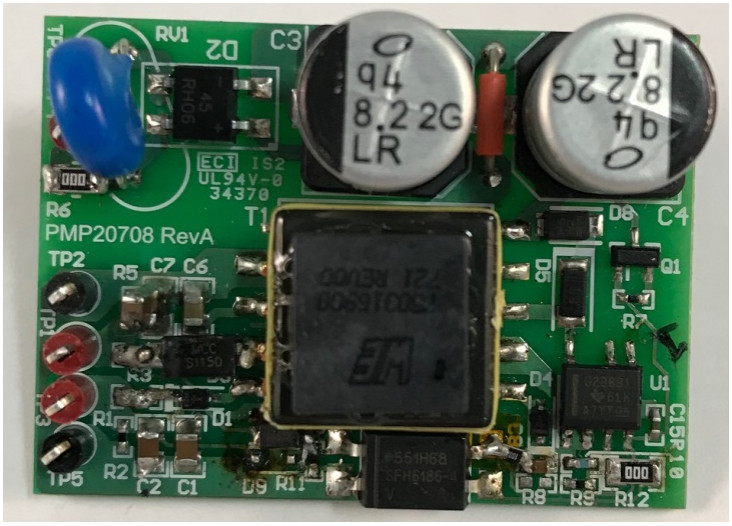
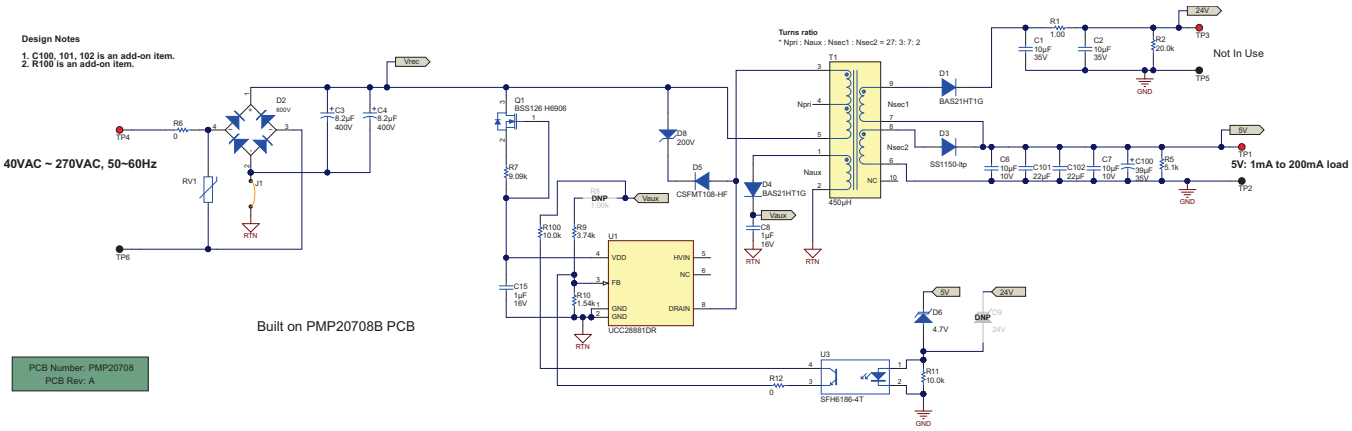
Test Report: PMP21455
Wide V_{AC} Input Flyback With an Integrated MOSFET Reference Design

Description

This reference design uses an off-line switcher with an integrated MOSFET to provide 5 V and 200 mA output from an ultra-wide 40-V_{AC} to 270-V_{AC} input. The board is in a small form factor of 30 mm × 41 mm × 12 mm with minimized populated parts.





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1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
V_{IN}	40 V_{AC}–270 V_{AC}
V_{OUT}	5 V
I_{OUT}	200 mA

2 Testing and Results

2.1 Efficiency Graphs

Figure 1, Figure 2, and Figure 3 show the converter efficiency for a 40-, 120-, and 270-V_{AC} input with a 5-V output

