TI reference design number: PMP10612

Input: 7.5V-18V

Output: 5V-40V (40W Max)

DC–DC Converter Test Results

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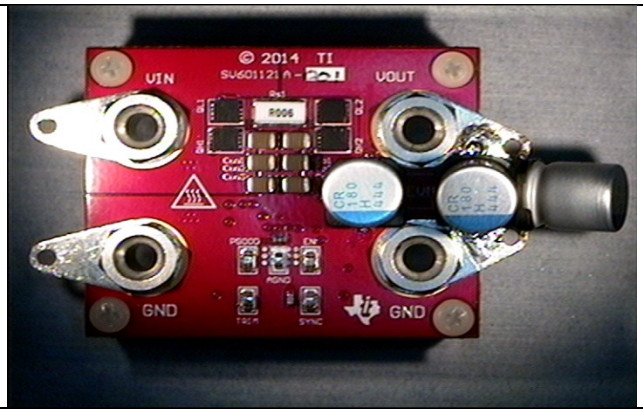
1. Circuit Description

PMP10612 is configured for 7.5-18Vin and was tested at a range of 5 to 40Vout. This design utilizes the LM5175, which is a wide VIN four switch synchronous Buck-Boost controller. This design is capable of regulating the output while the input is at, above or below the output. This design is ideal for industrial and automotive applications. The switching frequency is set to 500 kHz. The output voltage was adjusted by changing the voltage applied to TRIM test point.

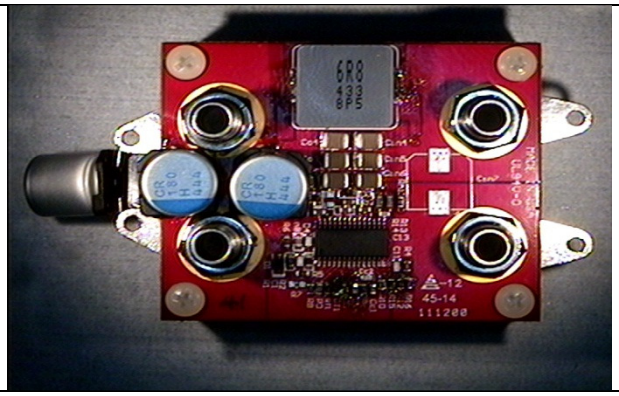
2. Fabrication

The PMP10612 is built on a LM5175EVM-HD PCB. This is a six layer board with overall dimensions of 1.97″ (50mm) x 1.7″ (43mm). The copper weight is 2oz.



Top View

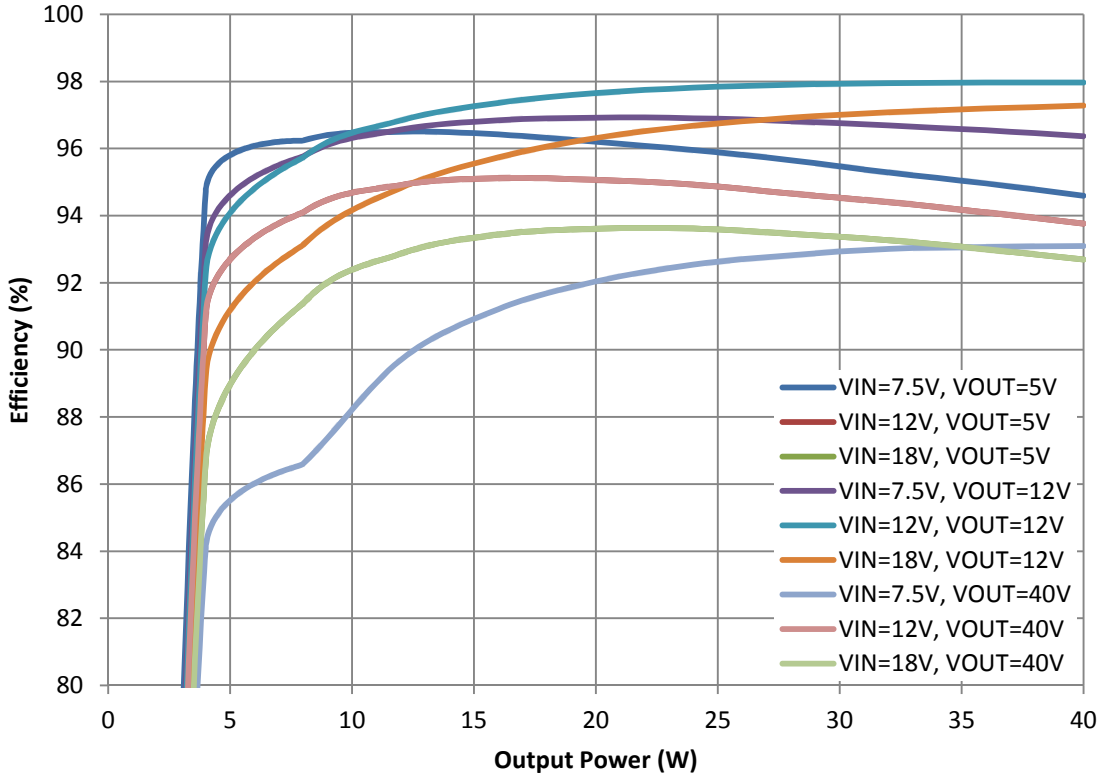
Buck-Boost Converter



Bottom View

Buck-Boost Converter

3. Efficiency



3.1 VOUT=5V

Vin	Iin	Vout	Iout	Eff%	Load	Pout
7.493	0.02	5.013	0	1.535	0	0
7.493	0.554	5.02	0.783	94.72	0.8	3.93066
7.493	1.108	5.032	1.588	96.238	1.6	7.990816
7.493	1.667	5.041	2.391	96.501	2.4	12.05303
7.493	2.232	5.047	3.196	96.418	3.2	16.13021
7.493	2.802	5.052	3.998	96.2	4	20.1979
7.494	3.379	5.059	4.802	95.956	4.8	24.29332
7.493	3.963	5.067	5.607	95.653	5.6	28.41067
7.494	4.552	5.07	6.411	95.287	6.4	32.50377
7.494	5.148	5.076	7.216	94.959	7.2	36.62842
7.494	5.749	5.082	8.019	94.595	8	40.75256
12.005	0.023	5.006	0.001	1.043	0	0.005006
12.004	0.358	5.003	0.782	91.06	0.8	3.912346
12.005	0.704	5.006	1.588	94.1	1.6	7.949528
12.005	1.051	5.009	2.391	94.912	2.4	11.97652
12.005	1.403	5.014	3.196	95.116	3.2	16.02474
12.005	1.758	5.017	3.998	95.064	4	20.05797
12.004	2.116	5.021	4.802	94.924	4.8	24.11084
12.005	2.479	5.025	5.607	94.659	5.6	28.17518
12.005	2.845	5.028	6.411	94.403	6.4	32.23451
12.005	3.216	5.035	7.216	94.098	7.2	36.33256
12.005	3.592	5.042	8.019	93.766	8	40.4318
18.011	0.024	5.034	0.001	0.676	0	0.005034
18.011	0.252	5.027	0.783	86.665	0.8	3.936141
18.011	0.484	5.022	1.588	91.393	1.6	7.974936
18.011	0.718	5.02	2.391	92.867	2.4	12.00282
18.011	0.954	5.022	3.196	93.436	3.2	16.05031
18.011	1.191	5.021	3.998	93.608	4	20.07396
18.011	1.43	5.021	4.803	93.616	4.8	24.11586
18.011	1.672	5.019	5.607	93.456	5.6	28.14153
18.011	1.917	5.022	6.411	93.267	6.4	32.19604
18.011	2.164	5.023	7.216	93.001	7.2	36.24597
18.011	2.413	5.024	8.019	92.692	8	40.28746

