LM5145 Synchronous Buck Converter

TI reference design number: PMP20178 Rev A

Input: 15V to 60V
Output: 5.2V @ 11A

DC – DC Test Results

Table of Contents

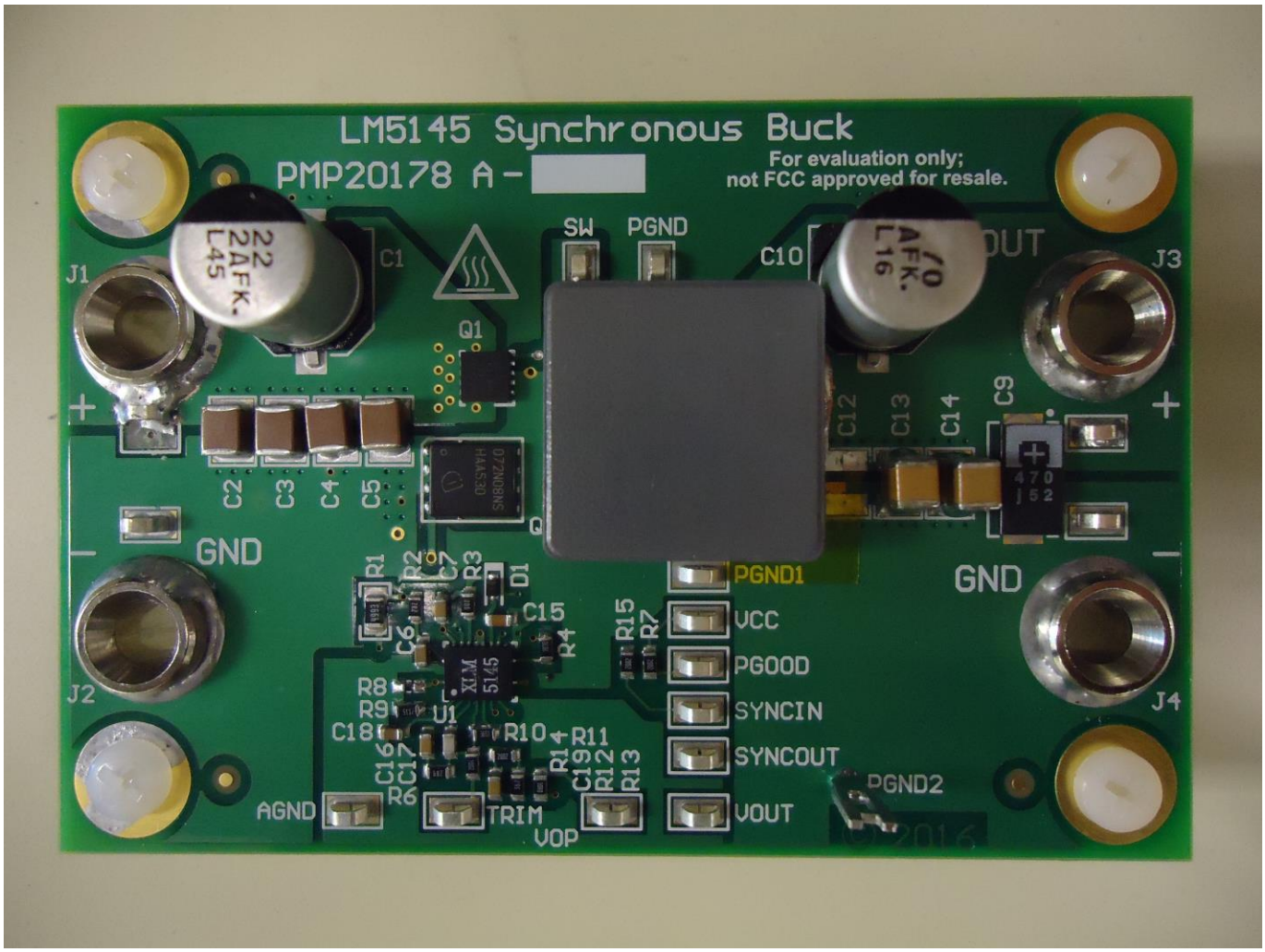
1 Circuit Description

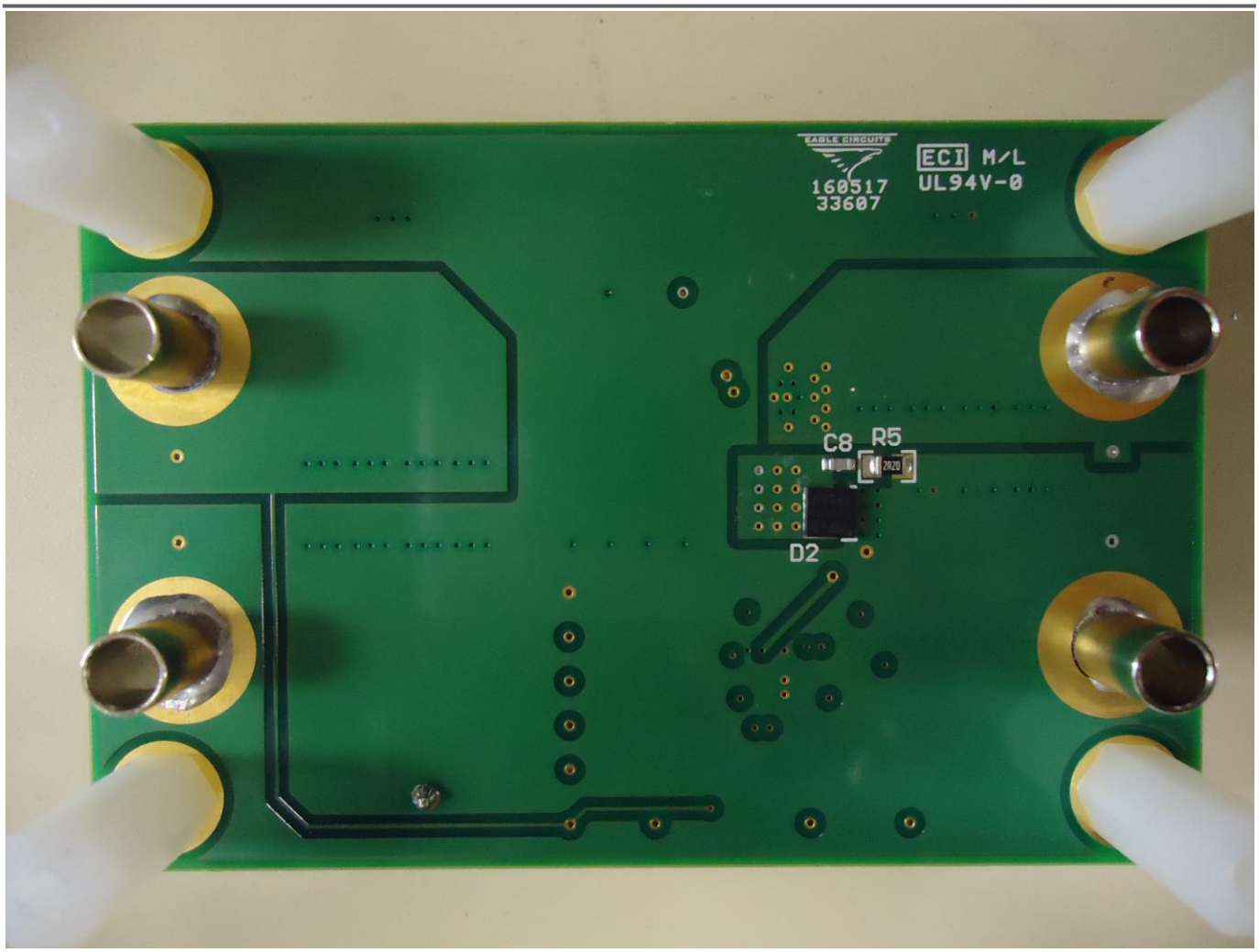
PMP20178 is a voltage-mode synchronous buck converter rated for 5.2V output at 11A from an input voltage of 15V to 60V. This design uses the LM5145 synchronous buck controller at a switching frequency of 200 kHz. Features include power good, synchronization and trim functions.

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

2 Photos

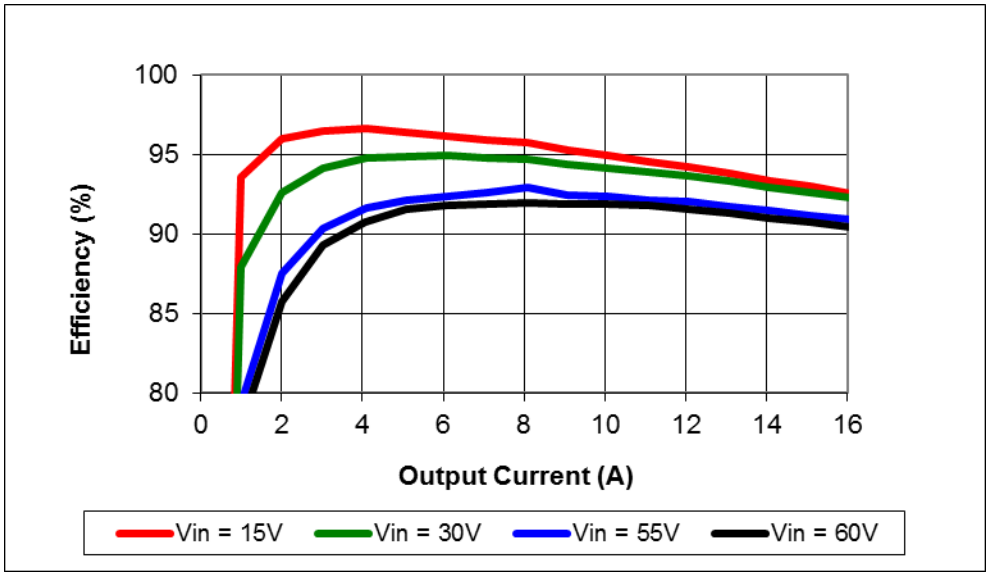
The photographs below show the PMP20178 Rev A printed circuit board assembly. This is a 4 layer board using 2 ounce copper on all layers. The overall board dimensions are 2” x 3”.




160517
33607
ECI M/L
UL94V-0
C8
R5
D2

3 Efficiency

The efficiency data is shown in the tables and graph below.



Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
15.005	0.019	5.215	0.002	3.658	0.29	0.01	0.27
15.005	0.373	5.215	1.004	93.542	5.60	5.24	0.36
15.005	0.726	5.211	2.006	95.963	10.89	10.45	0.44
15.005	1.082	5.211	3.006	96.487	16.24	15.66	0.57
15.004	1.470	5.212	4.088	96.592	22.06	21.30	0.75
15.004	1.832	5.211	5.086	96.427	27.49	26.51	0.98
15.004	2.198	5.211	6.086	96.169	32.98	31.71	1.26
15.003	2.566	5.211	7.088	95.936	38.50	36.93	1.56
15.003	2.934	5.211	8.088	95.739	44.02	42.14	1.88
15.003	3.313	5.210	9.090	95.290	49.70	47.36	2.34
15.002	3.691	5.210	10.090	94.939	55.37	52.57	2.80
15.002	4.073	5.210	11.088	94.542	61.10	57.77	3.34
15.001	4.458	5.210	12.088	94.169	66.88	62.98	3.90
15.001	4.848	5.210	13.090	93.771	72.73	68.20	4.53
15.001	5.242	5.209	14.090	93.347	78.63	73.40	5.23
15.000	5.638	5.209	15.092	92.961	84.57	78.62	5.95
15.000	6.040	5.209	16.092	92.524	90.60	83.83	6.77
15.000	6.446	5.209	17.092	92.081	96.69	89.03	7.66
14.999	6.859	5.209	18.092	91.599	102.88	94.24	8.64
15.000	7.281	5.209	19.092	91.053	109.21	99.44	9.77
14.999	7.708	5.208	20.094	90.517	115.62	104.65	10.96

PMP20178 Rev A Test Results

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
30.012	0.021	5.215	0.002	1.655	0.63	0.01	0.62
30.012	0.198	5.214	1.002	87.923	5.94	5.22	0.72
30.011	0.376	5.210	2.006	92.614	11.28	10.45	0.83
30.011	0.554	5.208	3.006	94.164	16.63	15.66	0.97
30.011	0.748	5.209	4.084	94.763	22.45	21.27	1.18
30.011	0.930	5.209	5.084	94.879	27.91	26.48	1.43
30.011	1.112	5.208	6.082	94.922	33.37	31.68	1.69
30.011	1.297	5.208	7.082	94.758	38.92	36.88	2.04
30.010	1.482	5.208	8.086	94.683	44.48	42.11	2.36
30.010	1.670	5.207	9.084	94.389	50.12	47.30	2.81
30.010	1.858	5.206	10.084	94.161	55.76	52.50	3.26
30.009	2.048	5.205	11.086	93.890	61.46	57.70	3.76
30.009	2.239	5.204	12.086	93.606	67.19	62.89	4.30
30.009	2.432	5.203	13.086	93.296	72.98	68.09	4.89
30.009	2.628	5.203	14.088	92.947	78.86	73.30	5.56
30.008	2.826	5.203	15.090	92.584	84.80	78.51	6.29
30.008	3.024	5.203	16.090	92.253	90.74	83.72	7.03
30.008	3.226	5.203	17.090	91.851	96.81	88.92	7.89
30.008	3.429	5.203	18.090	91.473	102.90	94.12	8.77
30.008	3.635	5.203	19.090	91.061	109.08	99.33	9.75
30.008	3.844	5.203	20.092	90.626	115.35	104.54	10.81

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
55.013	0.021	5.214	0.002	0.903	1.16	0.01	1.14
55.013	0.120	5.213	1.004	79.278	6.60	5.23	1.37
55.012	0.217	5.208	2.006	87.518	11.94	10.45	1.49
55.012	0.315	5.207	3.006	90.320	17.33	15.65	1.68
55.012	0.422	5.207	4.084	91.602	23.22	21.27	1.95
55.012	0.522	5.207	5.082	92.143	28.72	26.46	2.26
55.012	0.623	5.206	6.080	92.355	34.27	31.65	2.62
55.012	0.724	5.206	7.082	92.561	39.83	36.87	2.96
55.011	0.823	5.205	8.084	92.939	45.27	42.08	3.20
55.011	0.930	5.204	9.084	92.409	51.16	47.28	3.88
55.011	1.033	5.204	10.084	92.341	56.83	52.47	4.35
55.011	1.138	5.203	11.084	92.112	62.60	57.66	4.94
55.011	1.242	5.201	12.086	92.000	68.32	62.86	5.47
55.011	1.348	5.199	13.086	91.741	74.15	68.03	6.12
55.011	1.455	5.197	14.088	91.467	80.04	73.21	6.83
55.010	1.563	5.195	15.090	91.174	85.98	78.39	7.59
55.010	1.672	5.194	16.090	90.862	91.98	83.57	8.41
55.010	1.782	5.194	17.090	90.547	98.03	88.76	9.27
55.010	1.894	5.194	18.090	90.181	104.19	93.96	10.23
55.010	2.007	5.194	19.092	89.818	110.40	99.16	11.24
54.993	2.123	5.195	20.094	89.413	116.75	104.39	12.36

