



LM27403 Synchronous Buck Converter

TI reference design number: PMP7935 Rev B

Input: 12V

Output: 0.9V @ 45A

DC – DC Test Results

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1 Circuit Description

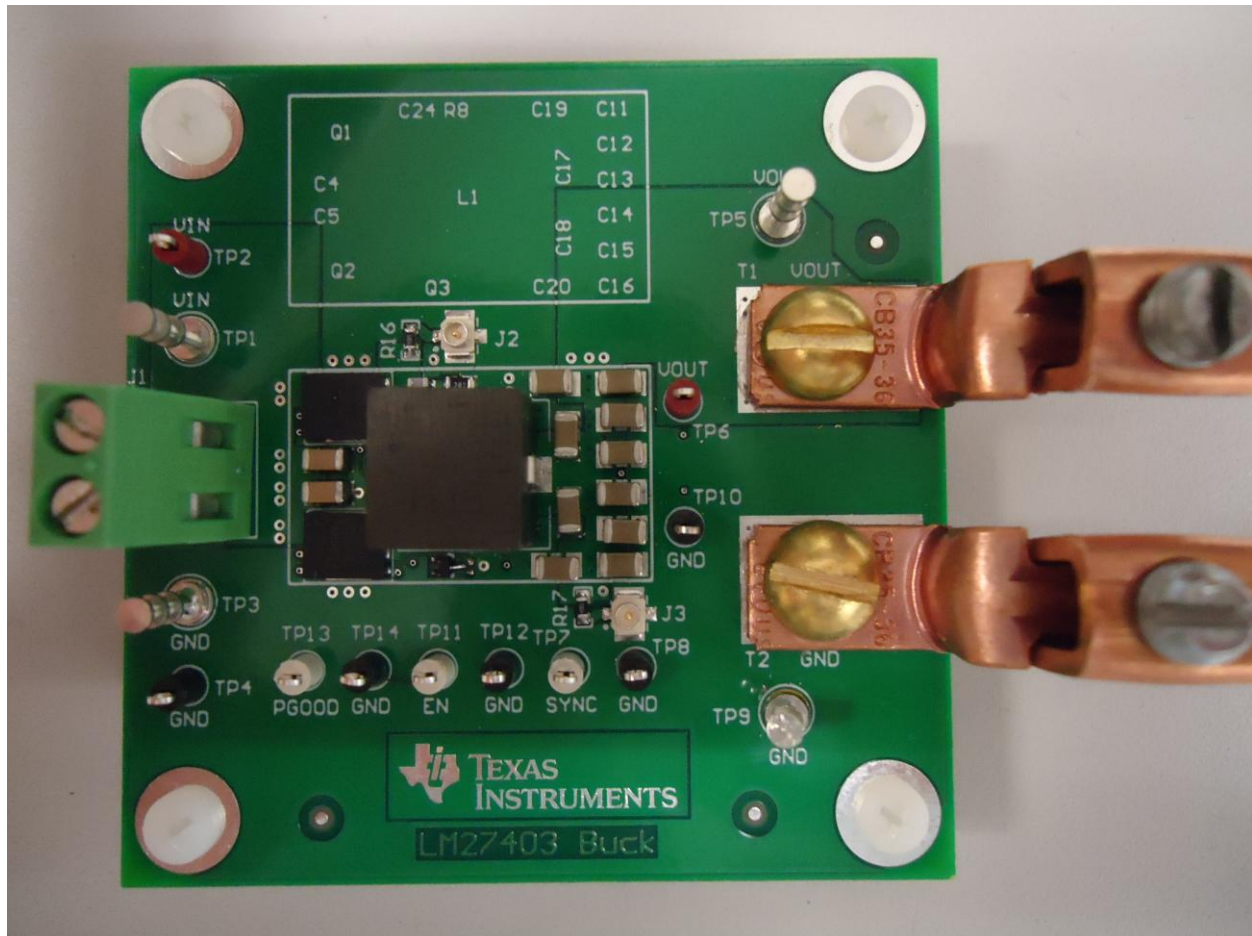
PMP7935 is a single-phase synchronous buck converter rated for 0.9V output at 45A from an input voltage of 12V. This design uses the LM27403 synchronous buck controller at a switching frequency of 300 kHz. CSD87350Q5D power block MOSFETs provide maximum efficiency when combined with a 250 nH ferrite output inductor. The design solution uses all ceramic capacitors to fit into a minimum board area.

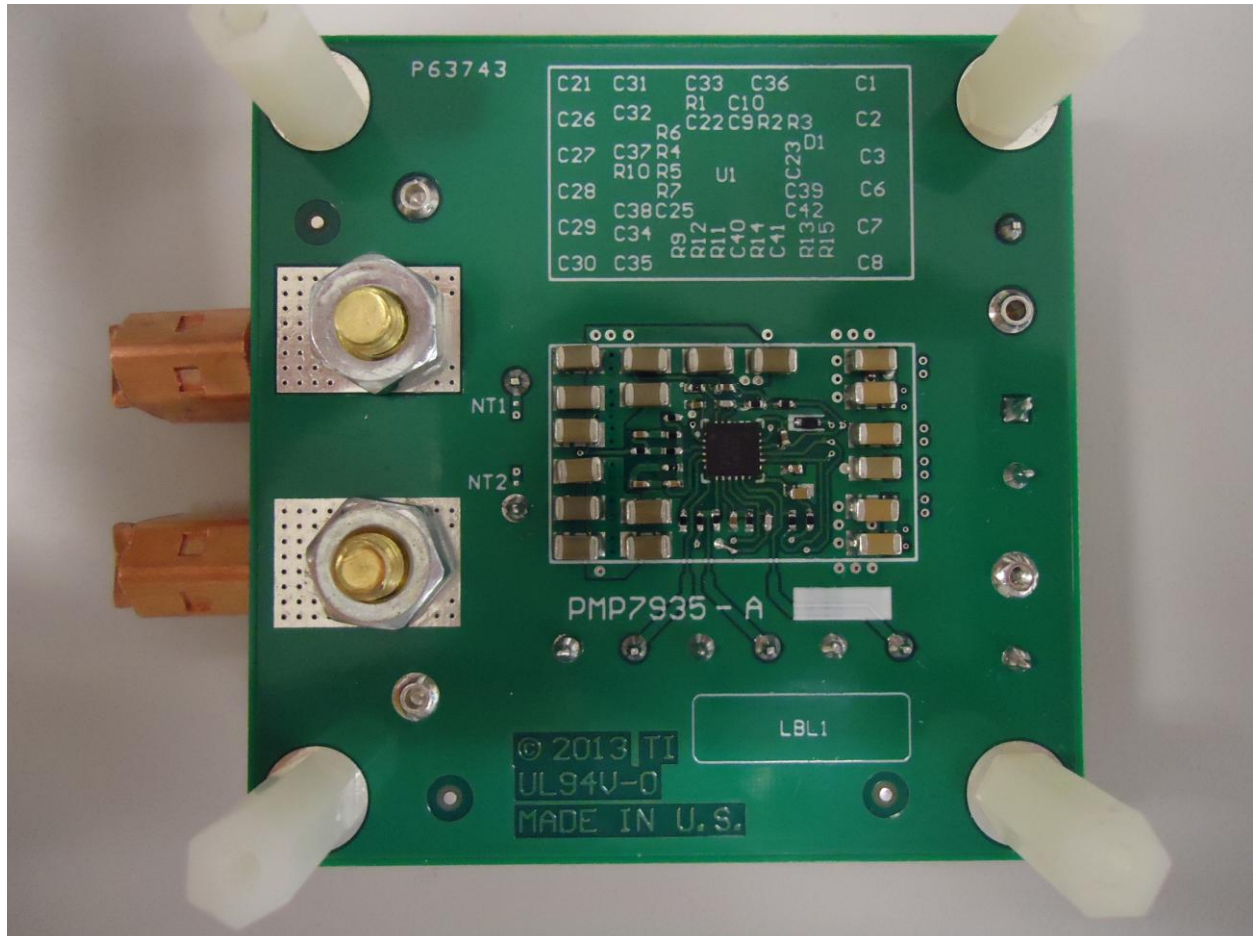
The effective output capacitance with dc bias and operating conditions is 1250 μF out of the total 2200 μF . With no external output capacitance, the output voltage transient is 60 mV for a load step of 20A. Adding an additional 16 x 100 μF ceramic or 4 x 330 μF polymer aluminum reduces the output voltage transient to 30 mV for the 20A load step. In general any combination of output capacitors greater than 2200 μF with less than 0.5 m Ω effective ESR will meet the 30 mV transient. For best performance, bulk polymers can be placed at the converter, with ceramic capacitors at the load.

