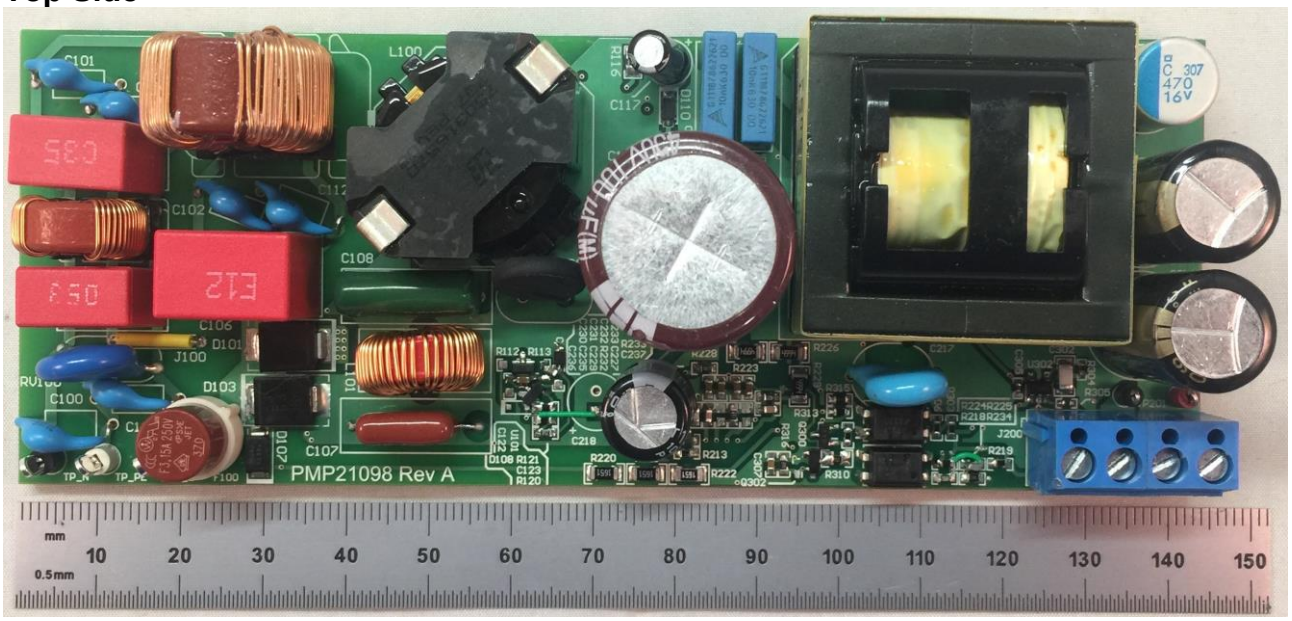
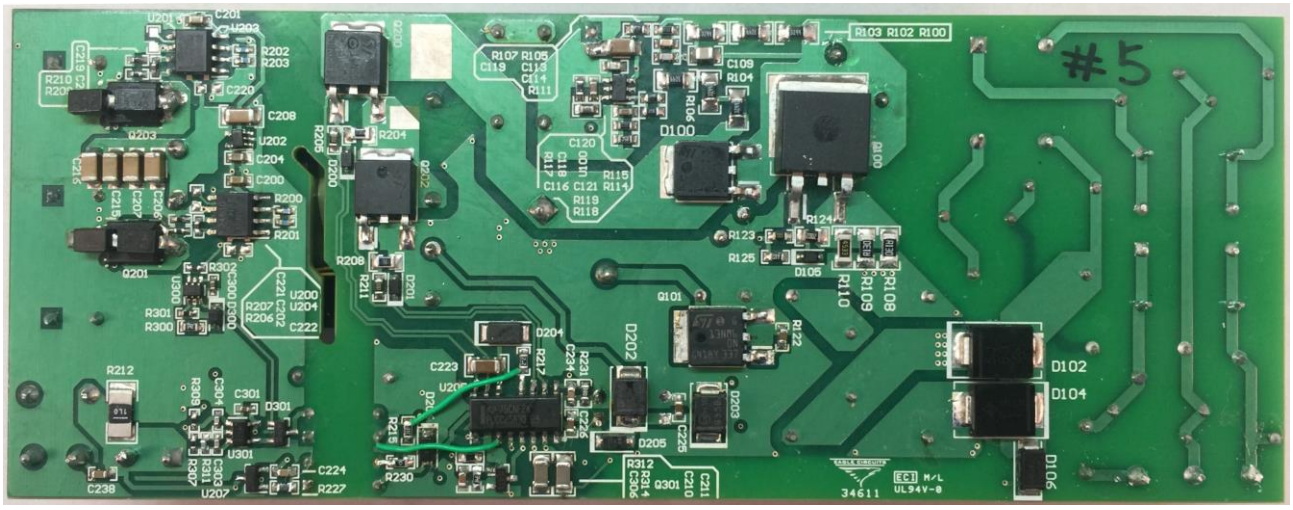
1 Photo

The photographs below show the top and bottom view of the PMP21098Rev A board.

Top Side



Bottom Side

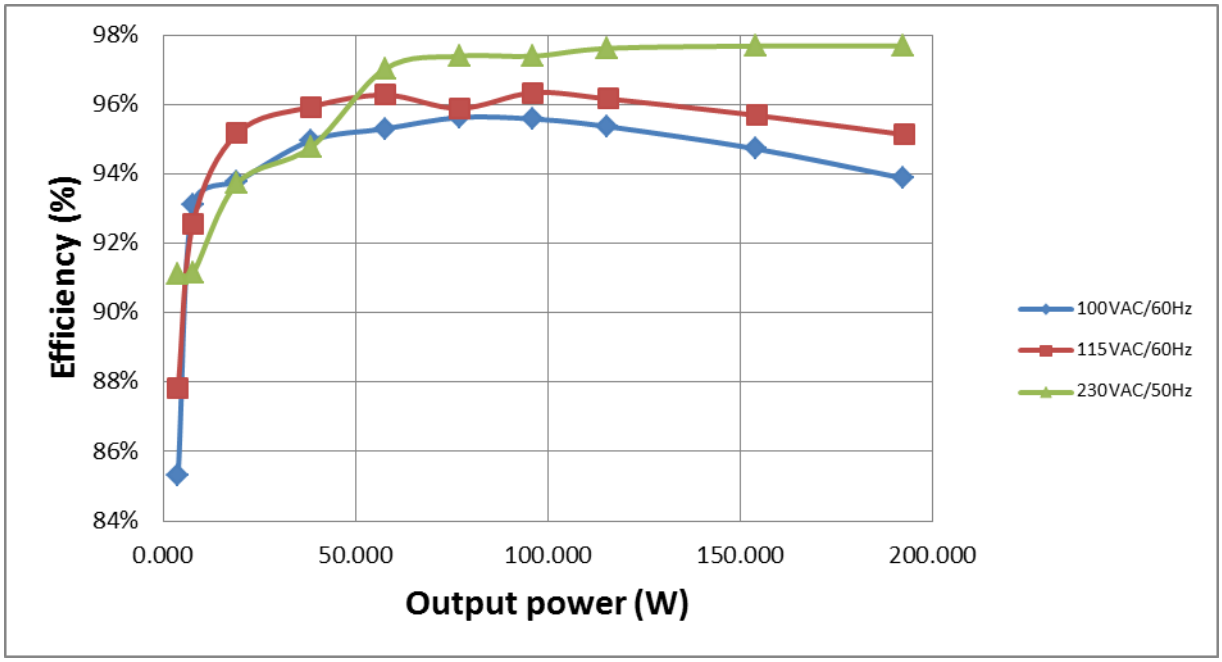


2 Efficiency, Power Factor and Harmonics

The efficiency curves are shown in the tables and graph below.

