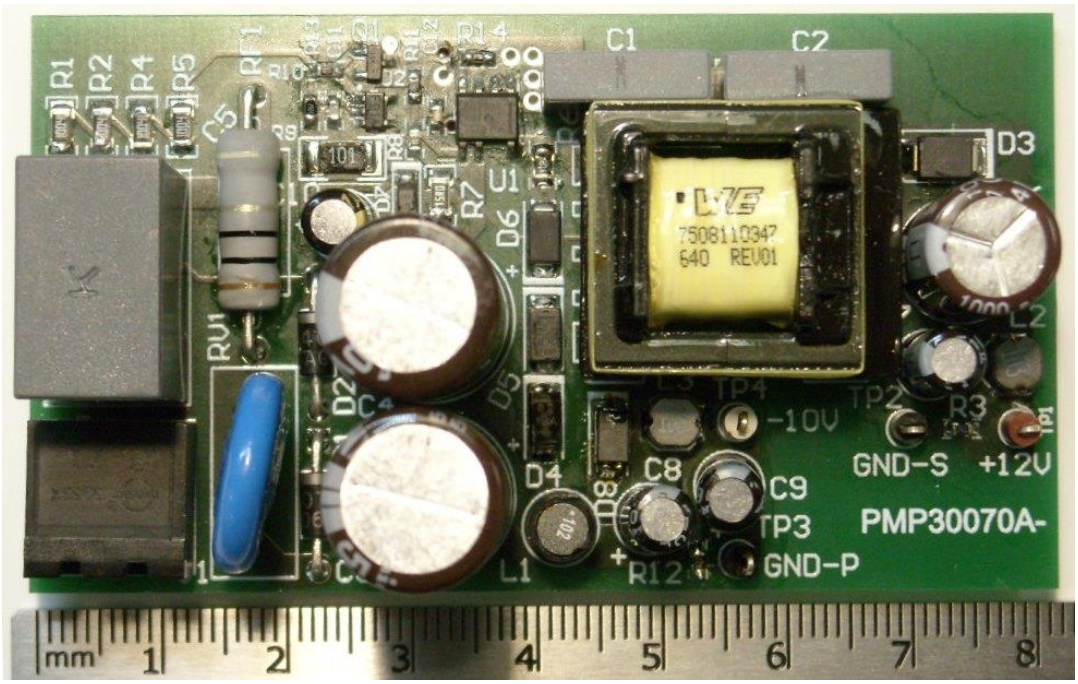
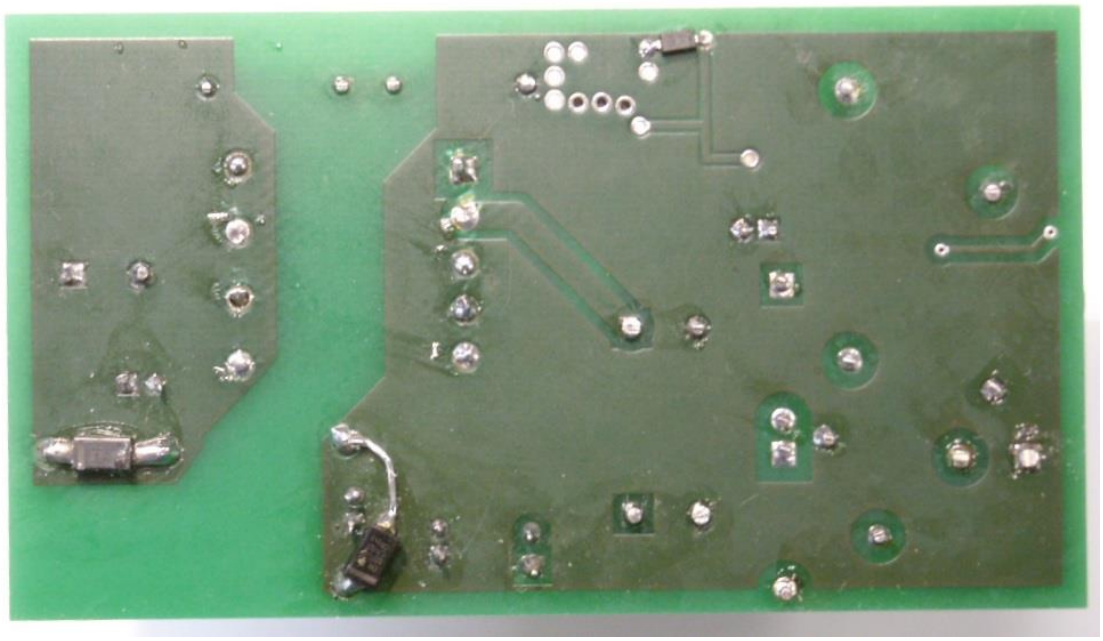
1 Photo of the prototype (45.72mm x 81.28mm).

PMP30070 Rev_C employs the PCB revision PMP30070 Rev_A.

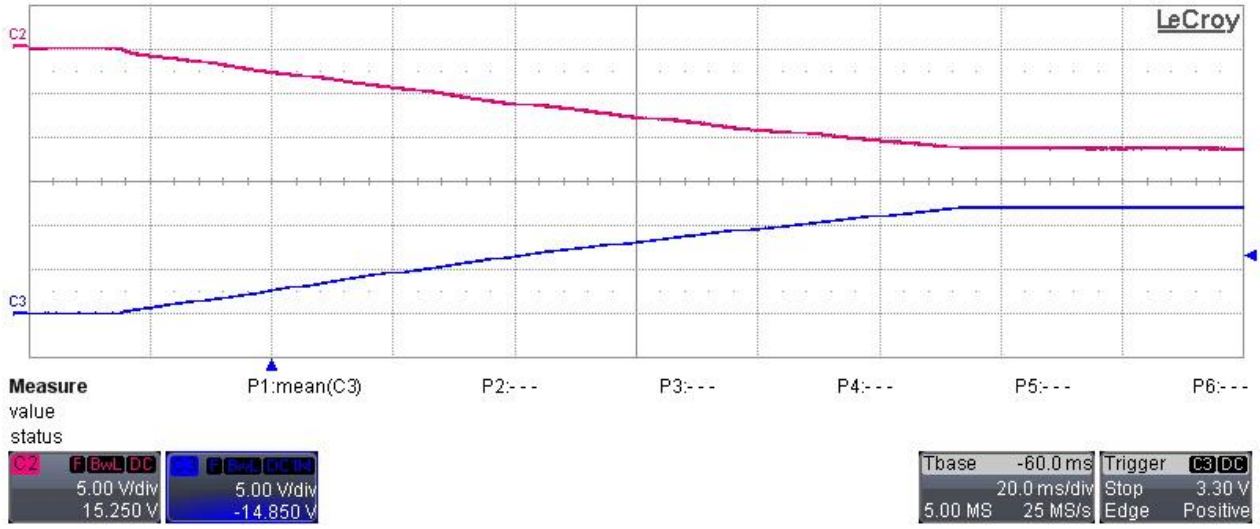




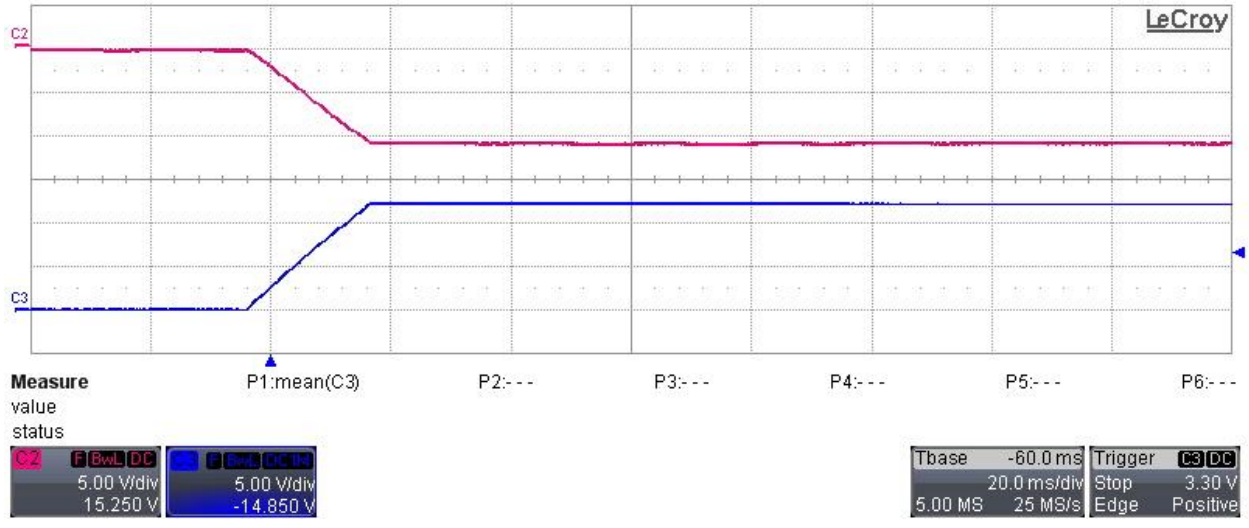
2 Startup

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 270VAC. Each channel was limited to 20MHz bandwidth.

