Test Data
For PMP10709
07/21/2015

Contents

1. Design Specifications

Vin Minimum	7V
Vin Maximum	20 VDC
Vout1	1V-10V @ 5A , Depends on DAC input provided
Iout 1	5A (never exceeds 5A to avoid Wireless charger's coil saturation)
Approximate Switching Frequency	400 KHz Approx

2. Circuit Description and PCB details

PMP10709 is a system optimized 50 W power designs for A13 Wireless Charger Transmitter used in automotive system.

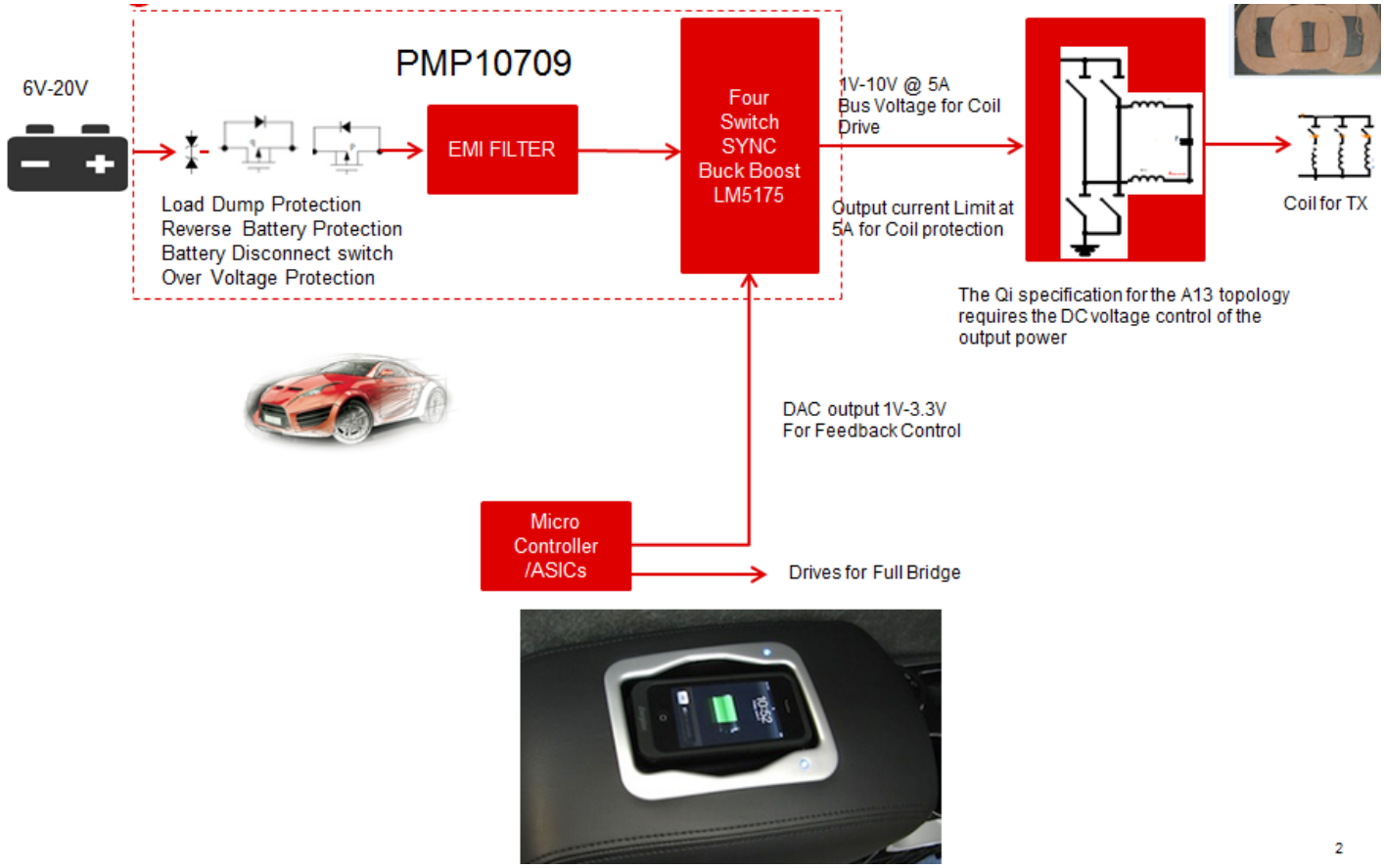
The design has various front end automotive protections such as Load dump through TVS (ISO pulse testing), Reverse Voltage (Through PFET's body diode), Battery Disconnect Switch with OVP protection (PFET).

PMP10709 is primarily four Switch synchronous Buck – Boost design, which supports wide Input voltage range (7V-20V) and delivers any output from 1V-10V based on DAC output of the A13 Wireless Charger. The DAC output changes from 1V to 3.3V which in turn changes the output voltage from 10V to 1V (on the fly) as needed by the algorithm of A13 wireless charger's transmitter.

This design utilizes best in Class Synchronous four Switch Buck Boost Controller LM5175. The design accepts an input voltage of 7Vin to 20Vin and provides the output of 1V- 10V@5 A. Output current never exceeds 5A to protect the charging Coil .The average current regulation loop of the IC at the output is used for this protection.

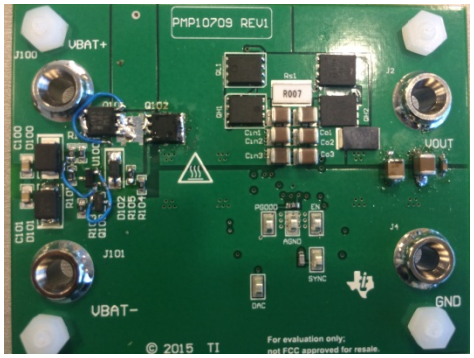
The Board dimension of PMP10709 PCB is 2325mil * 2800mil. Four layer PCB was used for the design.

3. System Block Diagram –A13 Wireless Charger Tx



The design was tested with Actual A13 Wireless Charger transmitter .

4. PMP10709 Board Photos

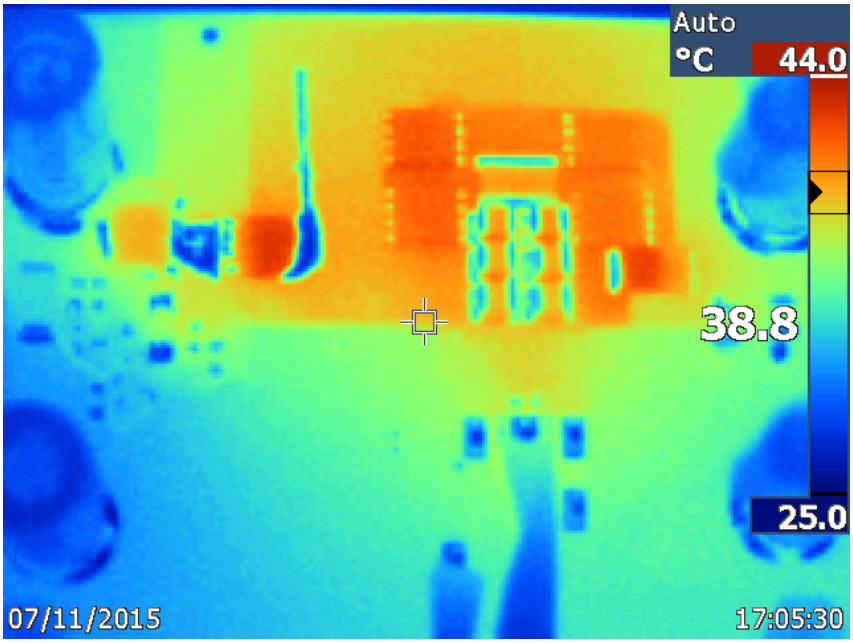


Board Photo (Top)

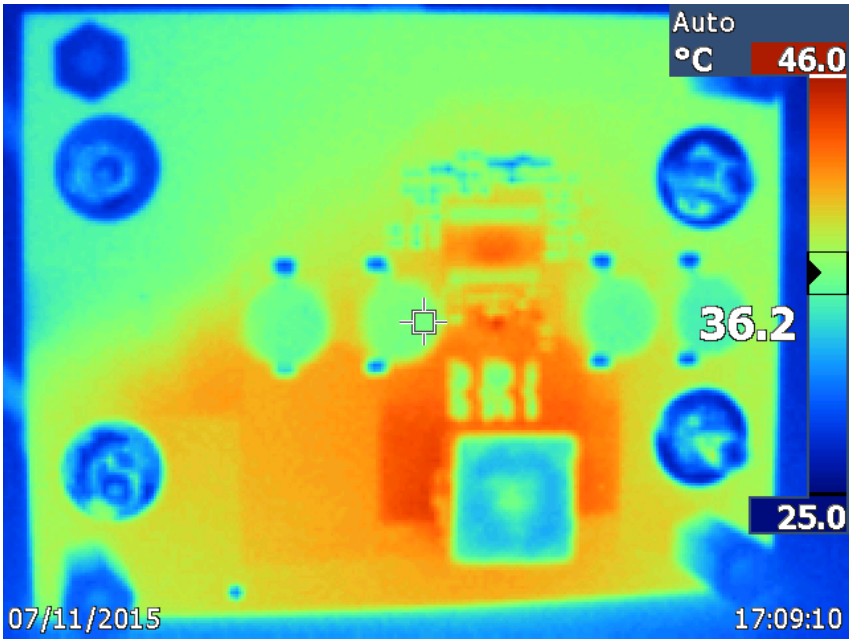
Board Photo (Bottom)

5. Thermal Data

IR thermal image taken at steady state with 12 Vin and the 10V output at full load (no airflow)

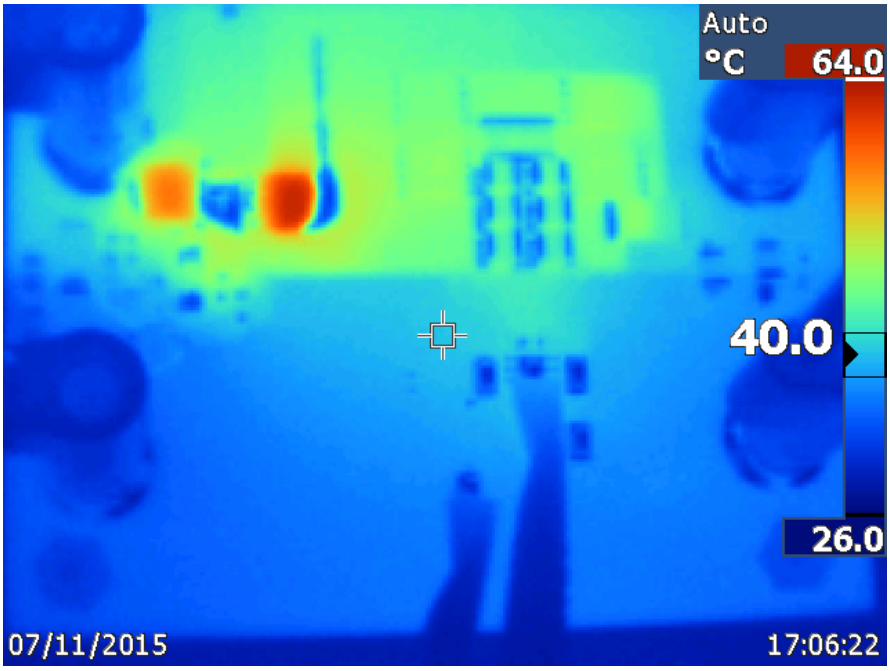


Board's thermal (Top)

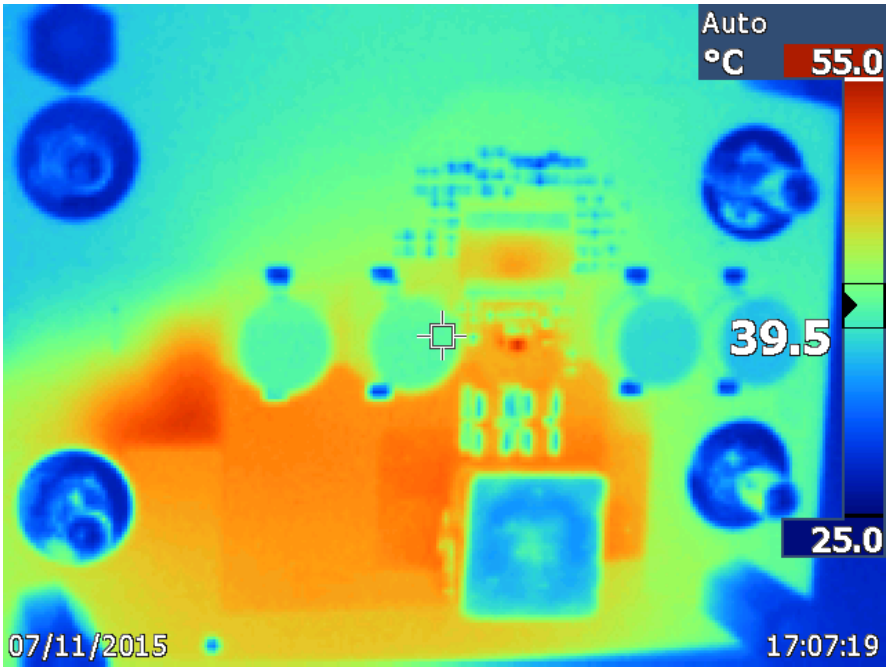


Board's thermal (Bottom)

IR thermal image taken at steady state with 6.5 Vin and the 10V output at full load (no airflow)



Board's thermal (Top)