At tests were performed at room temperature on an open bench. A 470 μF , 25V aluminum electrolytic input capacitor was used for input filter damping.

2 Photos

The photographs below show the PMP7935 Rev B assembly as built on PMP7935-A printed circuit board. This is a 4 layer board using 2 ounce copper on external layers and 1 ounce copper on internal layers. Power components are mounted on the top side of the board, with the control circuit on the bottom. The overall board dimensions are 2.5" x 2.5". The solution size component area is 1.1" x 0.65". The maximum component height is set by the inductor at 9.4 mm.

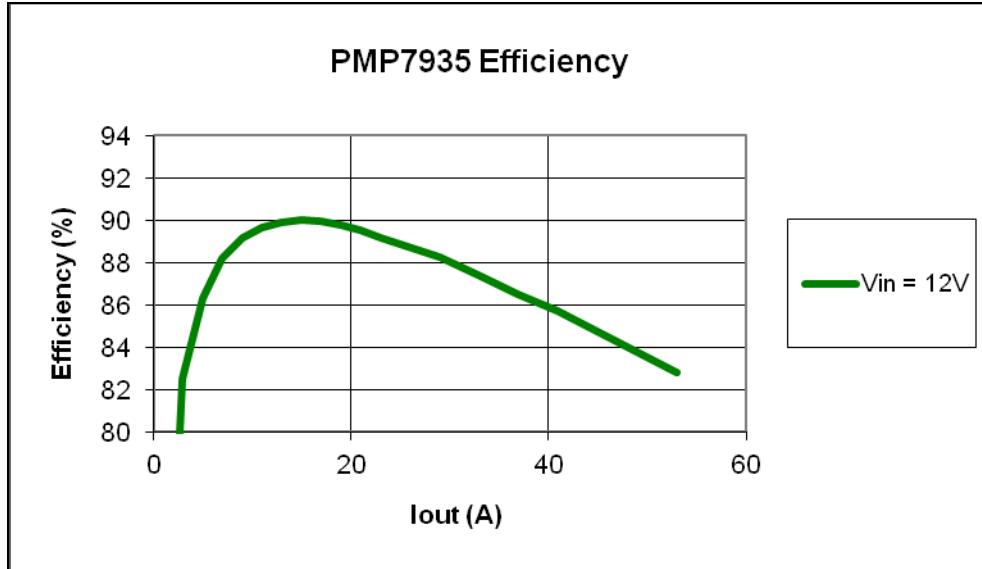




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3 Efficiency

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)
11.998	0.041	0.900	0.000	0.00	0.49	0.00	0.49
11.997	0.115	0.900	0.974	63.54	1.38	0.88	0.50
11.997	0.269	0.900	2.958	82.49	3.23	2.66	0.56
11.997	0.432	0.900	4.972	86.34	5.18	4.47	0.71
11.997	0.592	0.900	6.958	88.17	7.10	6.26	0.84
11.997	0.755	0.900	8.976	89.19	9.06	8.08	0.98
11.997	0.917	0.900	10.960	89.66	11.00	9.86	1.14
11.997	1.080	0.900	12.944	89.91	12.96	11.65	1.31
11.996	1.248	0.901	14.960	90.03	14.97	13.48	1.49
11.996	1.415	0.901	16.942	89.93	16.97	15.26	1.71
11.996	1.586	0.901	18.960	89.79	19.03	17.08	1.94
11.995	1.757	0.901	20.944	89.54	21.08	18.87	2.20
11.995	1.942	0.901	23.056	89.18	23.29	20.77	2.52
11.993	2.467	0.902	28.950	88.26	29.59	26.11	3.47
11.992	2.835	0.902	32.950	87.42	34.00	29.72	4.28
11.990	3.213	0.902	36.954	86.52	38.52	33.33	5.19
11.989	3.600	0.903	40.956	85.69	43.16	36.98	6.18
11.987	3.996	0.903	44.960	84.76	47.90	40.60	7.30
11.985	4.402	0.903	48.962	83.80	52.76	44.21	8.55
11.982	4.819	0.903	52.962	82.83	57.74	47.82	9.92
11.997	0.398	0.047	10.822	10.65	4.77	0.51	4.27

