Test Report
For PMP20774
4/12/2017

Table of Contents

1. Design Specifications

Vin Minimum	**6VDC**
Vin Maximum	**40VDC**
Vout	**5VDC, 9VDC, 15VDC, and 20VDC @ 3A**
Nominal Switching Frequency	**≈ 350KHz**

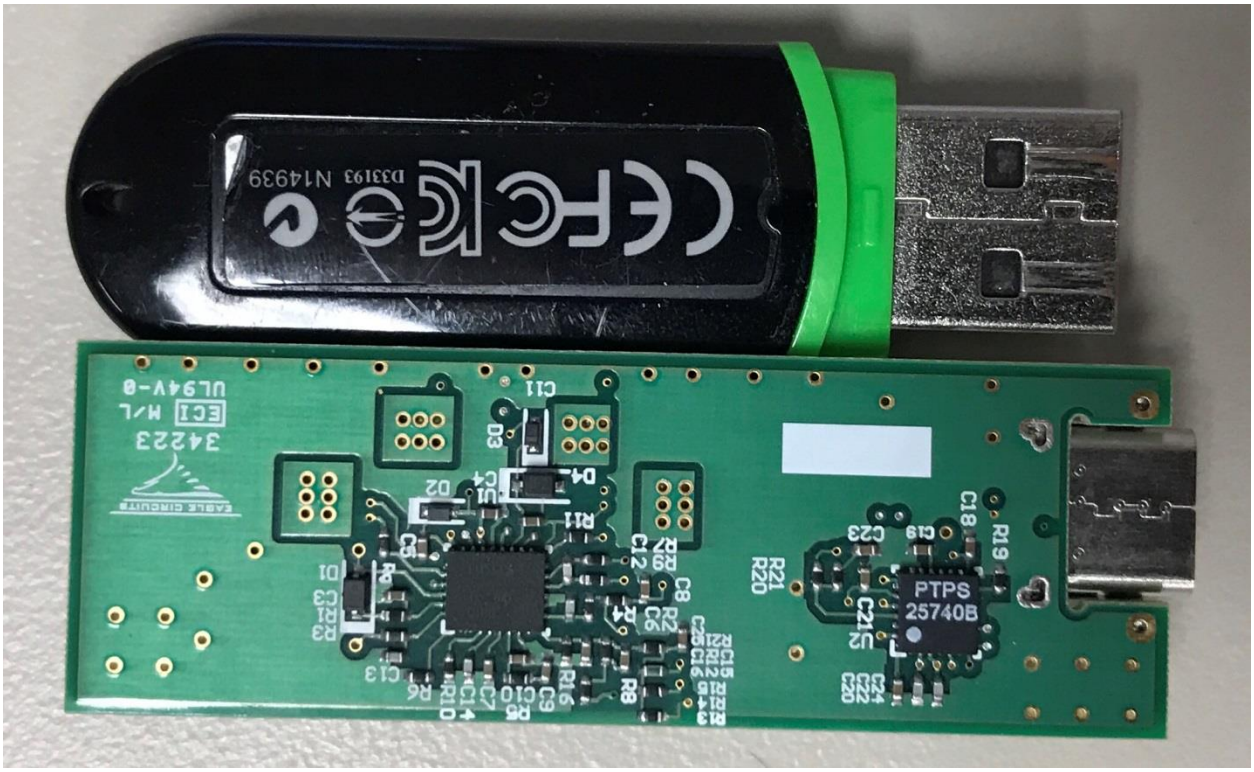
2. Circuit Description

PMP20774 is universal USB Type C™ Charger utilizing the LM5175 DCDC and TPS25740B PD controller for aftermarket car charger applications. This design has a minimum operating input voltage of 6V and a maximum input voltage of 40V. The design is capable of sourcing 3A continuous current at 5Vout, 9Vout, 15Vout and 20Vout. Switching frequency is set to 350kHz. Waveforms were taken at 12V and 24V input. A dedicated USB Type C™ load board was used to perform the PD negotiation. The actual efficiency of the DCDC will be higher because more current is drawn to power the load board.

3. PMP20774 Board Photos

Board Dimensions: 57mm x 19mm

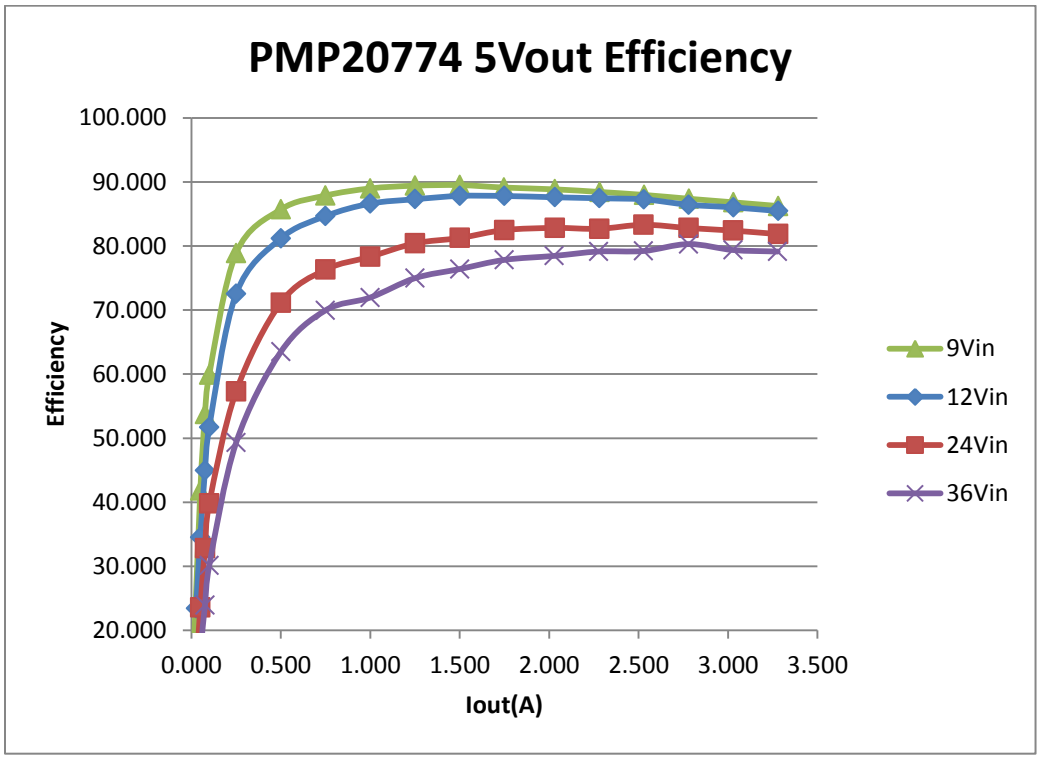
Board Photo (Top)

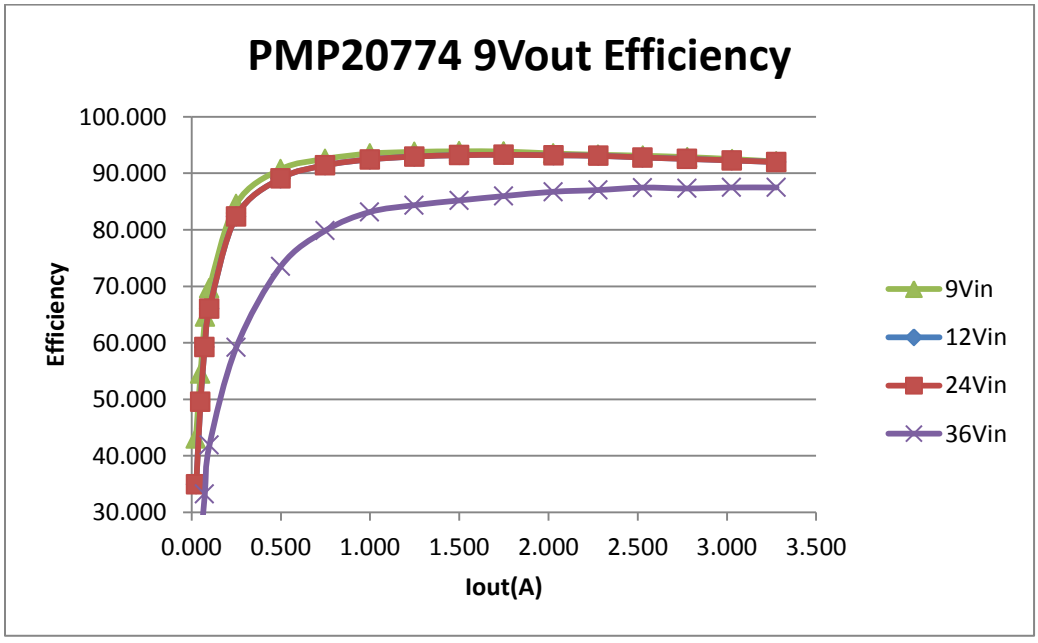


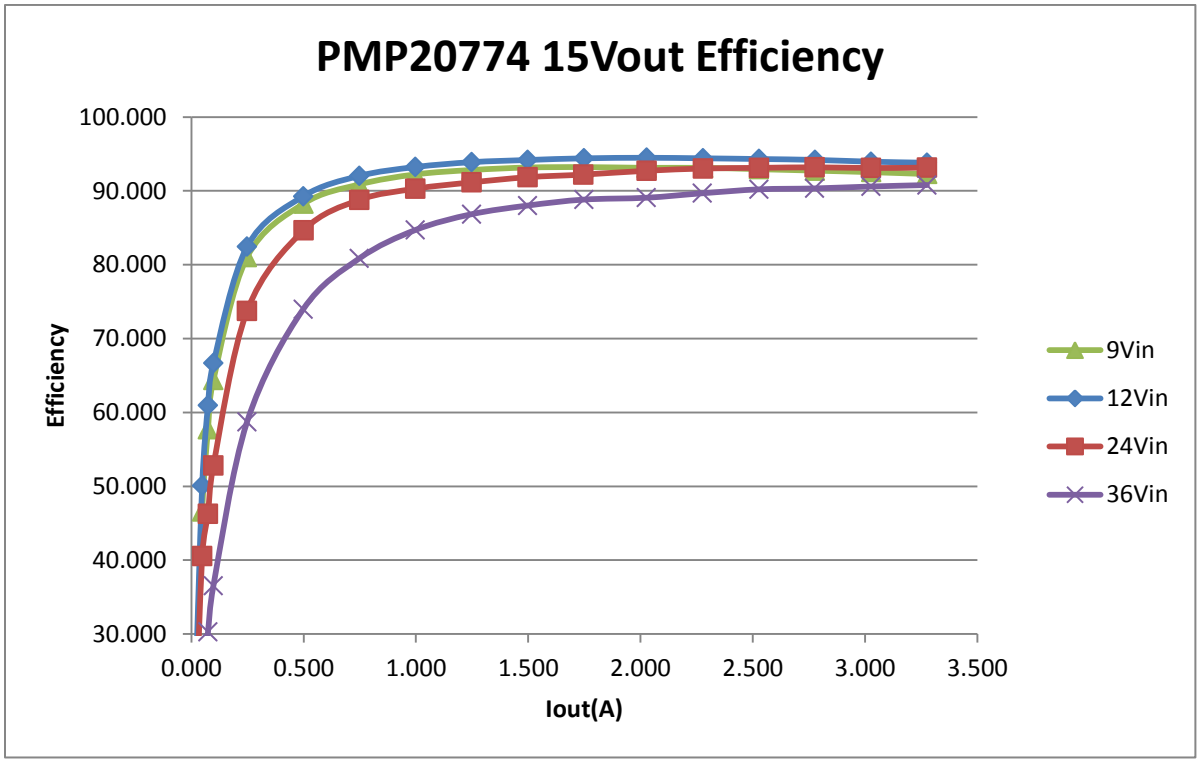
Board Photo (Bottom)

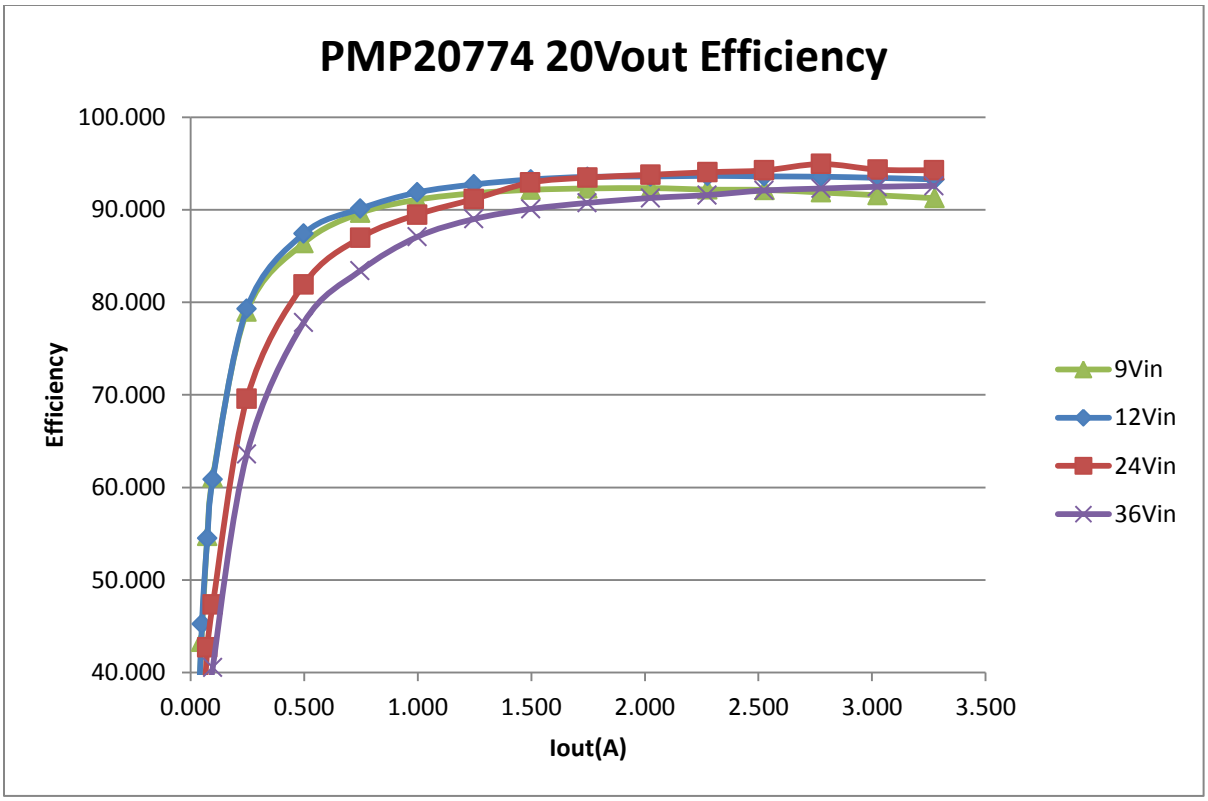
4 Efficiency

4.1 Efficiency Chart






PMP20774 15Vout Efficiency
100.000
90.000
80.000
70.000
60.000
50.000
40.000
30.000
Efficiency
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
Iout(A)
9Vin
12Vin
24Vin
36Vin


PMP20774 20Vout Efficiency
100.000
90.000
80.000
70.000
60.000
50.000
40.000
Efficiency
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
Iout(A)
9Vin
12Vin
24Vin
36Vin

4.2 Efficiency Data

5Vout

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Ploss(W)	Efficiency
9.007	0.036	4.978	0.000	0.324	0.000	0.324	0.000
9.006	0.042	4.975	0.012	0.378	0.060	0.319	15.781
9.006	0.066	4.971	0.050	0.594	0.249	0.346	41.814
9.006	0.078	4.968	0.076	0.703	0.378	0.325	53.743
9.006	0.092	4.964	0.100	0.829	0.496	0.332	59.912
9.006	0.174	4.944	0.250	1.567	1.236	0.331	78.868
9.006	0.318	4.909	0.500	2.864	2.455	0.409	85.709
9.006	0.462	4.875	0.750	4.161	3.656	0.505	87.868
9.006	0.604	4.840	1.000	5.440	4.840	0.599	88.982
9.006	0.746	4.806	1.250	6.719	6.008	0.711	89.415
9.006	0.888	4.772	1.500	7.998	7.158	0.840	89.502
9.006	1.032	4.738	1.748	9.294	8.283	1.011	89.122
9.005	1.194	4.701	2.032	10.752	9.552	1.200	88.843
9.005	1.338	4.669	2.282	12.049	10.655	1.393	88.435
9.005	1.482	4.637	2.532	13.346	11.740	1.606	87.968
9.006	1.628	4.605	2.782	14.661	12.810	1.851	87.373
9.006	1.772	4.572	3.030	15.958	13.854	2.104	86.817
9.006	1.918	4.541	3.280	17.273	14.896	2.377	86.238
12.006	0.038	4.979	0.000	0.456	0.000	0.456	0.000
12.006	0.046	4.975	0.026	0.552	0.129	0.423	23.422
12.006	0.060	4.972	0.050	0.720	0.249	0.472	34.510
12.006	0.070	4.969	0.076	0.840	0.378	0.463	44.930
12.007	0.080	4.965	0.100	0.961	0.497	0.464	51.694
12.006	0.142	4.945	0.250	1.705	1.236	0.469	72.519
12.006	0.252	4.912	0.500	3.026	2.456	0.569	81.178
12.006	0.360	4.879	0.750	4.322	3.659	0.663	84.662
12.006	0.466	4.846	1.000	5.595	4.846	0.749	86.615
12.006	0.574	4.813	1.250	6.892	6.016	0.876	87.296
12.006	0.680	4.780	1.500	8.164	7.170	0.995	87.817
12.006	0.788	4.747	1.750	9.461	8.307	1.154	87.806
12.006	0.910	4.710	2.032	10.925	9.571	1.354	87.606
12.005	1.016	4.678	2.280	12.197	10.666	1.531	87.450
12.005	1.122	4.646	2.530	13.469	11.755	1.715	87.271
12.004	1.236	4.613	2.780	14.837	12.825	2.012	86.440
12.004	1.344	4.581	3.030	16.134	13.879	2.254	86.026
12.005	1.454	4.548	3.280	17.455	14.918	2.538	85.461

24.014	0.036	4.985	0.000	0.864	0.000	0.864	0.000
24.014	0.040	4.982	0.026	0.961	0.130	0.831	13.485
24.014	0.044	4.979	0.050	1.057	0.249	0.808	23.559
24.014	0.048	4.976	0.076	1.153	0.378	0.775	32.805
24.014	0.052	4.972	0.100	1.249	0.497	0.751	39.819
24.014	0.090	4.952	0.250	2.161	1.238	0.923	57.286
24.014	0.144	4.919	0.500	3.458	2.460	0.998	71.130
24.014	0.200	4.886	0.750	4.803	3.665	1.138	76.303
24.014	0.258	4.853	1.000	6.196	4.853	1.342	78.332
24.014	0.312	4.820	1.250	7.492	6.025	1.467	80.413
24.013	0.368	4.787	1.500	8.837	7.180	1.657	81.251
24.013	0.420	4.754	1.750	10.086	8.319	1.766	82.487
24.013	0.482	4.717	2.032	11.574	9.585	1.989	82.817
24.012	0.538	4.685	2.280	12.919	10.682	2.237	82.685
24.012	0.588	4.653	2.528	14.119	11.763	2.356	83.312
24.012	0.646	4.620	2.780	15.512	12.844	2.668	82.801
24.012	0.702	4.587	3.028	16.856	13.890	2.966	82.401
24.012	0.760	4.554	3.280	18.249	14.938	3.311	81.858
36.011	0.036	5.002	0.000	1.296	0.000	1.296	0.000
36.011	0.038	4.999	0.012	1.368	0.060	1.308	4.384
36.011	0.042	4.996	0.050	1.512	0.250	1.263	16.515
36.011	0.044	4.992	0.076	1.584	0.379	1.205	23.947
36.010	0.046	4.989	0.100	1.656	0.499	1.158	30.119
36.011	0.070	4.970	0.250	2.521	1.242	1.278	49.286
36.010	0.108	4.937	0.500	3.889	2.468	1.421	63.469
36.010	0.146	4.904	0.750	5.258	3.678	1.580	69.955
36.010	0.188	4.871	1.000	6.770	4.871	1.899	71.953
36.011	0.224	4.838	1.250	8.066	6.048	2.018	74.978
36.011	0.262	4.805	1.500	9.435	7.208	2.227	76.400
36.011	0.298	4.773	1.750	10.731	8.352	2.379	77.832
36.010	0.340	4.736	2.028	12.244	9.605	2.638	78.451
36.010	0.376	4.704	2.278	13.540	10.716	2.824	79.141
36.010	0.414	4.672	2.528	14.908	11.810	3.098	79.217
36.010	0.446	4.639	2.780	16.061	12.896	3.164	80.298
36.010	0.488	4.606	3.028	17.573	13.948	3.625	79.370
36.010	0.526	4.572	3.278	18.941	14.989	3.953	79.131

