TIDA-00808
Test Report
1/4/2016

TEXAS INSTRUMENTS

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I. Overview

The TIDA-00808 is an inverting power supply reference design for industrial applications. It takes a wide input voltage between 4.5V and 55V and generates a negative 5V @ 1.75A output with 86% peak efficiency. Since this design is inverting, the maximum output current increases as the input voltage increases. The reference design features the LMZ36002 SIMPLE SWITCHER DC/DC step down power module for compact solution size and simplicity. The board dimension is 76.2 x 76.2 mm (3 x 3 inch) with the solution size of only 30.607 x 20.828 mm (1.205 x 0.82 inch).

II. Power Specification

Input Voltage: 4.5V – 55V

Output: -5V @ 1.75A

Total output power: 8.75W

Switching frequency: 500 kHz

III.   Reference Board

The Board dimension of TIDA-00808 PCB is 76.2*76.2 mm (3x3 inch) with a solution size of 30.607x20.828 mm (1.205x0.82 inch). Two layer PCB was used for the design.
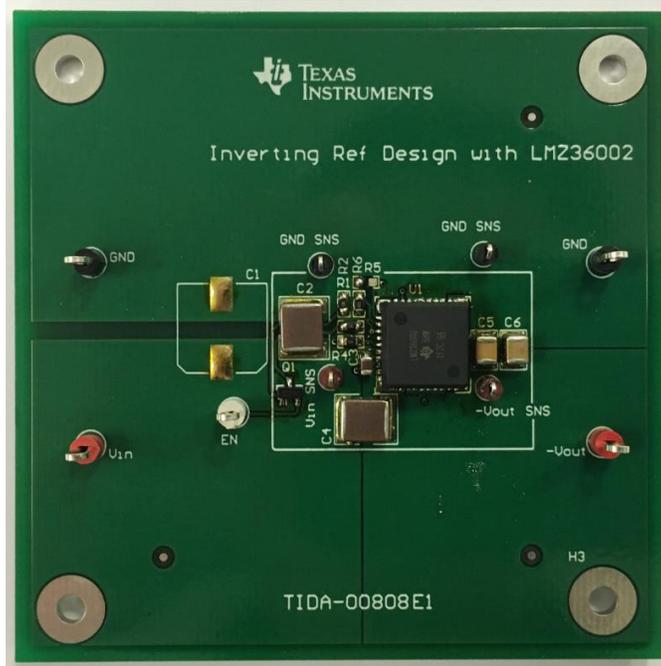
Figure 1: Reference board top view
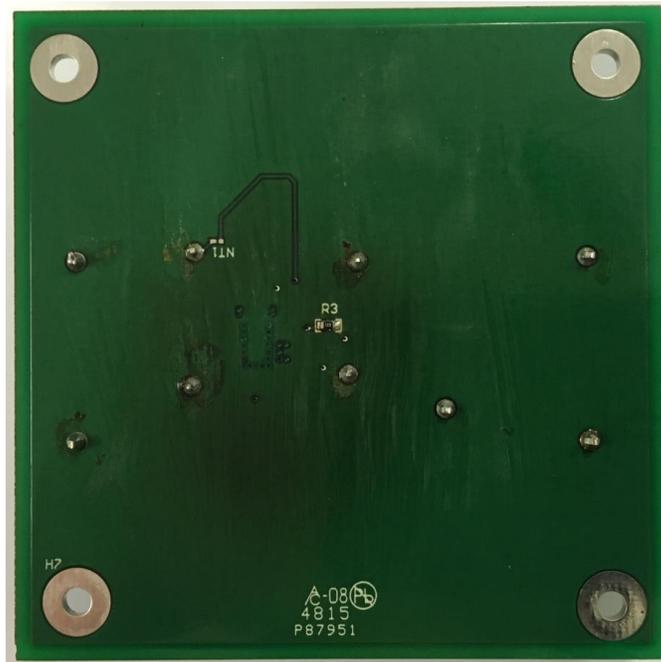
Figure 2: Reference board bottom view

IV.   Max Output Current

The maximum output current is limited by the switch current limit of the LMZ36002 Buck regulator, which consists of input current added with the output current for inverting designs. This means as the input voltage increases, the input current decreases which increases the maximum allowed output current while remaining under the switch current limit of the LMZ36002. See figure below for the relationship between input voltage and output current.
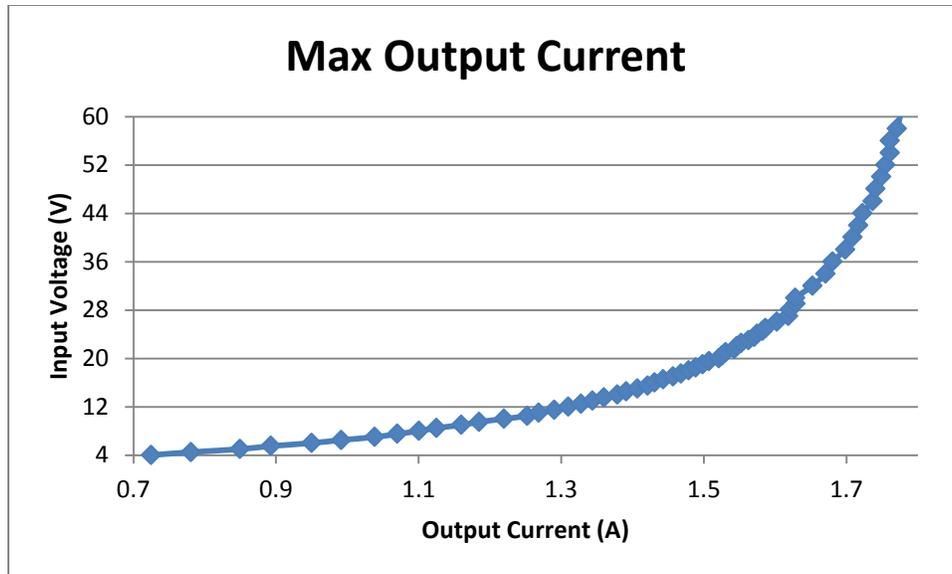
Figure 3: Relationship between input voltage and maximum output current