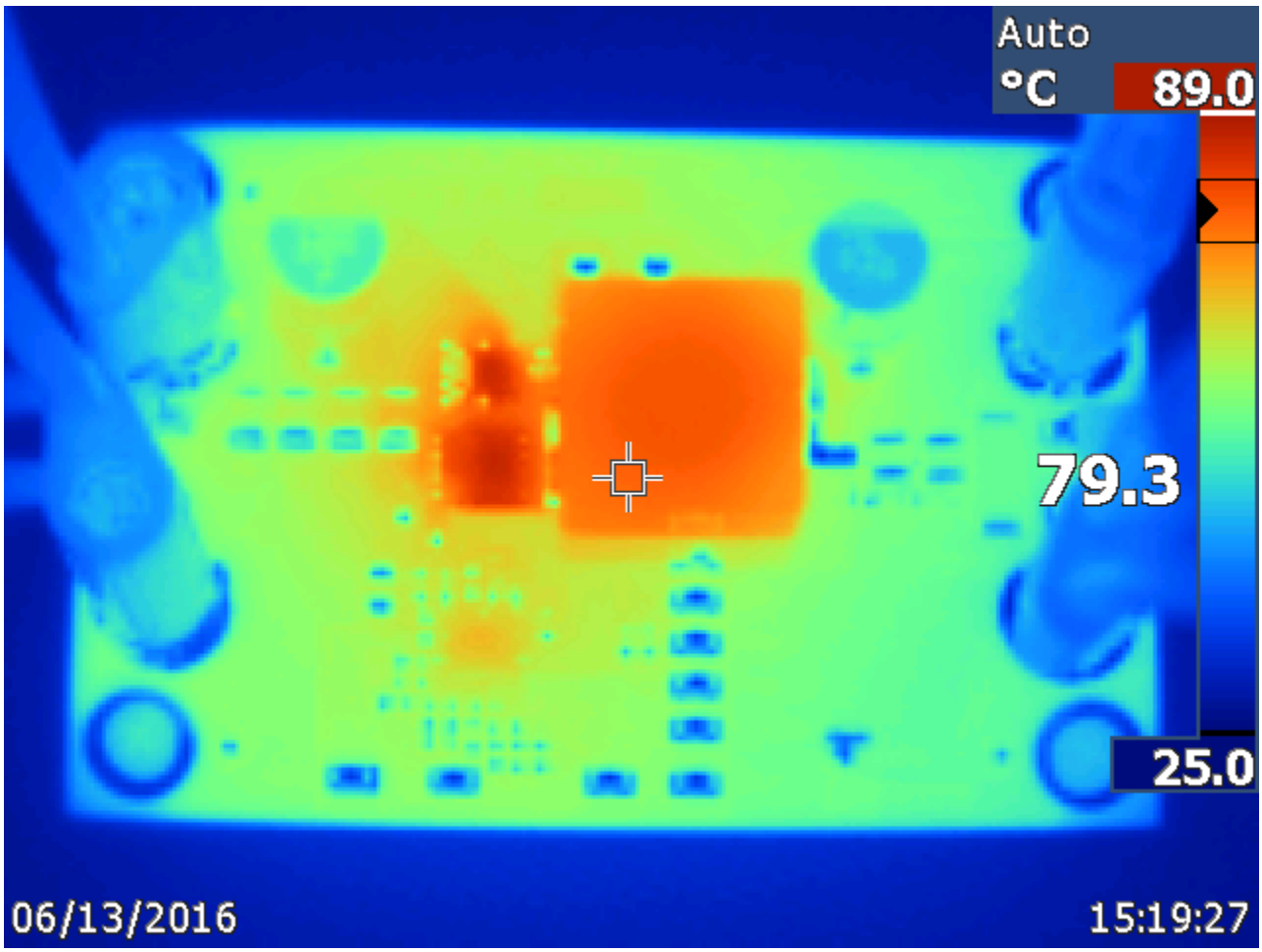
PMP20178 Rev A Test Results

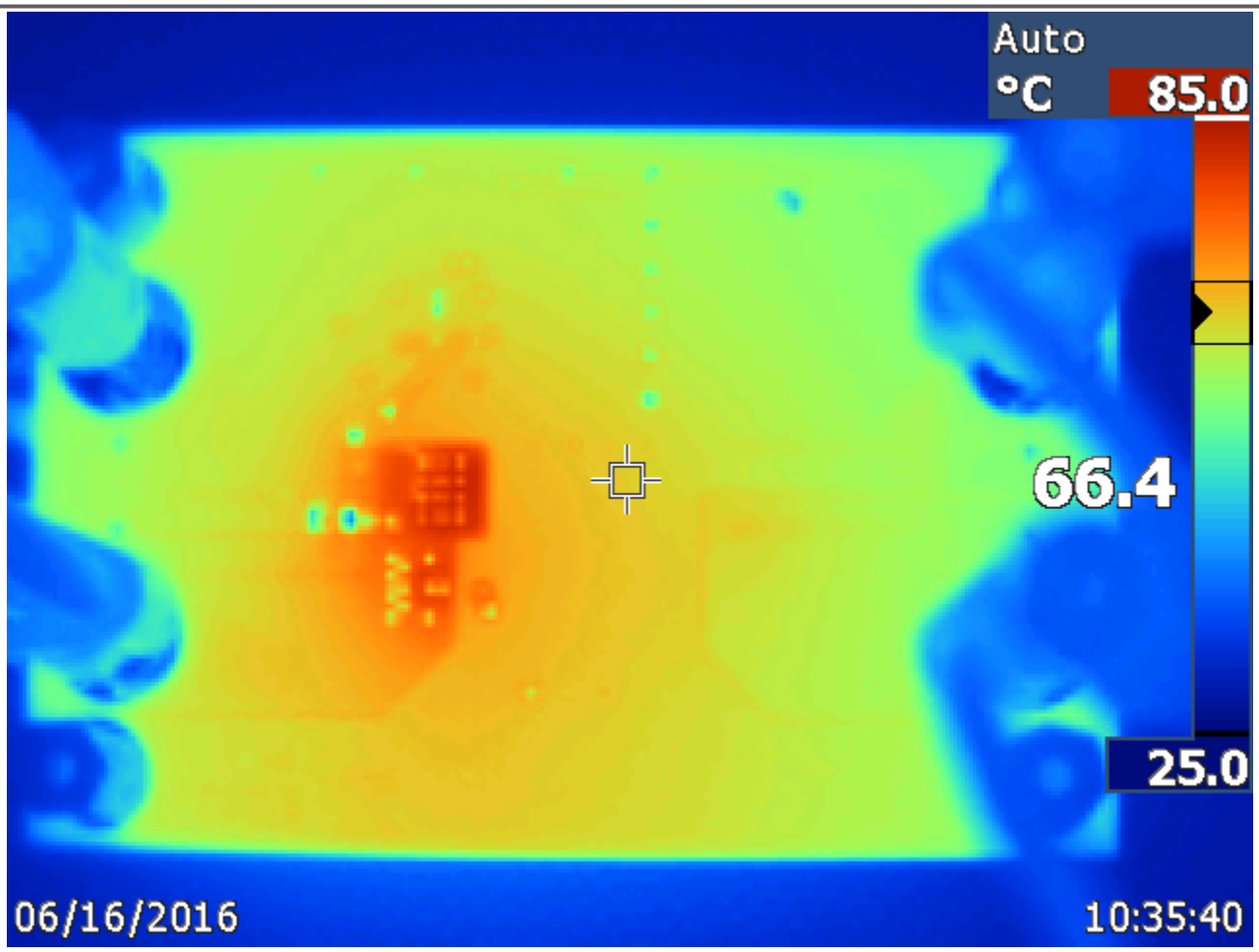
Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
60.018	0.021	5.214	0.002	0.827	1.26	0.01	1.25
60.018	0.112	5.212	1.004	77.847	6.72	5.23	1.49
60.018	0.203	5.208	2.006	85.745	12.18	10.45	1.74
60.018	0.292	5.206	3.006	89.303	17.53	15.65	1.87
60.018	0.390	5.207	4.078	90.714	23.41	21.23	2.17
60.018	0.481	5.206	5.076	91.545	28.87	26.43	2.44
60.018	0.574	5.206	6.076	91.813	34.45	31.63	2.82
60.018	0.668	5.205	7.076	91.865	40.09	36.83	3.26
60.018	0.762	5.204	8.082	91.972	45.73	42.06	3.67
60.017	0.857	5.204	9.084	91.904	51.43	47.27	4.16
60.017	0.952	5.203	10.086	91.845	57.14	52.48	4.66
60.017	1.047	5.202	11.084	91.759	62.84	57.66	5.18
60.017	1.144	5.201	12.086	91.545	68.66	62.85	5.81
60.016	1.242	5.199	13.086	91.268	74.54	68.03	6.51
60.017	1.341	5.197	14.088	90.972	80.48	73.22	7.27
60.016	1.440	5.195	15.090	90.716	86.42	78.40	8.02
60.016	1.540	5.195	16.090	90.430	92.42	83.58	8.85
60.016	1.642	5.194	17.090	90.076	98.55	88.77	9.78
60.016	1.745	5.194	18.090	89.719	104.73	93.96	10.77
60.016	1.848	5.194	19.090	89.403	110.91	99.16	11.75
59.989	1.955	5.196	20.092	89.024	117.28	104.41	12.87

4 Thermal Tests

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

4.1 11A Load, No Airflow

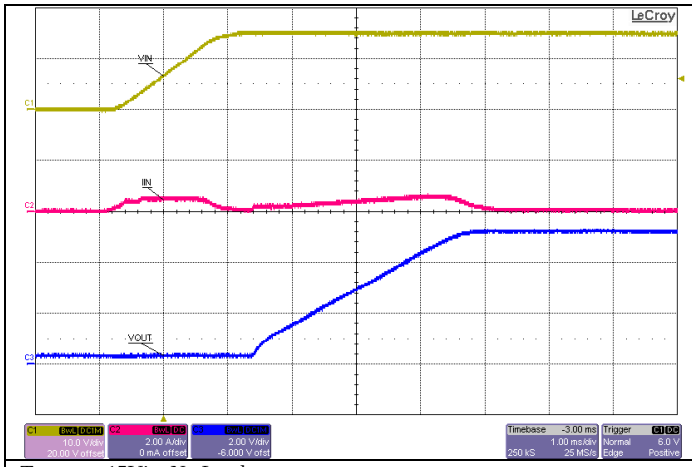



Auto
°C
85.0
66.4
25.0
06/16/2016
10:35:40

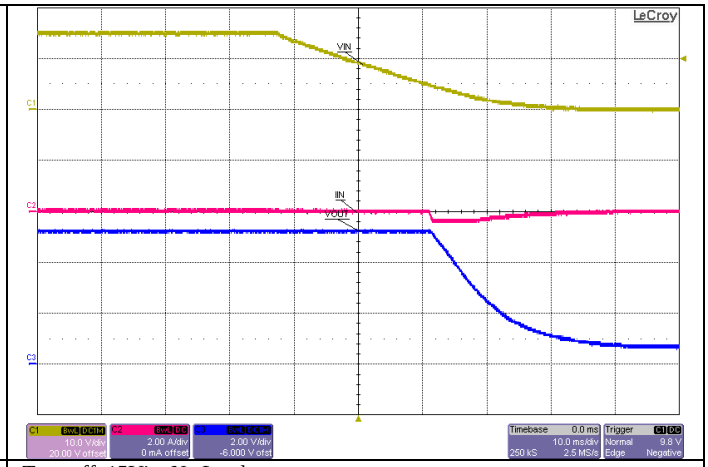
5 Startup and Shutdown Behavior

5.1 Turn-on and Turn-off from Vin

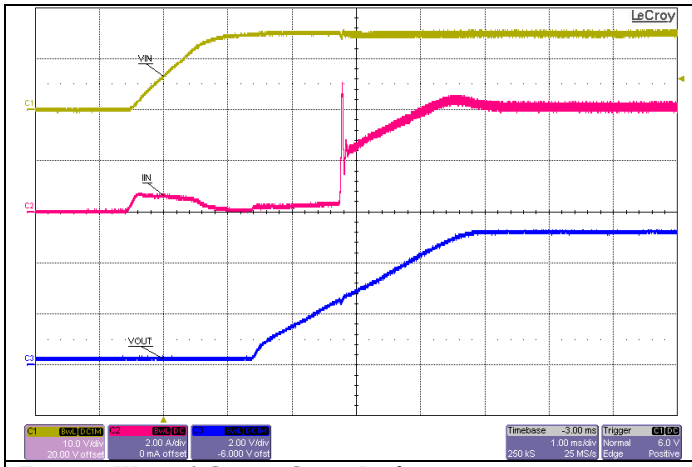
The output voltage is well controlled at turn-on, showing no evidence of over-shoot.



