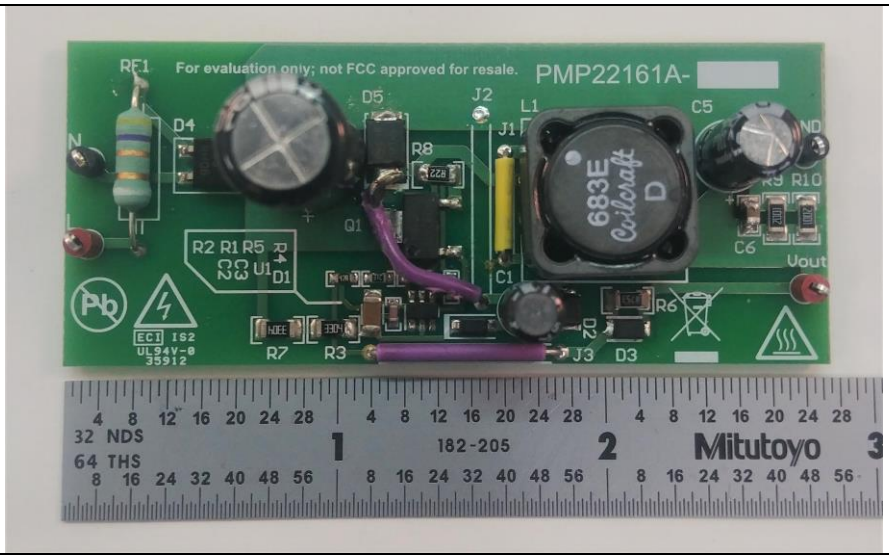
Test Report: PMP22161
3.6-W AC/DC Coupled Inductor Buck Reference Design

Description

This reference design is a non-isolated AC/DC power supply design using the UCC28704 PSR controller to implement a high voltage buck converter. The converter provides 6V at 600mA from an AC input of 100 VAC to 132 VAC. The design uses a coupled inductor to provide a 12V supply voltage to the controller, eliminating the need for a separate bias supply. This design is one layer, compact, and thermally efficient.



1 System Specification

1.1 Board Dimension:

- 2.8 in. x 1.2 in. x 0.5 in.

1.2 Input Characteristics

1.2.1 AC Input Voltage and Frequency Limitations:

PARAMETER	SPECIFICATIONS	
Input Voltage	100 – 132	Vac
Line Frequency	57 – 63	Hz

1.2.2 AC Input Current:

- 0.1A Max. at 100VAC.

1.3 Output Characteristics

The power supply unit should be able to supply 6V+/-5%, 3.6W output power continuously.

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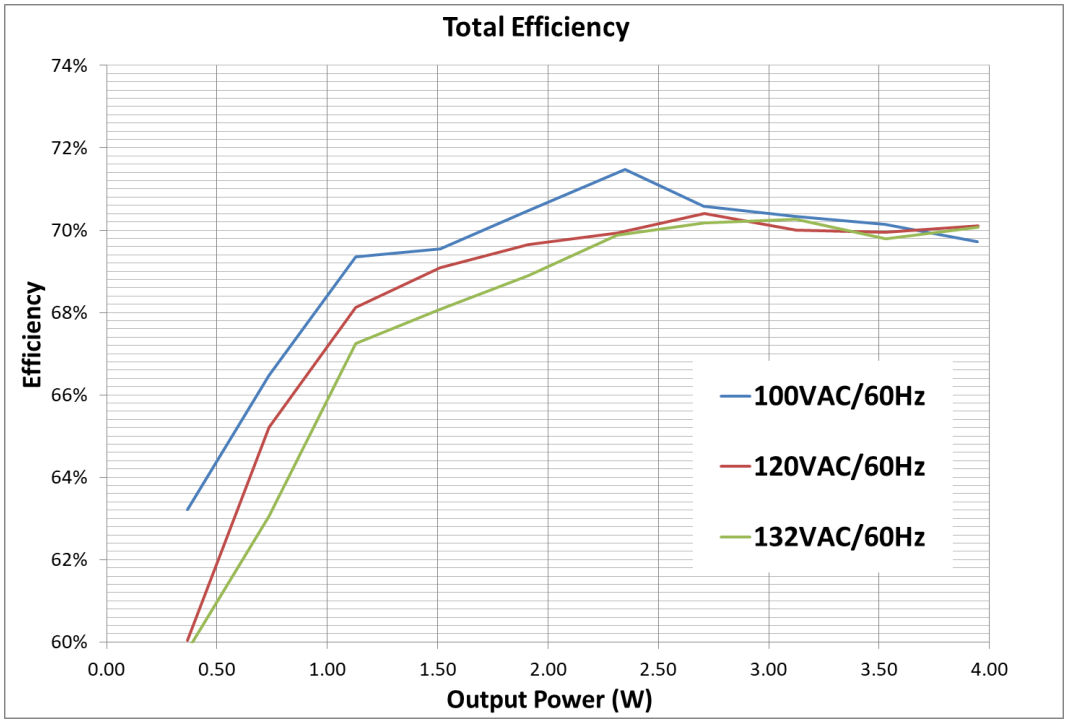
2 Testing and Results