V.   Efficiency

The efficiency and output regulation was measured at different input voltage conditions.
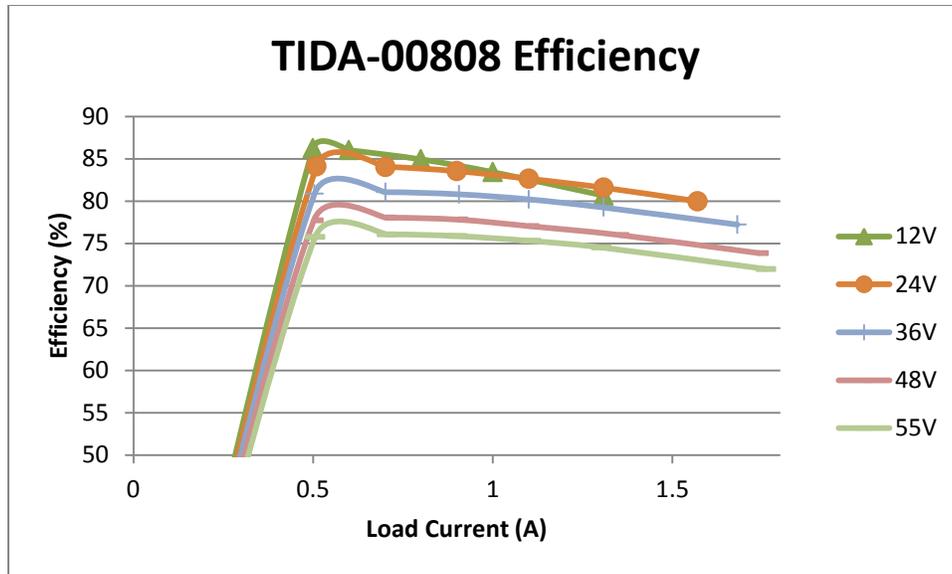
Figure 4: Power efficiency at various input voltages

VI.　Thermal

The thermal image was taken at 25°C room temperature, no air flow. The board was operating at 55V input, 1.5A load.
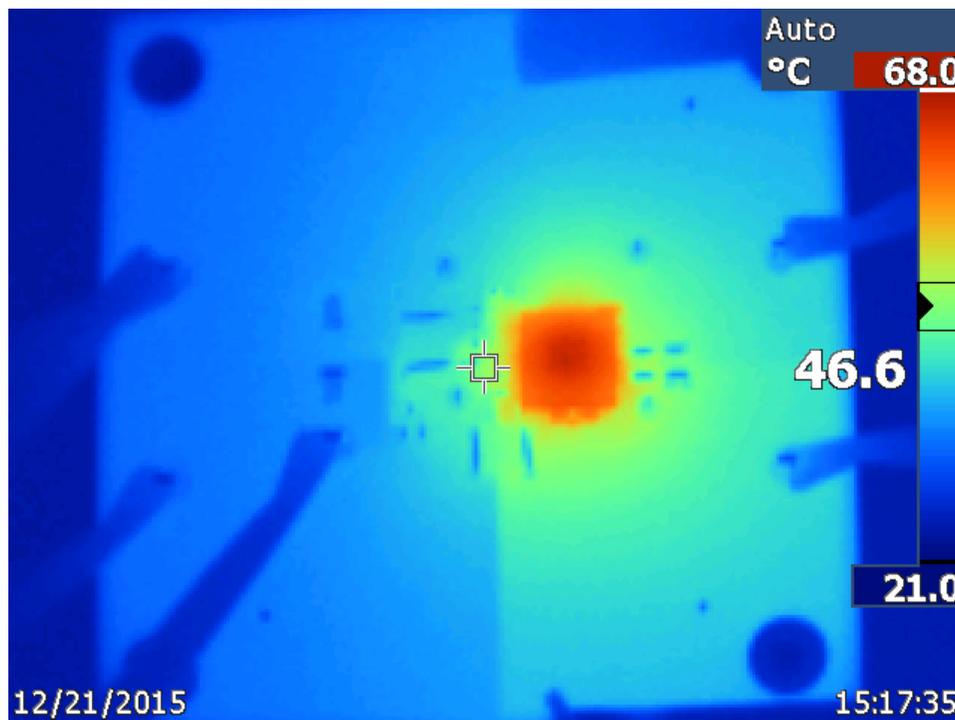
Figure 5: Thermal image from top view
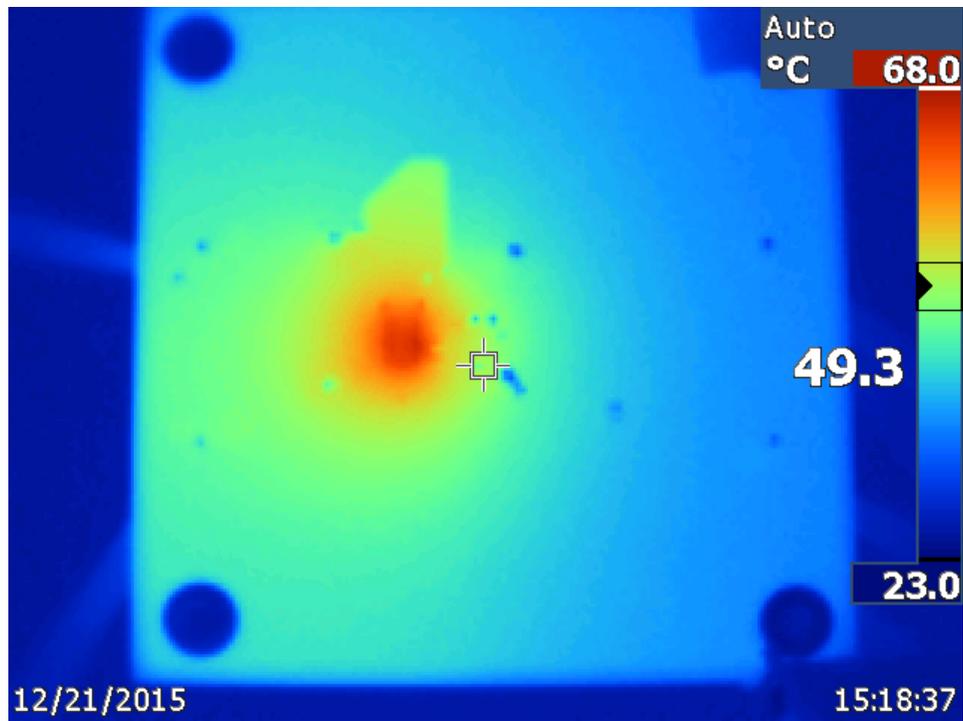
Figure 6: Thermal image from bottom view

