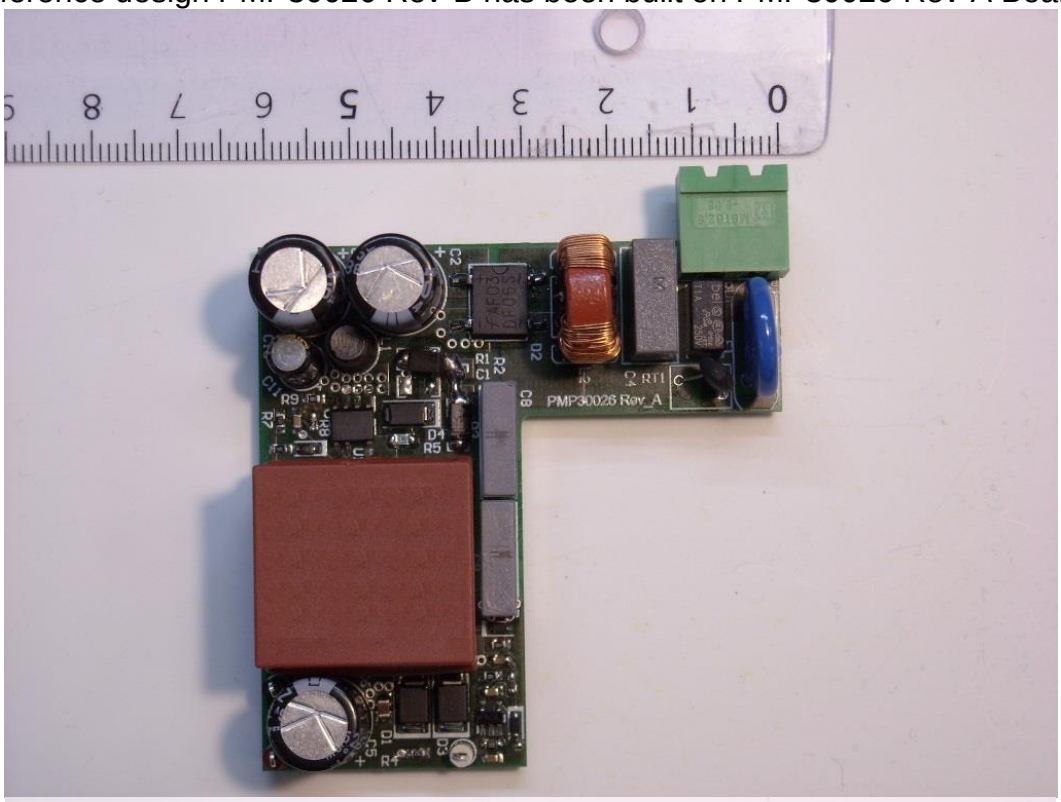
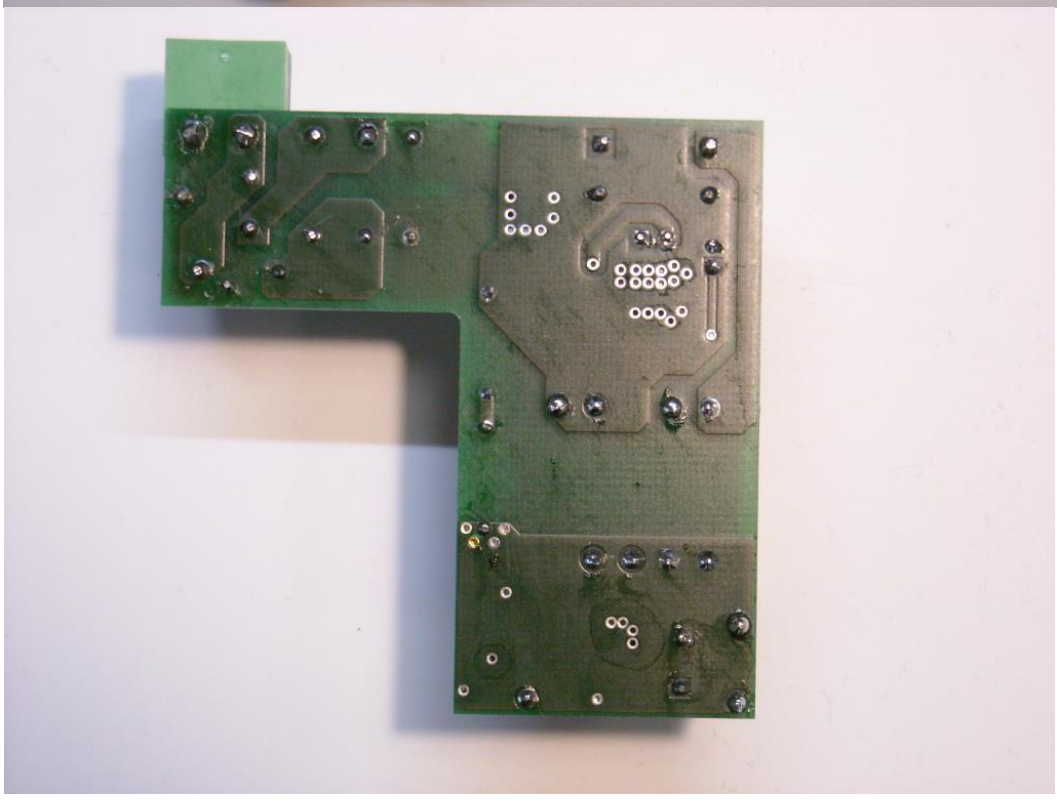
1 Photo of the prototype:

