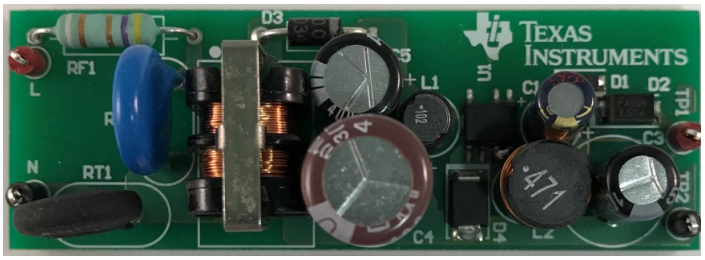
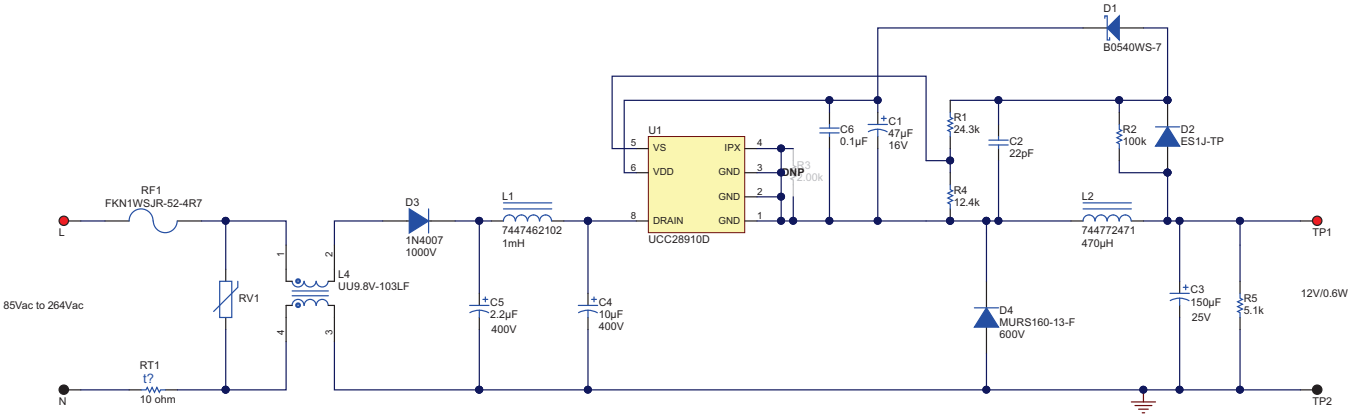
Test Report: PMP21384

PMP21384: Universal AC Input Integrated FET Buck Converter Reference Design

Description

This reference design utilizes the UCC28910 device, with its integrated 700-V FET, to implement an AC-to-DC high-side buck converter.





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1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
V_{IN}	85 V_{AC}–264 V_{AC}
V_{OUT}	12 V
Iout	50 mA nominal, 150 mA peak

2 Testing and Results

2.1 Efficiency Graphs

Figure 1 shows the converter efficiency for a 120 V_{AC} and 230 V_{AC} input with a 12-V output.

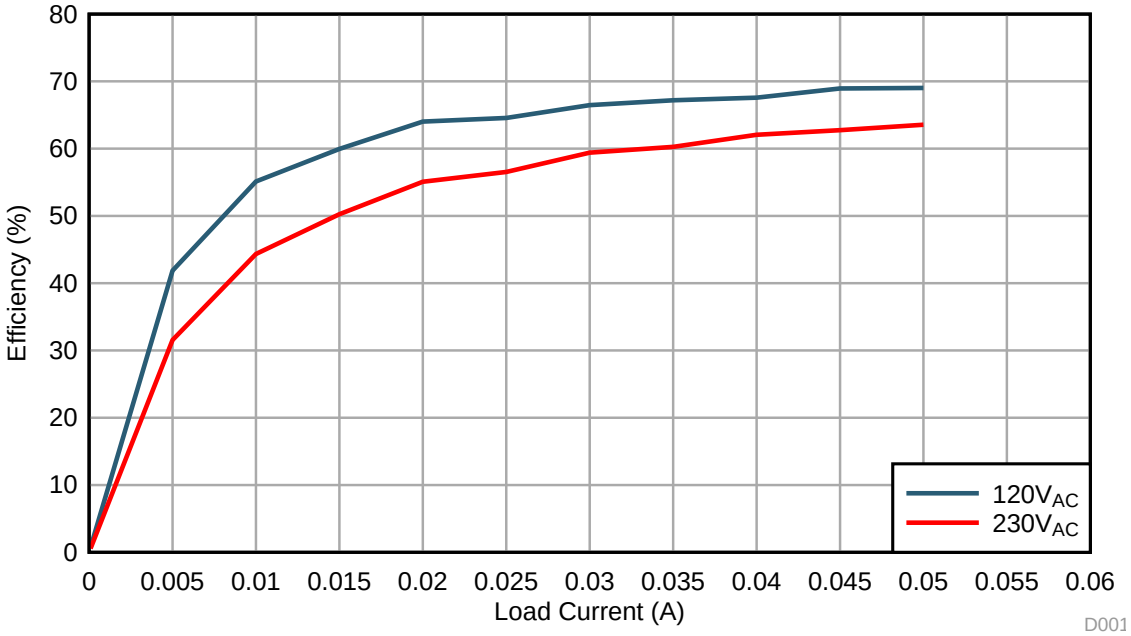

Figure 1. Converter Efficiency, 120 V_{AC}, 230 V_{AC}, 12-V Output

2.2 Efficiency Data

Table 2 and Table 3 list the efficiency data for 120 V_{AC} and 230 V_{AC} input with 12-V output.

