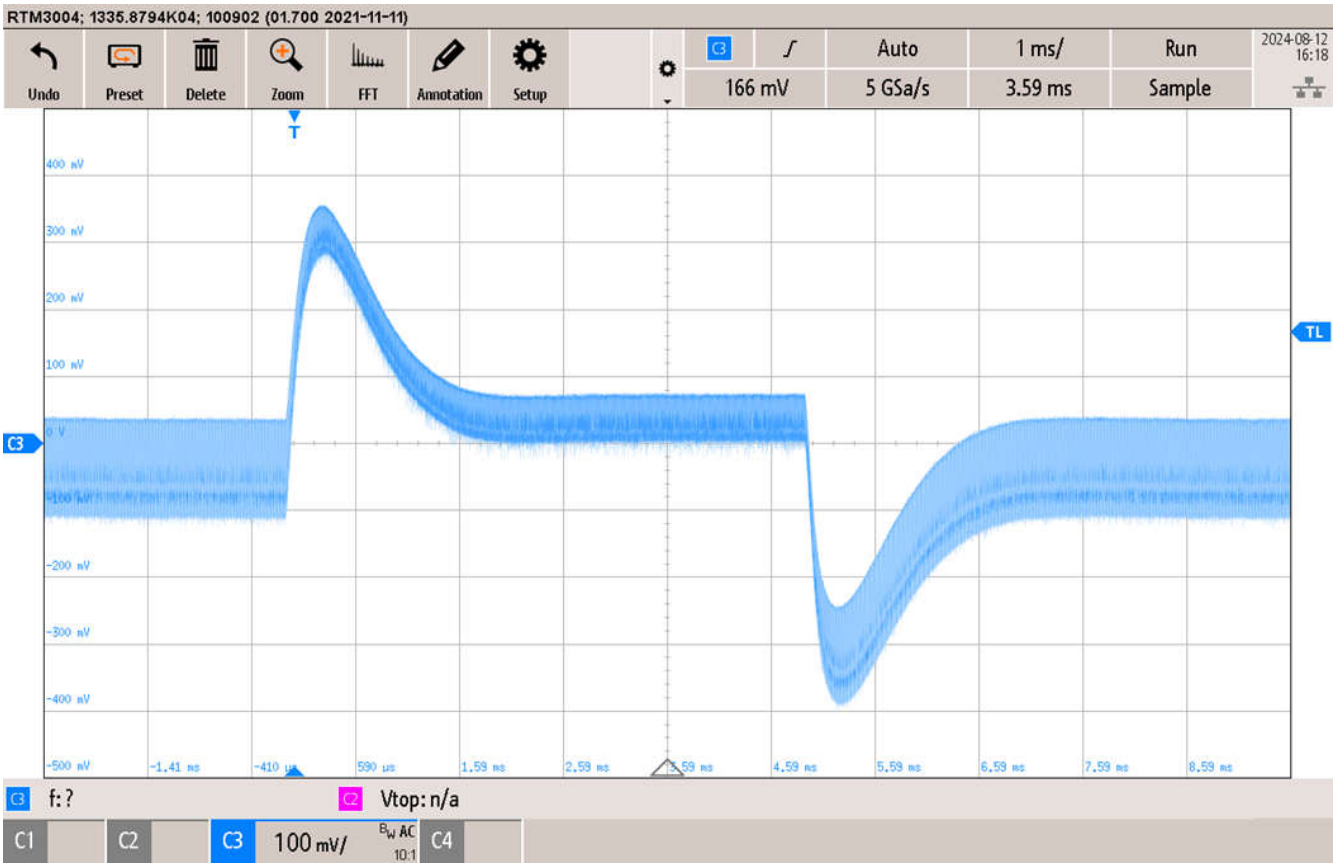

Figure 3-3. AC-Coupled Output Voltage, Output 1 (550mA) [Scale: 100mV-div, 1ms-div, 20MHz BW]

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3.2.2 Output Voltage 2

Figure 3-4 shows the behavior of output 2 (160mA) during a 50% load step on the 550mA output winding (550mA to 275mA to 550mA). Outputs 2 and 3 were loaded with 160mA each.