The reference design PMP30026 Rev-B has been built on PMP30026 Rev-A Board

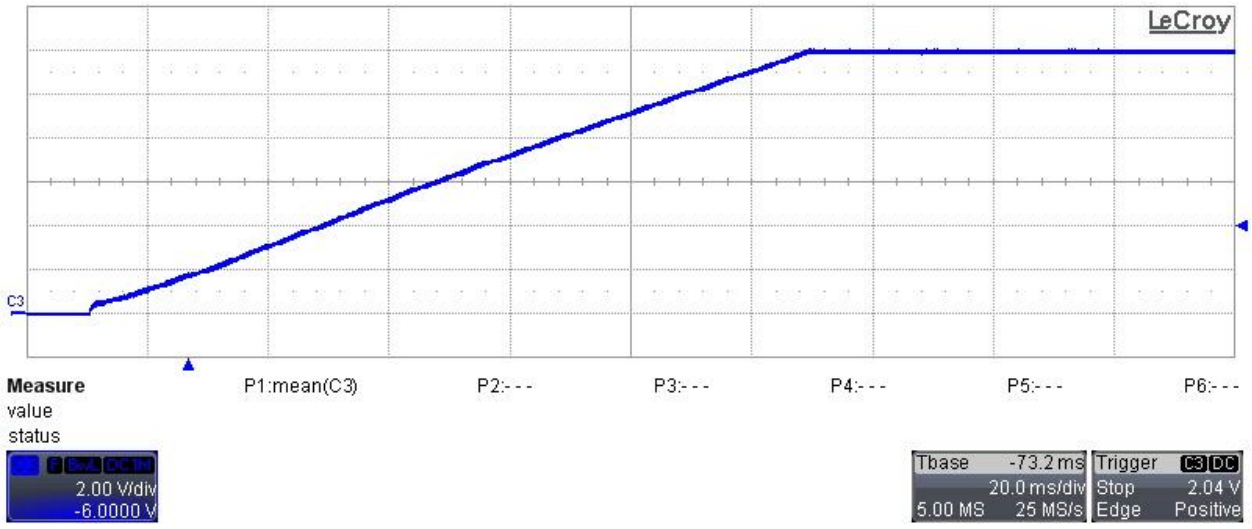




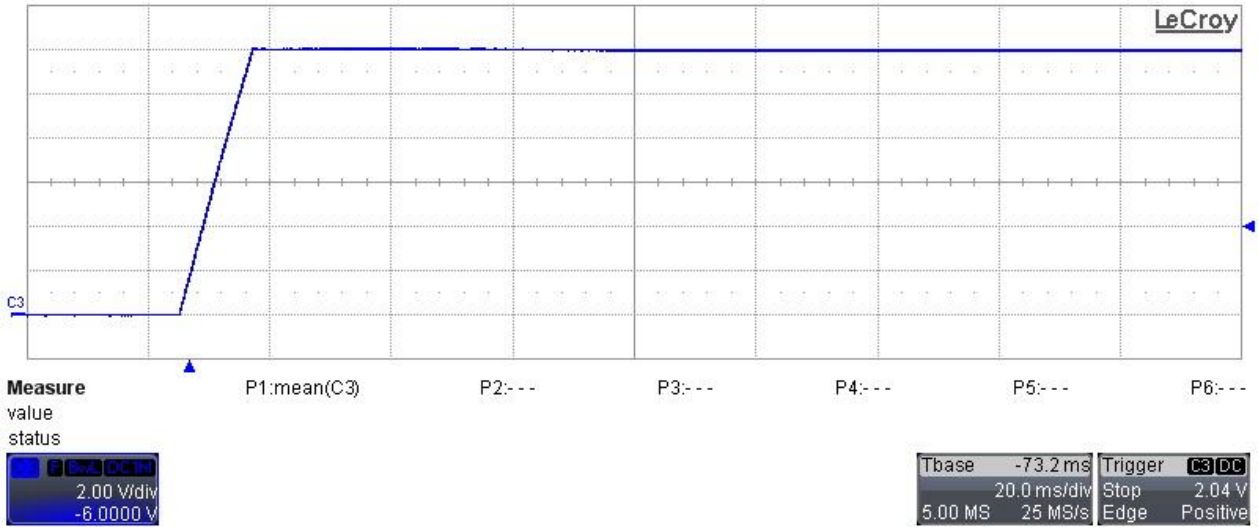
2 Startup

The output voltage behavior versus load and input AC voltage is shown in the images below. The input voltage was set to minimum and maximum value, respectively 90VAC and 265VAC.

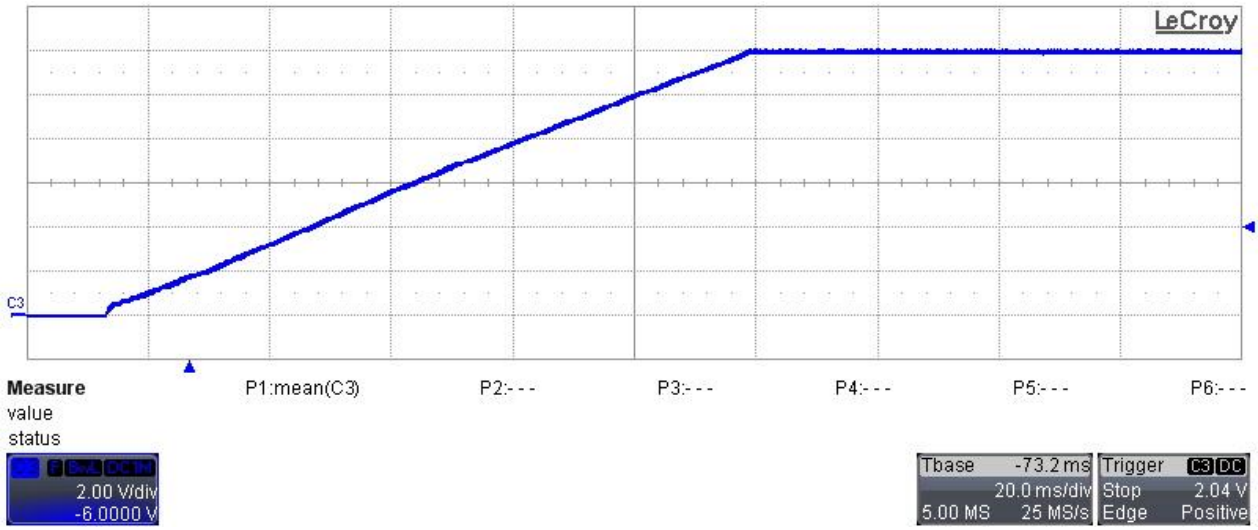
Ch.3: Output voltage (2V/div, 20ms/div, 20MHz BWL)
Full load, Vin = 90VAC, 60Hz:



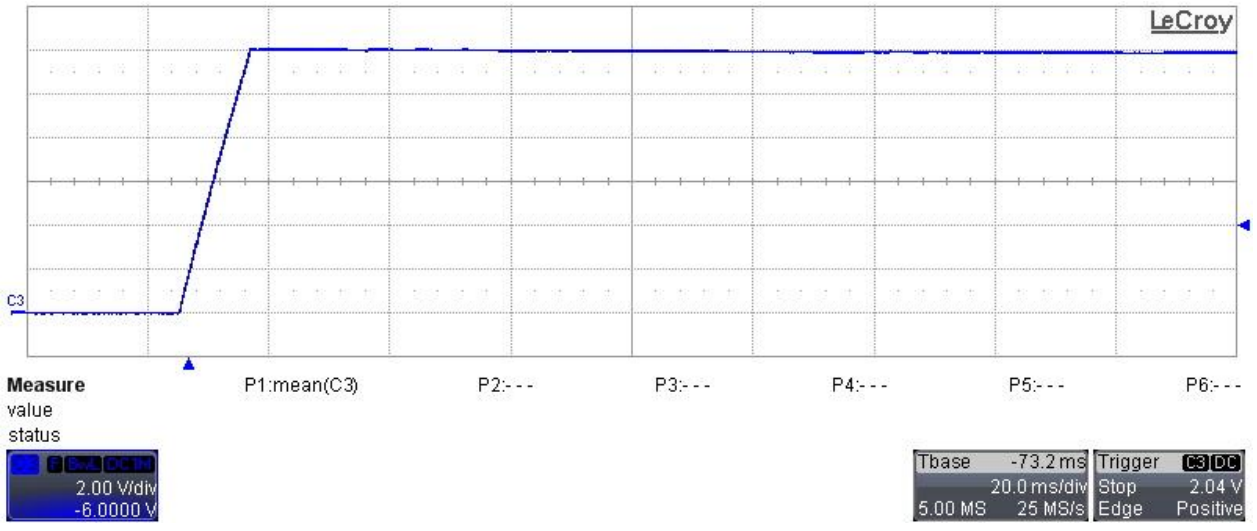
Ch.3: Output voltage (2V/div, 20ms/div, 20MHz BWL)
Zero load, Vin = 90VAC, 60Hz:



Ch.3: Output voltage (2V/div, 20ms/div, 20MHz BWL)
Full load, Vin = 265VAC, 50Hz:



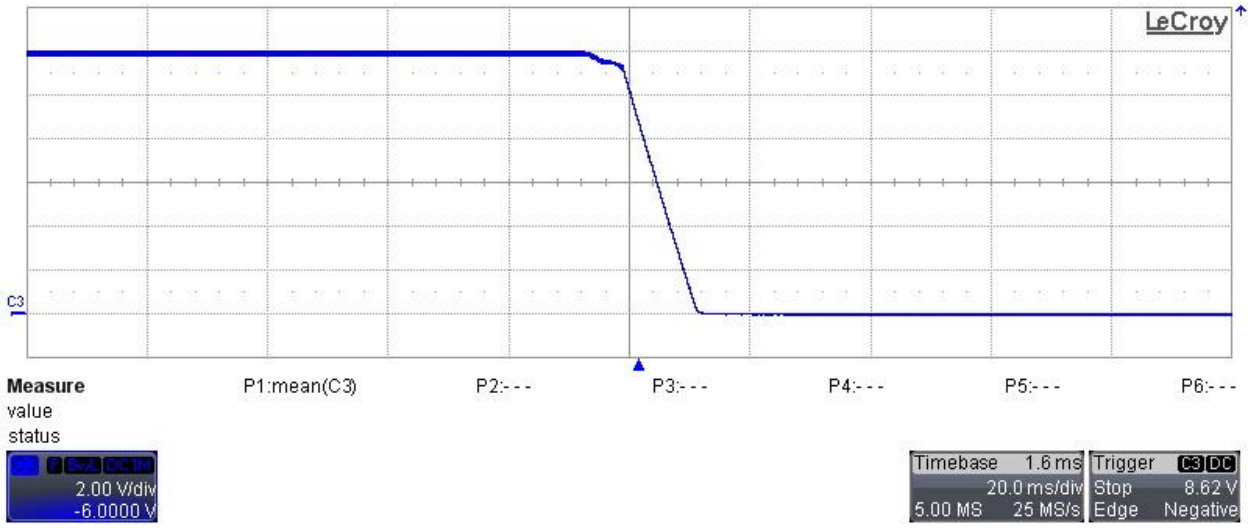
Ch.3: Output voltage (2V/div, 20ms/div, 20MHz BWL)
Zero load, Vin = 265VAC, 50Hz:



