UCC28700-Q1 Primary-Side Regulated Flyback Converter

TI reference design number: PMP20583 Rev A

Input: 37V to 125V
Outputs: 5V @ 80mA and Isolated 5V @ 80mA

DC – DC Test Results

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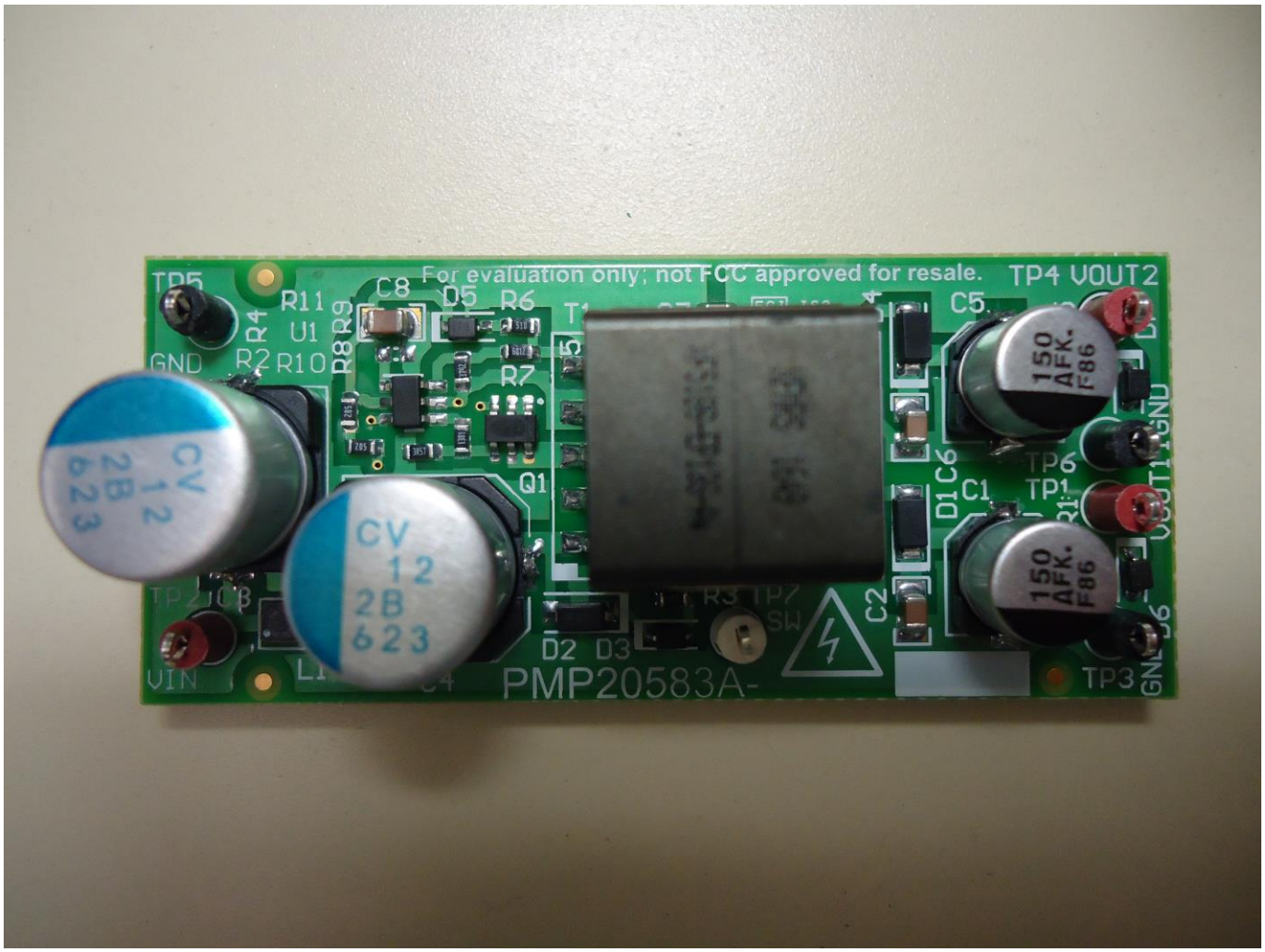
1 Circuit Description

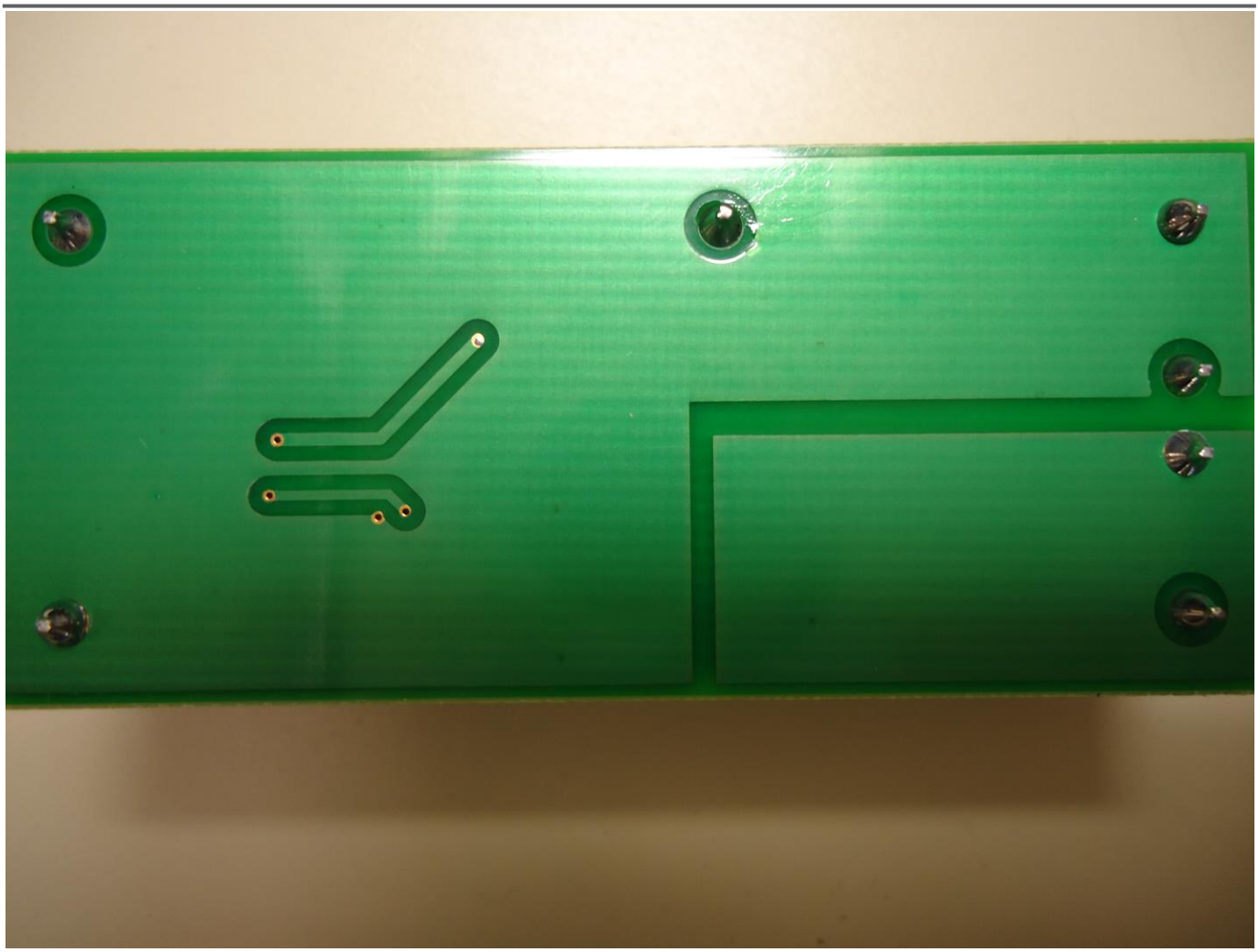
PMP20583 is a primary-side regulated flyback which provides a ground referenced 5V output and an isolated 5V output at up to 80mA each from an input voltage of 37V to 125V. This design uses the UCC28700-Q1 flyback controller for constant-voltage and constant current control of the output. Variable frequency operation minimizes standby power at no load. Features include quasi-resonant valley switching for highest efficiency and frequency dithering to improve EMI performance.

At tests were performed at room temperature on an open bench.

2 Photos

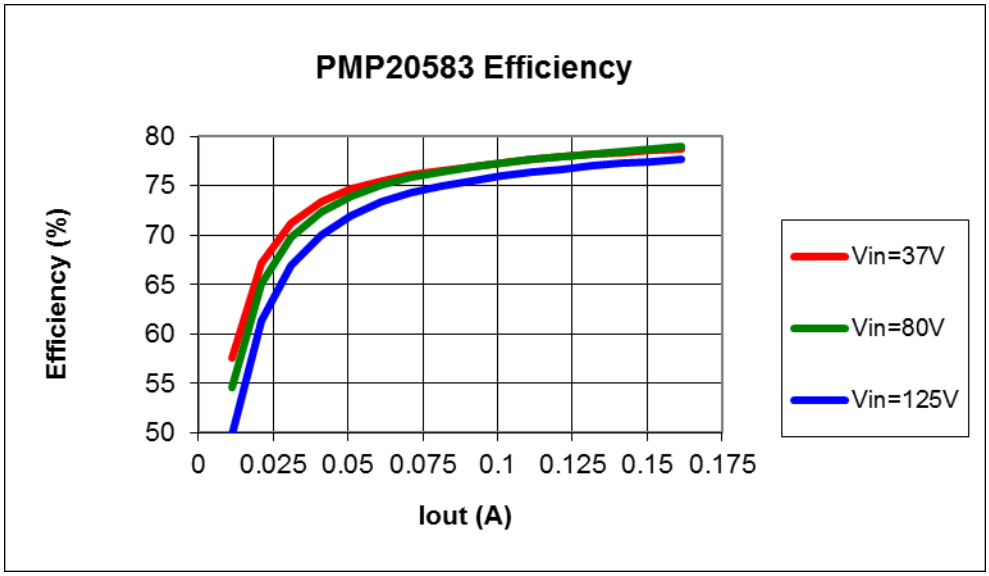
The photographs below show the PMP20583 Rev A printed circuit board assembly. This is a 2 layer board using 1 ounce copper. The overall board dimensions are 1.0” x 2.3”.