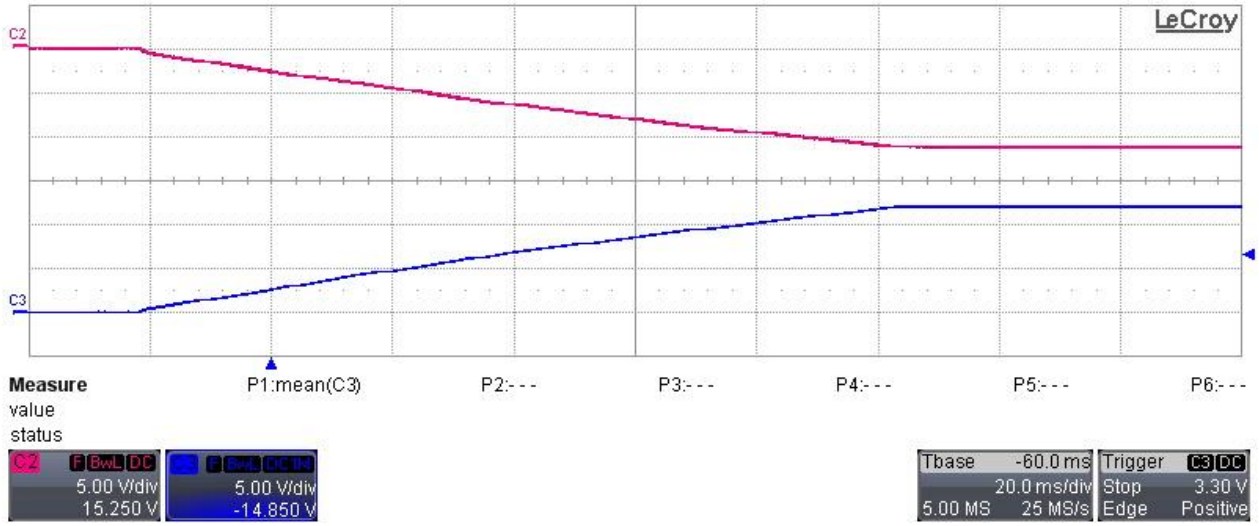
Ch.2: -10Vout (TP4) Voltage (5V/div, 20ms/div)
Ch.3: +12Vout (TP1) Voltage (5V/div)
Both outputs fully loaded, Vin = 90VAC, 60Hz:



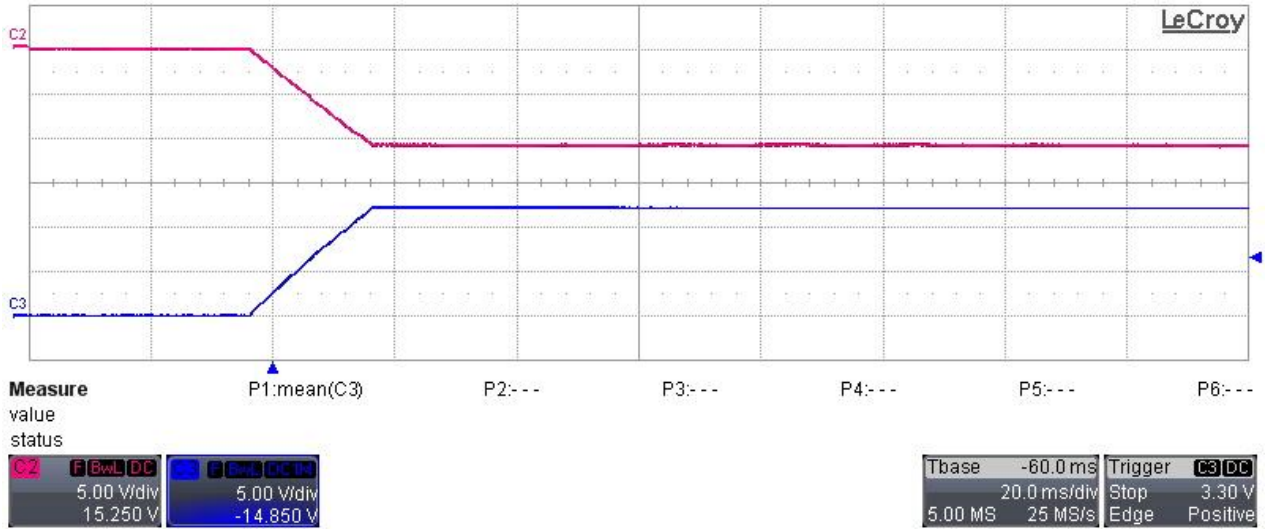
Ch.2: -10Vout (TP4) Voltage (5V/div, 20ms/div)
Ch.3: +12Vout (TP1) Voltage (5V/div)
Both outputs unloaded, Vin = 90VAC, 60Hz:



Ch.2: -10Vout (TP4) Voltage (5V/div, 20ms/div)
Ch.3: +12Vout (TP1) Voltage (5V/div)
Both outputs fully loaded, Vin = 270VAC, 50Hz:



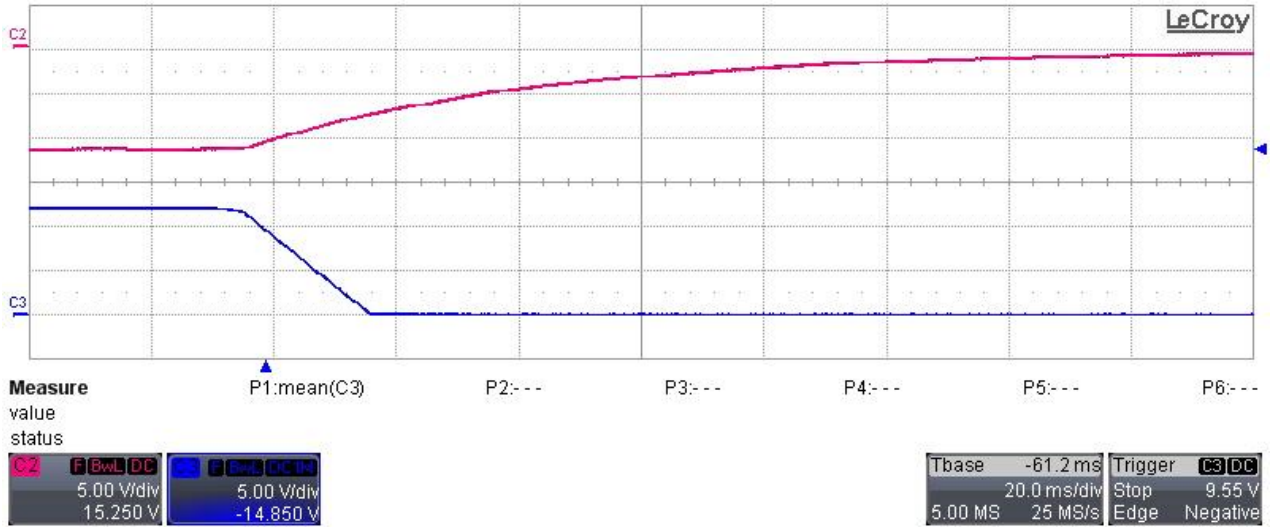
Ch.2: -10Vout (TP4) Voltage (5V/div, 20ms/div)
Ch.3: +12Vout (TP1) Voltage (5V/div)
Both outputs unloaded, Vin = 270VAC, 50Hz:



