



LM5122
Wide Input Synchronous Boost Controller
with Multiple Phase Capability

TI reference design number: PMP9293 Rev A

Input: 9V – 60V
Output: 12V @ 5A

DC – DC Test Results

Table of Contents

1. Circuit Description	4
2. Fabrication	4
3. Efficiency	6
4. Thermal	10
Top View	10
5. Power Up	11
5.1 Power Up at 9V Input – No Load Power Up at 9V Input – 5A	11
5.2 Power Up at 12V Input – No Load Power Up at 12V Input – 5A	11
5.3 Power Up at 24V Input – No Load Power Up at 24V Input – 5A	12
5.4 Power Up at 36V Input – No Load Power Up at 36V Input – 5A	12
5.5 Power Up at 48V Input – No Load Power Up at 48V Input – 5A	13
5.6 Power Up at 54V Input – No Load Power Up at 54V Input – 5A	13
5.7 Power Up at 60V Input – No Load Power Up at 60V Input – 5A	14
6. Switch Node voltage and Output Ripple voltage	15
6.1 9V Input – 5A load	15
6.2 12V Input – 5A load	15
6.3 24V Input – 5A load	16
6.4 36V Input – 5A load	16
6.5 48V Input – 5A load	17
6.6 54V Input – 5A load	17
6.7 60V Input – 5A load	18
7. Transient Response	19
7.1 9V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	19
7.2 12V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	19
7.3 24V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	20
7.4 36V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	20
7.5 48V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	21
7.6 54V Input - 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	21
7.7 60V Input - 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.	22
8. Short Circuit Tests	23
8.1 9V input - no load 9V input - 5A load	23
8.2 12V input - no load 12V input - 5A	23
8.3 24V input – no load 24V input – 5A load	24
8.4 36V input – no load 36V input – 5A load	24
8.5 48V input – no load 48V input – 5A load	25
8.6 54V input – no load 54V input – 5A load	25
8.7 60V input – no load 60V input – 5A load	26
9. Short Circuit Recovery Tests	27
9.1 9V input - no load 9V input - 5A load	27
9.2 12V input - no load 12V input - 5A	27
9.3 24V input – no load 24V input – 5A load	28
9.4 36V input – no load 36V input – 5A load	28
9.5 48V input – no load 48V input – 5A load	29

PMP9293 Rev A Test Results



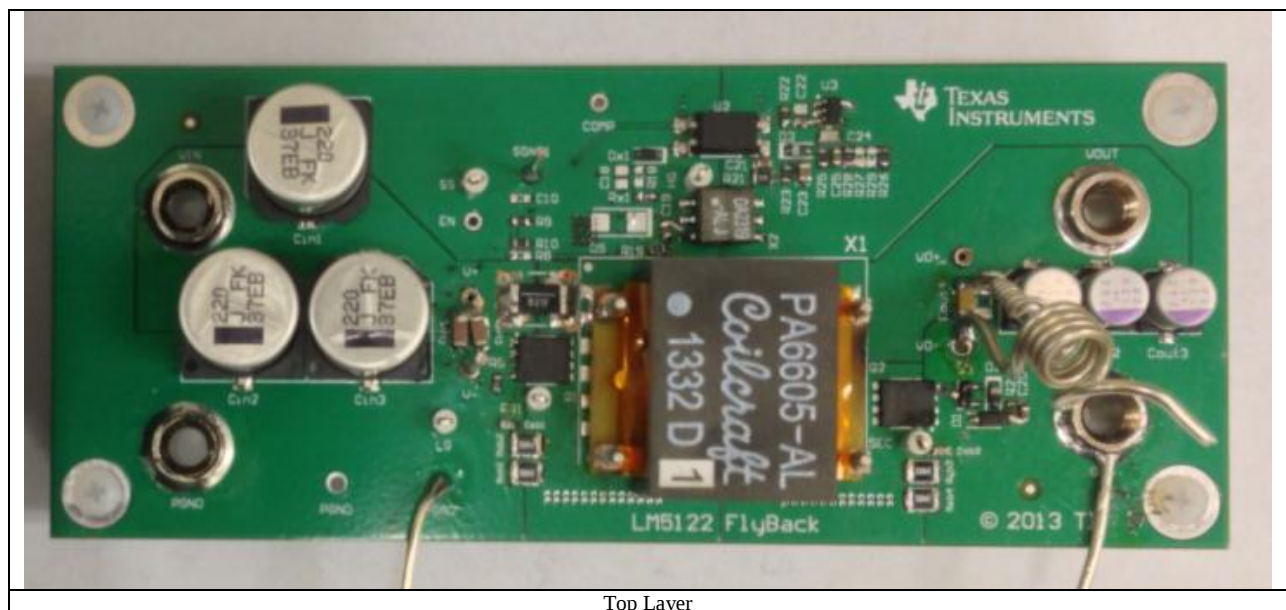
9.6 54V input – no load	54V input – 5A load	29
9.7 60V input – no load	60V input – 5A load	30

1. Circuit Description

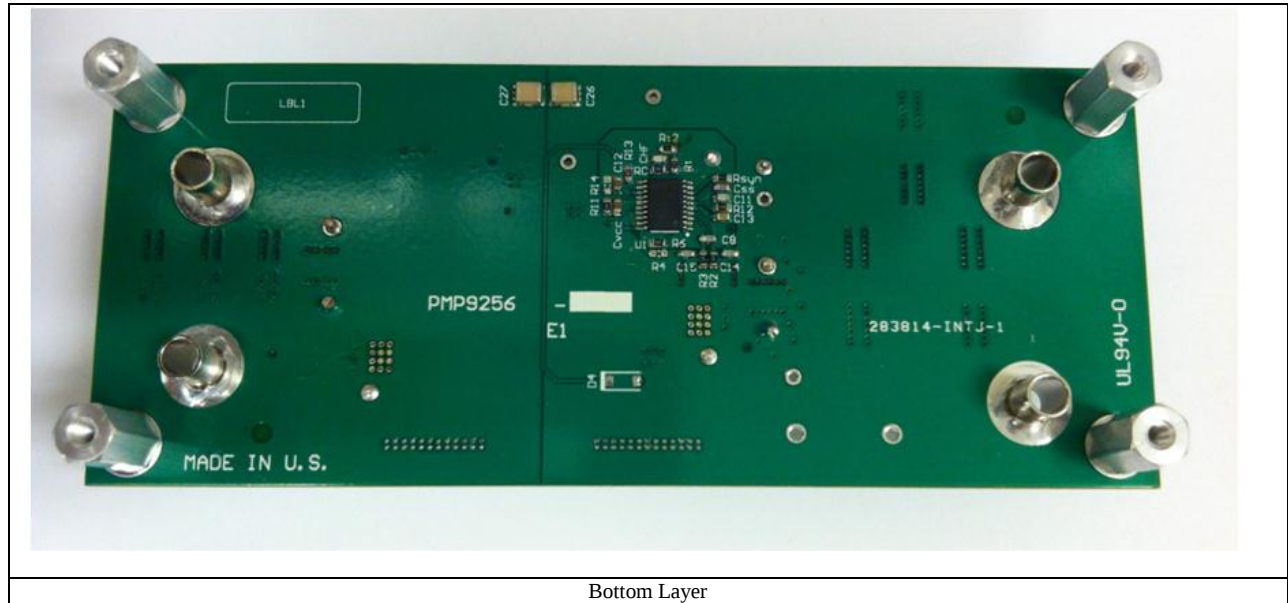
PMP9293 is an isolated synchronous Flyback converter utilizing the LM5122 for industrial applications. The benefit of using a synchronous Flyback is higher efficiency compared to a non-synchronous Flyback. This design has a minimum operating input voltage of 9V and an absolute maximum max input voltage of 60V. Switching frequency is set to 230 kHz. A custom Flyback transformer from Coilcraft is used in this design.

2. Fabrication

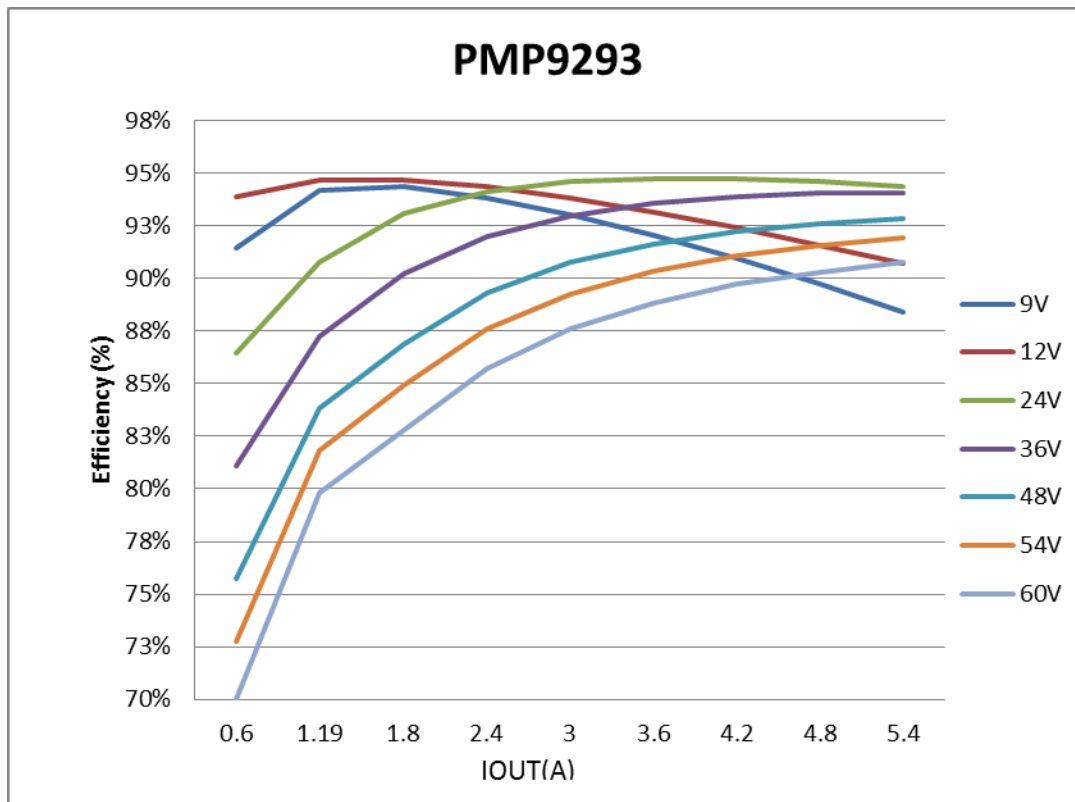
The LM5122 Flyback circuit was built on PMP9256 printed circuit board. This is a four layer board with overall dimensions of 5.025" (128mm) x 2.07" (53mm). The copper weight is 1oz on the outer layer and 0.5oz the inner layer. The overall height, including the inductor is 0.560" (14.3mm).