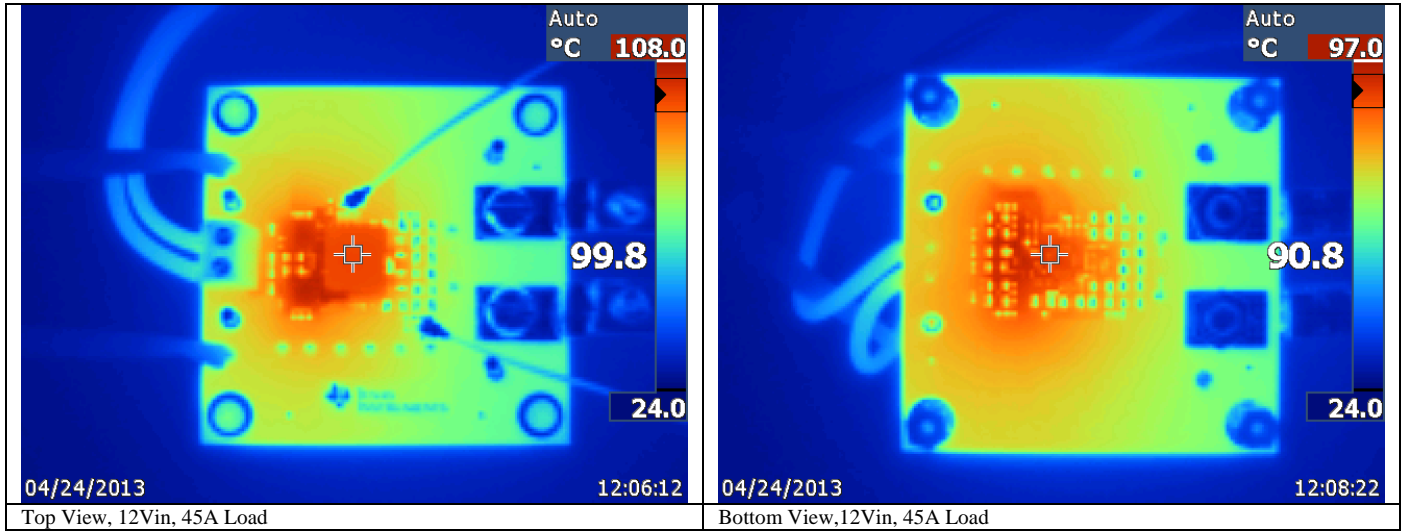
4 Thermal Tests

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

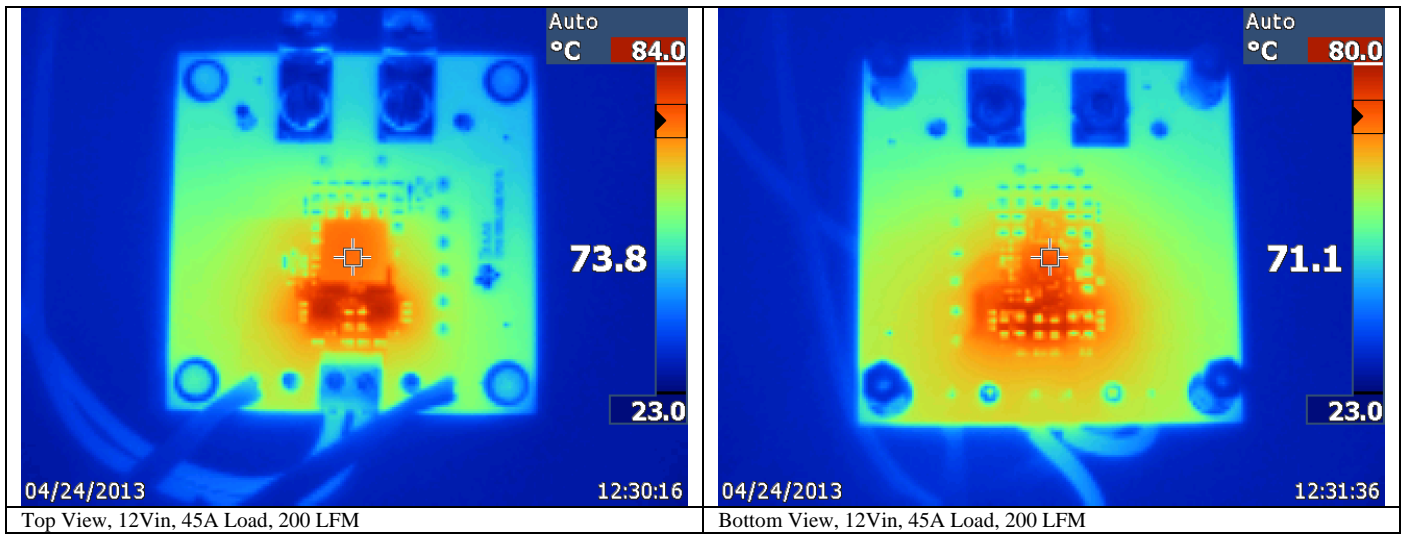
4.1 Test Setup



4.2 45A Load, No Airflow



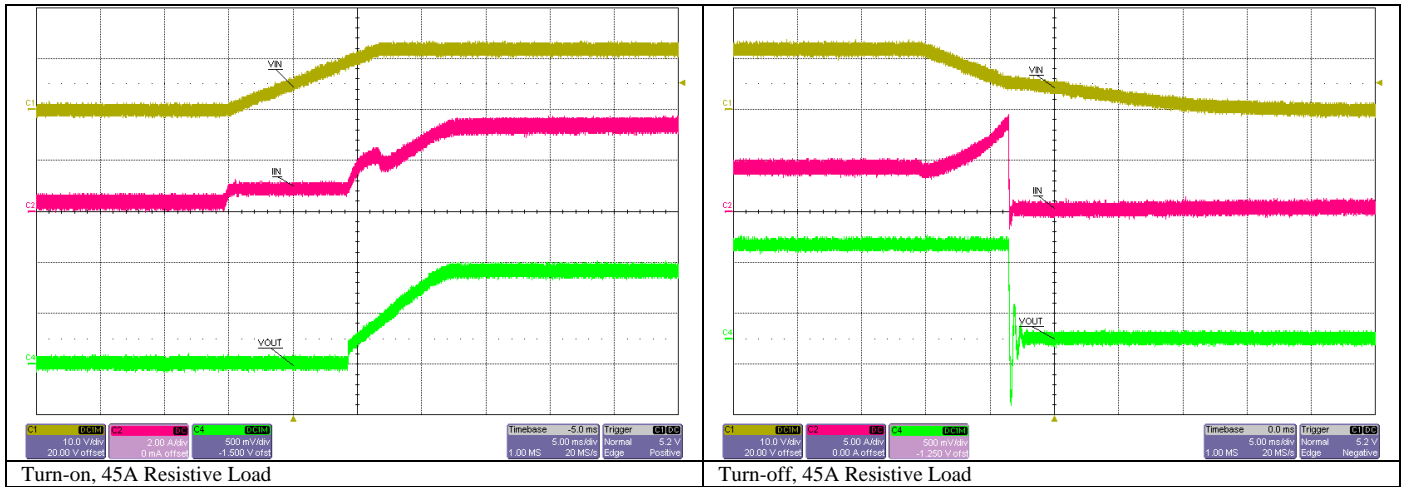
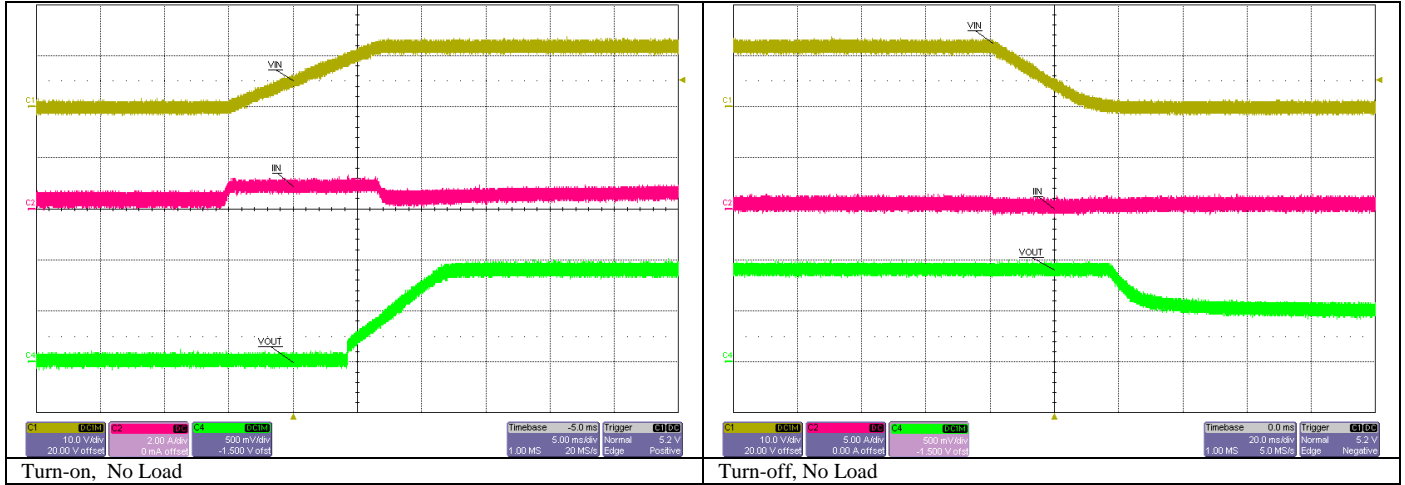
4.3 45A Load, 200 LFM Airflow