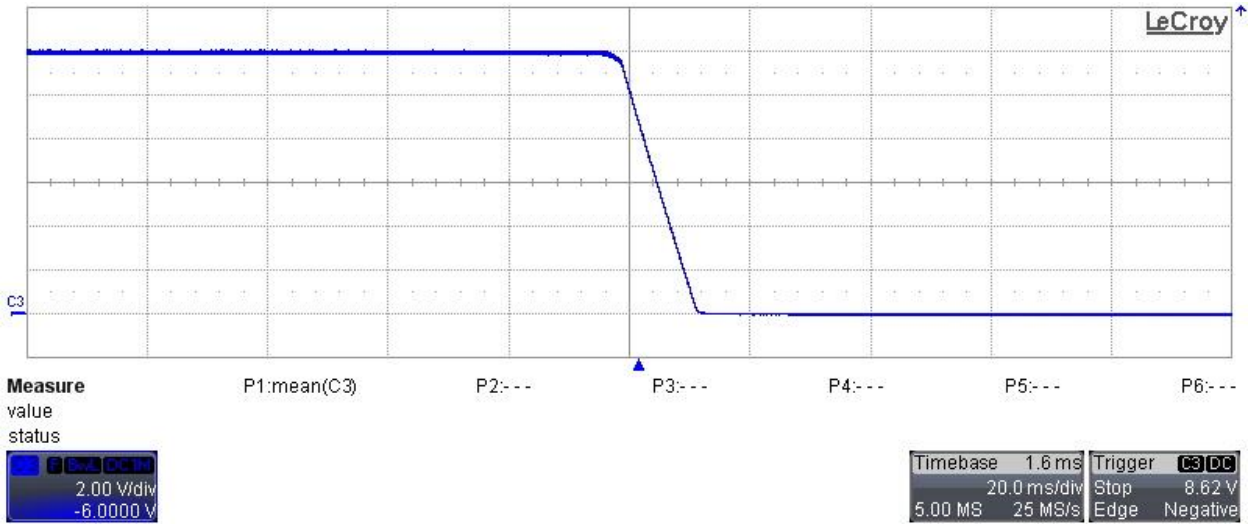
3 Shut down

During full load condition, the input AC source has been disconnected. The output voltage ramp down behavior is shown below.

Ch.3: Output voltage (2V/div, 20ms/div, 20MHz BWL)
Full load, Vin = 90VAC, 60Hz:

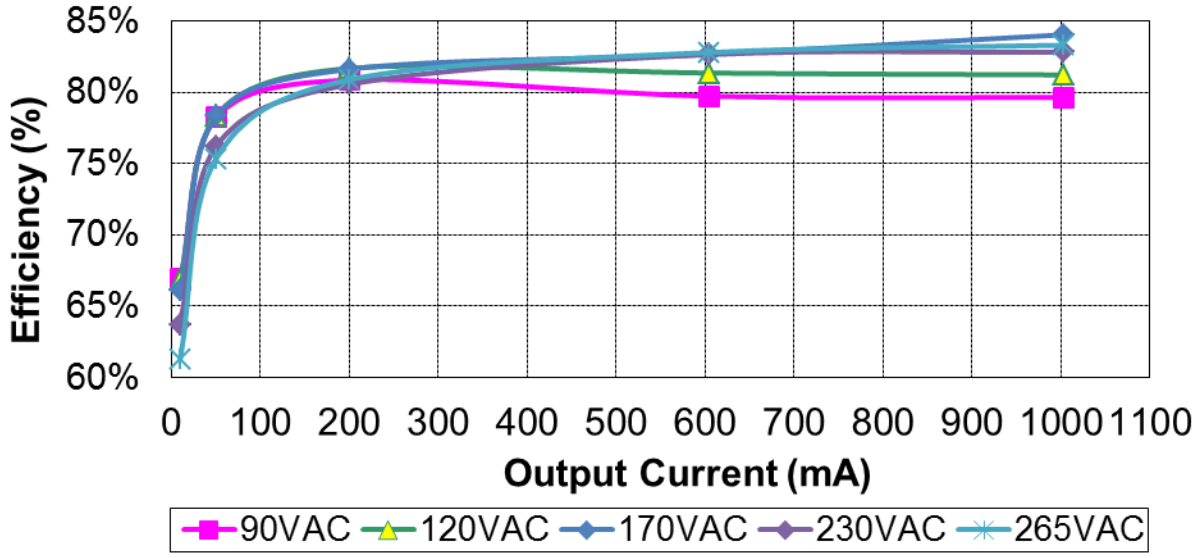


Ch.3: Output voltage (2V/div, 20ms/div, 20MHz BWL)
Full load, Vin = 265VAC, 50Hz:



4 Efficiency

The efficiency data, versus Vin and load, are shown in the tables and graph below.
The input voltage has been set respectively to 90VAC, 120VAC, 170VAC, 230VAC and 265VAC.



VAC (Vrms)	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
90	0.02374	11.96	0	0	0.0%
90	0.1830	11.89	10.3	0.122	66.9%
90	0.765	11.85	50.5	0.598	78.2%
90	2.937	11.87	200.1	2.37	80.9%
90	9.00	11.87	604.3	7.18	79.7%
90	14.96	11.88	1002.7	11.91	79.6%

VAC (Vrms)	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
120	0.02398	11.96	0	0	0.0%
120	0.1833	11.89	10.3	0.122	66.8%
120	0.762	11.84	50.4	0.597	78.3%
120	2.903	11.85	200.1	2.37	81.7%
120	8.81	11.86	604.3	7.17	81.4%
120	14.69	11.90	1002.7	11.93	81.2%

