LM5022 Isolated Flyback Converter

TI reference design number: PMP20745 Rev A

Input: 18V to 400V
Output: 15V @ 0.6A

DC – DC Test Results

Table of Contents

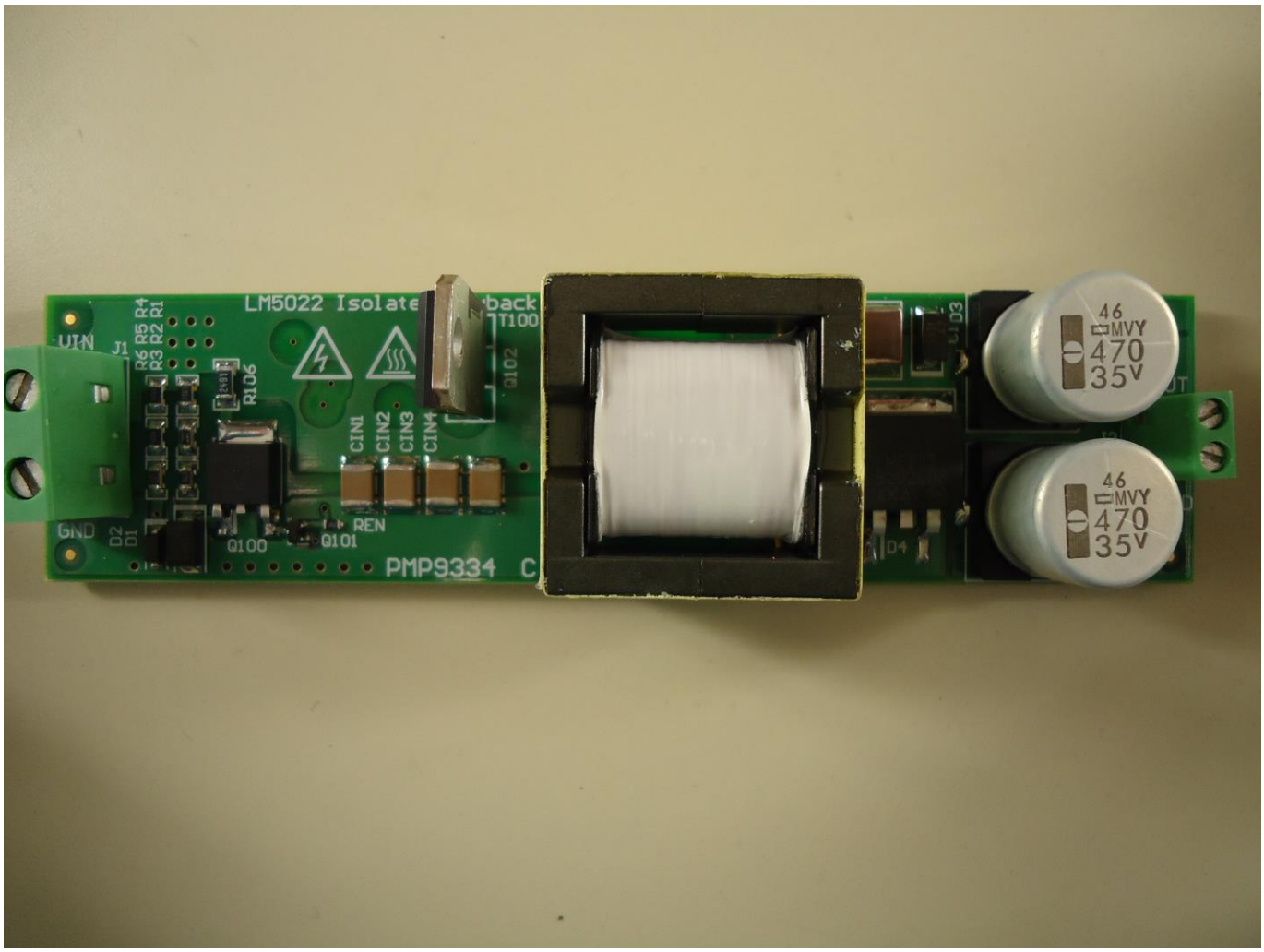
1 Circuit Description

PMP20745 is an isolated flyback converter utilizing the LM5022 for industrial applications. It uses primary side regulation from an auxiliary winding with a resistor divider network to the feedback pin of the LM5022. This design has a minimum operating input voltage of 18V and has been tested to 400V maximum. It also utilizes a high voltage standoff bias supply and powers itself from the auxiliary winding once the converter has started. Primary-side voltage regulation is based on current-mode control, which eases the design of the control loop compensation. The switching frequency is set to 80 kHz. A flyback transformer from GCI, part number G094215LF is used in this design and is readily available upon request.

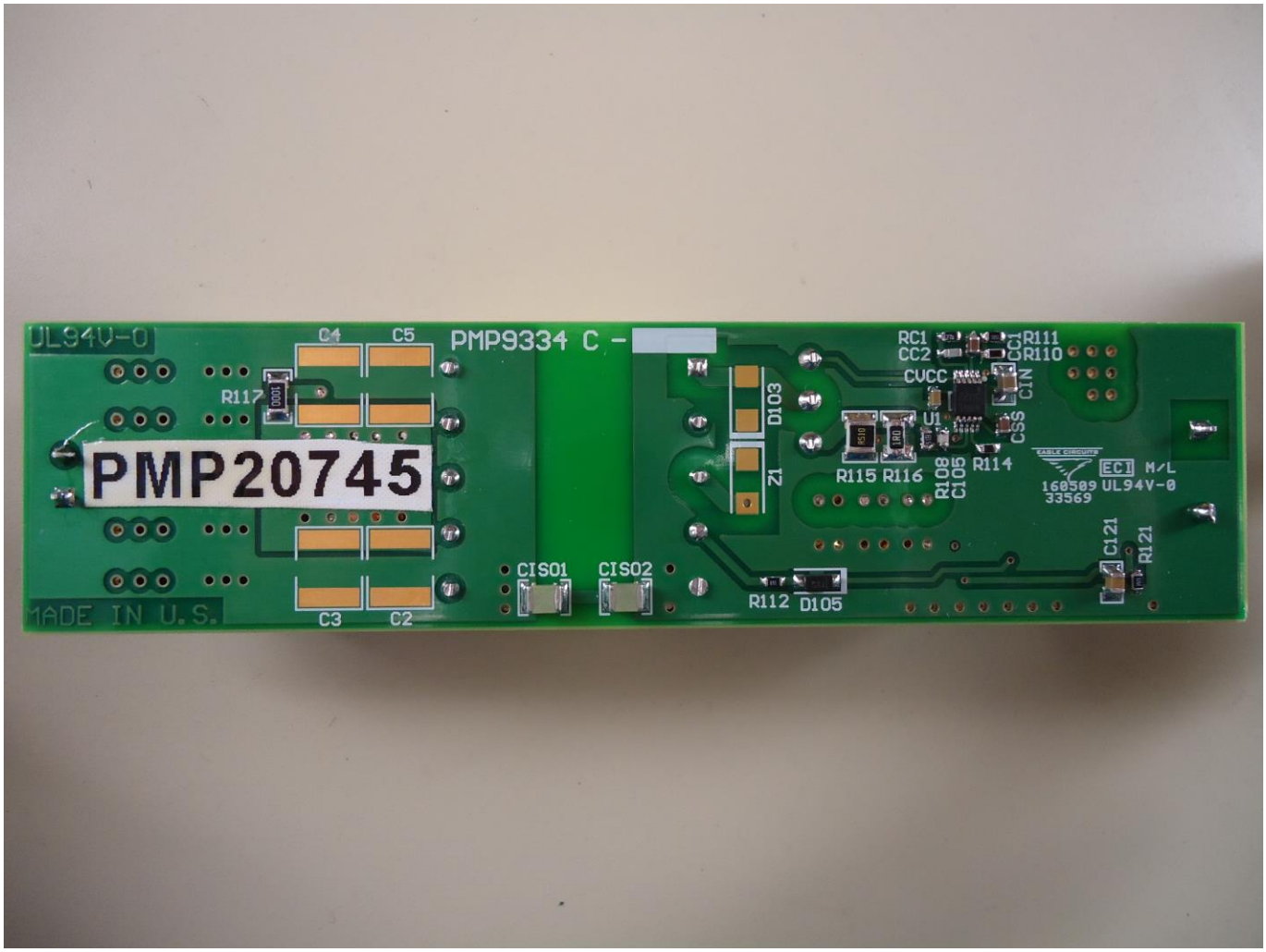
All tests were performed at room temperature on an open bench. The board was tested with two 2.7uF 250V film capacitors in series across the input to suppress input current ripple.

