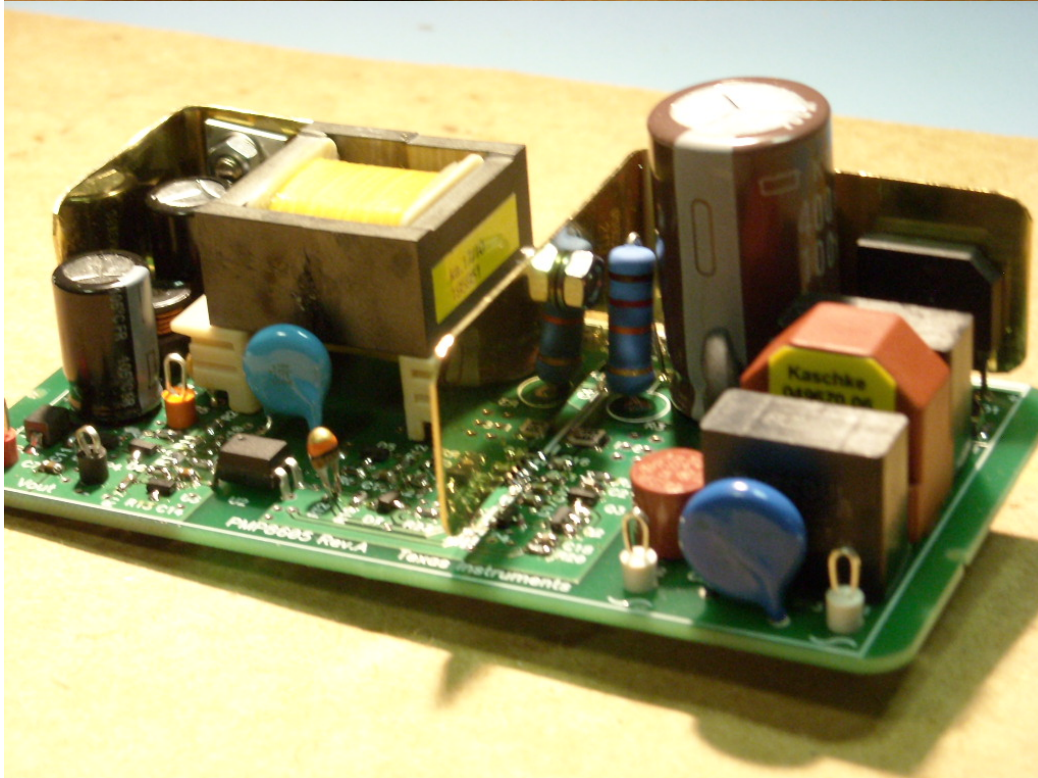
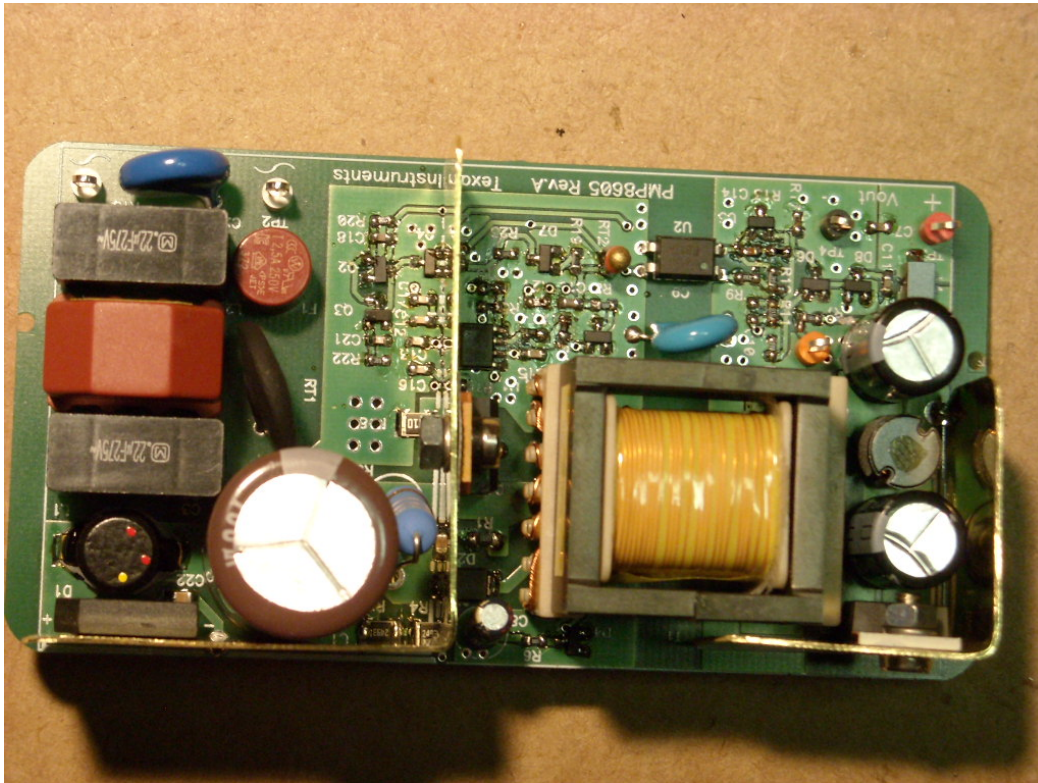