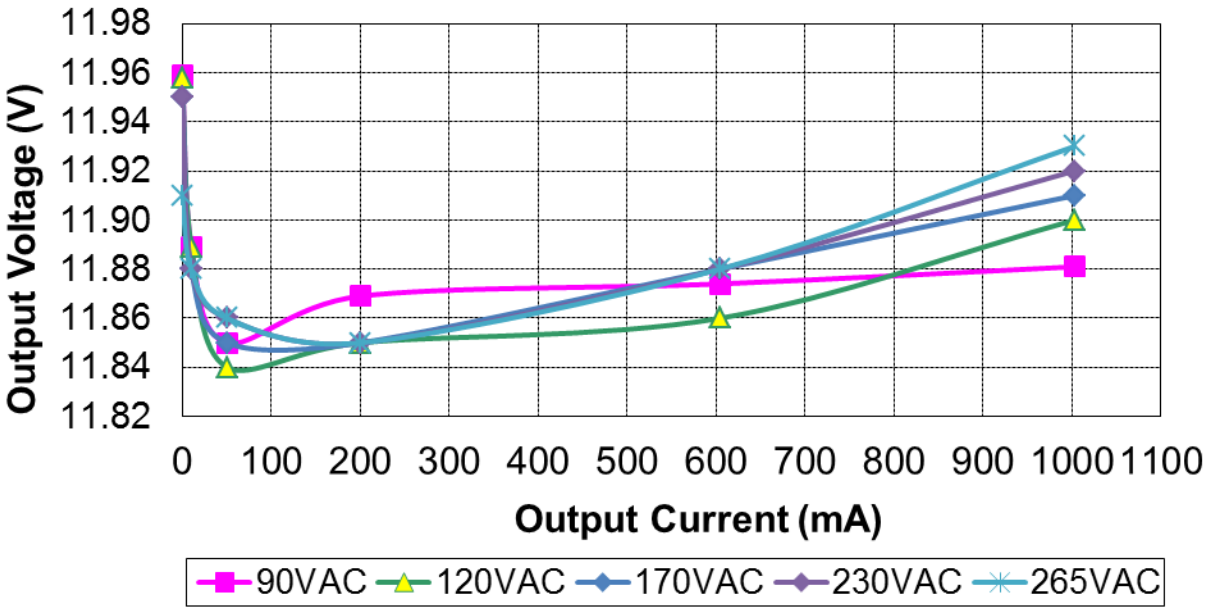
VAC (Vrms)	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
170	0.02535	11.95	0	0	0.0%
170	0.1850	11.88	10.3	0.122	66.1%
170	0.764	11.85	50.5	0.598	78.3%
170	2.905	11.85	200.1	2.37	81.6%
170	8.68	11.88	604.3	7.18	82.7%
170	14.21	11.91	1002.7	11.94	84.0%

VAC (Vrms)	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
230	0.02979	11.95	0	0	0.0%
230	0.1883	11.88	10.1	0.120	63.7%
230	0.783	11.86	50.3	0.597	76.2%
230	2.942	11.85	200.0	2.37	80.6%
230	8.69	11.88	604.2	7.18	82.6%
230	14.43	11.92	1002.6	11.95	82.8%

VAC (Vrms)	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
265	0.03739	11.91	0	0	0.0%
265	0.1959	11.88	10.1	0.120	61.2%
265	0.792	11.86	50.3	0.597	75.3%
265	2.930	11.85	200.0	2.37	80.9%
265	8.67	11.88	604.2	7.18	82.8%
265	14.36	11.93	1002.7	11.96	83.3%

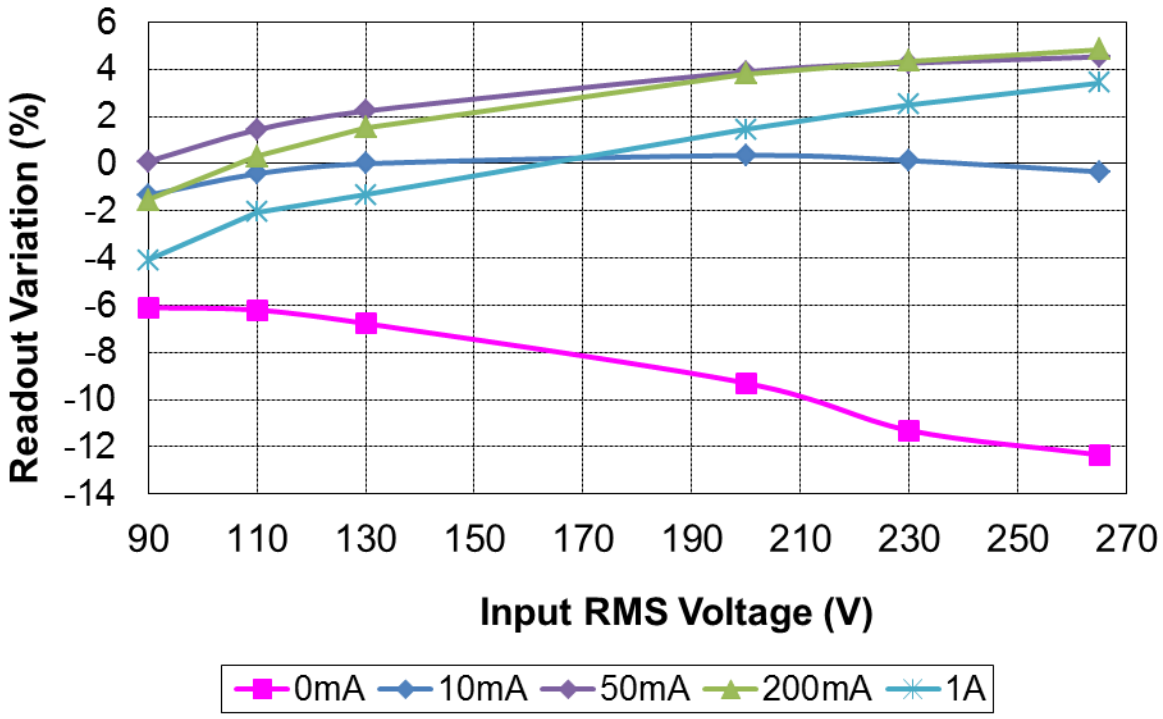
5 Output Voltage Regulation versus Load Current

The output voltage variation versus load current, for different input voltages, is plotted below.



6 Input AC voltage measurement

The secondary side winding negative voltage (pin 8 & 9 of T1) is detected by D6 & C12, which is proportional by turns ratio to input peak voltage (DC) present on C3 capacitor. This information is transferred, from primary side to secondary, side during Ton. The gain on U2 is set in order to get a DC voltage on TP3 proportional to input AC voltage. With R10/R11 gain, Vtp3 = Vin(RMS)/100. In the following graph and table is shown the percentage of deviation from the exact value. It is possible to see that the readout precision is kept within ±5% if a minimum load of 10mA is connected to the output of the power supply.

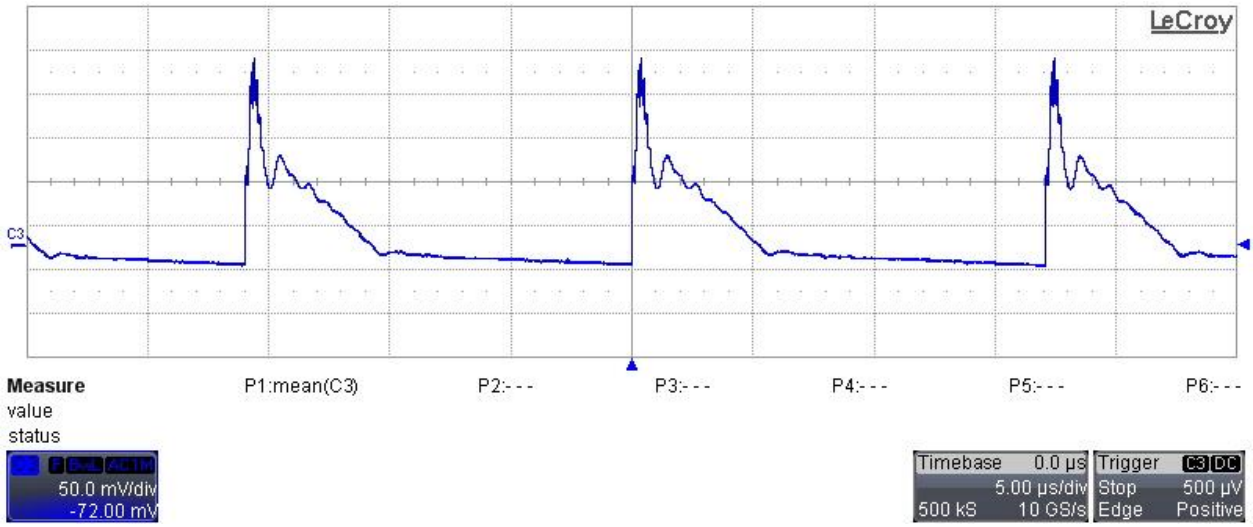


	V(TP3, Volt) vs Load current					Deviation (%)				
Vin (Vrms)	0mA	10mA	50mA	200mA	1A	0mA	10mA	50mA	200mA	1A
90	0.8451	0.8880	0.9009	0.8861	0.8632	-6.1	-1.3	0.1	-1.5	-4.1
110	1.0318	1.0953	1.1158	1.1035	1.0774	-6.2	-0.4	1.4	0.3	-2.1
130	1.212	1.300	1.329	1.320	1.283	-6.8	0.0	2.2	1.5	-1.3
200	1.814	2.007	2.078	2.076	2.029	-9.3	0.4	3.9	3.8	1.4
230	2.040	2.303	2.398	2.400	2.358	-11.3	0.1	4.3	4.3	2.5
265	2.323	2.641	2.770	2.778	2.741	-12.3	-0.3	4.5	4.8	3.4