2 Photos

The photographs below show the PMP20745 assembly as built on the PMP9334 Rev C printed circuit board. This is a 4-layer PCB with 1 oz. copper on all layers. Board dimensions are 4.4 in. x 1.1 in.



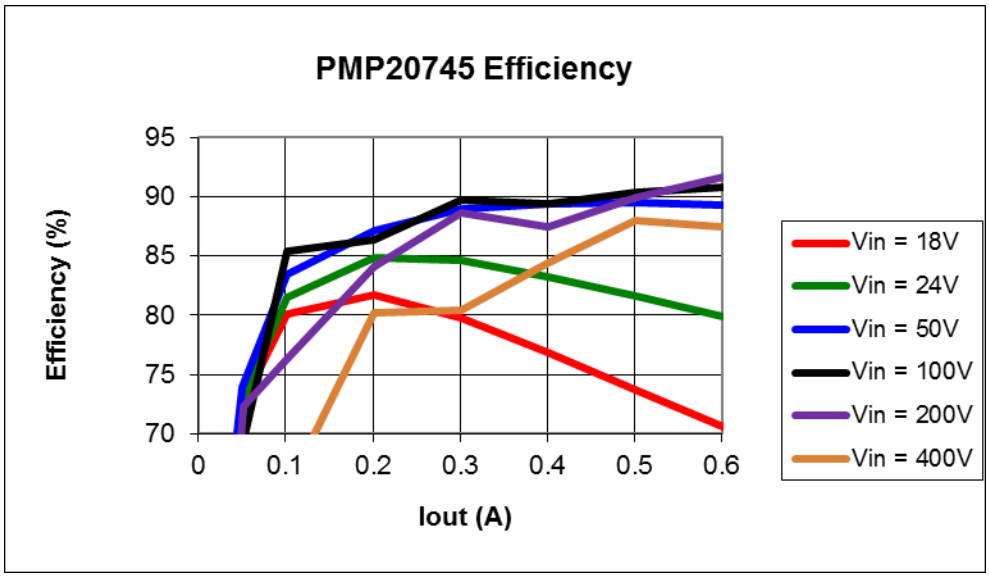
PMP20745 Rev A Test Results



3 Efficiency and Regulation

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

3.1 Efficiency



Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
18.0031	0.0221	19.1991	0.0001	0.398	0.002	0.396	0.48
17.9992	0.0305	18.7931	0.0113	0.549	0.212	0.337	38.68
17.9962	0.0406	18.6806	0.0213	0.731	0.398	0.333	54.46
17.9836	0.0727	18.5231	0.0512	1.307	0.948	0.359	72.54
17.9616	0.1292	18.3339	0.1014	2.321	1.859	0.462	80.11
17.9147	0.2460	17.8748	0.2014	4.407	3.600	0.807	81.69
17.8666	0.3644	17.2311	0.3012	6.511	5.190	1.321	79.72
17.8195	0.4796	16.3721	0.4012	8.546	6.568	1.978	76.86
17.7731	0.5883	15.3913	0.5010	10.456	7.711	2.745	73.75
17.7308	0.6870	14.3033	0.6010	12.181	8.596	3.585	70.57

PMP20745 Rev A Test Results

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
24.0182	0.0122	19.1984	0.0000	0.293	0.000	0.293	0.00
24.0141	0.0202	18.7460	0.0113	0.485	0.212	0.273	43.67
24.0119	0.0286	18.4713	0.0213	0.687	0.393	0.293	57.29
24.0025	0.0534	18.2343	0.0512	1.282	0.934	0.348	72.84
23.9849	0.0939	18.0919	0.1014	2.252	1.835	0.418	81.45
23.9523	0.1765	17.8202	0.2014	4.228	3.589	0.639	84.89
23.9191	0.2604	17.4860	0.3013	6.229	5.269	0.960	84.59
23.8858	0.3448	17.0890	0.4013	8.236	6.858	1.378	83.27
23.8524	0.4263	16.5618	0.5012	10.168	8.301	1.868	81.63
23.8206	0.5035	15.9390	0.6010	11.994	9.579	2.414	79.87

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
50.0334	0.0066	19.2223	0.0000	0.330	0.000	0.330	0.00
50.0311	0.0104	18.7623	0.0113	0.520	0.212	0.308	40.75
50.0297	0.0144	18.4834	0.0213	0.720	0.394	0.327	54.65
50.0254	0.0250	18.0561	0.0512	1.251	0.924	0.326	73.92
50.0180	0.0432	17.7843	0.1014	2.161	1.803	0.357	83.46
50.0037	0.0814	17.6059	0.2013	4.070	3.544	0.526	87.07
49.9879	0.1186	17.4919	0.3014	5.929	5.272	0.657	88.93
49.9738	0.1561	17.3729	0.4015	7.801	6.975	0.826	89.42
49.9582	0.1935	17.2512	0.5016	9.667	8.653	1.014	89.51
49.9442	0.2309	17.1282	0.6014	11.532	10.301	1.231	89.32