3 Efficiency

The efficiency data is shown in the tables and graph below. The 5V outputs were connected in parallel for the test.



Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
37.7254	0.000115	5.1402	0.00001	0.0043	0.0001	0.0043	1.19
37.6996	0.002640	5.1180	0.01120	0.0995	0.0573	0.0422	57.59
37.6825	0.004281	5.1097	0.02120	0.1613	0.1083	0.0530	67.15
37.6661	0.005930	5.1040	0.03116	0.2234	0.1590	0.0643	71.21
37.6489	0.007594	5.0970	0.04117	0.2859	0.2099	0.0760	73.40
37.6319	0.009264	5.0922	0.05115	0.3486	0.2605	0.0882	74.71
37.6141	0.010955	5.0880	0.06117	0.4121	0.3113	0.1008	75.53
37.5969	0.012641	5.0862	0.07117	0.4753	0.3620	0.1133	76.16
37.5793	0.014350	5.0840	0.08119	0.5393	0.4128	0.1265	76.55
37.5618	0.016040	5.0851	0.09118	0.6025	0.4637	0.1388	76.96
37.5442	0.017737	5.0881	0.10120	0.6659	0.5149	0.1510	77.32
37.5270	0.019433	5.0922	0.11119	0.7293	0.5662	0.1631	77.64
37.5093	0.021151	5.0995	0.12125	0.7934	0.6183	0.1750	77.94
37.4915	0.022862	5.1047	0.13126	0.8571	0.6700	0.1871	78.17
37.4744	0.024572	5.1087	0.14128	0.9208	0.7218	0.1991	78.38
37.4568	0.026275	5.1114	0.15127	0.9842	0.7732	0.2110	78.56
37.4391	0.027979	5.1139	0.16129	1.0475	0.8248	0.2227	78.74

PMP20583 Rev A Test Results

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
81.5691	0.000076	5.1369	0.00001	0.0062	0.0001	0.0062	0.82
81.5566	0.001286	5.1176	0.01118	0.1049	0.0572	0.0477	54.55
81.5494	0.002039	5.1092	0.02118	0.1663	0.1082	0.0581	65.05
81.5416	0.002794	5.1011	0.03115	0.2278	0.1589	0.0689	69.76
81.5339	0.003553	5.0929	0.04116	0.2897	0.2096	0.0801	72.36
81.5262	0.004313	5.0874	0.05113	0.3517	0.2601	0.0915	73.97
81.5180	0.005083	5.0856	0.06116	0.4143	0.3110	0.1033	75.07
81.5102	0.005853	5.0851	0.07116	0.4771	0.3618	0.1152	75.85
81.5025	0.006629	5.0851	0.08119	0.5402	0.4128	0.1274	76.42
81.4943	0.007401	5.0871	0.09117	0.6031	0.4638	0.1394	76.89
81.4866	0.008176	5.0896	0.10118	0.6663	0.5150	0.1513	77.29
81.4785	0.008948	5.0917	0.11117	0.7291	0.5661	0.1630	77.64
81.4707	0.009728	5.0960	0.12123	0.7925	0.6178	0.1747	77.95
81.4628	0.010503	5.0992	0.13123	0.8556	0.6692	0.1864	78.21
81.4547	0.011280	5.1030	0.14125	0.9188	0.7208	0.1980	78.45
81.4468	0.012046	5.1082	0.15125	0.9811	0.7726	0.2085	78.75
81.4387	0.012827	5.1134	0.16126	1.0446	0.8246	0.2200	78.94

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
125.0185	0.000087	5.1341	0.00001	0.0109	0.0001	0.0108	0.47
125.0093	0.000916	5.1145	0.01114	0.1145	0.0570	0.0575	49.79
125.0054	0.001409	5.1080	0.02115	0.1761	0.1080	0.0681	61.33
125.0002	0.001899	5.0986	0.03112	0.2373	0.1587	0.0786	66.87
124.9937	0.002393	5.0903	0.04114	0.2991	0.2094	0.0898	70.00
124.9872	0.002887	5.0846	0.05110	0.3609	0.2598	0.1011	72.00
124.9833	0.003388	5.0815	0.06112	0.4234	0.3106	0.1128	73.35
124.9781	0.003892	5.0813	0.07112	0.4864	0.3614	0.1251	74.29
124.9728	0.004400	5.0820	0.08114	0.5499	0.4123	0.1375	74.99
124.9676	0.004910	5.0852	0.09113	0.6136	0.4634	0.1502	75.52
124.9624	0.005422	5.0888	0.10115	0.6776	0.5147	0.1628	75.97
124.9572	0.005933	5.0918	0.11114	0.7413	0.5659	0.1754	76.34
124.9507	0.006447	5.0964	0.12121	0.8055	0.6177	0.1878	76.69
124.9481	0.006957	5.0990	0.13121	0.8692	0.6690	0.2002	76.97
124.9416	0.007468	5.1023	0.14123	0.9331	0.7206	0.2125	77.23
124.9351	0.007978	5.1052	0.15123	0.9967	0.7721	0.2247	77.46
124.9299	0.008490	5.1092	0.16124	1.0606	0.8238	0.2368	77.67

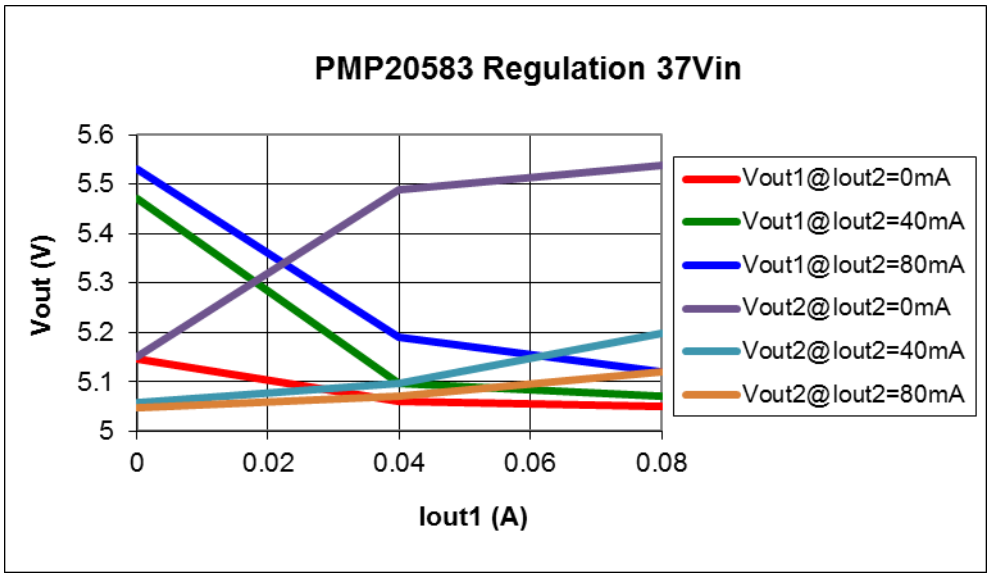
4 Standby Input Power

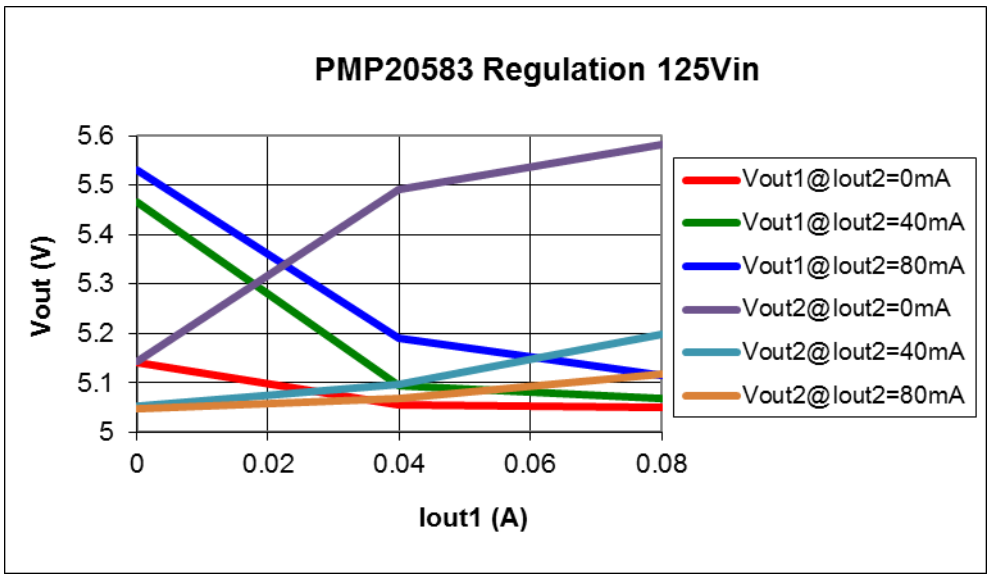
The input power was measured at no load, with no voltmeters or oscilloscope connected.

