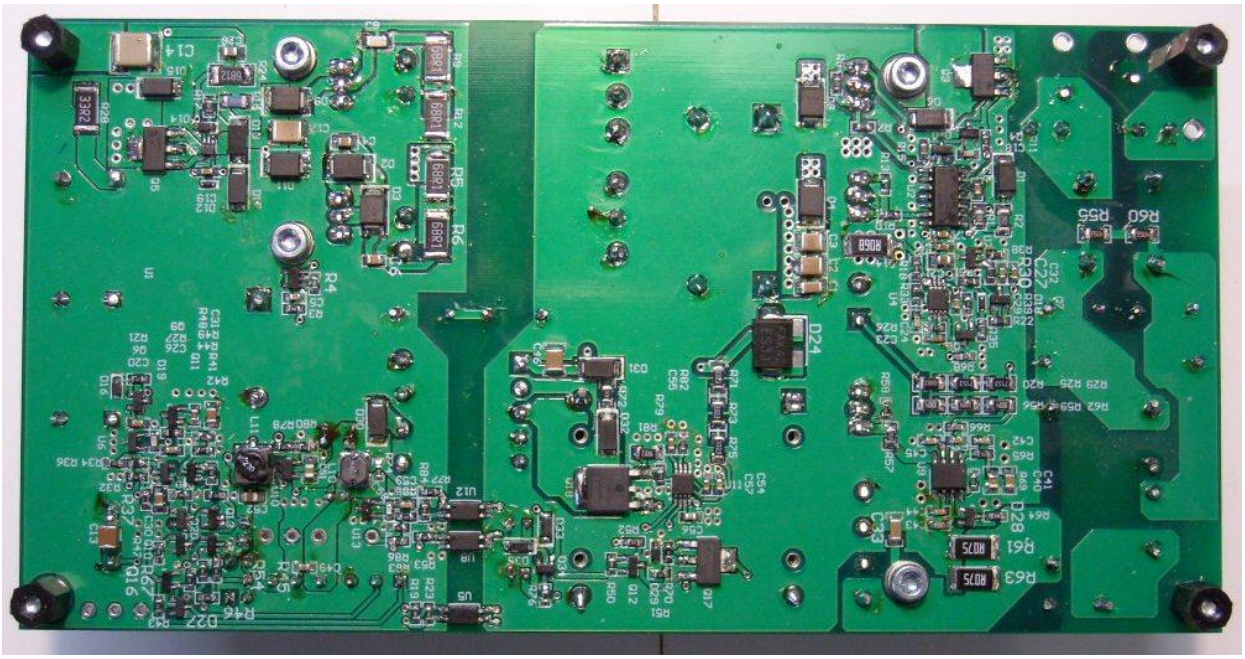
PHOTO OF THE PROTOTYPE

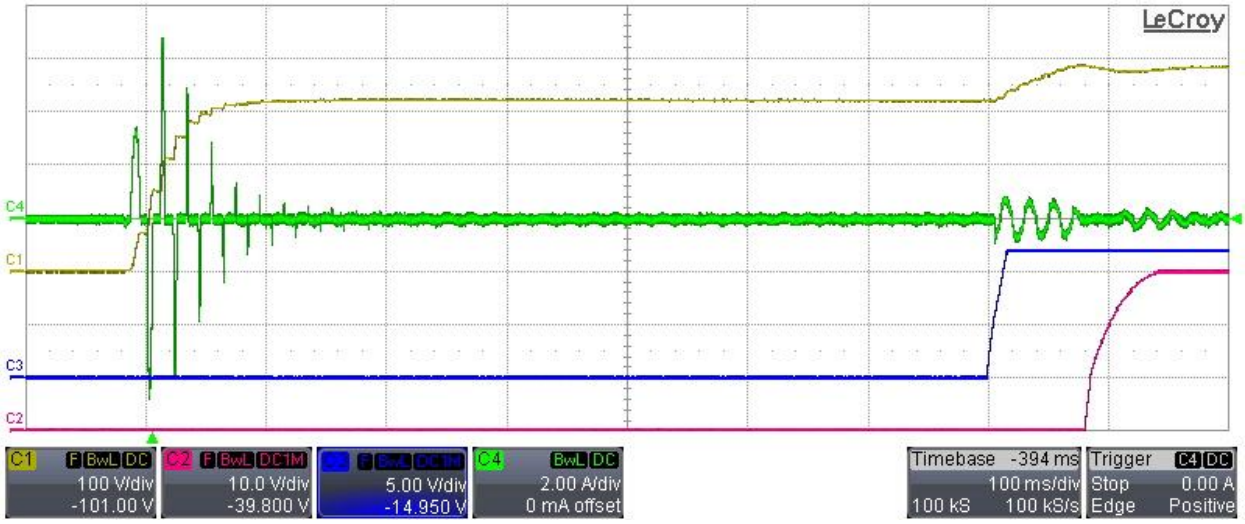
The PMP30183 Rev_B has been built on PMP30183 Rev_A PCB



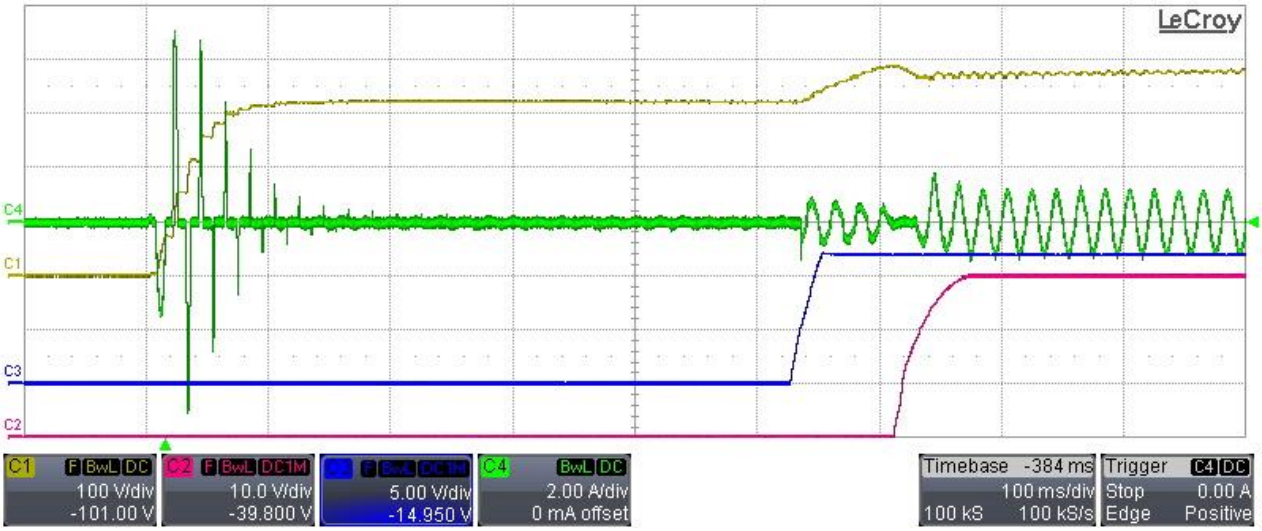
1 Startup behavior on PFC output voltage (C35, C36) and 30Vout (J2)

The behavior of the converter at startup is shown in the images below. The AC voltage has been applied while switch S1 was ON.
The converter goes into short circuit protection if at startup the load is > 5A, therefore first switch the converter ON, then apply full load.

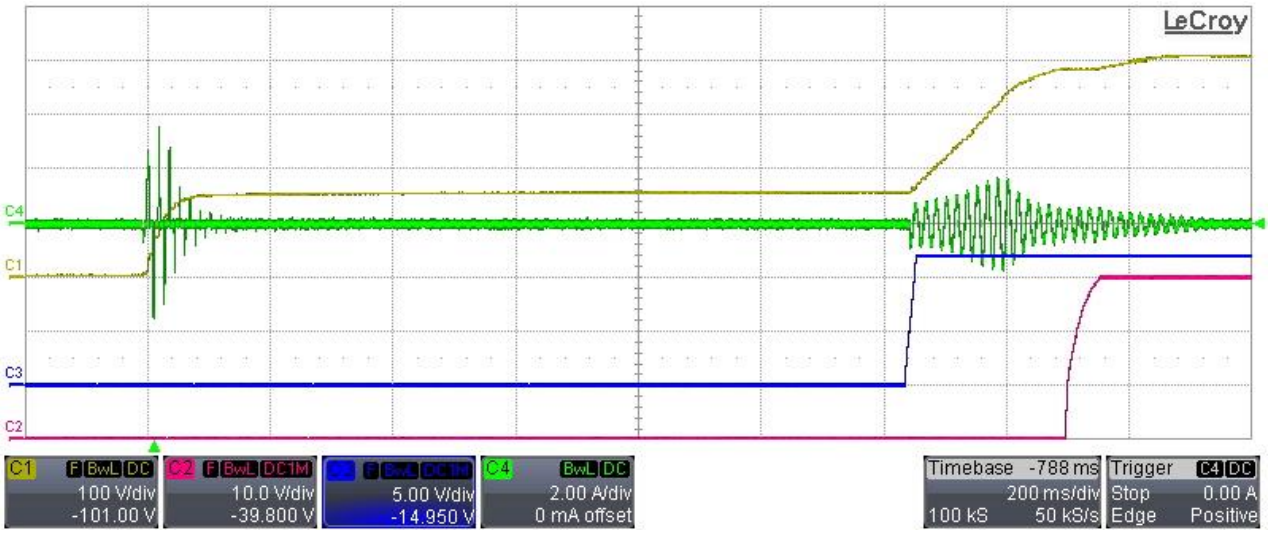
Ch1: PFC output voltage (100V/div, 100ms/div), 20MHz BWL for all waveforms.
Ch2: 30Vout, TP3 (10V/div)
Ch3: 12Vout, TP23 (5V/div)
Ch4: Input AC current (2A/div)
Vin = 230Vac, 50Hz, No load.



