Test Data
For TIDA-00744
12/16/2015

Table of Contents

1. Design Specifications

Vin Minimum	**3.8 V**
Vin Maximum	**36V**
Vin Nominal	**12V (automotive design)**
Vout 1 (pre boost)	**10V @ 5A (supply to dual buck controller)**
Iout 1	**5A**
Switching Frequency(Pre Boost)	**220 KHz**
Vout 2	**5V**
Iout 2	**5A**
Vout 3	**3.3V**
Iout 3	**5A**
Switching Frequency(Dual Buck Controller)	**2.2MHz (act as sync for Boost controller through freq divider)**
Protection	**Reverse polarity , Short Circuit protections at Outputs, Load Dump protection**

2. Circuit Description

PMP10709 is a 50 W System level SMPS design for mid power automotive infotainment system.

The design has protections such as Load dump through TVS (ISO pulse testing) as well as Reverse Voltage (Innovative Smart diode with very low Iq) Protection. Further all the Controllers (boost and dual bucks) are in SYNC for EMI optimized design.

The design is divided into four major blocks:

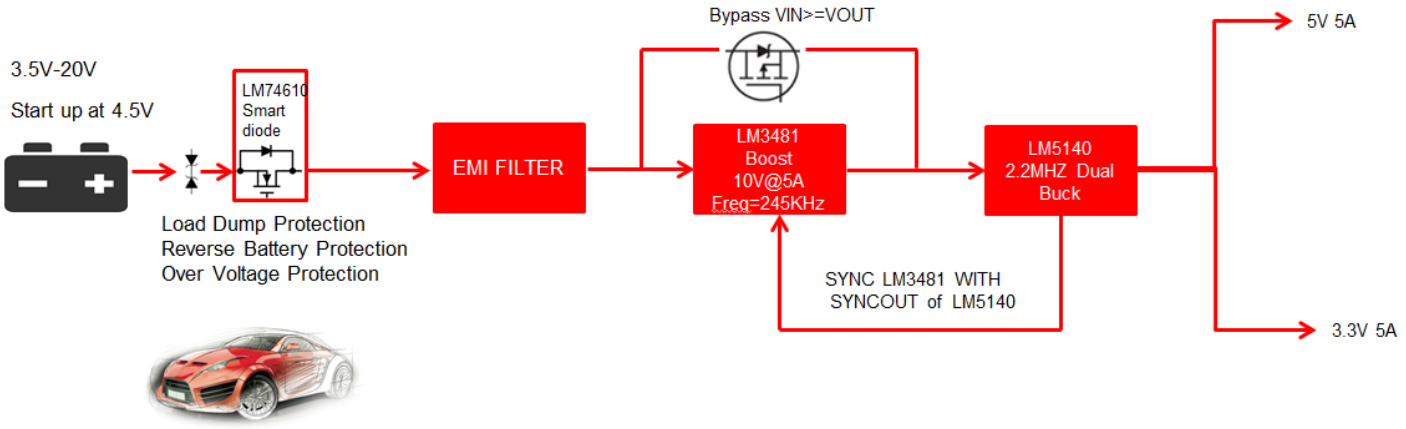
1. Protection: Reverse Battery protection through efficient smart diode and automotive transient protections through TVSs.

2. EMI Filter: A differential filter for Conducted EMI suppression.

3. Pre boost: Efficient Low cost Non-synchronous pre boost design for 50 W applications. The output is maintained at 10V and when Vin > Vout(programmed Boost Out) , the output follows the input and bypass operation is achieved (through a conducting PFET when VIN> programmed 10V boost output).

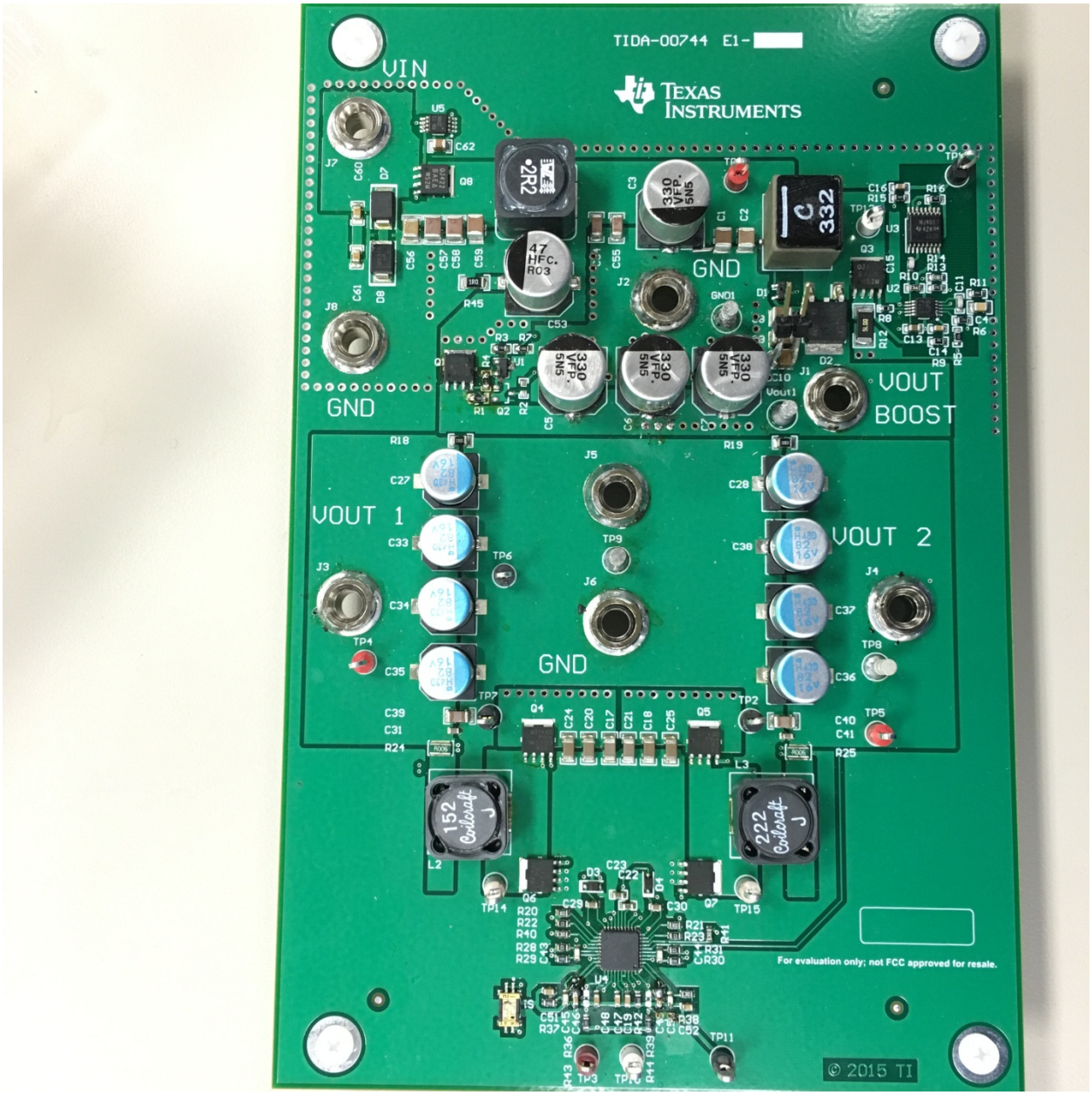
4. Dual Buck Controller: 2.2 MHZ switching for AM band avoidance as well as small size solution .Supports two output 5V@5 A as well as 3.3V@5 A . The Syncout of Controller is used to Sync Boost at F/9 frequency.

3. TIDA-00744 Block Diagram

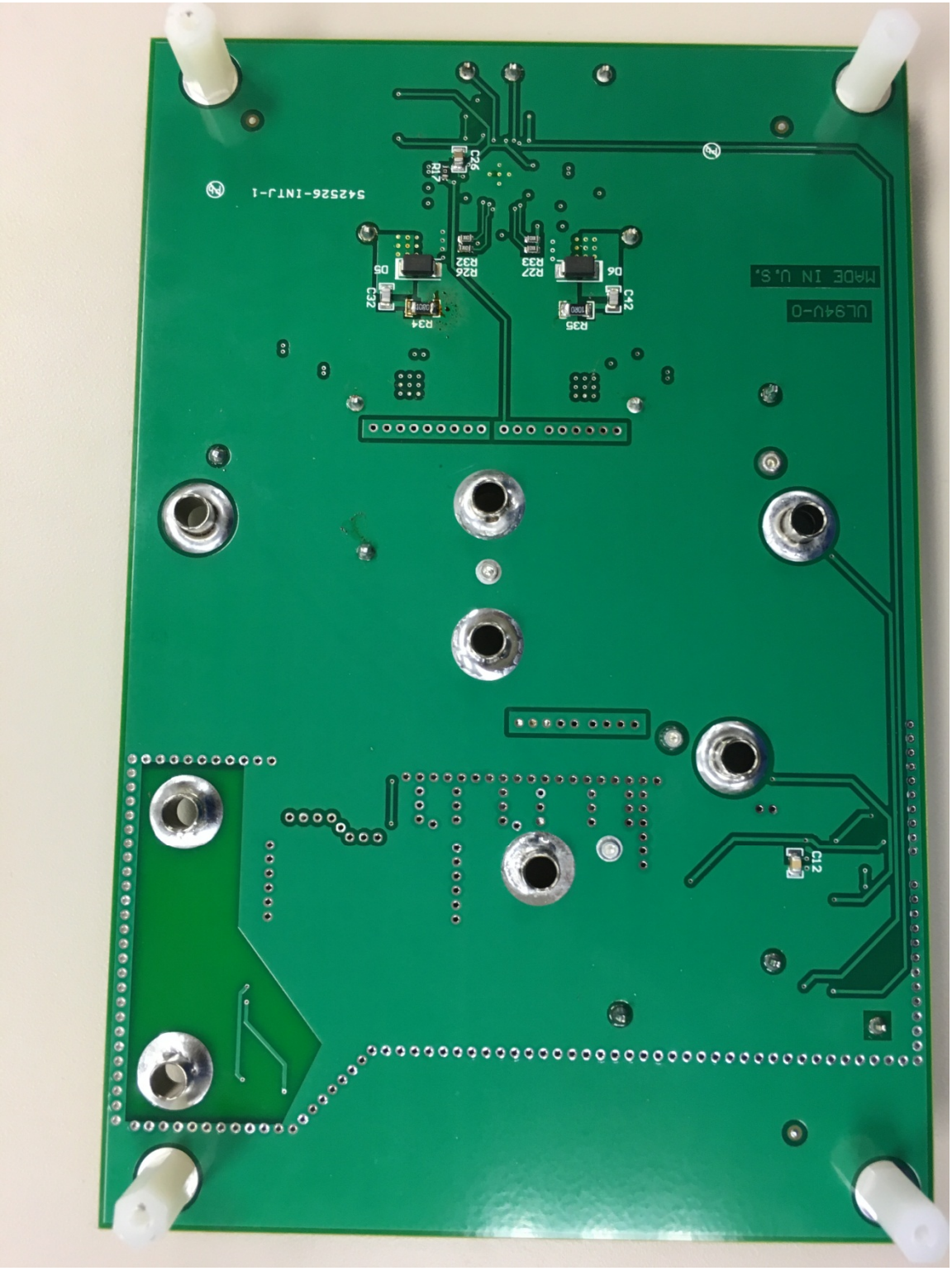


4. TIDA-00744 Board Photos

Board Dimensions: 4325mil *6550mi



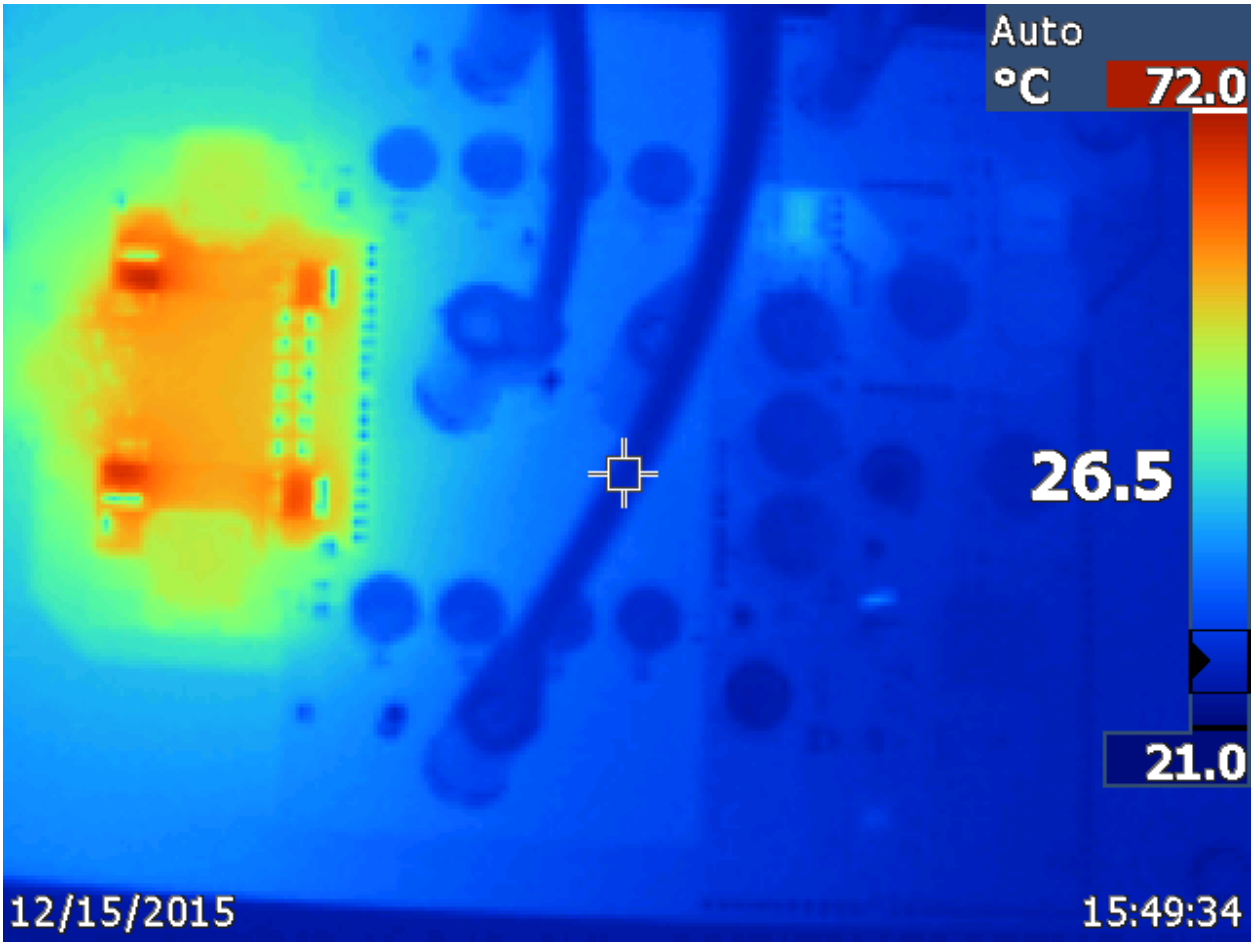
Board Photo (Top)



