Variable Outputs Single Cell Battery 80W Heater Element Power Stage Buck Boost Reference Design

TI reference design number: PMP20410

Input: 2.7V to 4.3V DC
Output: Selectable 1V to 10V @ 13A to 28A

DC – DC Test Results

Table of Contents

1 Test Specifications

Vin min	**2.7V**
Vin max	**4.3V**
Vout	**Selectable 1V to 10V**
Iout	**13A to 28A**
Fsw	**200kHz**

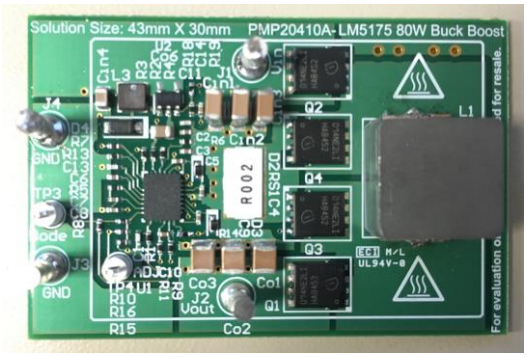
2 Circuit Description

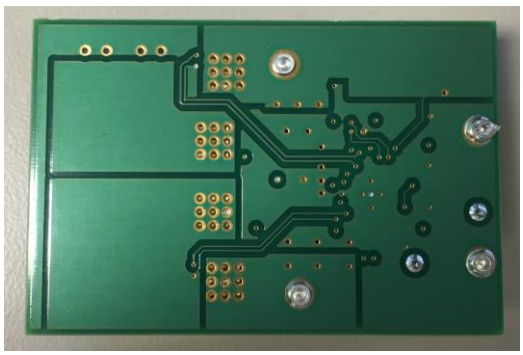
PMP20410 is a synchronous 4-switch buck-boost converter which utilizes the LM5175 controller as a heater element power stage. The output voltage can be selected from 1V to 10V at 13A to 28A using a trim resistor at the FB pin with a 0.2V to 3.1V bias voltage. This design also uses a non-sync boost regulator LMR62014 to provide the bias power for LM5175 which enables 2.7V input operation. The LM5175 pulse-by-pulse current limiting is inherent in the current-mode controller. The board includes enable, synchronization and power good functions. This design supports resistive heating element ranging from 0.1Ω to 0.5Ω, table below summarizes the various 80W operating conditions:

Resistance (Ω)	Voltage (V)	Current (A)
0.1	2.83	28.3
0.2	4	20
0.3	4.9	16.4
0.4	5.66	14.2
0.5	6.33	12.7

3 Board Photos

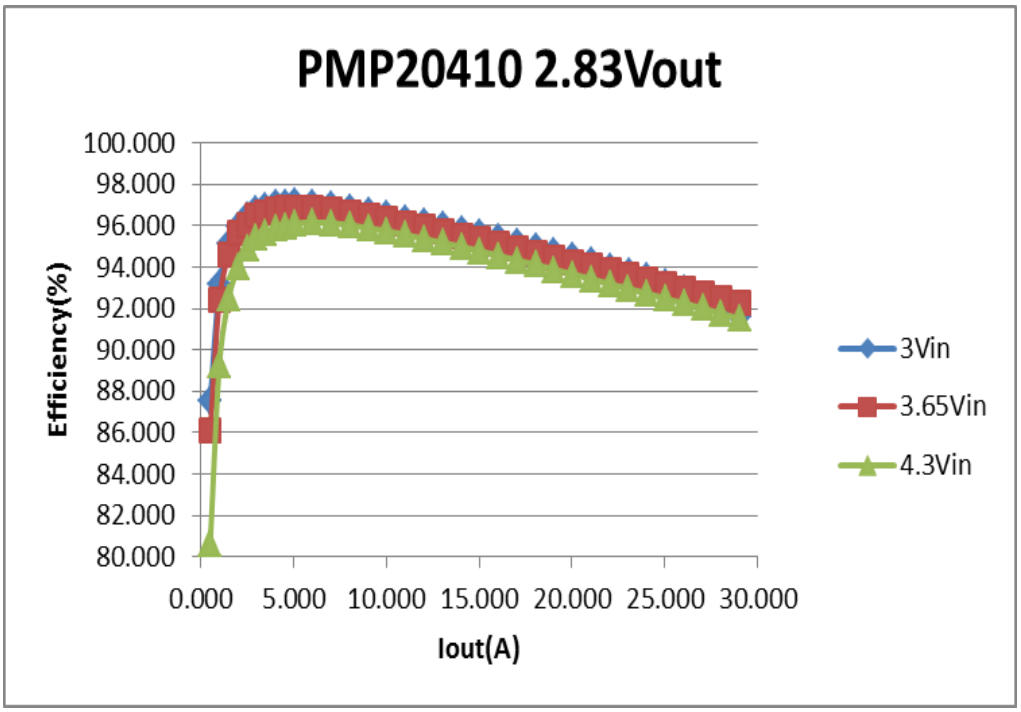
The design is built on PMP20410 printed circuit board. This is a 4-layer PCB with 2 oz. copper on external layers and internal layers. PCB dimensions are 54 x 36 mm.





4 Efficiency

4.1 2.83V Output Efficiency Results



4.2 2.83V Output Efficiency Data

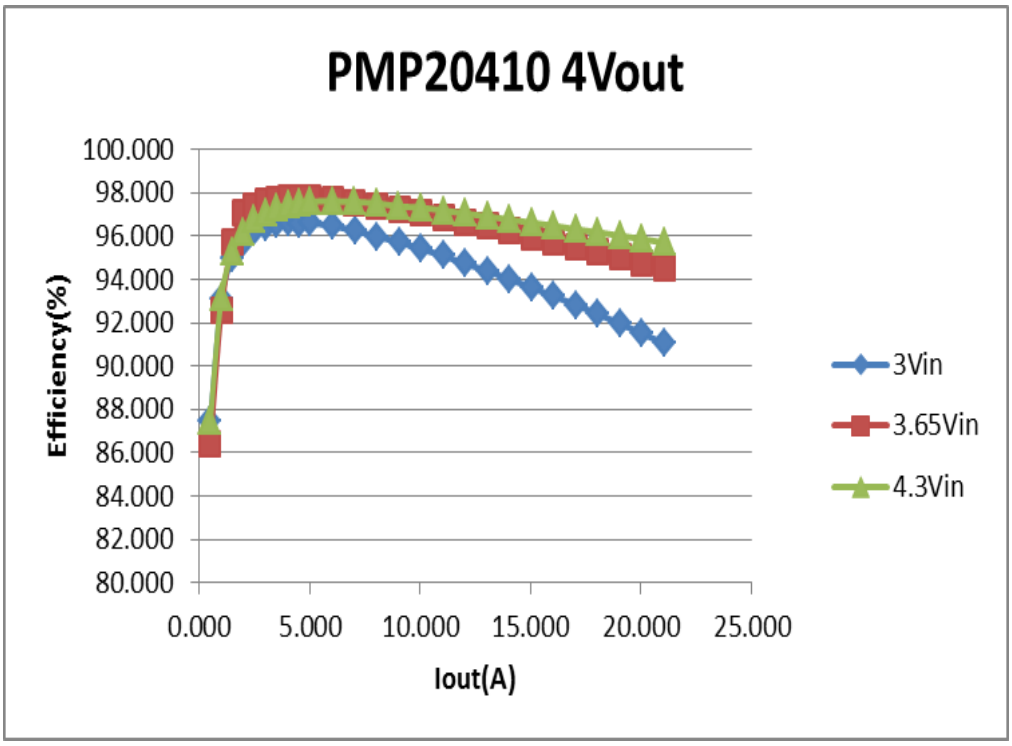
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Losses(W)	Efficiency
3.002	0.063	2.838	-0.002	0.189	-0.006	0.195	-3.002
3.002	0.538	2.840	0.498	1.615	1.414	0.201	87.561
3.002	1.014	2.841	0.998	3.044	2.835	0.209	93.144
3.002	1.493	2.841	1.500	4.481	4.262	0.219	95.104
3.002	1.973	2.842	2.000	5.922	5.684	0.239	95.970
3.002	2.453	2.842	2.500	7.363	7.105	0.258	96.502
3.002	2.936	2.842	3.000	8.813	8.527	0.285	96.762
3.002	3.419	2.842	3.500	10.262	9.949	0.314	96.944
3.002	3.952	2.843	4.050	11.862	11.514	0.349	97.061
3.001	4.437	2.843	4.548	13.317	12.930	0.387	97.097
3.001	4.924	2.843	5.048	14.778	14.353	0.425	97.126
3.001	5.902	2.844	6.048	17.714	17.200	0.514	97.097
3.001	6.886	2.844	7.048	20.668	20.046	0.623	96.988
3.001	7.876	2.845	8.050	23.639	22.900	0.739	96.873
3.001	8.870	2.845	9.050	26.622	25.751	0.871	96.729
3.001	9.871	2.846	10.050	29.625	28.598	1.027	96.533

3.001	10.874	2.846	11.050	32.635	31.447	1.188	96.360
3.001	11.881	2.846	12.050	35.657	34.299	1.358	96.191
3.001	12.897	2.847	13.052	38.704	37.156	1.548	96.000
3.001	13.916	2.847	14.052	41.764	40.007	1.756	95.795
3.001	14.940	2.848	15.054	44.833	42.867	1.966	95.615
3.001	15.972	2.848	16.054	47.929	45.725	2.204	95.401
3.001	17.005	2.848	17.054	51.031	48.575	2.456	95.188
3.001	18.047	2.849	18.054	54.159	51.431	2.728	94.963
3.001	19.096	2.849	19.056	57.299	54.296	3.003	94.759
3.001	20.153	2.850	20.056	60.471	57.159	3.313	94.522
3.001	21.212	2.851	21.056	63.648	60.024	3.624	94.307
3.001	22.287	2.851	22.054	66.876	62.886	3.990	94.034
3.001	23.367	2.852	23.058	70.114	65.756	4.358	93.784
3.000	24.459	2.853	24.058	73.384	68.626	4.758	93.517
3.000	25.561	2.853	25.058	76.689	71.495	5.194	93.227
3.000	26.682	2.854	26.060	80.046	74.379	5.667	92.920
3.000	27.819	2.855	27.058	83.466	77.248	6.218	92.550
3.000	29.001	2.855	28.060	87.007	80.120	6.887	92.084
3.000	30.205	2.856	29.062	90.621	83.005	7.615	91.596
3.651	0.060	2.839	0.000	0.219	0.000	0.219	0.000
3.651	0.450	2.840	0.498	1.643	1.414	0.229	86.075
3.651	0.840	2.840	0.998	3.067	2.834	0.232	92.426
3.651	1.232	2.841	1.498	4.498	4.255	0.243	94.602
3.651	1.627	2.841	2.000	5.940	5.681	0.258	95.655
3.651	2.023	2.840	2.498	7.385	7.093	0.292	96.046
3.650	2.420	2.840	3.000	8.834	8.520	0.314	96.443
3.650	2.818	2.840	3.500	10.287	9.940	0.347	96.627
3.651	3.253	2.841	4.044	11.875	11.489	0.387	96.745
3.650	3.653	2.841	4.544	13.335	12.911	0.424	96.819
3.650	4.054	2.841	5.044	14.799	14.332	0.467	96.844
3.650	4.860	2.843	6.044	17.740	17.181	0.559	96.848
3.650	5.671	2.843	7.046	20.702	20.032	0.670	96.766
3.650	6.487	2.843	8.048	23.680	22.884	0.796	96.638
3.650	7.308	2.844	9.048	26.676	25.732	0.944	96.461
3.650	8.130	2.844	10.048	29.675	28.577	1.098	96.301
3.650	8.957	2.844	11.048	32.694	31.426	1.268	96.122
3.650	9.788	2.845	12.048	35.727	34.272	1.455	95.928
3.650	10.626	2.845	13.050	38.787	37.125	1.662	95.715
3.650	11.466	2.845	14.050	41.852	39.976	1.877	95.516
3.650	12.312	2.846	15.052	44.938	42.832	2.106	95.313

3.650	13.161	2.846	16.052	48.037	45.683	2.354	95.099
3.650	14.012	2.846	17.050	51.144	48.530	2.614	94.889
3.650	14.868	2.846	18.050	54.267	51.379	2.888	94.678
3.650	15.730	2.847	19.052	57.413	54.235	3.178	94.465
3.650	16.598	2.847	20.056	60.577	57.096	3.481	94.254
3.650	17.468	2.847	21.056	63.755	59.953	3.802	94.037
3.650	18.343	2.848	22.056	66.943	62.806	4.137	93.820
3.650	19.220	2.848	23.054	70.146	65.654	4.491	93.597
3.649	20.107	2.849	24.056	73.380	68.526	4.854	93.385
3.649	20.998	2.849	25.058	76.632	71.386	5.246	93.154
3.649	21.892	2.849	26.060	79.892	74.254	5.638	92.943
3.649	22.793	2.850	27.060	83.178	77.113	6.065	92.709
3.649	23.696	2.850	28.060	86.473	79.971	6.501	92.482
3.649	24.607	2.851	29.060	89.795	82.837	6.958	92.251
4.299	0.077	2.839	0.000	0.331	0.000	0.331	0.000
4.299	0.408	2.838	0.498	1.754	1.413	0.341	80.578
4.299	0.738	2.839	0.998	3.173	2.833	0.340	89.283
4.299	1.071	2.839	1.500	4.605	4.258	0.347	92.469
4.299	1.404	2.839	1.998	6.036	5.672	0.364	93.972
4.299	1.740	2.839	2.500	7.481	7.098	0.383	94.880
4.299	2.076	2.839	3.000	8.925	8.518	0.407	95.440
4.299	2.415	2.838	3.500	10.383	9.934	0.449	95.673
4.299	2.785	2.838	4.044	11.973	11.477	0.496	95.855
4.299	3.124	2.838	4.542	13.431	12.892	0.539	95.987
4.299	3.465	2.838	5.044	14.896	14.316	0.580	96.106
4.299	4.150	2.839	6.044	17.841	17.157	0.684	96.164
4.299	4.838	2.839	7.044	20.799	19.995	0.804	96.136
4.299	5.533	2.839	8.046	23.787	22.843	0.944	96.032
4.299	6.231	2.839	9.046	26.788	25.685	1.103	95.884
4.299	6.932	2.840	10.048	29.800	28.533	1.267	95.747
4.299	7.637	2.840	11.046	32.832	31.372	1.460	95.555
4.299	8.347	2.841	12.046	35.883	34.220	1.663	95.366
4.299	9.061	2.841	13.048	38.952	37.072	1.880	95.173
4.299	9.779	2.842	14.050	42.038	39.930	2.108	94.985
4.299	10.500	2.842	15.052	45.136	42.775	2.362	94.768
4.299	11.224	2.842	16.052	48.248	45.623	2.625	94.559
4.299	11.951	2.842	17.050	51.373	48.458	2.915	94.327
4.299	12.683	2.842	18.052	54.519	51.310	3.209	94.114
4.299	13.420	2.843	19.052	57.687	54.156	3.531	93.880
4.299	14.161	2.843	20.054	60.872	57.009	3.863	93.654

4.299	14.904	2.843	21.054	64.066	59.855	4.211	93.427
4.299	15.654	2.843	22.054	67.290	62.698	4.591	93.177
4.299	16.406	2.844	23.054	70.522	65.554	4.968	92.956
4.298	17.164	2.844	24.056	73.778	68.409	5.369	92.723
4.299	17.926	2.844	25.056	77.057	71.253	5.804	92.467
4.298	18.691	2.844	26.058	80.342	74.107	6.235	92.240
4.298	19.463	2.845	27.058	83.658	76.970	6.688	92.005
4.298	20.242	2.845	28.060	87.004	79.821	7.183	91.744
4.298	21.021	2.845	29.060	90.356	82.679	7.676	91.504