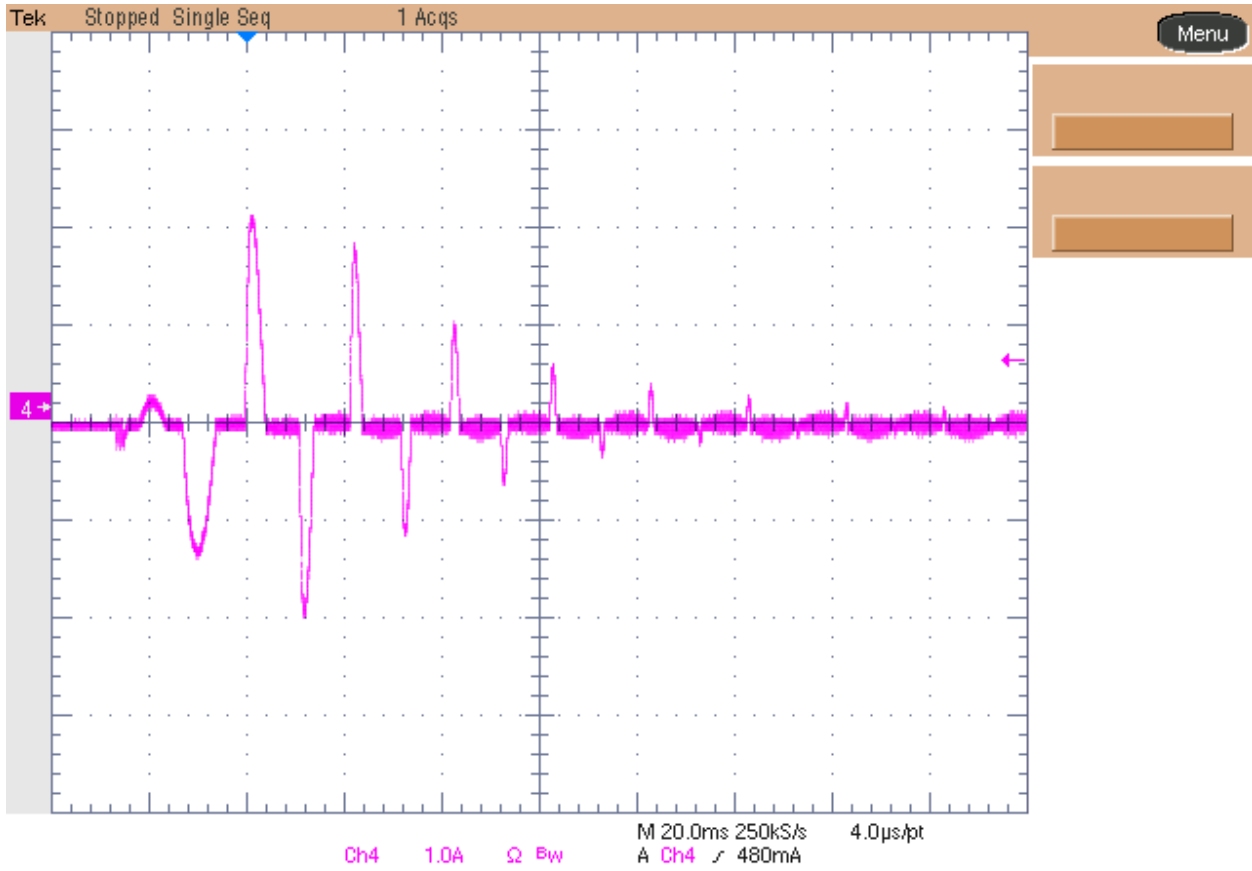
Photos of the Prototype



1. Inrush Current

The input current waveform at startup is shown in the picture below. The input voltage was set to 230Vac,50Hz.

Ch.4: Input AC current (1A/div, 20ms/div, 20MHz BWL)

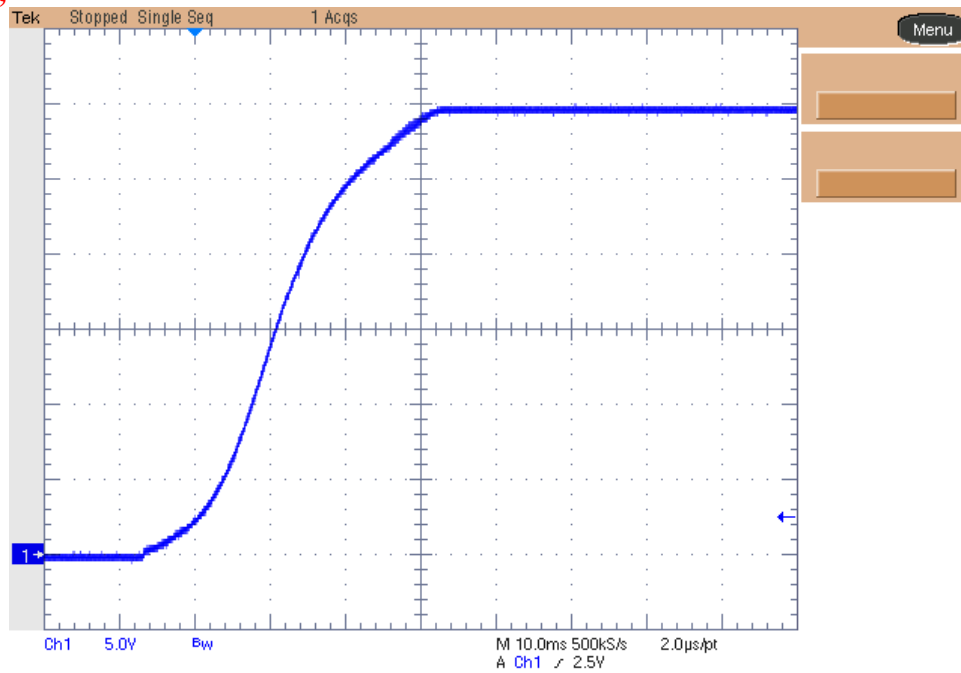


1 Startup

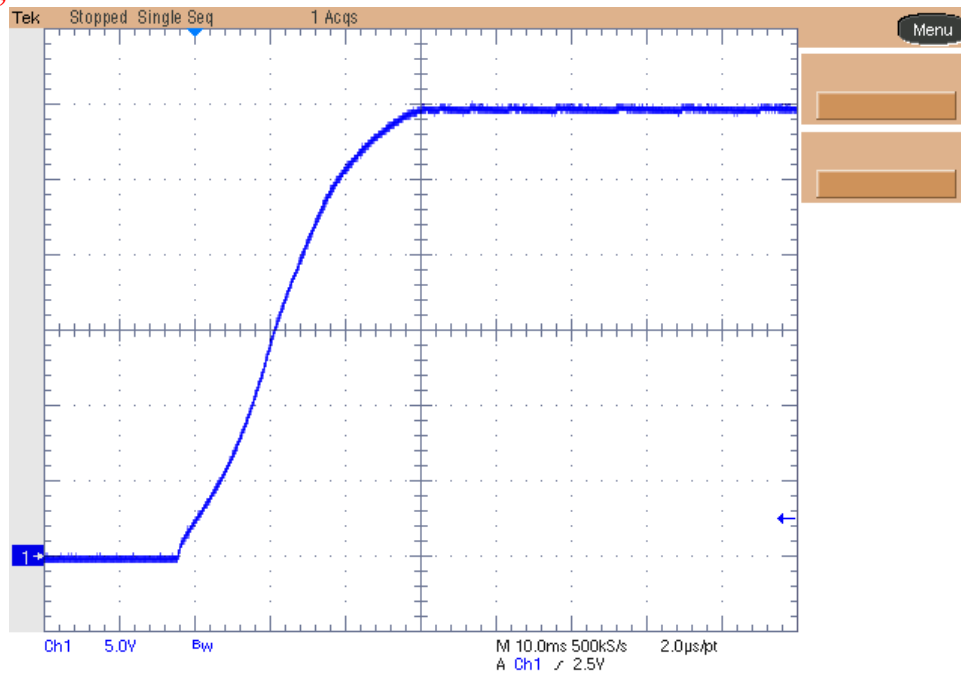
The output voltage behavior at startup is shown in the images below. The input voltage was set to 230Vac, 50Hz. The output fully loaded in the upper picture and unloaded in the bottom one.