VII.   Power Up

The reference board was tested under no load and full 3A load on both output channels at 12V input. C1 (yellow) is the input voltage, C2 (pink) is the output voltage on channel A, and C3 (blue) is the output voltage on channel B.
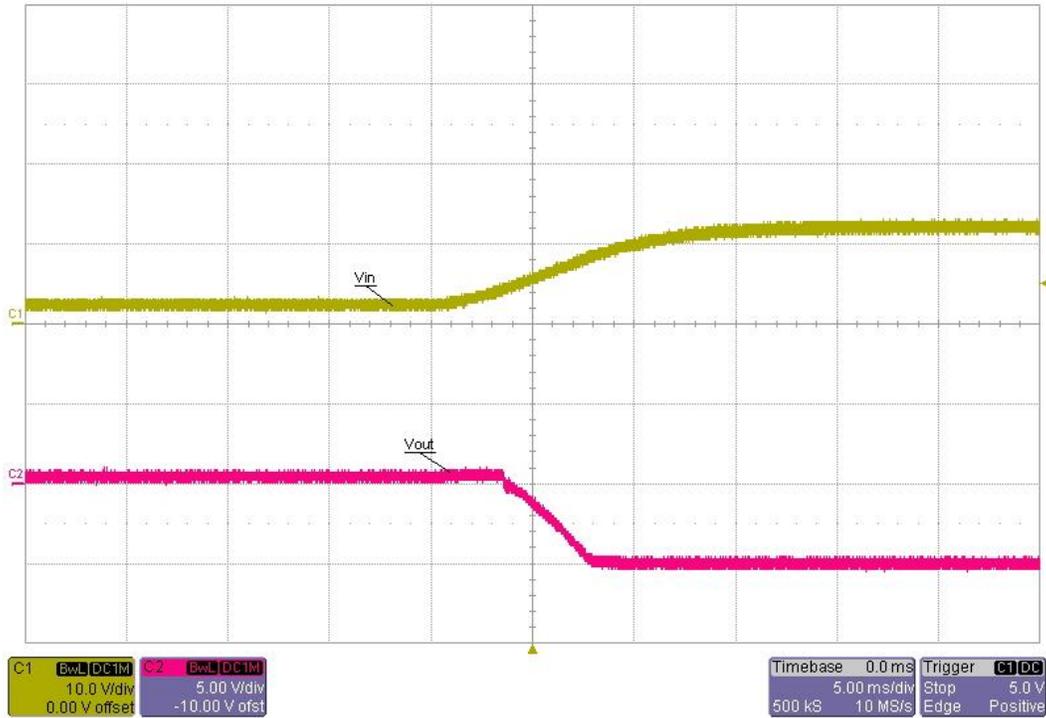
Figure 7: Power up into no load at 12V input
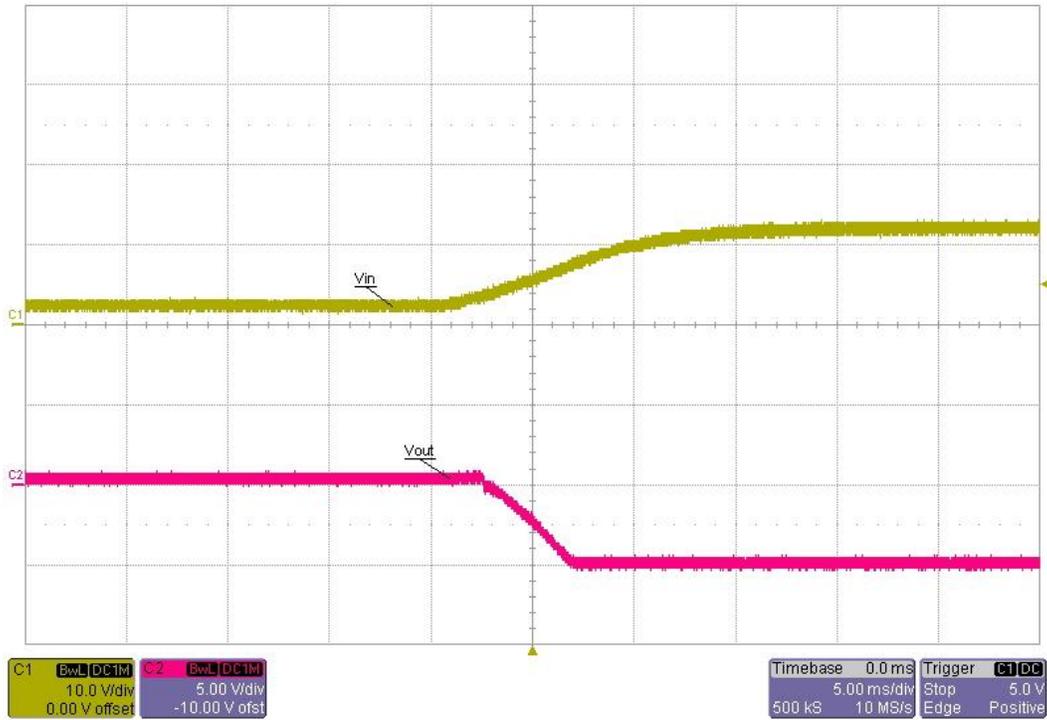