Top Layer



3. Efficiency



3.1 LM5122 Flyback Efficiency Data

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
8.998025	0.052685	11.89374	9.72E-05	0.24%	0.474064	0.001156	0.472908
8.997697	0.871532	11.89317	0.603016	91.46%	7.841778	7.171765	0.670013
8.997435	1.703896	11.89265	1.214167	94.19%	15.33069	14.43966	0.891031
8.996879	2.557839	11.89231	1.825601	94.34%	23.01257	21.71062	1.301952
8.996268	3.432229	11.89185	2.43681	93.85%	30.87725	28.97818	1.899069
8.99515	4.3313	11.89139	3.048055	93.03%	38.9607	36.2456	2.715091
8.994115	5.255448	11.89098	3.659354	92.06%	47.26811	43.5133	3.754802
8.992813	6.2078	11.89067	4.2709	90.97%	55.82558	50.78386	5.041727
8.991145	7.195113	11.89014	4.882013	89.73%	64.6923	58.0478	6.644507
8.988804	8.22052	11.88969	5.493315	88.39%	73.89264	65.31379	8.578857

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
11.99687	0.049863	11.89476	6.95E-05	0.14%	0.598205	0.000827	0.597378
11.99665	0.662908	11.8943	0.601666	89.99%	7.952671	7.1564	0.796271
11.9965	1.281036	11.89393	1.213061	93.88%	15.36795	14.42807	0.939889
11.99599	1.910119	11.89357	1.824572	94.71%	22.91377	21.70067	1.213094
11.99562	2.550281	11.89326	2.435853	94.70%	30.59221	28.97025	1.621963
11.99521	3.202083	11.89291	3.047063	94.35%	38.40966	36.23843	2.171231
11.99471	3.866382	11.8926	3.65841	93.82%	46.37613	43.50801	2.86812
11.99388	4.544598	11.89229	4.270092	93.16%	54.50737	50.78116	3.72621
11.99315	5.236356	11.892	4.881038	92.43%	62.80041	58.04532	4.755098
11.99228	5.945813	11.89155	5.492527	91.60%	71.30385	65.31467	5.98918
11.99182	6.67369	11.8913	6.103942	90.70%	80.02971	72.5838	7.445908

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
23.99891	0.043098	11.8952	5.65E-05	0.06%	1.0343	0.000672	1.033628
23.99881	0.344795	11.89475	0.60153	86.47%	8.274671	7.155046	1.119625
23.99862	0.662183	11.89441	1.21311	90.80%	15.89148	14.42924	1.462243
23.99827	0.971178	11.8942	1.824394	93.11%	23.3066	21.69971	1.60689
23.99804	1.282112	11.89394	2.435655	94.15%	30.76817	28.96954	1.798633
23.99776	1.59624	11.8936	3.046934	94.60%	38.30619	36.239	2.067183
23.99735	1.913409	11.89343	3.658277	94.76%	45.91675	43.50948	2.407267
23.99684	2.233853	11.89312	4.269961	94.74%	53.60541	50.78318	2.822233
23.99638	2.557142	11.89292	4.881274	94.61%	61.36216	58.05263	3.309532
23.9959	2.883646	11.89264	5.492409	94.40%	69.19568	65.31924	3.876445
23.99536	3.214216	11.89248	6.103952	94.12%	77.12628	72.59111	4.535176

PMP9293 Rev A Test Results



Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
35.99986	0.043073	11.89552	5.42E-05	0.04%	1.550638	0.000645	1.549993
35.99974	0.245154	11.89493	0.601701	81.10%	8.825469	7.157194	1.668275
35.99964	0.459211	11.89465	1.212581	87.25%	16.53142	14.42322	2.108201
35.9997	0.668224	11.89442	1.824321	90.20%	24.05587	21.69923	2.35664
35.9995	0.874699	11.89418	2.435371	91.99%	31.48874	28.96673	2.522009
35.99926	1.082505	11.89394	3.046726	92.99%	38.96938	36.23757	2.73181
35.99913	1.291696	11.8937	3.658158	93.57%	46.49993	43.50904	2.990892
35.9988	1.50251	11.8935	4.269831	93.89%	54.08856	50.78324	3.305323
35.99841	1.714442	11.89318	4.88111	94.06%	61.71719	58.05191	3.665278
35.99819	1.928532	11.89304	5.492238	94.09%	69.42366	65.31941	4.104252
35.9977	2.144397	11.89289	6.104014	94.04%	77.19336	72.59434	4.599023

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
47.99828	0.044622	11.8957	0.000149	0.08%	2.141791	0.001771	2.14002
47.99826	0.196922	11.89524	0.601704	75.72%	9.451932	7.157413	2.294519
47.99808	0.35854	11.89493	1.212751	83.82%	17.20921	14.42559	2.783624
47.99804	0.520335	11.89465	1.824393	86.89%	24.97507	21.70051	3.274562
47.99799	0.675822	11.89447	2.435646	89.31%	32.4381	28.97071	3.467397
47.99763	0.832023	11.89414	3.047029	90.75%	39.93511	36.24179	3.693325
47.99747	0.989212	11.89386	3.658379	91.64%	47.47969	43.51224	3.967452
47.99734	1.147148	11.89356	4.269764	92.23%	55.06006	50.78271	4.277352
47.9969	1.30626	11.8934	4.881212	92.60%	62.69642	58.05419	4.642239
47.99663	1.466182	11.89323	5.492278	92.82%	70.37179	65.32092	5.050871
47.99622	1.627224	11.8931	6.103868	92.95%	78.10061	72.59388	5.506724

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
53.99887	0.045903	11.89556	0.000219	0.10%	2.478733	0.002602	2.476132
53.99876	0.182059	11.8949	0.601325	72.76%	9.830955	7.152703	2.678253
53.99875	0.326412	11.8946	1.212663	81.84%	17.62586	14.42414	3.20172
53.99868	0.473118	11.89425	1.824321	84.93%	25.54772	21.69893	3.848788
53.99855	0.612249	11.89424	2.435599	87.63%	33.06054	28.96961	4.090939
53.99823	0.751802	11.89384	3.046881	89.27%	40.59597	36.2391	4.356866
53.99806	0.892077	11.89357	3.658489	90.33%	48.17041	43.51248	4.657934
53.99764	1.032578	11.89346	4.269687	91.08%	55.75677	50.78136	4.975414
53.99742	1.17411	11.89325	4.881158	91.57%	63.39891	58.05283	5.346076
53.99718	1.316209	11.89293	5.492396	91.91%	71.07157	65.3207	5.75087
53.99678	1.459825	11.89268	6.103912	92.09%	78.82584	72.59187	6.233973