Vin (V)	Iin (A)	Pin (W)
37	0.000110	0.00406
80	0.000065	0.00522
125	0.000064	0.00801

5 Output Voltage Regulation

Output voltage regulation data is shown in the tables and graphs below.





PMP20583 Rev A Test Results

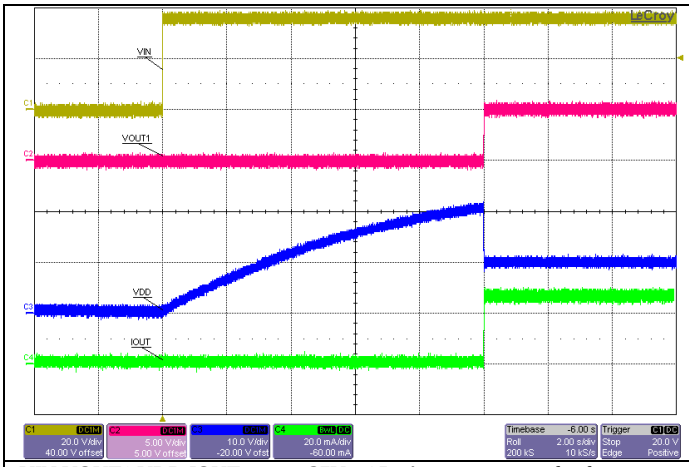
Vin (V)	Iin (A)	Vout1 (V)	Iout (A)	Vout2 (V)	Iout2 (A)	Losses (W)	Efficiency (%)
37.01	0.00012	5.1460	0.0000	5.1510	0.0000	0.0044	0.00
37.03	0.00787	5.0610	0.0400	5.4890	0.0000	0.0890	69.47
36.95	0.01537	5.0500	0.0800	5.5370	0.0000	0.1639	71.14
37.11	0.00786	5.4710	0.0000	5.0570	0.0400	0.0894	69.35
36.95	0.01443	5.0980	0.0400	5.0980	0.0400	0.1253	76.49
36.89	0.02144	5.0700	0.0800	5.1980	0.0400	0.1774	77.57
36.95	0.01528	5.5300	0.0000	5.0480	0.0800	0.1608	71.53
36.89	0.02159	5.1910	0.0400	5.0710	0.0800	0.1831	77.01
36.82	0.02828	5.1190	0.0800	5.1210	0.0800	0.2221	78.67

Vin (V)	Iin (A)	Vout1 (V)	Iout (A)	Vout2 (V)	Iout2 (A)	Losses (W)	Efficiency (%)
125.10	0.00008	5.1410	0.0000	5.1440	0.0000	0.0100	0.00
125.07	0.00245	5.0560	0.0400	5.4910	0.0000	0.1042	66.00
125.05	0.00464	5.0490	0.0800	5.5830	0.0000	0.1763	69.61
125.07	0.00244	5.4650	0.0000	5.0530	0.0400	0.1031	66.23
125.05	0.00436	5.0950	0.0400	5.0980	0.0400	0.1375	74.78
125.03	0.00643	5.0680	0.0800	5.1980	0.0400	0.1906	76.29
125.05	0.00460	5.5300	0.0000	5.0470	0.0800	0.1715	70.19
125.03	0.00646	5.1910	0.0400	5.0680	0.0800	0.1946	75.91
125.01	0.00843	5.1140	0.0800	5.1180	0.0800	0.2353	77.67

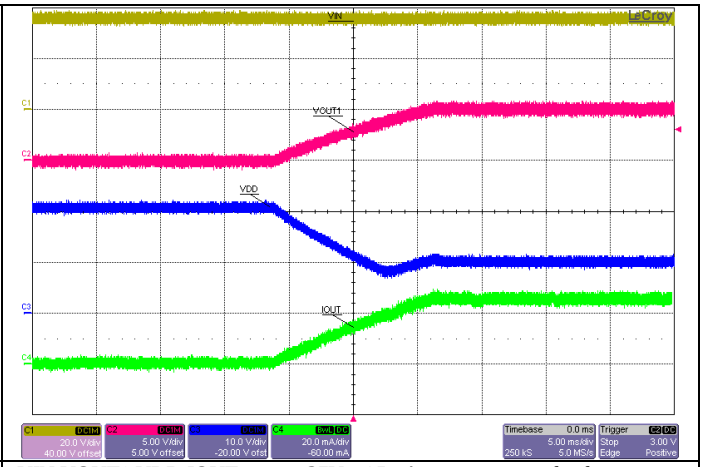
6 Startup Behavior

6.1 Turn-on from Vin with Cout = 150uF

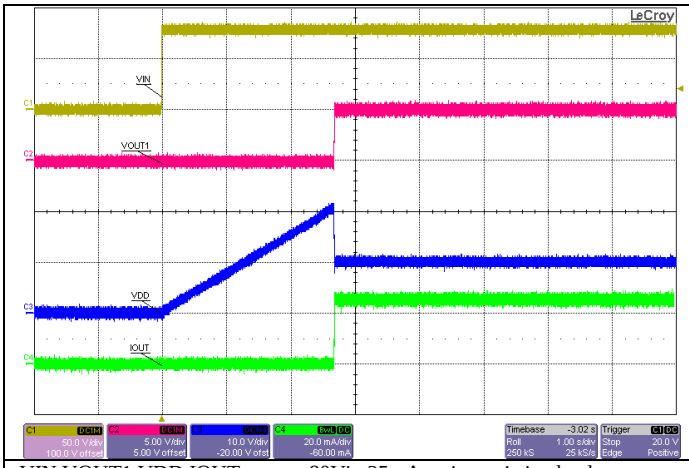
The output voltages were connected in series and a resistive load was used to test startup. The VDD capacitor is sized to start into 5V/25mA = 200 ohms and 150uF on each output. The startup delay time is set by the 4Meg ohm start resistor charging the 2.2uF VDD capacitor.



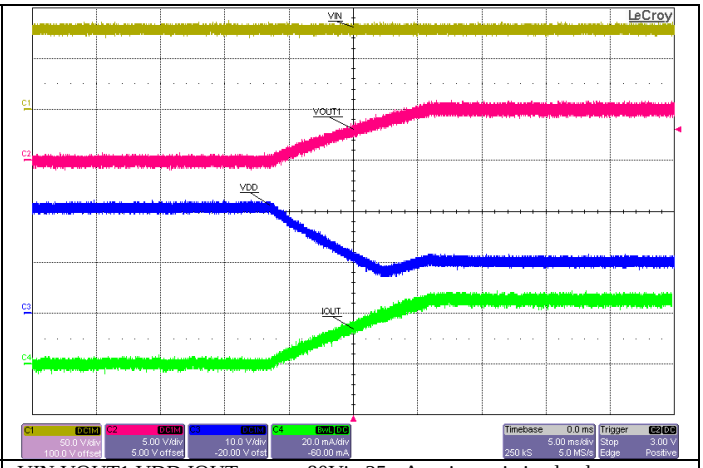
VIN VOUT1 VDD IOUT startup 37Vin 25mA series resistive load



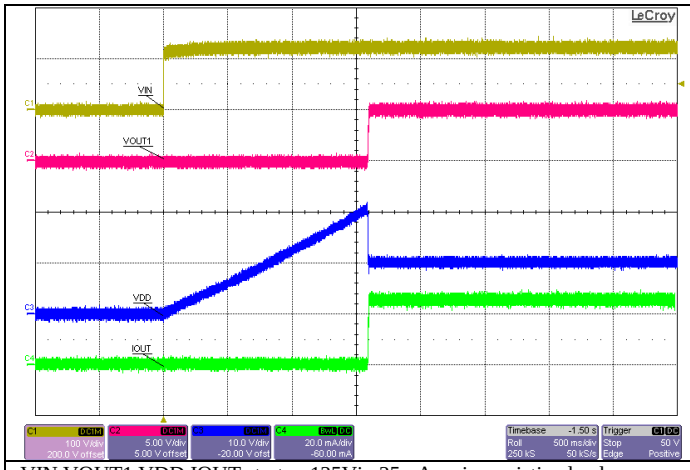
VIN VOUT1 VDD IOUT startup 37Vin 25mA series resistive load



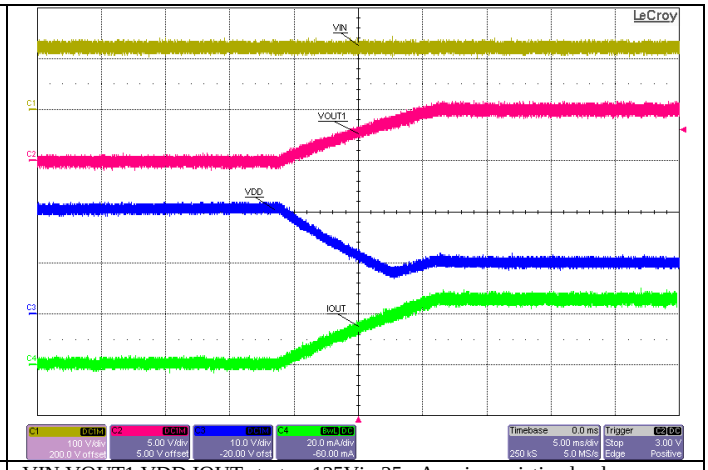
VIN VOUT1 VDD IOUT startup 80Vin 25mA series resistive load



