Test Report: PMP21582

260 W off-line multiple-output LLC-SRC reference design

TEXAS INSTRUMENTS

Description

PMP21582 is a two-output LLC-SRC that uses the UCC256302 converter. The main 30V output can be loaded up to 250W. The 13.8V output can be loaded up to 11W. An additional LDO creates a 3.3V output from the 13.8V rail. Figure 1 shows the top of the PMP21582 Rev A design.

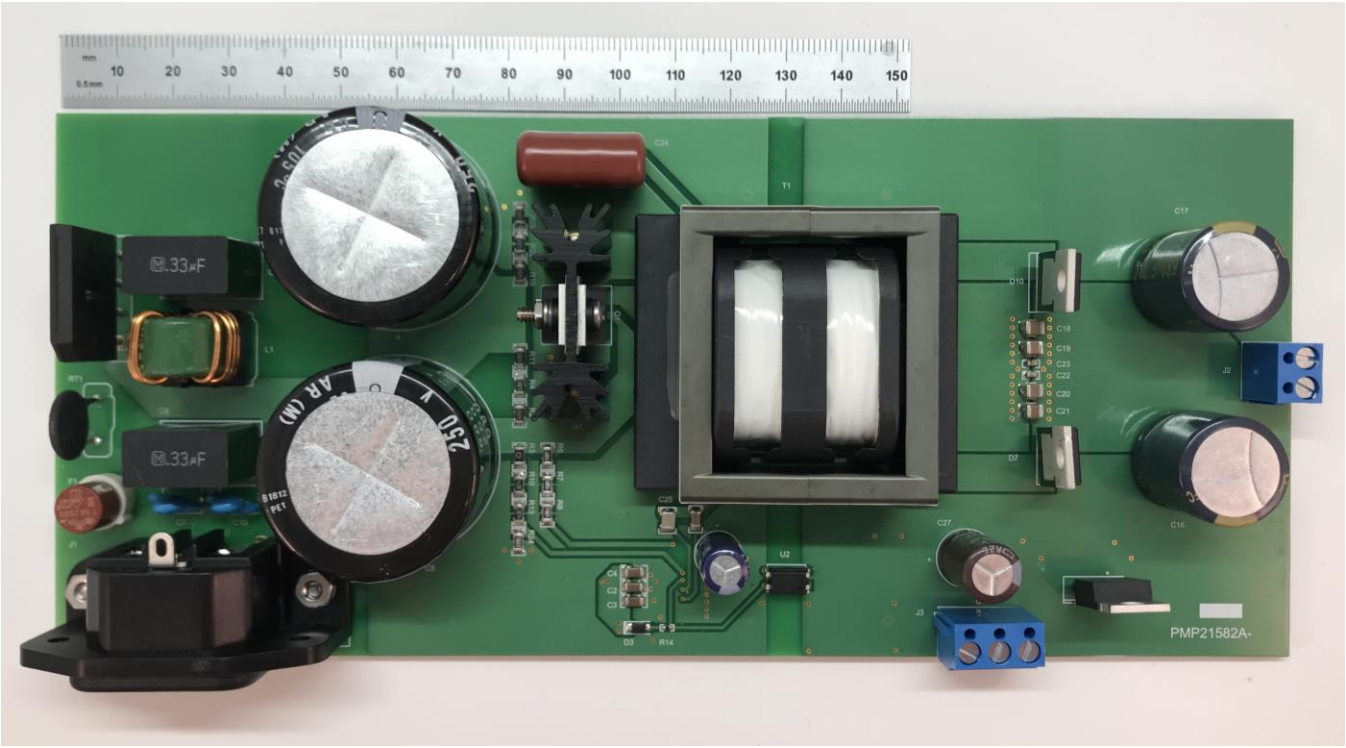

Figure 1. Board Top

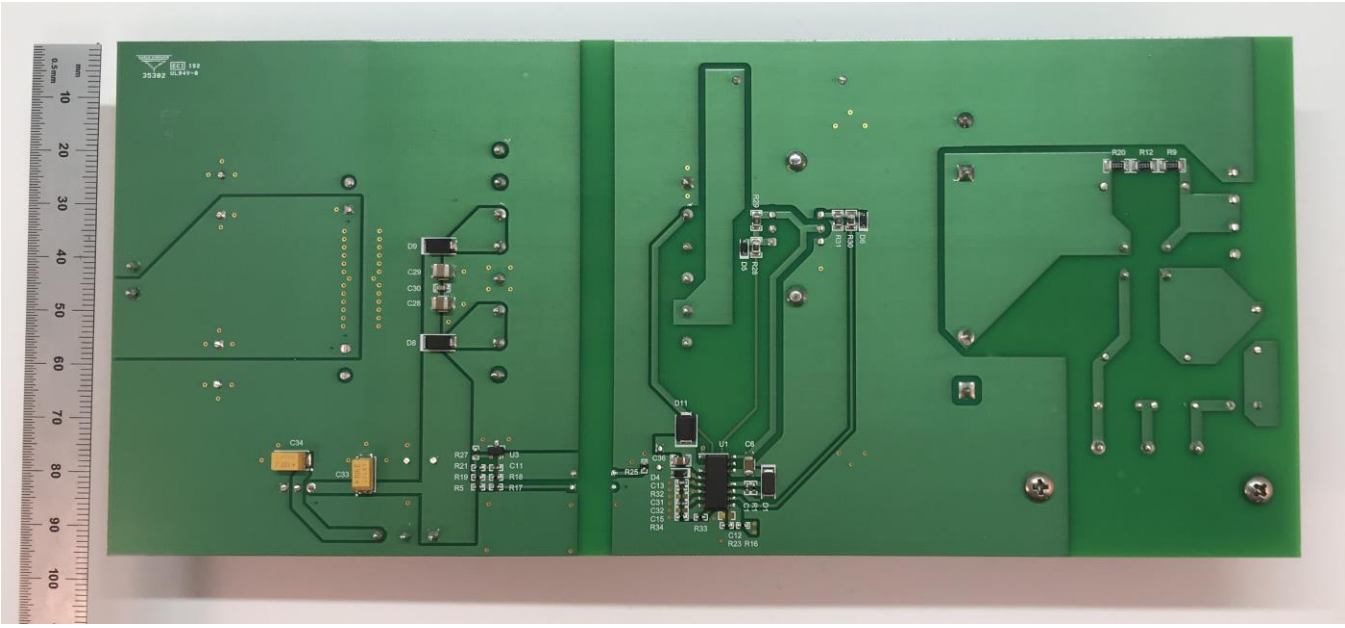

Figure 2. Board Bottom

1 Test Prerequisites

1.1 Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage Range	100VAC-130VAC, 120VAC nominal
Output Voltage 1	30V +/- 10%
Output Current 1	4A nominal, 8A max for 30s, 50% duty
Output Voltage 2	13.8V +/- 5%
Output Current 2	50mA min, 800mA max
Output Voltage 3	3.3V +/- 5%
Output Current 3	200mA max
Switching Frequency	74kHz-81kHz

2 Testing and Results

2.1 Efficiency Graphs

Efficiency was measured by varying the load on the 30 V rail with the 13.8 V rail loaded to 0.4 A. Figure 3 shows the total system efficiency and the power loss.

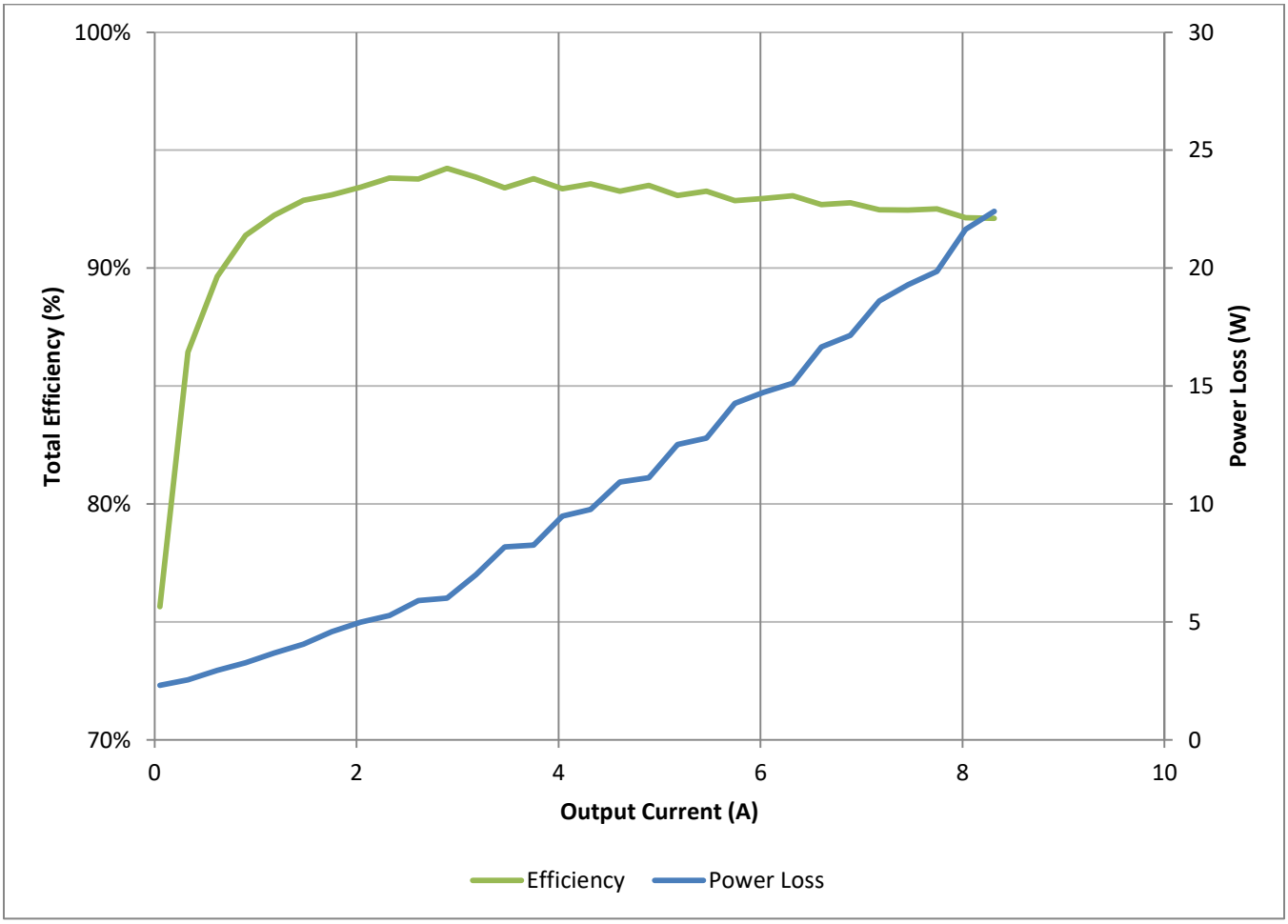

Figure 3.

2.2 Load Regulation

Figure 4 shows the load regulation of the 13.8 V rail and Figure 5 shows the load regulation of the 30 V rail. Both of these are plotted with respect to a varying load on the 30 V rail.