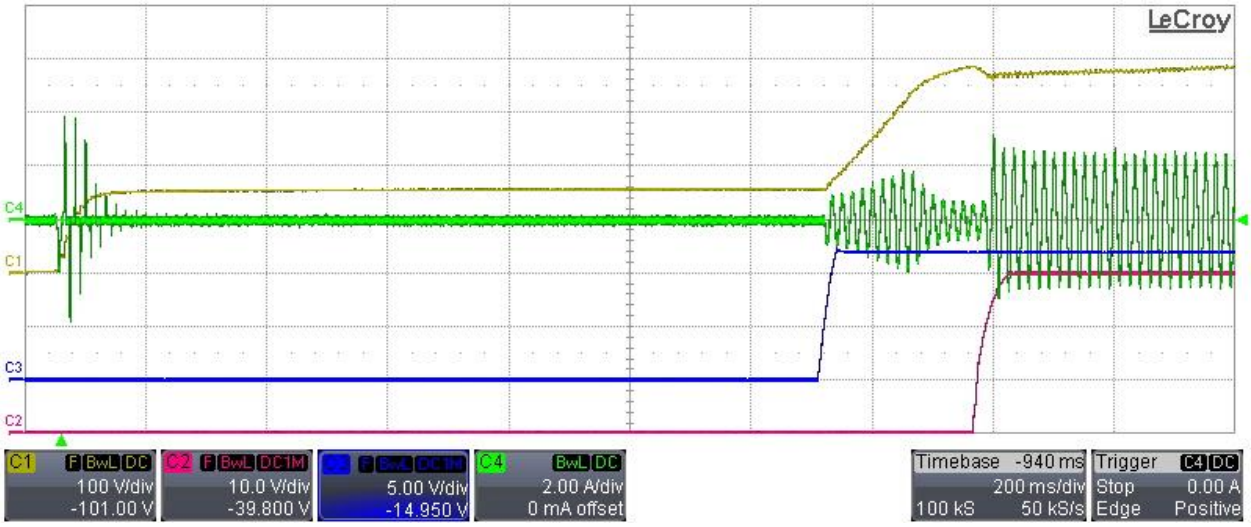
Vin = 230Vac, 50Hz, I-30Vout = 5A, I-12Vout = 300mA, I-3.3Vout = 200mA
Same scope setup same as above.



Vin = 115Vac, 60Hz, No load, same scope setup except time base = 200ms.



Vin = 115Vac, 60Hz, I-30Vout = 5A, I-12Vout = 300mA, I-3.3Vout = 200mA
Same scope setup same as above.

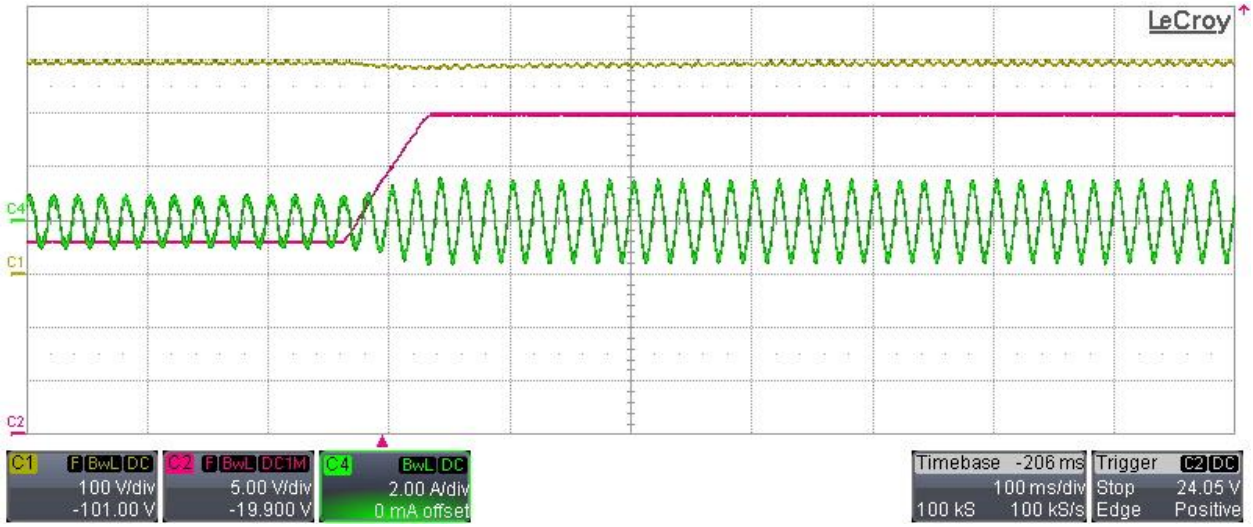


2 Output voltage switch between 18V and 30V

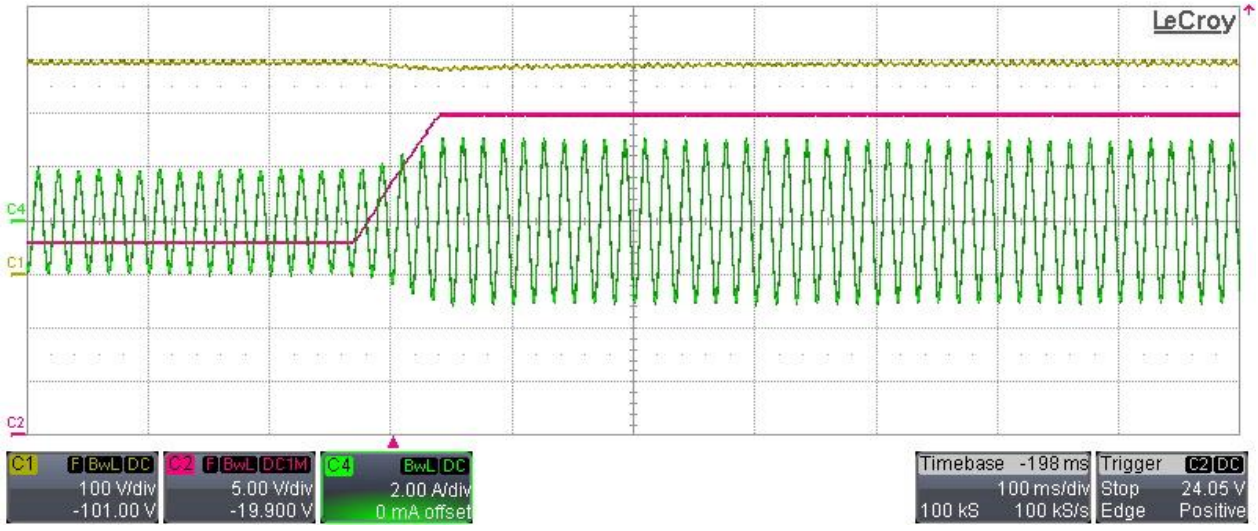
The main output voltage 30Vout can be switched between 18V and 30V by means of applying 3.3V on pin 1 of J3 (0V → 18Vout, 3.3V → 30Vout); in case of over-temperature protection (managed by U1, set to 80C, which measures H1 temperature), the voltage is reduced automatically.