2.1 PFC efficiency

T200 is disabled during the test. External 12V is supplied to RVCC node. The following measurement doesn't include the power consumption on the external 12V supply.



100V_{AC}/60Hz

Vin,rms(V)	Iin,rms(A)	Pin(W)	P.F.	ATHD(%)	Vout(V)	Iout(A)	Pout(W)	Losses(W)	Eff. (%)
99.97	2.061	204.90	0.994	9.290%	384.7	0.500	192.350	12.5500	93.88%
100.05	1.635	162.45	0.993	10.560%	384.7	0.400	153.880	8.5700	94.72%
100.05	1.222	121.02	0.990	12.670%	384.7	0.300	115.410	5.6100	95.36%
100.01	1.019	100.62	0.988	14.150%	384.7	0.250	96.175	4.4450	95.58%
100.01	0.818	80.48	0.984	16.300%	384.8	0.200	76.960	3.5200	95.63%
99.95	0.613	60.55	0.988	7.550%	384.7	0.150	57.705	2.8450	95.30%
99.98	0.412	40.51	0.984	9.220%	384.7	0.100	38.470	2.0400	94.96%
100.06	0.250	20.50	0.810	29.000%	384.5	0.050	19.225	1.2750	93.78%
100.09	0.159	8.25	0.510	50.000%	384.1	0.020	7.682	0.5680	93.12%
100	0.115	4.50	0.370		384	0.010	3.840	0.6600	85.33%

115V_{AC}/60Hz

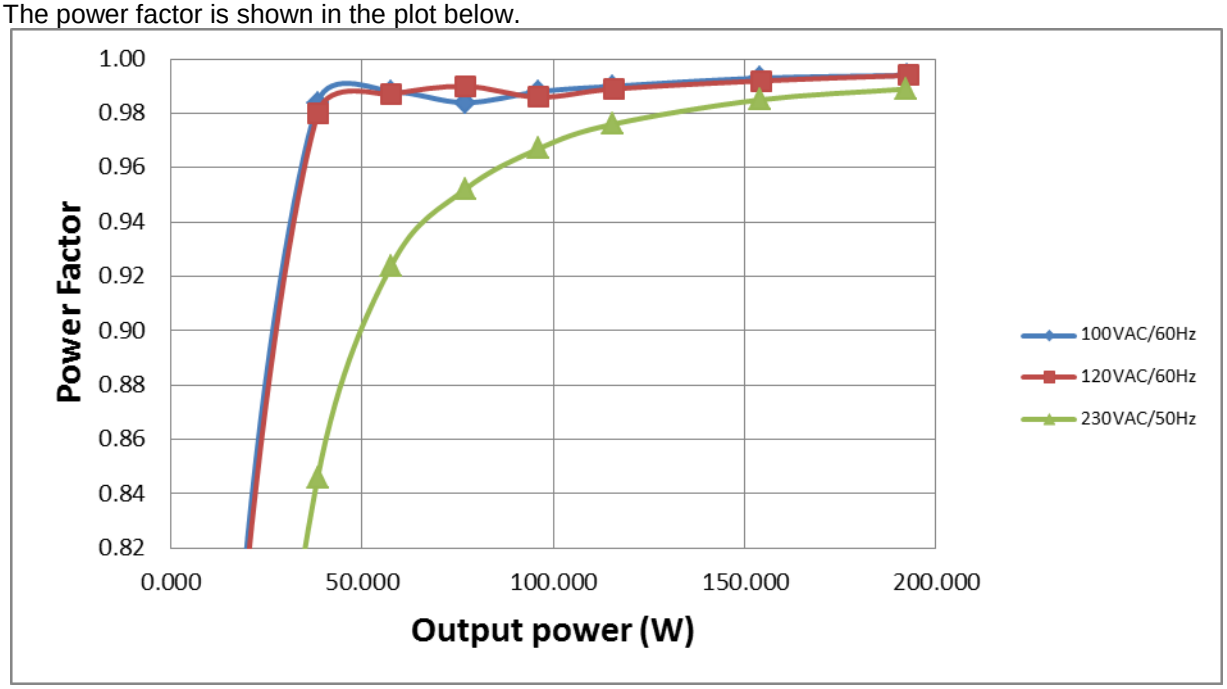
Vin,rms(V)	Iin,rms(A)	Pin(W)	P.F.	ATHD(%)	Vout(V)	Iout(A)	Pout(W)	Losses(W)	Eff. (%)
115.08	1.771	202.60	0.994	9.670%	384.7	0.501	192.735	9.8653	95.13%
115.08	1.412	161.22	0.992	11.150%	384.7	0.401	154.265	6.9553	95.69%
115	1.059	120.42	0.989	13.500%	384.7	0.301	115.795	4.6253	96.16%
115	0.881	99.83	0.986	15.230%	384.7	0.250	96.175	3.6550	96.34%
115.04	0.705	80.24	0.990	7.490%	384.7	0.200	76.940	3.3000	95.89%
115.05	0.528	59.94	0.987	9.650%	384.7	0.150	57.705	2.2350	96.27%
115.03	0.356	40.10	0.980	8.900%	384.7	0.100	38.470	1.6300	95.94%
114.98	0.221	20.20	0.800	25.000%	384.5	0.050	19.225	0.9750	95.17%
115.08	0.142	8.30	0.515	40.000%	384.1	0.020	7.682	0.6180	92.55%
114.95	0.107	4.37	0.358		384	0.010	3.840	0.5320	87.83%

230V_{AC}/50Hz

Vin,rms(V)	Iin,rms(A)	Pin(W)	P.F.	ATHD(%)	Vout(V)	Iout(A)	Pout(W)	Losses(W)	Eff. (%)
229.9	0.866	196.86	0.989	5.390%	384.6	0.500	192.300	4.5600	97.68%
230	0.695	157.53	0.985	5.300%	384.7	0.400	153.880	3.6500	97.68%
230	0.527	118.23	0.976	5.560%	384.7	0.300	115.410	2.8200	97.61%
230	0.444	98.75	0.967	5.800%	384.7	0.250	96.175	2.5750	97.39%
230	0.361	79.00	0.952	7.000%	384.7	0.200	76.940	2.0600	97.39%
230	0.280	59.47	0.924	7.900%	384.7	0.150	57.705	1.7650	97.03%
230	0.209	40.59	0.846	11.000%	384.7	0.100	38.470	2.1200	94.78%
230	0.137	20.50	0.642	26.000%	384.3	0.050	19.215	1.2850	93.73%
230.1	0.099	8.43	0.371		384.1	0.020	7.682	0.7470	91.14%
230	0.081	4.21	0.226		383.6	0.010	3.836	0.3740	91.12%