5 Startup and Shutdown Behavior

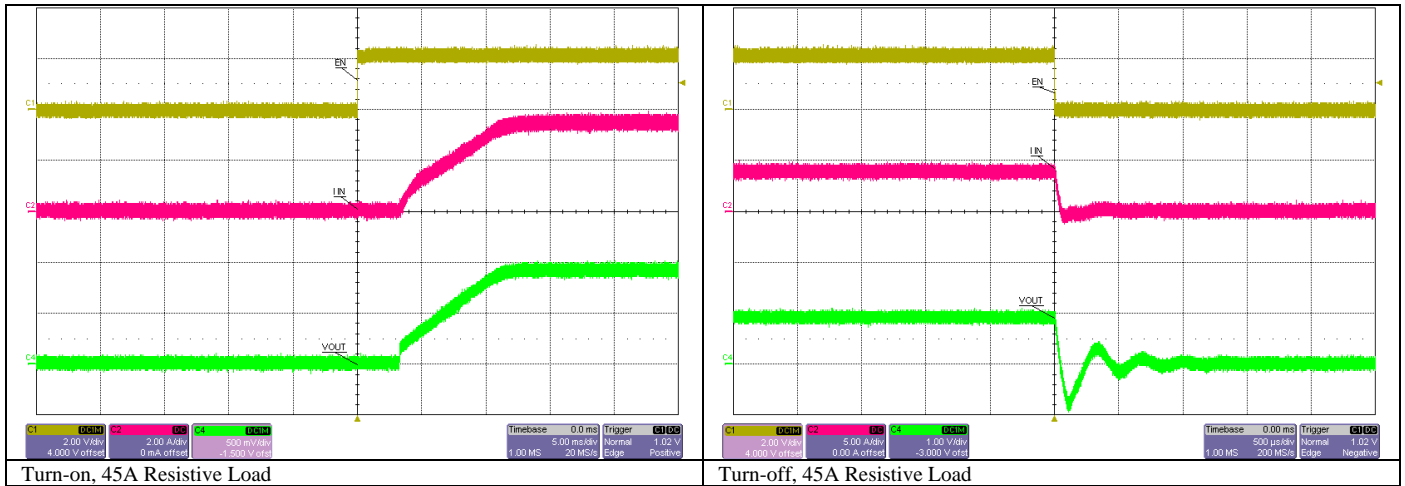
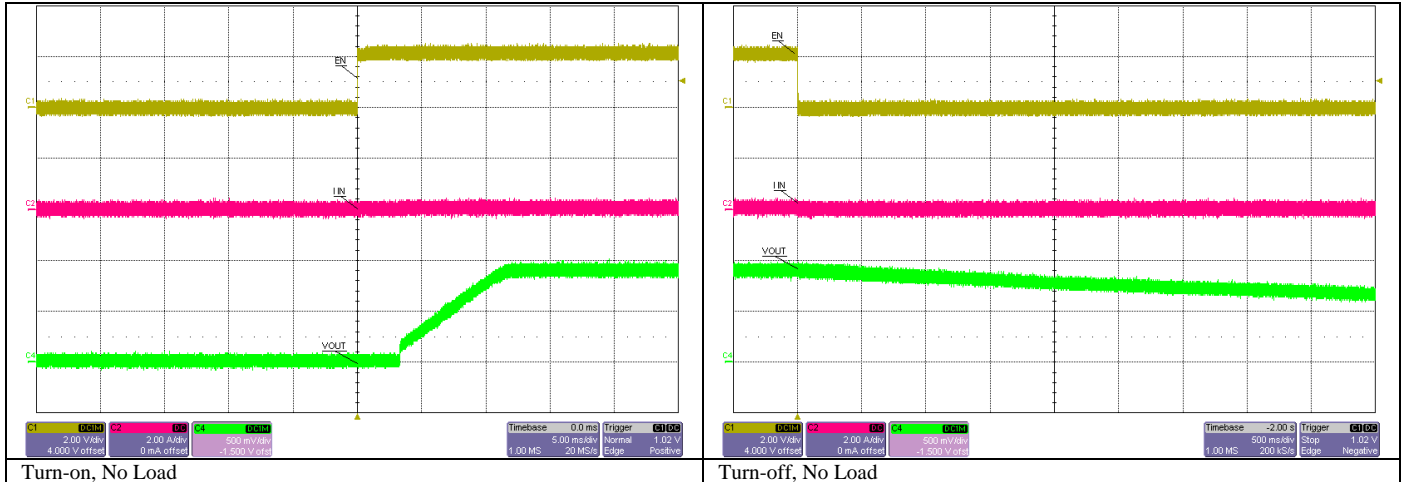
5.1 Turn-on and Turn-off from Vin

The output voltage is well controlled at turn-on, showing no evidence of over-shoot. Some ringing occurs at turn-off with load due to the output filter resonance.



5.2 Turn-on and Turn-off from EN

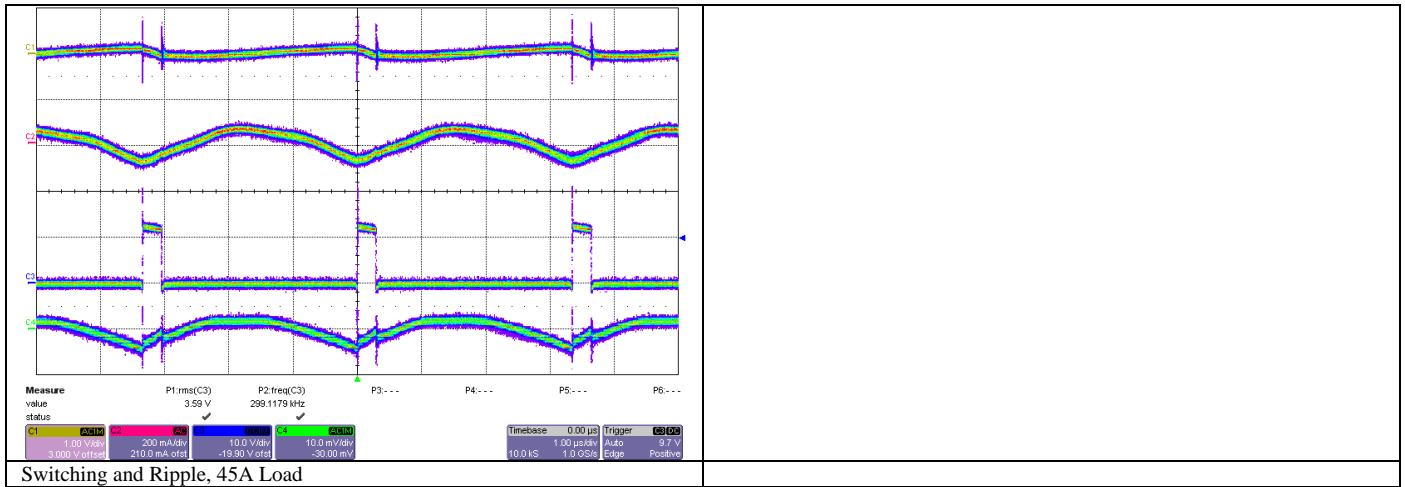
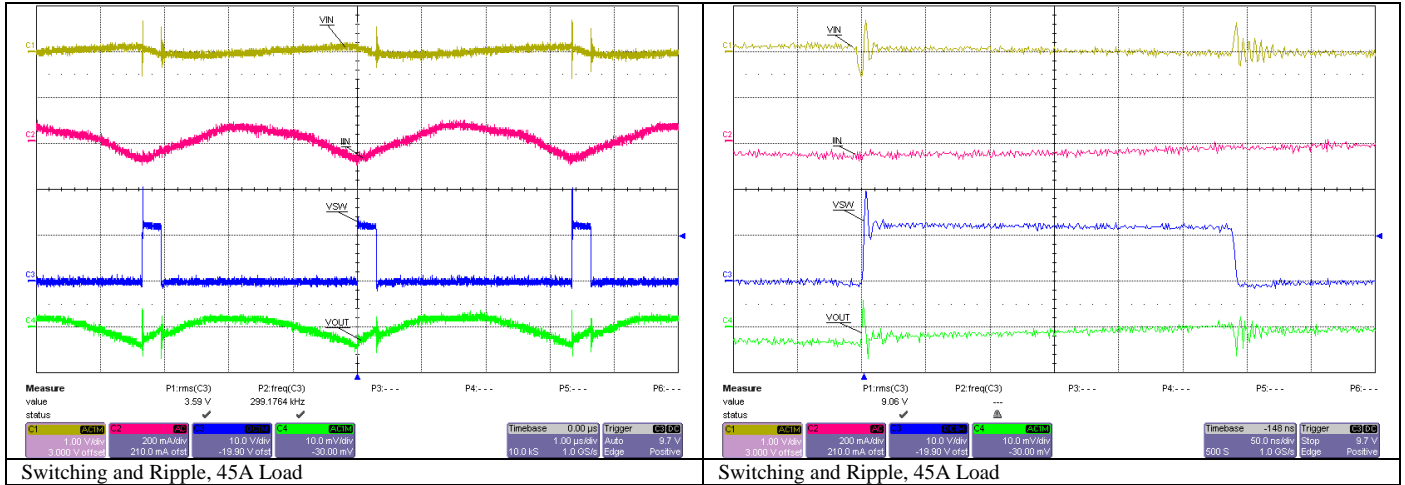
The output voltage is well controlled at turn-on, showing no evidence of over-shoot. Some ringing occurs at turn-off with load due to the output filter resonance.