3.2 VOUT=12V

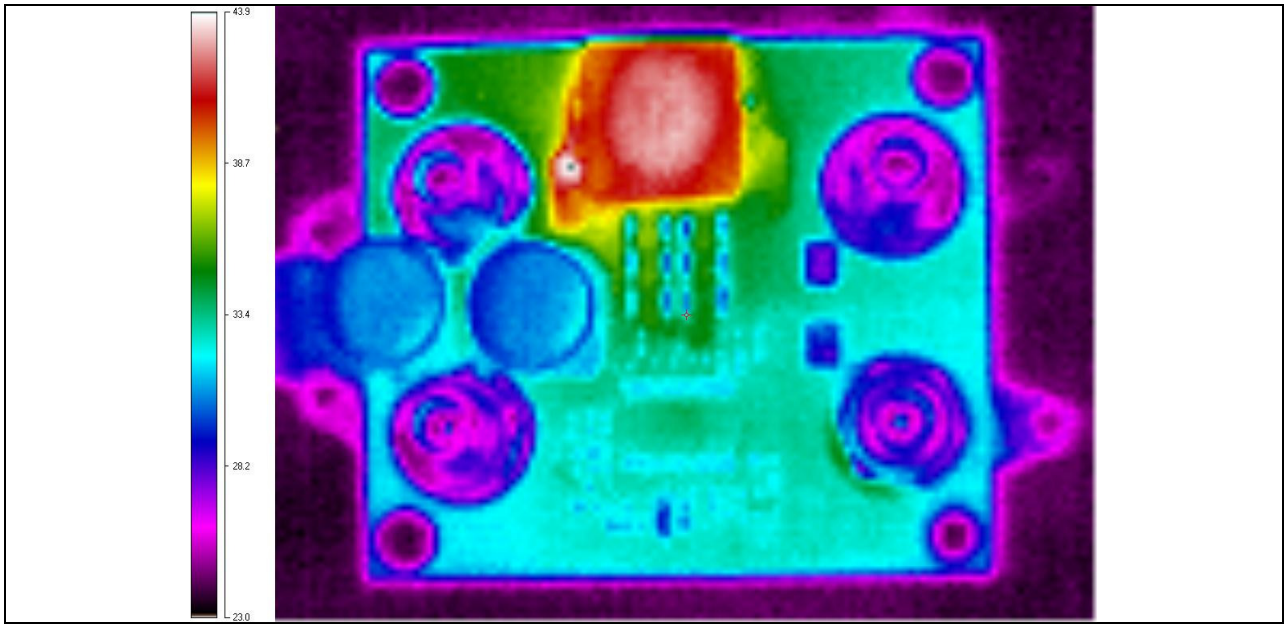
Vin	Iin	Vout	Iout	Eff%	Load	Pout
7.494	0.026	12.073	0	1.015	0	0
7.494	0.56	12.076	0.324	93.114	0.33	3.912624
7.494	1.103	12.077	0.655	95.767	0.66	7.910435
7.494	1.649	12.079	0.988	96.562	0.99	11.93405
7.494	2.197	12.082	1.319	96.841	1.32	15.93616
7.494	2.747	12.084	1.651	96.922	1.65	19.95068
7.494	3.301	12.086	1.983	96.904	1.98	23.96654
7.494	3.857	12.089	2.315	96.817	2.31	27.98604
7.494	4.417	12.091	2.647	96.687	2.64	32.00488
7.494	4.979	12.093	2.979	96.542	2.97	36.02505
7.494	5.544	12.095	3.31	96.367	3.3	40.03445
12.005	0.026	12.03	0	0.84	0	0
12.005	0.352	12.036	0.324	92.28	0.33	3.899664
12.005	0.687	12.036	0.656	95.735	0.66	7.895616
12.005	1.023	12.039	0.988	96.838	0.99	11.89453
12.005	1.359	12.042	1.319	97.361	1.32	15.8834
12.005	1.697	12.047	1.651	97.653	1.65	19.8896
12.005	2.035	12.048	1.983	97.811	1.98	23.89118
12.005	2.373	12.052	2.315	97.904	2.31	27.90038
12.005	2.713	12.054	2.647	97.952	2.64	31.90694
12.005	3.053	12.056	2.978	97.967	2.97	35.90277
12.005	3.394	12.059	3.31	97.97	3.3	39.91529
18.011	0.024	12.015	0	0.621	0	0
18.011	0.242	12.02	0.324	89.207	0.33	3.89448
18.011	0.47	12.023	0.655	93.129	0.66	7.875065
18.011	0.695	12.021	0.987	94.826	0.99	11.86473
18.011	0.92	12.021	1.319	95.734	1.32	15.8557
18.011	1.145	12.026	1.651	96.314	1.65	19.85493
18.011	1.37	12.031	1.983	96.676	1.98	23.85747
18.011	1.596	12.034	2.315	96.916	2.31	27.85871
18.011	1.822	12.038	2.647	97.08	2.64	31.86459
18.011	2.049	12.041	2.979	97.192	2.97	35.87014
18.011	2.276	12.046	3.31	97.276	3.3	39.87226

3.3 VOUT=40V

Vin	Iin	Vout	Iout	Eff%	Load	Pout
7.494	0.065	40.049	0	1.642	0	0
7.494	0.588	40.035	0.092	84.091	0.1	3.68322
7.494	1.19	40.012	0.193	86.606	0.2	7.722316
7.494	1.747	39.995	0.294	89.701	0.3	11.75853
7.494	2.305	39.972	0.394	91.214	0.4	15.74897
7.494	2.864	39.938	0.495	92.039	0.5	19.76931
7.494	3.423	39.883	0.595	92.539	0.6	23.73039
7.494	3.982	39.806	0.696	92.821	0.7	27.70498
7.494	4.536	39.691	0.797	93.01	0.8	31.63373
7.494	5.086	39.543	0.897	93.07	0.9	35.47007
7.494	5.626	39.338	0.998	93.095	1	39.25932
12.005	0.069	40.107	0	1.11	0	0
12.005	0.378	40.104	0.093	81.692	0.1	3.729672
12.005	0.723	40.099	0.193	89.248	0.2	7.739107
12.005	1.074	40.092	0.294	91.334	0.3	11.78705
12.005	1.436	40.082	0.394	91.665	0.4	15.79231
12.005	1.792	40.073	0.495	92.172	0.5	19.83614
12.005	2.136	40.072	0.595	93.003	0.6	23.84284
12.005	2.481	40.069	0.696	93.595	0.7	27.88802
12.005	2.827	40.068	0.796	94.049	0.8	31.89413
12.005	3.172	40.063	0.897	94.362	0.9	35.93651
12.005	3.518	40.061	0.998	94.62	1	39.98088
18.011	0.064	40.155	0	0.422	0	0
18.011	0.27	40.156	0.093	76.495	0.1	3.734508
18.011	0.494	40.157	0.193	87.103	0.2	7.750301
18.011	0.72	40.156	0.294	90.922	0.3	11.80586
18.011	0.948	40.153	0.394	92.665	0.4	15.82028
18.011	1.178	40.151	0.495	93.643	0.5	19.87475
18.011	1.409	40.145	0.595	94.128	0.6	23.88628
18.011	1.644	40.139	0.696	94.328	0.7	27.93674
18.011	1.884	40.131	0.796	94.194	0.8	31.94428
18.011	2.112	40.129	0.897	94.622	0.9	35.99571
18.011	2.34	40.129	0.998	94.964	1	40.04874