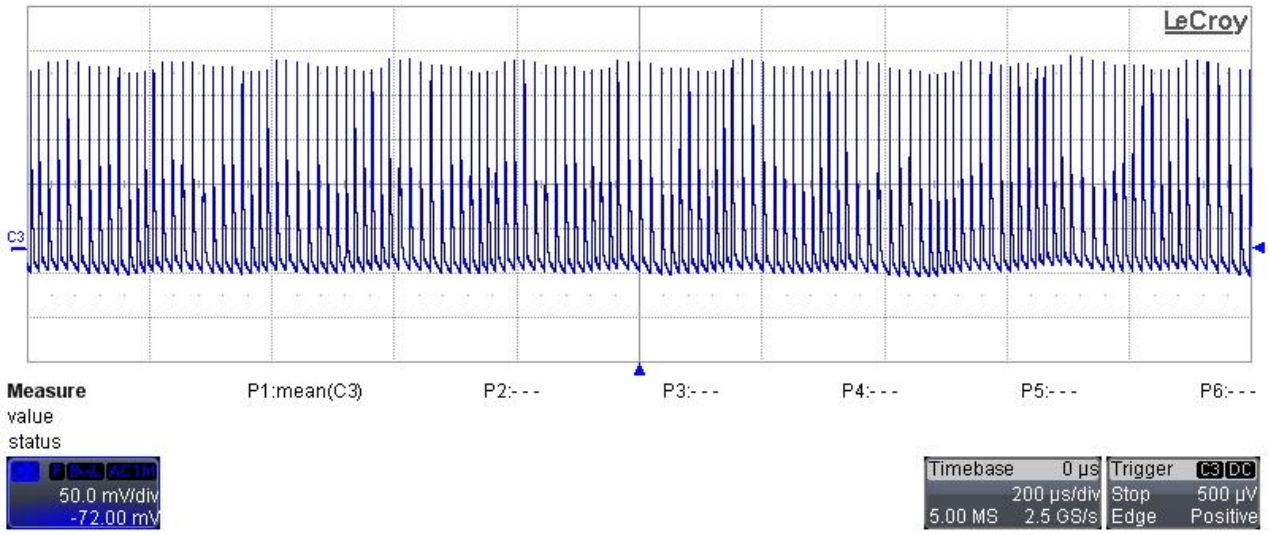
7 Output Ripple Voltage

The output ripple voltage has been measured by supplying the converter at 90VAC, 230VAC and 265VAC in full load condition and very light load as well to detect any low frequency ripple. (All screenshots have been taken with 20MHz bandwidth, AC coupling).

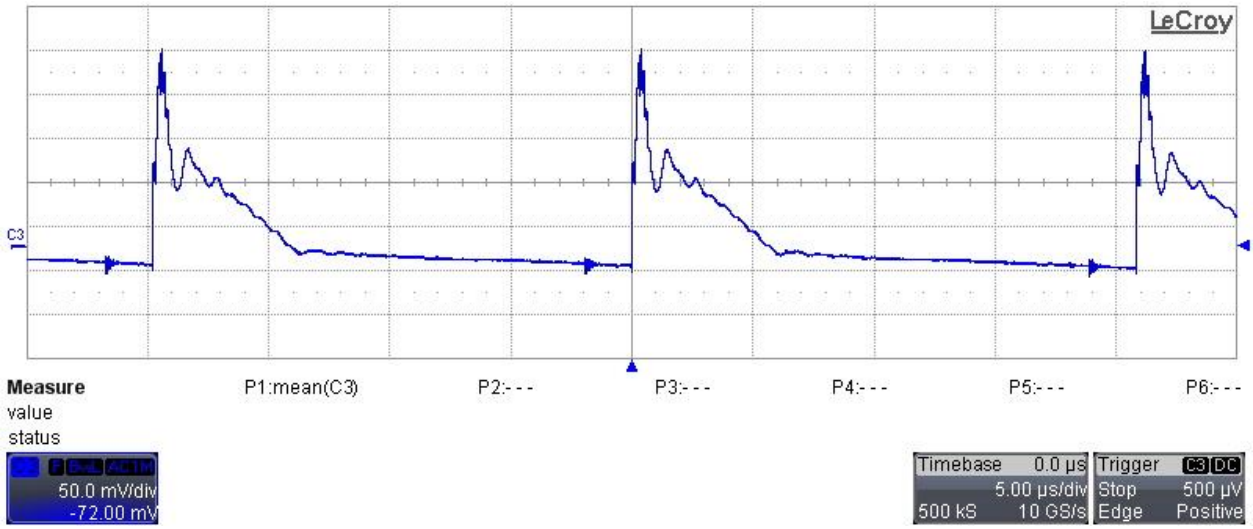
Full load, Vin = 90VAC, 60Hz:
Ch.3: Output voltage (50mV/div, 5us/div)



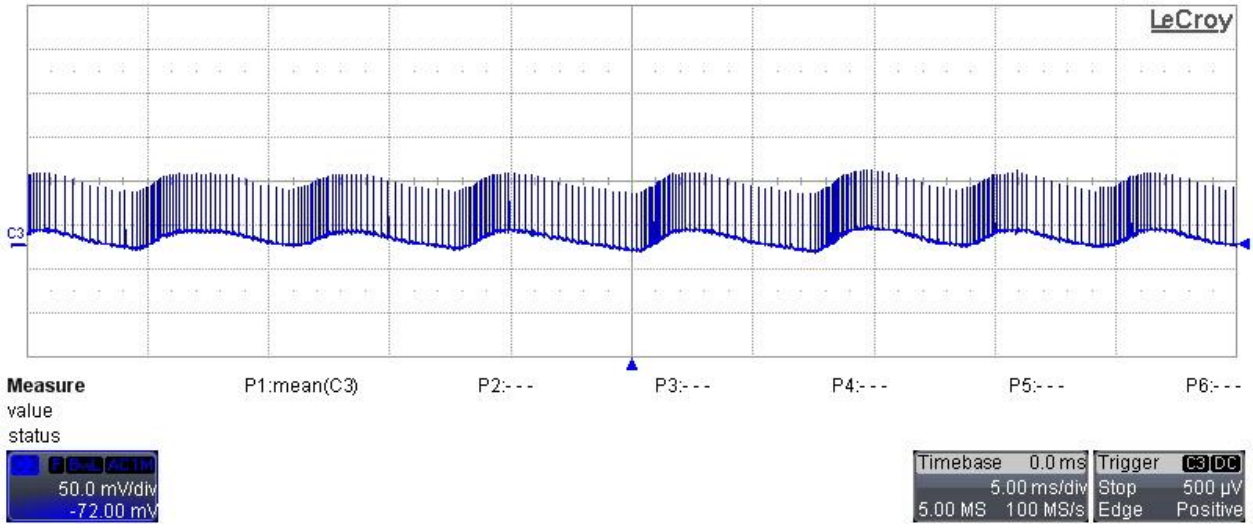
Full load, Vin = 90VAC, 60Hz:
Ch.3: Output voltage (50mV/div, 200us/div)



Full load, Vin = 265VAC, 50Hz:
Ch.3: Output voltage (50mV/div, 5us/div)