PMP9293 Rev A Test Results

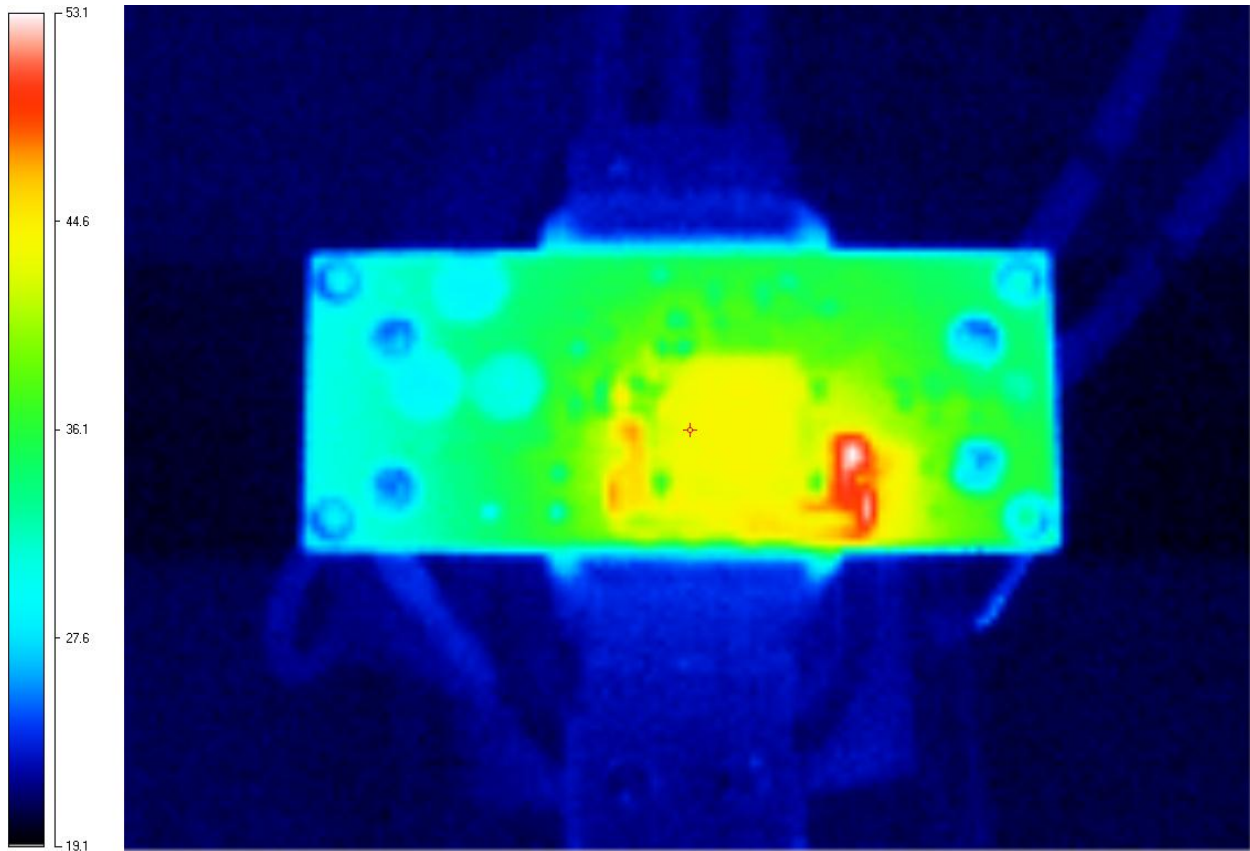


Vin (V)	Iin (A)	Vout (V)	Iout (A)	Efficiency (%)	Pin (W)	Pout (W)	Losses (W)
59.99798	0.046309	11.89519	0.000203	0.09%	2.778439	0.002419	2.77602
59.9979	0.170447	11.89458	0.60168	69.98%	10.22646	7.156732	3.069729
59.99784	0.301259	11.89414	1.212781	79.81%	18.07488	14.42499	3.649885
59.99751	0.436871	11.89395	1.82441	82.79%	26.21117	21.69944	4.511729
59.99751	0.563077	11.89376	2.435717	85.75%	33.78321	28.96983	4.813385
59.99746	0.689364	11.89339	3.046979	87.62%	41.36008	36.23891	5.121171
59.99707	0.816178	11.8931	3.658486	88.85%	48.96829	43.51072	5.457561
59.99692	0.943276	11.89286	4.270045	89.73%	56.59365	50.78307	5.810578
59.99659	1.071266	11.89267	4.880998	90.32%	64.2723	58.04811	6.224192
59.9964	1.199604	11.89246	5.492387	90.75%	71.97193	65.318	6.653931
59.9958	1.328932	11.89211	6.104014	91.04%	79.73034	72.5896	7.140741

4. Thermal

4.1 Steady State Temp - 24V in, 12V out at a load of 5A.

Top View

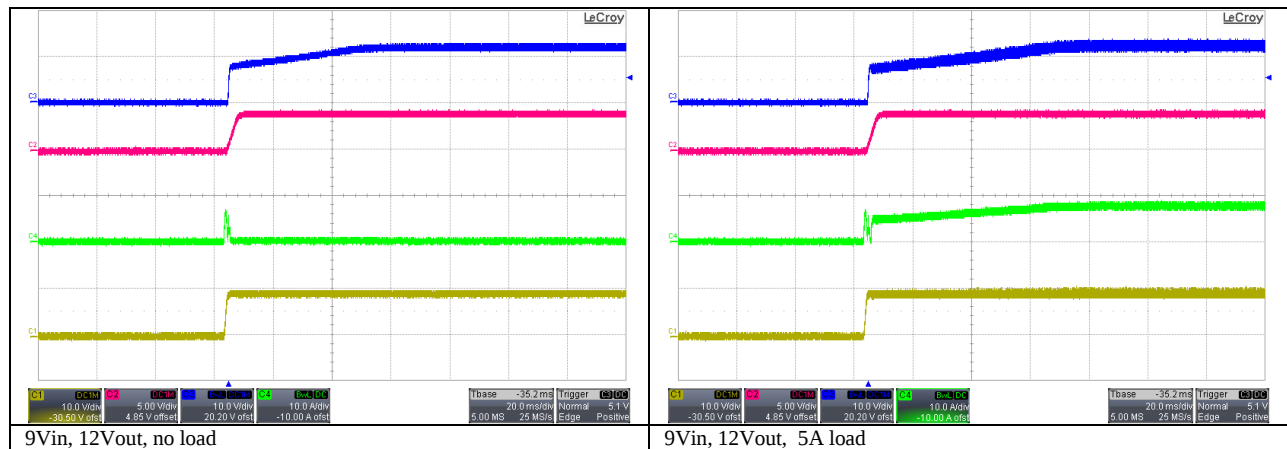


Secondary MOSFETs and snubber resistors are the warmest items.

5. Power Up

5.1 Power Up at 9V Input – No Load

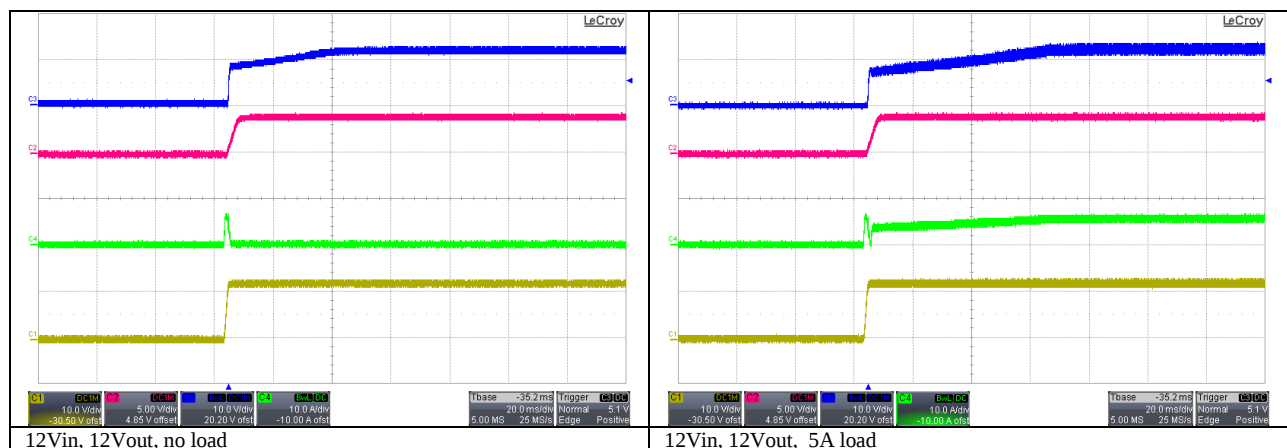
Power Up at 9V Input – 5A



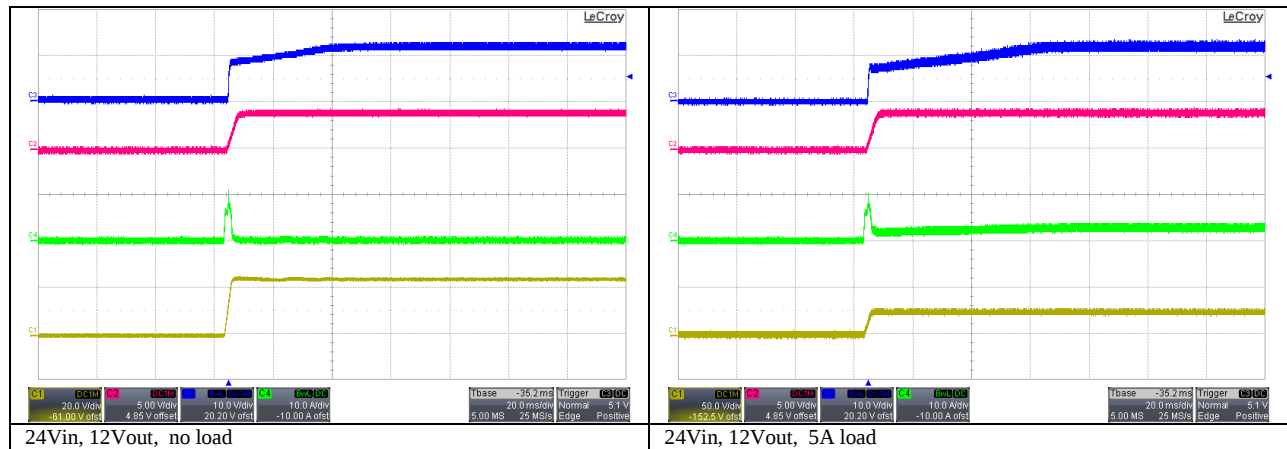
Channel 1 VIN
Channel 2 SS
Channel 3 VOUT
Channel 4 IIN