4.3 4V Output Efficiency Results



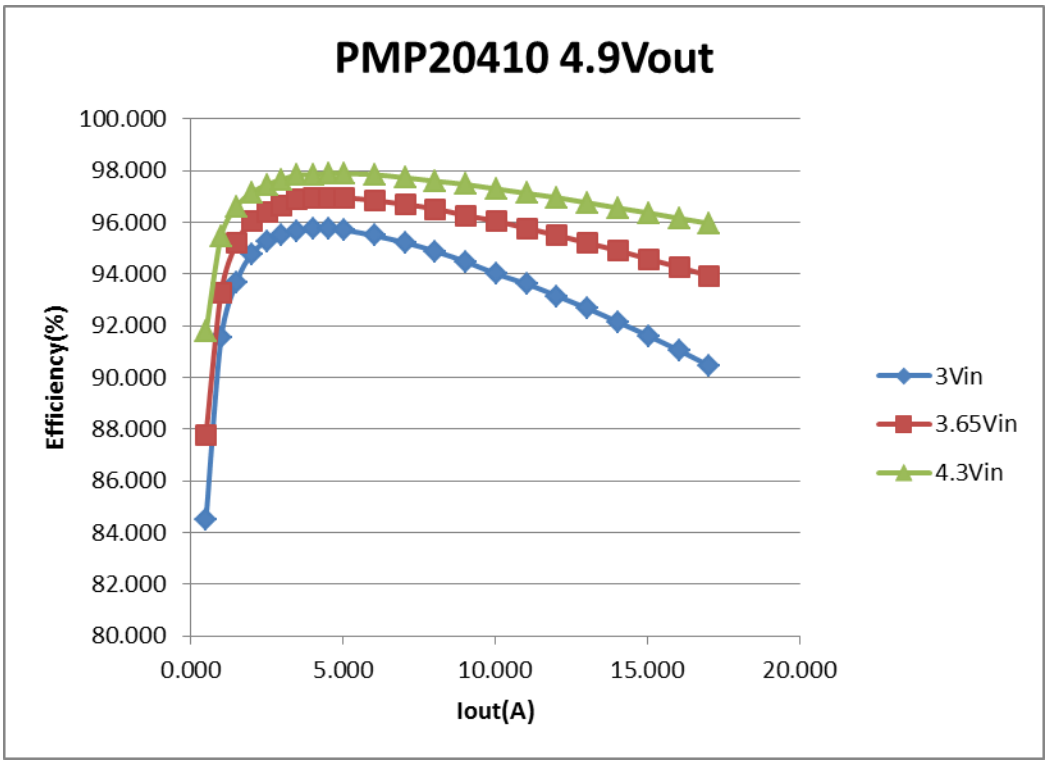
4.4 4V Output Efficiency Data

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Losses(W)	Efficiency
3.002	0.085	4.012	-0.004	0.255	-0.016	0.271	-6.289
3.002	0.758	4.012	0.496	2.275	1.990	0.286	87.452
3.002	1.430	4.013	0.996	4.292	3.997	0.296	93.108
3.002	2.106	4.013	1.496	6.321	6.004	0.318	94.974
3.002	2.790	4.013	1.996	8.375	8.010	0.365	95.646
3.002	3.471	4.014	2.496	10.419	10.018	0.401	96.152
3.002	4.156	4.014	2.996	12.475	12.025	0.450	96.389
3.002	4.842	4.014	3.496	14.533	14.033	0.500	96.560
3.002	5.599	4.014	4.044	16.806	16.234	0.573	96.592
3.002	6.289	4.014	4.542	18.878	18.233	0.645	96.582
3.002	6.984	4.015	5.044	20.963	20.250	0.712	96.602
3.001	8.382	4.015	6.044	25.157	24.270	0.888	96.472
3.001	9.793	4.016	7.044	29.393	28.290	1.103	96.247
3.001	11.218	4.017	8.046	33.668	32.317	1.351	95.989
3.001	12.651	4.018	9.046	37.969	36.343	1.626	95.717
3.001	14.098	4.018	10.046	42.314	40.369	1.945	95.404
3.001	15.557	4.019	11.048	46.690	44.400	2.291	95.094
3.001	17.031	4.019	12.046	51.111	48.416	2.694	94.728
3.001	18.519	4.021	13.048	55.577	52.460	3.117	94.392
3.001	20.024	4.021	14.048	60.093	56.489	3.603	94.004
3.001	21.544	4.022	15.050	64.654	60.531	4.123	93.624
3.001	23.079	4.023	16.050	69.259	64.565	4.694	93.222
3.000	24.634	4.024	17.050	73.912	68.610	5.302	92.827
3.000	26.208	4.025	18.050	78.631	72.651	5.979	92.396
3.000	27.801	4.026	19.050	83.404	76.694	6.711	91.954
3.000	29.415	4.027	20.052	88.250	80.749	7.501	91.500
3.000	31.049	4.028	21.052	93.150	84.802	8.348	91.038
3.651	0.072	4.010	-0.004	0.263	-0.016	0.279	-6.103
3.651	0.628	4.010	0.494	2.293	1.981	0.312	86.394
3.650	1.182	4.010	0.996	4.315	3.994	0.321	92.560
3.650	1.718	4.013	1.496	6.271	6.003	0.268	95.725
3.651	2.261	4.013	1.996	8.254	8.010	0.243	97.050
3.651	2.818	4.014	2.496	10.287	10.018	0.269	97.381
3.651	3.376	4.014	2.996	12.325	12.026	0.299	97.573
3.651	3.936	4.014	3.496	14.369	14.033	0.335	97.666
3.651	4.546	4.015	4.042	16.595	16.227	0.368	97.782
3.651	5.108	4.015	4.542	18.648	18.235	0.413	97.787

3.651	5.671	4.015	5.042	20.703	20.243	0.460	97.779
3.650	6.802	4.015	6.042	24.830	24.258	0.573	97.694
3.650	7.939	4.016	7.040	28.981	28.270	0.711	97.548
3.650	9.084	4.016	8.042	33.159	32.297	0.862	97.400
3.650	10.234	4.017	9.044	37.356	36.326	1.030	97.242
3.650	11.389	4.017	10.046	41.571	40.354	1.218	97.071
3.650	12.550	4.017	11.044	45.809	44.368	1.441	96.854
3.650	13.718	4.018	12.044	50.070	48.391	1.679	96.646
3.650	14.892	4.018	13.046	54.352	52.423	1.928	96.452
3.650	16.072	4.018	14.048	58.658	56.451	2.207	96.238
3.650	17.262	4.019	15.048	63.003	60.472	2.531	95.982
3.650	18.455	4.019	16.048	67.357	64.502	2.856	95.761
3.650	19.654	4.020	17.048	71.729	68.527	3.203	95.535
3.650	20.864	4.020	18.048	76.148	72.548	3.600	95.272
3.650	22.080	4.020	19.050	80.588	76.586	4.001	95.035
3.649	23.308	4.021	20.052	85.063	80.622	4.441	94.780
3.650	24.541	4.021	21.052	89.567	84.654	4.913	94.515
4.300	0.062	4.001	-0.002	0.267	-0.008	0.275	-3.002
4.300	0.528	4.002	0.496	2.270	1.985	0.285	87.436
4.300	0.995	4.002	0.996	4.278	3.986	0.292	93.181
4.300	1.462	4.003	1.496	6.286	5.989	0.298	95.266
4.299	1.932	4.004	1.996	8.307	7.992	0.315	96.211
4.299	2.403	4.005	2.496	10.332	9.996	0.336	96.749
4.300	2.875	4.004	2.996	12.361	11.997	0.364	97.057
4.300	3.347	4.005	3.496	14.390	14.002	0.389	97.297
4.299	3.863	4.006	4.040	16.608	16.183	0.426	97.436
4.300	4.337	4.006	4.540	18.647	18.187	0.460	97.534
4.299	4.812	4.006	5.040	20.688	20.190	0.498	97.593
4.299	5.766	4.007	6.040	24.791	24.200	0.591	97.615
4.299	6.724	4.007	7.040	28.907	28.210	0.697	97.587
4.299	7.687	4.007	8.042	33.047	32.228	0.820	97.519
4.299	8.654	4.008	9.040	37.204	36.229	0.975	97.380
4.299	9.623	4.008	10.044	41.370	40.259	1.111	97.314
4.299	10.597	4.009	11.044	45.555	44.273	1.281	97.188
4.299	11.573	4.009	12.044	49.752	48.283	1.470	97.046
4.299	12.555	4.009	13.046	53.970	52.304	1.666	96.913
4.299	13.539	4.010	14.046	58.200	56.319	1.881	96.769
4.299	14.528	4.010	15.048	62.453	60.342	2.111	96.619
4.299	15.518	4.010	16.048	66.709	64.358	2.351	96.476
4.299	16.513	4.011	17.046	70.985	68.369	2.617	96.314

4.299	17.511	4.011	18.048	75.273	72.393	2.880	96.174
4.299	18.513	4.011	19.050	79.580	76.412	3.168	96.019
4.299	19.520	4.011	20.052	83.907	80.436	3.471	95.863
4.298	20.530	4.012	21.050	88.244	84.448	3.796	95.699

4.5 4.9V Output Efficiency Results



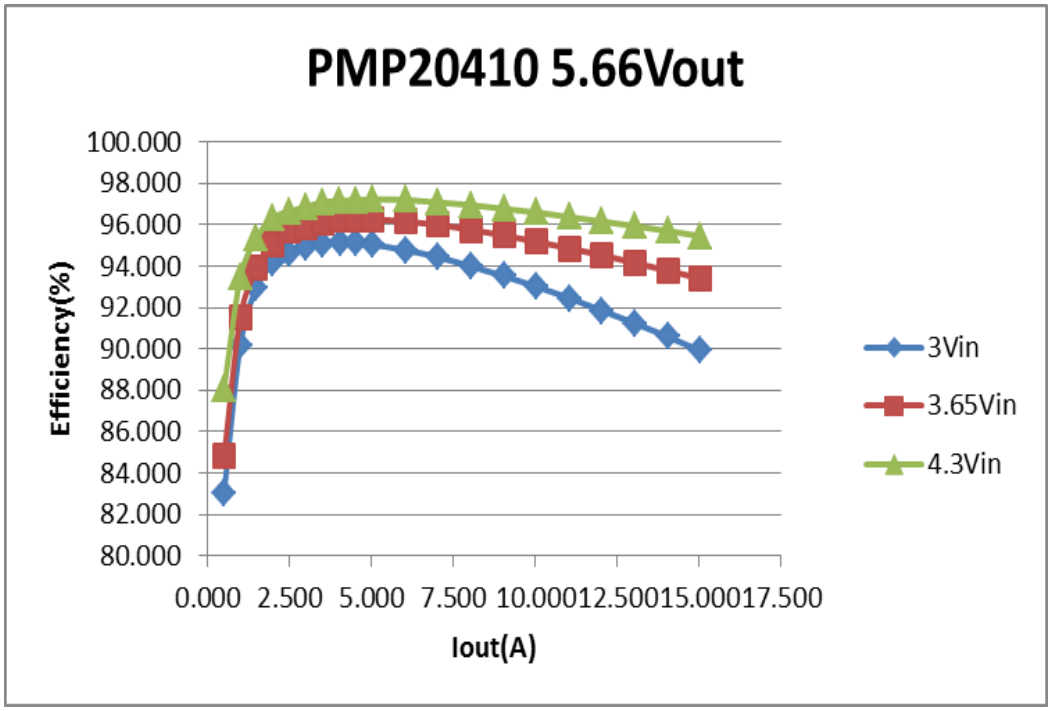
4.6 4.9V Output Efficiency Data

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Losses(W)	Efficiency
3.002	0.137	4.909	-0.002	0.411	-0.010	0.421	-2.388
3.002	0.960	4.910	0.496	2.882	2.435	0.447	84.505
3.002	1.780	4.910	0.996	5.343	4.891	0.452	91.535
3.002	2.613	4.911	1.496	7.843	7.347	0.497	93.668
3.002	3.446	4.911	1.996	10.344	9.803	0.541	94.774
3.002	4.291	4.912	2.498	12.880	12.269	0.611	95.258
3.001	5.135	4.912	2.996	15.412	14.717	0.695	95.488
3.001	5.982	4.912	3.496	17.954	17.173	0.780	95.653
3.001	6.914	4.913	4.044	20.751	19.867	0.884	95.740
3.001	7.768	4.913	4.544	23.314	22.326	0.989	95.759
3.001	8.629	4.914	5.044	25.897	24.784	1.113	95.701
3.001	10.363	4.915	6.042	31.102	29.694	1.407	95.475

3.001	12.119	4.916	7.044	36.367	34.626	1.741	95.212
3.001	13.895	4.916	8.046	41.697	39.558	2.140	94.868
3.001	15.691	4.917	9.046	47.087	44.484	2.604	94.471
3.001	17.505	4.918	10.040	52.530	49.378	3.152	94.000
3.001	19.344	4.919	11.046	58.043	54.335	3.708	93.612
3.001	21.207	4.920	12.046	63.635	59.270	4.365	93.141
3.000	23.098	4.922	13.048	69.305	64.219	5.086	92.661
3.000	25.016	4.922	14.048	75.054	69.150	5.904	92.134
3.000	26.966	4.924	15.050	80.907	74.111	6.796	91.600
3.000	28.944	4.926	16.050	86.838	79.058	7.780	91.040
3.000	30.957	4.927	17.048	92.881	84.001	8.881	90.439
3.651	0.084	4.909	-0.002	0.307	-0.010	0.316	-3.201
3.650	0.760	4.909	0.496	2.774	2.435	0.339	87.769
3.651	1.436	4.909	0.996	5.242	4.890	0.352	93.277
3.650	2.114	4.910	1.496	7.717	7.345	0.372	95.179
3.650	2.796	4.910	1.996	10.206	9.801	0.406	96.024
3.650	3.484	4.910	2.496	12.718	12.256	0.462	96.366
3.650	4.170	4.910	2.996	15.222	14.712	0.510	96.648
3.650	4.858	4.911	3.498	17.733	17.177	0.556	96.862
3.650	5.610	4.911	4.042	20.478	19.850	0.628	96.932
3.651	6.301	4.911	4.540	23.002	22.296	0.706	96.931
3.650	6.997	4.911	5.042	25.542	24.762	0.780	96.948
3.650	8.393	4.912	6.040	30.637	29.669	0.968	96.840
3.650	9.801	4.912	7.042	35.776	34.593	1.183	96.693
3.650	11.219	4.913	8.044	40.949	39.521	1.429	96.511
3.650	12.648	4.914	9.044	46.166	44.439	1.727	96.259
3.650	14.084	4.914	10.046	51.404	49.368	2.036	96.039
3.650	15.530	4.915	11.044	56.679	54.279	2.400	95.766
3.650	16.989	4.916	12.044	62.003	59.205	2.798	95.488
3.650	18.461	4.916	13.046	67.376	64.139	3.237	95.195
3.650	19.941	4.917	14.046	72.778	69.065	3.713	94.898
3.650	21.436	4.918	15.046	78.233	73.991	4.243	94.577
3.650	22.947	4.919	16.048	83.747	78.937	4.810	94.256
3.649	24.466	4.919	17.048	89.288	83.868	5.420	93.929
4.300	0.044	4.907	-0.002	0.189	-0.010	0.199	-5.188
4.300	0.617	4.908	0.496	2.653	2.434	0.219	91.762
4.299	1.191	4.908	0.996	5.120	4.888	0.232	95.466
4.299	1.768	4.908	1.496	7.601	7.343	0.259	96.594
4.299	2.346	4.908	1.996	10.086	9.797	0.289	97.132

4.299	2.924	4.908	2.496	12.572	12.251	0.320	97.453
4.299	3.503	4.909	2.996	15.061	14.707	0.353	97.653
4.299	4.083	4.909	3.498	17.554	17.171	0.382	97.822
4.299	4.715	4.909	4.040	20.271	19.833	0.438	97.839
4.299	5.296	4.910	4.540	22.769	22.289	0.480	97.893
4.299	5.880	4.910	5.040	25.280	24.744	0.536	97.881
4.299	7.050	4.910	6.040	30.310	29.655	0.655	97.839
4.299	8.228	4.910	7.040	35.375	34.568	0.806	97.721
4.299	9.413	4.911	8.042	40.468	39.491	0.977	97.586
4.299	10.601	4.911	9.044	45.574	44.415	1.158	97.459
4.299	11.794	4.911	10.044	50.704	49.327	1.377	97.285
4.299	12.992	4.912	11.044	55.854	54.243	1.611	97.116
4.299	14.195	4.912	12.044	61.022	59.159	1.863	96.948
4.299	15.409	4.912	13.046	66.238	64.085	2.153	96.749
4.299	16.627	4.913	14.046	71.473	69.006	2.467	96.548
4.298	17.850	4.913	15.048	76.728	73.933	2.795	96.357
4.299	19.078	4.913	16.048	82.010	78.850	3.159	96.148
4.299	20.311	4.914	17.048	87.307	83.772	3.535	95.951

4.7 5.66V Output Efficiency Results

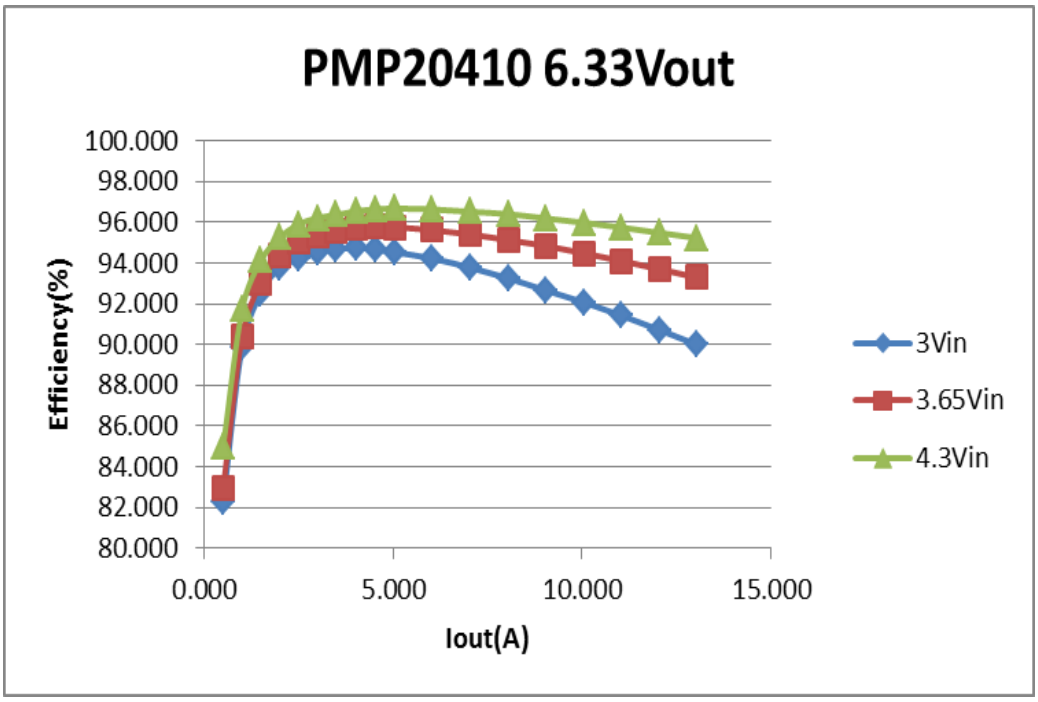


4.8 5.66V Output Efficiency Data

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Losses(W)	Efficiency
3.002	0.177	5.665	-0.004	0.531	-0.023	0.554	-4.266
3.001	1.128	5.666	0.496	3.386	2.810	0.575	83.007
3.001	2.081	5.667	0.994	6.246	5.633	0.613	90.185
3.001	3.038	5.667	1.496	9.118	8.478	0.640	92.977
3.001	4.003	5.668	1.996	12.014	11.313	0.702	94.160
3.001	4.982	5.668	2.496	14.952	14.147	0.805	94.615
3.001	5.961	5.669	2.996	17.891	16.984	0.907	94.931
3.001	6.945	5.669	3.496	20.845	19.820	1.025	95.083
3.001	8.028	5.670	4.044	24.094	22.928	1.166	95.162
3.001	9.023	5.670	4.542	27.078	25.755	1.323	95.113
3.001	10.025	5.671	5.042	30.087	28.592	1.495	95.032
3.001	12.049	5.672	6.042	36.161	34.271	1.891	94.772
3.001	14.100	5.673	7.044	42.317	39.962	2.355	94.436
3.001	16.185	5.675	8.044	48.570	45.647	2.923	93.982
3.001	18.296	5.676	9.046	54.903	51.342	3.561	93.514
3.001	20.437	5.677	10.046	61.323	57.034	4.290	93.005
3.000	22.614	5.679	11.046	67.850	62.728	5.122	92.451
3.000	24.827	5.680	12.044	74.489	68.413	6.076	91.844
3.000	27.084	5.682	13.048	81.259	74.138	7.121	91.236
3.000	29.381	5.684	14.048	88.140	79.844	8.296	90.587
3.000	31.724	5.686	15.048	95.169	85.559	9.611	89.902
3.650	0.127	5.666	-0.004	0.464	-0.023	0.486	-4.888
3.650	0.908	5.666	0.496	3.314	2.810	0.504	84.790
3.650	1.689	5.666	0.996	6.165	5.643	0.522	91.538
3.650	2.473	5.667	1.496	9.027	8.477	0.550	93.910
3.650	3.260	5.667	1.996	11.900	11.312	0.588	95.058
3.650	4.049	5.667	2.496	14.780	14.145	0.635	95.707
3.650	4.852	5.668	2.996	17.711	16.980	0.731	95.872
3.650	5.650	5.668	3.496	20.623	19.815	0.808	96.080
3.650	6.522	5.668	4.042	23.805	22.911	0.894	96.246
3.650	7.326	5.669	4.540	26.741	25.736	1.005	96.241
3.650	8.132	5.669	5.040	29.684	28.571	1.112	96.252
3.650	9.757	5.670	6.040	35.612	34.246	1.366	96.164
3.650	11.397	5.671	7.042	41.595	39.933	1.663	96.002
3.650	13.053	5.671	8.044	47.641	45.619	2.022	95.755
3.650	14.720	5.672	9.044	53.725	51.298	2.426	95.484
3.650	16.403	5.673	10.044	59.867	56.980	2.886	95.179

