TI reference design number: PMP9402 Rev A

Input: 6-40V
Nominal 12V

Output: 5V @ 5A

(USB CH 1: 5V @ 2.5A)

(USB CH 2: 5V @ 2.5A)

DC–DC Converter Test Results

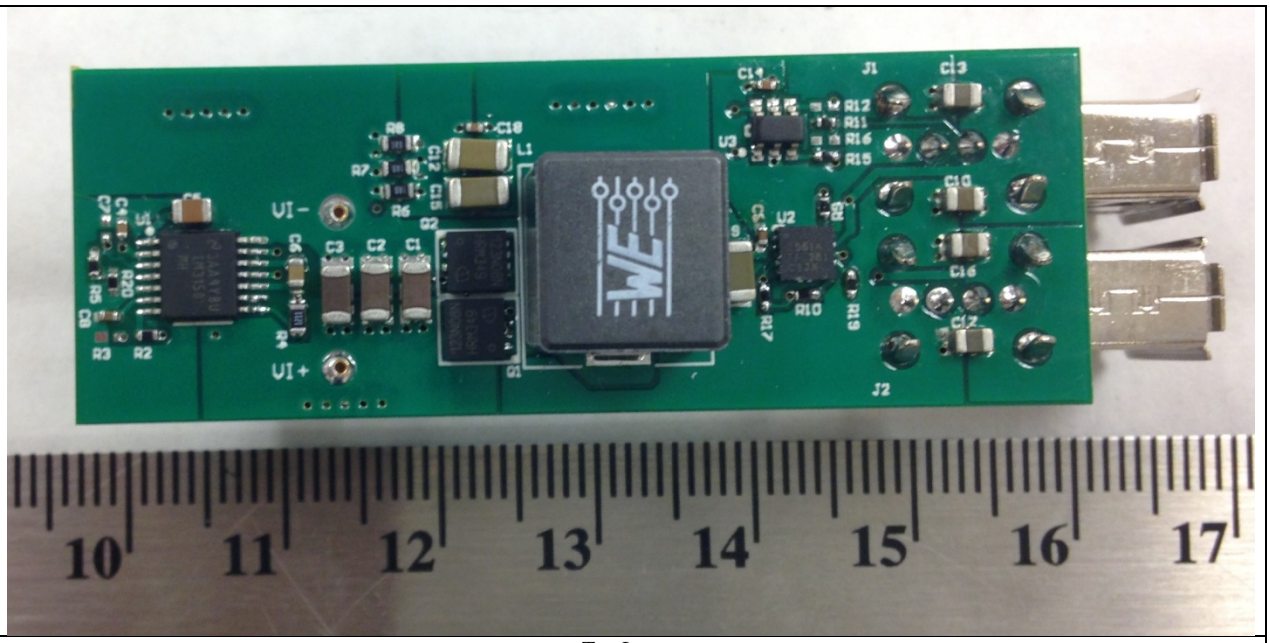
Table of Contents

1. Circuit Description

PMP9402 is a dual USB car charger. This design utilizes the LM3150, TPS2561 Dual Channel Power Switch and a TPS2513 USB Dedicated Charging Port Controller. This design operates from 6 to 40V in. The output is set to 5V; both channels have a 2.5A current limit. This design has a switching frequency of 300 kHz.

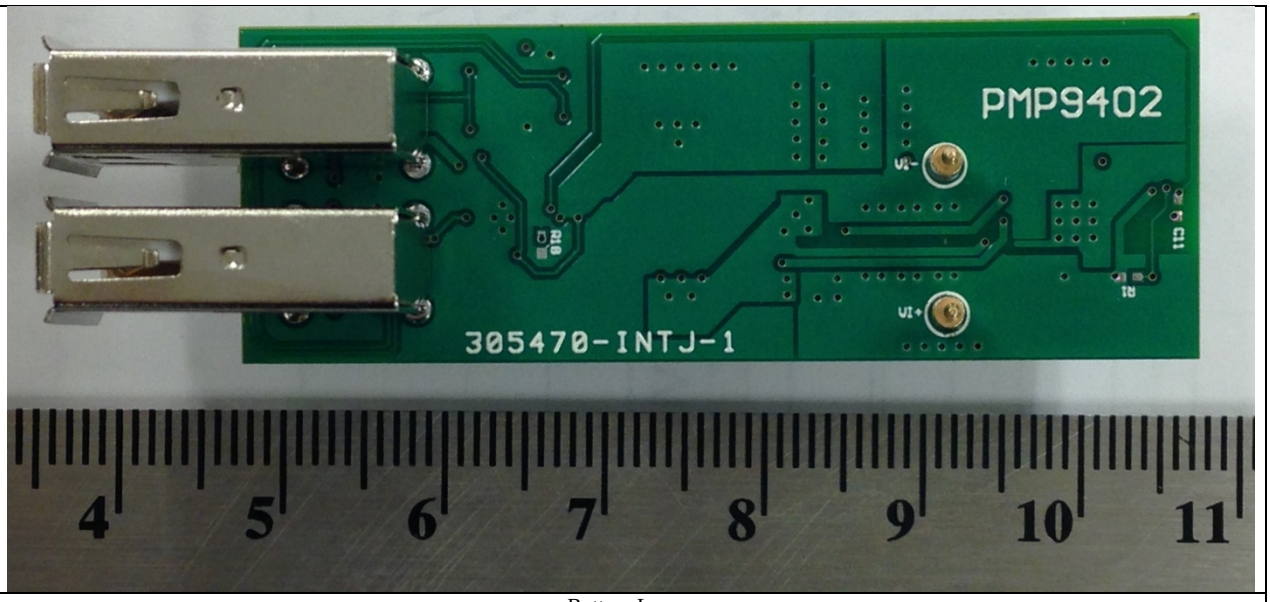
2. Fabrication

The PMP9402 is a two layer board with overall dimensions of 0.713” (18mm) x 2.2” (55mm). The copper weight is 1oz per layer.