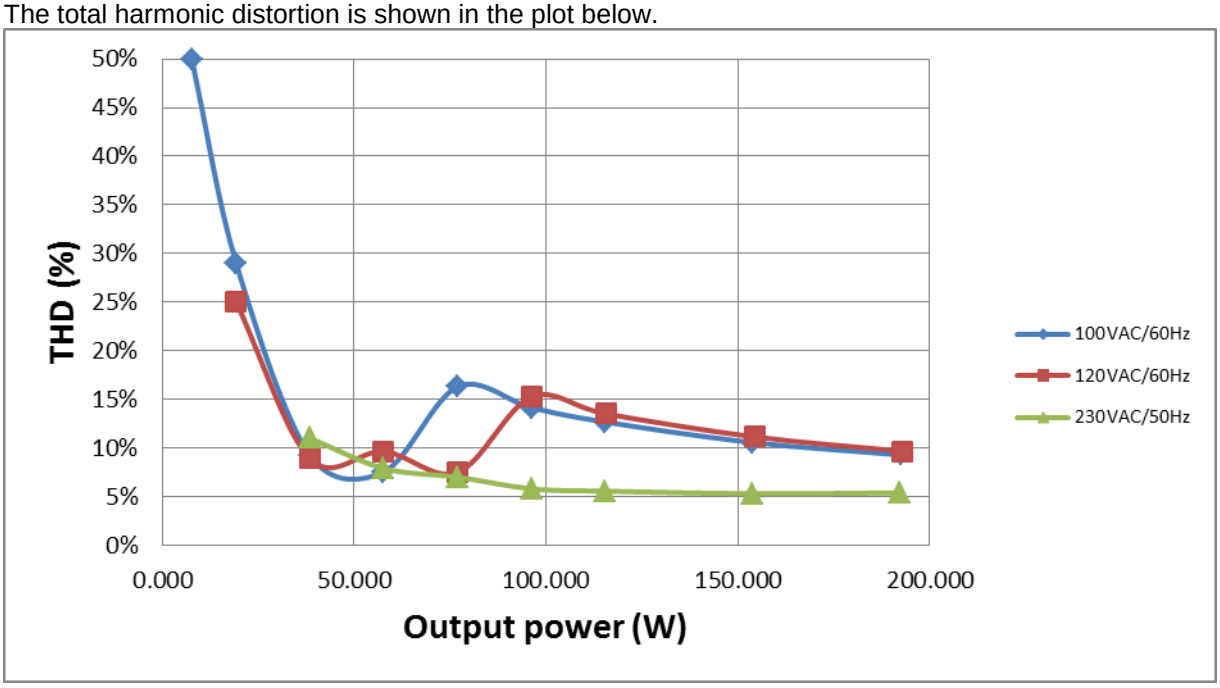
2.2 Power Factor

The power factor is shown in the plot below.

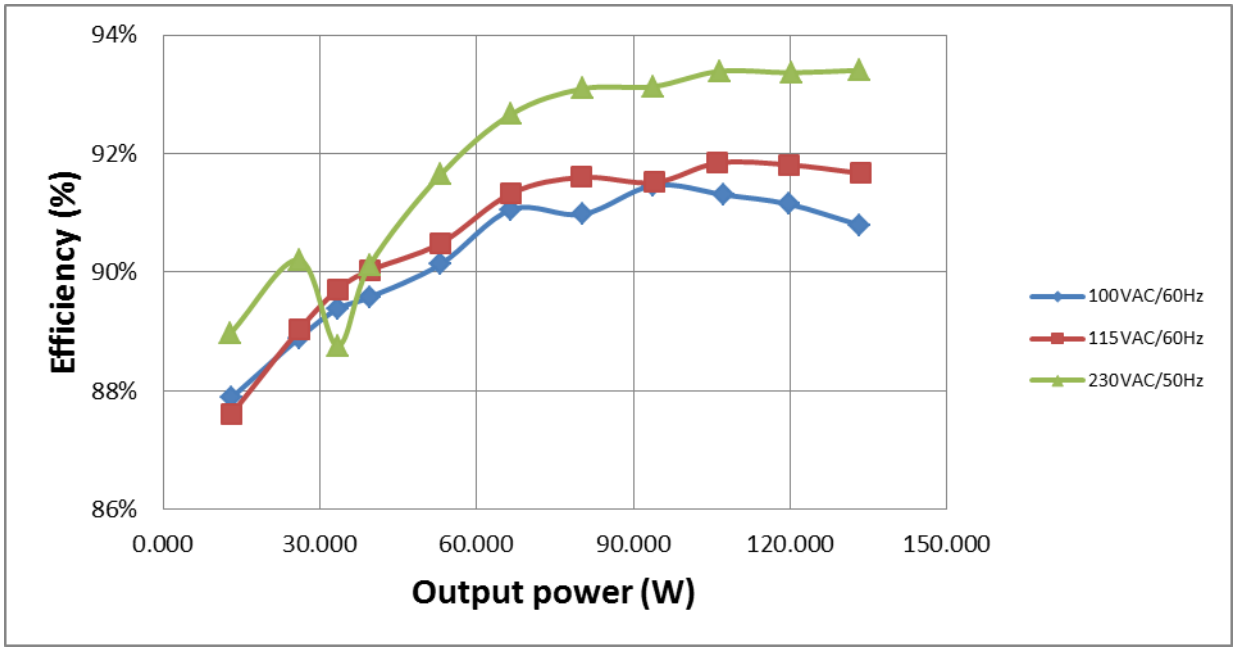


2.3 Total Harmonic Distortion

The total harmonic distortion is shown in the plot below.



2.4 Total efficiency



$100V_{AC}$/60Hz

Vin,rms(V)	Iin,rms(A)	Pin(W)	P.F.	ATHD(%)	Vout(V)	Iout(A)	Pout(W)	Losses(W)	Eff. (%)
99.98	1.482	146.94	0.992	11.5%	12.33	10.820	133.411	13.5294	90.79%
100.11	1.325	131.35	0.991	12.5%	12.33	9.710	119.724	11.6257	91.15%
99.98	1.189	117.62	0.989	13.3%	12.33	8.710	107.394	10.2257	91.31%
100.04	1.039	102.67	0.987	14.5%	12.34	7.610	93.907	8.7626	91.47%
100.09	0.896	88.30	0.984	16.3%	12.34	6.510	80.333	7.9666	90.98%
100.04	0.746	73.18	0.981	18.2%	12.34	5.400	66.636	6.5440	91.06%
100.09	0.595	58.87	0.988	7.8%	12.34	4.300	53.062	5.8080	90.13%
100.01	0.448	44.19	0.986	8.4%	12.34	3.208	39.587	4.6033	89.58%
100.02	0.379	37.29	0.982	10.7%	12.34	2.701	33.330	3.9597	89.38%
100.05	0.299	29.25	0.977	10.1%	12.34	2.107	26.000	3.2496	88.89%
100.07	0.215	14.81	0.688	12.9%	12.35	1.054	13.017	1.7951	87.88%