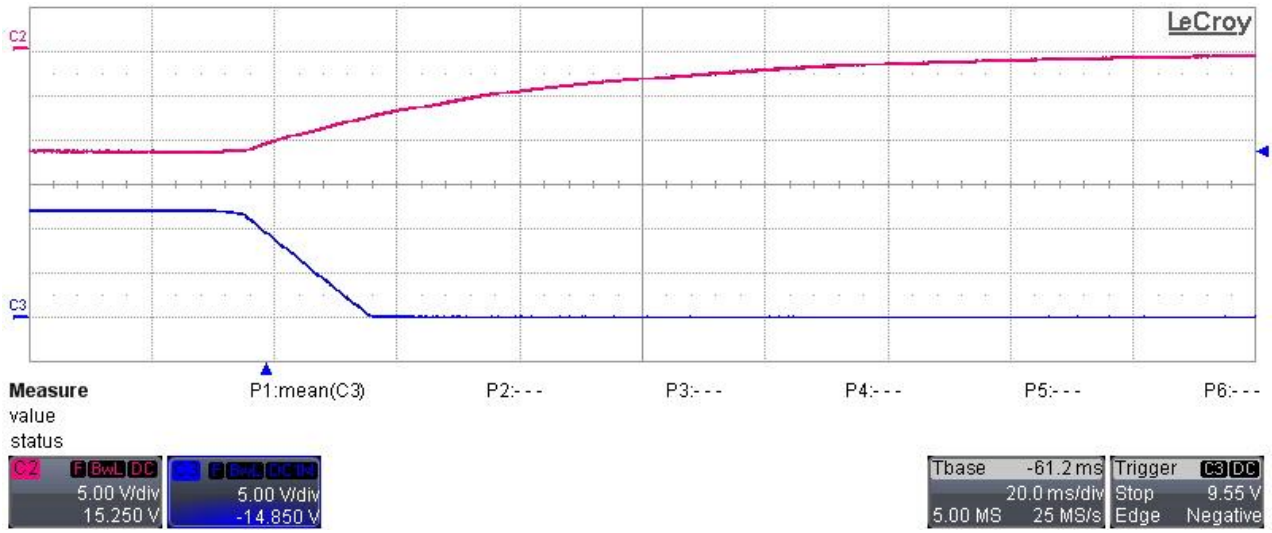
3 Shut down

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

Ch.2: -10Vout (TP4) Voltage (5V/div, 20ms/div)
Ch.3: +12Vout (TP1) Voltage (5V/div)
Both outputs fully loaded, Vin = 90VAC, 60Hz:

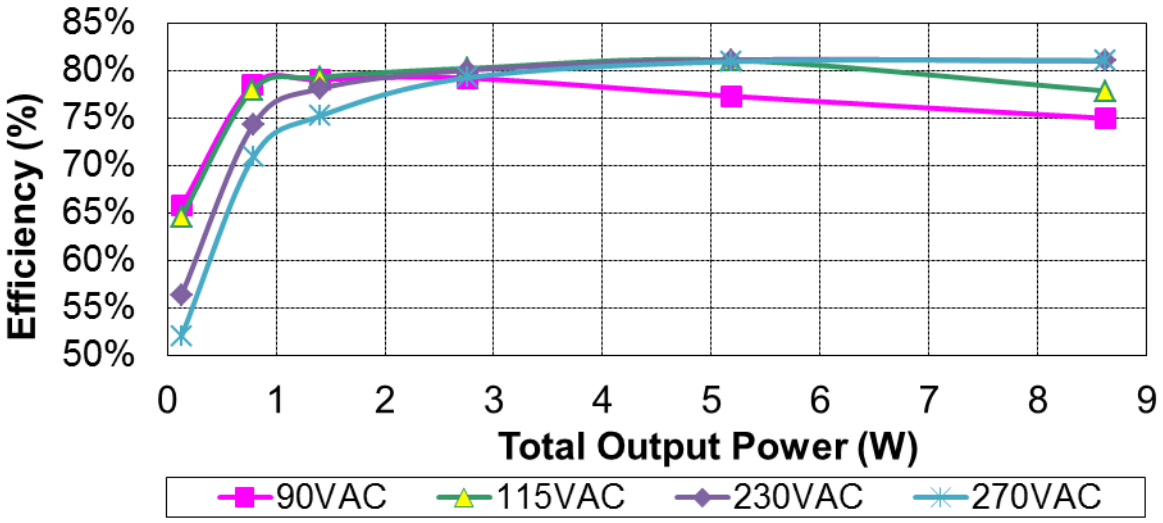


Ch.2: -10Vout (TP4) Voltage (5V/div, 20ms/div)
Ch.3: +12Vout (TP1) Voltage (5V/div)
Both outputs fully loaded, Vin = 270VAC, 50Hz:

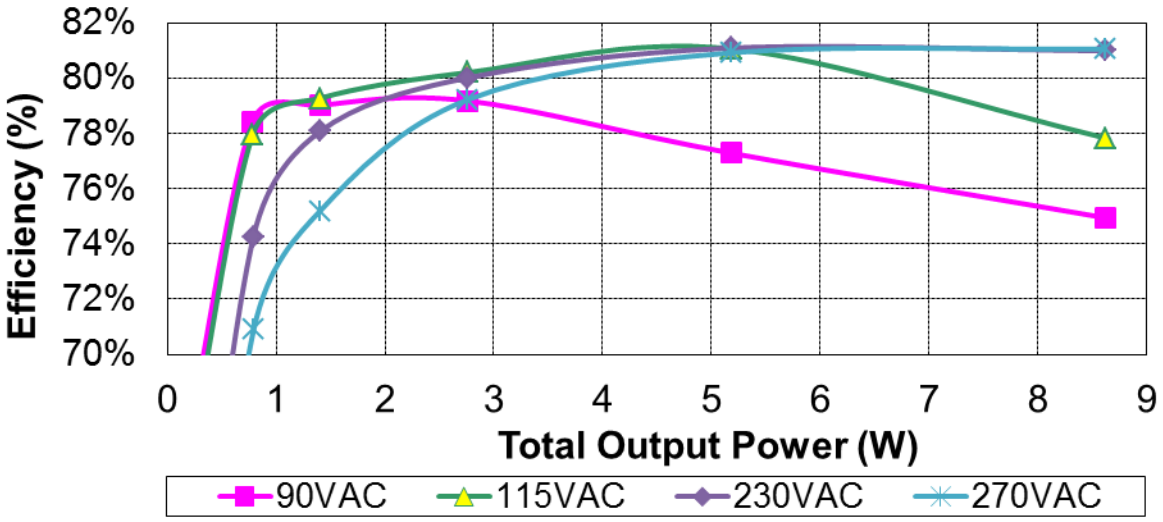


4 Efficiency

The efficiency data, versus Vin and load, are shown in the tables and graphs below.
The input voltage has been set respectively to 90VAC, 115VAC, 230VAC and 270VAC.
Both outputs have been loaded proportionally to their nominal ratings.



The graph below shows the same curves of the previous one, with expanded y-axis:



VAC (RMS)	Pin (W)	V_12V(V)	I_12V(mA)	V-10V(V)	I-10V(mA)	Pout (W)	Eff. (%)
90	0.0358	12.30	0	10.44	0	0	0.0%
90	0.198	11.91	10.9	11.35	0	0.13	65.7%
90	1.000	11.90	51.0	10.49	16.9	0.78	78.4%
90	1.774	11.91	101.8	10.83	17.5	1.40	79.0%
90	3.490	11.92	200.6	10.74	34.6	2.76	79.2%
90	6.703	11.90	401.1	11.24	36.3	5.18	77.3%
90	11.51	11.91	671.4	11.41	55.2	8.63	74.9%

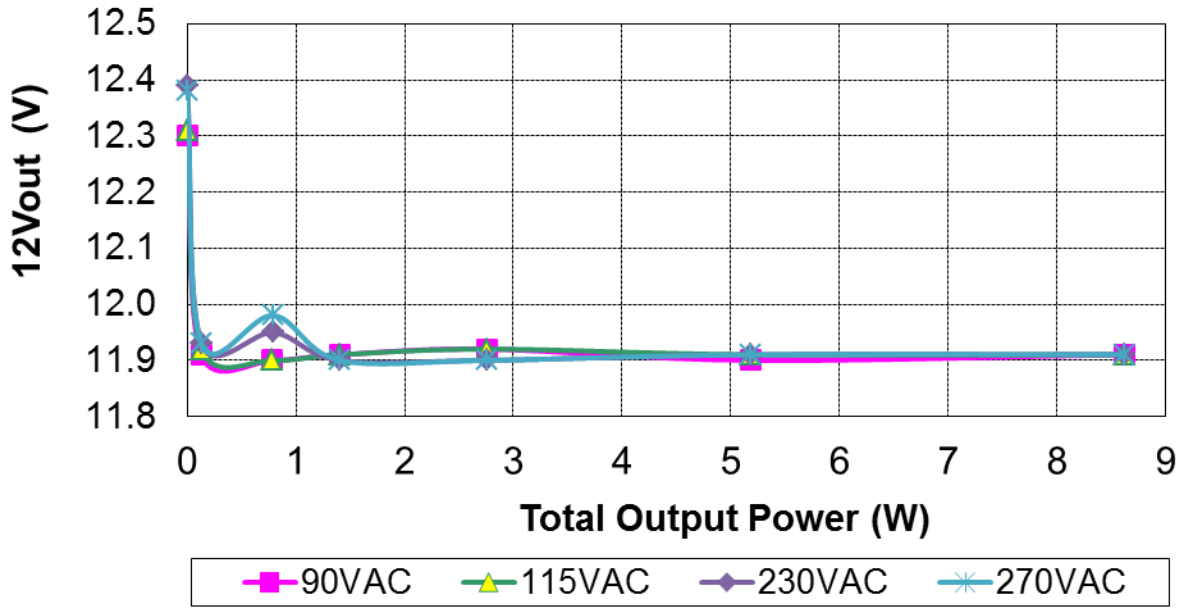
VAC (RMS)	Pin (W)	V_12V(V)	I_12V(mA)	V-10V(V)	I-10V(mA)	Pout (W)	Eff. (%)
115	0.0390	12.31	0	10.45	0	0	0.0%
115	0.201	11.92	10.9	11.36	0	0.13	64.6%
115	1.008	11.90	51.1	10.50	16.9	0.79	78.0%
115	1.770	11.91	101.9	10.84	17.5	1.40	79.3%
115	3.445	11.92	200.6	10.74	34.6	2.76	80.2%
115	6.397	11.91	401.1	11.25	36.3	5.19	81.1%
115	11.08	11.91	671.4	11.38	55.1	8.62	77.8%

