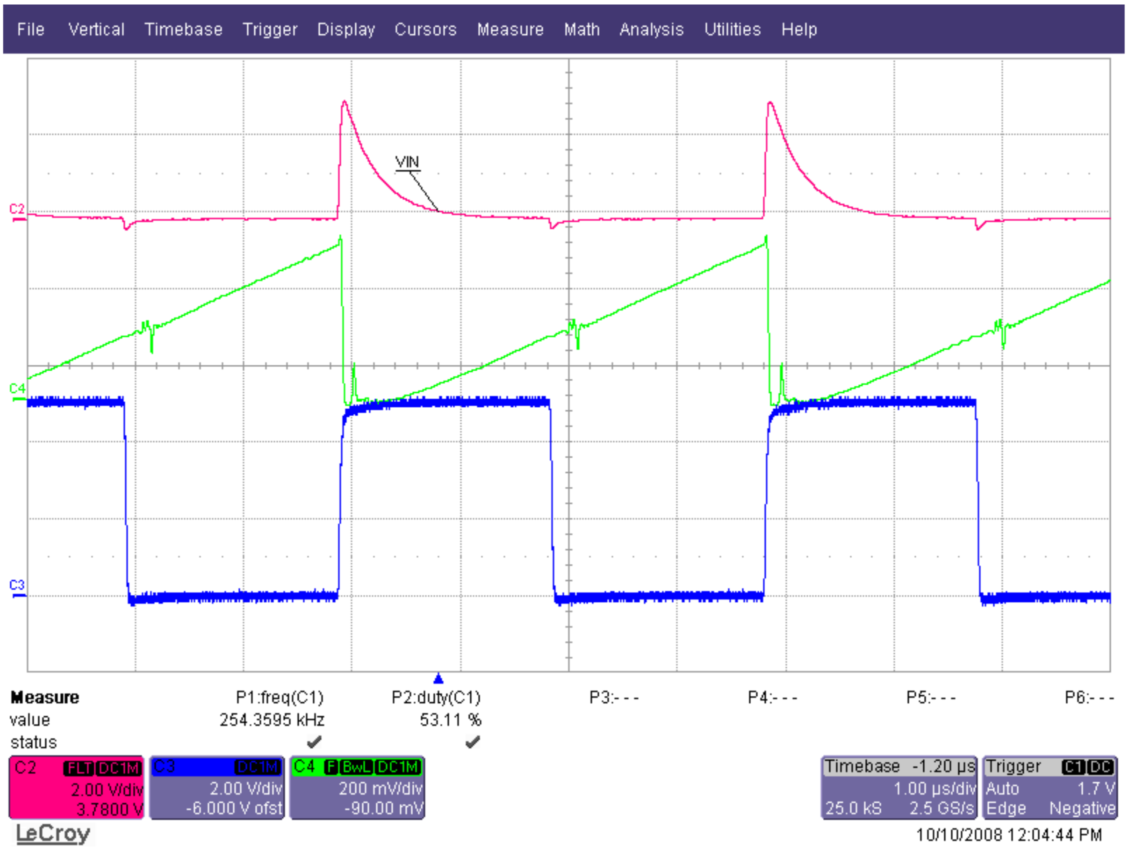
1 Main Waveforms

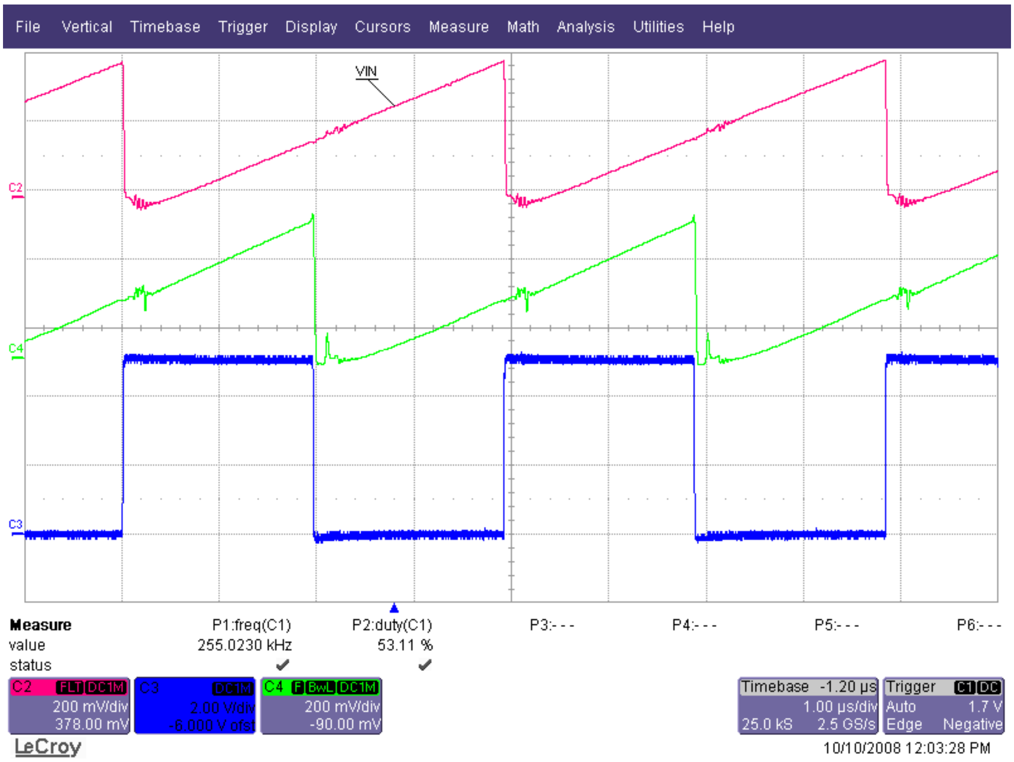
The converter is operating sharing (mostly measured by Current sense Signals) equally the currents between the two boost converters, the Master and the Slave. An indirect indication of the quality of current sharing between the two boost is also given by the thermal analysis data provided in the following.
The current sharing happens down to very low values of the converter output current (total of the two boosts) where in deep discontinuous mode (Iout<0.35A) only the Slave boost is conducting.

The following pictures show the main waveforms of the Synchronizing Circuit and of the Power Stage. Synchronized (U3) Switching frequency is fs=260kHz (unsynchronized frequency of U1 and U2 is 200kHz).