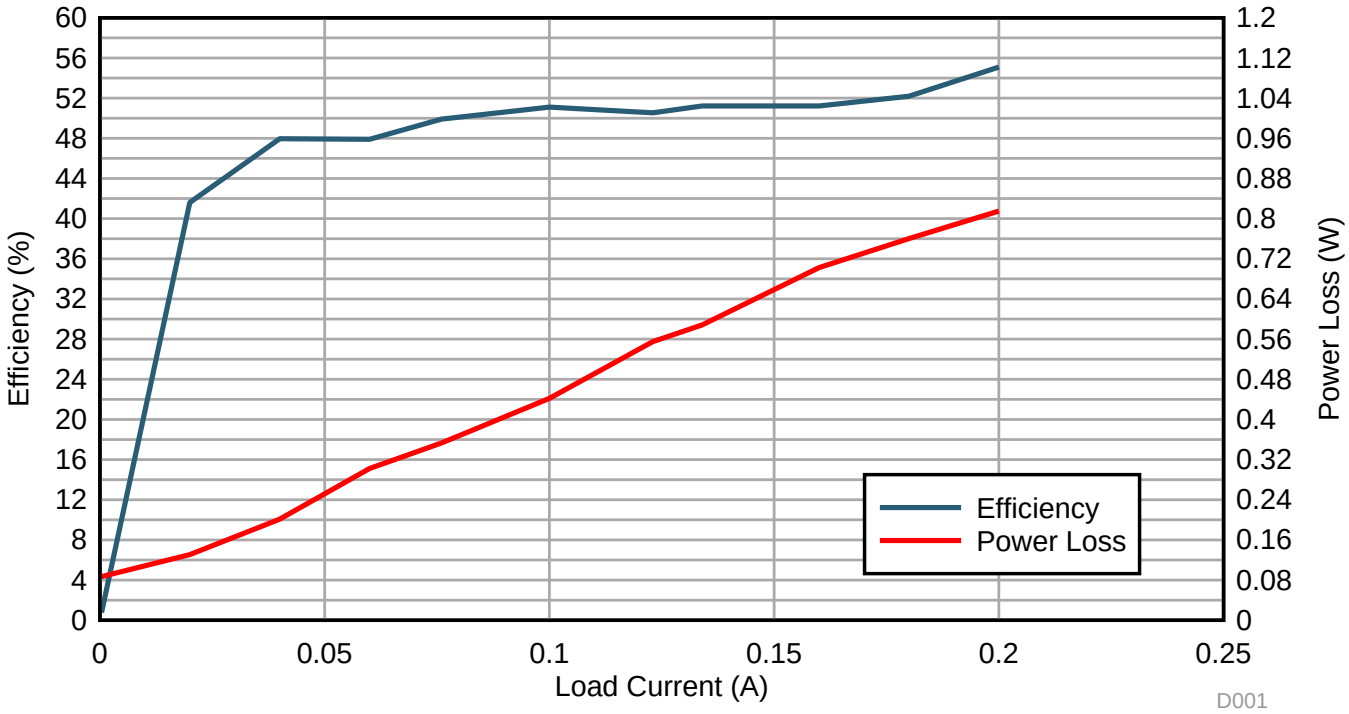


Figure 1. Converter Efficiency, 40 V_{AC}, 5-V Output

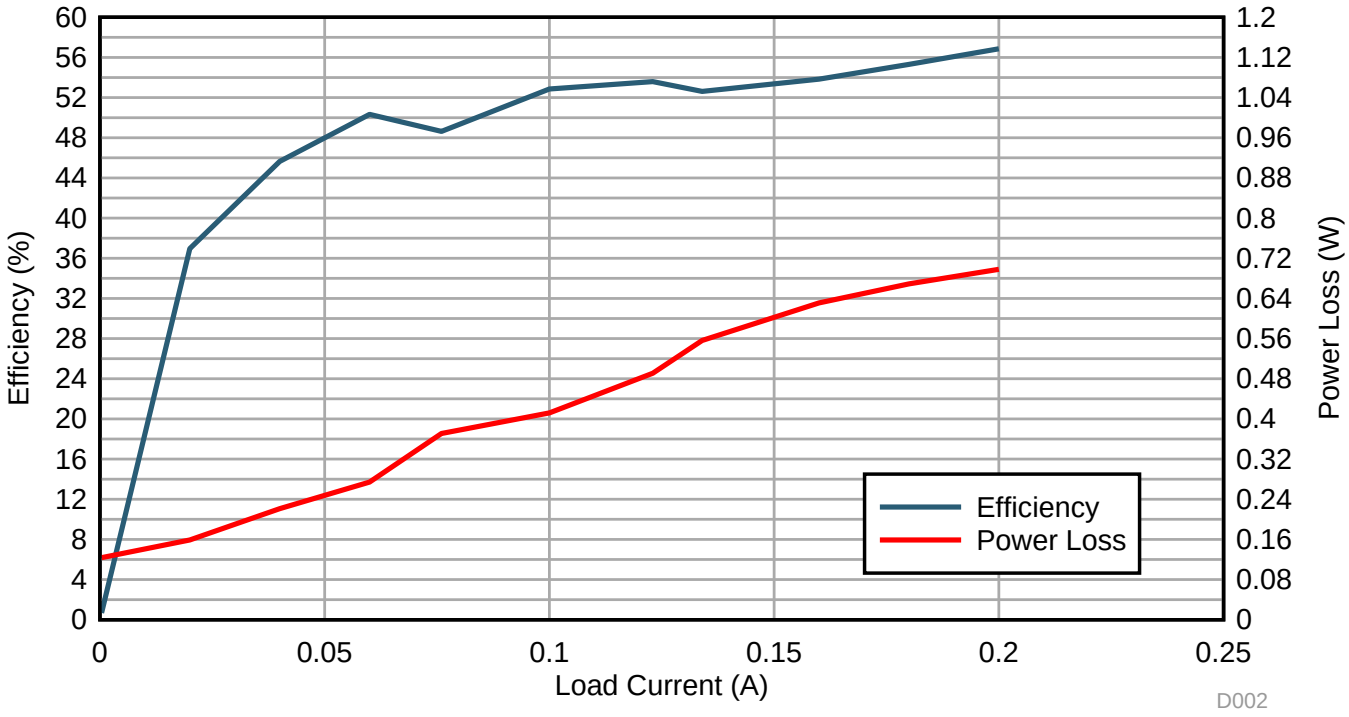


Figure 2. Converter Efficiency, 120 V_{AC}, 5-V Output

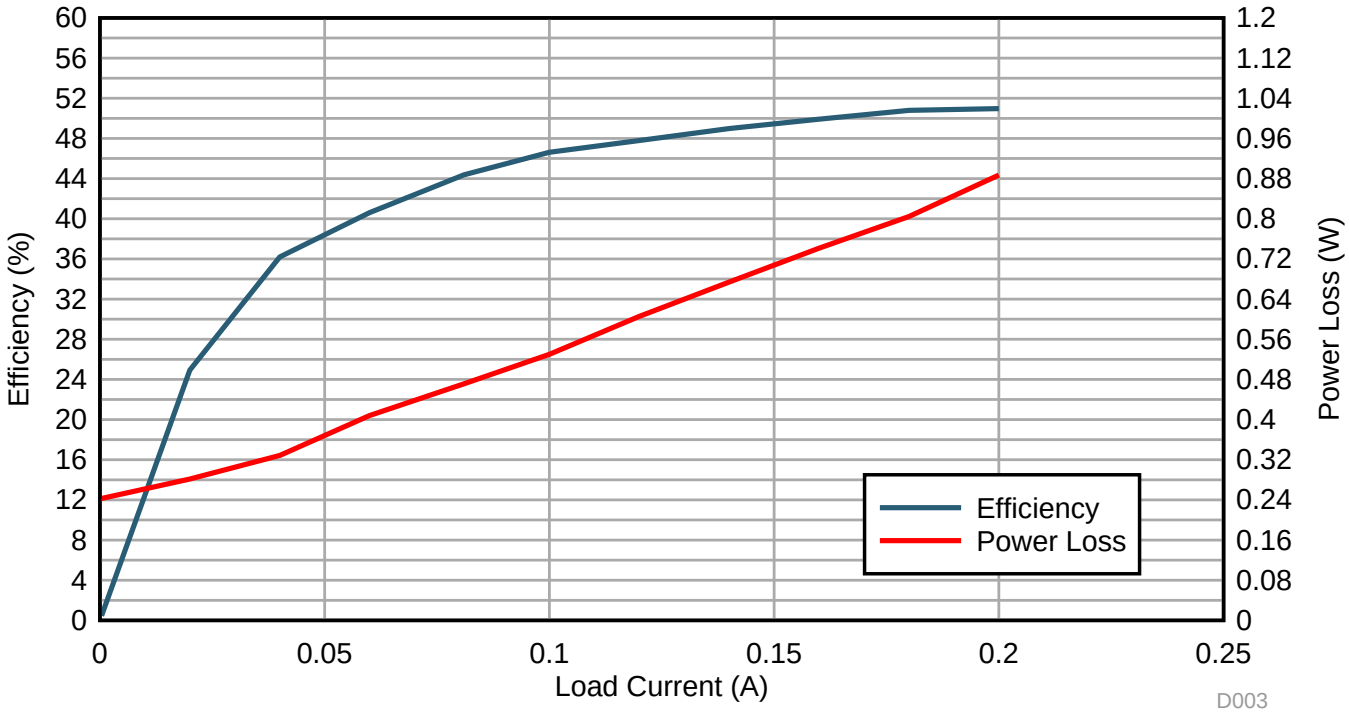


Figure 3. Converter Efficiency, 270 V_{AC}, 5-V Output

2.2 Efficiency Data

Table 2, Table 3, and Table 4 show the efficiency data for a 40-, 120-, and 270--V input with a 1-V output.

Table 2. Efficiency Data 40-V_{AC} Input With 1-V Output

I_{OUT}	V_{OUT}	V_{IN} AC	I_{IN} Arms (mA)	PIN	P_{OUT}	LOSSES	EFFICIENCY
0.000	5.250	40.0	5.90000	0.0860	0.00	0.09	0.0%
0.020	4.660	40.0	13.6400	0.2240	0.09	0.13	41.6%
0.040	4.640	40.0	21.630	0.3870	0.19	0.20	48.0%
0.060	4.630	40.0	30.000	0.5800	0.28	0.30	47.9%
0.076	4.630	40.0	35.000	0.7050	0.35	0.35	49.9%
0.100	4.620	40.0	43.000	0.9040	0.46	0.44	51.1%
0.123	4.610	40.0	52.000	1.1220	0.57	0.55	50.5%
0.134	4.610	40.0	55.000	1.2060	0.62	0.59	51.2%
0.160	4.610	40.0	64.000	1.4400	0.74	0.70	51.2%
0.180	4.610	40.0	70.000	1.5900	0.83	0.76	52.2%
0.200	5.000	40.0	78.000	1.8150	1.00	0.82	55.1%