5.2 Power Up at 12V Input – No Load

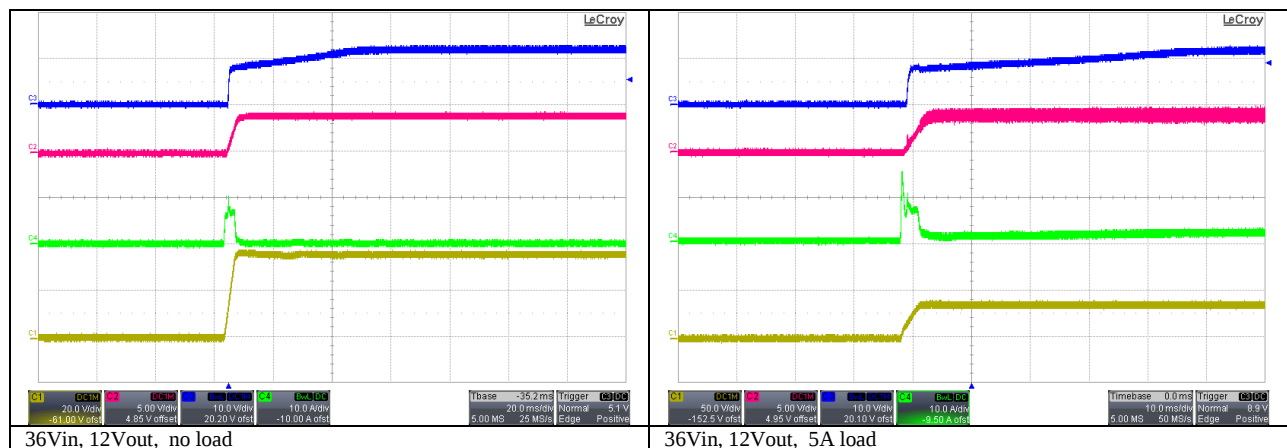
Power Up at 12V Input – 5A



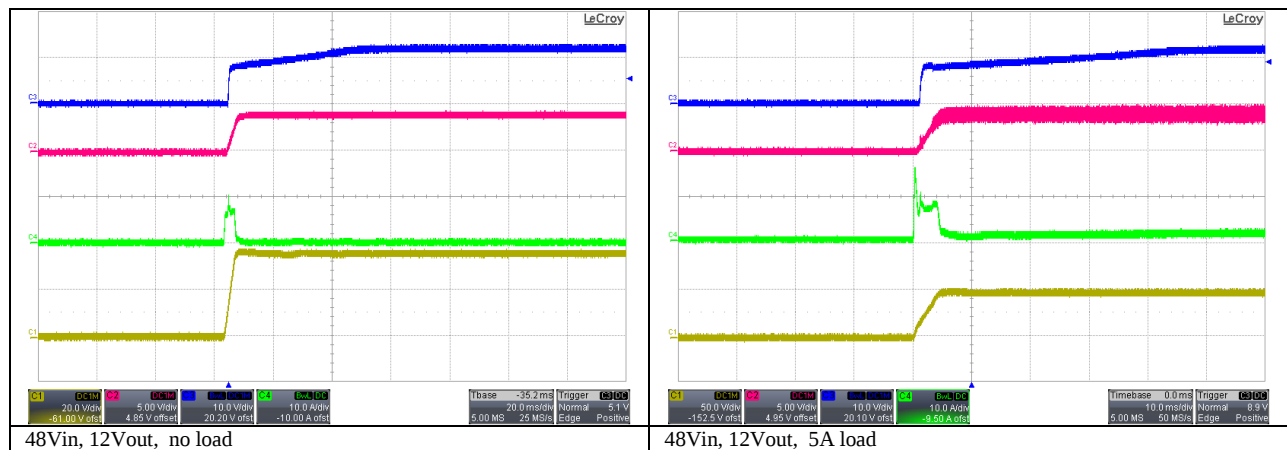
Channel 1 VIN
Channel 2 SS
Channel 3 VOUT
Channel 4 IIN

5.3 Power Up at 24V Input – No Load**Power Up at 24V Input – 5A**

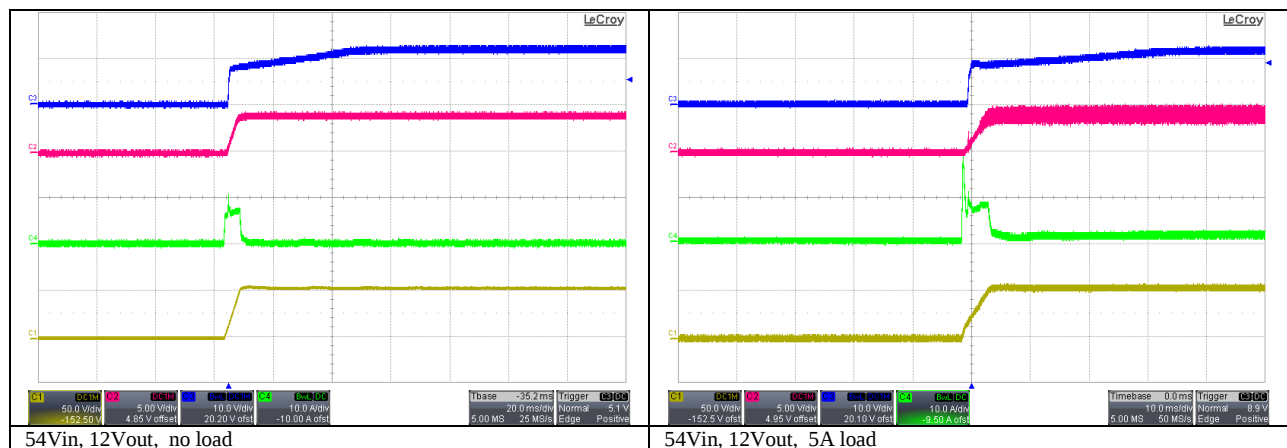
Channel 1 VIN
Channel 2 SS
Channel 3 VOUT
Channel 4 IIN

5.4 Power Up at 36V Input – No Load**Power Up at 36V Input – 5A**

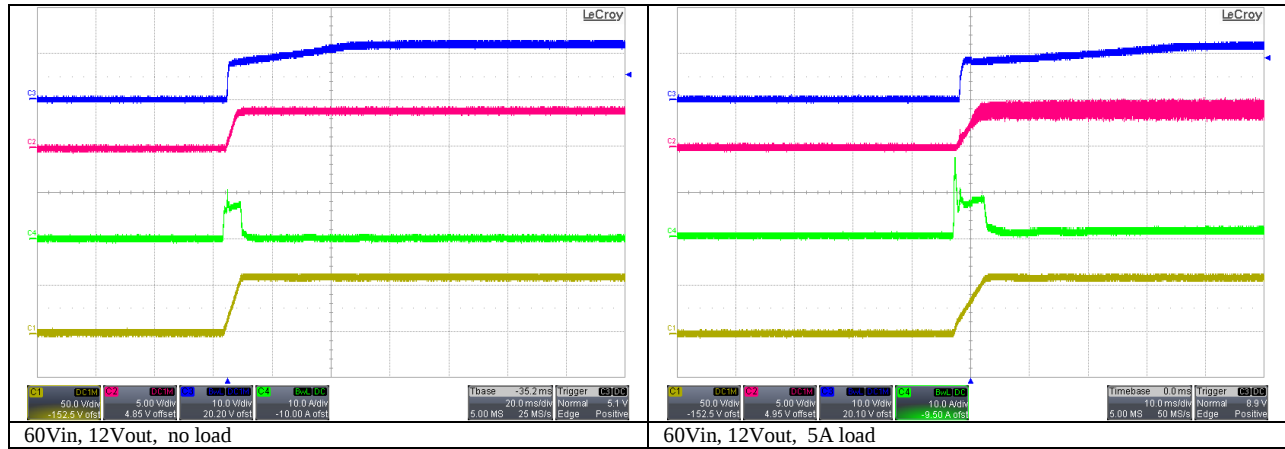
Channel 1 VIN
Channel 2 SS
Channel 3 VOUT
Channel 4 IIN

5.5 Power Up at 48V Input – No Load**Power Up at 48V Input – 5A**

Channel 1 VIN
Channel 2 SS
Channel 3 VOUT
Channel 4 IIN

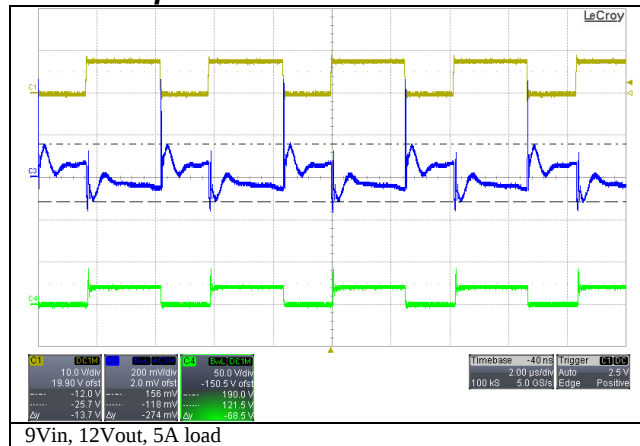
5.6 Power Up at 54V Input – No Load**Power Up at 54V Input – 5A**

