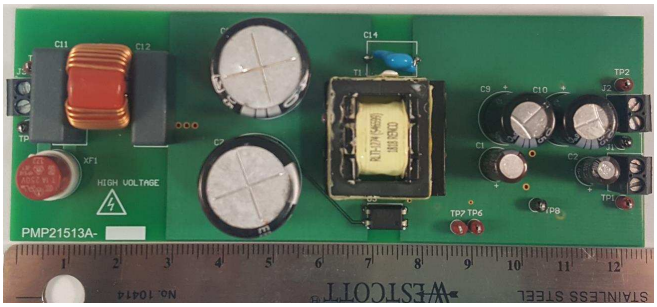
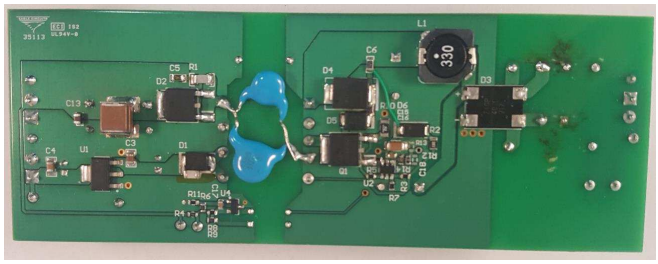
Test Report: PMP21513
25/50 W Flyback Reference Design for Audio Applications

Description

The quasi-resonant flyback design is a dual output converter with a 24 Volt output and a 6 Volt output that goes through a LDO to become 3.3 V. The voltages that are supplied are important for supplying power in audio applications. The 24 V line has a nominal 25 Watt output and can take peaks of 50 Watts which is ideal for the power requirements of audio applications. The design is also low noise for sensitive audio signals with less than 2.5% voltage ripple on the 24 V output. The 6 Volt line can handle 0.2 Amps of current out to supply any additional support devices.





1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
V_{IN}	90 to 264 VAC
V_{OUT}	24 V at 1.1 A/ 2.2 A
Nominal switching frequency	37.4 kHz at nominal load/ 74.8 kHz at full load

1.2 Considerations

The 6 Volt line needs 20 mA drawn from the 24 Volt load to reliably go to full load through the LDO.

2 Testing and Results

2.1 Efficiency Graphs

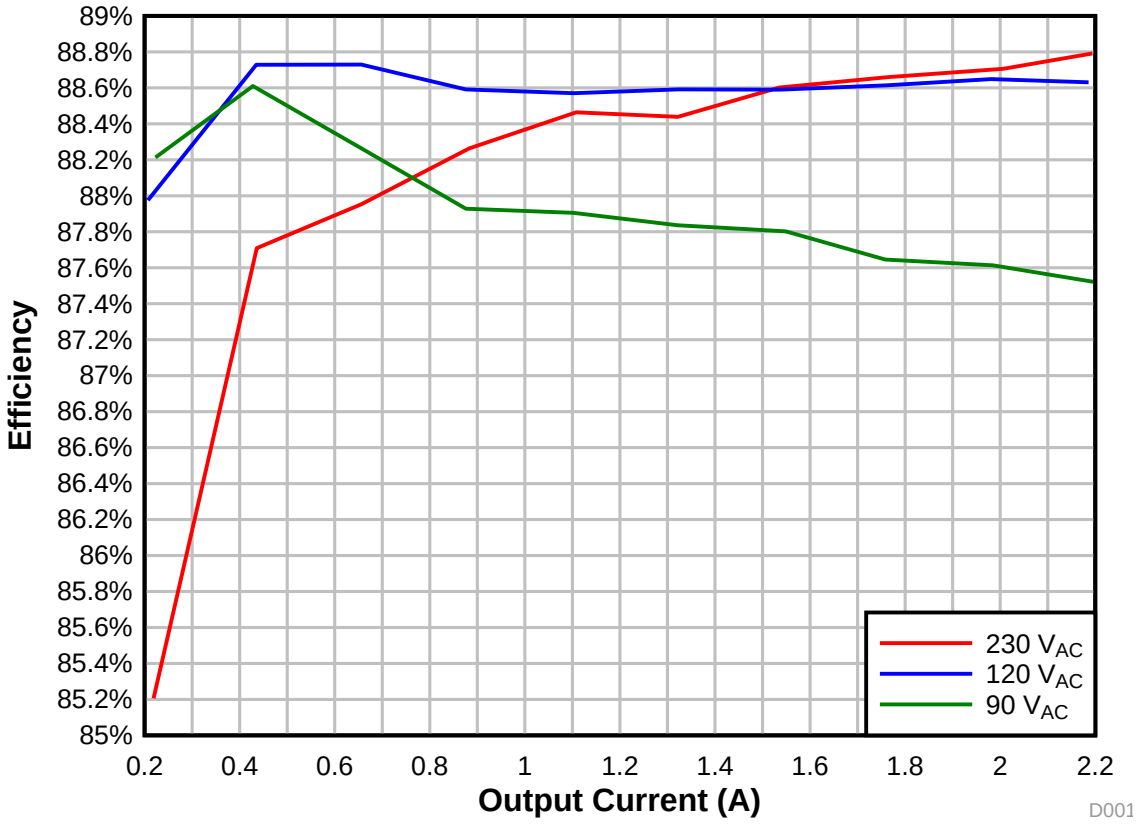


Figure 1. Efficiency Graph

Test was done with 6 V line unloaded.

2.2 Efficiency Data

Table 2. 230 VAC 50 Hz Efficiency Data

Vin (Volts AC)	Iin (Arms)	Pin (W)	Pf	Vout (V)	Iout (A)	Pin (W)	Eff
232.1	0.5355	59.55	0.479	24.1	2.194	59.55	0.888
232.1	0.495	54.5	0.474	24.1	2.006	54.5	0.887
232.2	0.4423	47.97	0.467	24.11	1.764	47.97	0.887
232.3	0.3916	41.77	0.459	24.11	1.535	41.77	0.886
232.3	344.5	36.04	0.451	24.11	1.322	36.04	0.884
232.4	295.7	30.21	0.44	24.12	1.108	30.21	0.885
232.4	0.2444	24.13	0.425	24.12	0.883	24.13	0.883
232.5	0.1919	17.99	0.405	24.12	0.656	17.99	0.880
232.6	0.138	11.99	0.374	24.12	0.436	11.99	0.877
232.6	0.0869	6.202	0.307	24.13	0.219	6.202	0.852
232.7	0.0484	0.181	0.016	24.14	0	0.181	0.000

Efficiency data was taken with the 6 Volt line unloaded.

Table 3. 120 VAC 60 Hz Efficiency Data

Vin (Volts AC)	Iin (Arms)	Pin (W)	Pf	Vout (V)	Iout (A)	Pin (W)	Eff
119.24	0.884	59.49	0.564	24.12	2.186	59.49	0.886
119.32	0.8061	53.9	0.56	24.12	1.981	53.9	0.886
119.4	0.7234	47.96	0.555	24.12	1.762	47.96	0.886
119.5	0.6373	41.82	0.549	24.12	1.536	41.82	0.886
119.59	0.5557	36.02	0.542	24.12	1.323	36.02	0.886
119.69	0.4712	30.05	0.533	24.13	1.103	30.05	0.8864
119.8	0.383	23.86	0.52	24.13	0.876	23.86	0.886
119.9	0.2958	17.84	0.503	24.13	0.656	17.84	0.887
120	0.2068	11.83	0.477	24.13	0.435	11.83	0.887
120.1	0.1116	5.68	0.425	24.14	0.207	5.68	0.880
120.25	0.03	0.091	0.025	24.15	0	0.091	0

Efficiency data was taken with the 6 Volt line unloaded.

Table 4. 90 VAC 50 Hz Efficiency Data

Vin (Volts AC)	Iin (Arms)	Pin (W)	Pf	Vout (V)	Iout (A)	Pin (W)	Eff
89.57	1.195	60.6	0.566	24.13	2.198	60.6	0.875
89.65	1.084	54.67	0.563	24.13	1.985	54.67	0.876
89.75	0.964	48.4	0.559	24.13	1.758	48.4	0.876
89.86	0.8514	42.57	0.557	24.13	1.549	42.57	0.878
89.96	0.73	36.29	0.553	24.13	1.321	36.29	0.878
90.08	0.6133	30.25	0.547	24.13	1.102	30.25	0.879
90.22	0.4942	24.04	0.539	24.13	0.876	24.04	0.879
90.34	0.3803	18.1	0.527	24.13	0.662	18.1	0.883
90.49	0.2563	11.66	0.504	24.14	0.428	11.66	0.886
90.65	0.145	6.1	0.465	24.13	0.223	6.1	0.882
90.82	0.019	0.075	0.044	24.14	0	0.075	0

Efficiency data was taken with the 6 Volt line unloaded.