4. Thermal

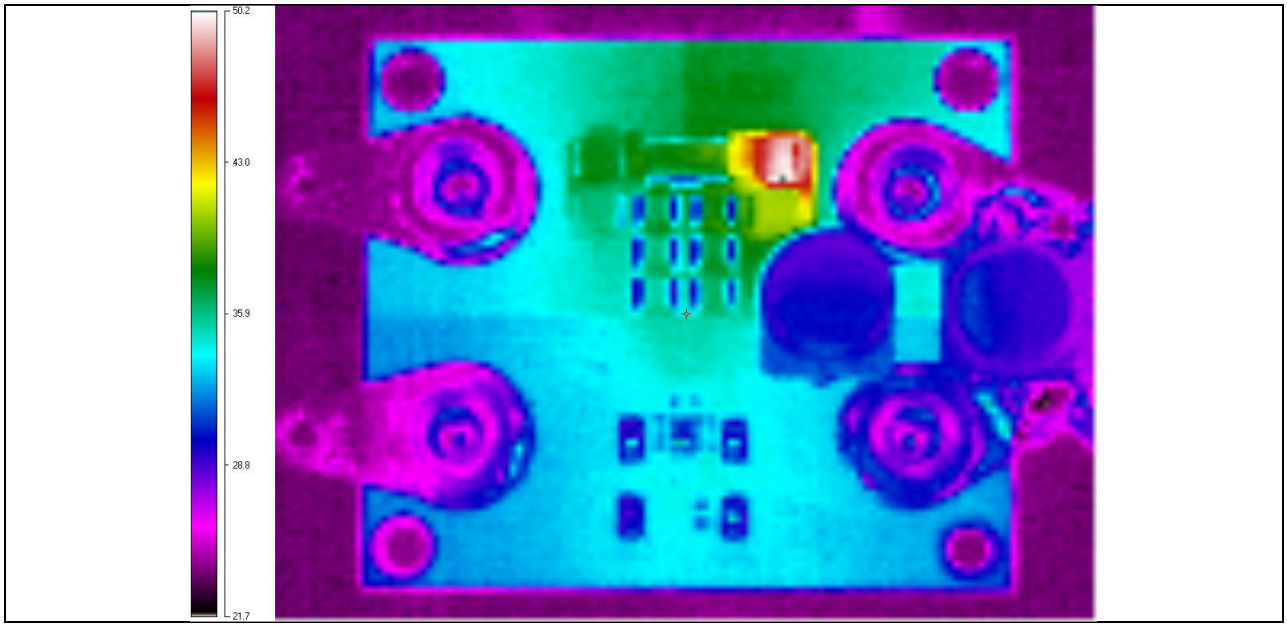
4.1 Steady State Thermal Image, VIN=12V and VOUT=40V, IOUT=1A.



Bottom View

The hotspot is inductor.

4.2 Steady State Thermal Image, VIN=12V and VOUT=40V, IOUT= 1.0A.

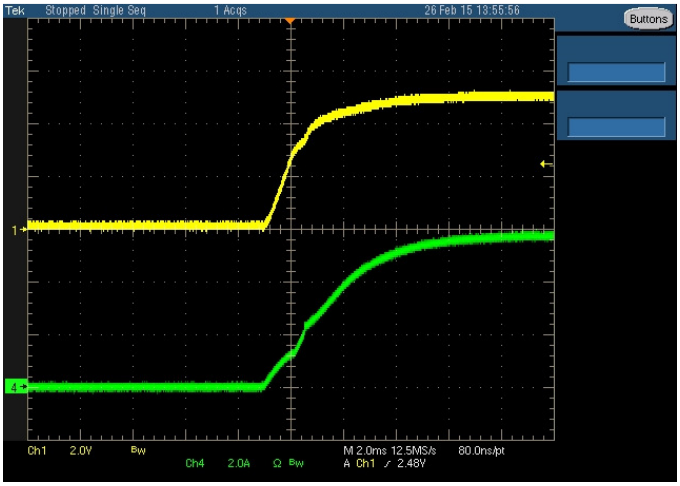


Top View

The hotspot is low side FET (QL2) of boost leg.

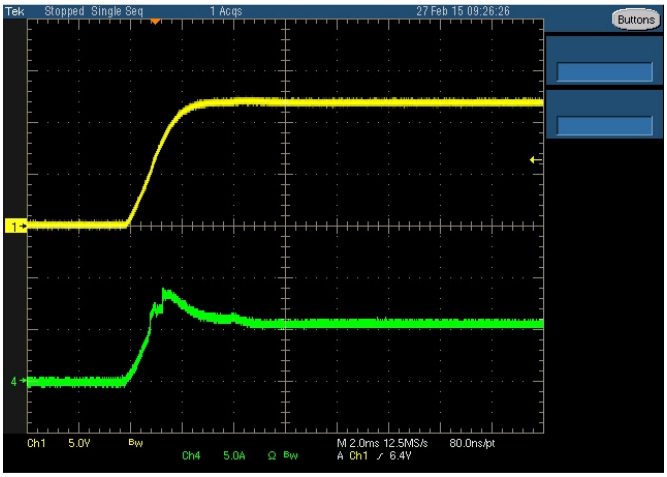
5. Power Up

5.1 Power Up (VIN=7.5V , VOUT=5V, Full Load)



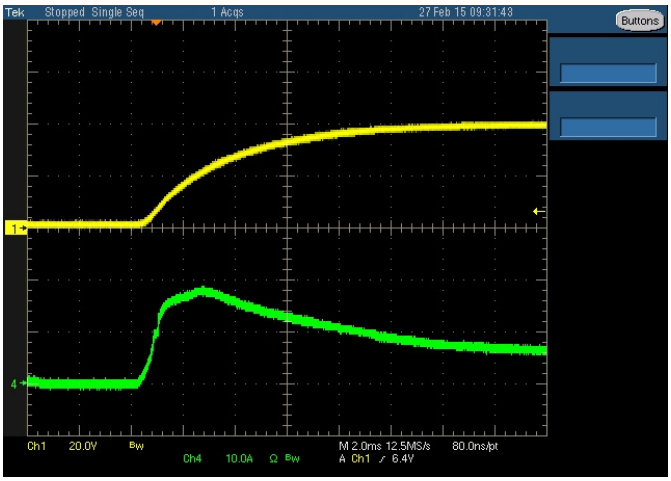
Channel 1: VOUT (2V/div)
Channel 4: IIN (2A/div)