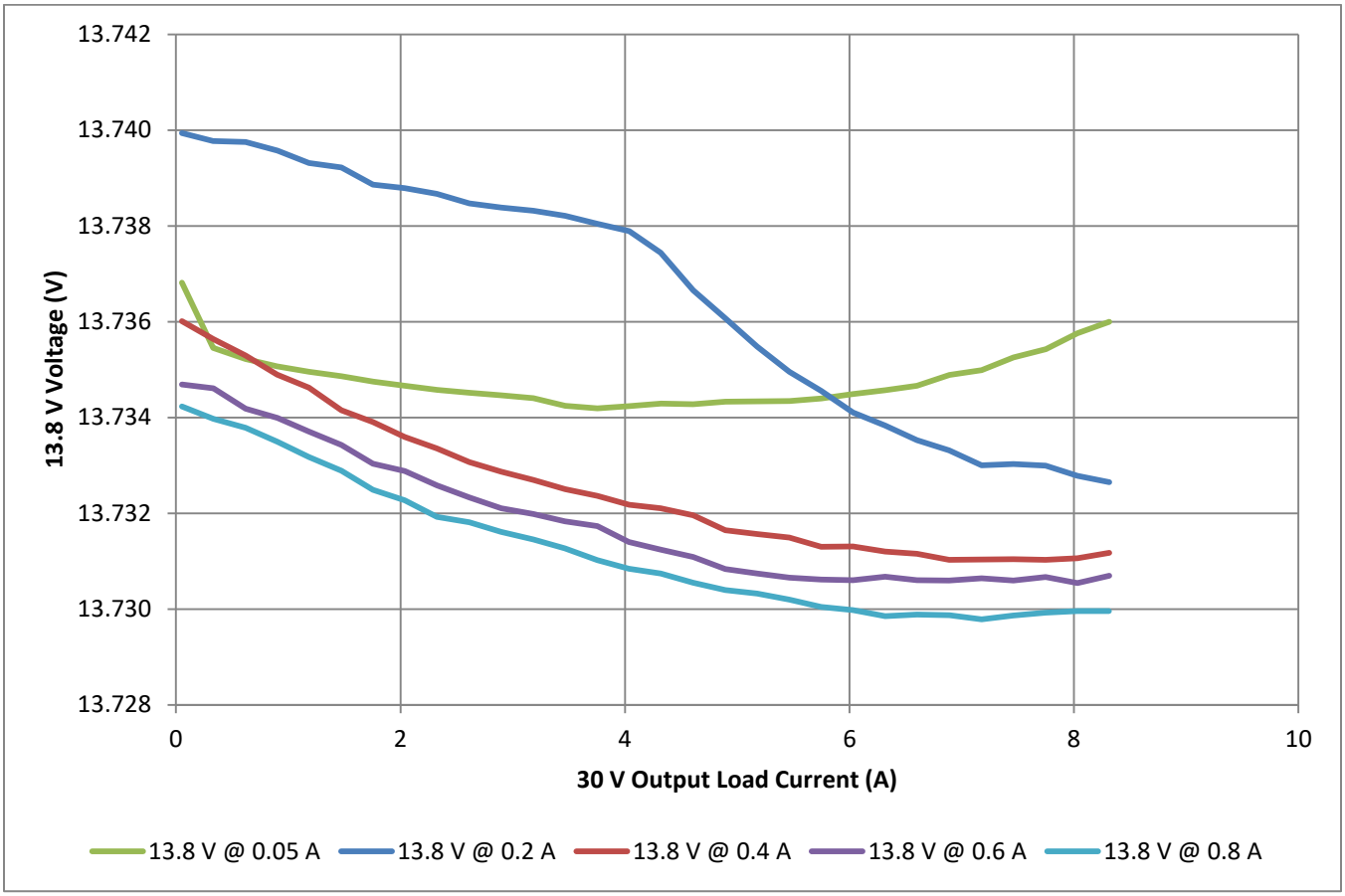

Figure 4.

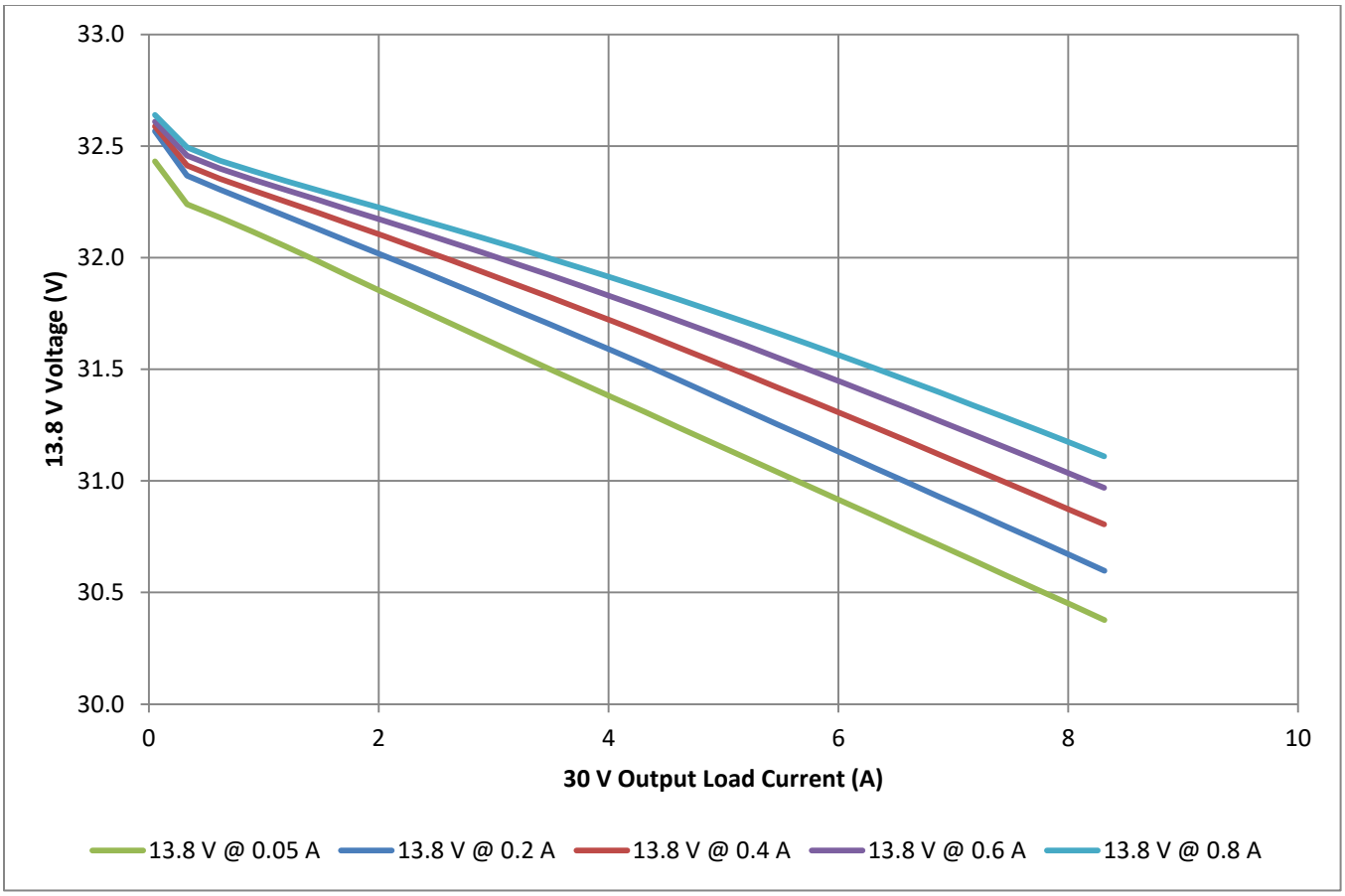

Figure 5.

2.3 Efficiency Data

PIN (W)	VO1 (V)	IO1 (A)	PO1 (W)	VO2 (V)	IO2 (A)	PO2 (W)	POUT (W)	EFF (%)	PLOSS (W)
13.8	32.23959	0.331863	10.69913	13.73545	0.050283	0.690663	11.38979	82.53	2.410211
15.9	32.36741	0.331619	10.73365	13.73977	0.200303	2.752115	13.48576	84.82	2.414237
18.8	32.41276	0.331741	10.75264	13.73564	0.4003	5.49837	16.25101	86.44	2.548987
21.7	32.45728	0.331985	10.77533	13.73461	0.600423	8.24657	19.0219	87.66	2.678101
24.6	32.49321	0.331985	10.78726	13.73397	0.800547	10.99469	21.78195	88.54	2.818052
98.5	31.6405	2.896171	91.63628	13.73446	0.050292	0.690738	92.32702	93.73	6.172978
101	31.82861	2.896293	92.18499	13.73838	0.200305	2.751872	94.93686	94.00	6.06314
104	31.93748	2.896293	92.50029	13.73287	0.400289	5.497119	97.99741	94.23	6.002589
108	32.02377	2.896659	92.76195	13.7321	0.600412	8.244924	101.0069	93.52	6.993129
111	32.08895	2.895438	92.91155	13.73161	0.800532	10.99259	103.9041	93.61	7.09586
183	31.04072	5.466463	169.6829	13.73434	0.050294	0.69076	170.3737	93.10	12.62631
186	31.25453	5.465364	170.8174	13.73495	0.200303	2.751151	173.5685	93.32	12.43149
190	31.41963	5.464997	171.7082	13.73149	0.400289	5.496569	177.2048	93.27	12.79522
194	31.55252	5.465119	172.4382	13.73066	0.600402	8.243915	180.6822	93.14	13.31784
198	31.66254	5.465119	173.0396	13.7302	0.800532	10.99146	184.031	92.94	13.96899
275	30.37681	8.313917	252.5502	13.736	0.0503	0.690919	253.2412	92.09	21.75884
279	30.5972	8.314894	254.4125	13.73265	0.200299	2.750636	257.1631	92.17	21.8369
284	30.80482	8.313673	256.1012	13.73117	0.400282	5.496335	261.5975	92.11	22.4025
288	30.96864	8.313673	257.4631	13.7307	0.600405	8.243975	265.7071	92.26	22.2929
293	31.10992	8.313429	258.6301	13.72996	0.800519	10.99109	269.6212	92.02	23.37884

2.4 Thermal Image

The thermal image was taken with a 120 Vac input with both outputs at full load after a 5 minute soak with no airflow. The corresponding table shows the measurements at certain local maxima. Sp1 to Sp5 were selected from right to left. In order these points are on D10, D7, secondary winding of T1, primary winding of T1, and D2.