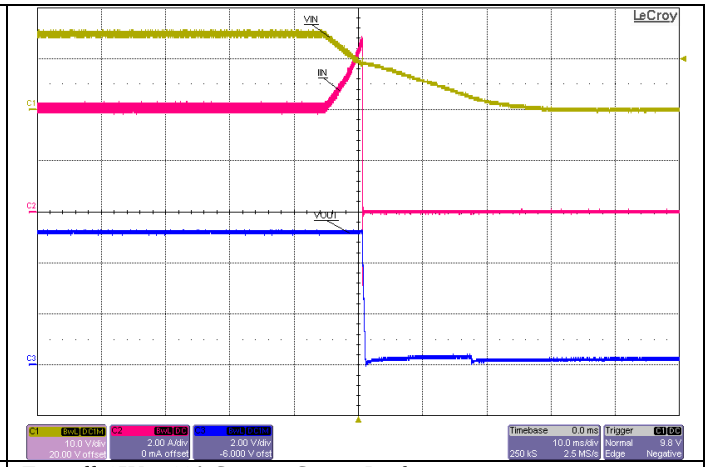
Turn-on, 15Vin, No Load



Turn-off, 15Vin, No Load

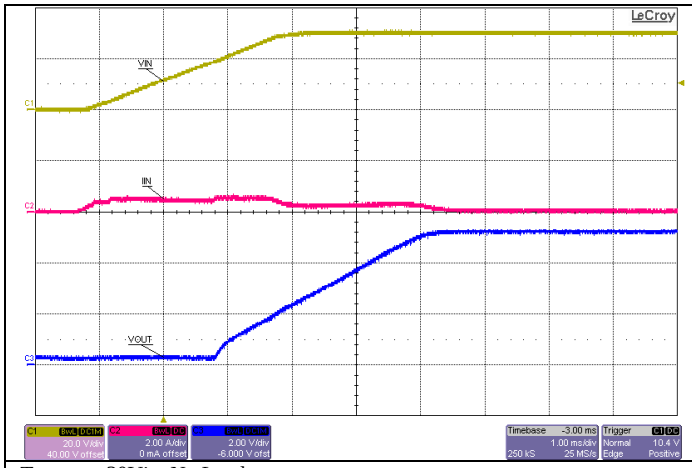


Turn-on, 15Vin, 11A Constant Current Load

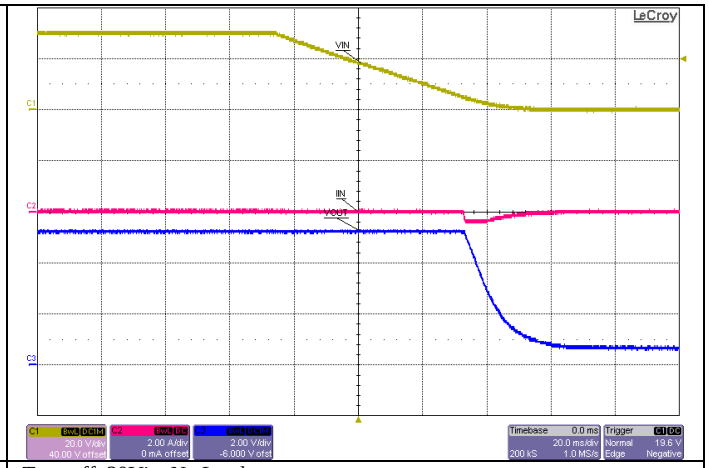


Turn-off, 15Vin, 11A Constant Current Load

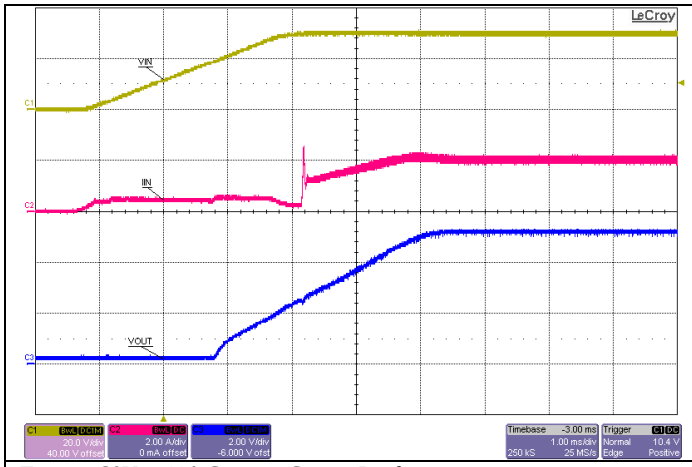
PMP20178 Rev A Test Results



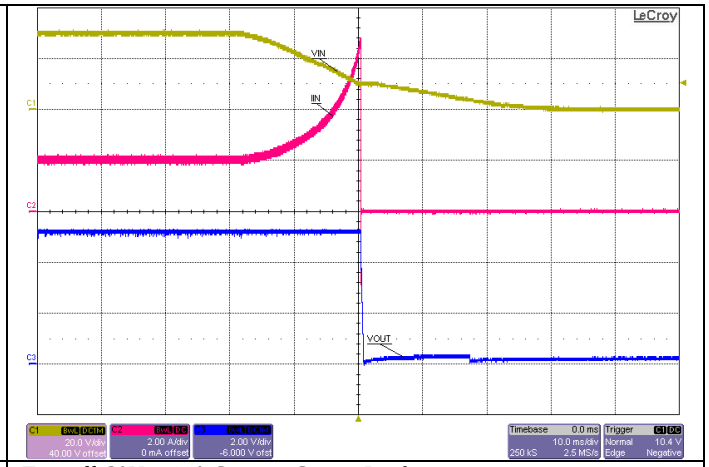
Turn-on, 30Vin, No Load



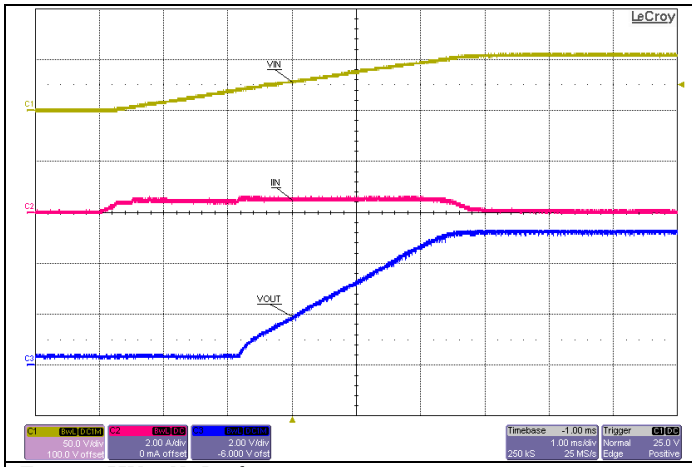
Turn-off, 30Vin, No Load



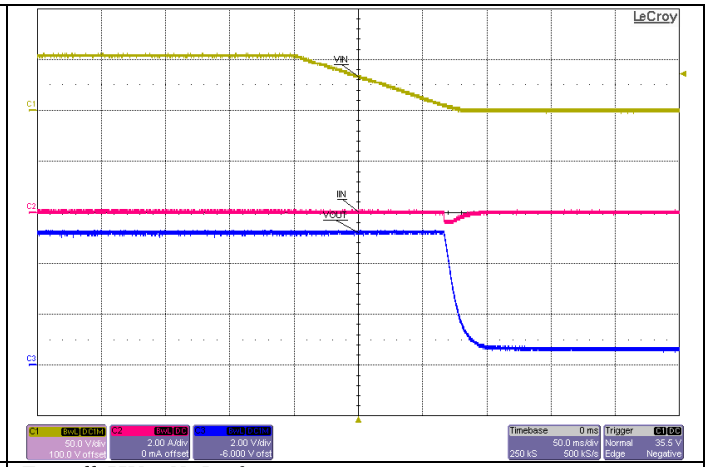
Turn-on, 30Vin, 11A Constant Current Load



Turn-off, 30Vin, 11A Constant Current Load

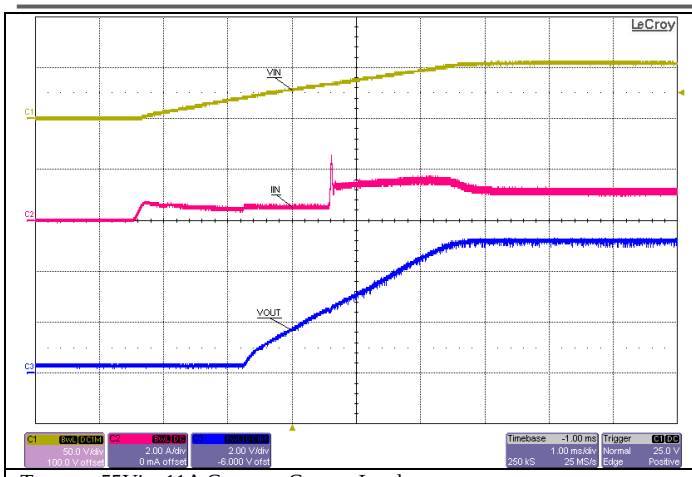


Turn-on, 55Vin, No Load

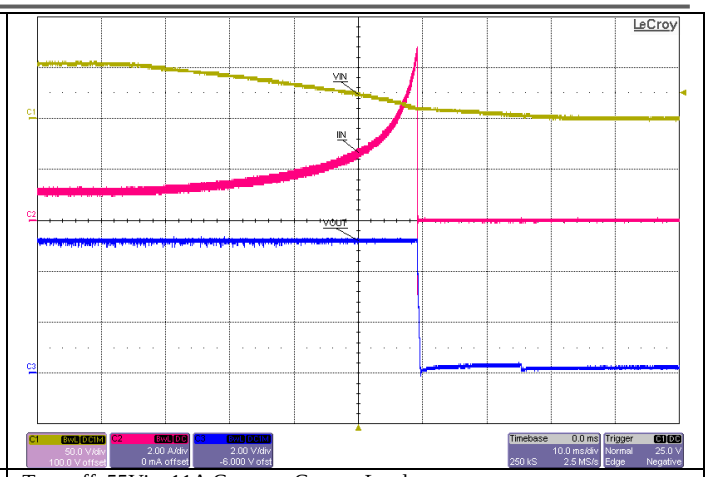


Turn-off, 55Vin, No Load

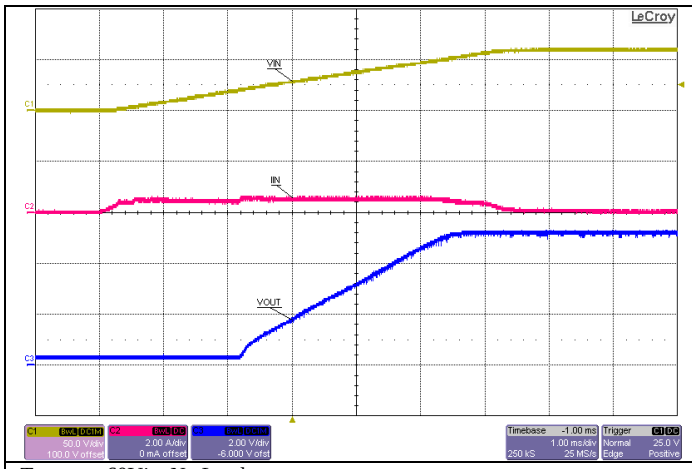
PMP20178 Rev A Test Results



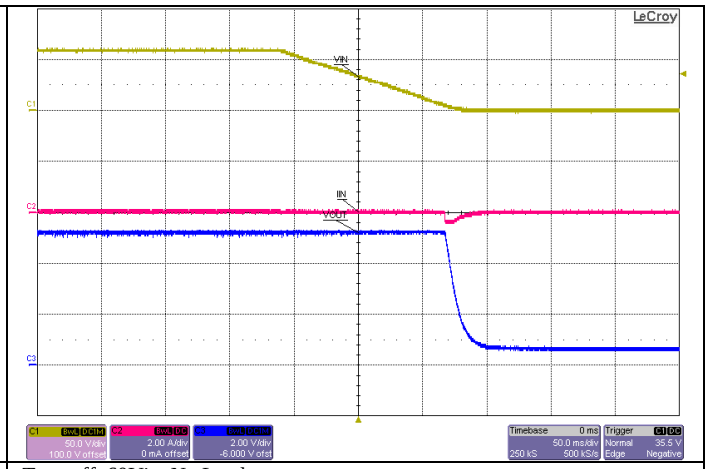
Turn-on, 55Vin, 11A Constant Current Load



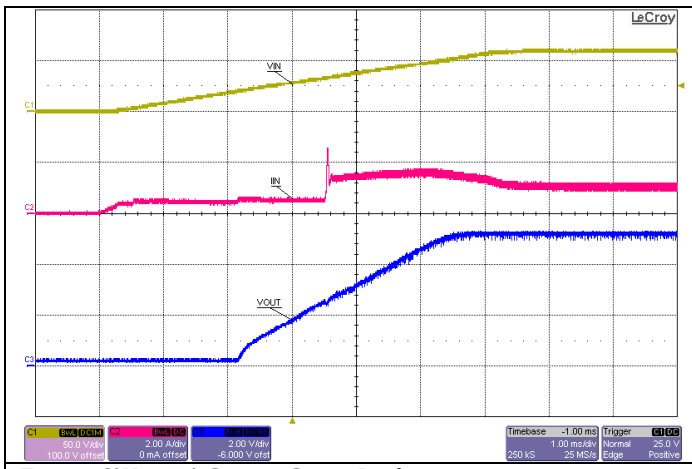
Turn-off, 55Vin, 11A Constant Current Load