Switch from 18V to 30V:

Ch1: PFC output voltage (100V/div, 100ms/div), 20MHz BWL for all waveforms.
Ch2: 30Vout, TP3 (5V/div)
Ch4: Input AC current (2A/div)
Vin = 230Vac, 50Hz, I-30Vout = 6.6A, I-12Vout = 0, I-3.3Vout = 200mA

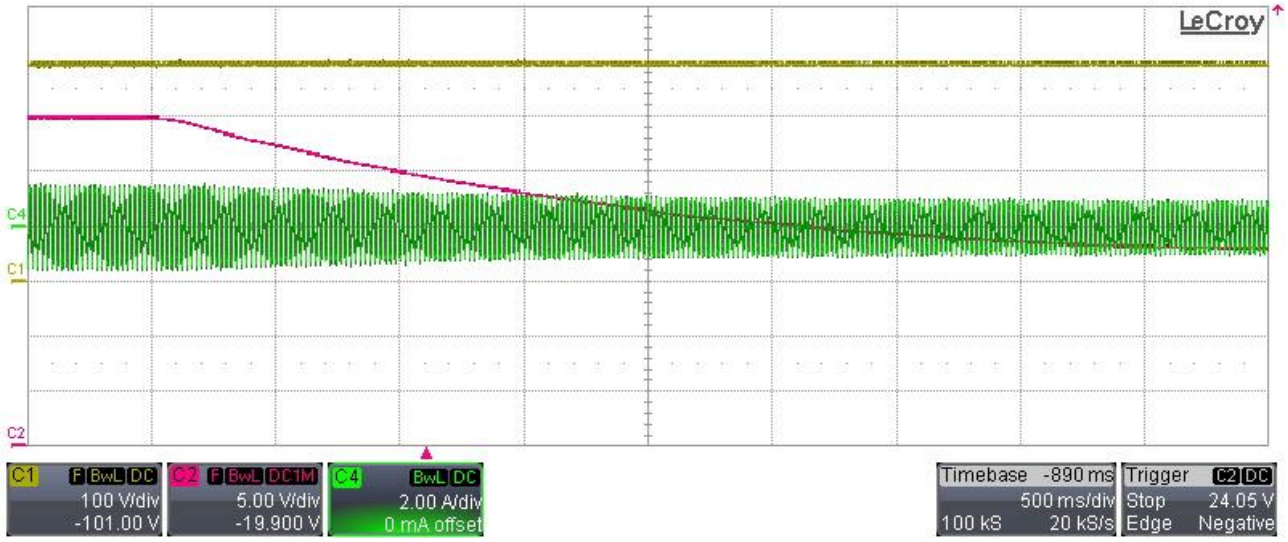


Vin = 115Vac, 60Hz, I-30Vout = 6.6A, I-12Vout = 0, I-3.3Vout = 200mA.
Same scope setup same as above.



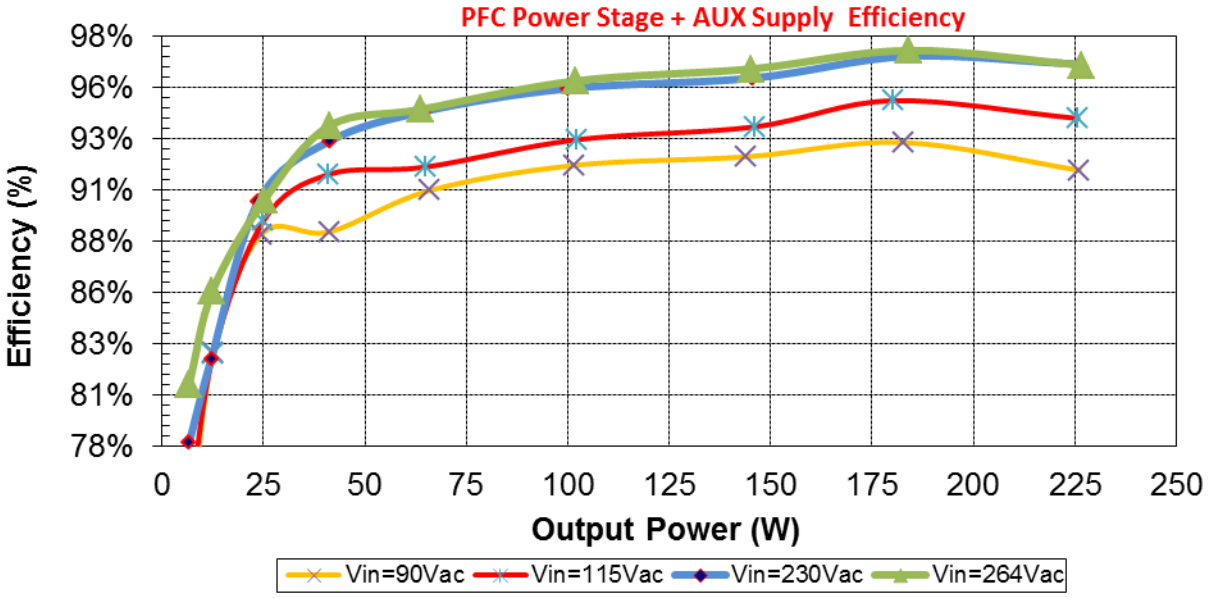
Switch from 30V to 18V:

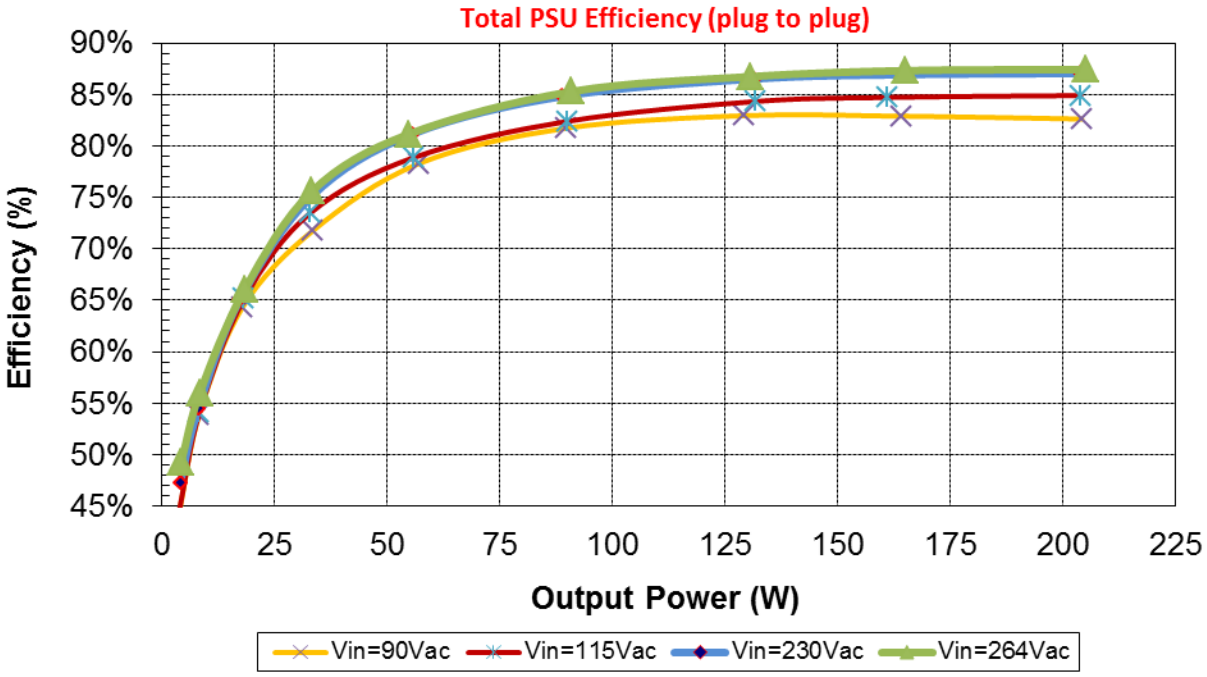
Vin = 230Vac, 50Hz, I-30Vout = 6.6A, I-12Vout = 0, I-3.3Vout = 200mA
Same scope setup same as above, except time base = 500ms.



3 Efficiency

The efficiency data are shown in the tables and graphs below. The data show the PFC + AUX PSU efficiency and the total plug-to-plug. The Auxiliary power supply was feeding only the housekeeping for this measurement.





PFC Stage + AUX Supply, Vin = 90Vac, 60Hz						
Iout (mA)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	PF (%)	Efficiency (%)
0	398.0	0	90	2.12	0	0%
16.29	398.0	6.48	90	8.85	92.2	73.3%
31.68	398.0	12.61	90	15.27	96.7	82.6%
61.52	398.0	24.48	90	27.72	98.8	88.3%
103.7	398.1	41.29	90	46.69	99.4	88.4%
165.7	398.1	65.95	90	72.91	99.8	90.5%
255.3	398.3	101.69	90	110.9	99.9	91.7%
361.1	398.4	143.86	90	156.2	99.9	92.1%
458.2	398.6	182.64	90	196.8	99.9	92.8%
567.0	398.7	226.06	90	247.2	99.9	91.4%

PFC Stage + AUX Supply, Vin = 115Vac, 60Hz						
Iout (mA)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	PF (%)	Efficiency (%)
0	398.3	0	115	1.85	0	0%
16.23	398.3	6.46	115	8.68	86.6	74.5%
31.66	398.4	12.61	115	15.29	93.7	82.5%
62.83	398.4	25.03	115	28.13	97.1	89.0%
102.7	398.4	40.92	115	44.85	98.7	91.2%
163.0	398.4	64.94	115	70.89	99.4	91.6%
256.3	398.5	102.14	115	109.9	99.7	92.9%
366.4	398.5	146.01	115	156.1	99.8	93.6%
452	398.6	180.17	115	190.0	99.8	94.8%
566	398.8	225.72	115	240.2	99.9	94.0%