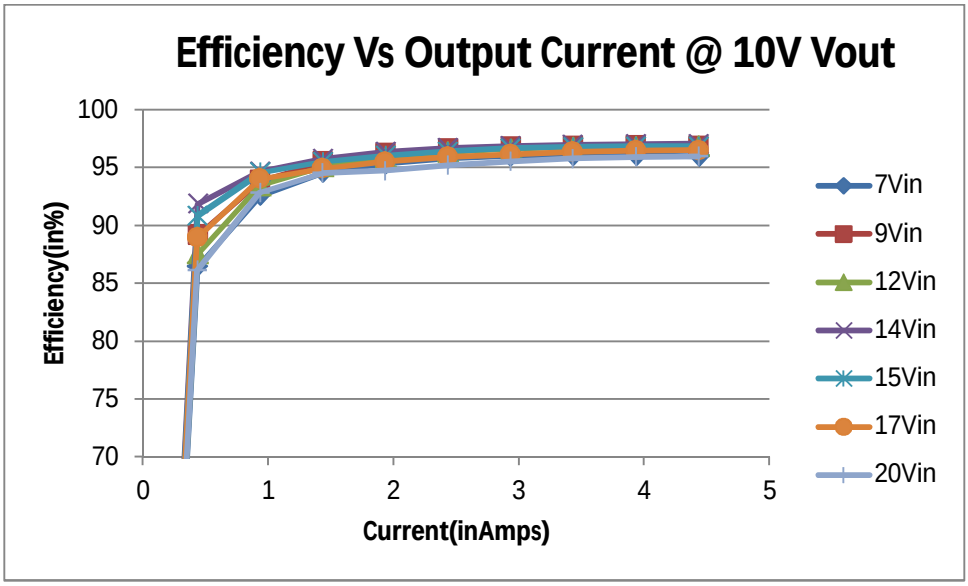
Board's thermal (Bottom

6. Efficiency

6.1 Efficiency Curve

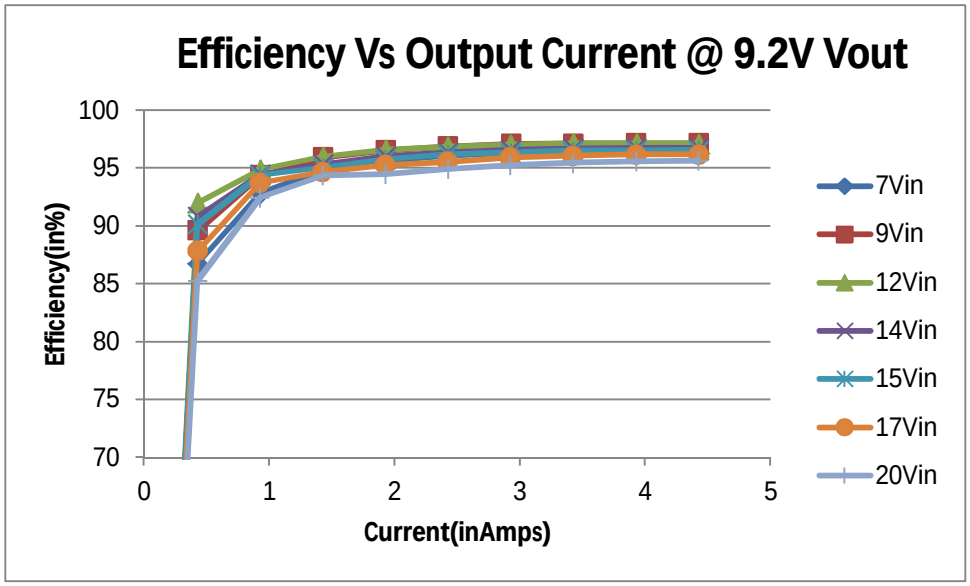
6.1.1 Efficiency Chart – 10V output at Various Input Voltages

DAC Input = 1V



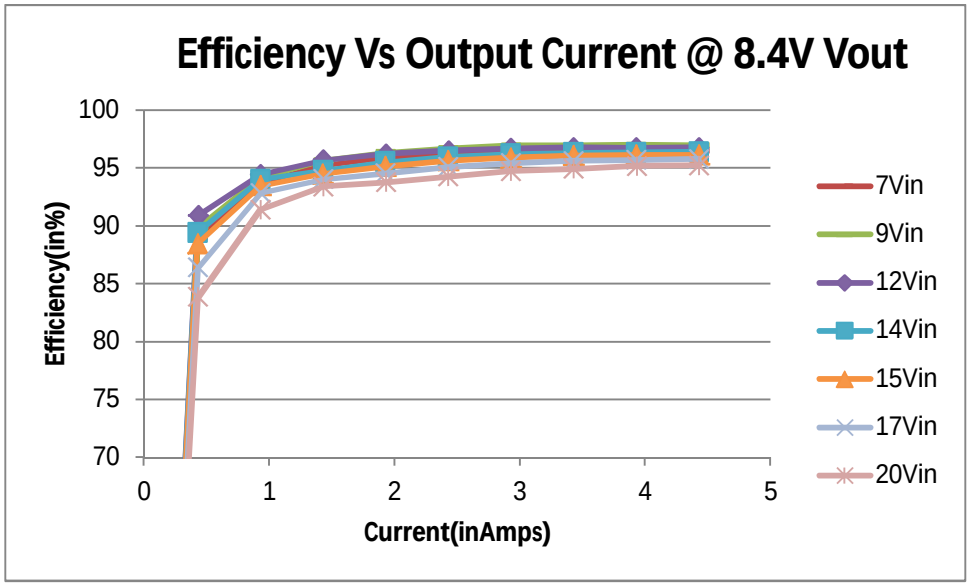
6.1.2 Efficiency Chart – 9.2V output at Various Input Voltages

DAC Input = 1.2 V



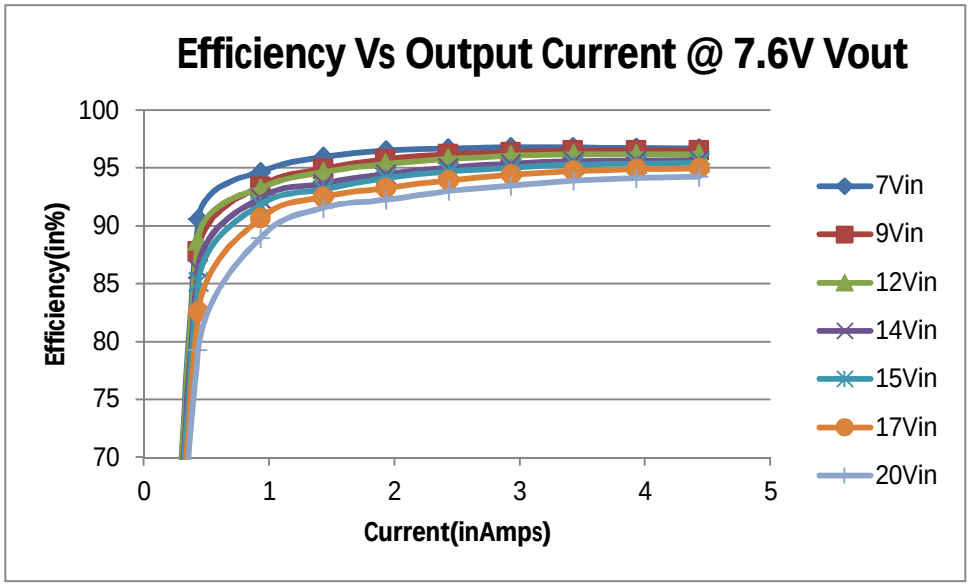
6.1.3 Efficiency Chart – 8.4V output at Various Input Voltages

DAC Input = 1.4 V



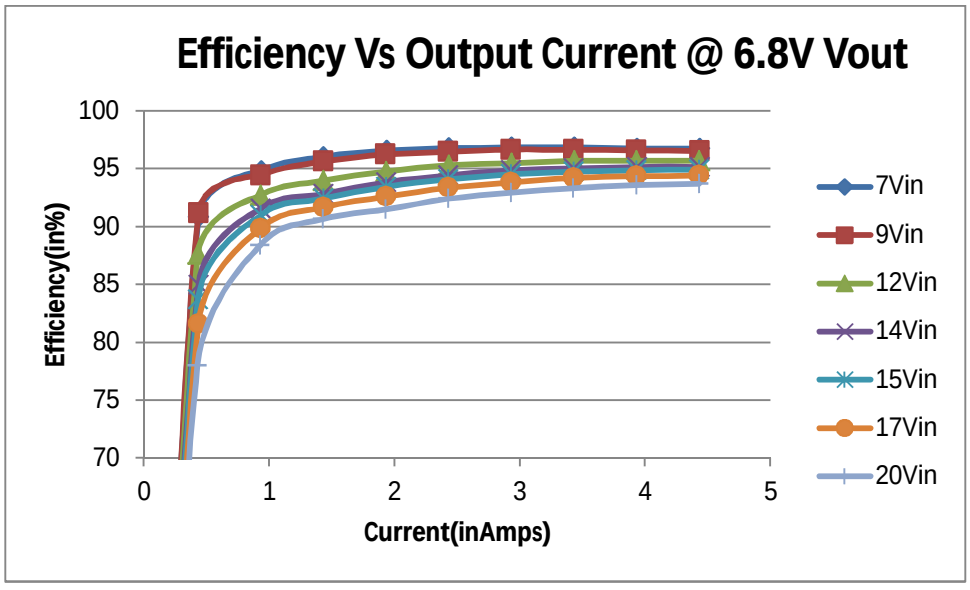
6.1.4 Efficiency Chart – 7.6 V output at Various Input Voltages

DAC Input = 1.6 V



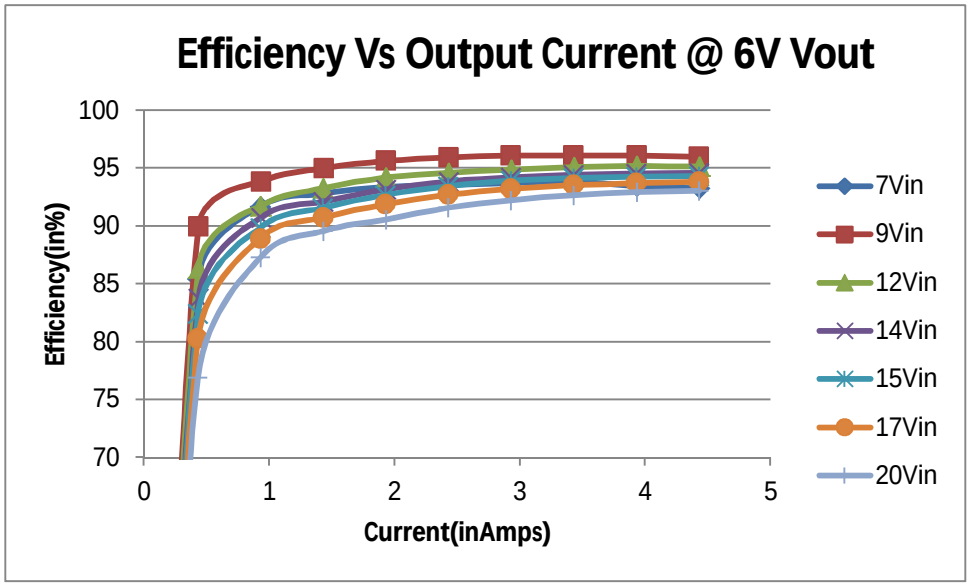
6.1.5 Efficiency Chart – 6.8 V output at Various Input Voltages

DAC Input = 1.8 V



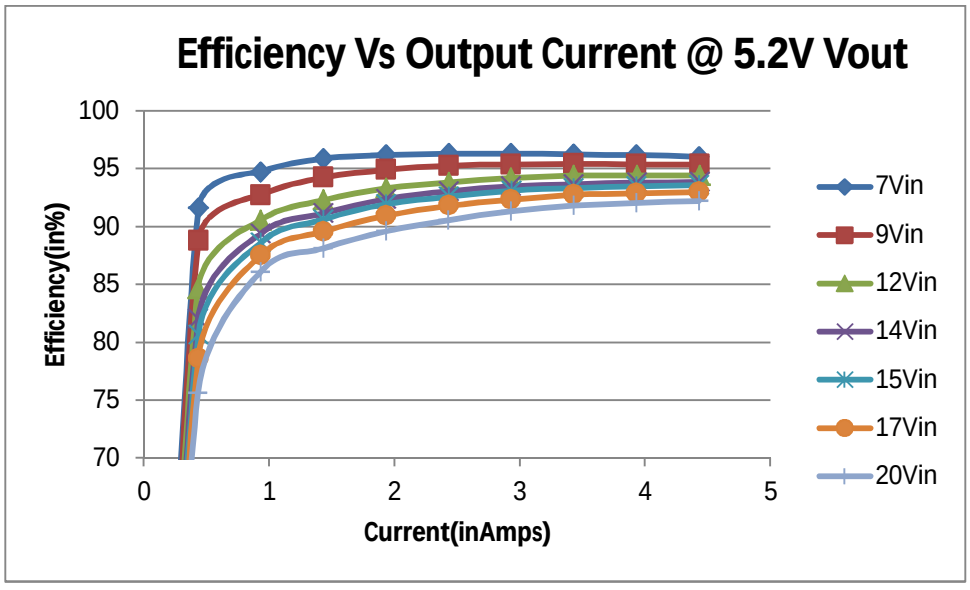
6.1.6 Efficiency Chart – 6 V output at Various Input Voltages

DAC Input = 2 V



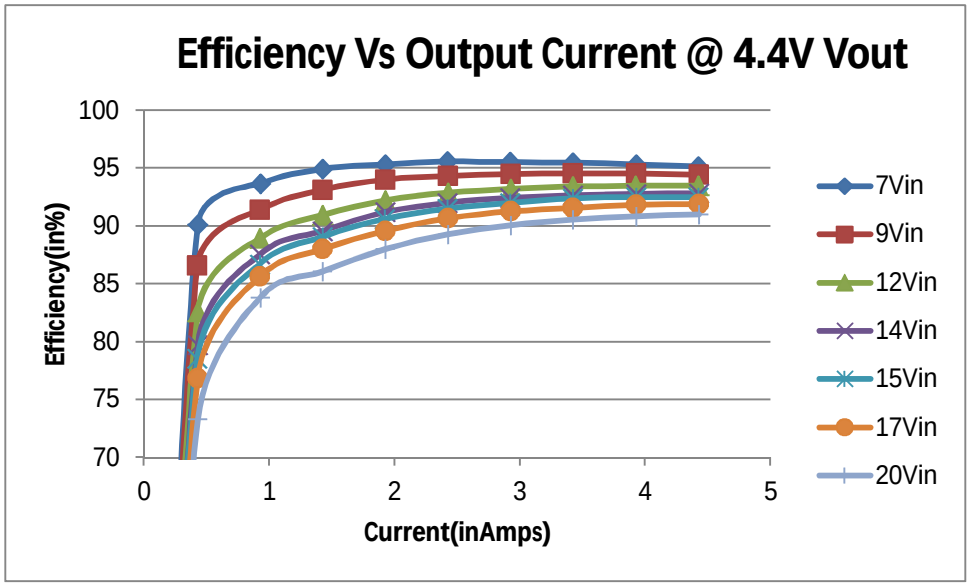
6.1.7 Efficiency Chart – 5.2 V output at Various Input Voltages

DAC Input = 2.2 V



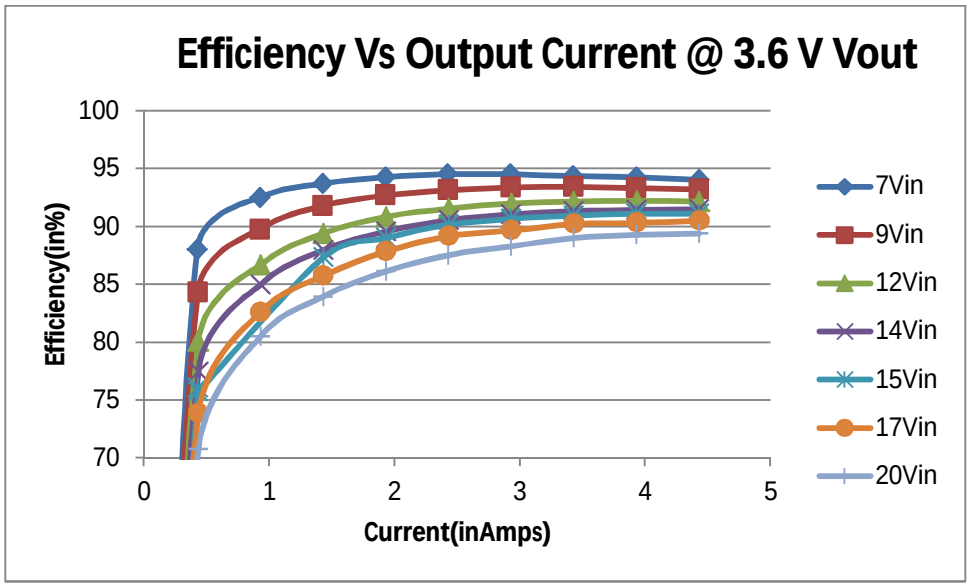
6.1.8 Efficiency Chart – 4.4 V output at Various Input Voltages

