TIDA-00781
Test Report
10/2/2015

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I. Overview

The TIDA-00781 is a 12W SEPIC power supply reference design for industrial applications. It takes 12V nominal input voltage, and generates a 12V @ 1A output with 92% peak efficiency. The SEPIC converter topology allows voltage step-up and step-down conversion. The design covers a wide input range of 2.5V to 20V with a minimum start-up input voltage of 3.5V. When using a noisy 12V supply, the design can operate uninterrupted while maintaining a regulated 12V output. The reference design features the LM3481 as the SEPIC controller and uses a single coupled inductor to achieve compact solution size. The component area of the SEPIC is about 39 x 26 mm (1.5 x 1 inch). The reference board is layout-optimized for improved EMI performance.

The design can also use the output voltage to operate, which means after the output voltage reaches 12V under normal operating conditions, the input voltage can be reduced to as low as 2.5V with the system still maintaining output voltage regulation within 5%. Note that at input voltage of 2.5V, the high input current causes the inductor to heat up to over 130 °C so this is not a recommended operating condition.

II. Power Specification

Input Voltage:	12V nominal, 2.5V – 20V (minimum start-up Vin of 3.5V)
Output:	12V @ 1A
Total output power:	12W
Switching frequency:	500 kHz

III. Reference Board

The board size is 76.2 x 54.8 mm (3 x 2.16 inch). The SEPIC component area is 38.989 x 26.035 mm (1.535 x 1.025 inch).

Figure 1 Reference board top view

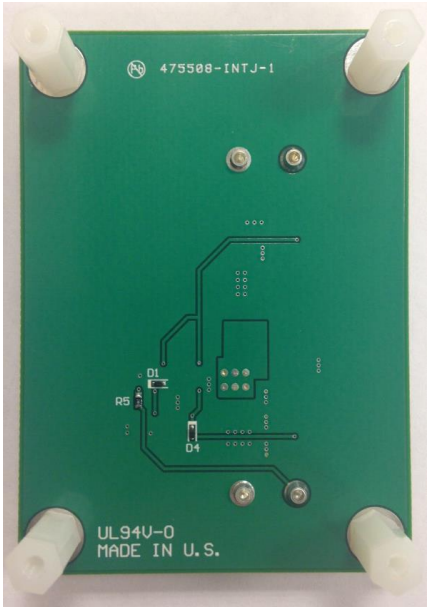

Figure 2 Reference board bottom view

IV. Efficiency and Regulation

The efficiency and output regulation was measured at different input voltage conditions.

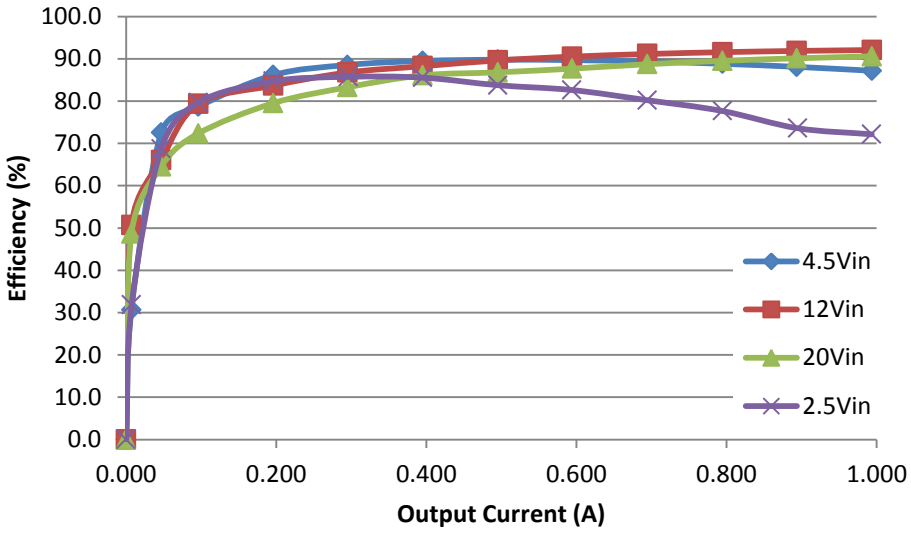

Figure 3 Power efficiency

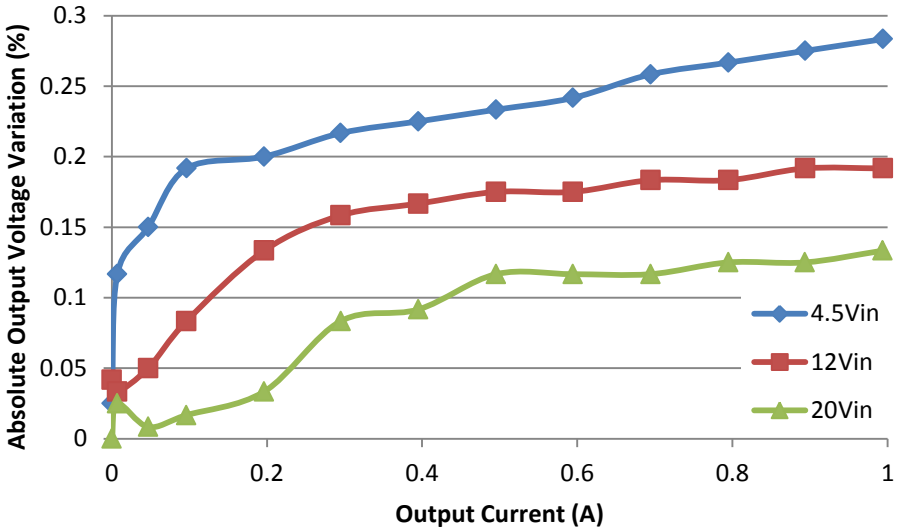

Figure 4 Output regulation

V. Thermal

The thermal image was taken at 23°C room temperature, no air flow. The board was operating at 12V input, full load.