Table 3. Efficiency Data 120-V_{AC} Input With 1-V Output

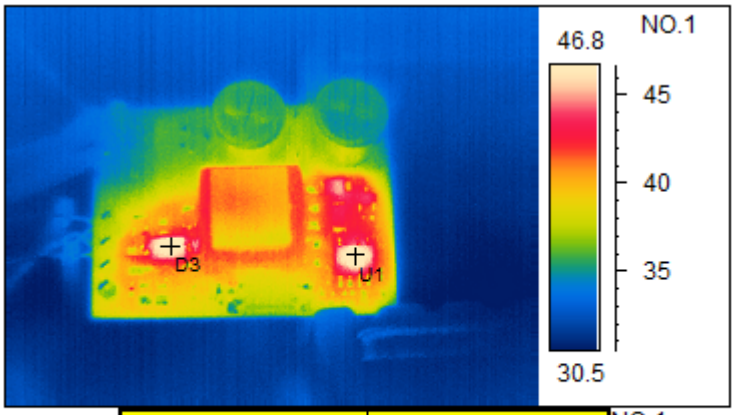
I_{OUT}	V_{OUT}	V_{IN} AC	I_{IN} Arms (mA)	PIN	P_{OUT}	LOSSES	EFFICIENCY
0.000	5.330	120.0	4.16000	0.1230	0.00	0.12	0.0%
0.020	4.657	120.0	7.5000	0.2520	0.09	0.16	37.0%
0.040	4.644	120.0	11.000	0.4070	0.19	0.22	45.6%
0.060	4.630	120.0	15.000	0.5520	0.28	0.27	50.3%
0.076	4.620	120.0	18.000	0.7220	0.35	0.37	48.6%
0.100	4.620	120.0	22.000	0.8740	0.46	0.41	52.9%
0.123	4.610	120.0	26.000	1.0580	0.57	0.49	53.6%
0.134	4.610	120.0	28.000	1.1740	0.62	0.56	52.6%
0.160	4.600	120.0	31.000	1.3670	0.74	0.63	53.8%
0.180	4.600	120.0	34.000	1.4970	0.83	0.67	55.3%
0.200	4.600	120.0	36.000	1.6180	0.92	0.70	56.9%

Table 4. Efficiency Data 270-V_{AC} Input With 1-V Output

I_{OUT}	V_{OUT}	V_{IN} AC	I_{IN} Arms (mA)	PIN	P_{OUT}	LOSSES	EFFICIENCY
0.000	5.420	270.0	3.73000	0.2420	0.00	0.24	0.0%
0.022	4.673	270.0	6.0000	0.3750	0.10	0.27	27.4%
0.040	4.660	270.0	8.000	0.5150	0.19	0.33	36.2%
0.060	4.650	270.0	10.000	0.6870	0.28	0.41	40.6%
0.081	4.640	270.0	12.000	0.8470	0.38	0.47	44.4%
0.100	4.630	270.0	14.000	0.9930	0.46	0.53	46.6%
0.120	4.620	270.0	16.000	1.1600	0.55	0.61	47.8%
0.140	4.622	270.0	18.000	1.3210	0.65	0.67	49.0%
0.160	4.617	270.0	20.000	1.4800	0.74	0.74	49.9%
0.180	4.614	270.0	22.000	1.6350	0.83	0.80	50.8%
0.200	4.610	270.0	24.000	1.8090	0.92	0.89	51.0%

2.3 Thermal Images

Figure 4 shows the thermal image operation at 120-V_{AC} input and 5 V at 0.2-A output, with no airflow. The board ran for 20 minutes under these conditions before the thermal image was taken.



Spot analysis	Value
U1 Temperature	48.0°C
D3 Temperature	47.4°C

Figure 4. Top Thermal

2.4 Dimensions

Figure 5 and Figure 5 present the top and bottom PMP21455 photos (and their dimensions) with a 5-V output.

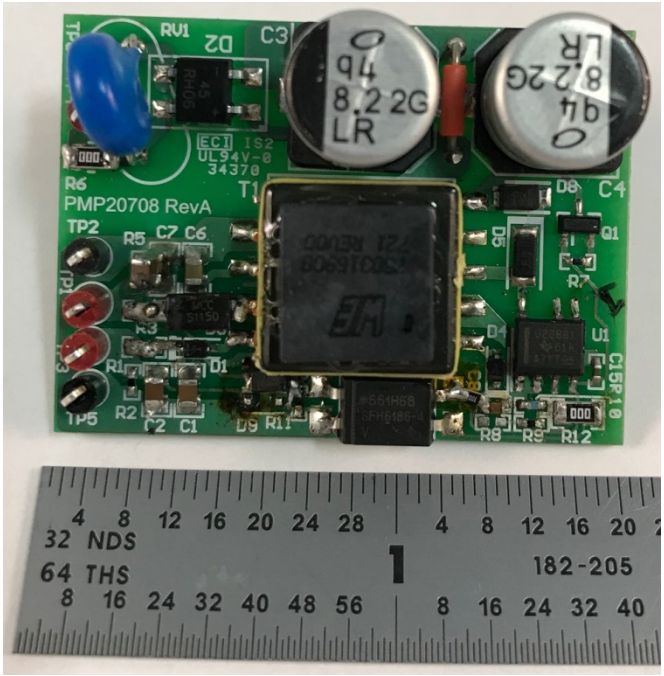


Figure 5. PMP21455 Device Dimensions (Top View)

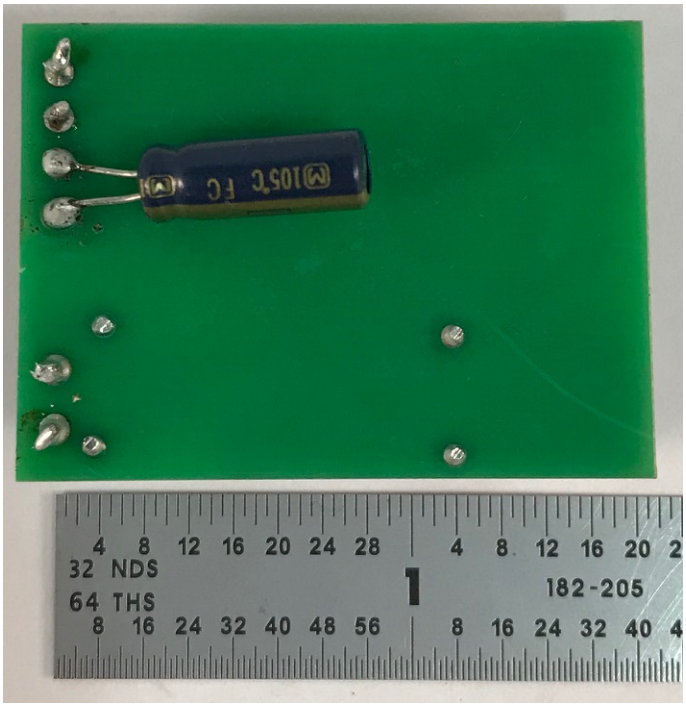


Figure 6. PMP21455 Device Dimensions (Bottom View)

3 Waveforms

3.1 Switching

Figure 7 and Figure 8 show the switch node voltage with the input voltage at 40 V_{AC} and the 5-V output is at no load then full load (0.2 A), respectively.