Channel 1 VIN
Channel 2 SS
Channel 3 VOUT
Channel 4 IIN

5.7 Power Up at 60V Input – No Load**Power Up at 60V Input – 5A**

6. Switch Node voltage and Output Ripple voltage

6.1 9V Input – 5A load



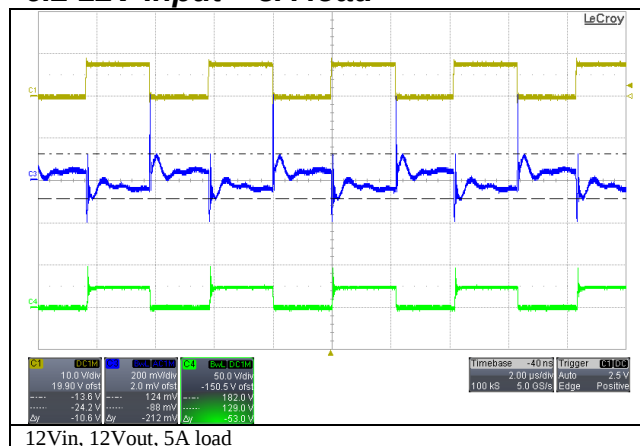
Less than 280mV p-p Ripple

Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

6.2 12V Input – 5A load



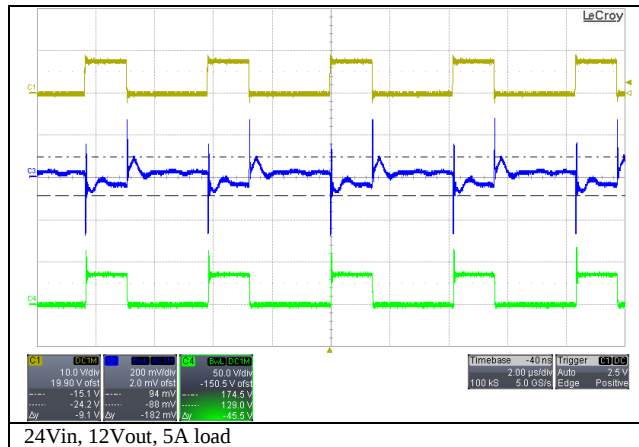
Less than 212mV p-p Ripple

Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

6.3 24V Input – 5A load



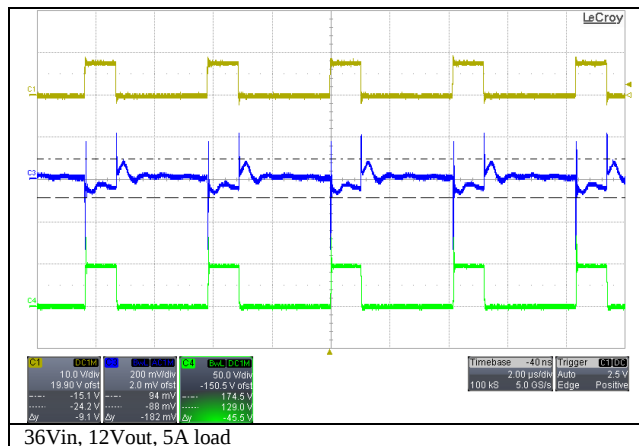
Less than 182mV p-p Ripple

Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

6.4 36V Input – 5A load



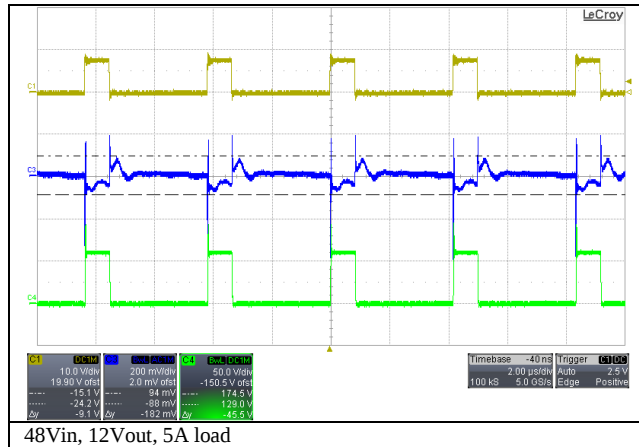
Less than 182mV p-p Ripple

Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

6.5 48V Input – 5A load



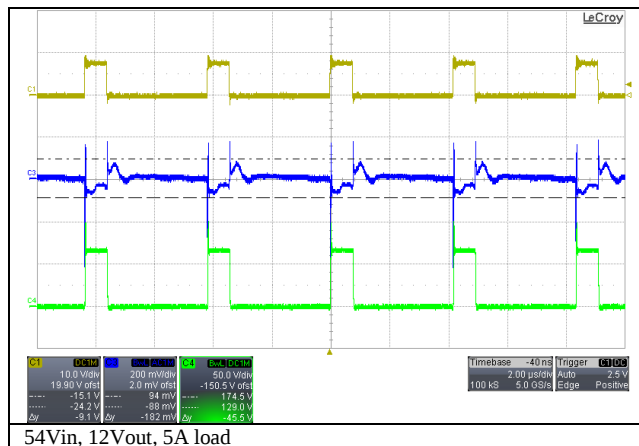
Less than 182mV p-p Ripple

Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

6.6 54V Input – 5A load



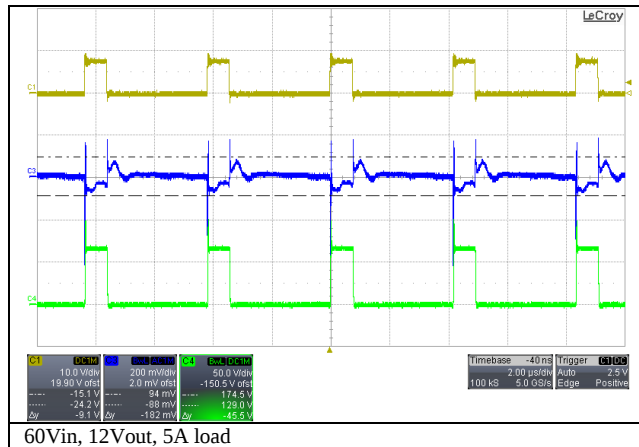
Less than 182mV p-p Ripple

Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

6.7 60V Input – 5A load



Less than 182mV p-p Ripple

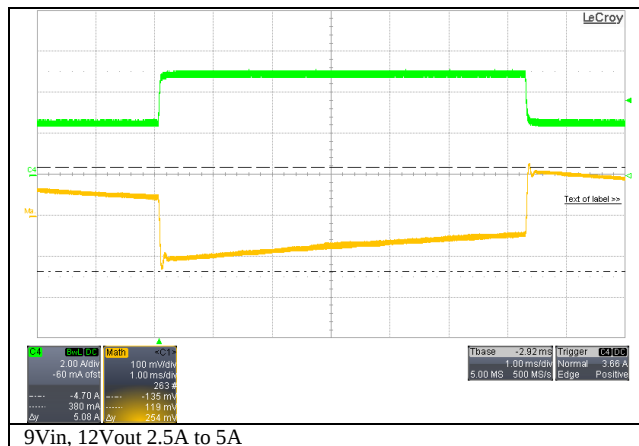
Channel 1 VSW_{PRI}

Channel 3 VOUT

Channel 4 VSW_{SEC}

7. Transient Response

7.1 9V Input – 2.5A to 5A, 100mA/μs, 100 Hz, 50% duty cycle, 12V out.

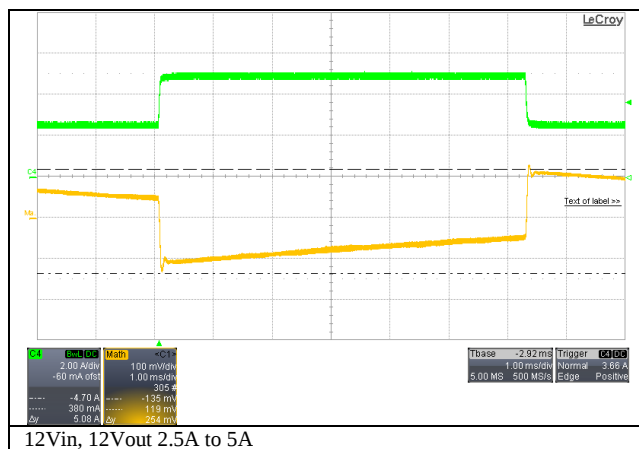


Cursors indicate ~254mV maximum deviation across output capacitor.

Channel 1 VOUT

Channel 4 IOUT

7.2 12V Input – 2.5A to 5A, 100mA/μs, 100 Hz, 50% duty cycle, 12V out.

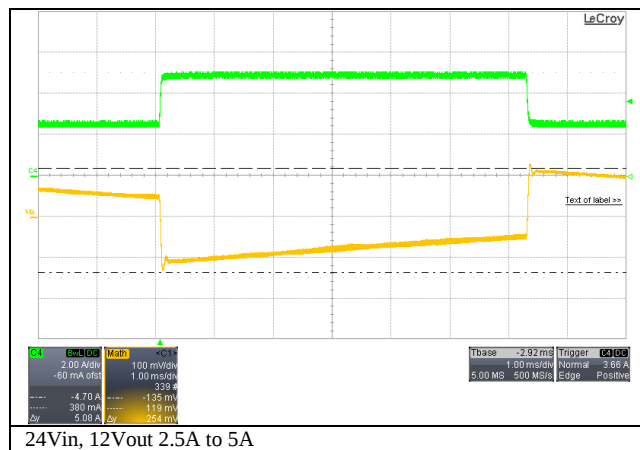


Cursors indicate ~254mV maximum deviation across output capacitor.

Channel 1 VOUT

Channel 4 IOUT

7.3 24V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.

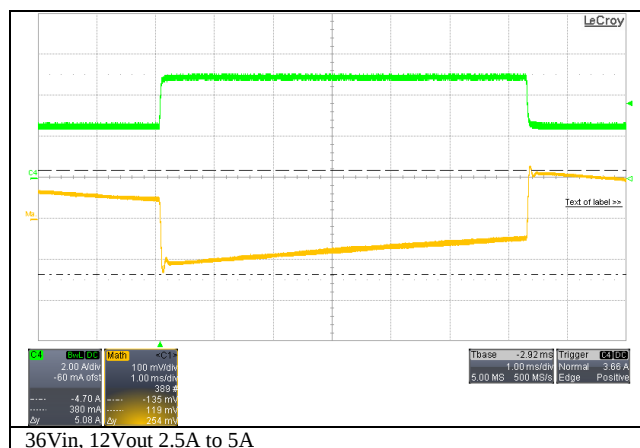


Cursors indicate ~254mV maximum deviation across output capacitor.

Channel 1 VOUT

Channel 4 IOU

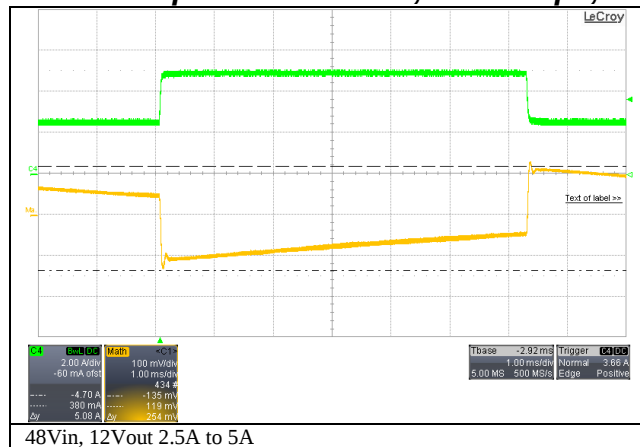
7.4 36V Input – 2.5A to 5A, 100mA/ μ s, 100 Hz, 50% duty cycle, 12V out.



Cursors indicate ~254mV maximum deviation across output capacitor.