Ch.1: Output voltage (5V/div, 10ms/div, DC coupling, 20MHz BWL)

$I_{out} = 2A$;

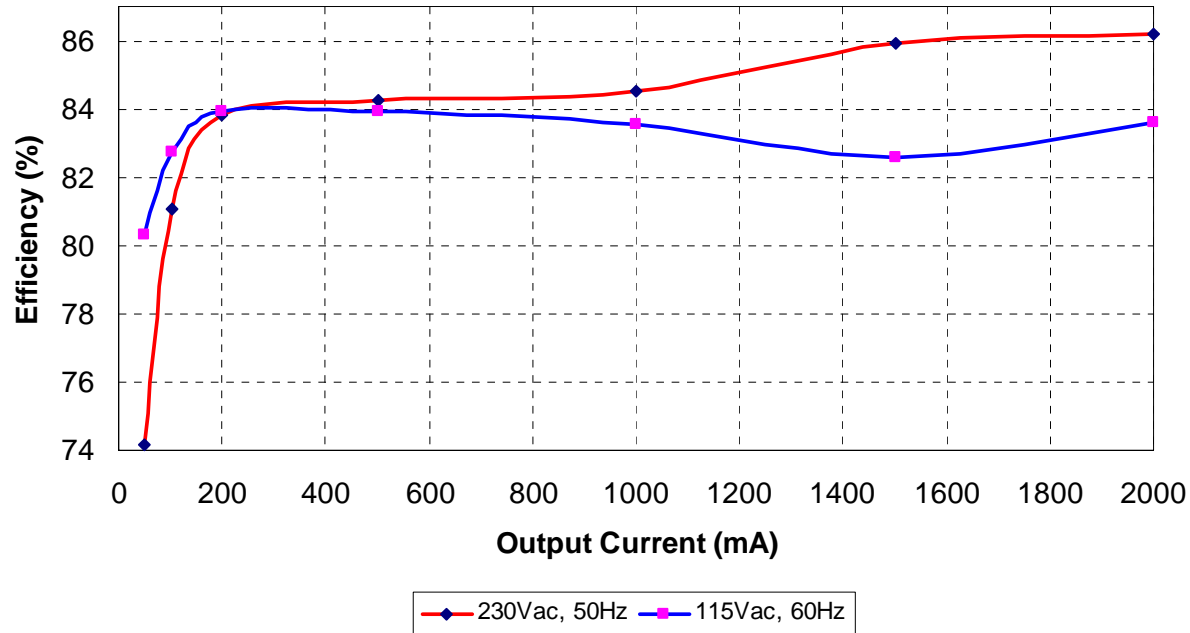


$I_{out} = 0A$;



2 Efficiency

The efficiency data are shown in the tables and graph below. An AC voltage source has been used, set to 230Vac, 50Hz and 115Vac, 60Hz.

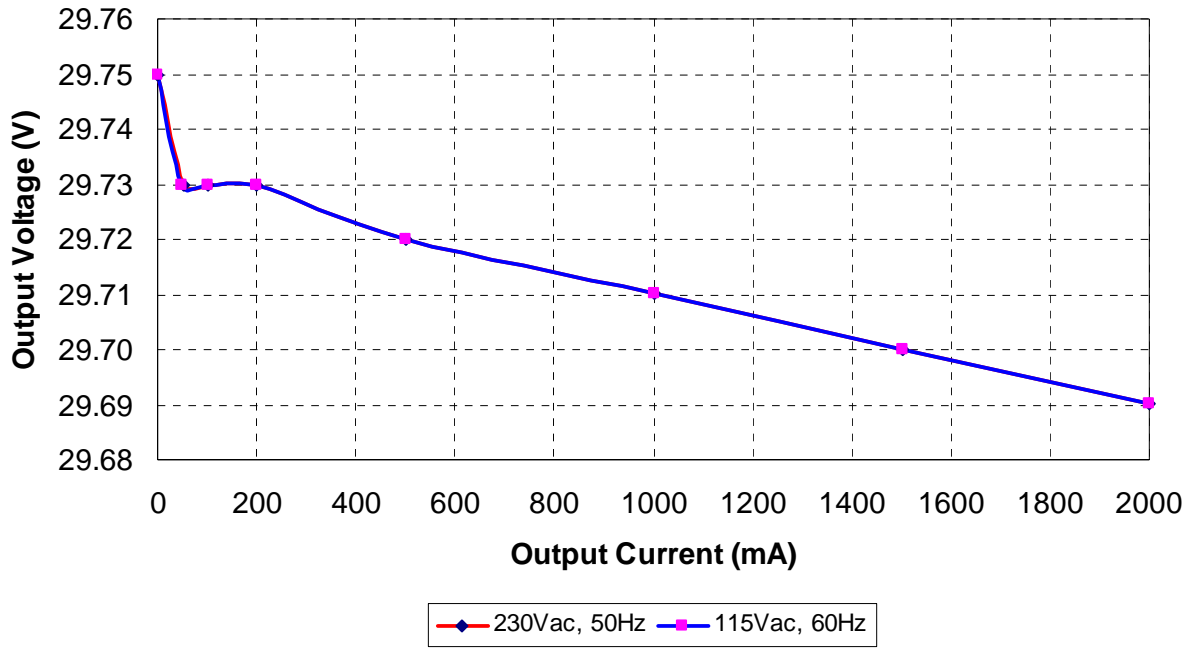


Iout (mA)	Vout (V)	Pout (W)	Pin (W)	Vin (Vac)	Ploss (W)	Eff (%)
0	29.75	0.00	0.29	230	0.290	0.00
50.9	29.73	1.51	2.04	230	0.527	74.18
101.7	29.73	3.02	3.73	230	0.706	81.06
200.5	29.73	5.96	7.11	230	1.149	83.84
500.3	29.72	14.87	17.65	230	2.781	84.24
1000.4	29.71	29.72	35.16	230	5.438	84.53
1501	29.70	44.58	51.89	230	7.310	85.91
2000	29.69	59.38	68.90	230	9.520	86.18