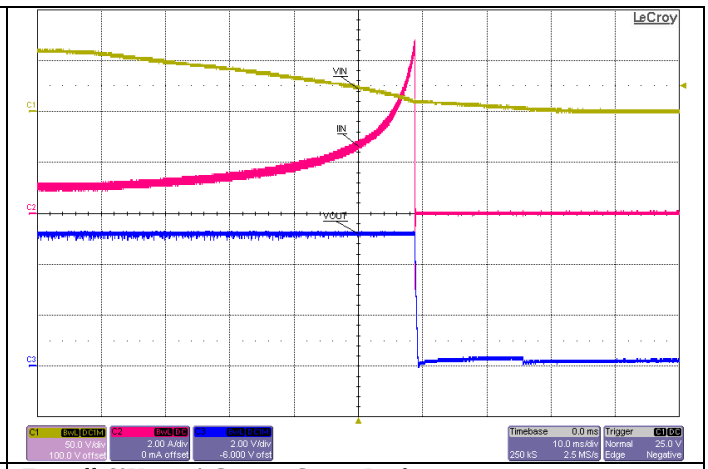
Turn-on, 60Vin, No Load



Turn-off, 60Vin, No Load



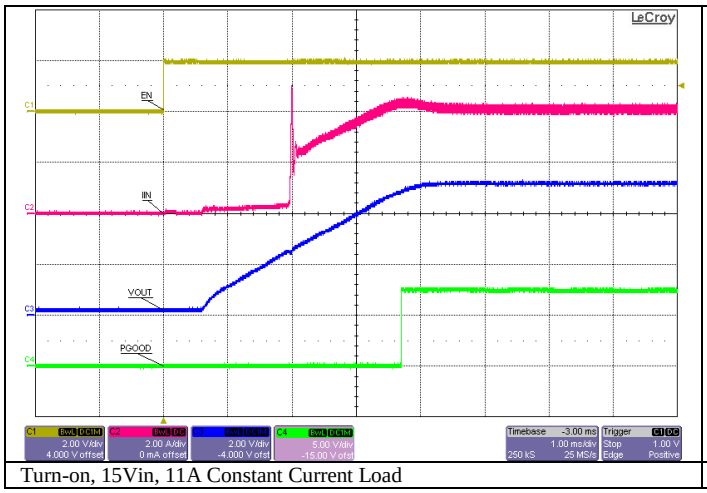
Turn-on, 60Vin, 11A Constant Current Load



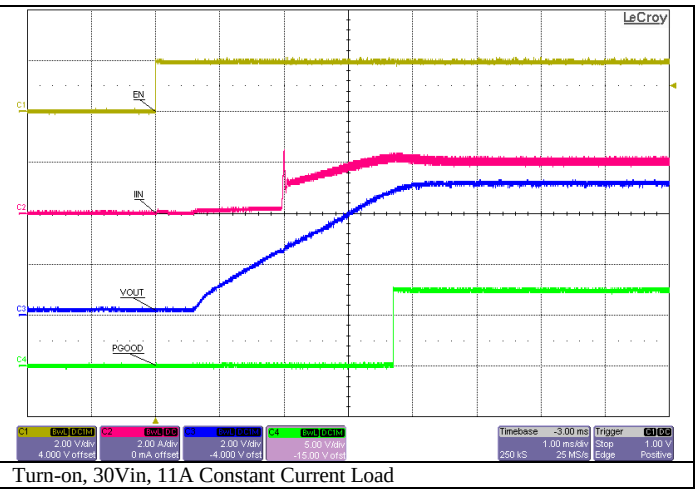
Turn-off, 60Vin, 11A Constant Current Load

5.2 Turn-on from EN

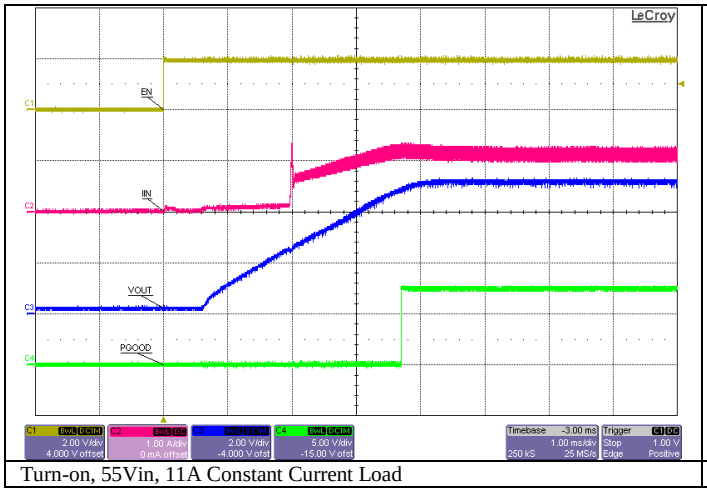
The output voltage is well controlled at turn-on, showing no evidence of over-shoot.



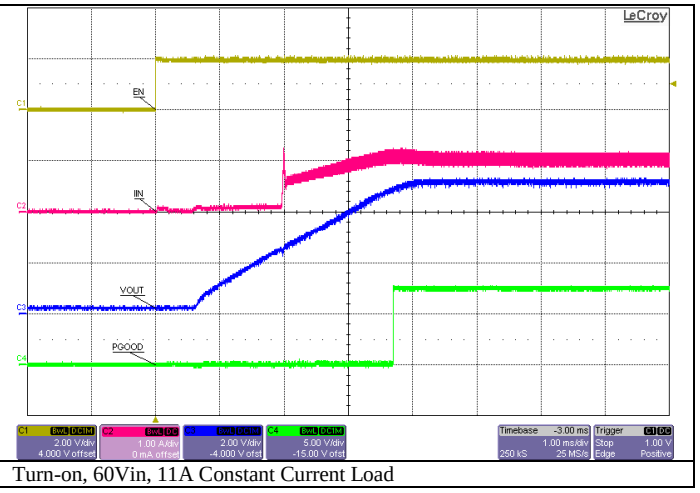
Turn-on, 15Vin, 11A Constant Current Load



Turn-on, 30Vin, 11A Constant Current Load



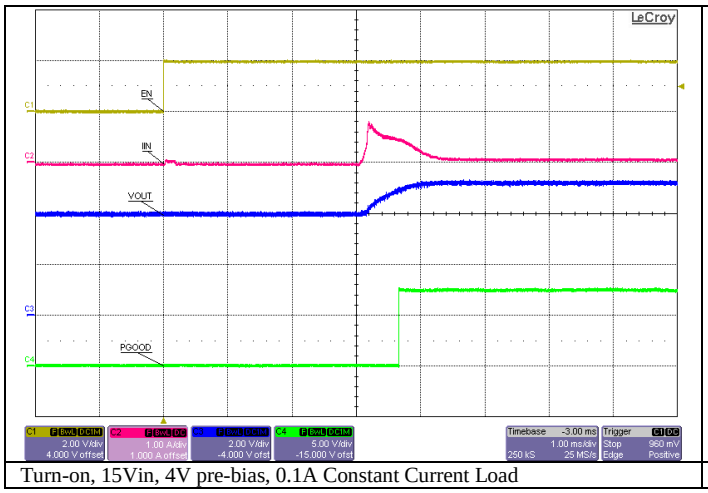
Turn-on, 55Vin, 11A Constant Current Load



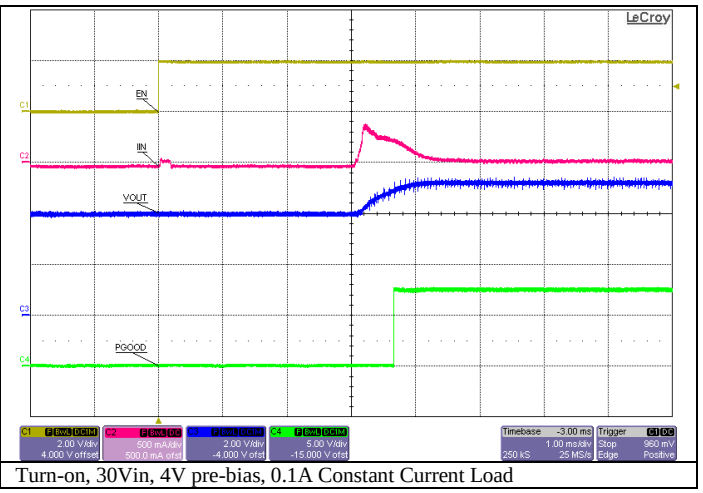
Turn-on, 60Vin, 11A Constant Current Load

5.3 Turn-on from EN with Pre-bias

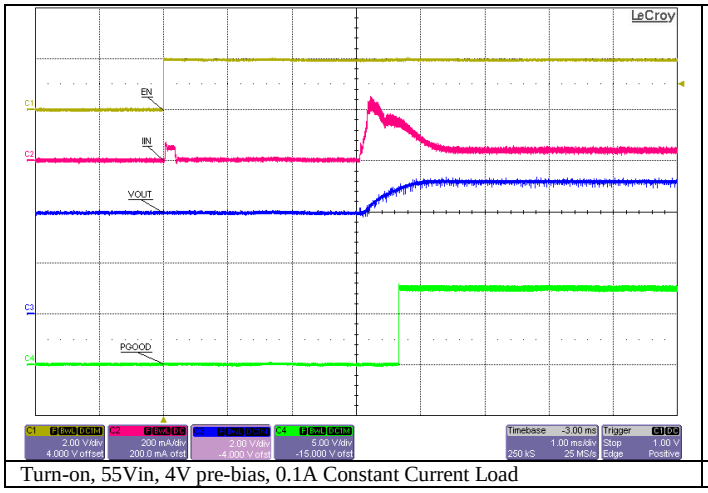
The output voltage is well controlled at turn-on, showing no evidence of over-shoot.