VIN VOUT1 VDD IOUT startup 80Vin 25mA series resistive load

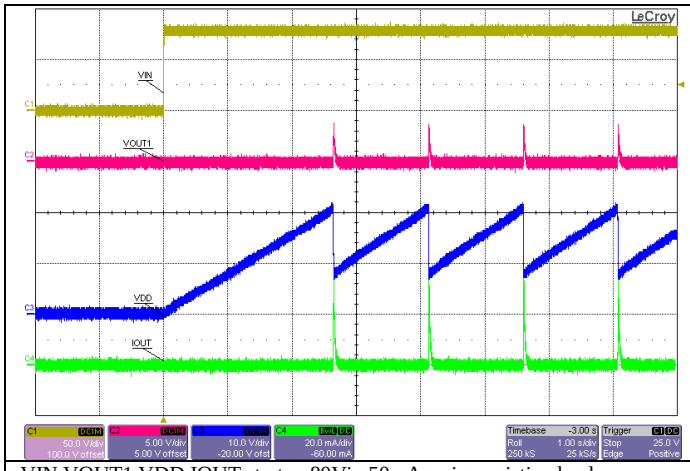


VIN VOUT1 VDD IOUT startup 125Vin 25mA series resistive load

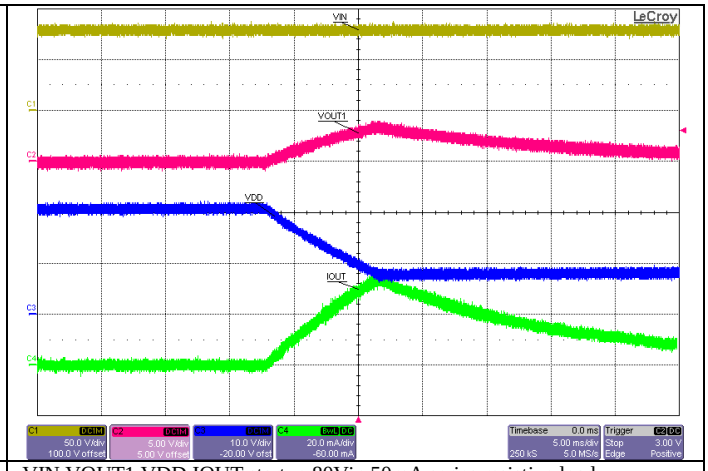


VIN VOUT1 VDD IOUT startup 125Vin 25mA series resistive load

When the load is increased to 5V/50mA = 100 ohms on each output, the VDD bias voltage collapses during startup and the converter cycles on and off. This cycling provides overload protection.



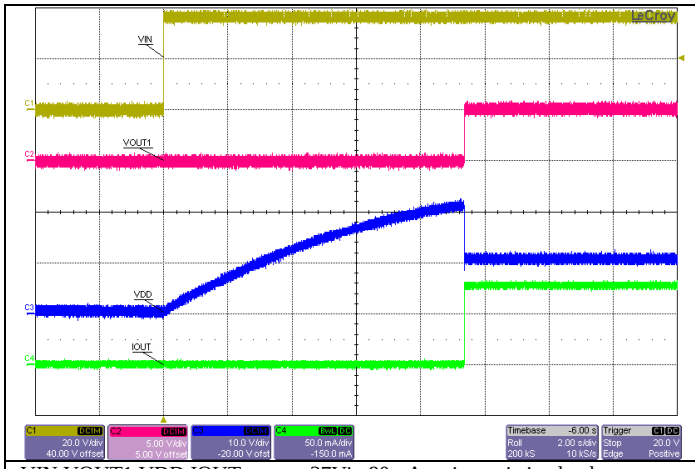
VIN VOUT1 VDD IOUT startup 80Vin 50mA series resistive load



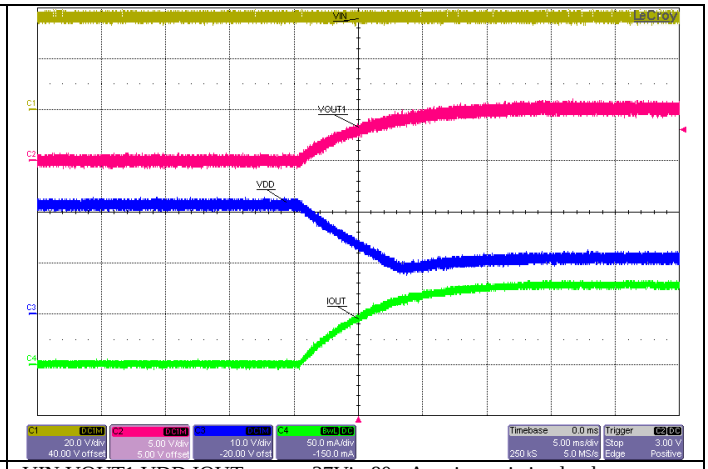
VIN VOUT1 VDD IOUT startup 80Vin 50mA series resistive load

6.2 Turn-on from Vin with Cout = 82uF

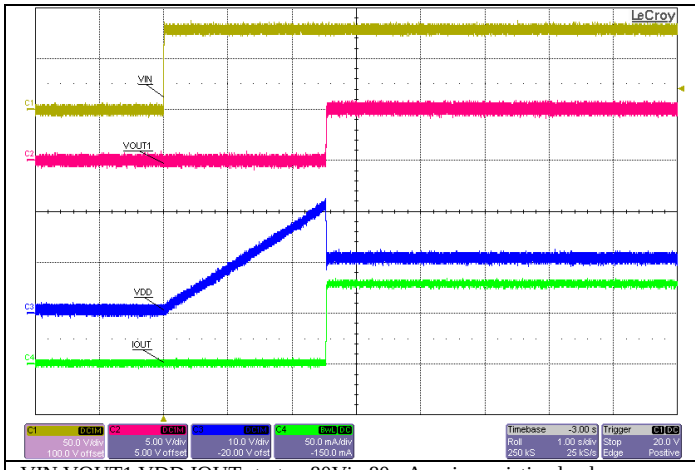
The output voltages were connected in series and a resistive load was used to test startup. Decreasing the output capacitors to 82uF al1ows the converter to start into 5V/80mA=62.5 ohms on each output.



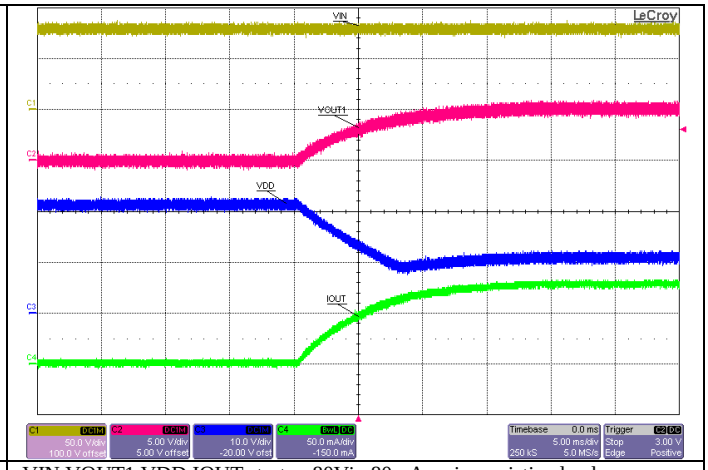
VIN VOUT1 VDD IOUT startup 37Vin 80mA series resistive load



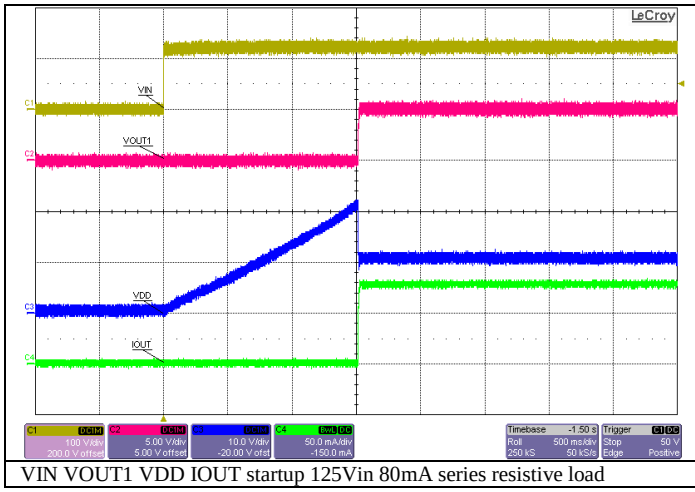
VIN VOUT1 VDD IOUT startup 37Vin 80mA series resistive load



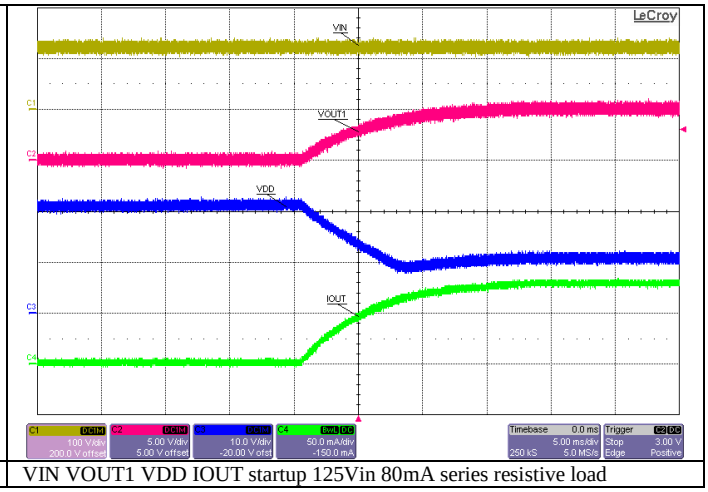
VIN VOUT1 VDD IOUT startup 80Vin 80mA series resistive load