Channel 1 VOUT

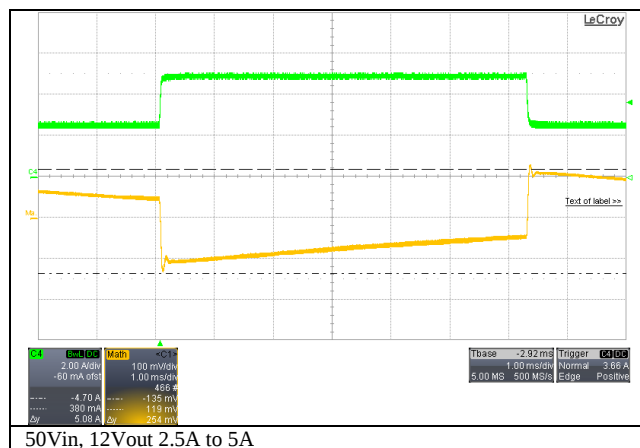
Channel 4 IOU

7.5 48V Input – 2.5A to 5A, 100mA/μs, 100 Hz, 50% duty cycle, 12V out.


Cursors indicate ~254mV maximum deviation across output capacitor.

Channel 1 VOUT

Channel 4 IOUT

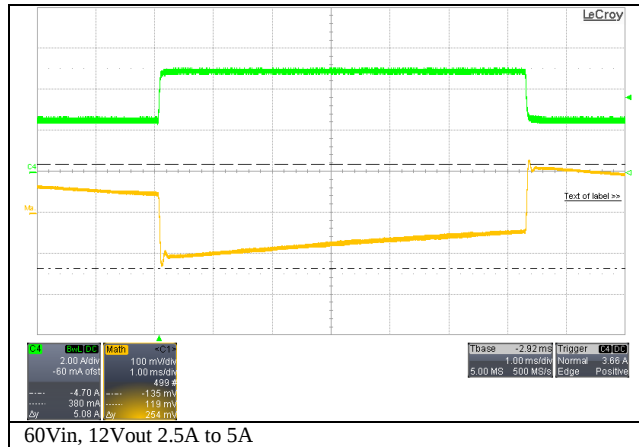
7.6 54V Input - 2.5A to 5A, 100mA/μs, 100 Hz, 50% duty cycle, 12V out.


Cursors indicate ~254mV maximum deviation across output capacitor

Channel 1 VOUT

Channel 4 IOUT

7.7 60V Input - 2.5A to 5A, 100mA/μs, 100 Hz, 50% duty cycle, 12V out.



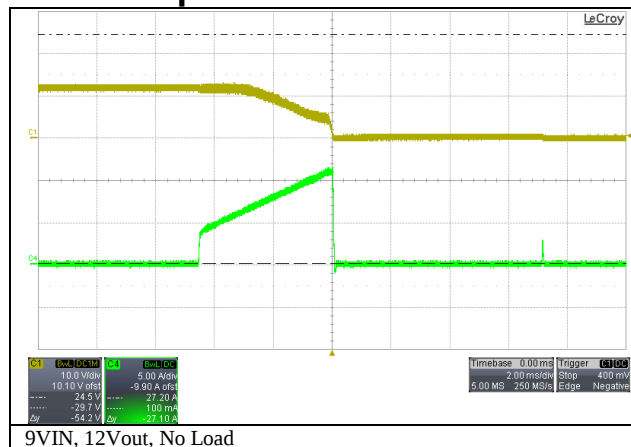
Cursors indicate ~254mV maximum deviation across output capacitor.