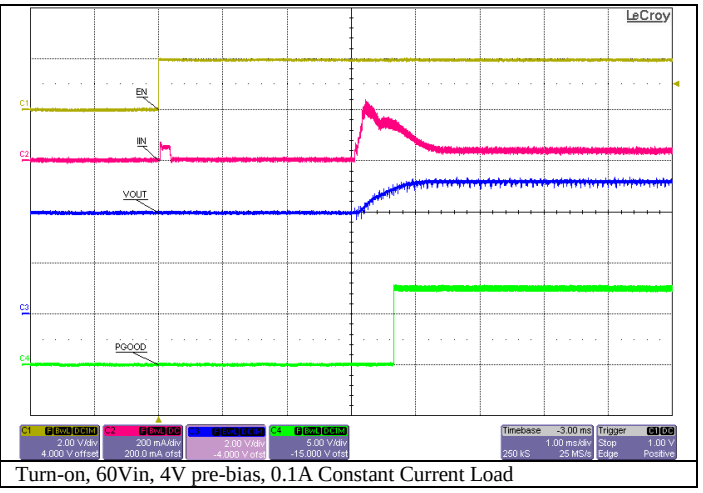
Turn-on, 15Vin, 4V pre-bias, 0.1A Constant Current Load



Turn-on, 30Vin, 4V pre-bias, 0.1A Constant Current Load



Turn-on, 55Vin, 4V pre-bias, 0.1A Constant Current Load

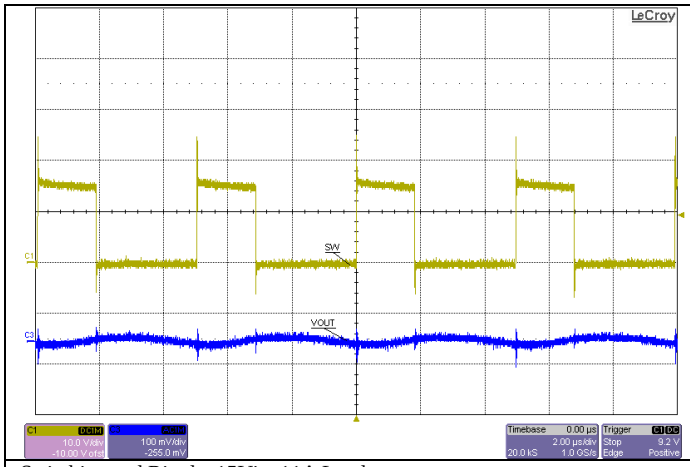


Turn-on, 60Vin, 4V pre-bias, 0.1A Constant Current Load

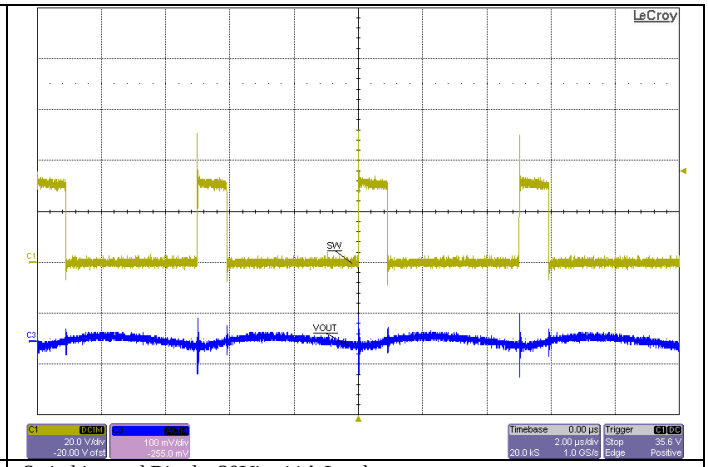
6 Switching and Ripple

6.1 Switching and Ripple

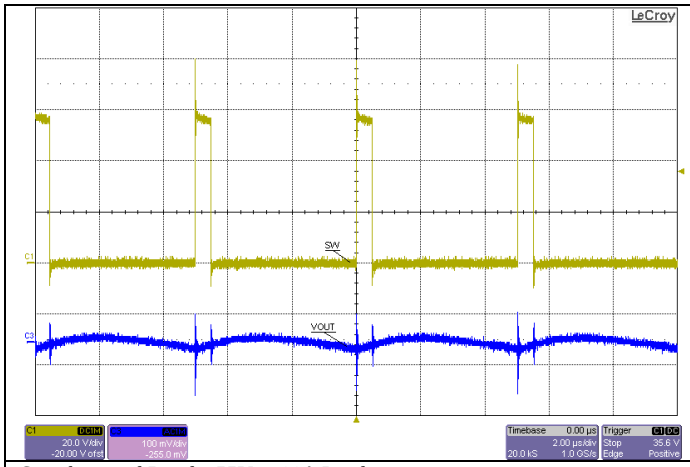
Switching and ripple were measured at full bandwidth using 500 MHz probes and 350 MHz oscilloscope.



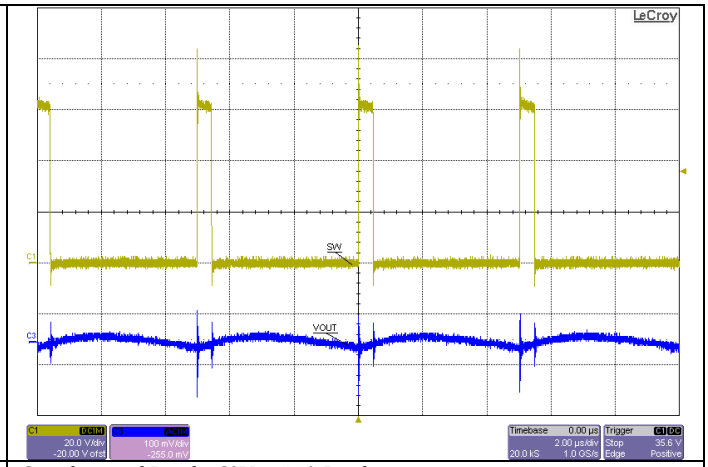
Switching and Ripple, 15Vin, 11A Load



Switching and Ripple, 30Vin, 11A Load



Switching and Ripple, 55Vin, 11A Load

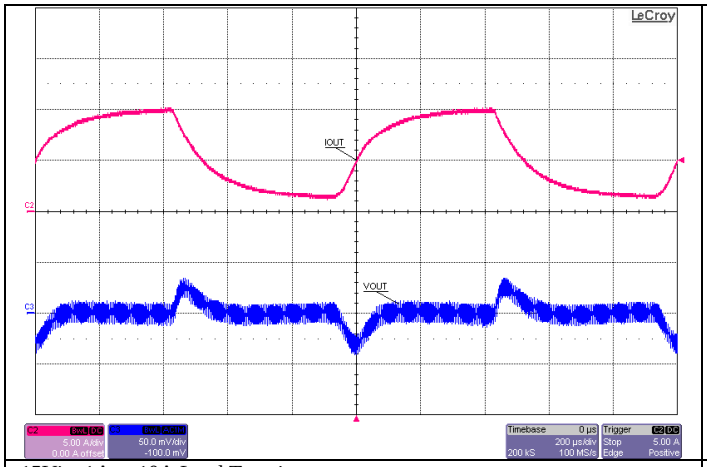


Switching and Ripple, 60Vin, 11A Load

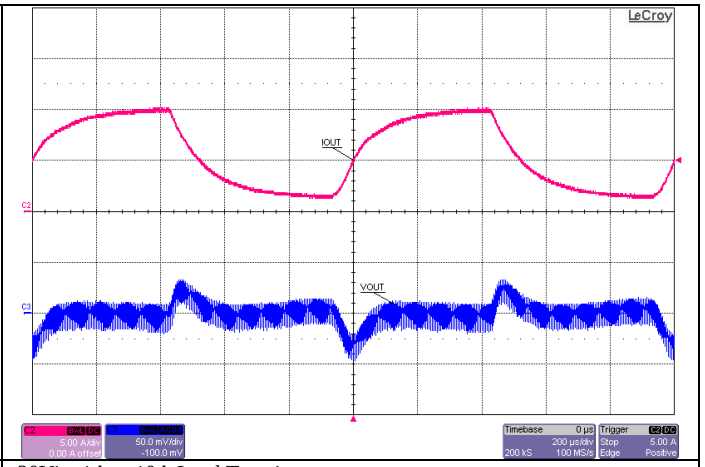
7 Load Transient Response

7.1 Load Transient Response with 0.1A/µs Slew Rate

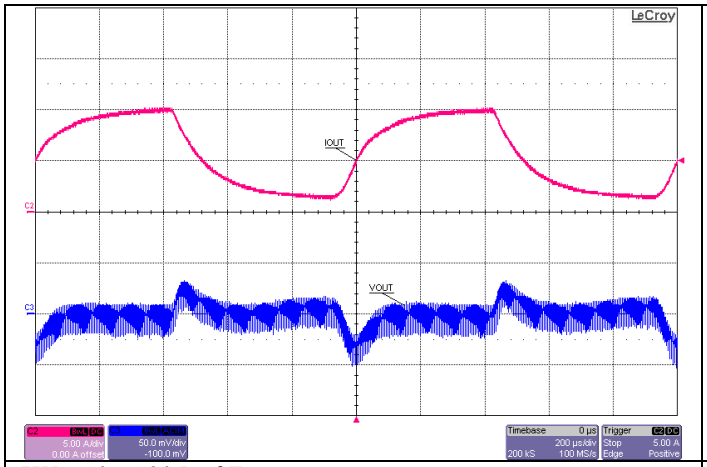
The output voltage deviation is less than 50mV for a 1A to 10A load transient.