Top Layer

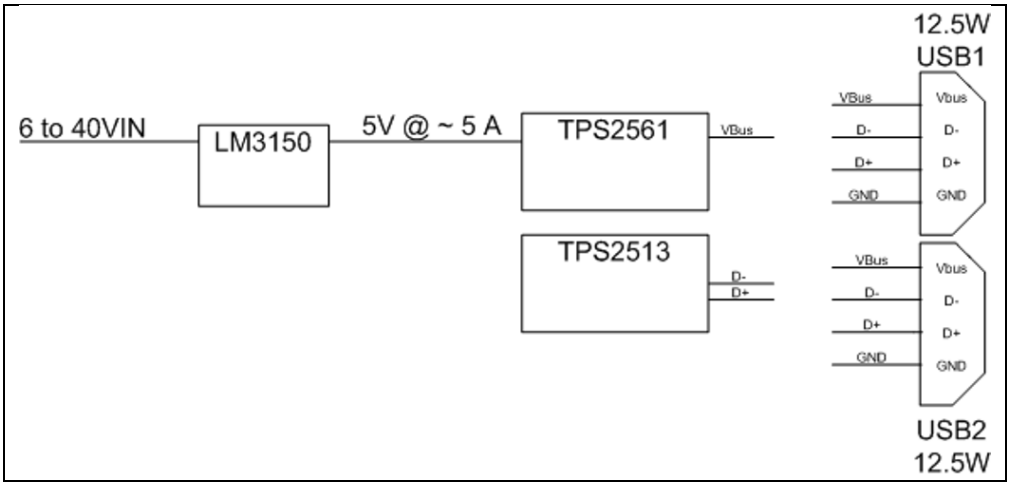
USB Direct Charging Port



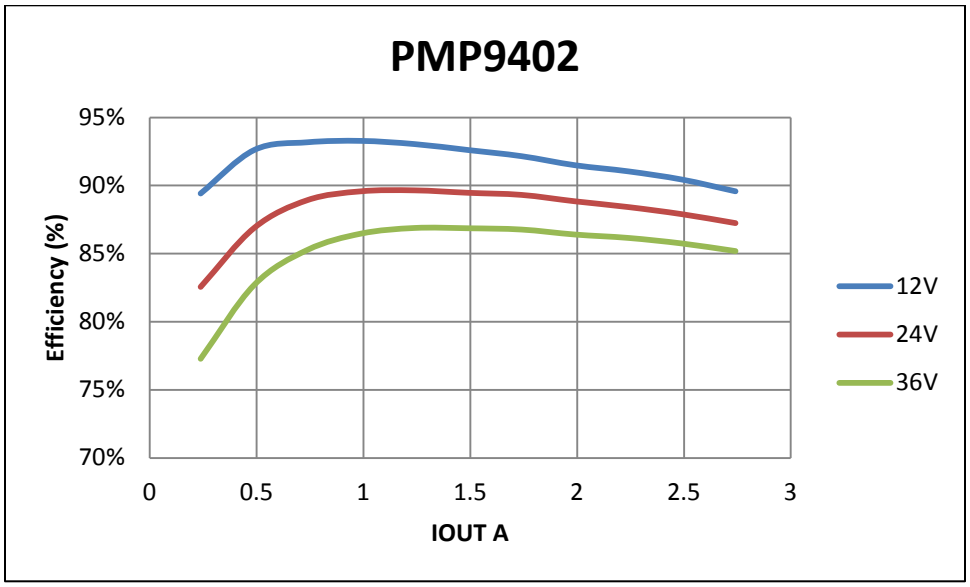
Bottom Layer

USB Direct Charging Port

2.1 Block Diagram



3. Efficiency



3.1 12VIN

Vin (V)	Iin (A)	Iout 1 (A)	Vout 1 (V)	Iout 2 (A)	Vout 2 (V)	Pin (W)	Pout (W)	Efficiency (%)
12.00	0.02	0.00	5.12	0.00	5.12	0.20	0.00	-0.18%
12.00	0.24	0.25	5.10	0.25	5.10	2.86	2.57	90.00%
12.00	0.46	0.50	5.09	0.50	5.09	5.51	5.11	92.87%
12.00	0.68	0.75	5.07	0.75	5.07	8.16	7.63	93.49%
12.00	0.90	1.00	5.06	1.00	5.06	10.84	10.14	93.59%
12.00	1.13	1.25	5.04	1.25	5.05	13.55	12.64	93.28%
11.99	1.36	1.50	5.03	1.50	5.03	16.27	15.12	92.90%
11.99	1.59	1.75	5.01	1.75	5.02	19.03	17.58	92.38%
11.99	1.82	2.00	5.00	2.00	5.00	21.80	20.03	91.88%
11.99	2.05	2.25	4.99	2.25	4.99	24.63	22.48	91.24%
11.99	2.30	2.50	4.99	2.50	4.99	27.55	24.97	90.67%