3.650	18.101	5.674	11.044	66.060	62.662	3.398	94.856
3.649	19.812	5.675	12.044	72.304	68.348	3.956	94.528
3.649	21.546	5.676	13.044	78.630	74.035	4.596	94.156
3.649	23.298	5.677	14.046	85.021	79.736	5.285	93.784
3.649	25.069	5.678	15.048	91.475	85.440	6.035	93.403
4.299	0.081	5.664	-0.004	0.348	-0.023	0.371	-6.506
4.299	0.742	5.664	0.496	3.190	2.809	0.381	88.056
4.299	1.404	5.664	0.996	6.036	5.641	0.395	93.455
4.299	2.067	5.664	1.496	8.886	8.474	0.412	95.359
4.299	2.733	5.665	1.998	11.750	11.318	0.432	96.326
4.299	3.403	5.665	2.496	14.630	14.139	0.491	96.645
4.299	4.076	5.665	2.996	17.523	16.972	0.550	96.859
4.299	4.748	5.665	3.498	20.412	19.817	0.595	97.086
4.299	5.480	5.666	4.040	23.558	22.889	0.668	97.162
4.299	6.154	5.666	4.538	26.457	25.712	0.746	97.182
4.299	6.832	5.666	5.040	29.372	28.557	0.815	97.226
4.299	8.191	5.666	6.040	35.212	34.225	0.987	97.197
4.299	9.559	5.667	7.040	41.093	39.894	1.198	97.083
4.299	10.935	5.667	8.042	47.008	45.576	1.431	96.955
4.299	12.321	5.668	9.042	52.963	51.254	1.709	96.773
4.299	13.712	5.669	10.044	58.943	56.936	2.007	96.596
4.298	15.111	5.669	11.042	64.954	62.599	2.355	96.374
4.298	16.518	5.670	12.042	71.002	68.276	2.726	96.161
4.298	17.939	5.670	13.046	77.109	73.973	3.136	95.933
4.298	19.365	5.671	14.046	83.236	79.655	3.581	95.698
4.298	20.802	5.672	15.048	89.414	85.350	4.065	95.454

4.9 6.33V Output Efficiency Results

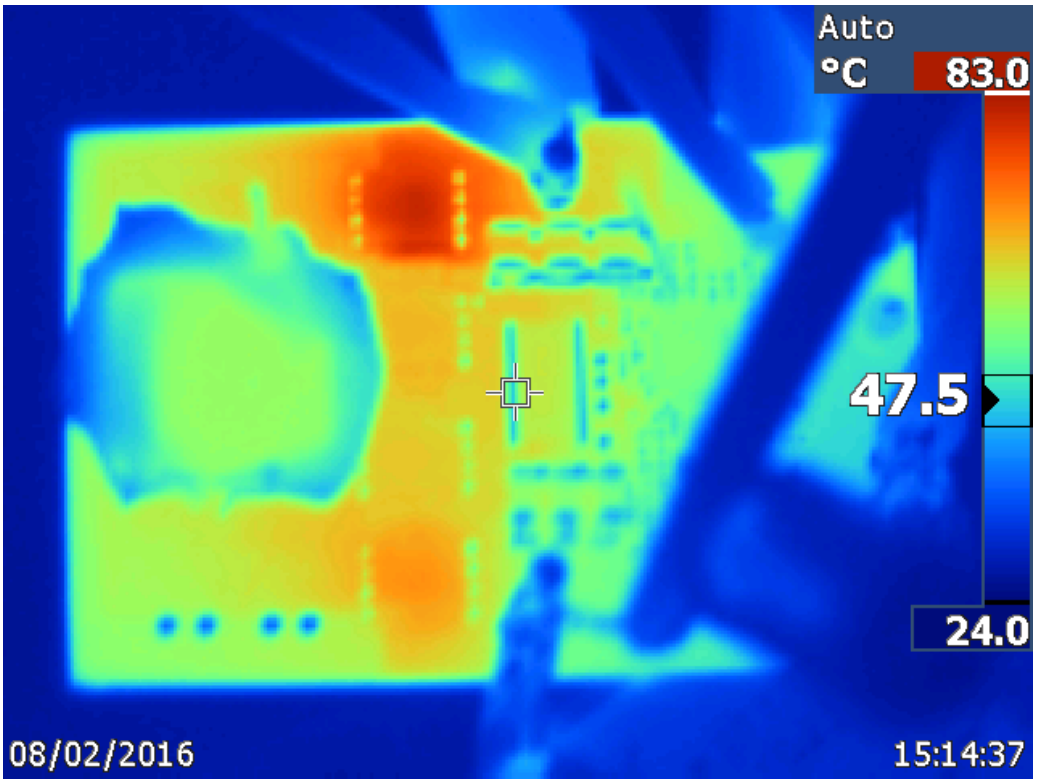


4.10 6.33V Output Efficiency Data

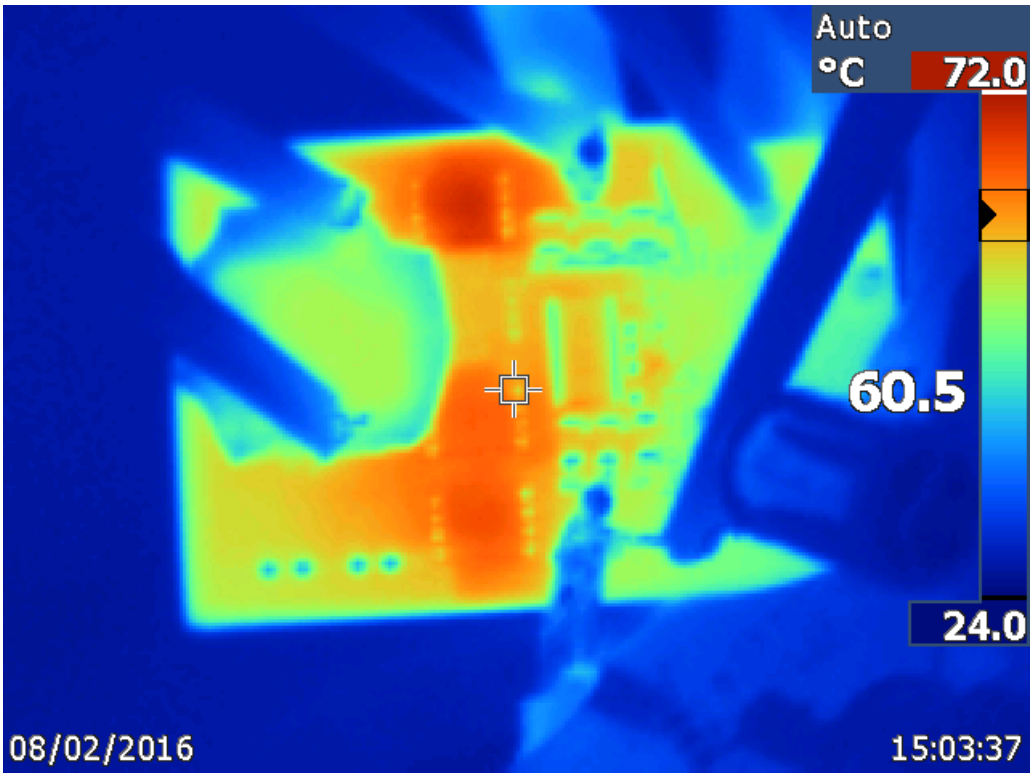
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Losses(W)	Efficiency
3.001	0.209	6.335	-0.004	0.627	-0.025	0.653	-4.039
3.001	1.273	6.336	0.496	3.821	3.142	0.678	82.246
3.001	2.340	6.336	0.996	7.023	6.311	0.712	89.864
3.001	3.414	6.337	1.496	10.246	9.480	0.766	92.524
3.001	4.495	6.338	1.996	13.491	12.650	0.840	93.772
3.001	5.596	6.339	2.496	16.794	15.821	0.973	94.206
3.001	6.694	6.339	2.996	20.088	18.992	1.096	94.544
3.001	7.800	6.340	3.496	23.407	22.163	1.244	94.685
3.001	9.018	6.340	4.044	27.061	25.640	1.421	94.748
3.001	10.140	6.341	4.542	30.430	28.802	1.628	94.650
3.001	11.271	6.342	5.042	33.825	31.976	1.849	94.534
3.001	13.557	6.343	6.042	40.682	38.327	2.354	94.213
3.001	15.880	6.345	7.042	47.648	44.680	2.968	93.771
3.001	18.246	6.347	8.044	54.748	51.053	3.696	93.250
3.000	20.647	6.348	9.042	61.950	57.398	4.552	92.653
3.000	23.093	6.350	10.046	69.284	63.790	5.494	92.070
3.000	25.583	6.352	11.046	76.745	70.159	6.586	91.418
3.000	28.122	6.353	12.046	84.364	76.531	7.833	90.715
3.000	30.718	6.356	13.046	92.145	82.915	9.230	89.983

3.650	0.165	6.335	-0.004	0.602	-0.025	0.628	-4.207
3.650	1.038	6.335	0.496	3.789	3.142	0.646	82.937
3.650	1.913	6.336	0.996	6.983	6.310	0.672	90.370
3.650	2.791	6.336	1.496	10.187	9.479	0.708	93.052
3.650	3.672	6.337	1.996	13.403	12.648	0.755	94.366
3.650	4.559	6.337	2.496	16.641	15.817	0.824	95.049
3.650	5.458	6.337	2.998	19.923	18.999	0.924	95.364
3.650	6.354	6.338	3.496	23.192	22.158	1.034	95.542
3.650	7.334	6.338	4.042	26.769	25.620	1.149	95.708
3.650	8.236	6.339	4.542	30.060	28.790	1.270	95.776
3.650	9.145	6.339	5.042	33.377	31.962	1.415	95.760
3.650	10.974	6.340	6.040	40.052	38.295	1.756	95.614
3.650	12.821	6.341	7.040	46.792	44.643	2.149	95.407
3.650	14.690	6.342	8.042	53.613	51.004	2.609	95.133
3.649	16.575	6.343	9.044	60.489	57.367	3.122	94.838
3.649	18.482	6.344	10.044	67.444	63.723	3.721	94.483
3.649	20.407	6.346	11.044	74.473	70.080	4.393	94.101
3.649	22.355	6.347	12.044	81.577	76.438	5.138	93.701
3.649	24.329	6.348	13.046	88.780	82.819	5.961	93.285
4.299	0.119	6.333	-0.004	0.512	-0.025	0.537	-4.952
4.299	0.860	6.334	0.496	3.697	3.141	0.556	84.968
4.299	1.600	6.334	0.996	6.879	6.309	0.570	91.707
4.299	2.342	6.334	1.496	10.068	9.476	0.592	94.116
4.299	3.088	6.335	1.996	13.275	12.644	0.632	95.242
4.299	3.835	6.335	2.496	16.487	15.812	0.676	95.902
4.299	4.589	6.335	2.996	19.728	18.980	0.748	96.209
4.299	5.346	6.335	3.496	22.982	22.147	0.835	96.367
4.299	6.167	6.336	4.040	26.511	25.597	0.915	96.550
4.299	6.924	6.336	4.540	29.765	28.765	1.000	96.641
4.299	7.684	6.336	5.040	33.032	31.935	1.098	96.677
4.299	9.214	6.337	6.040	39.608	38.275	1.333	96.635
4.299	10.753	6.337	7.040	46.222	44.615	1.607	96.523
4.298	12.304	6.338	8.044	52.888	50.986	1.902	96.403
4.298	13.865	6.339	9.044	59.599	57.330	2.269	96.193
4.298	15.435	6.340	10.044	66.343	63.677	2.666	95.982
4.298	17.015	6.340	11.044	73.134	70.024	3.110	95.748
4.298	18.607	6.341	12.042	79.977	76.363	3.613	95.482
4.298	20.215	6.342	13.046	86.888	82.744	4.144	95.231

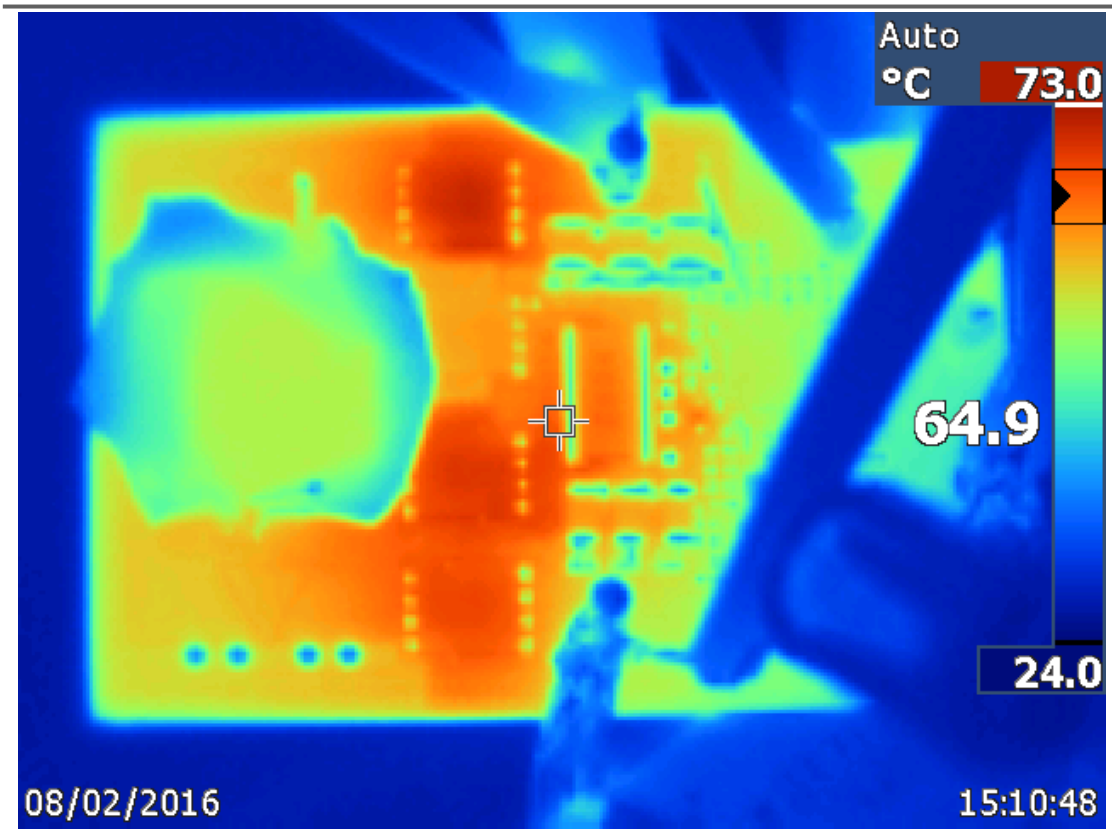
5 Thermal



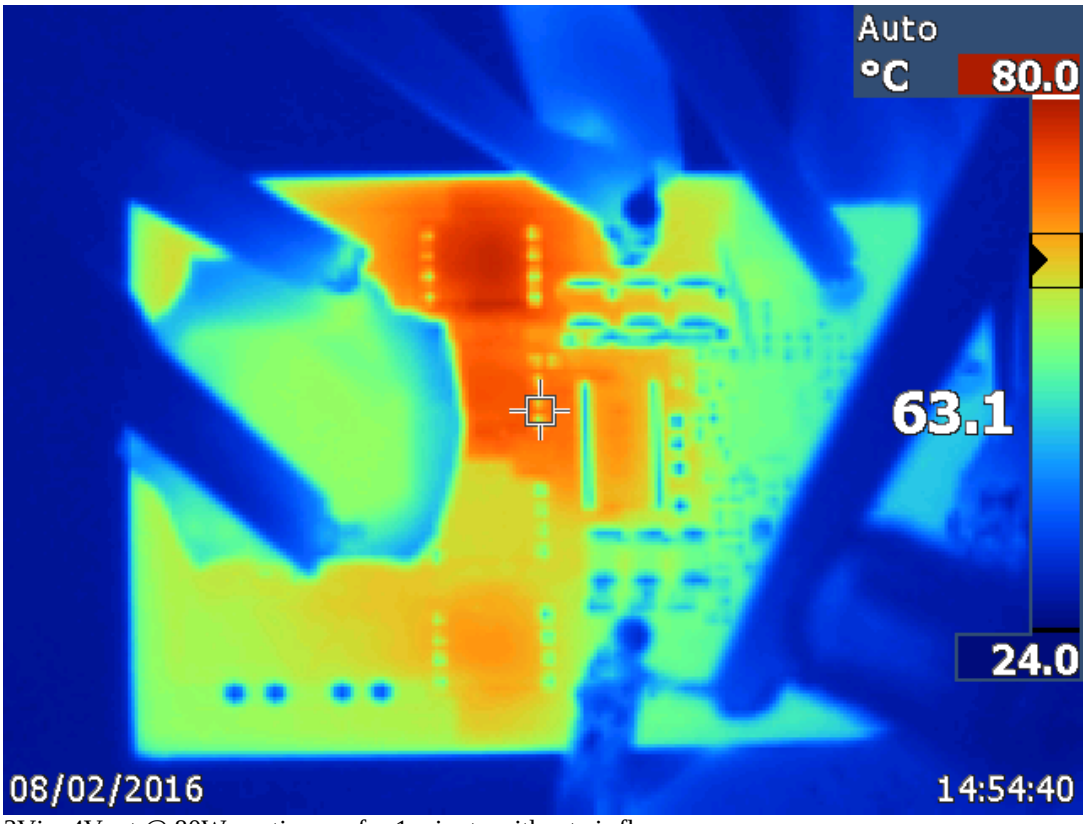
3Vin, 2.83Vout @ 80W continuous for 1 minute without air flow.