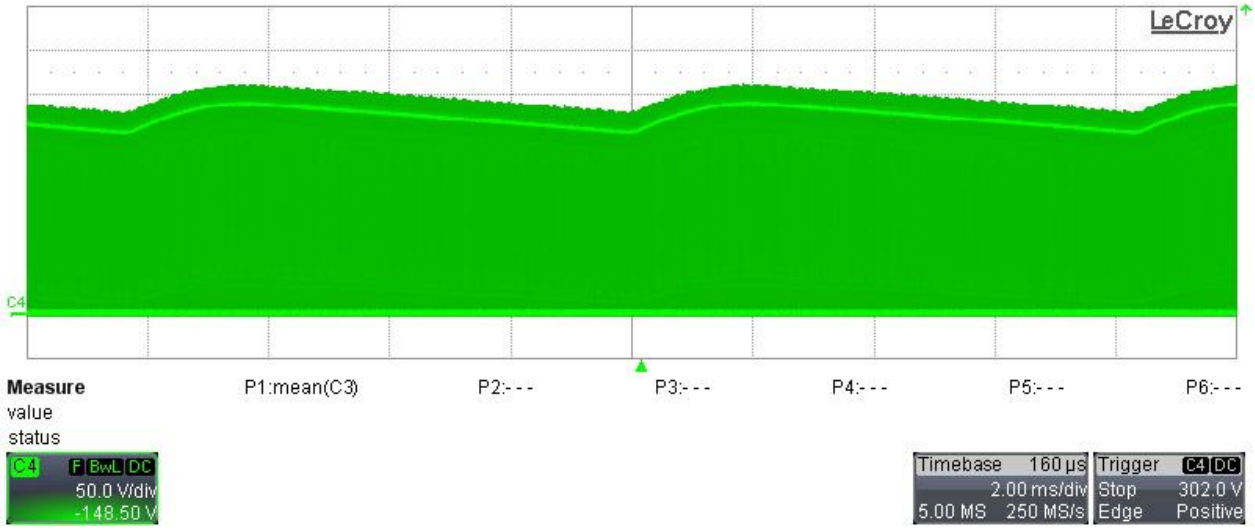
Load = 13mA, Vin = 230VAC, 50Hz:
Ch.3: Output voltage (50mV/div, 5ms/div)



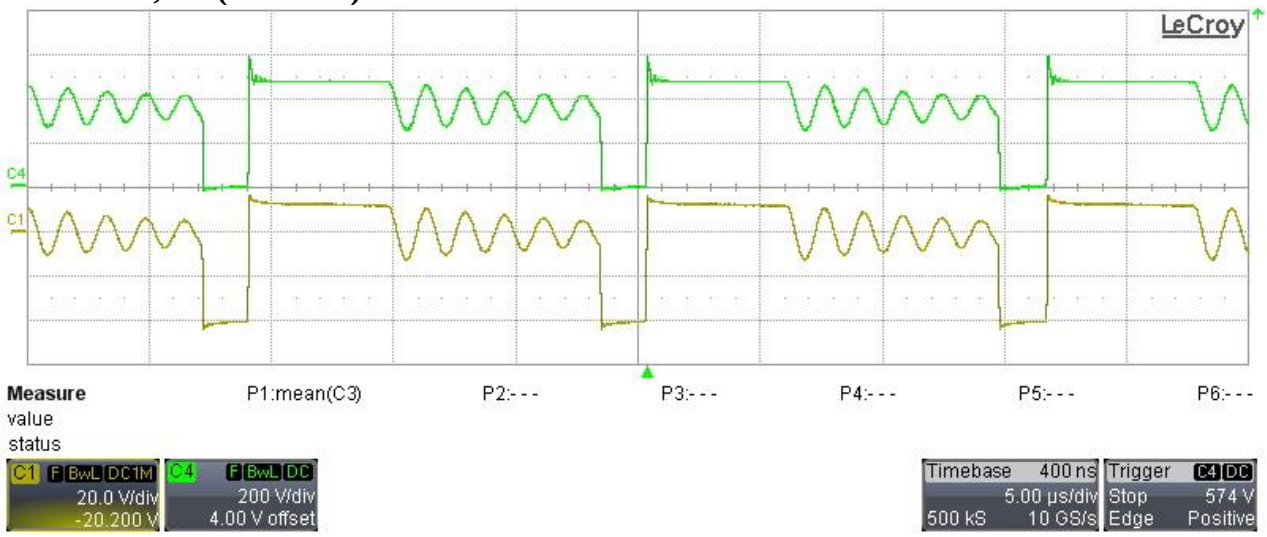
8 Switch nodes

The images below show the switch node of U1 (pin 8), taken at 90VAC (useful to show 120Hz ripple) and 265VAC input voltage while the output was fully loaded. The second screenshot shows also TP18 voltage (anode of D1, D3); for all waveforms both probes were set to DC coupling and 200MHz bandwidth limit.

Vin = 90VAC, 60Hz:
Ch.4: Pin 8, U1 (50V/div, 2ms/div)



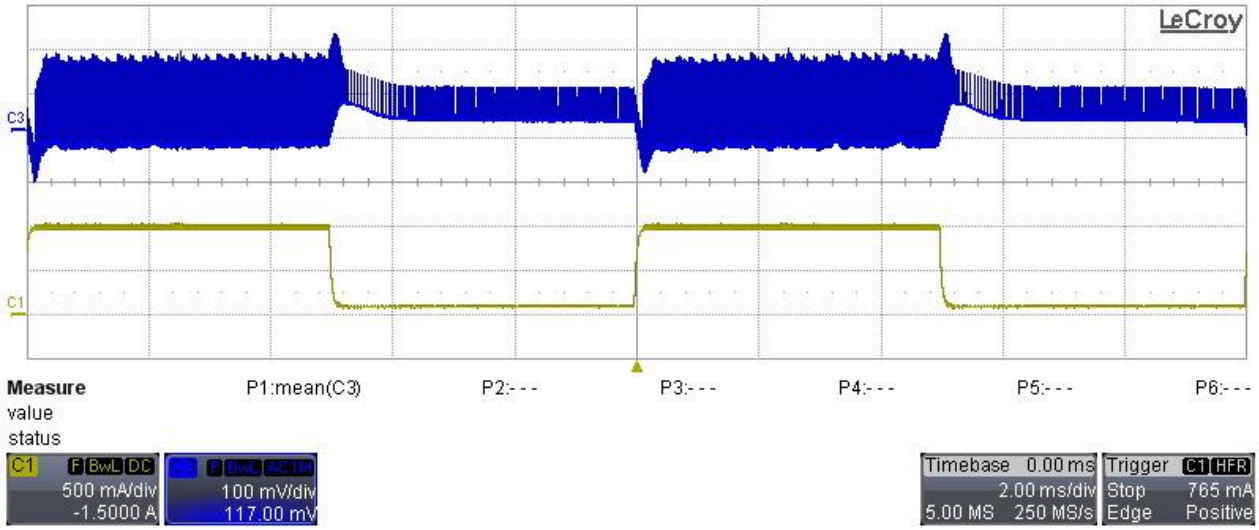
Vin = 265VAC, 50Hz:
Ch.1: TP18 Voltage (20V/div, 5us/div)
Ch.4: Pin 8, U1 (200V/div)