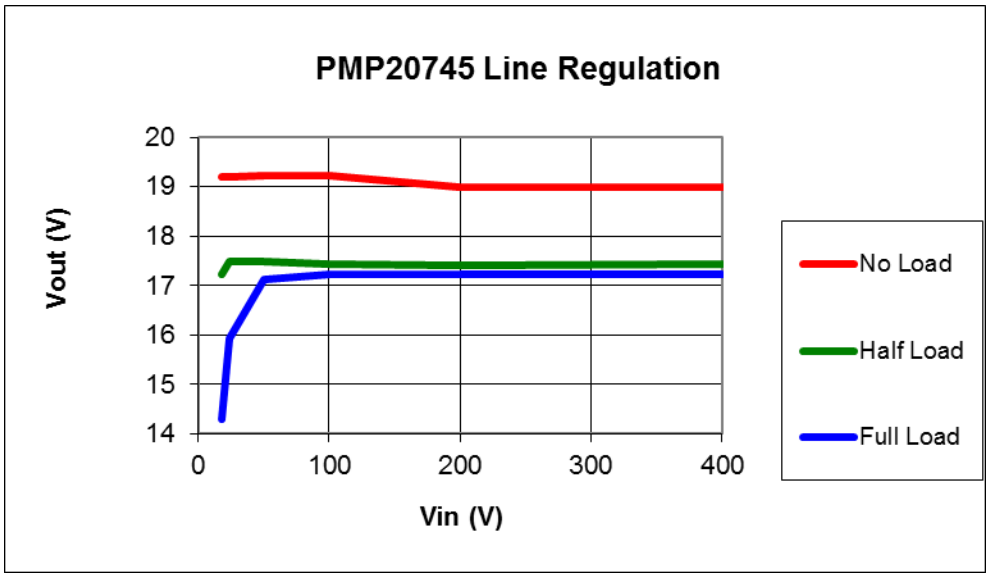
Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
100.0391	0.0037	19.2372	0.0000	0.370	0.000	0.370	0.00
100.0391	0.0057	18.7714	0.0112	0.570	0.210	0.360	36.87
100.0383	0.0077	18.4931	0.0212	0.770	0.392	0.378	50.90
100.0351	0.0134	18.0637	0.0512	1.340	0.925	0.416	69.00
100.0322	0.0211	17.7774	0.1014	2.111	1.803	0.308	85.41
100.0250	0.0409	17.5470	0.2014	4.091	3.534	0.557	86.38
100.0188	0.0585	17.4261	0.3013	5.851	5.250	0.601	89.74
100.0104	0.0779	17.3491	0.4014	7.791	6.964	0.827	89.39
100.0030	0.0959	17.2858	0.5016	9.590	8.671	0.920	90.41
99.9949	0.1141	17.2241	0.6015	11.409	10.360	1.049	90.80

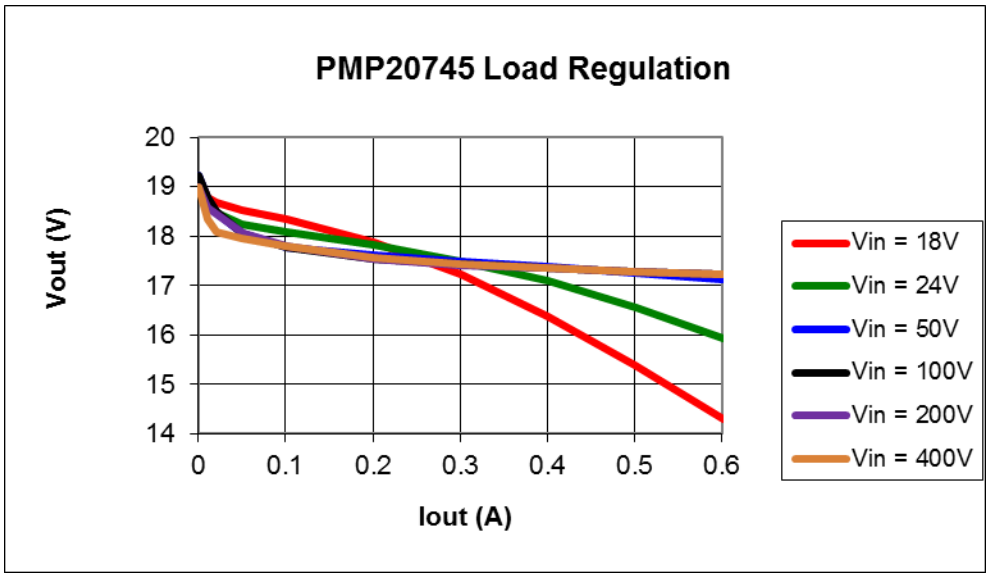
PMP20745 Rev A Test Results

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
200.0358	0.0025	19.0042	0.0000	0.500	0.000	0.500	0.00
200.0407	0.0028	18.5716	0.0112	0.560	0.208	0.352	37.14
200.0383	0.0045	18.4344	0.0211	0.900	0.389	0.511	43.21
200.0383	0.0064	18.0525	0.0513	1.280	0.926	0.354	72.34
200.0358	0.0118	17.7909	0.1013	2.360	1.802	0.558	76.35
200.0333	0.0210	17.5489	0.2013	4.201	3.533	0.668	84.10
200.0309	0.0296	17.4204	0.3013	5.921	5.249	0.672	88.65
200.0222	0.0398	17.3481	0.4013	7.961	6.962	0.999	87.45
200.0210	0.0482	17.2808	0.5015	9.641	8.666	0.975	89.89
200.0185	0.0565	17.2226	0.6016	11.301	10.361	0.940	91.68

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Losses (W)	Efficiency (%)
400.0815	0.0015	18.9922	0.0000	0.600	0.000	0.600	0.00
400.0790	0.0018	18.3542	0.0112	0.720	0.206	0.515	28.55
400.0765	0.0022	18.0881	0.0210	0.880	0.380	0.500	43.16
400.0741	0.0044	17.9558	0.0508	1.760	0.912	0.848	51.82
400.0765	0.0069	17.8063	0.1008	2.761	1.795	0.966	65.02
400.0741	0.0110	17.5537	0.2012	4.401	3.532	0.869	80.25
400.0716	0.0163	17.4409	0.3007	6.521	5.244	1.277	80.42
400.0691	0.0206	17.3497	0.4010	8.241	6.957	1.284	84.42
400.0691	0.0246	17.2773	0.5009	9.842	8.654	1.188	87.93
400.0691	0.0296	17.2354	0.6011	11.842	10.360	1.482	87.49