5.2 Power Up (VIN=7.5V, VOUT=12V, Full Load)



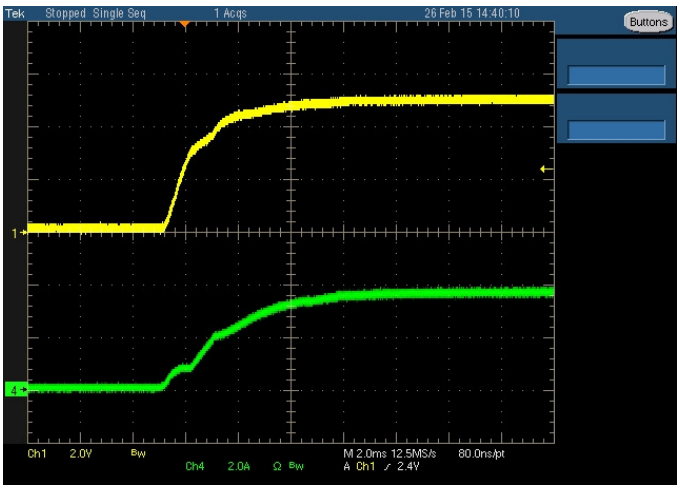
Channel 1: VOUT (5V/div)
Channel 4: IIN(5A/div)

5.3 Power Up (VIN=7.5V, VOUT=40V , Full Load)



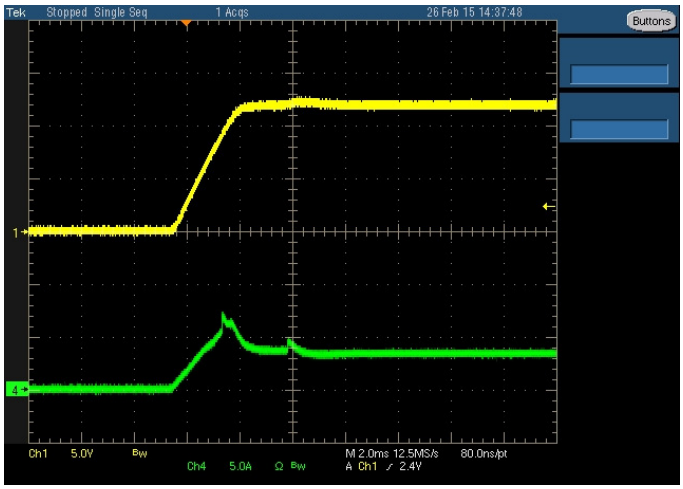
Channel 1: VOUT (20V/div)
Channel 4: IIN (10A/div)

5.4 Power Up (VIN=12V, VOUT=5V, Full Load)



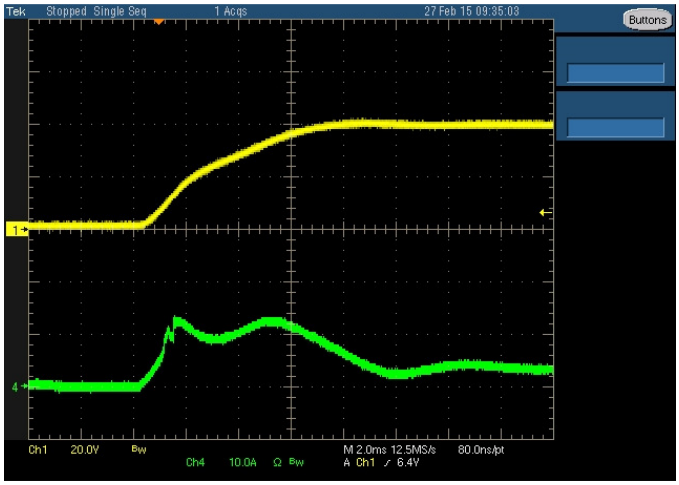
Channel 1: VOUT (2V/div)
Channel 4: IIN (2A/div)

5.5 Power Up (VIN=12V, VOUT=12V, Full Load)



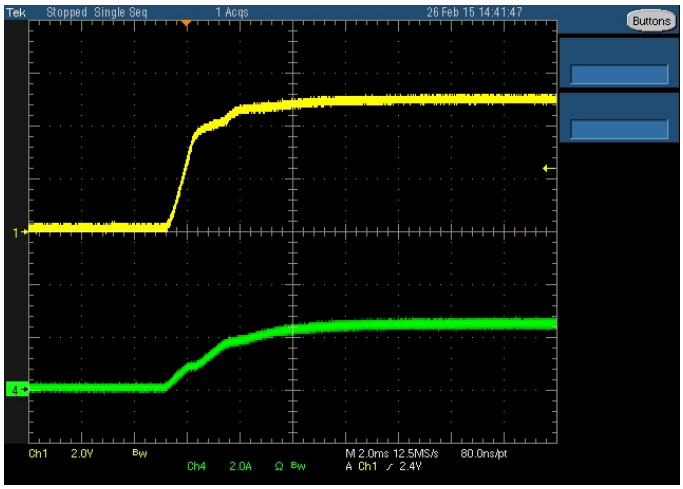
Channel 1: VOUT (5V/div)
Channel 4: IIN (5A/div)

5.6 Power Up(VIN=12V, VOUT=40V, Full Load)



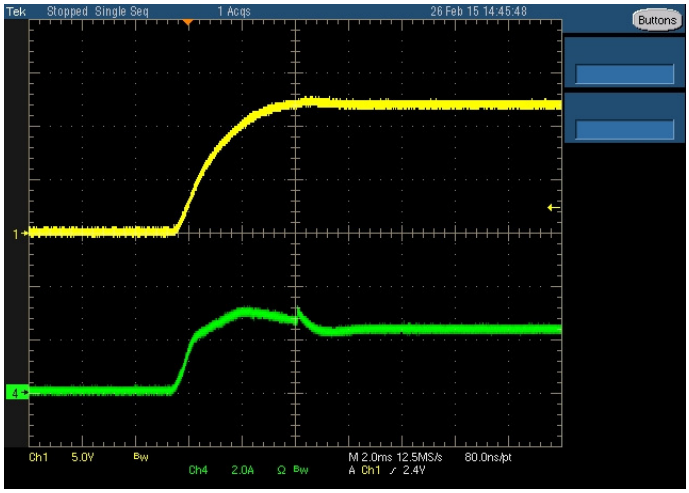
Channel 1 VOUT (20V/div)
Channel 4 IIN (10A/div)

5.7 Power Up (VIN=18V, VOUT=5V, Full Load)



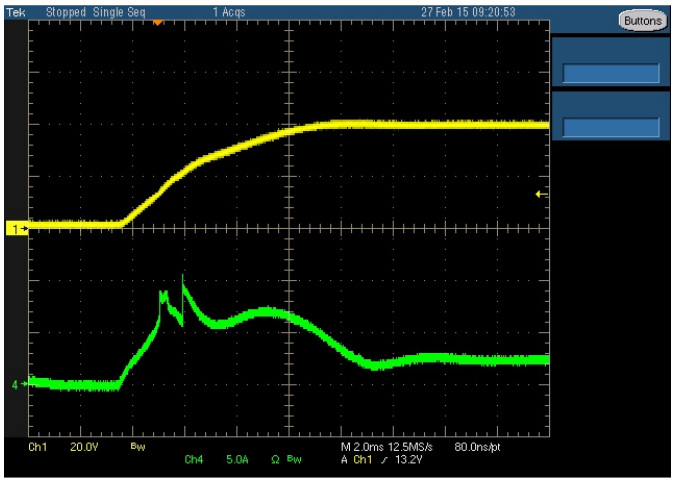
Channel 1: VOUT (2V/div)
Channel 4: IIN (2A/div)