Channel 1 VOUT

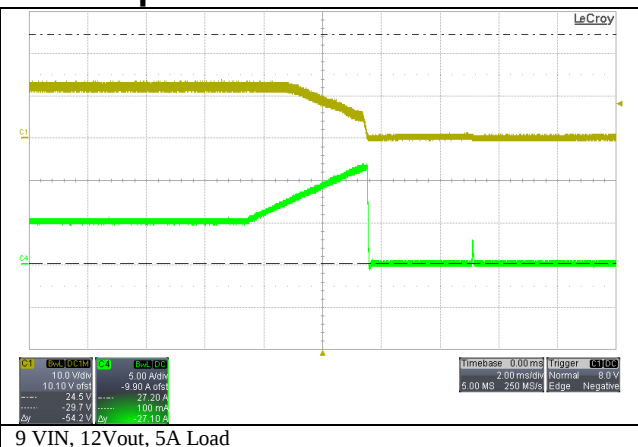
Channel 4 IOUT

8. Short Circuit Tests

8.1 9V input - no load

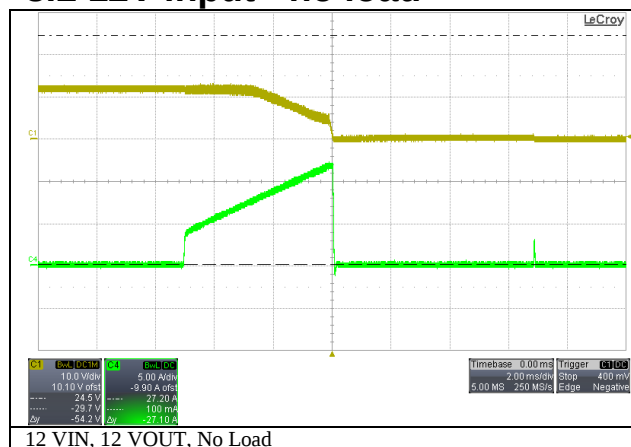


9V input - 5A load

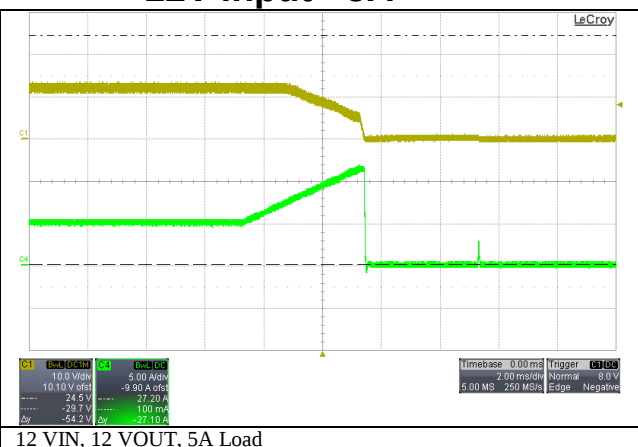


Channel 1 VOUT
Channel 4 IOUT

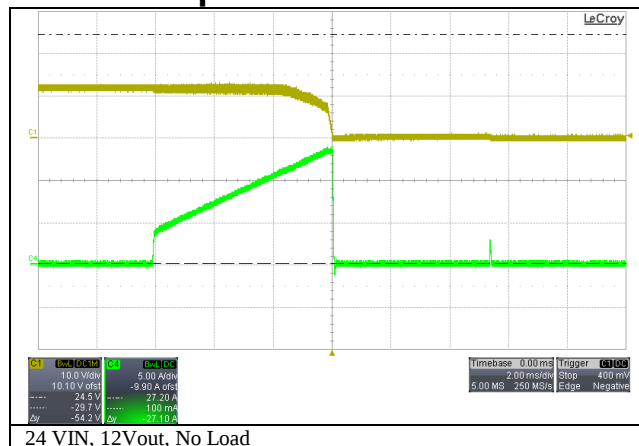
8.2 12V input - no load



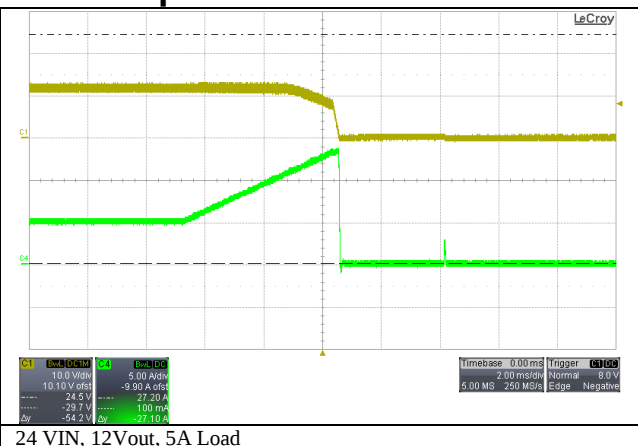
12V input - 5A



Channel 1 VOUT
Channel 4 IOUT

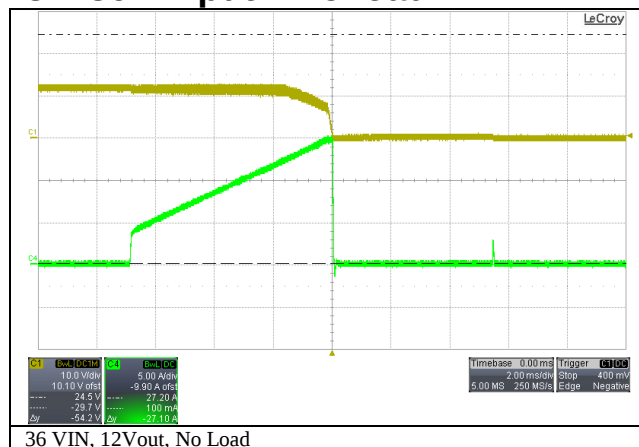
8.3 24V input – no load

24 VIN, 12Vout, No Load

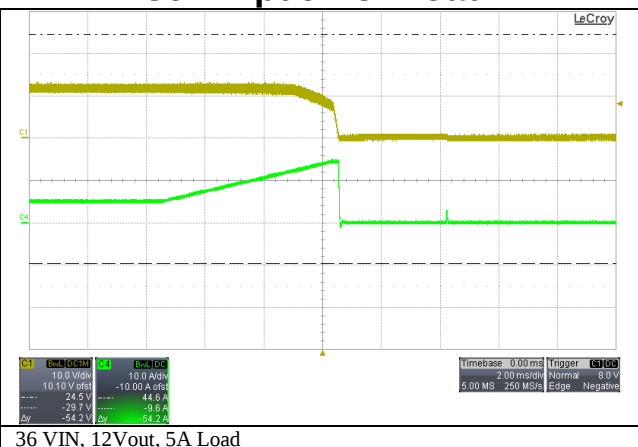
24V input – 5A load

24 VIN, 12Vout, 5A Load

Channel 1 VOUT
Channel 4 IOUT

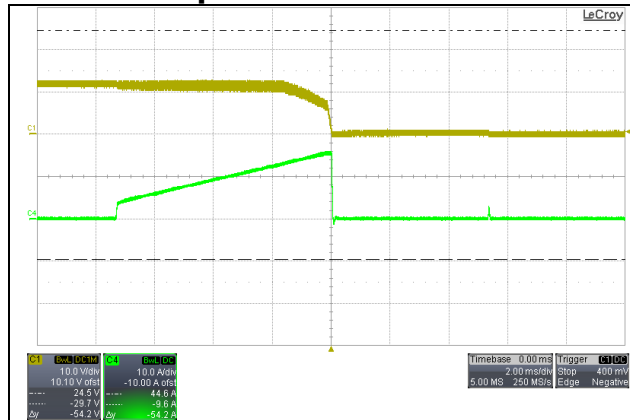
8.4 36V input – no load

36 VIN, 12Vout, No Load

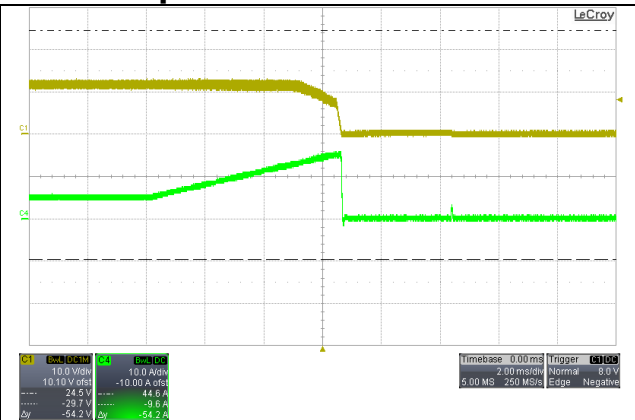
36V input – 5A load

36 VIN, 12Vout, 5A Load

Channel 1 VOUT
Channel 4 IOUT

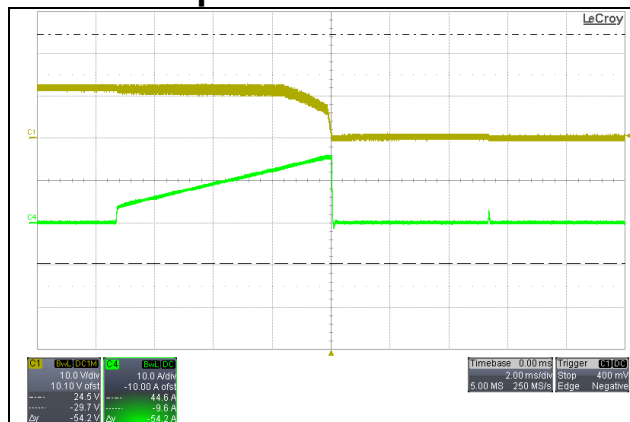
8.5 48V input – no load

48 VIN, 12Vout, no load

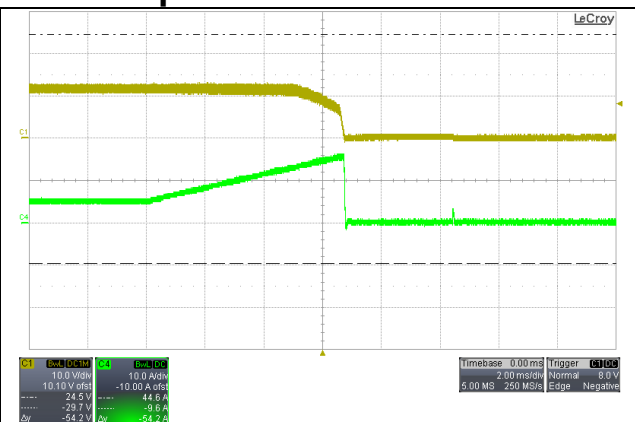
48V input – 5A load

48 VIN, 12Vout, 5A Load

Channel 1 VOUT
Channel 4 IOUT

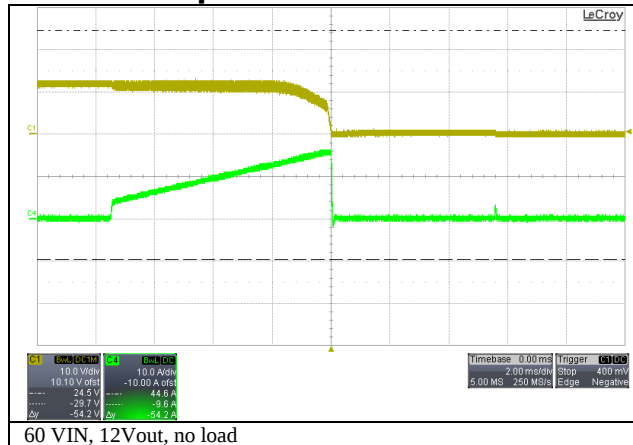
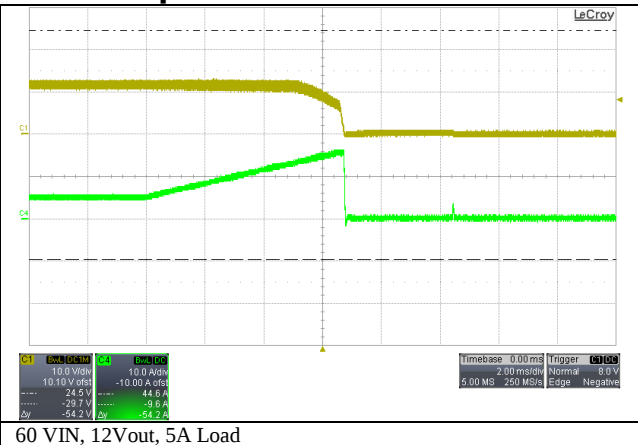
8.6 54V input – no load