PFC Stage + AUX Supply, Vin = 230Vac, 50Hz						
Iout (mA)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	PF (%)	Efficiency (%)
0	397.8	0	230	1.91	0	0%
16.77	398.0	6.67	230	8.54	62.6	78.2%
30.41	398.1	12.11	230	14.72	72.2	82.2%
59.66	398.1	23.75	230	26.41	84.9	89.9%
103.4	398.2	41.18	230	44.35	89.3	92.9%
162.3	398.2	64.64	230	68.53	94.2	94.3%
250.8	398.3	99.90	230	104.7	97.1	95.4%
365.4	398.3	145.54	230	151.7	98.5	95.9%
462	398.3	184.01	230	189.7	99.1	97.0%
568	398.5	226.35	230	234.3	99.3	96.6%

PFC Stage + AUX Supply, Vin = 264Vac, 50Hz						
Iout (mA)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	PF (%)	Efficiency (%)
0	398.2	0	264	1.17	0	0%
16.78	398.2	6.68	264	8.25	62.6	81.0%
31.10	398.3	12.39	264	14.48	72.2	85.5%
63.07	398.3	25.12	264	27.92	84.9	90.0%
103.4	398.4	41.21	264	44.02	89.3	93.6%
160.1	398.4	63.80	264	67.57	94.2	94.4%
255.5	398.4	101.78	264	106.2	97.1	95.8%
364.6	398.4	145.26	264	150.7	98.5	96.4%
462	398.4	184.06	264	189.2	99.1	97.3%
569	398.5	226.75	264	234.8	99.3	96.6%

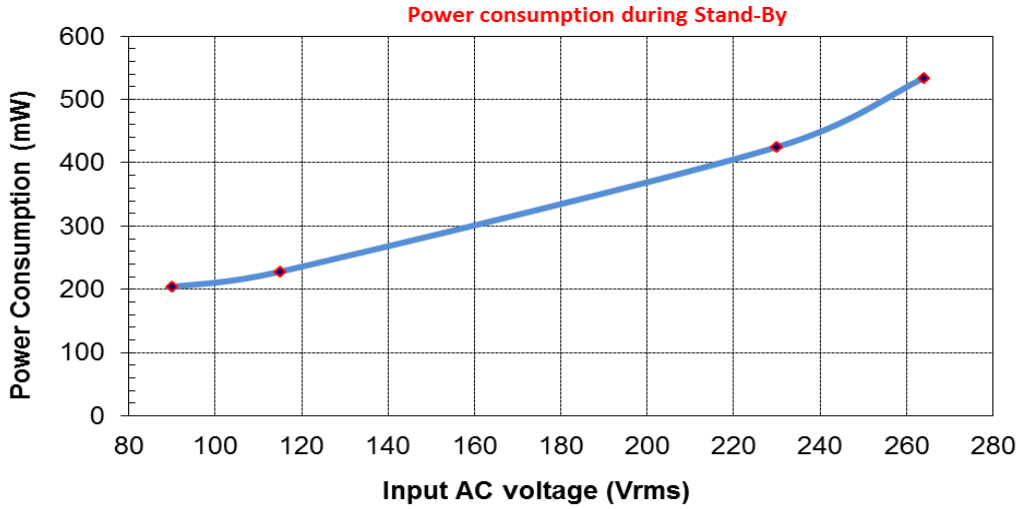
Plug to plug efficiency, Vin = 90Vac, 60Hz					
Iout (A)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	Efficiency (%)
0	29.80	0	90	2.328	0%
0.134	29.80	3.996	90	8.925	44.8%
0.276	29.80	8.219	90	15.27	53.8%
0.597	29.80	17.79	90	27.69	64.2%
1.128	29.80	33.61	90	46.82	71.8%
1.914	29.80	57.04	90	72.86	78.3%
3.012	29.79	89.73	90	109.8	81.7%
4.340	29.79	129.3	90	155.9	82.9%
5.512	29.79	164.2	90	198.1	82.9%
6.855	29.79	204.2	90	247.2	82.6%

Plug to plug efficiency, Vin = 115Vac, 60Hz					
Iout (A)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	Efficiency (%)
0	29.80	0	115	2.254	0%
0.130	29.80	3.874	115	8.680	44.6%
0.279	29.80	8.314	115	15.37	54.1%
0.613	29.80	18.27	115	28.03	65.2%
1.109	29.79	33.04	115	44.94	73.5%
1.878	29.79	55.95	115	70.93	78.9%
3.026	29.79	90.14	115	109.4	82.4%
4.422	29.79	131.7	115	156.3	84.3%
5.407	29.79	161.1	115	190.2	84.7%
6.848	29.79	204.0	115	240.3	84.9%

Plug to plug efficiency, Vin = 230Vac, 50Hz					
Iout (A)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	Efficiency (%)
0	29.79	0	230	1.419	0%
0.137	29.79	4.081	230	8.630	47.3%
0.272	29.79	8.103	230	14.87	54.5%
0.583	29.79	17.37	230	26.68	65.1%
1.119	29.79	33.34	230	44.36	75.1%
1.865	29.79	55.56	230	68.47	81.1%
2.988	29.78	88.98	230	104.9	84.8%
4.415	29.78	131.5	230	152.0	86.5%
5.534	29.78	164.8	230	189.6	86.9%
6.848	29.78	203.9	230	234.3	87.0%

Plug to plug efficiency, Vin = 264Vac, 50Hz					
Iout (A)	Vout (V)	Pout (W)	Vin (V)	Pin (W)	Efficiency (%)
0	29.79	0	264	1.381	0%
0.142	29.79	4.230	264	8.592	49.2%
0.283	29.79	8.431	264	15.05	56.0%
0.617	29.79	18.38	264	27.82	66.1%
1.118	29.79	33.31	264	44.06	75.6%
1.840	29.79	54.81	264	67.55	81.1%
3.050	29.79	90.86	264	106.6	85.3%
4.391	29.78	130.8	264	150.8	86.7%
5.544	29.78	165.1	264	189.1	87.3%
6.883	29.78	205.0	264	234.5	87.4%

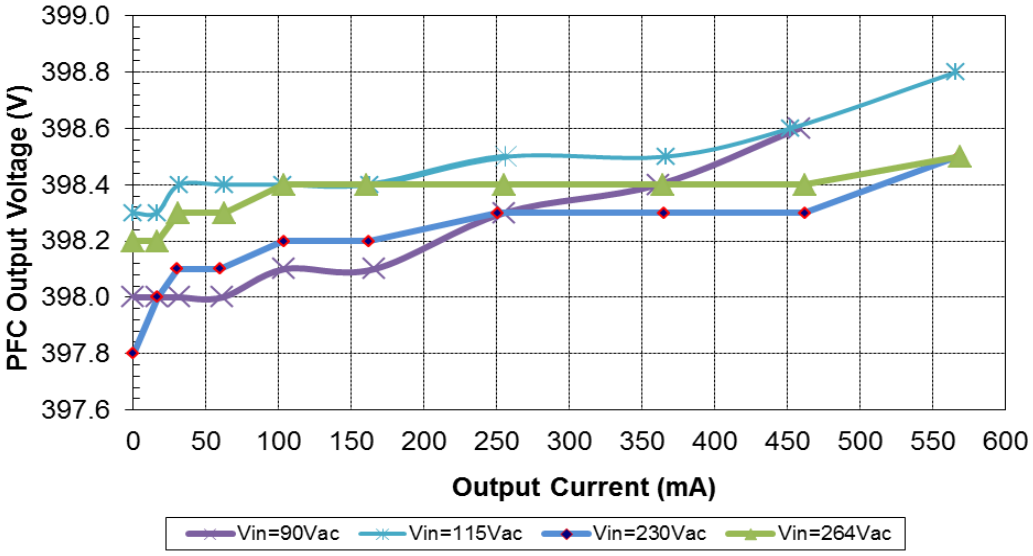
The converter has been switched OFF by S1 and the stand-by losses measured (3.3Vout and 12Vout are always ON, but unloaded). Four input AC voltages have been selected.



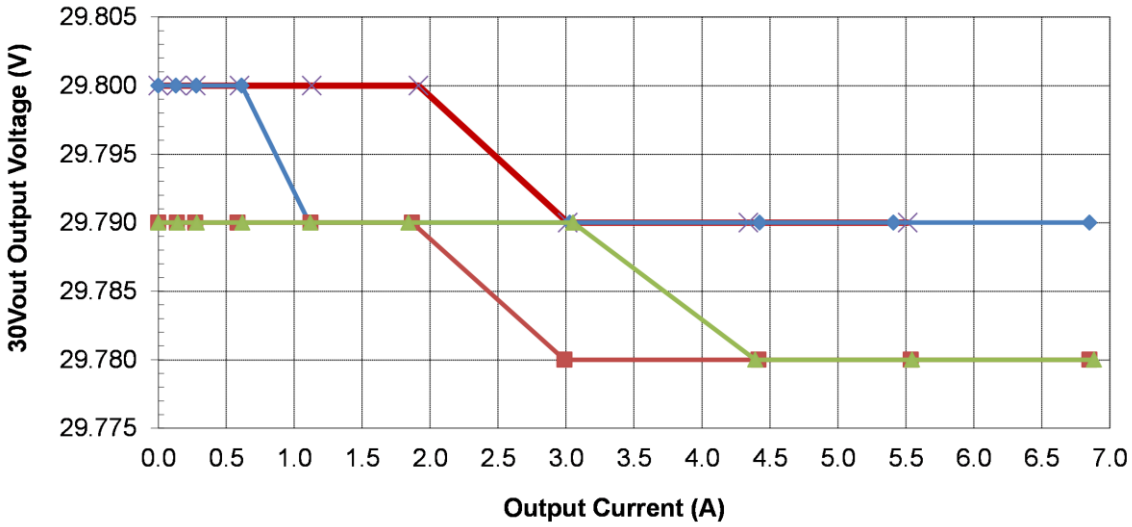
4 Output voltage regulation (PFC and 30Vout) vs. load

The graphs below show the static variation of output voltage versus load regarding PFC output (top picture, taken at different input AC voltages) and 30V output.