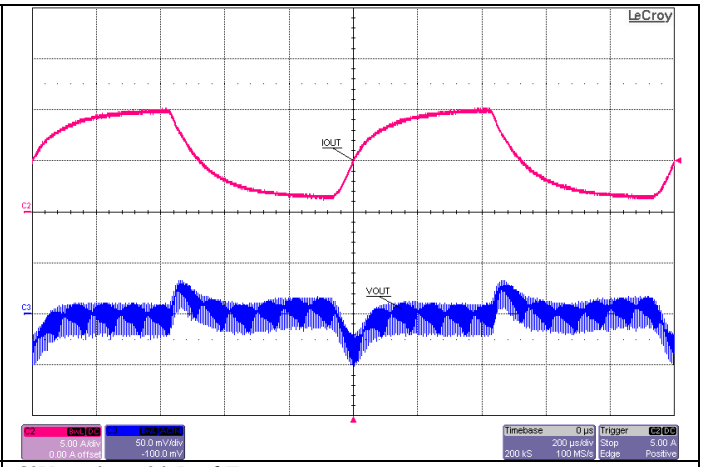
15Vin, 1A to 10A Load Transient



30Vin, 1A to 10A Load Transient



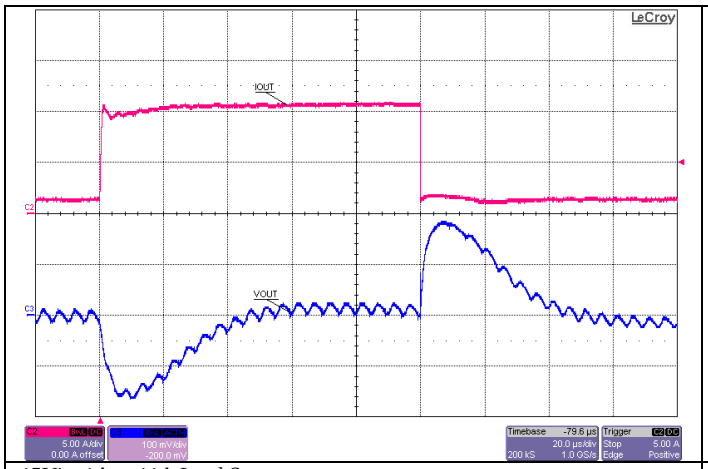
55Vin, 1A to 10A Load Transient



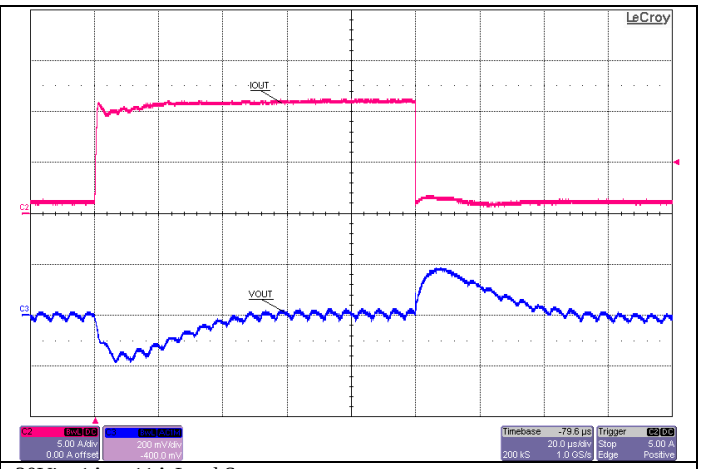
60Vin, 1A to 10A Load Transient

7.1 Load Transient Response with Fast Slew Rate

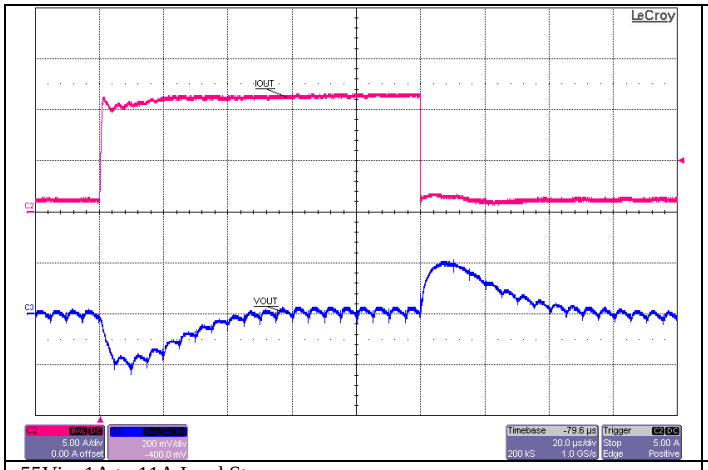
The output voltage deviation is less than 200mV for a 10A load step.



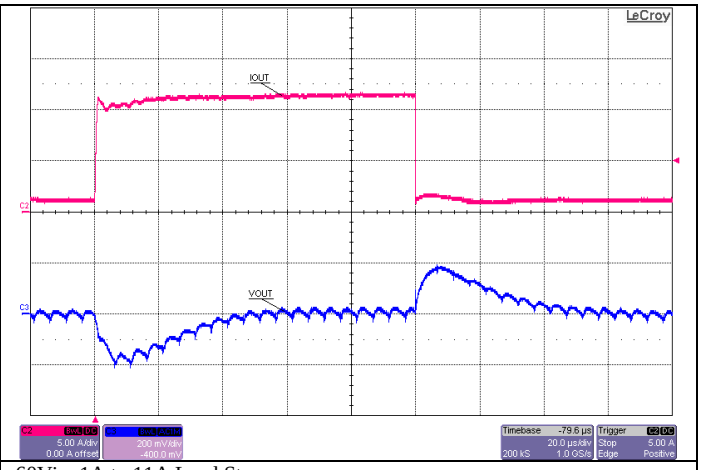
15Vin, 1A to 11A Load Step



30Vin, 1A to 11A Load Step



55Vin, 1A to 11A Load Step

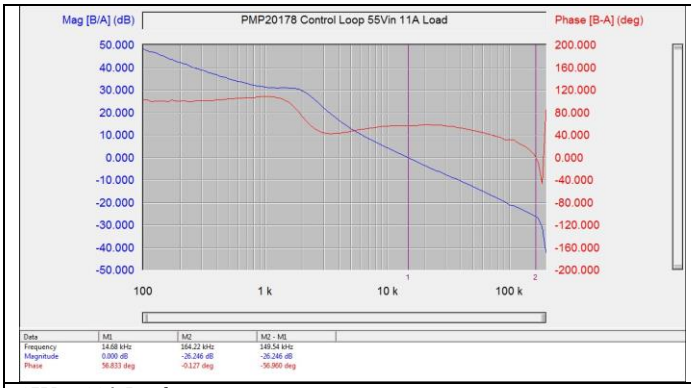


60Vin, 1A to 11A Load Step

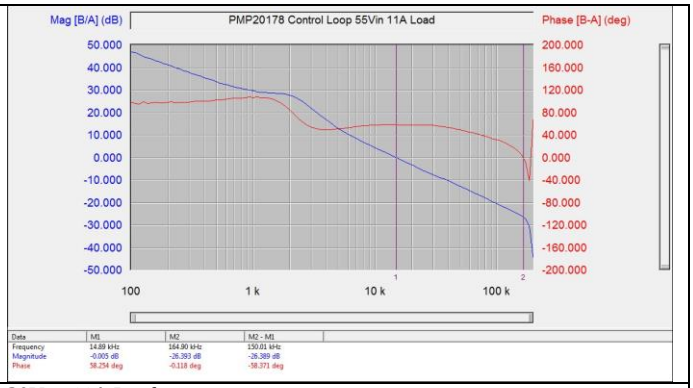
8 Frequency Response

8.1 Frequency Response

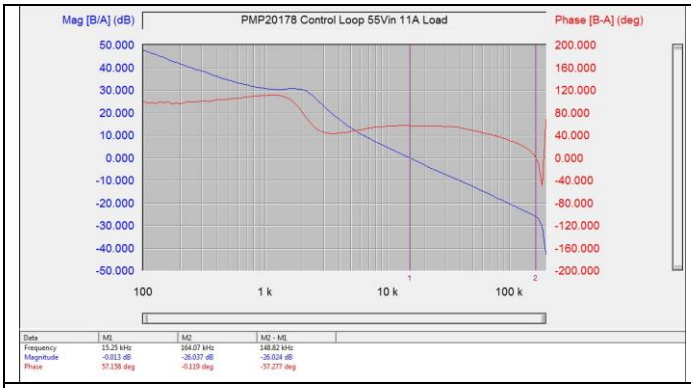
The control loop exhibits a bandwidth of 15 kHz with phase margin of 57°, and gain margin of 26 dB.



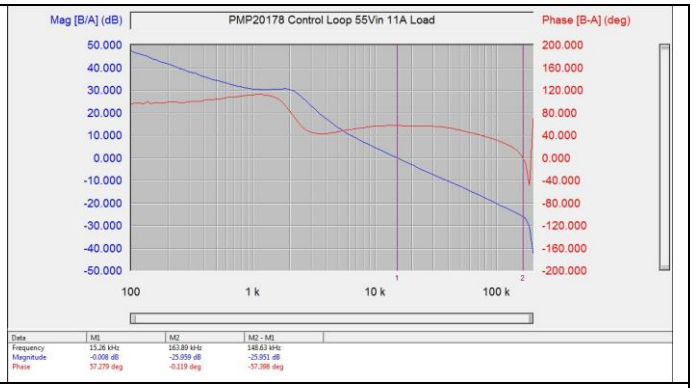
15Vin, 11A Load



30Vin, 11A Load



55Vin, 11A Load

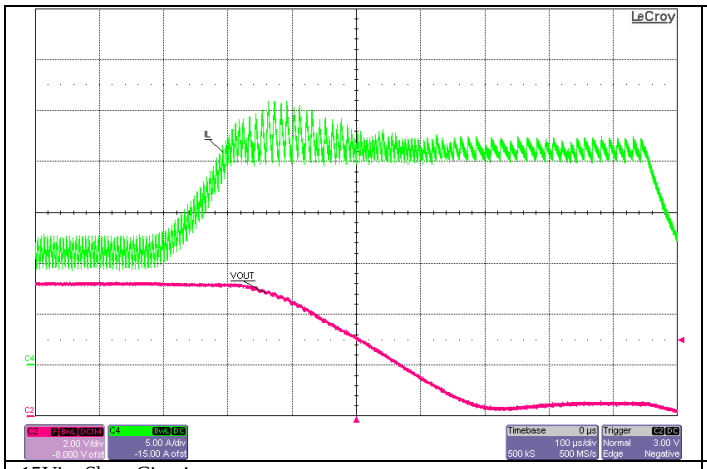


60Vin, 11A Load

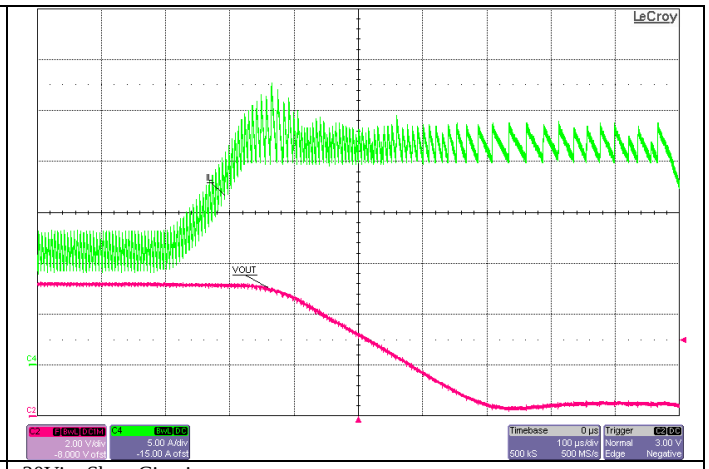
9 Over-Current Protection

9.1 Short Circuit Protection

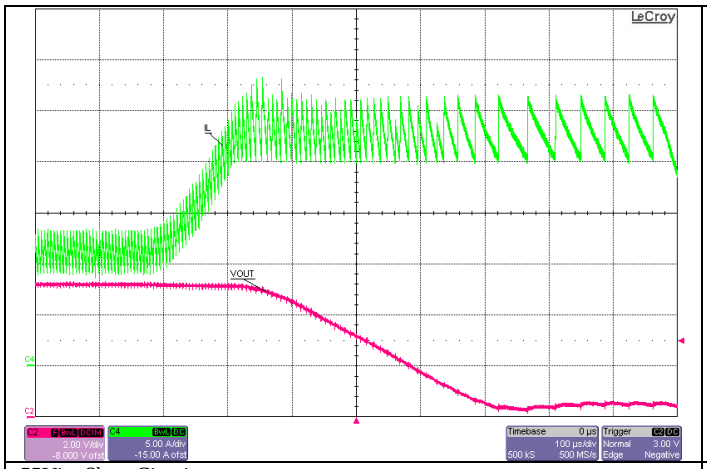
An active load was used to check short circuit protection. The results show that the inductor current is well controlled.