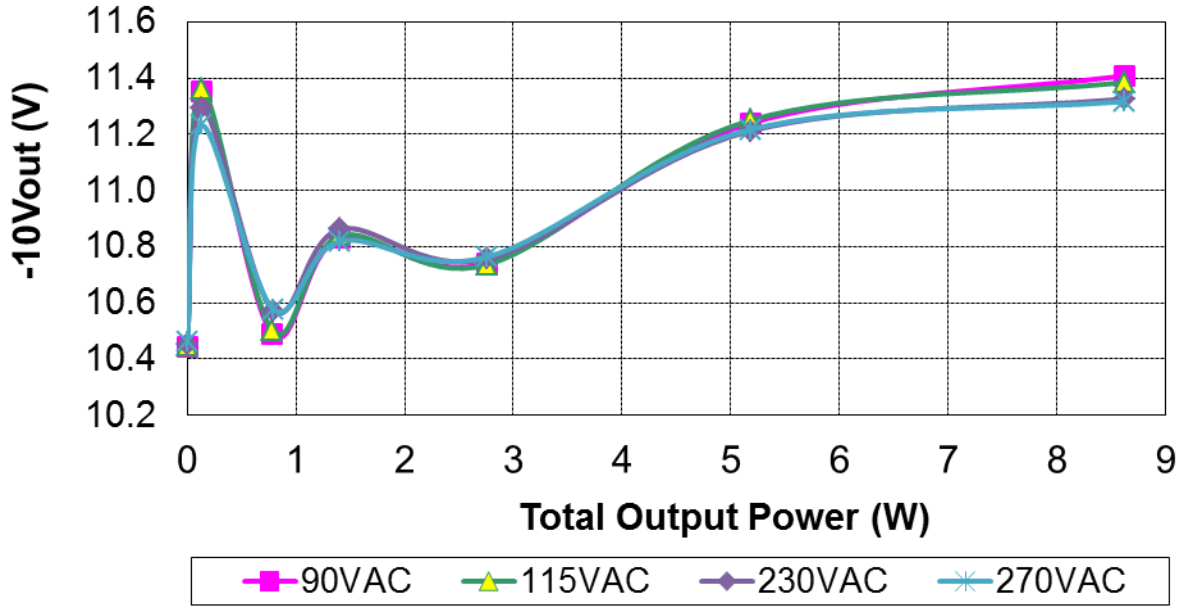
VAC (RMS)	Pin (W)	V_12V(V)	I_12V(mA)	V-10V(V)	I-10V(mA)	Pout (W)	Eff. (%)
230	0.0660	12.39	0	10.45	0	0	0.0%
230	0.231	11.93	10.9	11.29	0	0.13	56.3%
230	1.065	11.95	51.1	10.57	17.1	0.79	74.3%
230	1.797	11.90	101.9	10.86	17.5	1.40	78.1%
230	3.450	11.90	200.6	10.76	34.7	2.76	80.0%
230	6.390	11.91	401.0	11.21	36.2	5.18	81.1%
230	10.64	11.91	671.4	11.33	54.8	8.62	81.0%

VAC (RMS)	Pin (W)	V_12V(V)	I_12V(mA)	V-10V(V)	I-10V(mA)	Pout (W)	Eff. (%)
270	0.0844	12.38	0	10.46	0	0	0.0%
270	0.250	11.93	10.9	11.23	0	0.13	52.0%
270	1.118	11.98	51.1	10.58	17.1	0.79	70.9%
270	1.864	11.90	101.9	10.82	17.5	1.40	75.2%
270	3.485	11.90	200.6	10.76	34.7	2.76	79.2%
270	6.404	11.91	401.0	11.22	36.2	5.18	80.9%
270	10.63	11.91	671.4	11.32	54.7	8.62	81.1%

5 Output Voltage Regulation versus Load Current

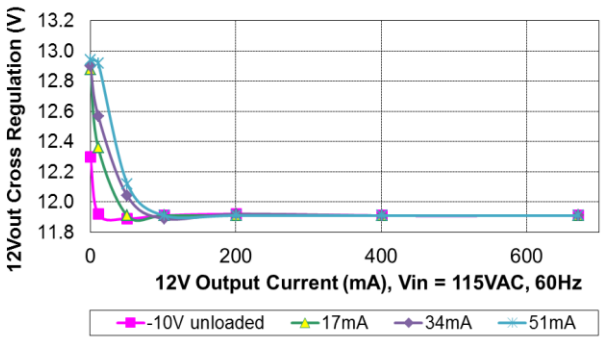
The output voltage variation, for both outputs and different input AC voltages, versus load current, is plotted below. Load conditions were the same like point 4.

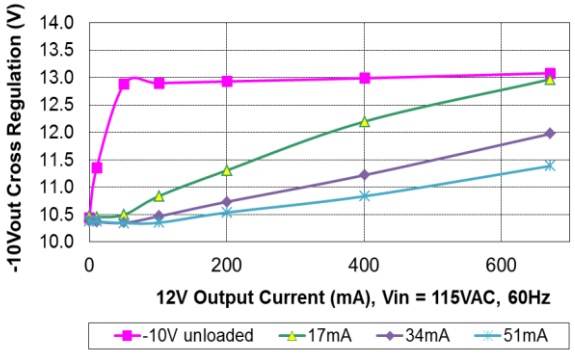


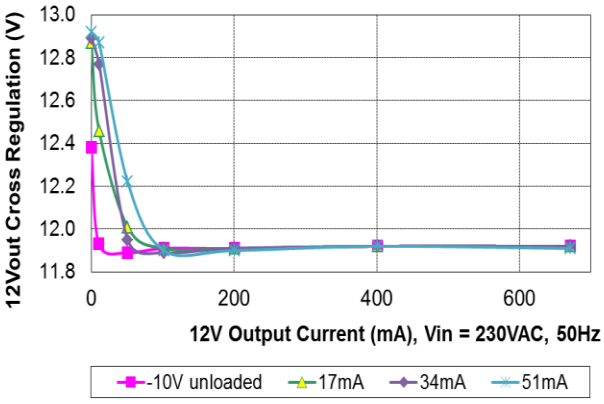


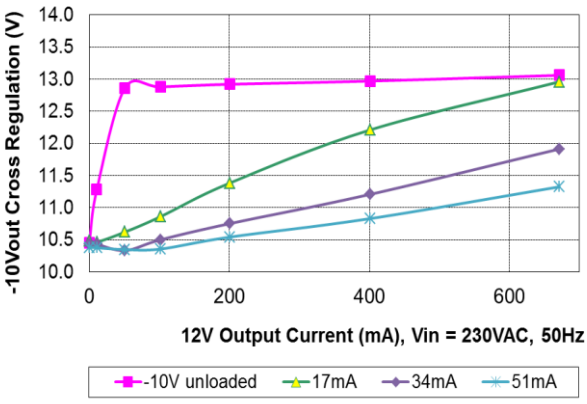
6 Cross Regulation vs. Load

Cross regulation has been measured at 115VAC, 60Hz and 230VAC, 50Hz source voltage. The load was set in order to measure the 12V and -10V output voltages vs. load on 12Vout, when the load on -10V was set respectively to 0, 17mA, 34mA and 51mA (set by fixed load resistor). The graphs below show the results.