3.2 Regulation

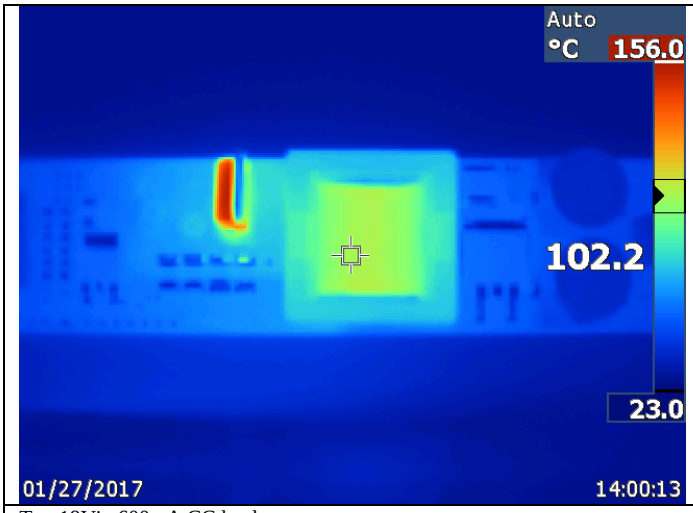




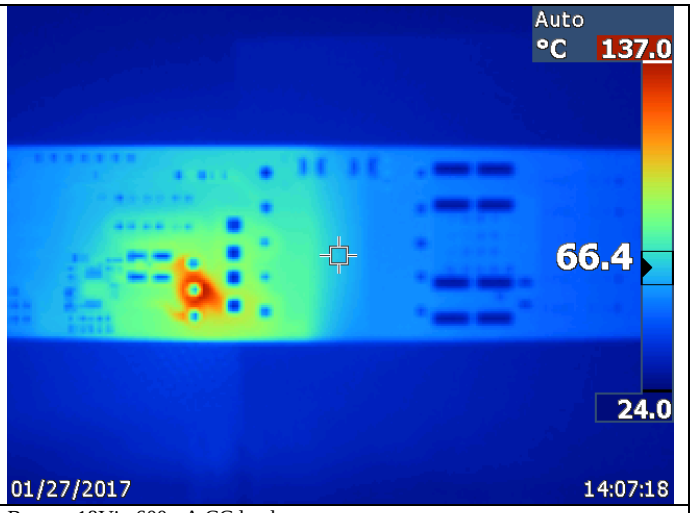
4 Thermal

4.1 Thermal Plots

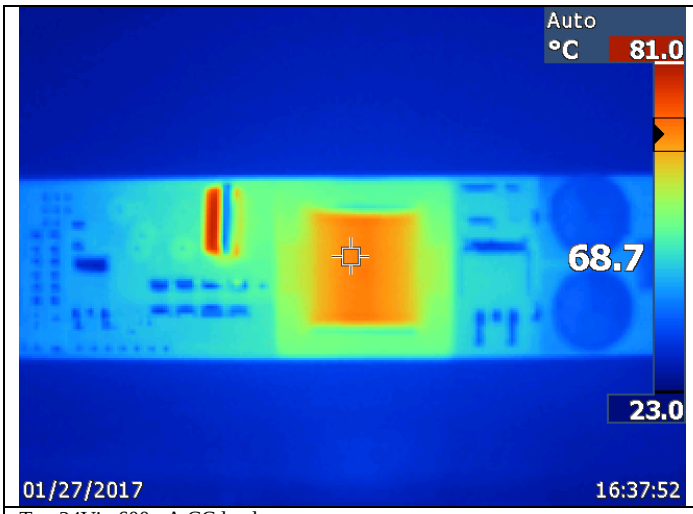
Thermal plots were taken on an open bench with no heatsink or airflow.