9Vout

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Ploss(W)	Efficiency
9.006	0.040	9.049	0.000	0.360	0.000	0.360	0.000
9.006	0.056	9.046	0.024	0.504	0.217	0.287	43.045
9.006	0.092	9.043	0.050	0.829	0.452	0.376	54.567
9.006	0.118	9.039	0.076	1.063	0.687	0.376	64.645
9.006	0.144	9.036	0.100	1.297	0.904	0.393	69.677
9.006	0.296	9.018	0.250	2.666	2.254	0.411	84.570
9.006	0.550	8.987	0.500	4.953	4.493	0.460	90.711
9.006	0.806	8.955	0.750	7.259	6.716	0.543	92.526
9.006	1.060	8.924	1.000	9.547	8.924	0.623	93.475
9.006	1.316	8.892	1.250	11.852	11.115	0.737	93.778
9.006	1.572	8.860	1.500	14.158	13.290	0.867	93.874
9.006	1.828	8.828	1.750	16.463	15.450	1.014	93.844
9.006	2.118	8.793	2.028	19.075	17.832	1.243	93.482
9.006	2.376	8.761	2.278	21.398	19.958	1.440	93.271
9.006	2.634	8.730	2.530	23.722	22.086	1.636	93.103
9.006	2.892	8.699	2.780	26.045	24.182	1.863	92.846
9.006	3.152	8.666	3.030	28.387	26.259	2.128	92.503
9.006	3.414	8.635	3.278	30.746	28.305	2.441	92.061
12.006	0.036	9.048	0.000	0.432	0.000	0.432	0.000
12.006	0.056	9.045	0.026	0.672	0.235	0.437	34.977
12.006	0.076	9.042	0.050	0.912	0.452	0.460	49.545
12.006	0.094	9.039	0.074	1.129	0.669	0.460	59.266
12.006	0.114	9.035	0.100	1.369	0.904	0.465	66.013
12.006	0.228	9.017	0.250	2.737	2.254	0.483	82.348
12.006	0.420	8.986	0.500	5.043	4.493	0.550	89.102
12.006	0.612	8.955	0.750	7.348	6.716	0.631	91.408
12.006	0.804	8.924	1.000	9.653	8.924	0.729	92.447
12.006	0.996	8.892	1.250	11.958	11.115	0.842	92.956
12.006	1.188	8.861	1.500	14.263	13.291	0.971	93.189
12.006	1.380	8.830	1.750	16.568	15.452	1.116	93.261
12.006	1.596	8.795	2.030	19.161	17.853	1.308	93.172
12.006	1.788	8.764	2.280	21.466	19.981	1.485	93.081
12.006	1.982	8.733	2.528	23.795	22.078	1.718	92.782
12.006	2.176	8.702	2.778	26.125	24.175	1.950	92.537
12.006	2.370	8.670	3.028	28.453	26.253	2.201	92.266
12.006	2.564	8.638	3.278	30.784	28.315	2.469	91.979

24.014	0.046	9.046	0.000	1.105	0.000	1.105	0.000
24.014	0.052	9.043	0.012	1.249	0.109	1.140	8.690
24.014	0.058	9.040	0.050	1.393	0.452	0.941	32.452
24.014	0.074	9.037	0.076	1.777	0.687	1.090	38.648
24.014	0.084	9.033	0.100	2.017	0.903	1.114	44.783
24.014	0.140	9.015	0.250	3.362	2.254	1.108	67.034
24.014	0.236	8.983	0.500	5.667	4.492	1.176	79.255
24.014	0.332	8.951	0.750	7.973	6.714	1.259	84.209
24.013	0.430	8.920	1.000	10.326	8.920	1.405	86.388
24.013	0.530	8.888	1.250	12.727	11.110	1.616	87.300
24.012	0.626	8.857	1.500	15.032	13.285	1.746	88.382
24.013	0.722	8.825	1.748	17.337	15.427	1.910	88.981
24.013	0.832	8.790	2.030	19.979	17.844	2.135	89.315
24.013	0.928	8.759	2.278	22.284	19.954	2.330	89.543
24.013	1.024	8.729	2.528	24.589	22.067	2.522	89.742
24.013	1.122	8.698	2.780	26.943	24.179	2.763	89.744
24.013	1.220	8.665	3.028	29.296	26.238	3.057	89.564
24.013	1.316	8.633	3.278	31.601	28.298	3.303	89.546
36.010	0.044	9.066	0.000	1.584	0.000	1.584	0.000
36.011	0.046	9.063	0.026	1.656	0.236	1.421	14.225
36.010	0.052	9.060	0.050	1.873	0.453	1.420	24.191
36.010	0.056	9.057	0.074	2.017	0.670	1.346	33.235
36.010	0.060	9.054	0.100	2.161	0.905	1.255	41.904
36.010	0.106	9.035	0.250	3.817	2.259	1.558	59.172
36.010	0.170	9.003	0.500	6.122	4.502	1.620	73.535
36.010	0.234	8.971	0.750	8.426	6.729	1.698	79.851
36.011	0.298	8.940	0.998	10.731	8.922	1.809	83.138
36.010	0.366	8.908	1.248	13.180	11.117	2.063	84.347
36.010	0.434	8.876	1.500	15.628	13.314	2.315	85.187
36.010	0.500	8.844	1.750	18.005	15.477	2.528	85.958
36.010	0.572	8.809	2.028	20.598	17.864	2.734	86.727
36.010	0.638	8.777	2.278	22.974	19.994	2.981	87.026
36.010	0.702	8.746	2.528	25.279	22.110	3.169	87.464
36.010	0.770	8.714	2.778	27.728	24.207	3.521	87.302
36.010	0.834	8.682	3.026	30.032	26.271	3.761	87.476
36.010	0.900	8.649	3.278	32.409	28.351	4.058	87.479

15Vout

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Ploss(W)	Efficiency
9.006	0.084	15.039	0.000	0.757	0.000	0.757	0.000
9.006	0.130	15.036	0.010	1.171	0.150	1.020	12.842
9.006	0.172	15.033	0.048	1.549	0.722	0.827	46.581
9.006	0.214	15.030	0.074	1.927	1.112	0.815	57.708
9.006	0.254	15.026	0.098	2.288	1.473	0.815	64.374
9.006	0.510	15.008	0.248	4.593	3.722	0.871	81.033
9.006	0.942	14.977	0.500	8.484	7.489	0.995	88.273
9.006	1.366	14.946	0.748	12.302	11.180	1.122	90.879
9.006	1.792	14.915	0.998	16.139	14.886	1.253	92.233
9.006	2.222	14.885	1.248	20.012	18.577	1.435	92.830
9.006	2.652	14.854	1.498	23.884	22.251	1.633	93.163
9.006	3.086	14.823	1.748	27.793	25.910	1.883	93.223
9.006	3.576	14.788	2.028	32.206	29.990	2.215	93.121
9.006	4.012	14.757	2.280	36.131	33.647	2.485	93.124
9.006	4.448	14.727	2.528	40.058	37.229	2.829	92.937
9.006	4.888	14.696	2.778	44.021	40.826	3.195	92.742
9.006	5.328	14.664	3.028	47.985	44.403	3.581	92.536
9.006	5.772	14.633	3.278	51.981	47.966	4.015	92.276
12.006	0.054	15.041	0.000	0.648	0.000	0.648	0.000
12.006	0.086	15.038	0.010	1.033	0.150	0.882	14.563
12.006	0.120	15.034	0.048	1.441	0.722	0.719	50.089
12.006	0.152	15.031	0.074	1.825	1.112	0.713	60.950
12.006	0.184	15.028	0.098	2.209	1.473	0.736	66.667
12.006	0.376	15.010	0.248	4.514	3.722	0.792	82.459
12.006	0.696	14.979	0.498	8.356	7.459	0.897	89.268
12.006	1.012	14.948	0.748	12.150	11.181	0.969	92.026
12.006	1.330	14.917	0.998	15.968	14.887	1.081	93.232
12.006	1.648	14.885	1.248	19.786	18.577	1.209	93.890
12.006	1.968	14.855	1.498	23.628	22.253	1.375	94.181
12.006	2.286	14.823	1.748	27.446	25.911	1.534	94.410
12.006	2.644	14.789	2.028	31.744	29.993	1.751	94.484
12.006	2.966	14.759	2.278	35.610	33.620	1.990	94.412
12.006	3.288	14.728	2.528	39.476	37.232	2.243	94.317
12.006	3.610	14.697	2.778	43.342	40.827	2.515	94.198
12.006	3.934	14.665	3.026	47.231	44.375	2.856	93.953
12.006	4.256	14.633	3.276	51.097	47.937	3.161	93.814

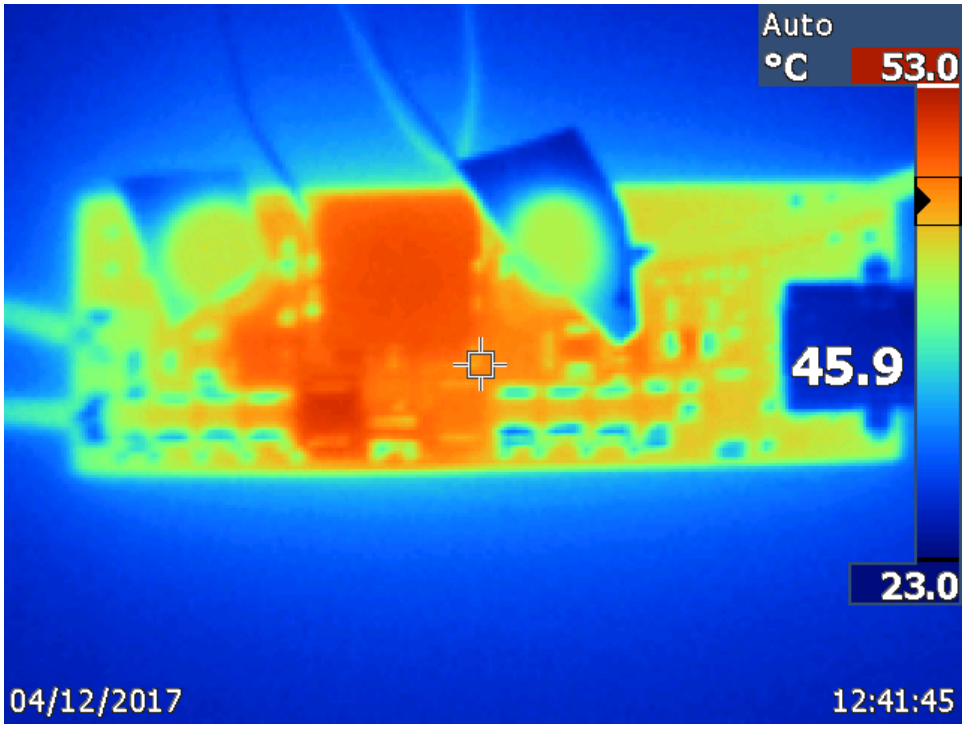
24.014	0.054	15.026	0.000	1.297	0.000	1.297	0.000
24.014	0.062	15.023	0.010	1.489	0.150	1.339	10.090
24.014	0.074	15.019	0.048	1.777	0.721	1.056	40.570
24.014	0.100	15.016	0.074	2.401	1.111	1.290	46.272
24.014	0.116	15.014	0.098	2.786	1.471	1.314	52.820
24.013	0.210	14.996	0.248	5.043	3.719	1.324	73.747
24.013	0.368	14.965	0.500	8.837	7.483	1.354	84.674
24.013	0.524	14.934	0.748	12.583	11.171	1.412	88.781
24.013	0.686	14.904	0.998	16.473	14.874	1.599	90.295
24.013	0.848	14.873	1.248	20.363	18.562	1.801	91.155
24.013	1.008	14.843	1.498	24.205	22.234	1.971	91.857
24.013	1.168	14.812	1.746	28.047	25.862	2.185	92.209
24.013	1.346	14.779	2.028	32.322	29.971	2.351	92.726
24.013	1.504	14.749	2.278	36.116	33.597	2.518	93.027
24.013	1.664	14.719	2.528	39.958	37.209	2.749	93.119
24.013	1.822	14.688	2.776	43.752	40.774	2.978	93.194
24.013	1.984	14.658	3.026	47.642	44.354	3.288	93.099
24.013	2.142	14.626	3.276	51.437	47.916	3.521	93.155
36.010	0.070	15.039	0.000	2.521	0.000	2.521	0.000
36.010	0.074	15.037	0.010	2.665	0.150	2.514	5.643
36.010	0.084	15.034	0.048	3.025	0.722	2.303	23.858
36.010	0.102	15.031	0.074	3.673	1.112	2.561	30.283
36.010	0.112	15.028	0.098	4.033	1.473	2.560	36.517
36.010	0.176	15.010	0.248	6.338	3.722	2.615	58.734
36.010	0.280	14.978	0.498	10.083	7.459	2.623	73.981
36.010	0.384	14.948	0.748	13.828	11.181	2.647	80.857
36.010	0.488	14.916	0.998	17.573	14.886	2.687	84.710
36.010	0.594	14.885	1.248	21.390	18.576	2.814	86.844
36.010	0.702	14.853	1.498	25.279	22.250	3.029	88.018
36.010	0.810	14.822	1.748	29.168	25.909	3.260	88.825
36.010	0.934	14.787	2.026	33.633	29.958	3.675	89.073
36.010	1.040	14.756	2.276	37.450	33.585	3.865	89.679
36.010	1.146	14.726	2.528	41.268	37.227	4.040	90.210
36.010	1.254	14.695	2.776	45.157	40.793	4.364	90.337
36.010	1.360	14.663	3.026	48.973	44.369	4.605	90.598
36.010	1.466	14.631	3.276	52.791	47.930	4.861	90.792

20Vout

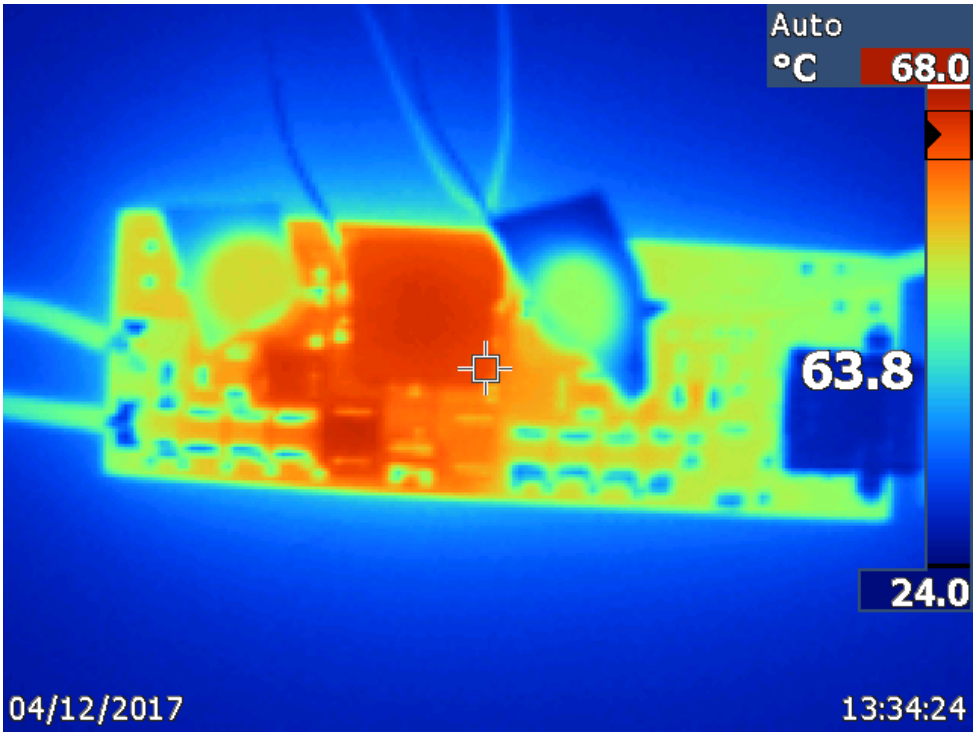
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Ploss(W)	Efficiency
9.006	0.130	19.997	0.000	1.171	0.000	1.171	0.000
9.006	0.190	19.994	0.024	1.711	0.480	1.231	28.042
9.006	0.246	19.991	0.048	2.215	0.960	1.256	43.313
9.006	0.300	19.988	0.074	2.702	1.479	1.223	54.745
9.006	0.356	19.985	0.098	3.206	1.959	1.248	61.086
9.006	0.696	19.967	0.248	6.268	4.952	1.316	79.000
9.005	1.276	19.936	0.498	11.491	9.928	1.563	86.399
9.006	1.844	19.904	0.748	16.607	14.888	1.718	89.652
9.006	2.418	19.874	0.998	21.776	19.834	1.942	91.082
9.006	2.996	19.843	1.248	26.981	24.764	2.217	91.782
9.006	3.576	19.813	1.498	32.205	29.679	2.526	92.158
9.006	4.160	19.782	1.748	37.464	34.579	2.885	92.300
9.006	4.816	19.748	2.028	43.372	40.048	3.323	92.338
9.005	5.406	19.718	2.276	48.683	44.878	3.806	92.183
9.006	5.998	19.688	2.528	54.017	49.771	4.246	92.140
9.006	6.596	19.657	2.776	59.400	54.568	4.832	91.865
9.006	7.202	19.625	3.026	64.858	59.387	5.472	91.563
9.005	7.812	19.595	3.276	70.351	64.193	6.158	91.247
12.006	0.096	19.997	0.000	1.153	0.000	1.153	0.000
12.006	0.140	19.994	0.024	1.681	0.480	1.201	28.548
12.006	0.184	19.990	0.050	2.209	1.000	1.210	45.246
12.006	0.226	19.987	0.074	2.713	1.479	1.234	54.508
12.006	0.268	19.984	0.098	3.218	1.958	1.259	60.867
12.006	0.520	19.965	0.248	6.243	4.951	1.292	79.310
12.005	0.946	19.934	0.498	11.357	9.927	1.430	87.412
12.006	1.376	19.903	0.748	16.520	14.887	1.633	90.116
12.006	1.798	19.872	0.998	21.587	19.832	1.756	91.868
12.006	2.224	19.840	1.248	26.701	24.761	1.940	92.733
12.006	2.650	19.809	1.498	31.816	29.674	2.142	93.268
12.006	3.078	19.779	1.748	36.955	34.573	2.381	93.556
12.006	3.560	19.744	2.026	42.741	40.001	2.740	93.589
12.006	3.990	19.713	2.276	47.904	44.867	3.037	93.661
12.006	4.424	19.682	2.526	53.115	49.718	3.397	93.604
12.006	4.856	19.652	2.776	58.300	54.553	3.748	93.572
12.006	5.292	19.620	3.026	63.535	59.370	4.165	93.444
12.006	5.730	19.588	3.276	68.794	64.169	4.625	93.278

24.013	0.088	19.970	0.000	2.113	0.000	2.113	0.000
24.013	0.110	19.967	0.024	2.641	0.479	2.162	18.141
24.013	0.130	19.964	0.048	3.122	0.958	2.163	30.697
24.012	0.144	19.962	0.074	3.458	1.477	1.981	42.720
24.013	0.172	19.959	0.098	4.130	1.956	2.174	47.356
24.013	0.296	19.941	0.248	7.108	4.945	2.163	69.575
24.013	0.504	19.911	0.498	12.103	9.916	2.187	81.932
24.013	0.712	19.881	0.748	17.097	14.871	2.227	86.977
24.013	0.922	19.850	0.998	22.140	19.811	2.330	89.478
24.013	1.130	19.821	1.248	27.135	24.736	2.399	91.160
24.014	1.326	19.781	1.496	31.842	29.593	2.249	92.936
24.014	1.538	19.751	1.748	36.933	34.524	2.409	93.479
24.014	1.774	19.718	2.026	42.600	39.950	2.651	93.778
24.014	1.984	19.688	2.276	47.643	44.810	2.833	94.054
24.013	2.194	19.659	2.526	52.686	49.659	3.026	94.256
24.013	2.390	19.629	2.776	57.392	54.490	2.902	94.944
24.013	2.618	19.598	3.026	62.867	59.304	3.563	94.332
24.013	2.830	19.566	3.274	67.958	64.060	3.898	94.264
36.010	0.078	19.979	0.000	2.809	0.000	2.809	0.000
36.010	0.084	19.976	0.024	3.025	0.479	2.545	15.850
36.010	0.106	19.973	0.048	3.817	0.959	2.858	25.116
36.010	0.120	19.970	0.072	4.321	1.438	2.883	33.274
36.010	0.134	19.967	0.098	4.825	1.957	2.869	40.552
36.009	0.216	19.949	0.248	7.778	4.947	2.831	63.606
36.008	0.354	19.917	0.498	12.747	9.919	2.828	77.814
36.010	0.494	19.887	0.746	17.789	14.836	2.953	83.399
36.010	0.632	19.856	0.998	22.758	19.816	2.942	87.072
36.010	0.772	19.825	1.248	27.800	24.741	3.059	88.997
36.010	0.914	19.793	1.498	32.913	29.650	3.263	90.086
36.010	1.056	19.762	1.746	38.026	34.505	3.522	90.739
36.010	1.216	19.727	2.026	43.788	39.967	3.822	91.273
36.010	1.358	19.695	2.274	48.902	44.786	4.116	91.584
36.010	1.498	19.665	2.526	53.943	49.674	4.269	92.086
36.010	1.640	19.634	2.776	59.056	54.504	4.552	92.292
36.010	1.780	19.603	3.024	64.098	59.279	4.819	92.482
36.010	1.922	19.571	3.274	69.211	64.075	5.136	92.579

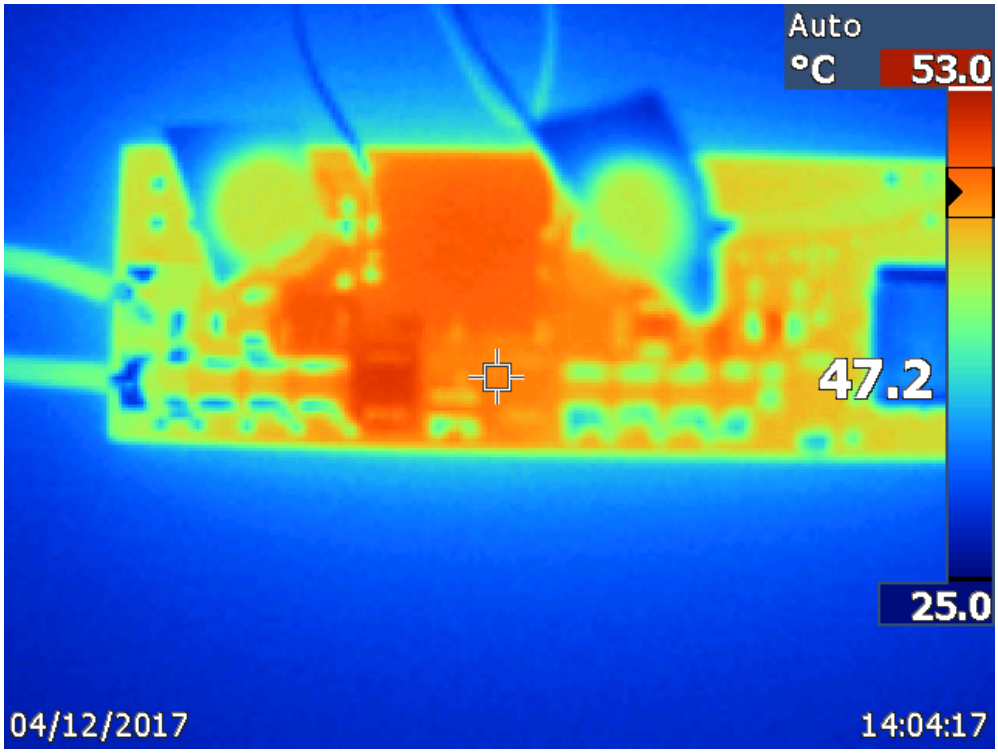
5 Thermal



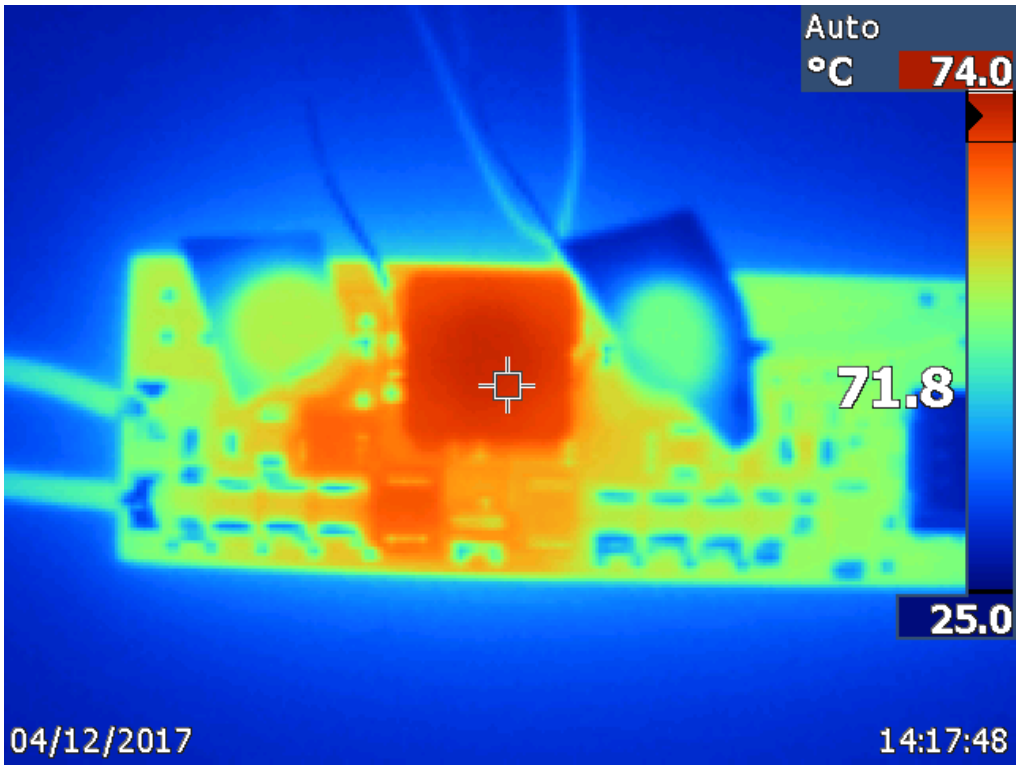
Thermal equilibrium was taken at 12Vin, 5Vout full load. No air flow.