Figure 8: Power up into 1A load at 12V input
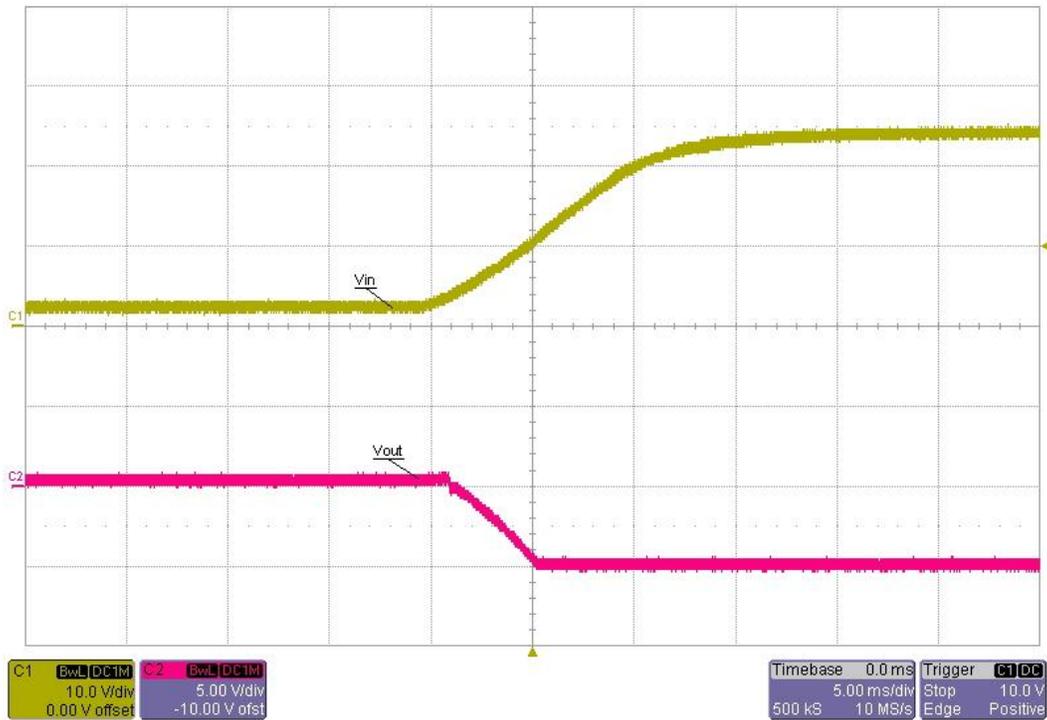
Figure 9: Power up into 1A load at 24V input
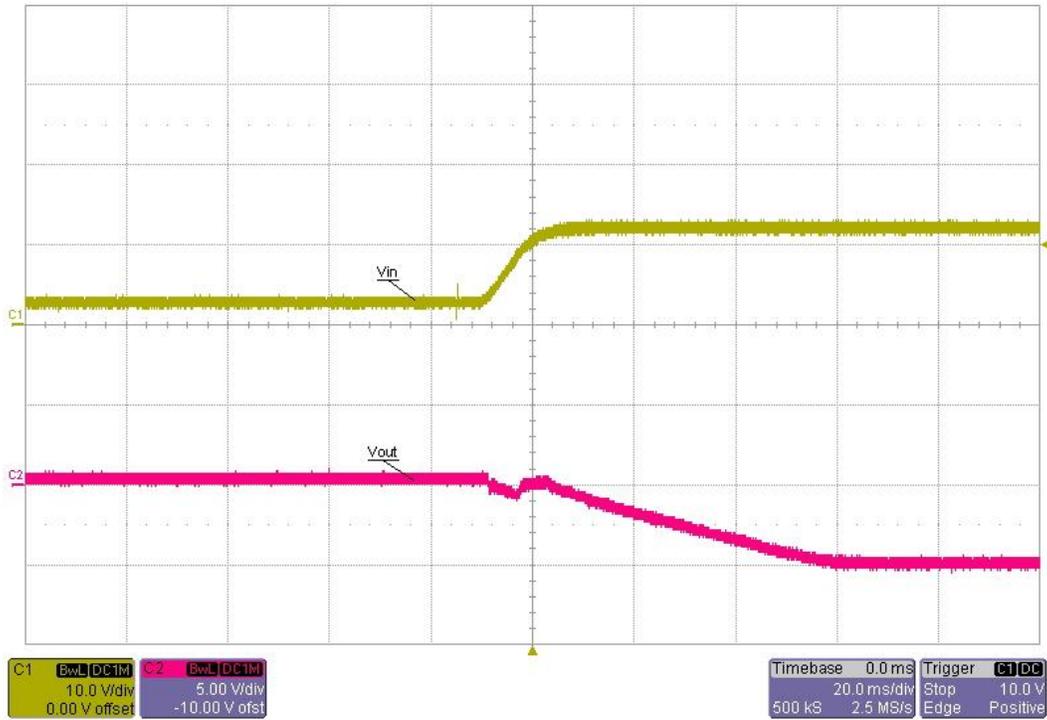
Figure 10: Power up into 1.3A load at 12V input with 0.1uF soft-start capacitor
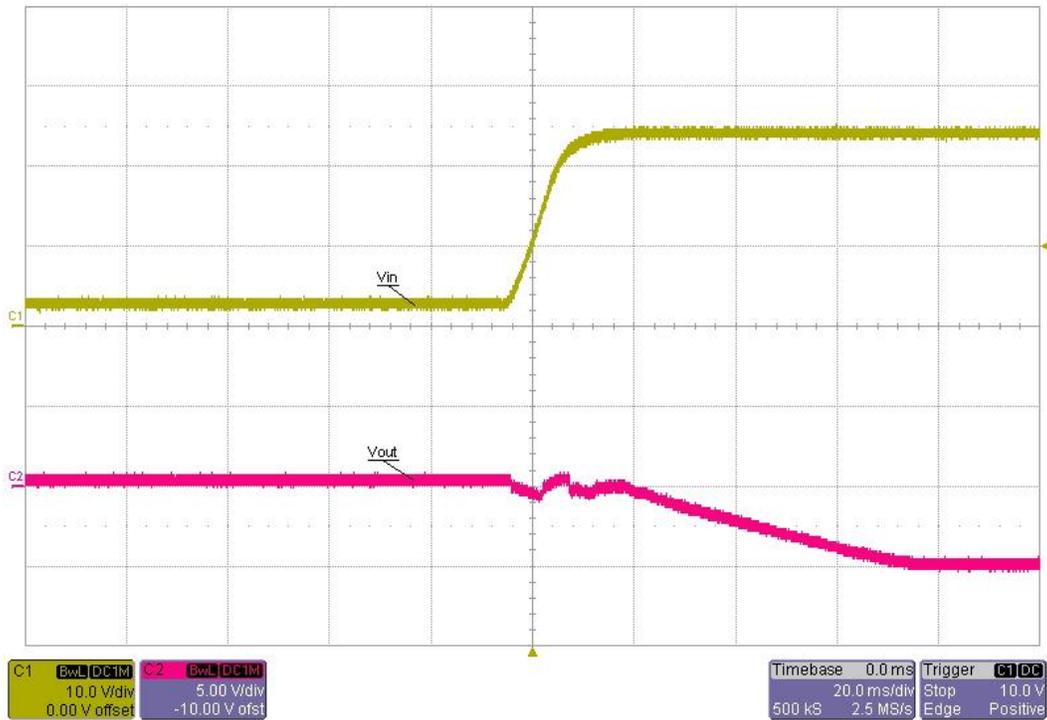
Figure 11: Power up into 1.5A load at 24V input with 0.1uF soft-start capacitor