3.2 24VIN

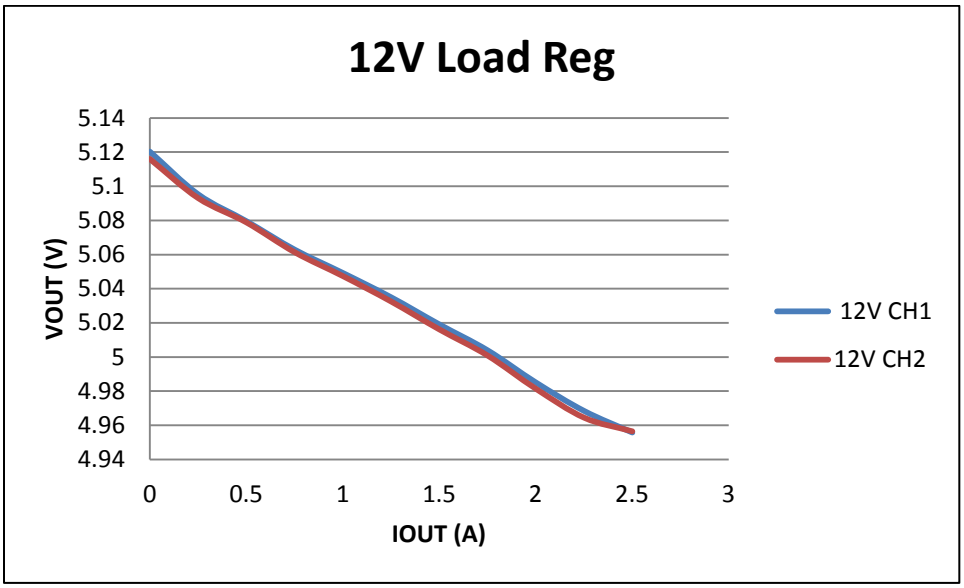
Vin (V)	Iin (A)	Iout 1 (A)	Vout 1 (V)	Iout 2 (A)	Vout 2 (V)	Pin (W)	Pout (W)	Efficiency (%)
24.00	0.02	0.00	5.15	0.00	5.15	0.42	0.00	0.00%
24.00	0.12	0.22	5.13	0.24	5.13	2.86	2.36	82.76%
24.00	0.24	0.47	5.11	0.49	5.12	5.65	4.93	87.18%
24.00	0.35	0.73	5.10	0.74	5.10	8.37	7.47	89.25%
24.00	0.46	0.98	5.09	0.99	5.09	11.11	9.99	89.93%
24.00	0.58	1.23	5.07	1.24	5.08	13.88	12.51	90.10%
24.00	0.70	1.48	5.06	1.49	5.06	16.70	15.01	89.85%
24.00	0.81	1.73	5.04	1.74	5.05	19.56	17.50	89.46%
24.00	0.93	1.98	5.03	1.99	5.03	22.40	19.95	89.08%
24.00	1.05	2.23	5.01	2.24	5.02	25.30	22.40	88.54%
24.00	1.18	2.48	5.00	2.49	5.00	28.26	24.84	87.90%

3.3 36 VIN

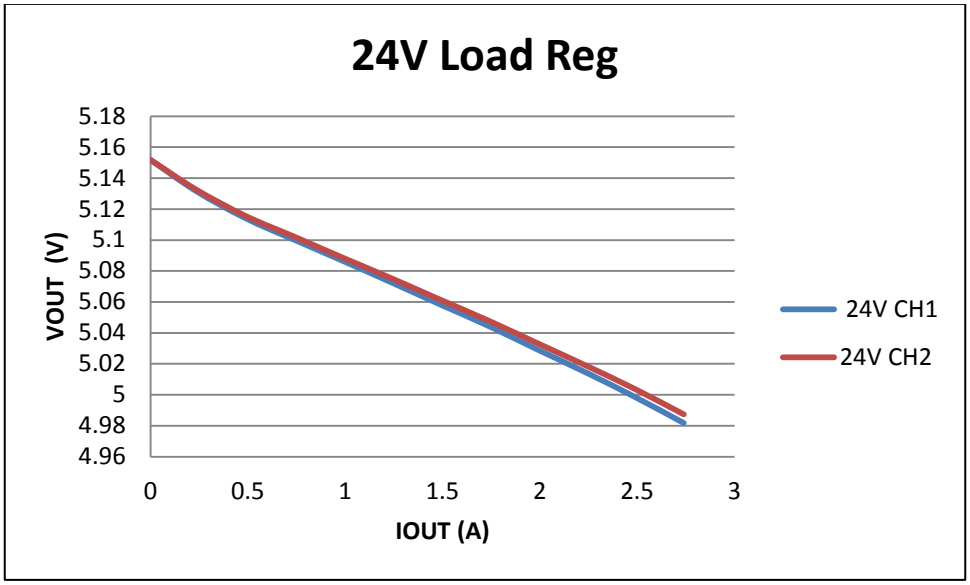
Vin (V)	Iin (A)	Iout 1 (A)	Vout 1 (V)	Iout 2 (A)	Vout 2 (V)	Pin (W)	Pout (W)	Efficiency (%)
36.01	0.02	0.00	5.17	0.00	5.17	0.60	0.00	0.00%
36.01	0.09	0.22	5.15	0.24	5.15	3.09	2.37	76.83%
36.01	0.17	0.48	5.13	0.49	5.14	5.97	4.95	82.86%
36.01	0.24	0.73	5.12	0.74	5.12	8.76	7.50	85.61%
36.01	0.32	0.98	5.11	0.99	5.11	11.54	10.03	86.90%
36.01	0.40	1.23	5.09	1.24	5.09	14.39	12.55	87.22%
36.01	0.48	1.48	5.08	1.49	5.08	17.27	15.06	87.22%
36.00	0.56	1.73	5.06	1.74	5.07	20.15	17.56	87.13%
36.00	0.64	1.98	5.05	1.99	5.05	23.09	20.03	86.76%
36.00	0.72	2.23	5.03	2.24	5.04	26.03	22.49	86.42%
36.00	0.81	2.48	5.02	2.49	5.02	29.08	24.93	85.75%