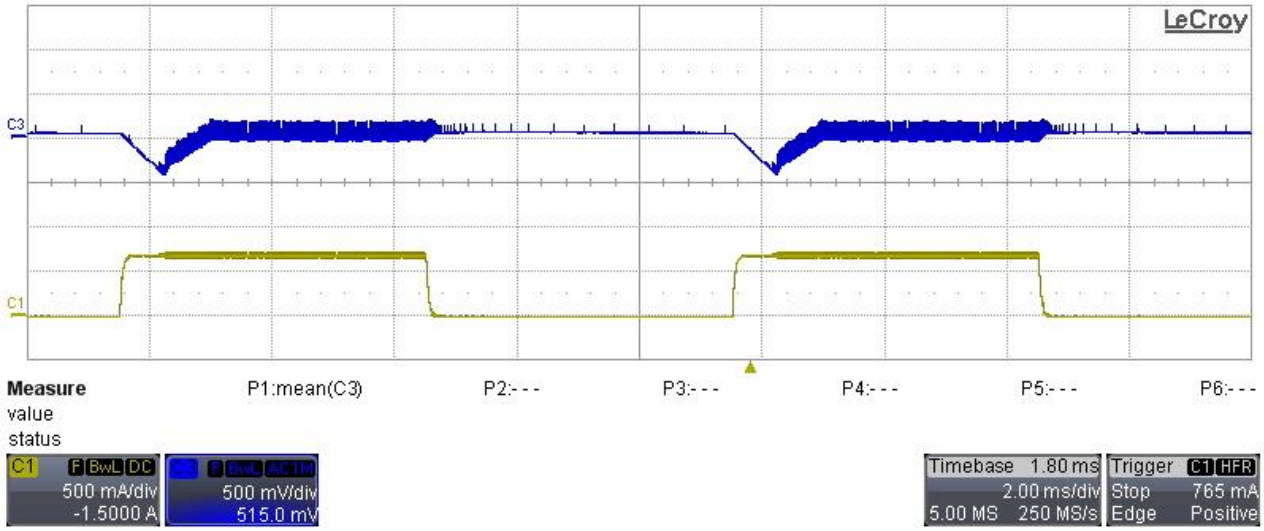
9 Transient Response

The images below show the transient response on output voltage in different load transient range and Vin conditions.

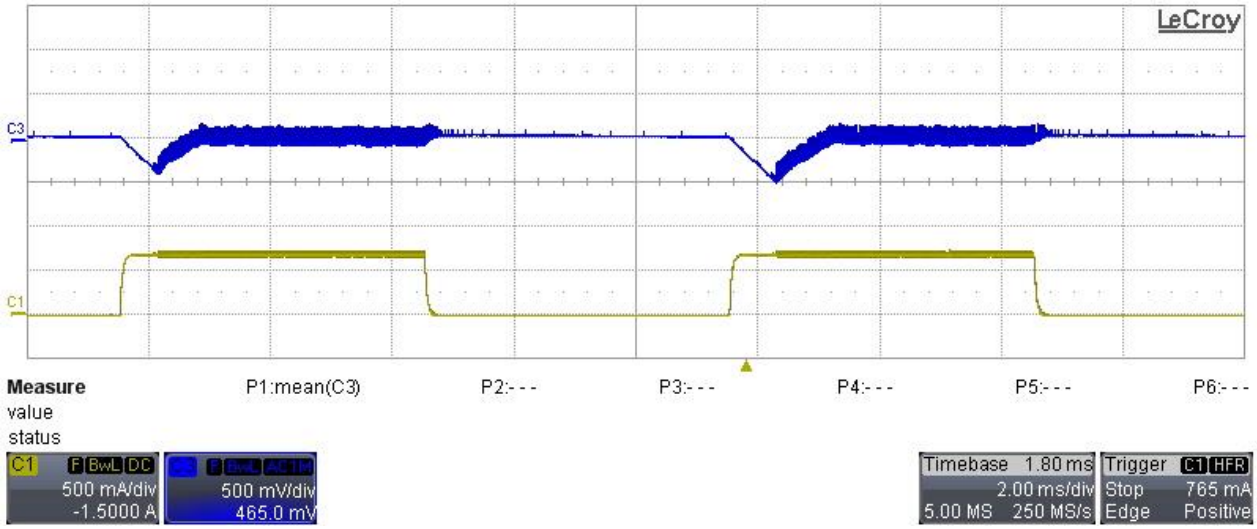
Vin = 230VAC, 50Hz; Iout = 100mA → 1A
Ch.1: Output current (500mA/div, 2ms/div, DC coupling, 20MHz BWL)
Ch.3: Output voltage (100mV/div, DC coupling, 20MHz BWL)



Vin = 230VAC, 50Hz; Iout = 10mA → 700mA
Ch.1: Output current (500mA/div, 2ms/div, DC coupling, 20MHz BWL)
Ch.3: Output voltage (500mV/div, DC coupling, 20MHz BWL)



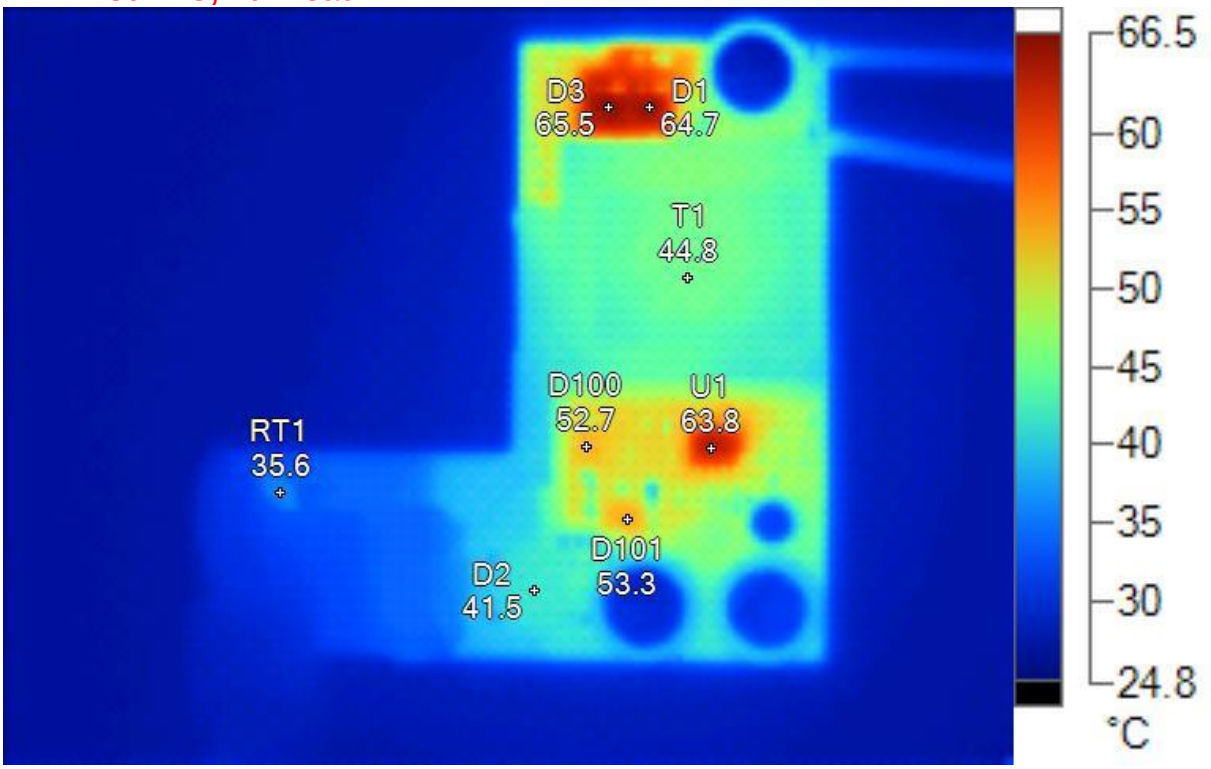
Vin = 90VAC, 50Hz; Iout = 10mA → 700mA
Ch.1: Output current (500mA/div, 2ms/div, DC coupling, 20MHz BWL)
Ch.3: Output voltage (500mV/div, DC coupling, 20MHz BWL)



10 Thermal Analysis

During the thermal analysis, the converter has been placed horizontally on the bench in still air conditions, while fully loaded and supplied @ 230Vrms (first image) and 115VAC (second one).