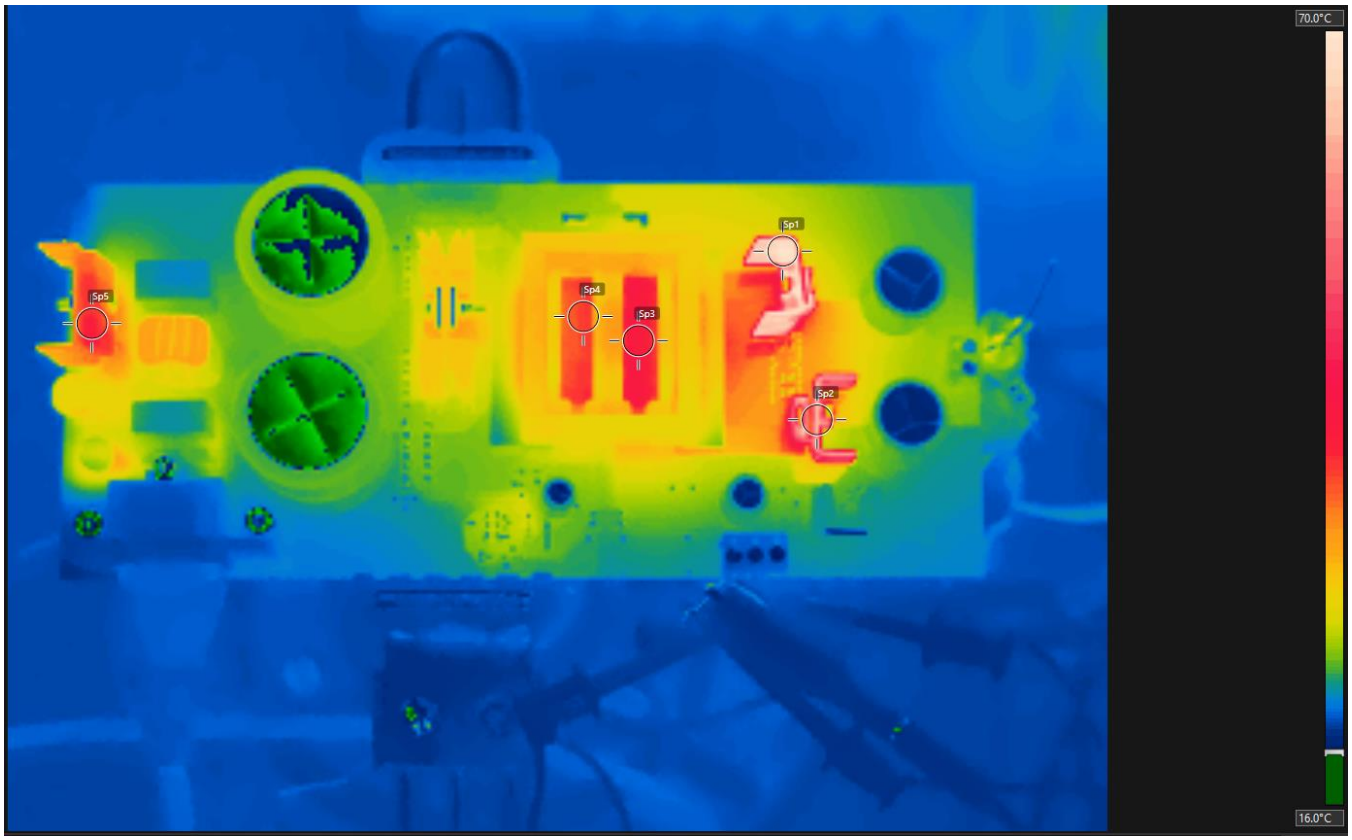

Figure 6.

Measurements	
Sp1	69.9 °C
Sp2	64.5 °C
Sp3	45.0 °C
Sp4	42.2 °C
Sp5	44.5 °C

2.5 Dimensions

PMP21582 Rev A board is 8700mil x 3800mil

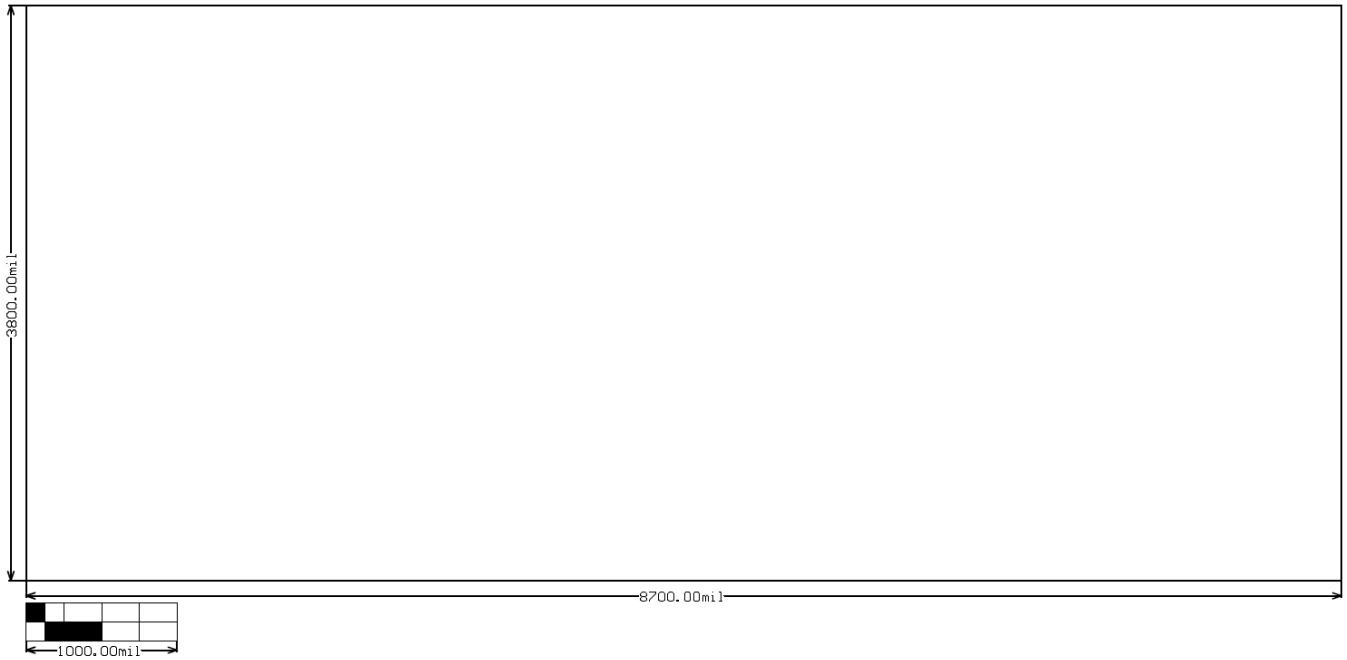

Figure 7. Board dimensions of PMP21582.

3 Waveforms

3.1 Switching

The switch node was measured with 120VAC input voltage and all outputs at full load.