2.1 Efficiency Data



2.1.1 100VAC/60Hz Efficiency Measurement

Vin (V)	Iin (A)	Pin (W)	P.F.	Vout (V)	Iout (A)	Pout(W)	Efficiency (%)
100.02	0.016	0.58	0.374	6.31	0.058	0.37	63.22%
100.02	0.026	1.11	0.421	6.33	0.116	0.74	66.47%
100.02	0.036	1.63	0.448	6.37	0.177	1.13	69.34%
100.02	0.046	2.17	0.475	6.41	0.236	1.51	69.55%
100.02	0.055	2.71	0.494	6.44	0.297	1.91	70.48%
100.01	0.064	3.29	0.513	6.58	0.357	2.35	71.48%
100.01	0.073	3.84	0.526	6.51	0.416	2.71	70.58%
100.01	0.082	4.44	0.542	6.55	0.477	3.12	70.33%
100.01	0.091	5.03	0.551	6.58	0.536	3.53	70.15%
100.01	0.101	5.66	0.563	6.62	0.596	3.95	69.71%

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2.1.2 120VAC/60Hz Efficiency Measurement

Vin (V)	Iin (A)	Pin (W)	P.F.	Vout (V)	Iout (A)	Pout(W)	Efficiency (%)
120.04	0.014	0.61	0.360	6.31	0.058	0.37	60.04%
120.04	0.024	1.13	0.393	6.33	0.116	0.74	65.22%
120.04	0.033	1.66	0.420	6.37	0.177	1.13	68.12%
120.04	0.041	2.19	0.443	6.41	0.236	1.51	69.09%
120.03	0.049	2.74	0.464	6.44	0.297	1.91	69.65%
120.03	0.057	3.31	0.479	6.48	0.357	2.31	69.92%
120.03	0.065	3.85	0.491	6.51	0.416	2.71	70.40%
120.03	0.073	4.46	0.506	6.55	0.477	3.12	70.00%
120.03	0.081	5.04	0.518	6.58	0.536	3.53	69.94%
120.03	0.089	5.63	0.527	6.62	0.597	3.95	70.11%

2.1.3 132VAC/60Hz Efficiency Measurement

Vin (V)	Iin (A)	Pin (W)	P.F.	Vout (V)	Iout (A)	Pout(W)	Efficiency (%)
132.04	0.014	0.61	0.341	6.31	0.058	0.37	59.80%
132.04	0.023	1.17	0.384	6.33	0.116	0.74	63.06%
132.04	0.031	1.68	0.407	6.36	0.177	1.13	67.25%
132.04	0.039	2.22	0.429	6.40	0.236	1.51	68.07%
132.04	0.047	2.77	0.447	6.44	0.297	1.91	68.89%
132.04	0.054	3.31	0.461	6.48	0.357	2.31	69.88%
132.04	0.062	3.86	0.472	6.51	0.416	2.71	70.18%
132.04	0.069	4.45	0.486	6.55	0.477	3.12	70.26%
132.03	0.077	5.06	0.500	6.59	0.536	3.53	69.78%
132.03	0.084	5.64	0.509	6.62	0.596	3.95	70.06%

2.2 No Load Power Consumption

No load power consumption was measured with PA1000 power meter using **5-minute-average** and Kikisui PCR 2000LA source.

120VAC/60Hz: P_{in}=57.5mW.

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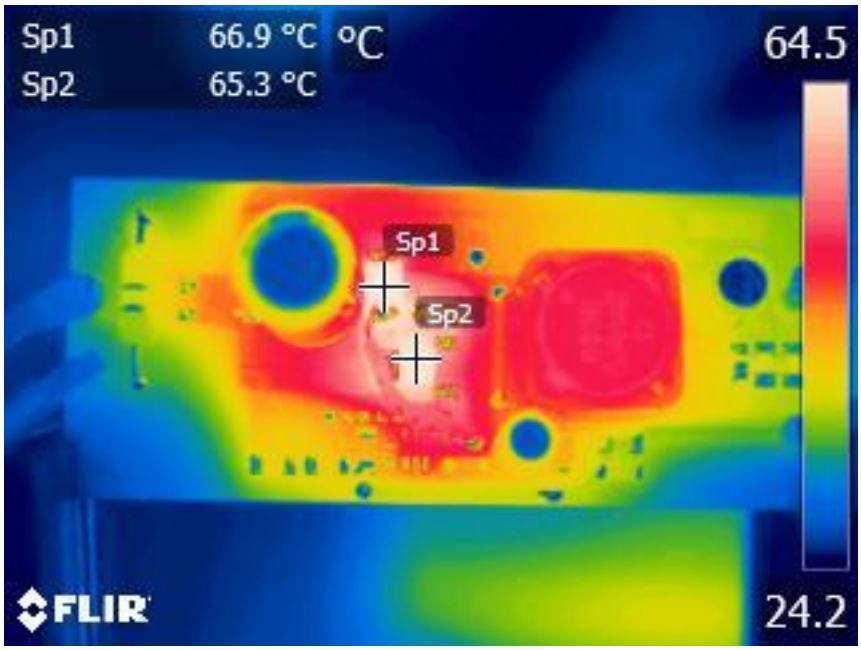
2.3 Thermal Images