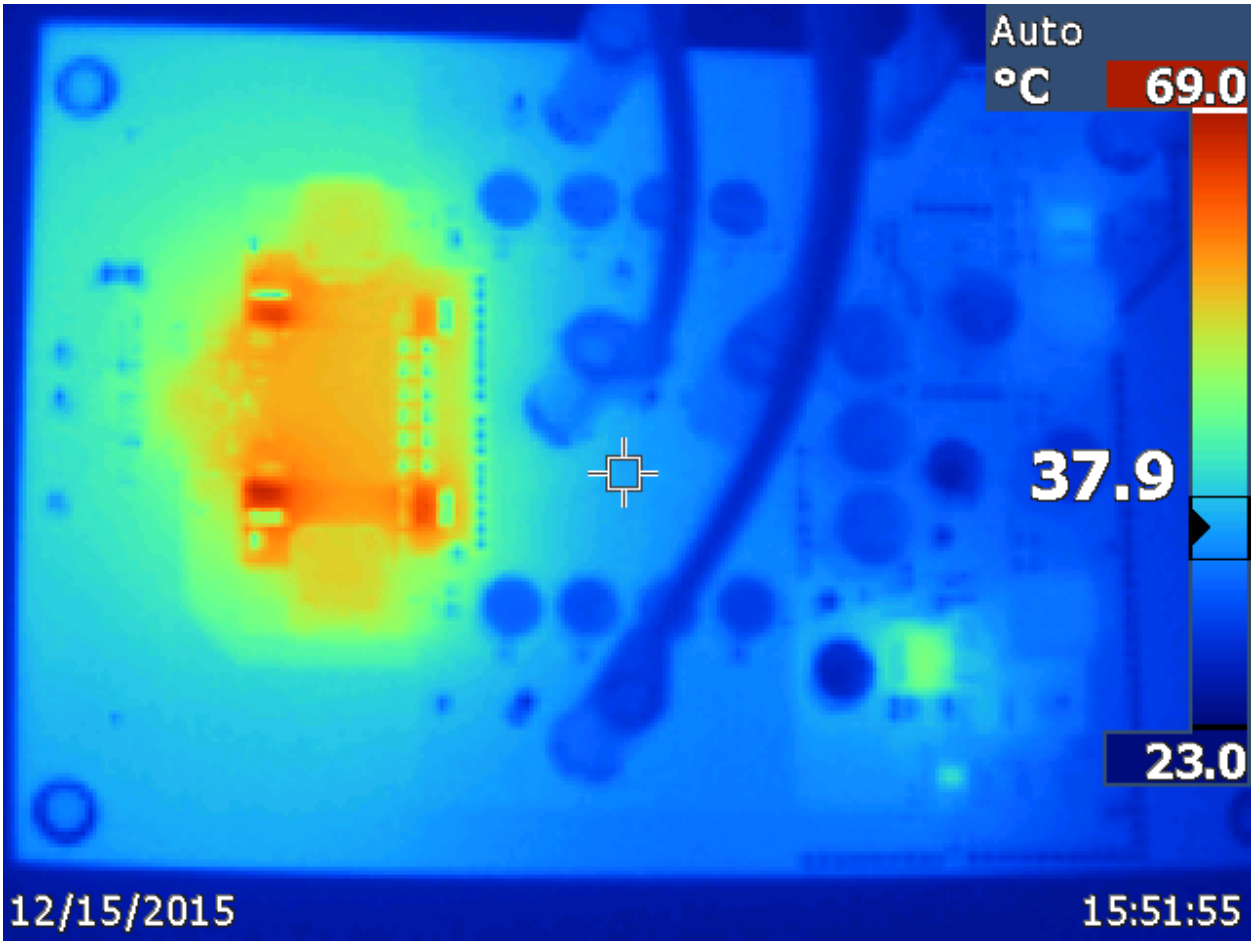
Board Photo (Bottom)

4. Thermal Data

IR thermal image taken at steady state with 12 Vin and 5V@5A and 3.3V @ 5A (Boost is Bypassed)



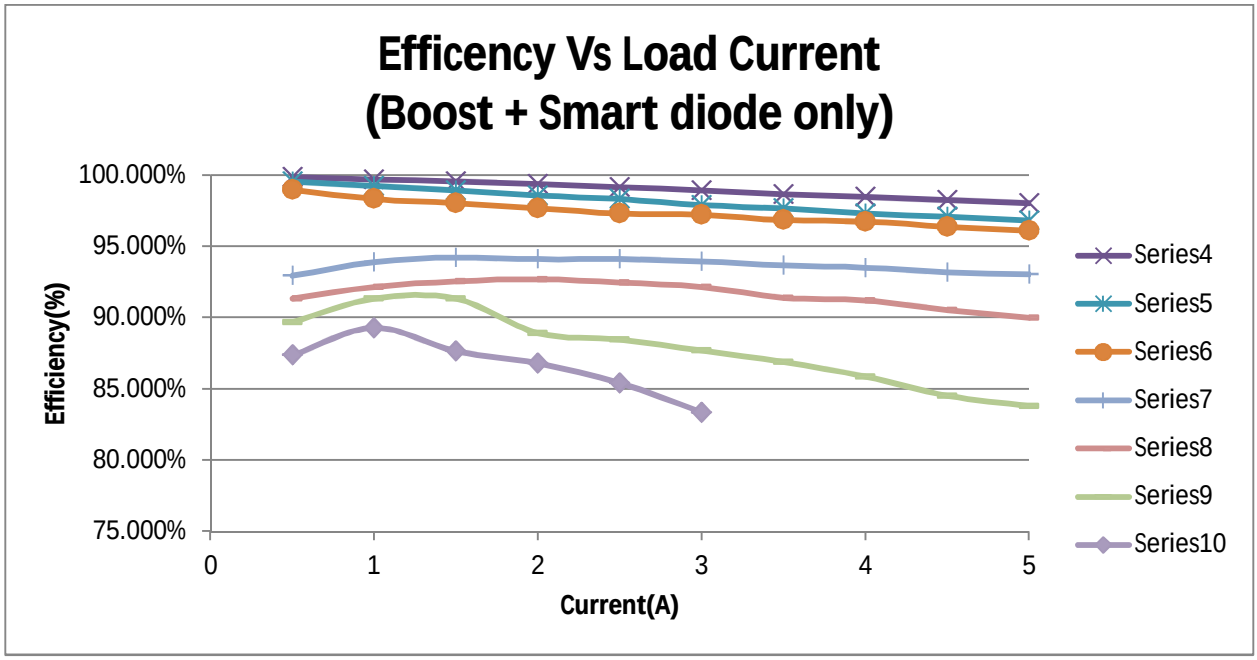
IR thermal image taken at steady state with 6 Vin and 5V@5A and 3.3V @ 5A (Boost is operational)



5. Efficiency data

5.1 Pre Boost Efficiency – LM3481 only

5.1.1 Efficiency Chart –Pre boost



5.1.2 Efficiency Data- Pre Boost

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
14.4	0.5	14.38	0.5	99.861%
14.4	1	14.36	1	99.722%
14.4	1.5	14.34	1.5	99.583%
14.4	2	14.31	2	99.375%
14.4	2.5	14.28	2.5	99.167%
14.4	3	14.25	3	98.958%
14.4	3.5	14.21	3.5	98.681%
14.4	4	14.18	4	98.472%
14.4	4.5	14.15	4.5	98.264%
14.4	5	14.12	5	98.056%

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
12	0.5	11.95	0.5	99.583%
12	1	11.91	1	99.250%
12	1.5	11.87	1.5	98.917%
12	2	11.83	2	98.583%
12	2.5	11.8	2.5	98.333%
12	3	11.75	3	97.917%
12	3.5	11.72	3.5	97.667%
12	4	11.68	4	97.333%
12	4.5	11.65	4.5	97.083%
12	5	11.62	5	96.833%

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
10.8	0.5	10.69	0.5	98.981%
10.8	1	10.62	1	98.333%
10.8	1.5	10.59	1.5	98.056%
10.8	2	10.55	2	97.685%
10.8	2.5	10.51	2.5	97.315%
10.8	3	10.5	3	97.222%
10.8	3.5	10.46	3.5	96.852%
10.8	4	10.45	4	96.759%
10.8	4.5	10.41	4.5	96.389%
10.8	5	10.38	5	96.111%

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
8	0.6704	9.97	0.5	92.948%
8	1.327	9.97	1	93.915%
8	1.9816	9.96	1.5	94.242%
8	2.6432	9.95	2	94.109%
8	3.3033	9.95	2.5	94.129%
8	3.9712	9.95	3	93.958%
8	4.6419	9.94	3.5	93.685%
8	5.3143	9.94	4	93.521%
8	5.994	9.932	4.5	93.206%
8	6.6715	9.932	5	93.045%

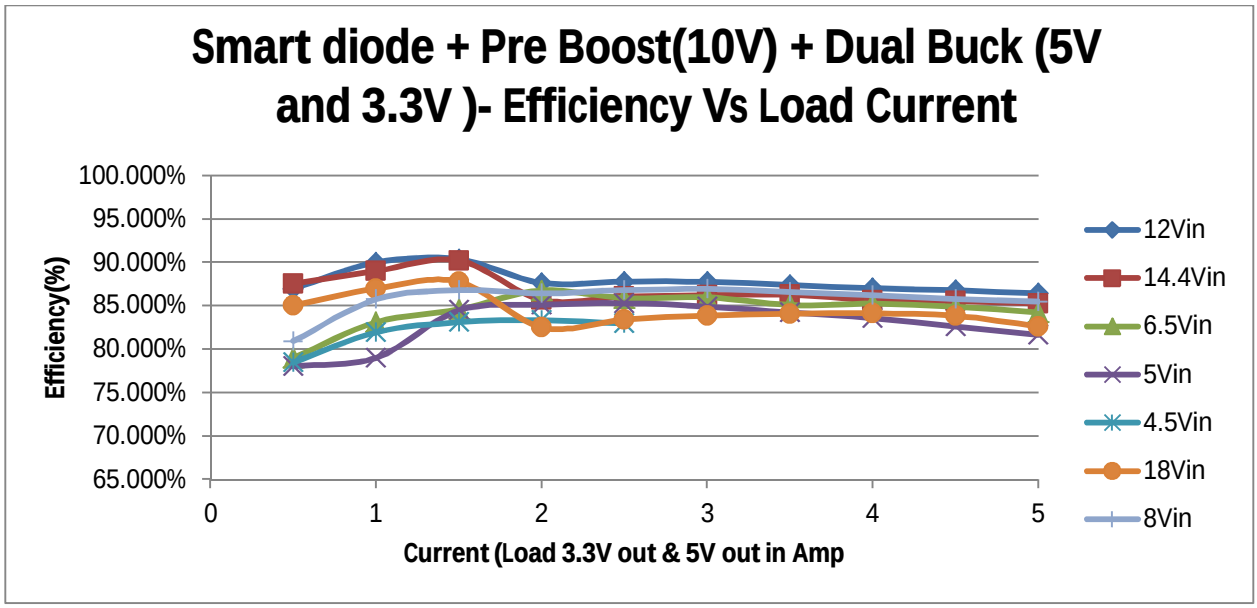
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
6	0.9096	9.97	0.5	91.341%
6	1.8028	9.97	1	92.171%
6	2.6902	9.96	1.5	92.558%
6	3.5775	9.95	2	92.709%
6	4.4837	9.95	2.5	92.465%
6	5.3981	9.95	3	92.162%
6	6.3433	9.94	3.5	91.409%
6	7.2645	9.94	4	91.220%
6	8.227	9.932	4.5	90.543%
6	9.1956	9.932	5	90.007%