Iout (mA)	Vout (V)	Pout (W)	Pin (W)	Vin (Vac)	Ploss (W)	Eff (%)
0	29.75	0.00	0.14	115	0.140	0.00
50.8	29.73	1.51	1.88	115	0.370	80.33
101.6	29.73	3.02	3.65	115	0.629	82.76
200.4	29.73	5.96	7.10	115	1.142	83.91
500.3	29.72	14.87	17.72	115	2.851	83.91
1000.3	29.71	29.72	35.58	115	5.861	83.53
1501	29.70	44.58	53.99	115	9.410	82.57
2000	29.69	59.38	71.05	115	11.670	83.57

3 Output Voltage Regulation

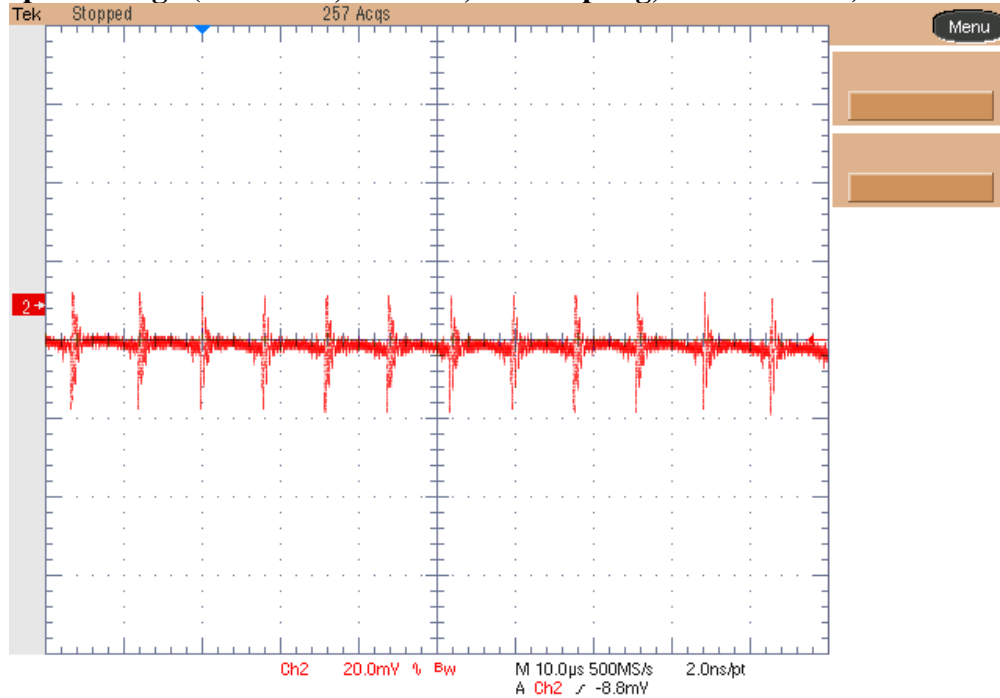
The output voltage variation as function of load and input AC voltage is shown below. The two curves are exactly coincident.



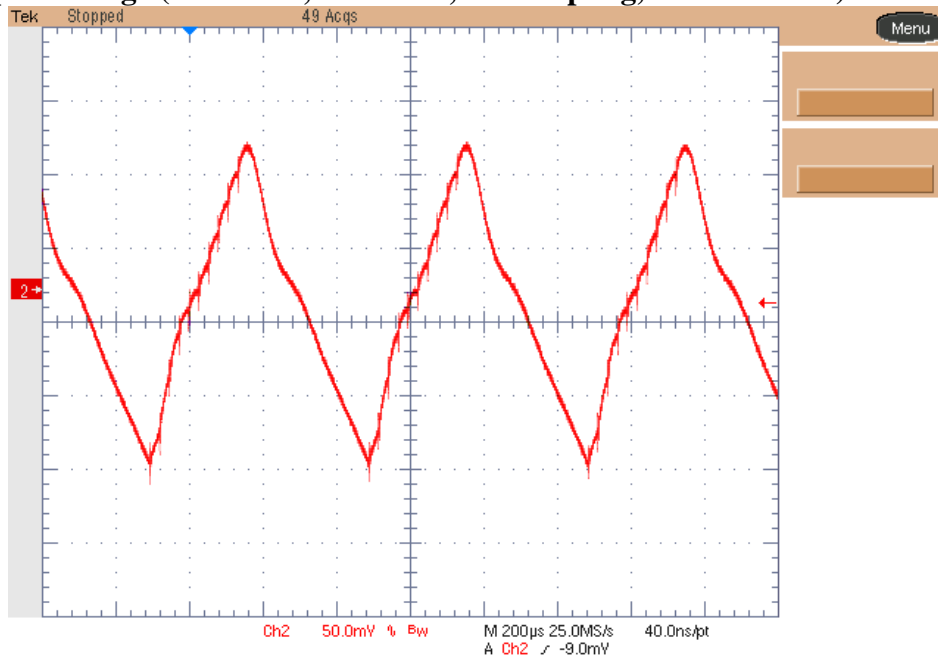
4 Output Ripple Voltage

The output ripple voltage of the power supply, measured at 2A, 500mA and 10mA load, is shown in the plots below. The input was set to 230Vac, 50Hz.