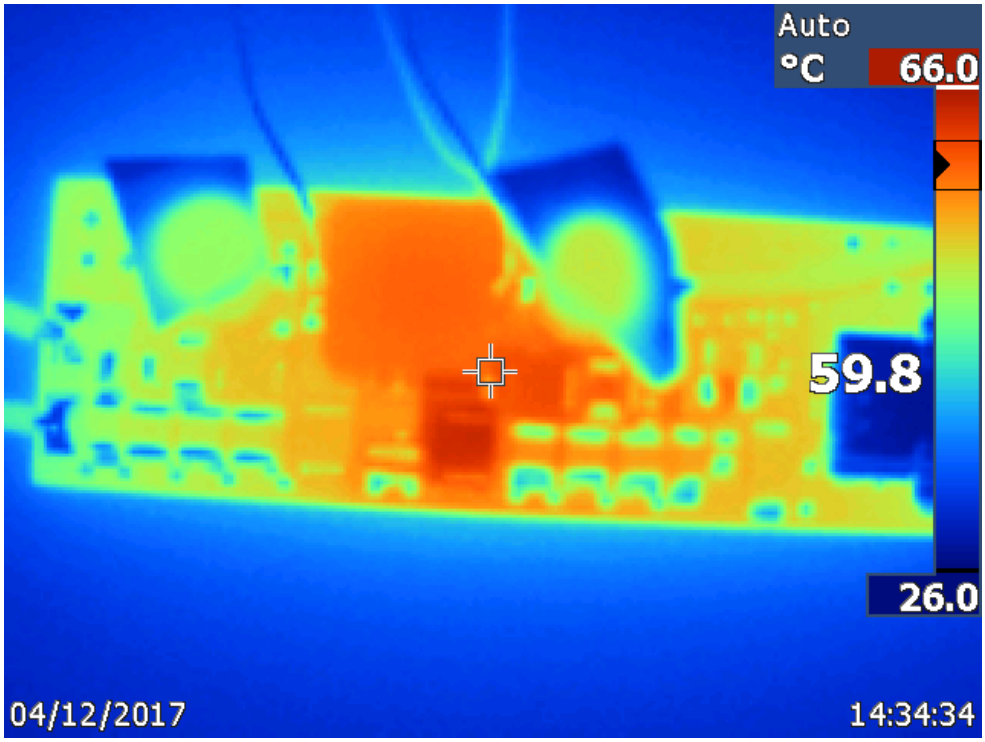
Thermal equilibrium was taken at 24Vin, 5Vout full load. No air flow.



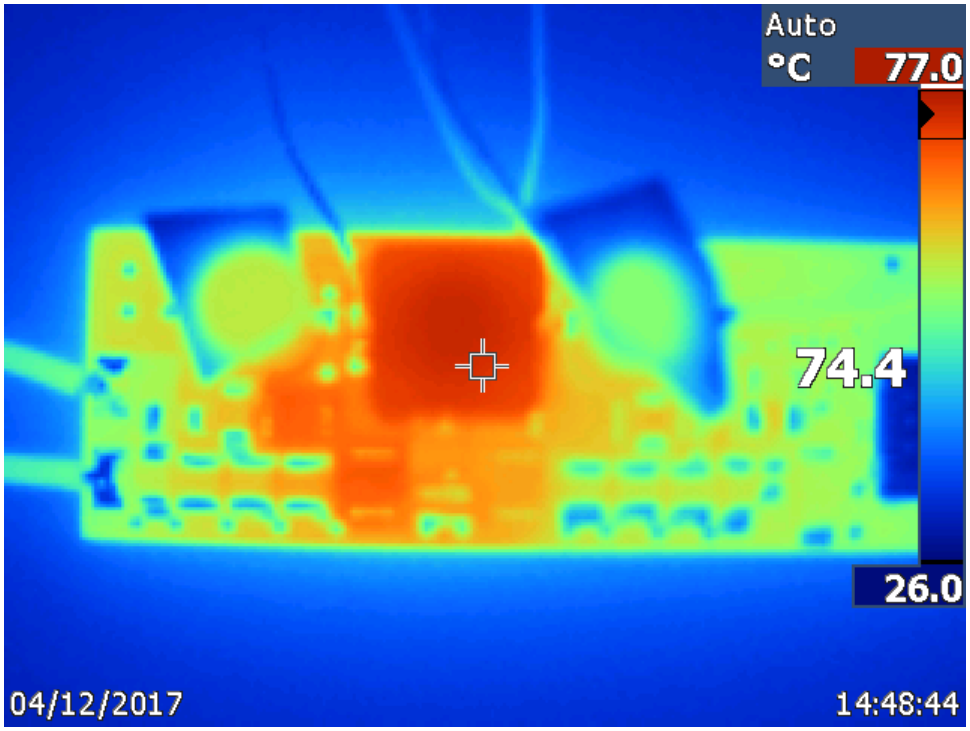
Thermal equilibrium was taken at 12Vin, 9Vout full load. No air flow.



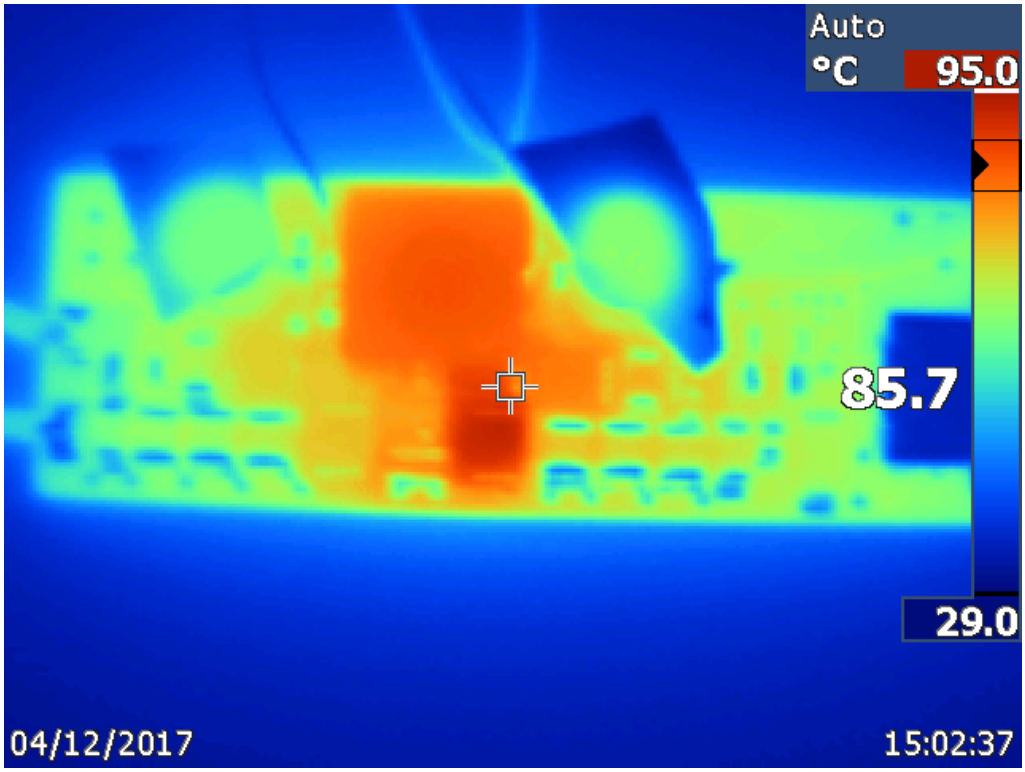
Thermal equilibrium was taken at 24Vin, 9Vout full load. No air flow.



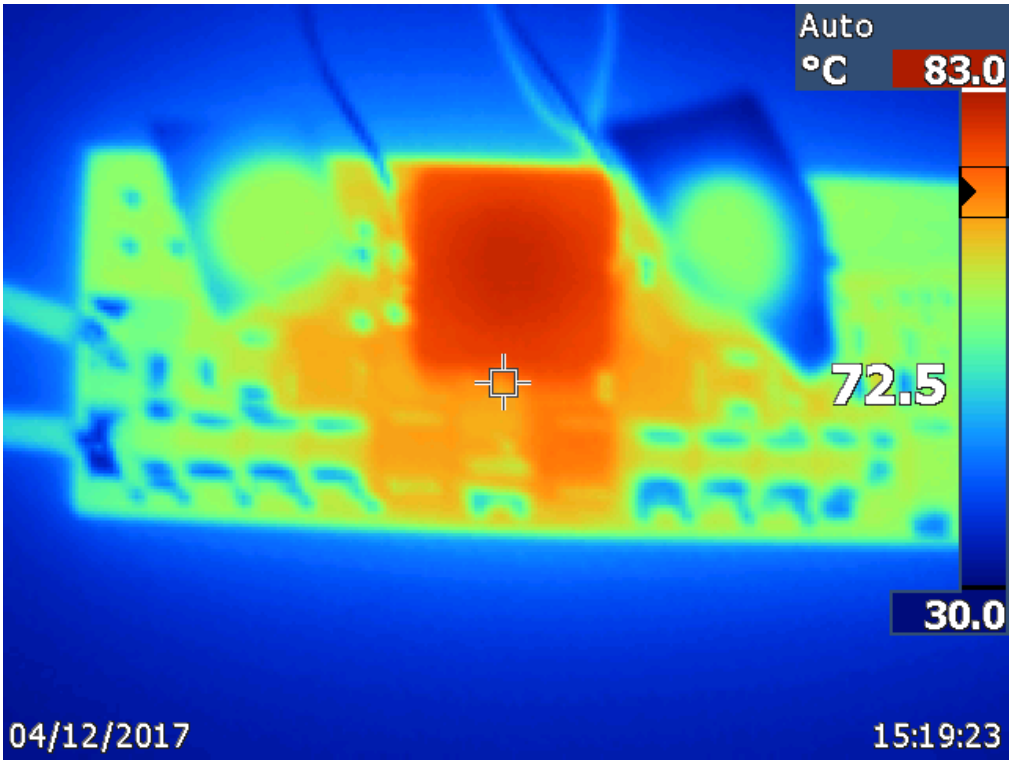
Thermal equilibrium was taken at 12Vin, 15Vout full load. No air flow.



Thermal equilibrium was taken at 24Vin, 15Vout full load. No air flow.



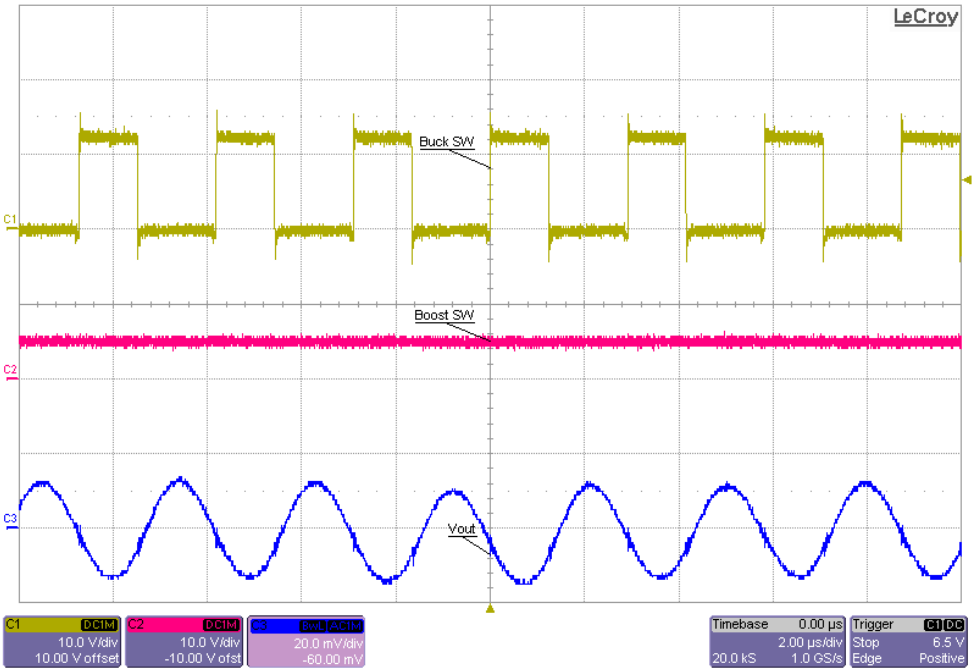
Thermal equilibrium was taken at 12Vin, 20Vout full load. No air flow.



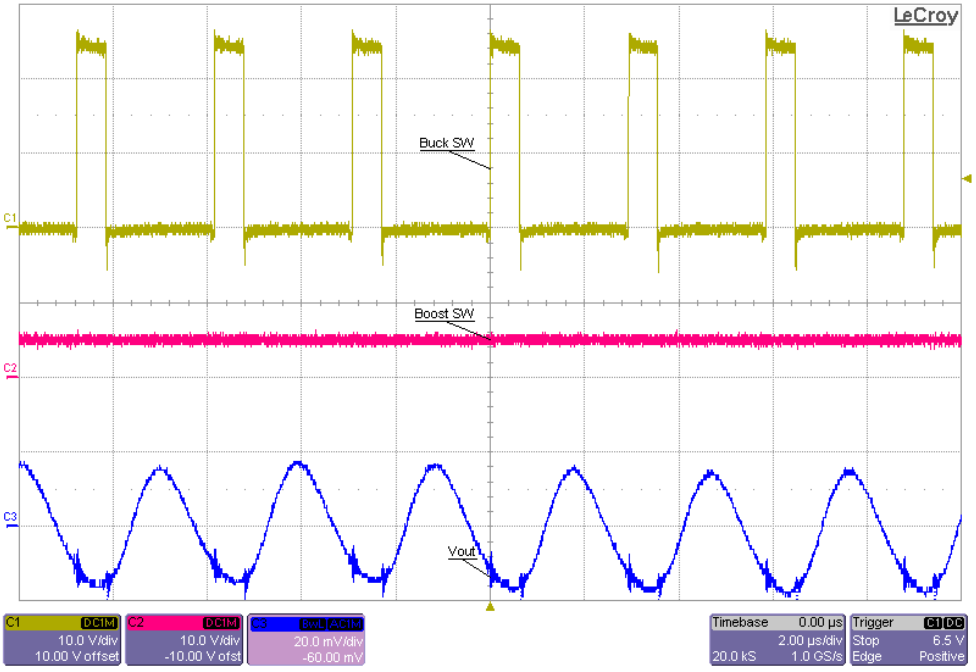
Thermal equilibrium was taken at 24Vin, 20Vout full load. No air flow.

6 Waveform

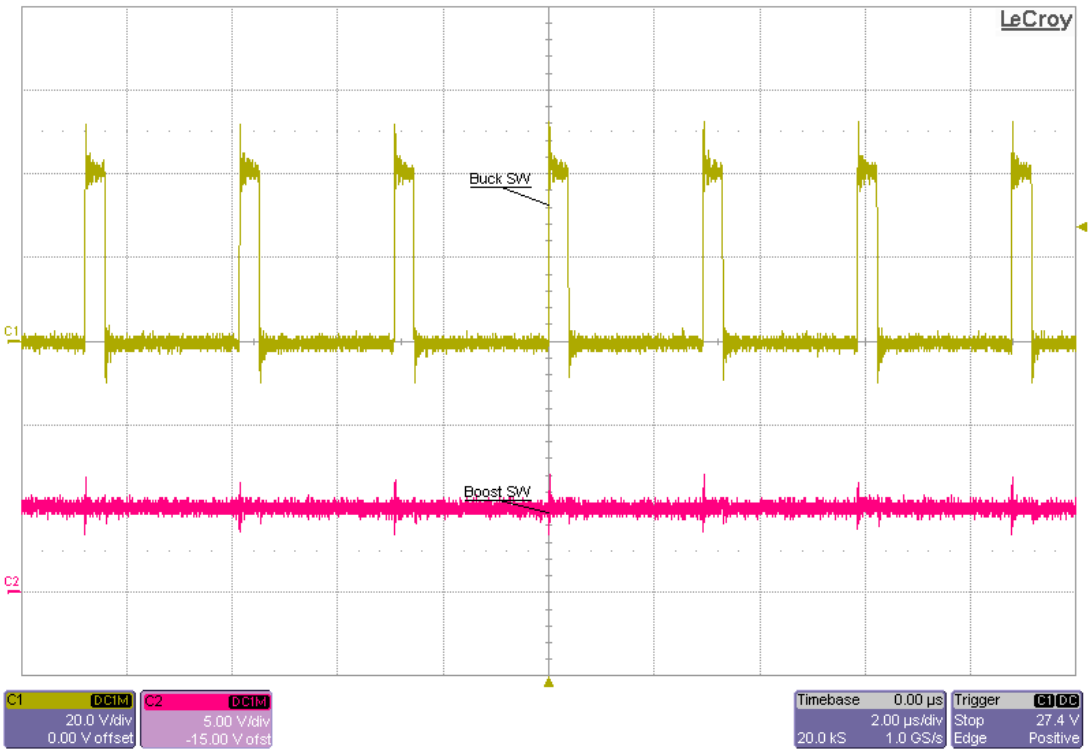
6.1 Switching and Output Ripple Waveform



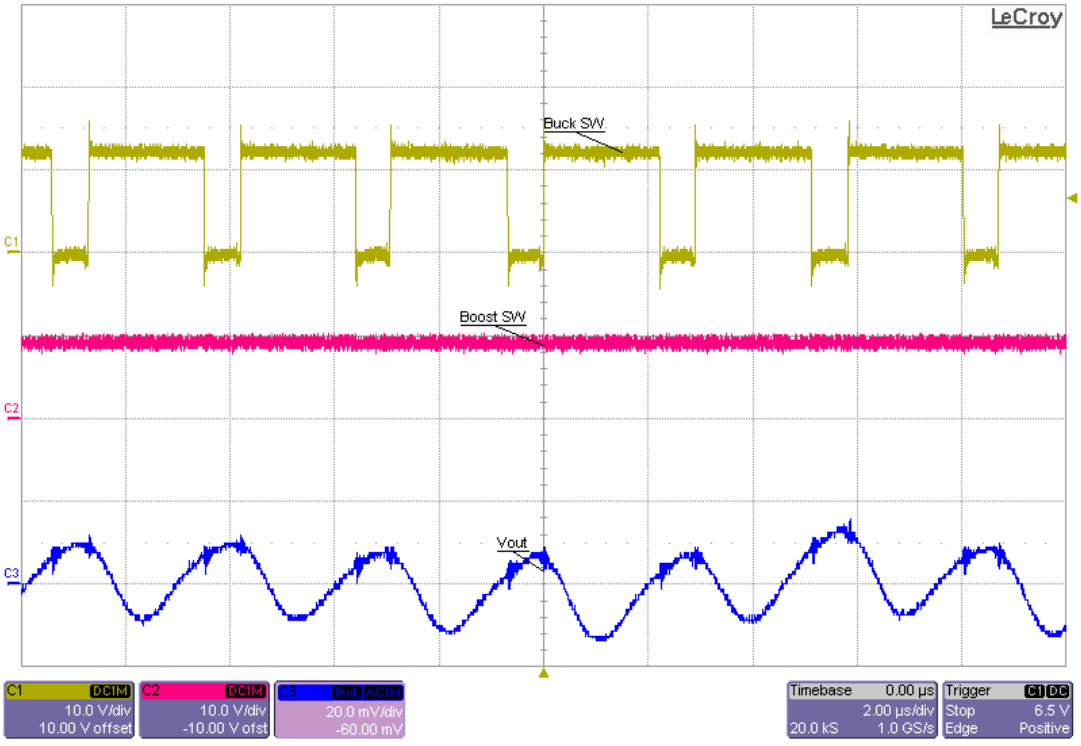
12Vin, 5Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.