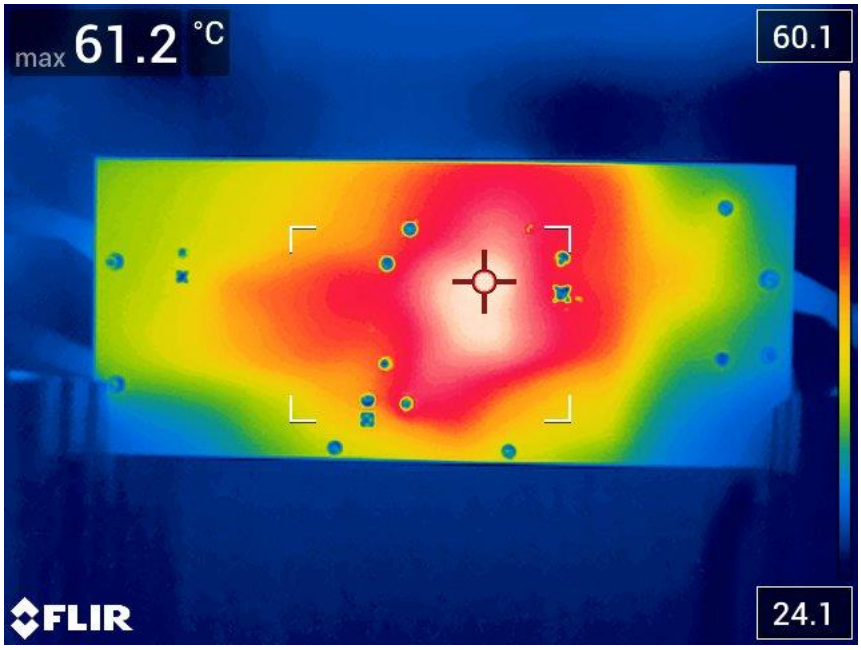
The thermal images below show a top view and bottom view of the board. The board is placed vertically during the test. The ambient temperature was 25ºC with no air flow. The output was loaded with 6V/0.6A for 30 minutes.

2.3.1 100V_{AC}/60Hz, Top Side

Sp1 – D5
Sp2 – Q1



2.3.2 100V_{AC}/60Hz, Bottom Side



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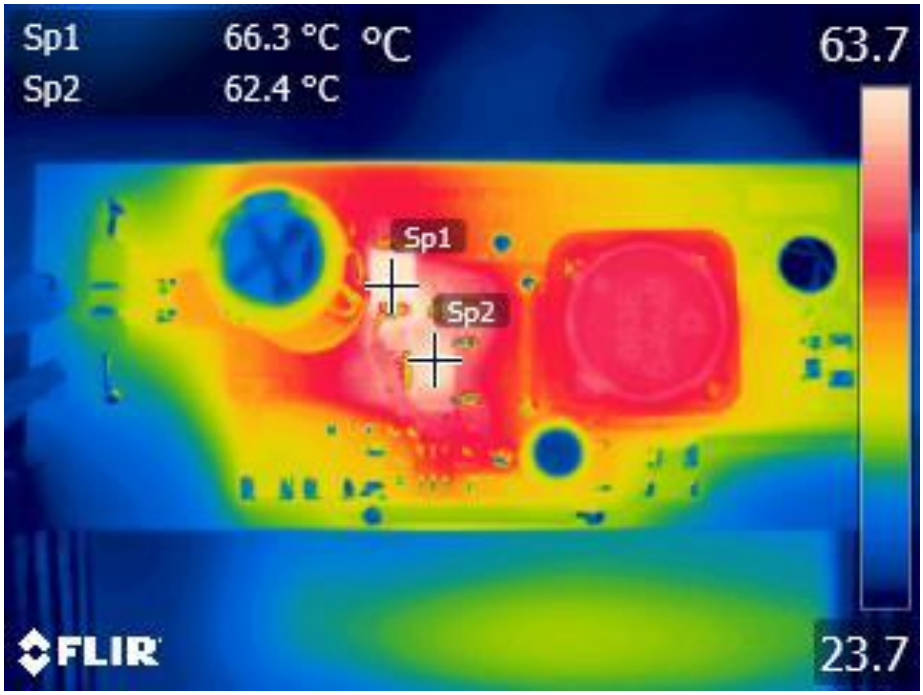
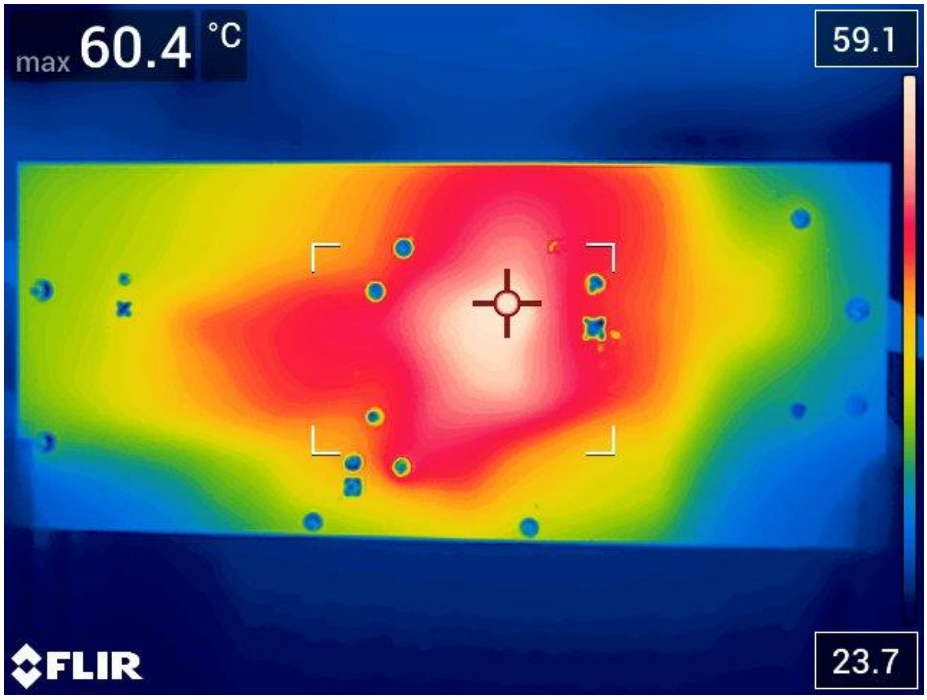
2.3.3 120V_{AC}/60Hz, Top Side