2.3 Thermal Images

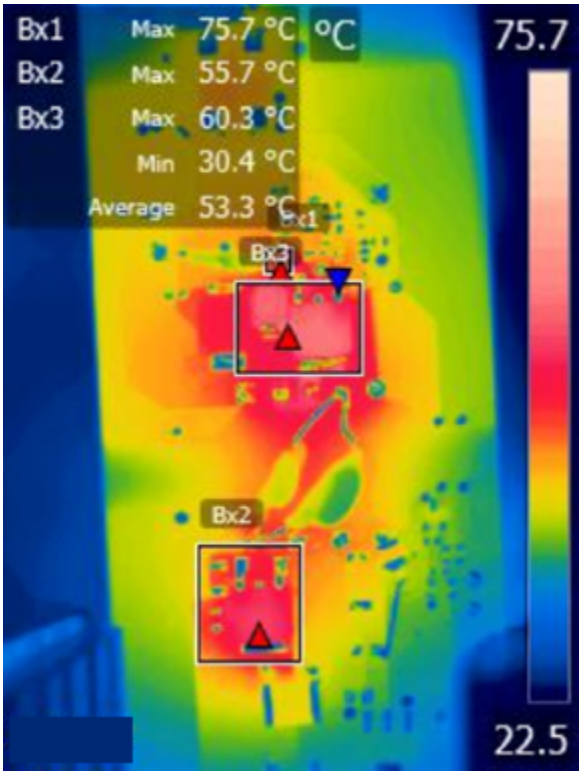


Figure 2. 230 VAC Front Side

Test was done with 24 V/1.1 A and 6 V/0.2 A output.

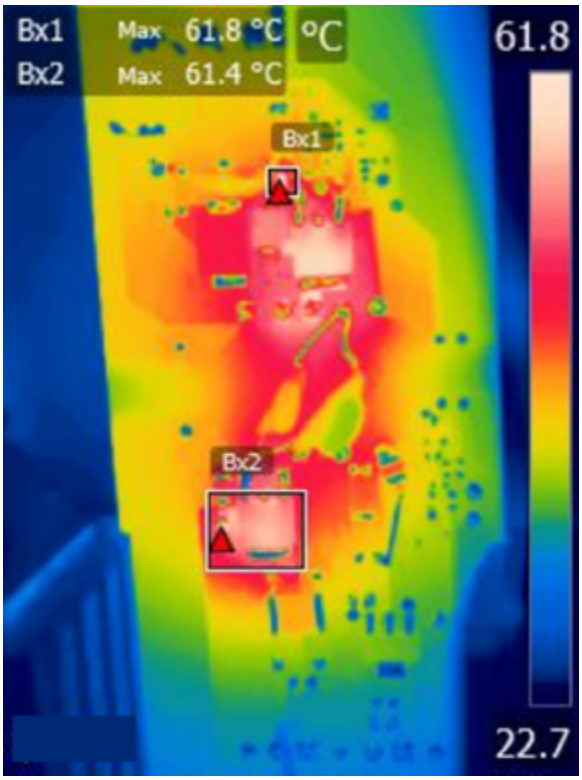


Figure 3. 230 VAC Back Side

Test was done with 24 V/1.1 A and 6 V/0.2 A output.

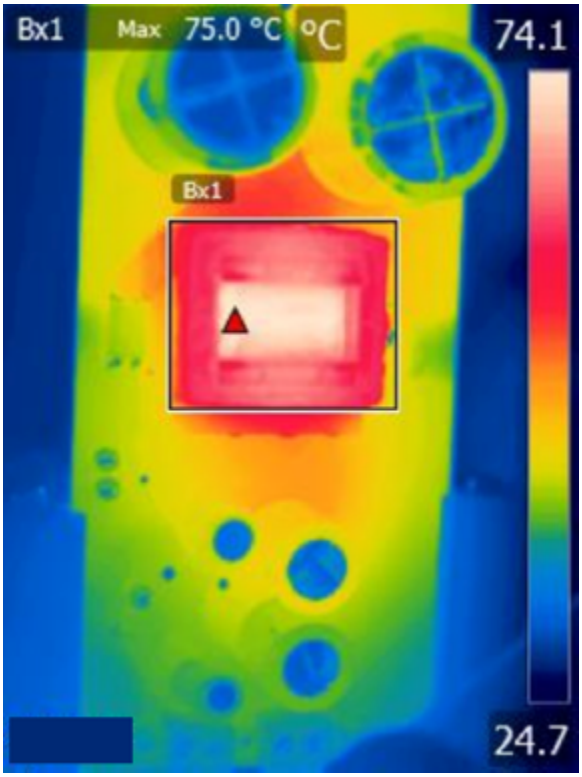


Figure 4. 120 VAC Front Side

Test was done with 24 V/1.1 A and 6 V/0.2 A output.

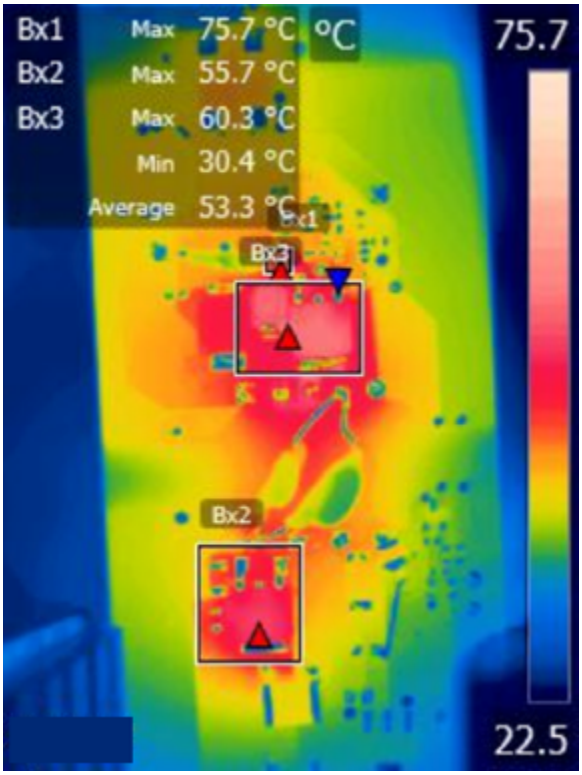


Figure 5. 120 VAC Back Side

Test was done with 24 V/1.1 A and 6 V/0.2 A output.

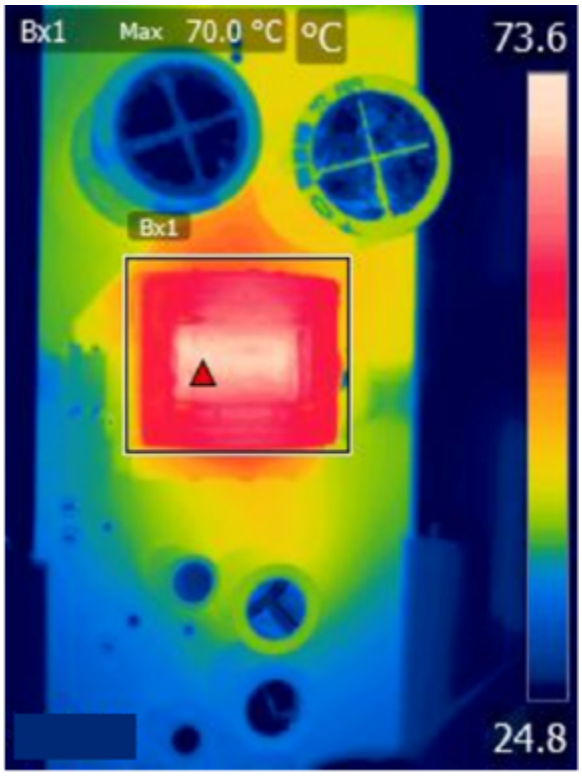


Figure 6. 90 VAC Front Side

Test was done with 24 V/1.1 A and 6 V/0.2 A output.