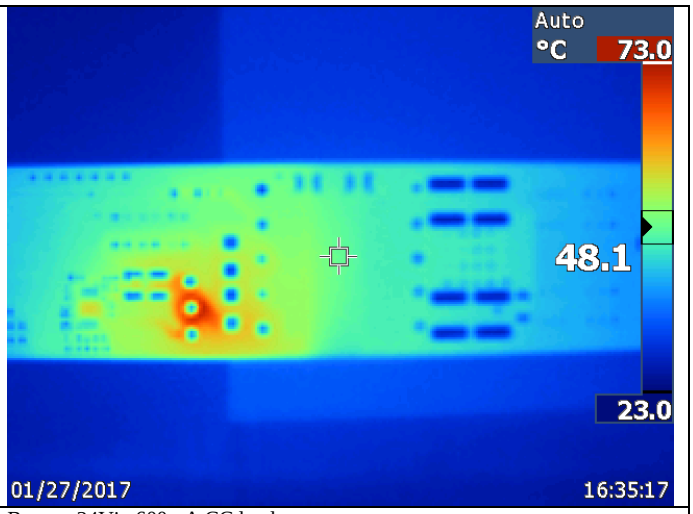
Top 18Vin 600mA CC load



Bottom 18Vin 600mA CC load



Top 24Vin 600mA CC load



Bottom 24Vin 600mA CC load

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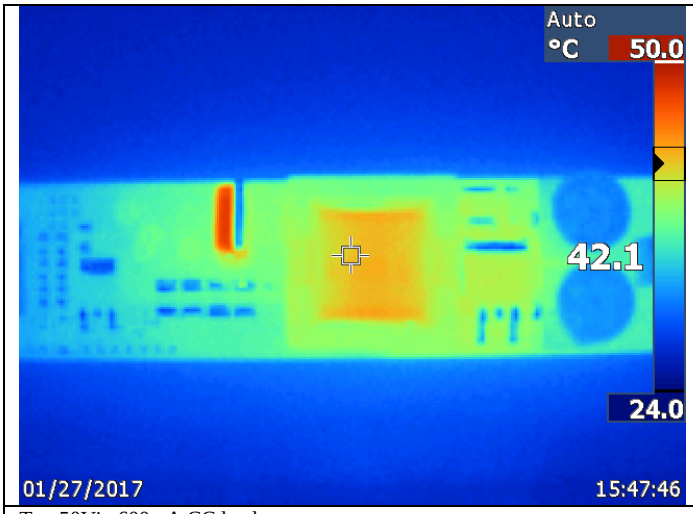
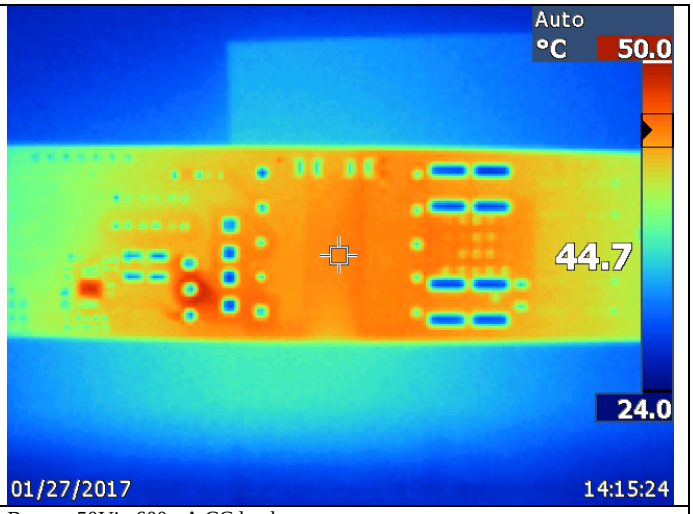
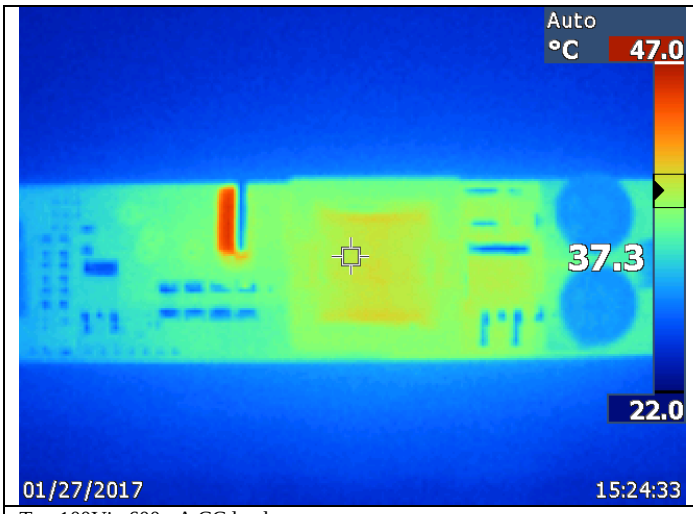
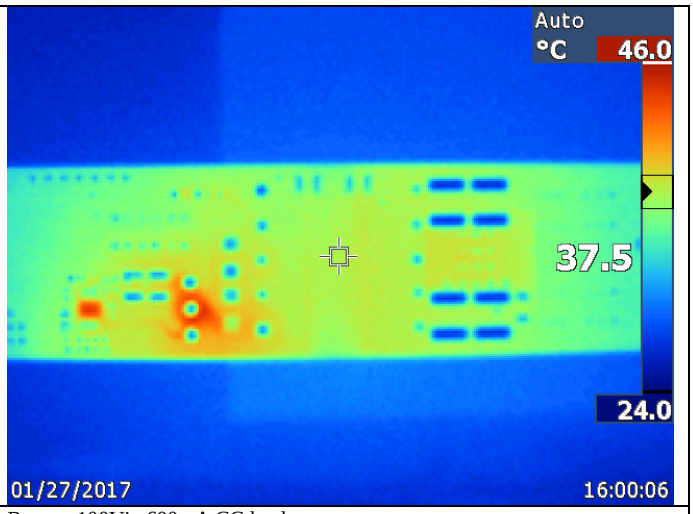
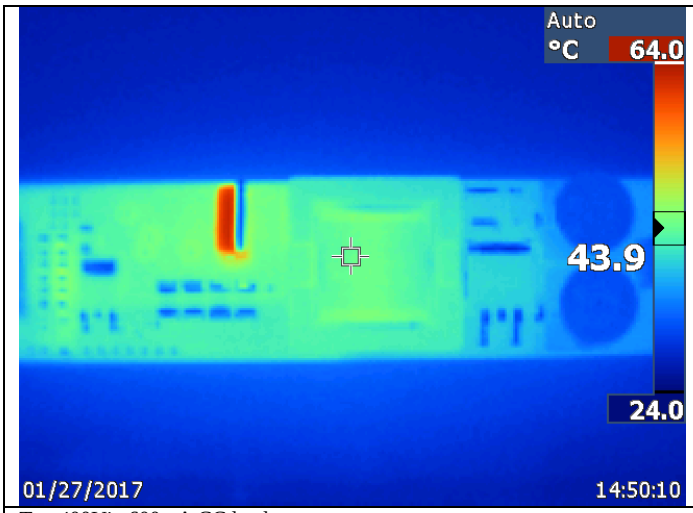
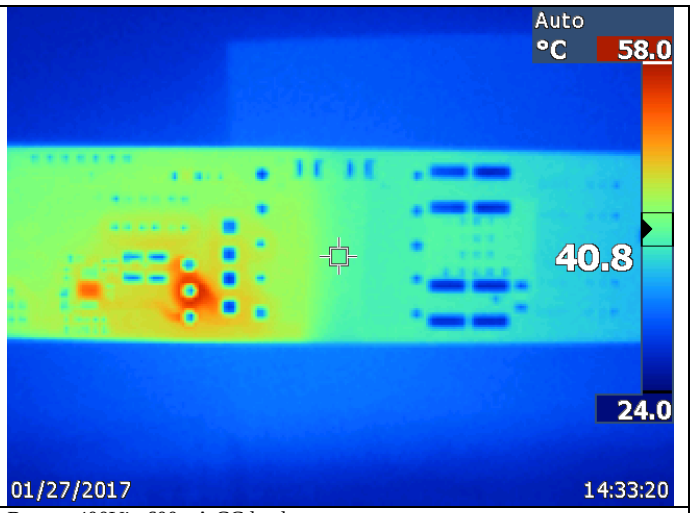
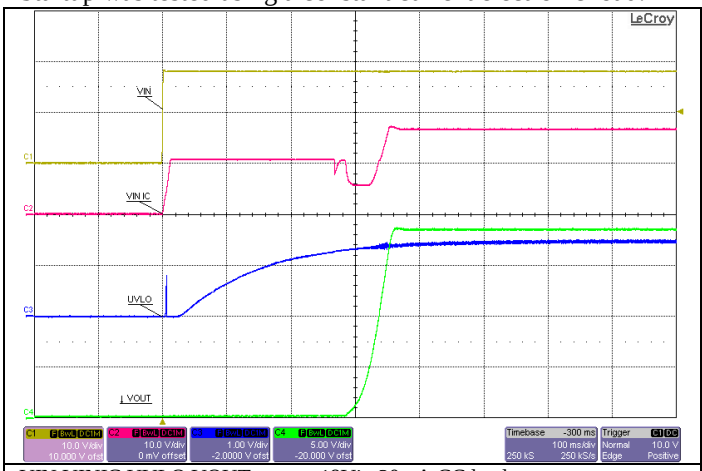
	
Top 50Vin 600mA CC load	Bottom 50Vin 600mA CC load
	
Top 100Vin 600mA CC load	Bottom 100Vin 600mA CC load
	
Top 400Vin 600mA CC load	Bottom 400Vin 600mA CC load

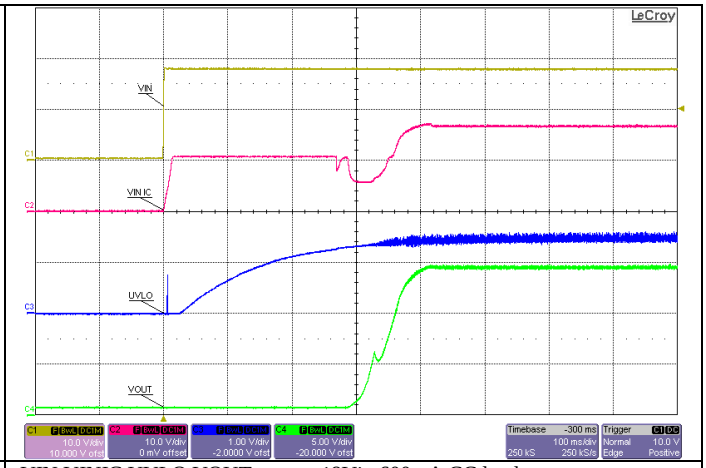
5 Startup

5.1 Startup from Vin

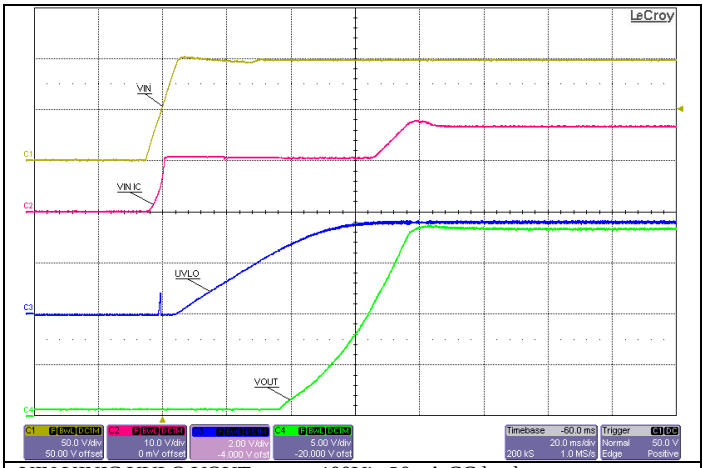
Startup was tested using a constant current electronic load.