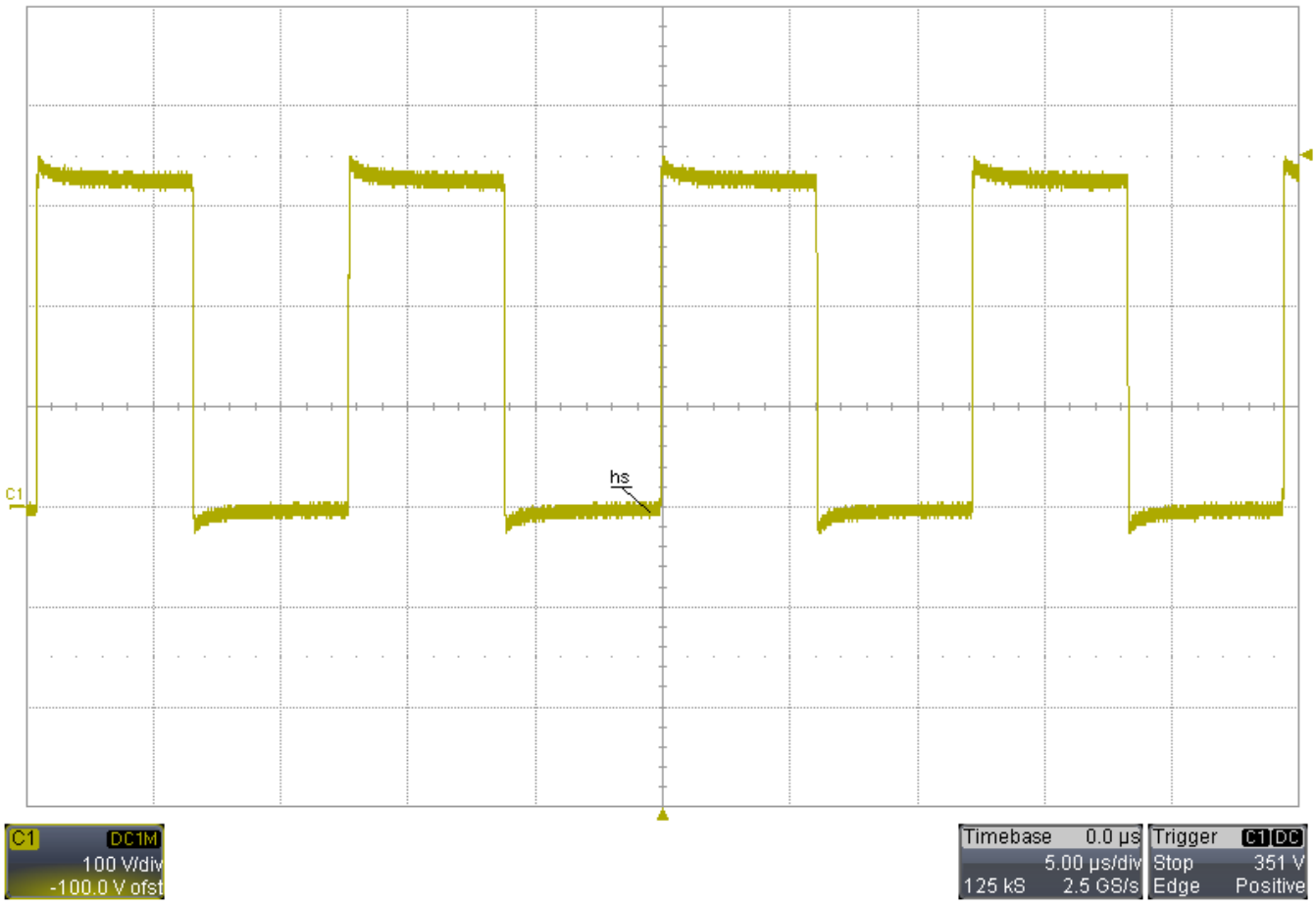

Figure 8. Primary Switching Node Waveform

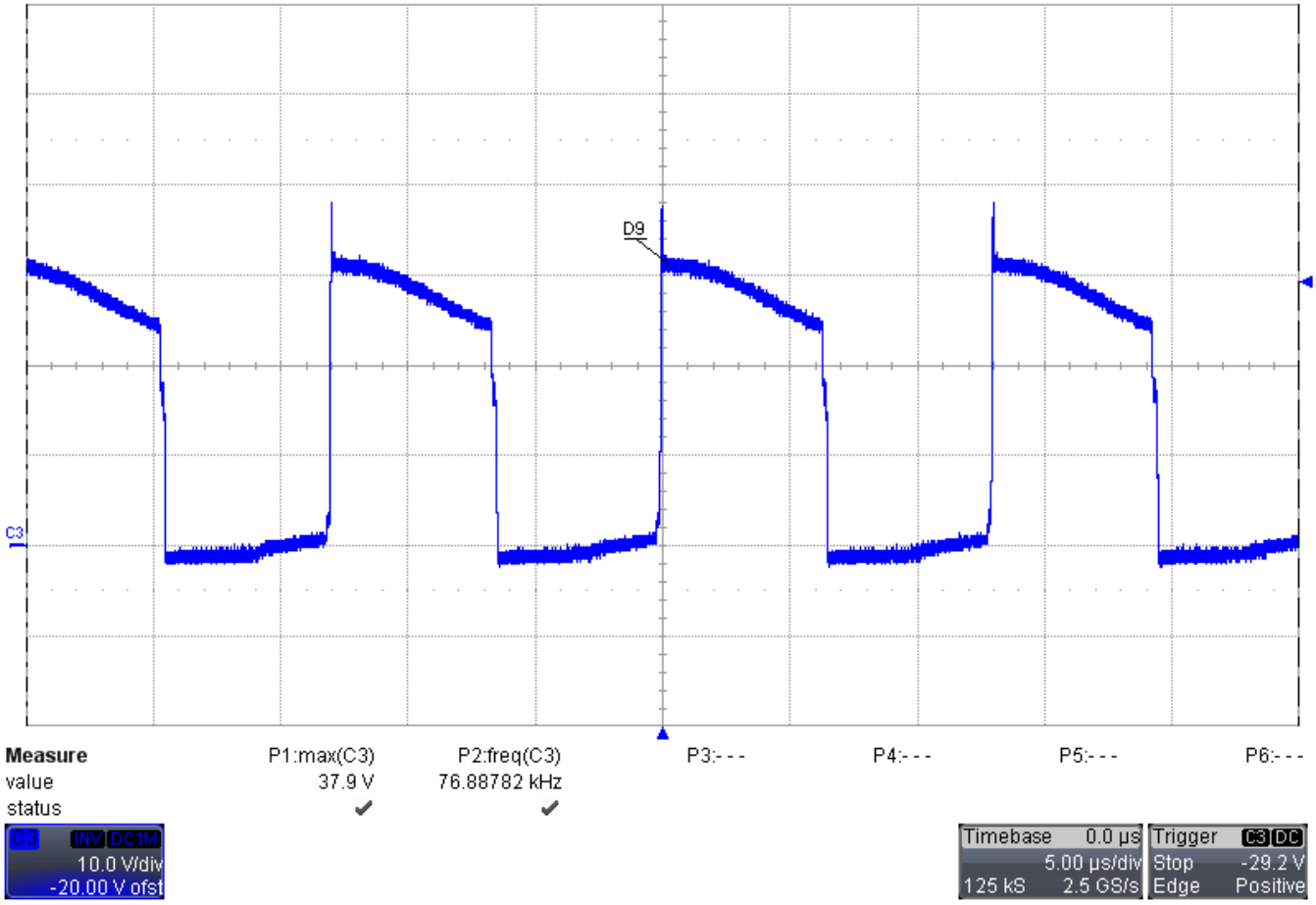

Figure 9. Secondary Switching Node Waveform (D9)

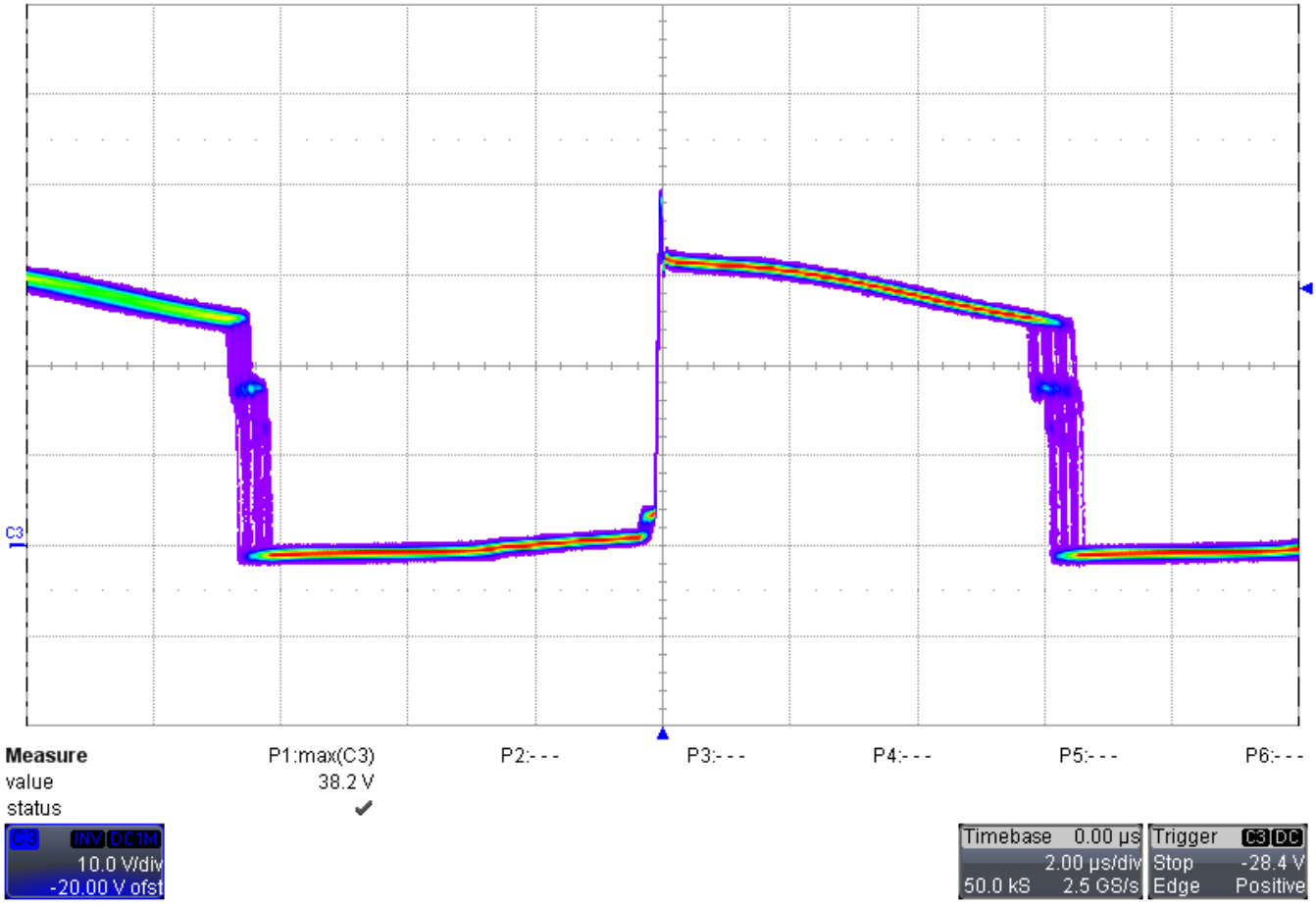

Figure 10. Secondary Switching Node Waveform (D9) with persistence mode on oscilloscope

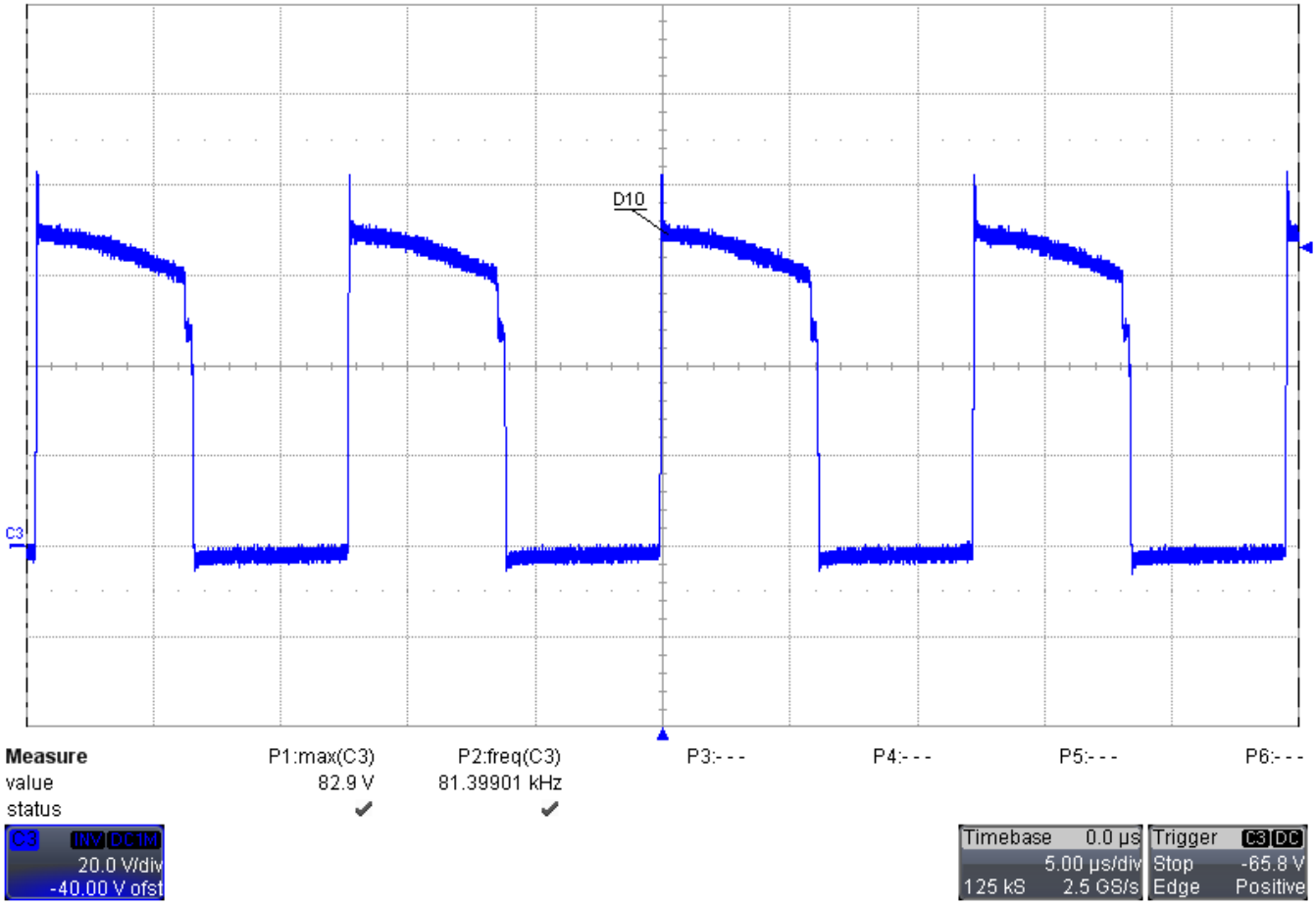

Figure 11. Secondary Switching Node Waveform (D10)