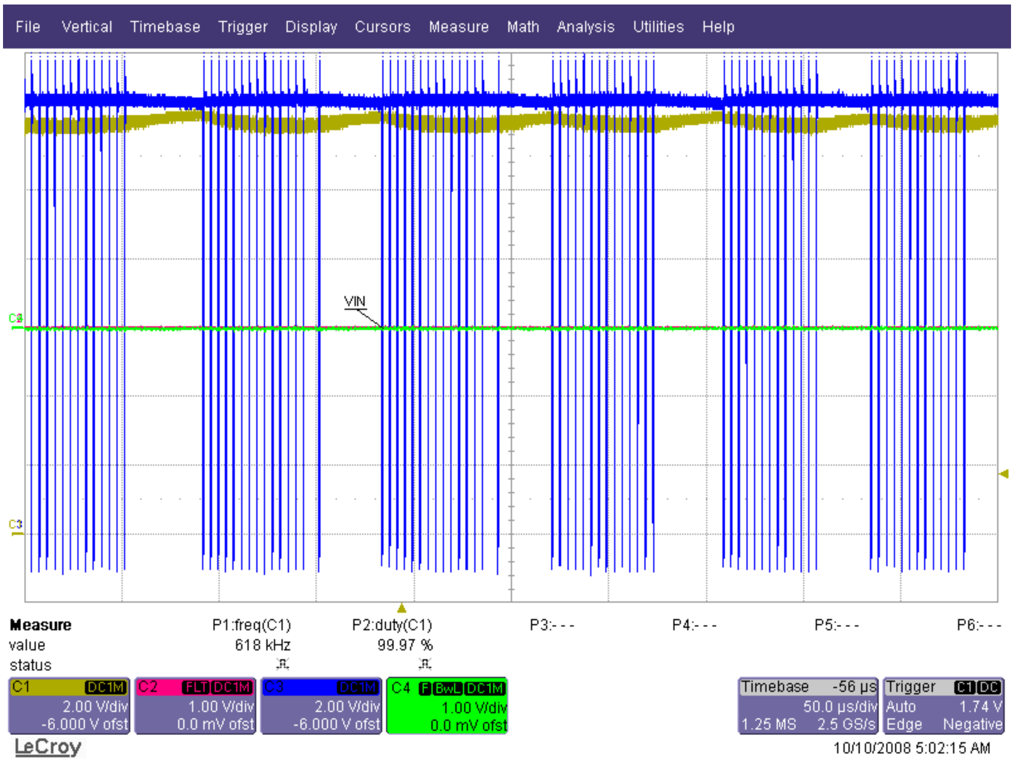
At full Load, 15A, Duty cycle is D=50% at 6.5V input, D=30% at 9V input, D=7% at 12V.



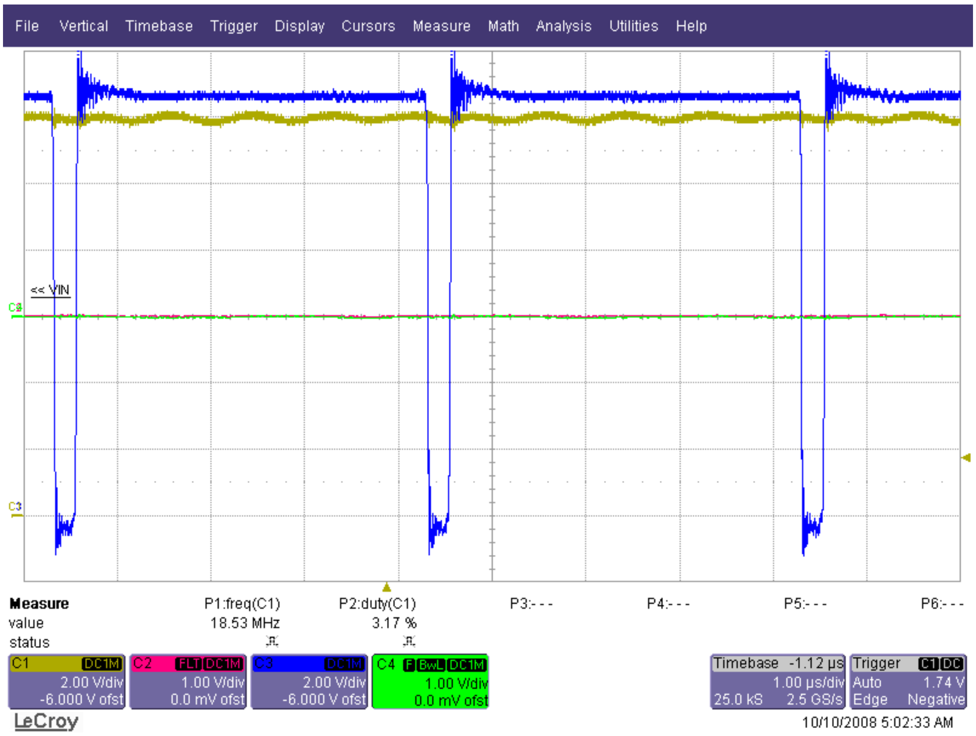
Synchronization Circuit 1: Out U3-TLC555D (C3), Gate of Q4 (C2), Synch_Master signal (C4)



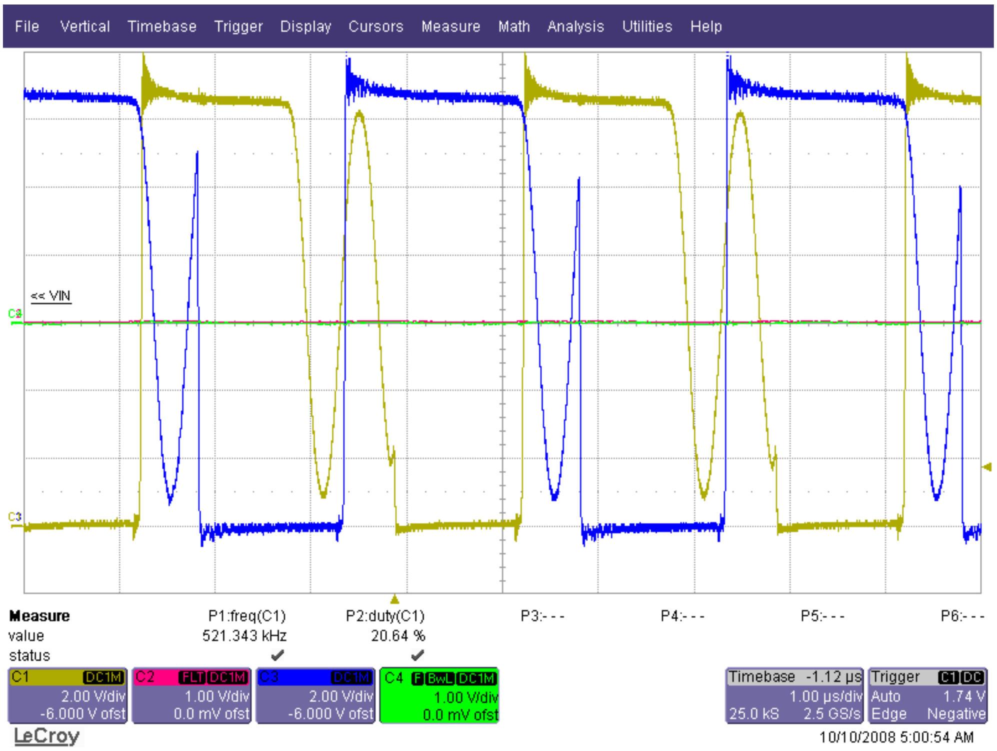
Synchronization Circuit 2: Out U3-TLC555D (C3), Synch_Master signal (C4), Synch Slave (C2)