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
4.5	1.235	9.97	0.5	89.699%
4.5	2.4253	9.97	1	91.352%
4.5	3.6348	9.96	1.5	91.339%
4.5	4.9731	9.95	2	88.923%
4.5	6.2485	9.95	2.5	88.466%
4.5	7.5648	9.95	3	87.687%
4.5	8.8977	9.94	3.5	86.889%
4.5	10.2886	9.94	4	85.877%
4.5	11.75	9.932	4.5	84.528%
4.5	13.17	9.932	5	83.793%

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
3.5	1.63	9.97	0.5	87.379%
3.5	3.19	9.97	1	89.297%
3.5	4.87	9.96	1.5	87.650%
3.5	6.55	9.95	2	86.805%
3.5	8.32	9.95	2.5	85.422%
3.5	10.22	9.94	3	83.366%

5.2 System's Efficiency (Smart diode + Pre Boost + Dual Buck)

5.2.1 Efficiency Chart



5.2.2 Efficiency data- Complete system's Efficiency data

Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
12	0.3976	3.295	0.5	5.005	0.5	86.980%
12	0.7684	3.295	1	5.005	1	90.014%
12	1.1481	3.295	1.5	5.005	1.5	90.367%
12	1.5781	3.295	2	5.005	2	87.658%
12	1.9692	3.295	2.5	5.005	2.5	87.811%
12	2.3638	3.295	3	5.005	3	87.782%
12	2.7688	3.295	3.5	5.005	3.5	87.433%
12	3.1784	3.295	4	5.005	4	87.046%
12	3.5855	3.295	4.5	5.005	4.5	86.808%
12	4.0016	3.295	5	5.005	5	86.424%

Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
14.4	0.3292	3.295	0.5	5.005	0.5	87.544%
14.4	0.6475	3.295	1	5.005	1	89.018%
14.4	0.958	3.295	1.5	5.005	1.5	90.249%
14.4	1.3452	3.295	2	5.005	2	85.696%
14.4	1.6738	3.295	2.5	5.005	2.5	86.090%
14.4	2.0045	3.295	3	5.005	3	86.264%
14.4	2.3376	3.295	3.5	5.005	3.5	86.301%
14.4	2.6909	3.295	4	5.005	4	85.680%
14.4	3.0313	3.295	4.5	5.005	4.5	85.566%
14.4	3.3785	3.295	5	5.005	5	85.302%

Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
6.5	0.808	3.295	0.5	5.005	0.5	79.018%
6.5	1.5365	3.295	1	5.005	1	83.106%
6.5	2.264	3.295	1.5	5.005	1.5	84.602%
6.5	2.9426	3.295	2	5.005	2	86.789%
6.5	3.7164	3.295	2.5	5.005	2.5	85.898%
6.5	4.4543	3.295	3	5.005	3	86.002%
6.5	5.25151	3.295	3.5	5.005	3.5	85.104%
6.5	5.9906	3.295	4	5.005	4	85.262%
6.5	6.7682	3.295	4.5	5.005	4.5	84.899%
6.5	7.5772	3.295	5	5.005	5	84.261%

Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
5	1.0637	3.295	0.5	5.005	0.5	78.030%
5	2.10073	3.295	1	5.005	1	79.020%
5	2.9466	3.295	1.5	5.005	1.5	84.504%
5	3.9003	3.295	2	5.005	2	85.122%
5	4.8644	3.295	2.5	5.005	2.5	85.314%
5	5.8627	3.295	3	5.005	3	84.944%
5	6.898	3.295	3.5	5.005	3.5	84.227%
5	7.9419	3.295	4	5.005	4	83.607%
5	9.039	3.295	4.5	5.005	4.5	82.642%
5	10.1611	3.295	5	5.005	5	81.684%

Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
4.5	1.1752	3.295	0.5	5.005	0.5	78.474%
4.5	2.2504	3.295	1	5.005	1	81.961%
4.5	3.3285	3.295	1.5	5.005	1.5	83.121%
4.5	4.4256	3.295	2	5.005	2	83.353%
4.5	5.5568	3.295	2.5	5.005	2.5	82.981%

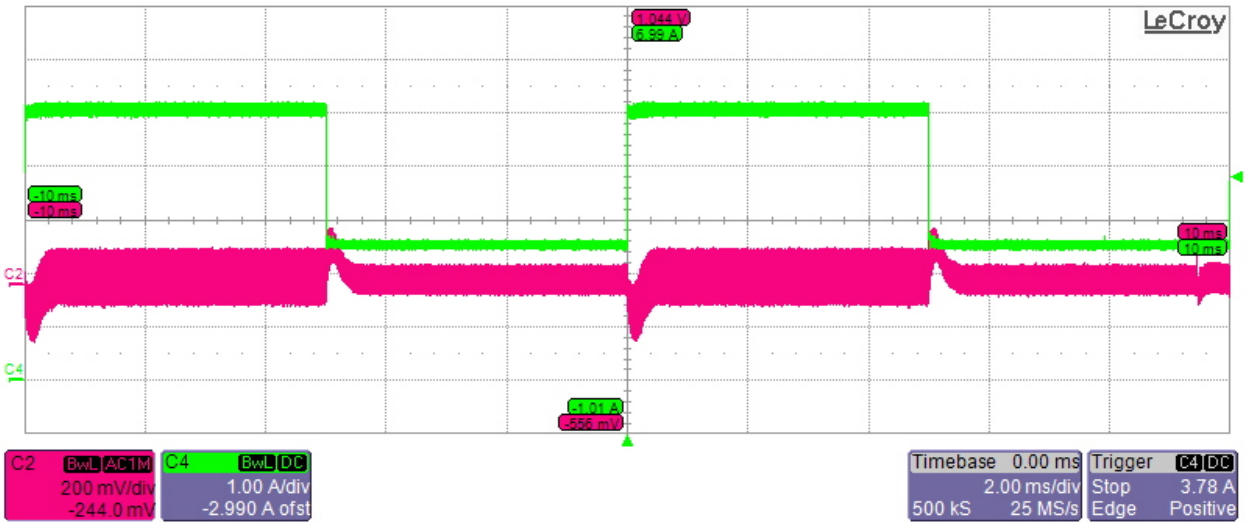
Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
18	0.271	3.295	0.5	5.005	0.5	85.076%
18	0.53	3.295	1	5.005	1	87.002%
18	0.7878	3.295	1.5	5.005	1.5	87.797%
18	1.1174	3.295	2	5.005	2	82.533%
18	1.3821	3.295	2.5	5.005	2.5	83.408%
18	1.6486	3.295	3	5.005	3	83.910%
18	1.91888	3.295	3.5	5.005	3.5	84.106%
18	2.1919	3.295	4	5.005	4	84.148%
18	2.4744	3.295	4.5	5.005	4.5	83.859%
18	2.7899	3.295	5	5.005	5	82.639%

Vin(V)	Iin(A)	Vout1(V)	Iout1(A)	Vout2(V)	Iout2(A)	Efficiency(%)
8	0.6408	3.295	0.5	5.005	0.5	80.953%
8	1.2098	3.295	1	5.005	1	85.758%
8	1.792	3.295	1.5	5.005	1.5	86.844%
8	2.401	3.295	2	5.005	2	86.422%
8	2.9872	3.295	2.5	5.005	2.5	86.829%
8	3.5797	3.295	3	5.005	3	86.949%
8	4.1923	3.295	3.5	5.005	3.5	86.617%
8	4.8121	3.295	4	5.005	4	86.241%
8	5.44	3.295	4.5	5.005	4.5	85.823%
8	6.065	3.295	5	5.005	5	85.532%

6. Waveforms

6.1 System's Transient performance

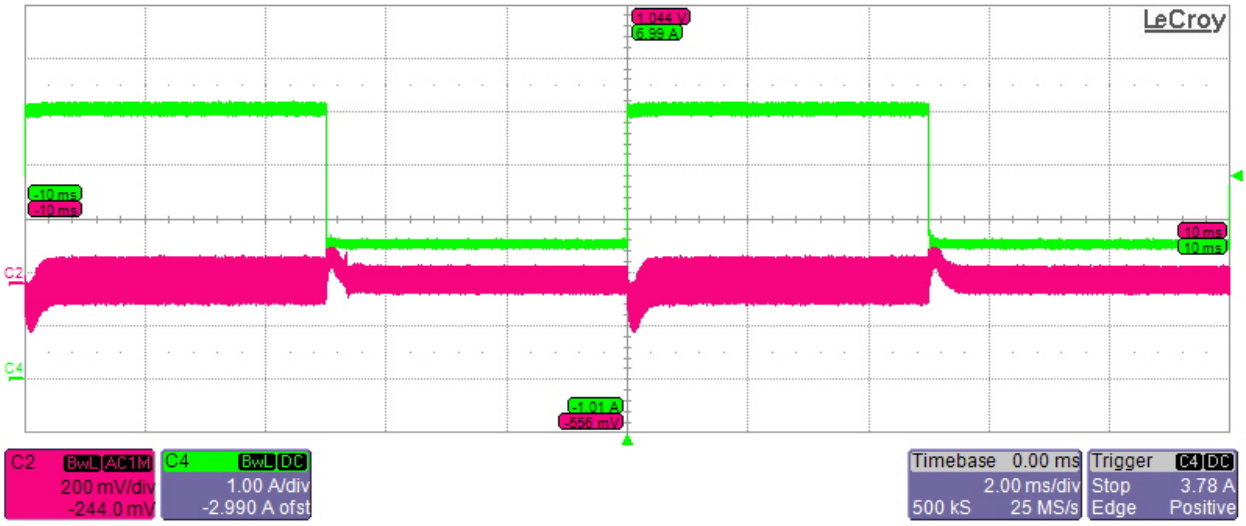
6.1.1 Pre Boost – Transient performance



Transient performance of 10V_Boost at Low Vin (4V) and 2.5A to 5A Current transient (Load on Boost output only)

C2- 10V_AC coupled

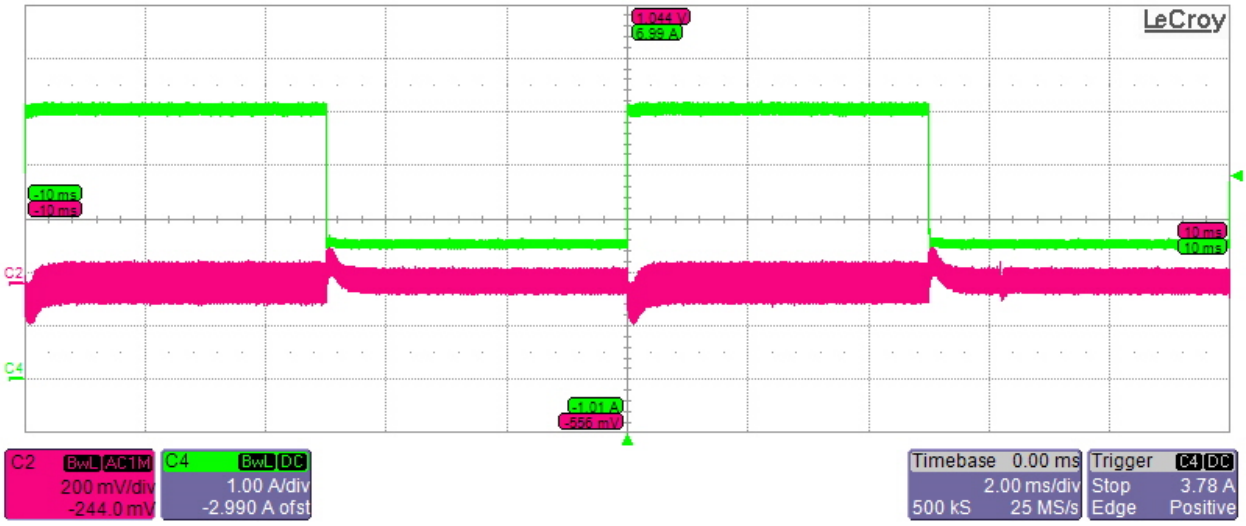
C4- 10 V Load



Transient performance of 10V_Boost at 5V and 2.5A to 5A Current transient (Load on Boost output only)