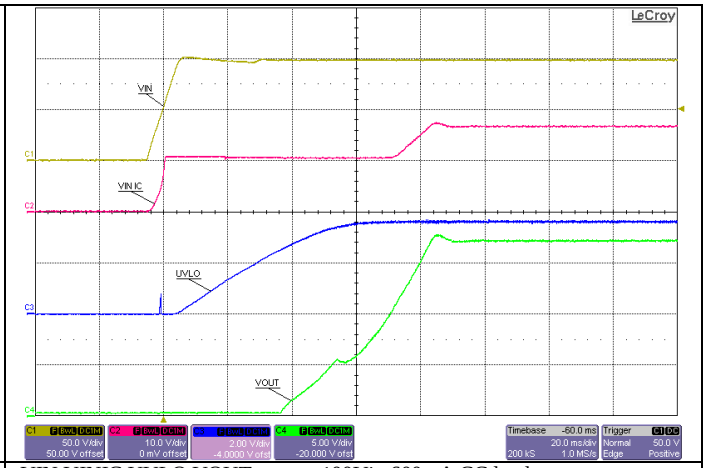
VIN VINIC UVLO VOUT startup 18Vin 20mA CC load



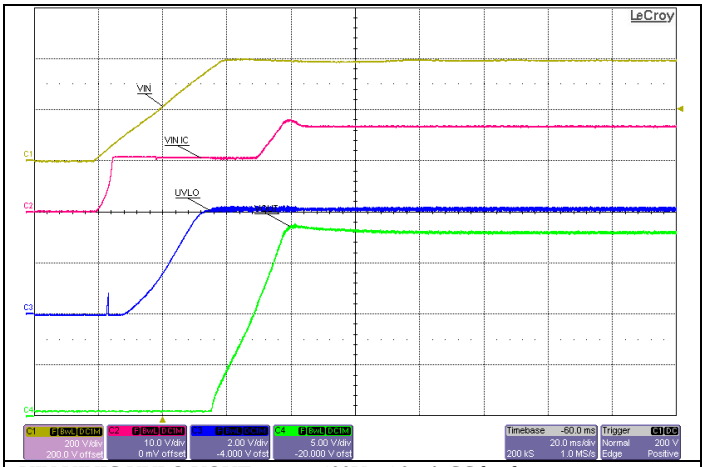
VIN VINIC UVLO VOUT startup 18Vin 600mA CC load



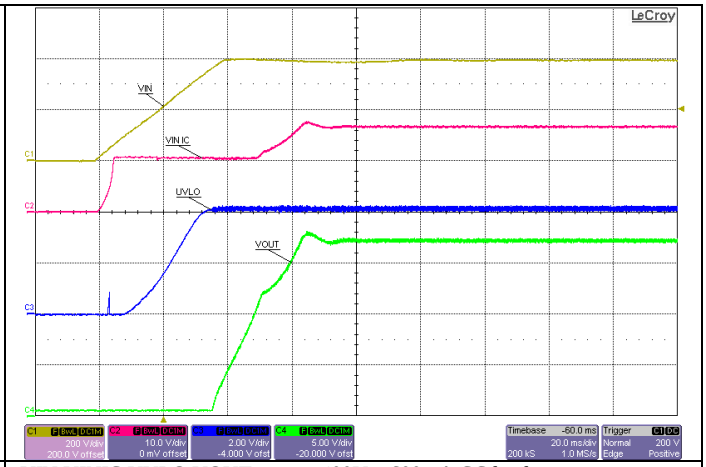
VIN VINIC UVLO VOUT startup 100Vin 20mA CC load



VIN VINIC UVLO VOUT startup 100Vin 600mA CC load



VIN VINIC UVLO VOUT startup 400Vin 20mA CC load

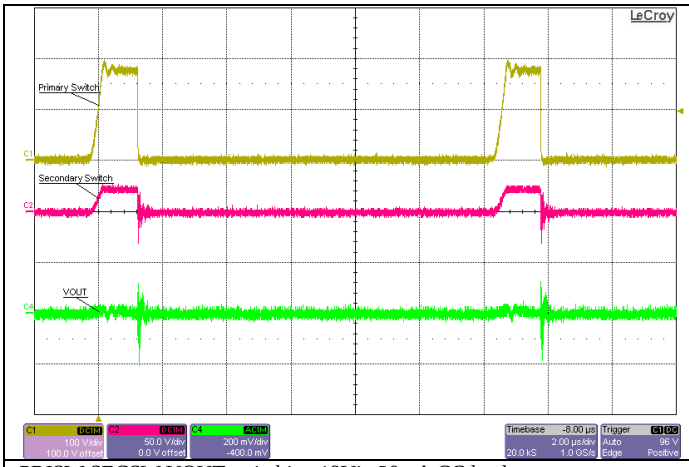


VIN VINIC UVLO VOUT startup 400Vin 600mA CC load

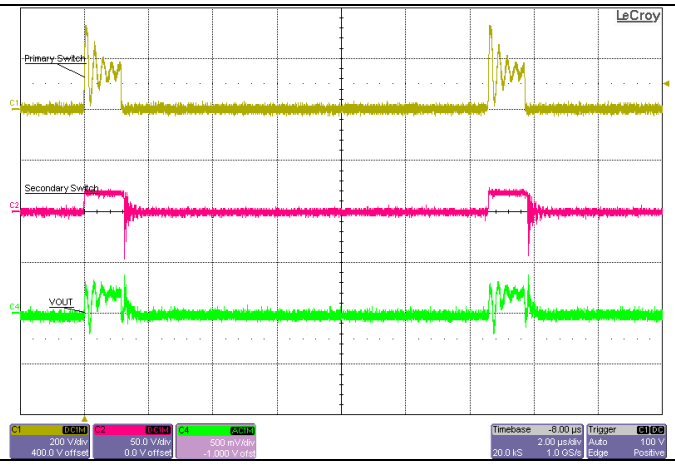
6 Switching and Ripple

6.1 Switching and Ripple

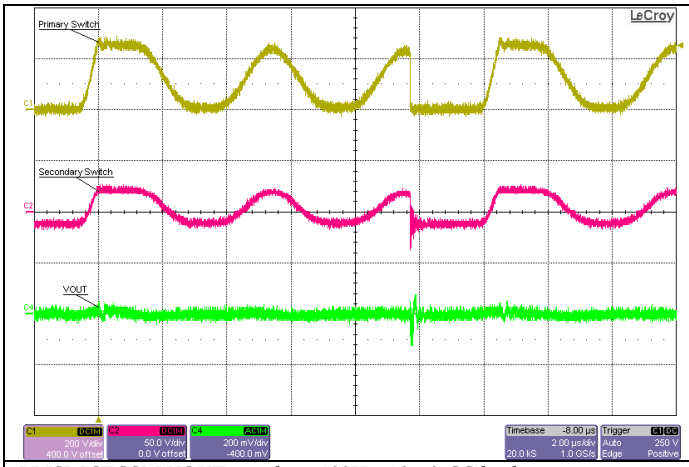
Switching and ripple were measured at full bandwidth using 500 MHz probes and 350 MHz oscilloscope.