Table 2. Efficiency Data 120 V_{AC} Input With 12-V Output

Iout	Vout	Vin AC	Iin Arms (mA)	Pin	Pout	Losses	Efficiency
0.000	12.030	120.2	0.00000	0.0000	0.00	0.00	0.0%
0.005	11.990	120.2	4.5210	0.1432	0.06	0.08	41.9%
0.010	11.960	120.2	6.740	0.2170	0.12	0.10	55.1%
0.015	11.950	12.2	8.830	0.2990	0.18	0.12	59.9%
0.020	11.940	120.2	10.820	0.3730	0.24	0.13	64.0%
0.025	11.930	120.2	12.880	0.4620	0.30	0.16	64.6%
0.030	11.920	120.2	14.700	0.5380	0.36	0.18	66.5%
0.035	11.940	120.2	16.590	0.6220	0.42	0.20	67.2%
0.040	11.960	120.2	18.590	0.7080	0.48	0.23	67.6%
0.045	11.960	120.2	20.230	0.7807	0.54	0.24	68.9%
0.050	11.950	120.2	22.010	0.8658	0.60	0.27	69.0%

Table 3. Efficiency Data 230 V_{AC} Input With 12-V Output

Iout	Vout	Vin AC	Iin Arms (mA)	Pin	Pout	Losses	Efficiency
0.000	12.040	230.2	0.00000	0.0000	0.00	0.00	0.0%
0.005	11.990	230.2	3.2420	0.1900	0.06	0.13	31.6%
0.010	11.970	230.2	4.660	0.2700	0.12	0.15	44.3%
0.015	11.960	230.2	6.040	0.3570	0.18	0.18	50.3%
0.020	11.950	230.2	7.390	0.4340	0.24	0.20	55.1%
0.025	11.940	230.2	8.782	0.5280	0.30	0.23	56.5%
0.030	11.940	230.2	10.000	0.6030	0.36	0.24	59.4%
0.035	11.930	230.2	11.290	0.6930	0.42	0.28	60.3%
0.040	11.930	230.2	12.460	0.7690	0.48	0.29	62.1%
0.045	11.920	230.2	13.650	0.8550	0.54	0.32	62.7%
0.050	11.910	230.2	14.810	0.9370	0.60	0.34	63.6%

2.3 Thermal Images

The thermal image in Figure 2 shows operation at 120 V_{AC} input and 12 V at 50-mA output, with no airflow. The board ran for 20 minutes with these conditions before the thermal image was taken.

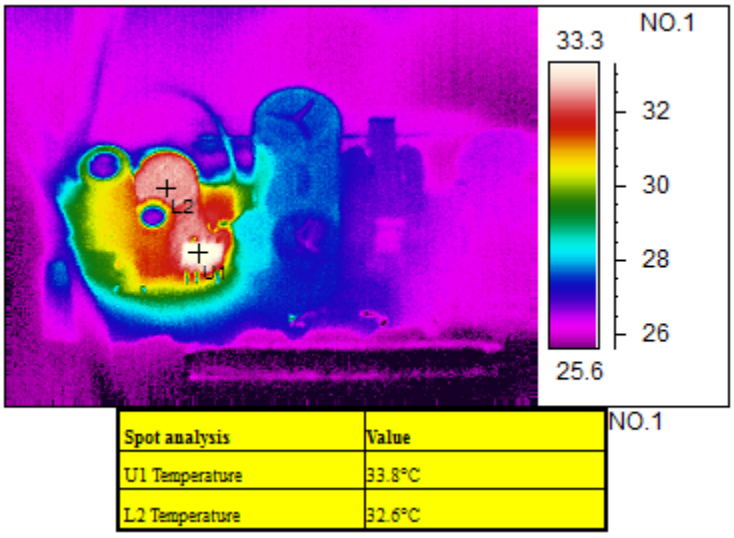

Figure 2. Thermal Image, 120 V_{AC} Input, 12 V at 50-mA Output

The thermal image in Figure 4 shows operation at 230V input and 12 V at 50-mA output, with no airflow. The board ran for 20 minutes with these conditions before the thermal image was taken.

Figure 3.

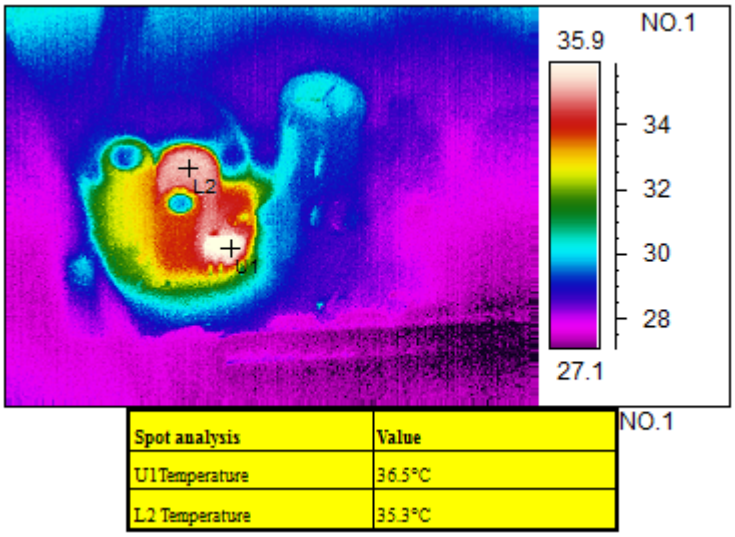

Figure 4. Thermal Image, 230 V_{AC} Input, 12 V at 50-mA Output

2.4 Dimensions

Figure 5 shows the PMP21384 device dimensions.

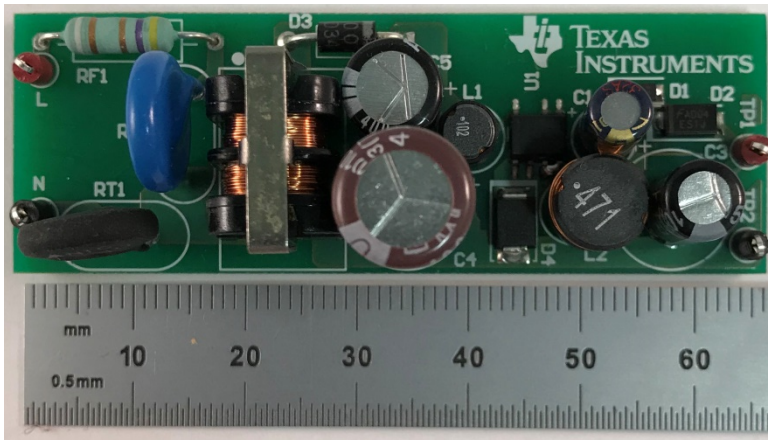

Figure 5. PMP21384 Device Dimensions

3 Waveforms

3.1 Switching

Figure 6 shows the switch node voltage. The input voltage is 85 V_{AC} and the 12-V output is loaded to 50 mA (100 V/div, 20 µs/div).