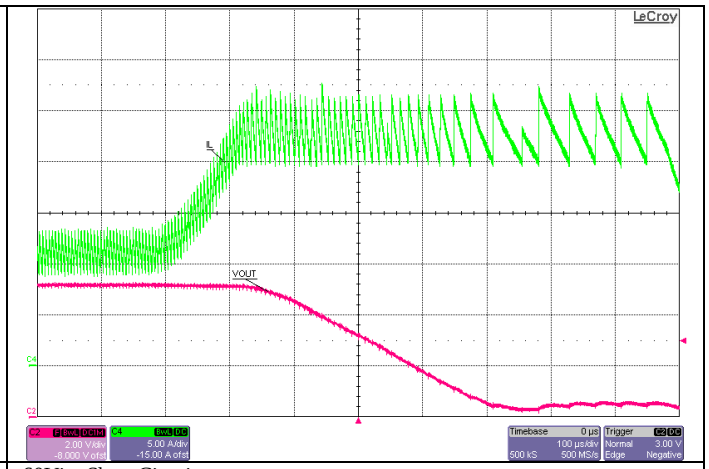
15Vin, Short Circuit



30Vin, Short Circuit



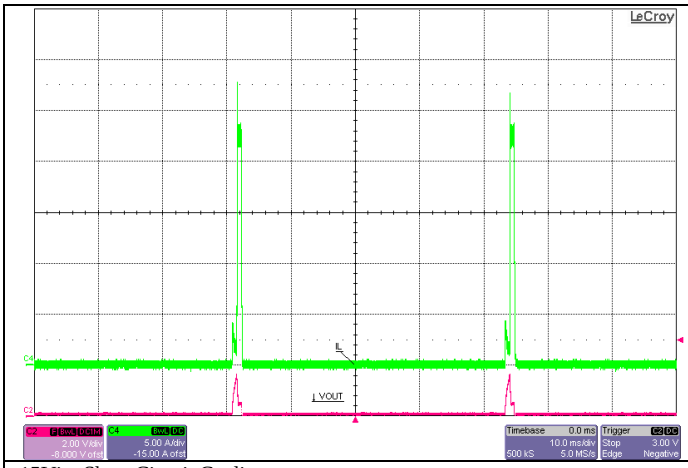
55Vin, Short Circuit



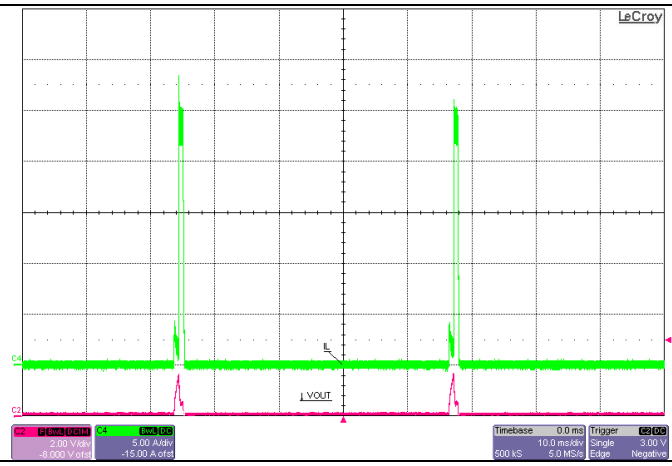
60Vin, Short Circuit

9.2 Short Circuit Cycling

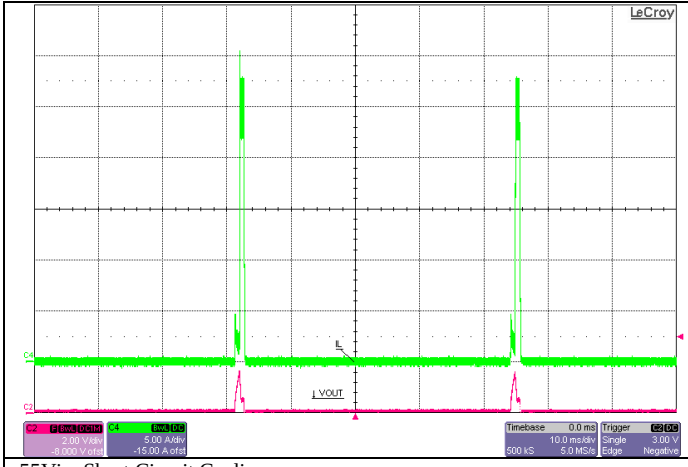
The results show hiccup protection.



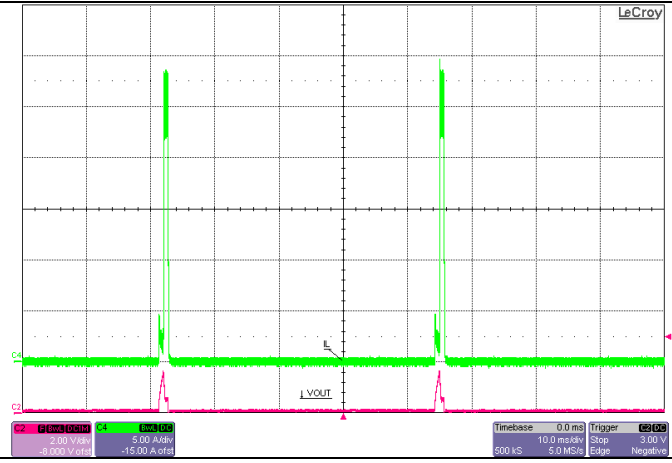
15Vin, Short Circuit Cycling



30Vin, Short Circuit Cycling



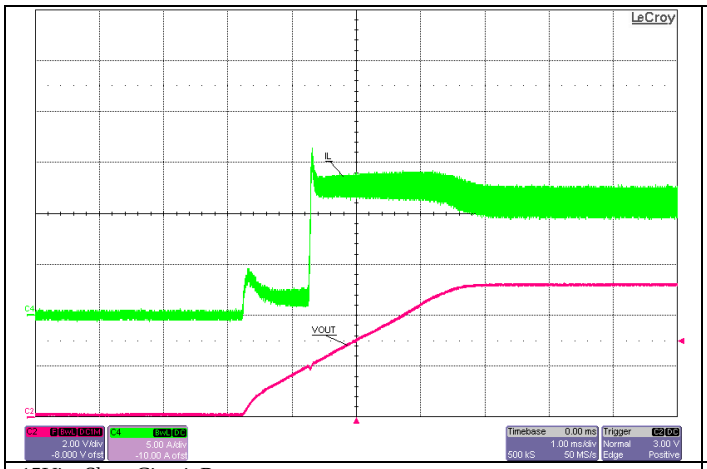
55Vin, Short Circuit Cycling



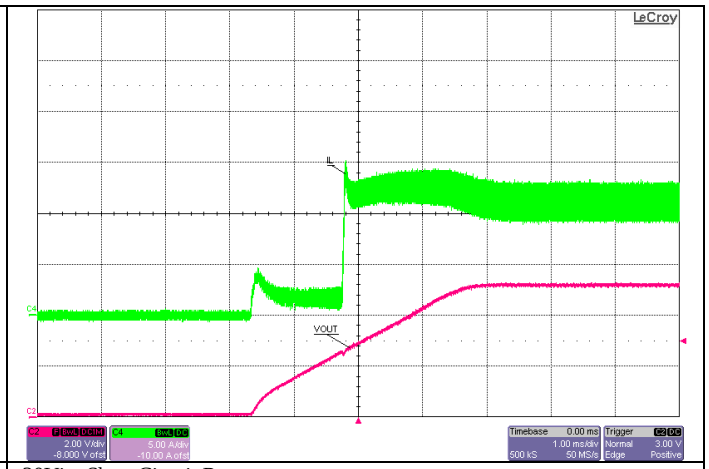
60Vin, Short Circuit Cycling

9.3 Short Circuit Recovery

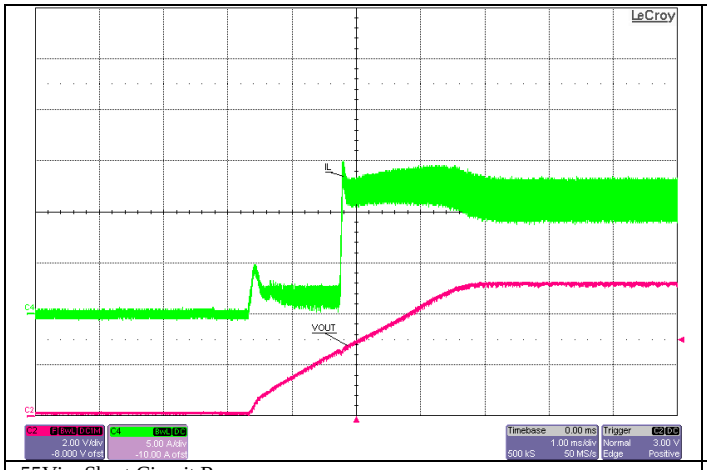
The results show normal restart of the output voltage when the short is removed.



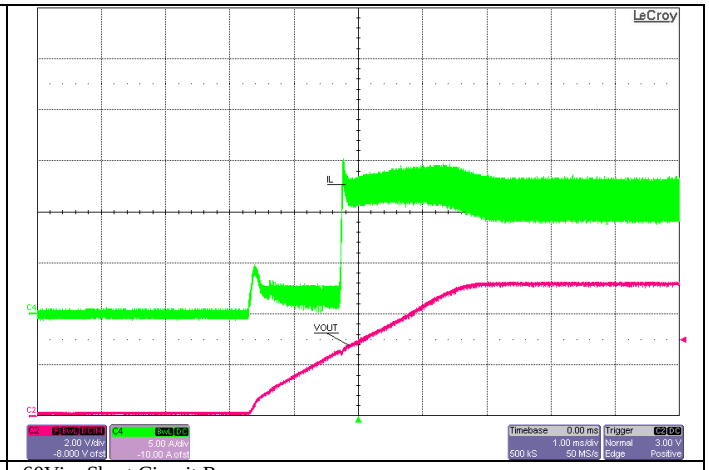
15Vin, Short Circuit Recovery



30Vin, Short Circuit Recovery



55Vin, Short Circuit Recovery



60Vin, Short Circuit Recovery

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