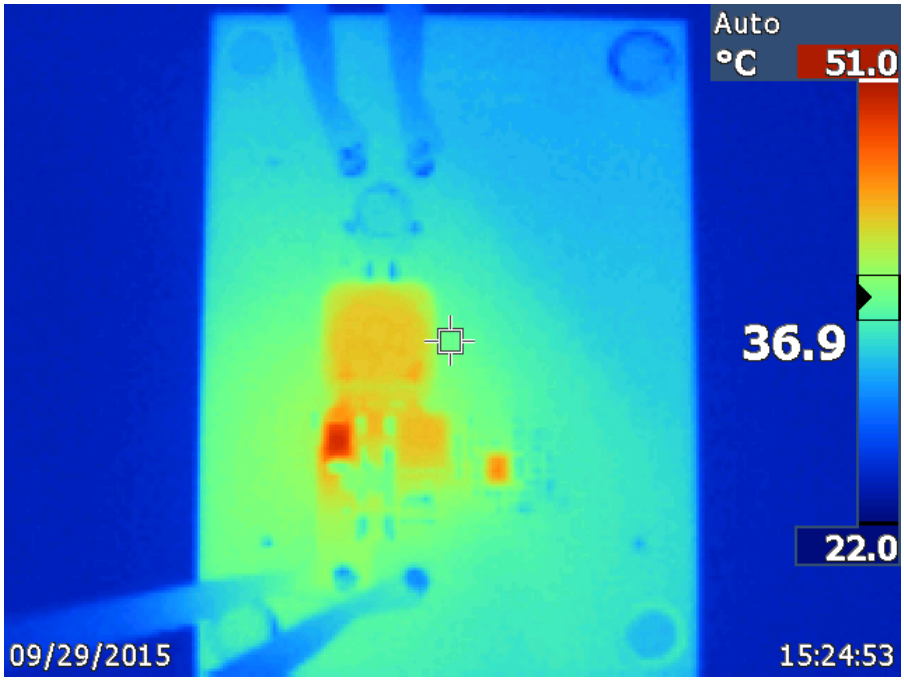

Figure 5 Thermal image from top view

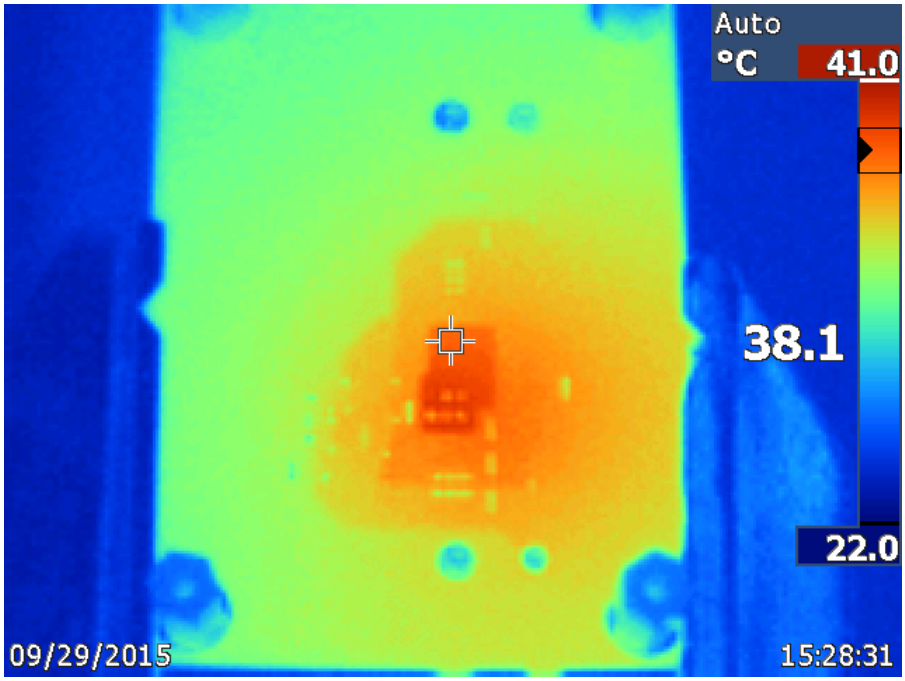

Figure 6 Thermal image from bottom view

VI. Power Up

The reference board was tested under no load and full load at 12V input. C1 (yellow) is the input voltage, and C2 (pink) is the output voltage.