DAC Input = 2.4 V



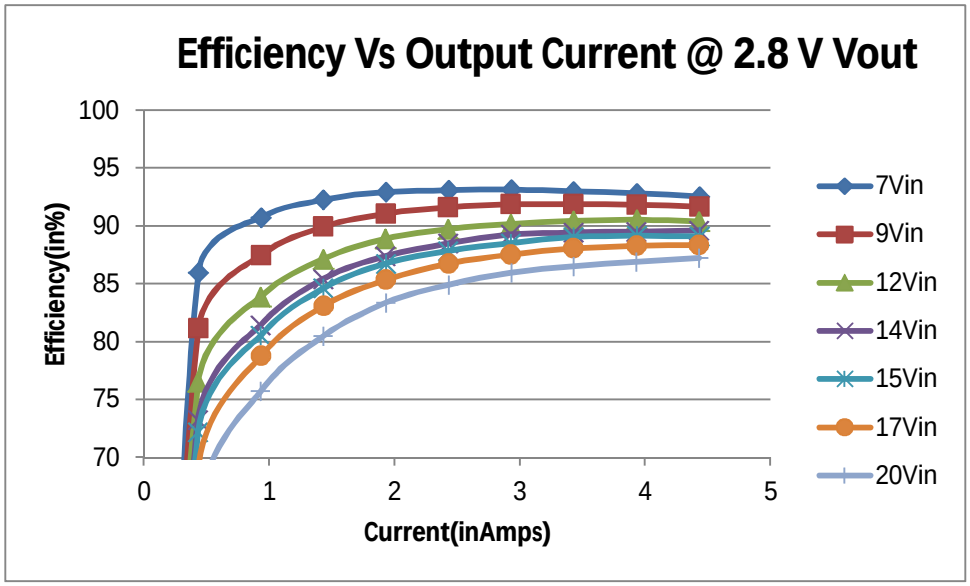
6.1.9 Efficiency Chart – 3.6 V output at Various Input Voltages

DAC Input = 2.6 V



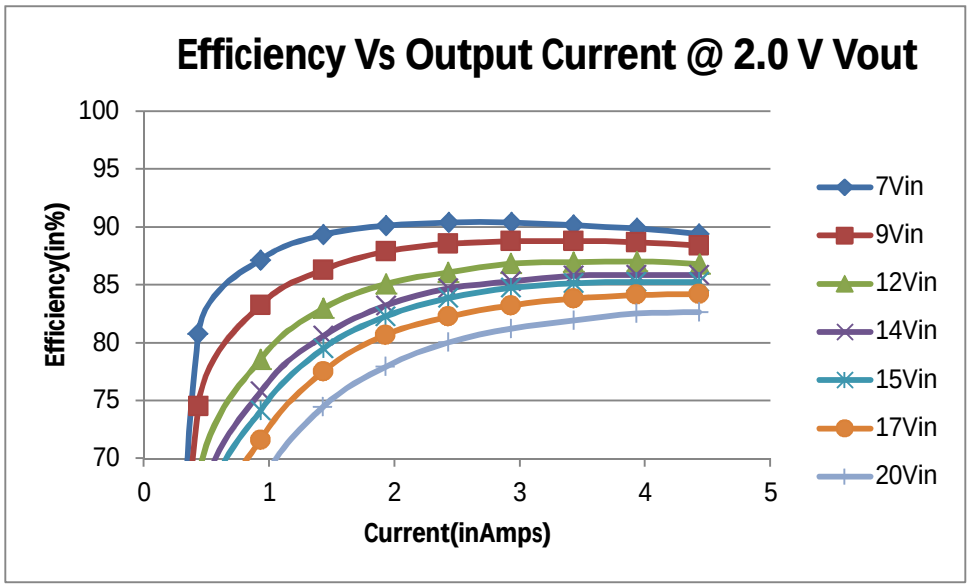
6.1.10 Efficiency Chart – 2.8 V output at Various Input Voltages

DAC Input = 2.8 V



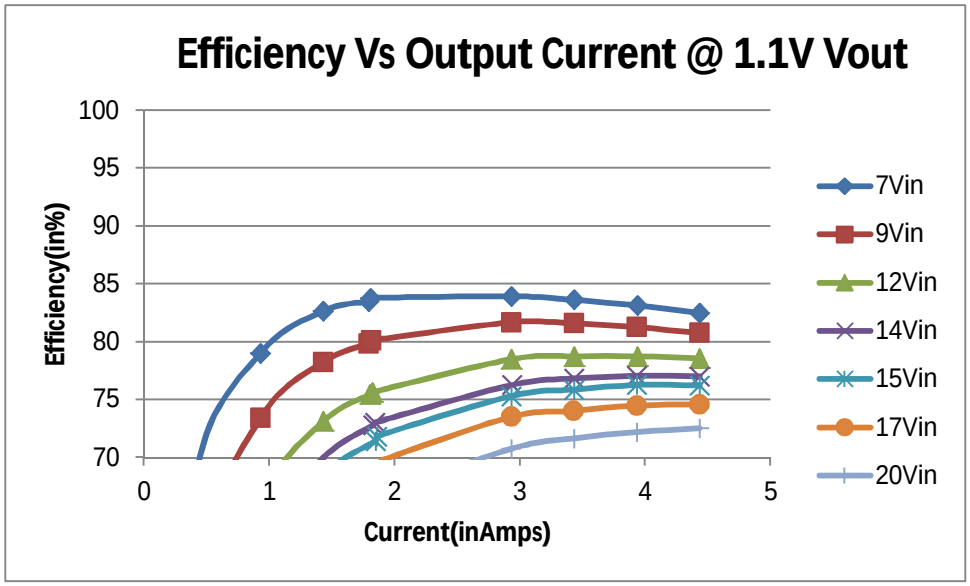
6.1.11 Efficiency Chart – 2 V output at Various Input Voltages

DAC Input = 3 V



6.1.12 Efficiency Chart – 1 V output at Various Input Voltages

DAC Input = 3.3 V



6.2 Efficiency Data

6.2.1 Efficiency Data – 10V and 9.2 V Output

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)	Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
7.004	0.088	10.017	0	0	7.103	0.077	9.177	0	0
7.004	0.721	10.014	0.436	86.459	7.103	0.637	9.174	0.428	86.78
7.004	1.445	10.012	0.936	92.594	7.103	1.292	9.173	0.929	92.859
7.004	2.17	10.013	1.436	94.605	7.103	1.946	9.174	1.429	94.843
7.004	2.902	10.014	1.935	95.333	7.103	2.604	9.175	1.928	95.638
7.003	3.635	10.014	2.436	95.829	7.103	3.263	9.175	2.427	96.076
7.003	4.37	10.015	2.934	96.016	7.102	3.926	9.176	2.926	96.293
7.003	5.112	10.016	3.434	96.077	7.102	4.594	9.177	3.427	96.392
7.003	5.866	10.017	3.94	96.074	7.102	5.268	9.178	3.929	96.384
7.003	6.614	10.015	4.439	95.982	7.102	5.941	9.177	4.429	96.331
9.002	0.055	10.014	0	0	9.002	0.047	9.171	0	0
9.002	0.545	10.013	0.437	89.189	9.002	0.49	9.171	0.431	89.61
9.002	1.109	10.012	0.936	93.87	9.002	1.005	9.172	0.931	94.386
9.002	1.673	10.013	1.436	95.474	9.002	1.52	9.173	1.431	95.933

9.002	2.237	10.014	1.935	96.224	9.002	2.039	9.175	1.931	96.523
9.002	2.804	10.014	2.435	96.603	9.002	2.555	9.176	2.428	96.866
9.002	3.374	10.015	2.935	96.778	9.002	3.077	9.176	2.931	97.096
9.002	3.946	10.016	3.434	96.827	9.002	3.598	9.177	3.428	97.127
9.001	4.522	10.016	3.936	96.856	9.002	4.124	9.178	3.929	97.134
9.001	5.095	10.015	4.435	96.852	9.001	4.648	9.177	4.429	97.152
12.003	0.051	10.004	0	0	12.003	0.025	9.174	0	0
12.003	0.414	10.004	0.435	87.574	12.003	0.358	9.176	0.431	92.036
12.002	0.833	10.004	0.934	93.459	12.002	0.75	9.177	0.931	94.915
12.002	1.257	10.006	1.434	95.109	12.002	1.138	9.177	1.429	96.015
12.002	1.682	10.006	1.935	95.91	12.002	1.527	9.178	1.929	96.602
12.002	2.106	10.008	2.434	96.373	12.002	1.918	9.179	2.429	96.855
12.002	2.533	10.009	2.935	96.63	12.002	2.309	9.18	2.929	97.025
12.002	2.959	10.01	3.434	96.791	12.002	2.701	9.181	3.43	97.142
12.002	3.39	10.011	3.936	96.845	12.002	3.097	9.182	3.932	97.131
12.002	3.818	10.01	4.436	96.903	12.002	3.489	9.18	4.43	97.116
14.006	0.027	10.011	0	0	14.006	0.027	9.171	0	0
14.006	0.34	10.012	0.437	91.878	14.006	0.31	9.172	0.43	90.836
14.006	0.706	10.014	0.935	94.689	14.006	0.646	9.173	0.932	94.489
14.006	1.072	10.014	1.436	95.775	14.006	0.982	9.173	1.43	95.372
14.006	1.435	10.016	1.934	96.38	14.006	1.315	9.173	1.929	96.074
14.006	1.8	10.016	2.434	96.7	14.006	1.649	9.175	2.426	96.374
14.006	2.164	10.017	2.931	96.868	14.006	1.985	9.177	2.926	96.583
14.006	2.53	10.018	3.43	96.971	14.006	2.322	9.178	3.427	96.713
14.006	2.899	10.019	3.932	97.023	14.006	2.661	9.179	3.929	96.765
14.006	3.268	10.018	4.434	97.047	14.006	3	9.178	4.429	96.743
15.009	0.028	10.009	0	0	15.009	0.029	9.17	0	0
15.009	0.32	10.01	0.436	90.87	15.009	0.29	9.171	0.428	90.18
15.009	0.66	10.011	0.936	94.593	15.009	0.6	9.172	0.927	94.415
15.009	1.002	10.011	1.435	95.523	15.008	0.918	9.172	1.428	95.066
15.009	1.344	10.012	1.935	96.04	15.008	1.23	9.172	1.928	95.795
15.009	1.683	10.013	2.432	96.403	15.008	1.542	9.173	2.427	96.2
15.009	2.024	10.015	2.932	96.661	15.008	1.856	9.174	2.925	96.335
15.009	2.367	10.016	3.433	96.787	15.008	2.169	9.176	3.424	96.517
15.009	2.712	10.017	3.935	96.837	15.008	2.488	9.178	3.927	96.524
15.009	3.055	10.016	4.433	96.834	15.008	2.803	9.177	4.427	96.575

17.012	0.032	10.007	0	0	17.011	0.031	9.169	0	0
17.012	0.287	10.008	0.434	88.961	17.011	0.262	9.17	0.427	87.855
17.012	0.583	10.009	0.932	94.055	17.011	0.532	9.171	0.925	93.738
17.012	0.887	10.009	1.431	94.919	17.011	0.812	9.171	1.426	94.678
17.012	1.19	10.008	1.932	95.511	17.011	1.09	9.17	1.926	95.251
17.012	1.491	10.009	2.431	95.927	17.011	1.367	9.17	2.423	95.549
17.012	1.793	10.01	2.93	96.154	17.011	1.643	9.171	2.923	95.913
17.012	2.094	10.011	3.429	96.364	17.011	1.921	9.172	3.423	96.076
17.012	2.4	10.013	3.934	96.479	17.011	2.202	9.174	3.927	96.177
17.011	2.705	10.013	4.435	96.507	17.011	2.482	9.173	4.427	96.181

20.012	0.035	10.007	0	0	20.012	0.033	9.17	0	0
20.012	0.252	10.008	0.434	86.128	20.012	0.23	9.171	0.428	85.279
20.012	0.503	10.008	0.934	92.861	20.012	0.459	9.171	0.926	92.454
20.012	0.758	10.009	1.433	94.553	20.012	0.693	9.171	1.427	94.366
20.012	1.02	10.008	1.932	94.725	20.012	0.935	9.17	1.928	94.487
20.012	1.277	10.007	2.431	95.194	20.012	1.171	9.169	2.426	94.922
20.012	1.534	10.007	2.931	95.544	20.012	1.406	9.169	2.923	95.252
20.012	1.791	10.009	3.43	95.785	20.012	1.643	9.169	3.423	95.455
20.012	2.051	10.01	3.933	95.918	20.012	1.882	9.17	3.926	95.589
20.012	2.31	10.008	4.433	95.972	20.012	2.119	9.169	4.424	95.657

6.2.2 Efficiency Data – 2V and 1 V Output

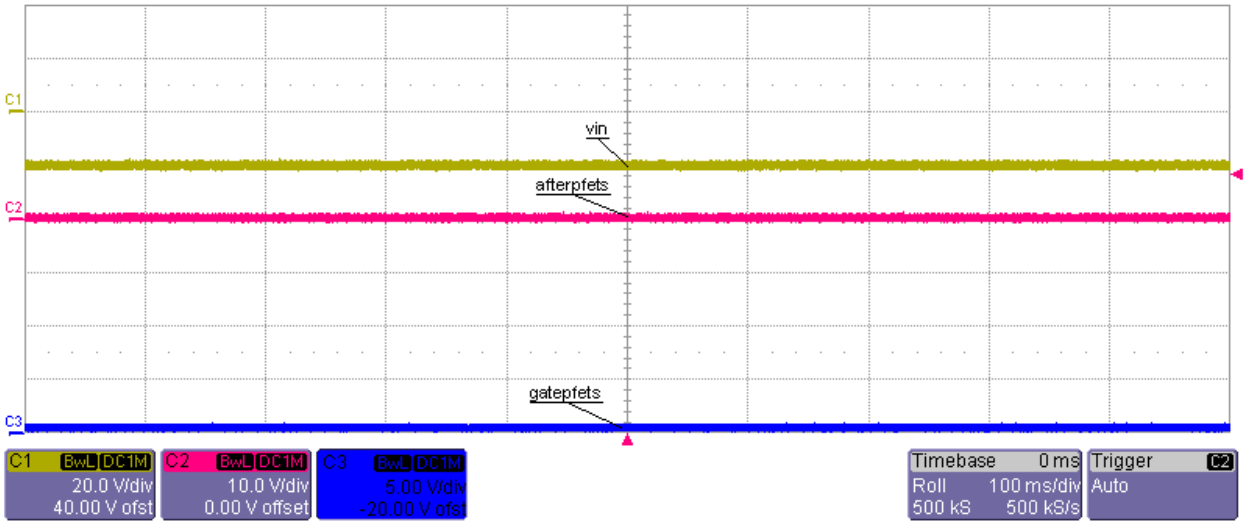
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)	Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
7.004	0.024	1.955	0	0	7.004	0.025	1.078	0	0
7.004	0.149	1.956	0.431	80.782	7.004	0.096	1.077	0.431	69.036
7.004	0.298	1.956	0.93	87.154	7.004	0.181	1.077	0.93	79.009
7.004	0.447	1.956	1.43	89.341	7.004	0.266	1.077	1.43	82.665
7.004	0.598	1.956	1.93	90.132	7.004	0.33	1.077	1.792	83.501
7.004	0.751	1.957	2.43	90.409	7.004	0.332	1.077	1.809	83.786
7.004	0.906	1.958	2.93	90.408	7.004	0.538	1.078	2.934	83.936
7.004	1.064	1.959	3.43	90.166	7.004	0.632	1.078	3.434	83.629
7.004	1.224	1.96	3.932	89.896	7.004	0.729	1.078	3.938	83.142
7.004	1.385	1.958	4.431	89.437	7.004	0.828	1.079	4.435	82.516