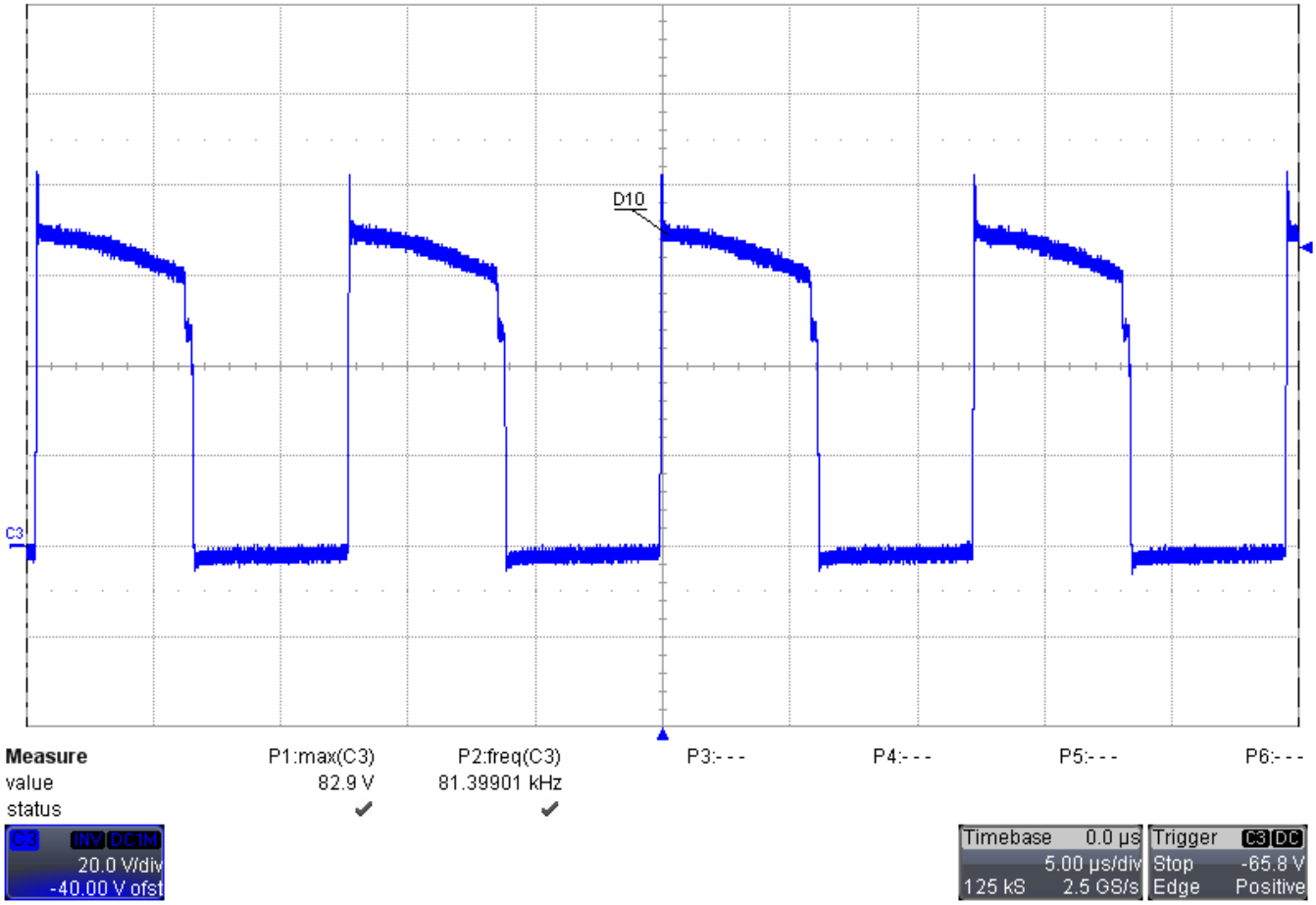

Figure 12. Secondary Switching Node Waveform (D10) with persistence mode on oscilloscope

3.2 Output Voltage Ripple

Measurements were taken using the tip and barrel method across the output caps of the rail. Figure 13 shows the output ripple of the 30V output with all outputs at full load and 120VAC input.

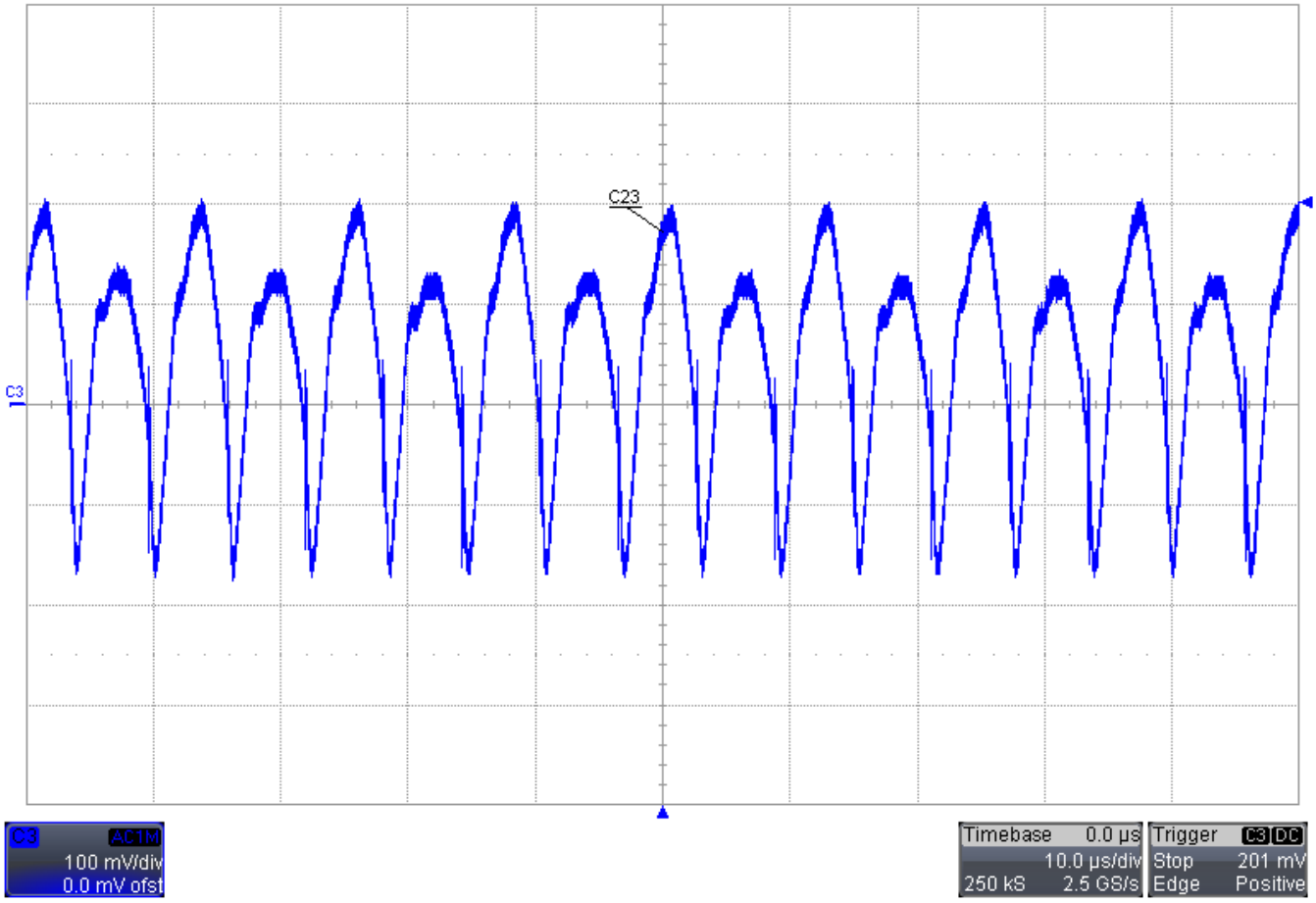

Figure 13. Output 1 Voltage Ripple (C23)

Figure 14 shows the output ripple of the 13.8V output with all outputs at full load and 120VAC input.

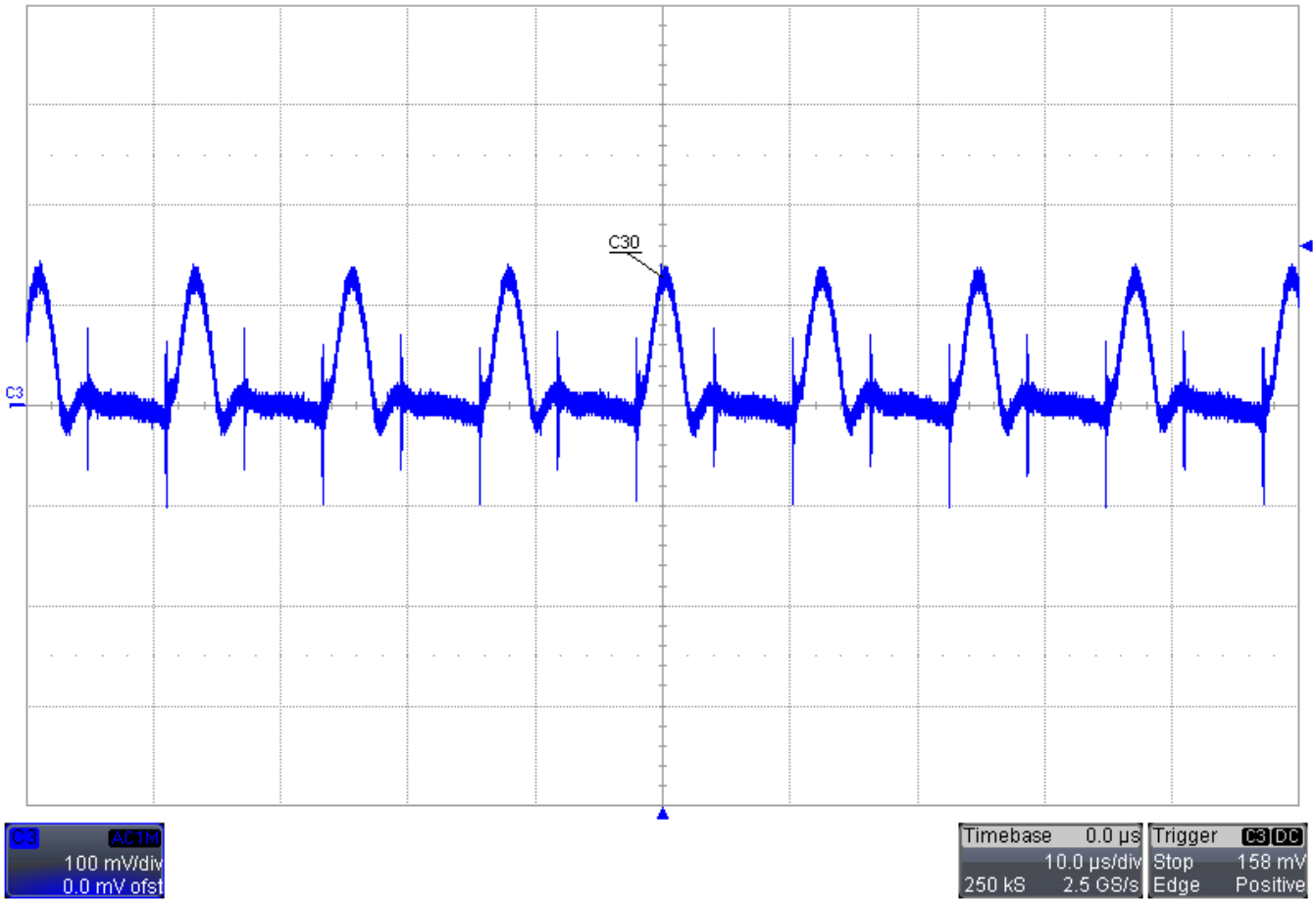

Figure 14. Output 2 Voltage Ripple (C30)

3.3 Bode Plot

Figure 15 shows the frequency response for the 13.8V output with both outputs at full load and a 120VAC input. At these conditions, the loop had a bandwidth of 4.031kHz and a phase margin of 51.35°. The gain crosses the 0dB axis with a

-28.8dB/dec slope.