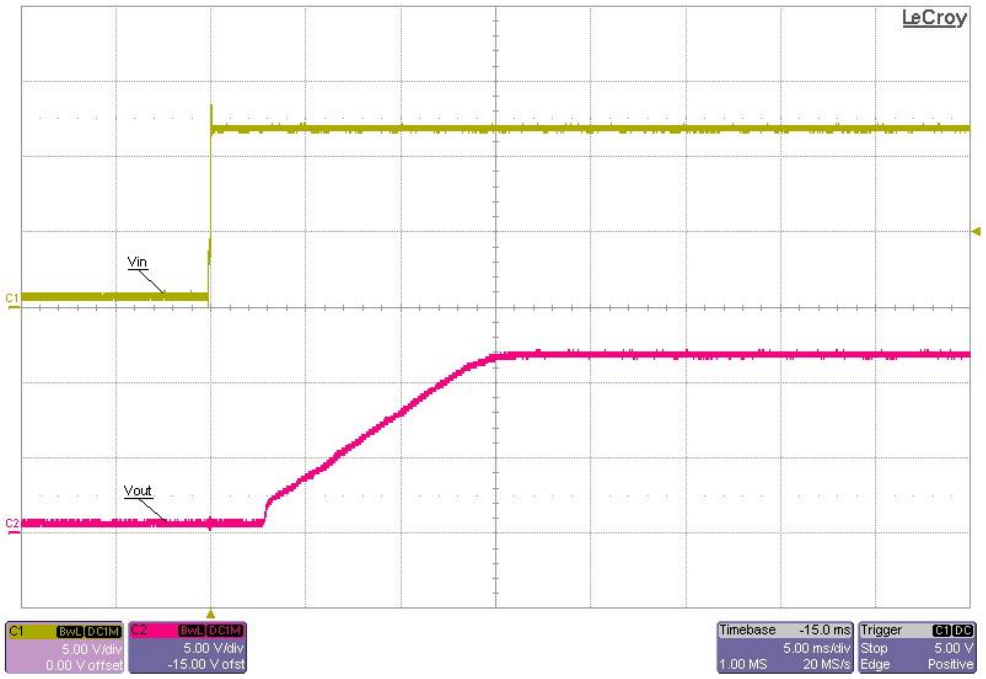

Figure 7 Power up into no load at 12V input

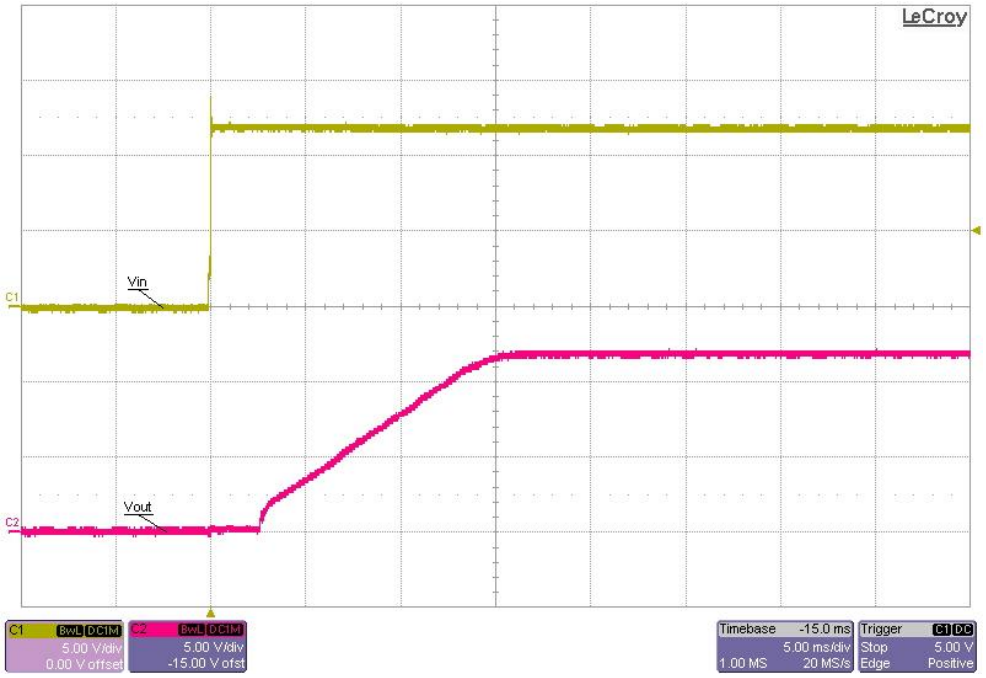

Figure 8 Power up into full load at 12V input

VII. Switching Waveforms

The switch node voltage was measured at the drain terminal of the Q1 FET. C1 (yellow) is the switch node voltage.