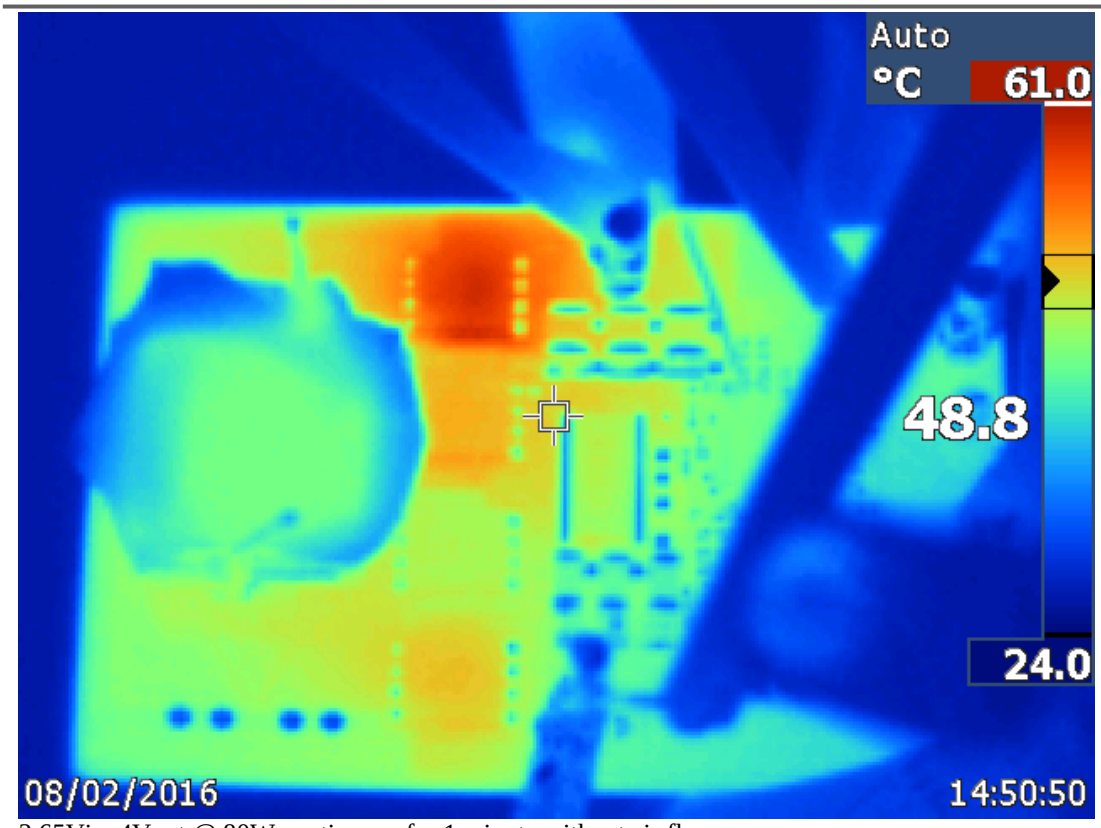
3.65Vin, 2.83Vout @ 80W continuous for 1 minute without air flow.



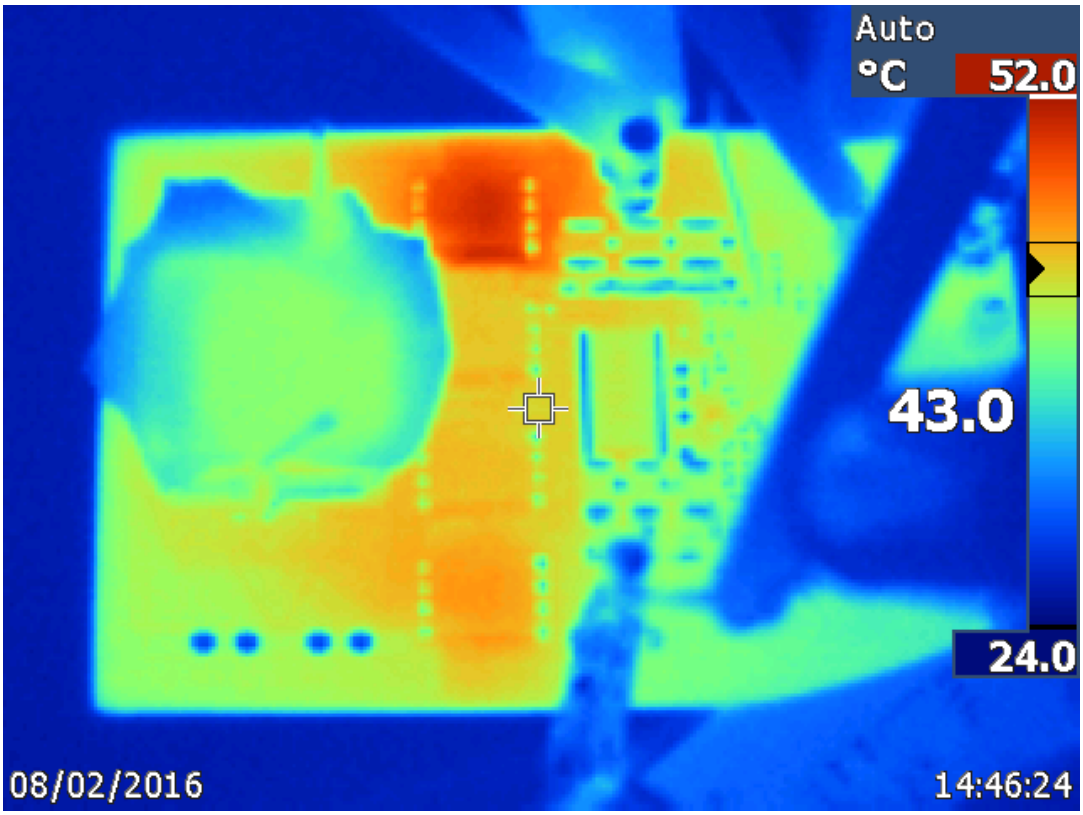
4.3Vin, 2.83Vout @ 80W continuous for 30 seconds without air flow.



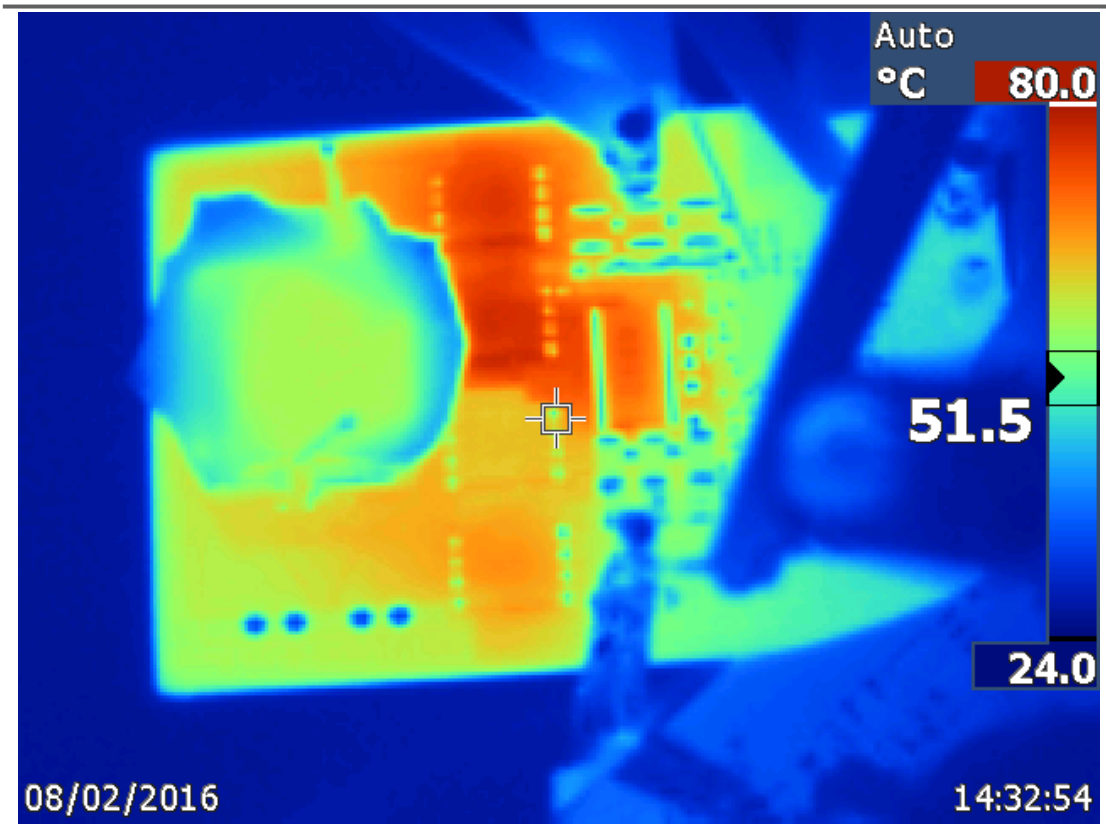
3Vin, 4Vout @ 80W continuous for 1 minute without air flow.



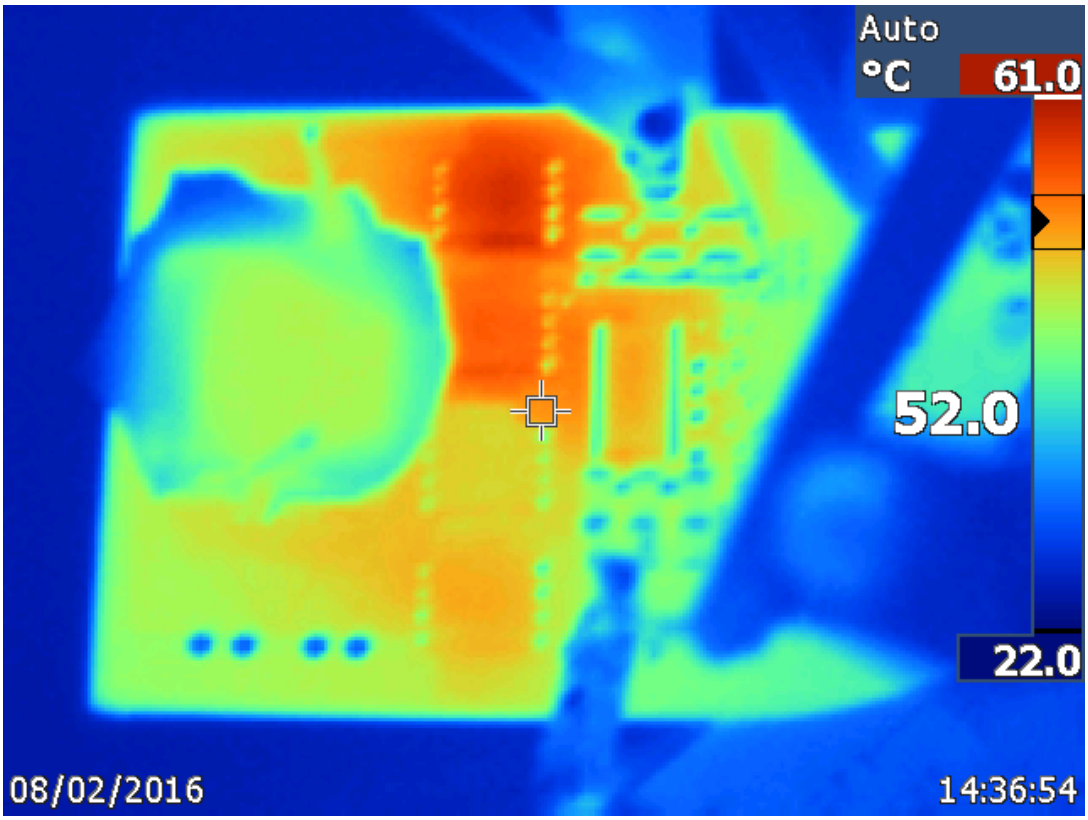
3.65Vin, 4Vout @ 80W continuous for 1 minute without air flow.



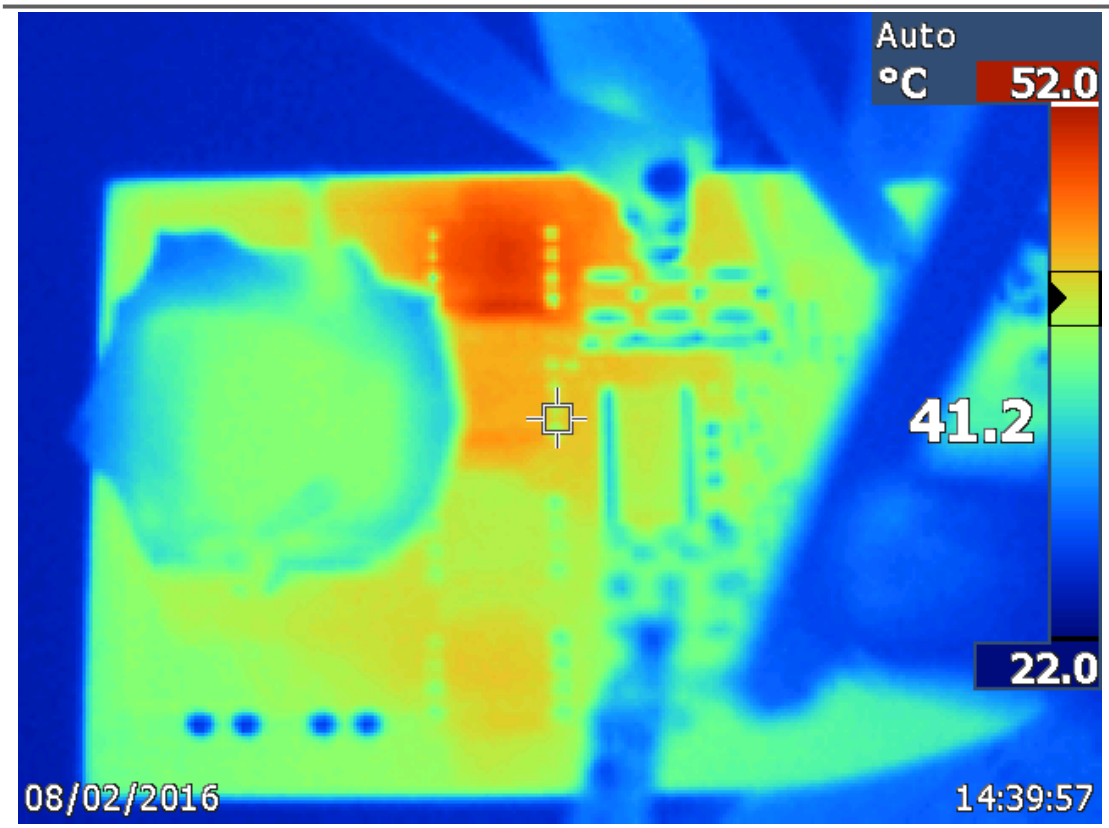
4.3Vin, 4Vout @ 80W continuous for 1 minute without air flow.