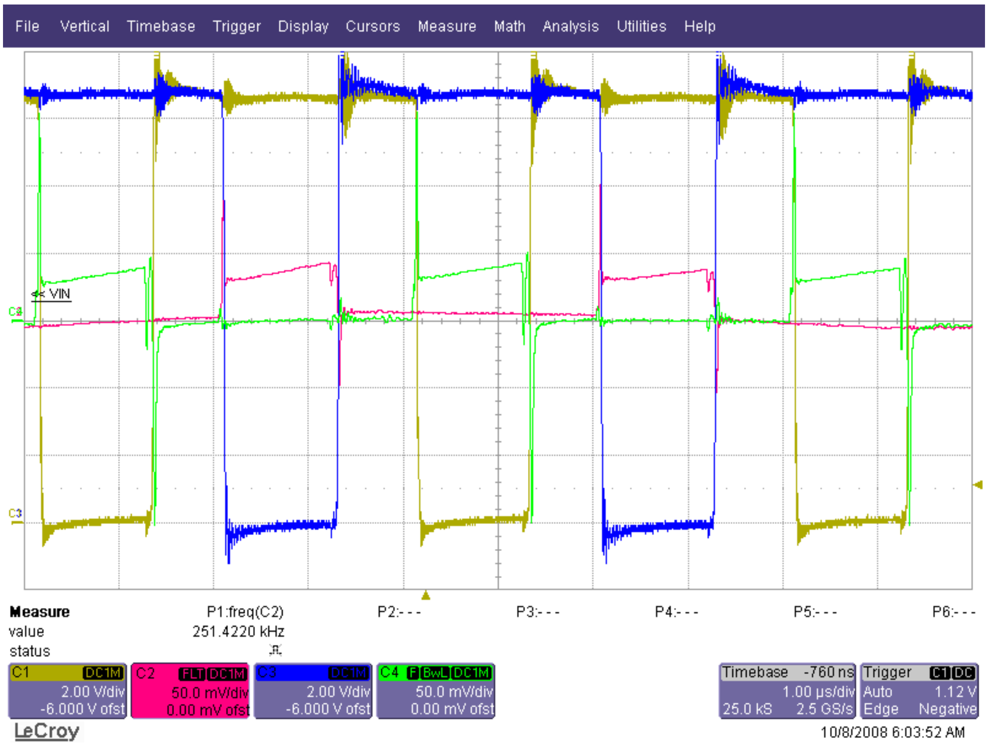
Current Sharing 1 (Iout<0.35A) : VdsQ1 (C1, yellow), VdsQ2 (C3, blue), in deep discontinuous mode/burst mode only on slave boost (Q2)



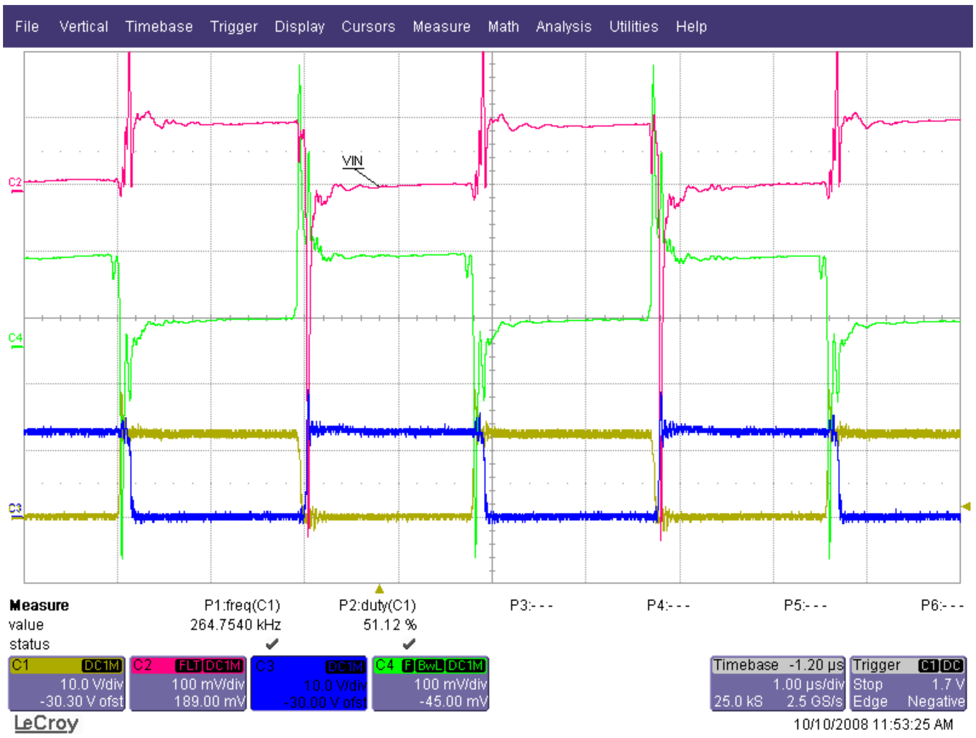
Current Sharing 2 (Iout<0.35A) : VdsQ1 (C1, yellow), VdsQ2 (C3, blue), in deep discontinuous mode/burst mode only on slave boost (Q2)



Current Sharing 3 (Iout=1A) : VdsQ1 (C1, yellow), VdsQ2 (C3, blue), in discontinuous mode with both master and slave conducting



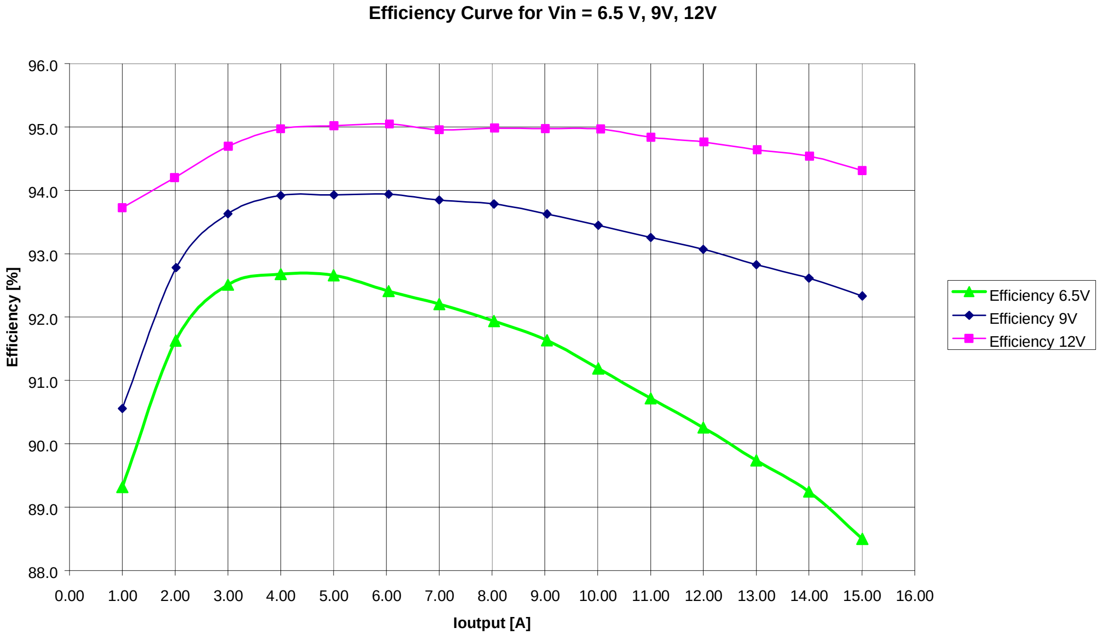
Current Sharing 4 (Vin=9V Iout=5A): VdsQ1 (C1, yellow), VdsQ2 (C3, blue), Vsense Q1 (C4, green), Vsense Q2 (C2, purple)