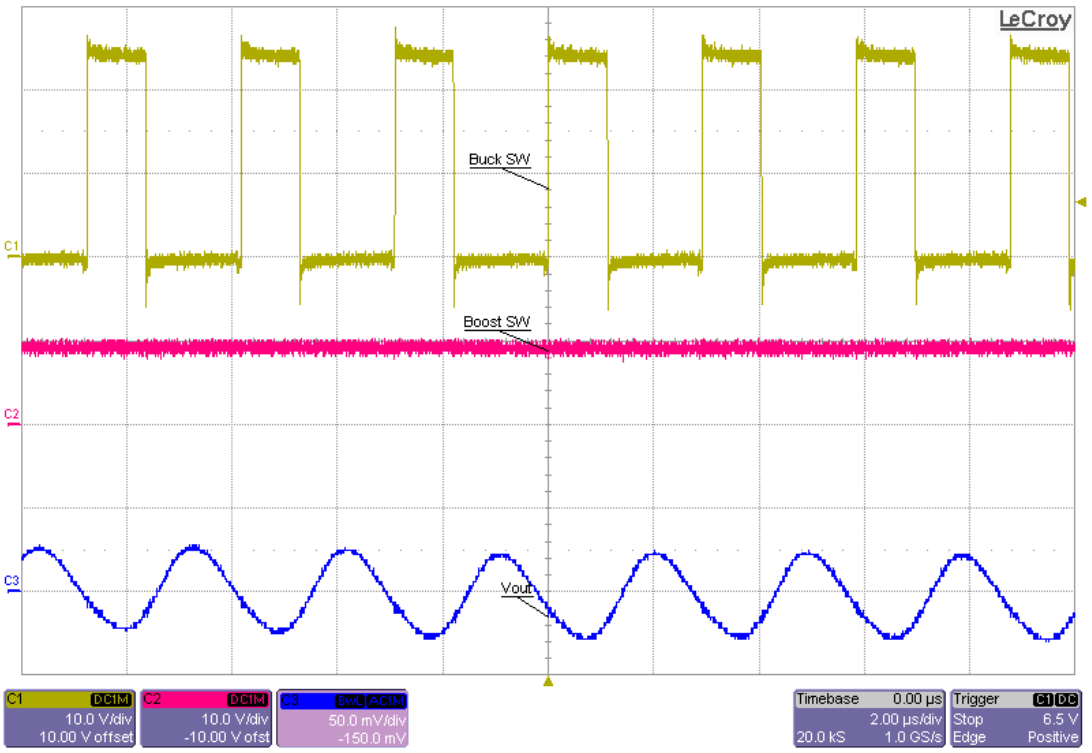
24Vin, 5Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.



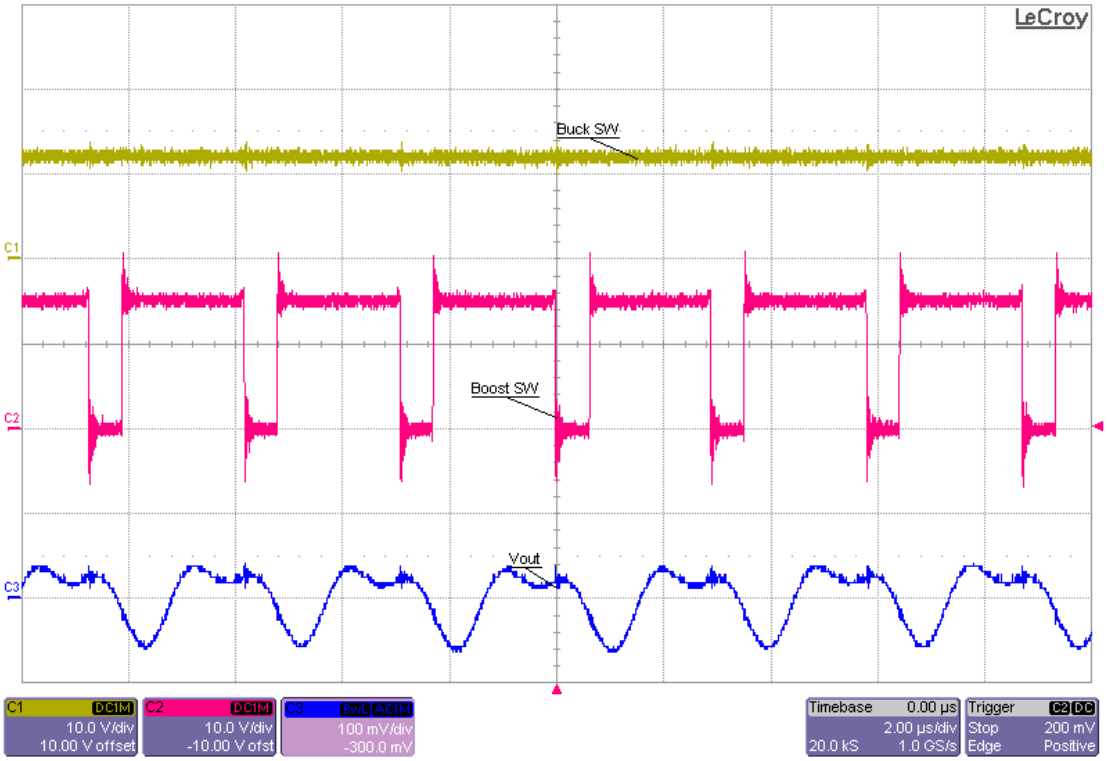
40Vin, 5Vout full load. Ch1 buck switch, Ch2 boost switch.



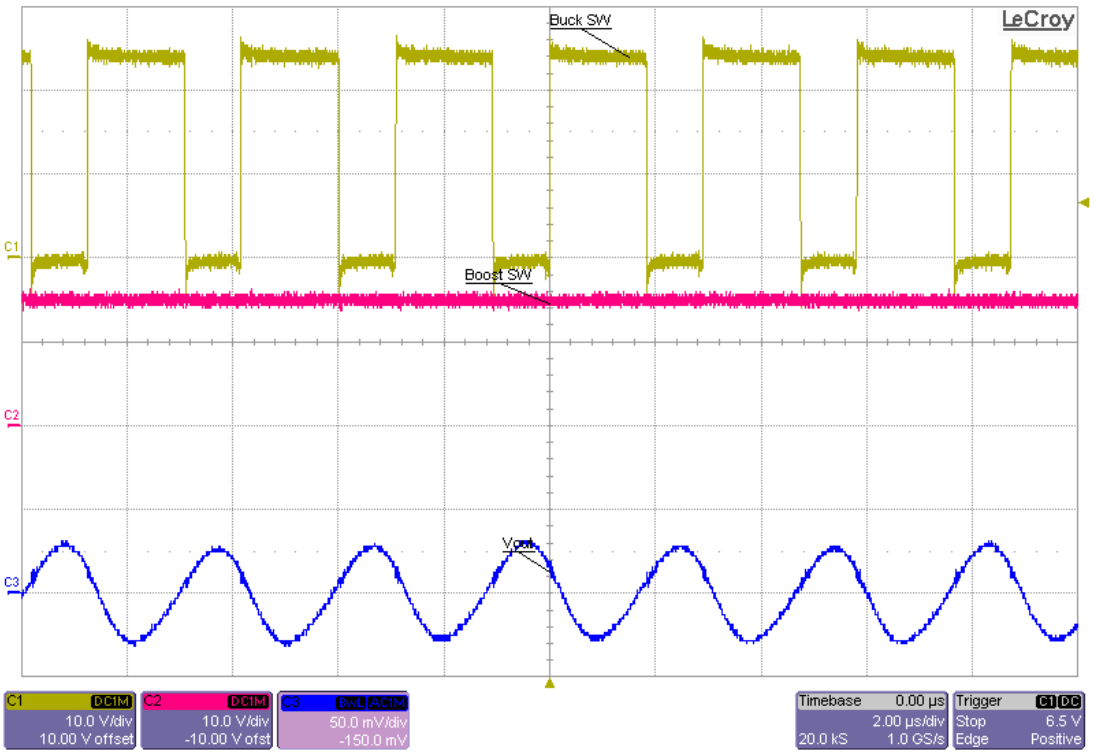
12Vin, 9Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.



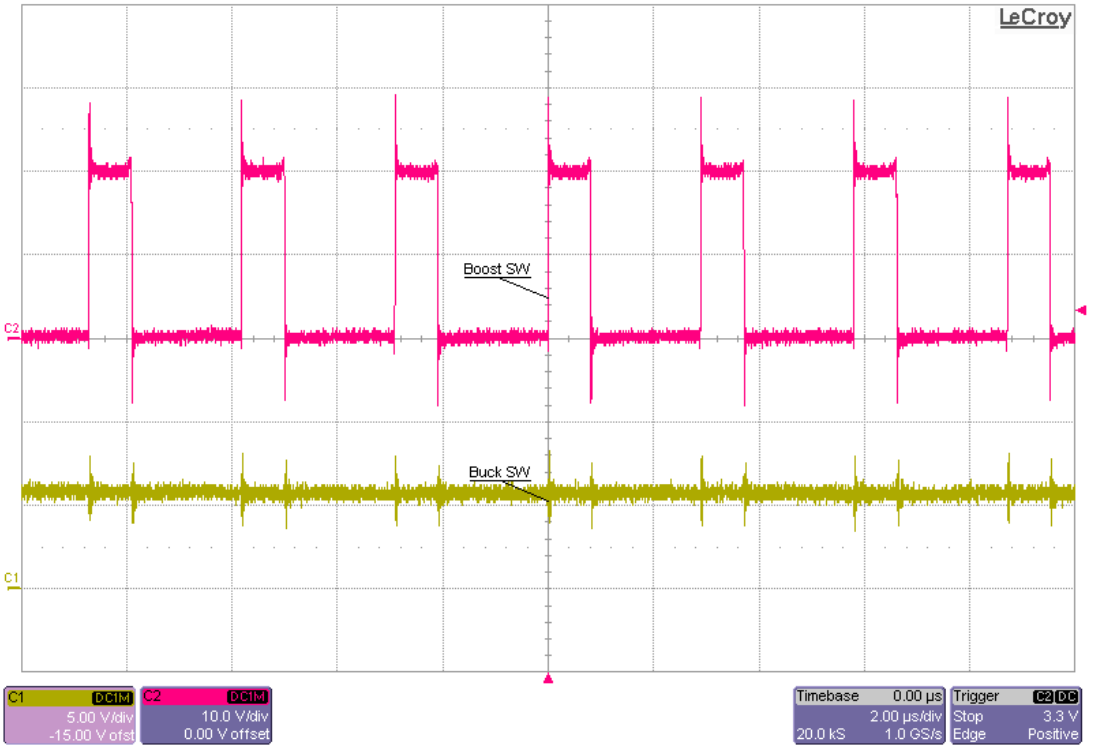
24Vin, 9Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.



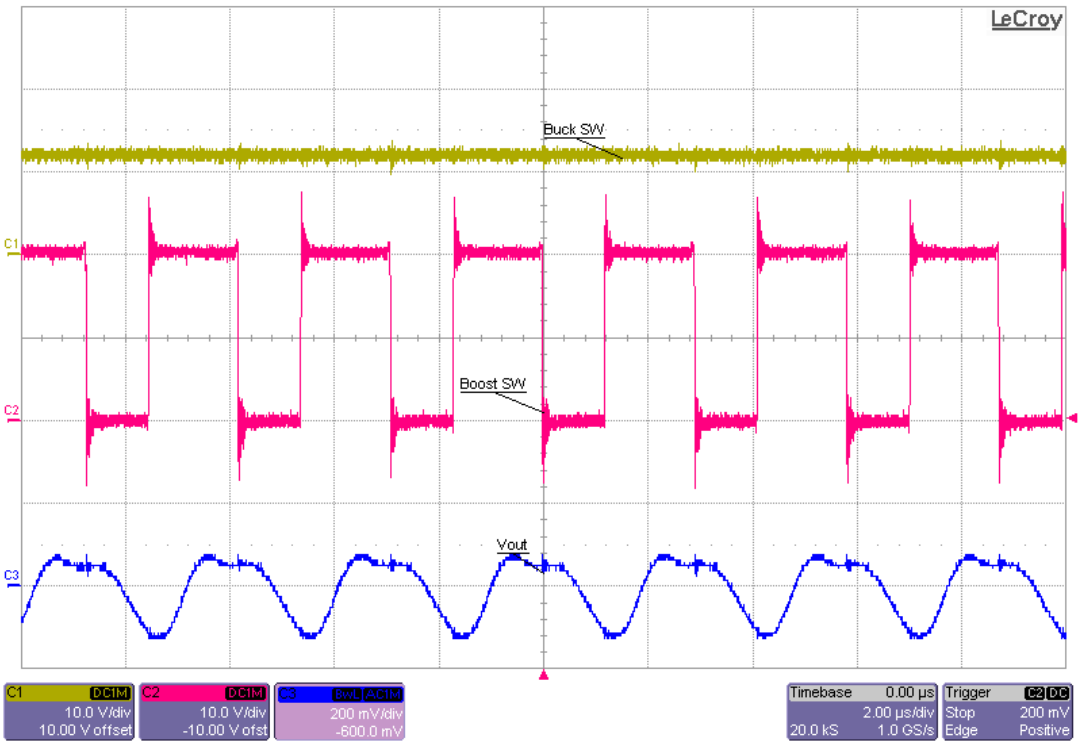
12Vin, 15Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.



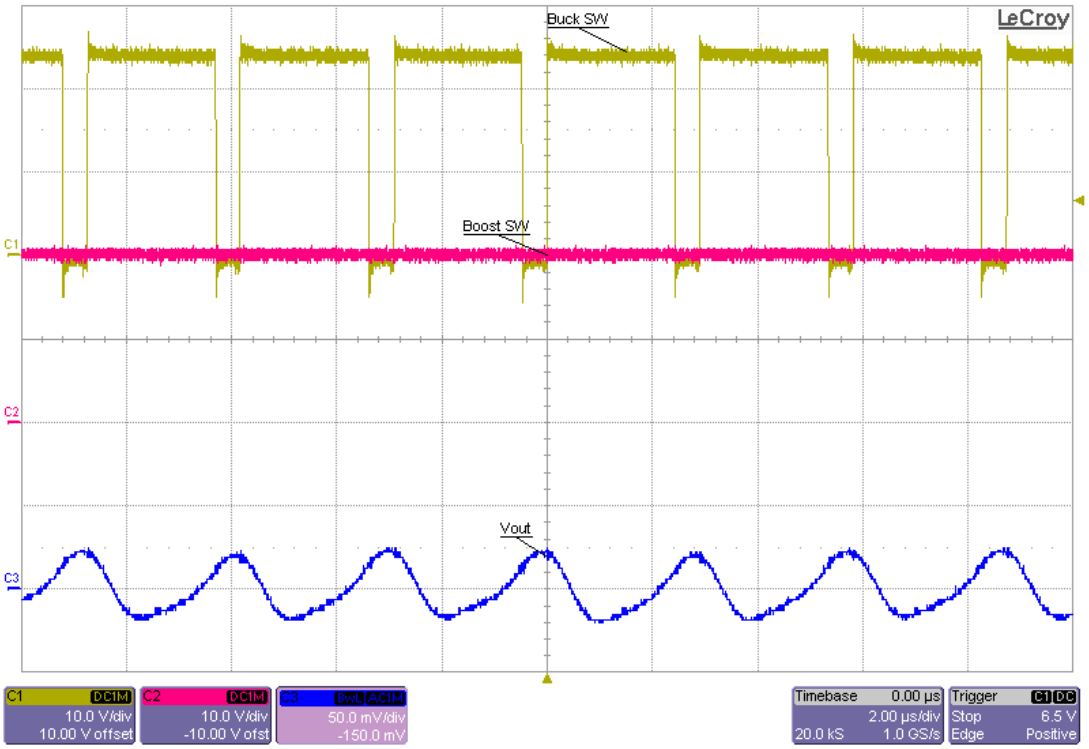
24Vin, 15Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.



6Vin, 20Vout full load. Ch1 buck switch, Ch2 boost switch.

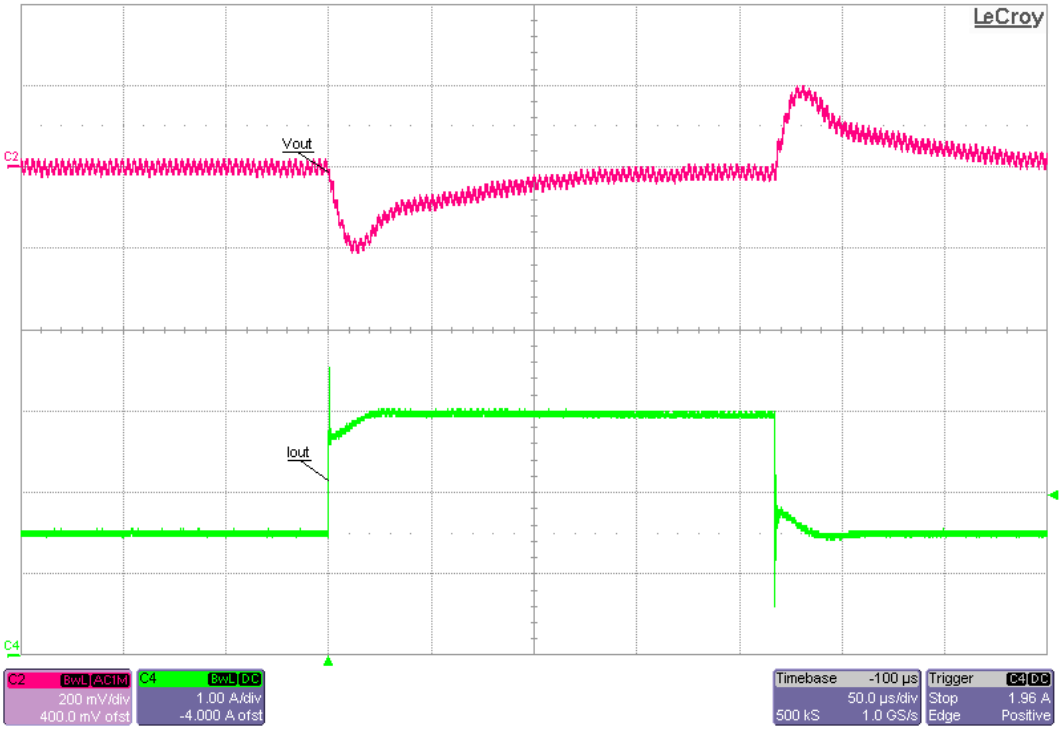


12Vin, 20Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.

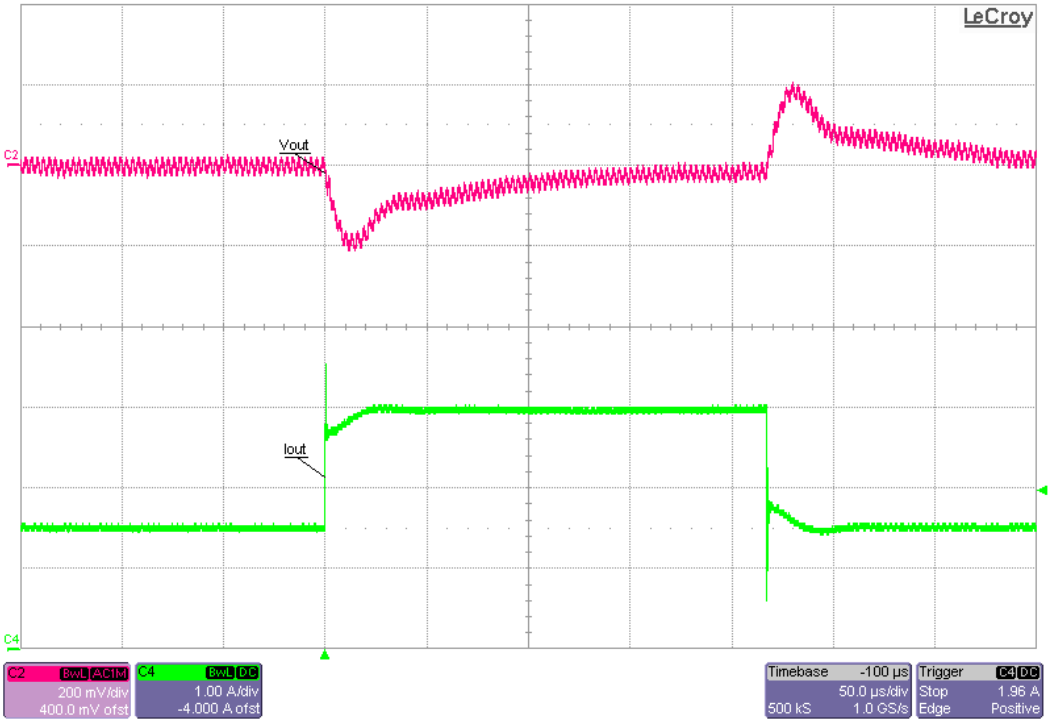


24Vin, 20Vout full load. Ch1 buck switch, Ch2 boost switch, Ch3 output ripple.