Sp1 – D5
Sp2 – Q1



2.3.4 120V_{AC}/60Hz, Bottom Side



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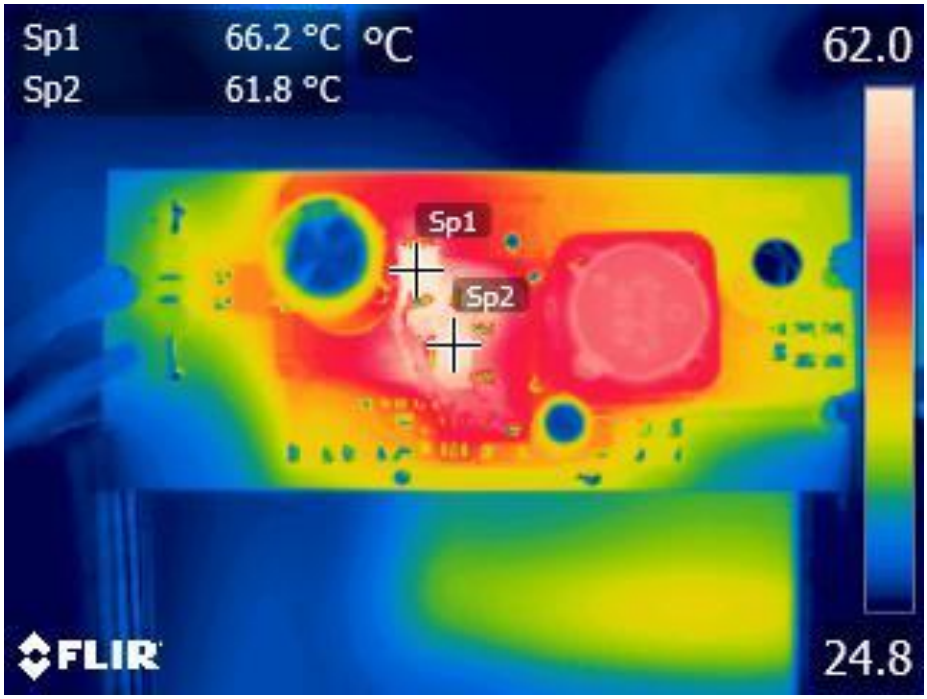
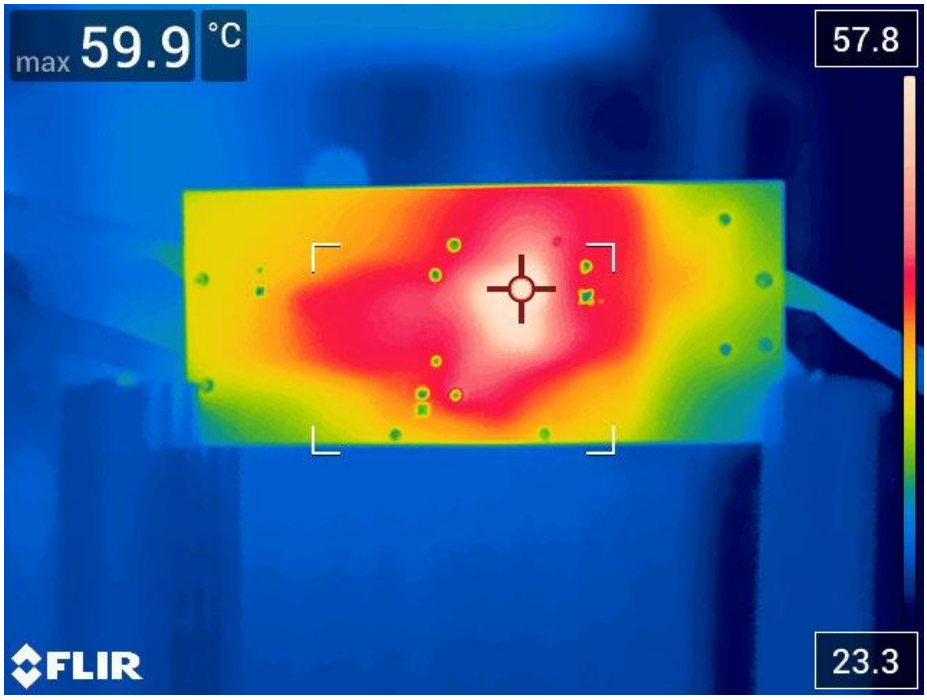
2.3.5 132V_{AC}/60Hz, Top Side