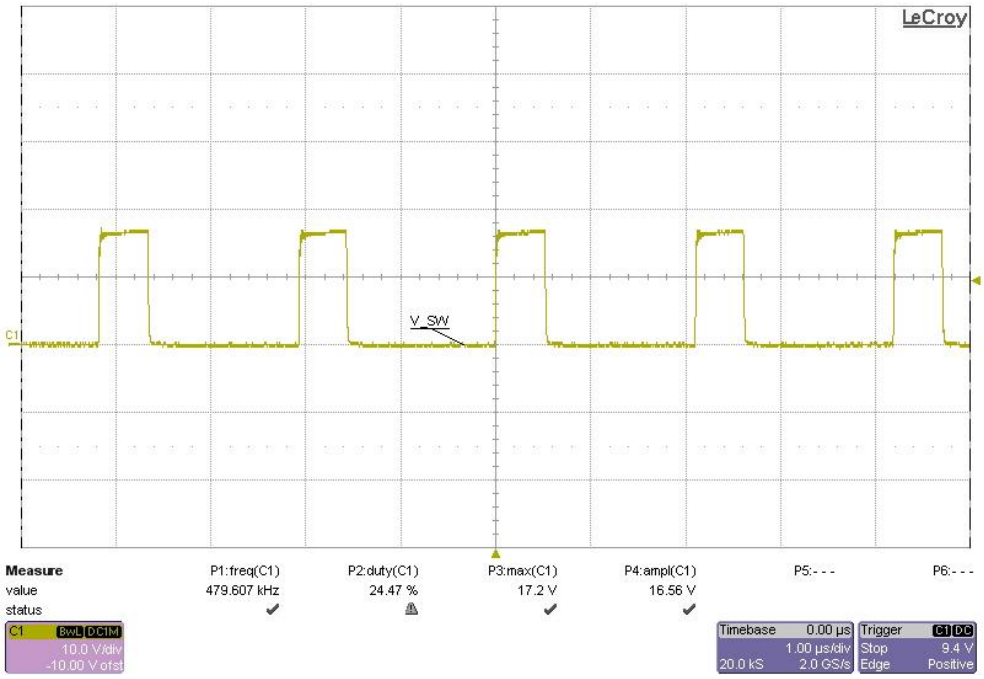

Figure 9 Switch node voltage at full load, 4.5V input

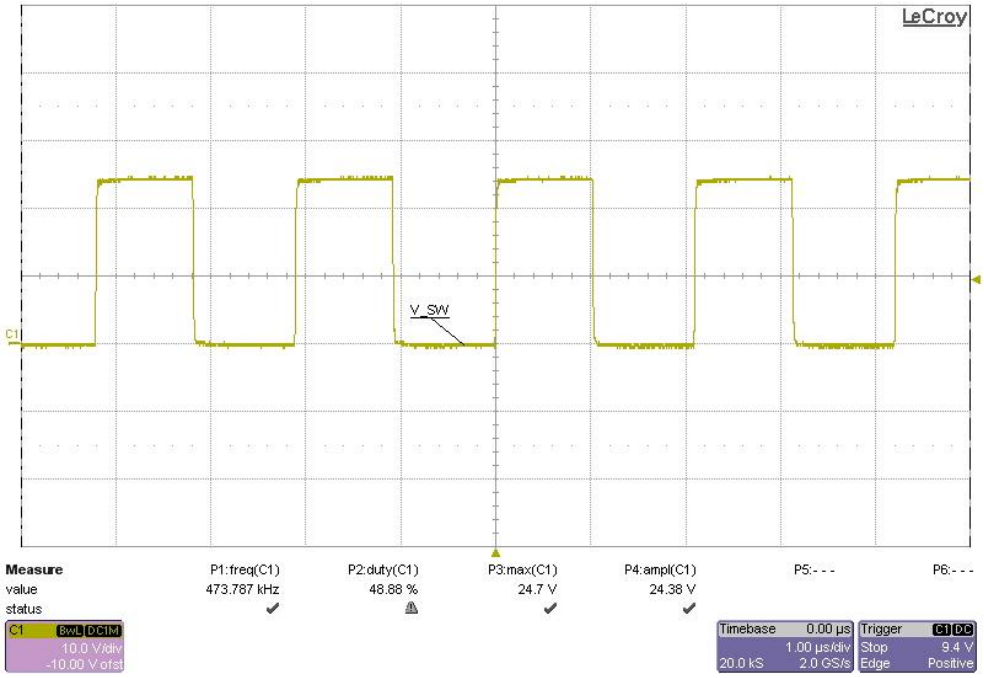

Figure 10 Switch node voltage at full load, 12V input

The voltages across the output diode D2 was measured at full load and 20V input, where the diode had the highest voltage pulses. The result shows that the max voltage across the diode is lower than its 40V rating. C1 (yellow) shows the voltage across the diode.