PFC output voltage vs. load and Vin_AC:

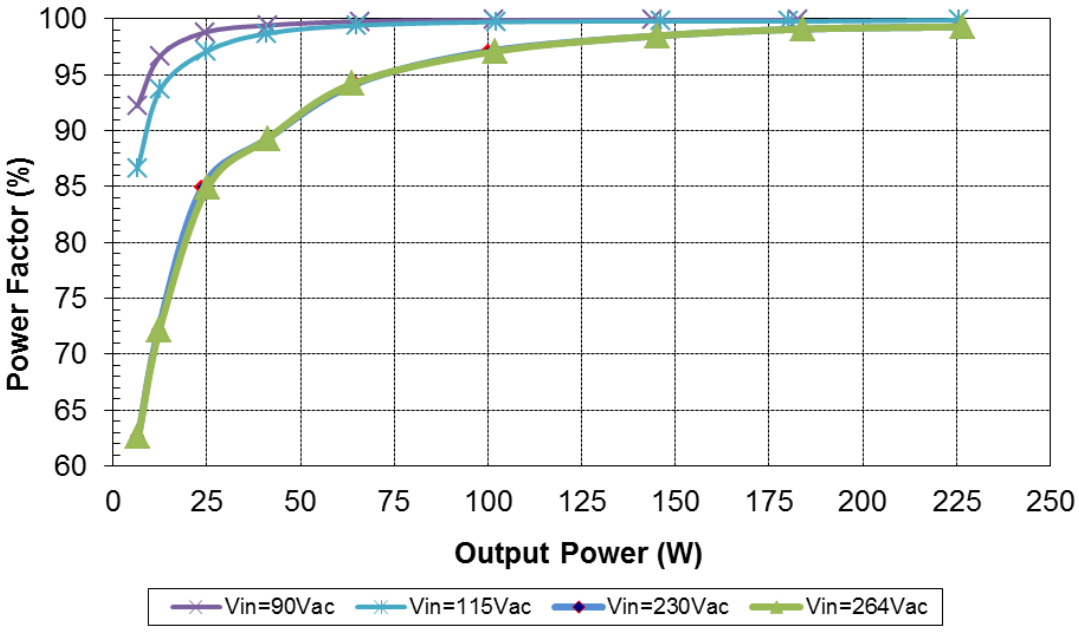


30Vout main output voltage vs. load:



5 Power factor

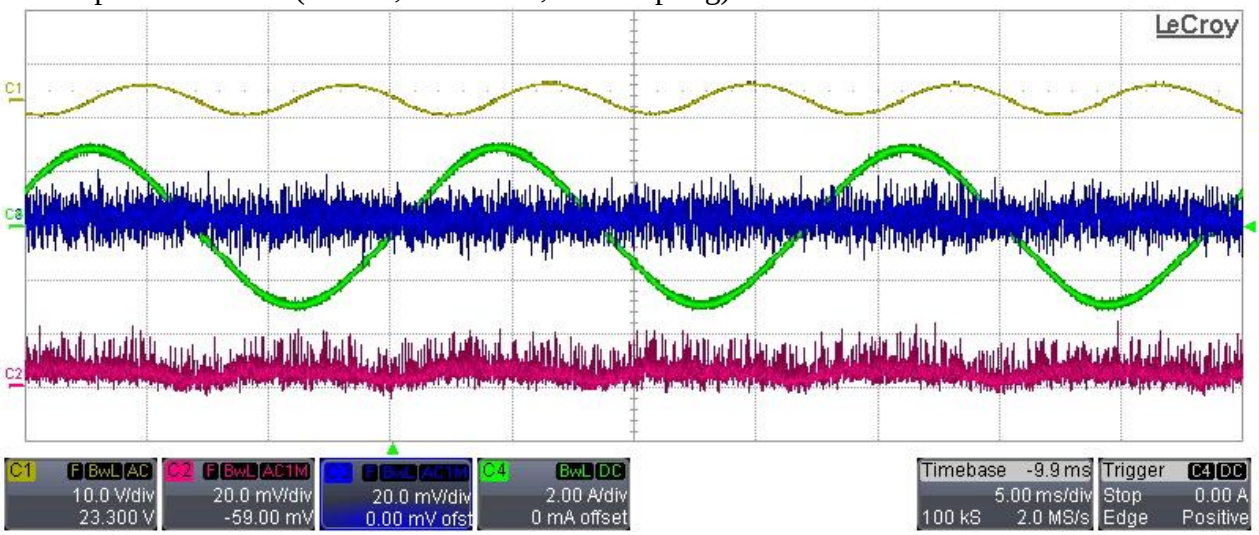
The Power Factor graph versus Vin and main output current is shown below (same loads condition of the efficiency tables):



6 Output ripple voltage

The output ripple voltages for all outputs are shown in the plot below. The input was set to 115Vac, 60Hz and all outputs fully loaded.

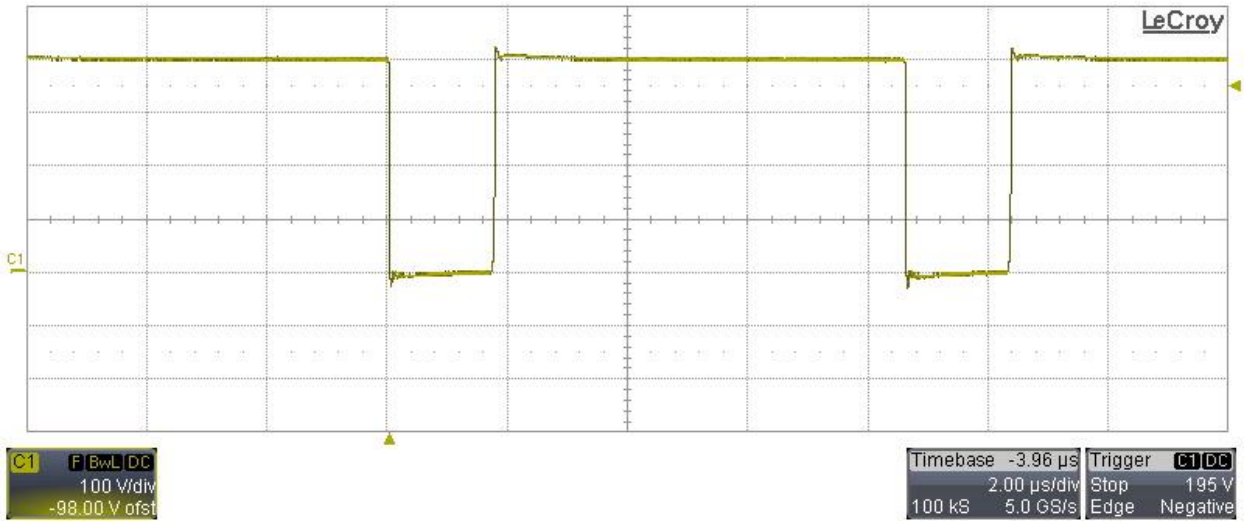
Ch1: PFC output voltage (10V/div, 5ms/div, AC coupling), 20MHz BWL for all waveforms.
Ch2: 30Vout, TP3 (20mV/div, AC coupling)
Ch3: 12Vout, TP23 (20mV/div, AC coupling)
Ch4: Input AC current (2A/div, 20mV/div, DC coupling)



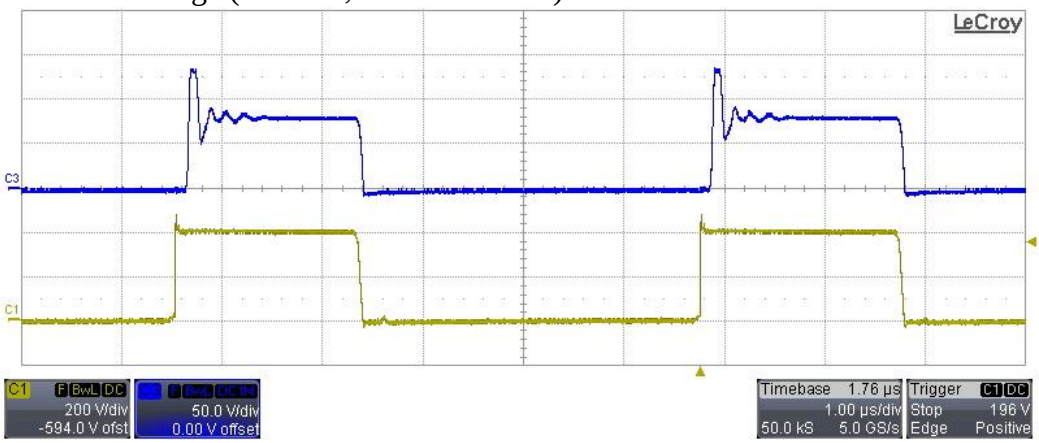
7 Switching Node Waveforms

The image below shows the PFC Boost switch node (Drain of Q15) at full load and Vin = 230Vac, 50Hz.