VIN VOUT1 VDD IOUT startup 80Vin 80mA series resistive load



VIN VOUT1 VDD IOUT startup 125Vin 80mA series resistive load

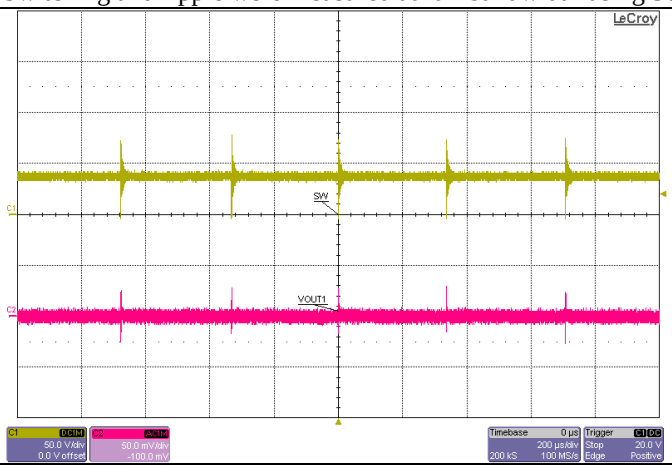


VIN VOUT1 VDD IOUT startup 125Vin 80mA series resistive load

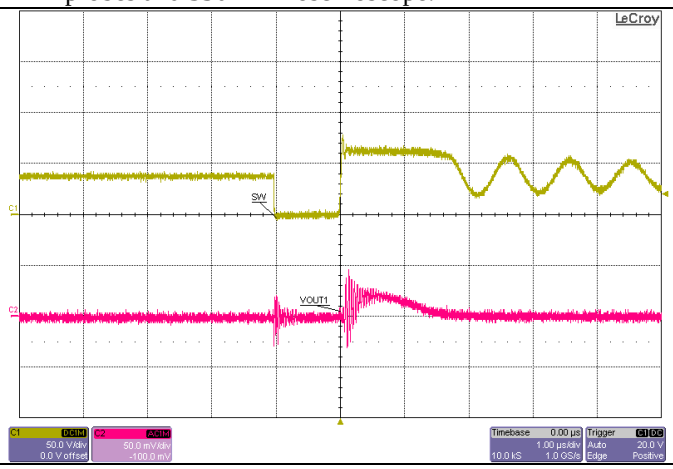
7 Switching and Ripple

7.1 Switching and Ripple

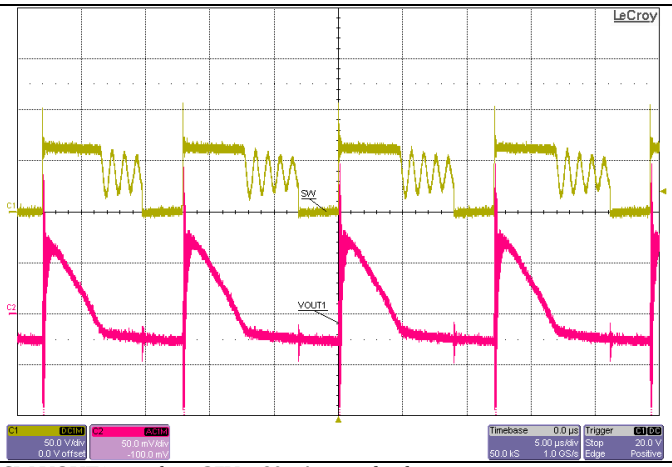
Switching and ripple were measured at full bandwidth using 500 MHz probes and 350 MHz oscilloscope.



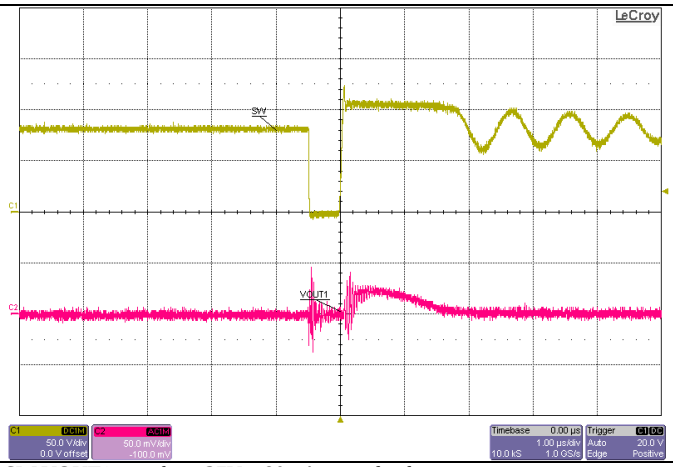
SW VOUT1 switching 37Vin 0mA load



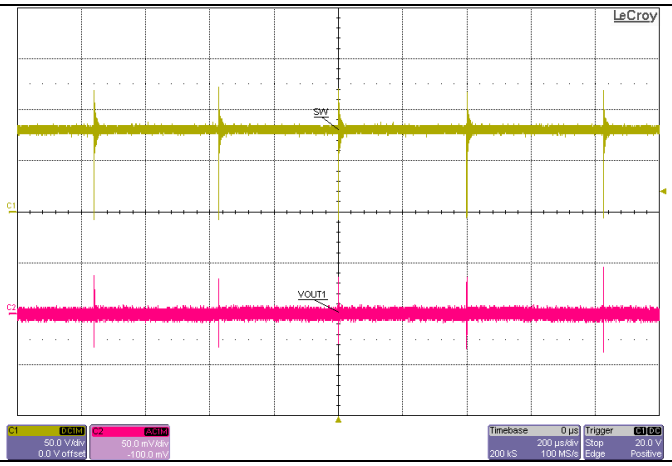
SW VOUT1 switching 37Vin 0mA load



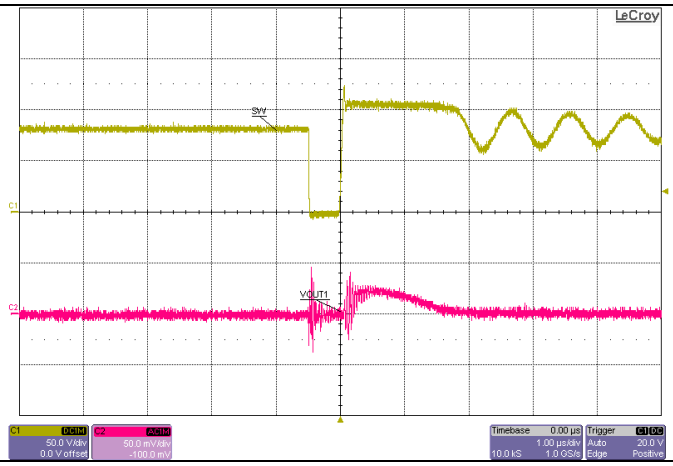
SW VOUT1 switching 37Vin 80mA series load



SW VOUT1 switching 37Vin 80mA series load



SW VOUT1 switching 80Vin 0mA load



SW VOUT1 switching 80Vin 0mA load

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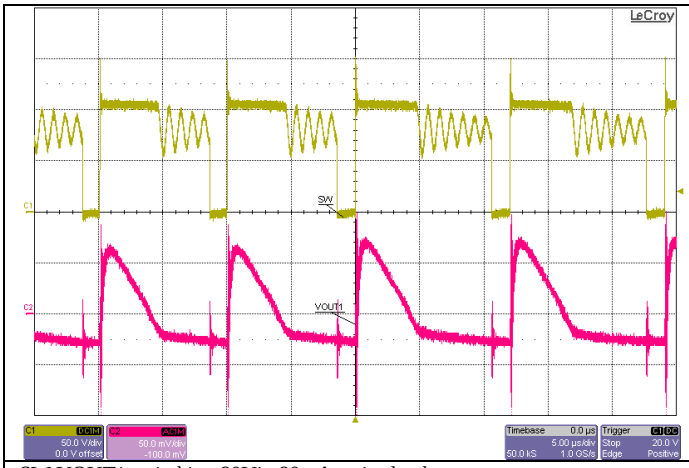
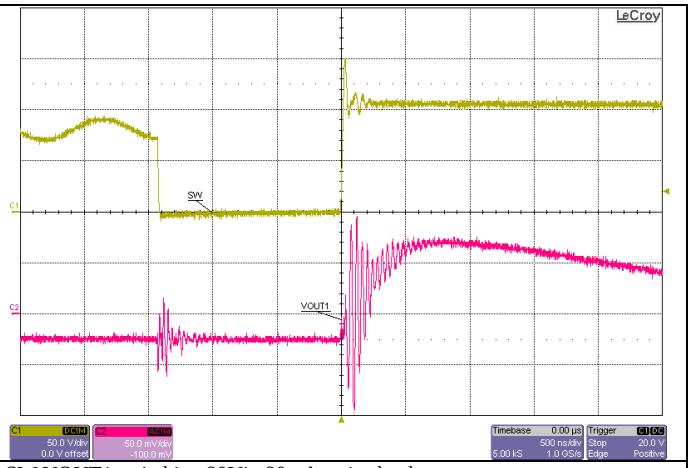
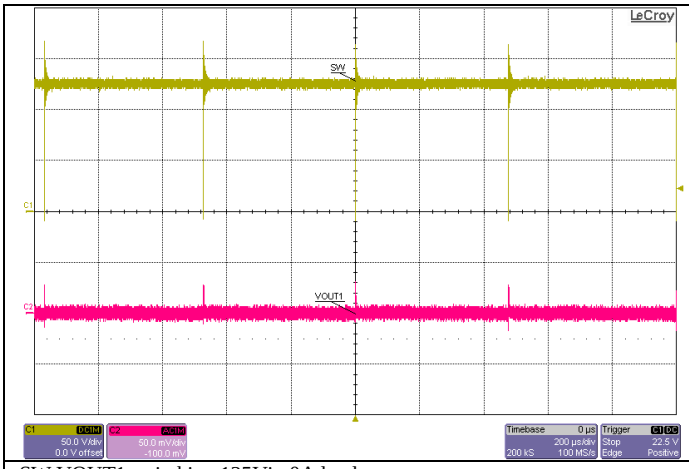