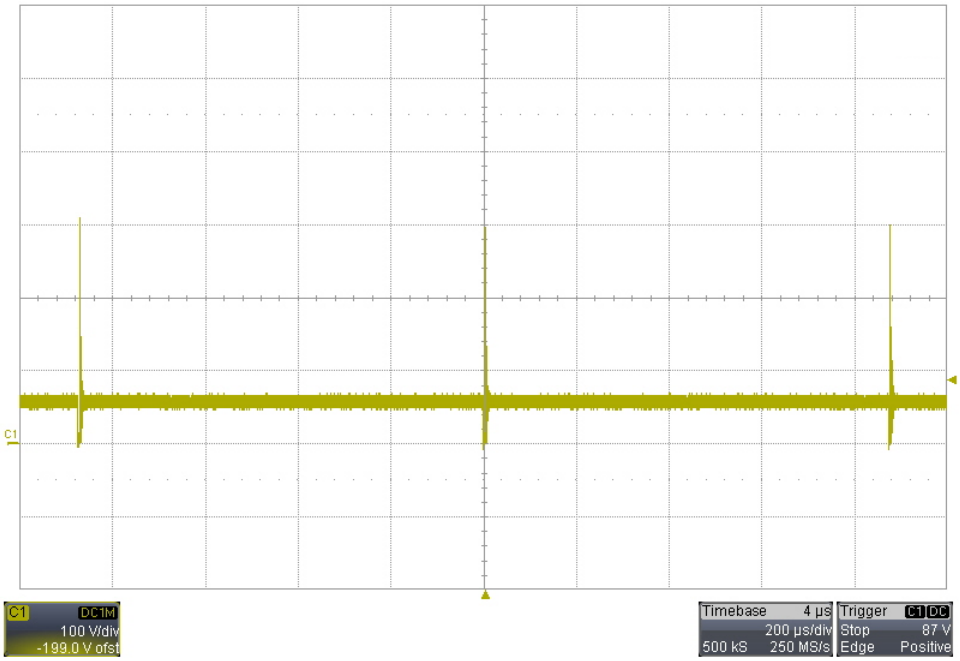


Figure 7. Switch Node Voltage, V_{IN} = 40 V, 5-V V_{OUT} = 0-mA Load

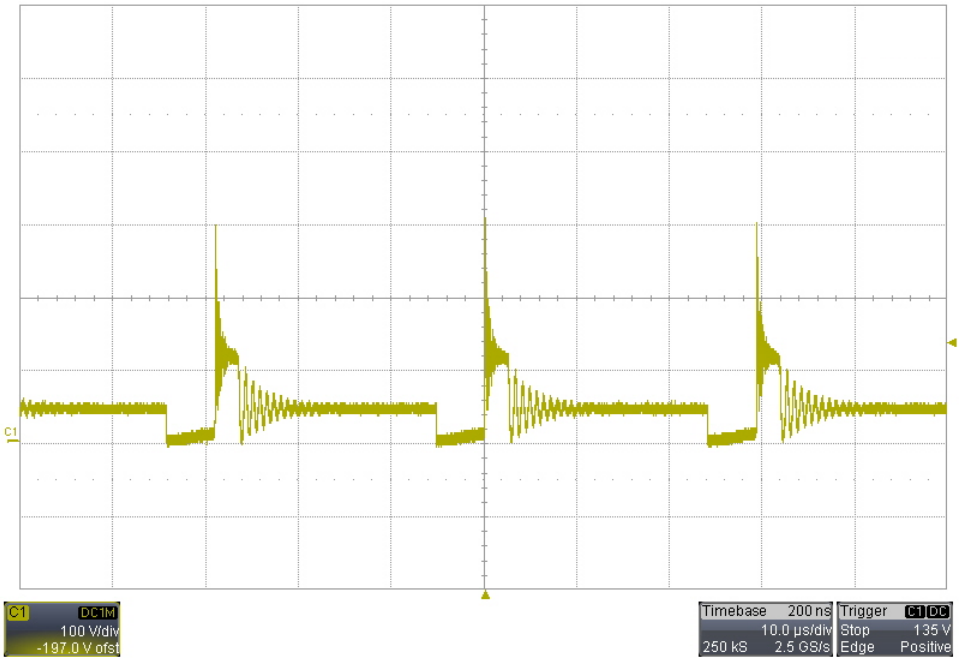


Figure 8. Switch Node Voltage, V_{IN} = 40 V, 5-V V_{OUT} = 200-mA Load

Figure 9 and Figure 10 show the switch node voltage with the input voltage at 120 V_{AC} and the 5-V output is at no load then full load (0.2 A), respectively.

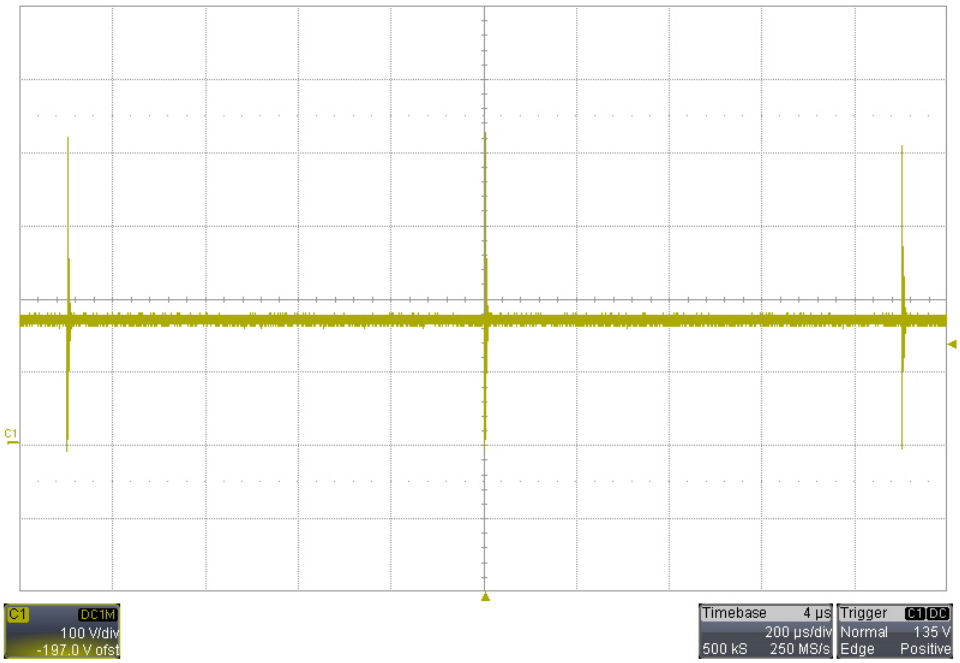


Figure 9. Switch Node Voltage, V_{IN} = 120 V, 5-V V_{OUT} = 0-mA Load

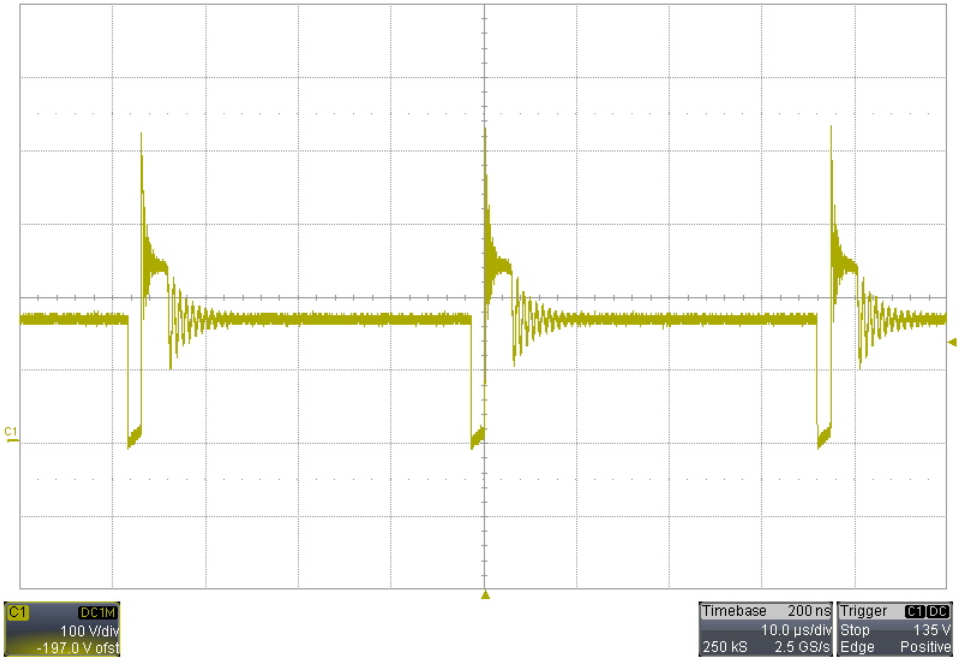


Figure 10. Switch Node Voltage, V_{IN} = 120 V, 5-V V_{OUT} = 200-mA Load

Figure 11 and Figure 12 show the switch node voltage with the input voltage at 40 V_{AC} and the 5-V output is at no load then full load (0.2 A), respectively.