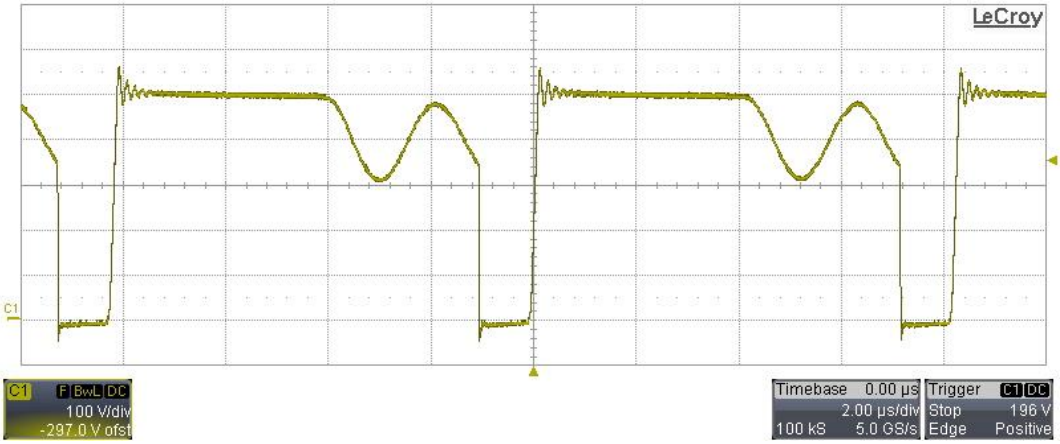
Ch1: Q6 Drain voltage, TP14 (100V/div, 2us/div, 200MHz BWL)



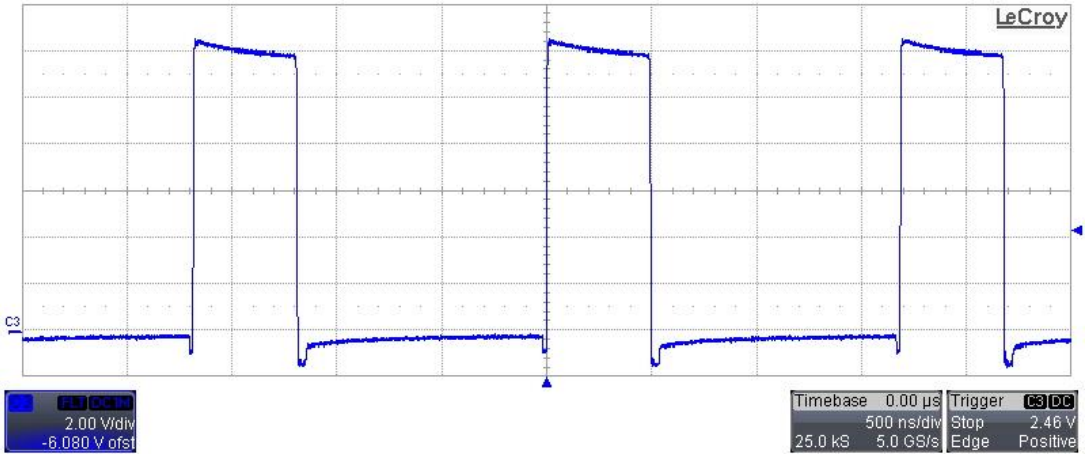
Two-switch forward waveforms, Vin = 230Vac, I-30Vout = 6.6A:
Ch1: Q1 Source voltage (100V/div, 1us/div, 200MHz BWL)
Ch3: D7 Cathode voltage (50V/div, 200MHz BWL)



Auxiliary PSU switch-node, Vin = 230Vac, all outputs fully loaded:
Ch1: Q18 Drain voltage (100V/div, 2us/div, 200MHz BWL)



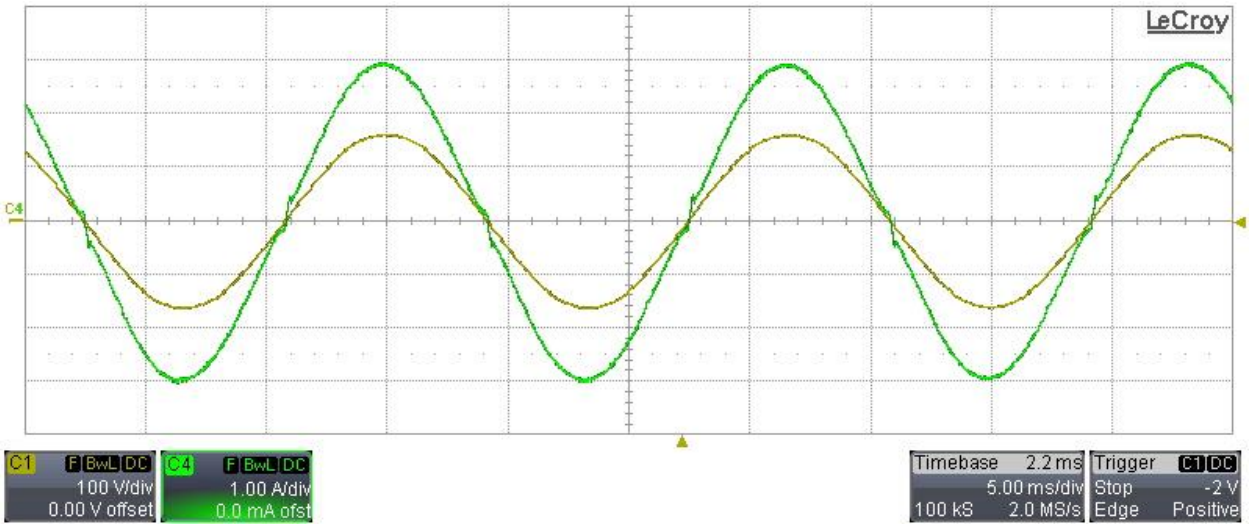
Buck switch-node, Vin = 230Vac, all outputs fully loaded:
Ch3: U10 - "PH" pin 3 voltage, (2V/div, 500ns/div, 200MHz BWL)



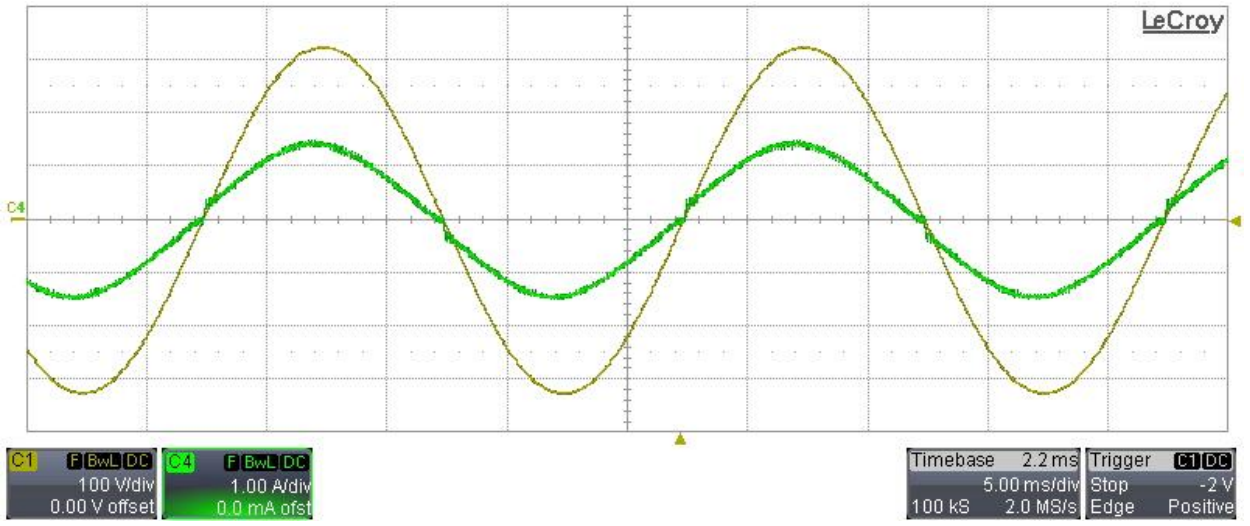
8 Input voltage and current waveforms

The images below show the input voltage and current waveforms while the source was set respectively to 115Vac, 60Hz and 230Vac, 50Hz, with all outputs fully loaded.