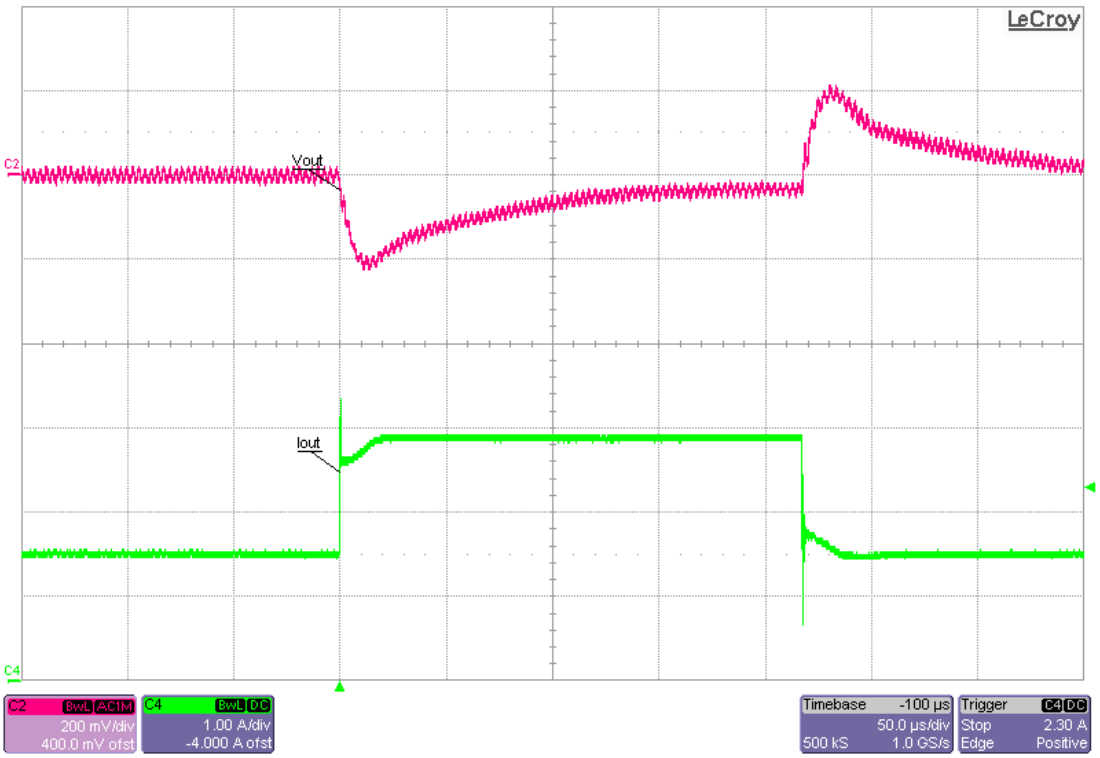
6.2 Load Transient



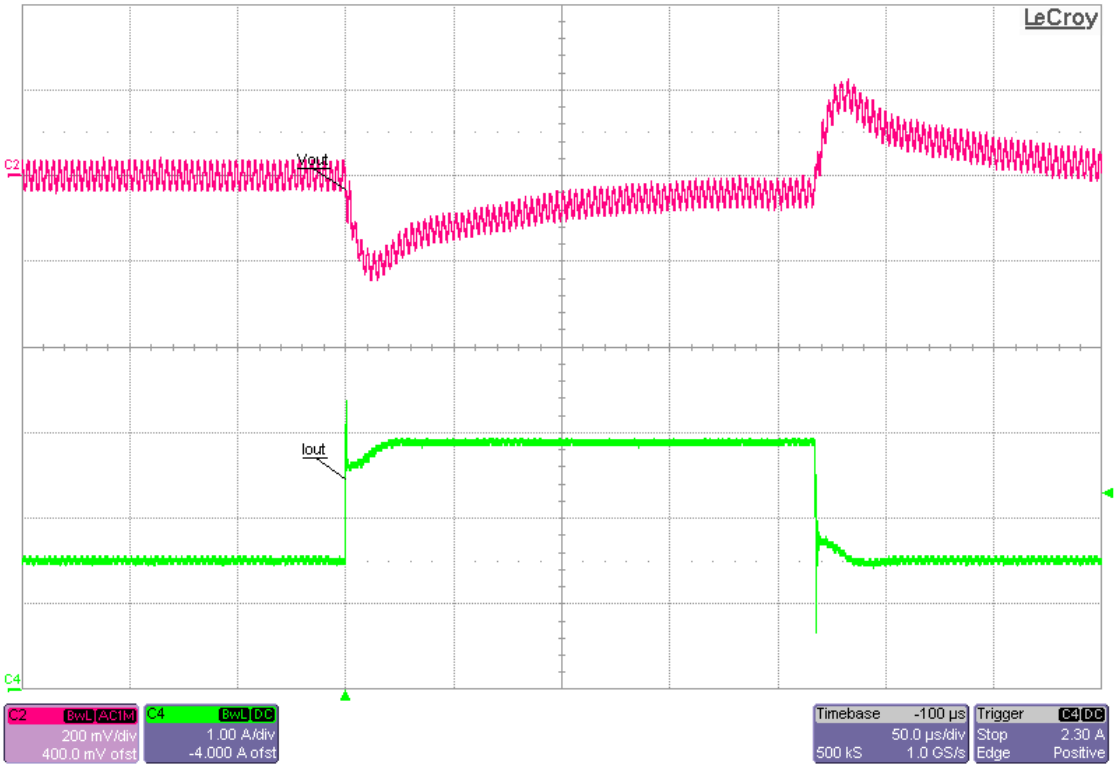
12Vin, 5Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.



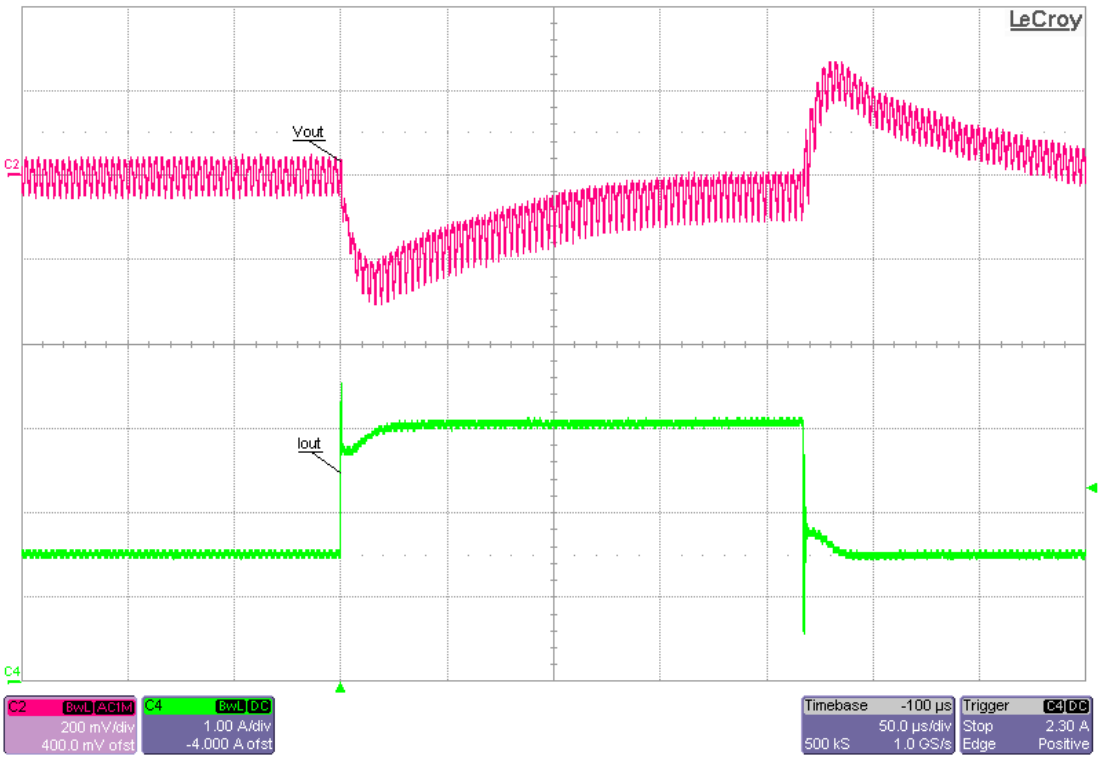
24Vin, 5Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.



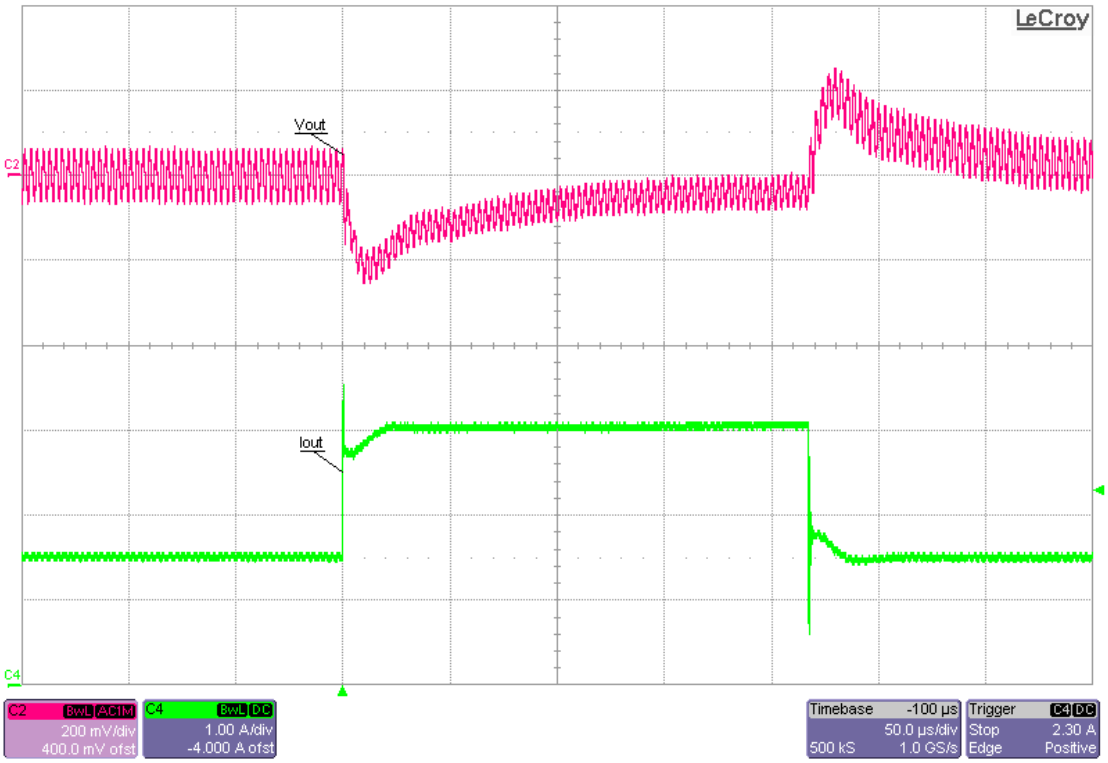
12Vin, 9Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.



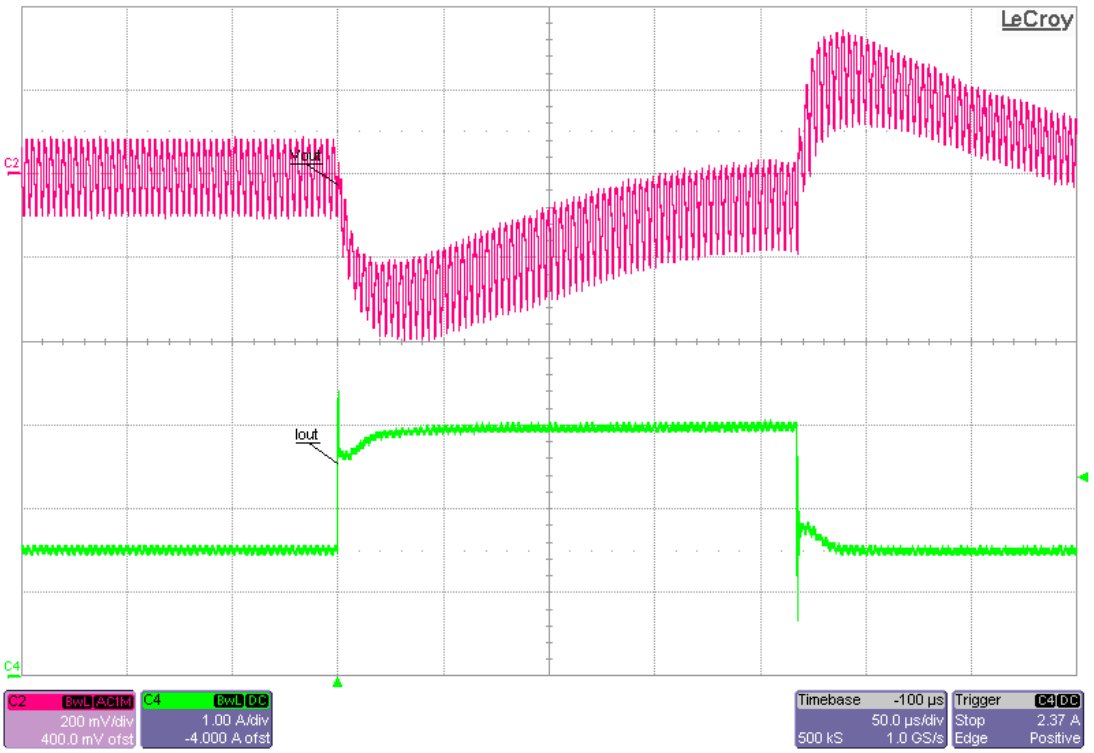
24Vin, 9Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.



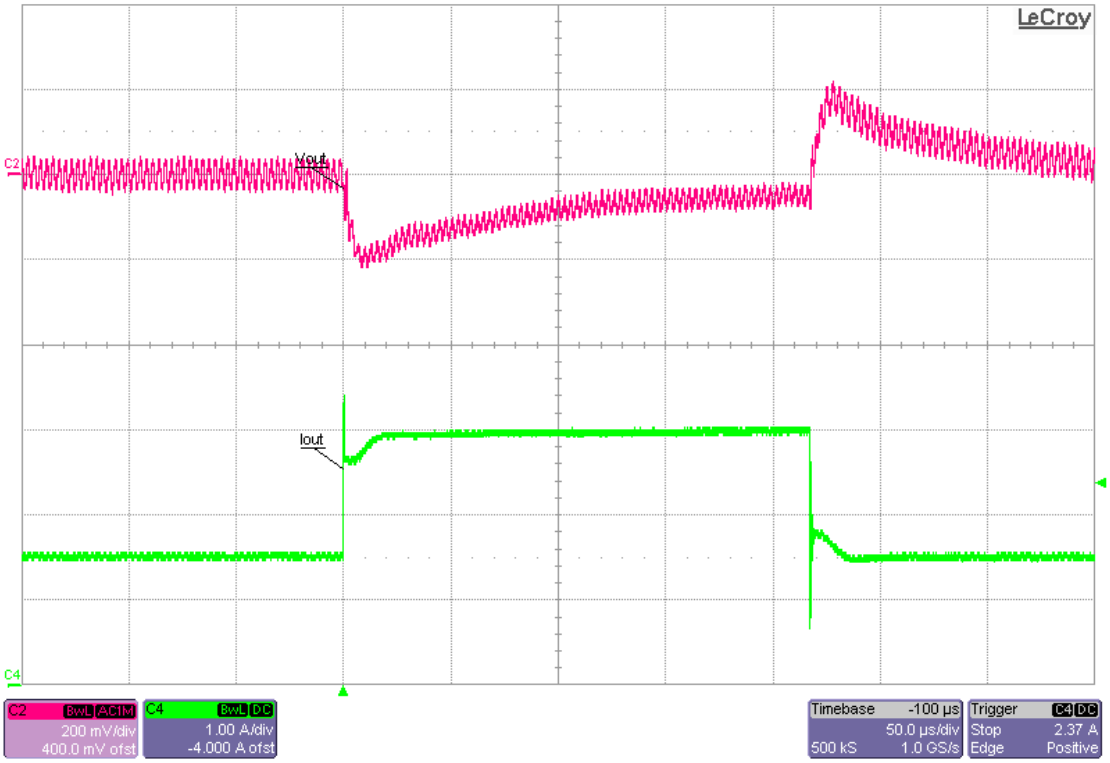
12Vin, 15Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.



24Vin, 15Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.

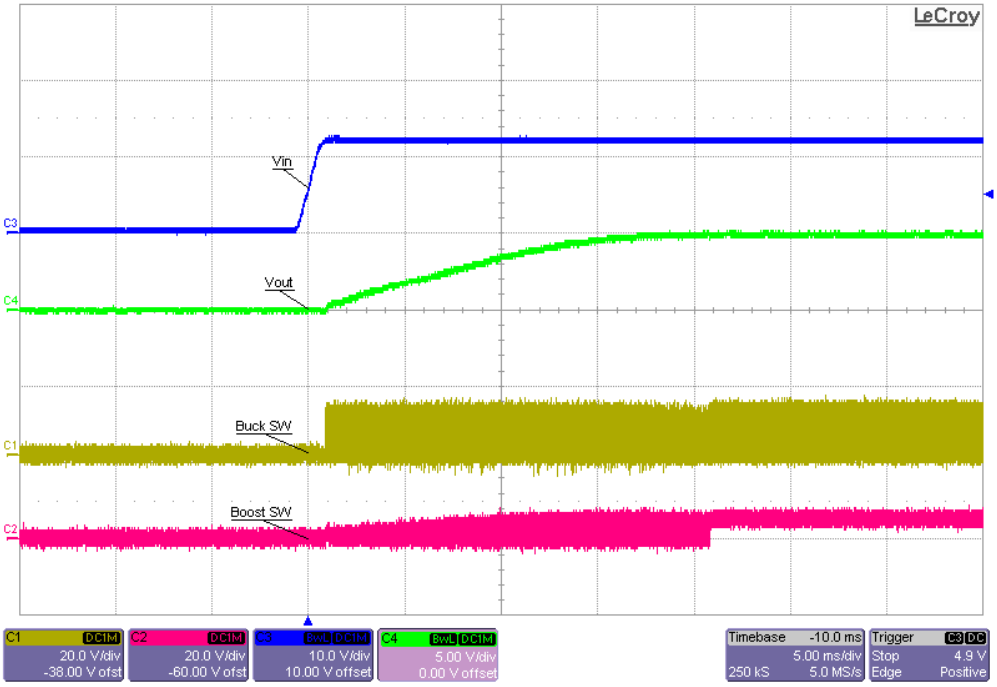


12Vin, 20Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.

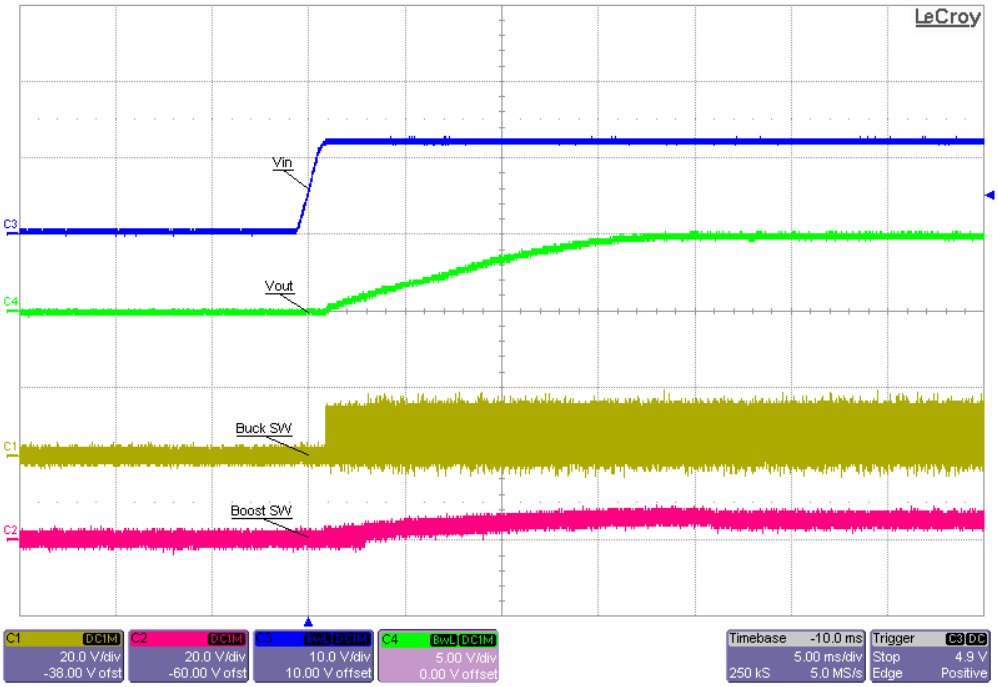


24Vin, 20Vout, 1.5A to 3A load step. Ch2 measures output voltage, Ch4 measures output current.