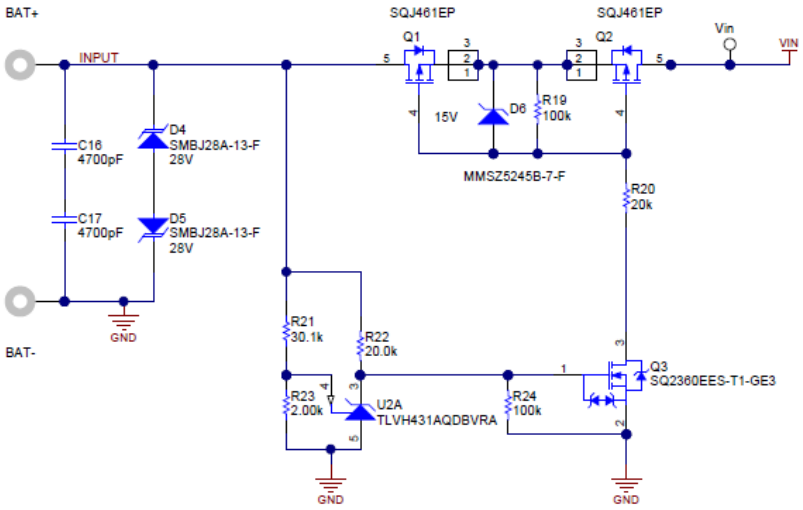
9.002	0.028	1.956	0	0	9.002	0.03	1.078	0	0
9.002	0.126	1.957	0.432	74.536	9.002	0.086	1.079	0.431	60.071
9.002	0.243	1.956	0.931	83.248	9.002	0.152	1.078	0.932	73.426
9.002	0.36	1.956	1.43	86.31	9.002	0.219	1.078	1.431	78.248
9.002	0.477	1.956	1.93	87.916	9.002	0.269	1.078	1.794	79.864
9.002	0.596	1.957	2.428	88.563	9.002	0.271	1.078	1.813	80.114
9.002	0.717	1.957	2.928	88.778	9.002	0.43	1.078	2.933	81.681
9.002	0.839	1.958	3.426	88.818	9.002	0.504	1.078	3.434	81.592
9.002	0.964	1.958	3.931	88.695	9.002	0.58	1.078	3.936	81.266
9.002	1.089	1.957	4.429	88.416	9.002	0.657	1.077	4.435	80.762
12.002	0.029	1.957	0	0	12.002	0.033	1.078	0	0
12.002	0.103	1.958	0.43	68.107	12.002	0.075	1.081	0.431	51.759
12.002	0.193	1.957	0.93	78.571	12.002	0.126	1.08	0.932	66.56
12.002	0.281	1.957	1.43	82.979	12.002	0.176	1.079	1.432	73.147
12.002	0.37	1.957	1.931	85.098	12.003	0.215	1.079	1.805	75.469
12.002	0.46	1.957	2.429	86.101	12.002	0.217	1.079	1.826	75.65
12.002	0.55	1.958	2.928	86.85	12.002	0.336	1.079	2.934	78.503
12.002	0.643	1.958	3.428	86.974	12.002	0.392	1.079	3.434	78.756
12.002	0.737	1.958	3.932	87.037	12.002	0.449	1.078	3.937	78.756
12.002	0.832	1.956	4.433	86.834	12.002	0.507	1.078	4.436	78.587
14.006	0.029	1.96	0	0	14.006	0.034	1.082	0	0
14.006	0.093	1.961	0.432	65.038	14.006	0.07	1.084	0.43	47.543
14.006	0.172	1.959	0.932	75.789	14.006	0.114	1.083	0.928	62.944
14.006	0.248	1.959	1.429	80.594	14.006	0.158	1.083	1.43	69.983
14.006	0.324	1.958	1.929	83.231	14.006	0.194	1.082	1.828	72.793
14.006	0.401	1.959	2.428	84.689	14.006	0.195	1.082	1.843	73.014
14.006	0.48	1.959	2.928	85.32	14.006	0.297	1.081	2.935	76.272
14.006	0.559	1.959	3.429	85.798	14.006	0.345	1.081	3.434	76.823
14.006	0.64	1.959	3.929	85.866	14.006	0.394	1.081	3.934	77.064
14.006	0.721	1.958	4.428	85.856	14.006	0.444	1.08	4.434	77.006
15.009	0.03	1.964	0	0	15.009	0.034	1.084	0	0
15.009	0.089	1.964	0.43	63.222	15.009	0.069	1.087	0.431	45.238
15.009	0.164	1.962	0.93	74.129	15.009	0.11	1.086	0.931	61.24
15.009	0.235	1.961	1.43	79.505	15.009	0.151	1.085	1.43	68.46
15.008	0.306	1.96	1.928	82.285	15.009	0.187	1.084	1.85	71.451

15.008	0.378	1.96	2.428	83.886	15.009	0.187	1.084	1.86	71.837
15.008	0.451	1.96	2.927	84.758	15.008	0.281	1.083	2.933	75.32
15.008	0.526	1.96	3.429	85.136	15.009	0.326	1.082	3.431	75.871
15.008	0.602	1.96	3.931	85.279	15.009	0.372	1.082	3.936	76.276
15.008	0.678	1.958	4.43	85.244	15.008	0.419	1.081	4.435	76.24
17.011	0.03	1.969	0	0	17.011	0.031	1.092	0	0
17.011	0.083	1.97	0.43	59.997	17.011	0.065	1.093	0.43	42.506
17.011	0.15	1.967	0.929	71.614	17.011	0.103	1.092	0.928	57.837
17.011	0.213	1.966	1.429	77.537	17.011	0.14	1.09	1.429	65.403
17.011	0.276	1.965	1.928	80.692	17.011	0.177	1.089	1.927	69.696
17.011	0.341	1.965	2.428	82.248	17.011	0.174	1.09	1.894	69.747
17.011	0.406	1.964	2.927	83.235	17.011	0.255	1.088	2.931	73.515
17.011	0.472	1.964	3.427	83.827	17.011	0.296	1.087	3.429	74.024
17.011	0.539	1.964	3.928	84.138	17.011	0.337	1.086	3.932	74.488
17.011	0.606	1.961	4.428	84.233	17.011	0.379	1.085	4.432	74.587
20.011	0.031	1.978	0	0	20.011	0.028	1.102	0	0
20.011	0.076	1.978	0.427	55.536	20.011	0.056	1.103	0.427	42.029
20.011	0.135	1.976	0.928	67.879	20.011	0.092	1.101	0.93	55.618
20.011	0.189	1.974	1.427	74.48	20.011	0.126	1.1	1.43	62.386
20.011	0.244	1.974	1.928	77.946	20.011	0.16	1.098	1.93	66.187
20.011	0.299	1.973	2.427	80.031	20.011	0.16	1.098	1.953	66.975
20.011	0.355	1.973	2.925	81.237	20.011	0.227	1.096	2.933	70.767
20.011	0.412	1.972	3.426	81.946	20.011	0.262	1.095	3.431	71.658
20.011	0.469	1.972	3.928	82.535	20.011	0.298	1.094	3.936	72.208
20.011	0.527	1.969	4.427	82.656	20.011	0.334	1.093	4.435	72.527

7 Protections

7.1 Reverse Protection –PFET

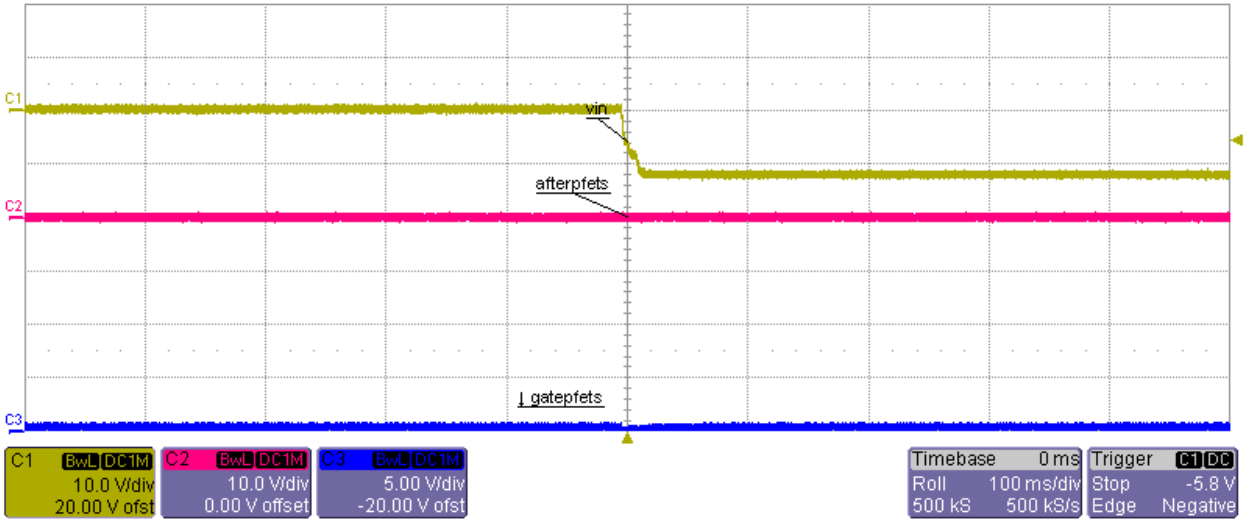




C1- Input

C2- Vin

Continuous Reverse Voltage at Input

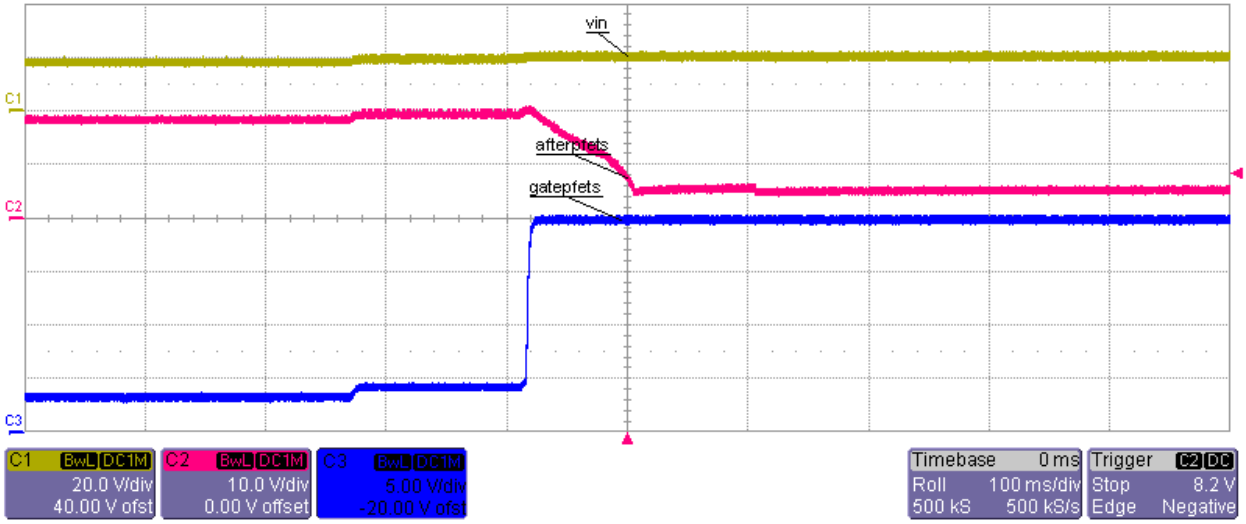


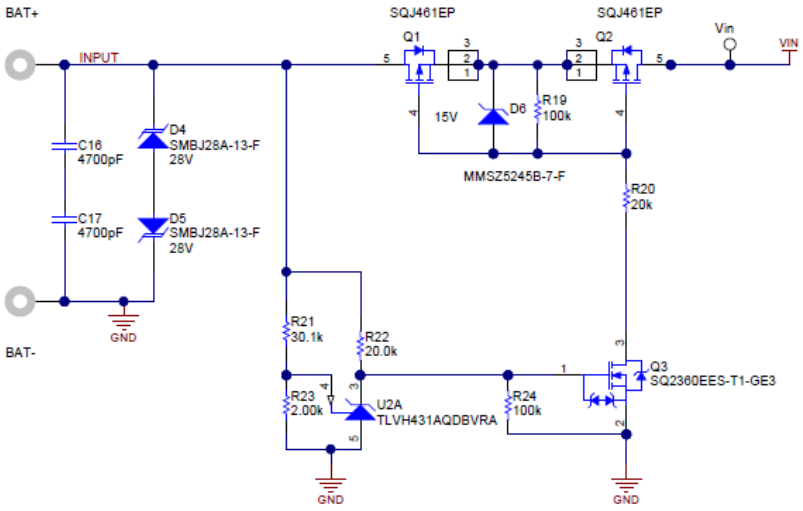
C1- Input

C2- VIN

Transition to Reverse Voltage at Input

6.2 Input Overvoltage Protection – PFET Fault switch



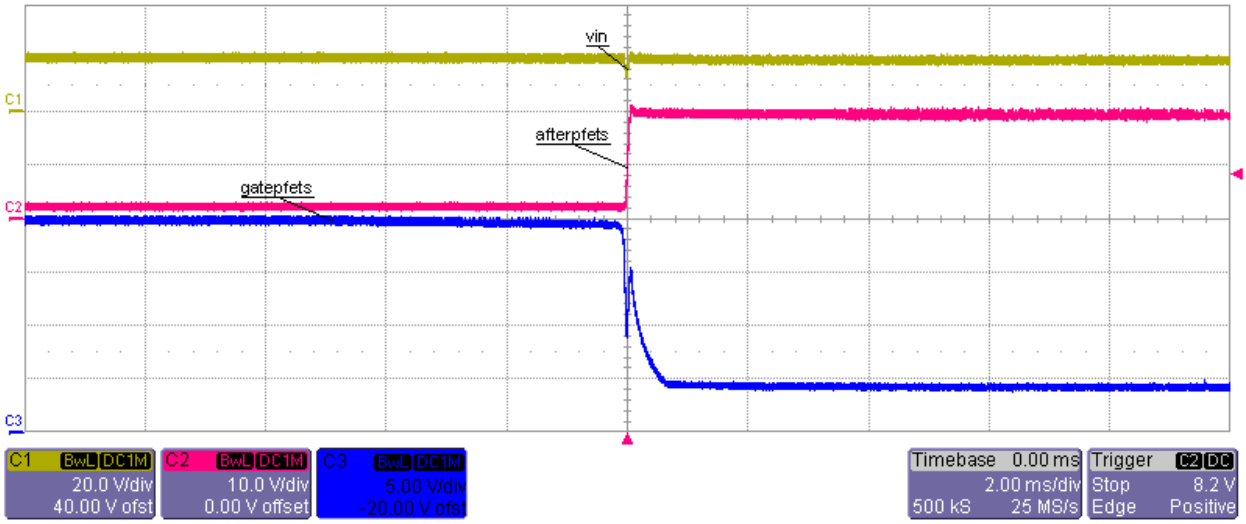


C1- Input

C2- Vin

C3-Q2 PFET's gate

Transition to Overvoltage condition .