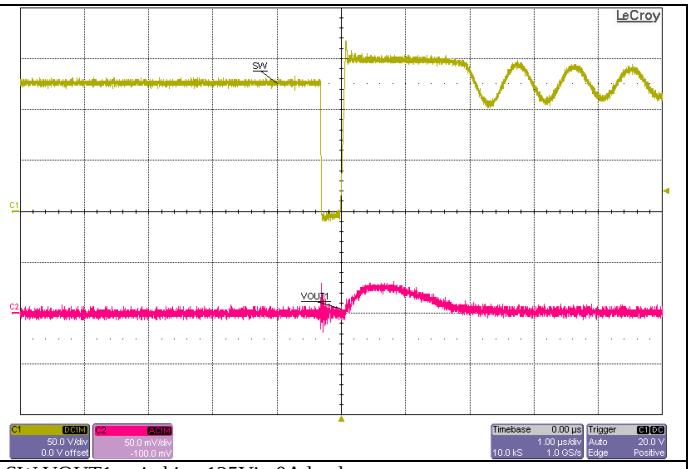
SW VOUT1 switching 80Vin 80mA series load



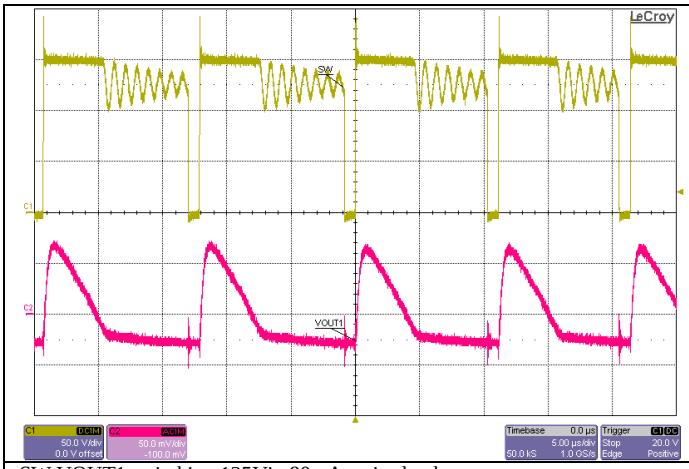
SW VOUT1 switching 80Vin 80mA series load



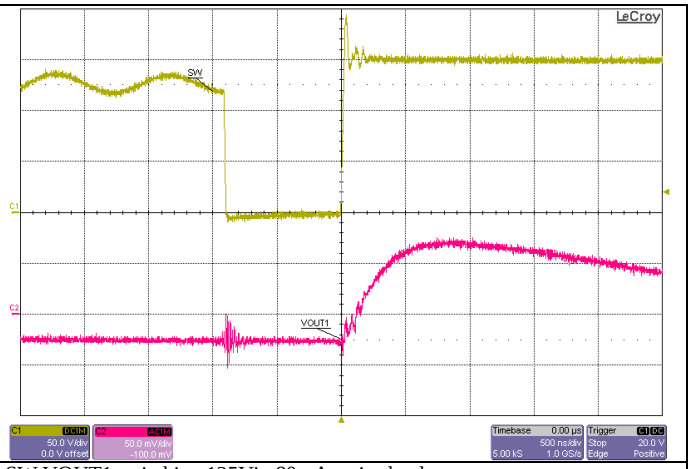
SW VOUT1 switching 125Vin 0A load



SW VOUT1 switching 125Vin 0A load

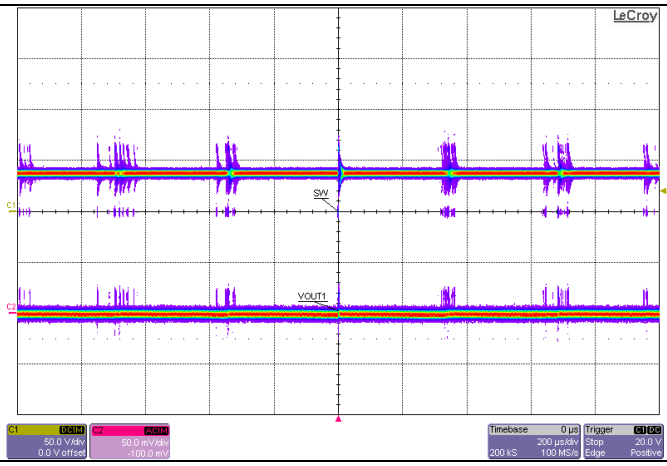


SW VOUT1 switching 125Vin 80mA series load

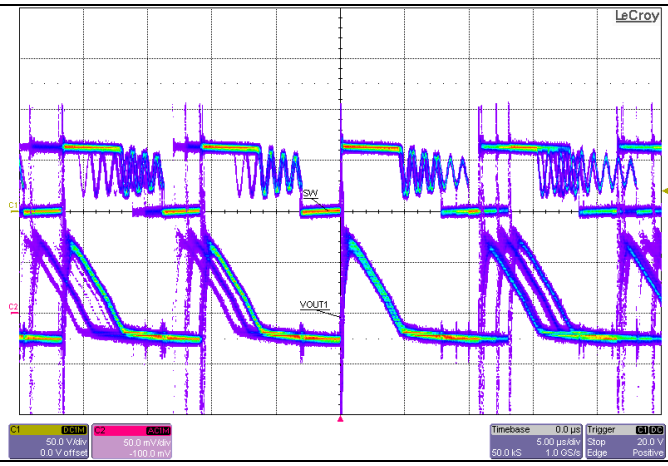


SW VOUT1 switching 125Vin 80mA series load

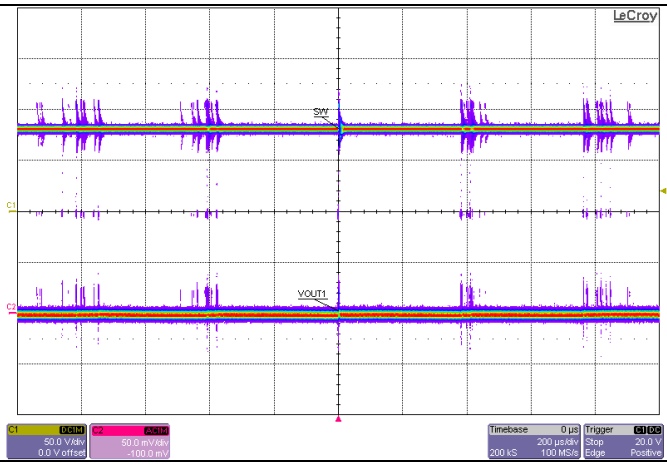
7.2 Frequency Dithering



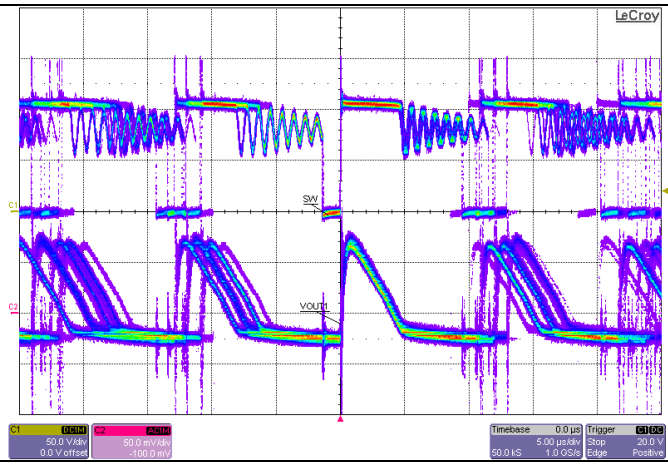
SW VOUT1 switching 37Vin 0mA load



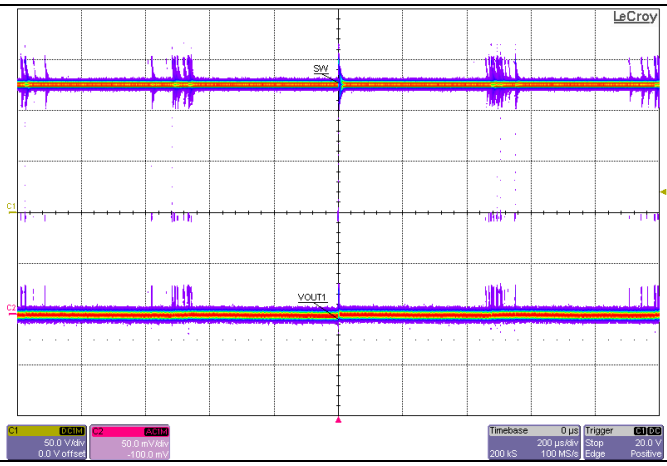
SW VOUT1 switching 37Vin 80mA series load