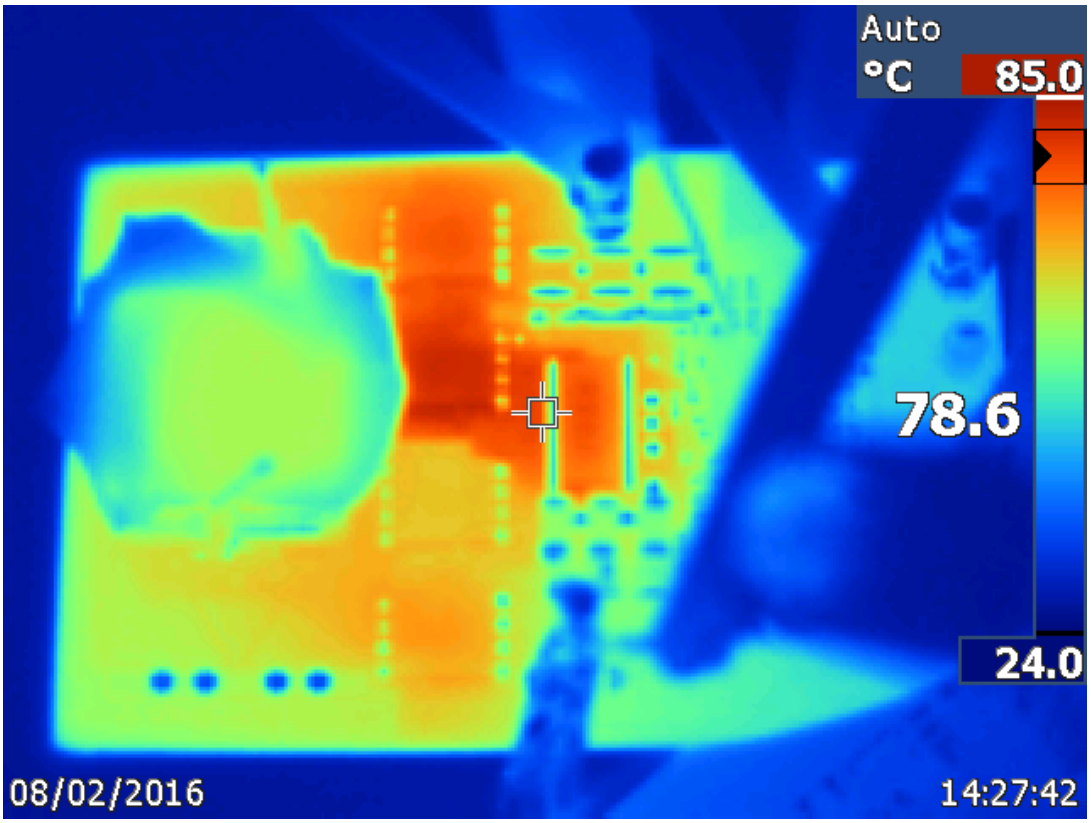
3Vin, 4.9Vout @ 80W continuous for 1 minute without air flow.



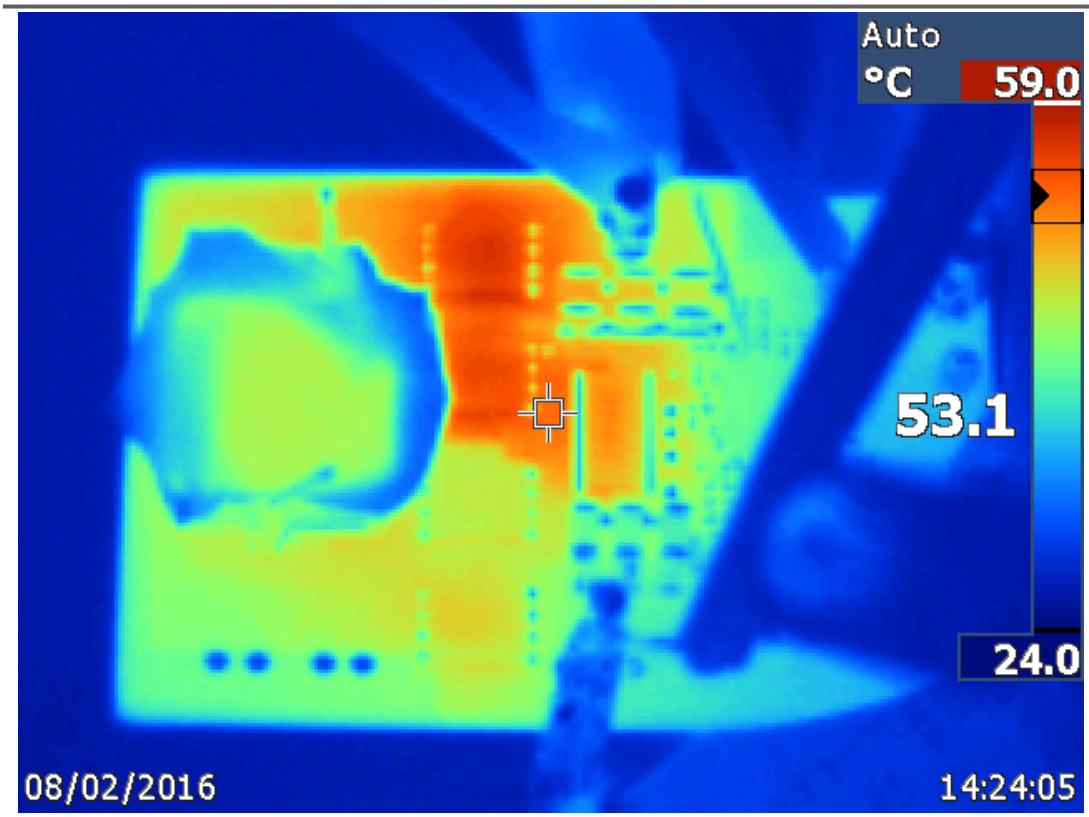
3.65Vin, 4.9Vout @ 80W continuous for 1 minute without air flow.



4.3Vin, 4.9Vout @ 80W continuous for 1 minute without air flow.



3Vin, 5.66Vout @ 80W continuous for 1 minute without air flow.



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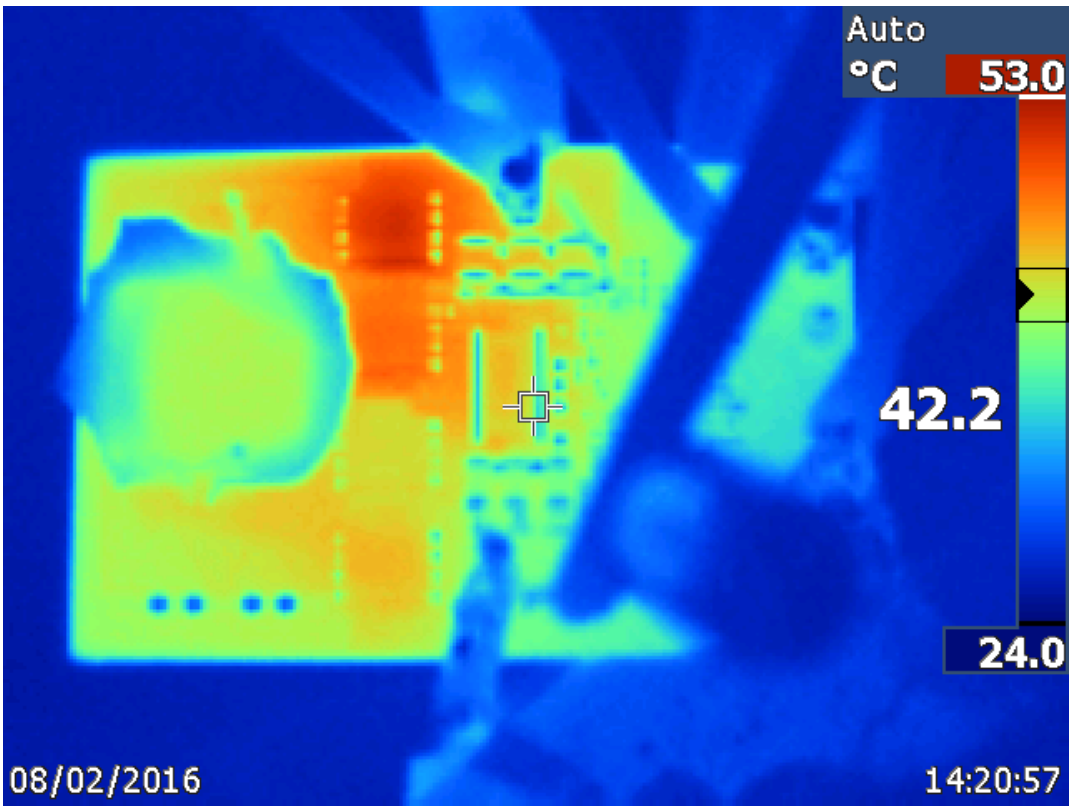
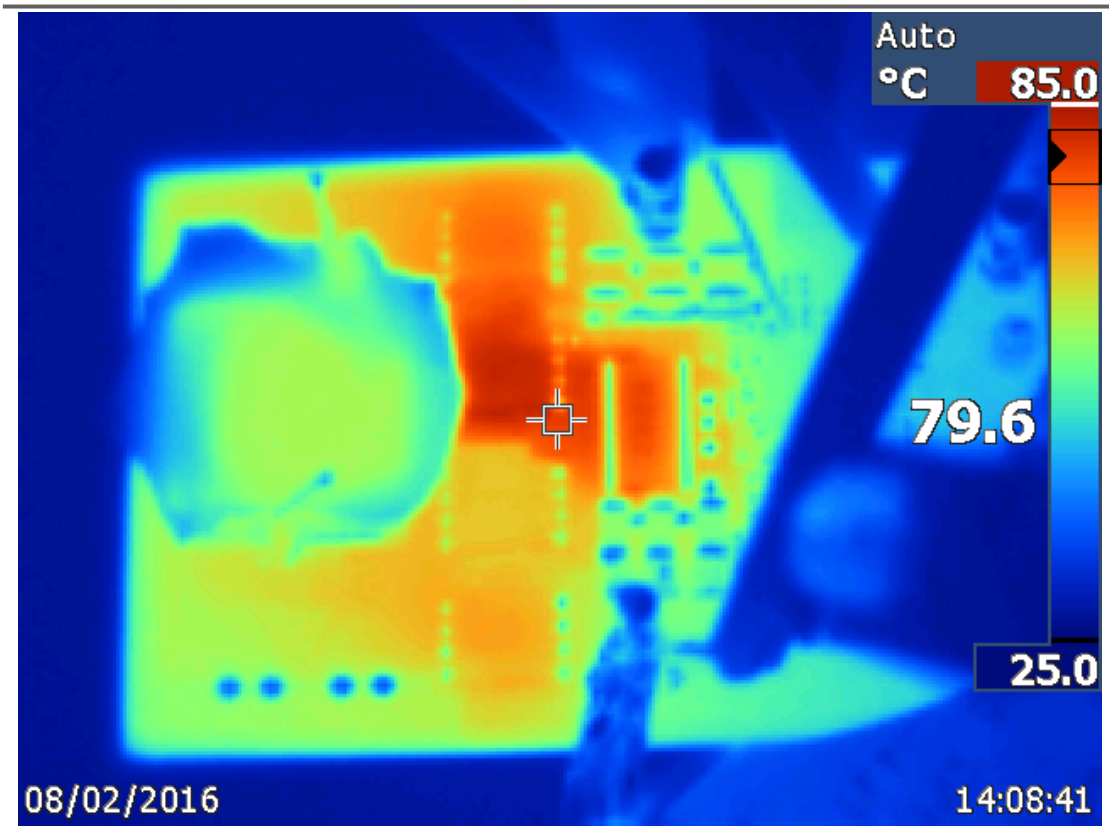
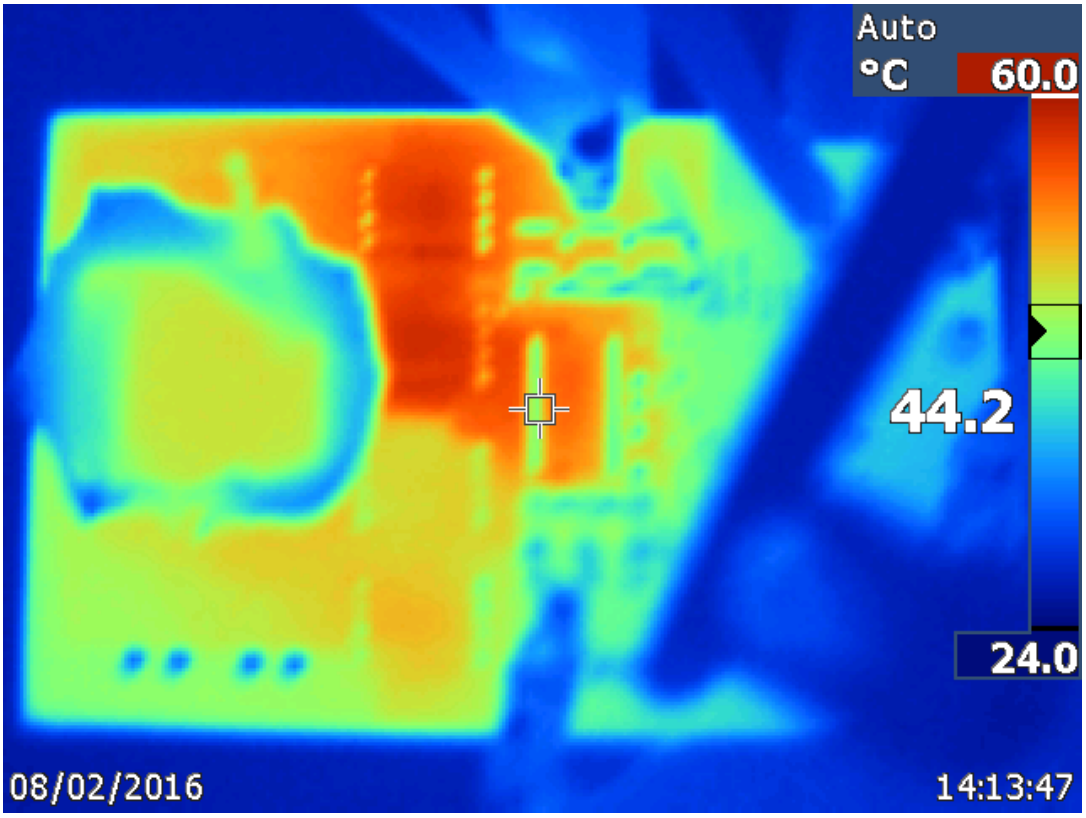


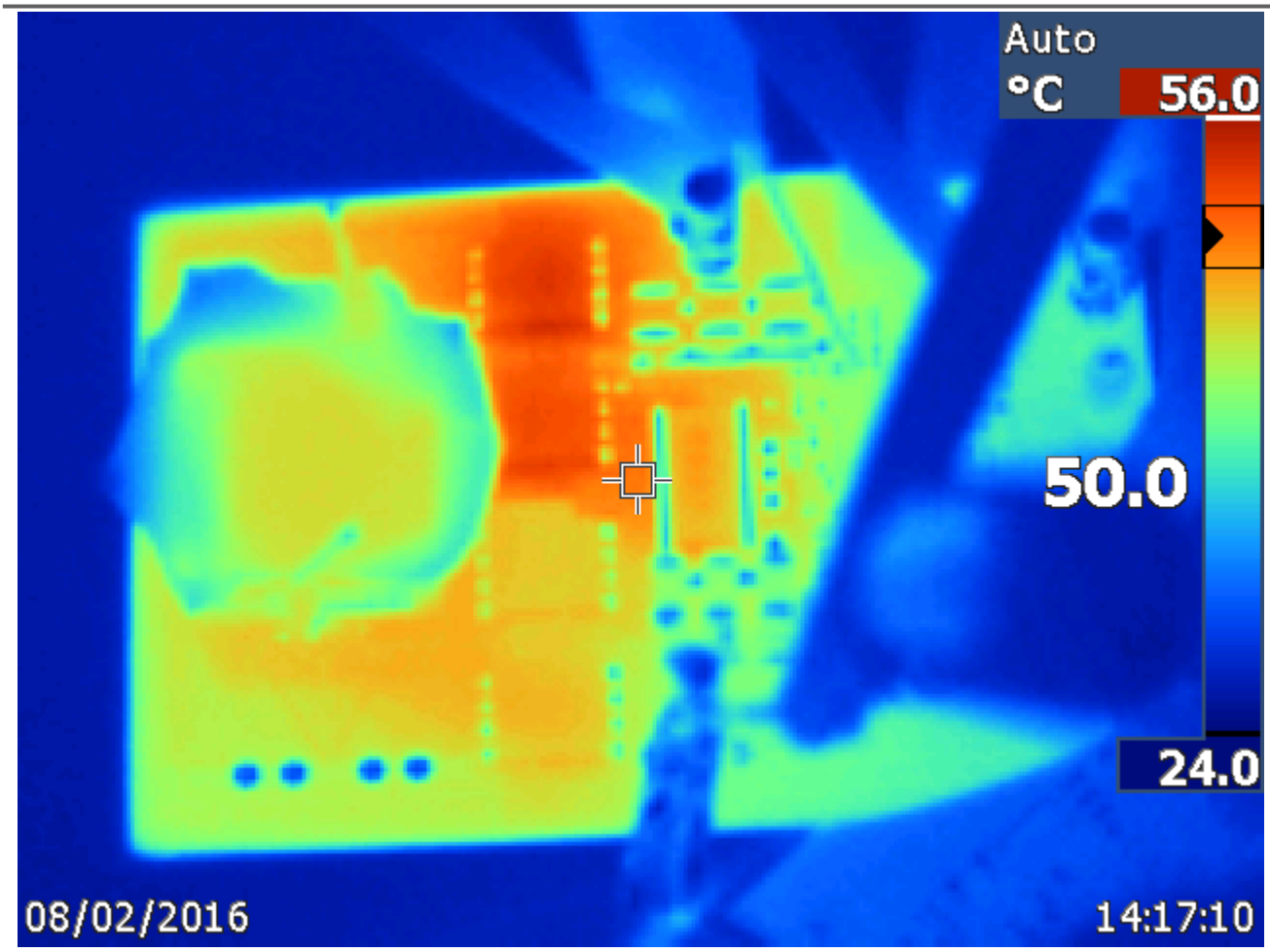
4.3Vin, 5.66Vout @ 80W continuous for 1 minute without air flow.



3Vin, 6.33Vout @ 80W continuous for 1 minute without air flow.