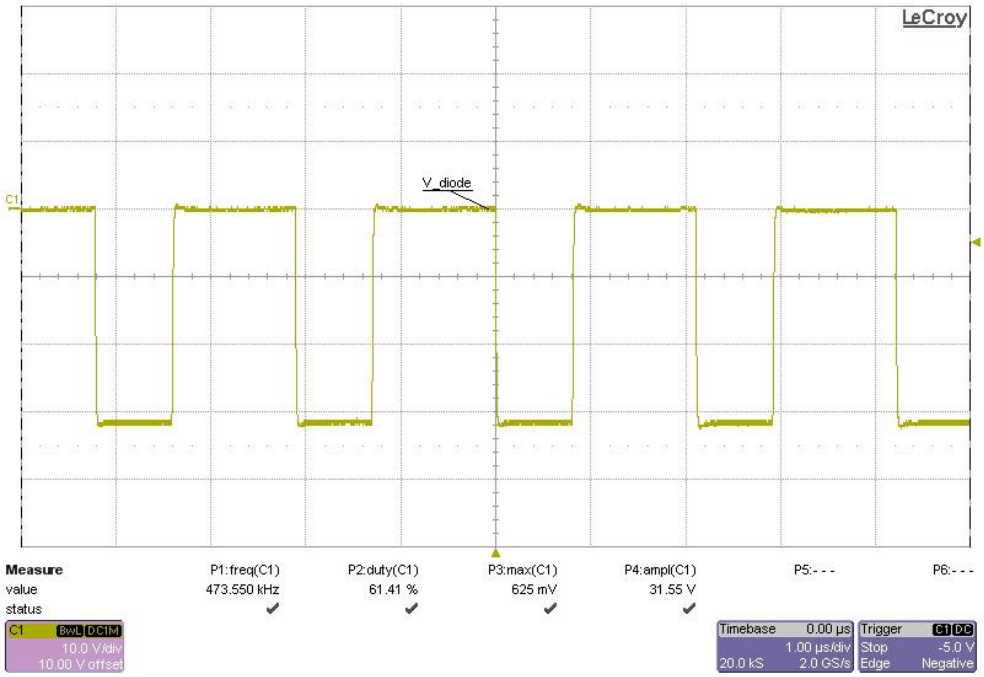

Figure 11 Output diode anode (+) to cathode (-) voltage at full load, 20V input

VIII. Load Transients

The load transient responses were tested by applying output load steps from 50% to 100% at different input voltages. C1 (yellow) is the output current, and C2 (pink) is the output voltage in AC mode.