115V_{AC}/60Hz

Vin,rms(V)	Iin,rms(A)	Pin(W)	P.F.	ATHD(%)	Vout(V)	Iout(A)	Pout(W)	Losses(W)	Eff. (%)
115.01	1.278	145.67	0.991	12.5%	12.33	10.830	133.534	12.1361	91.67%
115.07	1.145	130.40	0.990	13.5%	12.33	9.710	119.724	10.6757	91.81%
115.02	1.017	115.59	0.988	14.6%	12.33	8.610	106.161	9.4287	91.84%
115.09	0.906	102.75	0.985	15.9%	12.34	7.620	94.031	8.7192	91.51%
115.05	0.774	87.43	0.982	17.5%	12.34	6.490	80.087	7.3434	91.60%
115.02	0.642	72.96	0.988	8.8%	12.34	5.400	66.636	6.3240	91.33%
115.04	0.517	58.64	0.987	10.0%	12.34	4.300	53.062	5.5780	90.49%
115.09	0.389	43.95	0.981	10.2%	12.35	3.204	39.569	4.3806	90.03%
115.02	0.332	37.32	0.978	8.9%	12.35	2.711	33.481	3.8392	89.71%
115.05	0.262	29.20	0.968	8.6%	12.35	2.105	25.997	3.2033	89.03%
115.01	0.189	14.85	0.682	9.6%	12.35	1.053	13.005	1.8405	87.60%

230V_{AC}/50Hz

Vin,rms(V)	Iin,rms(A)	Pin(W)	P.F.	ATHD(%)	Vout(V)	Iout(A)	Pout(W)	Losses(W)	Eff. (%)
230	0.631	142.71	0.983	5.9%	12.32	10.820	133.302	9.4076	93.41%
230	0.571	128.76	0.980	5.8%	12.33	9.750	120.218	8.5425	93.37%
230	0.509	114.07	0.975	5.7%	12.33	8.640	106.531	7.5388	93.39%
229.9	0.452	100.70	0.969	6.1%	12.34	7.600	93.784	6.9160	93.13%
230	0.391	86.16	0.959	6.3%	12.34	6.500	80.210	5.9500	93.09%
230.1	0.330	71.91	0.946	7.3%	12.34	5.400	66.636	5.2740	92.67%
230	0.273	57.90	0.923	9.6%	12.34	4.300	53.062	4.8380	91.64%
230	0.219	43.82	0.872	9.6%	12.34	3.200	39.488	4.3320	90.11%
230	0.196	37.55	0.835	10.3%	12.34	2.701	33.330	4.2197	88.76%
230.1	0.173	28.79	0.723	11.9%	12.35	2.103	25.972	2.8180	90.21%
230	0.128	14.53	0.493	26.5%	12.35	1.047	12.930	1.6016	88.98%

3 Standby Input Power

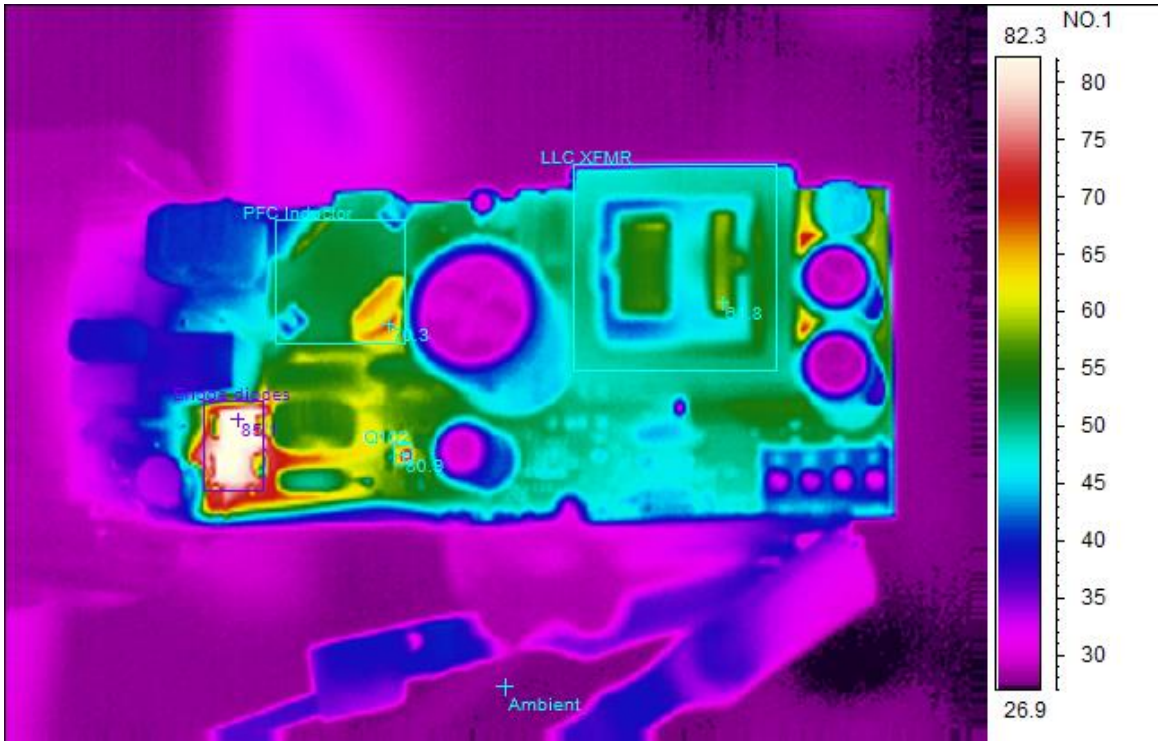
Standby input power test results are shown in the table below:

Vout(V)	Iout(mA)	Pout(W)	Vin(V)	Iin(mA)	Fin(Hz)	Pin(W)
12.34	0	0	230	58.12	50	0.2508
12.29	2.24	0.0275296	230	58.28	50	0.3113
12.34	29.37	0.3624258	230	61.34	50	0.7534
12.34	91.9	1.134046	230	67.68	50	1.647
12.34	210.8	2.601272	230	75.62	50	3.29
12.34	0	0	115	40.35	60	0.2828
12.34	1.792	0.02211328	114.99	38.89	60	0.2352
12.34	29.55	0.364647	114.98	50.8	60	0.7171
12.34	91.7	1.131578	115.07	67.38	60	1.608
12.34	210.8	2.601272	115	92.21	60	3.276