5.8 Power Up(VIN=18V, VOUT=12V, Full Load)



Channel 1: VOUT (5V/div)
Channel 4: IIN (2A/div)

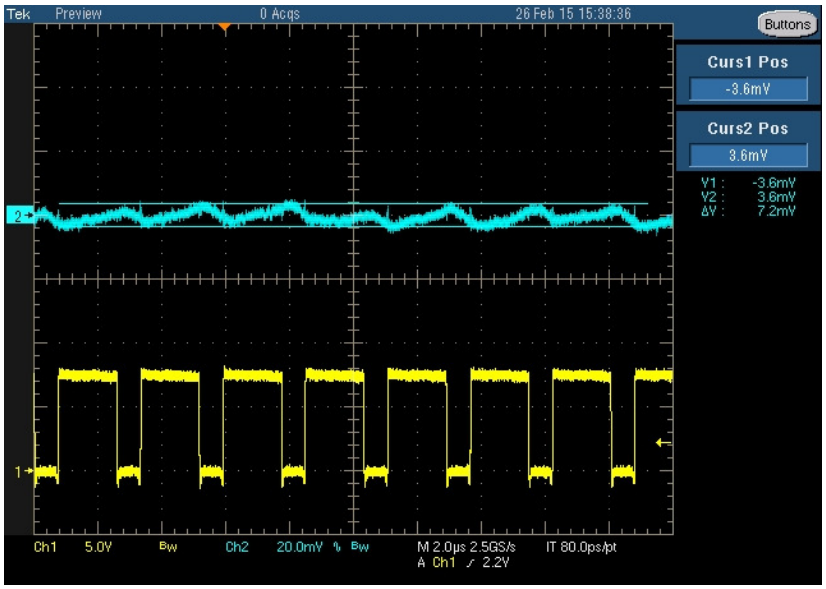
5.9 Power Up (VIN=18V, VOUT=40V, Full Load)



Channel 1: VOUT (20V/div)
Channel 4: IIN (5A/div)

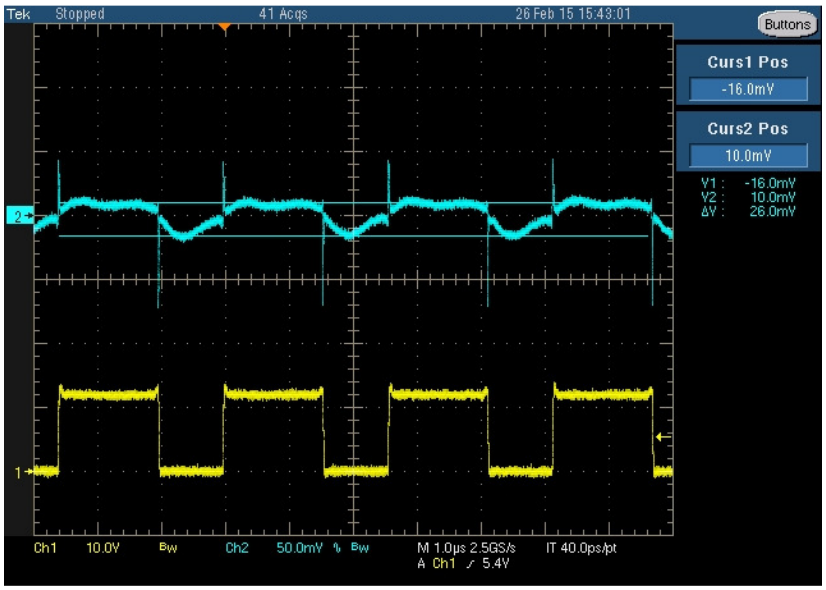
6. Switching and Ripple

6.1 VIN=7.5V, VOUT=5V, Full Load



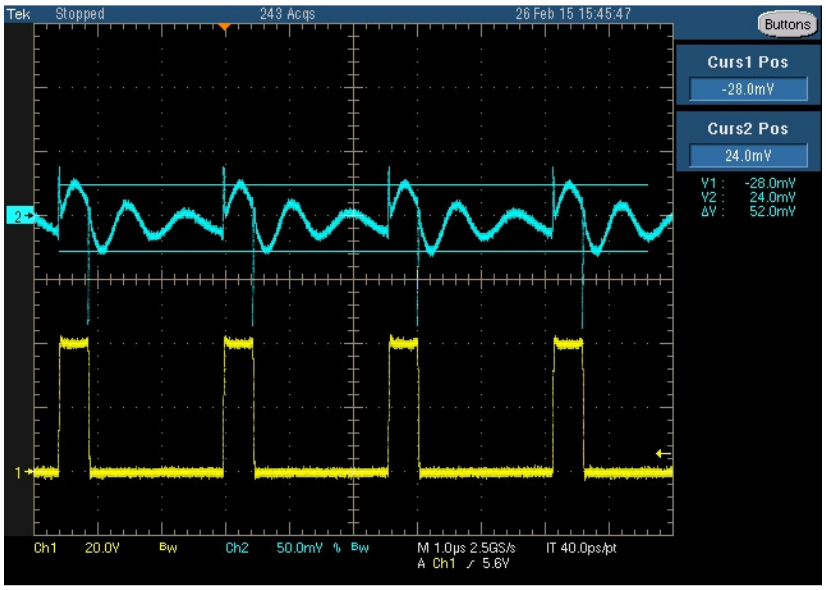
Channel 1: VSW1 (5V/div)
Channel 2: VOUT (20mv/div), ac coupling

6.2 VIN=7.5V,VOUT=12V, Full Load



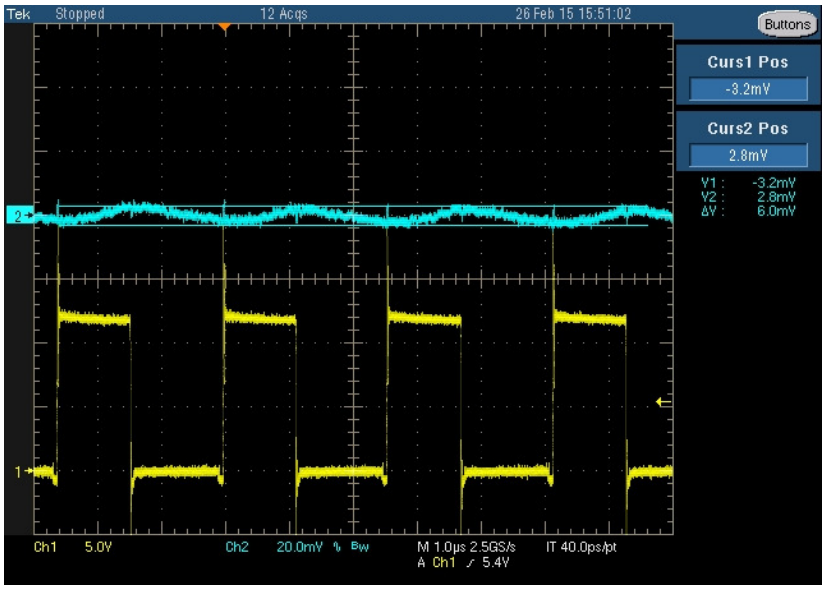
Channel 1: VSW2 (10V/div)
Channel 2: VOUT (50mv/div), ac coupling