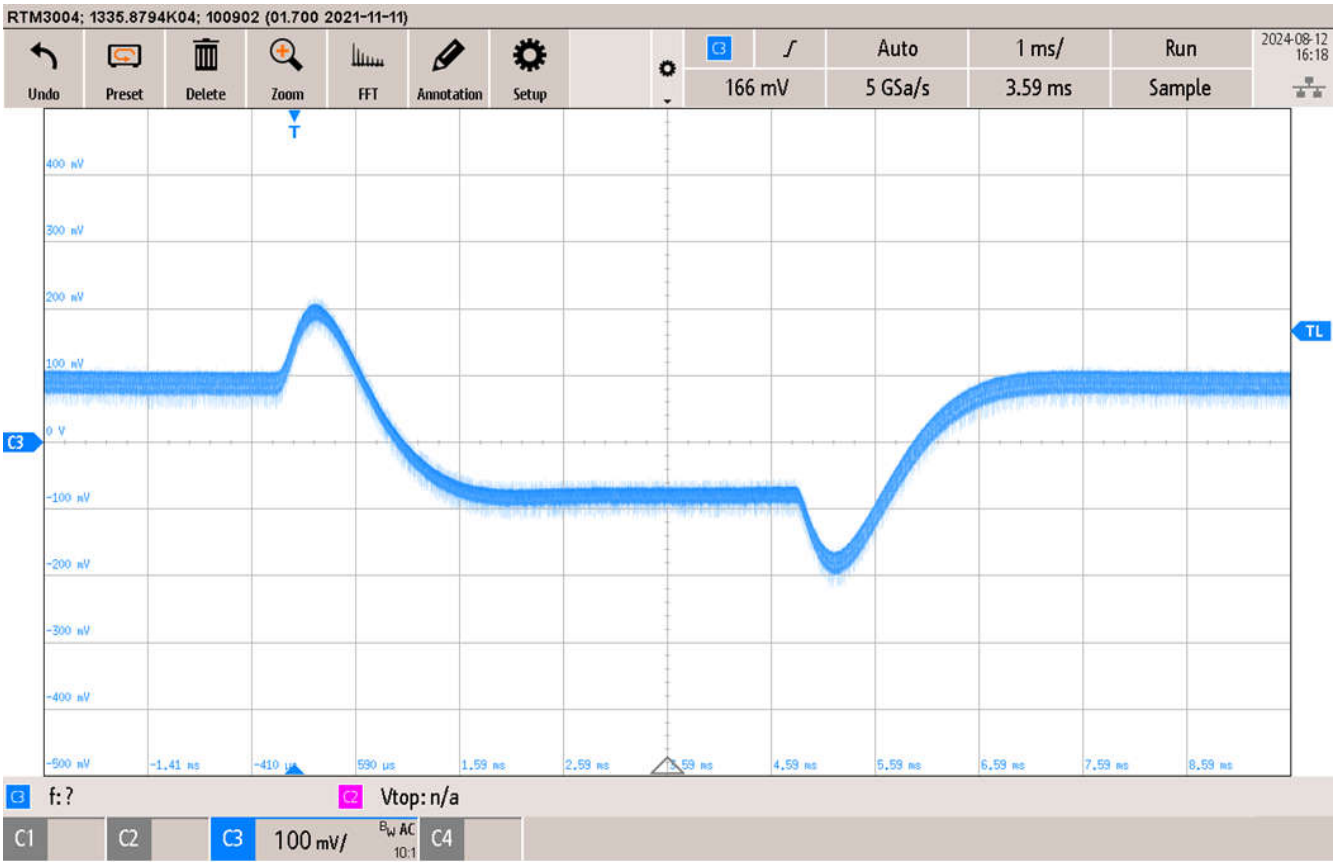

Figure 3-4. AC-Coupled Output Voltage, Output 2 (160mA) [Scale: 100mV-div, 1ms-div, 20MHz BW]

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3.2.3 Output Voltage 3

Figure 3-5 shows the behavior of output 3 (160mA) during a 50% load step on the 550mA output winding (550mA to 275mA to 550mA). Outputs 2 and 3 were loaded with 160mA each.