Sp1 – D5
Sp2 – Q1



2.3.6 132V_{AC}/60Hz, Bottom Side



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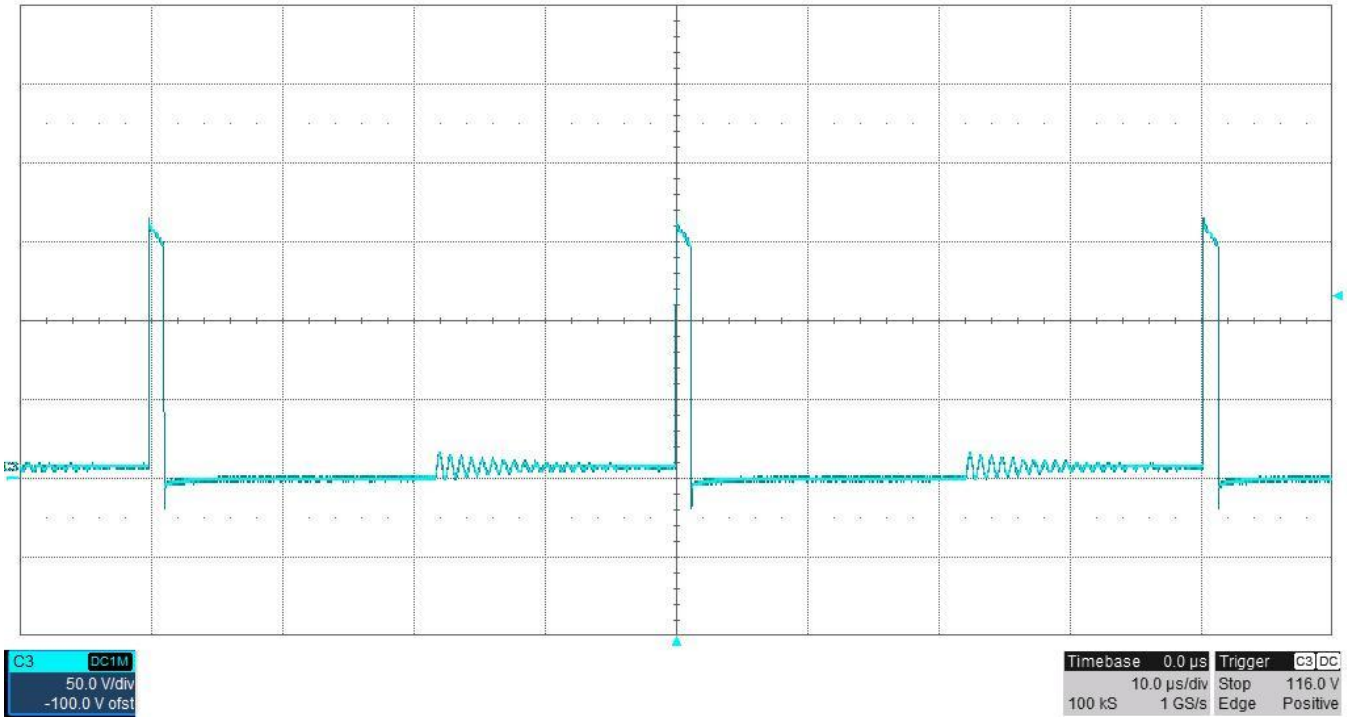
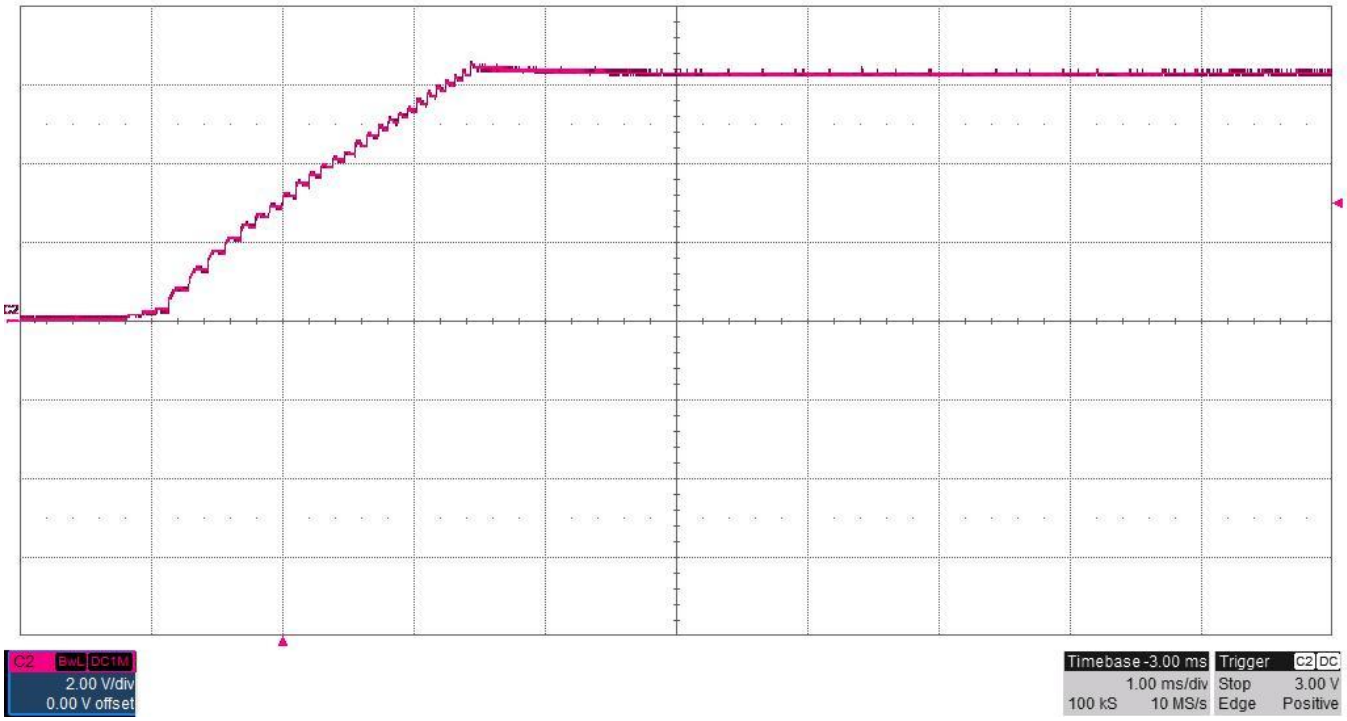
2.4 Switching