4. Load Regulation

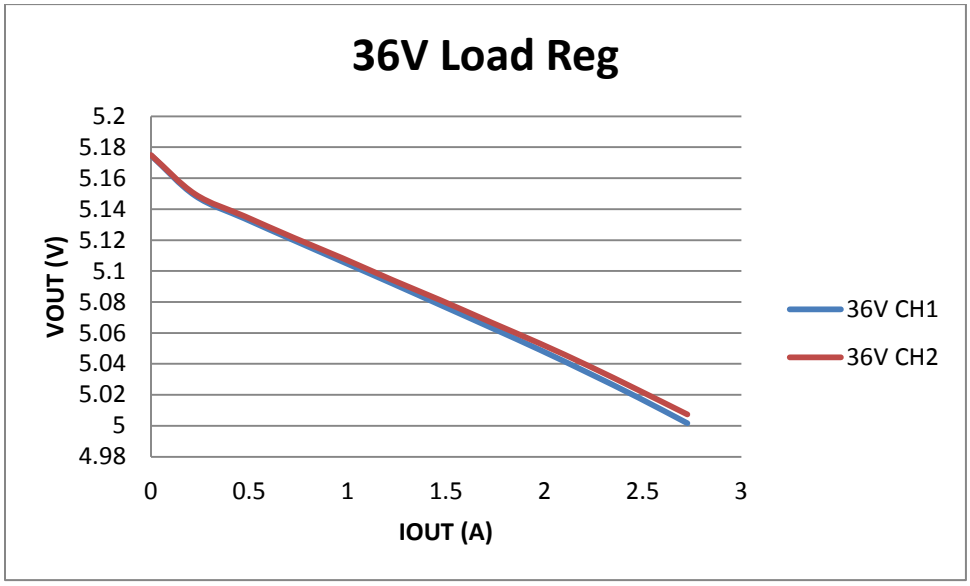
4.1 12VIN



4.2 24VIN

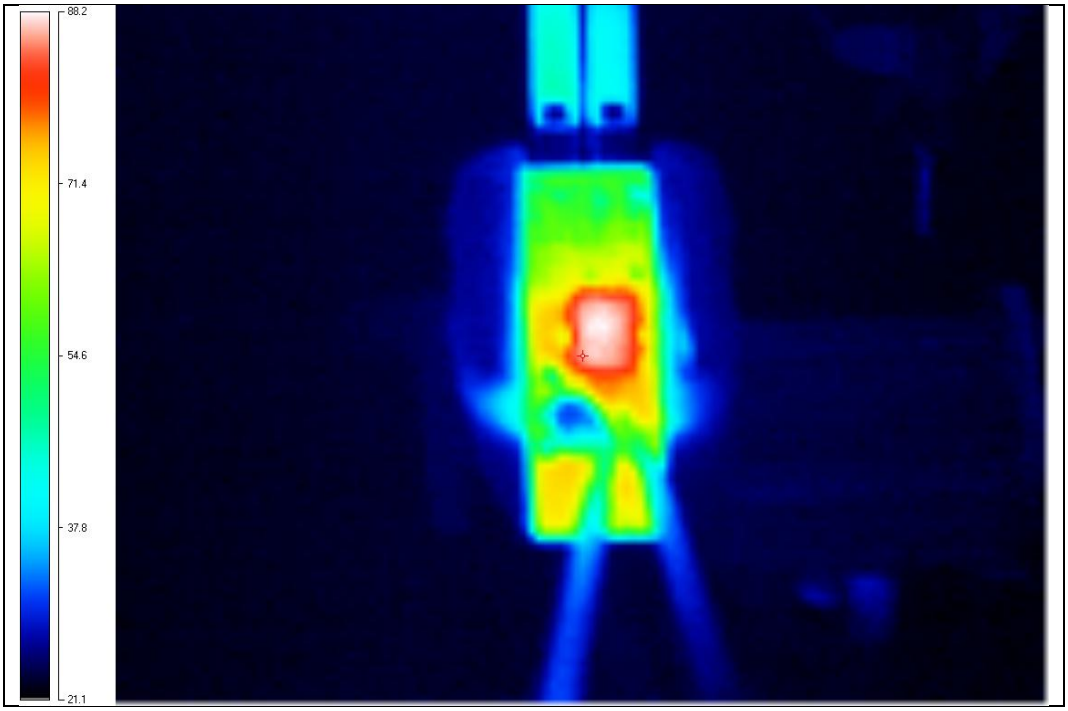


4.3 36VIN


36V Load Reg
VOUT (V)
5.2
5.18
5.16
5.14
5.12
5.1
5.08
5.06
5.04
5.02
5
4.98
0
0.5
1
1.5
2
2.5
3
IOUT (A)
36V CH1
36V CH2

5. Thermal

5.1 Steady State Temperature, 12Vin and 25W out.

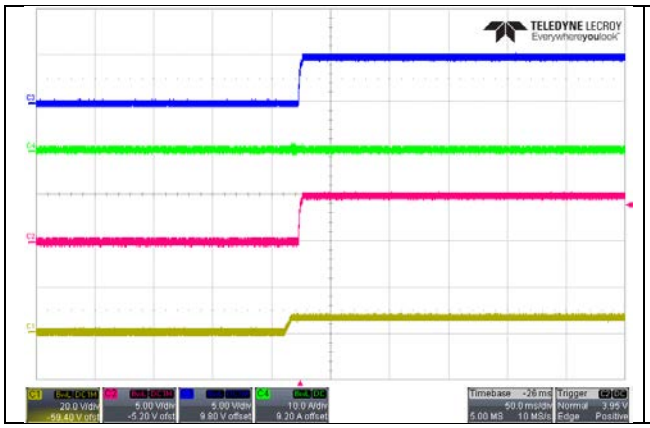


Top View

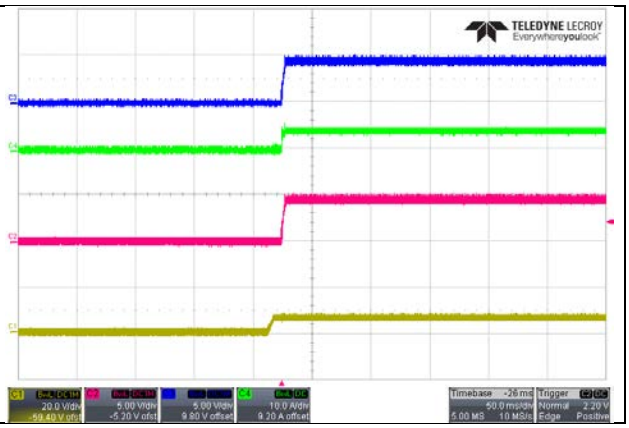
The inductor is the warmest component. The image displays a 67°C temperature rise.