4 Thermal Images

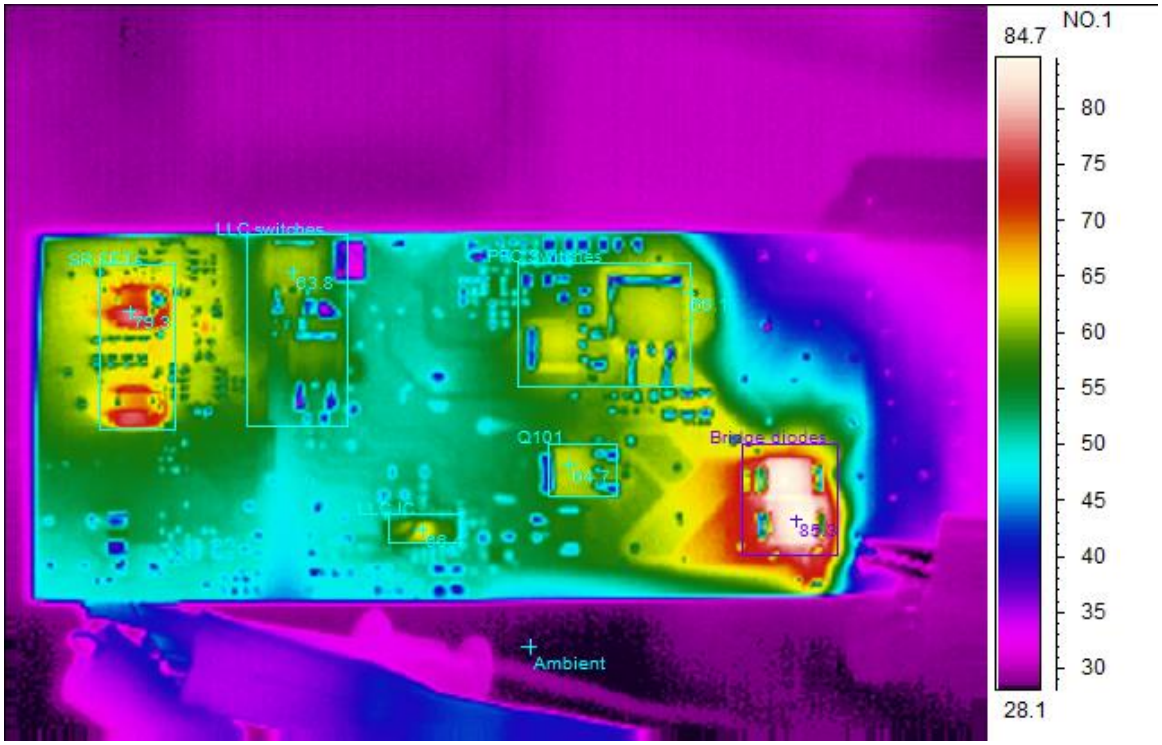
The thermal images below show a top view and bottom view of the board. The board is placed vertically during the test. The ambient temperature was 25ºC with no air flow. The output was loaded with 12V/10.8A.

4.1 100V/60Hz, Top Side



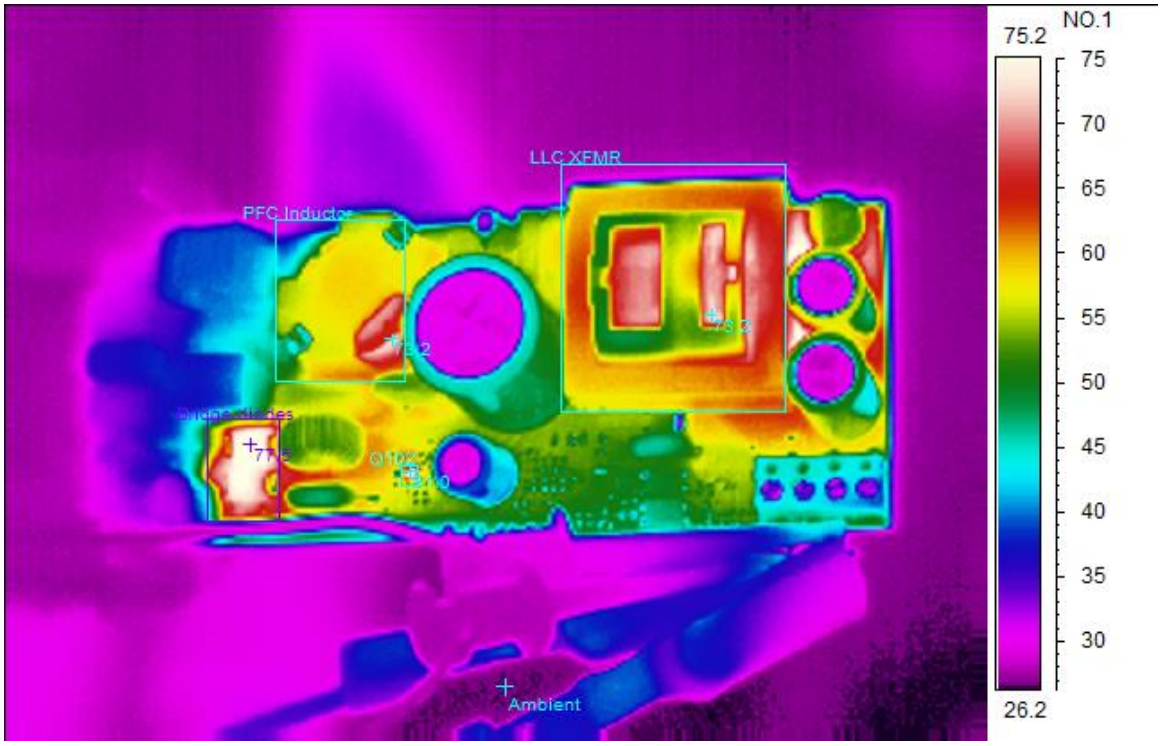
Spot analysis	**Value**
Ambient Temperature	27.7°C
Area analysis	**Value**
Bridge diodesMax	85.1°C
PFC InductorMax	70.3°C
LLC XFMRMax	61.8°C
Q102 Max	80.9°C

4.2 100V/60Hz, Bottom Side



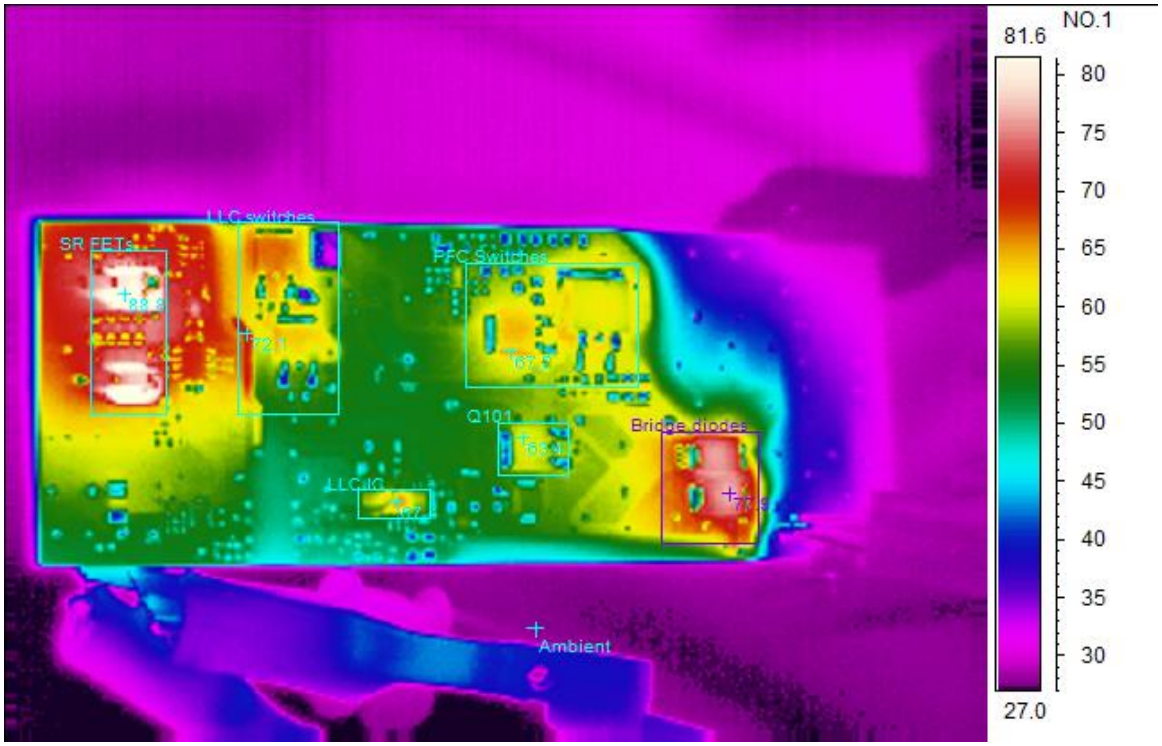
Spot analysis	Value
Ambient Temperature	28.4°C
Area analysis	**Value**
Bridge diodesMax	85.3°C
PFC SwitchesMax	66.1°C
Q101Max	64.7°C
LLC switchesMax	63.8°C
SR FETsMax	79.3°C
LLC ICMax	66.4°C