6.3 VIN=7.5V, VOUT=40V, Full Load



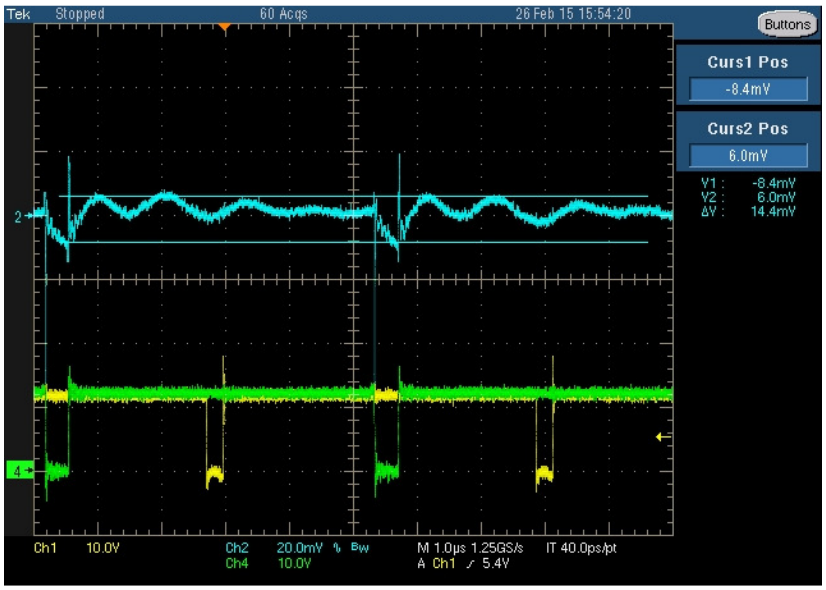
Channel 1: VSW1 (20V/div)
Channel 2: VOUT (50mv/div), ac coupling

6.4 VIN=12V, VOUT=5V, Full Load



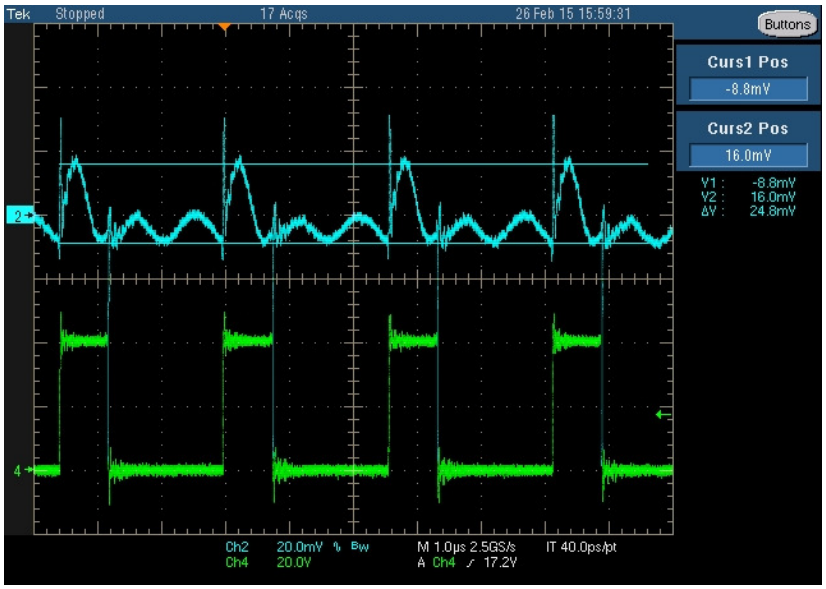
Channel 1: VSW1 (5V/div)
Channel 2: VOUT (20mv/div), ac coupling

6.5 VIN=12V, VOUT=12V, Full Load



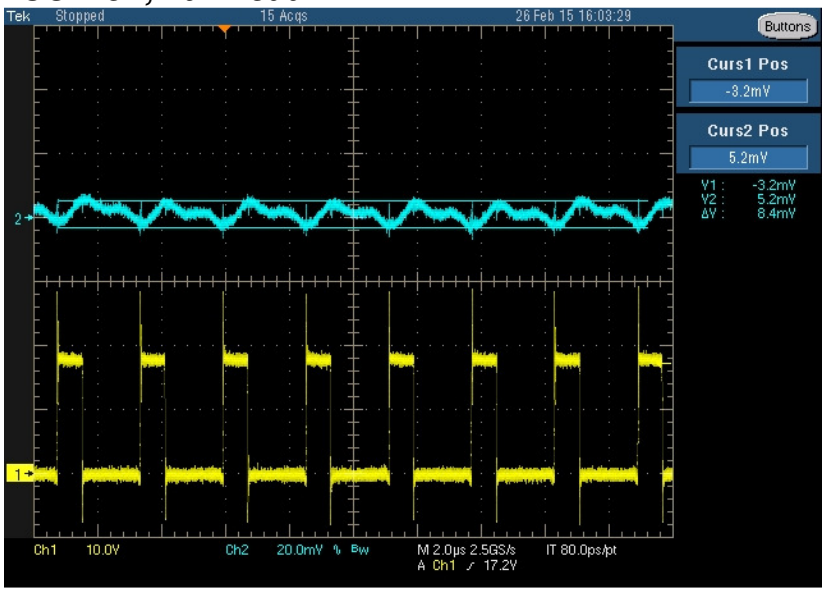
Channel 1: VSW1 (10V/div)
Channel 4: VSW2 (10V/div)
Channel 2: VOUT (20mv/div), ac coupling

6.6 VIN=12V, VOUT=40V, Full Load



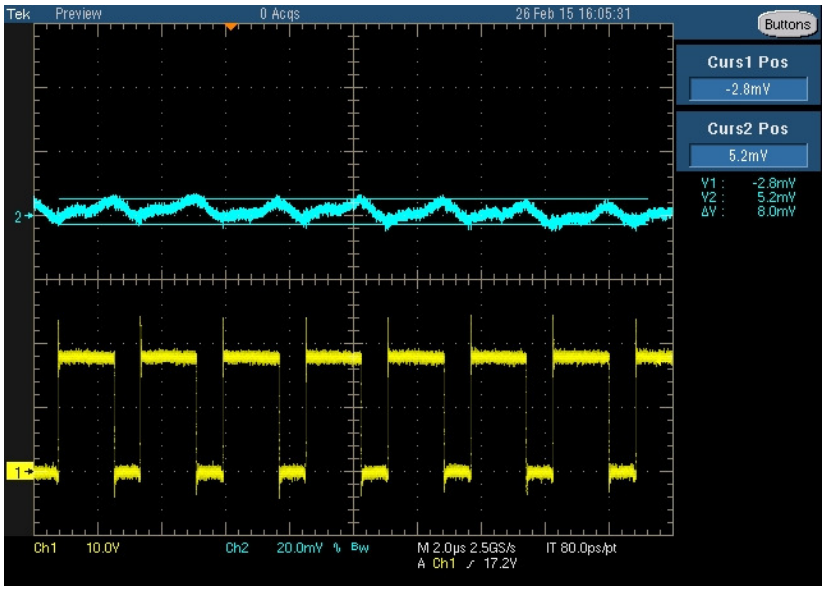
Channel 4: VSW1 (20V/div)
Channel 2: VOUT (20mv/div), ac coupling