6. Power Up

6.1 Power Up at 6V Input – No Load

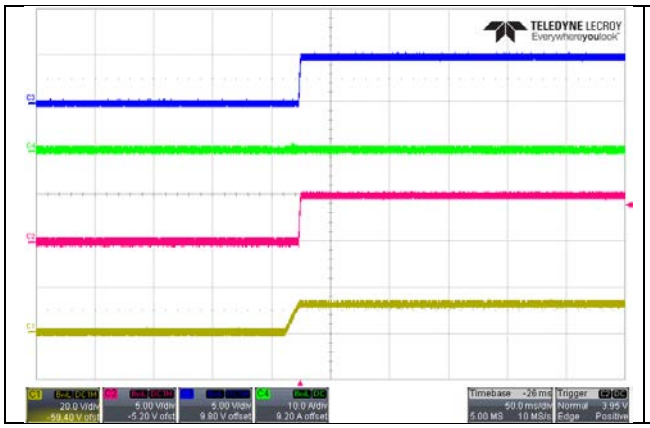


6V Input –Dual 2.5A Load

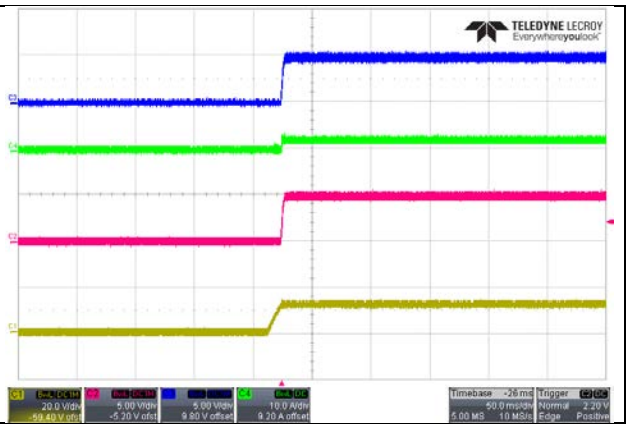


Channel 1 VIN
Channel 2 J1 5Vout
Channel 3 J2 5Vout
Channel 4 IIN

6.2 Power Up at 12V Input – No Load

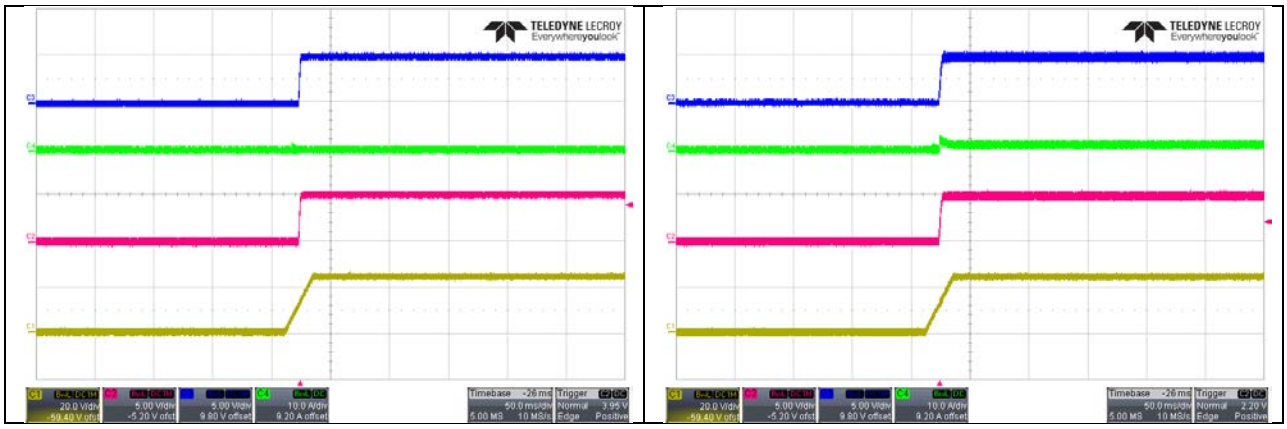


12V Input –Dual 2.5A Load



Channel 1 VIN
Channel 2 J1 5Vout
Channel 3 J2 5Vout
Channel 4 IIN

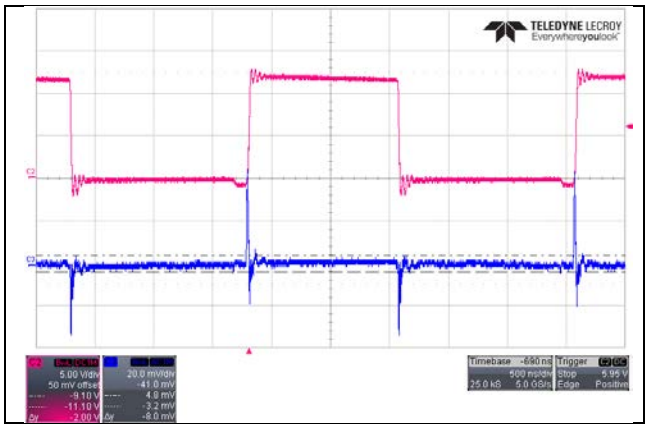
6.3 Power Up at 24V Input – No Load *24V Input –Dual 2.5A Load*



Channel 1 VIN
Channel 2 J1 5Vout
Channel 3 J2 5Vout
Channel 4 IIN

7. Switching and Ripple

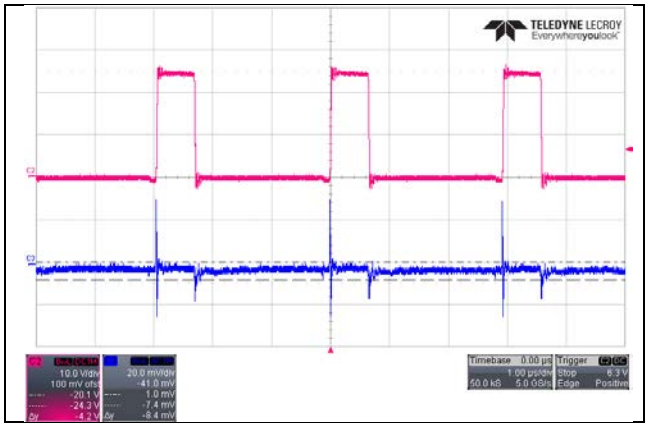
7.1 12 VIN LM3150 5VOUT @ 5A



The cursors indicate less than 10mV ripple.