6 Switching and Ripple

6.1 Switching and Ripple

Switching and ripple tests were made with a 470 μ F, 25V aluminum electrolytic input capacitor for input filter damping.



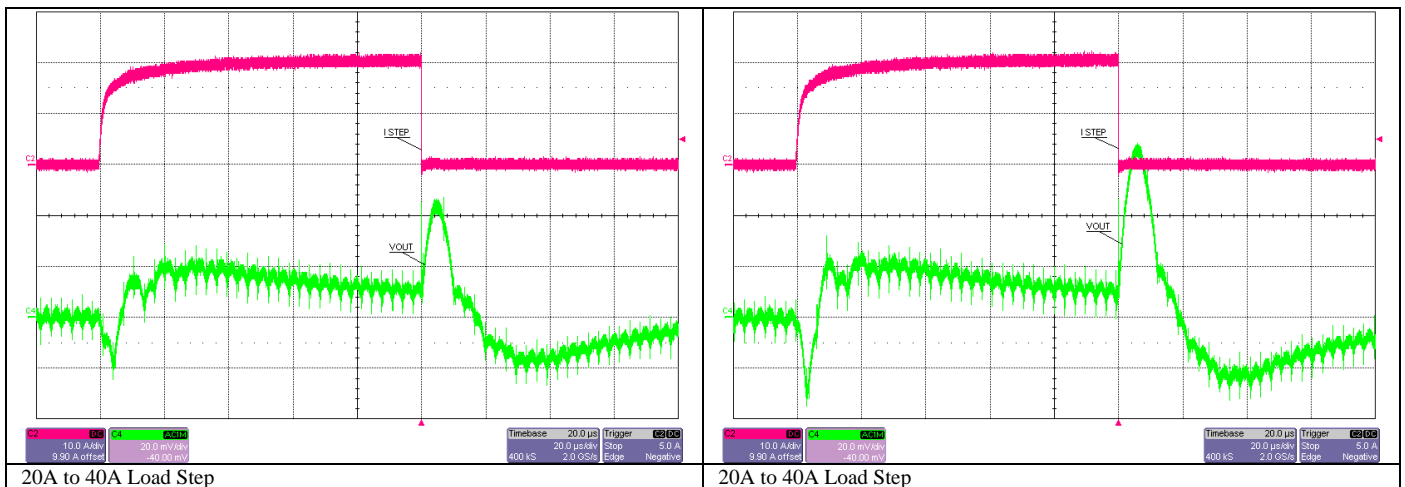
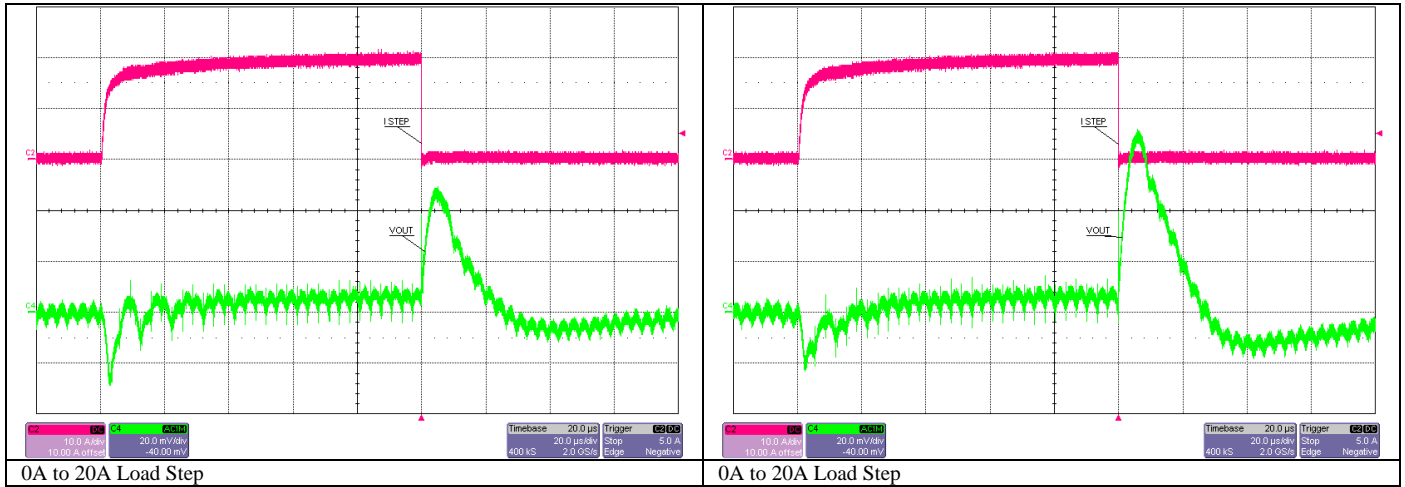
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7 Load Transient Response

Load transient response for each condition was taken at two points to represent the minimum and maximum deviation. This difference occurs when the transient step coincides with either the converter off-time or on-time interval.

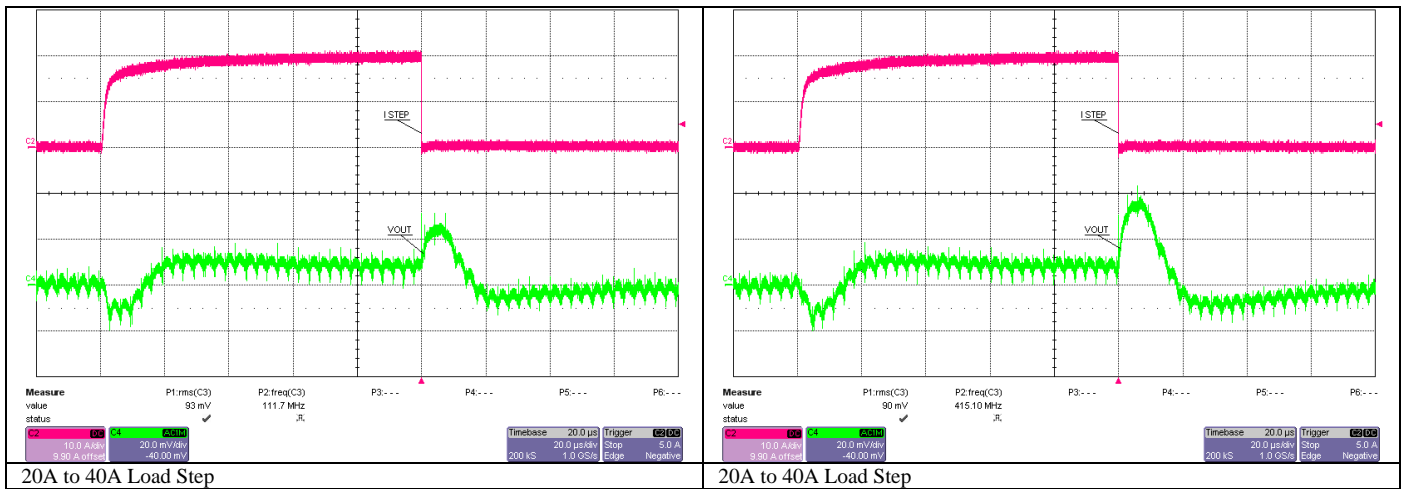
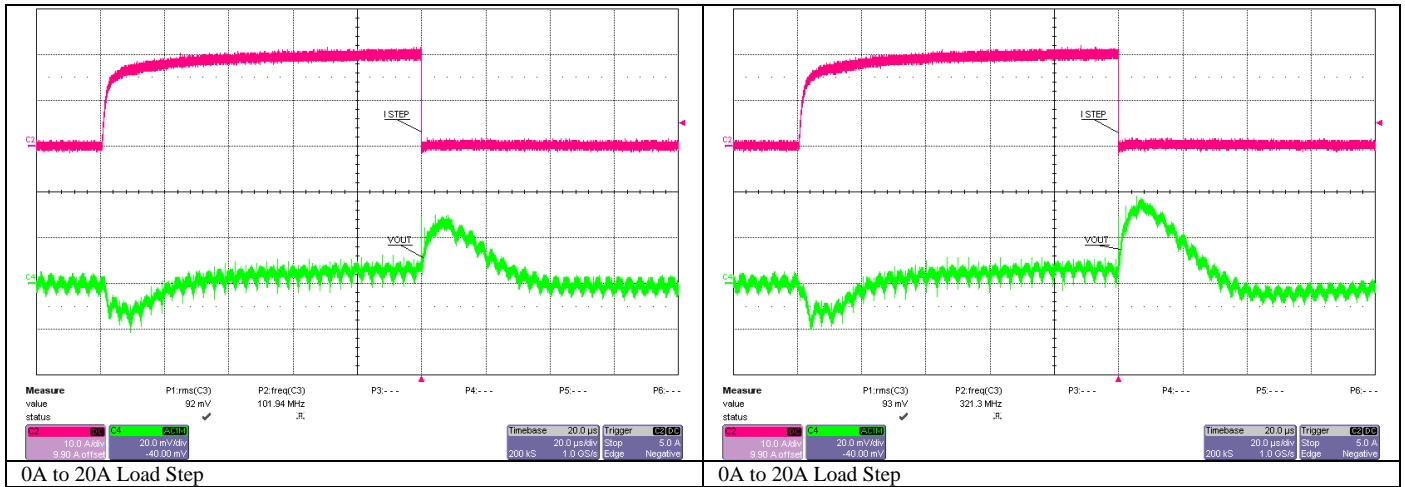
7.1 No External Output Capacitor