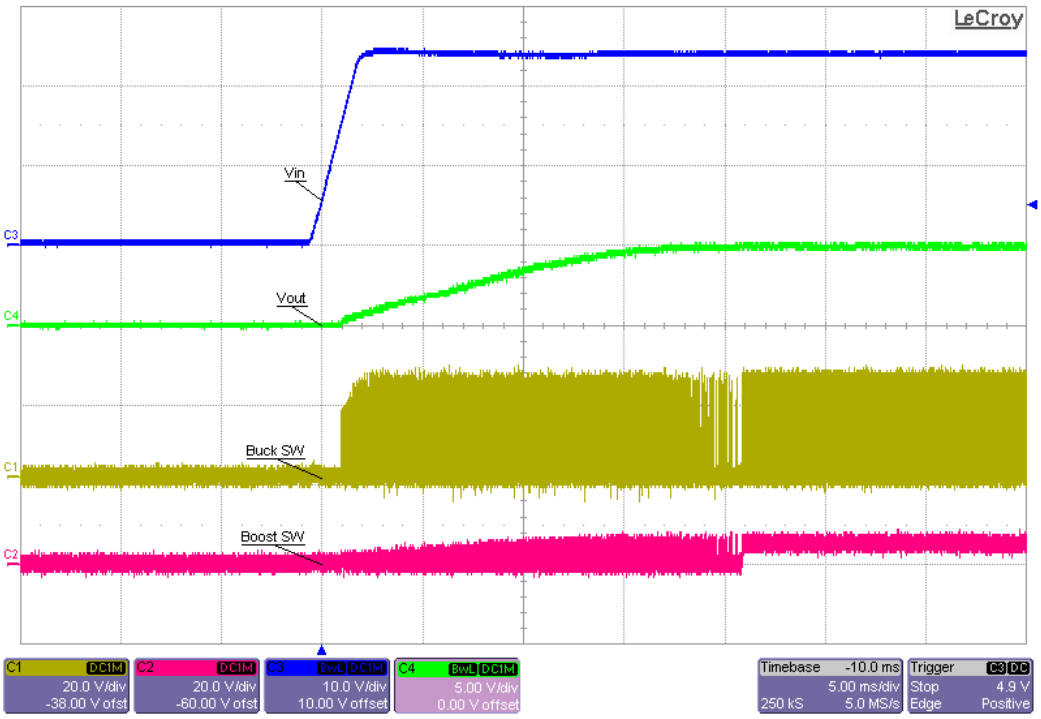
6.3 Start Up



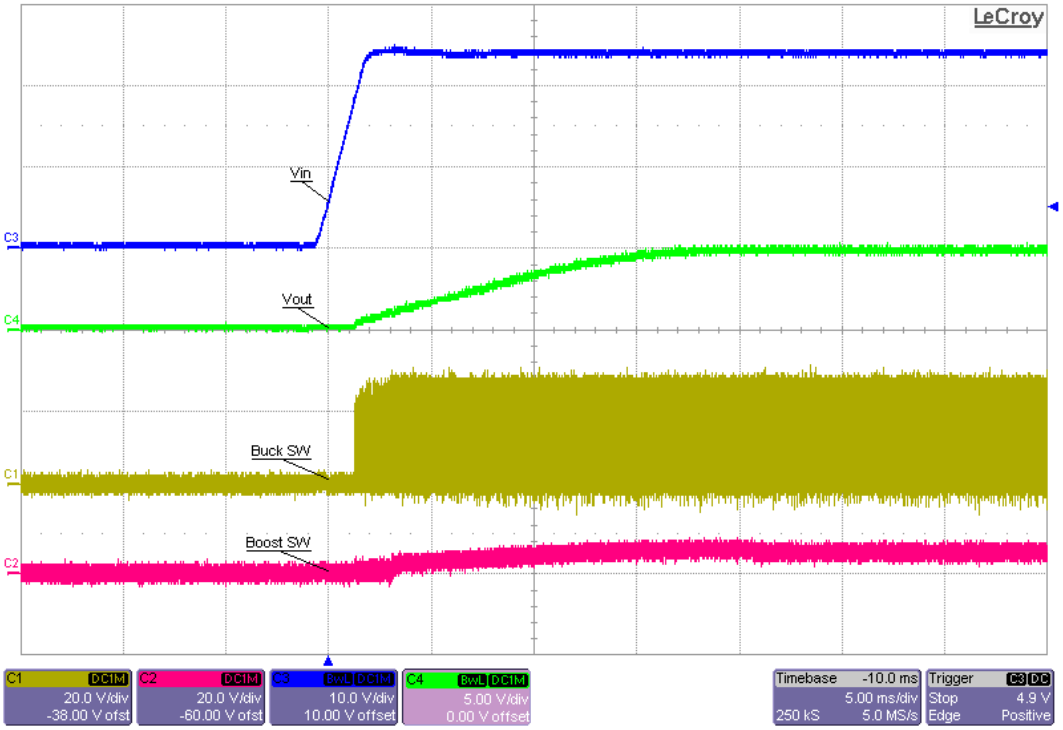
12Vin, 5Vout @0A. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures input voltage, and Ch4 measures output voltage.



12Vin, 5Vout @3A. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures input voltage, and Ch4 measures output voltage.

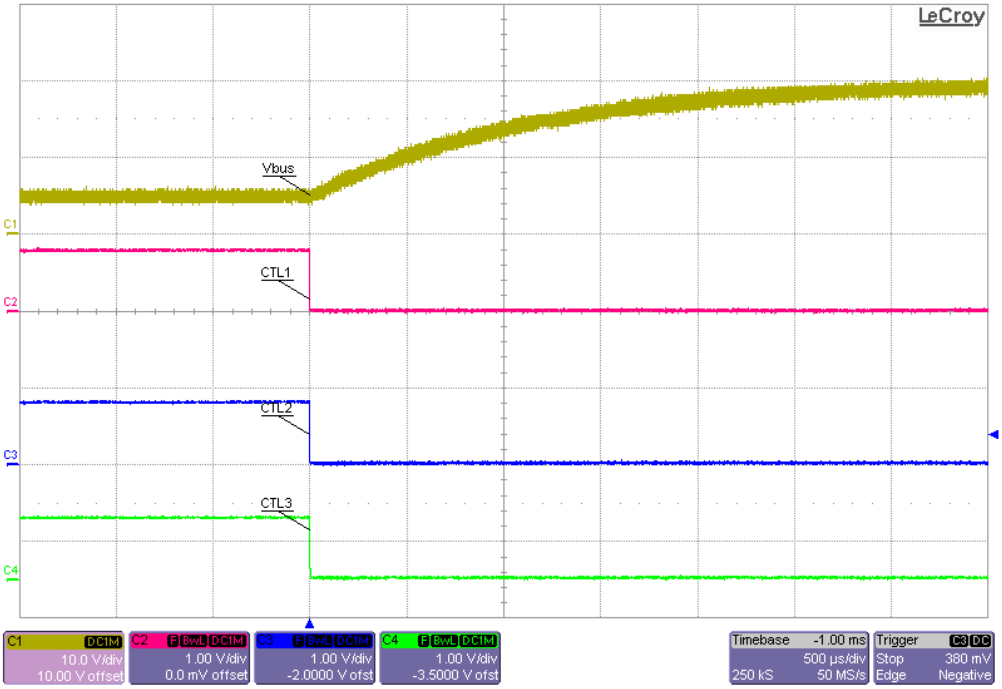


24Vin, 5Vout @0A. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures input voltage, and Ch4 measures output voltage.

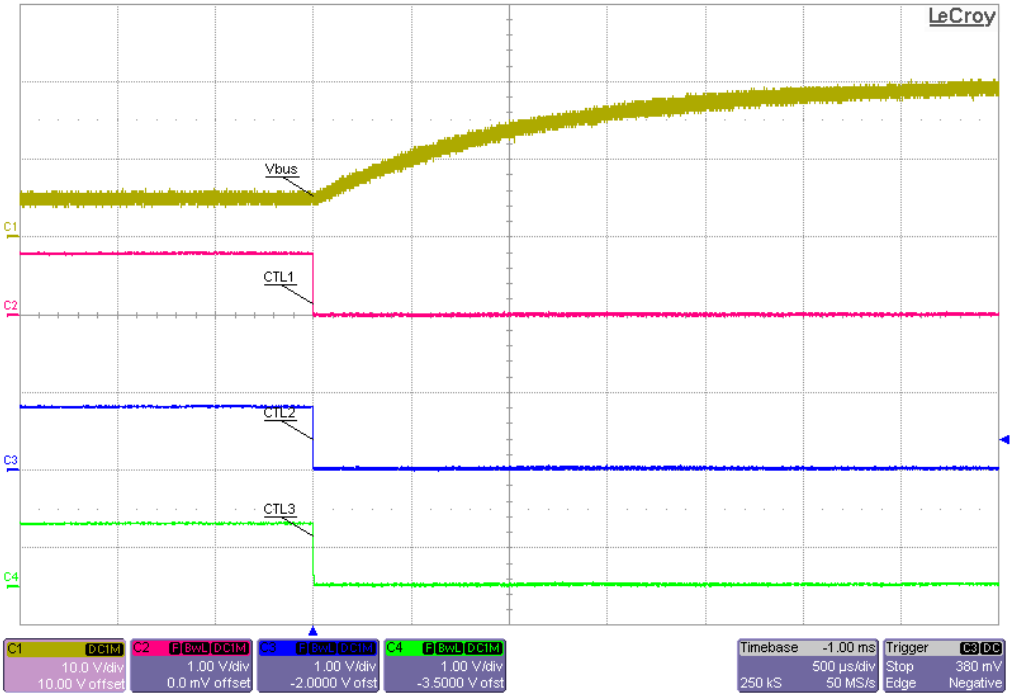


24Vin, 5Vout @3A. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures input voltage, and Ch4 measures output voltage.

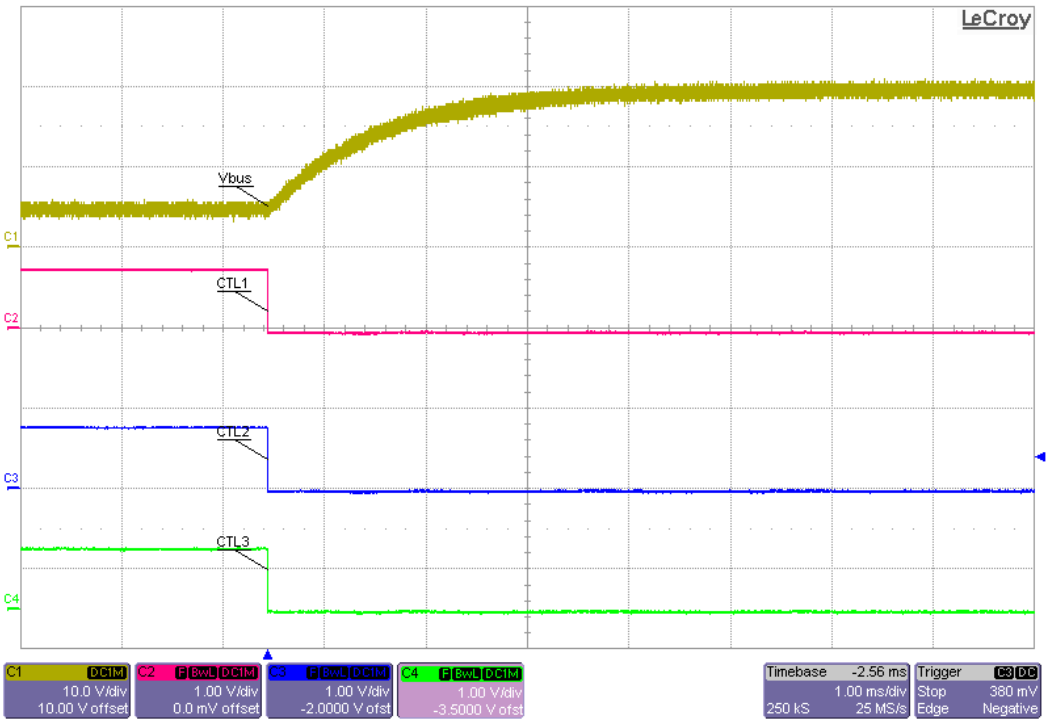
6.4 Voltage Transition



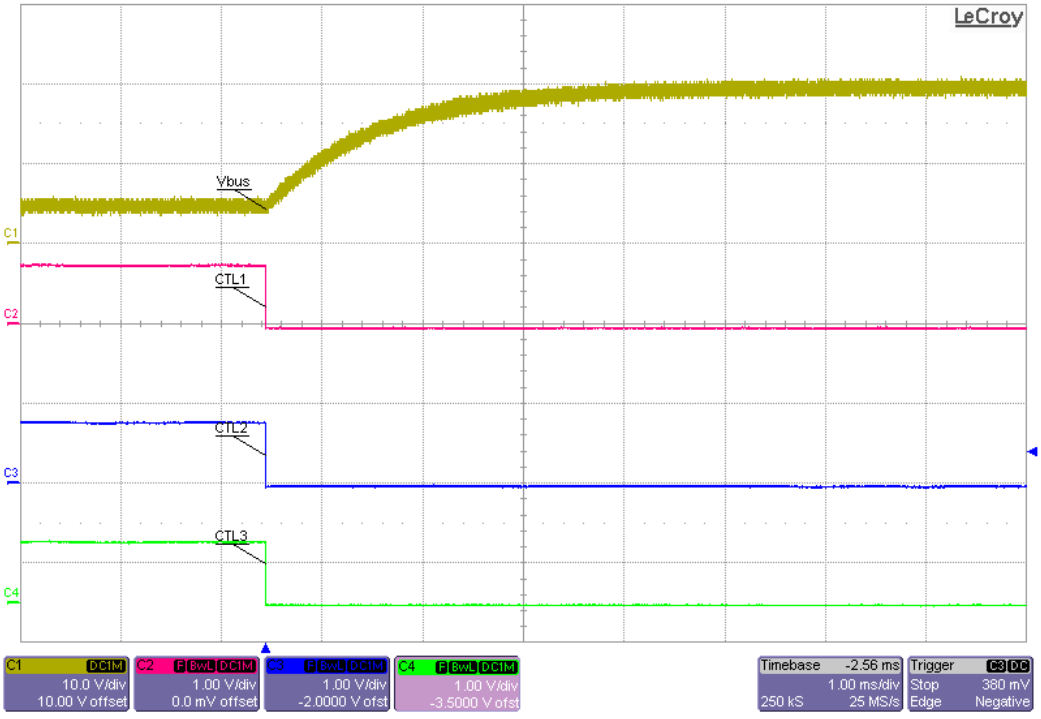
12Vin, 5Vout to 20V @0A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.



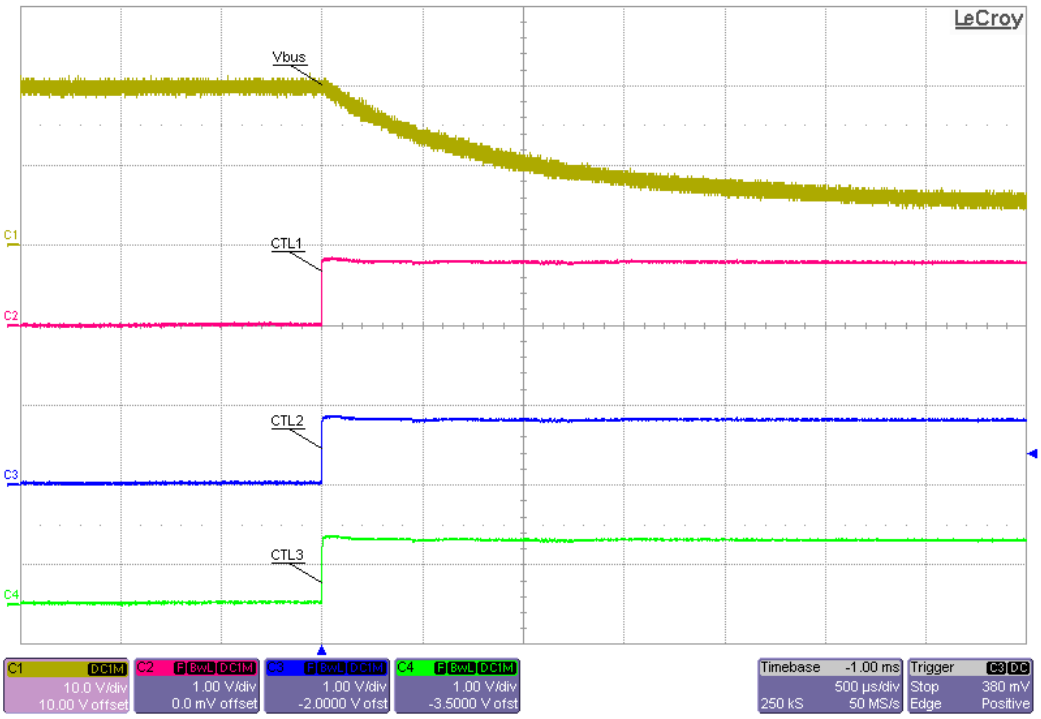
24Vin, 5Vout to 20V @0A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.



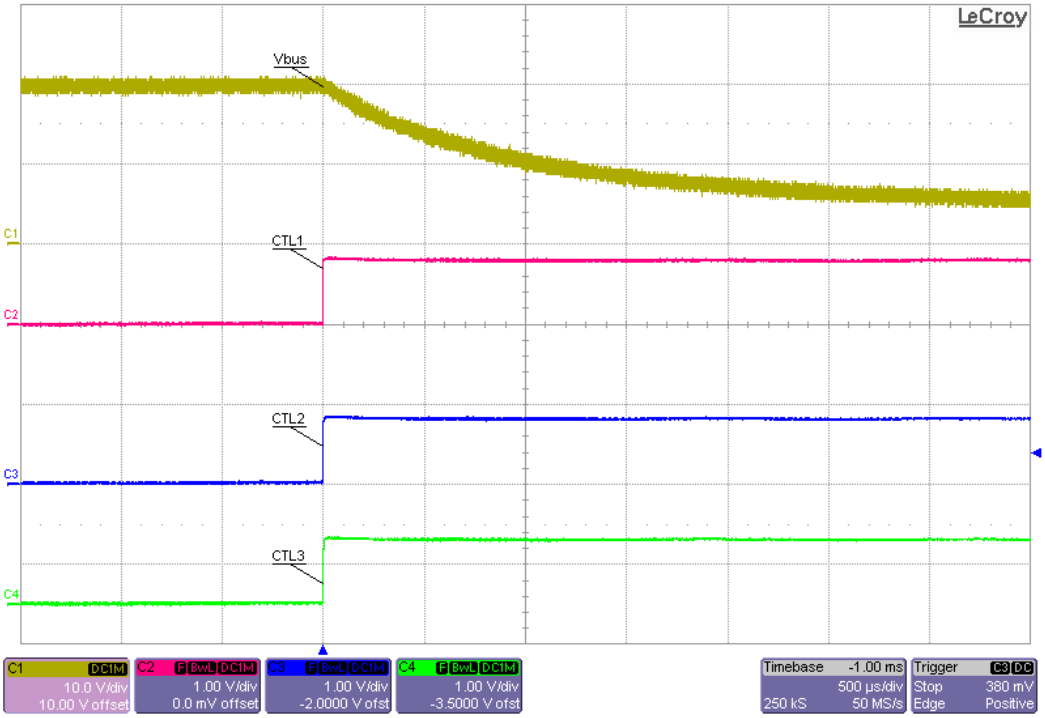
12Vin, 5Vout to 20V @3A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.



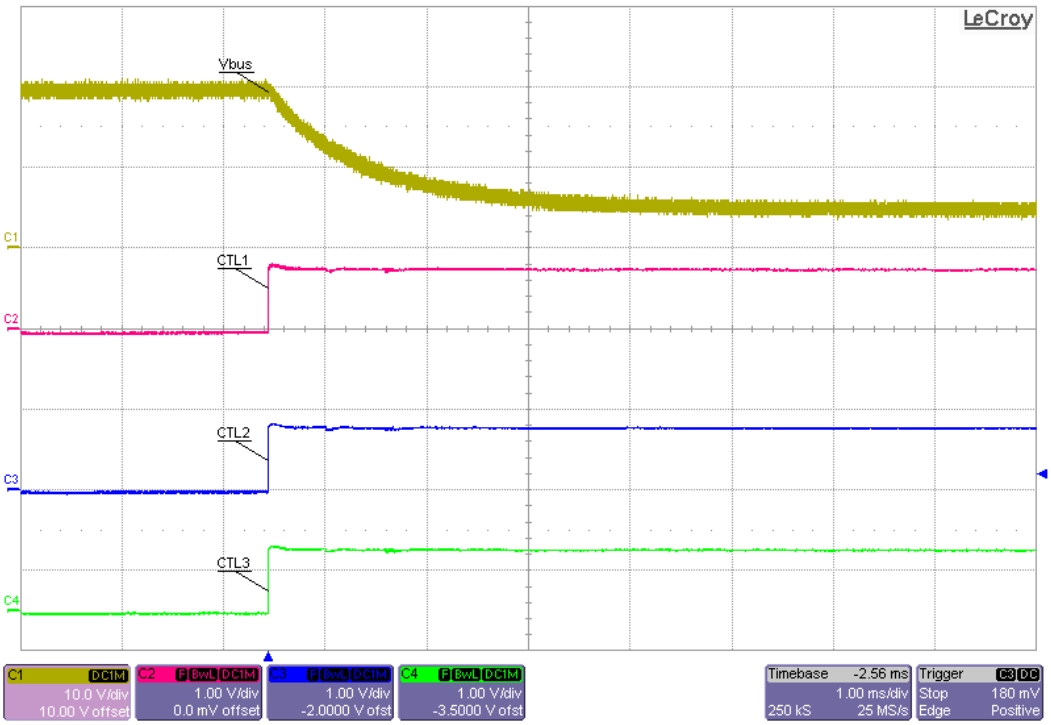
24Vin, 5Vout to 20V @3A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.



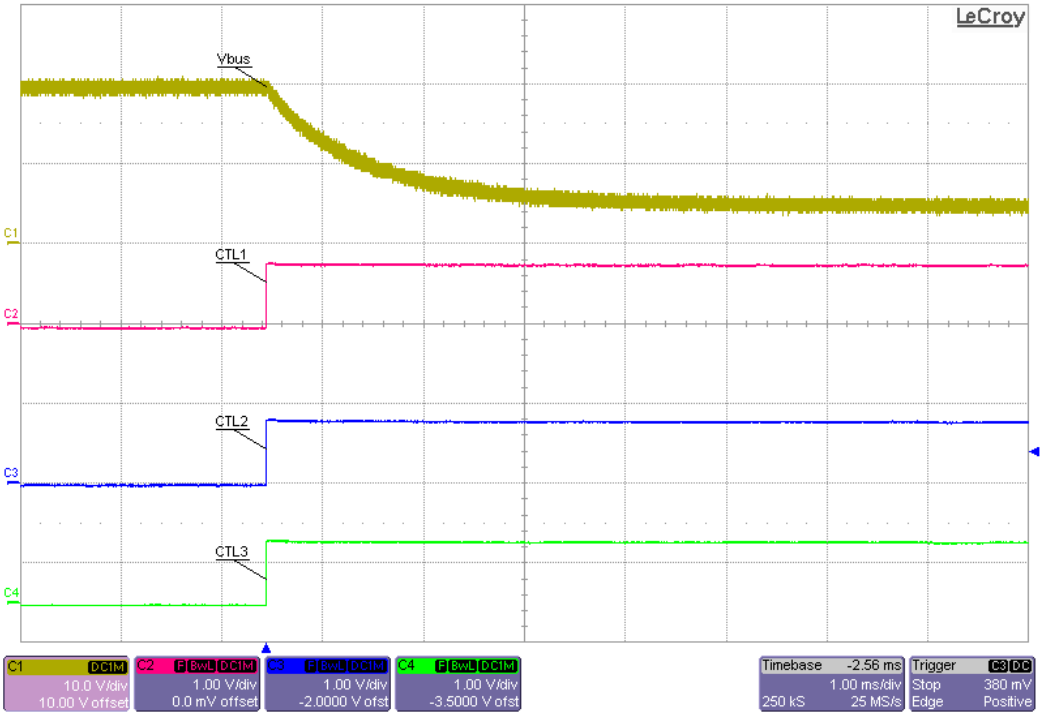
12Vin, 20Vout to 5V @0A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.