Channel 2 VSW
Channel 3 5Vout

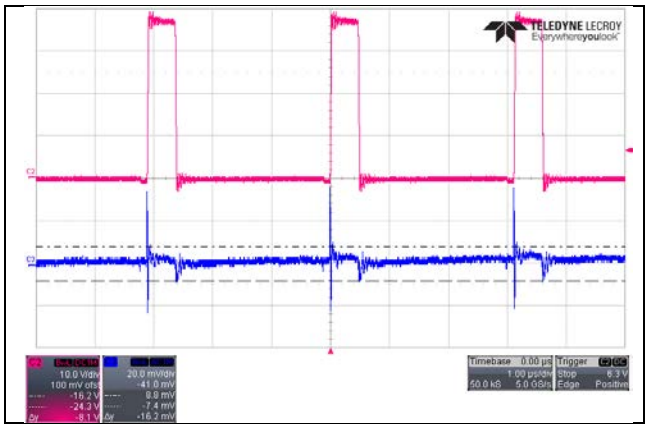
7.2 24 VIN LM3150 5VOUT @ 5A



The cursors indicate less than 10mV ripple.

Channel 2 VSW
Channel 3 5Vout

7.3 36 VIN LM3150 5VOUT @ 5A



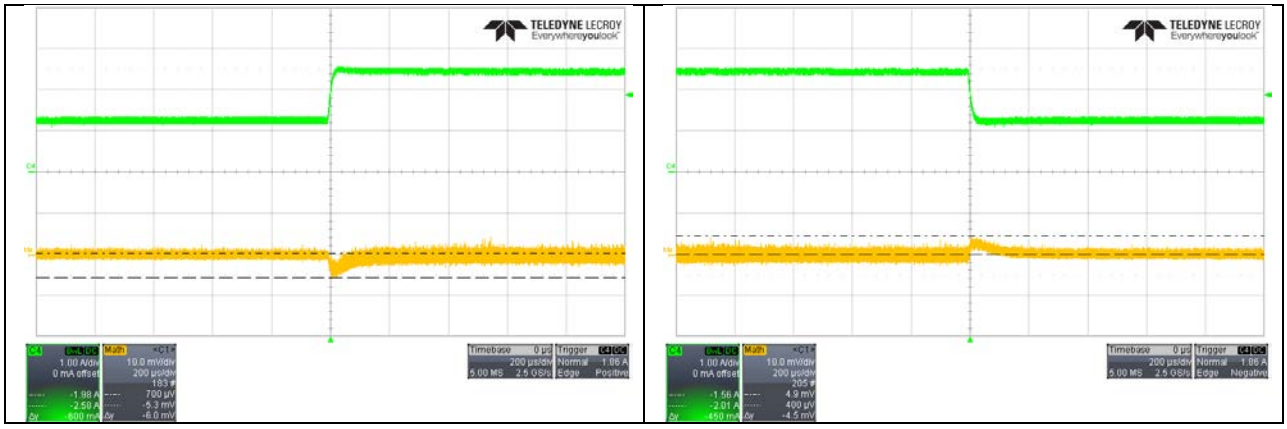
The cursors indicate less than 17mV ripple.

Channel 2 VSW
Channel 3 5Vout

8. Transient Response

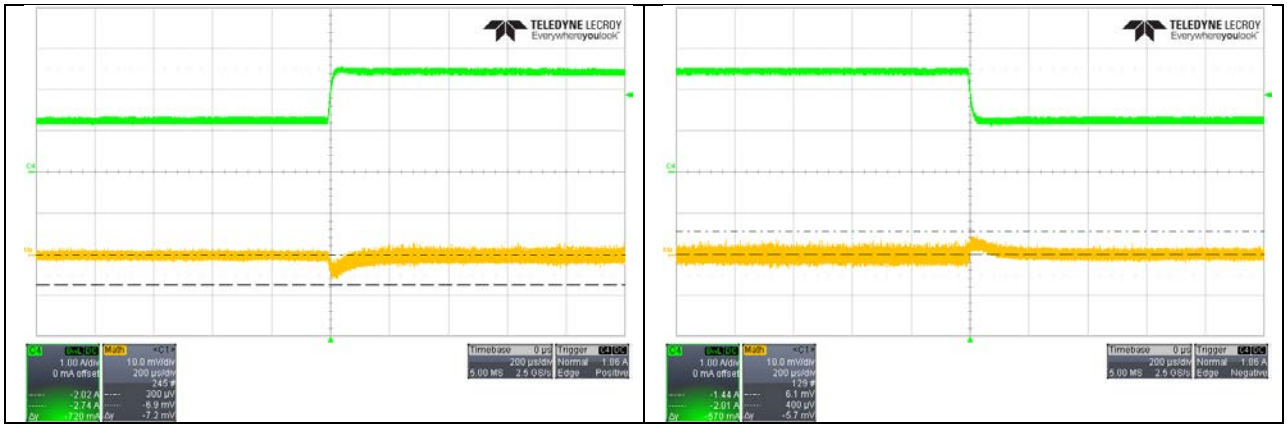
A load step was applied to each channel and the transient response of the controller was monitored.

8.1 12V Input – 1.25A to 2.5A Step, 1.6A/µs, 400 Hz. USB Ch1



Cursors indicate less than 6mV deviation across output capacitor.