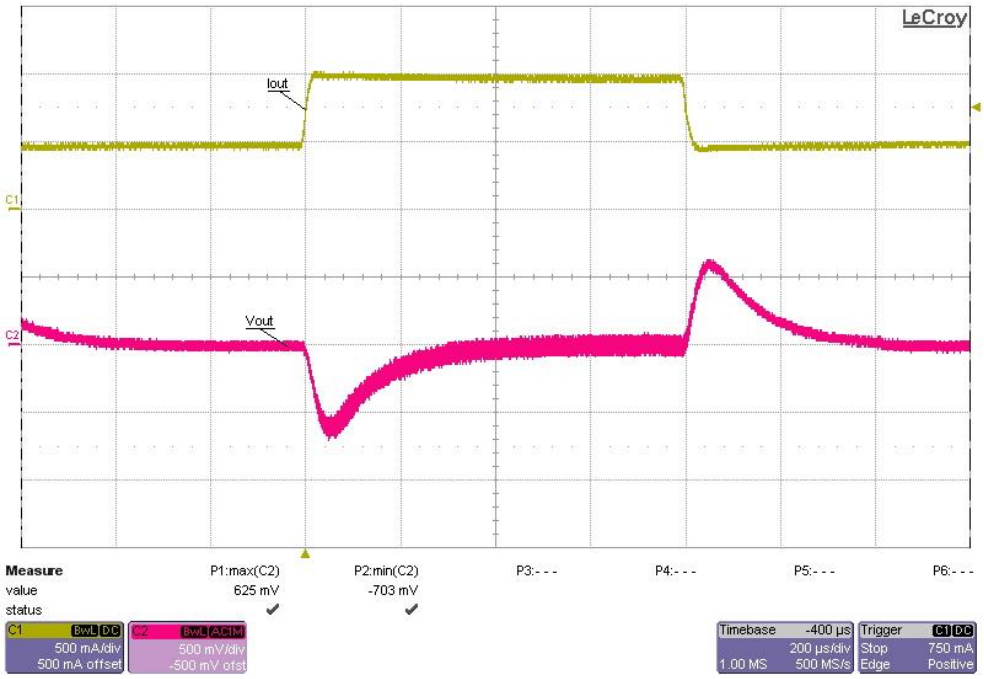

Figure 12 Output load transient response at 4.5V input

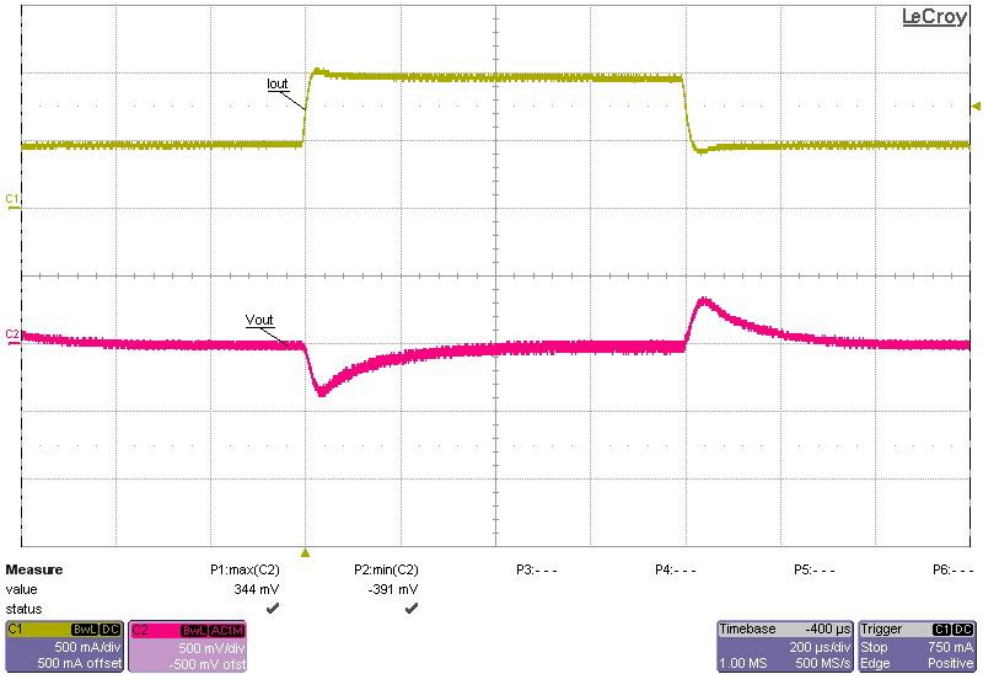

Figure 13 Output load transient response at 12V input

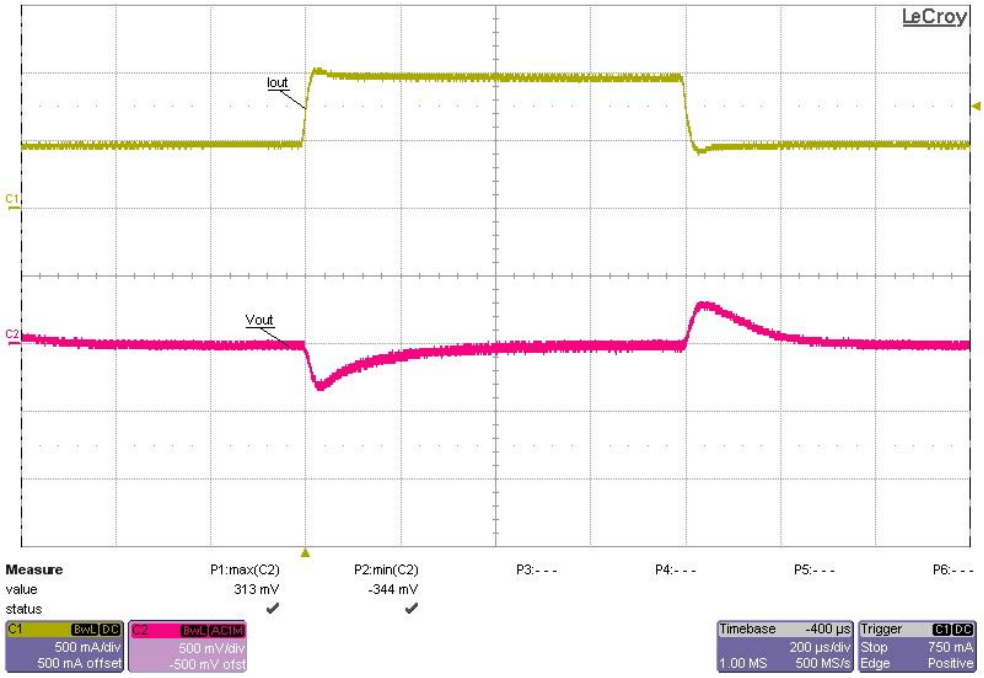

Figure 14 Output load transient response at 20V input

IX. Output Voltage Ripples

The output ripples were measured directly at the output capacitors at full load condition. C1 (yellow) is the output voltage ripple in AC mode.