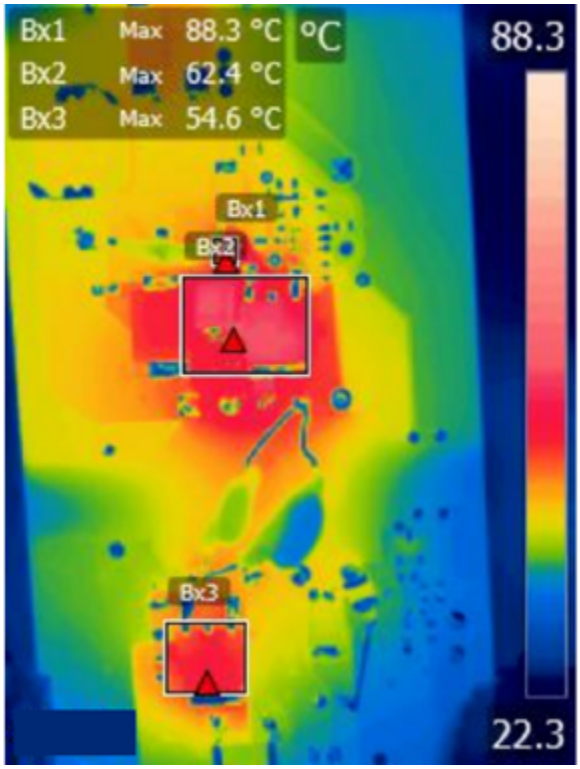


Figure 7. 90 VAC Back Side

Test was done with 24 V/1.1 A and 6 V/0.2 A output.

3 Waveforms

3.1 Switching

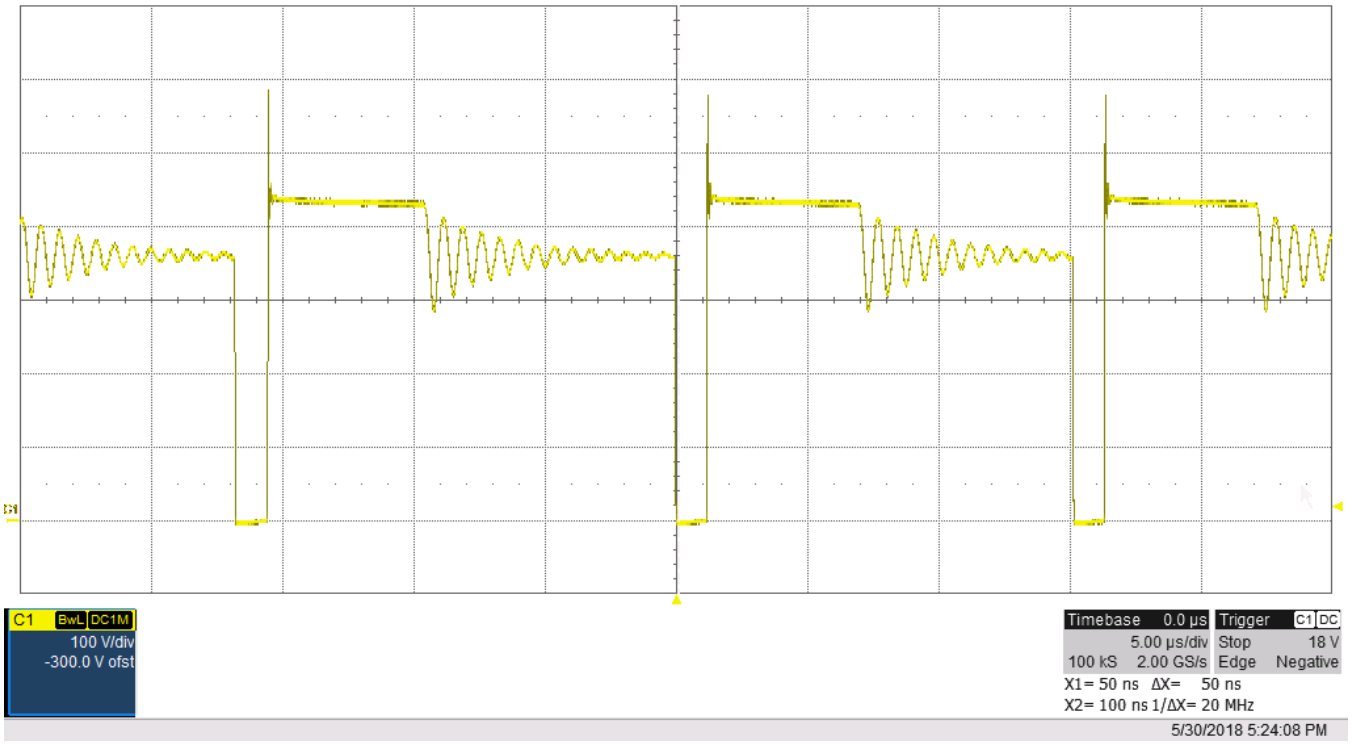


Figure 8. V_{DS} of Primary Side MOSFET (Q1)

Testing done at 265 VAC and full load on both 24 V and 6 V outputs.

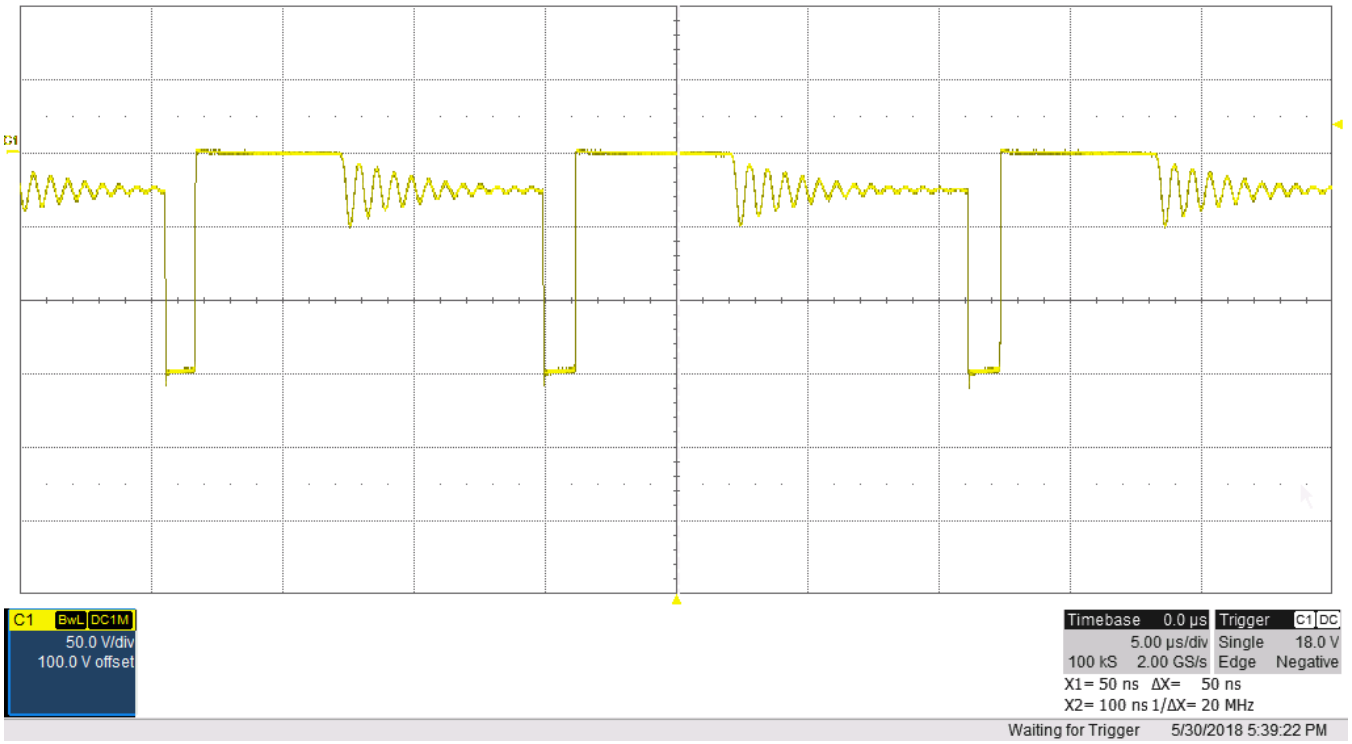


Figure 9. Voltage Across 24 V Line Rectifier (D2)

Testing done at 265 VAC and full load on both 24 V and 6 V outputs.