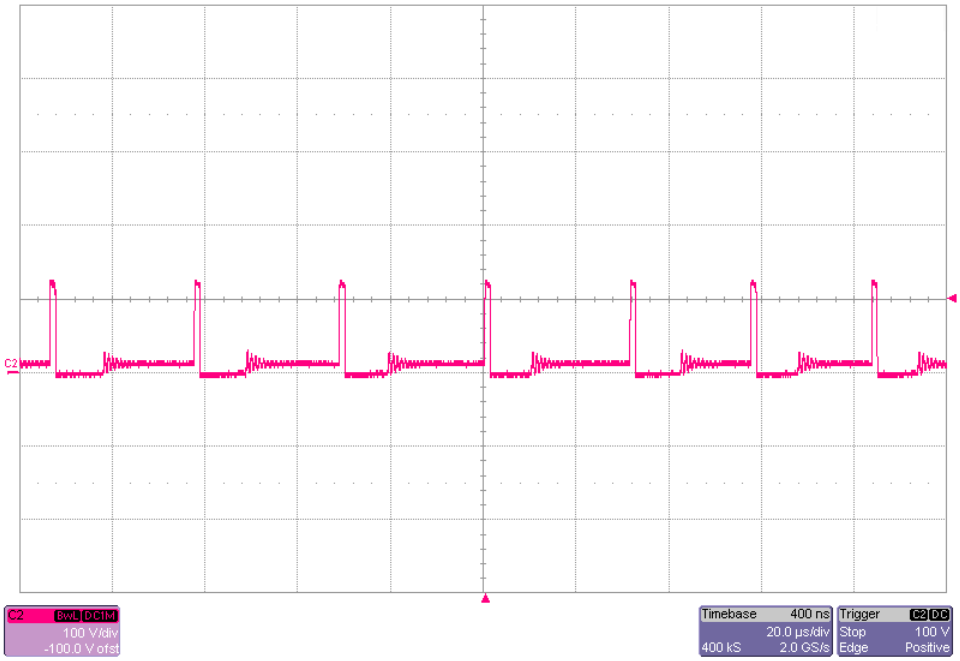

Figure 6. Switch Node Voltage, V_{IN} = 85 V_{AC}, 12-V V_{OUT} = 50-mA Load

Figure 7 shows the switch node voltage where the input voltage is 120 V_{AC} and the 12-V output is loaded to 50 mA (100 V/div, 20 µs/div).

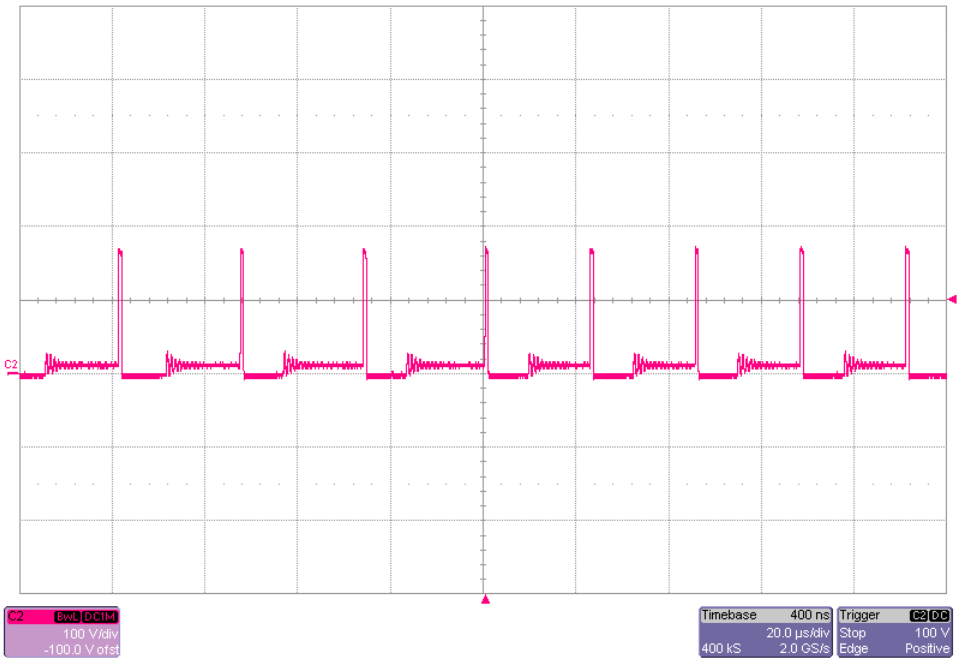

Figure 7. Switch Node Voltage, V_{IN} = 120 V_{AC}, 12-V Output Load = 50 mA

Figure 8 shows the switch node voltage where the input voltage is 264 V_{AC} and the 12-V output is loaded to 50 mA (100 V/div, 20 µs/div).