C2- 10V_AC coupled

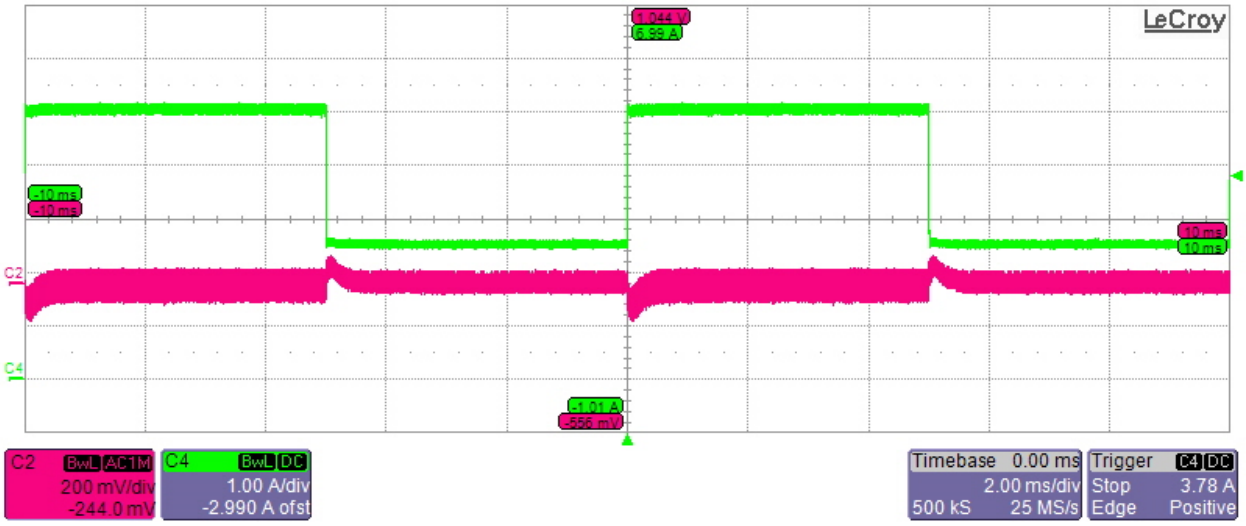
C4- 10 V Load



Transient performance of 10V_Boost at 6V and 2.5A to 5A Current transient (Load on Boost output only)

C2- 10V_AC coupled

C4- 10 V Load

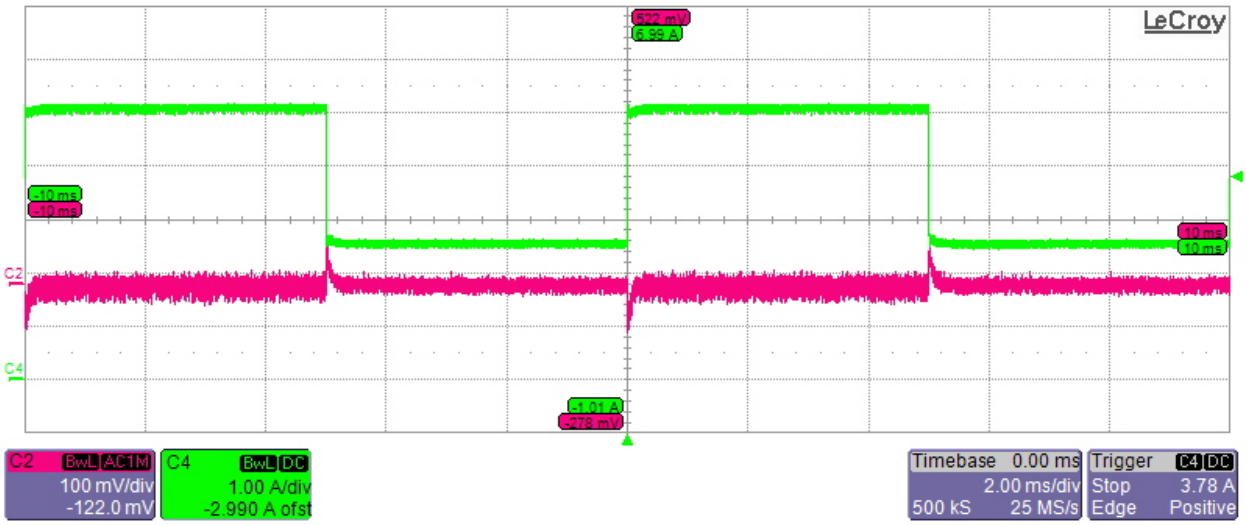


Transient performance of 10V_Boost at 8V and 2.5A to 5A Current transient (Load on Boost output only)

C2- 10V_AC coupled

C4- 10 V Load

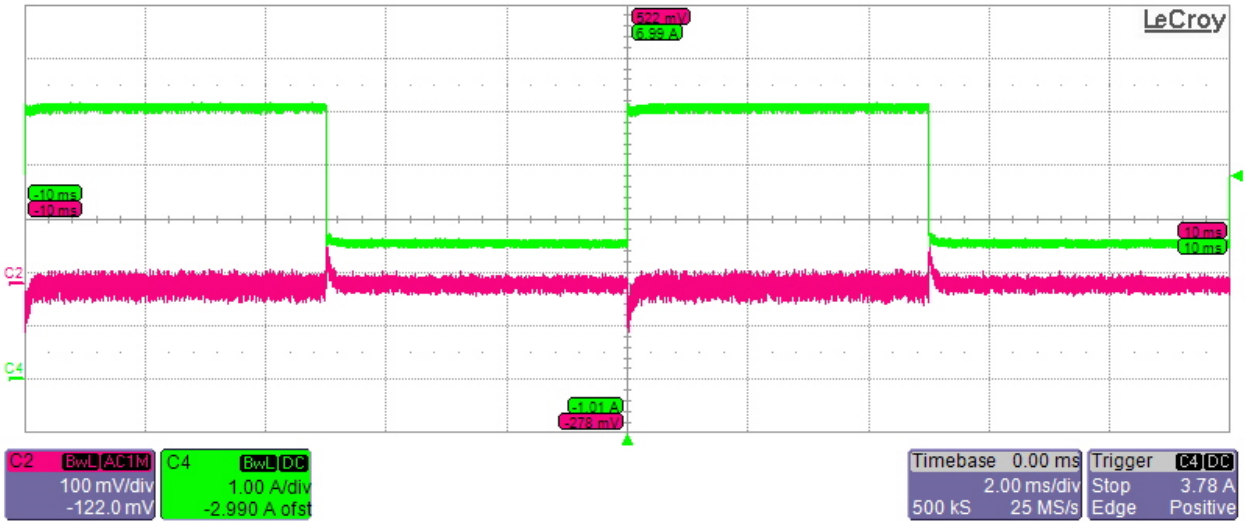
6.1.2 Dual Buck – Transient performance



Transient performance of 3.3V_Buck at Low Vin (5V) and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 3.3V_AC coupled

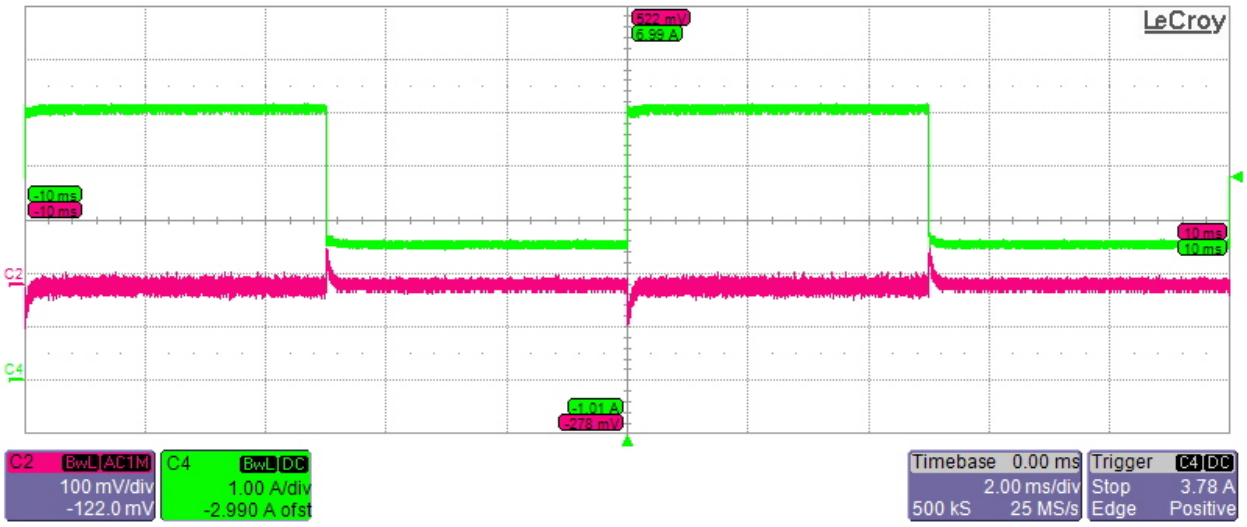
C4- 3.3V Load



Transient performance of 3.3V_Buck at 6V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 3.3V_AC coupled

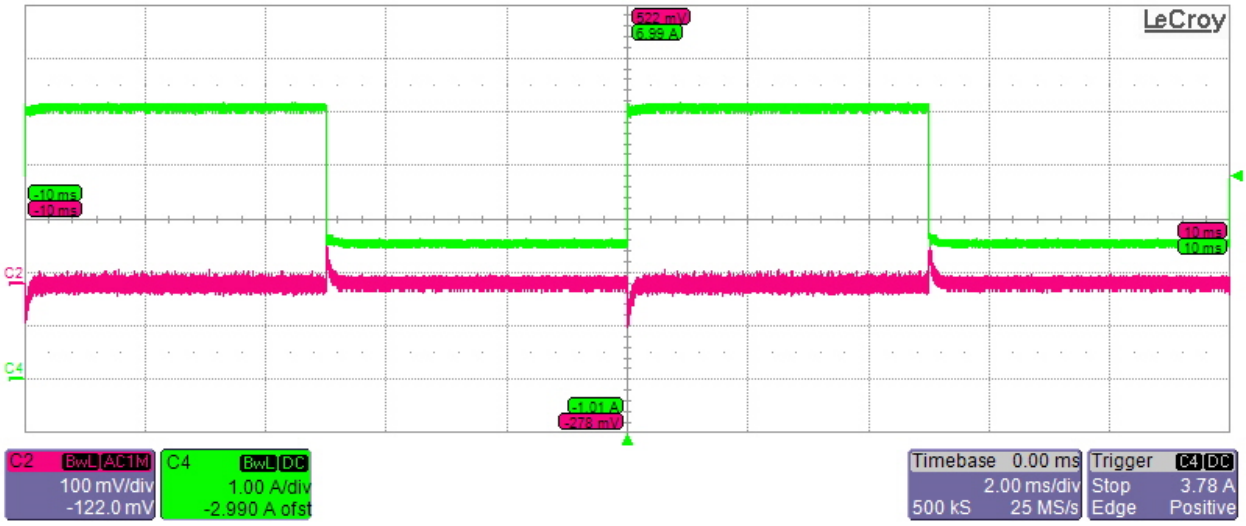
C4- 3.3V Load



Transient performance of 3.3V_Buck at 8V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 3.3V_AC coupled

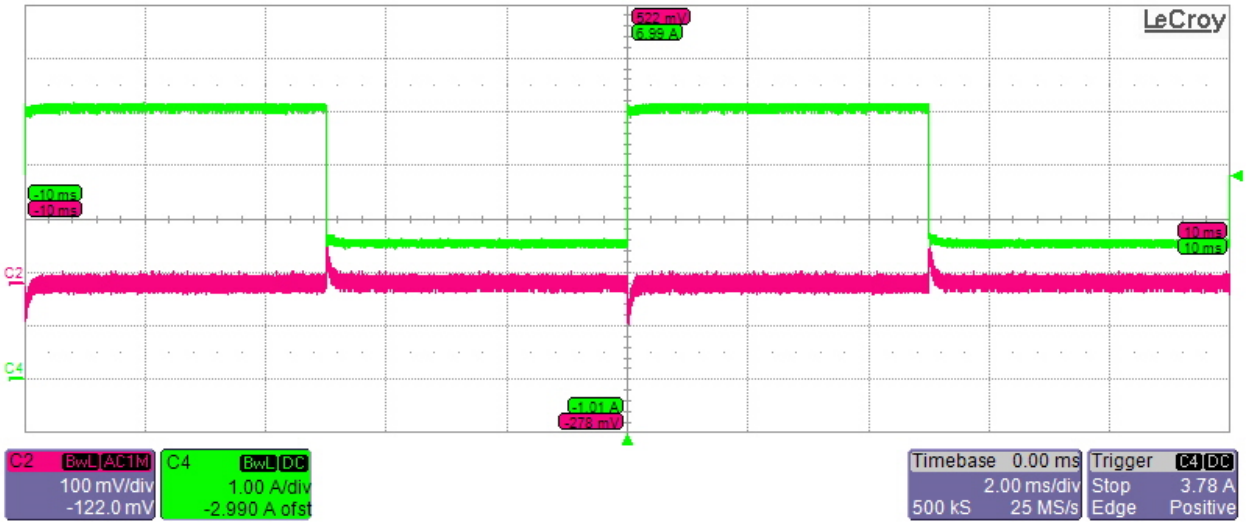
C4- 3.3V Load



Transient performance of 3.3V_Buck at 12V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 3.3V_AC coupled