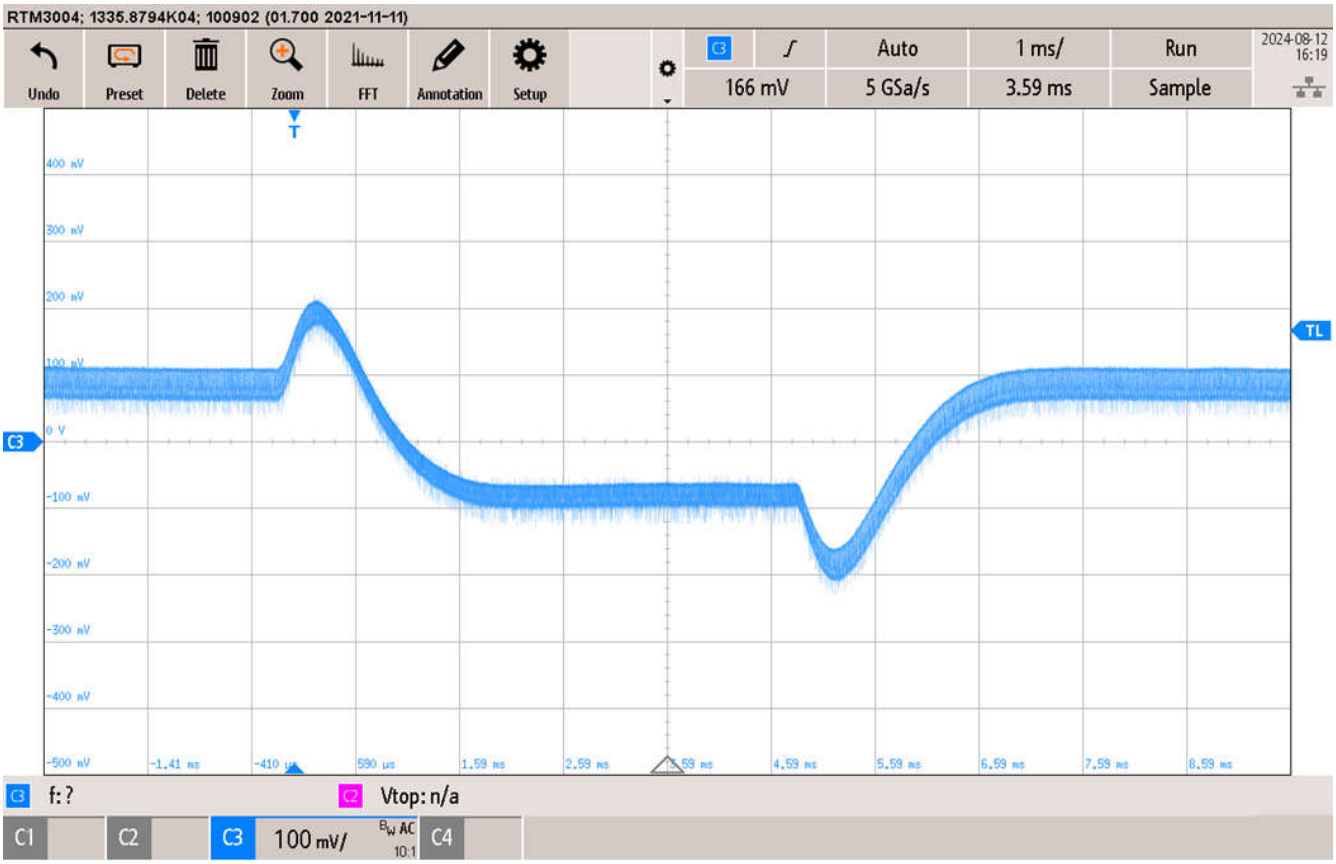

Figure 3-5. AC-Coupled Output Voltage, Output 3 (160mA) [Scale: 100mV/div, 1ms/div, 20MHz BW]

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3.3 Start-up Sequence

Figure 3-6 shows the startup behavior into full load (550mA + 2 × 160mA).