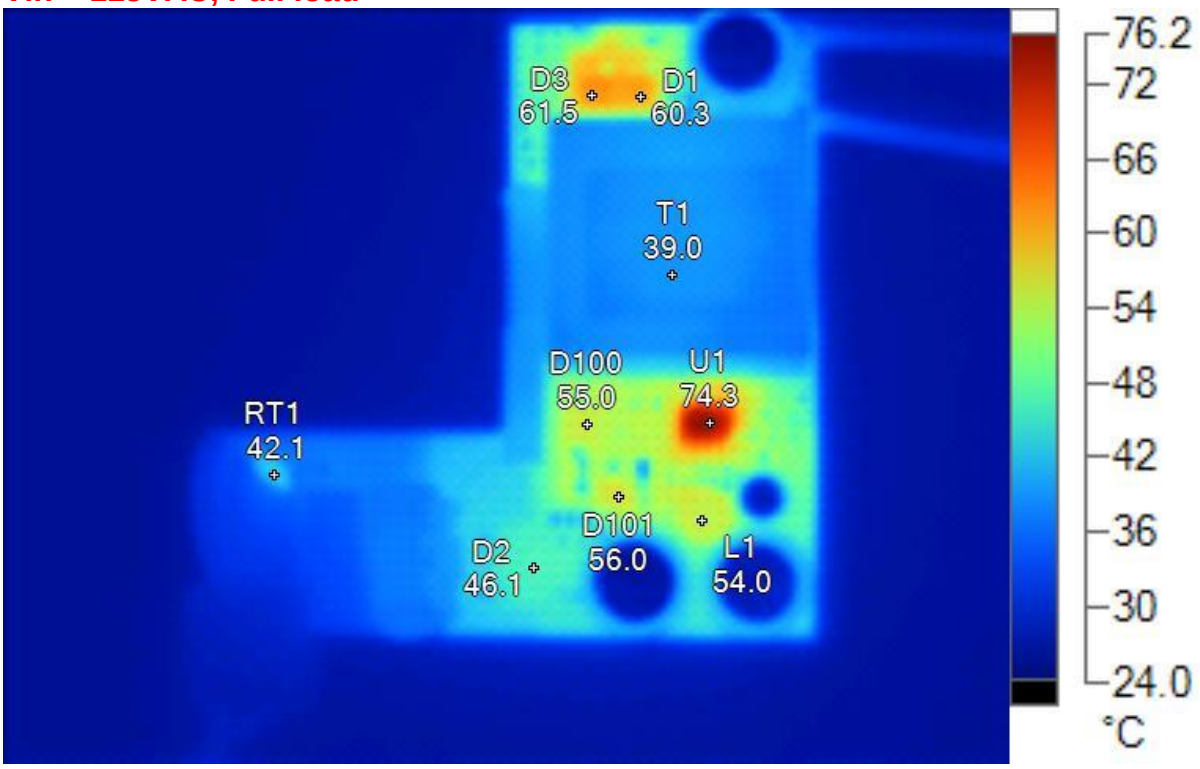
Vin = 230VAC, Full load



Main Image Markers, Vin = 230VAC, 50Hz

Name	Temperature	Emissivity	Background
D3	65.5°C	0.95	23.0°C
D1	64.7°C	0.95	23.0°C
U1	63.8°C	0.95	23.0°C
D101	53.3°C	0.95	23.0°C
D100	52.7°C	0.95	23.0°C
RT1	35.6°C	0.95	23.0°C
D2	41.5°C	0.95	23.0°C
T1	44.8°C	0.95	23.0°C

Vin = 115VAC, Full load

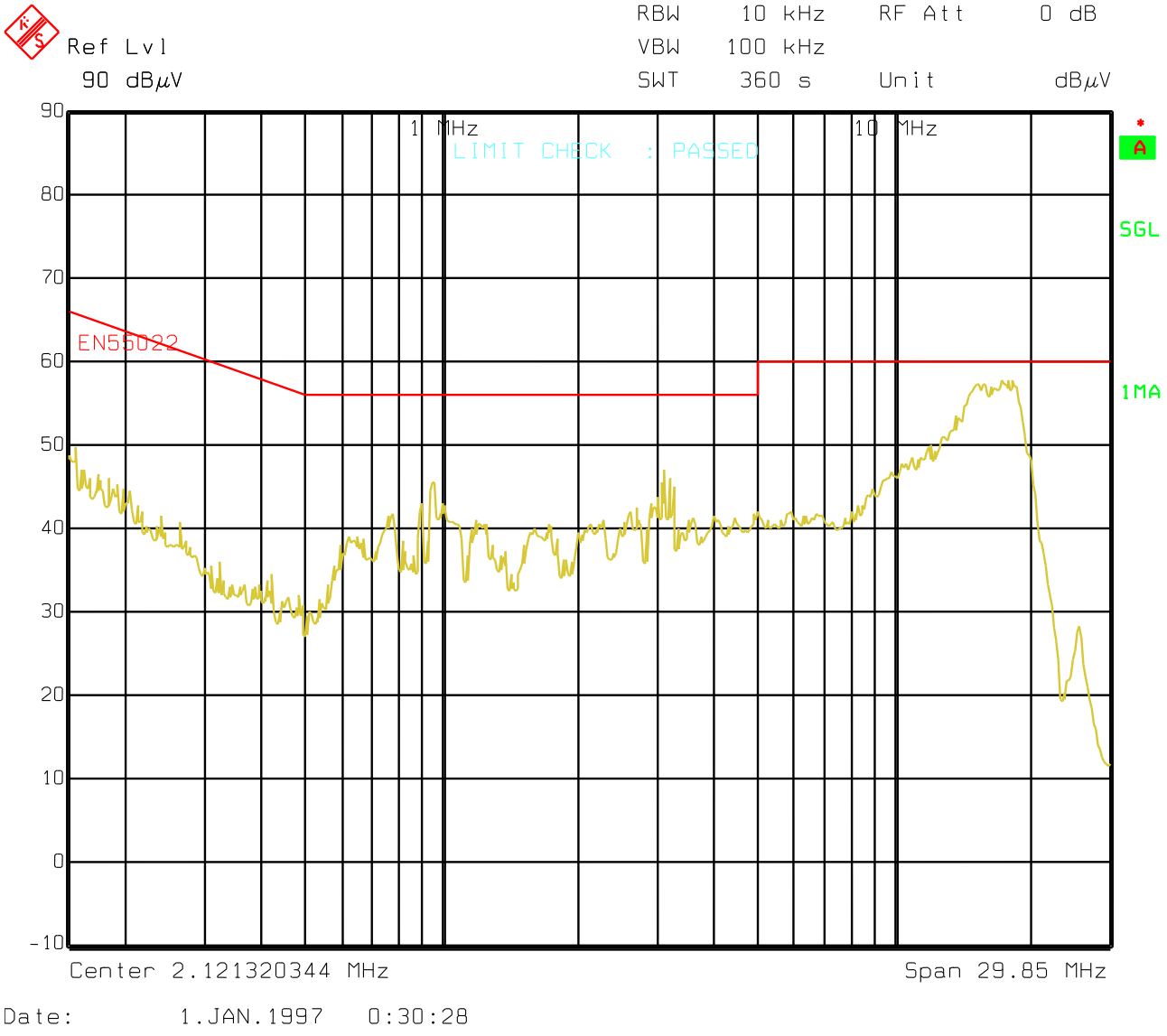


Main Image Markers, Vin = 115VAC, 60Hz

Name	Temperature	Emissivity	Background
RT1	42.1°C	0.95	23.0°C
U1	74.3°C	0.95	23.0°C
D101	56.0°C	0.95	23.0°C
D100	55.0°C	0.95	23.0°C
L1	54.0°C	0.95	23.0°C
D3	61.5°C	0.95	23.0°C
D1	60.3°C	0.95	23.0°C
T1	39.0°C	0.95	23.0°C
D2	46.1°C	0.95	23.0°C

11 EMI measurement

The graph below shows the EMI measurement of the converter connected to an isolation transformer by means of a Hameg HM6050-2 LISN. The supply voltage was 230VAC. The converter has been loaded with a power resistor adjusted to deliver full load. The output negative terminal of the converter has been connected to the ground of the LISN. The detector of the receiver was set to “quasi-peak” and the limit is the equivalent EN55022 grade B.



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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265