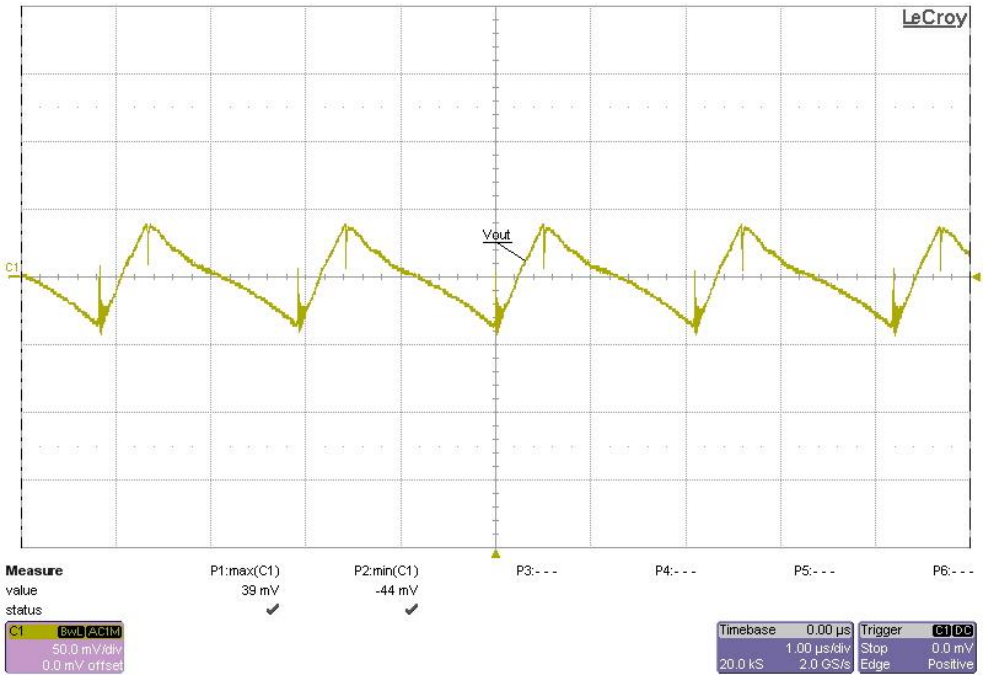

Figure 15 Output ripple at full load, 4.5Vin

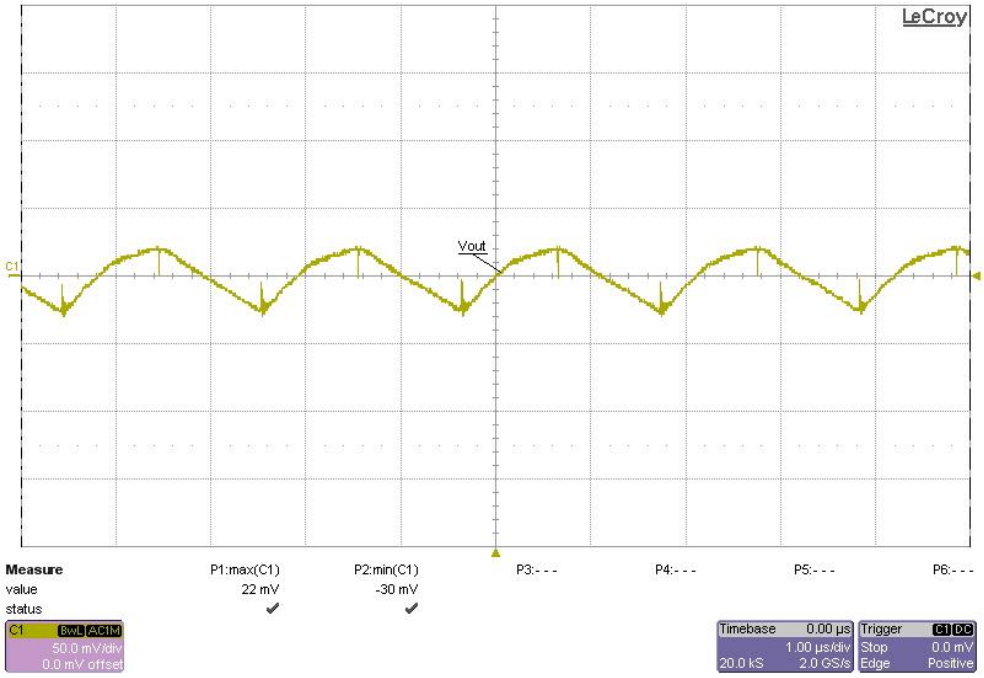

Figure 16 Output ripple at full load, 12Vin

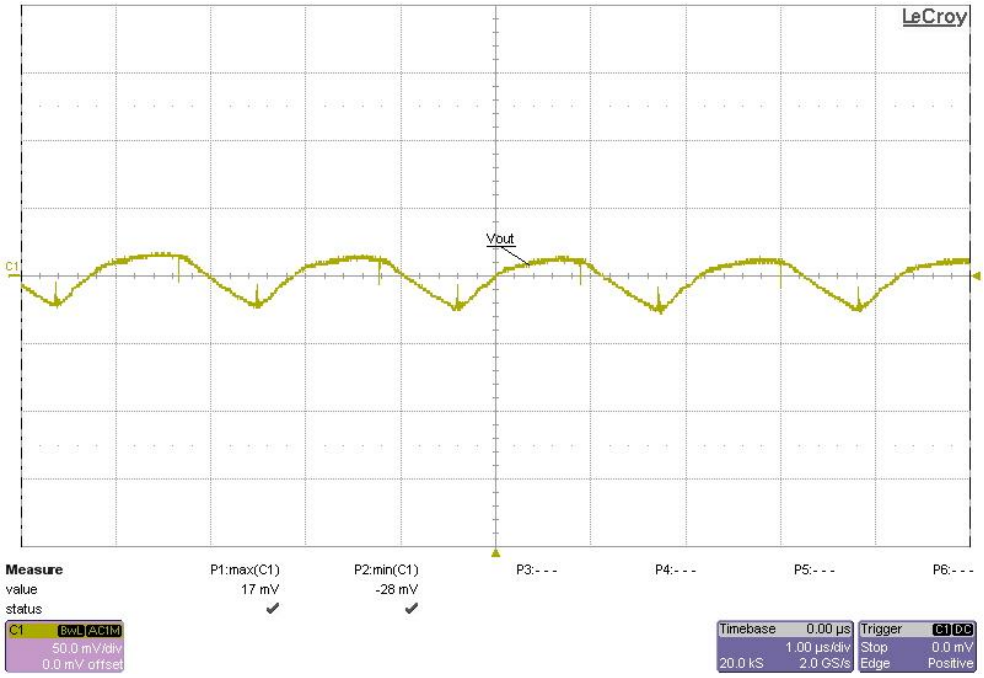

Figure 17 Output ripple at full load, 20Vin

Appendix: Efficiency and Regulation Test Data

4.5V input

Load (A)	Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)	Vout Variation (%)
0	4.496	0.036	11.997	0.000	0.161	0.000	0.0	0.025
0.01	4.492	0.061	11.986	0.007	0.272	0.083	30.6	0.117
0.05	4.475	0.173	11.982	0.047	0.774	0.561	72.5	0.150
0.1	4.452	0.329	11.977	0.096	1.464	1.152	78.7	0.192
0.2	4.408	0.619	11.976	0.196	2.727	2.349	86.1	0.200
0.3	4.364	0.914	11.974	0.295	3.990	3.532	88.5	0.217
0.4	4.317	1.225	11.973	0.395	5.288	4.732	89.5	0.225
0.5	4.267	1.548	11.972	0.495	6.607	5.932	89.8	0.233
0.6	4.216	1.881	11.971	0.594	7.932	7.114	89.7	0.242
0.7	4.161	2.236	11.969	0.695	9.303	8.313	89.4	0.258
0.8	4.102	2.611	11.968	0.795	10.710	9.512	88.8	0.267
0.9	4.037	3.007	11.967	0.894	12.141	10.695	88.1	0.275
1	3.964	3.443	11.966	0.994	13.644	11.893	87.2	0.283

12V input

Load (A)	Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)	Vout Variation (%)
0	11.999	0.003	11.995	0.000	0.037	0.000	0.0	0.042
0.01	11.997	0.014	11.996	0.007	0.164	0.083	50.7	0.033
0.05	11.993	0.071	11.994	0.047	0.850	0.562	66.1	0.050
0.1	11.981	0.121	11.990	0.096	1.452	1.152	79.3	0.083
0.2	11.963	0.235	11.984	0.196	2.810	2.351	83.7	0.133
0.3	11.947	0.341	11.981	0.295	4.074	3.534	86.8	0.158
0.4	11.931	0.450	11.980	0.395	5.365	4.734	88.2	0.167
0.5	11.915	0.556	11.979	0.495	6.622	5.935	89.6	0.175
0.6	11.899	0.661	11.979	0.594	7.865	7.119	90.5	0.175
0.7	11.882	0.768	11.978	0.695	9.129	8.319	91.1	0.183
0.8	11.866	0.876	11.978	0.795	10.397	9.519	91.6	0.183
0.9	11.849	0.983	11.977	0.894	11.652	10.703	91.9	0.192
1	11.832	1.093	11.977	0.994	12.929	11.904	92.1	0.192