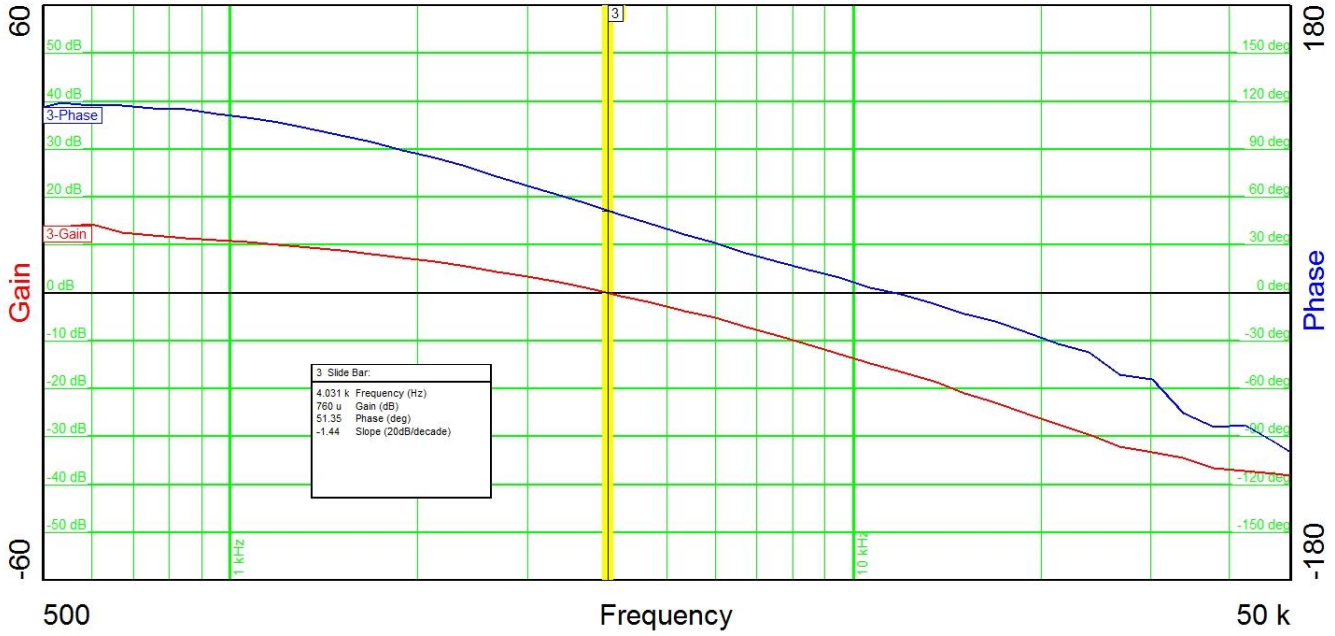

Figure 15. Frequency response graph

3.4 Load Transients

In Figure 16, the 30V rail was given a step between 4A and 8A while the 13.8V rail was loaded to 0.8A. Input is 120VAC.

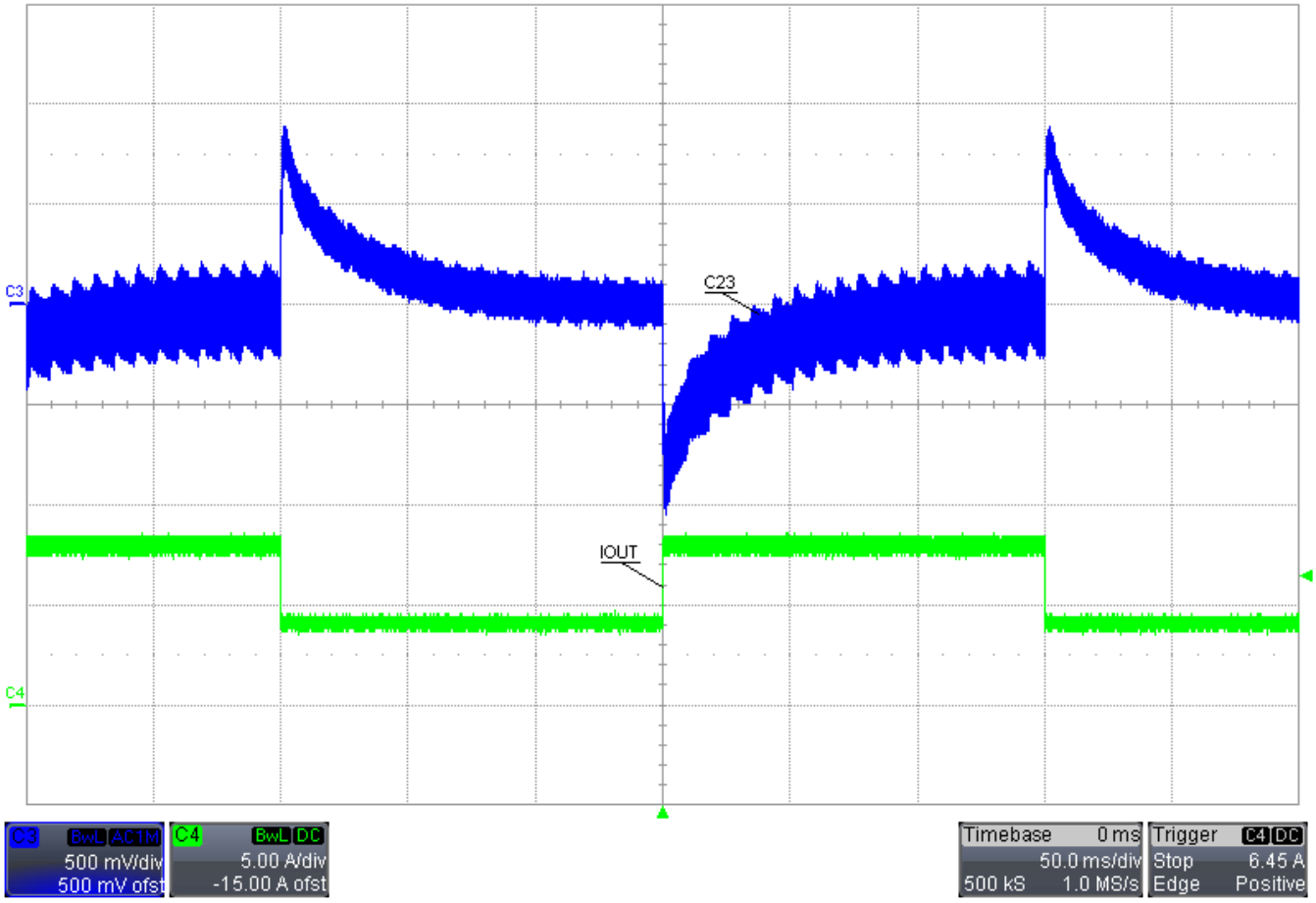

Figure 16. Load Transient on Output 1 (C23). Output current from the 30V rail is shown.

The 13.8V rail was given a pulse between 0.1A and 0.8A. Figure 17 shows the response with a 120VAC input and the 30V rail loaded to 1A.

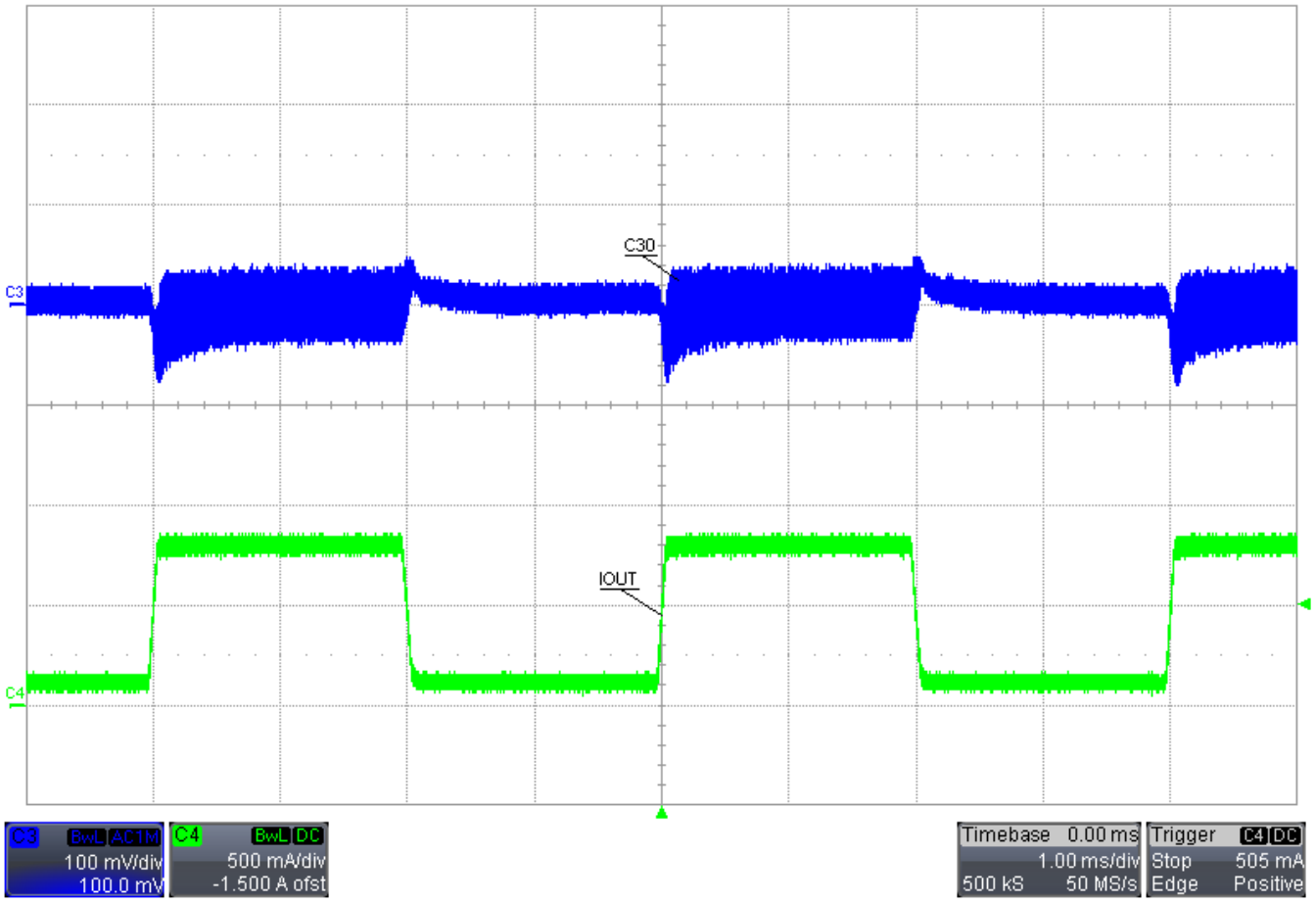

Figure 17. Load Transient on Output 2 (C30). Output current from the 13.8V rail is shown.

The 13.8V rail was given a pulse between 0.1A and 0.8A. Figure 18 shows the response with a 120VAC input and the 30V rail loaded to 8.3A.