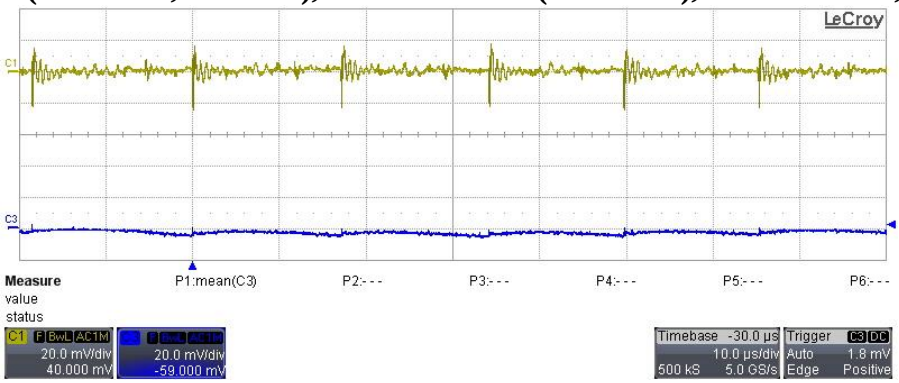




7 Output Ripple Voltage

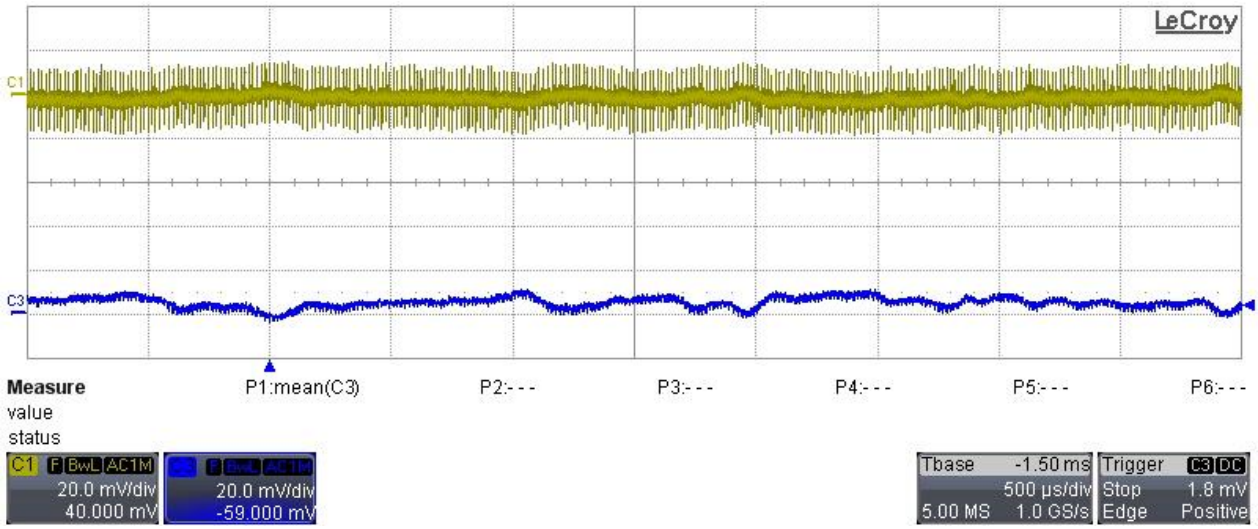
Since one output is non-isolated, we supplied the converter with DC source; this way we can connect the ground of the scope to primary side. Input DC voltage was 127V and 380V (equivalent to the peak of 90VAC and 270VAC). The graphs below show the ripple voltage for each output. All screenshots have been taken with 20MHz bandwidth, AC coupling.

Ch.1: -10Vout (20mV/div, 10us/div), Ch.3: +12Vout (20mV/div), Vin = 127Vdc, Full load

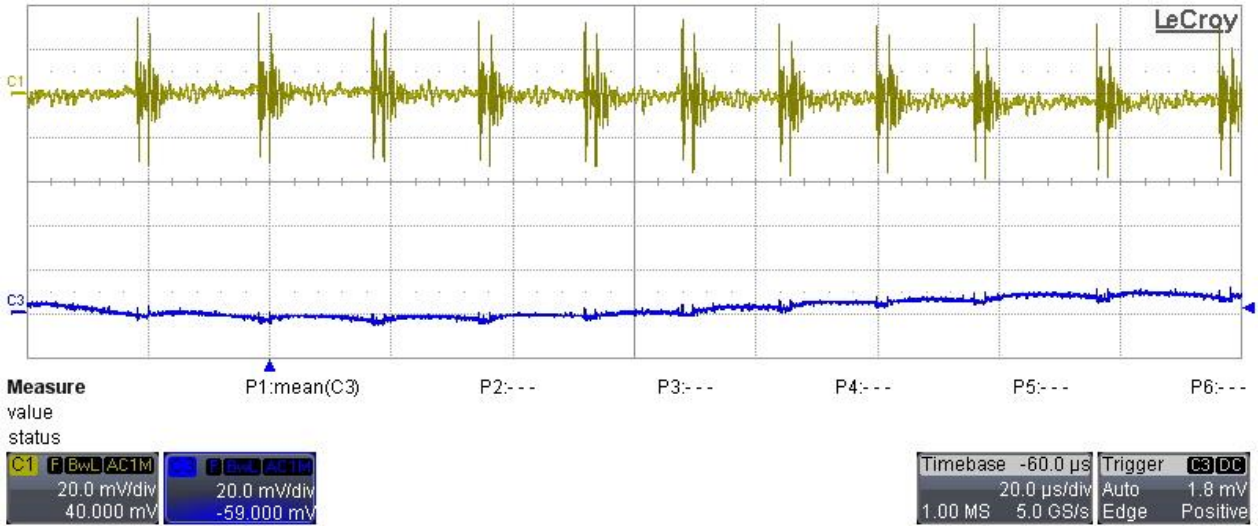


Below are reported the same conditions like above, but with **500us/div**.

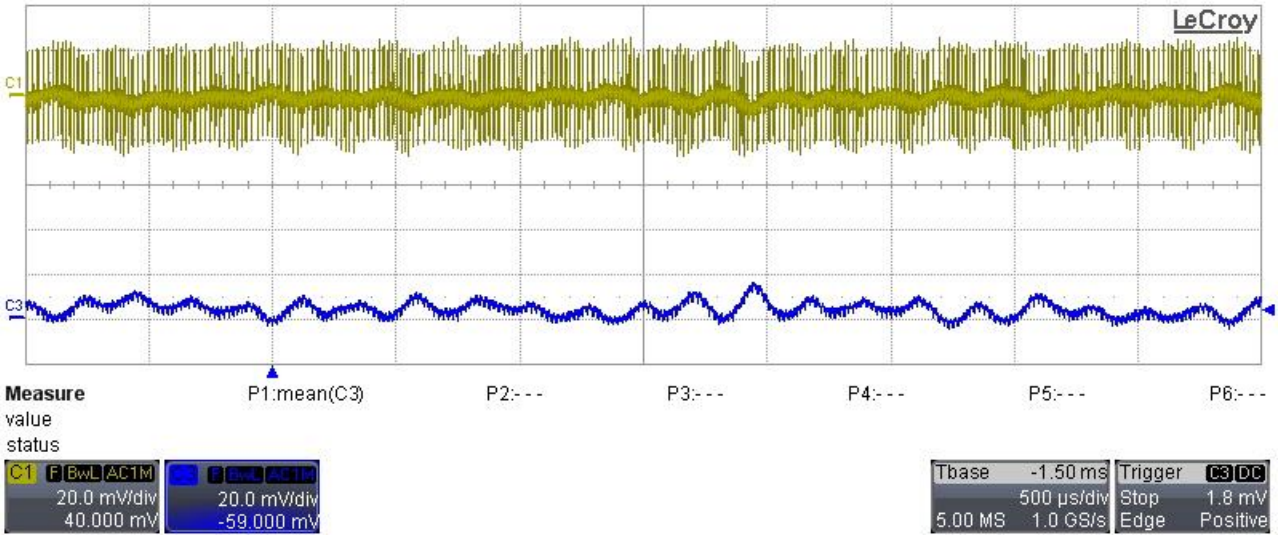
Ch.1: -10Vout (20mV/div, 500us/div),
Ch.3: +12Vout (20mV/div),
Vin = 127Vdc, Full load on both outputs



Ch.1: -10Vout (20mV/div, 20us/div),
Ch.3: +12Vout (20mV/div),
Vin = 380Vdc, Full load on both outputs