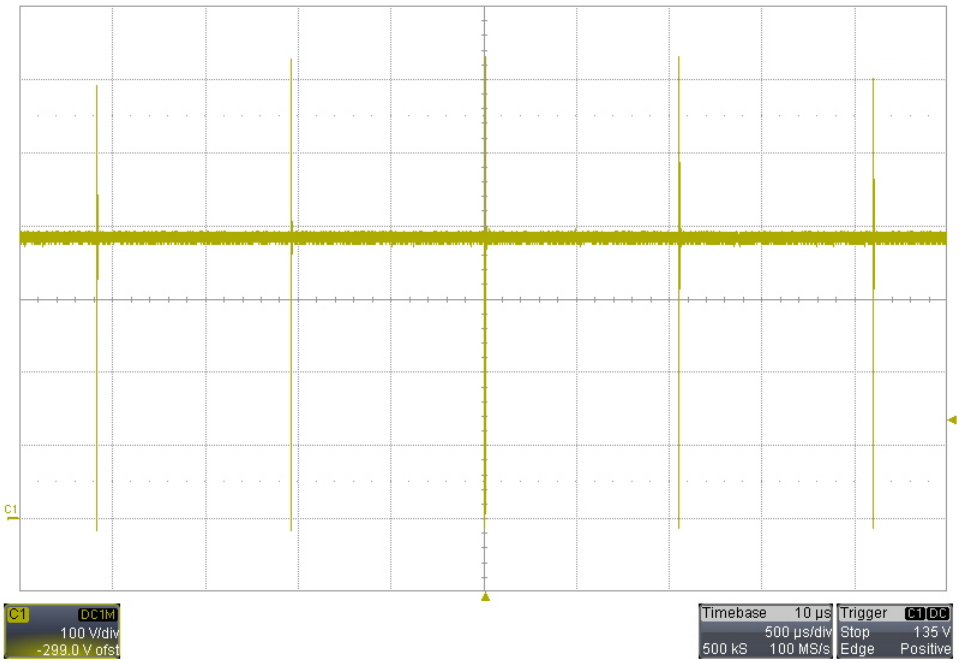


Figure 11. Switch Node Voltage, V_{IN} = 270 V, 5-V V_{OUT} = 0-mA Load

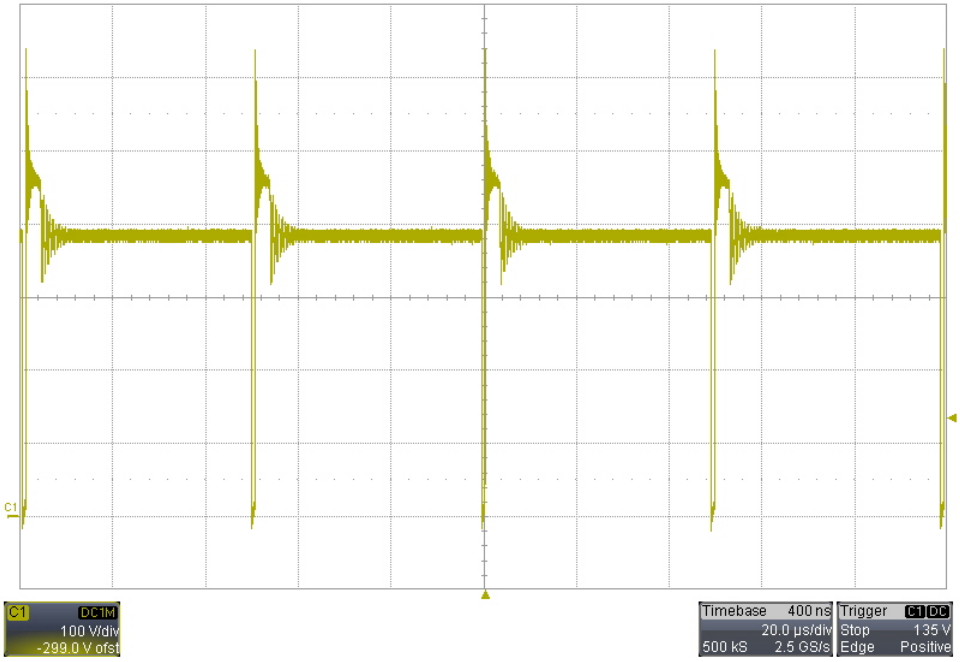


Figure 12. Switch Node Voltage, V_{IN} = 270 V, 5-V V_{OUT} = 200-mA Load

3.2 Output Voltage Ripple

Figure 13 shows the output ripple voltage with an input voltage of 40 V_{AC} and the 5-V output loaded to 0 mA.

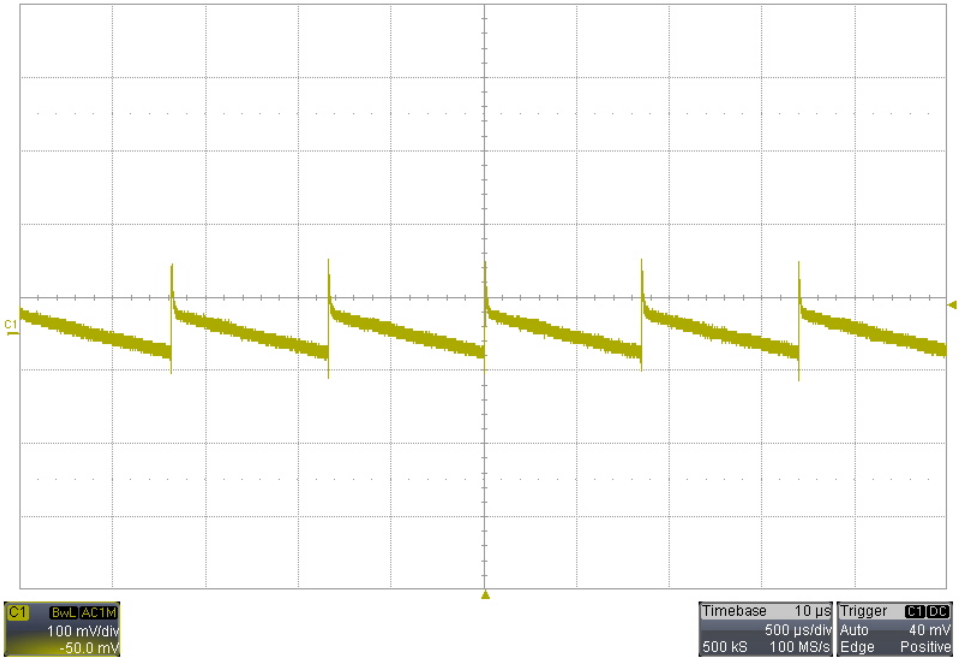


Figure 13. Output Voltage Ripple, V_{IN} = 40 V_{AC}, 5-V V_{OUT} = 0-mA Load

Figure 14 shows the output ripple voltage with an input voltage of 40 V_{AC} and the 5-V output loaded to 200 mA.

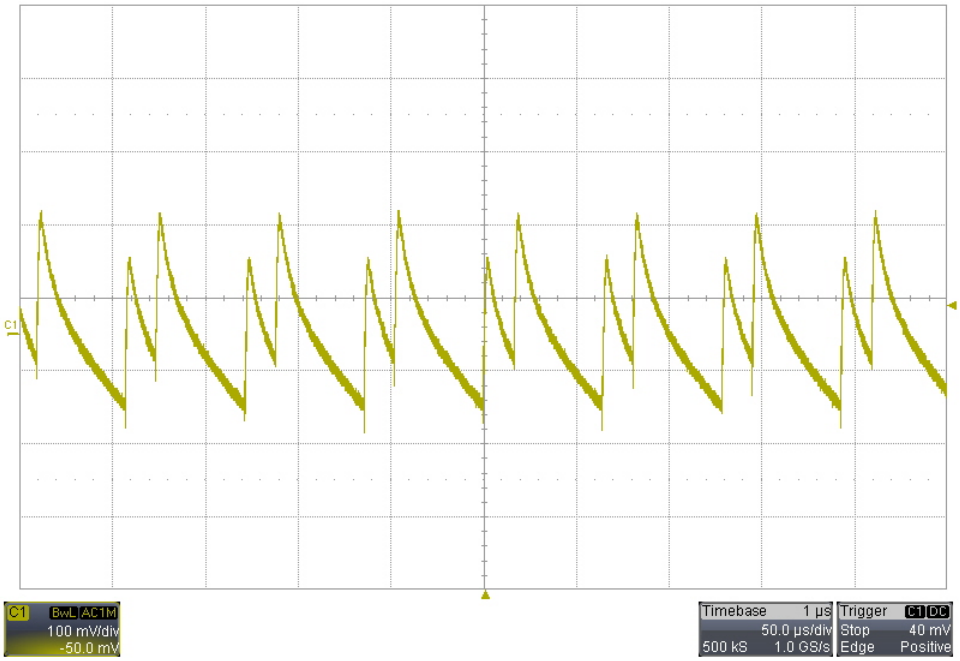


Figure 14. Output Voltage Ripple, V_{IN} = 40 V_{AC}, 5-V V_{OUT} = 200-mA Load

Figure 15 shows the output ripple voltage with an input voltage of 120 V_{AC} and the 5-V output loaded to 0 mA.