24Vin, 20Vout to 5V @0A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.

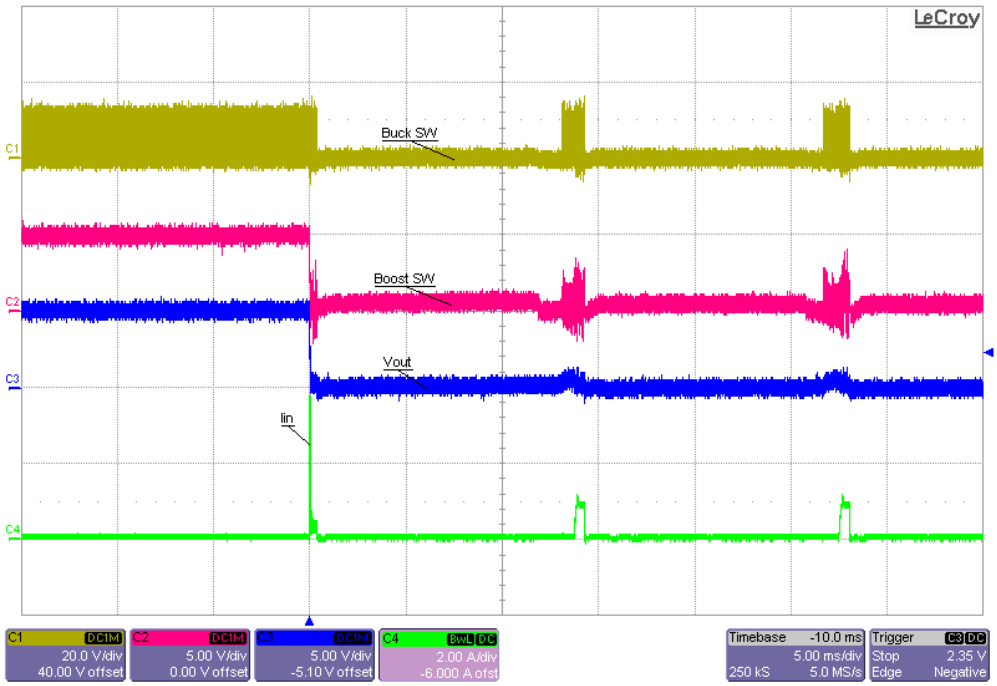


12Vin, 20Vout to 5V @3A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.

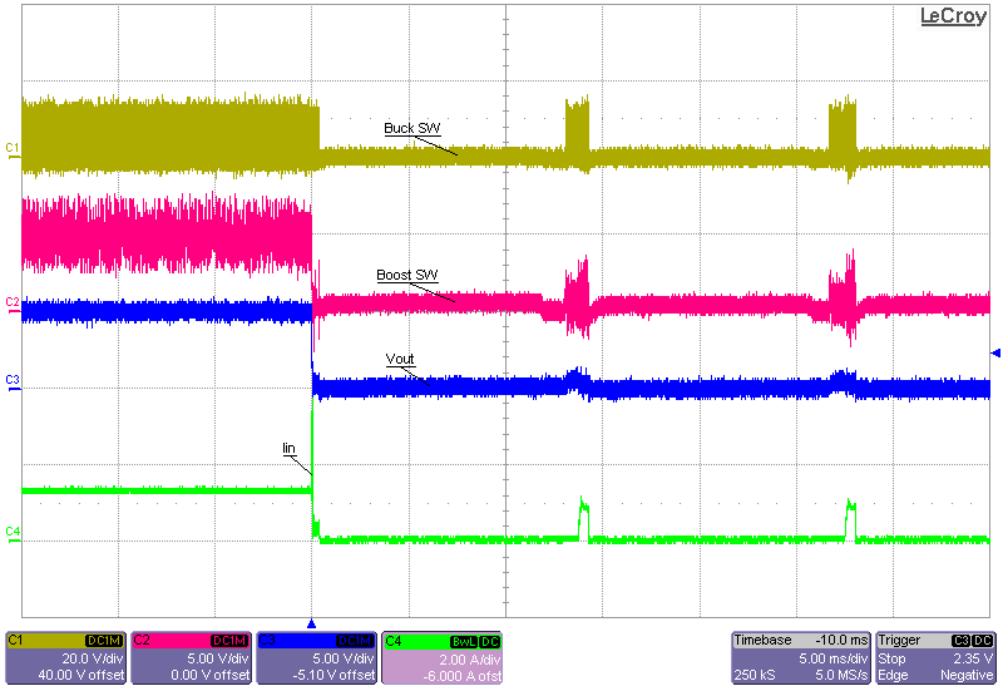


24Vin, 20Vout to 5V @3A transition. Ch1 measures Vbus, Ch2 measures CTL1, Ch3 measures CTL2, and Ch4 measures CTL3.

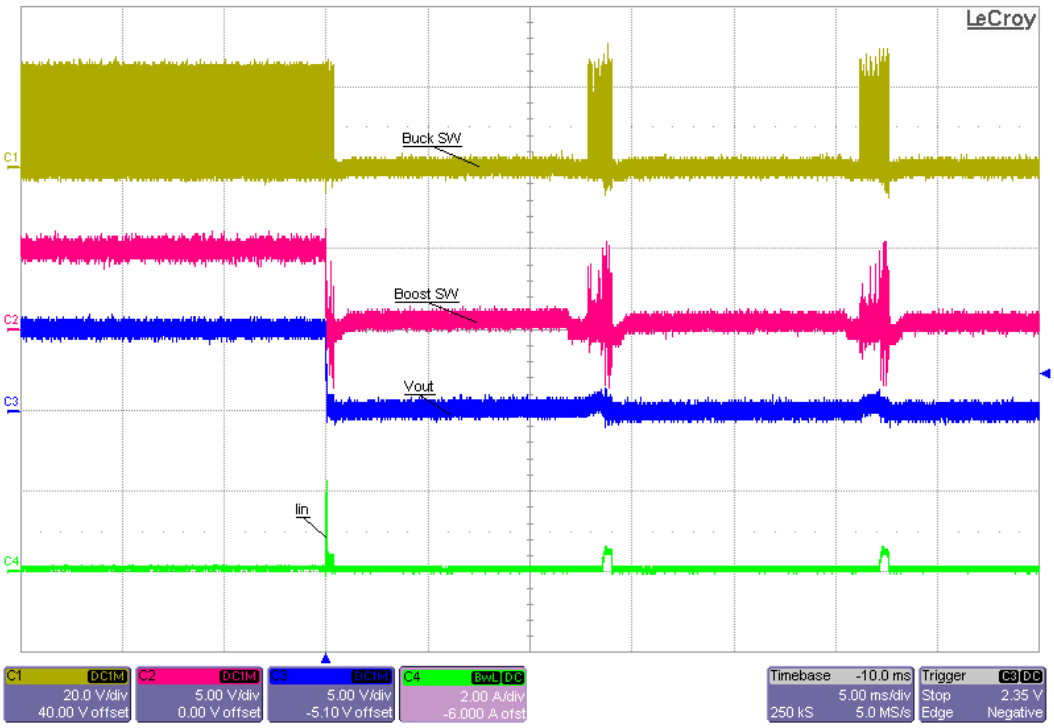
6.6 Short Circuit



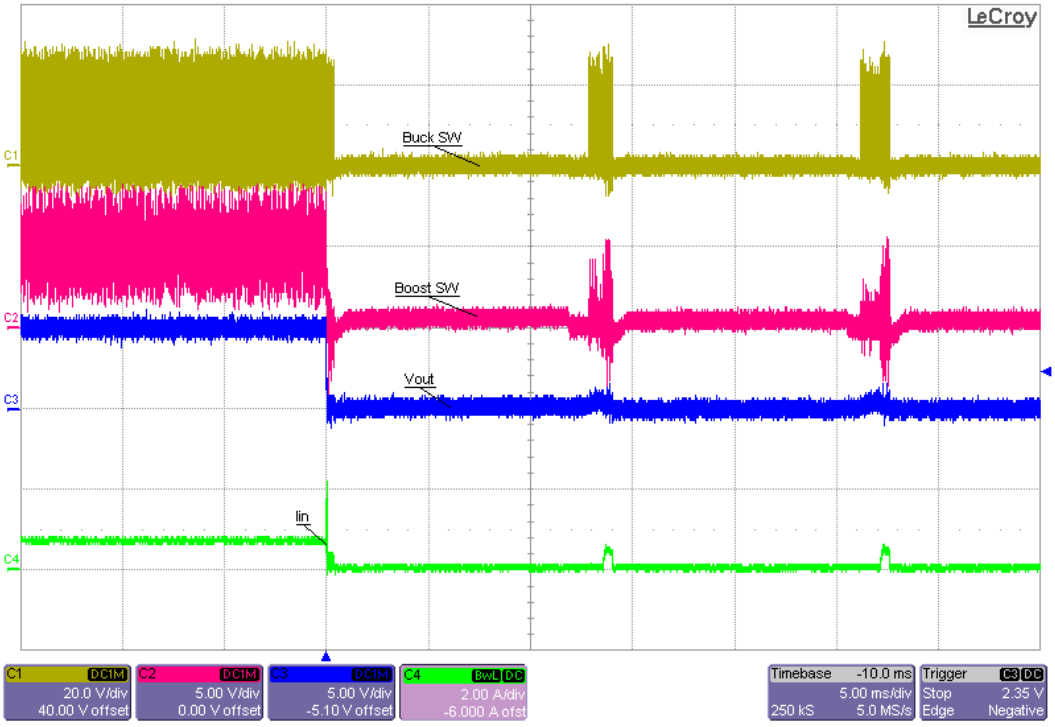
12Vin, 5Vout @0A short. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.



12Vin, 5Vout @3A short. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.

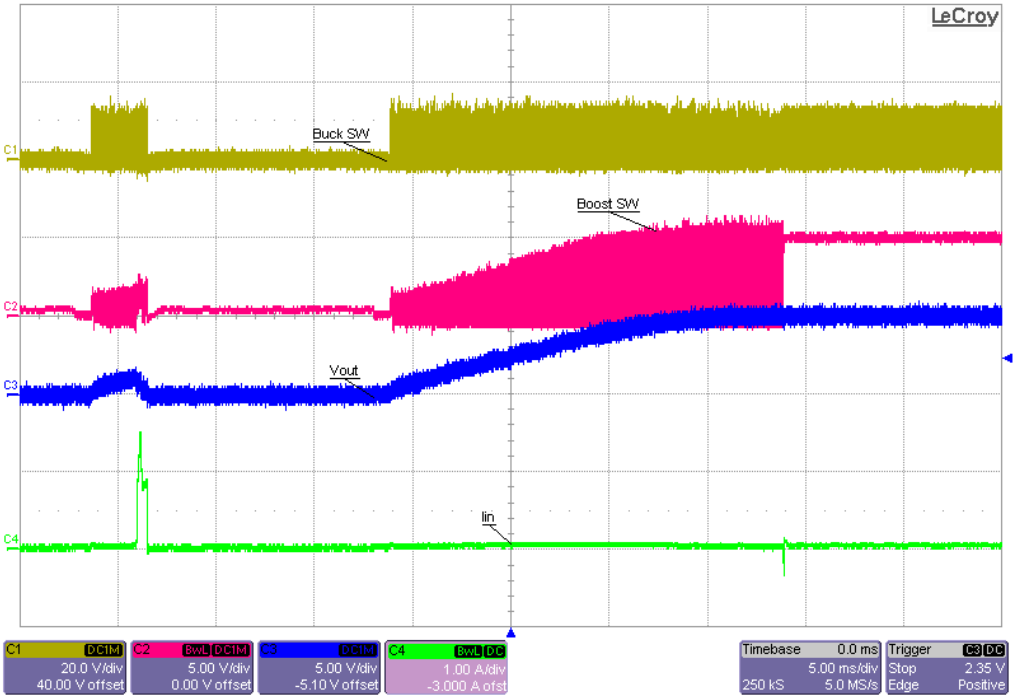


24Vin, 5Vout @0A short. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.

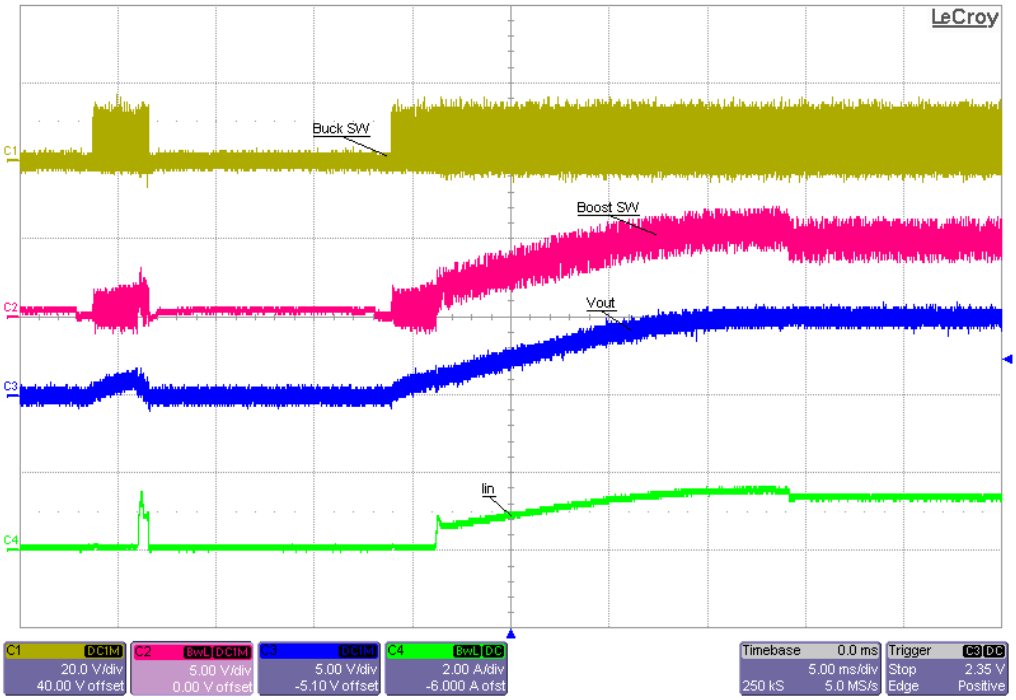


24Vin, 5Vout @3A short. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.

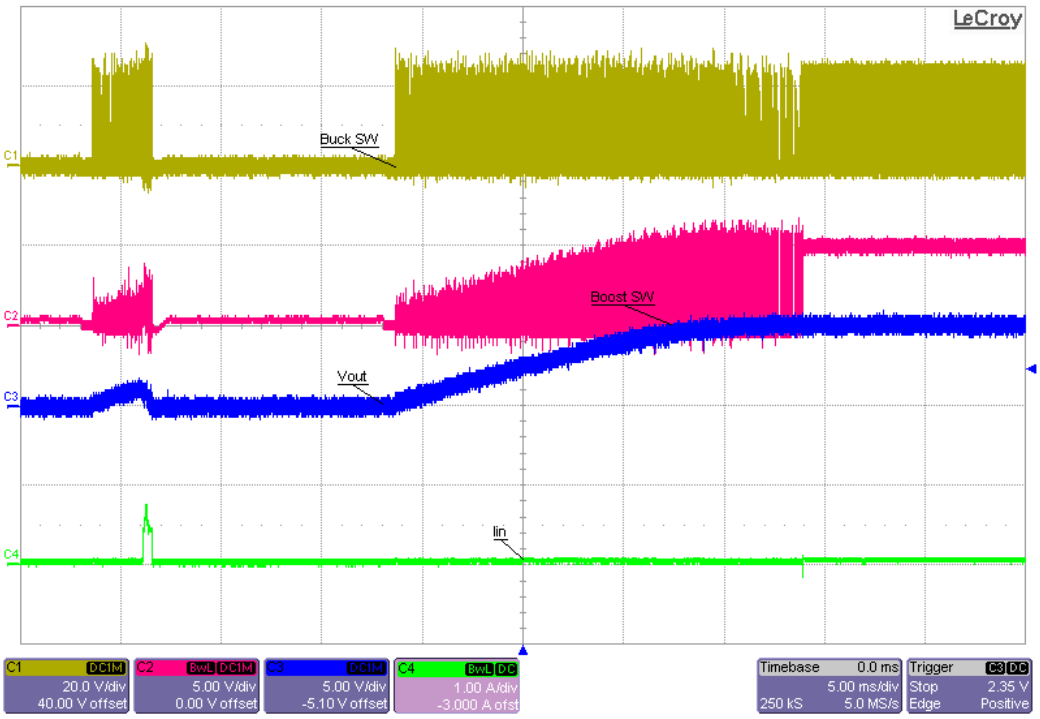
6.7 Short Circuit Recovery



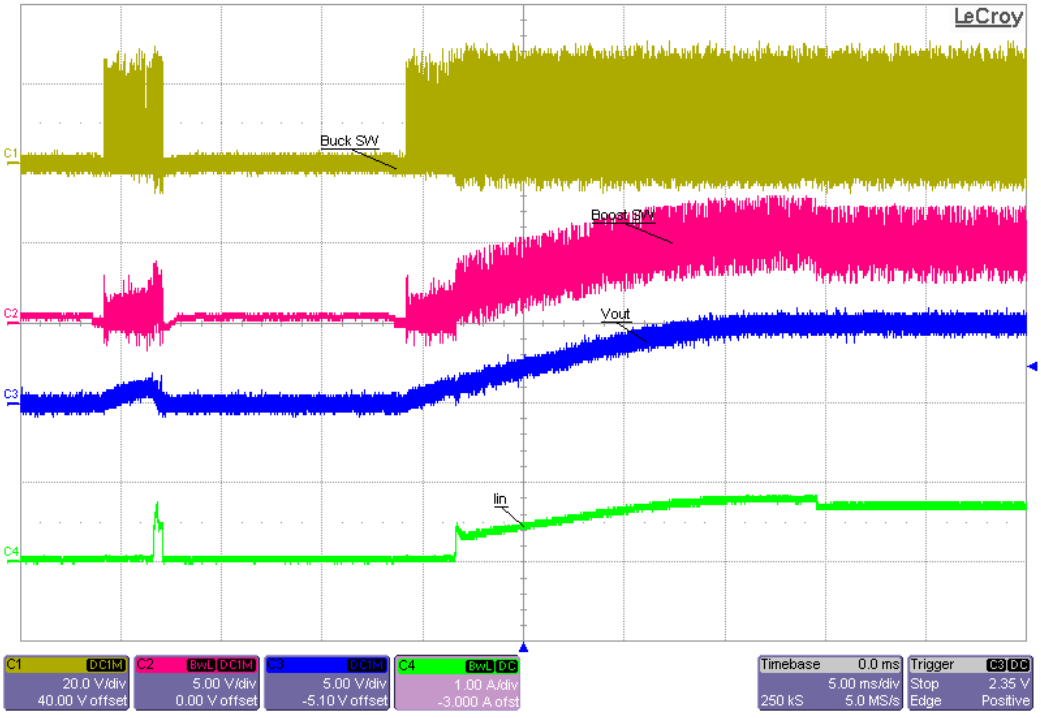
12Vin, 5Vout @0A short recovery. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.



12Vin, 5Vout @3A short recovery. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.

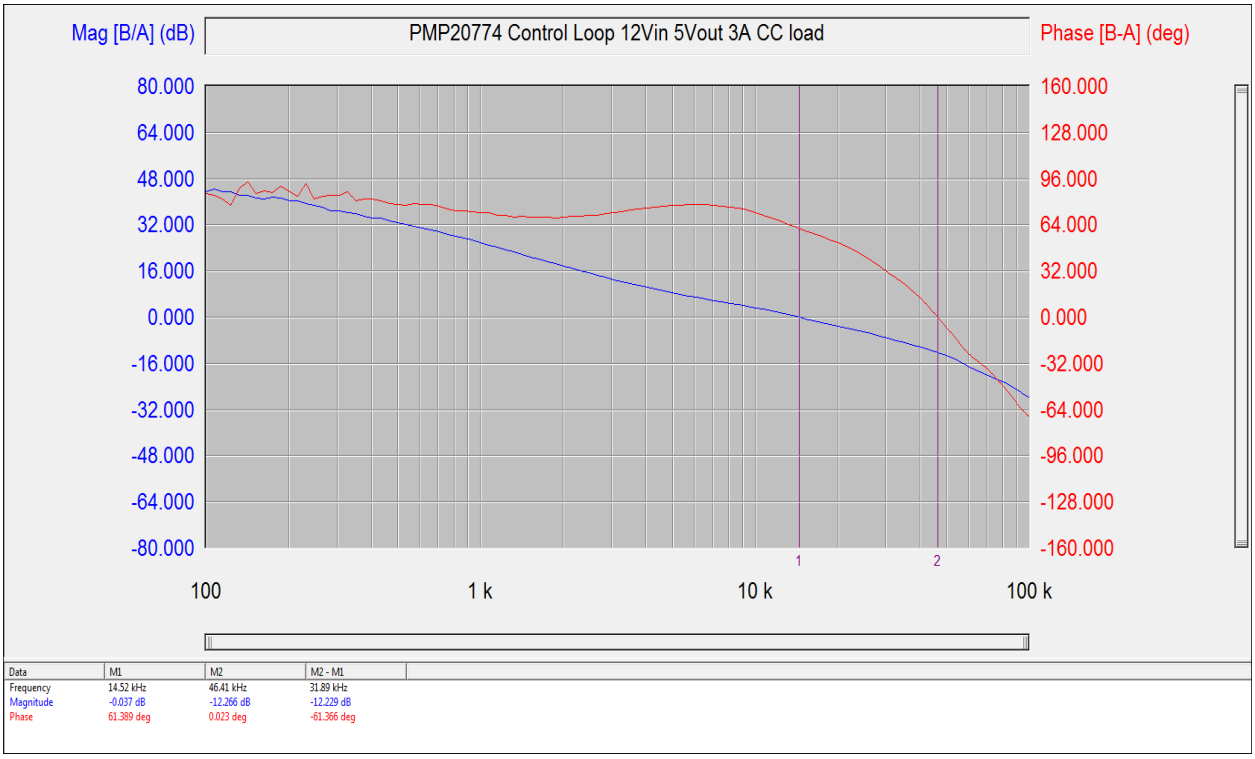


24Vin, 5Vout @0A short recovery. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.