6.7 VIN=18V, VOUT=5V, Full Load



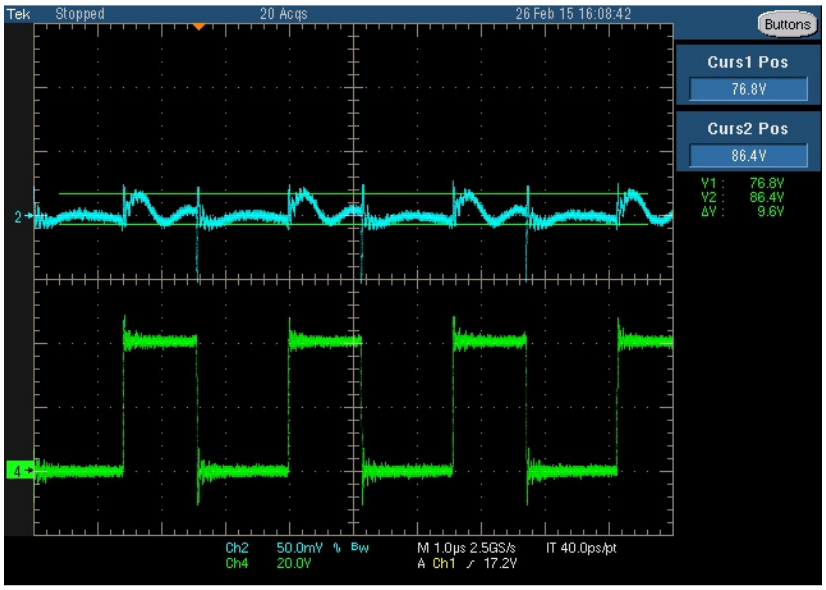
Channel 1: VSW1 (10V/div)
Channel 2: VOUT(20mv/div), ac coupling

6.8 VIN=18V, VOUT=12V, Full Load



Channel 1: VSW1 (10V/div)
Channel 2: VOUT (20mv/div), ac coupling

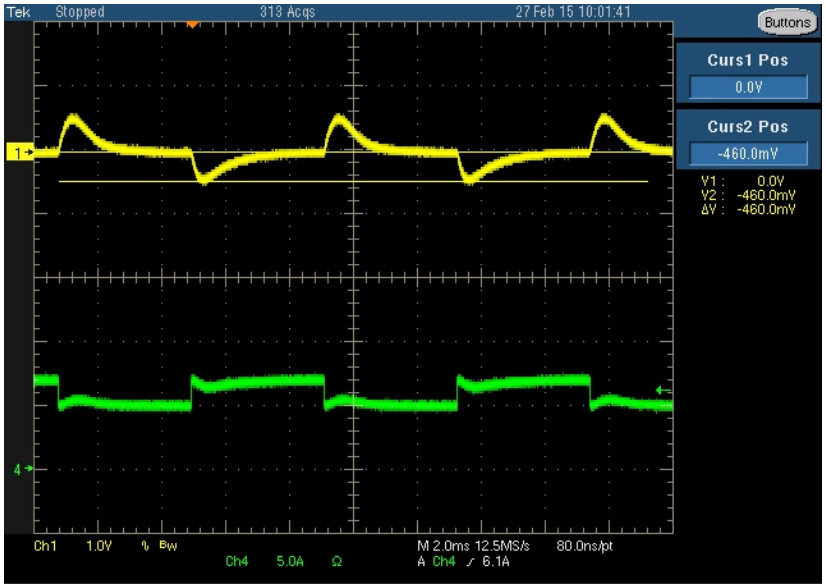
6.9 VIN=18V, VOUT=40V, Full Load



Channel 4: VSW2 (20V/div)
Channel 2: VOUT (50mv/div), ac coupling

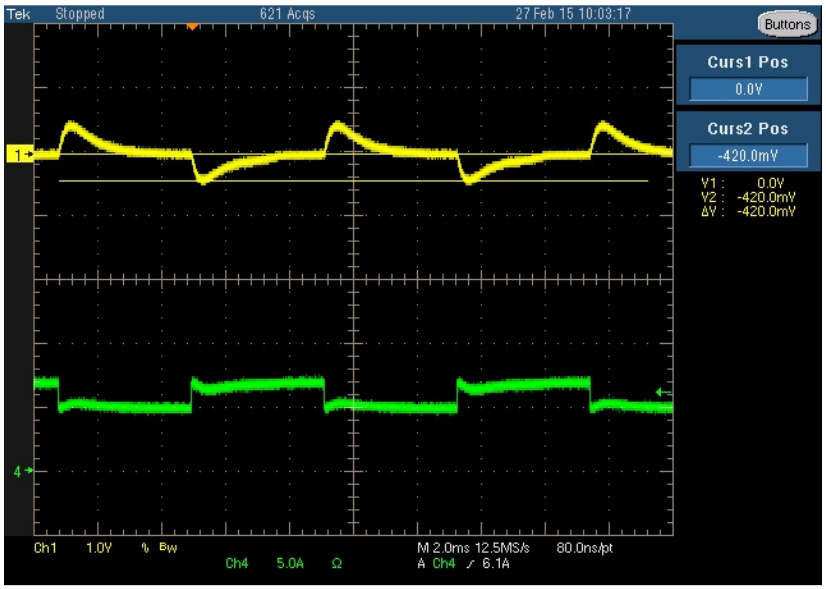
7. Transient Response

7.1 VIN=7.5V, VOUT=5V, 5 to 7 Amp Step (100mA/µs)



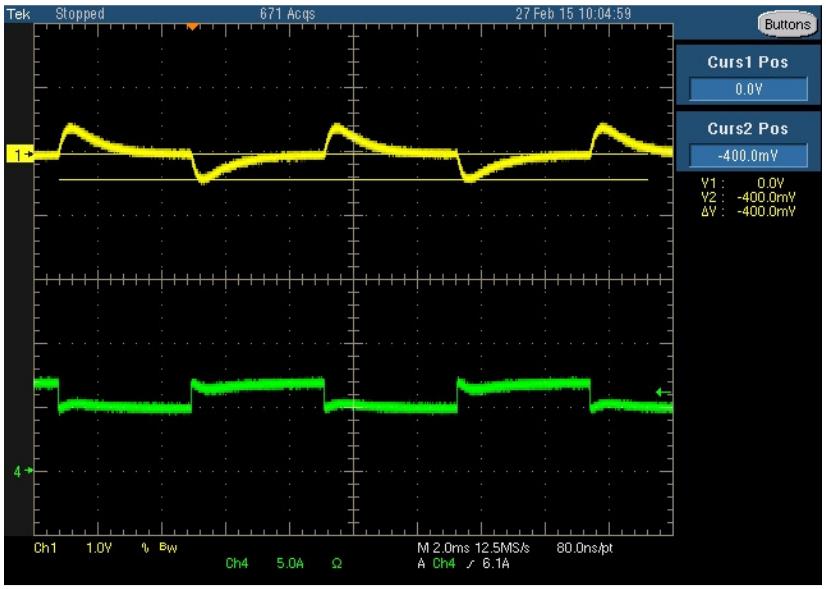
Channel 4: IOUT (5A/div)
Channel 1: VOUT(1V/div), ac coupling