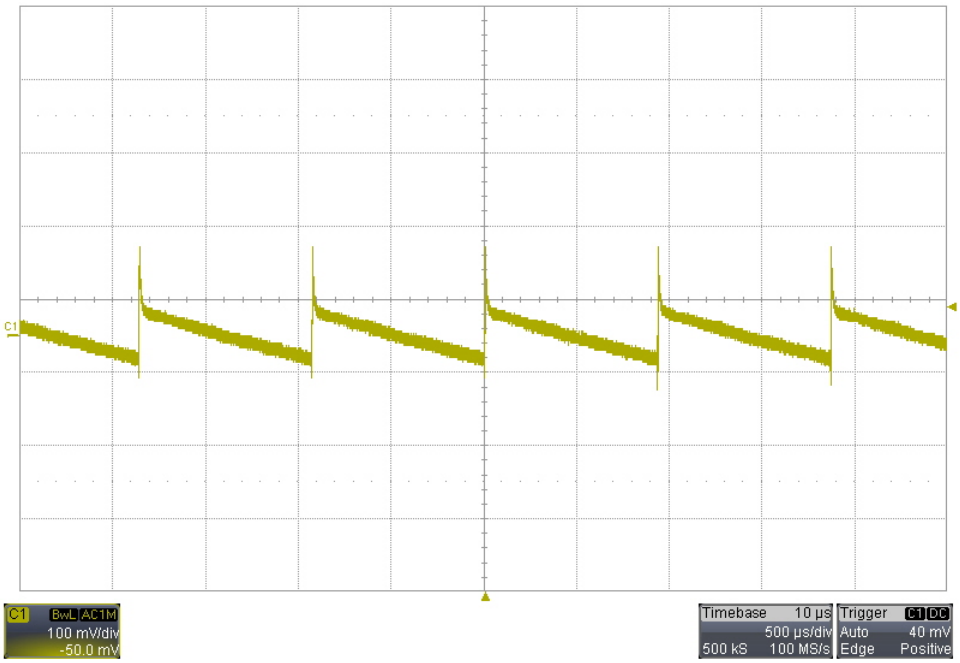


Figure 15. Output Voltage Ripple, V_{IN} = 120 V_{AC}, 5-V V_{OUT} = 0-mA Load

Figure 16 shows the output ripple voltage with an input voltage of 120 V_{AC} and the 5-V output loaded to 200 mA.

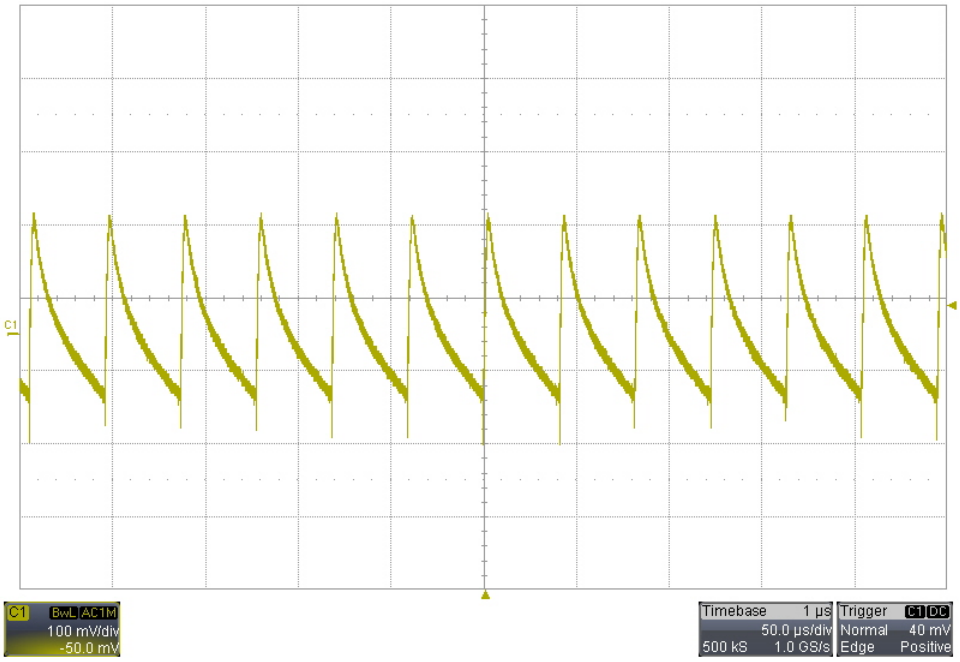


Figure 16. Output Voltage Ripple, V_{IN} = 120 V_{AC}, 5-V V_{OUT} = 200-mA Load

Figure 17 shows the output ripple voltage with an input voltage of 270 V_{AC} and the 5-V output loaded to 0 mA.

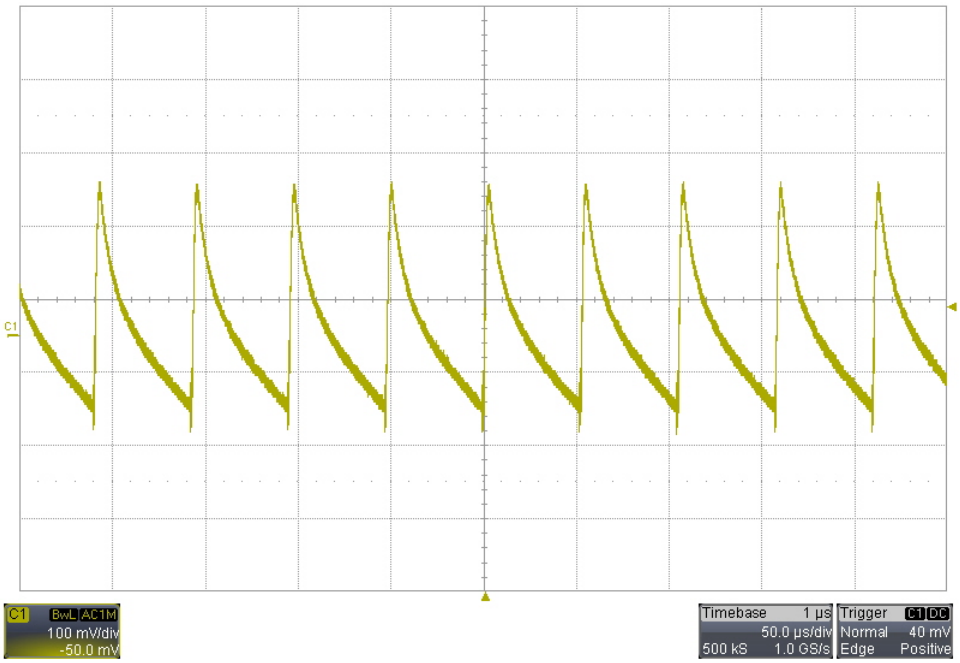


Figure 17. Output Voltage Ripple, V_{IN} = 270 V_{AC}, 5-V V_{OUT} = 0-mA Load

Figure 18 shows the output ripple voltage with an input voltage of 270 V_{AC} and the 5-V output loaded to 200 mA.