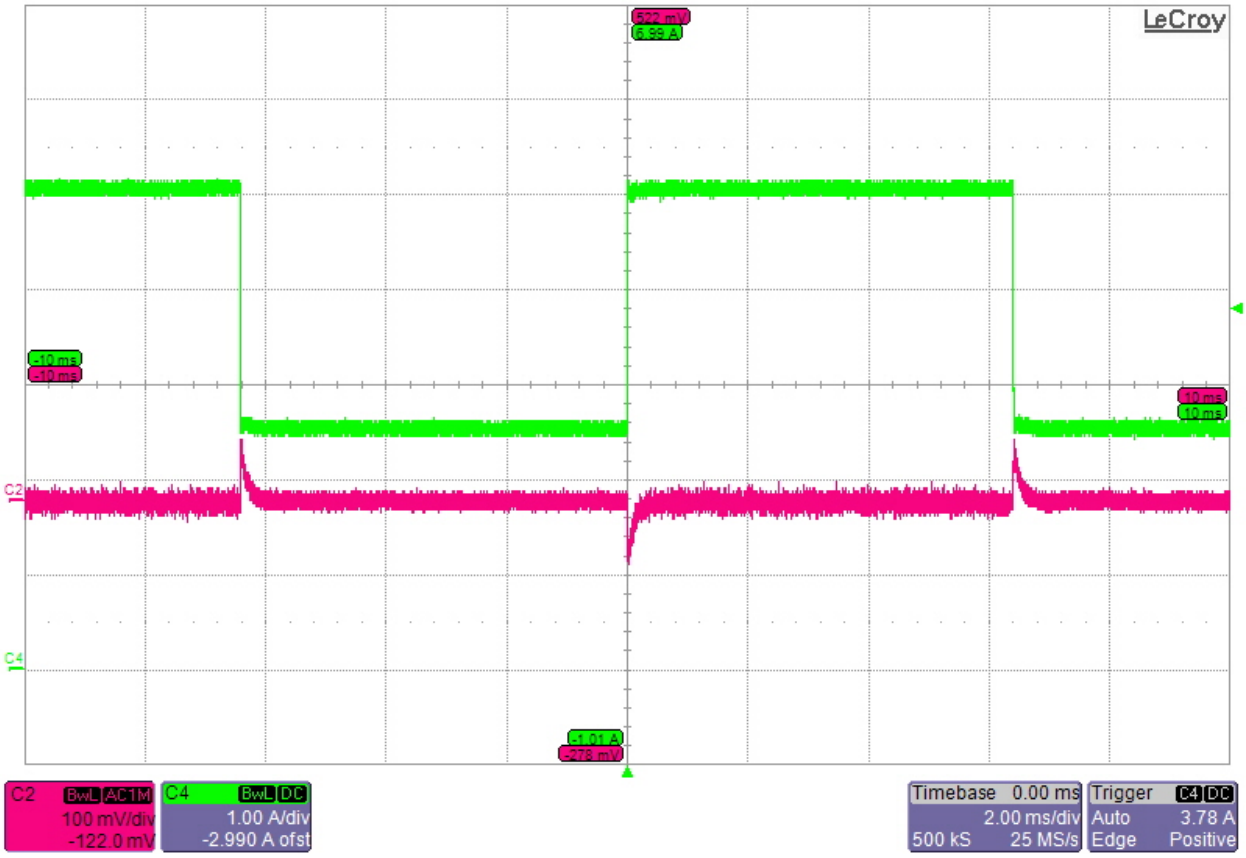
C4- 3.3V Load



Transient performance of 3.3V_Buck at 18V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 3.3V_AC coupled

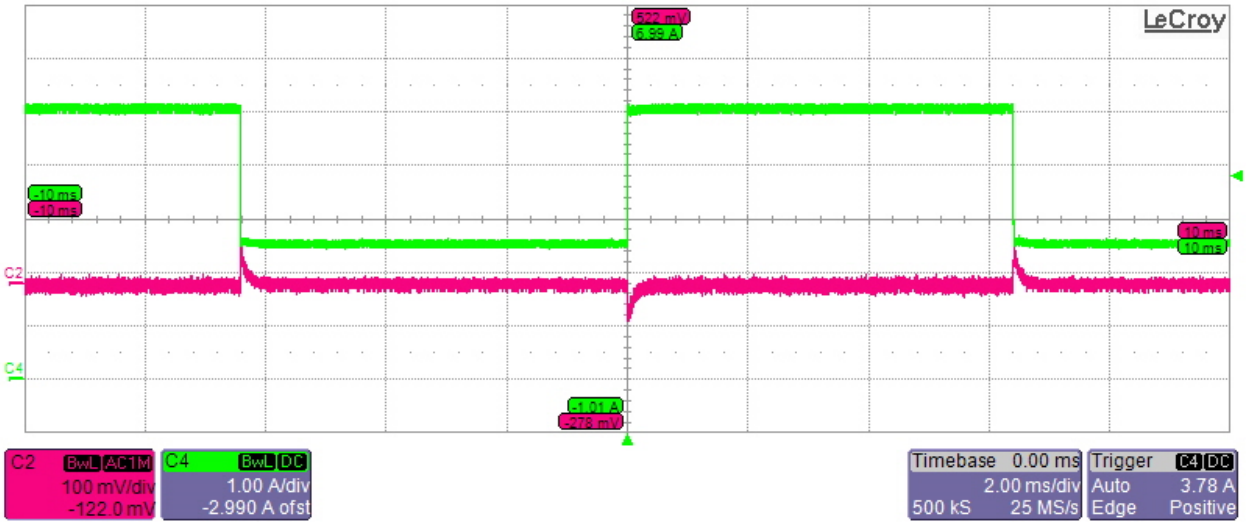
C4- 3.3V Load



Transient performance of 5V_Buck at 12V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 5V_AC coupled

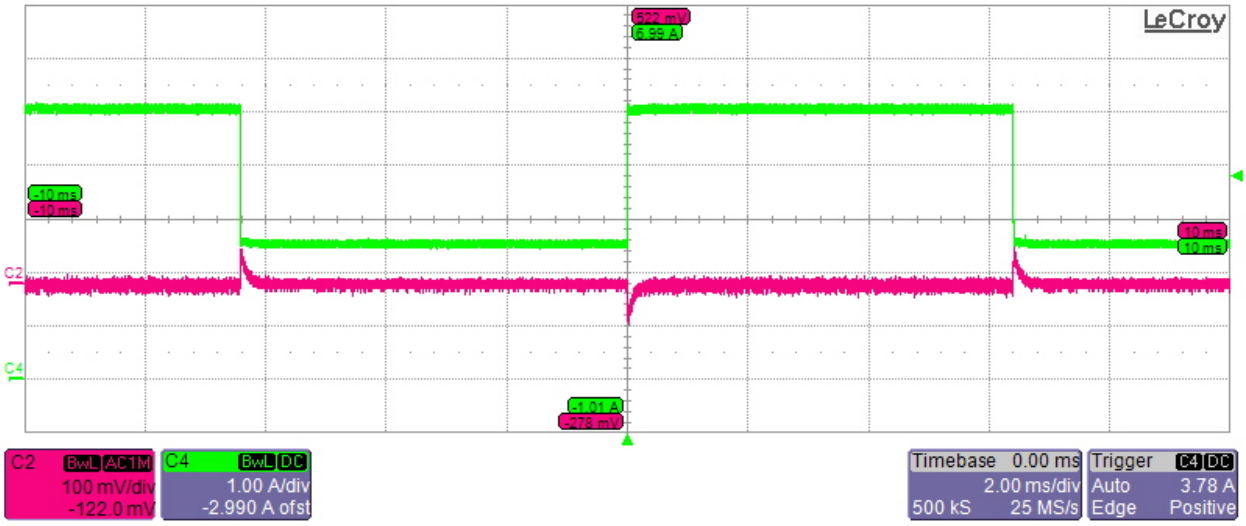
C4- 5V Load



Transient performance of 5V_Buck at 18V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 5V_AC coupled

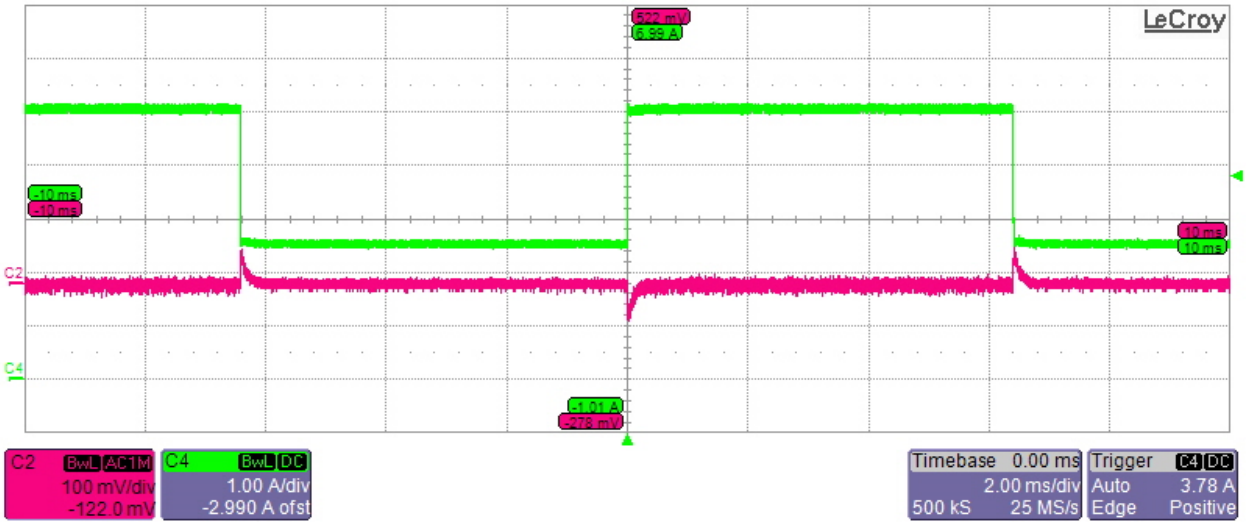
C4- 5V Load



Transient performance of 5V_Buck at 8V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 5V_AC coupled

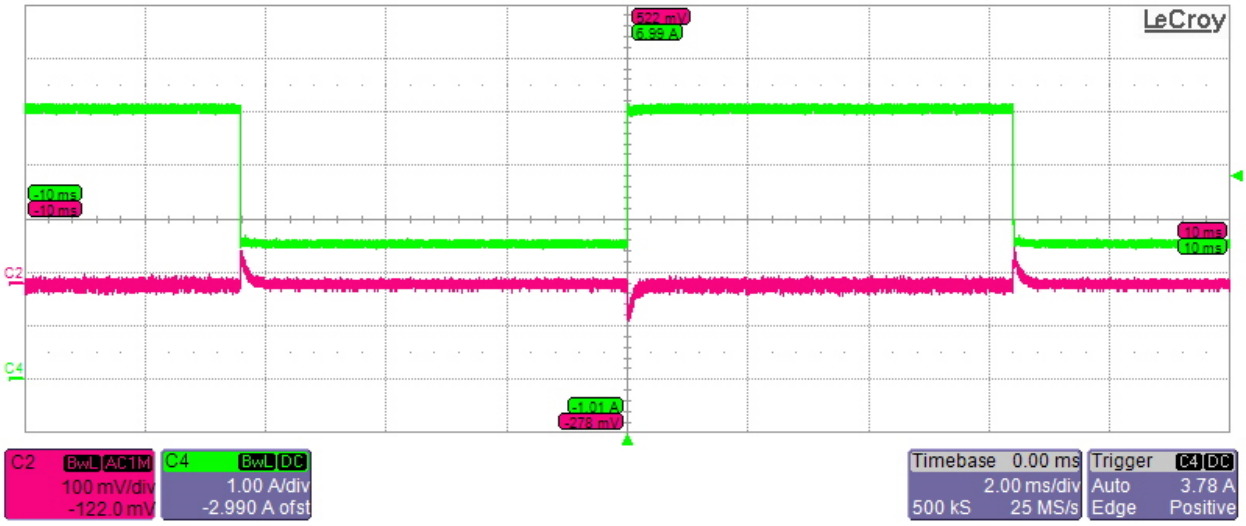
C4- 5V Load



Transient performance of 5V_Buck at 6V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 5V_AC coupled

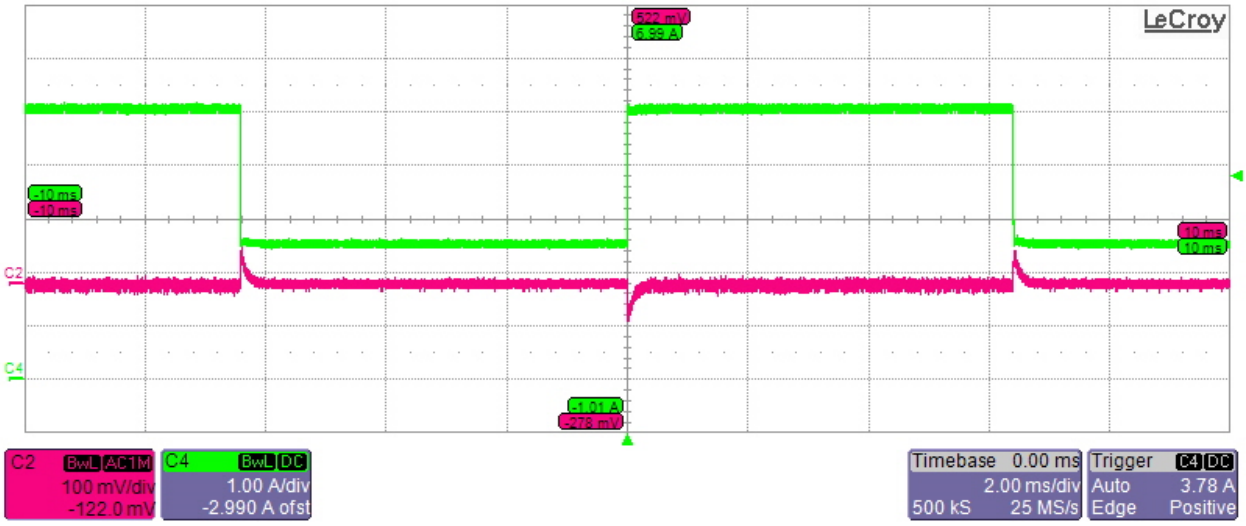
C4- 5V Load



Transient performance of 5V_Buck at 4.5V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 5V_AC coupled