4.3 115V/60Hz, Top Side



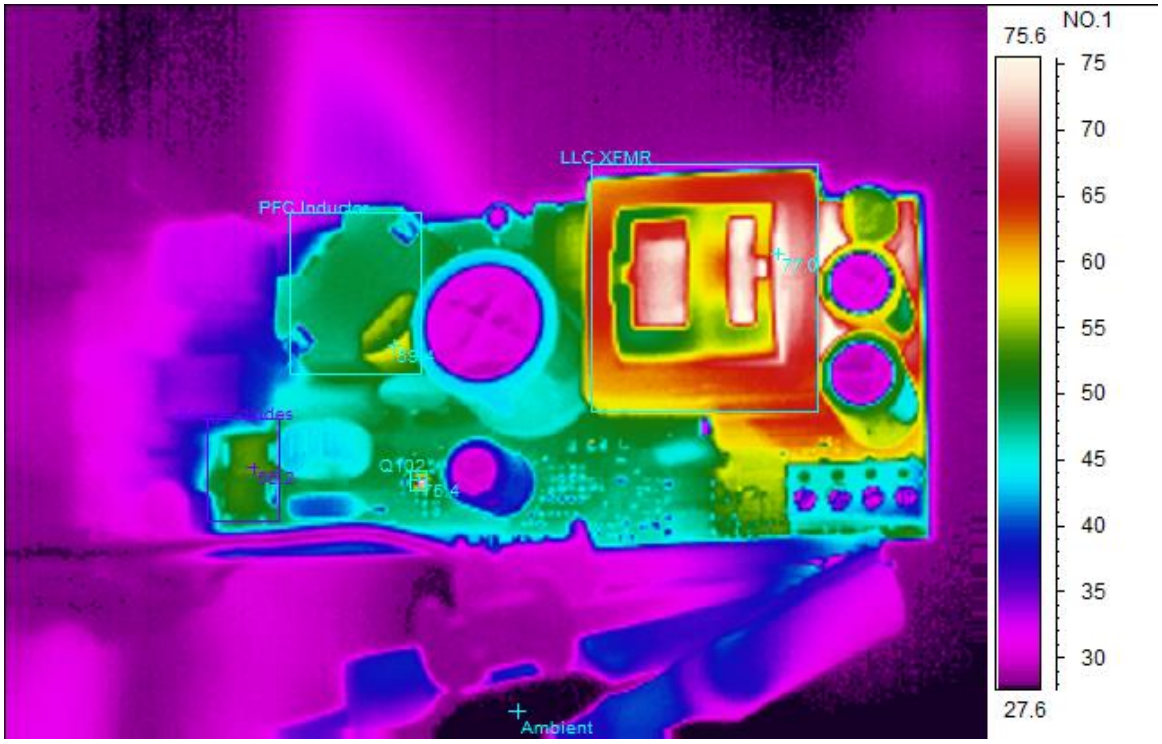
Spot analysis	Value
Ambient Temperature	26.8°C
Area analysis	**Value**
Bridge diodesMax	77.5°C
PFC InductorMax	73.2°C
LLC XFMRMax	73.2°C
Q102 Max	81.0°C

4.4 115V/60Hz, Bottom Side



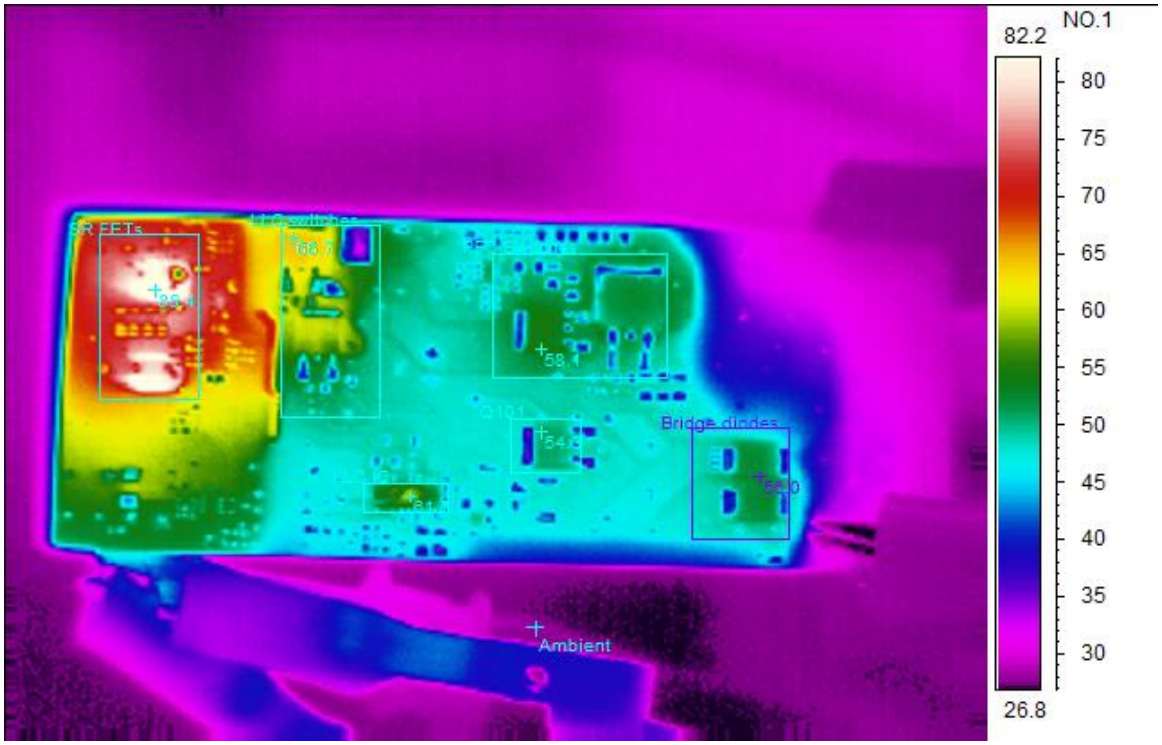
Spot analysis	Value
Ambient Temperature	28.3°C
Area analysis	**Value**
Bridge diodesMax	77.9°C
PFC SwitchesMax	67.2°C
Q101Max	63.4°C
LLC switchesMax	72.1°C
SR FETsMax	88.8°C
LLC ICMax	67.4°C

4.5 230V/50Hz, Top Side



Spot analysis	Value
Ambient Temperature	27.6°C
Area analysis	**Value**
Bridge diodesMax	56.2°C
PFC InductorMax	59.4°C
LLC XFMRMax	77.0°C
Q102 Max	75.4°C