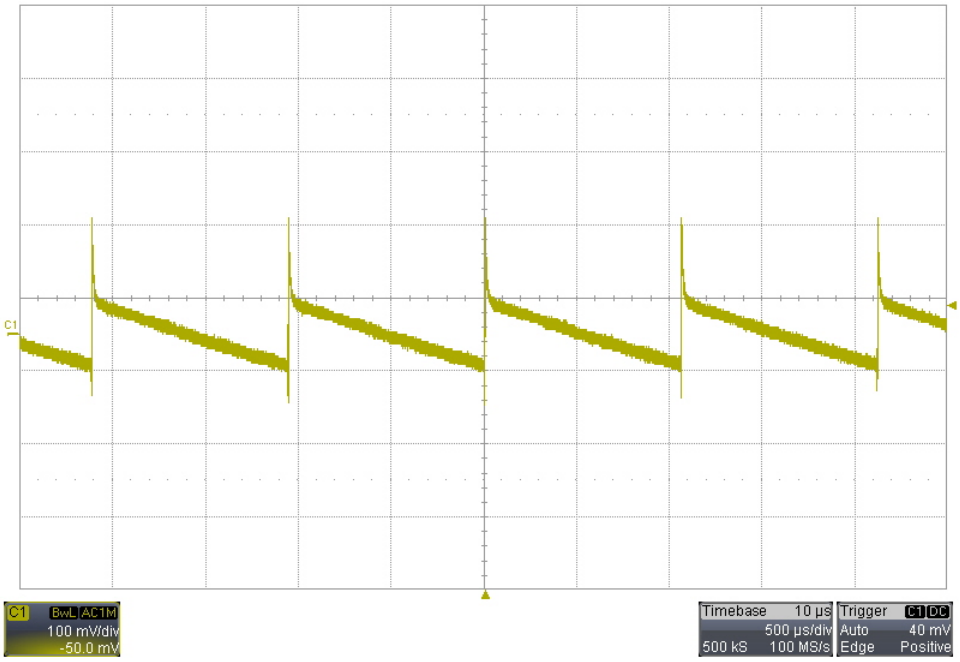


Figure 18. Output Voltage Ripple, V_{IN} = 270 VAC, 5-V V_{OUT} = 200-mA Load

3.3 Start-up Sequence

Figure 19 and Figure 20 show the output voltage start-up waveform for 40 -V_{AC} input at no load then full load (0.2 A), respectively.

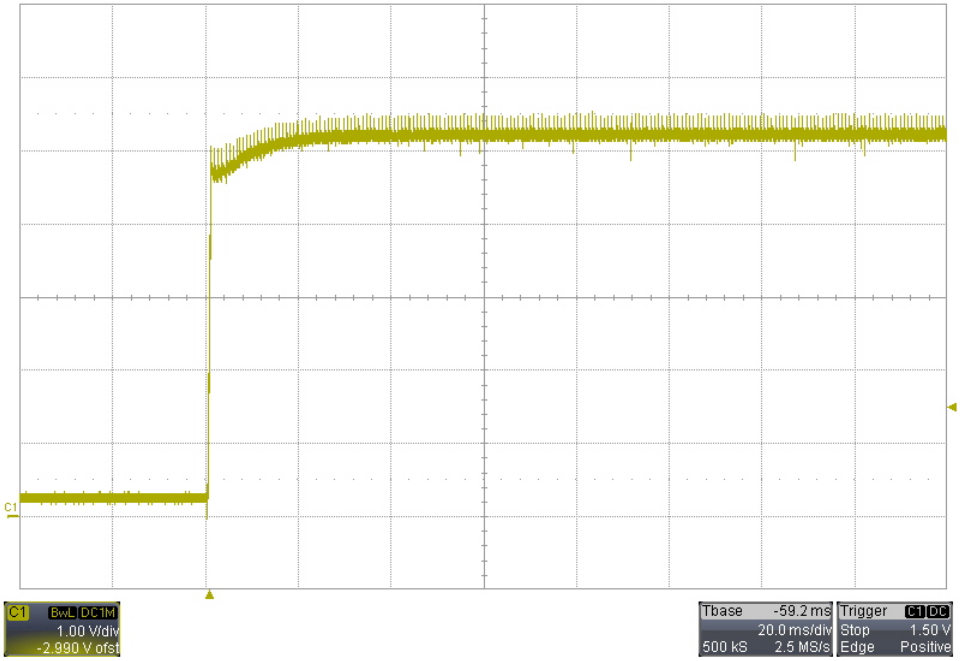


Figure 19. Output Voltage Start-up Waveform, 40 V_{AC}, 5-V V_{OUT} = 0-mA Load

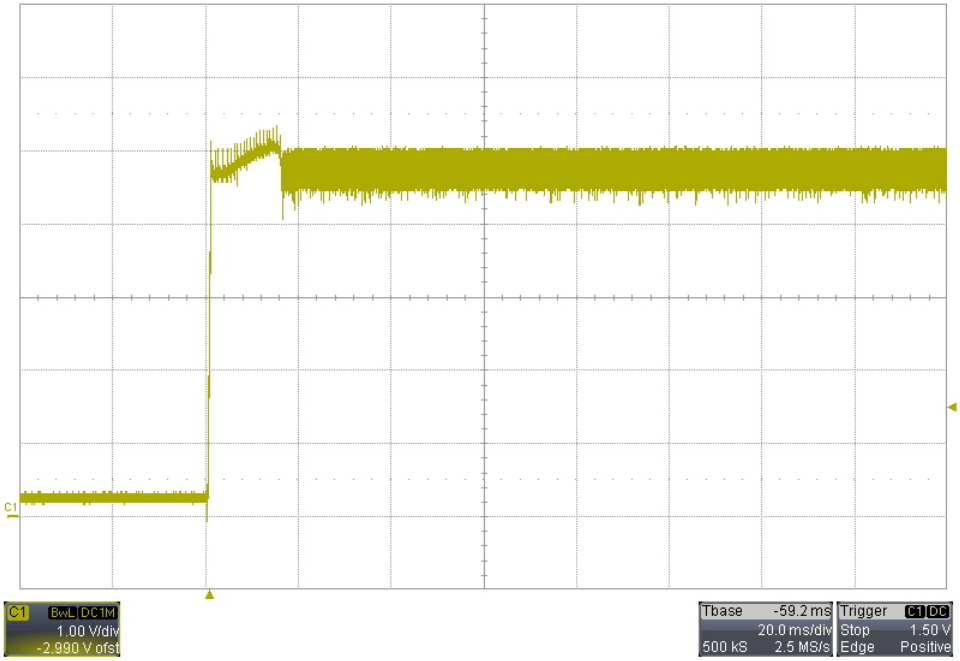


Figure 20. Output Voltage Start-up Waveform, 40 V_{AC}, 5-V V_{OUT} = 200-mA Load

Figure 21 and Figure 22 show the output voltage start-up waveform for 120-V_{AC} input at no load then full load (0.2 A), respectively.