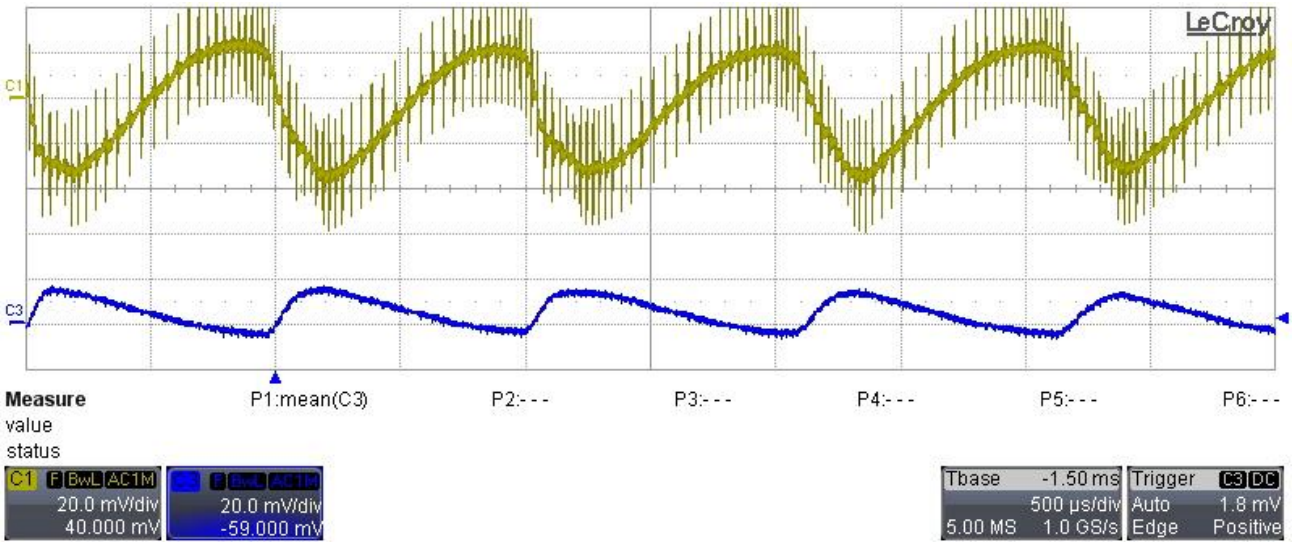


Ch.1: -10Vout (20mV/div, 500us/div),
Ch.3: +12Vout (20mV/div),
Vin = 380Vdc, Full load on both outputs

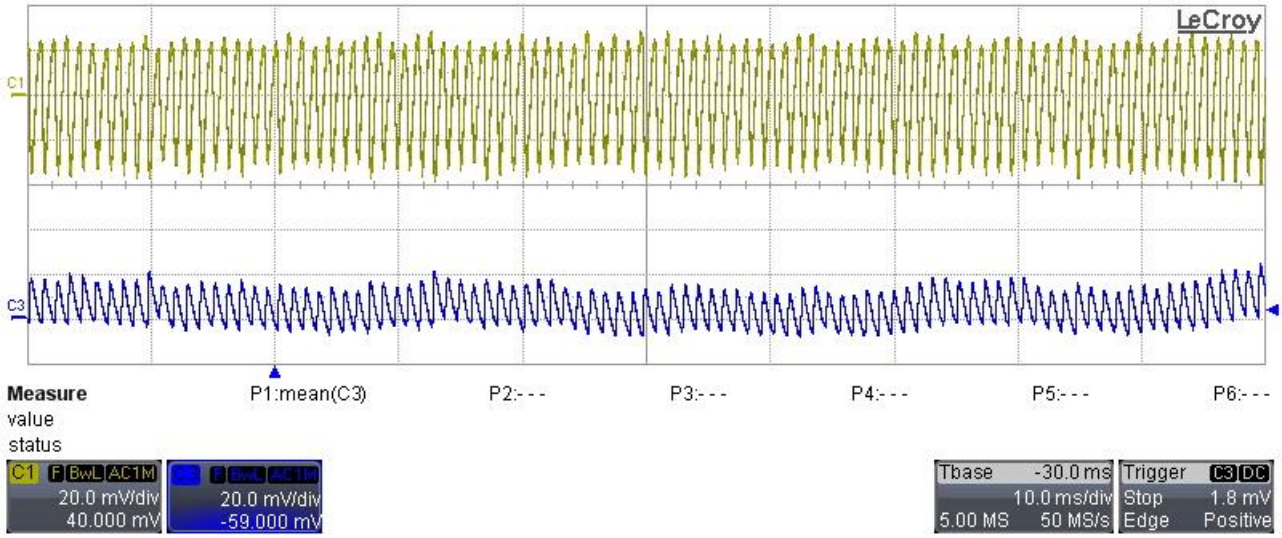


We had a worst case condition when the load was only 60mA on 12Vout and 50mA on -10Vout. This is shown in the screenshot below:

Ch.1: -10Vout (20mV/div, 500us/div),
Ch.3: +12Vout (20mV/div),
Vin = 320Vdc



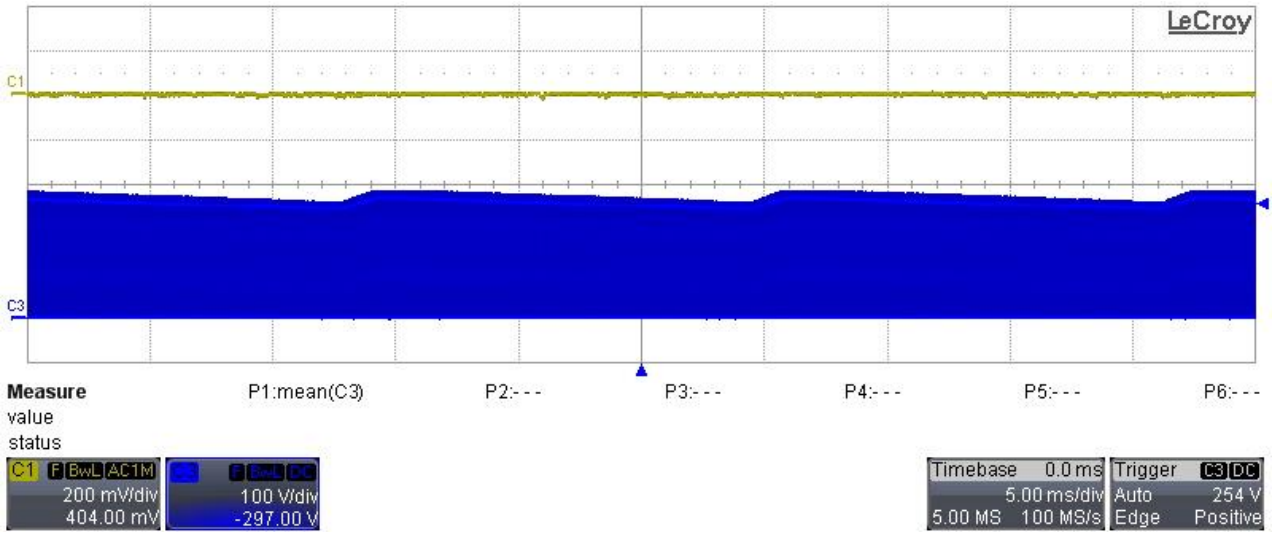
The screenshot below shows the same situation like above but taken for longer time (time division 10msec/div).
Ch.1: -10Vout (20mV/div, 10ms/div),
Ch.3: +12Vout (20mV/div),
Vin = 320Vdc



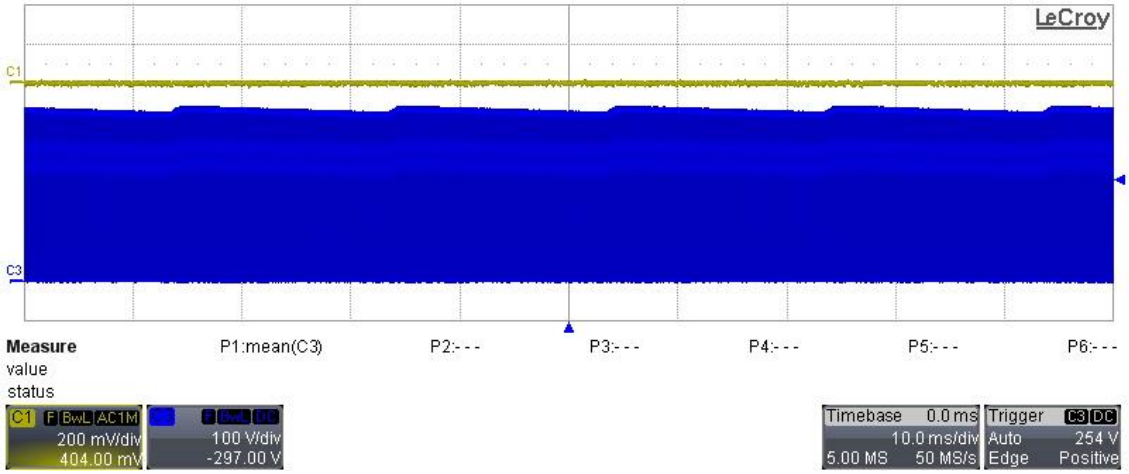
8 Switch nodes

The images below show the switch node of U1 (pin 8), taken at 115VAC (useful to show 120Hz ripple) and 230VAC input voltage while both outputs were fully loaded. For all waveforms both probes were set to DC coupling and 200MHz bandwidth limit.