7.2 VIN=12V, VOUT=5V, 5 to 7 Amp Step (100mA/µs)



Channel 4: Iout (5A/div)
Channel 1: Vout(1V/div), ac coupling

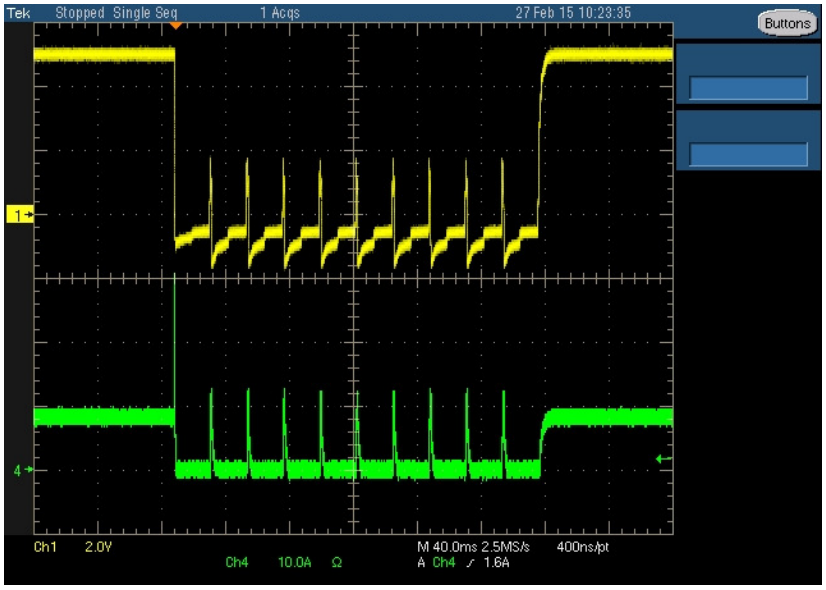
7.3 VIN=18V, VOUT=5V, 5 to 7 Amp Step (100mA/µs)



Channel 4: Iout (5A/div)
Channel 1: Vout(1V/div), ac coupling

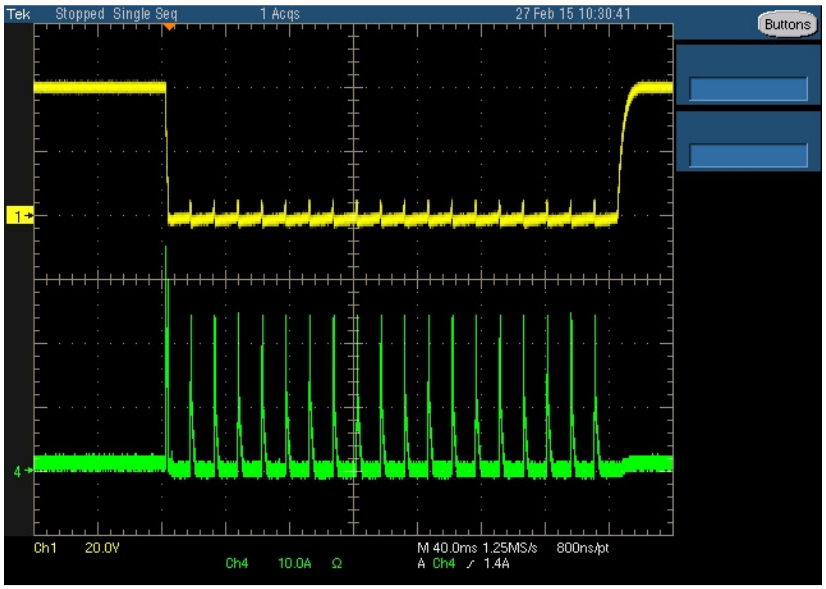
8 Short Circuit Recovery Full Load

8.1 VIN=7.5V, VOUT=5V



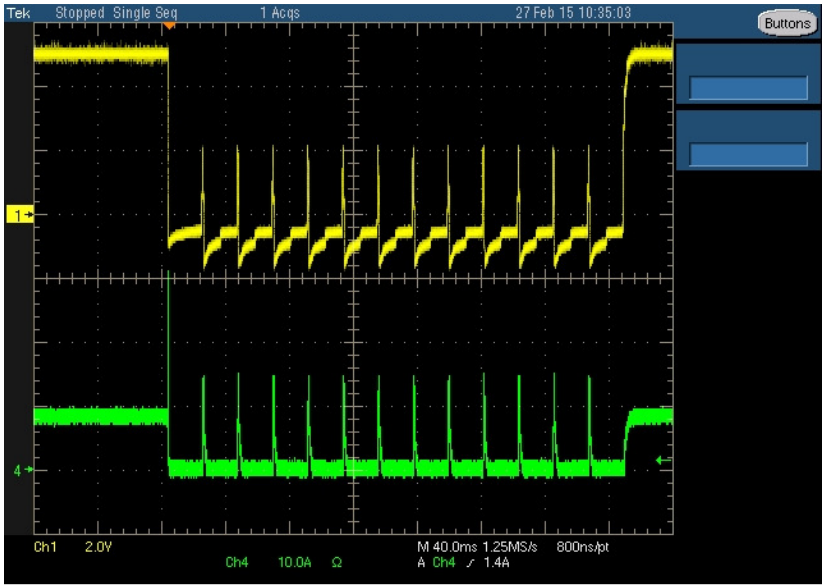
Channel 1: VOUT (2V/div)
Channel 4: IOUT (10A/div)

8.2 VIN=7.5V, VOUT=40V



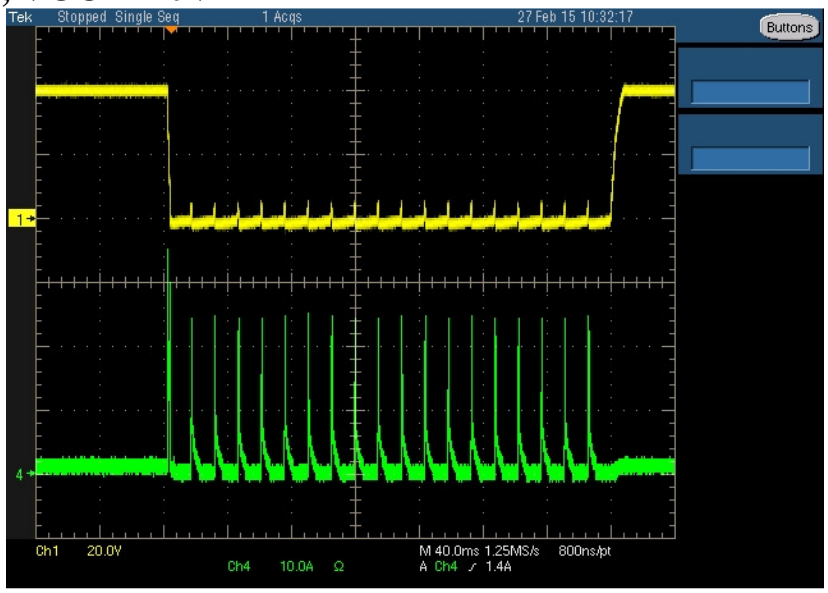
Channel 1: VOUT (20V/div)
Channel 4: IOUT (10A/div)

8.3 VIN=18V, VOUT=5V



Channel 1: VOUT (2V/div)
Channel 4: IOUT (10A/div)

8.4 VIN=18V, VOUT=40V



Channel 1: VOUT (20V/div)
Channel 4: IOUT (10A/div)

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