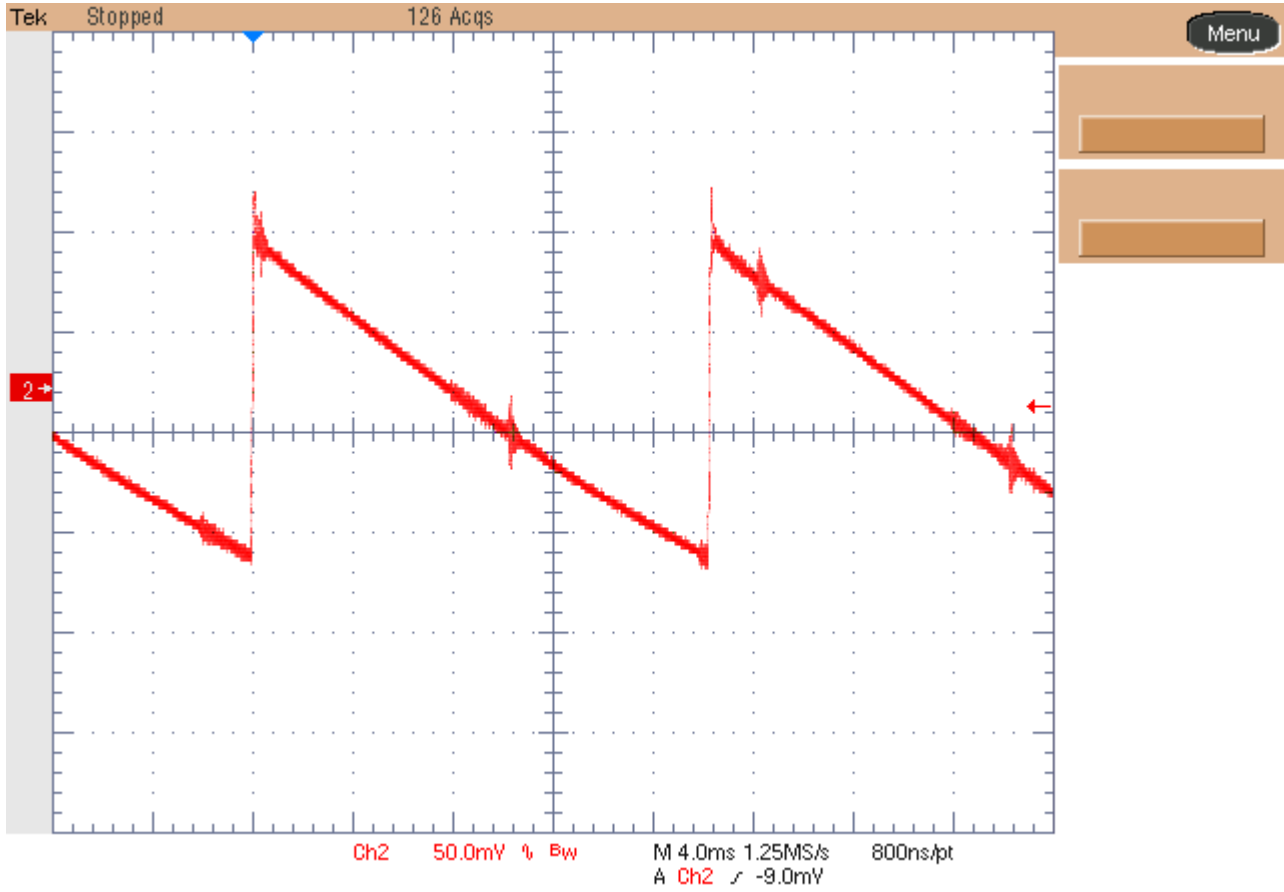
Ch.2: Output Voltage (20mV/div, 10us/div, AC coupling, 20MHz BWL) → Iout = 2A



Ch.2: Output Voltage (50mV/div, 200us/div, AC coupling, 20MHz BWL) → Iout = 0.5A



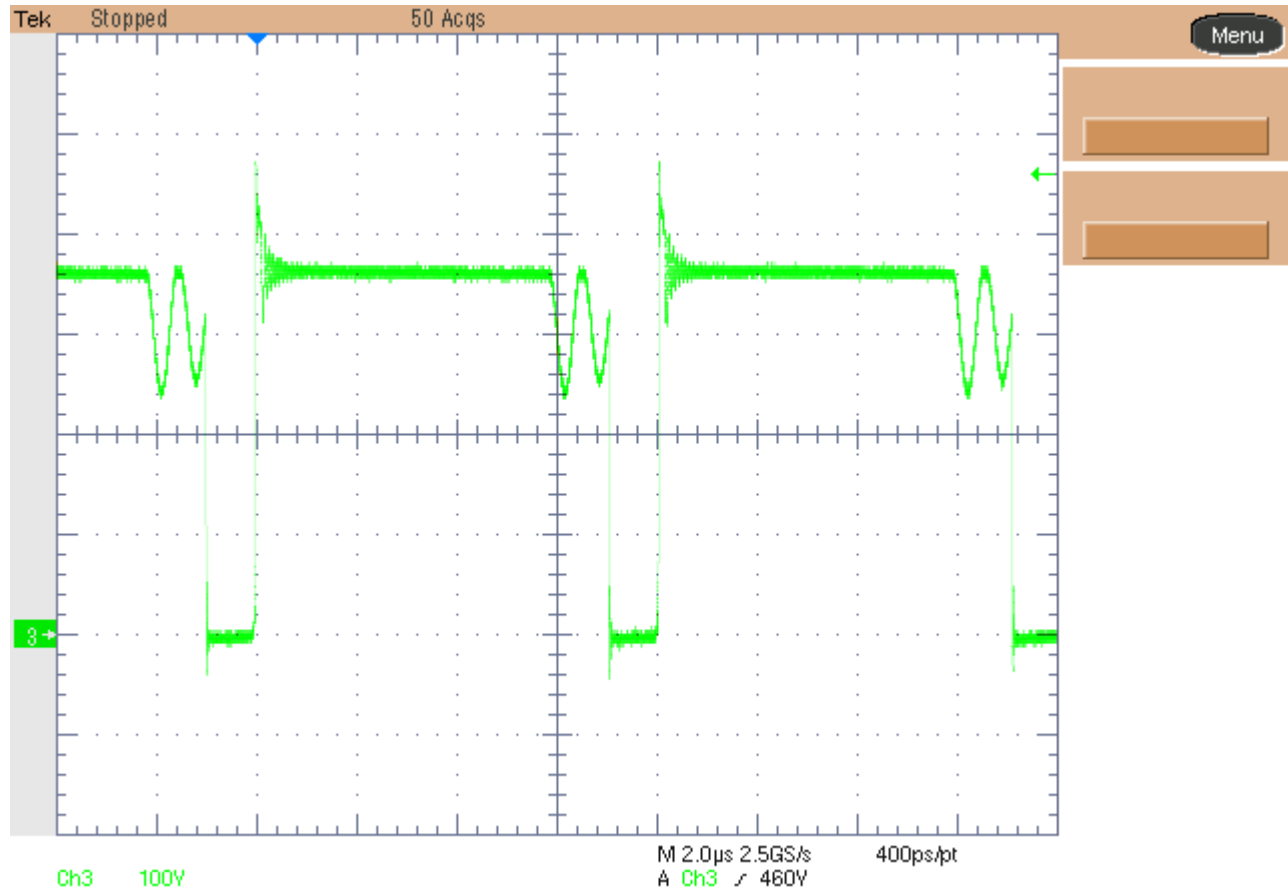
Ch.2: Output Voltage (50mV/div, 4ms/div, AC coupling, 20MHz BWL) → $I_{out} = 10mA$