With no external capacitors, the output voltage transient is 60mV for a 20A load step.



7.2 16 x 100 μ F External Output Capacitor

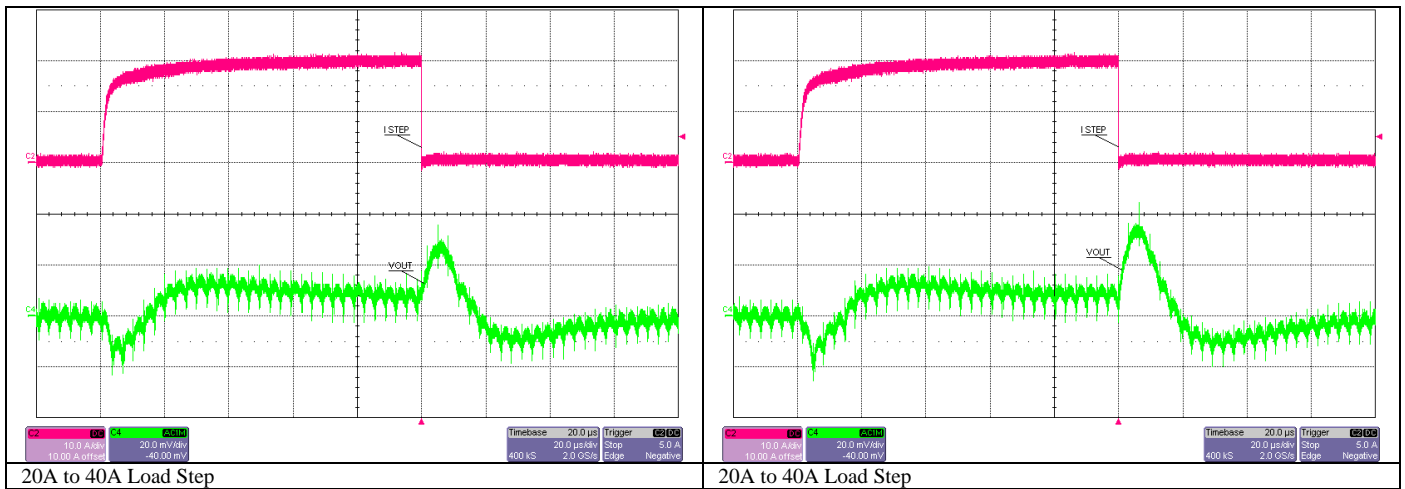
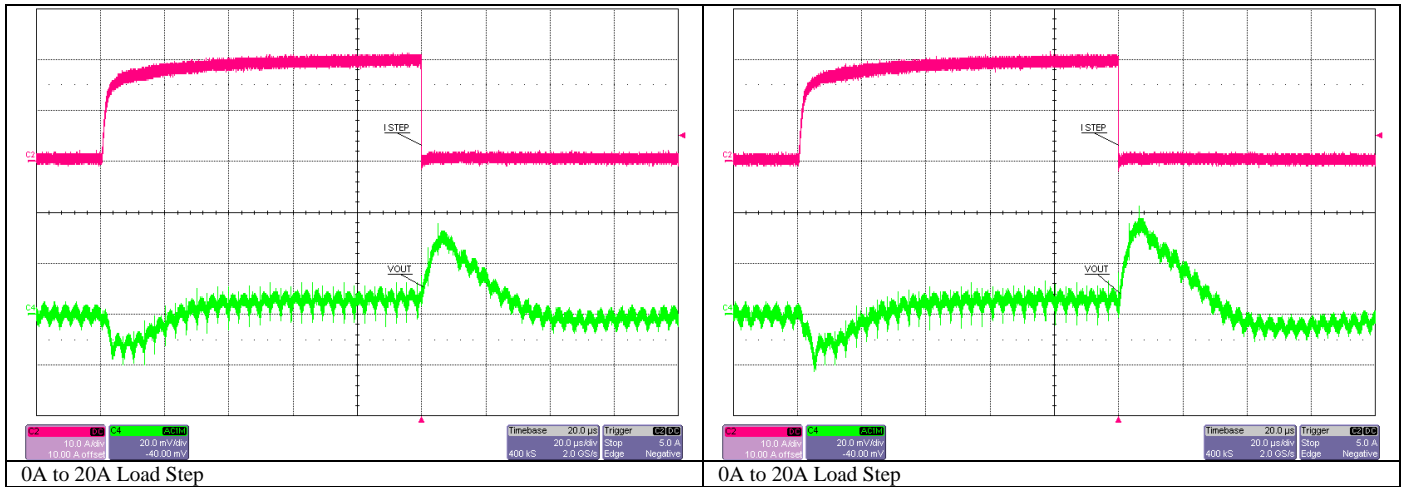
With 16 x 100 μ F, 6.3V, X5R ceramic external capacitors, the output voltage transient is 30mV for a 20A load step.