8.2 12V Input – 1.25A to 2.5A Step, 1.6A/µs, 400 Hz. USB Ch2

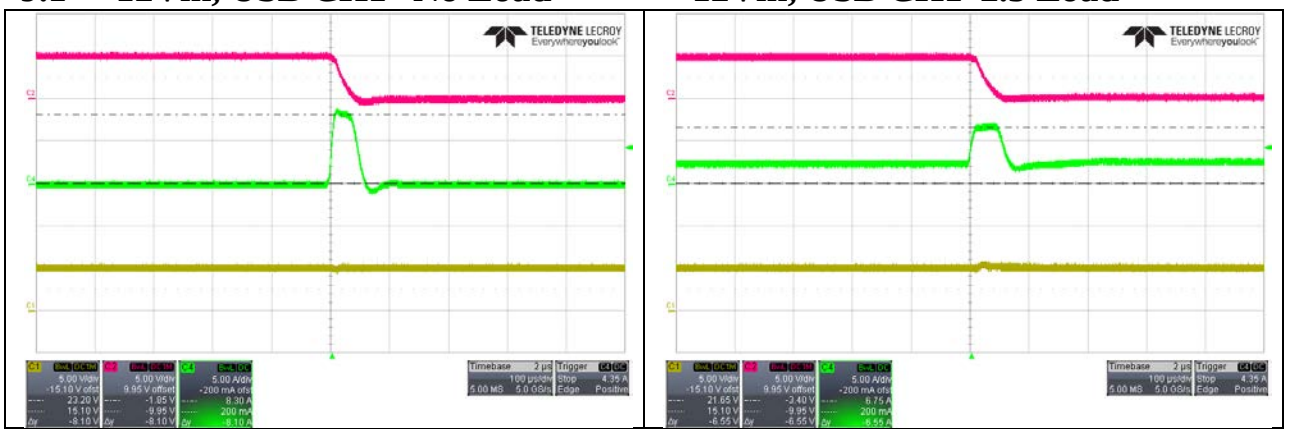


Cursors indicate less than 8mV deviation across output capacitor.

9. Current Limit Tests

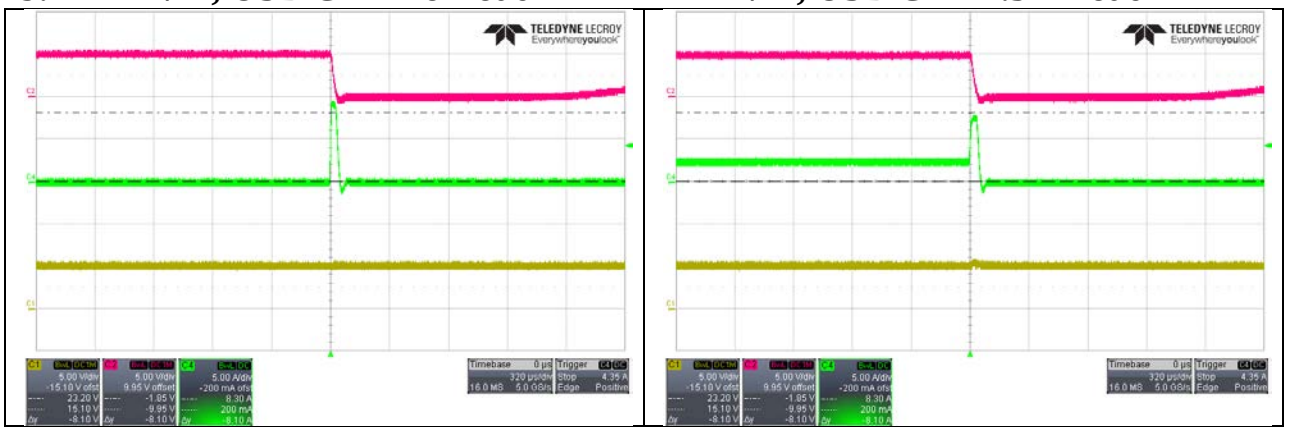
An over current load step was applied to each of the outputs using an electronic load.

9.1 12Vin, USB CH1 No Load 12Vin, USB CH1 2.5 Load



Channel 1 LM3150
Channel 2 USB CH1
Channel 4 IOUT

9.2 12Vin, USB CH2 No Load 12Vin, USB CH2 2.5A Load

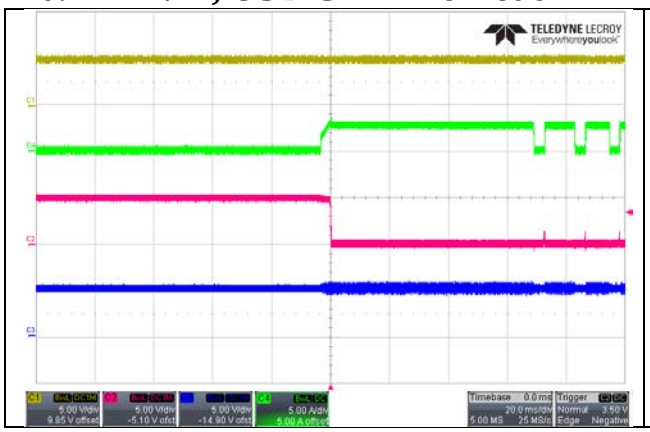


Channel 1 LM3150
Channel 2 USB CH2
Channel 4 IOUT

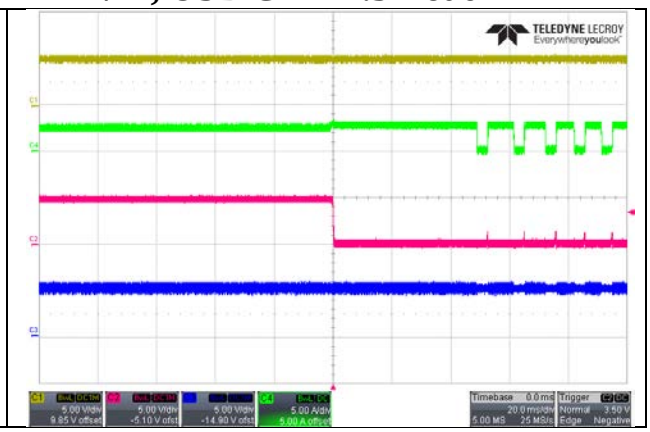
10 Short Circuit Tests

A short circuit was applied to each of the outputs using an electronic load.