5 Switching Node Waveform

The image below shows the peak voltage on the drain of the Mosfet Q1 with a 320Vdc input at different loads, as well as the voltage on D2.

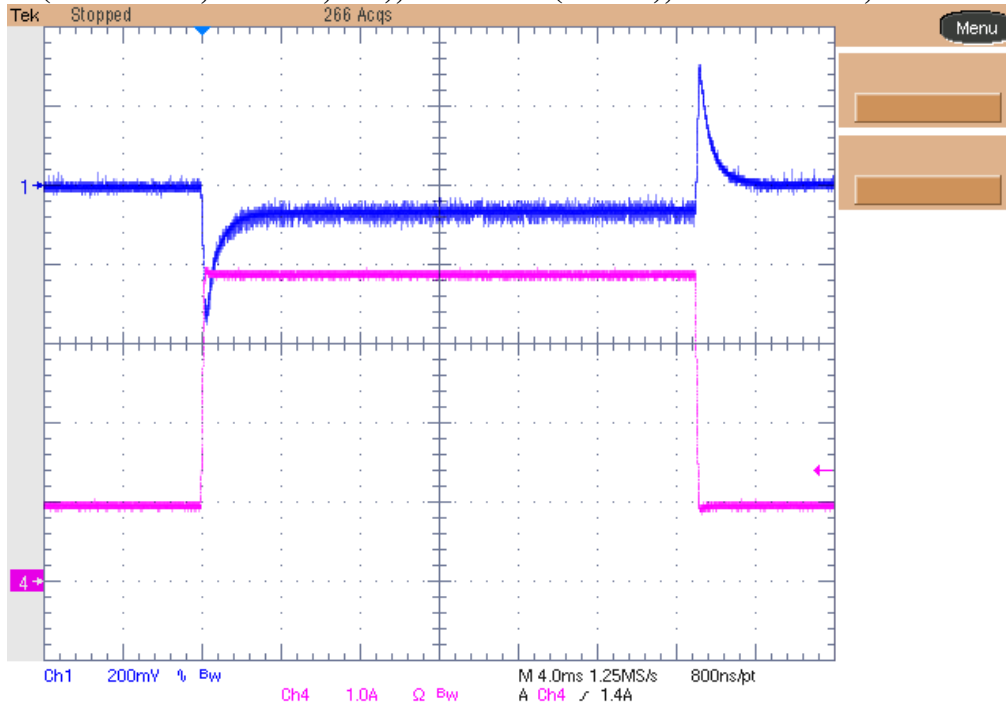
Ch3: Q1 Drain voltage (100V/div, 4us/div, No BWL), full load.



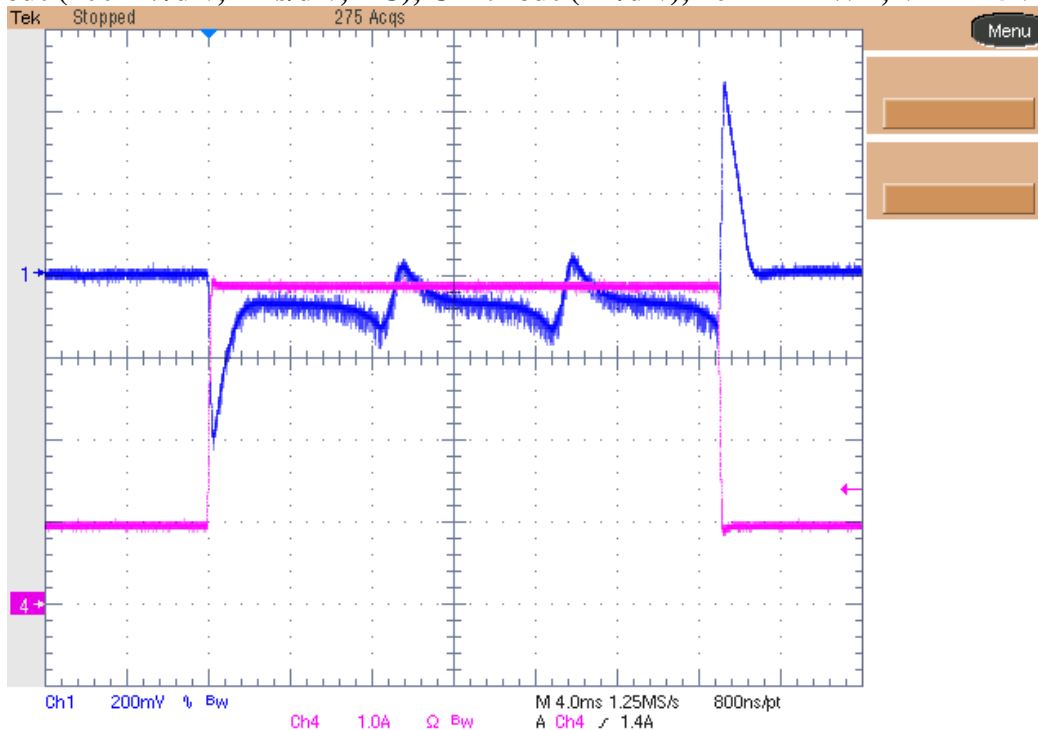
6 Transient Response

The image below shows the transient response on the output voltage. The load has been switched between 1A and 4A.