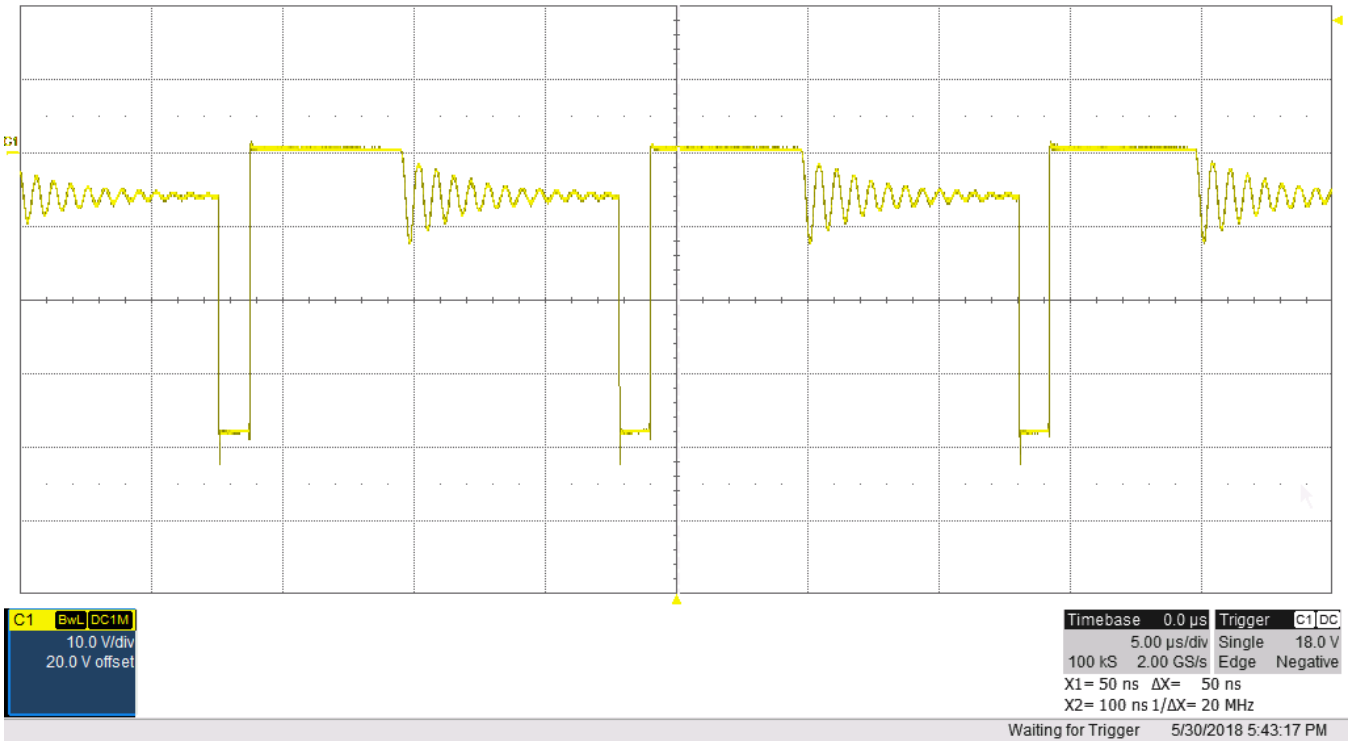


Figure 10. Voltage Across 6 V Line Rectifier (D1)

Testing done at 265 VAC and full load on both 24 V and 6 V outputs.

3.2 Output Voltage Ripple

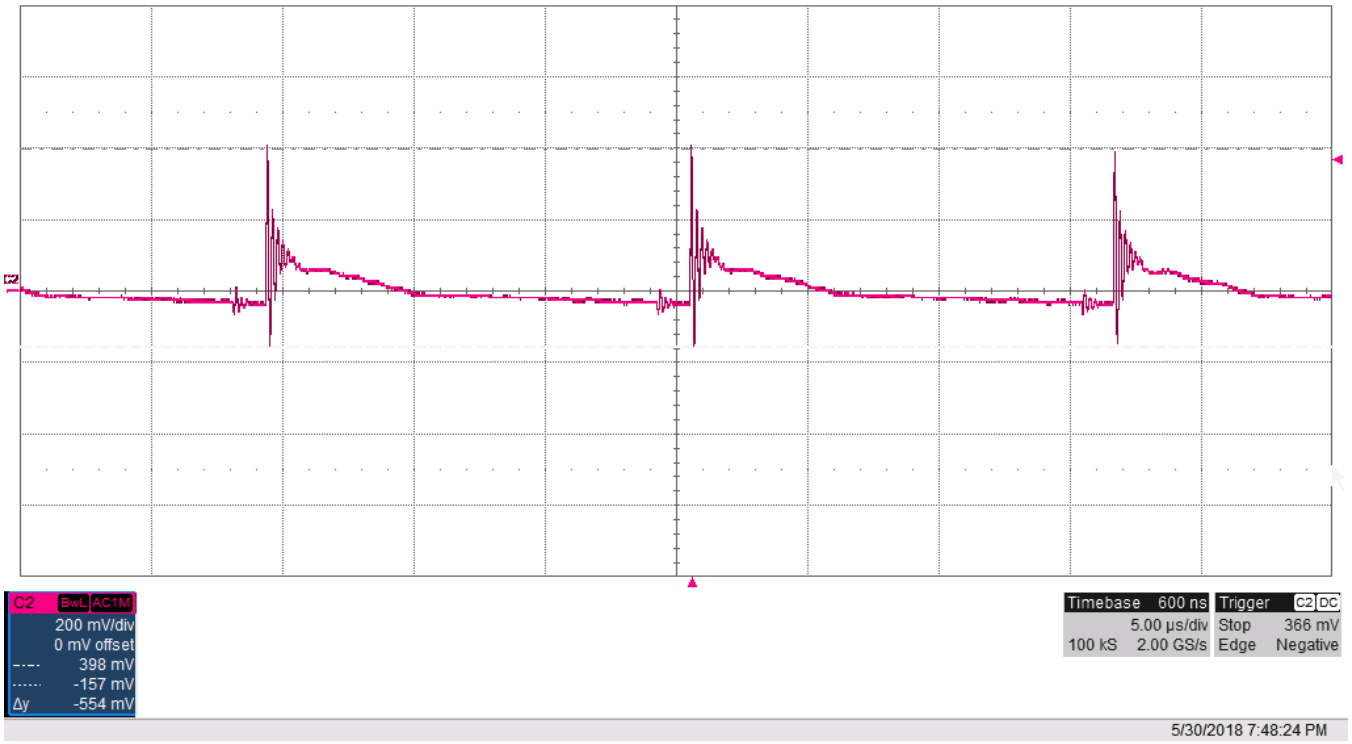


Figure 11. 230 VAC Voltage Ripple on 24 V Line

Testing done at 230 VAC and full load on both 24 V and 6 V outputs.