C4- 5V Load



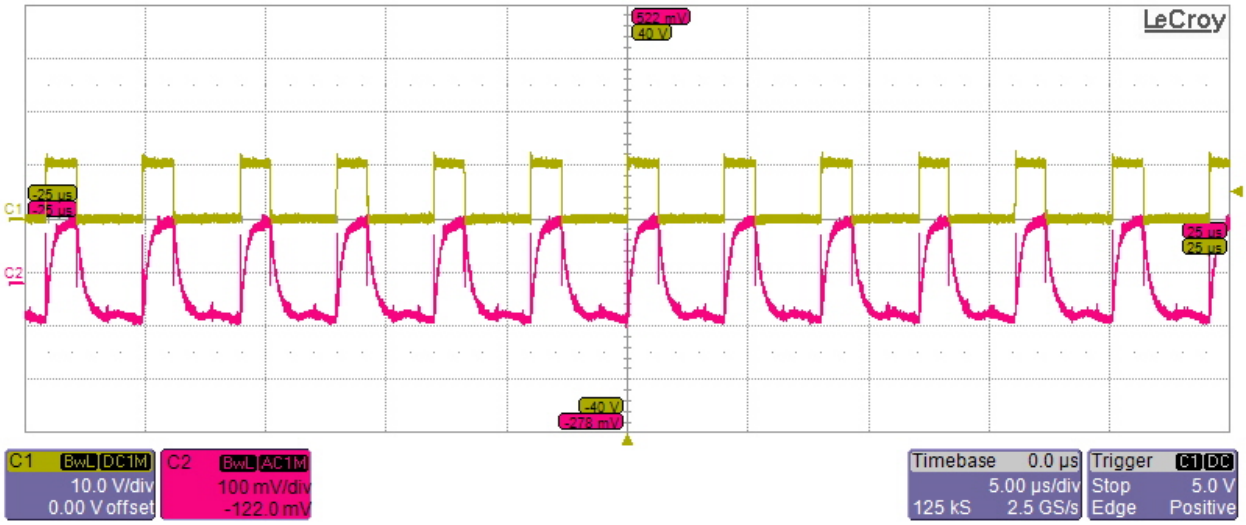
Transient performance of 5V_Buck at 3.5V and 2.5A to 5A Current transient (No Load on Other buck output)