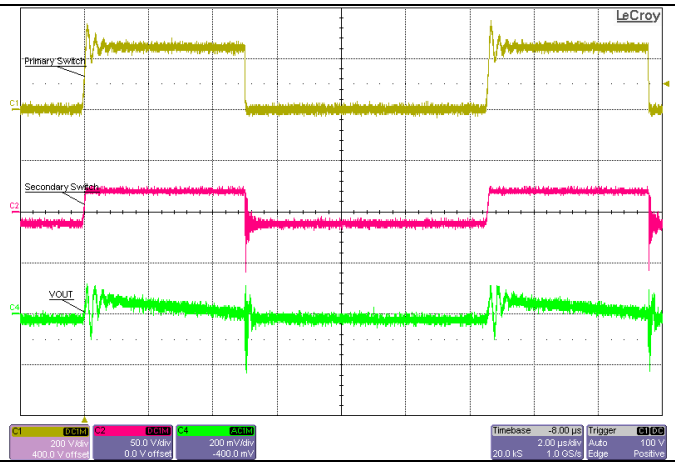
PRISW SECSW VOUT switching 18Vin 20mA CC load



PRISW SECSW VOUT switching 18Vin 600mA CC load



PRISW SECSW VOUT switching 100Vin 20mA CC load



PRISW SECSW VOUT switching 100Vin 600mA CC load

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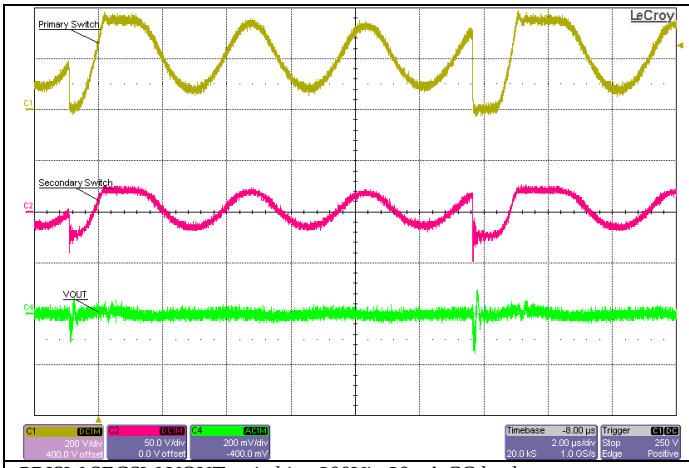
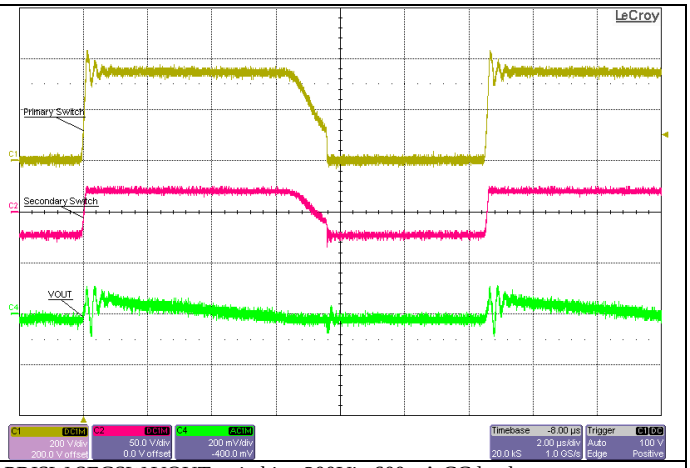
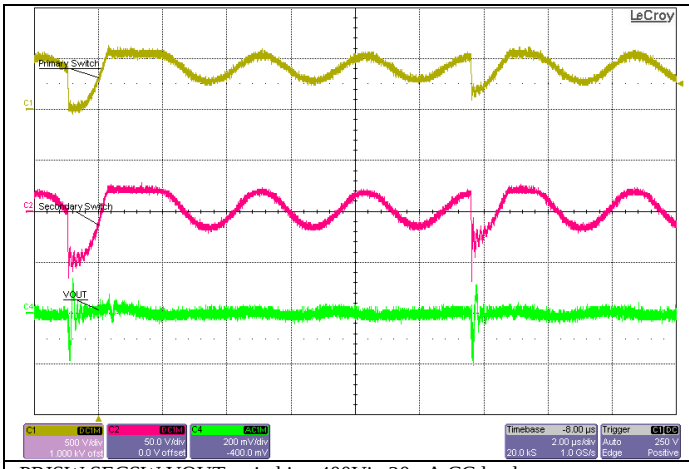


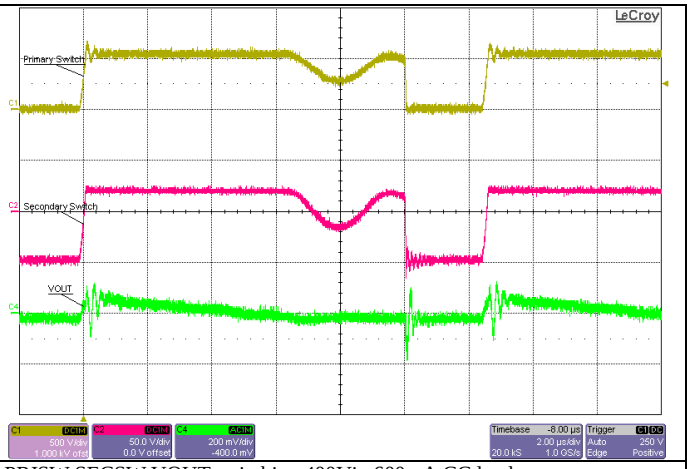
PRISW SECSW VOUT switching 200Vin 20mA CC load



PRISW SECSW VOUT switching 200Vin 600mA CC load



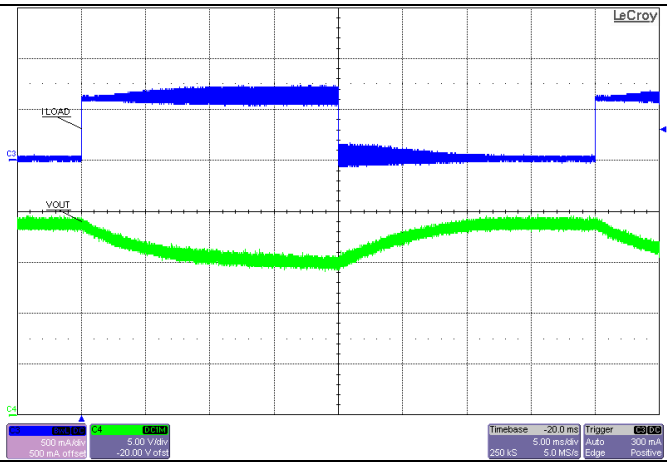
PRISW SECSW VOUT switching 400Vin 20mA CC load



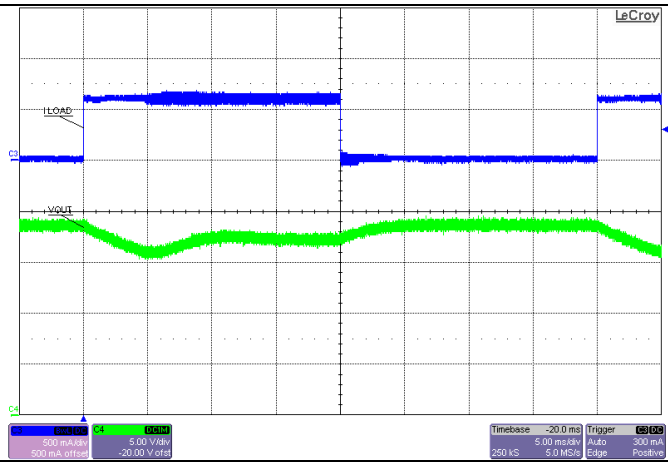
PRISW SECSW VOUT switching 400Vin 600mA CC load