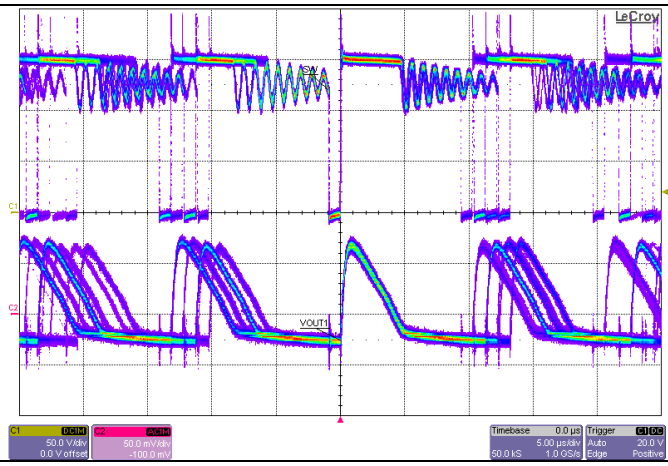
SW VOUT1 switching 80Vin 0mA load



SW VOUT1 switching 80Vin 80mA series load



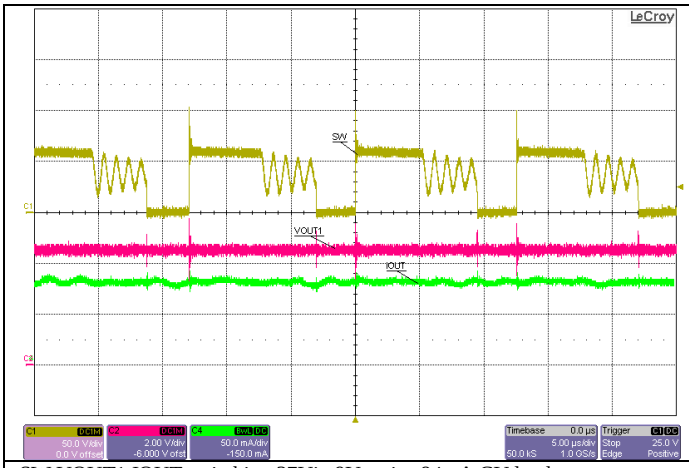
SW VOUT1 switching 125Vin 0A load



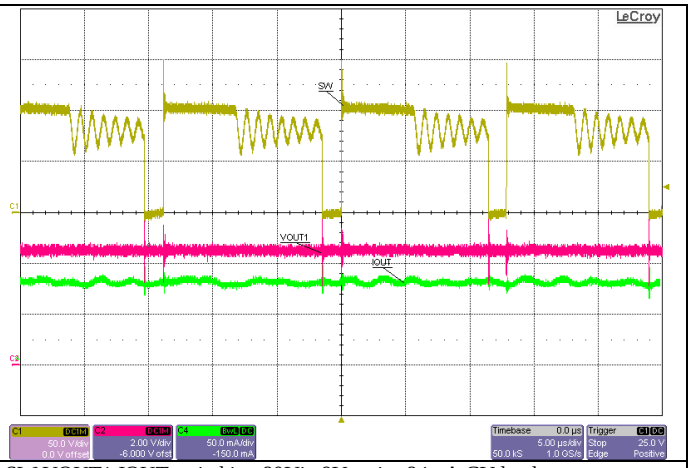
SW VOUT1 switching 125Vin 80mA series load

7.1 Switching and Ripple into Constant-Voltage Load

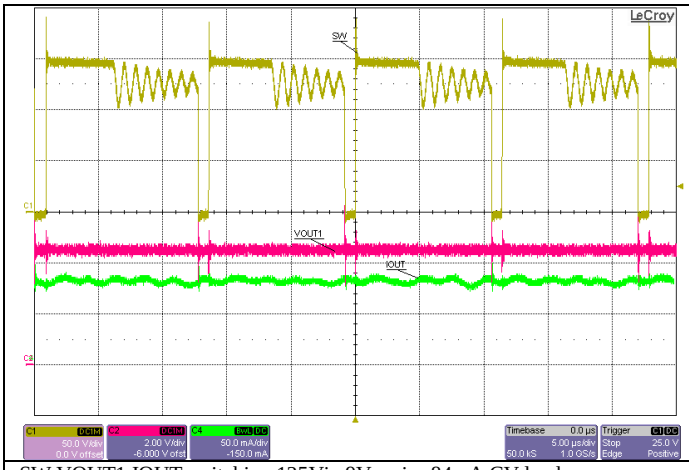
The outputs were wired in series and connected to a constant 9V load. Measured current limit was 84mA.



SW VOUT1 IOUT switching 37Vin 9V series 84mA CV load



SW VOUT1 IOUT switching 80Vin 9V series 84mA CV load

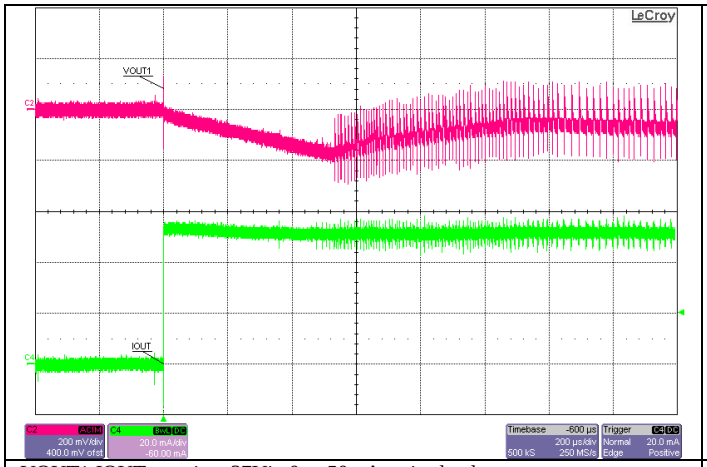


SW VOUT1 IOUT switching 125Vin 9V series 84mA CV load

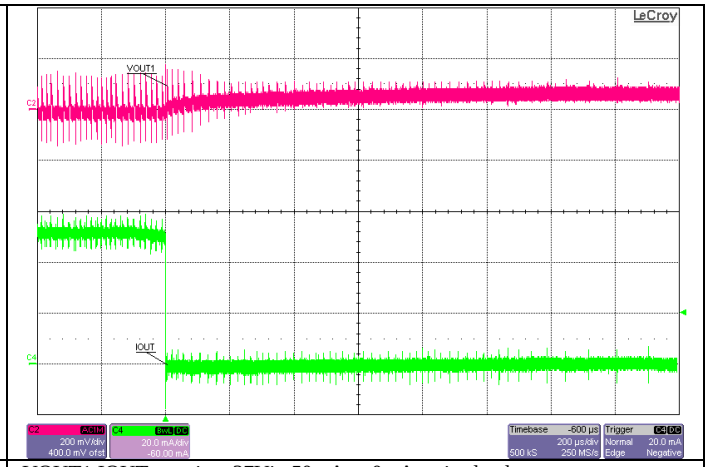
8 Load Transient Response

8.1 Load Transient Response with Cout = 150uF

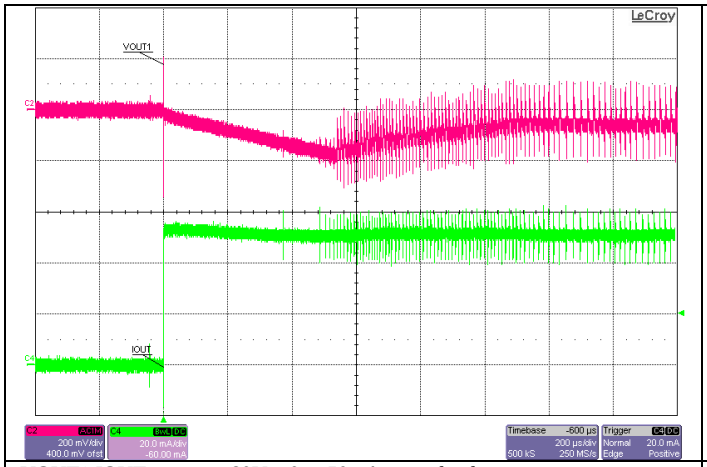
A fixed resistor was used to manually step the current.