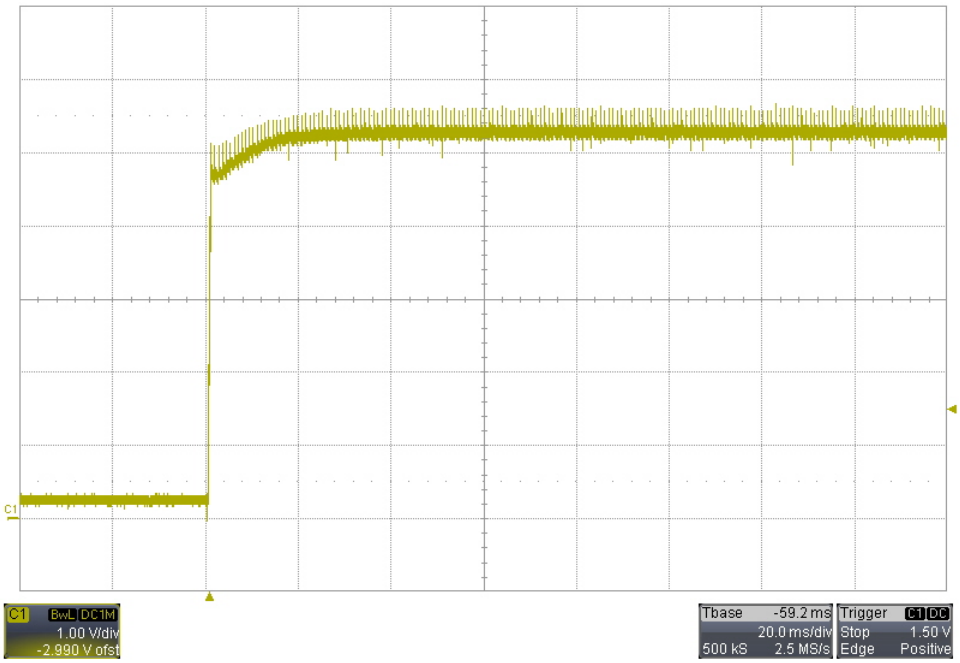


Figure 21. Output Voltage Start-up Waveform, 120 V_{AC}, 5-V V_{OUT} = 0-mA Load

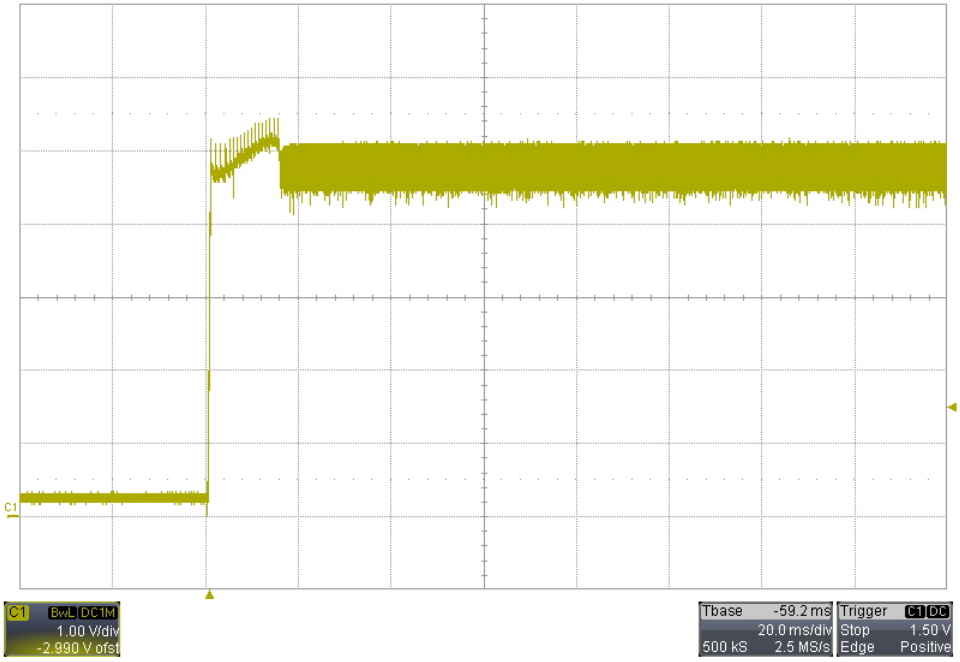


Figure 22. Output Voltage Start-up Waveform, 120 V_{AC}, 5-V V_{OUT} = 200-mA Load

Figure 23 and Figure 24 show the output voltage start-up waveform for 120-V_{AC} input at no load then full load (0.2 A), respectively.

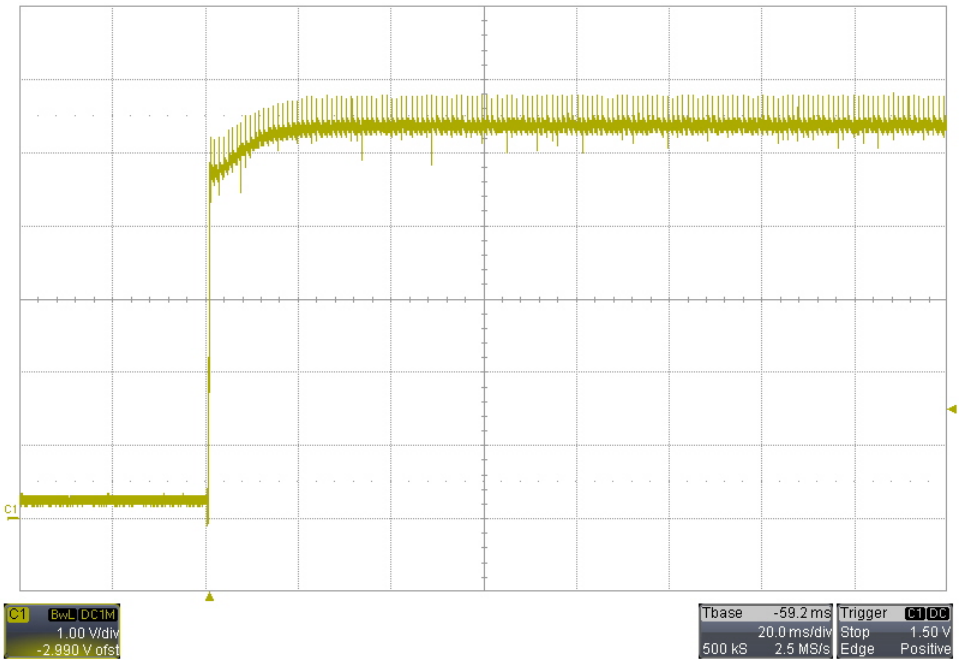


Figure 23. Output Voltage Start-up Waveform, 270 V_{AC}, 5-V V_{OUT} = 0-mA Load

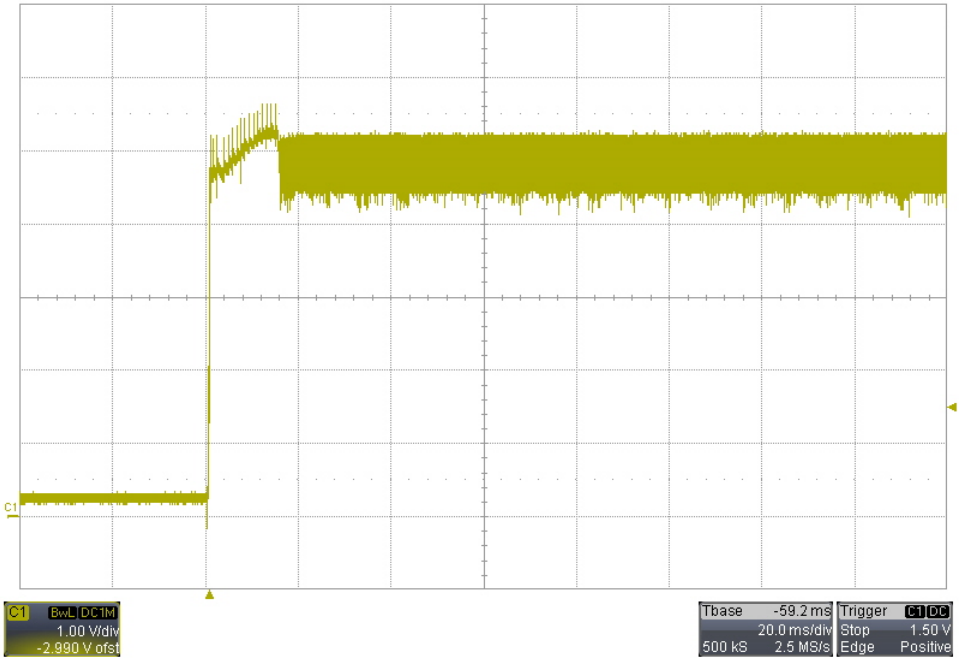


Figure 24. Output Voltage Start-up Waveform, 270 V_{AC}, 5-V V_{OUT} = 200-mA Load

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