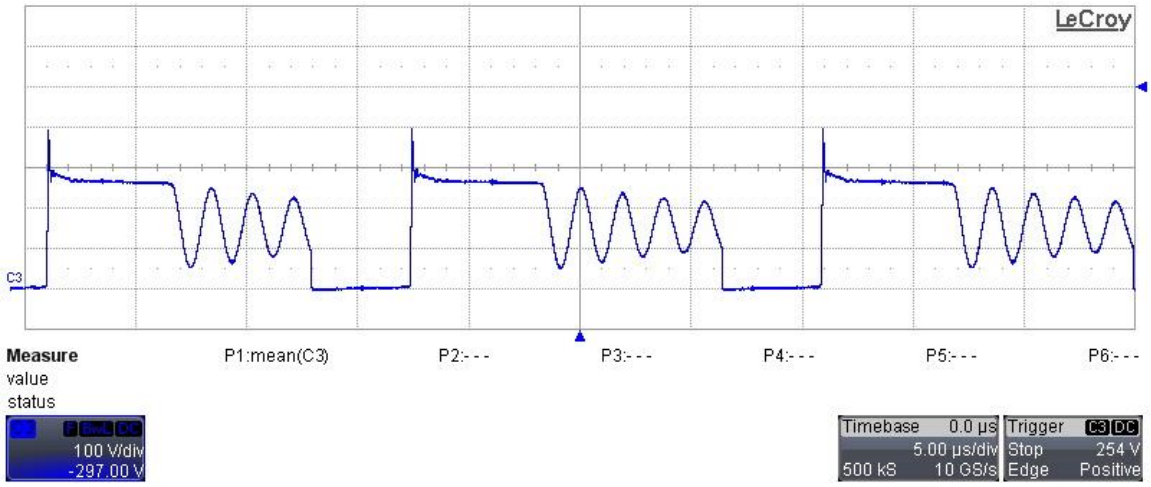
Ch.1: +12Vout (200mV/div, 5ms/div, AC Coupling),
Ch.3: U1 Switch-node (Pin-8) (100V/div),
Vin = 115VAC, 60Hz



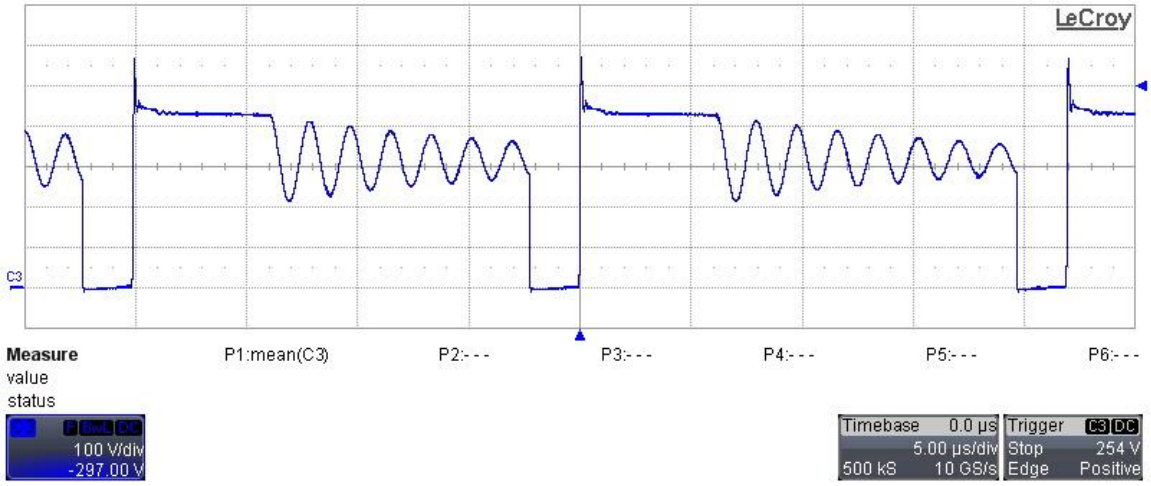
Ch.1: +12Vout (200mV/div, 10ms/div), Ch.3: U1 Pin-8 (100V/div), Vin = 230VAC, 50Hz



Ch.3: U1 Pin-8 (100V/div, 5us/div), Vin = 115VAC, 60Hz, full load



Ch.3: U1 Pin-8 (100V/div, 5us/div), Vin = 230VAC, 50Hz, full load



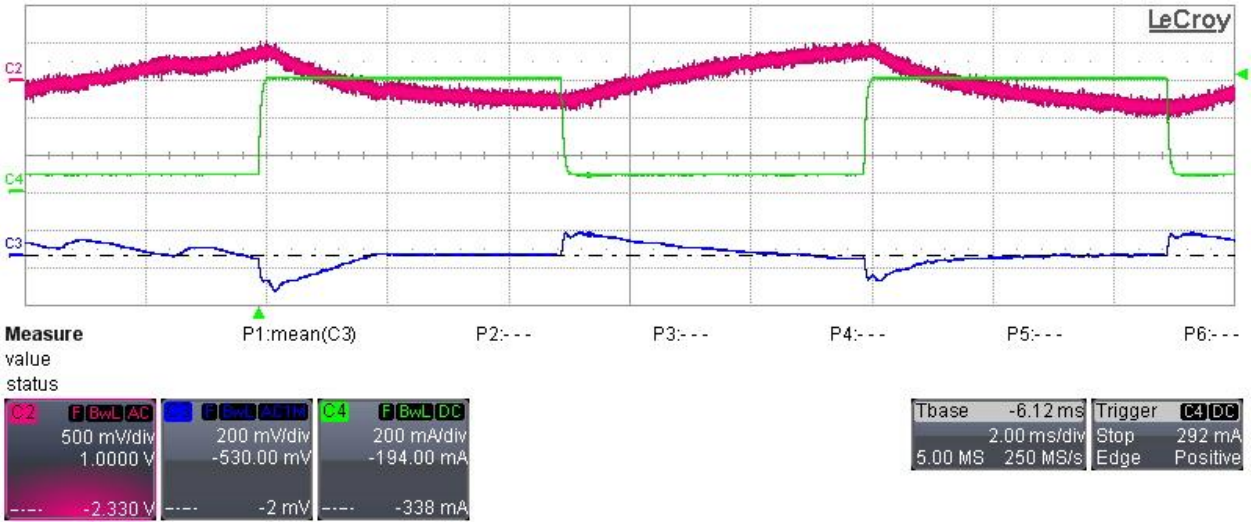
The converter switches OFF at 400Vdc (285VAC), by means of U2. Just before switching off, at 400Vdc input, the switch-node screenshot has been captured and shown below.

Ch.1: U1 Pin-8 (100V/div, 10us/div, 200MHz BWL),
Vin = 400Vdc, full load

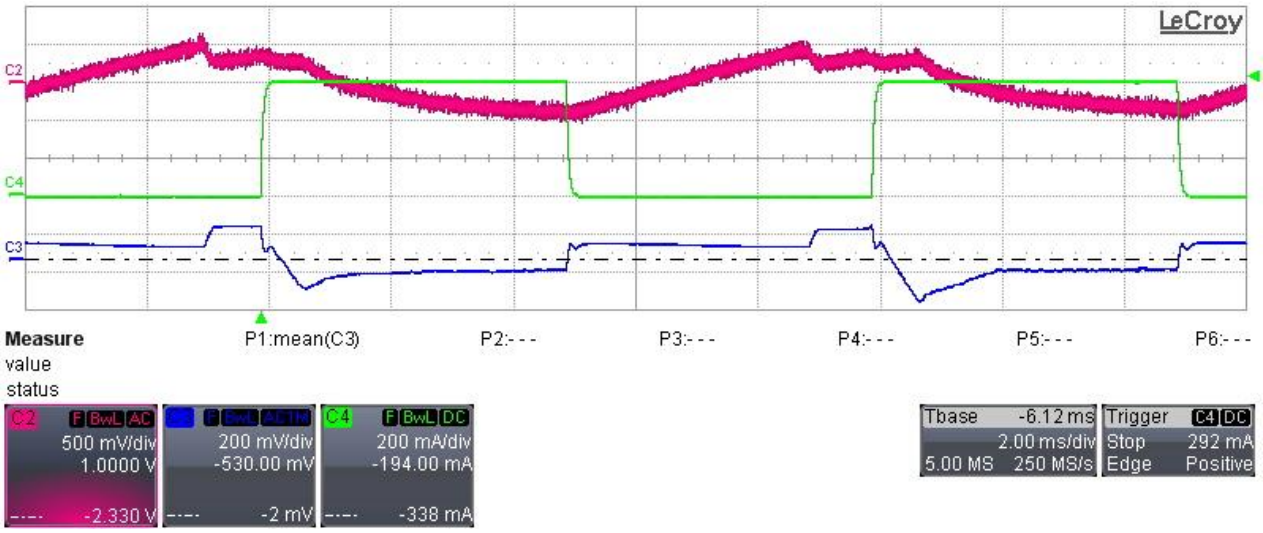
9 Transient Response

The images below show the transient response on output voltages in different load transient range and Vin conditions. For all waveforms the bandwidth was limited to 20MHz.