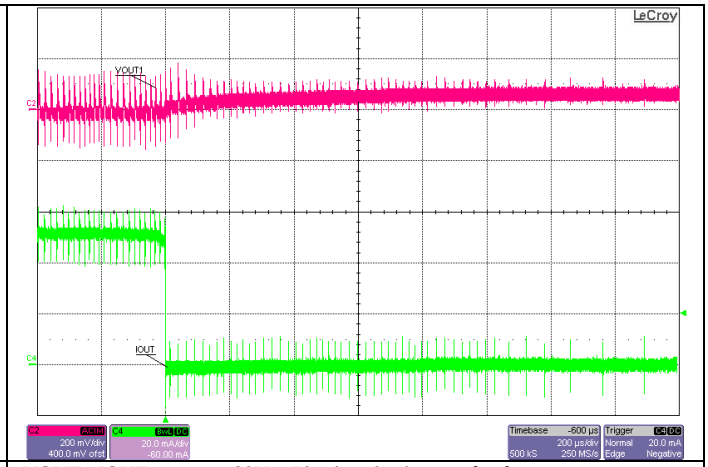
VOUT1 IOUT transient 37Vin 0 to 50mA series load step



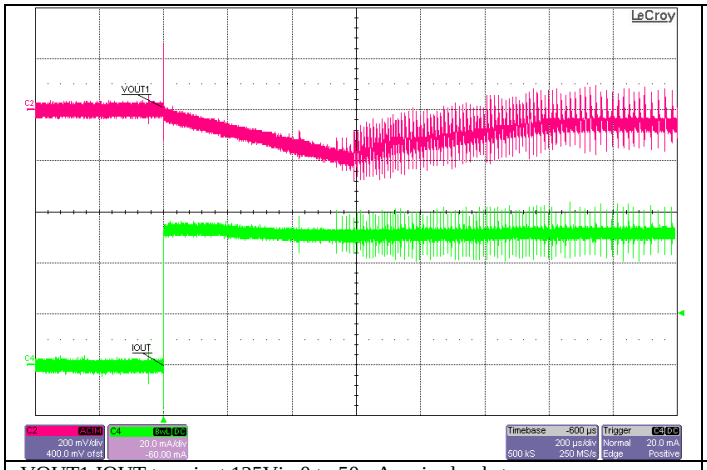
VOUT1 IOUT transient 37Vin 50mA to 0mA series load step



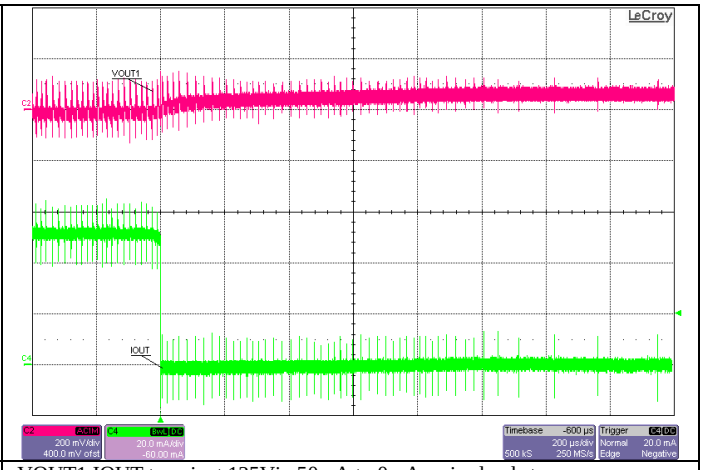
VOUT1 IOUT transient 80Vin 0 to 50mA series load step



VOUT1 IOUT transient 80Vin 50mA to 0mA series load step



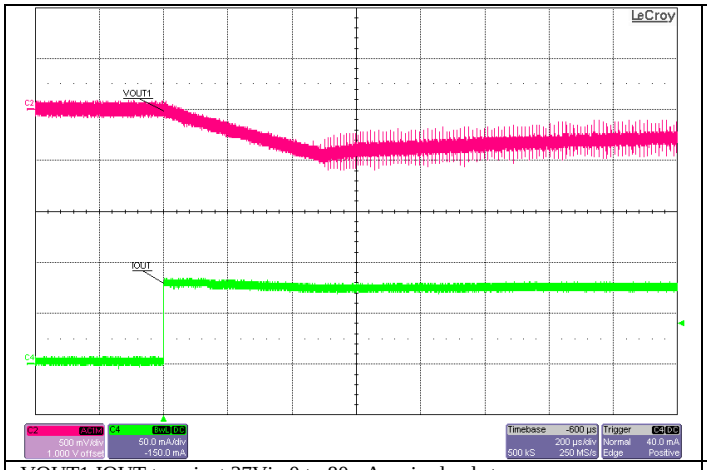
VOUT1 IOUT transient 125Vin 0 to 50mA series load step



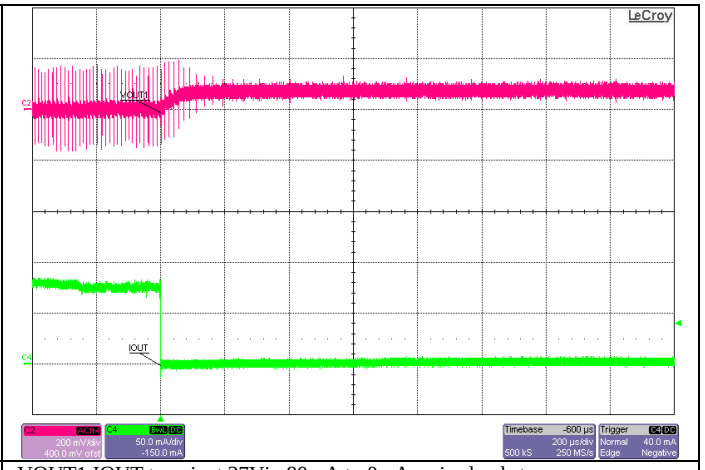
VOUT1 IOUT transient 125Vin 50mA to 0mA series load step

8.1 Load Transient Response with Cout = 82uF

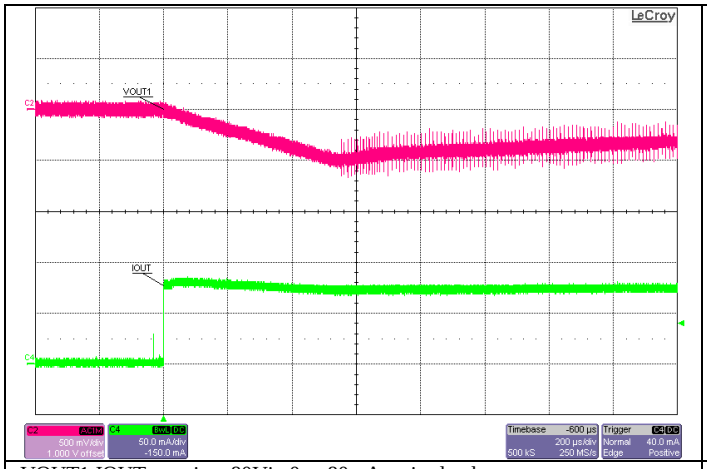
A fixed resistor was used to manually step the current.



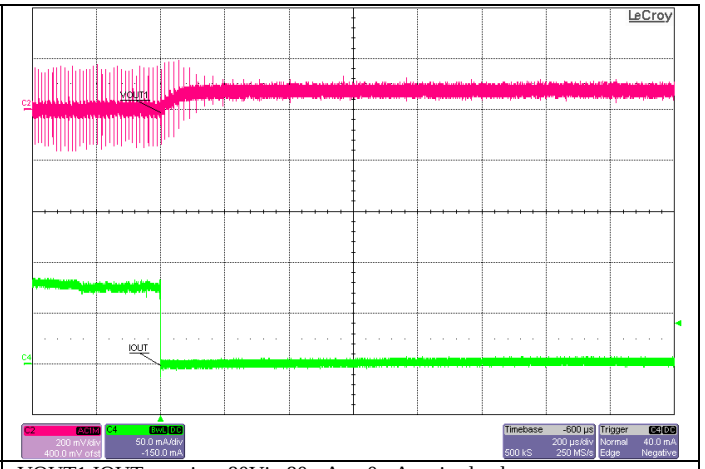
VOUT1 IOUT transient 37Vin 0 to 80mA series load step



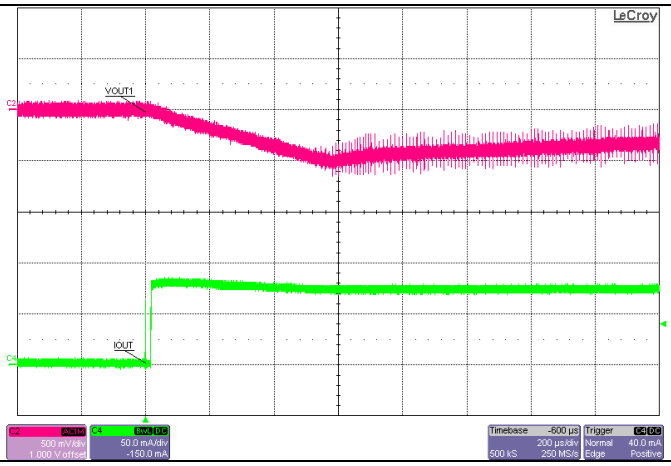
VOUT1 IOUT transient 37Vin 80mA to 0mA series load step



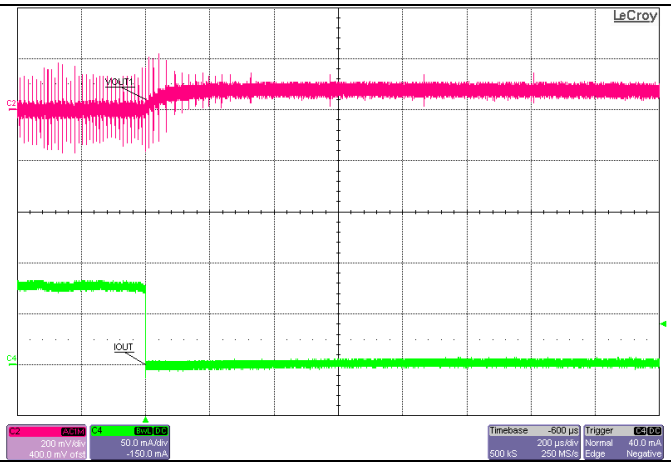
VOUT1 IOUT transient 80Vin 0 to 80mA series load step



VOUT1 IOUT transient 80Vin 80mA to 0mA series load step



VOUT1 IOUT transient 125Vin 0 to 80mA series load step



VOUT1 IOUT transient 125Vin 80mA to 0mA series load step

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