C1- Input

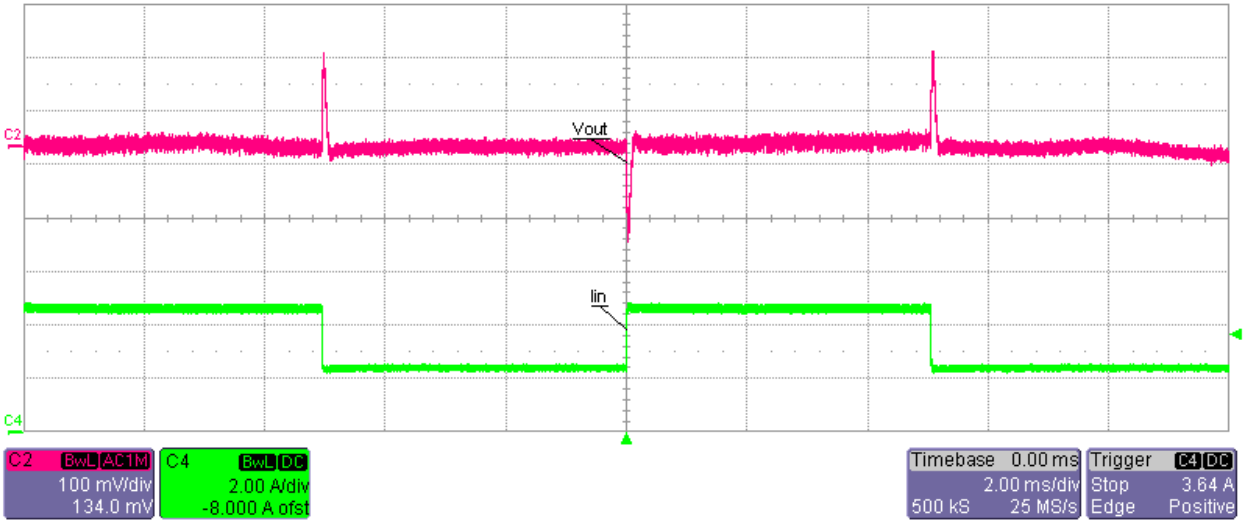
C2- Vin

C3-Q2 PFET's gate

Transition From Overvoltage to normal condition

8 Waveforms

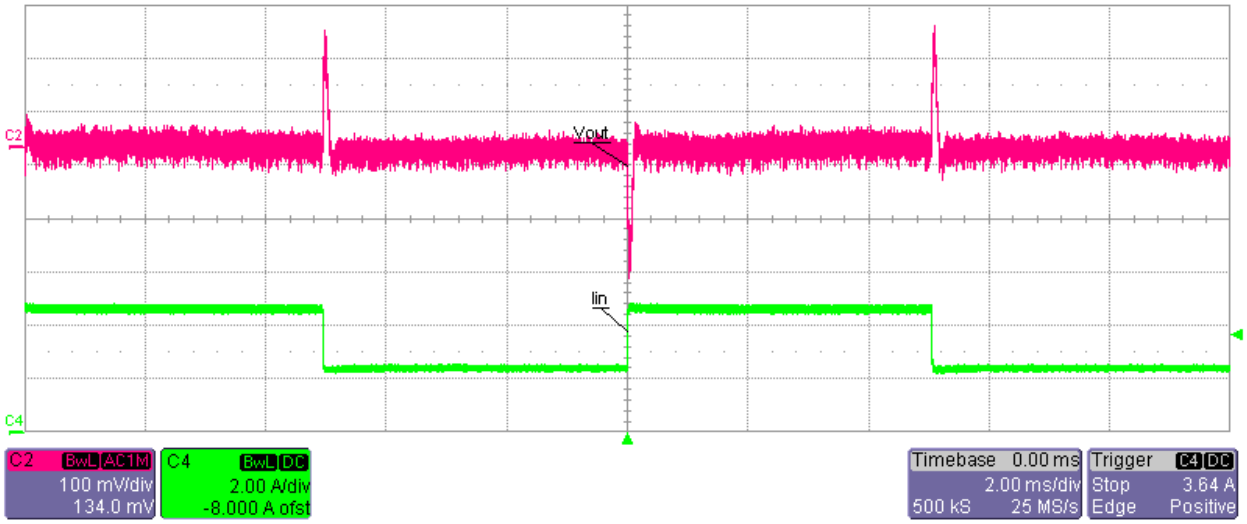
8.1 Load Transient Response



Load Transient Response at 7 Vin and 50%-to-100% (2.5-to-5A) Load Step on 2V Output Voltage

Ch2 – Vout1 (AC coupled)

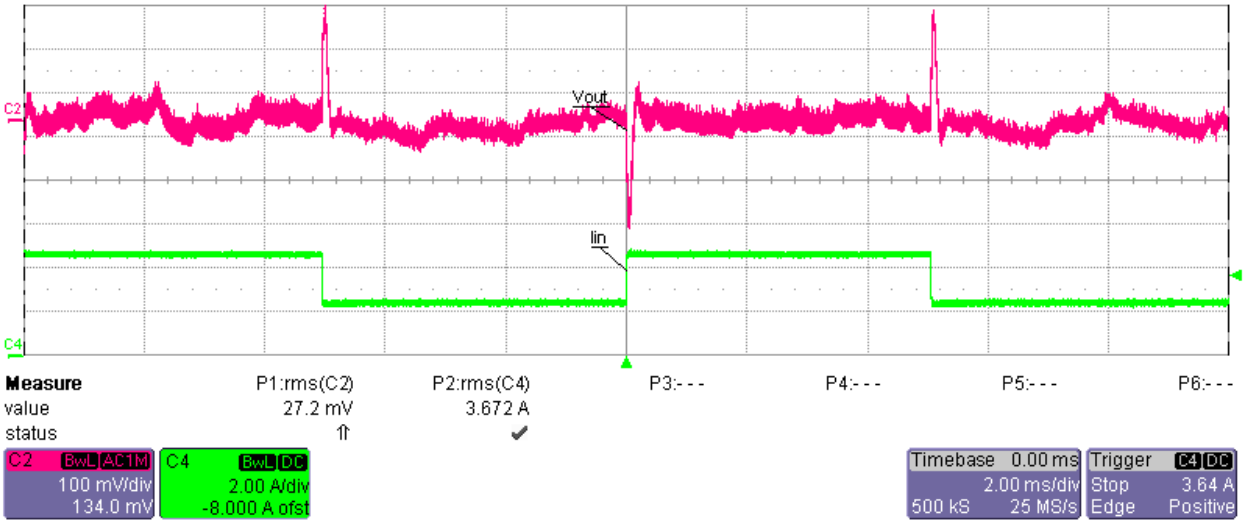
Ch4 - Iout 1



Load Transient Response at 7 Vin and 50%-to-100% (2.5-to-5A) Load Step on 7V Output Voltage

Ch2 – Vout1 (AC coupled)

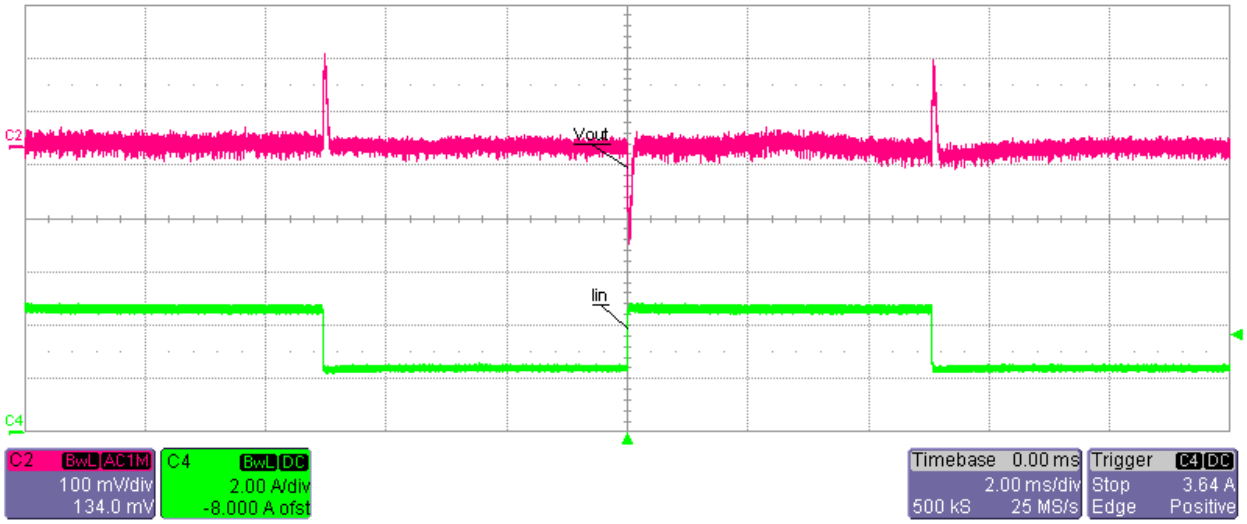
Ch4 - Iout 1



Load Transient Response at 7 Vin and 50%-to-100% (2.5-to-5A) Load Step on 10 V Output Voltage

Ch2 – Vout1 (AC coupled)

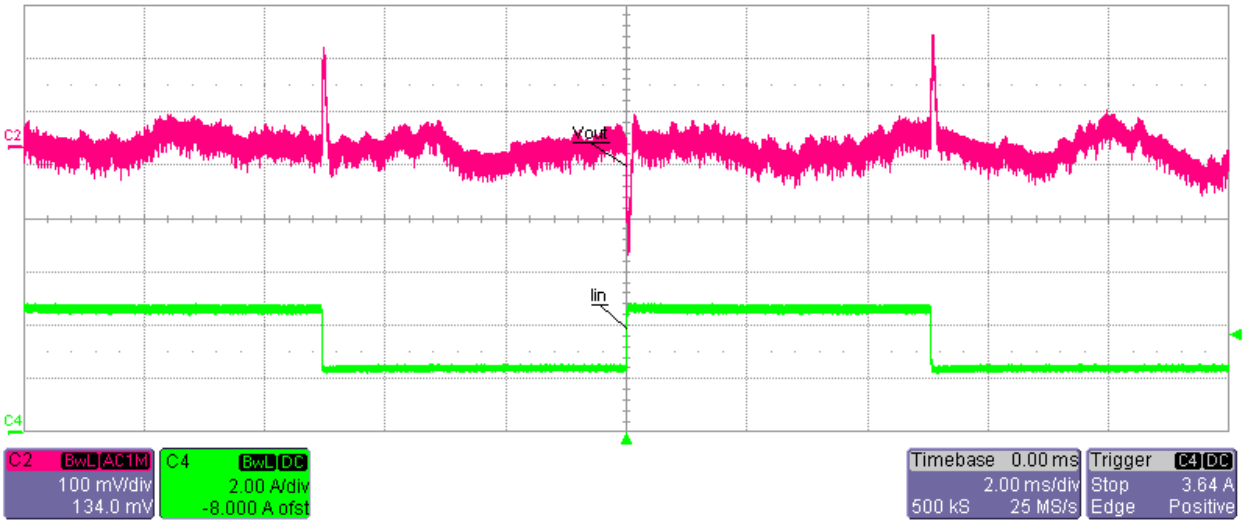
Ch4 - Iout 1



Load Transient Response at 12 Vin and 50%-to-100% (2.5-to-5A) Load Step on 2V Output Voltage

Ch2 – Vout1 (AC coupled)

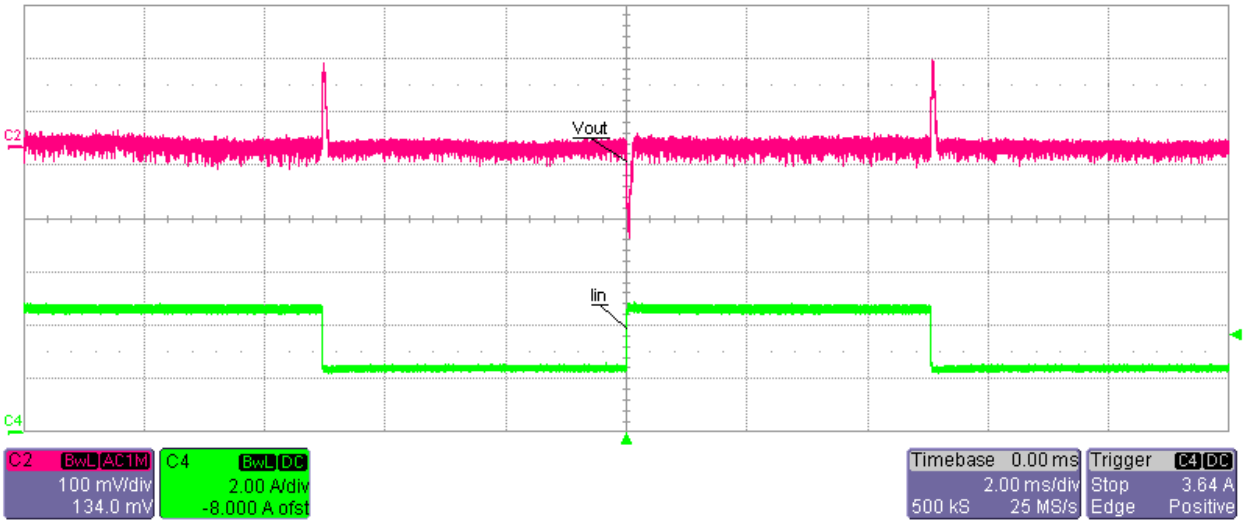
Ch4 - Iout 1



Load Transient Response at 12 Vin and 50%-to-100% (2.5-to-5A) Load Step on 10V Output Voltage

Ch2 – Vout1 (AC coupled)