54 VIN, 12Vout, no load

54V input – 5A load

54 VIN, 12Vout, 5A Load

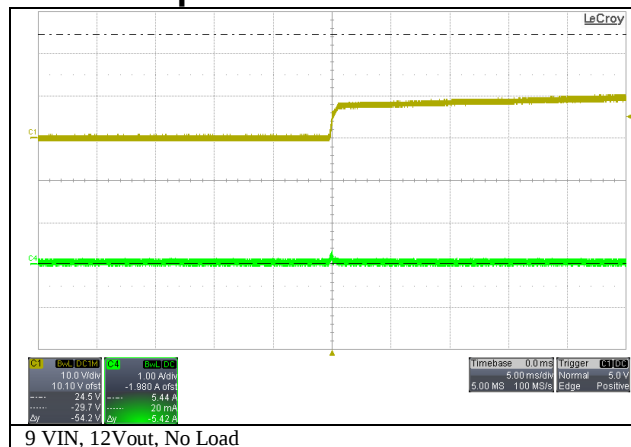
Channel 1 VOUT
Channel 4 IOUT

8.7 60V input – no load**60V input – 5A load**

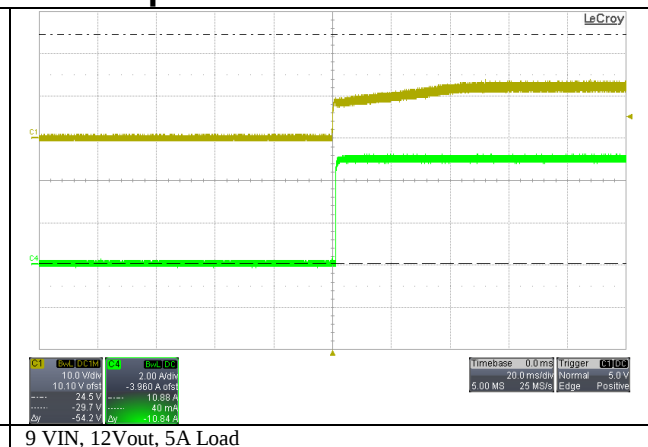
Channel 1 VOUT
Channel 4 IOUT

9. Short Circuit Recovery Tests

9.1 9V input - no load

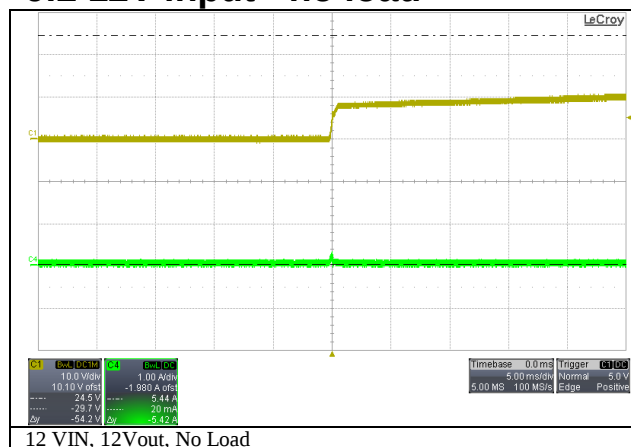


9V input - 5A load

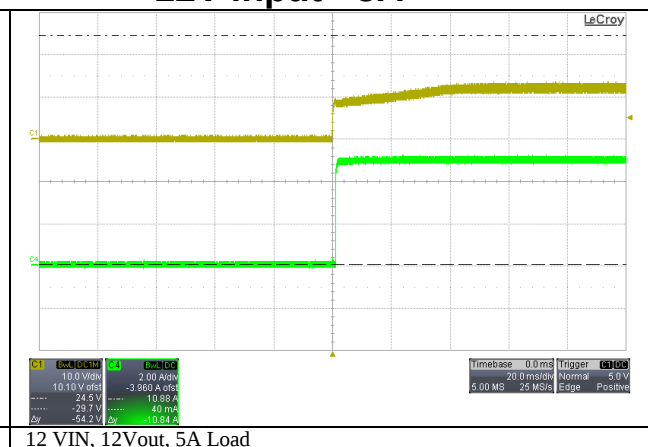


Channel 1 VOUT
Channel 4 IOUT

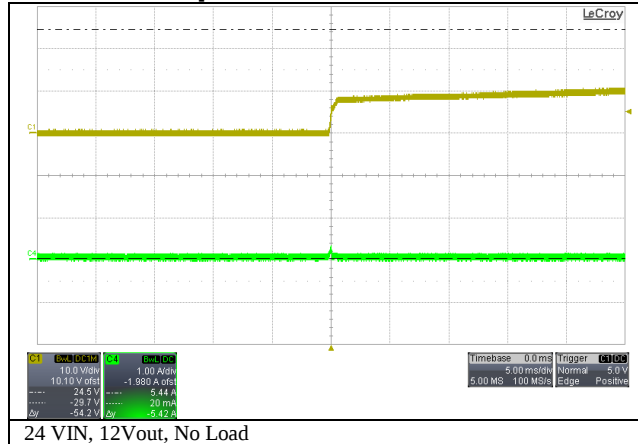
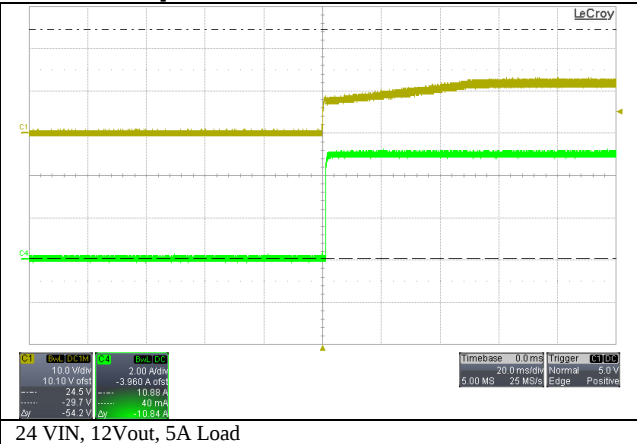
9.2 12V input - no load



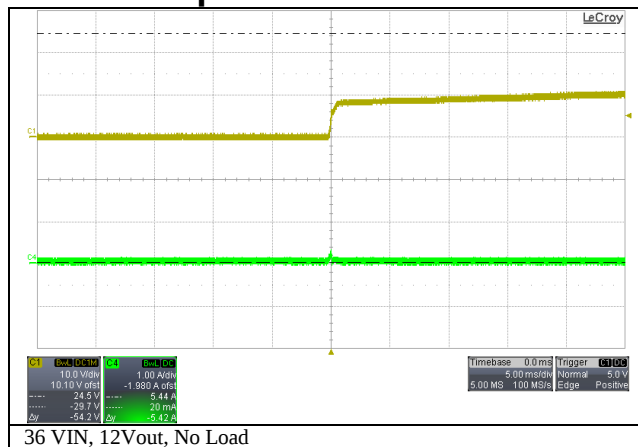
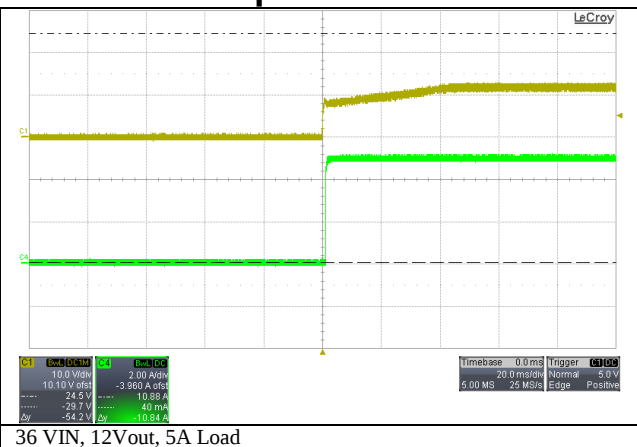
12V input - 5A



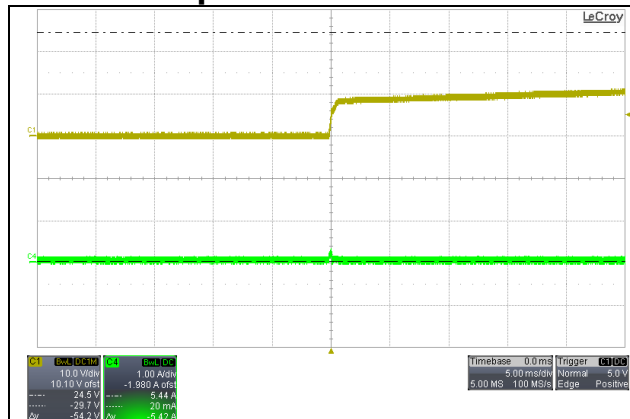
Channel 1 VOUT
Channel 4 IOUT

9.3 24V input – no load**24V input – 5A load**

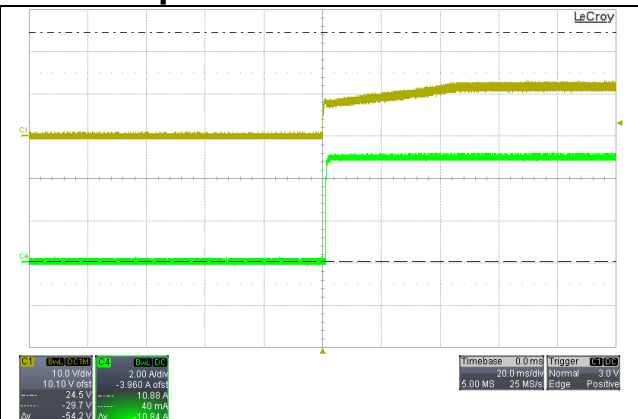
Channel 1 VOUT
Channel 4 IOUT

9.4 36V input – no load**36V input – 5A load**

Channel 1 VOUT
Channel 4 IOUT

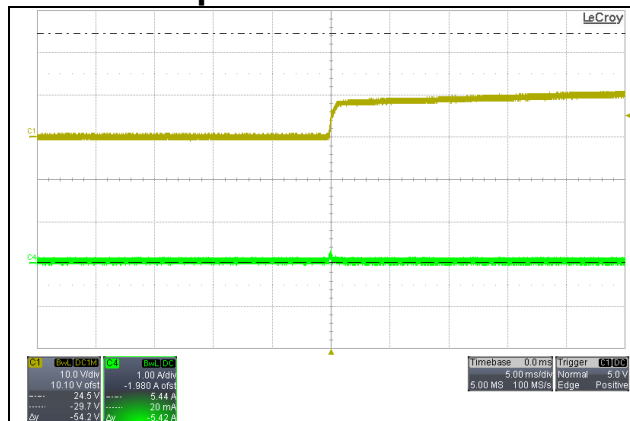
9.5 48V input – no load

48 VIN, 12Vout, no load

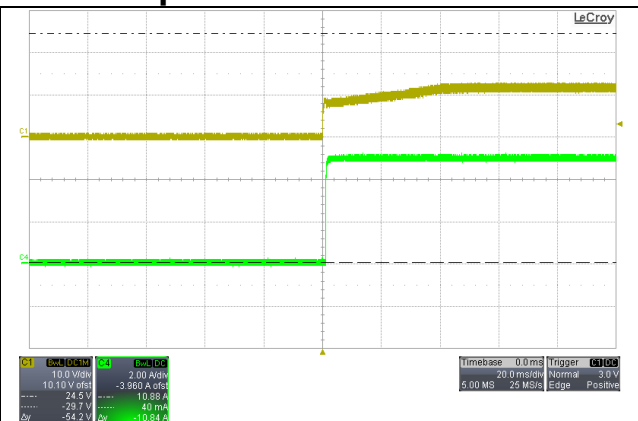
48V input – 5A load

48 VIN, 12Vout, 5A Load

Channel 1 VOUT
Channel 4 IOUT

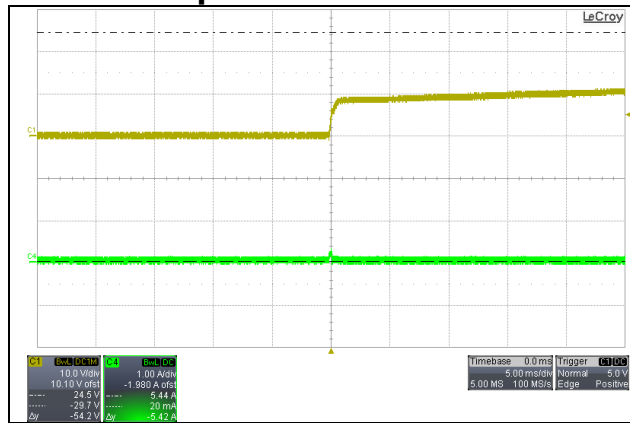
9.6 54V input – no load

54 VIN, 12Vout, no load

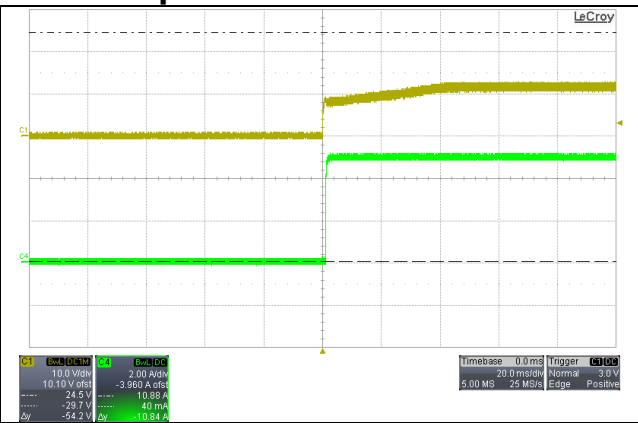
54V input – 5A load

54 VIN, 12Vout, 5A Load

Channel 1 VOUT
Channel 4 IOUT

9.7 60V input – no load

60 VIN, 12Vout, no load

60V input – 5A load

60 VIN, 12Vout, 5A Load

Channel 1 VOUT
Channel 4 IOUT

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2021, Texas Instruments Incorporated