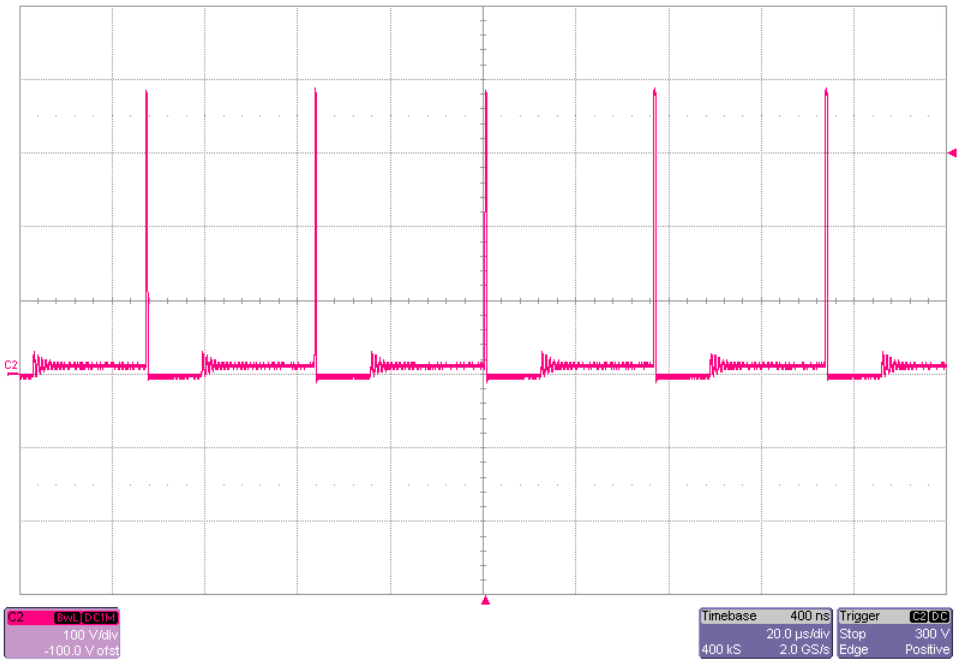

Figure 8. Switch Node Voltage, V_{IN} = 264 V_{AC}, 12-V Output Load = 50 mA

3.2 Output Voltage Ripple

Figure 9 shows the output ripple voltage. The image was taken with the 12-V output loaded to 50 mA and the input voltage set to 120 V_{AC} (50 mV/div, 200 µs/div).

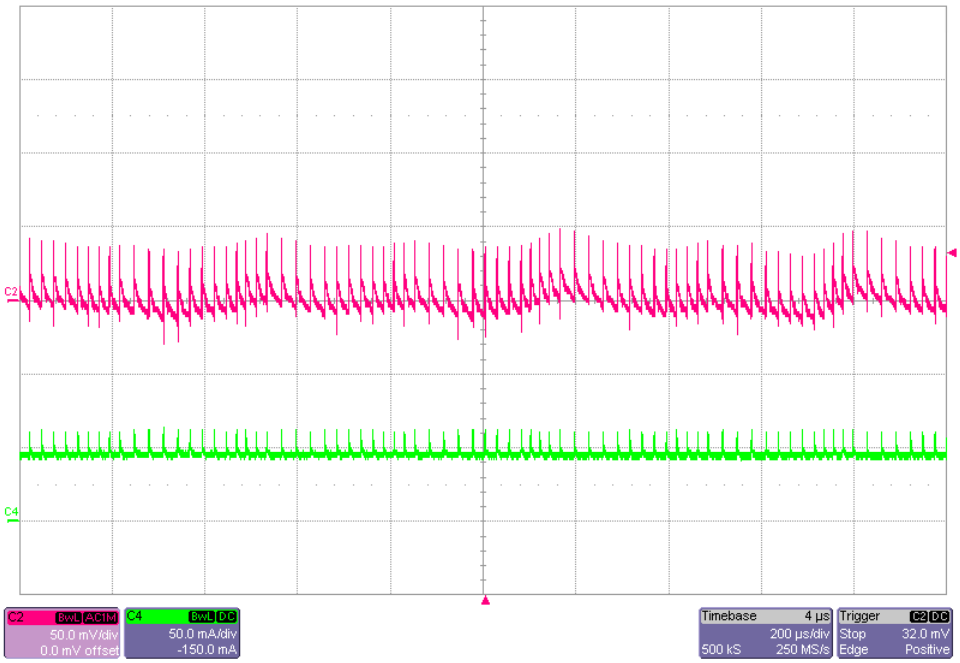

Figure 9. Output Voltage Ripple, V_{IN} = 120 V_{AC}, 12 V V_{OUT} = 50-mA Load

Figure 10 shows the output ripple voltage. The image was taken with the 12-V output with no load and the input voltage set to 120 V_{AC} (50 mV/div, 5 ms/div).

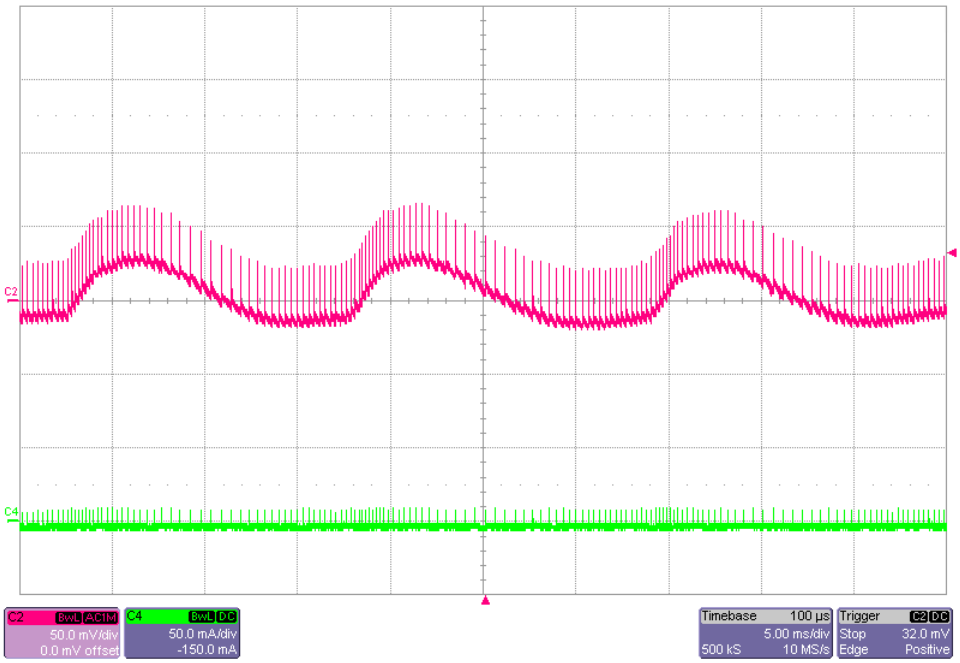

Figure 10. Output Voltage Ripple, V_{IN} = 120 V_{AC}, 12 V V_{OUT} = 0-mA Load

Figure 11 shows the output ripple voltage. The image was taken with the 12-V output loaded to 50 mA and the input voltage set to 230 V_{AC} (50 mV/div, 200 µs/div).