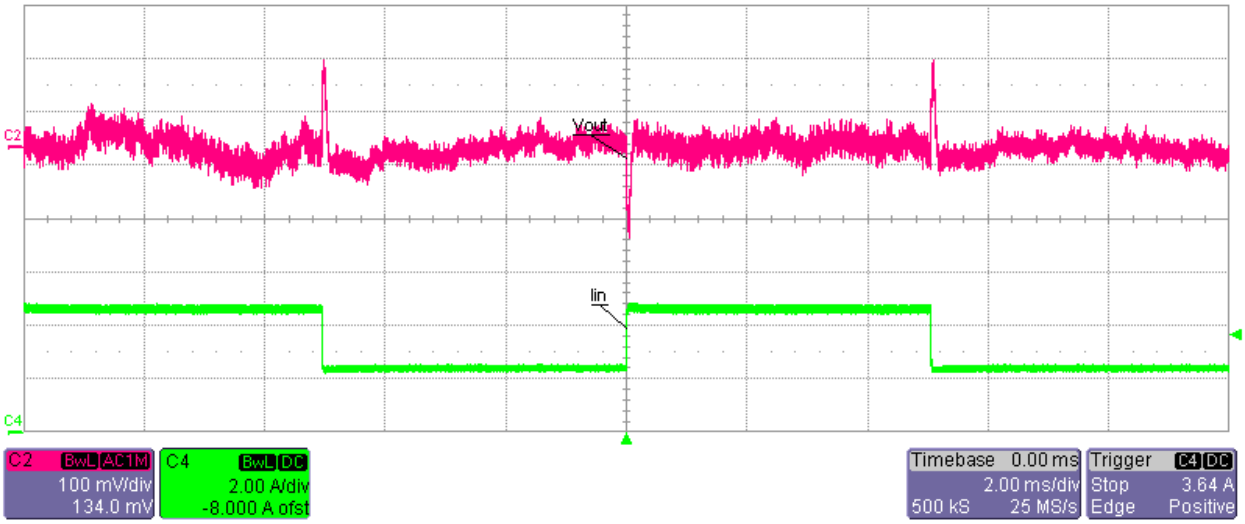
Ch4 - Iout 1



Load Transient Response at 18 Vin and 50%-to-100% (2.5-to-5A) Load Step on 2V Output Voltage

Ch2 – Vout1 (AC coupled)

Ch4 - Iout 1

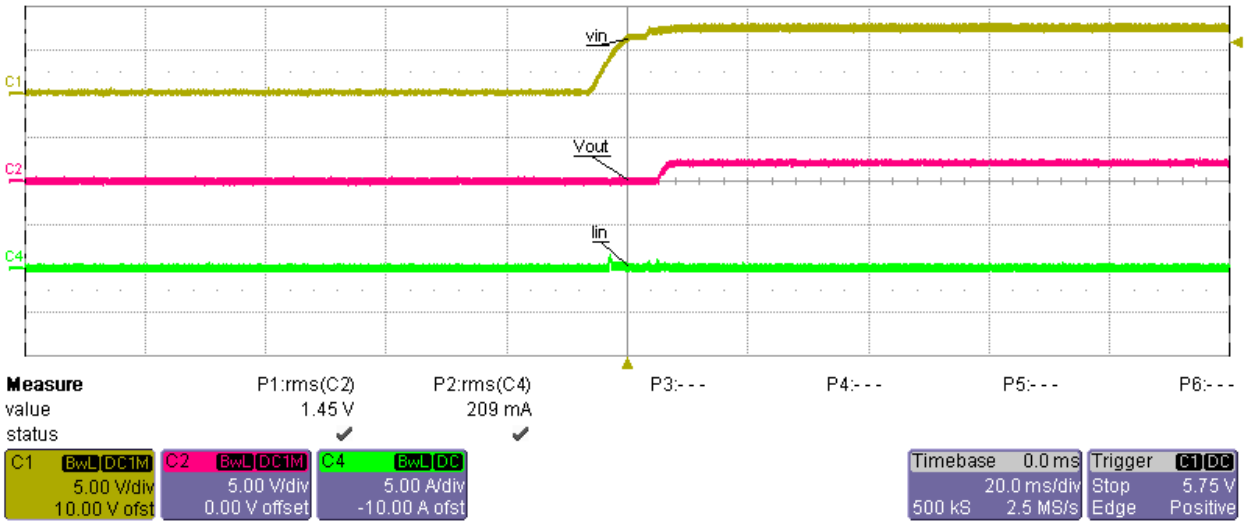


Load Transient Response at 18 Vin and 50%-to-100% (2.5-to-5A) Load Step on 10V Output Voltage

Ch2 – Vout1 (AC coupled)

Ch4 - Iout 1

8.2 Startup

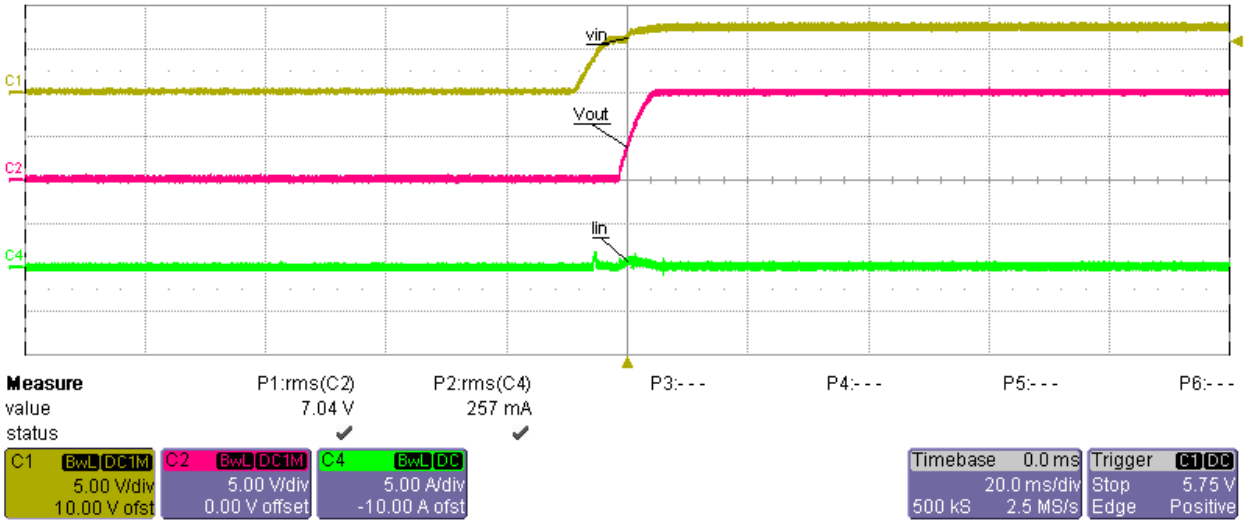


Startup into No Load at 7Vin and 2V output

Ch1-Vin

Ch2-Vout

C4-Iin

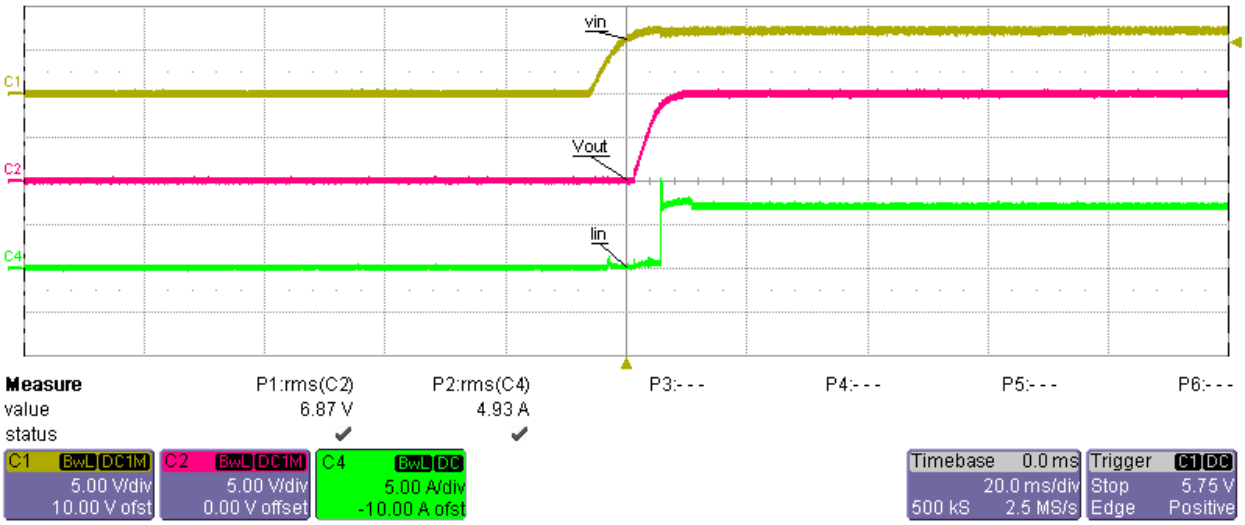


Startup into No Load at 7Vin and 10V output

Ch1-Vin

Ch2-Vout

C4-Iin

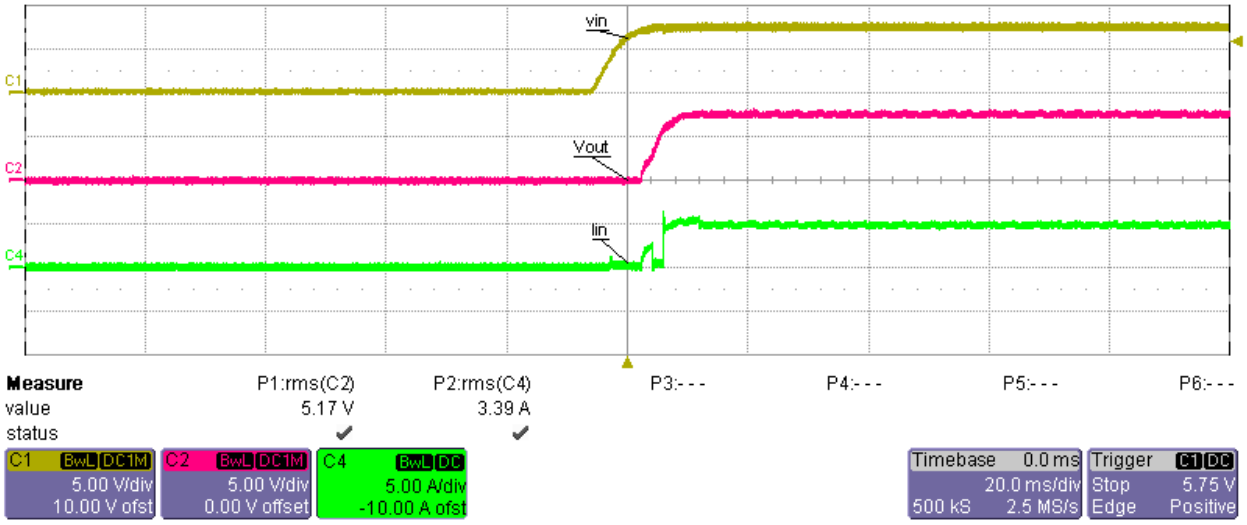


Startup into Full Load at 7 Vin and 10 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

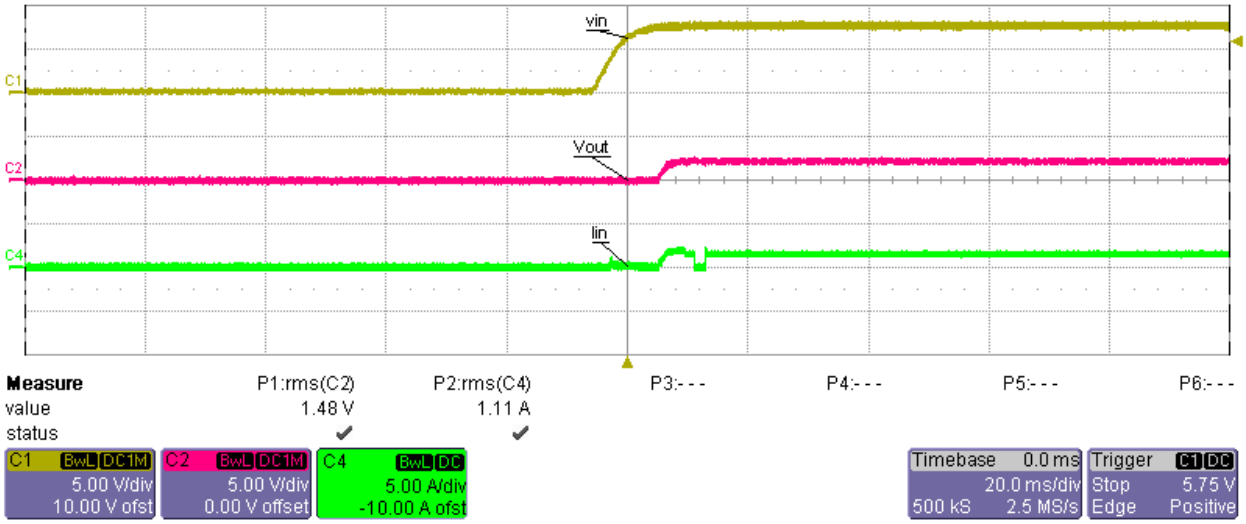


Startup into Full Load at 7 Vin and 7 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

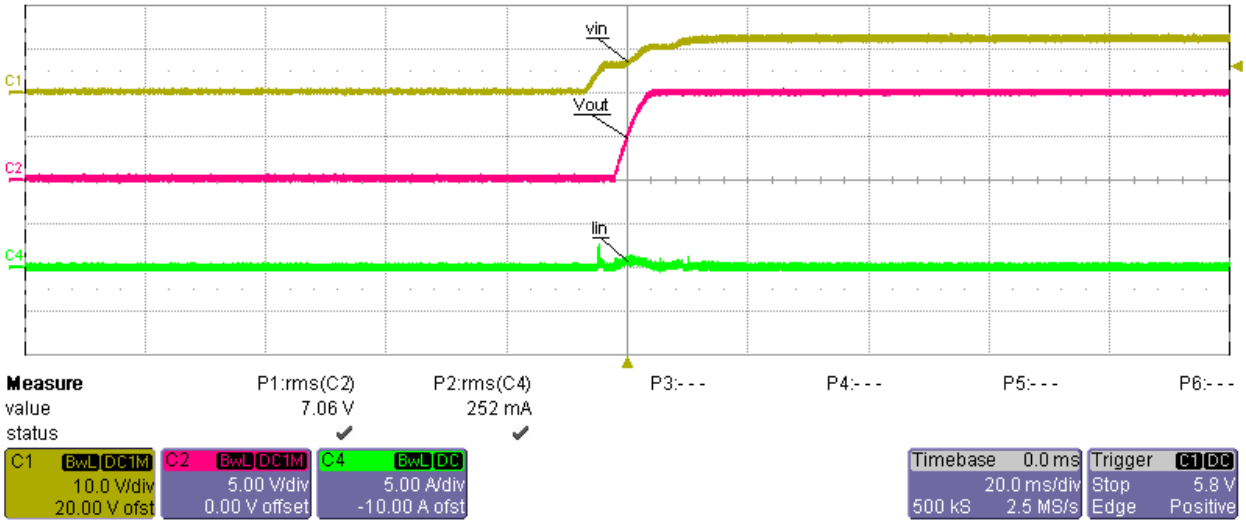


Startup into Full Load at 7 Vin and 2 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