10.1 12Vin, USB CH1 No Load

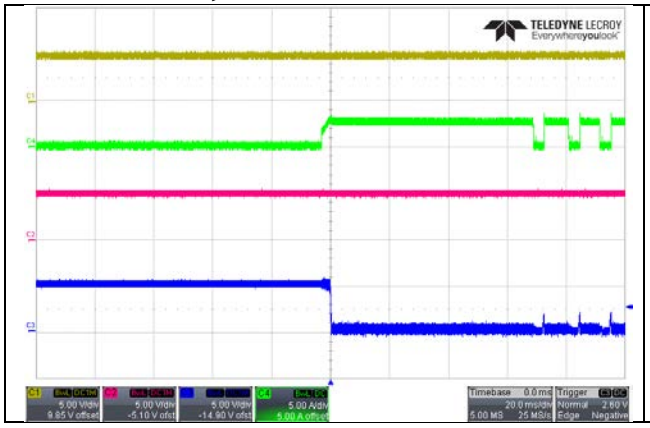


12Vin, USB CH1 2.5 Load

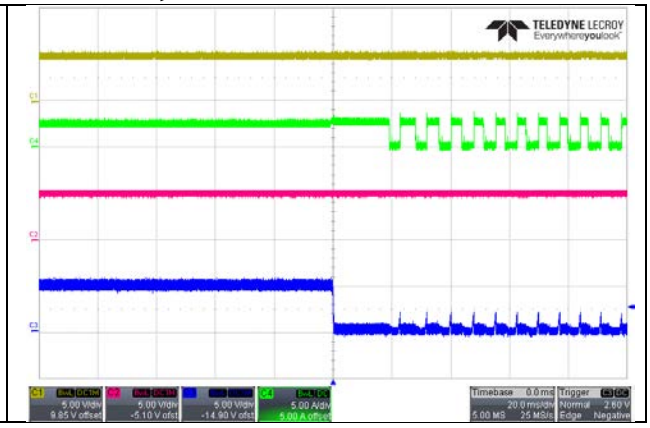


Channel 1 LM3150
Channel 2 USB CH1
Channel 3 USB CH2
Channel 4 IOUT

10.2 12Vin, USB CH2 No Load



12Vin, USB CH2 2.5A Load

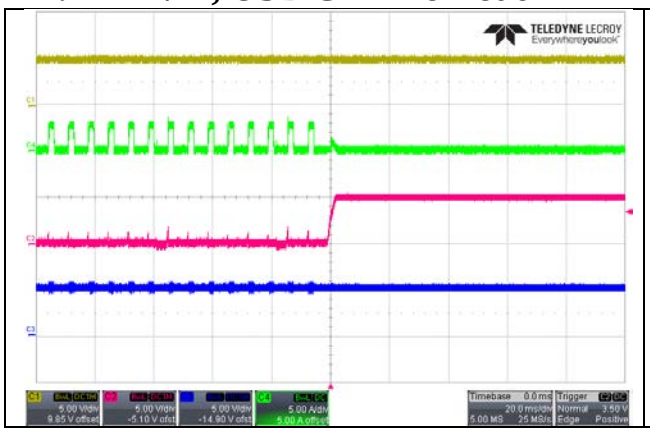


Channel 1 LM3150
Channel 2 USB CH1
Channel 3 USB CH2
Channel 4 IOUT

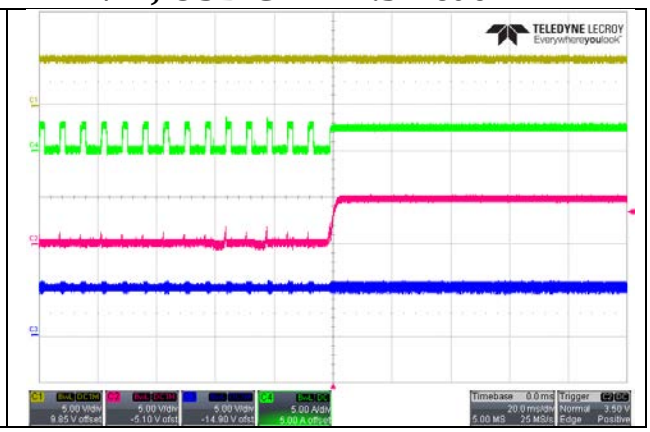
11. Short Circuit Recovery Tests

A short circuit was applied to each of the outputs using an electronic load and then allowed to restart.

11.1 12Vin, USB CH1 No Load

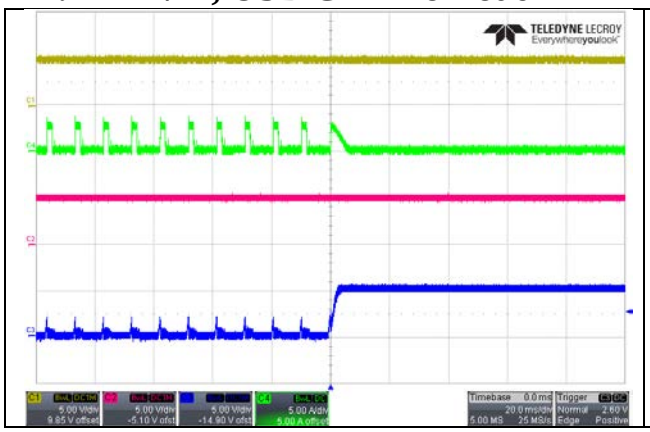


12Vin, USB CH1 2.5 Load

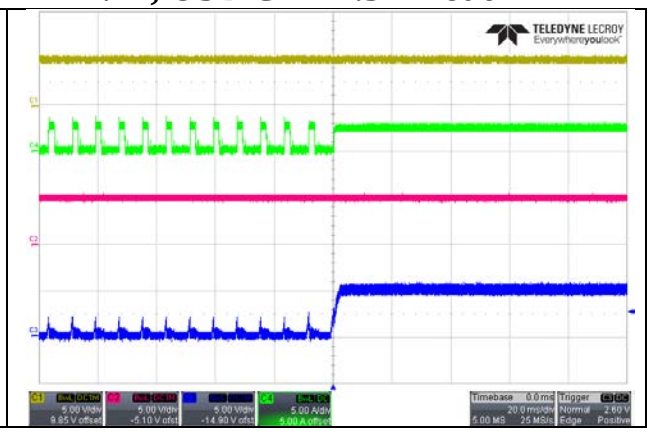


Channel 1 LM3150
Channel 2 USB CH1
Channel 3 USB CH2
Channel 4 IOUT

11.2 12Vin, USB CH2 No Load



12Vin, USB CH2 2.5A Load



Channel 1 LM3150
Channel 2 USB CH1
Channel 3 USB CH2
Channel 4 IOUT

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