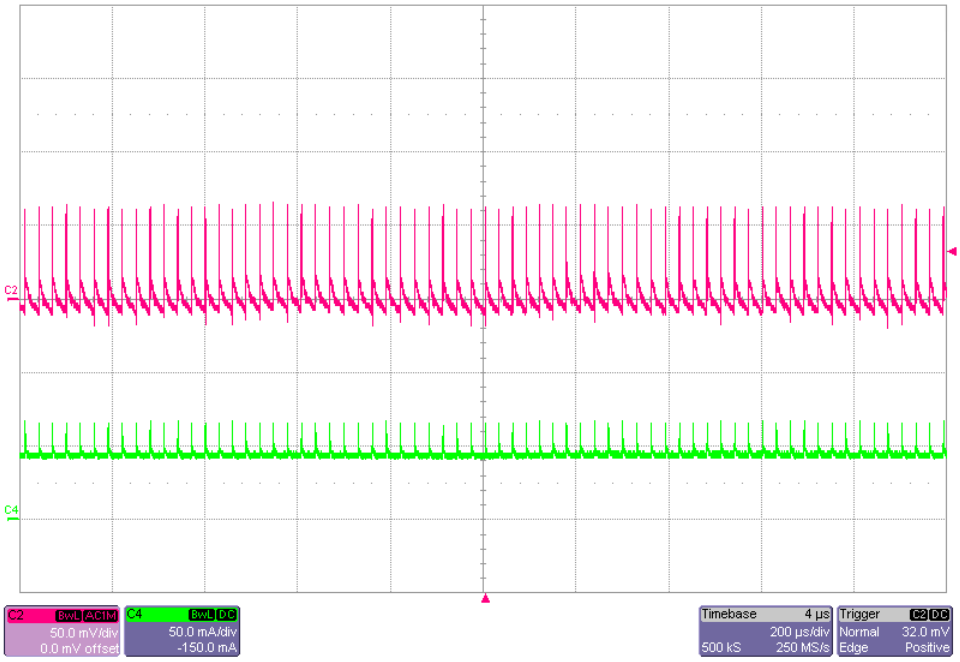

Figure 11. Output Voltage Ripple, V_{IN} = 230 V_{AC}, 12 V V_{OUT} = 50-mA Load

Figure 12 shows the output ripple voltage. The image was taken with the 12-V output with no load and the input voltage set to 230 V_{AC} (50 mV/div, 5 ms/div).

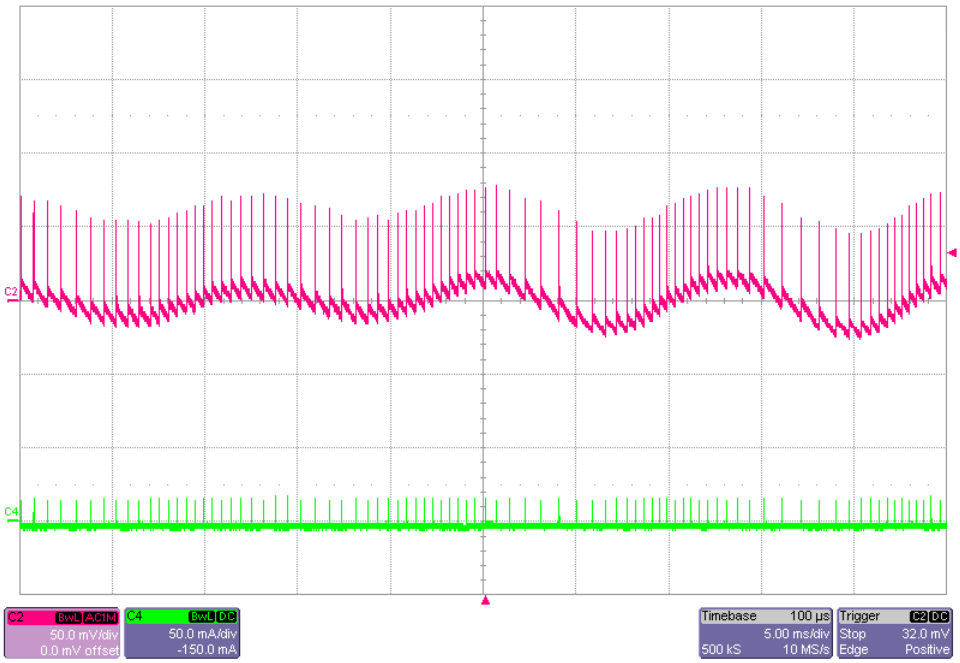

Figure 12. Output Voltage Ripple, V_{IN} = 230 V_{AC}, 12 V V_{OUT} = 0-mA Load

3.3 Load Transients

Figure 13 shows the 12-V output voltage when the load current is stepped from 50 mA to 150 mA with an input voltage of 120 V_{AC} (500 mV/div, 50 mA/div, 5 ms/div).