VIII. Switching Waveforms

The switch node voltage was measured directly from the LMZ36002 module. C1 (yellow) is the switch node voltage.
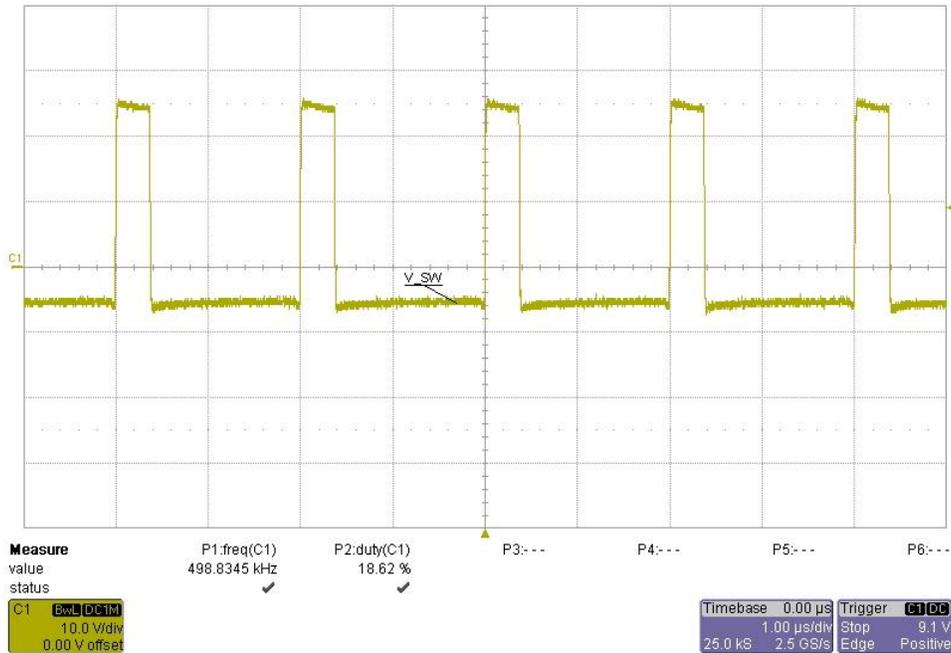
Figure 12: Switch node voltage to GND at 1.5A load, 24V input