4.6 230V/50Hz, Bottom Side

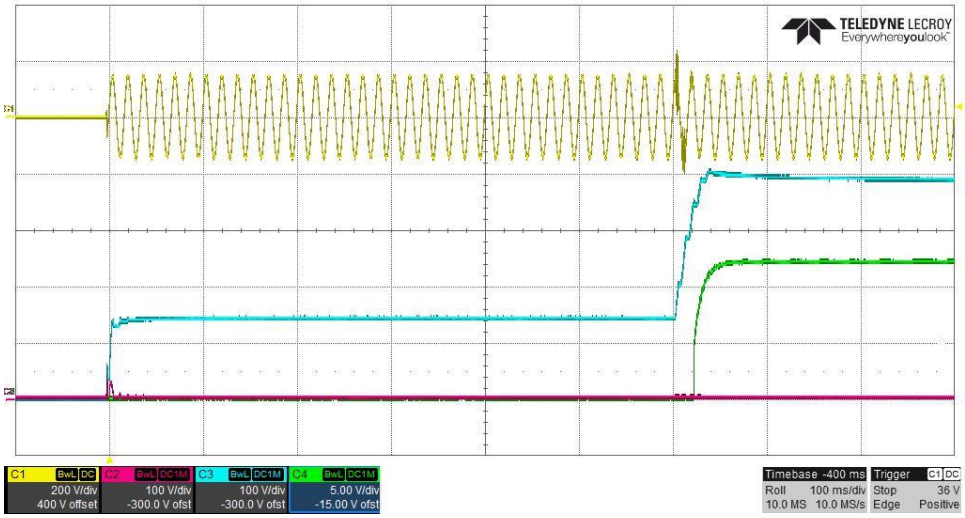


Spot analysis	Value
Ambient Temperature	28.4°C
Area analysis	**Value**
Bridge diodesMax	56.0°C
PFC SwitchesMax	58.1°C
Q101Max	54.3°C
LLC switchesMax	66.7°C
SR FETsMax	89.4°C
LLC ICMax	61.7°C

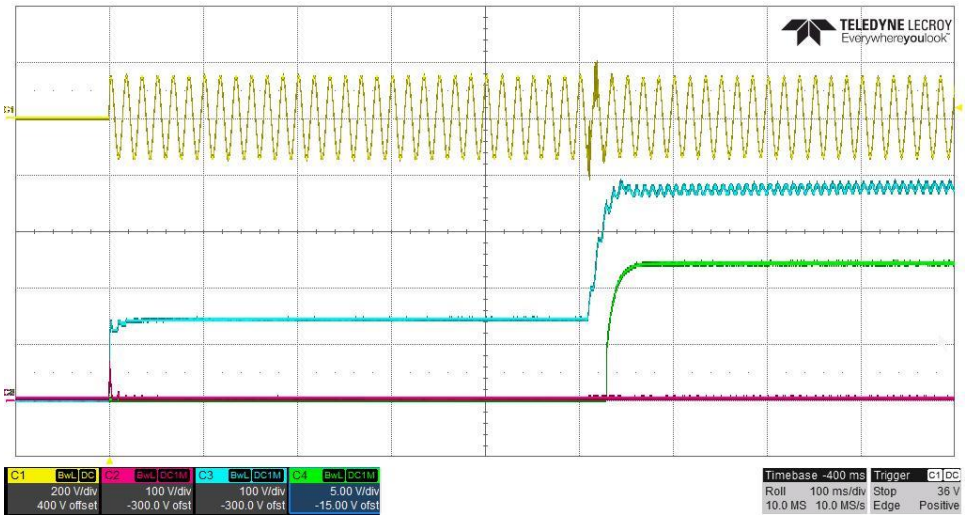
5 Startup

The voltages at startup are shown in the images below, where Channel 1 is the input voltage, Channel 2 is the V_{DS} voltage of Q101, Channel 3 is HV to GND, and Channel 4 is output voltage.