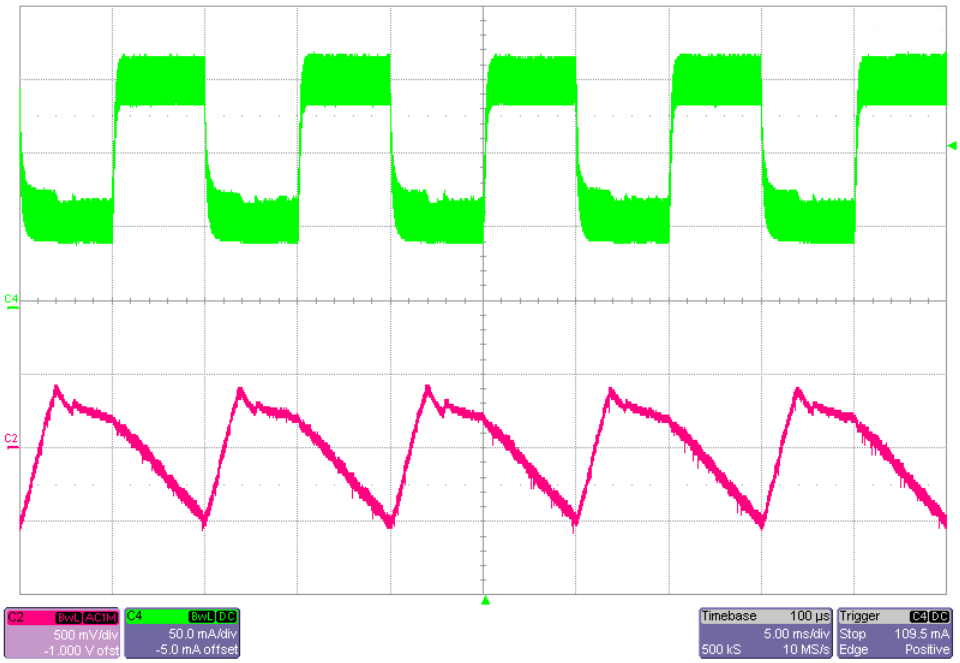

Figure 13. Load Transients, V_{IN} = 120 V_{AC}, 12 V V_{OUT} From 50-mA to 150-mA Load

Figure 14 shows the 12-V output voltage when the load current is stepped between 50 mA and 150 mA with an input voltage of 230 V_{AC} (500 mV/div, 50 mA/div, 5 ms/div).

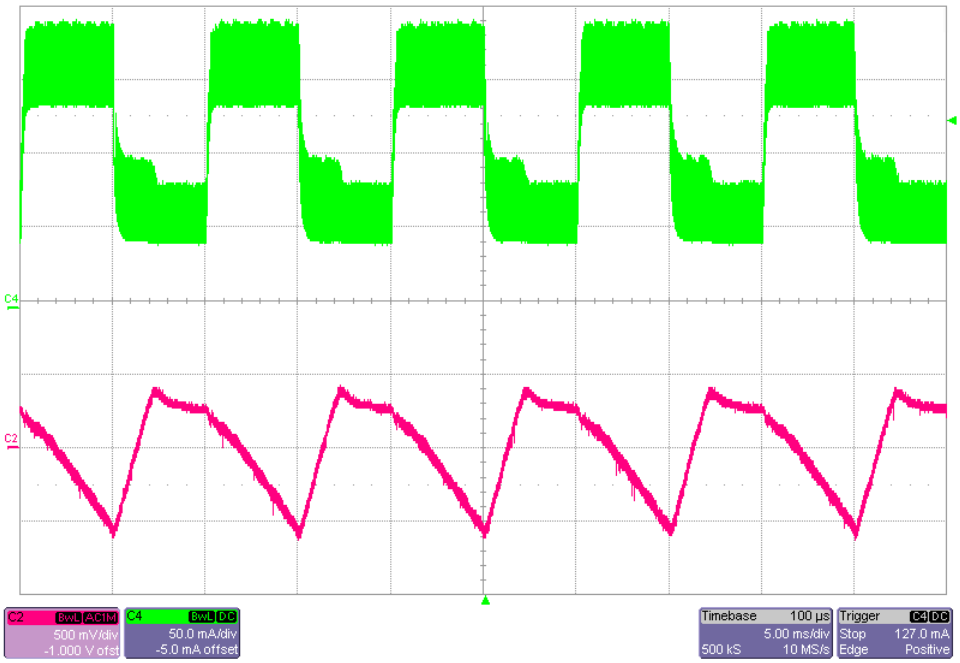

Figure 14. Load Transients, V_{IN} = 230 V_{AC}, 12 V V_{OUT} From 50-mA to 150-mA Load

3.4 Start-up Sequence

Figure 15 shows the output voltage startup waveform after the application of 85 V_{AC} and output loaded to 0 A (5 V/div, 20 ms/div).

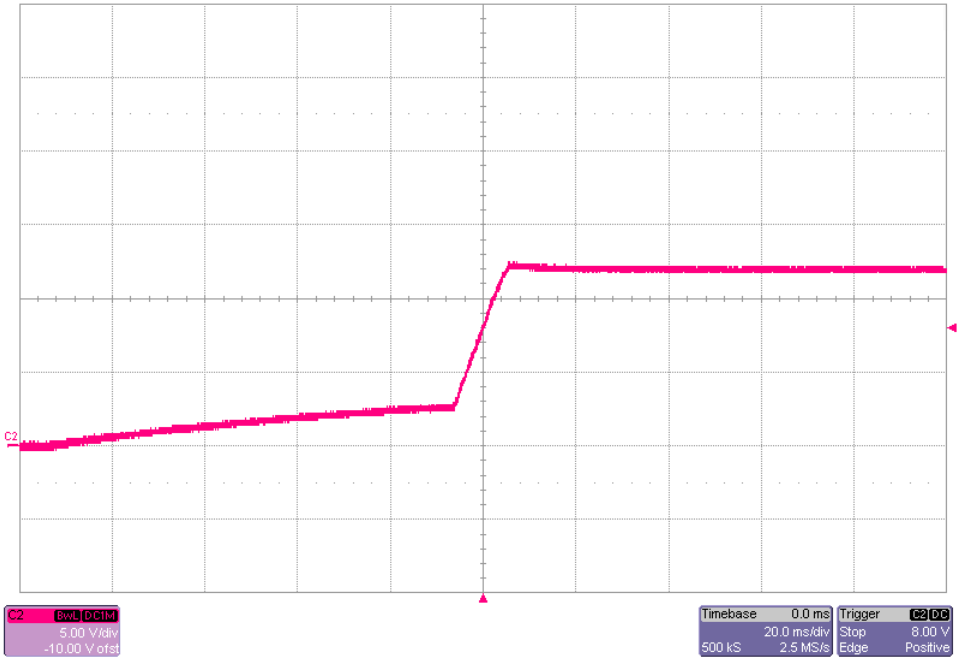

Figure 15. Output Voltage Startup Waveform, 85 V_{AC}, V_{OUT} = 0-mA Load

Figure 16 shows the output voltage startup waveform after the application of 85 V_{AC} and output loaded to 50 mA (5 V/div, 20 ms/div).