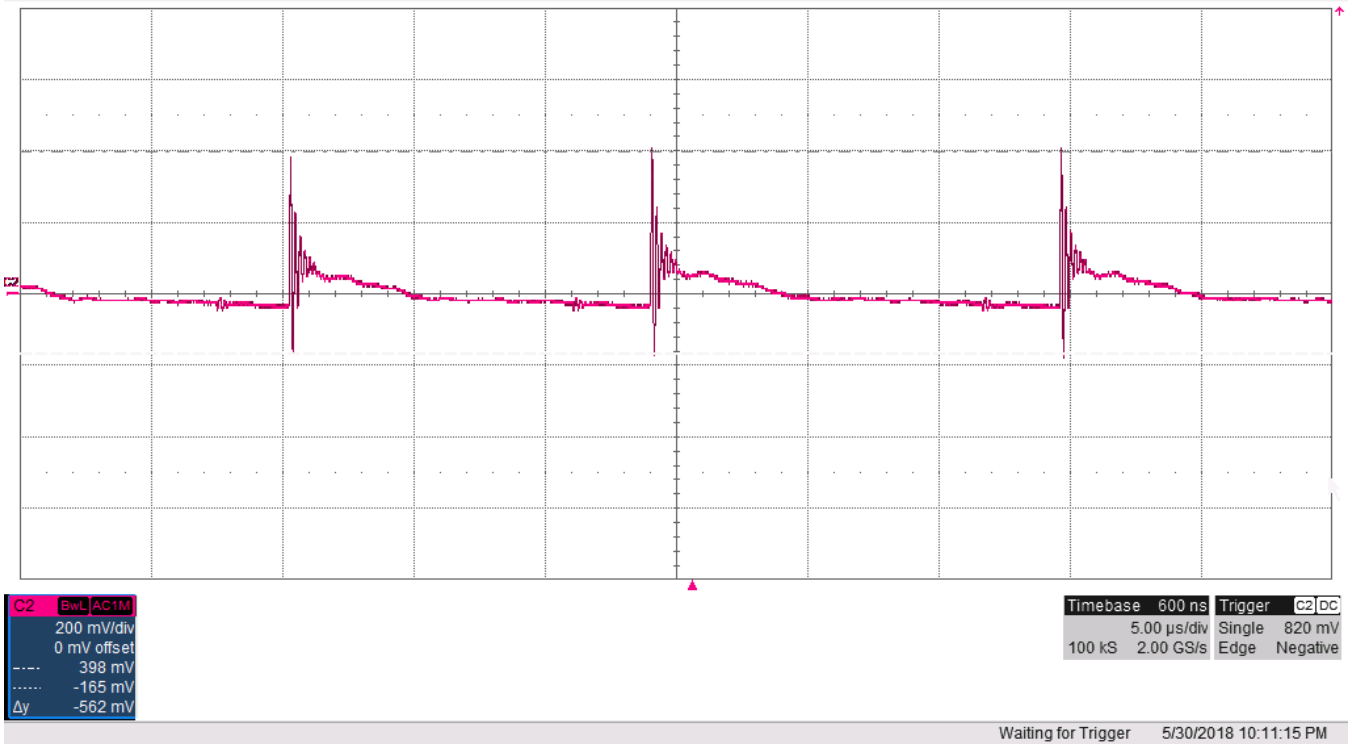


Figure 12. 120 VAC Voltage Ripple on 24 V Line

Testing done at 120 VAC and full load on both 24 V and 6 V outputs.

3.3 Bode Plot

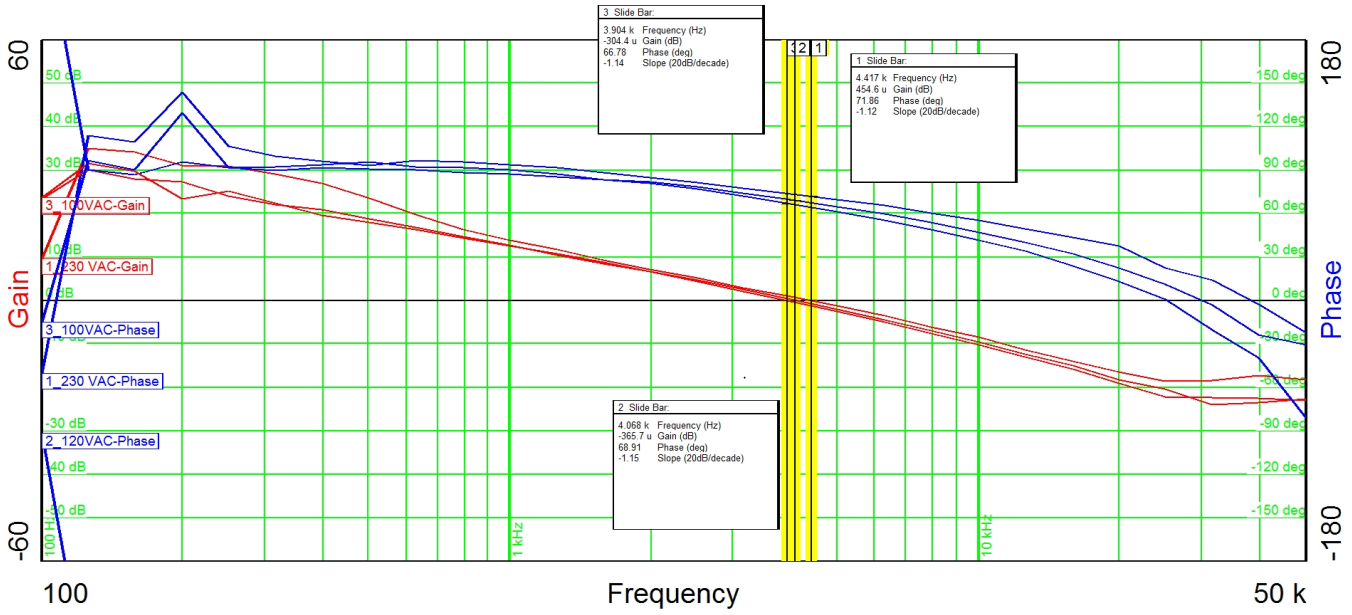


Figure 13. Bode Plot For Various Input Voltages

Tests were done with the 24 V and 6 V line fully loaded.

3.4 Load Transients

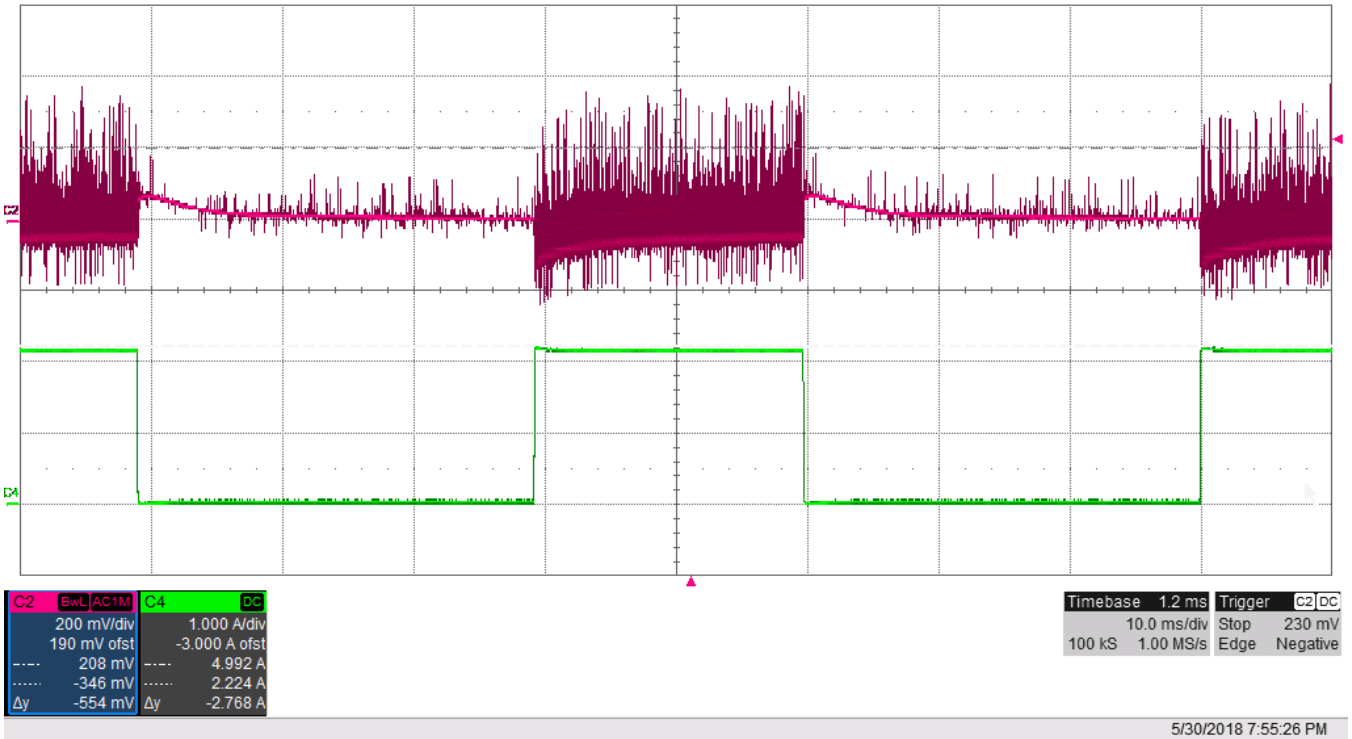


Figure 14. 230 VAC Load Transient

Test was run at 230 VAC input from no load to 2.2 A.