Current Sharing 5 (Vin=6.5V Iout=10A) : VdsQ1 (C1, yellow), VdsQ2 (C3, blue), Vsense Q1 (C4, green), Vsense Q2 (C2, purple)

2 Efficiency and Load Regulation

The efficiency diagrams are shown in the figure below for 6.5V, 9V, 12V input voltage, as a function of the output current.



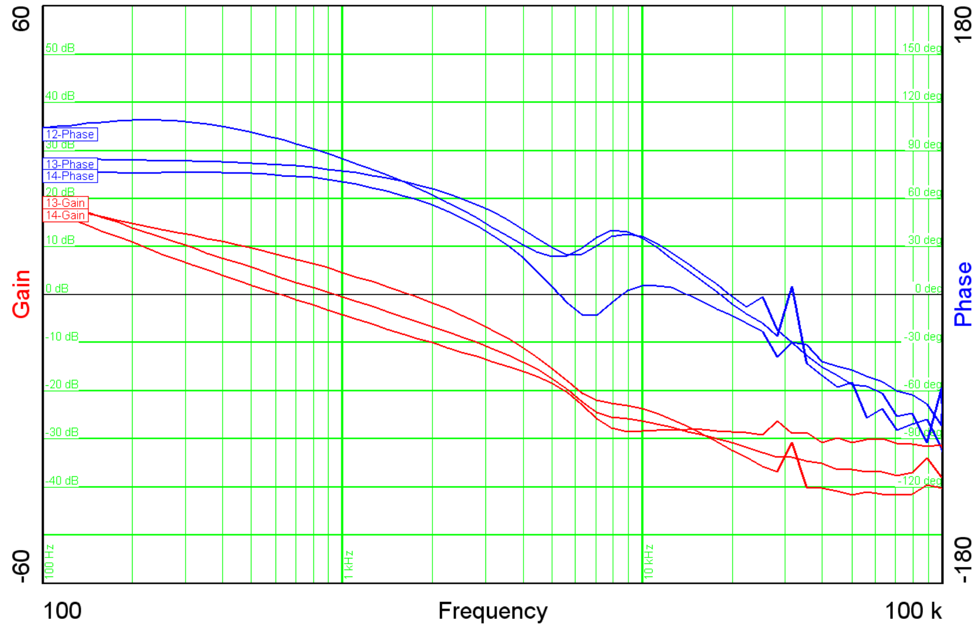
The following table shows the measured values:

Vin[V]	Iin[mA]	Vout1[V]	Iout1[mA]	Pin[W]	Pout2[W]	η%
6.558	2.10	**12.30**	**1.00**	13.772	12.300	**89.3**
6.549	4.12	**12.30**	**2.01**	26.982	24.723	**91.6**
6.539	6.10	**12.30**	**3.00**	39.888	36.900	**92.5**
6.530	8.13	**12.30**	**4.00**	53.089	49.200	**92.7**
6.520	10.18	**12.30**	**5.00**	66.374	61.500	**92.7**
6.563	12.25	**12.30**	**6.04**	80.397	74.292	**92.4**
6.553	14.25	**12.30**	**7.00**	93.380	86.100	**92.2**
6.535	16.46	**12.30**	**8.04**	107.566	98.892	**91.9**
6.524	18.60	**12.30**	**9.04**	121.346	111.192	**91.6**
6.507	20.75	**12.30**	**10.01**	135.020	123.123	**91.2**
6.496	22.96	**12.30**	**11.00**	149.148	135.300	**90.7**
6.552	24.96	**12.30**	**12.00**	163.538	147.600	**90.3**
6.539	27.25	**12.30**	**13.00**	178.188	159.900	**89.7**
6.563	29.40	**12.30**	**14.00**	192.952	172.200	**89.2**
6.550	31.85	**12.30**	**15.01**	208.618	184.623	**88.5**
9.116	1.49	**12.30**	**1.00**	13.583	12.300	**90.6**
9.109	2.94	**12.30**	**2.02**	26.780	24.846	**92.8**
9.102	4.33	**12.30**	**3.00**	39.412	36.900	**93.6**
9.095	5.76	**12.30**	**4.00**	52.387	49.200	**93.9**
9.087	7.22	**12.30**	**5.01**	65.608	61.623	**93.9**
9.080	8.71	**12.30**	**6.04**	79.087	74.292	**93.9**