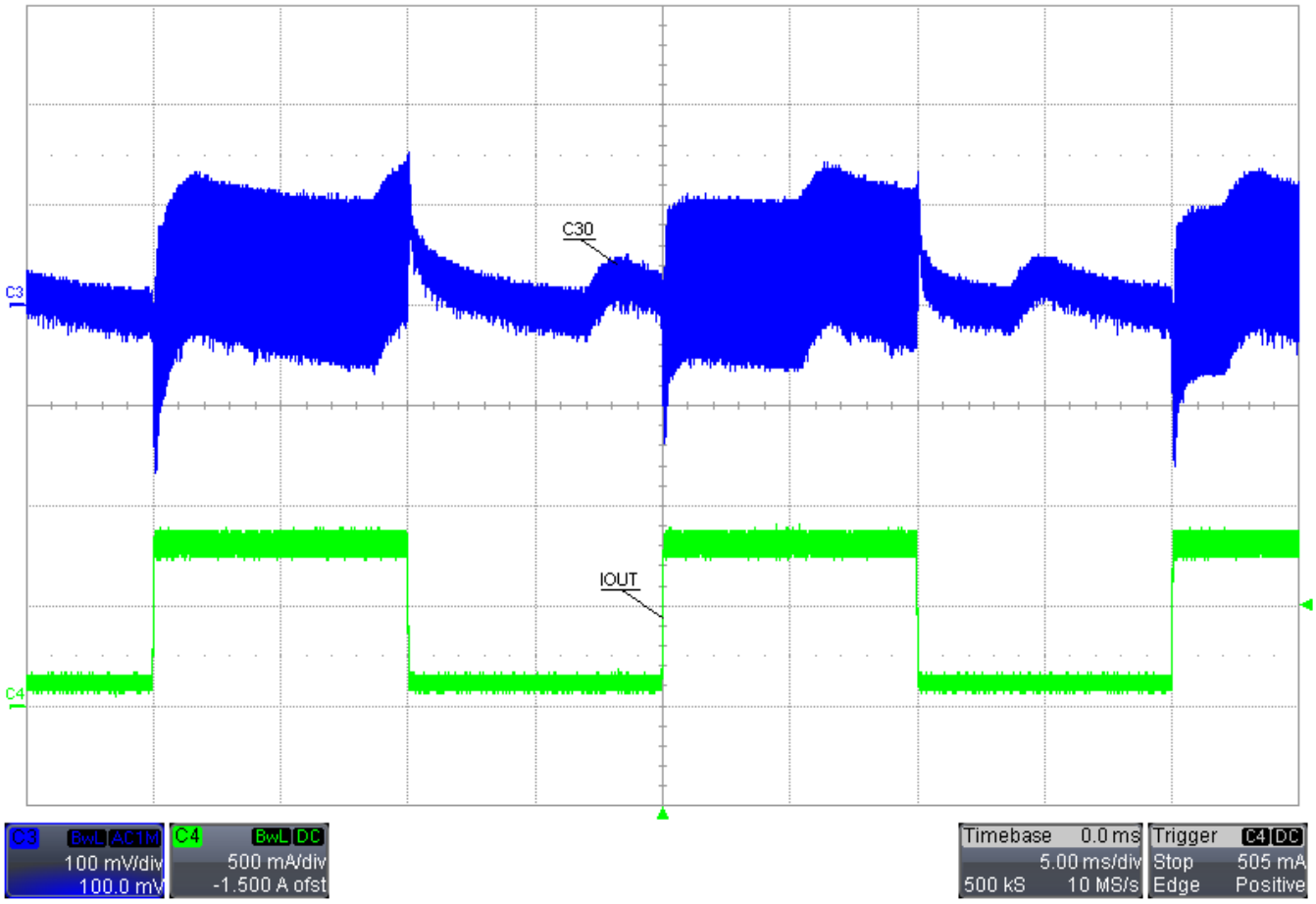

Figure 18. Load Transient on Output 2 (C30). Output current from the 13.8V rail is shown.

3.5 Start Up Sequence

Start up sequencing was measured by applying a 120VAC source to the input.

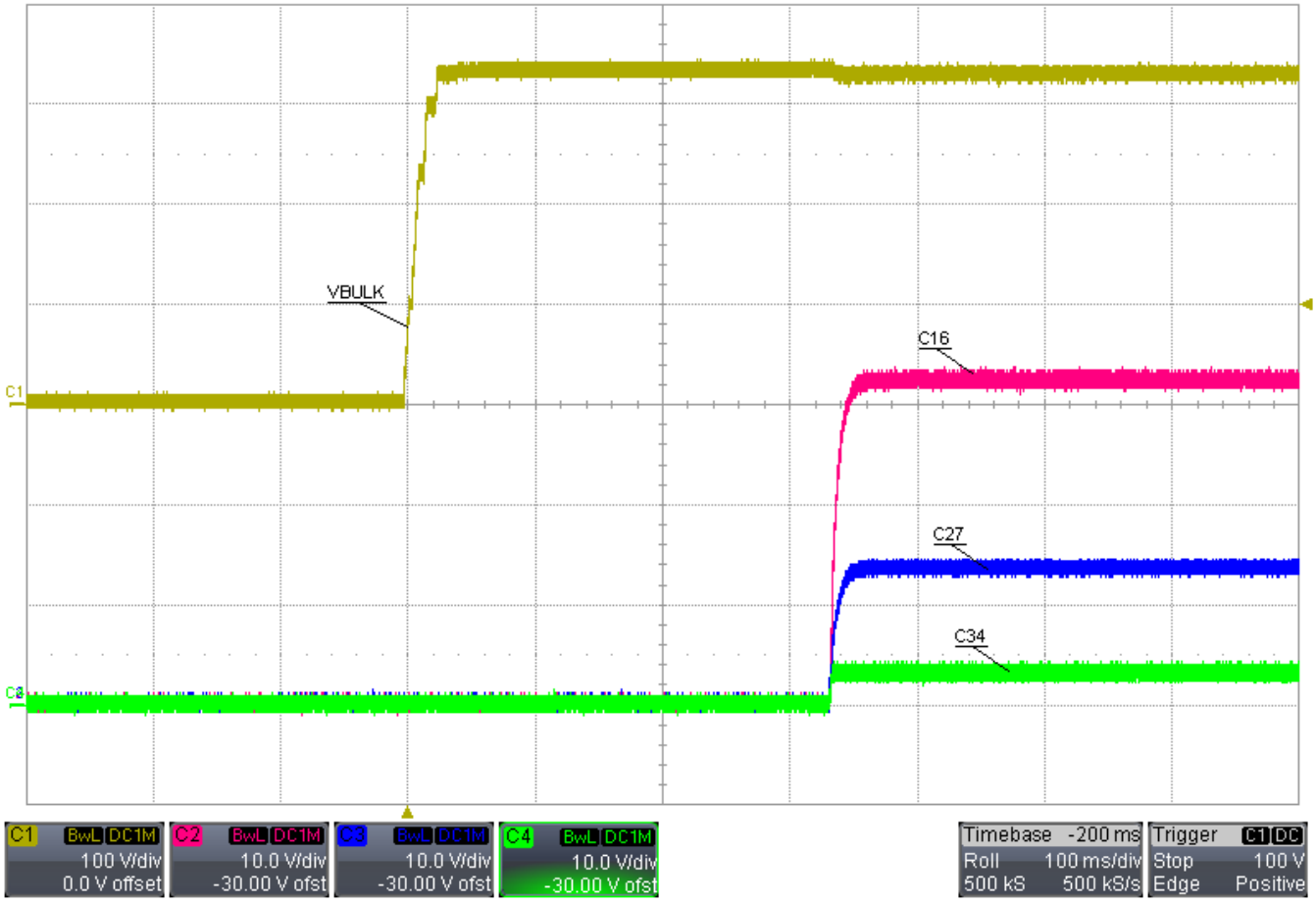

Figure 19. Start up voltages of the input and outputs 1, 2, and 3.

3.6 Conducted EMI

The following conducted emissions measurements were taken using a peak detector with the spectrum analyzer set to max hold. A 120VAC/60Hz input was applied with an 8.3A load on the 30V output and a 0.8A load on the 13.8V output. The line and neutral measurements of PMP21582 Rev A are compared to the CISPR-25 Class B regulations for quasi-peak and average tests. Figures 20 and 21 were measured with the secondary ground shorted to earth ground and Figures 22 and 23 show the measurement without earth grounding the secondary output.