20V input

Load (A)	Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)	Vout Variation (%)
0	20.003	0.002	12.000	0.000	0.048	0.000	0.0	0.000
0.01	20.002	0.009	11.997	0.007	0.170	0.083	48.6	0.025
0.05	19.998	0.044	12.001	0.047	0.870	0.561	64.5	-0.008
0.1	19.992	0.080	12.002	0.096	1.593	1.152	72.3	-0.017
0.2	19.982	0.148	11.996	0.196	2.959	2.353	79.5	0.033
0.3	19.972	0.213	11.990	0.295	4.248	3.537	83.3	0.083
0.4	19.962	0.276	11.989	0.395	5.504	4.738	86.1	0.092
0.5	19.952	0.343	11.986	0.495	6.842	5.938	86.8	0.117
0.6	19.942	0.407	11.986	0.594	8.124	7.122	87.7	0.117
0.7	19.933	0.471	11.986	0.694	9.382	8.324	88.7	0.117
0.8	19.923	0.534	11.985	0.795	10.641	9.524	89.5	0.125
0.9	19.913	0.597	11.985	0.894	11.884	10.710	90.1	0.125
1	19.904	0.661	11.984	0.994	13.149	11.910	90.6	0.133

2.5Vin

Load (A)	Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)	Vout Variation (%)
0	2.4906	0.0675	11.9843	0	0.168	0.000	0.0	0.131
0.01	2.4844	0.1101	11.9763	0.00728	0.274	0.087	31.9	0.197
0.05	2.4514	0.3319	11.9748	0.04668	0.814	0.559	68.7	0.210
0.1	2.4118	0.5985	11.9736	0.096049	1.443	1.150	79.7	0.220
0.2	2.4446	1.1332	11.9726	0.19597	2.770	2.346	84.7	0.228
0.3	2.4715	1.6723	11.9694	0.29604	4.133	3.543	85.7	0.255
0.4	2.4987	2.2108	11.9657	0.39495	5.524	4.726	85.5	0.286
0.5	2.3964	2.9518	11.9625	0.49526	7.074	5.925	83.8	0.312
0.6	2.453	3.5067	11.962	0.59407	8.602	7.106	82.6	0.317
0.7	2.4211	4.276	11.959	0.69435	10.353	8.304	80.2	0.342
0.8	2.4338	5.0268	11.9566	0.79459	12.234	9.501	77.7	0.362
0.9	2.4255	5.8963	11.7613	0.89478	14.301	10.524	73.6	1.989
1	2.4609	6.4429	11.5125	0.99366	15.855	11.440	72.1	4.063

Note: 2.5Vin is not a recommended operating condition for long periods of time due to high component and board temperature caused by the large input current

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