Ch1: Input AC Voltage (100V/div, 5ms/div, 20MHz BWL)
Ch4: Input Current (1A/div, 20MHz BWL)
Vin = 115Vac, 60Hz, all outputs fully loaded



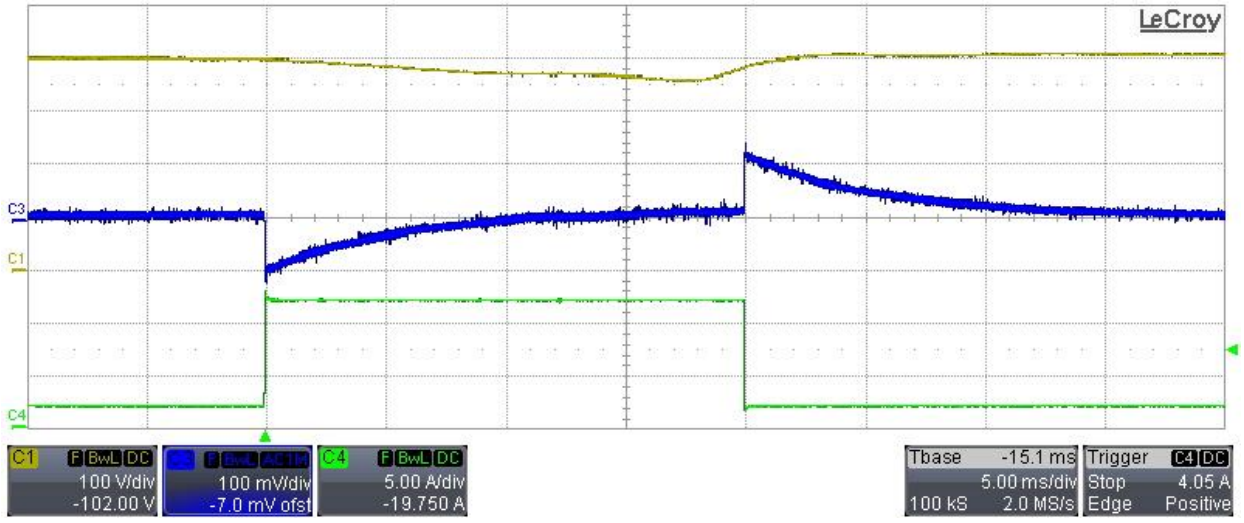
Ch1: Input AC Voltage (100V/div, 5ms/div, 20MHz BWL)
Ch4: Input Current (1A/div, 20MHz BWL)
Vin = 230Vac, 50Hz, all outputs fully loaded



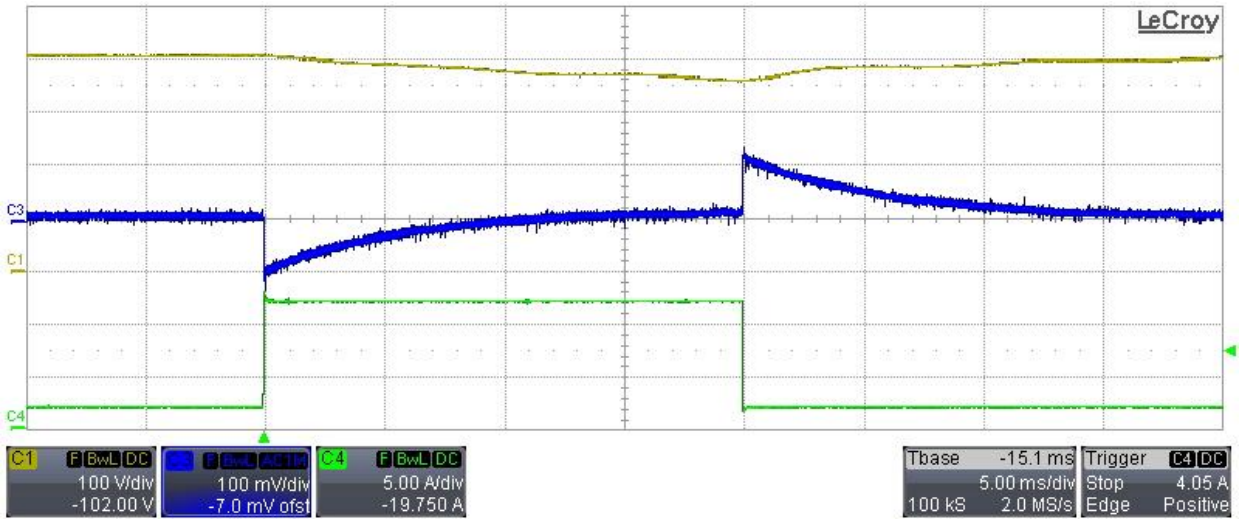
9 Transient response

The graphs below show the responses of the main output (30Vout) during output current variation between 2A and 12A, measured at 230Vac and 115V AC input (20MHz BWL).

Ch1: PFC Output voltage (100V/div, 5ms/div, DC coupling)
Ch3: 30Vout – Output voltage (100mV/div, AC coupling)
Ch4: 30Vout - Output current (5A/div, DC coupling)
Vin = 230Vac, 50Hz, 12Vout and 3.3Vout loads set to zero current