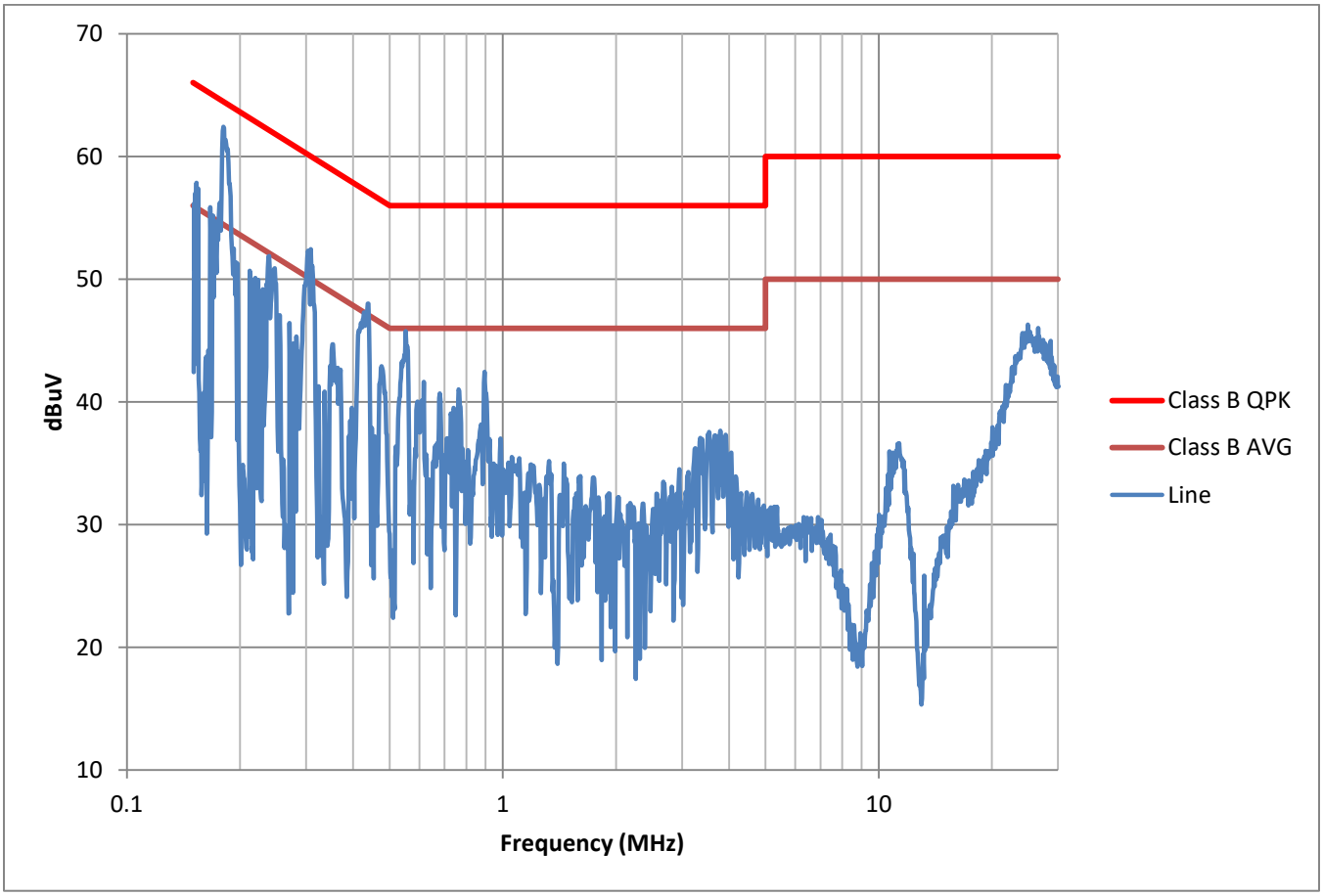

Figure 20. Earthed output, Line Measurement

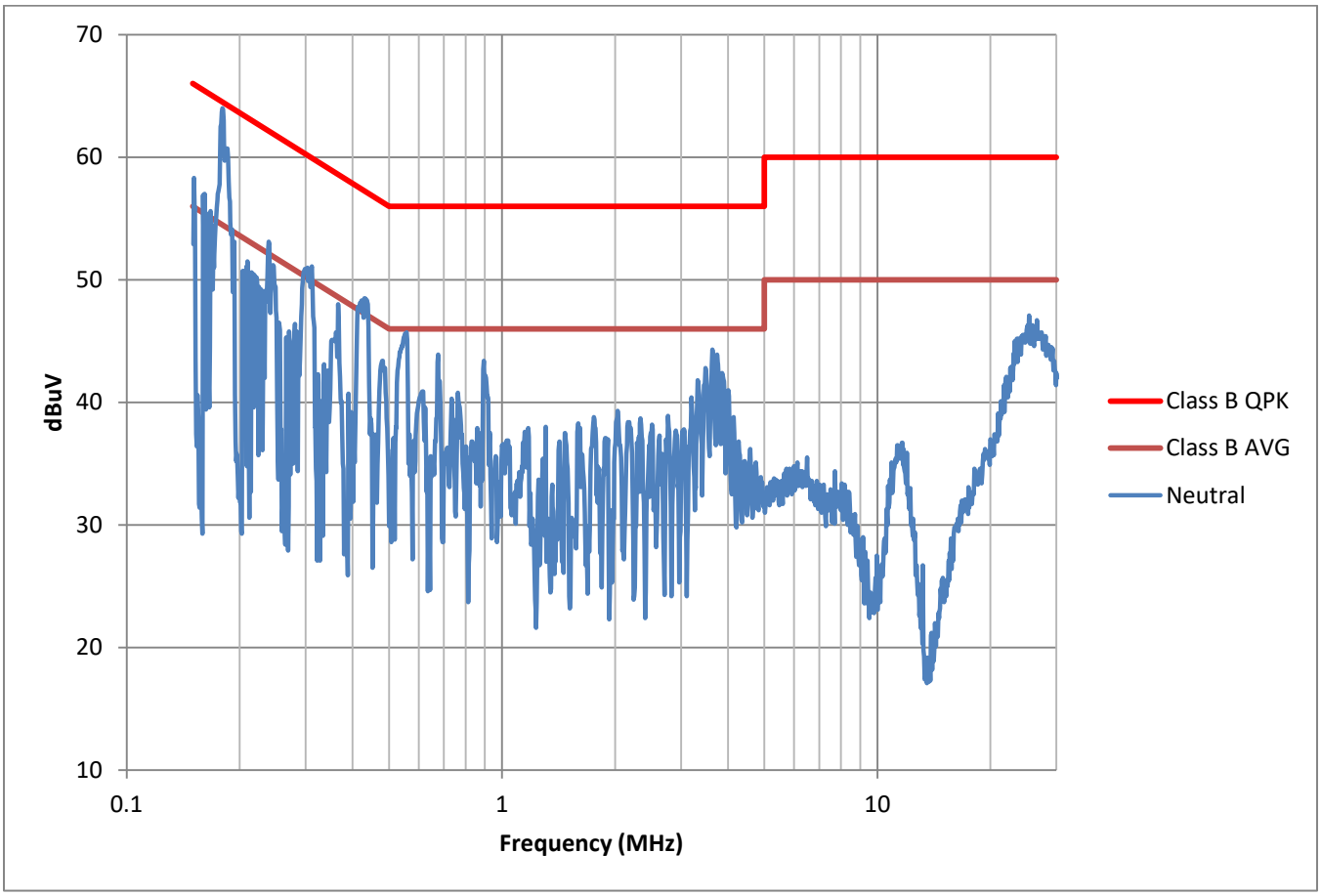

Figure 21. Earthed output, Neutral Measurement

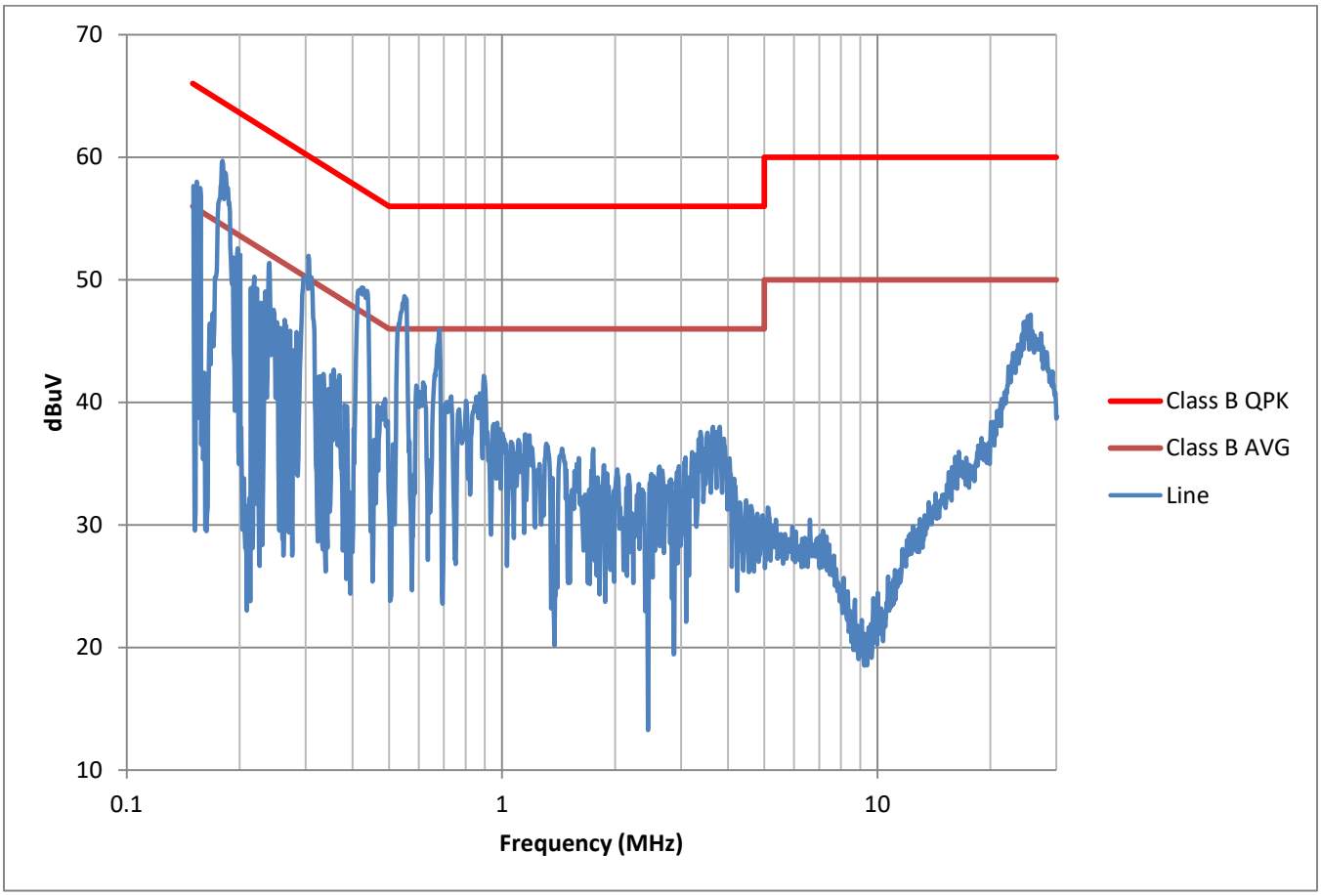

Figure 22. Non-Earthed output, Line Measurement

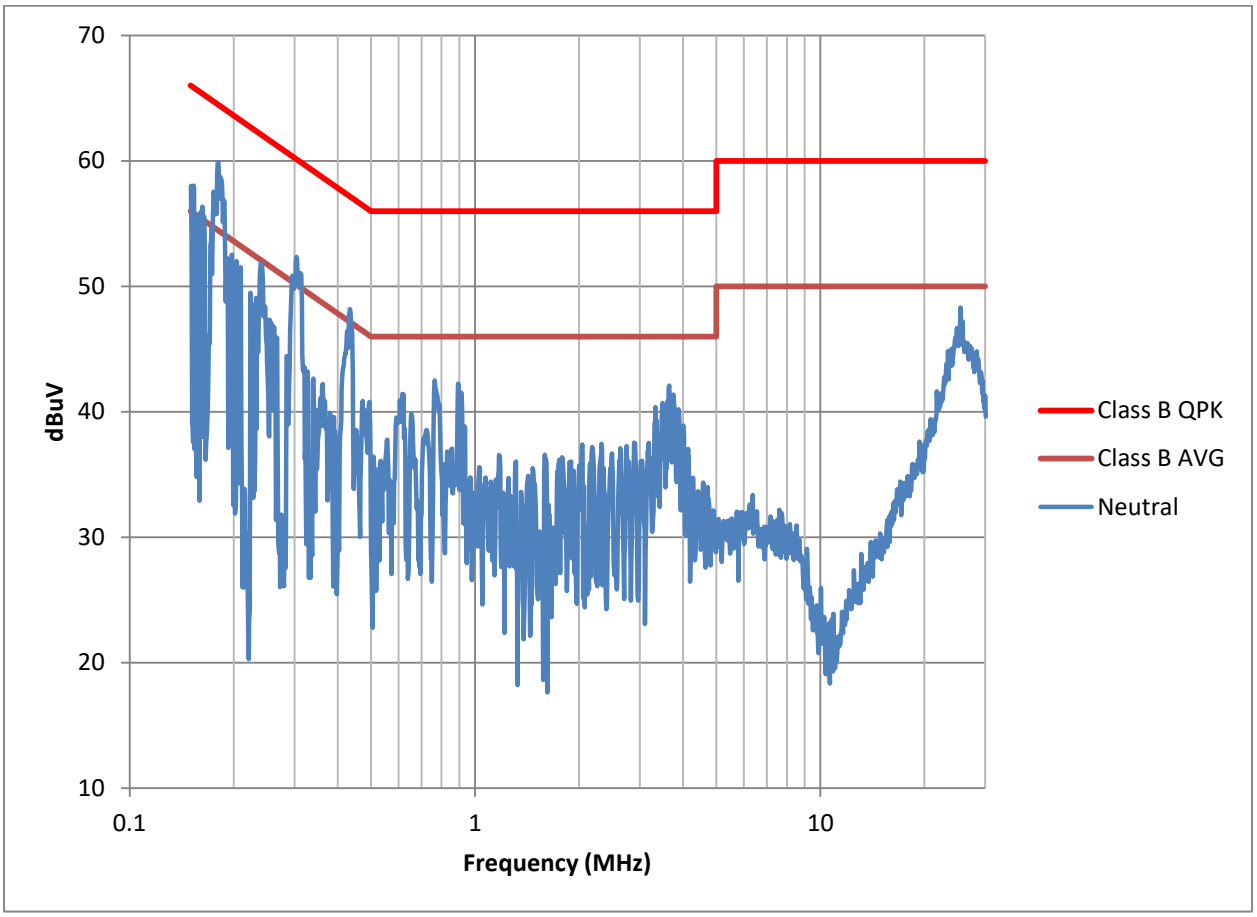

Figure 23. Non-Earthed output, Neutral Measurement

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