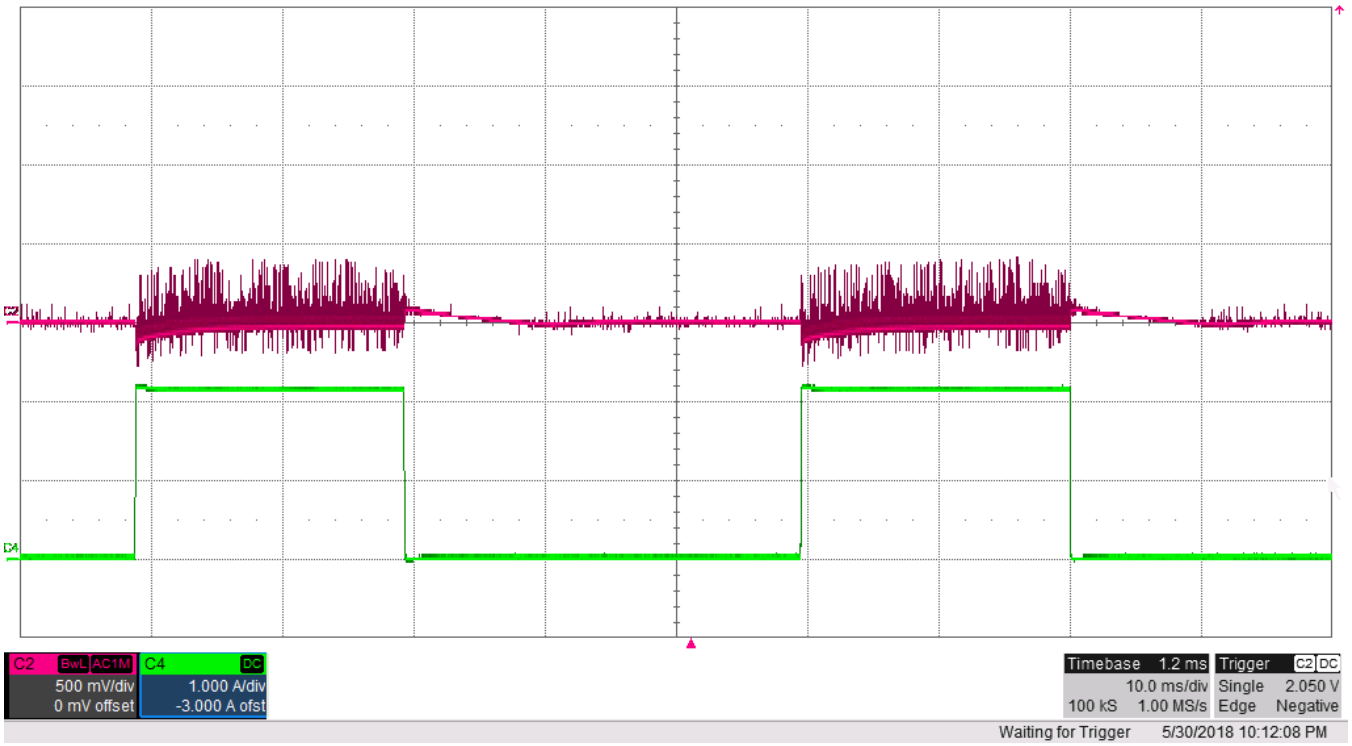


Figure 15. 120 VAC Load Transient

Test was run at 120 VAC input from no load to 2.2 A.

3.5 Start-up Sequence

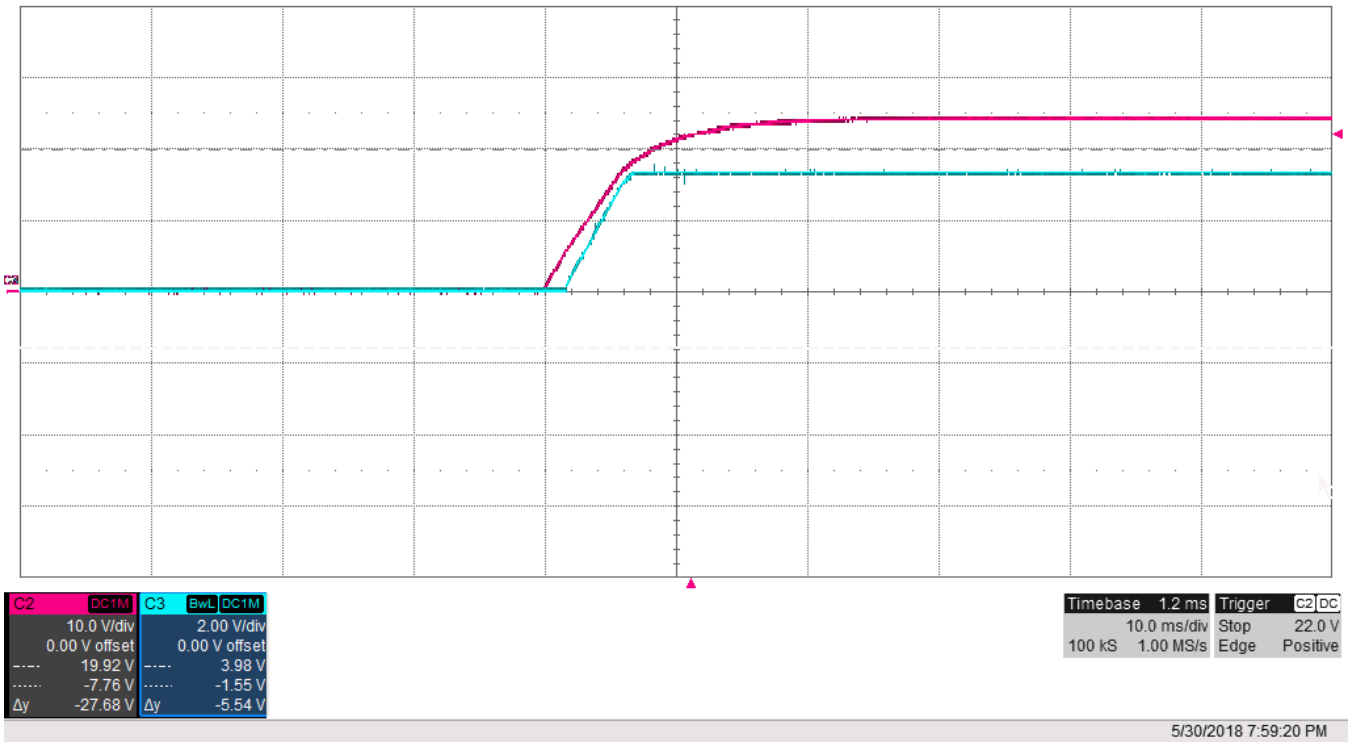


Figure 16. 230 VAC Start-up

Test was done at 230 VAC input with the output unloaded.

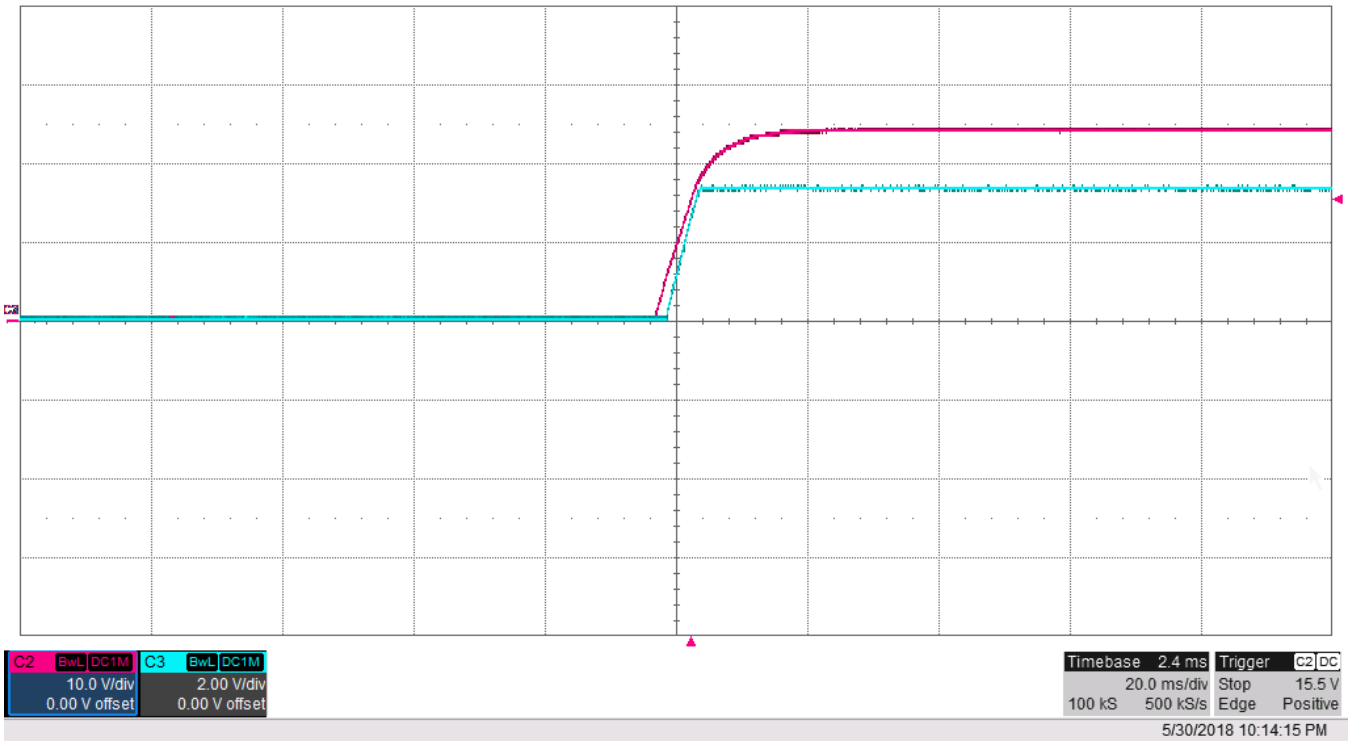


Figure 17. 120 VAC Start-up

Test was done at 120 VAC input with the output unloaded.