IX. Load Transients

The load transient responses were tested by applying a load step from 50% to 100% of maximum output current for a given input voltage. C1 (yellow) is the output current and C2 (pink) is the output voltage in AC mode.
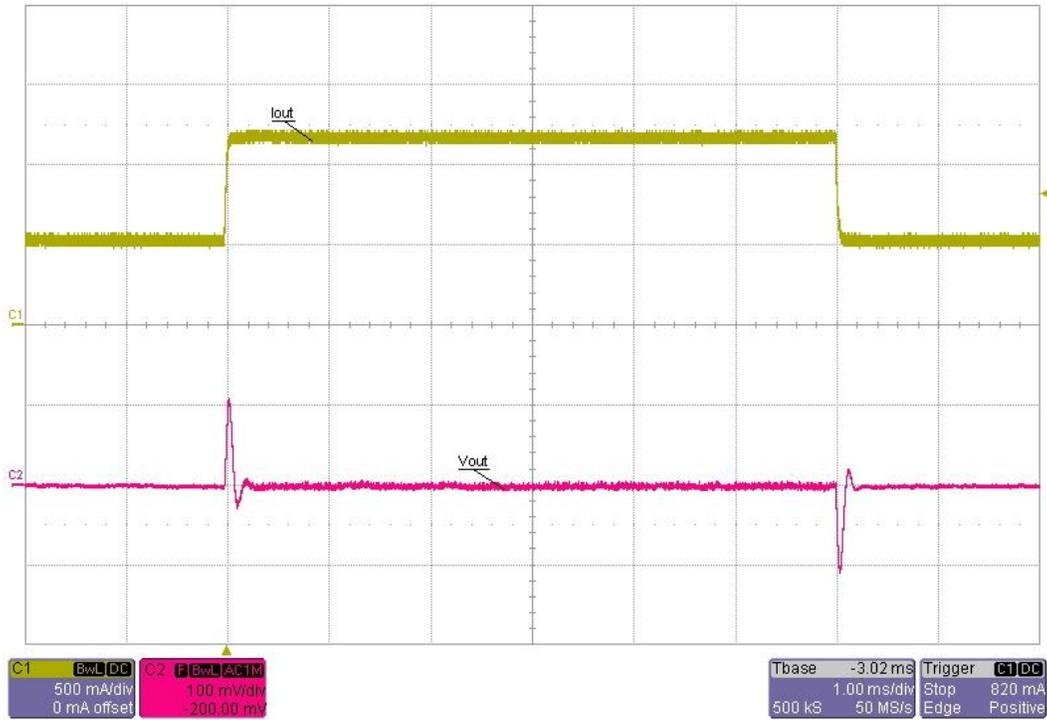
Figure 13: Output load transient response at 12V input, load current switching from 0.65A to 1.3A
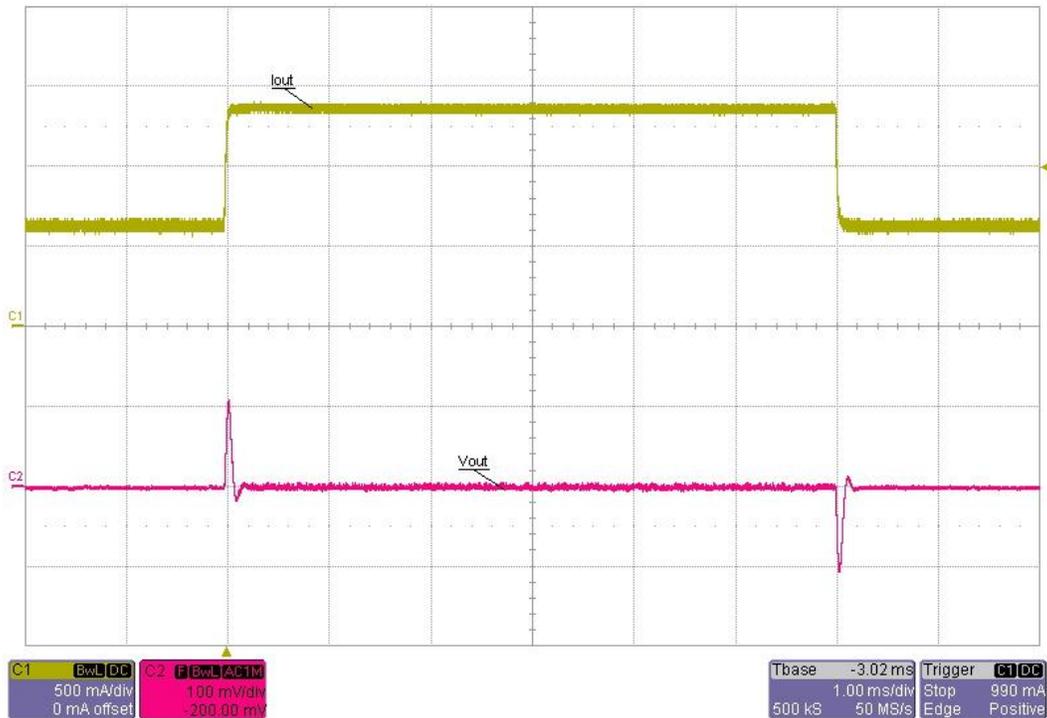
Figure 14: Output load transient response at 24V input, load current switching from 0.75A to 1.5A
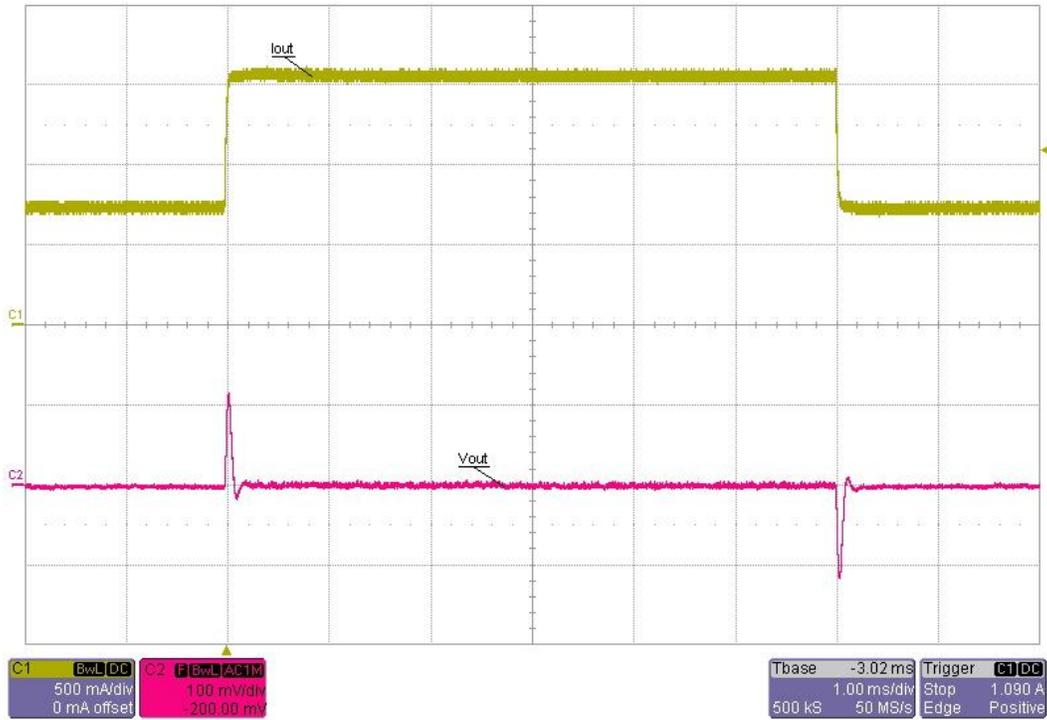
Figure 15: Output load transient response at 36V input, load current switching from 0.85A to 1.7A
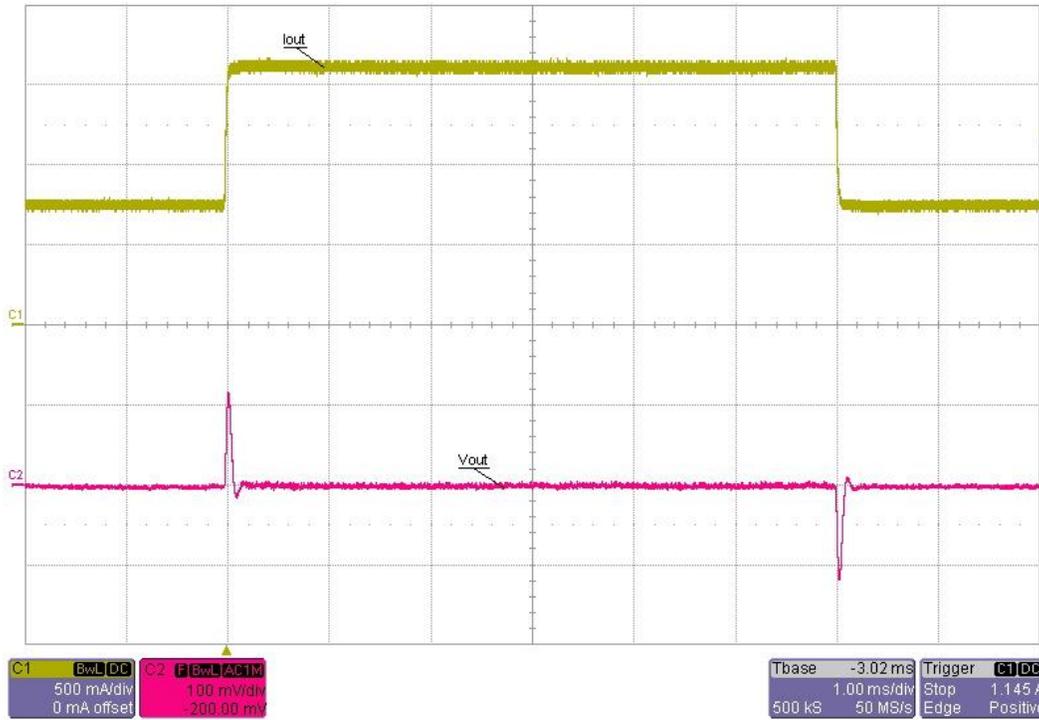
Figure 16: Output load transient response at 48V input, load current switching from 0.875A to 1.75A