C2- 5V_AC coupled

C4- 5V Load

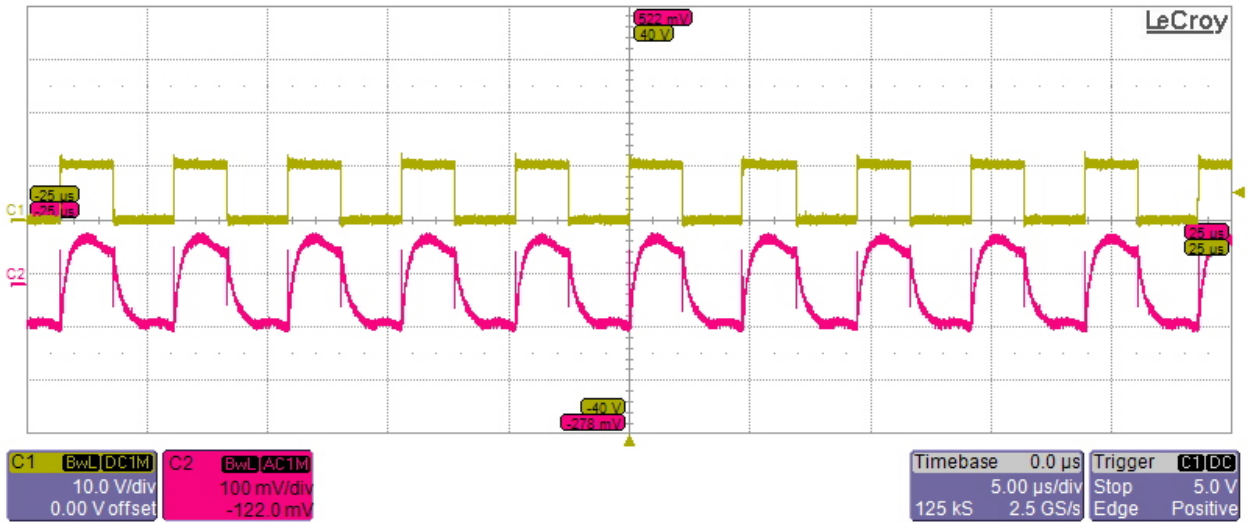
6.2 Output Voltage ripple Waveforms

6.2.1 Boost-Output Voltage ripple



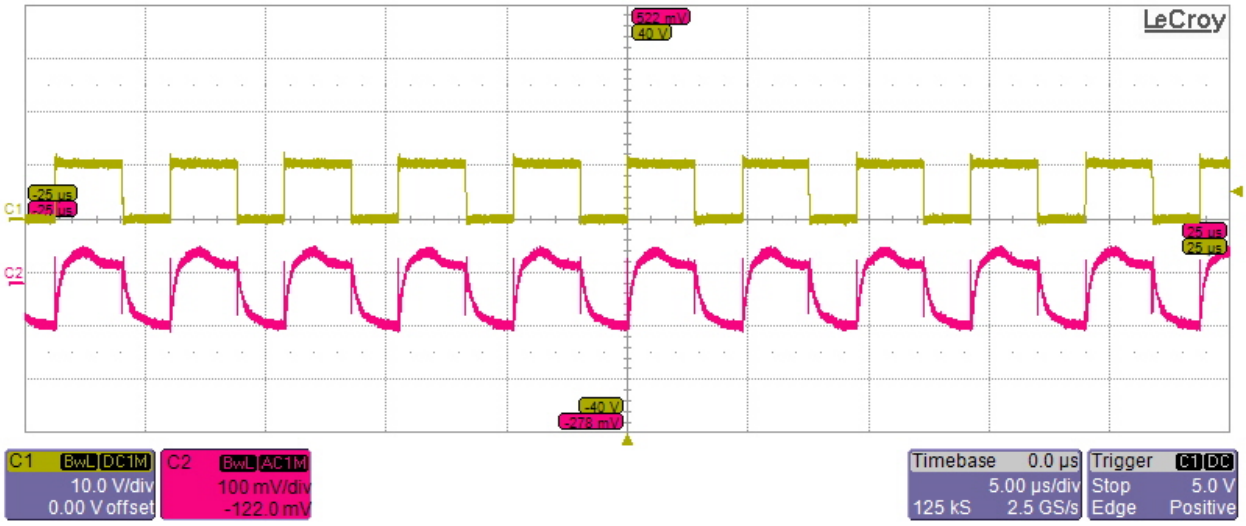
Ch2- 10V Ripple at 3.5Vin and 5A Load

Ch1-Switch Node 10V Boost



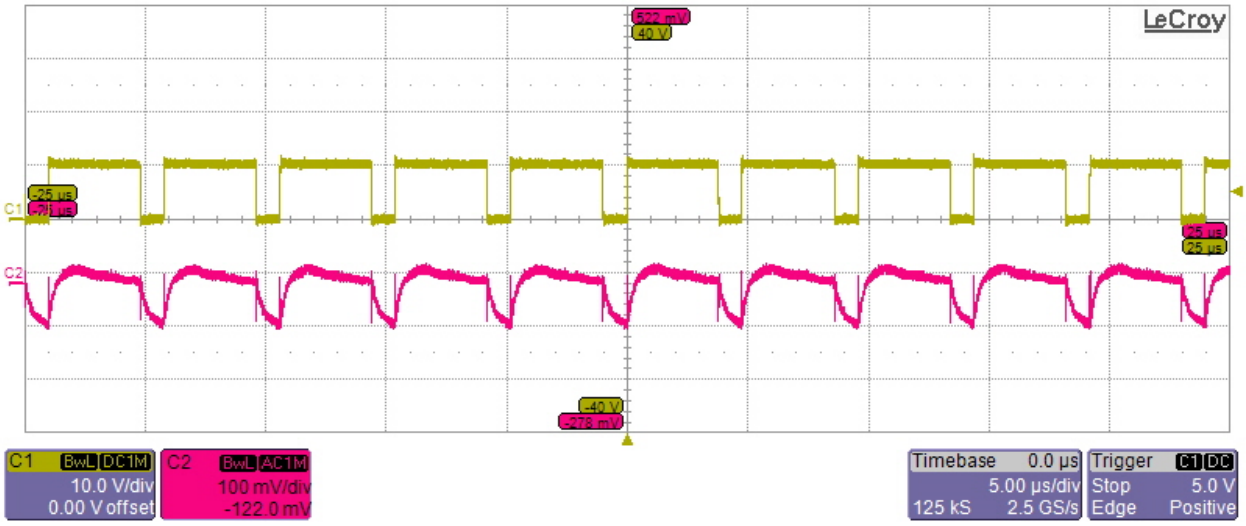
Ch2- 10V Ripple at 5Vin and 5A Load

Ch1-Switch Node 10V Boost



Ch2- 10V Ripple at 6.8Vin and 5A Load

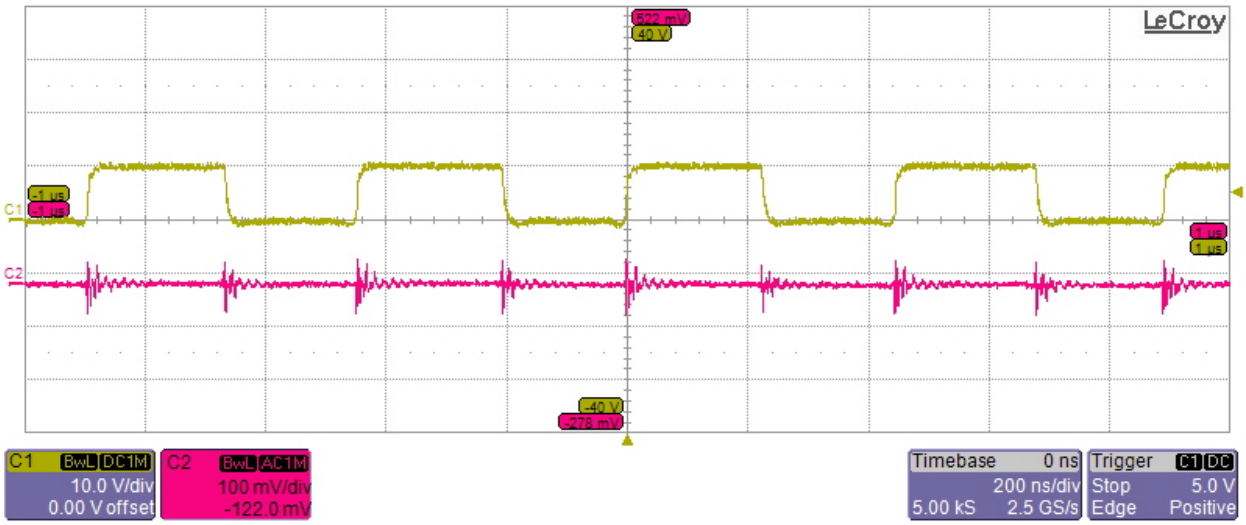
Ch1-Switch Node 10V Boost



Ch2- 10V Ripple at 8Vin and 5A Load

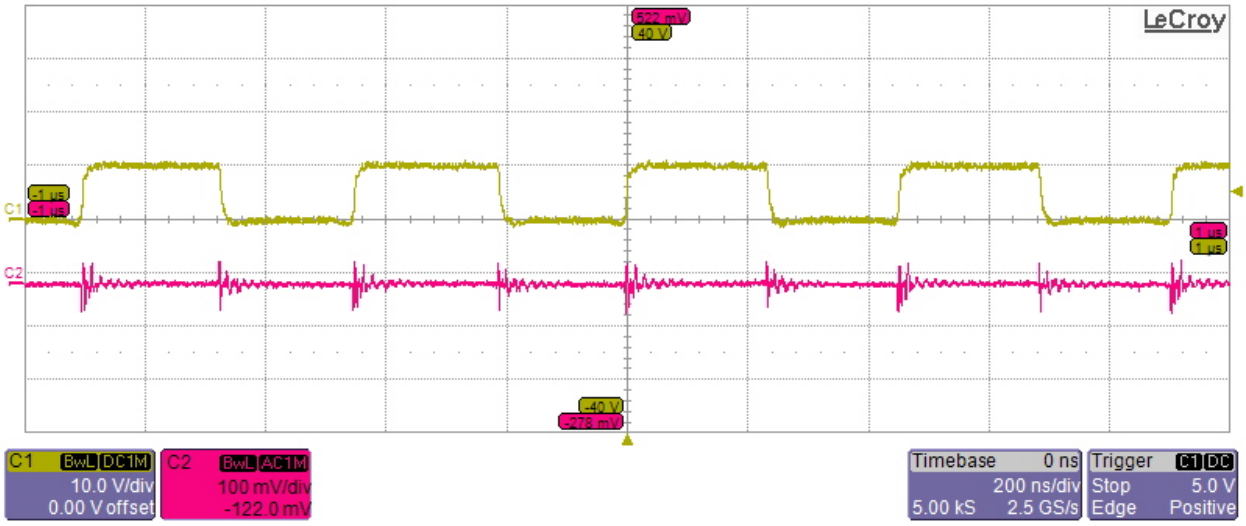
Ch1-Switch Node 10V Boost

6.2.2 Dual Buck -Output Voltage ripple



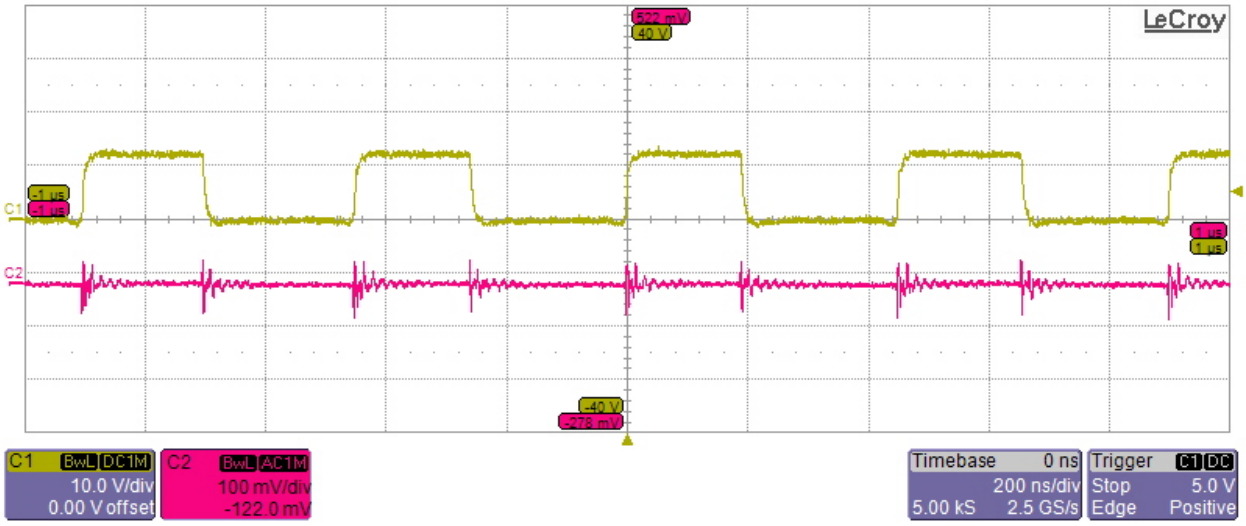
Ch2- 5V Ripple at 3.5 Vin and 5A Load

Ch1-Switch Node 5V Buck



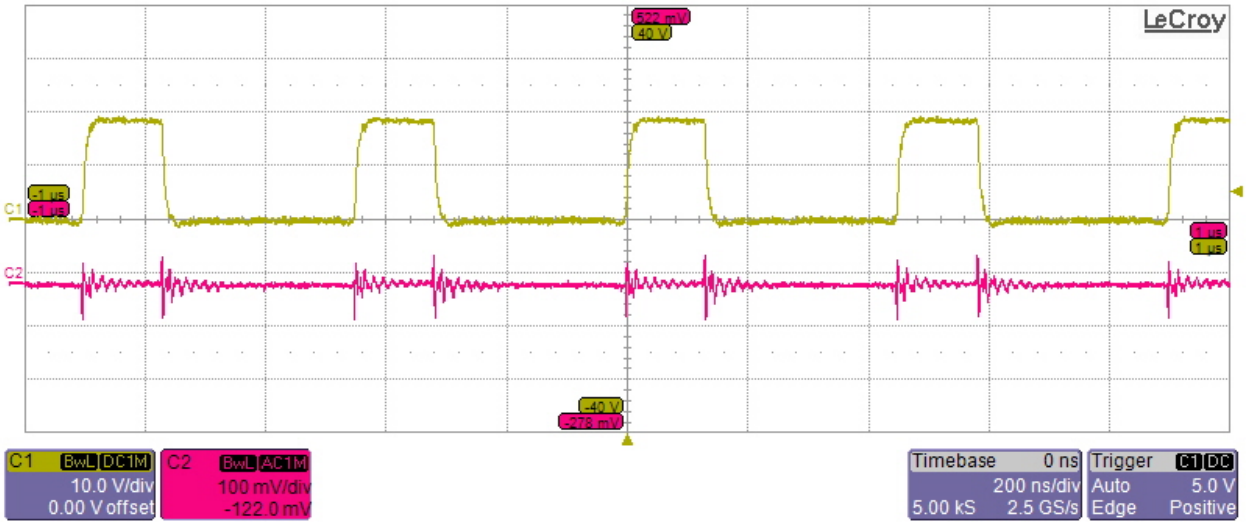
Ch2- 5V Ripple at 8 Vin and 5A Load

Ch1-Switch Node 5V Buck



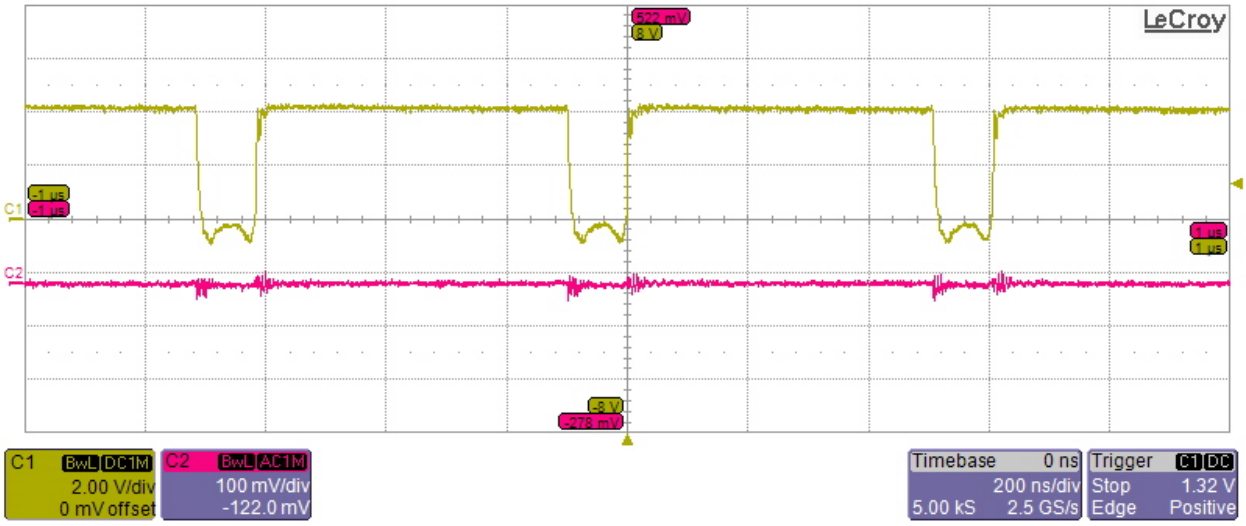
Ch2- 5V Ripple at 12 Vin and 5A Load

Ch1-Switch Node 5V Buck



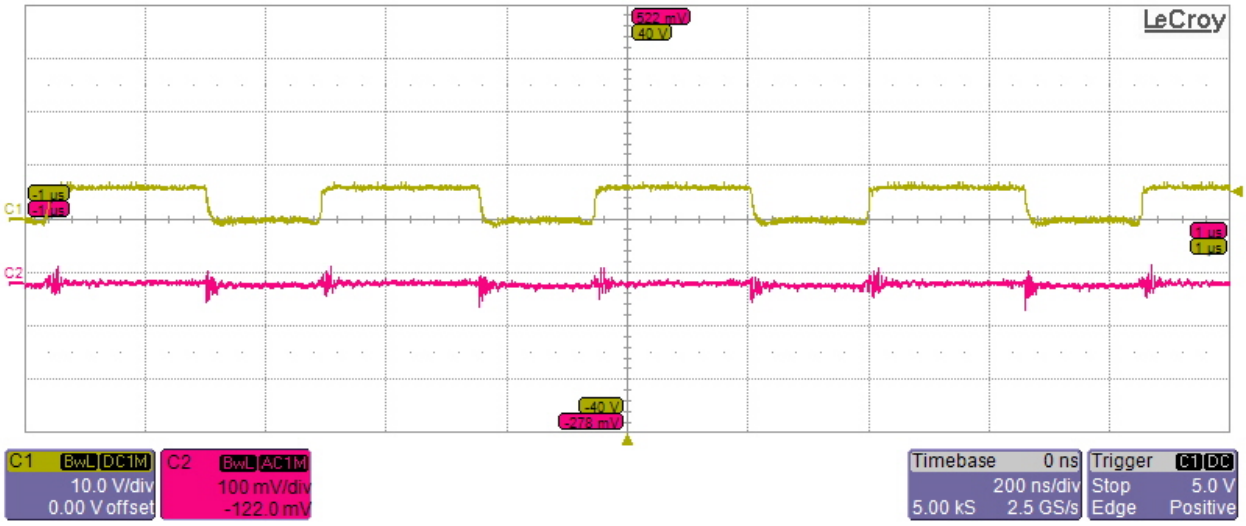
Ch2- 5V Ripple at 18 Vin and 5A Load

Ch1-Switch Node 5V Buck



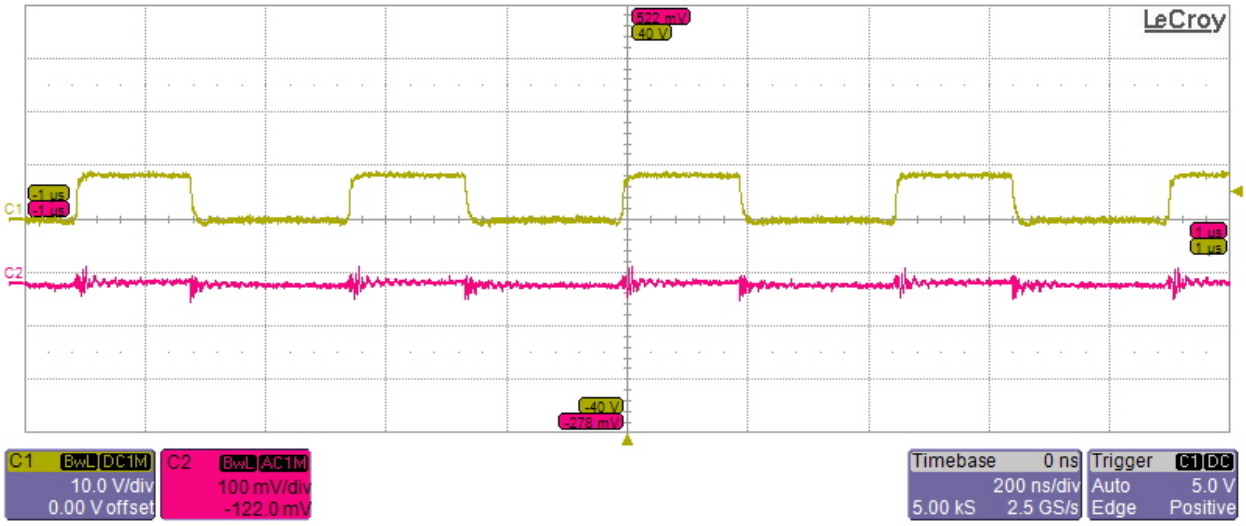
Ch2- 3.3V Ripple at 4.5 Vin and 5A Load

Ch1-Switch Node 3.3V Buck



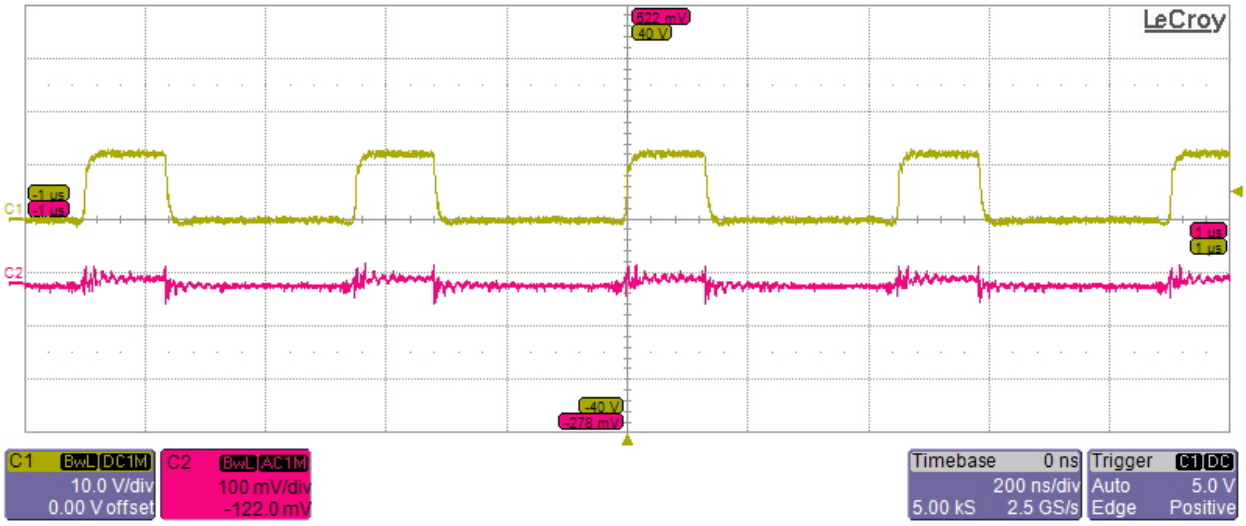