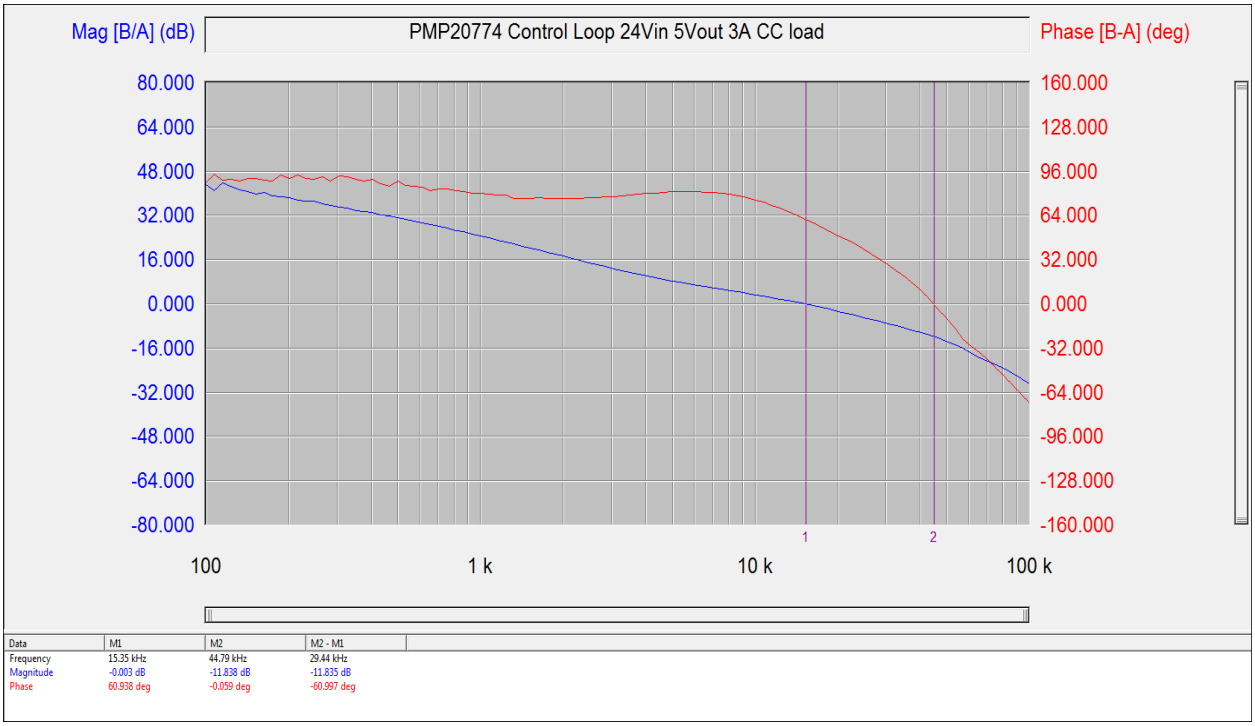


24Vin, 5Vout @3A short recovery. Ch1 measures buck switch, Ch2 measures boost switch, Ch3 measures output voltage, and Ch4 measures input current.

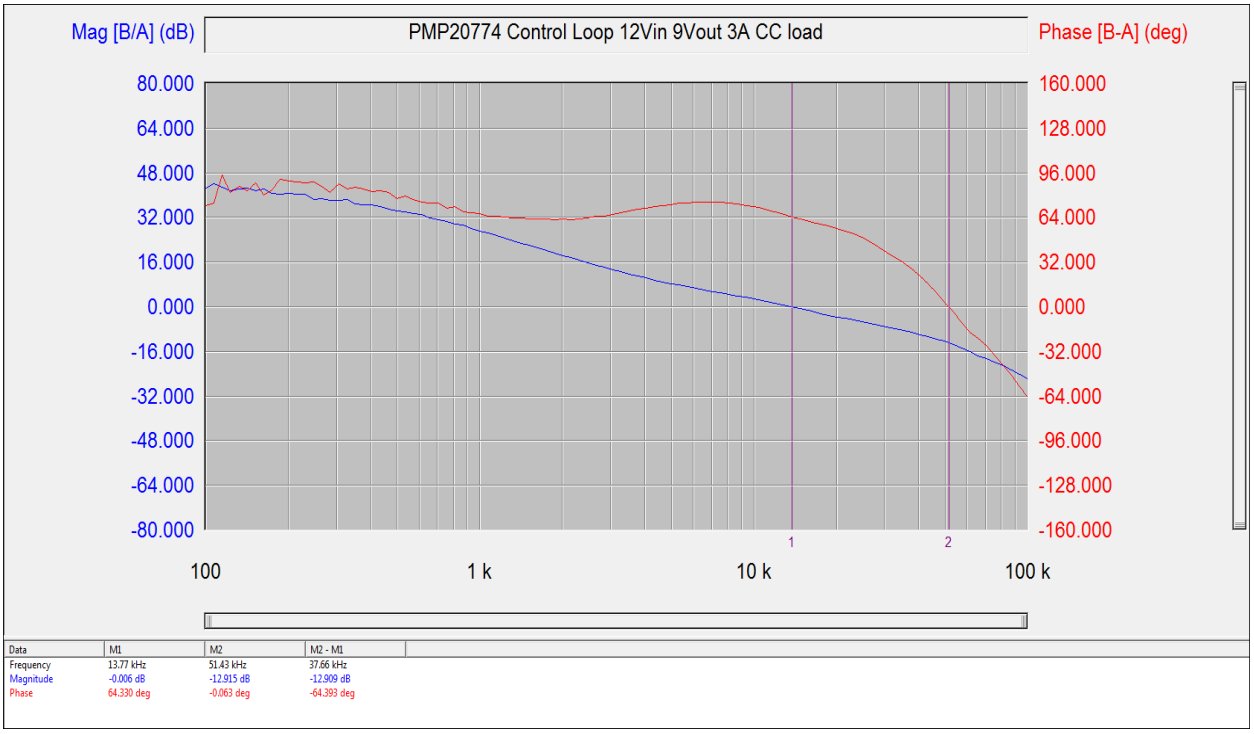
7 Loop Response



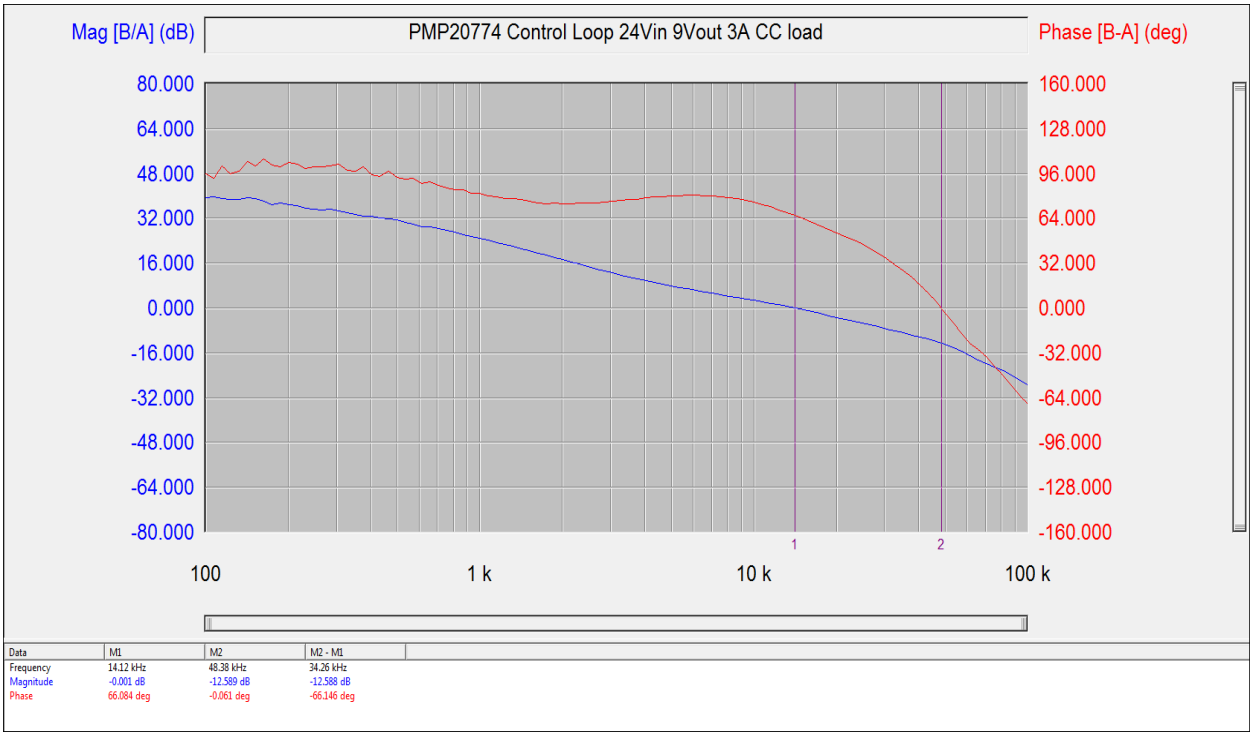
12Vin, 5Vout full load loop response, phase margin of 61.389 degrees, gain margin of 12.266dB.



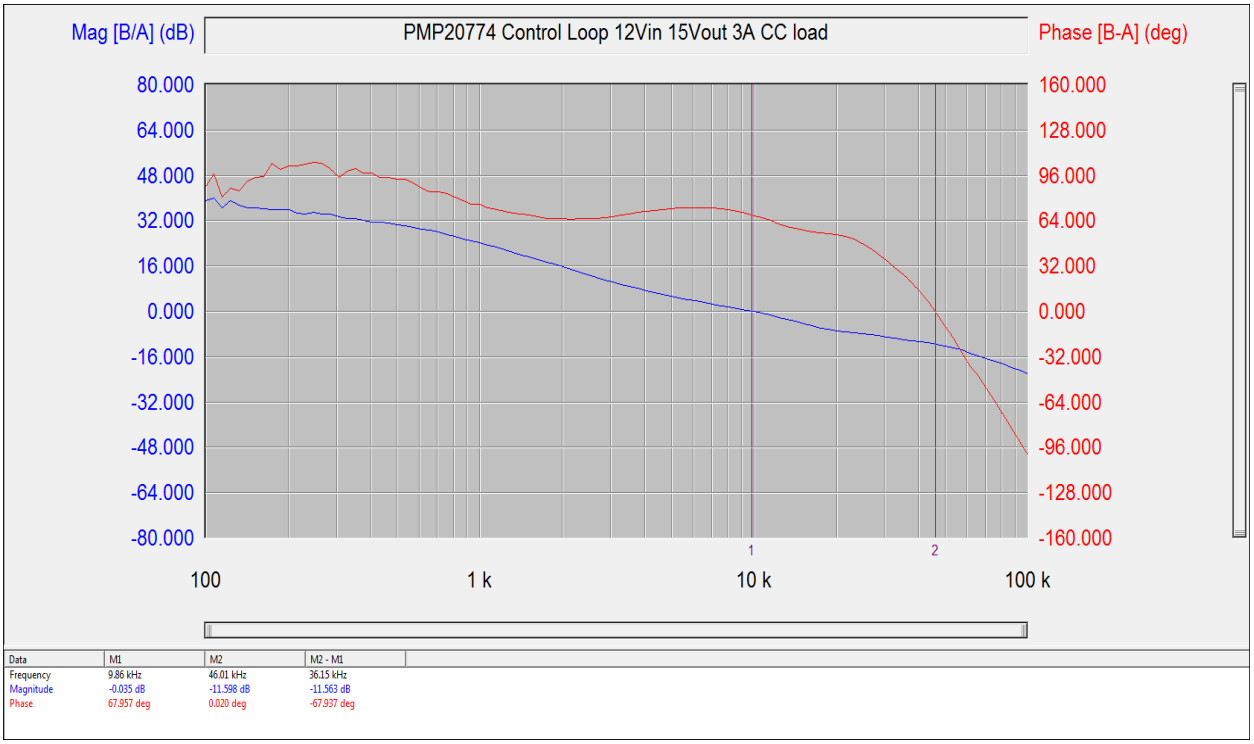
24Vin, 5Vout full load loop response, phase margin of 60.938 degrees, gain margin of 11.838dB.



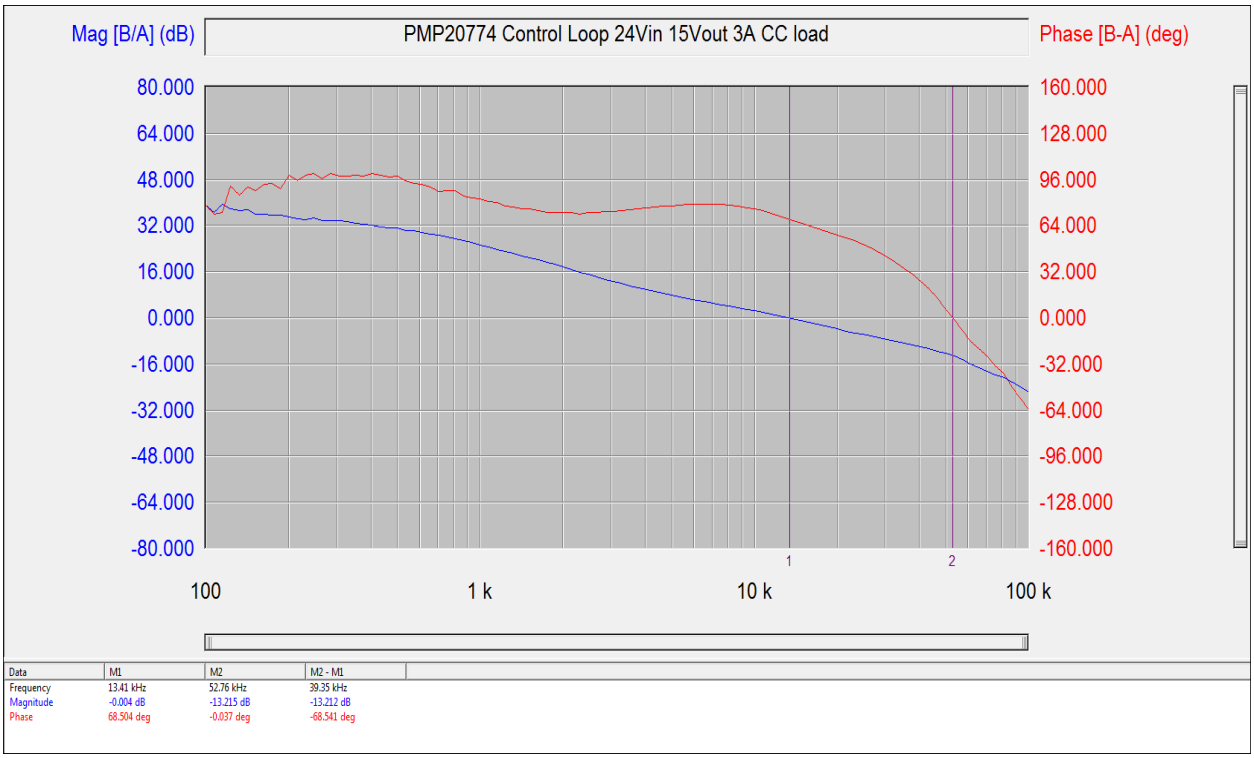
12Vin, 9Vout full load loop response, phase margin of 64.33 degrees, gain margin of 12.915dB.



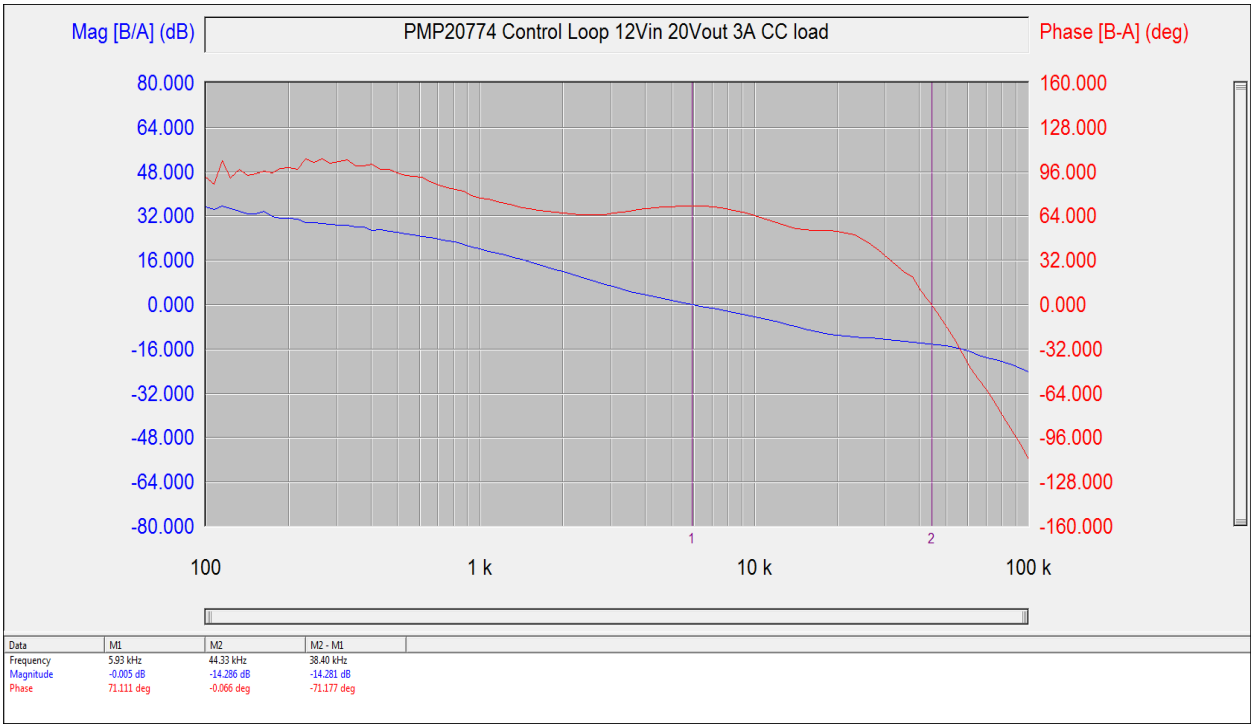
24Vin, 9Vout full load loop response, phase margin of 66.084 degrees, gain margin of 12.589dB.



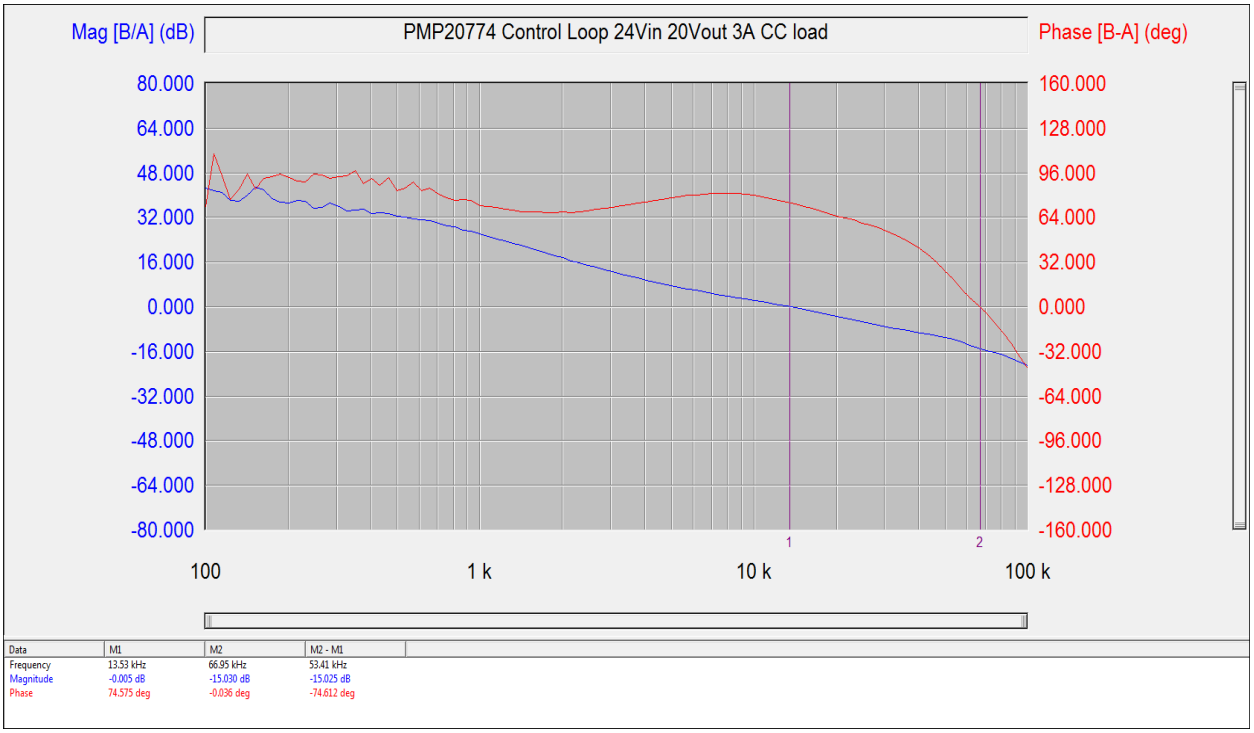
12Vin, 15Vout full load loop response, phase margin of 67.957 degrees, gain margin of 11.598dB.



24Vin, 15Vout full load loop response, phase margin of 68.504 degrees, gain margin of 13.215dB.



12Vin, 20Vout full load loop response, phase margin of 71.111 degrees, gain margin of 14.286dB.



24Vin, 20Vout full load loop response, phase margin of 74.575 degrees, gain margin of 15.03b dB.

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