7 Load Transient Response

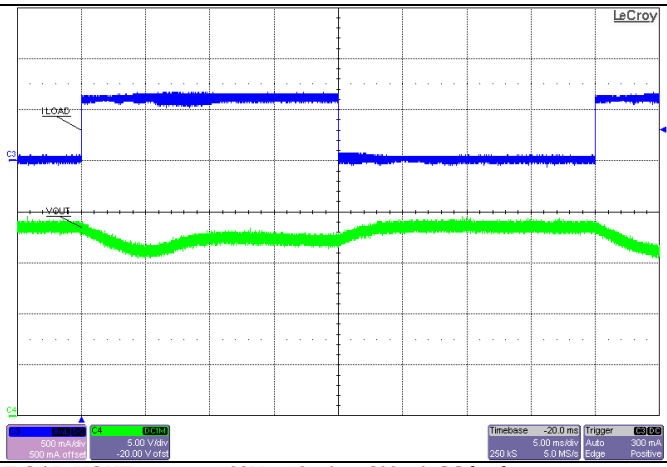
7.1 Load Transient Response



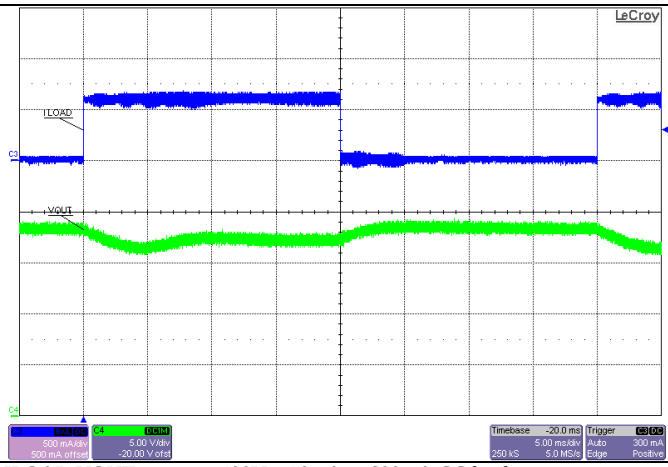
ILOAD VOUT transient 18Vin 20mA to 600mA CC load step



ILOAD VOUT transient 100Vin 20mA to 600mA CC load step



ILOAD VOUT transient 200Vin 20mA to 600mA CC load step

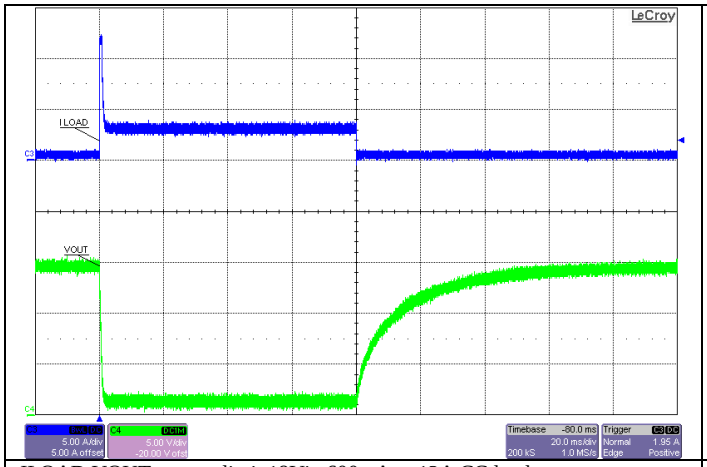


ILOAD VOUT transient 400Vin 20mA to 600mA CC load step

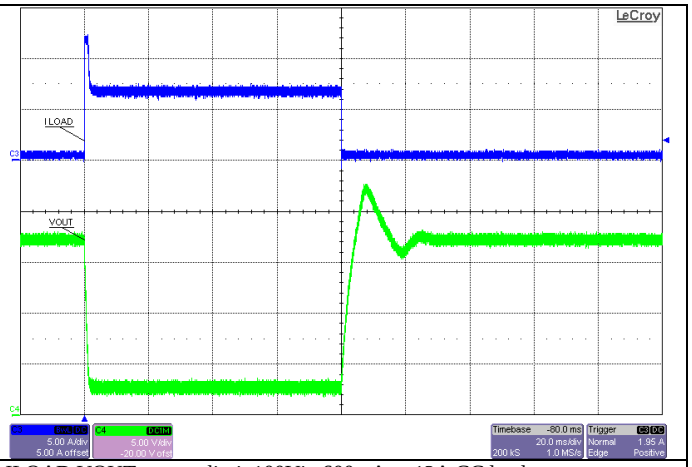
8 Current Limit

8.1 Current Limit

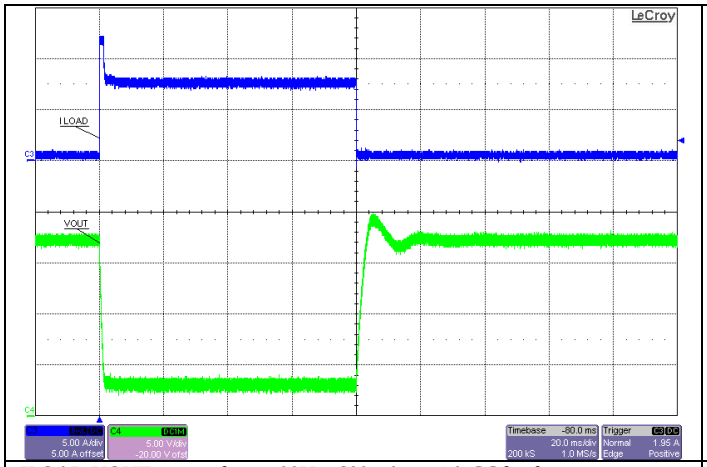
A constant-current electronic load was used to step the output current from full load to a current limited condition.



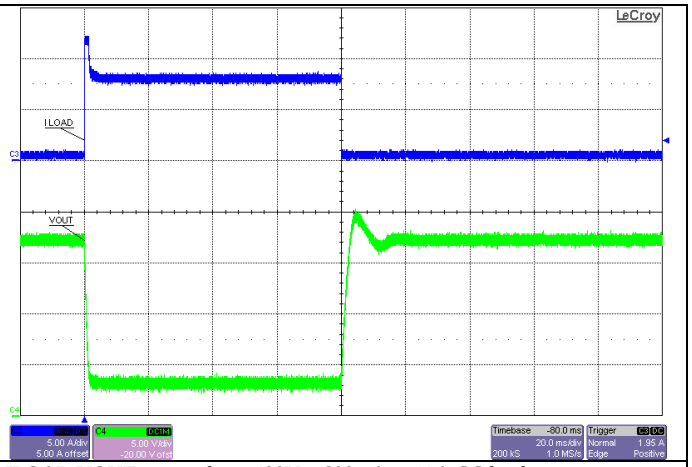
ILOAD VOUT current limit 18Vin 600mA to 12A CC load step



ILOAD VOUT current limit 100Vin 600mA to 12A CC load step



ILOAD VOUT current limit 200Vin 600mA to 12A CC load step



ILOAD VOUT current limit 400Vin 600mA to 12A CC load step

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