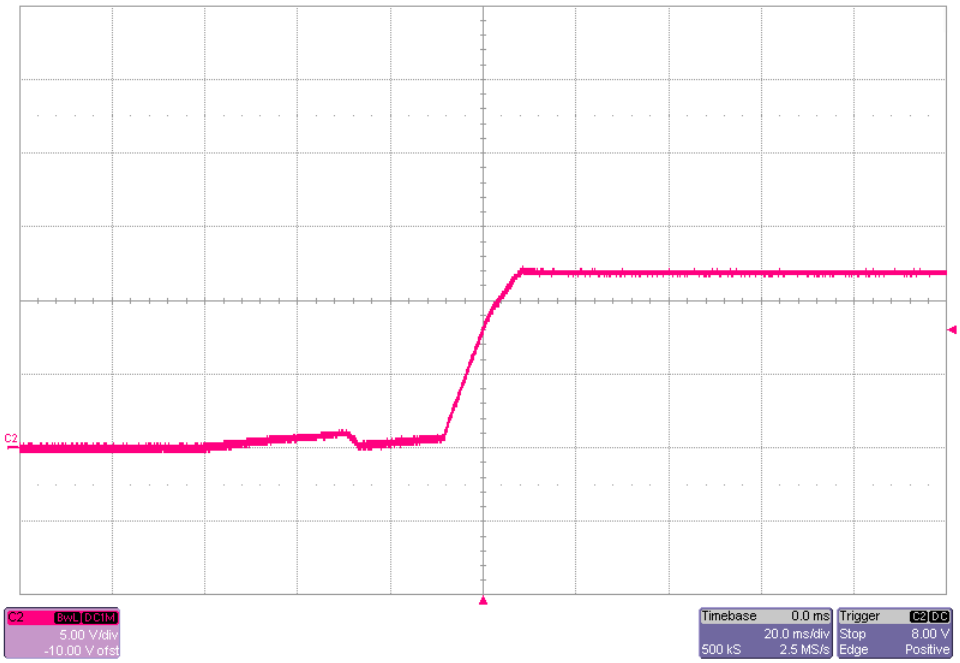

Figure 16. Output Voltage Startup Waveform, 85 V_{AC}, V_{OUT} = 50-mA Load

Figure 17 shows the output voltage startup waveform after the application of 120 V_{AC} and output loaded to 0 A (5 V/div, 20 ms/div)

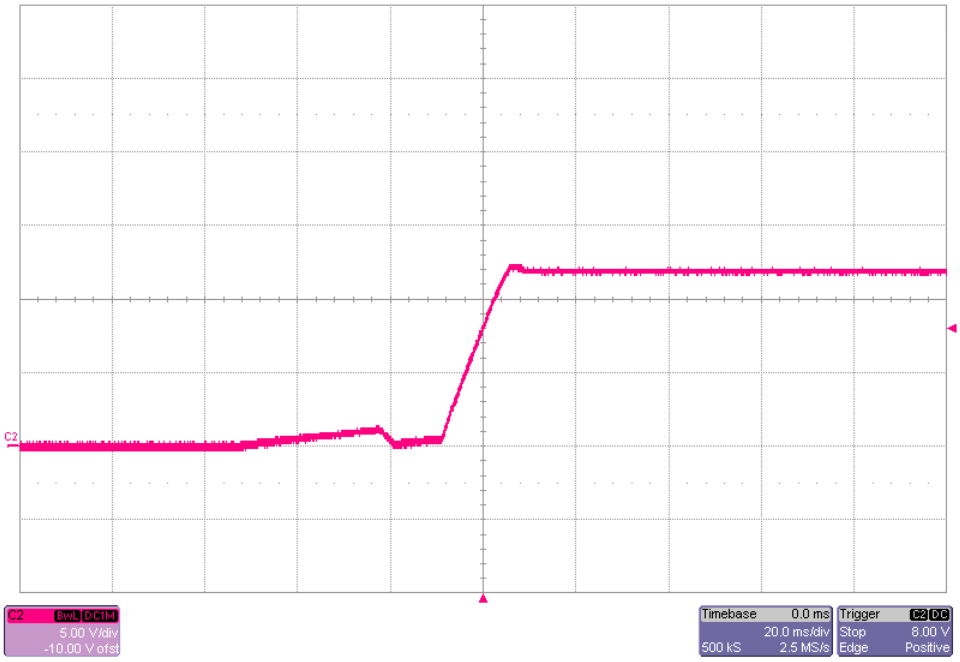

Figure 17. Output Voltage Startup Waveform, 120 V_{AC}, V_{OUT} = 0-mA Load

Figure 18 shows the output voltage startup waveform after the application of 120 V_{AC} and output loaded to 50 mA (5 V/div, 20 ms/div).