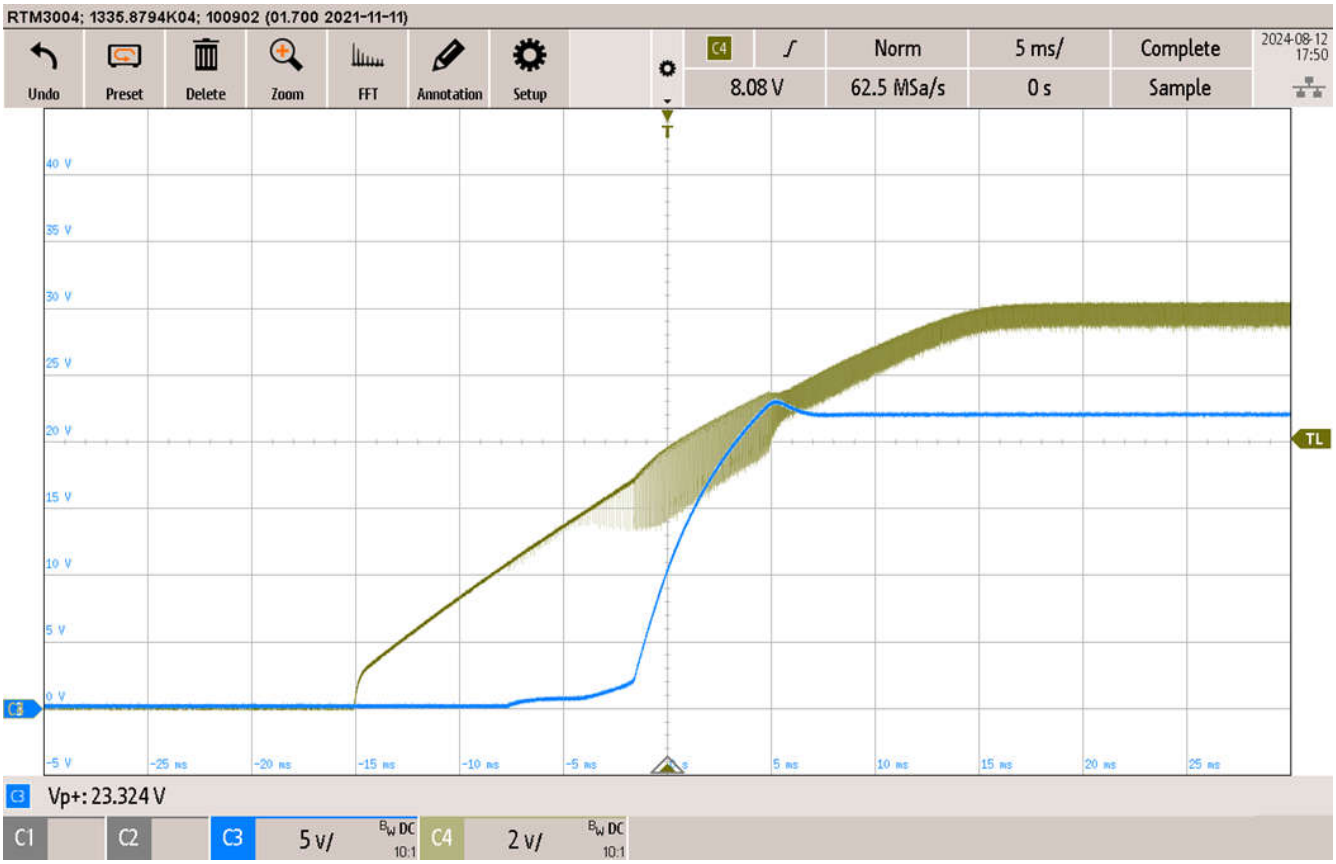

Figure 3-6. Start-up

- CH3: DC-coupled output voltage, output 1 (550mA) [scale: 5V/div, 5ms/div, 20MHz BW]
- CH4: DC-coupled input voltage [scale: 2V/div, 5ms/div, 20MHz BW]

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