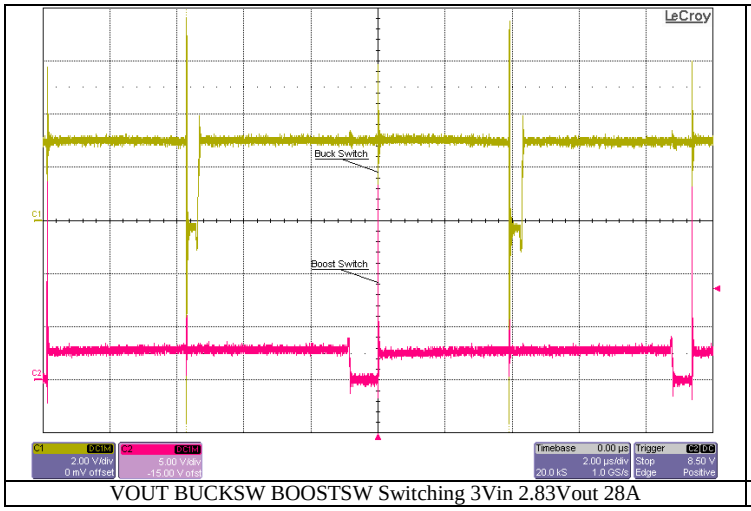
3.65Vin, 6.33Vout @ 80W continuous for 1 minute without air flow.



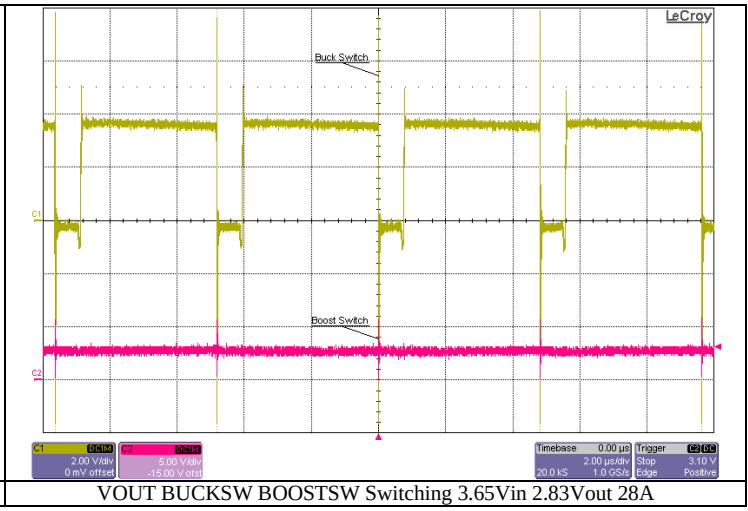
4.3Vin, 6.33Vout @ 80W continuous for 1 minute without air flow.

6 Switching

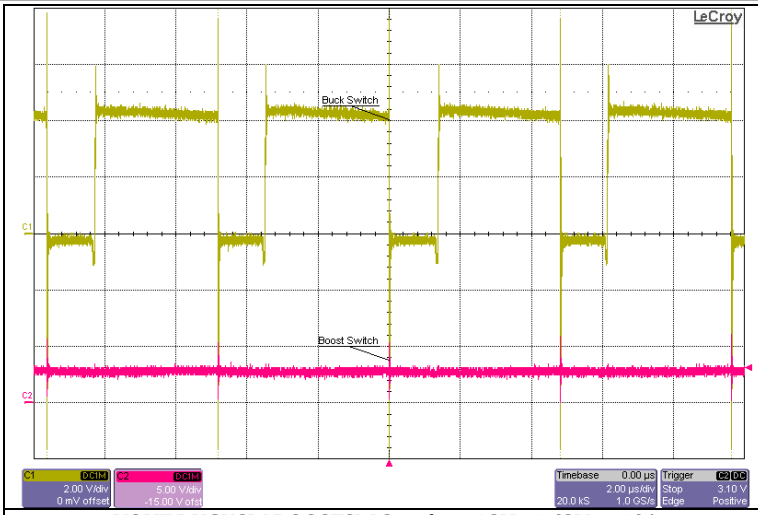
6.1 2.83V output



VOUT BUCKSW BOOSTSW Switching 3Vin 2.83Vout 28A

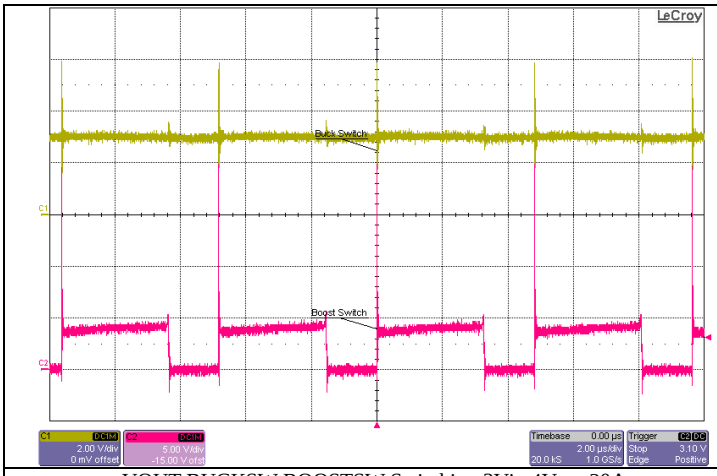


VOUT BUCKSW BOOSTSW Switching 3.65Vin 2.83Vout 28A

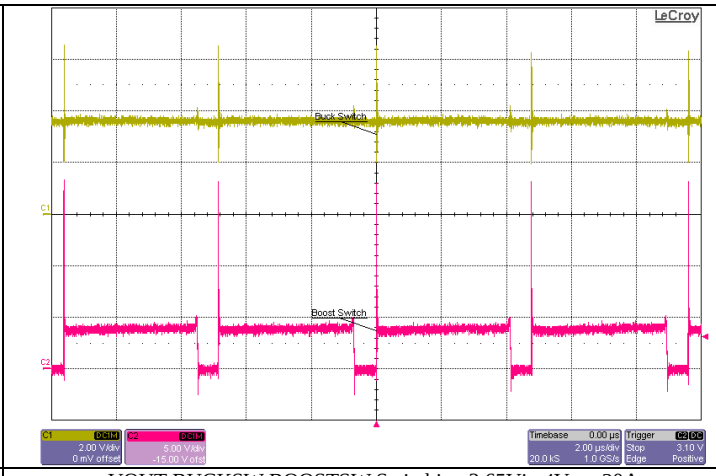


VOUT BUCKSW BOOSTSW Switching 4.3Vin 2.83Vout 28A

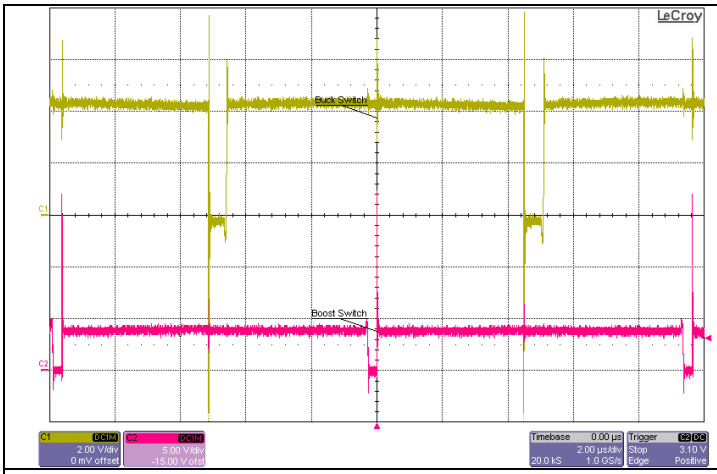
6.2 4V Output



VOUT BUCKSW BOOSTSW Switching 3Vin 4Vout 20A

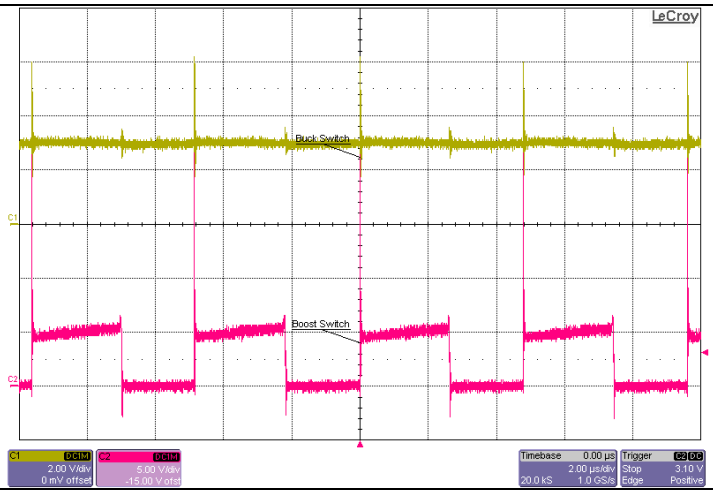


VOUT BUCKSW BOOSTSW Switching 3.65Vin 4Vout 20A

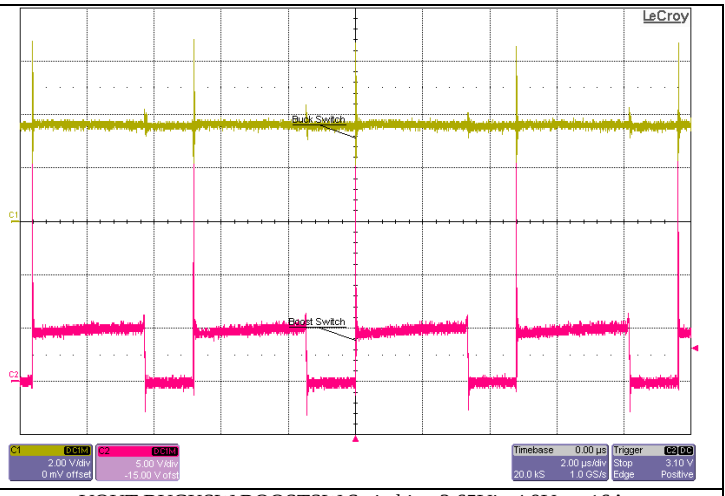


VOUT BUCKSW BOOSTSW Switching 4.3Vin 4Vout 20A

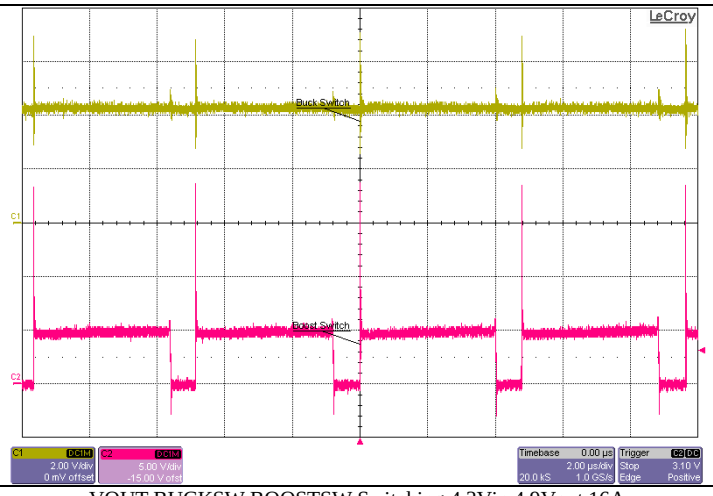
6.3 4.9V Output



VOUT BUCKSW BOOSTSW Switching 3Vin 4.9Vout 16A

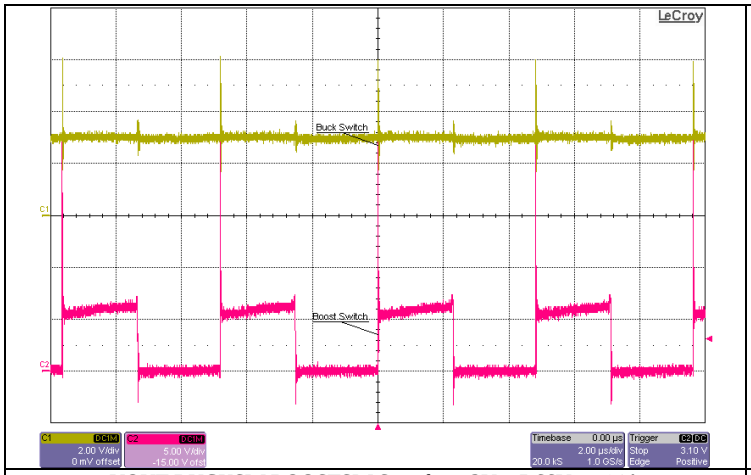


VOUT BUCKSW BOOSTSW Switching 3.65Vin 4.9Vout 16A

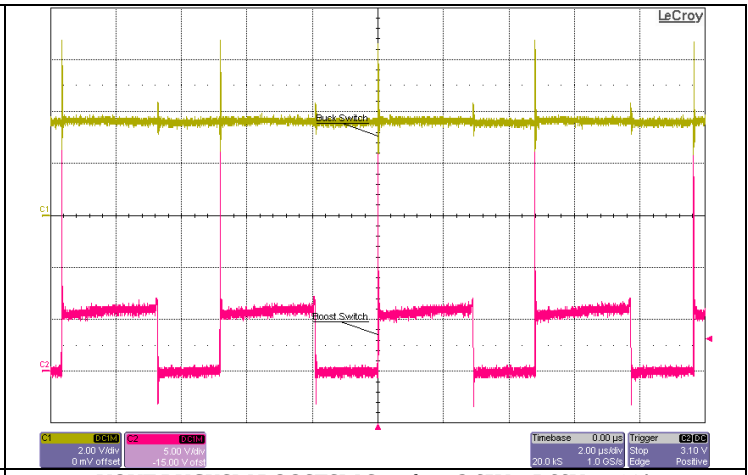


VOUT BUCKSW BOOSTSW Switching 4.3Vin 4.9Vout 16A

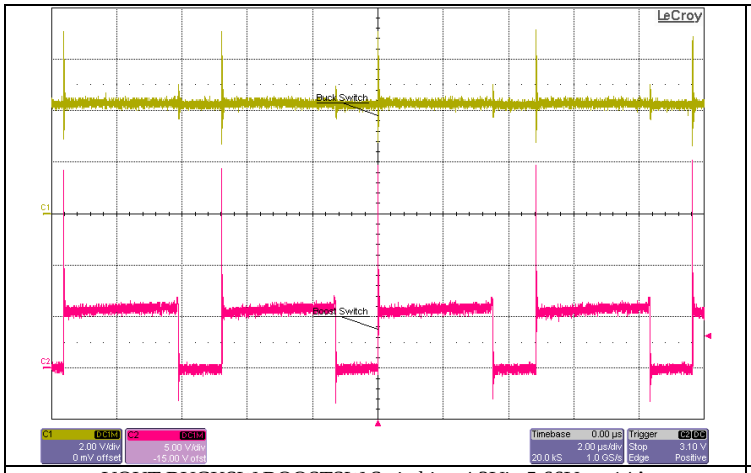
6.4 5.66V Output



VOUT BUCKSW BOOSTSW Switching 3Vin 5.66Vout 14A

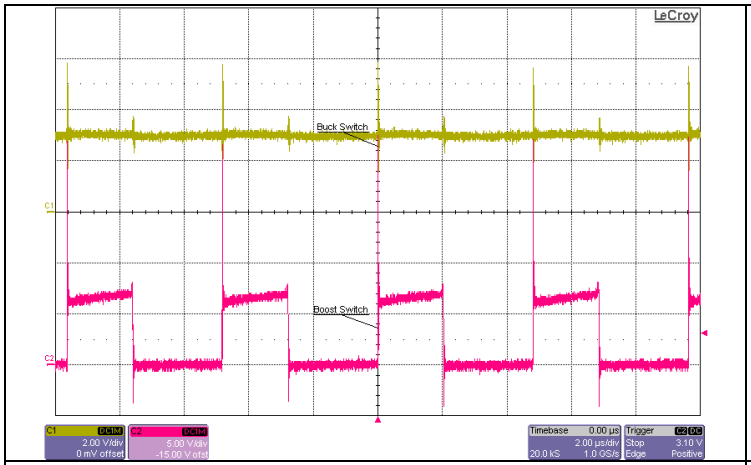


VOUT BUCKSW BOOSTSW Switching 3.65Vin 5.66Vout 14A

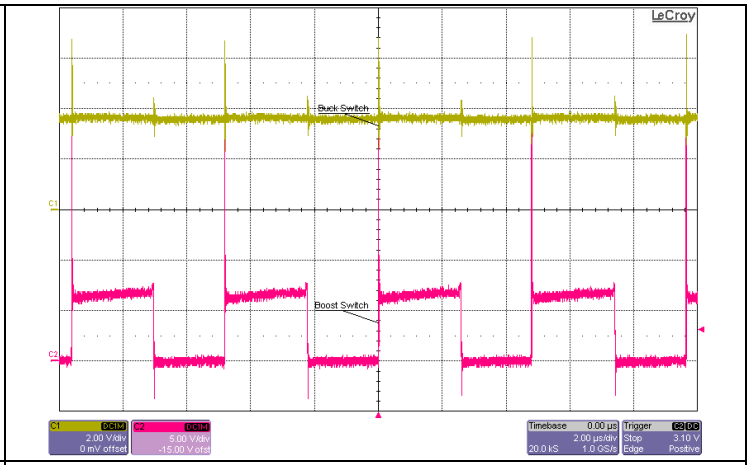


VOUT BUCKSW BOOSTSW Switching 4.3Vin 5.66Vout 14A

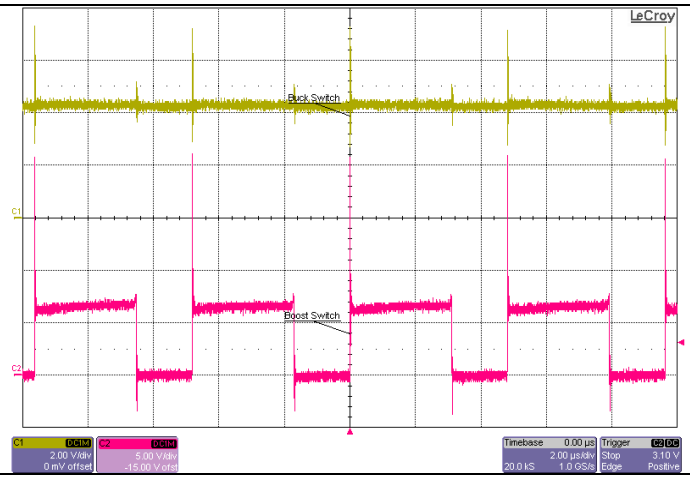
6.5 6.33V Output



VOUT BUCKSW BOOSTSW Switching 3Vin 6.33Vout 13A



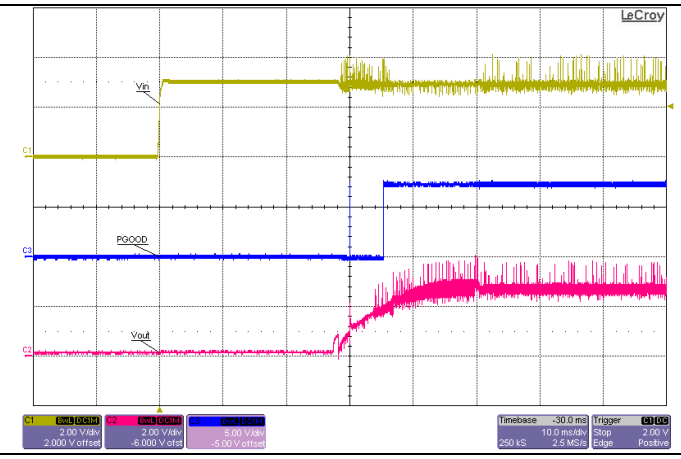
VOUT BUCKSW BOOSTSW Switching 3.65Vin 6.33Vout 13A