X. Output Voltage Ripples

The output ripple was measured directly at the output capacitors. C1 (yellow) is the output voltage ripple in AC mode.
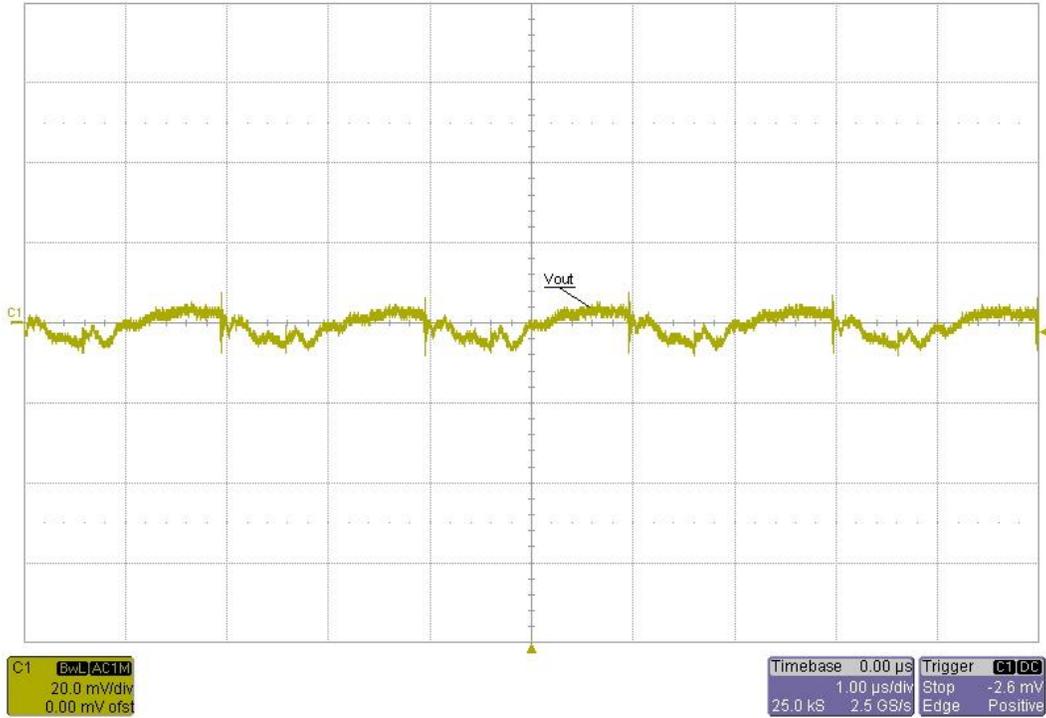
Figure 17: Output ripple 12Vin, 1.3A load
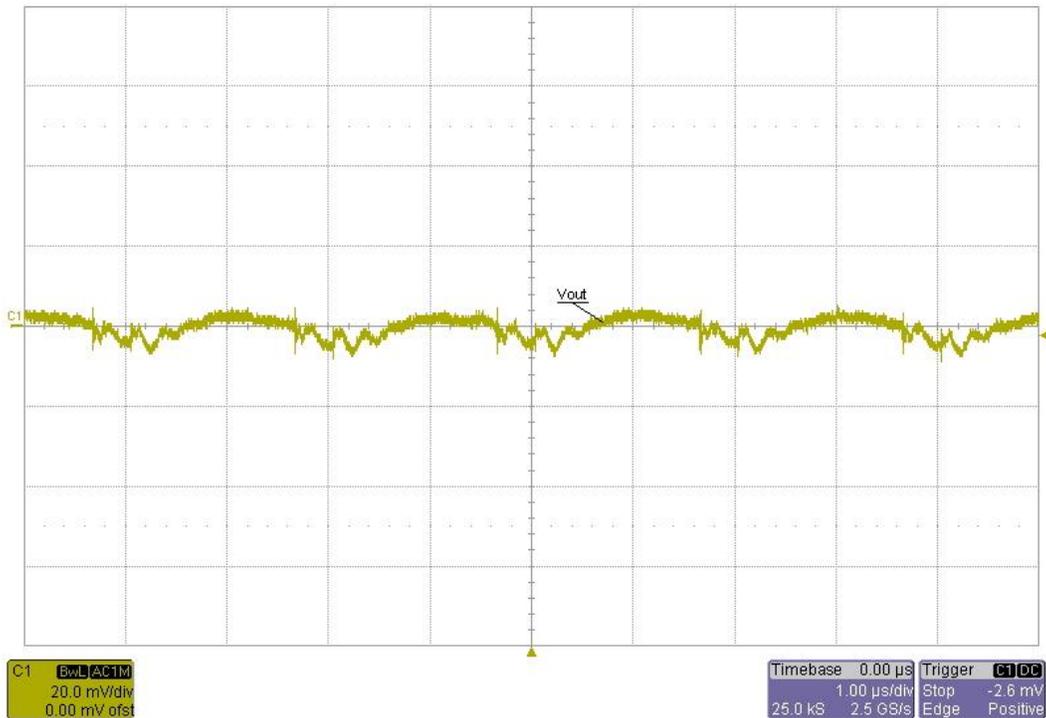
Figure 18: Output ripple at 24Vin, 1.5A load
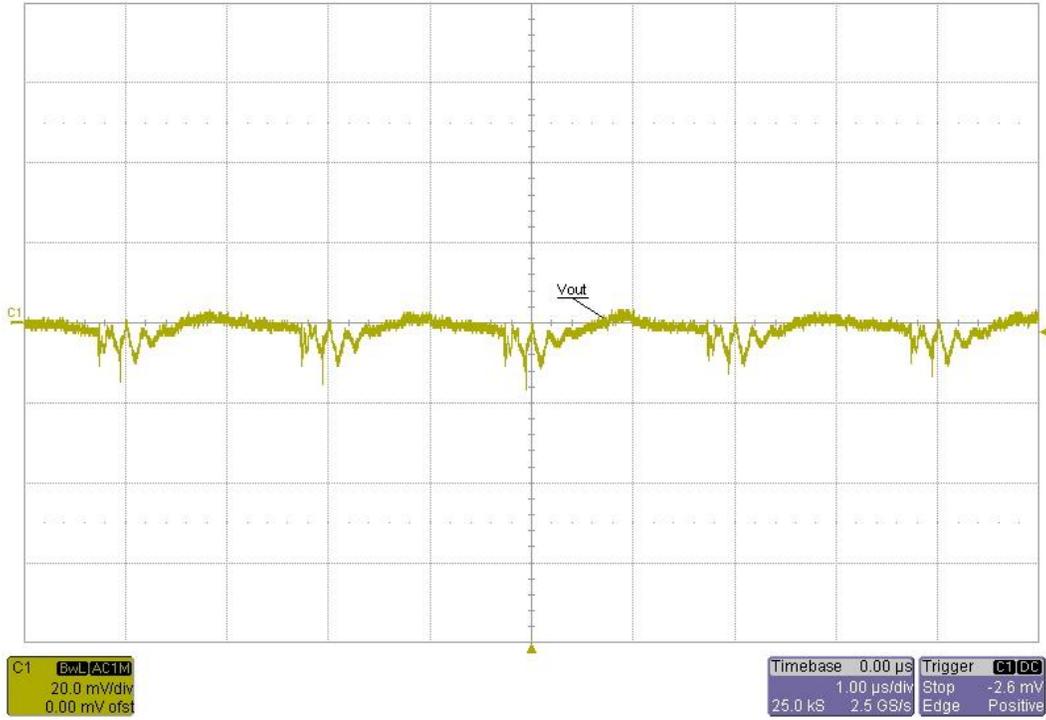
Figure 19: Output ripple at 48Vin, 1.75A load