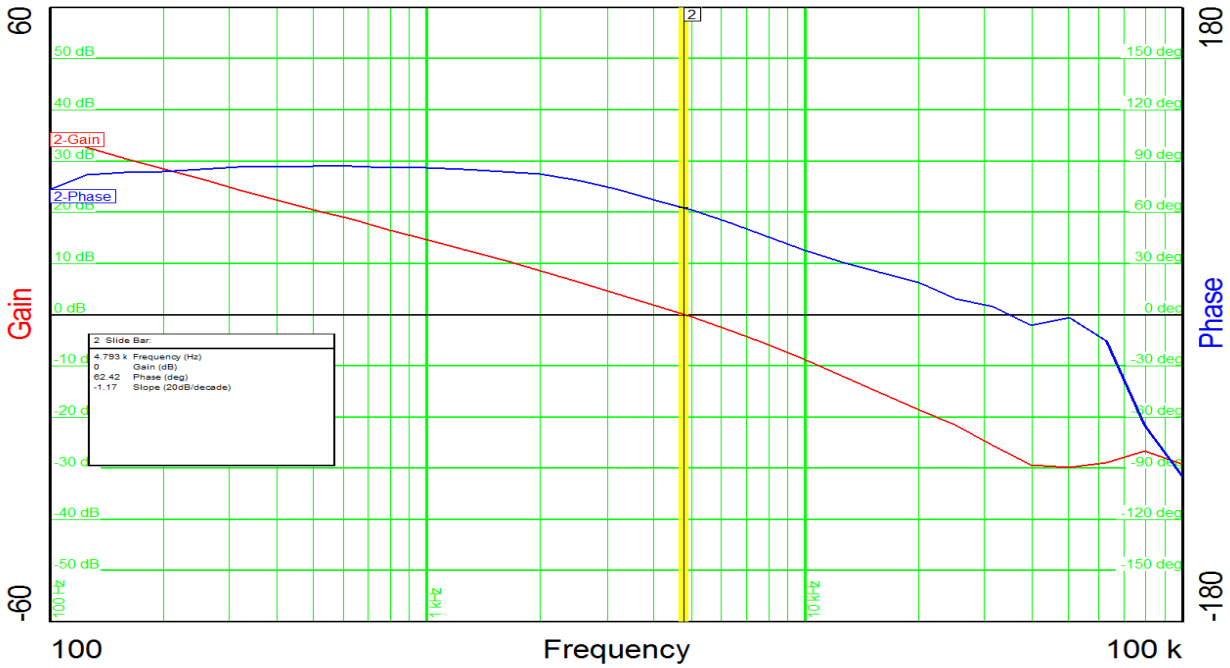


Vin = 115Vac, 60Hz, 12Vout and 3.3Vout loads set to zero current

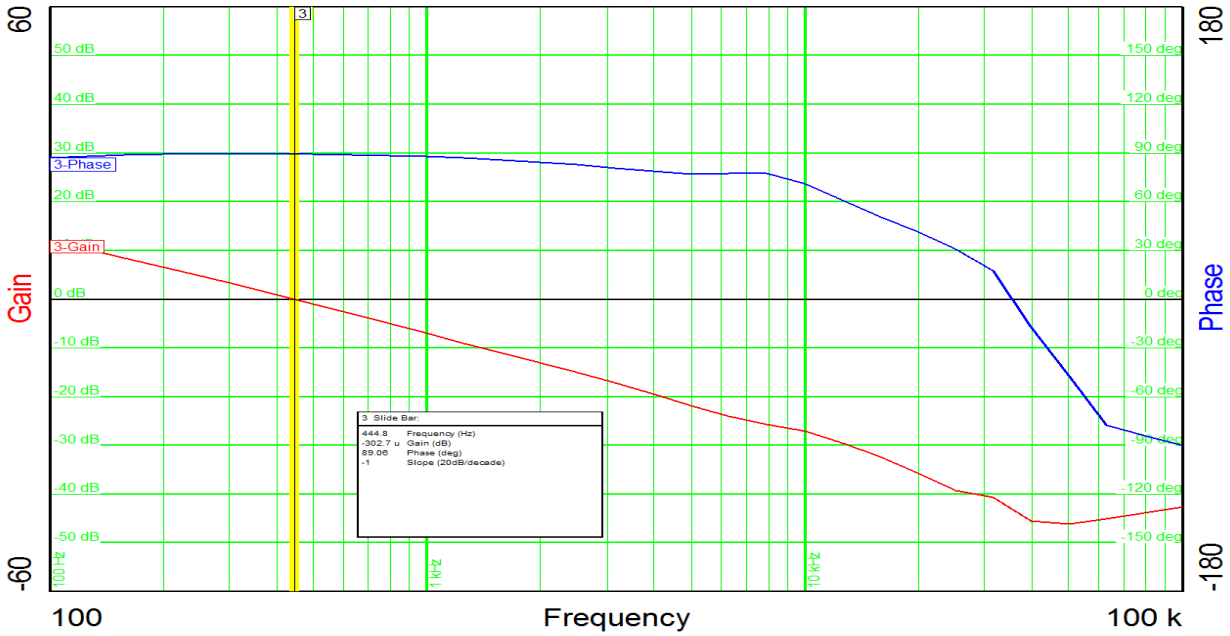


10 Loop Response

The graphs below show the bode plots of main DC/DC converter (30Vout) and auxiliary PSU (12Vout) when respectively loaded @ 6.6A and 300mA. The input voltage was always 230Vac.
30Vout loop (TP3, TP4, TP9): Fco = 4.793 KHz, PM = 62.42 deg, GM = 27.3dB.



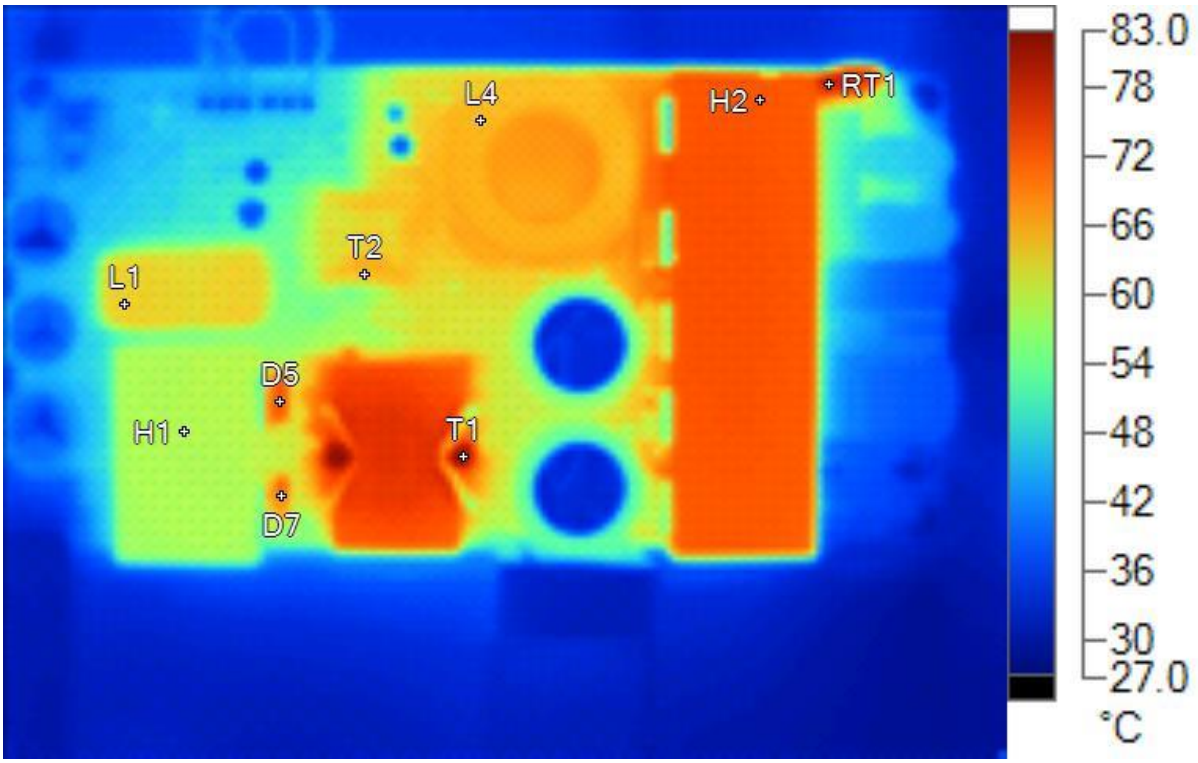
12Vout loop (V(C51), TP28): Fco = 444.8 Hz, PM = 89.06 deg, GM = 43.1dB.



11 Thermal analysis

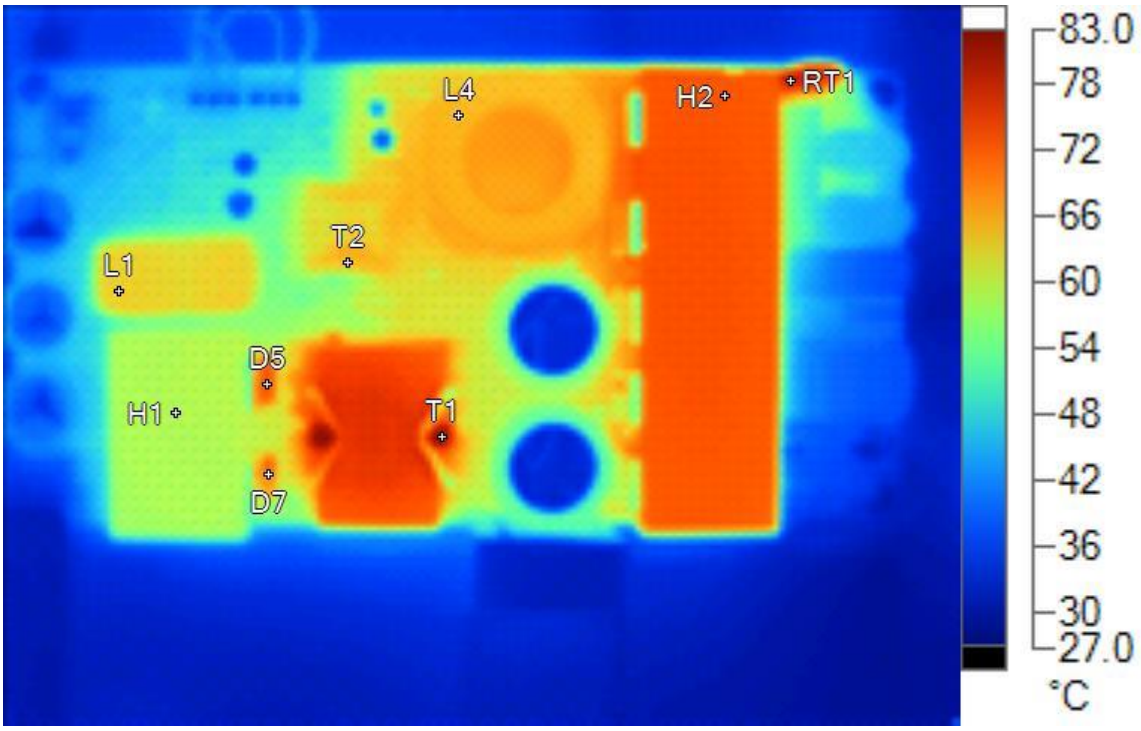
The thermal images have been taken by supplying the board at 115Vac, 60Hz (worst case condition) and 230Vac, 50Hz. The board was placed vertically on the bench in still air condition. The ambient temperature was 25C and all outputs fully loaded.

Vin = 230Vac, after half hour, full load:



Name	Temperature	Emissivity	Background
L1	63.0°C	0.95	25.0°C
T2	65.0°C	0.95	25.0°C
L4	64.6°C	0.95	25.0°C
RT1	78.3°C	0.95	25.0°C
H2	72.5°C	0.95	25.0°C
T1	81.0°C	0.95	25.0°C
D5	72.9°C	0.95	25.0°C
H1	58.5°C	0.95	25.0°C
D7	69.3°C	0.95	25.0°C

Vin = 115Vac, after one hour, full load (worst case):



Name	Temperature	Emissivity	Background
L1	109.5°C	0.95	25.0°C
T1	122.3°C	0.95	25.0°C
D7	102.4°C	0.95	25.0°C
D5	107.8°C	0.95	25.0°C
H1	80.7°C	0.95	25.0°C
H2	89.6°C	0.95	25.0°C
RT1	107.0°C	0.95	25.0°C
L4	75.4°C	0.95	25.0°C
T2	76.8°C	0.95	25.0°C

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