2.4.1 SW to GND, 120V_{AC}/60Hz – 6V/0.6A



2.5 Startup

2.5.1 120V_{AC}/60Hz – 6V/0A



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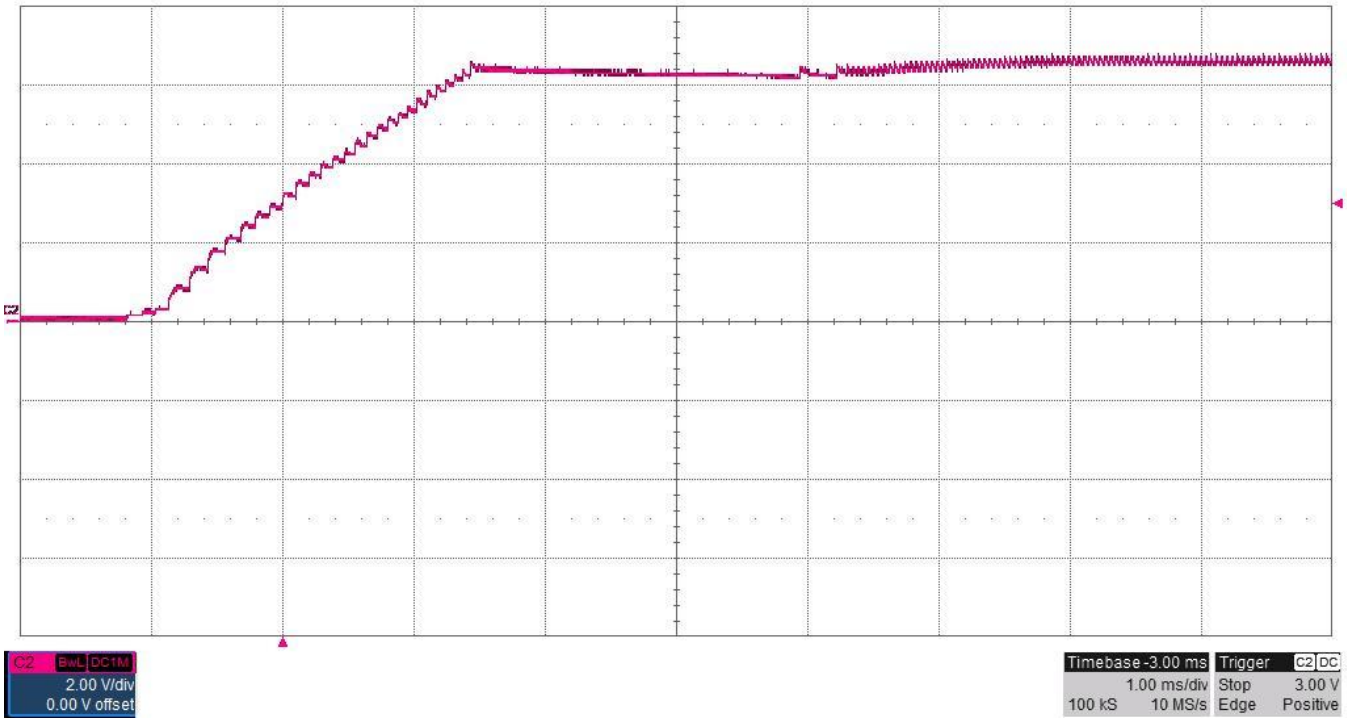
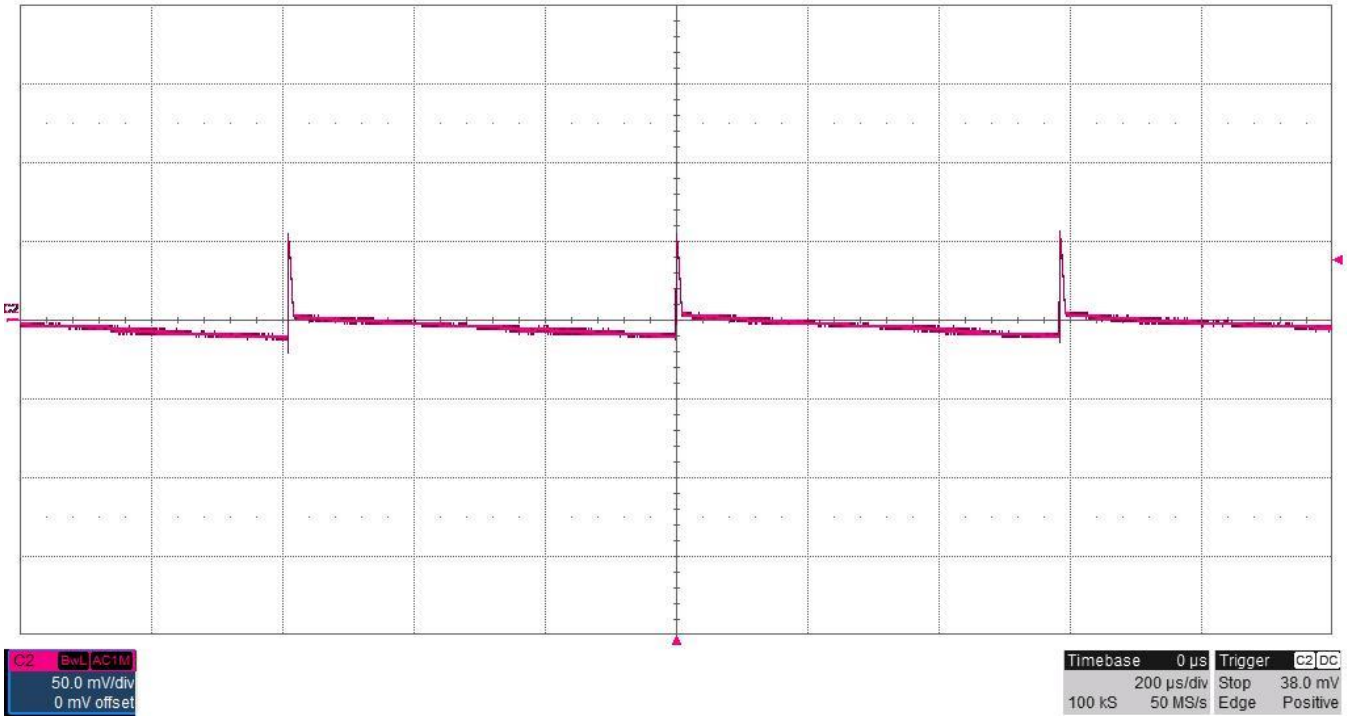
2.5.2 120V_{AC}/60Hz – 6V/0.6A