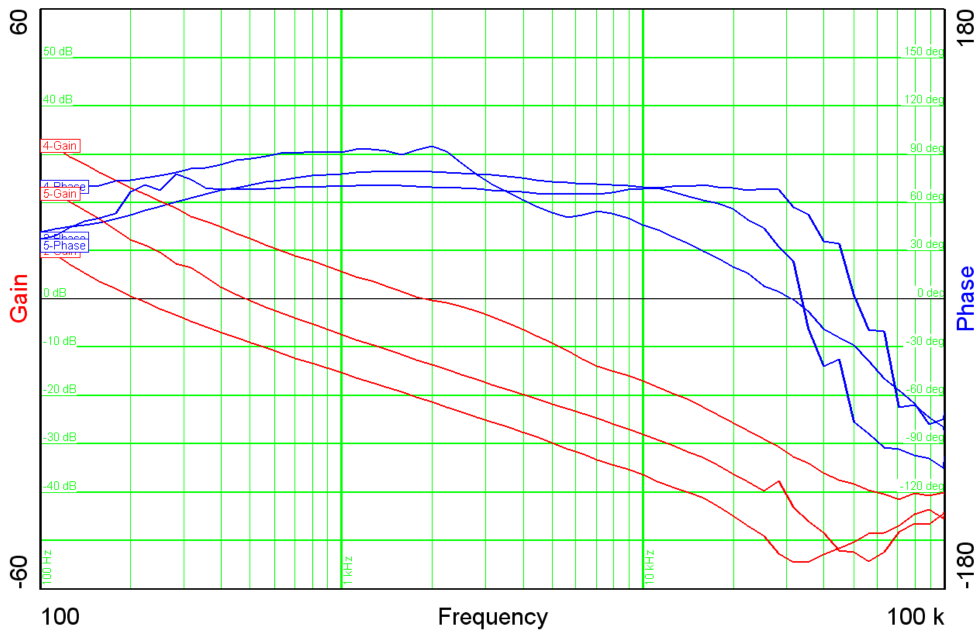
9.066	10.12	**12.30**	**7.00**	91.748	86.100	**93.8**
9.059	11.64	**12.30**	**8.04**	105.447	98.892	**93.8**
9.045	13.13	**12.30**	**9.04**	118.761	111.192	**93.6**
9.037	14.58	**12.30**	**10.01**	131.759	123.123	**93.4**
9.023	16.08	**12.30**	**11.00**	145.090	135.300	**93.3**
9.016	17.59	**12.30**	**12.00**	158.591	147.600	**93.1**
9.033	19.07	**12.30**	**13.00**	172.259	159.900	**92.8**
9.026	20.60	**12.30**	**14.00**	185.936	172.200	**92.6**
9.093	21.99	**12.30**	**15.01**	199.955	184.623	**92.3**
12.040	1.09	**12.30**	**1.00**	13.124	12.300	**93.7**
12.030	2.16	**12.30**	**1.99**	25.985	24.477	**94.2**
12.030	3.25	**12.30**	**3.01**	39.098	37.023	**94.7**
12.020	4.31	**12.30**	**4.00**	51.806	49.200	**95.0**
12.010	5.40	**12.30**	**5.01**	64.854	61.623	**95.0**
12.010	6.53	**12.30**	**6.06**	78.425	74.538	**95.0**
12.010	7.55	**12.30**	**7.00**	90.676	86.100	**95.0**
12.010	8.68	**12.30**	**8.05**	104.247	99.015	**95.0**
12.030	9.70	**12.30**	**9.01**	116.691	110.823	**95.0**
12.020	10.84	**12.30**	**10.06**	130.297	123.738	**95.0**
12.020	11.88	**12.30**	**11.01**	142.798	135.423	**94.8**
12.010	12.98	**12.30**	**12.01**	155.890	147.723	**94.8**
12.010	14.09	**12.30**	**13.02**	169.221	160.146	**94.6**
12.000	15.19	**12.30**	**14.01**	182.280	172.323	**94.5**
12.010	16.30	**12.30**	**15.01**	195.763	184.623	**94.3**

3 Control Loop Frequency Response

The figures below show the open loop response for 6.5V, 9V, 12V input voltage:



Vin=6.5V (14-Gain and Phase), Vin=9V (13-Gain and Phase), Vin=12V (12-Gain and Phase) @ 15A Output



Vin=6.5V (2-Gain and Phase), Vin=9V (5-Gain and Phase), Vin=12V (4-Gain and Phase) @ Discontinuous Mode (no load)

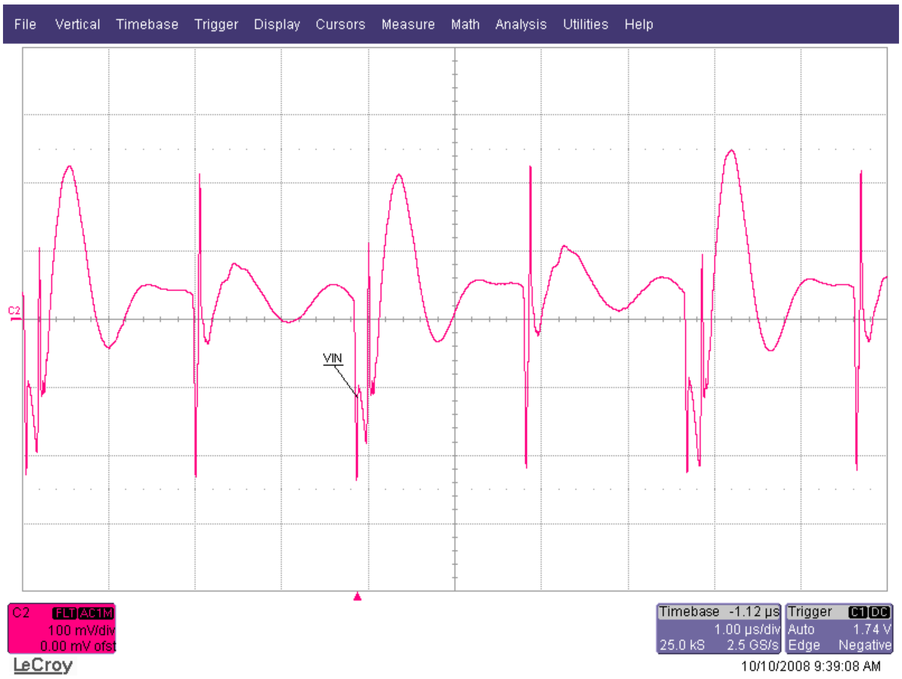
4 Load Transients

The figure below show the response to load transients. The current on the Output is stepping from 2 A to full load 15A load and viceversa, with Vin=6.5V.

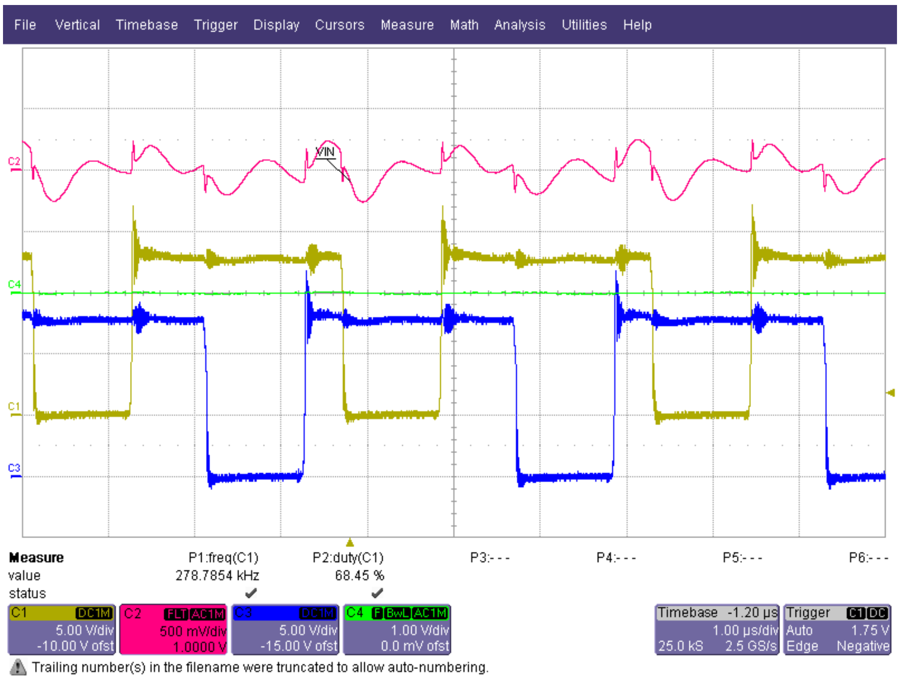
Vout (C2), Iout (C4, 10A/V current probe)