Ch1: Vout (200mV/div, 4ms/div, AC), Ch4: Iout (1A/div), 20MHz BWL, Vin=230Vac, 50Hz



Ch1: Vout (200mV/div, 4ms/div, AC), Ch4: Iout (1A/div), 20MHz BWL, Vin=115Vac, 60Hz



7 Thermal Measurement

The picture below shows the thermal image of the power supply when connected to 230Vac mains and loaded at 40W steady state. The board has been placed horizontal on the bench in still air condition. The ambient temperature was 23C.

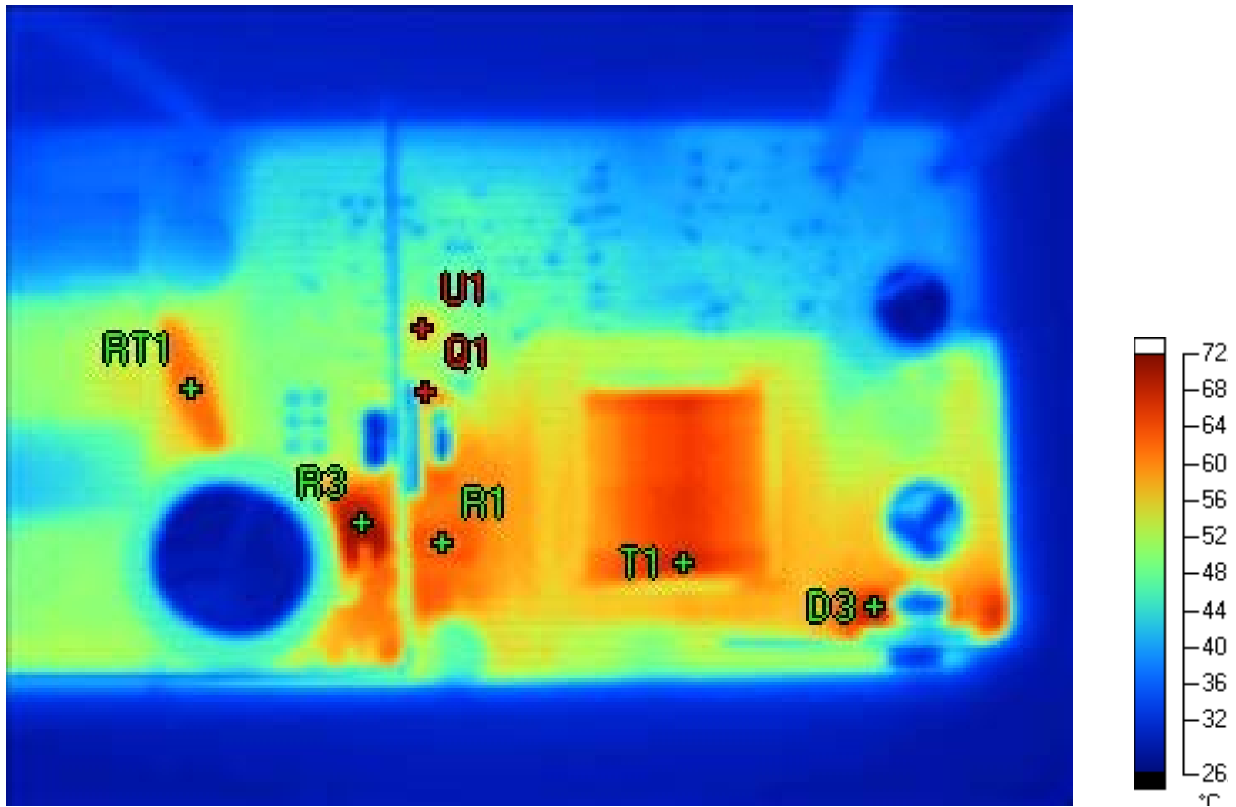


Image Info

Average Temperature	41.5 °C
Calibration Range	-20.0 °C to 350.0 °C
Camera Model	Ti40FT
Image Range	27.4 °C to 71.3 °C
Image Time	6/4/2013 8:16:57 PM
Manufacturer	Fluke
Camera Serial Number	Ti40FT-070263

Markers

Label	Temperature	Emissivity	Background
T1	67.4 °C	0.95	23.0 °C
D3	67.5 °C	0.95	23.0 °C
R1	67.1 °C	0.95	23.0 °C
R3	71.1 °C	0.95	23.0 °C
RT1	61.5 °C	0.95	23.0 °C
Q1	56.3 °C	0.95	23.0 °C
U1	56.1 °C	0.95	23.0 °C