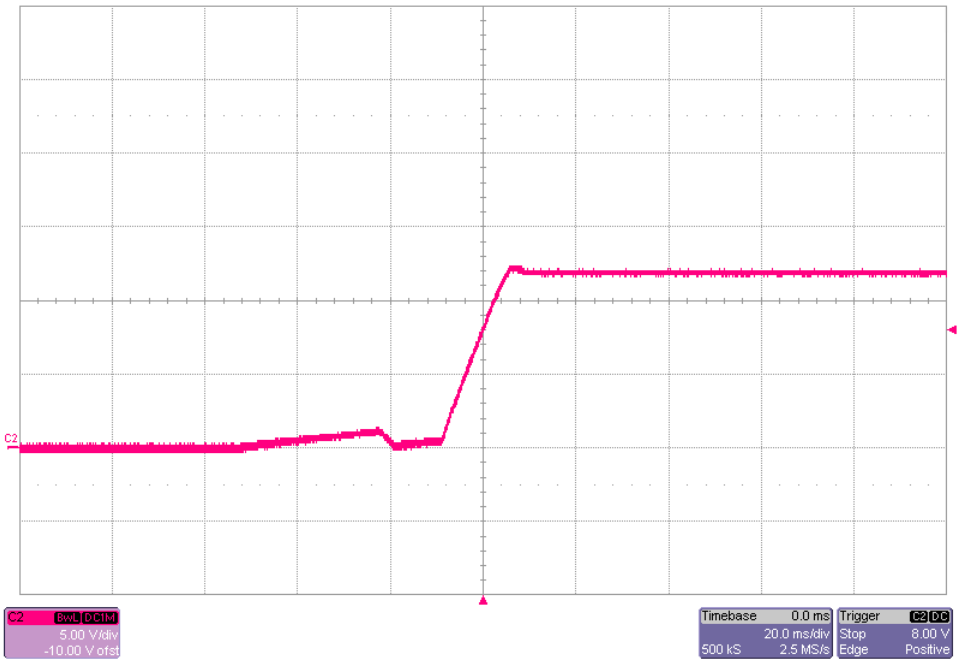

Figure 18. Output Voltage Startup Waveform, 120 V_{AC}, V_{OUT} = 50-mA Load

Figure 19 shows the output voltage startup waveform after the application of 230 V_{AC} and output loaded to 0 A (5 V/div, 20 ms/div).

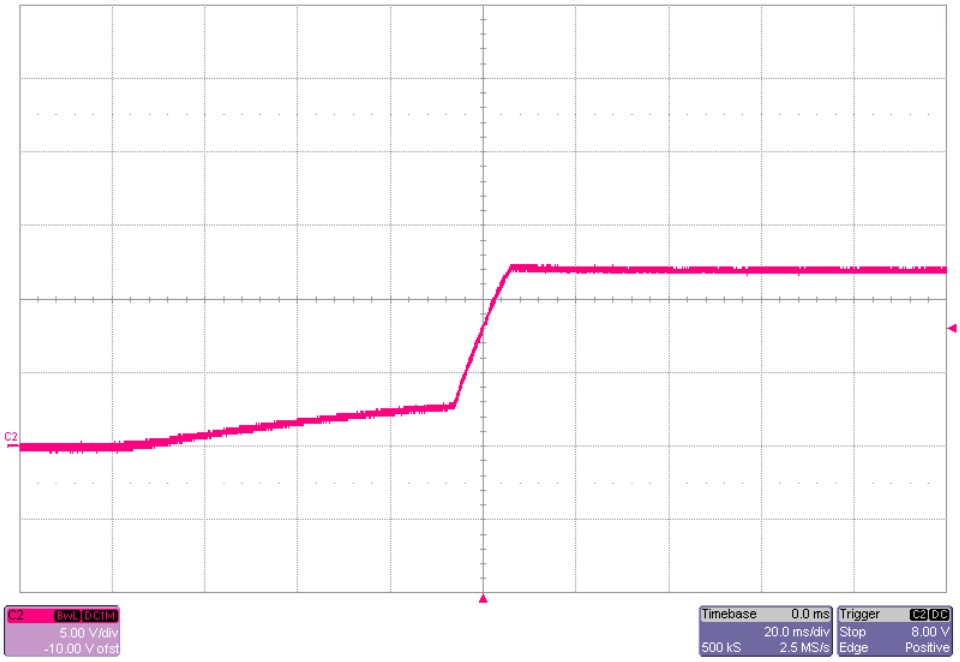

Figure 19. Output Voltage Startup Waveform, 230 V_{AC}, V_{OUT} = 0-mA Load

Figure 20 shows the output voltage startup waveform after the application of 230 V_{AC} and output loaded to 50 mA (5 V/div, 20 ms/div).

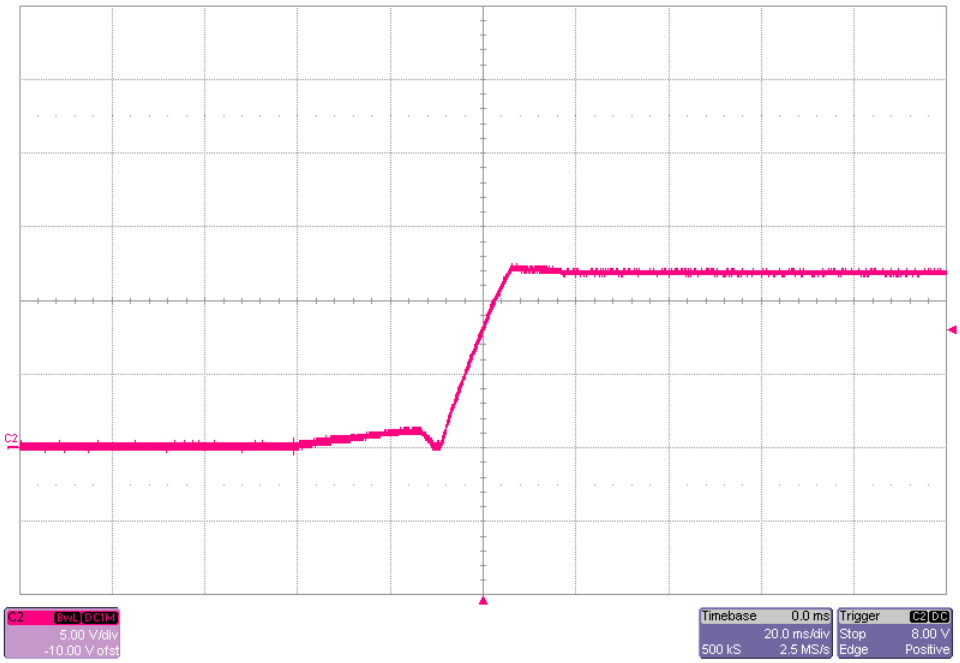

Figure 20. Output Voltage Startup Waveform, 230 V_{AC}, V_{OUT} = 50-mA Load

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