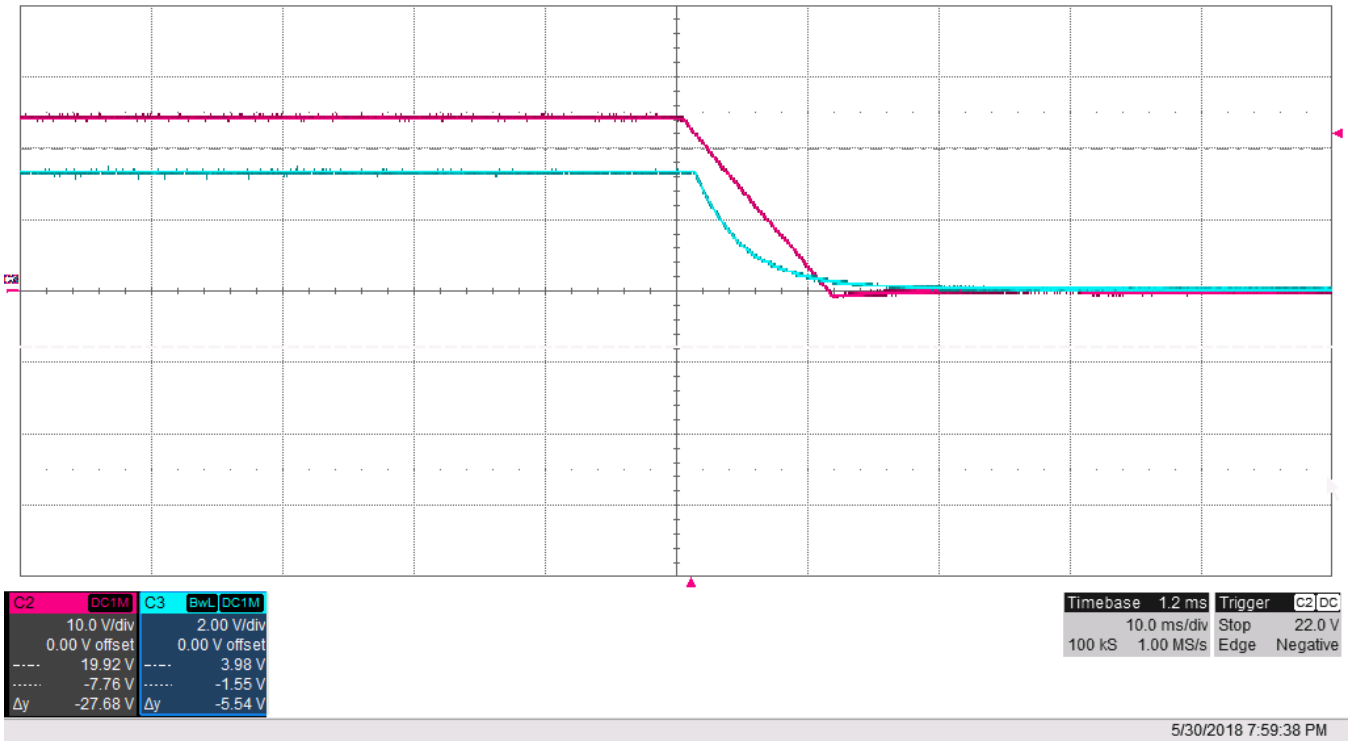


Figure 18. 230 VAC Shutdown

Test was done at 230 VAC with the output fully loaded.

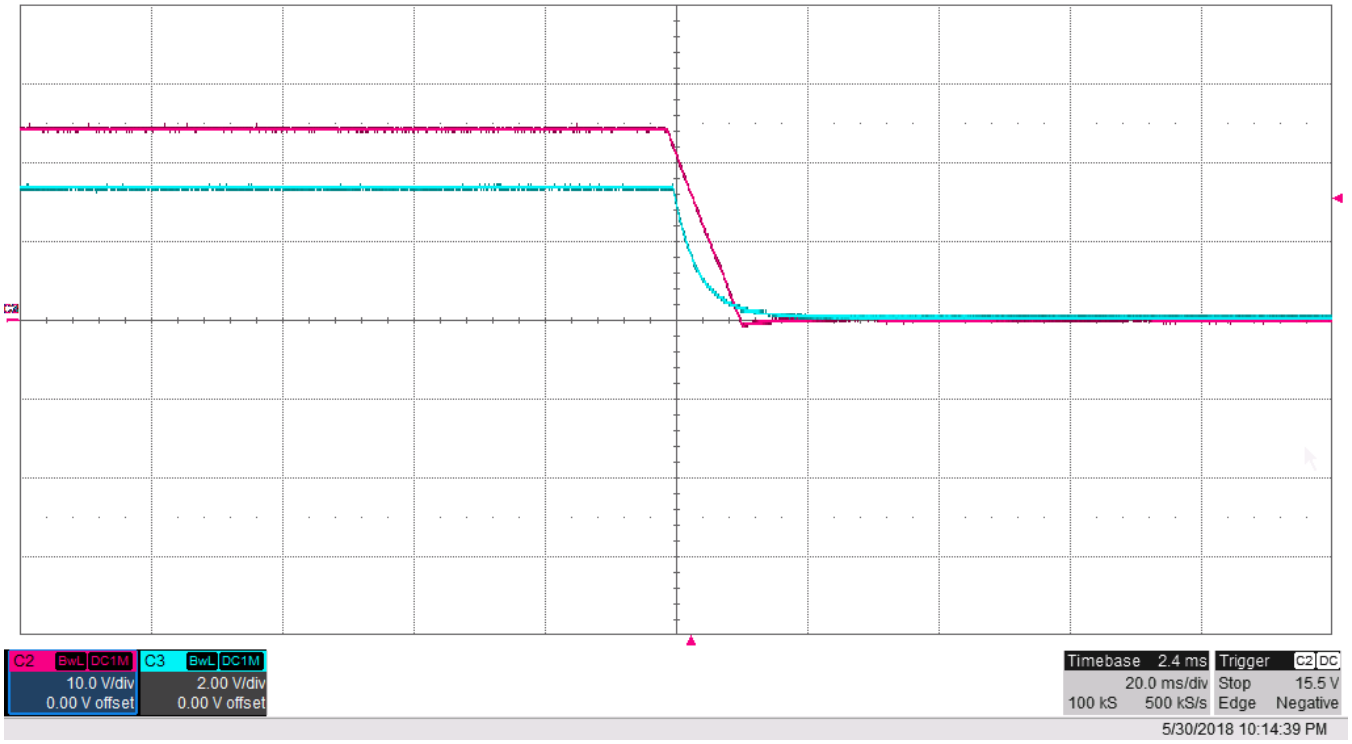


Figure 19. 120 VAC Shutdown

Test was done at 120 VAC with the output fully loaded.