5 Output and Input Ripple Voltage

The output ripple voltage is shown in the figures below:

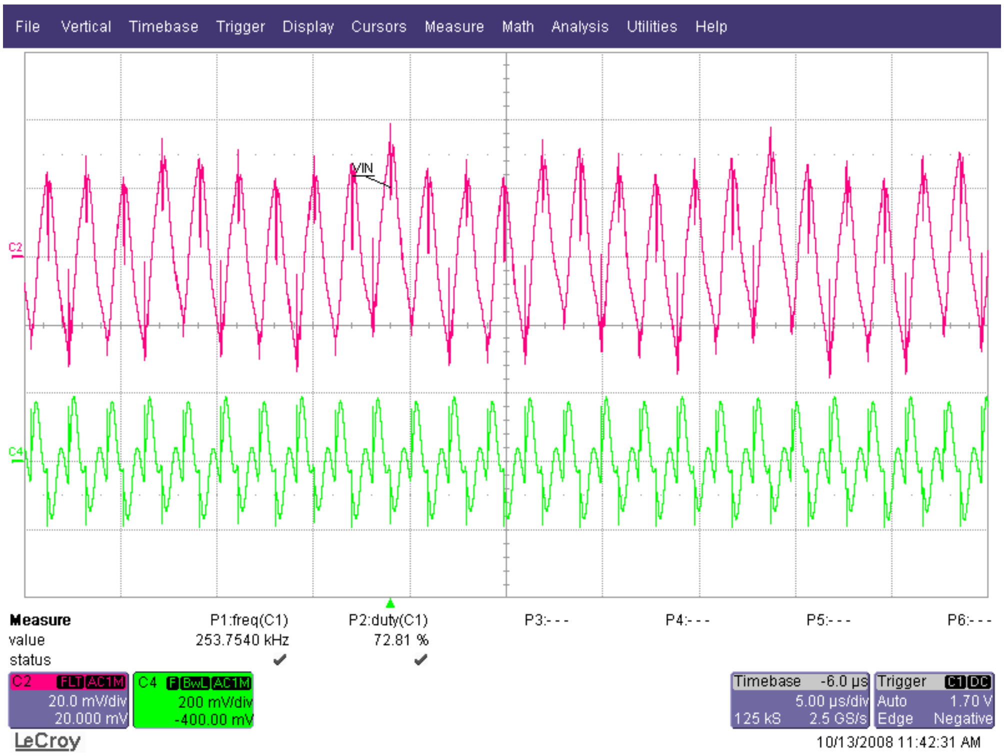


Output Voltage Ripple at full load 15A @ Vin=6.5V



Output Voltage Ripple at full load 15A @ Vin=9V (C2), Vds Q1 (C1) and VdcQ2 (C3)

Input Voltage Ripple (C2), Output Voltage Ripple (C4) at full load 15A @ Vin=6.5V



Input Voltage Ripple (C2), Output Voltage Ripple (C4) at full load 15A @ Vin=9V

6 Thermal Images

The thermal images of board in different input and load conditions are shown in the following.
In every picture the hottest spot is indicated, together with the temperature of the most significant components.

Several conditions of output load have been tested, for the three selected input voltage, to check for maximum operating temperature that could be hold by the board:

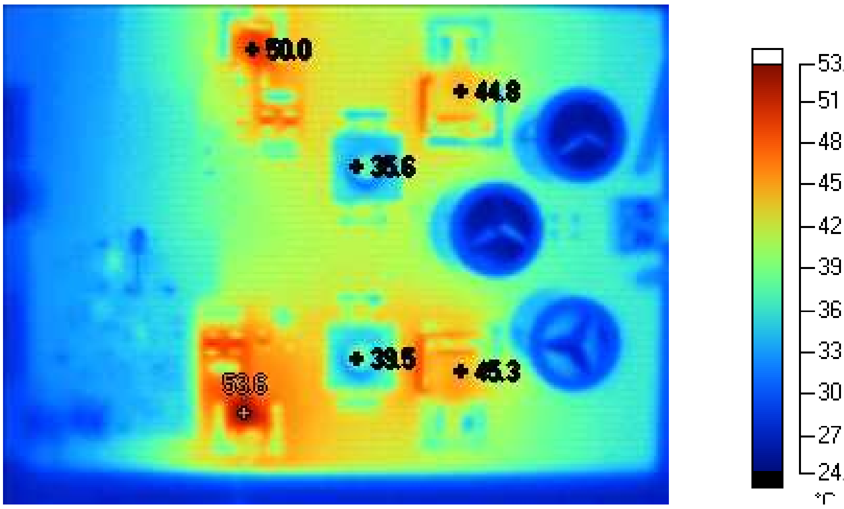
A. Stop and Start application – Iout=15A per 5sec, followed by 20sec of no load;
B. Stop and Start application – the same timing of point A is applied to Remote Shutdown (constant maximum load always present in the output);
C. Continuous load 15A (maximum output current according to the design);
D. Continuous load 10A (maximum allowable output current to operate up to T=85°C ambient).

Layout of the actual revision is not completely symmetrical, showing a larger copper area on the Master boost part. This is responsible of thermal difference (up to 14°C in the worst measured case) between the hottest spot in the correspondent component in the two boost converters.
The thermal difference is to neglect (up to 5.5°C) in the recommended conditions of operation (A, C).

Measured Maximum Temperatures (hot spot) in the different situations are summarized in the following table, and detailed in the pictures (Tamb=25°C):

Vin ⇒	***6.5***	***9***	***12***	
A.	53.7	52.1	51.5	***Iout=15A T=25sec D=20%***
B.	69.5	68.4	70.8	***Iout=15A T=25sec D=20% on Shutdown input***
C.	118.8	90.1	85.7	***Iout=15A continuous***
D.	71.5	62.3	59.5	***Iout=10A continuous***