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7.3 4 x 330 μ F External Output Capacitor

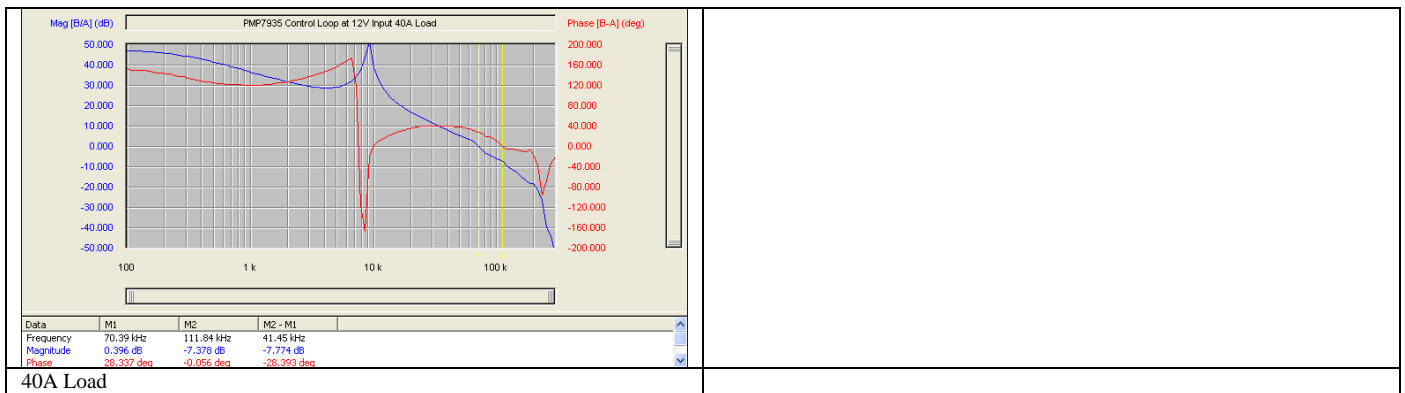
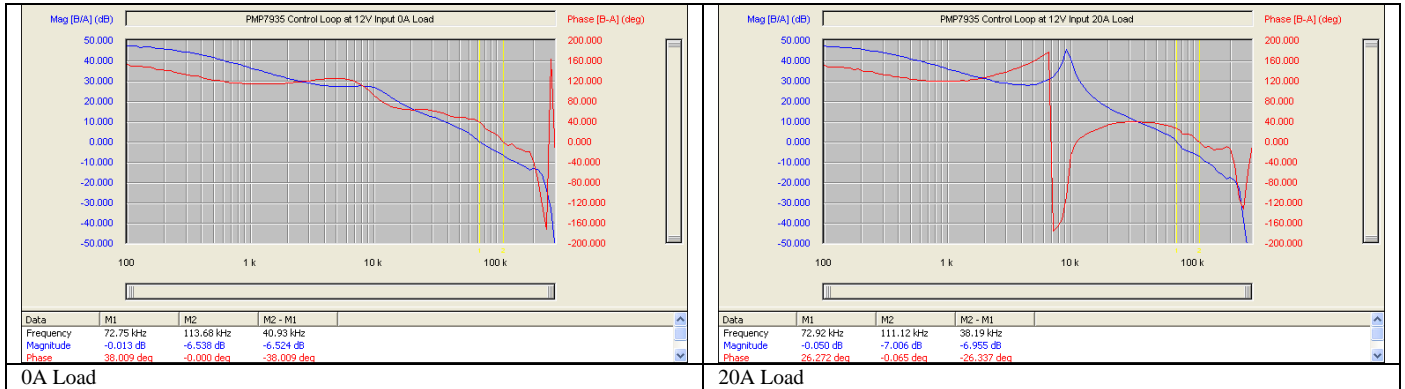
With 4 x 330 μ F, 2V, 6 m Ω polymer aluminum external capacitors, the output voltage transient is 30mV for a 20A load step.



8 Frequency Response

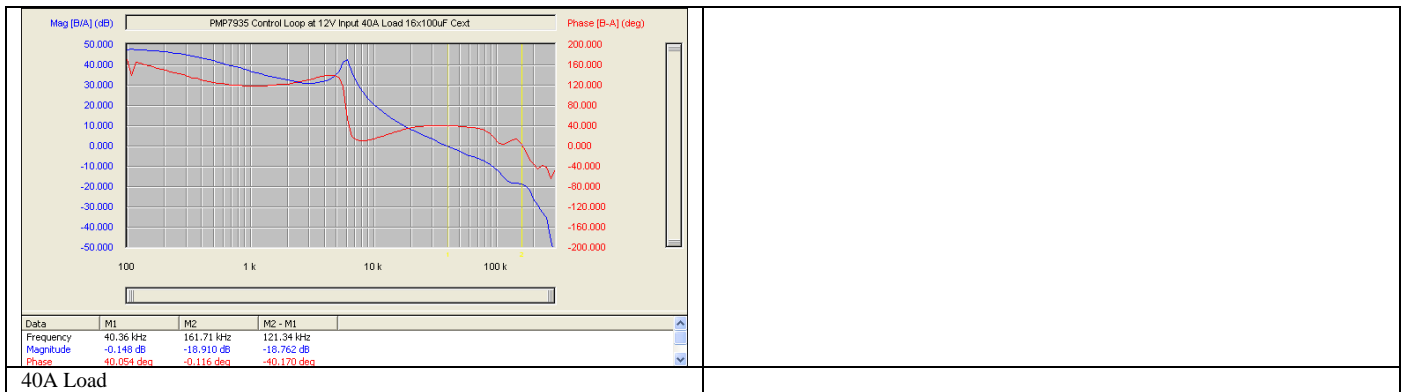
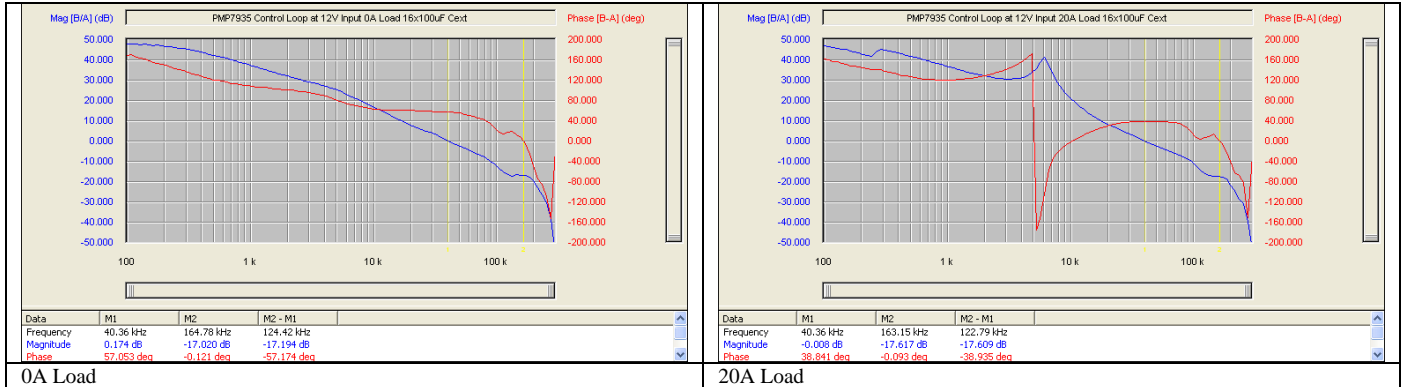
8.1 No External Output Capacitor

With no external capacitors, the control loop exhibits a high bandwidth of 70 kHz and low phase margin of 28° at full load.