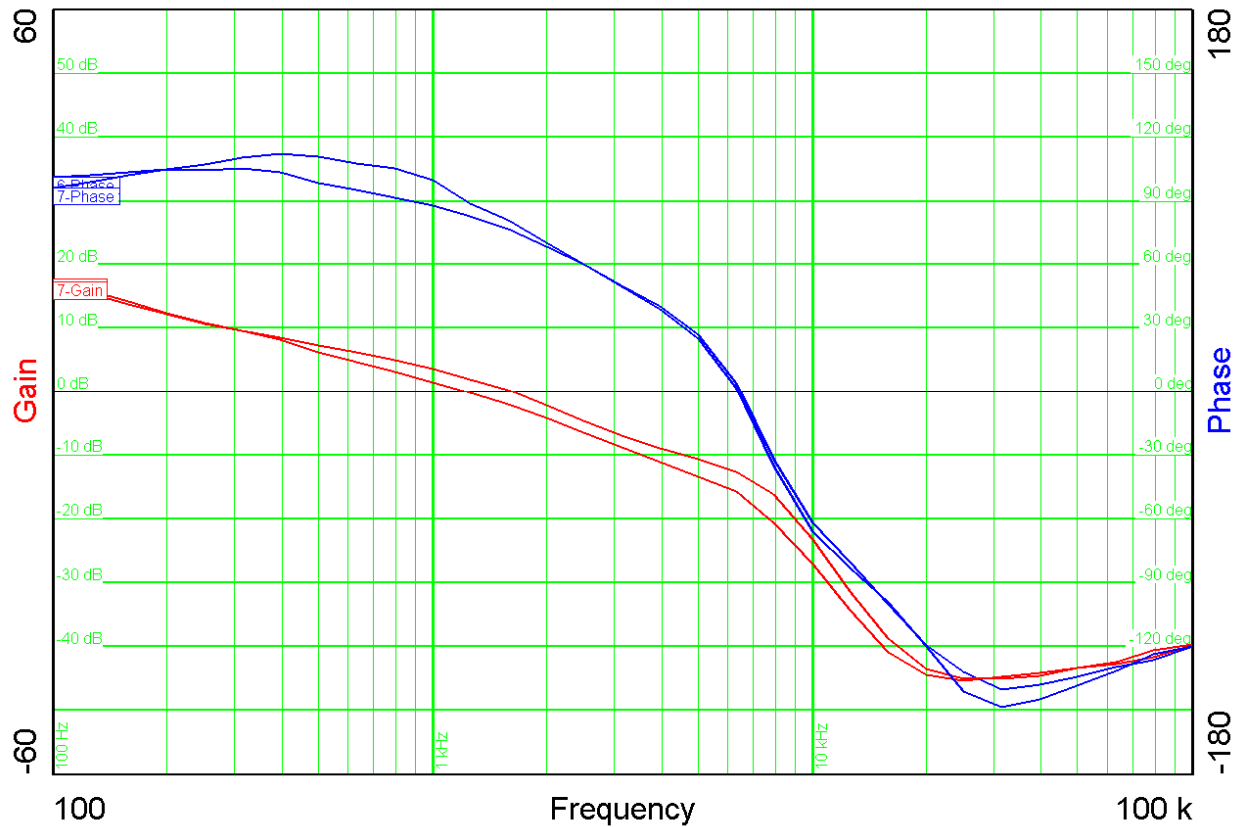
8 Loop Analysis

The graph below shows the loop analysis performed with a Venable System. The input voltage was 200Vdc and 320Vdc and the load set to 40W. The worst case measurement was:

Crossover frequency $F_{co} = 1.6\text{KHz}$

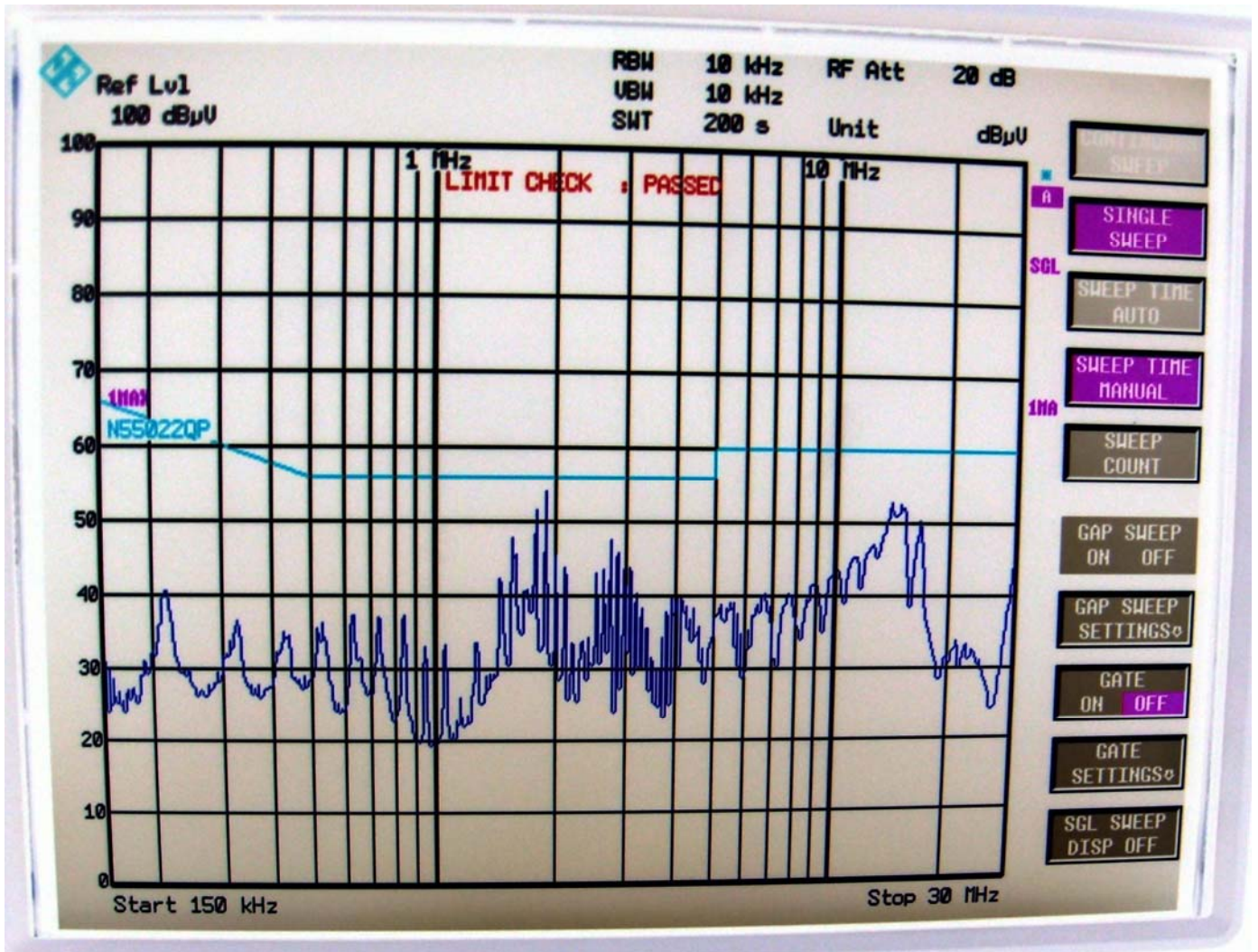
Phase margin = 80.36 deg.

Gain margin = 12.95 dB.



9 EMI Measurement

The graph below shows the conducted emission EMI noise and the EN55022 Class-B Quasi-Peak limits (measurement from the worst case line). The load was connected to a LISN and an isolation transformer; the load was a power resistor, set to 22.5 Ohm (40W load), while the input voltage was 230Vac. The receiver was set to Quasi-peak detector, 10 KHz bandwidth. The negative terminal of the converter has been connected to the ground of the LISN.



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