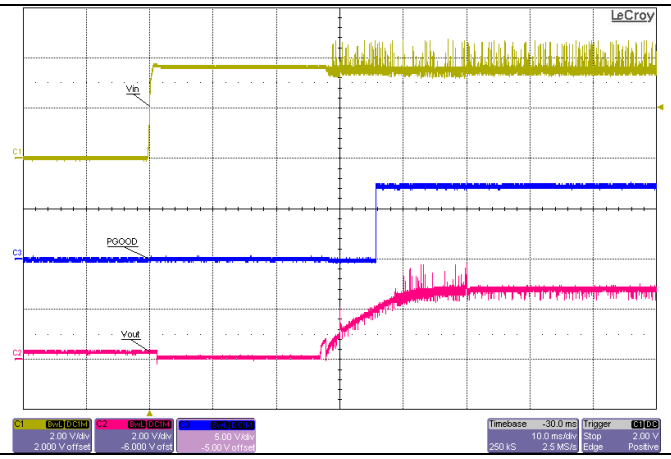
VOUT BUCKSW BOOSTSW Switching 4.3Vin 6.33Vout 13A

7 Start Up

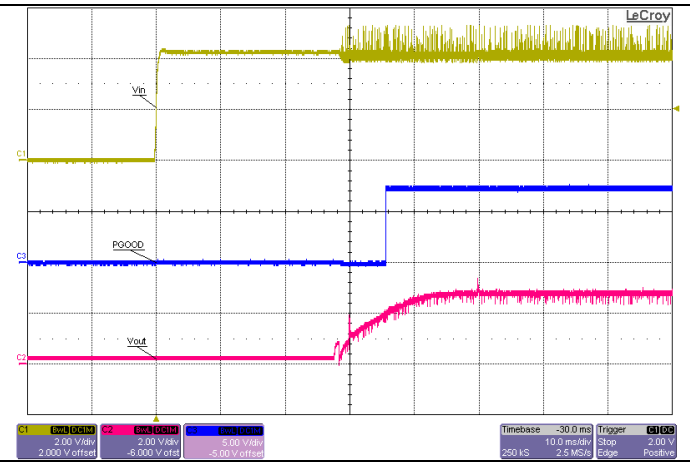
7.1 2.83V output



Full Load Start Up 3Vin 2.83Vout 28A

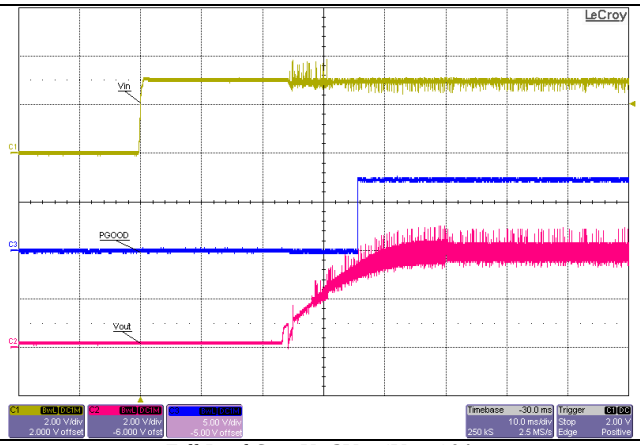


Full Load Start Up 3.65Vin 2.83Vout 28A

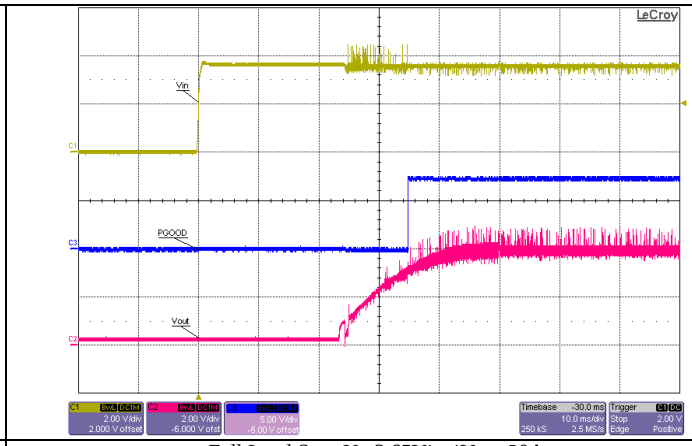


Full Load Start Up 4.3Vin 2.83Vout 28A

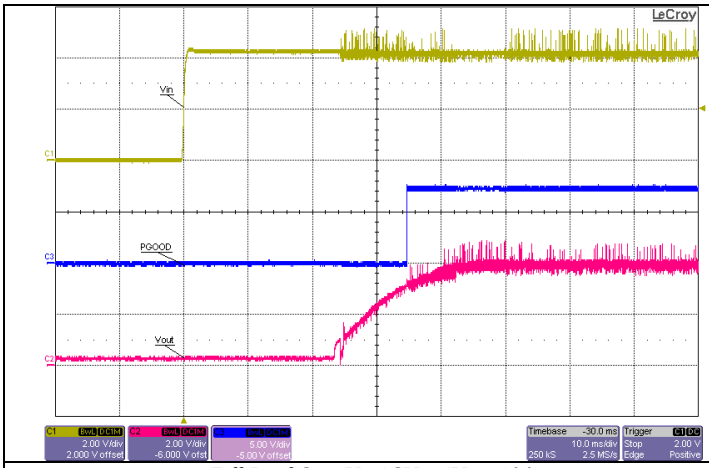
7.2 4V Output



Full Load Start Up 3Vin 4Vout 20A

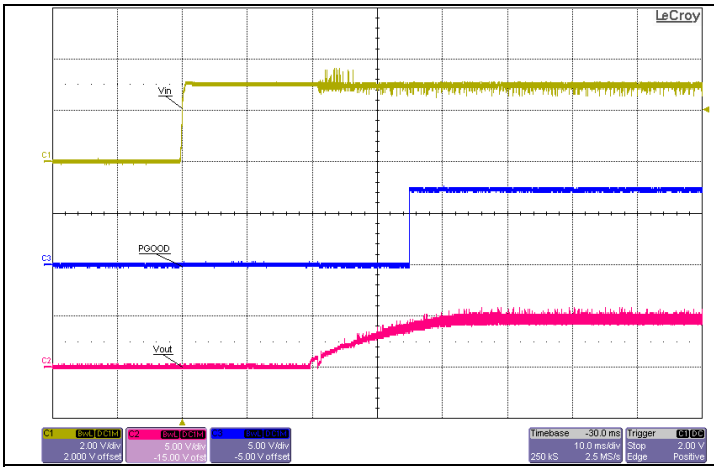


Full Load Start Up 3.65Vin 4Vout 20A

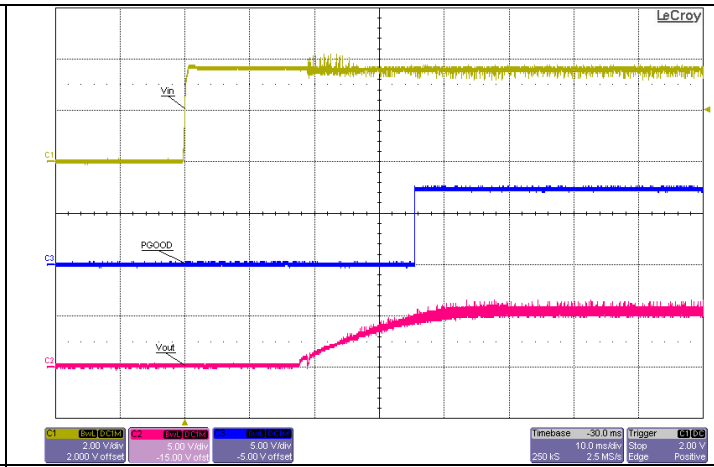


Full Load Start Up 4.3Vin 4Vout 20A

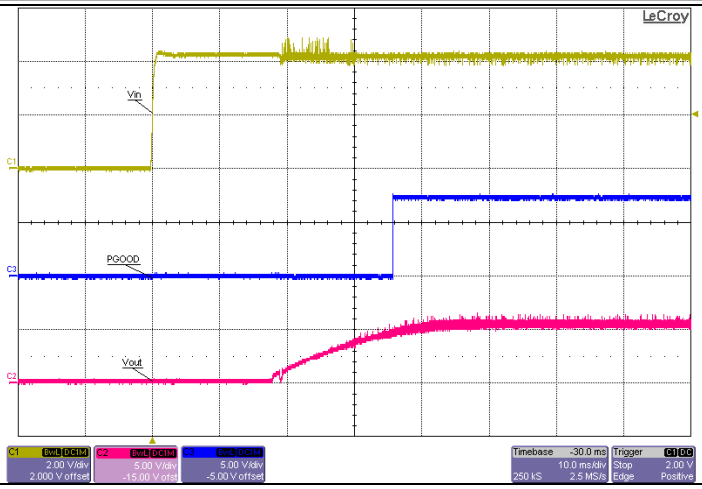
7.3 4.9V Output



Full Load Start Up 3Vin 4.9Vout 16A

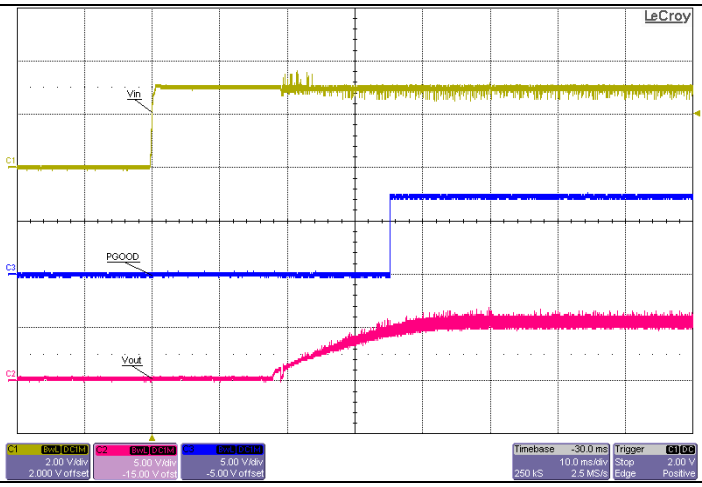


Full Load Start Up 3.64Vin 4.9Vout 16A

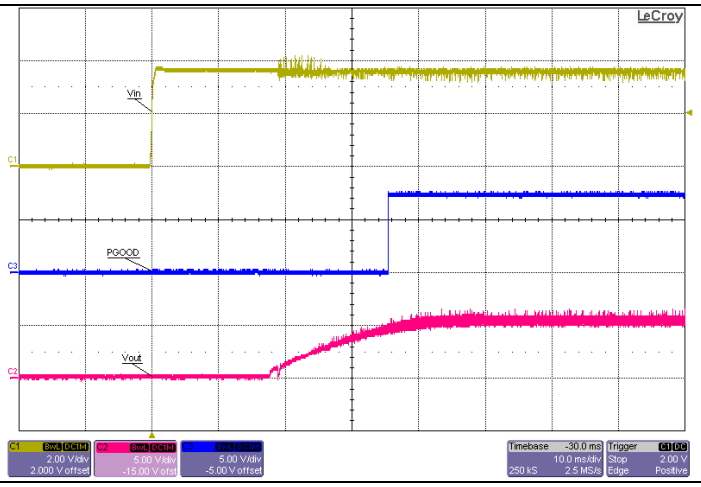


Full Load Start Up 4.3Vin 4.9Vout 16A

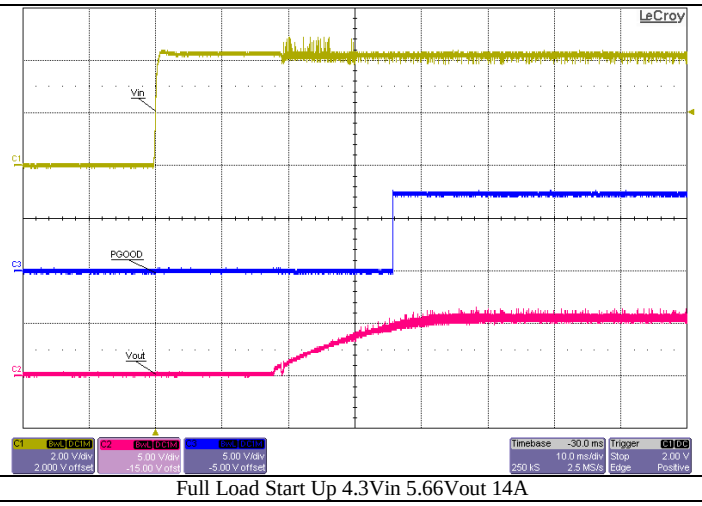
7.4 5.66V Output



Full Load Start Up 3Vin 5.66Vout 14A

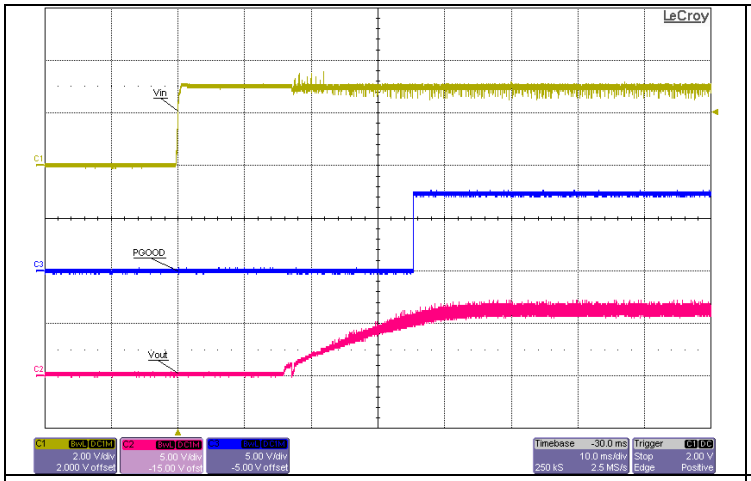


Full Load Start Up 3.65Vin 5.66Vout 14A

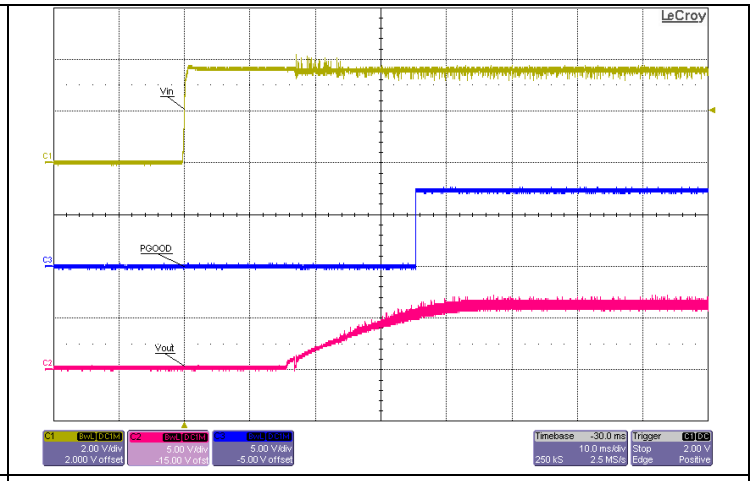


Full Load Start Up 4.3Vin 5.66Vout 14A

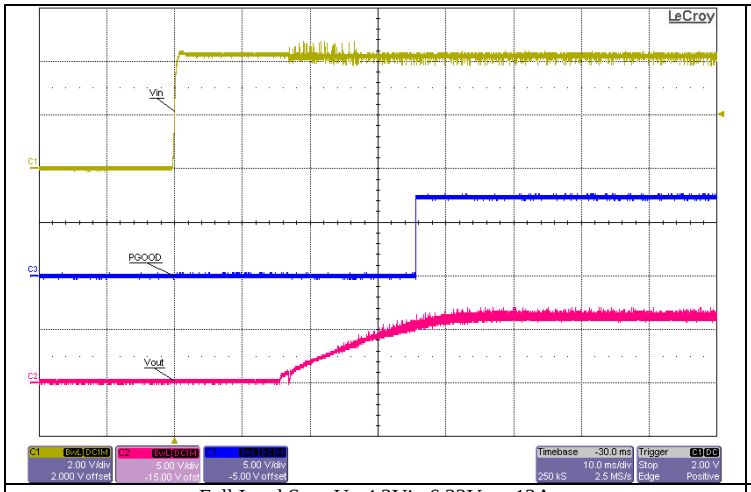
7.5 6.33V Output



Full Load Start Up 3Vin 6.33Vout 13A



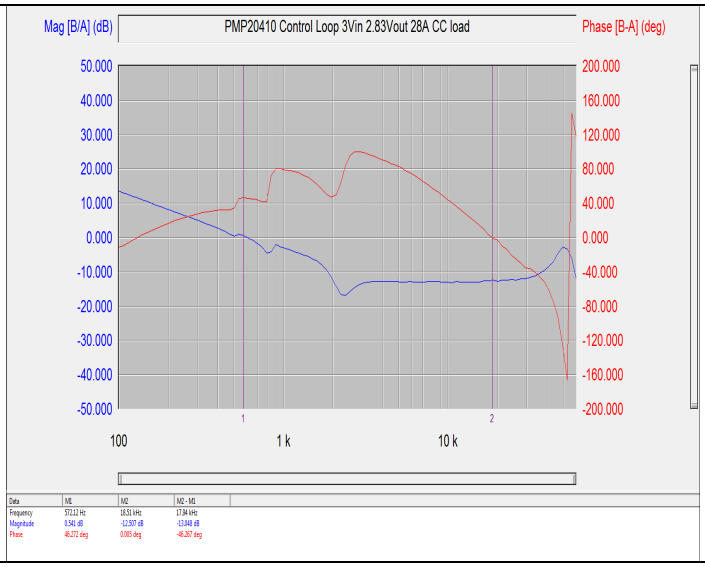
Full Load Start Up 3.65Vin 6.33Vout 13A



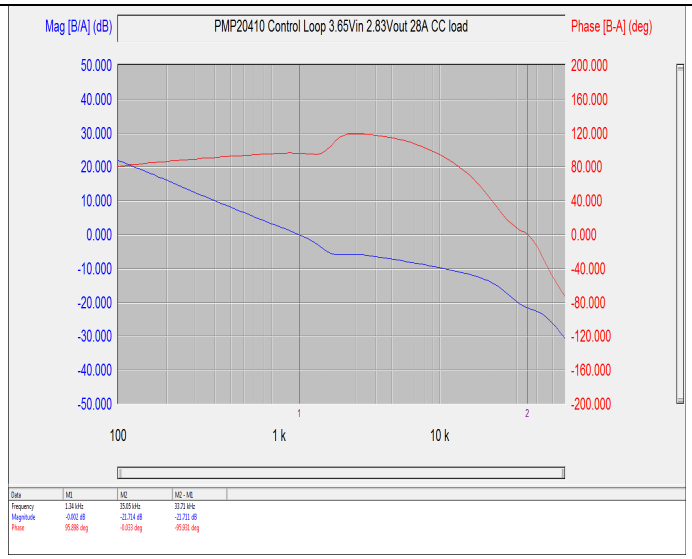