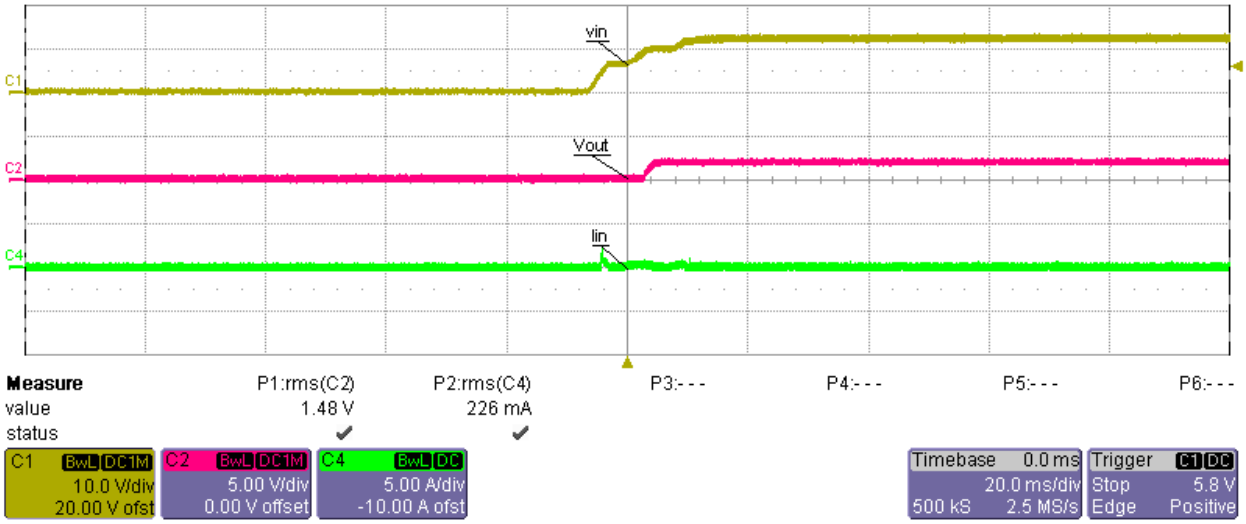


Startup into No Load at 12 Vin and 10 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

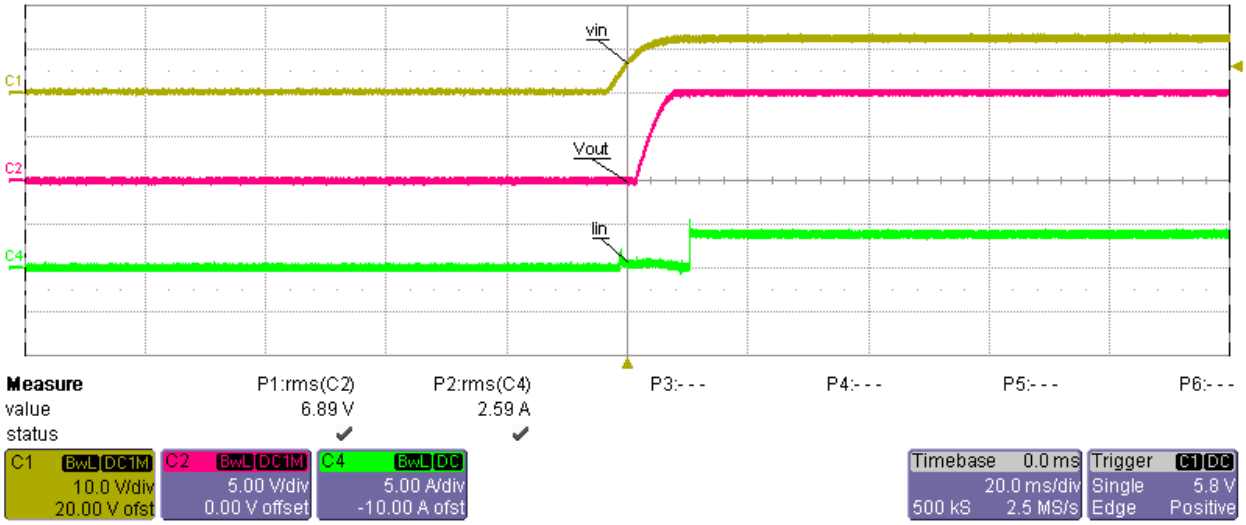


Startup into No Load at 12 Vin and 2 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

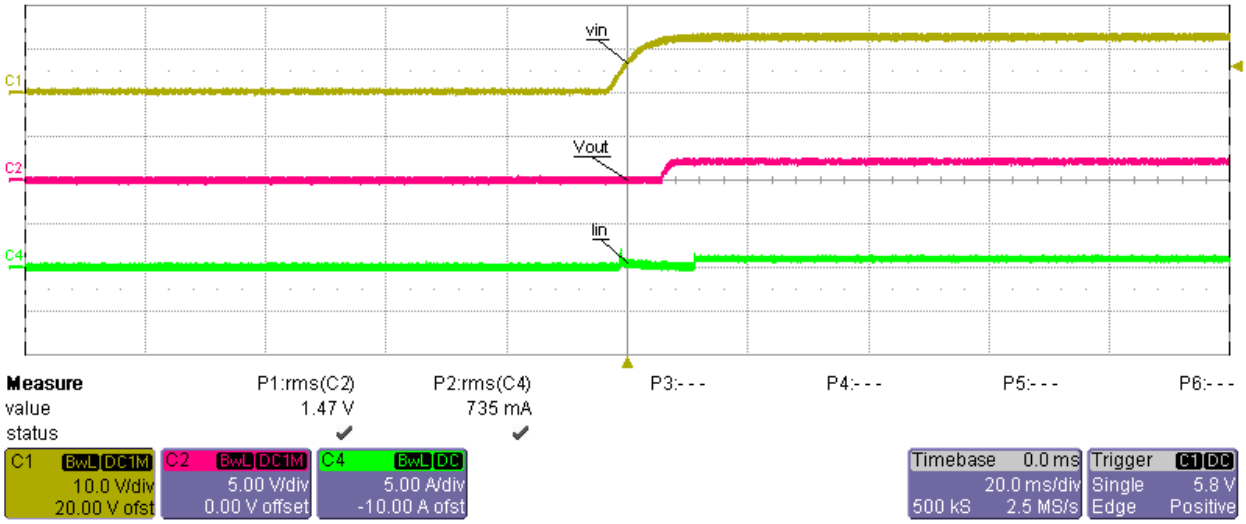


Startup into Full Load at 12 VIN and 10 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

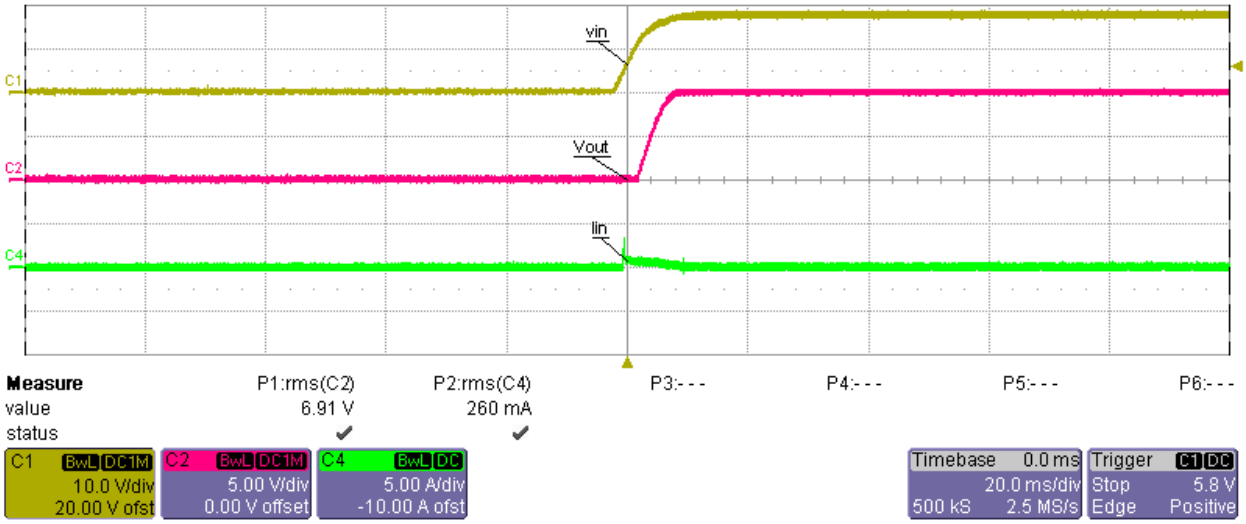


Startup into Full Load at 12 VIN and 2 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

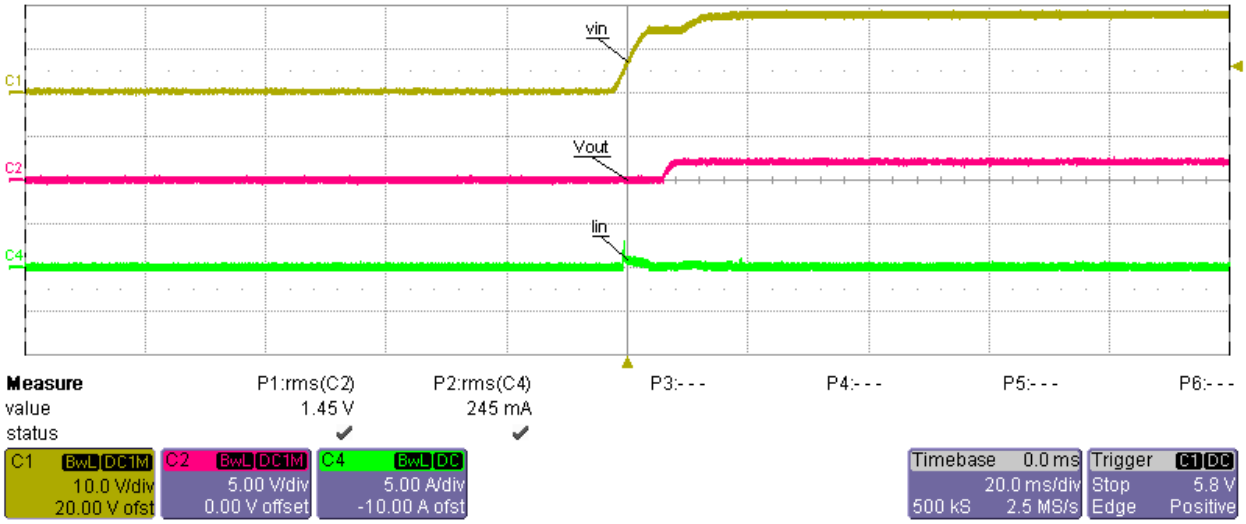


Startup into No Load at 18 VIN and 10 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

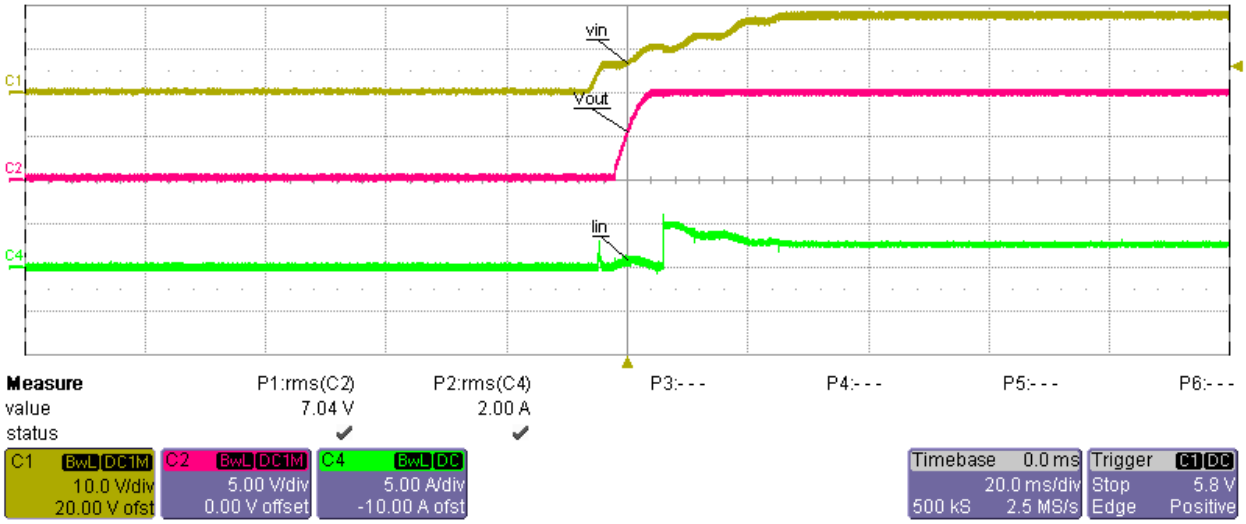


Startup into No Load at 18 VIN and 2 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

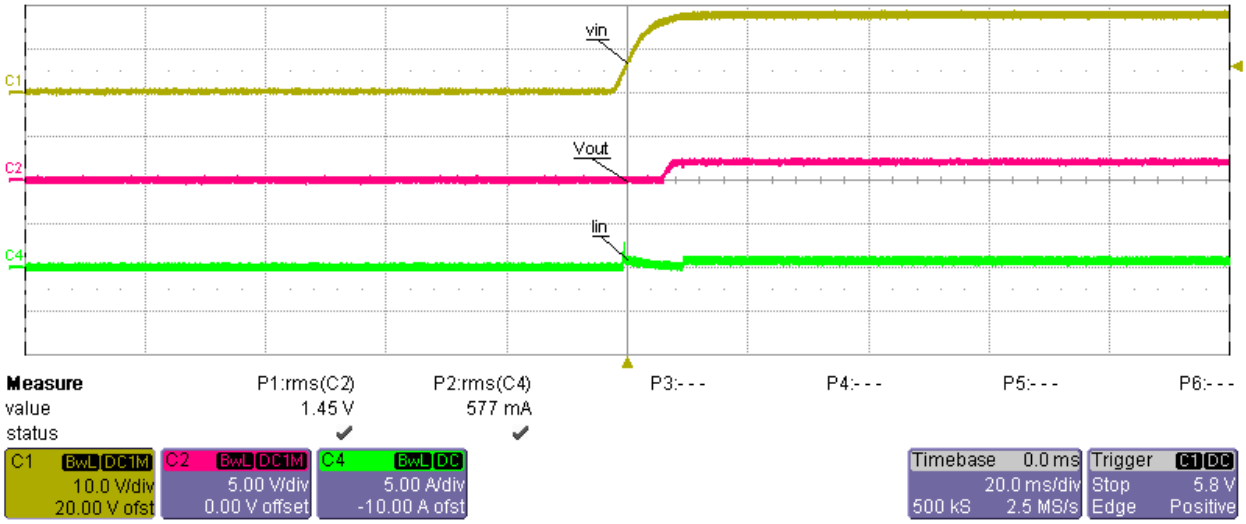


Startup into Full Load at 18 VIN and 10 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin



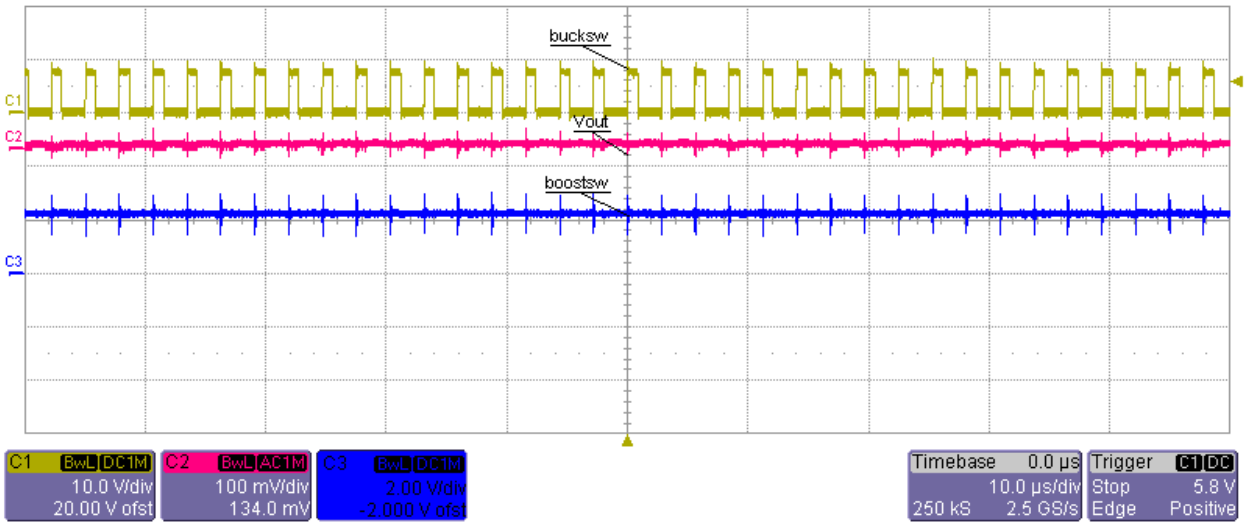
Startup into Full Load at 18 VIN and 2 V output Voltage

Ch1-Vin

Ch2-Vout

C4-Iin

8.3 Output Voltage Ripple and Switch Node Voltage

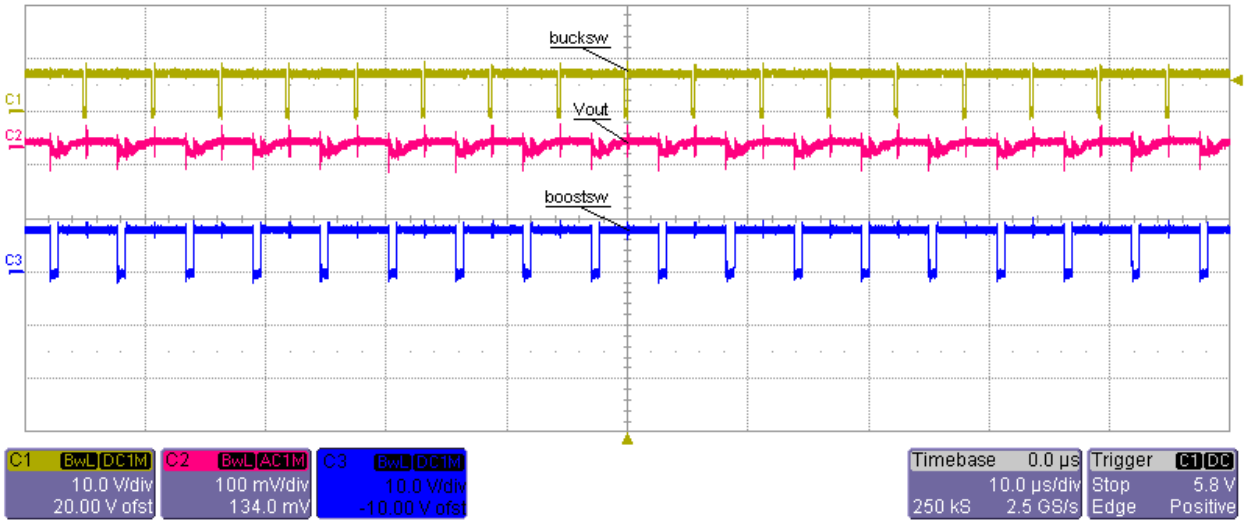


Switch Node Voltages and Output Voltage Ripple at 7 Vin and Full Load at 2V output .

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node

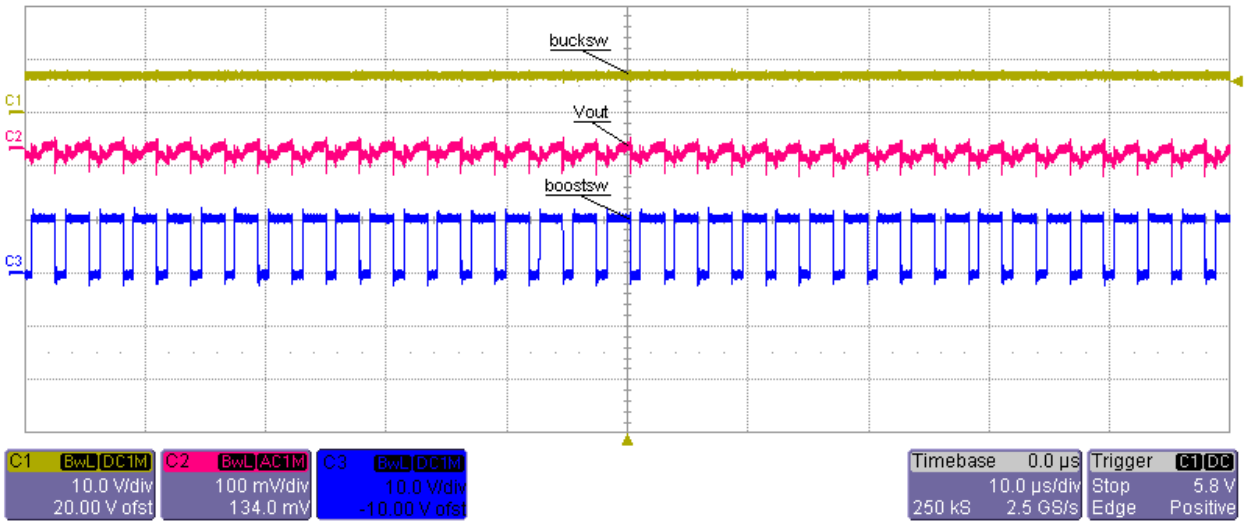


Switch Node Voltages and Output Voltage Ripple at 7 Vin and Full Load at 7V output(Transition) .

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node

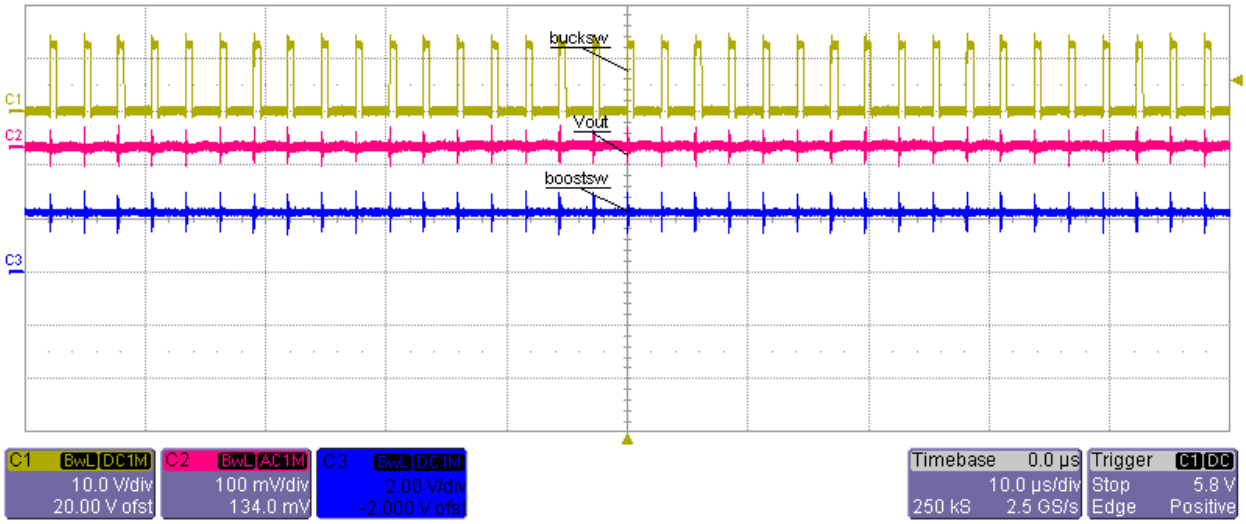


Switch Node Voltages and Output Voltage Ripple at 7 Vin and Full Load at 10 V output.

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node

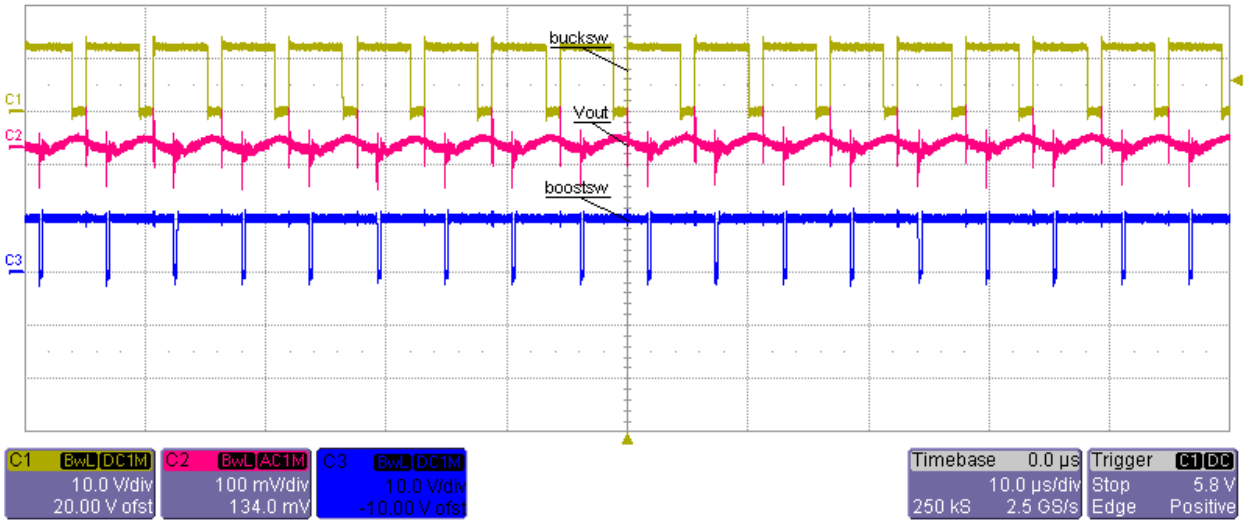


Switch Node Voltages and Output Voltage Ripple at 12 Vin and Full Load at 2 V output.

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node

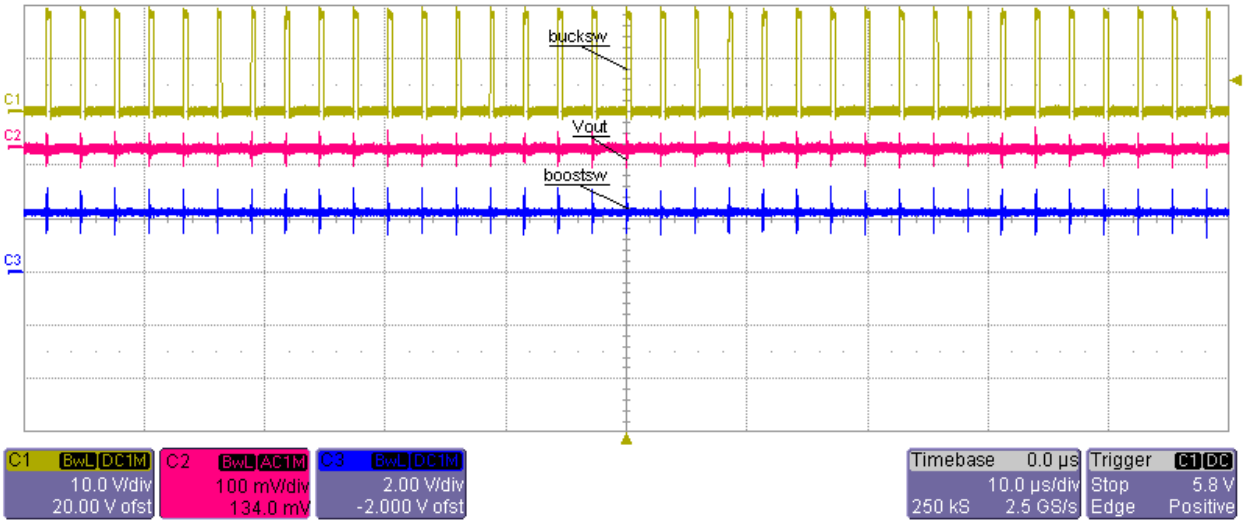


Switch Node Voltages and Output Voltage Ripple at 12 Vin and Full Load at 10 V output.

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node

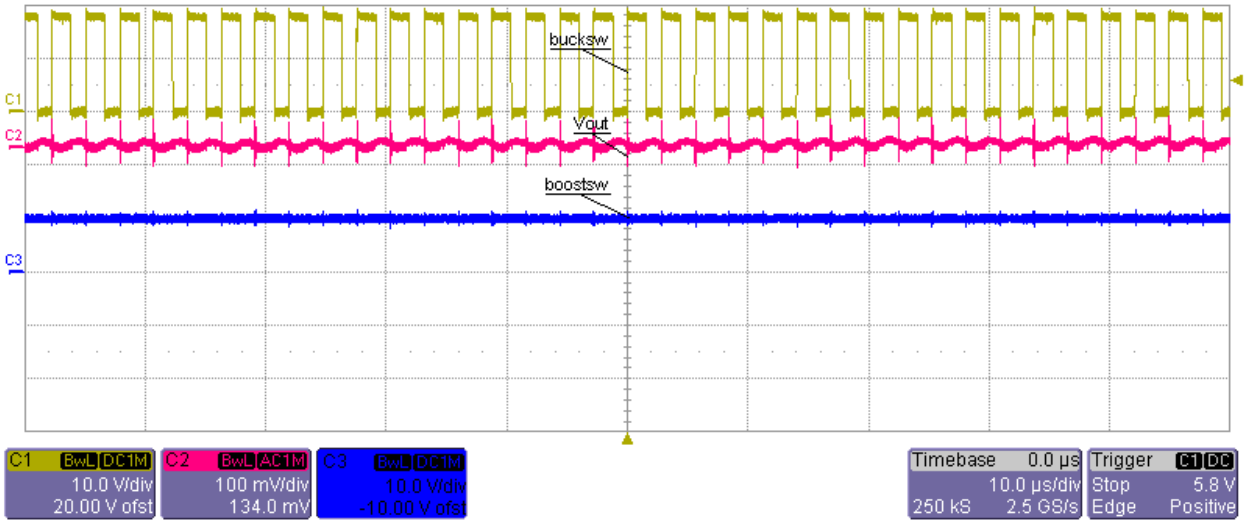


Switch Node Voltages and Output Voltage Ripple at 18 Vin and Full Load at 2 V output.

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node



Switch Node Voltages and Output Voltage Ripple at 18 Vin and Full Load at 10 V output.

Ch2-Output Voltage Ripple

Ch3-Boost Switch node

Ch1- Buck Switch node

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (https:www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265