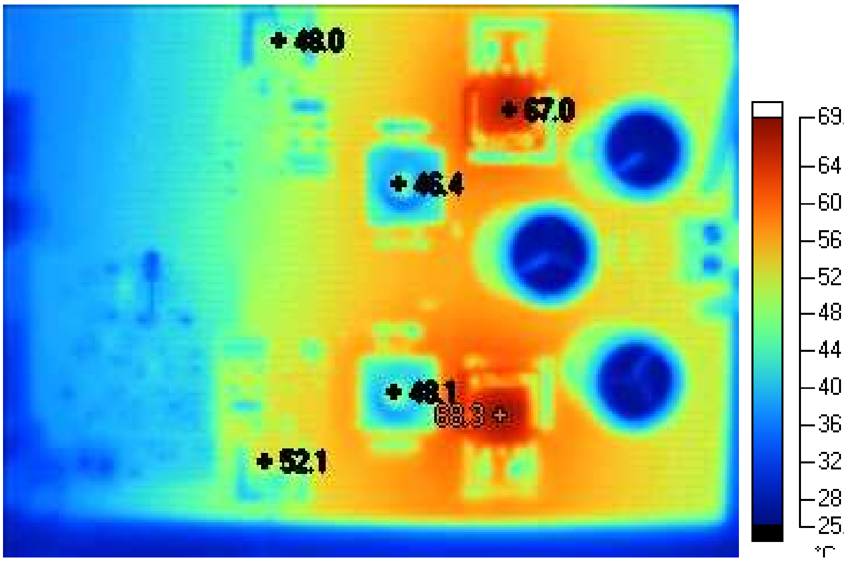
A. ***Iout=15A T=25°C D=20%***



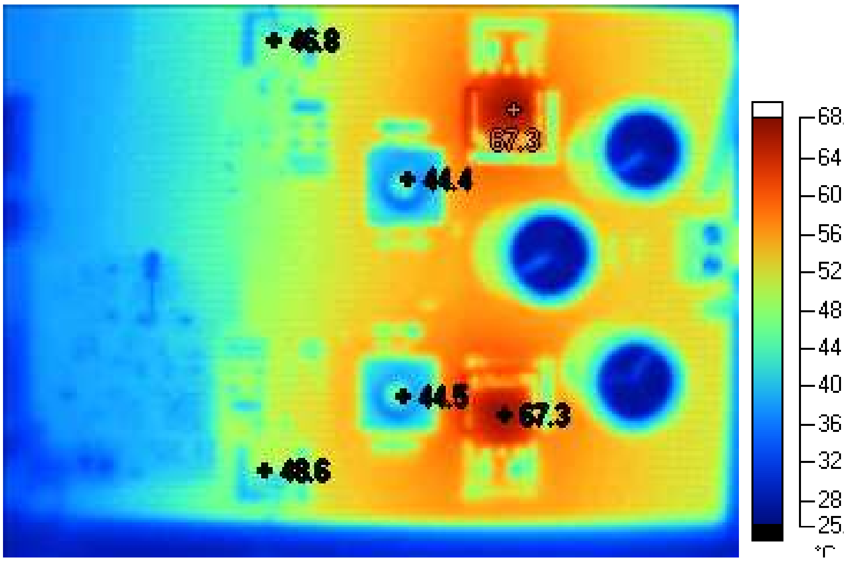
Output Power 15A T=25sec D=20%
Vin=6.5V

The same thermal pictures at Vin=9V and Vin=12V show neglectable temperature differences.

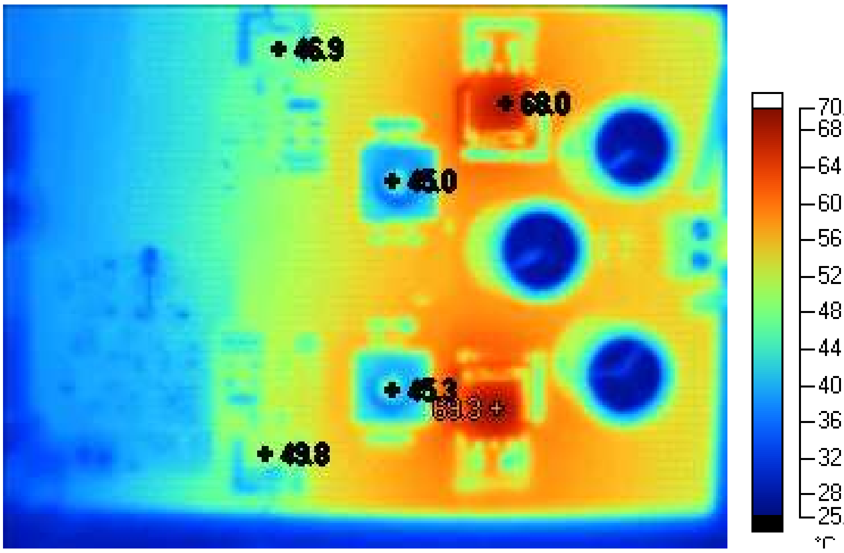
B. ***Iout=15A T=25sec D=20% on Shutdown Input***