2.6 Ripple Voltages

2.6.1 120V_{AC}/60Hz – 6V/0A



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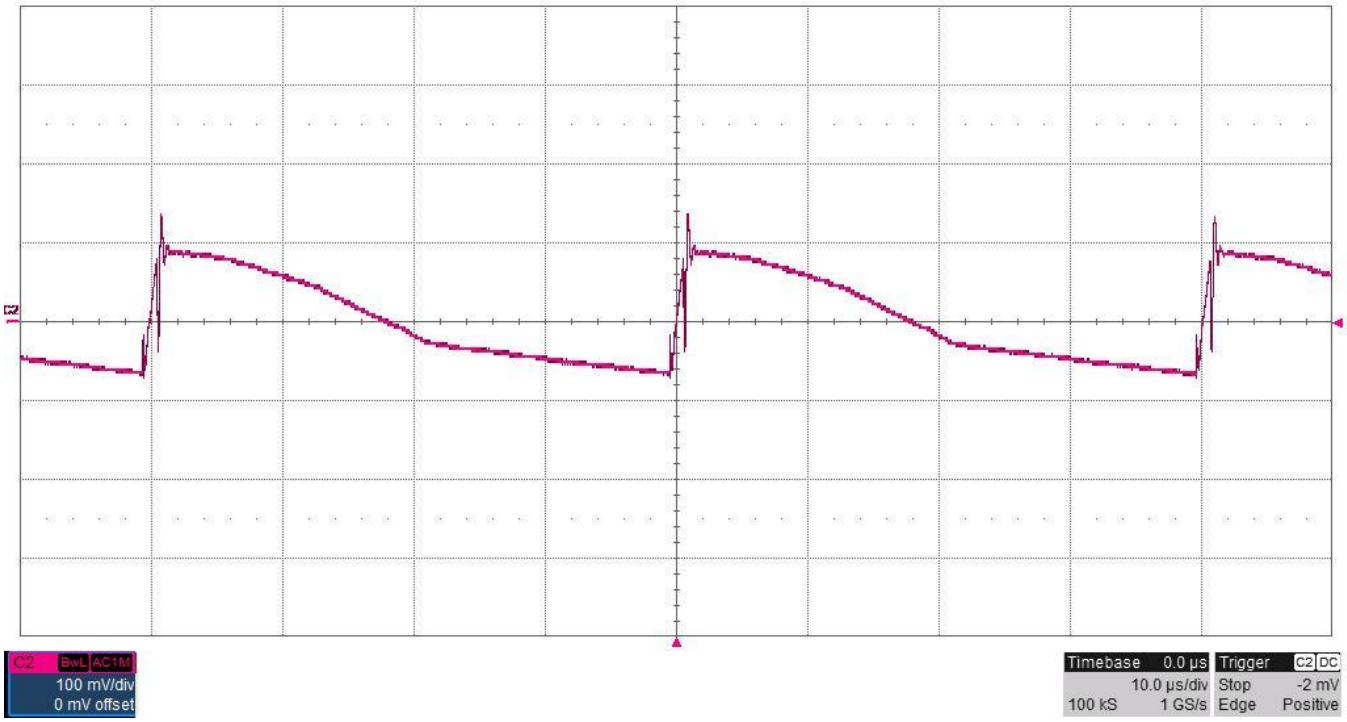
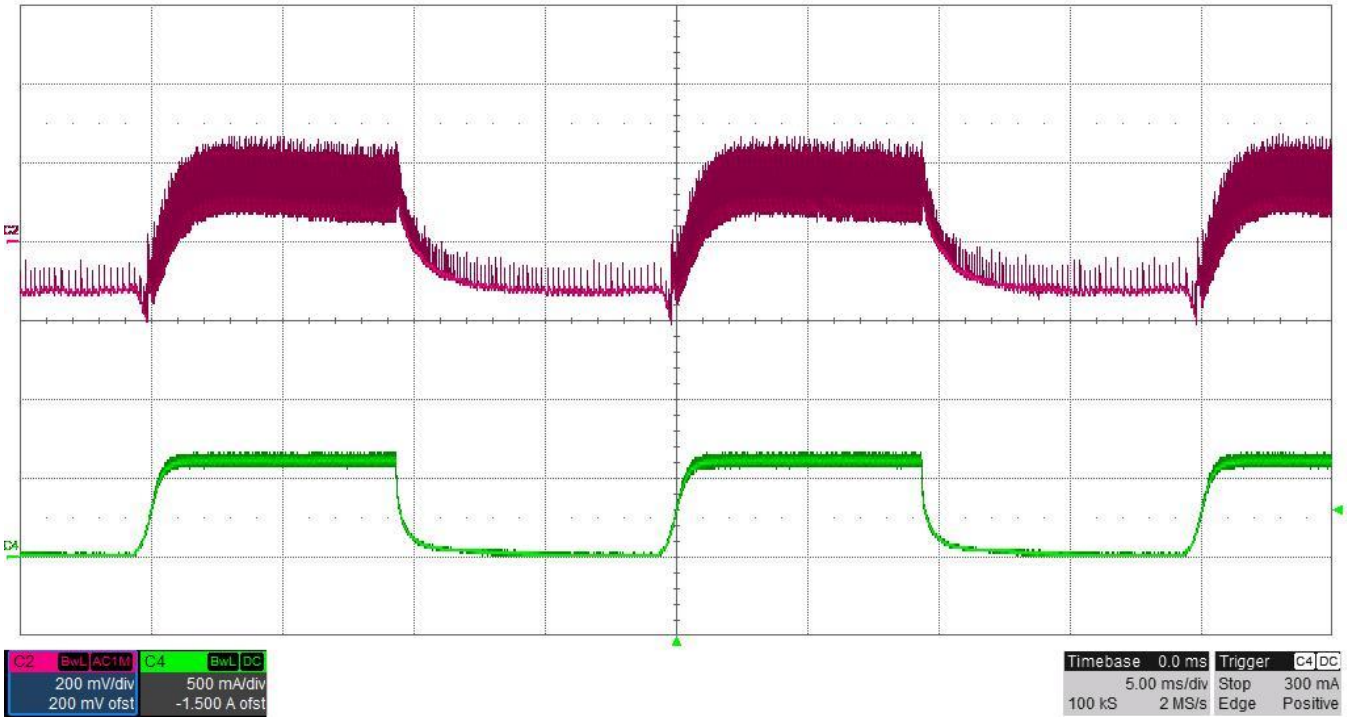
2.6.2 120V_{AC}/60Hz – 6V/0.6A



2.7 Load Response

Load response is tested at 120V_{AC}/60Hz input, where Channel 2 is the output voltage in AC level and Channel 4 is output current.

2.7.1 Load step from 0A to 0.6A:



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