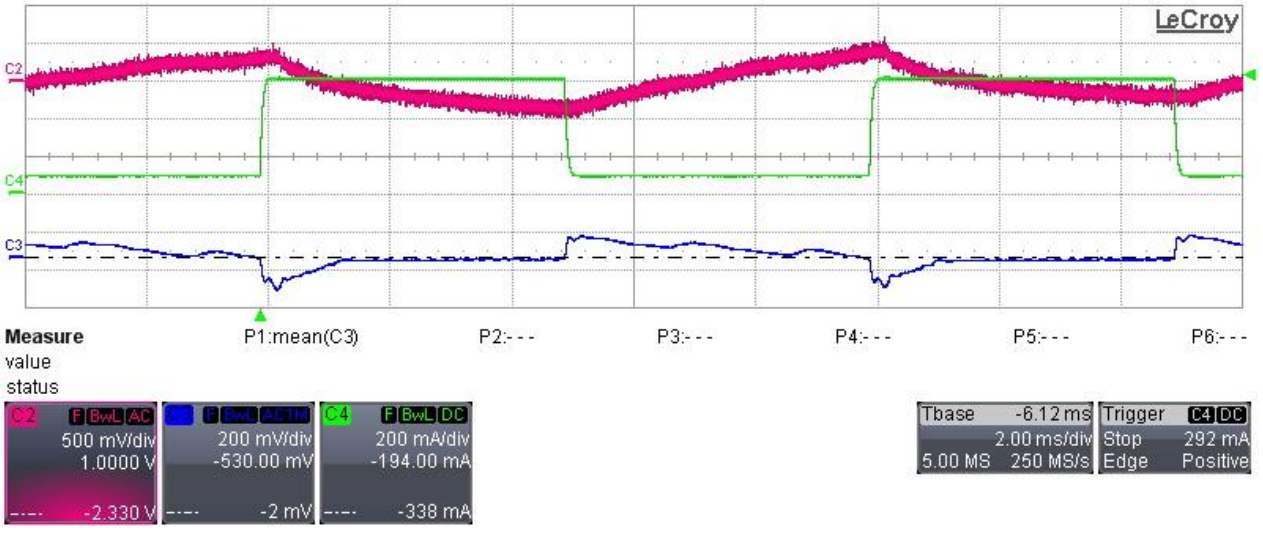
Ch.2: -10V Output Voltage (500mV/div, 2ms/div, AC coupling)
Ch.3: +12V Output Voltage (200mV/div, AC coupling)
Ch.4: +12V Output Current (200mA/div, DC coupling)
Vin = 90VAC, 60Hz; Iout(-10V) = 50mA constant, Iout(+12V) = 100mA → 600mA



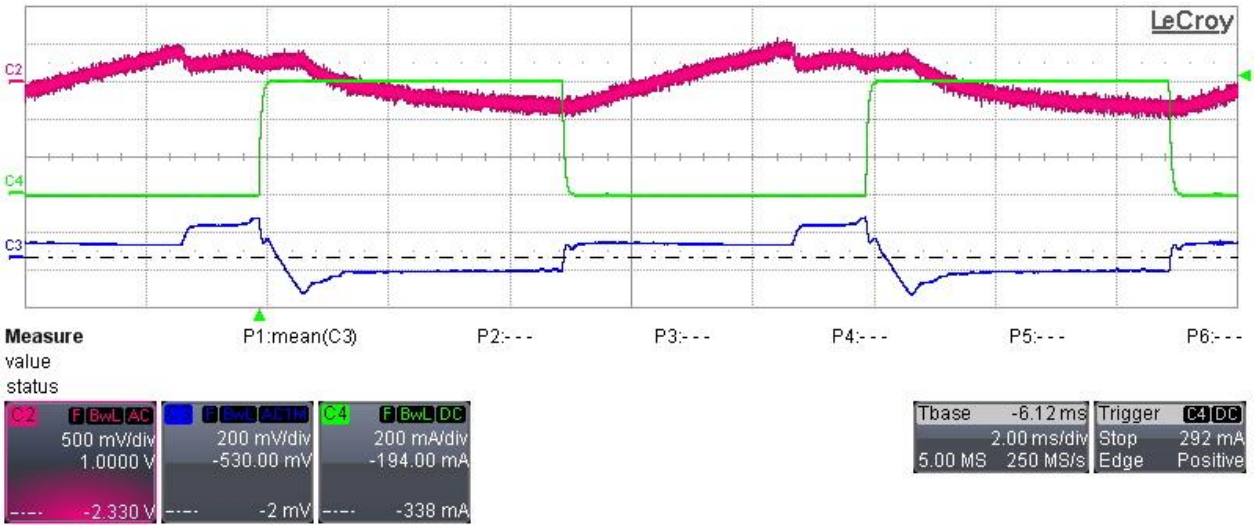
Ch.2: -10V Output Voltage (500mV/div, 2ms/div, AC coupling)
Ch.3: +12V Output Voltage (200mV/div, AC coupling)
Ch.4: +12V Output Current (200mA/div, DC coupling)
Vin = 90VAC, 60Hz; Iout(-10V) = 50mA constant, Iout(+12V) = 0mA → 600mA



Ch.2: -10V Output Voltage (500mV/div, 2ms/div, AC coupling)
Ch.3: +12V Output Voltage (200mV/div, AC coupling)
Ch.4: +12V Output Current (200mA/div, DC coupling)
Vin = 270VAC, 50Hz; Iout(-10V) = 50mA constant, Iout(+12V) = 100mA → 600mA

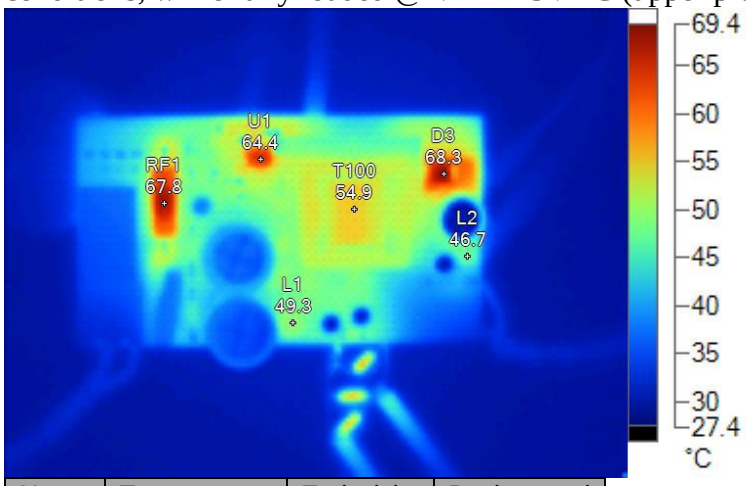


Ch.2: -10V Output Voltage (500mV/div, 2ms/div, AC coupling)
Ch.3: +12V Output Voltage (200mV/div, AC coupling)
Ch.4: +12V Output Current (200mA/div, DC coupling)
Vin = 270VAC, 50Hz; Iout(-10V) = 50mA constant, Iout(+12V) = 0mA → 600mA

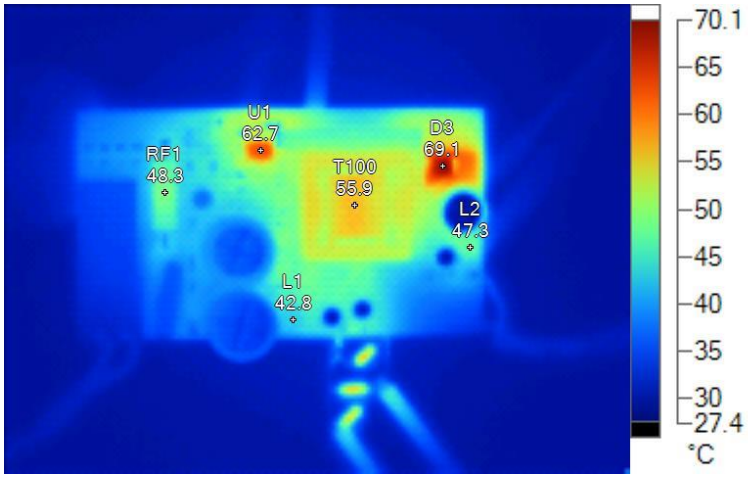


10 Thermal Analysis

During the thermal analysis, the converter has been placed horizontal on the bench in still air conditions, while fully loaded @ Vin=115VAC (upper picture) and 230VAC (bottom one).



Name	Temperature	Emissivity	Background
RF1	67.8°C	0.95	23.0°C
U1	64.4°C	0.95	23.0°C
D3	68.3°C	0.95	23.0°C
T100	54.9°C	0.95	23.0°C
L1	49.3°C	0.95	23.0°C
L2	46.7°C	0.95	23.0°C



Name	Temperature	Emissivity	Background
RF1	48.3°C	0.95	23.0°C
U1	62.7°C	0.95	23.0°C
T100	55.9°C	0.95	23.0°C
D3	69.1°C	0.95	23.0°C
L2	47.3°C	0.95	23.0°C
L1	42.8°C	0.95	23.0°C

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (https:www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

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