3.6 EMI

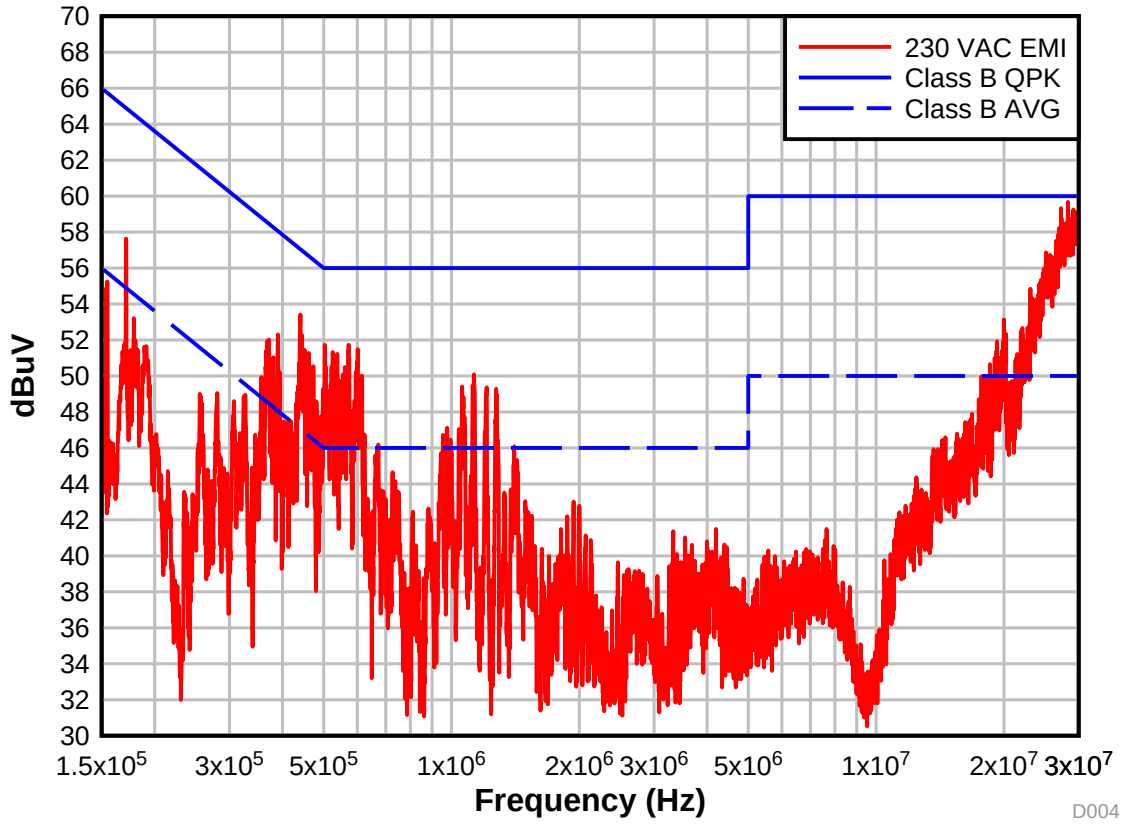


Figure 20. Peak Detector, Max-Hold - 230 VAC/50 Hz Input, Full Load

Test was done at 230 VAC with a fully loaded output.

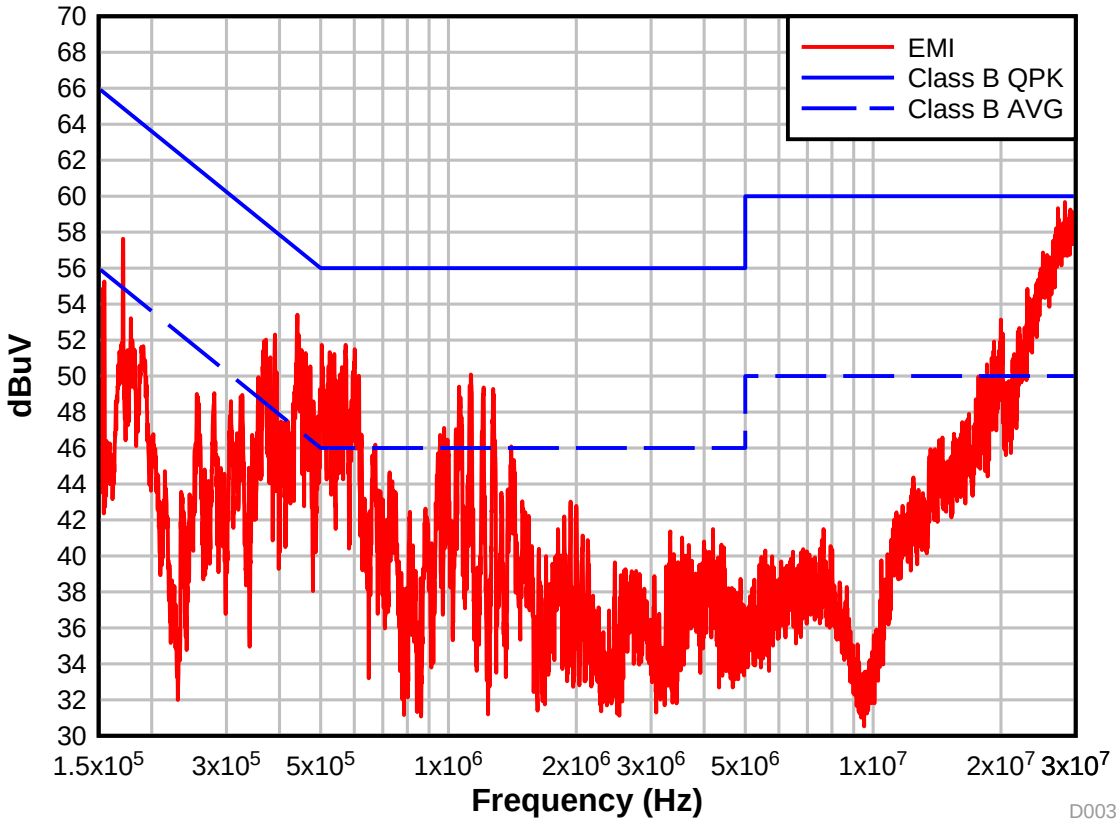


Figure 21. Peak Detector, Max-Hold - 120 VAC/50 Hz Input, Full Load

Test was done at 120 VAC with a fully loaded output.

3.7 Cross Regulation

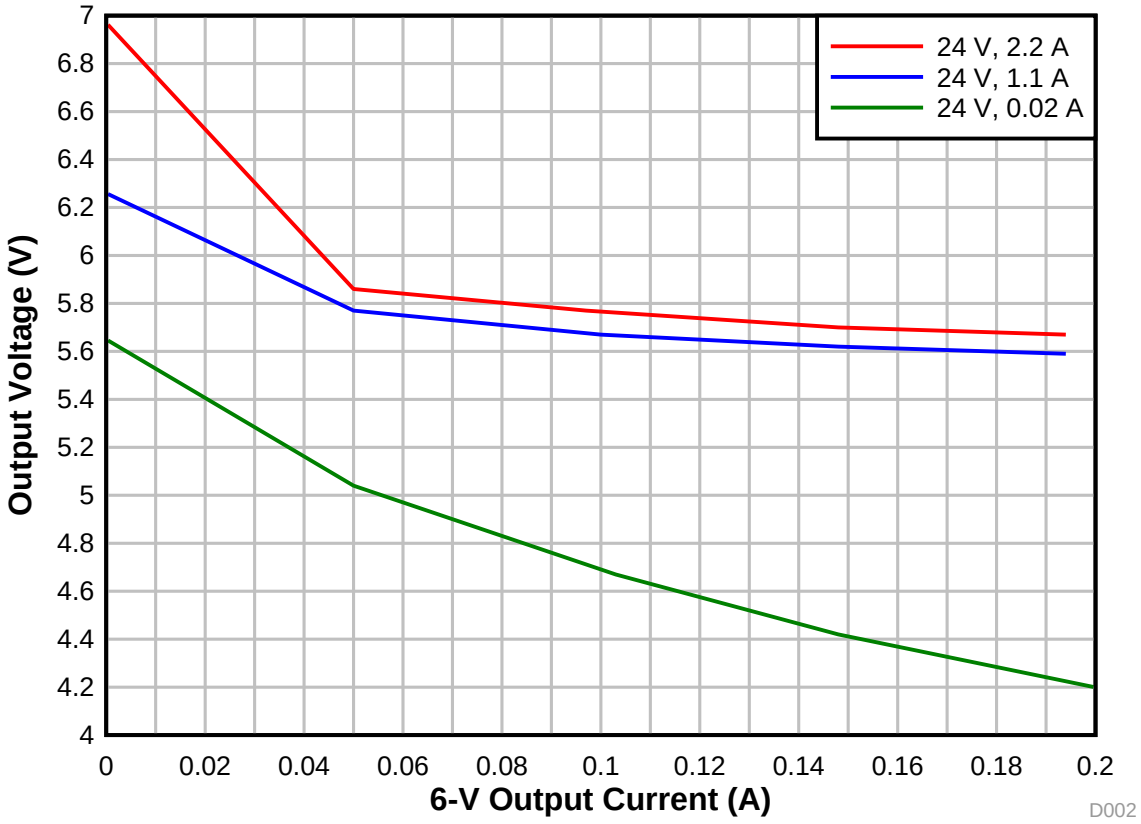


Figure 22. Cross Regulation of 6 V Line

Test was done at 230 VAC/50 Hz input.

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