Appendix: Efficiency Test Data

Vin	Iin	Vout	Iout	Pin	Pout	Efficiency
4.5187	0.0012	-5.0403	0	0.005422	0	0
4.5064	0.6784	-4.995	0.5	3.057142	2.4975	81.69395
4.4982	0.8401	-4.9917	0.6001	3.778938	2.995519	79.26881
4.5032	1.0114	-4.9882	0.7	4.554536	3.49174	76.6651
4.498	1.1671	-4.9855	0.7801	5.249616	3.889189	74.0852
8.0333	0.0006	-5.041	0	0.00482	0	0
7.9956	0.3639	-4.9931	0.4999	2.909599	2.496051	85.78676
7.9972	0.4406	-4.9923	0.6	3.523566	2.99538	85.00989
8.0021	0.5437	-4.9914	0.7301	4.350742	3.644221	83.76092
7.9918	0.6021	-4.9901	0.8002	4.811863	3.993078	82.98404
8.0005	0.6862	-4.9886	0.9003	5.489943	4.491237	81.80844
8.0033	0.8655	-4.9848	1.1004	6.926856	5.485274	79.18851
12.059	0.0004	-5.041	0	0.004824	0	0
12.057	0.24	-4.993	0.4998	2.89368	2.495501	86.23972
12.046	0.2892	-4.9943	0.5999	3.483703	2.996081	86.00275
12.029	0.3911	-4.9923	0.8003	4.704542	3.995338	84.92512
12.012	0.498	-4.9881	1.0004	5.981976	4.990095	83.41884
12.043	0.6714	-4.9834	1.3086	8.08567	6.521277	80.65228
15.085	0.0003	-5.0408	0	0.004526	0	0
14.99	0.1941	-4.9948	0.5019	2.909559	2.50689	86.16048
15.071	0.2711	-4.9928	0.7	4.085748	3.49496	85.54027
15.055	0.3527	-4.99	0.9002	5.309899	4.491998	84.59668
15.037	0.4621	-4.9862	1.1545	6.948598	5.756568	82.84503
15.019	0.5736	-4.9828	1.4005	8.614898	6.978411	81.00399
18.09	0.0002	-5.0408	0	0.003618	0	0
18.011	0.1624	-4.9959	0.5017	2.924986	2.506443	85.69076
18	0.2282	-4.9943	0.7018	4.1076	3.505	85.32963
18.029	0.2948	-4.9913	0.9	5.314949	4.49217	84.51953
18.017	0.3664	-4.9884	1.1042	6.601429	5.508191	83.43938
18.005	0.4385	-4.985	1.3002	7.895193	6.481497	82.09422
17.993	0.5077	-4.9803	1.4784	9.135046	7.362876	80.60031
24.039	0.0002	-5.0413	0	0.004808	0	0
24.017	0.126	-4.9914	0.5098	3.026142	2.544616	84.08778
24.01	0.1736	-4.9909	0.7019	4.168136	3.503113	84.04507

24.001	0.224	-4.989	0.9002	5.376224	4.491098	83.53628
24.06	0.2759	-4.9862	1.1002	6.638154	5.485817	82.6407
24.05	0.3323	-4.9834	1.3084	7.991815	6.520281	81.58698
24.039	0.4068	-4.9797	1.5705	9.779065	7.820619	79.97307
36.037	0.0001	-5.0421	0	0.003604	0	0
36.059	0.0862	-4.9887	0.5038	3.108286	2.513307	80.8583
36.055	0.1198	-4.988	0.7019	4.319389	3.501077	81.05492
36.05	0.1551	-4.986	0.9061	5.591355	4.517815	80.8
36.044	0.1897	-4.9841	1.1003	6.837547	5.484005	80.20428
36.038	0.2282	-4.9807	1.3084	8.223872	6.516748	79.24185
36.026	0.3006	-4.976	1.6806	10.82942	8.362666	77.22176
48.114	0	-5.0428	0	0	0	0
48.069	0.067	-4.9882	0.5018	3.220623	2.503079	77.72033
48.066	0.0936	-4.9868	0.704	4.498978	3.510707	78.03344
48.062	0.1205	-4.9842	0.9041	5.791471	4.506215	77.80778
48.058	0.1483	-4.9805	1.1024	7.127001	5.490503	77.03805
48.055	0.1843	-4.9771	1.3523	8.856537	6.730532	75.99508
48.045	0.244	-4.9736	1.7407	11.72298	8.657546	73.85106
55.097	0	-5.0444	0	0	0	0
55.027	0.0605	-4.9877	0.5057	3.329134	2.52228	75.76386
55.023	0.0841	-4.9852	0.706	4.627434	3.519551	76.05837
55.02	0.1077	-4.9826	0.9022	5.925654	4.495302	75.8617
55.016	0.133	-4.9799	1.1063	7.317128	5.509263	75.2927
55.012	0.1581	-4.9769	1.3023	8.697397	6.481417	74.52134
55.002	0.2212	-4.9729	1.7607	12.16644	8.755785	71.96668

Appendix: Maximum Output Current Data

Vin	Iin	Vout	Iout
4.0054	1.2571	-4.9864	0.725
4.4996	1.1738	-4.9864	0.7807
5.0007	1.1331	-4.9874	0.8497
5.5018	1.0646	-4.9858	0.8928
6.0014	1.0288	-4.9866	0.95
6.5002	0.9835	-4.9867	0.9917
6.9947	0.9494	-4.9823	1.0385
7.508	0.9059	-4.9858	1.0701
8.0039	0.87	-4.986	1.1005

8.4958	0.8336	-4.9856	1.1253
8.994	0.8095	-4.9858	1.1601
9.5008	0.7802	-4.9857	1.185
10.0049	0.7617	-4.985	1.22
10.502	0.7448	-4.981	1.2525
11.0019	0.7169	-4.982	1.2685
11.496	0.6975	-4.9815	1.2904
11.995	0.6782	-4.9847	1.3099
12.499	0.6591	-4.9849	1.3279
13.003	0.6407	-4.9848	1.3439
13.507	0.623	-4.9843	1.36
14.001	0.6101	-4.9837	1.3789
14.504	0.5939	-4.9838	1.3912
15.007	0.5804	-4.9838	1.407
15.499	0.5679	-4.9839	1.4214
16.002	0.5537	-4.9837	1.4309
16.504	0.5414	-4.9832	1.443
17.006	0.5308	-4.9836	1.457
17.499	0.52	-4.9825	1.4682
18.001	0.5095	-4.9824	1.479
18.503	0.4992	-4.983	1.4885
19.004	0.4896	-4.9829	1.4984
19.506	0.4802	-4.9826	1.5073
20.008	0.4686	-4.9871	1.5213
20.5	0.4607	-4.9845	1.5257
21.005	0.4509	-4.9843	1.5308
21.504	0.4465	-4.9814	1.5426
22.004	0.4383	-4.9818	1.5465
22.518	0.4306	-4.9813	1.5527
23.022	0.4244	-4.9809	1.5626
23.51	0.4182	-4.9804	1.5707
24.036	0.4105	-4.9797	1.5747
24.504	0.4051	-4.9793	1.5826
25.019	0.3984	-4.9798	1.5866
26.033	0.3877	-4.9798	1.6026
27.016	0.3785	-4.9797	1.6185
28.05	0.3658	-4.9795	1.6207
29.047	0.3559	-4.9792	1.6287
30.025	0.3451	-4.9784	1.6286
32.012	0.3306	-4.9789	1.6527
34.016	0.3165	-4.9782	1.6708
36.011	0.3028	-4.9777	1.6807
38.02	0.2904	-4.9784	1.6988

40.052	0.2799	-4.9774	1.7087
42.023	0.2704	-4.9765	1.7168
44.017	0.2612	-4.9765	1.7227
46.031	0.2541	-4.9761	1.7368
48.033	0.2461	-4.9748	1.7409
50.043	0.2391	-4.9753	1.749
52.023	0.2327	-4.9748	1.755
54.008	0.2266	-4.975	1.7609
56.008	0.2201	-4.9749	1.7609
58.006	0.2157	-4.975	1.771
60.018	0.2109	-4.9756	1.7751

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