Output Power 15A T=25sec D=20% on Shutdown Vin=6.5V

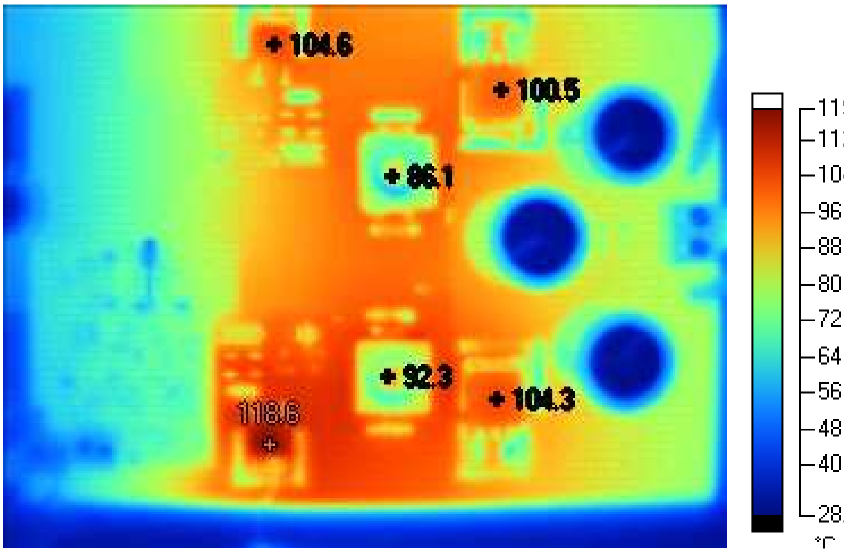


Output Power 15A T=25sec D=20% on Shutdown Vin=9V

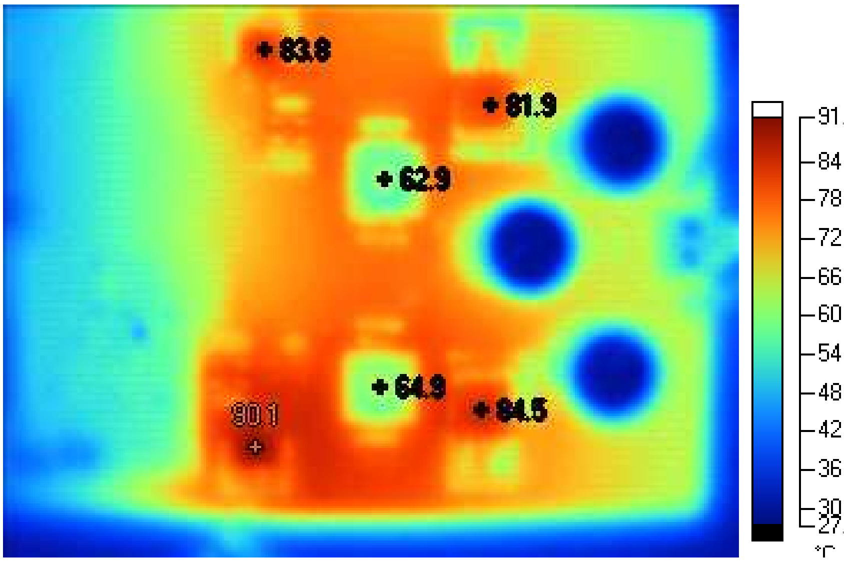


Output Power 15A T=25sec D=20% on Shutdown Vin=12V

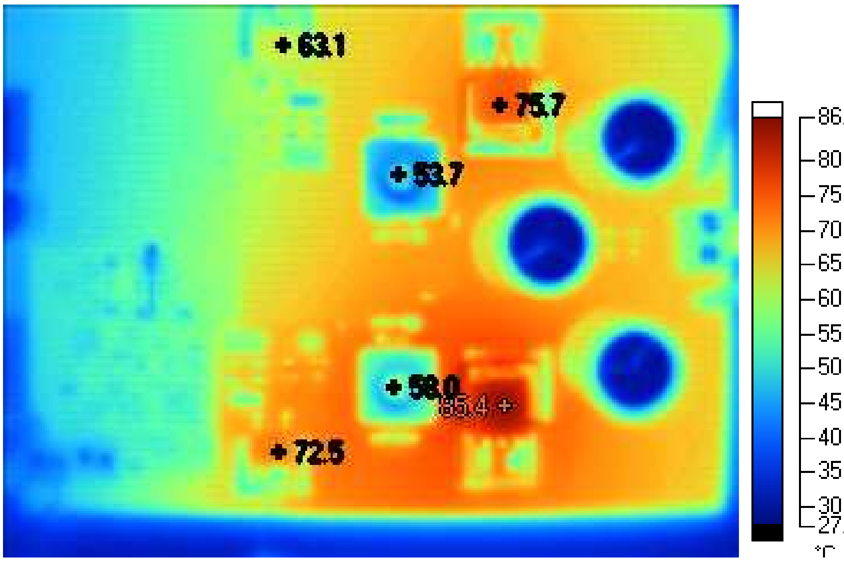
C. Iout=15A continuous



Output Power Continuous 15A Vin=6.5V

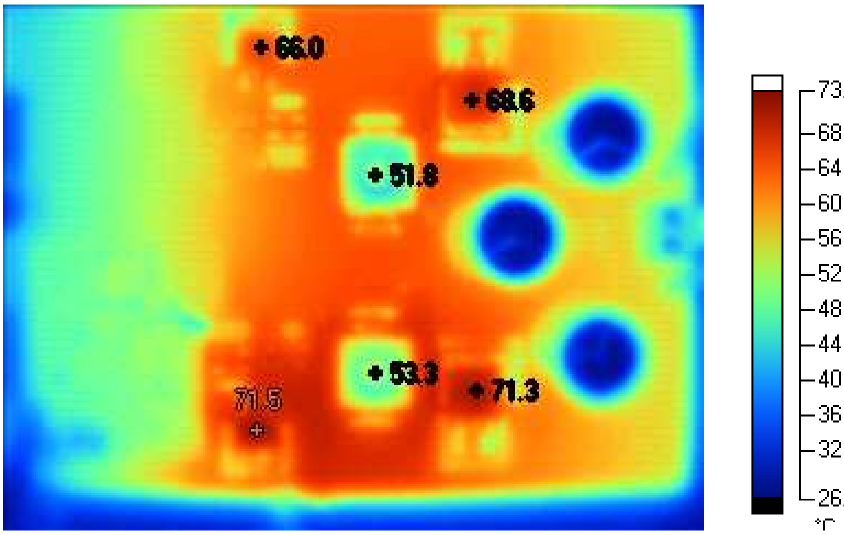


Output Power Continuous 15A Vin=9V

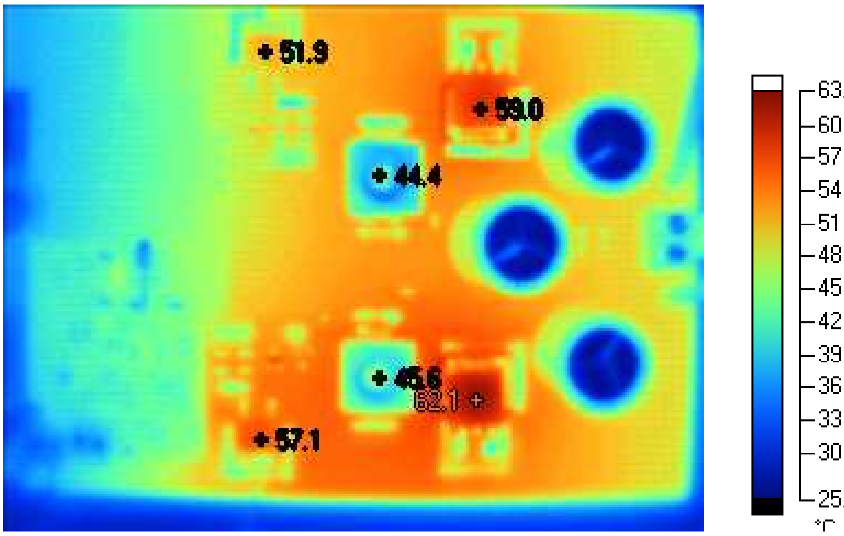


Output Power Continuous 15A Vin=12V

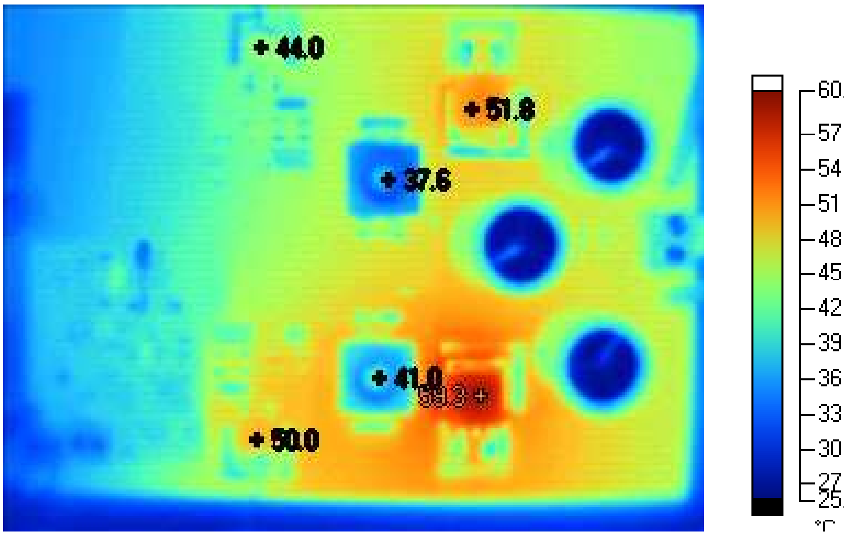
D. ***Iout=10A continuous***



Output Power Continuous 10A Vin=6.5V



Output Power Continuous 10A Vin=9V



Output Power Continuous 10A
Vin=12V