Ch2- 3.3V Ripple at 6Vin and 5A Load

Ch1-Switch Node 3.3V Buck



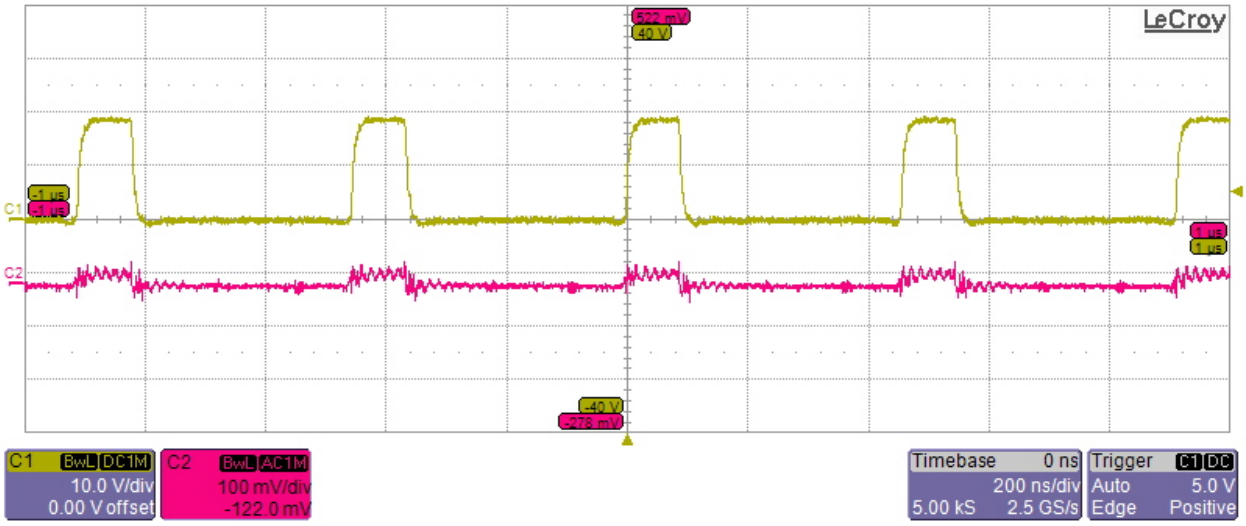
Ch2- 3.3V Ripple at 8 Vin and 5A Load

Ch1-Switch Node 3.3V Buck



Ch2- 3.3V Ripple at 12 Vin and 5A Load

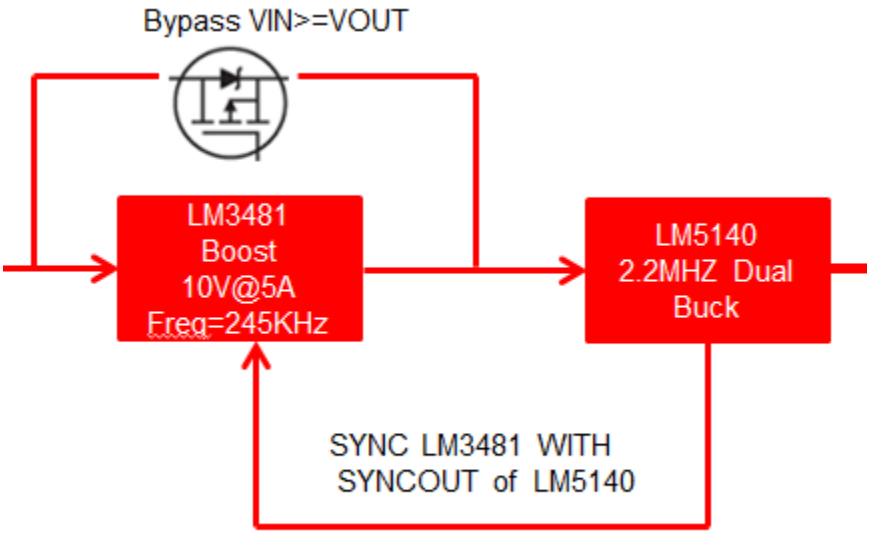
Ch1-Switch Node 3.3V Buck

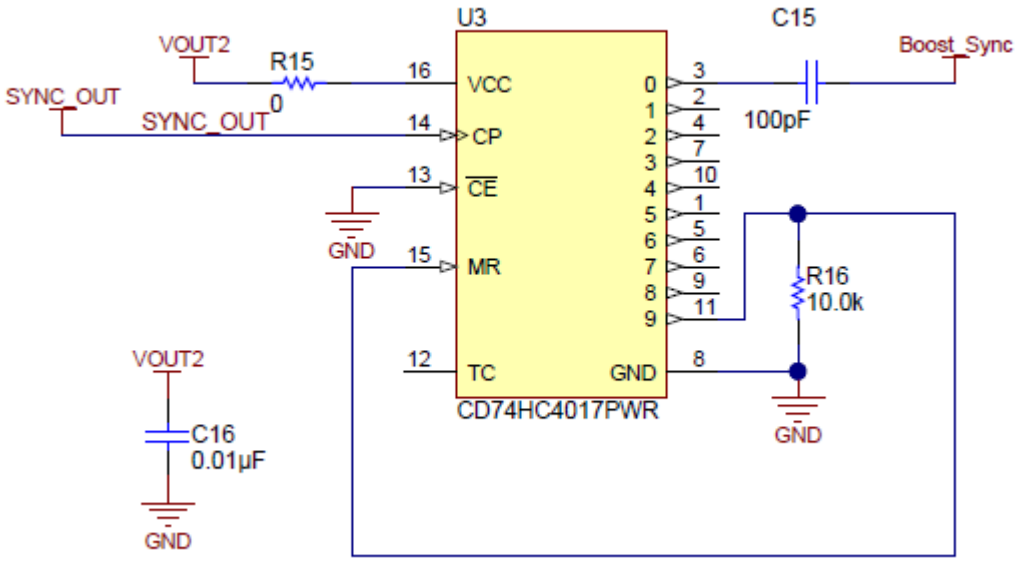


Ch2- 3.3V Ripple at 18 Vin and 5A Load

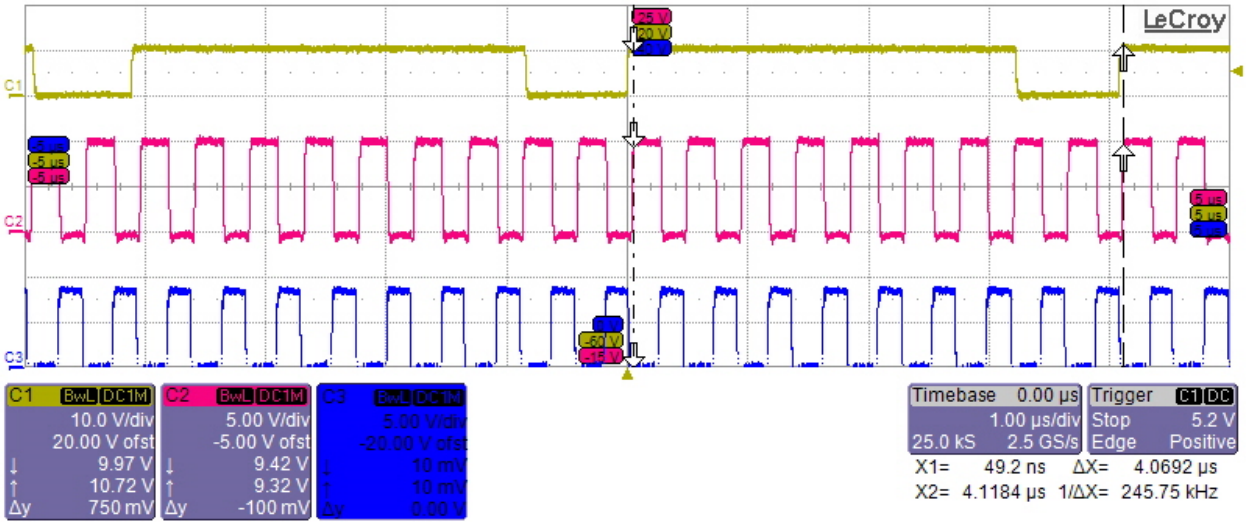
Ch1-Switch Node 3.3V Buck

7. Synchronization – Boost and Buck Controllers





Buck SYNC_OUT used to synchronize Boost controller at Freq/9 (divide/9through counter)

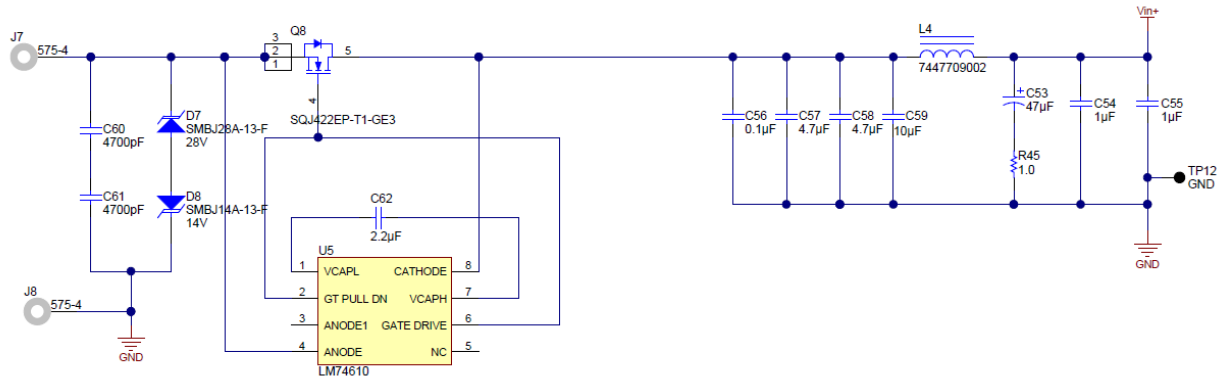


C2 – 5V Switch node at 8Vin and 5A Load

C3- 3.3V Switch node at 8Vin and 5A Load

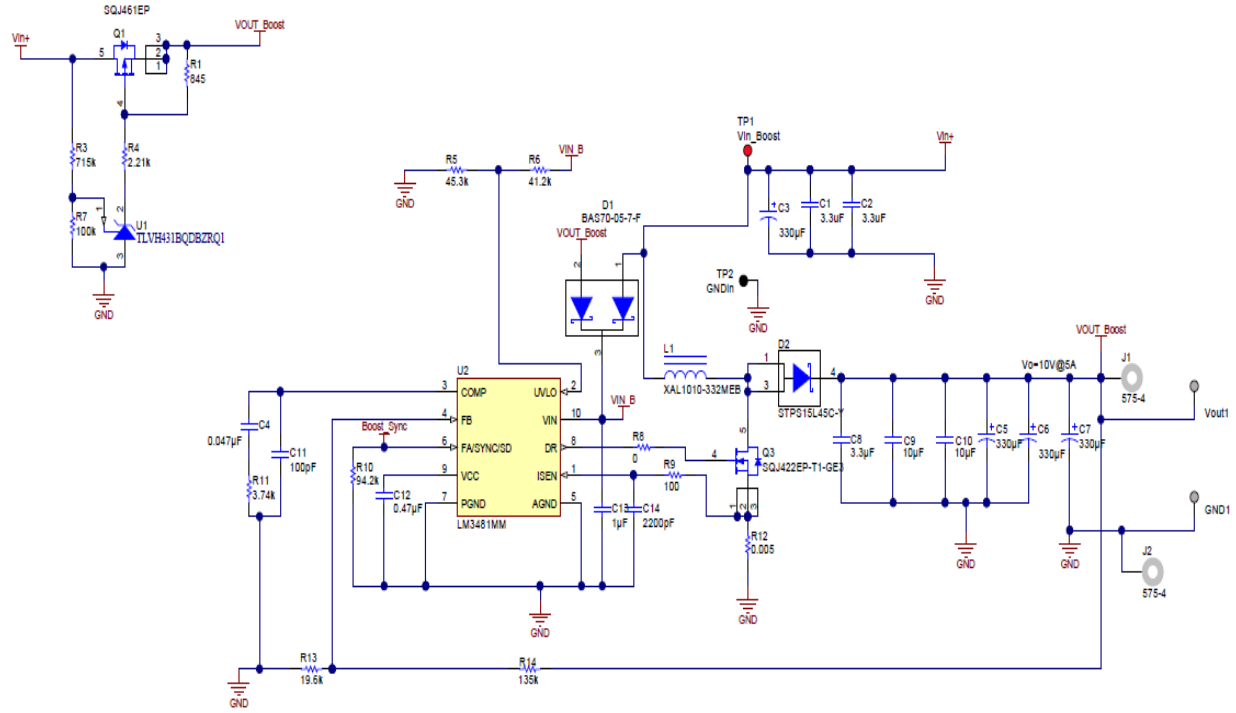
C1- 10V Pre Boost Switch Node at 8Vin

8. Smart diode –Front End Reverse Protection



It is designed to drive an external MOSFET to emulate an ideal diode when connected in series with a power source. A unique advantage of this scheme is that it is not referenced to ground and thus has Zero Iq.

9. Boost Bypass- PFET



So When Vin>10.5 V , Boost is bypassed through PFET .

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