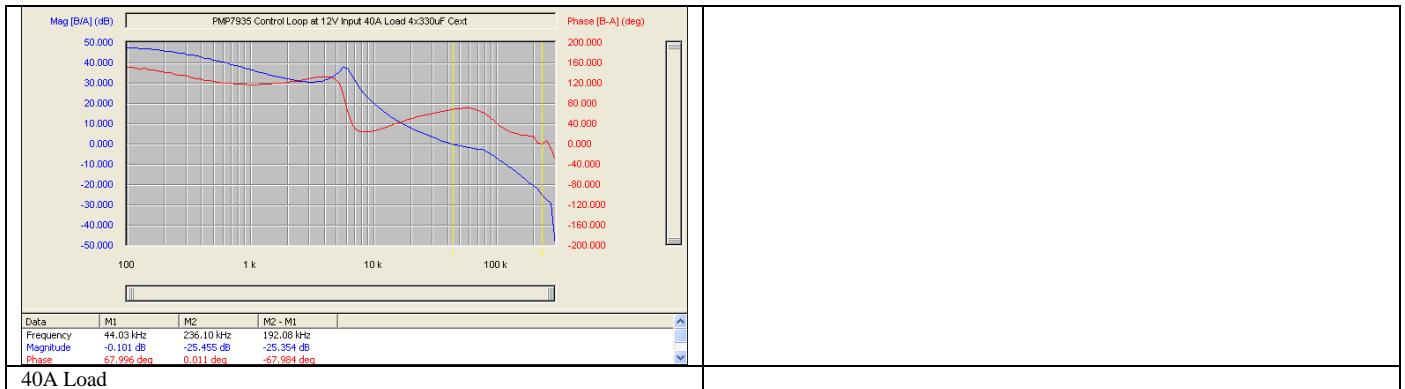
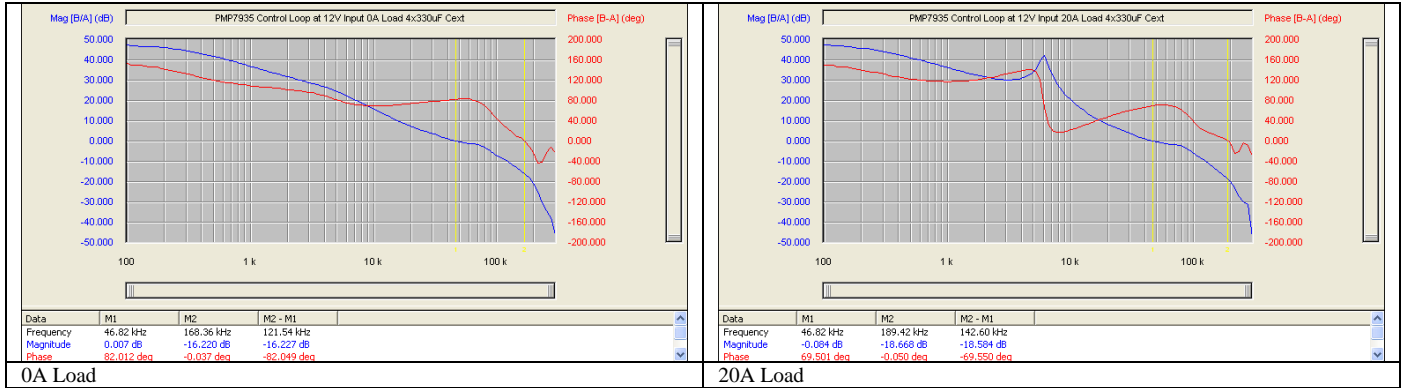
8.2 16 x 100 μ F External Output Capacitor

With 16 x 100 μ F, 6.3V, X5R ceramic external capacitors, the control loop exhibits a bandwidth of 40 kHz and phase margin of 40° at full load.



8.3 4 x 330 μ F External Output Capacitor

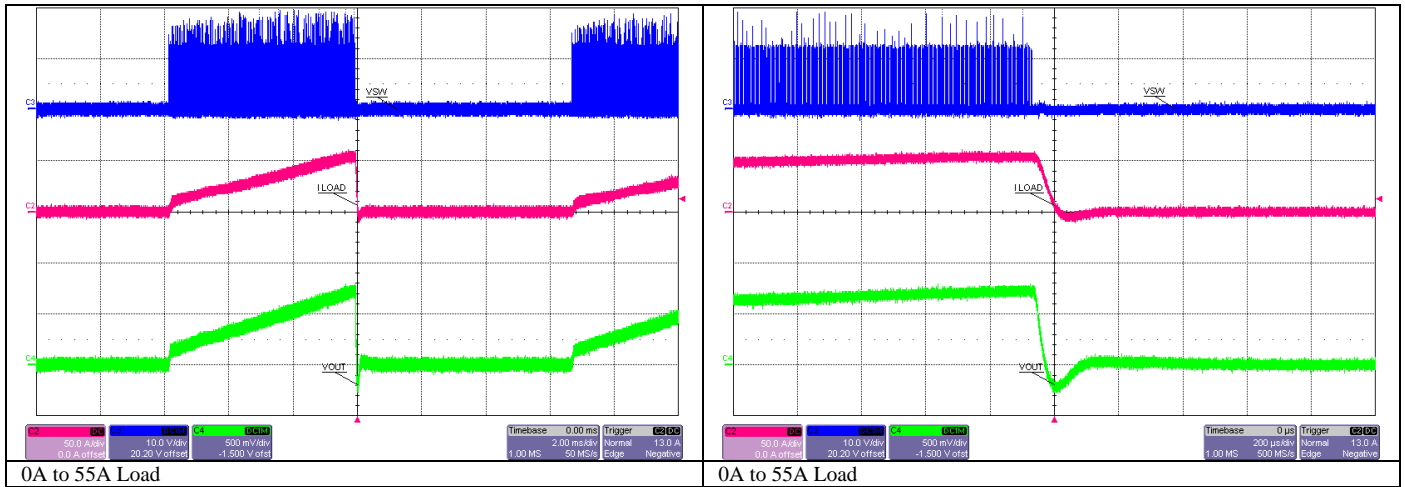
With 4 x 330 μ F, 2V, 6 m Ω polymer aluminum external capacitors, the control loop exhibits a bandwidth of 44 kHz and phase margin of 67 $^\circ$ at full load.



9 Over-Current Protection

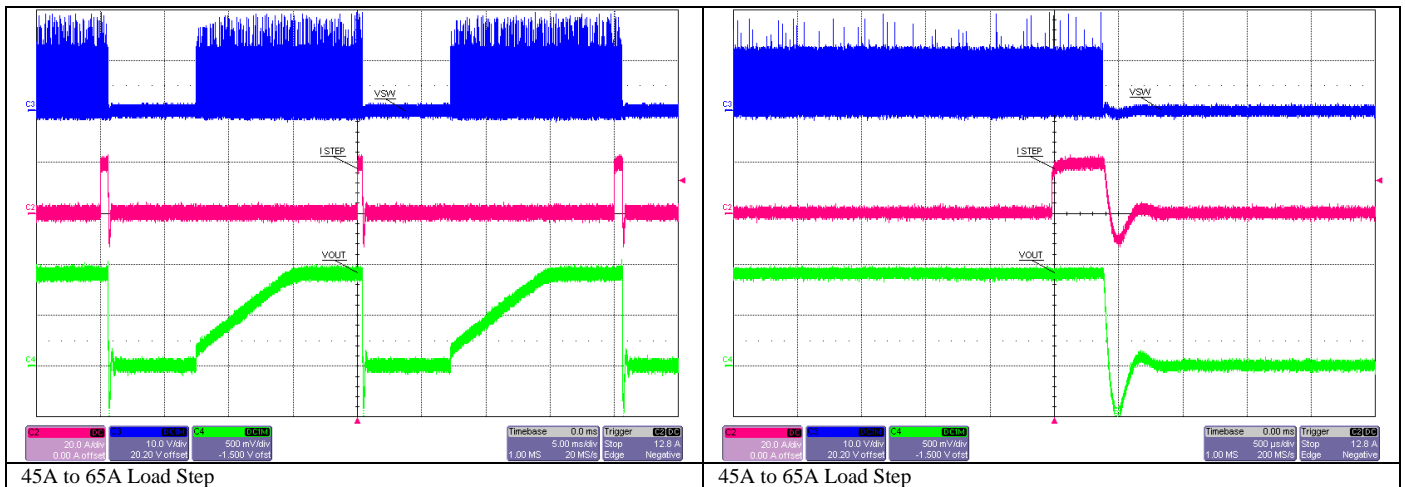
9.1 Current Limit Protection

A pulsed MOSFET current limit test was performed to check the current limit threshold. The results show current limit at 55A, with hiccup protection and normal restart of the output voltage when the load is removed.



9.2 Short Circuit Protection

A pulsed MOSFET load was used to check short circuit protection. The results show hiccup protection with normal restart of the output voltage when the short is removed.



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