Full Load Start Up 4.3Vin 6.33Vout 13A

8 Frequency Response

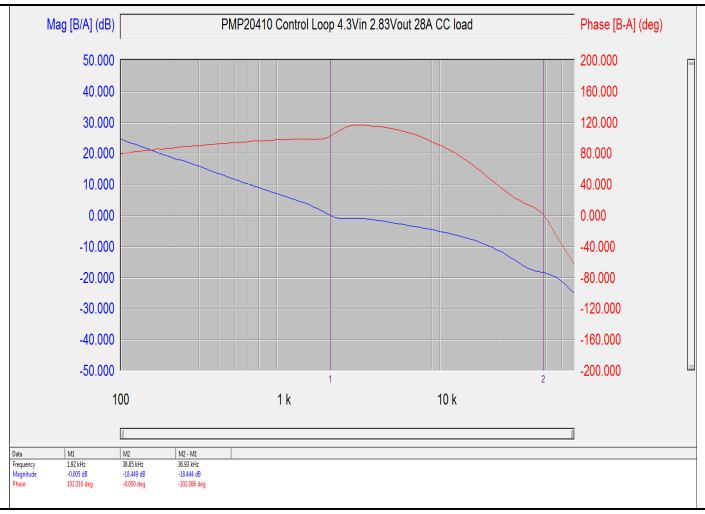
8.1 2.83V Output



Control Loop 3Vin 2.83Vout 28A CC load

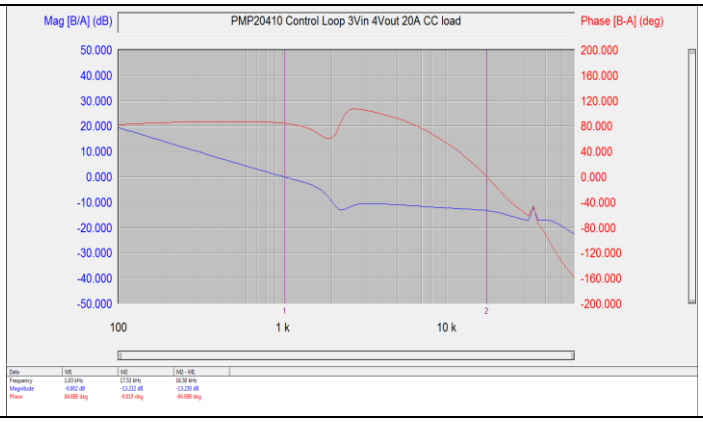


Control Loop 3.65Vin 2.83Vout 28A CC load

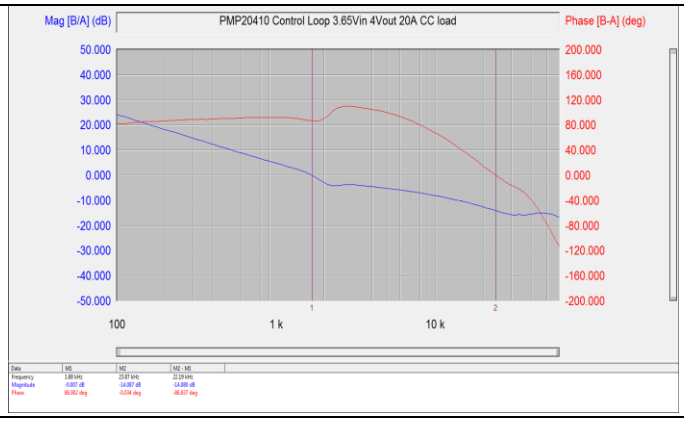


Control Loop 4.3Vin 2.83Vout 28A CC load

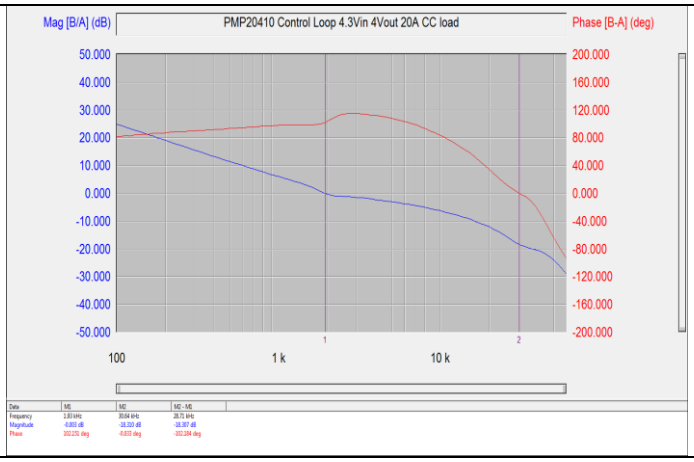
8.2 4V Output



Control Loop 3Vin 4Vout 20A CC load

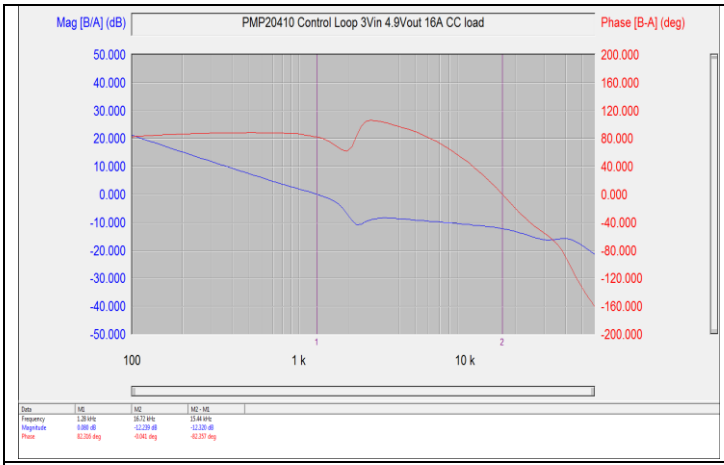


Control Loop 3.65Vin 4Vout 20A CC load

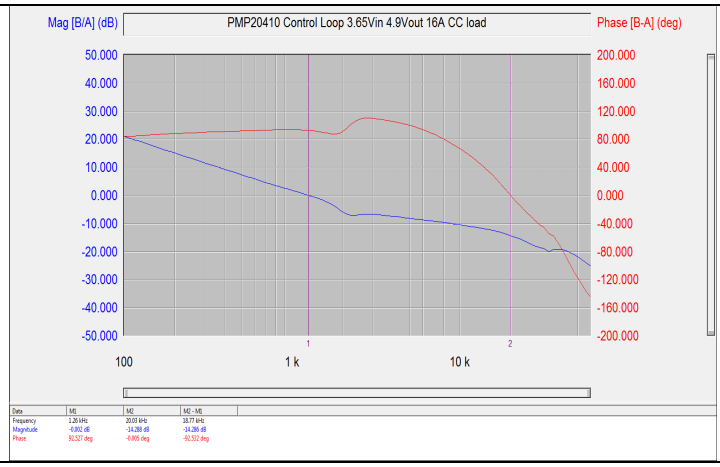


Control Loop 4.3Vin 4Vout 20A CC load

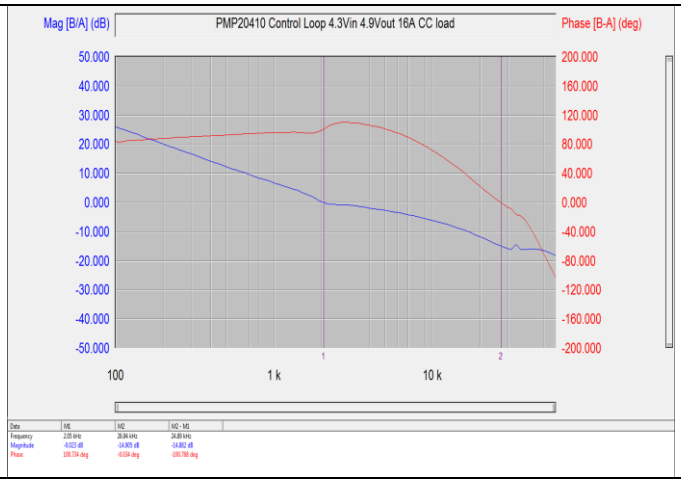
8.3 4.9V Output



Control Loop 3Vin 4.9Vout 16A CC load

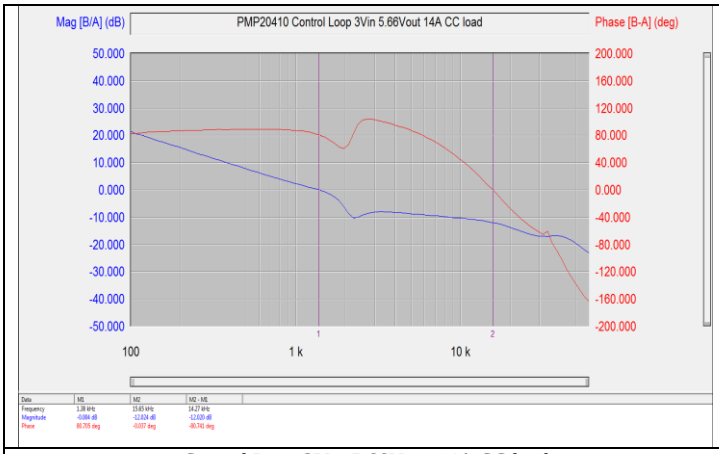


Control Loop 3.65Vin 4.9Vout 16A CC load

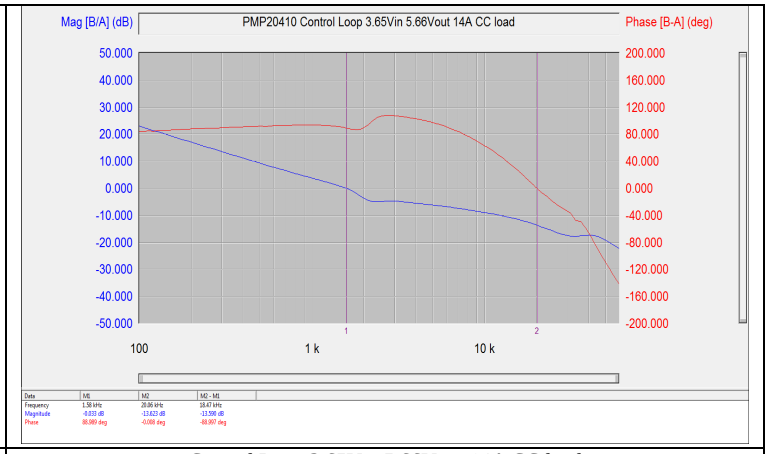


Control Loop 4.3Vin 4.9Vout 16A CC load

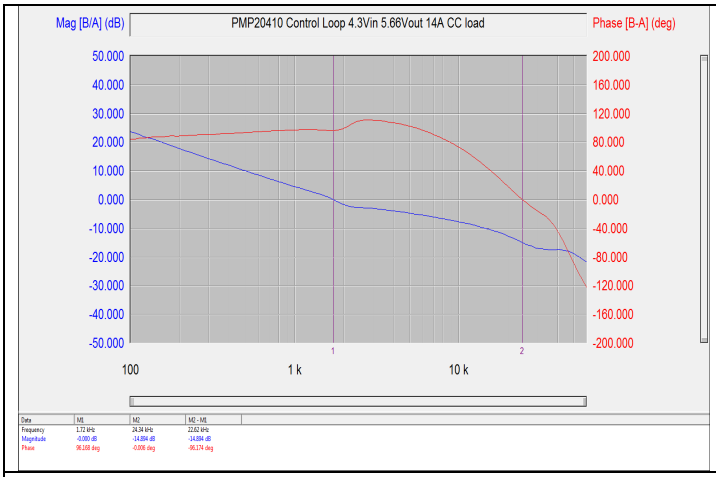
8.4 5.66V Output



Control Loop 3Vin 5.66Vout 14A CC load

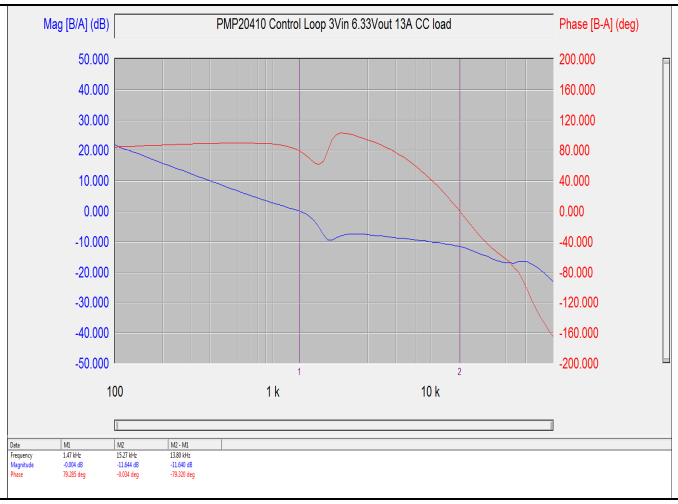


Control Loop 3.65Vin 5.66Vout 14A CC load

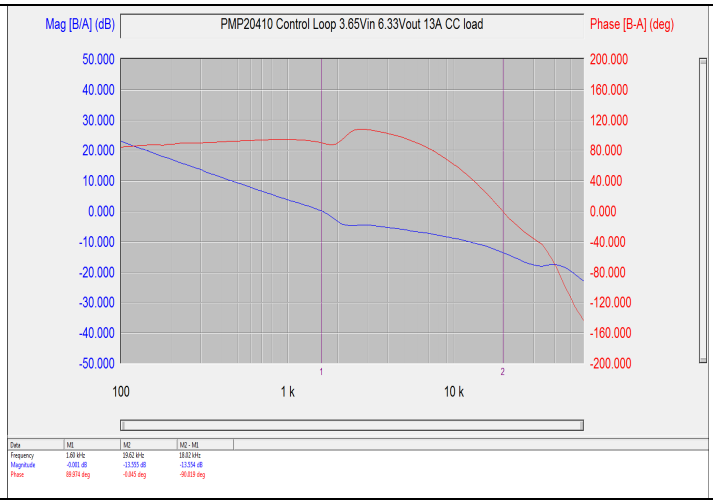


Control Loop 4.3Vin 5.66Vout 14A CC load

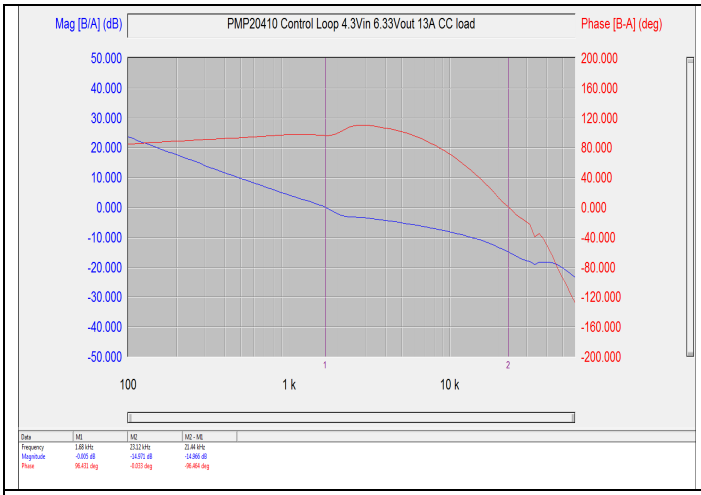
8.5 6.33V Output



Control Loop 3Vin 6.33Vout 13A CC load



Control Loop 3.65Vin 6.33Vout 13A CC load



Control Loop 4.3Vin 6.33Vout 13A CC load

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