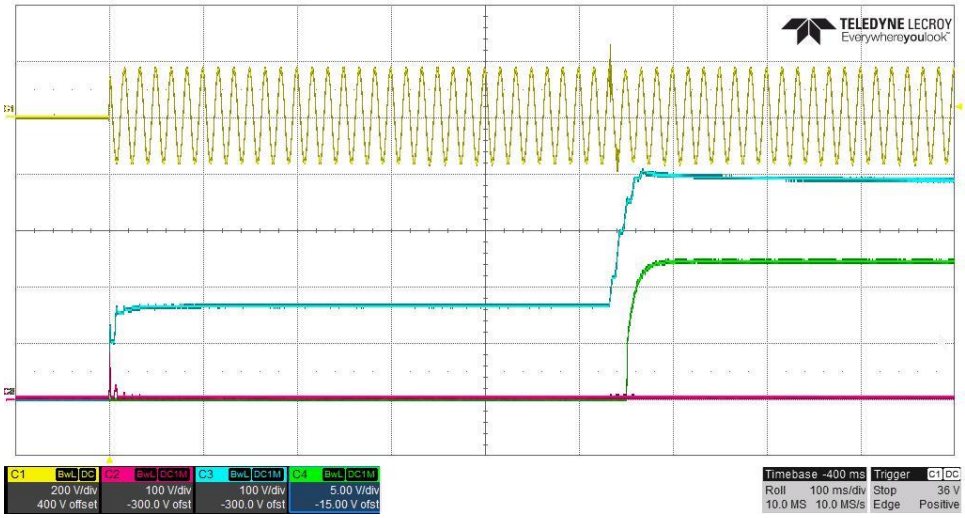
5.1 100V_{AC}/60Hz – No Load



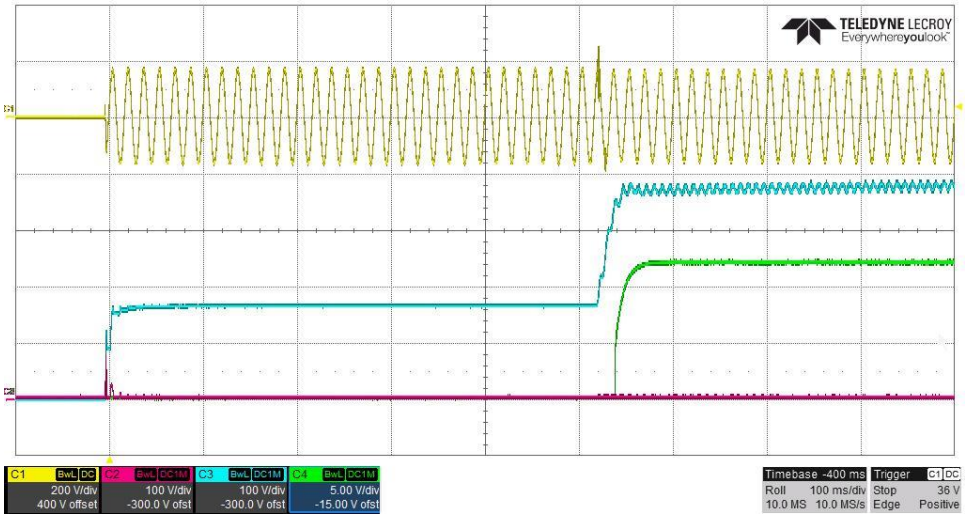
5.2 100V_{AC}/60Hz –12V/10.8A



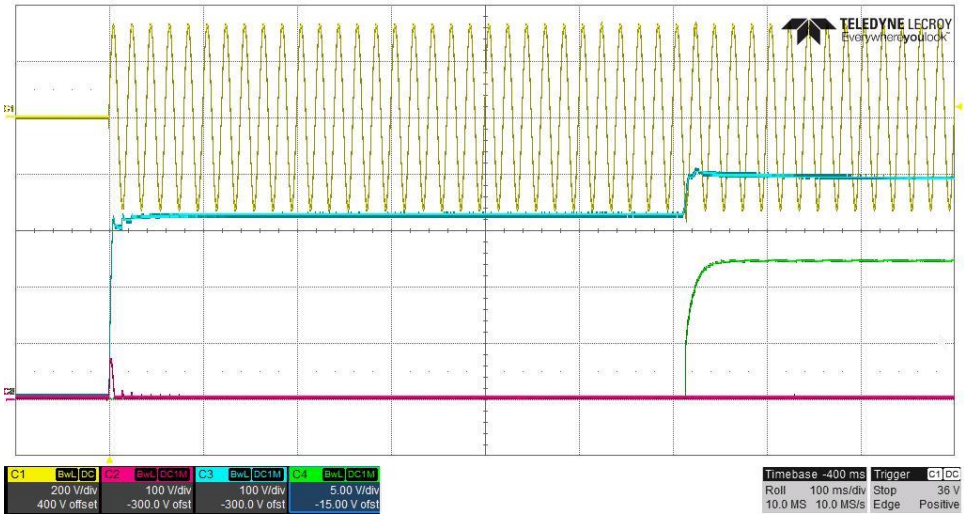
5.3 $115V_{AC}$/60Hz – No Load



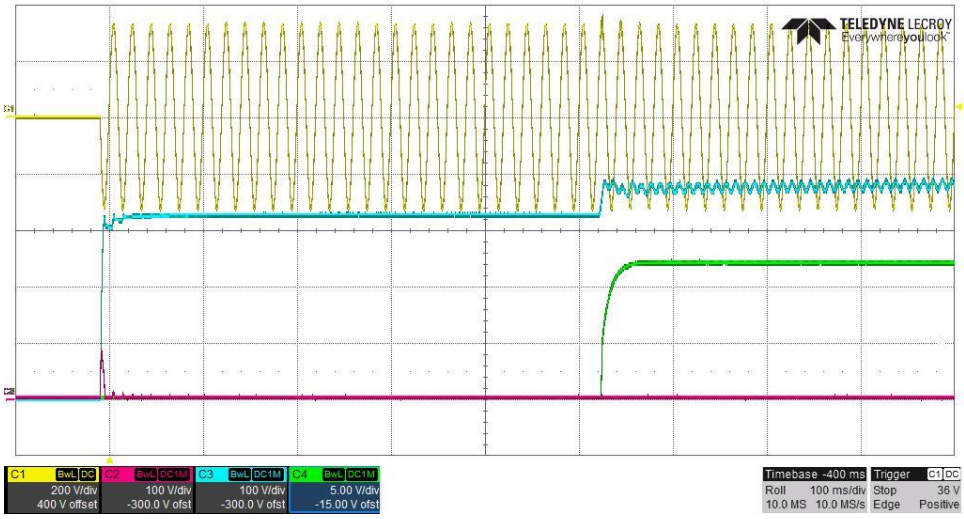
5.4 $115V_{AC}$/60Hz –12V/10.8A



5.5 230V_{AC}/50Hz – No Load



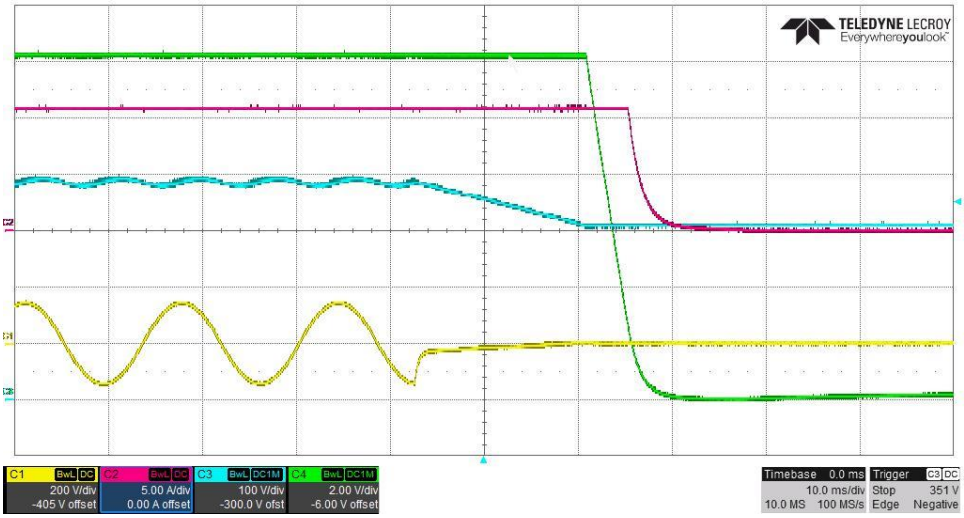
5.6 230V_{AC}/50Hz – 12V/10.8A



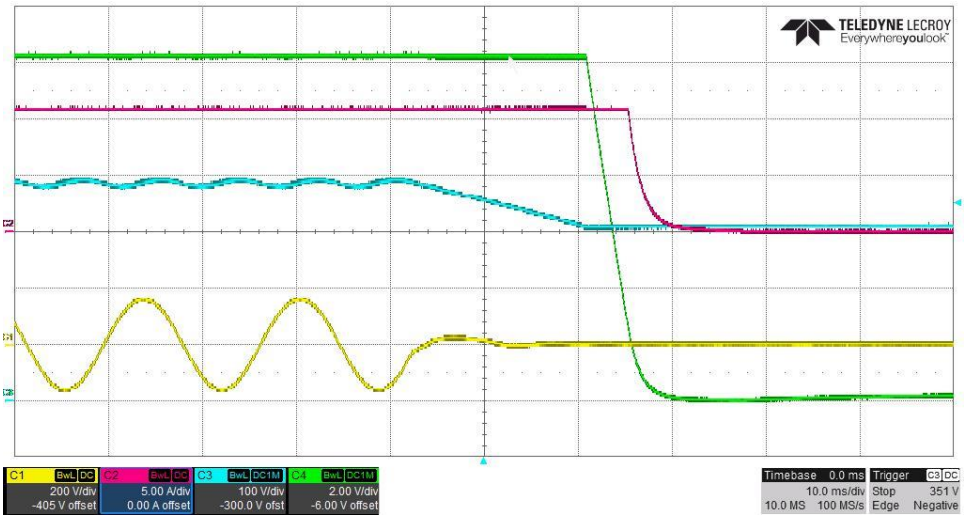
6 Turn-off

The voltages at turn-off are shown in the images below, where Channel 1 is the input voltage, Channel 2 is the output current, Channel 3 is HV to GND, and Channel 4 is output voltage.

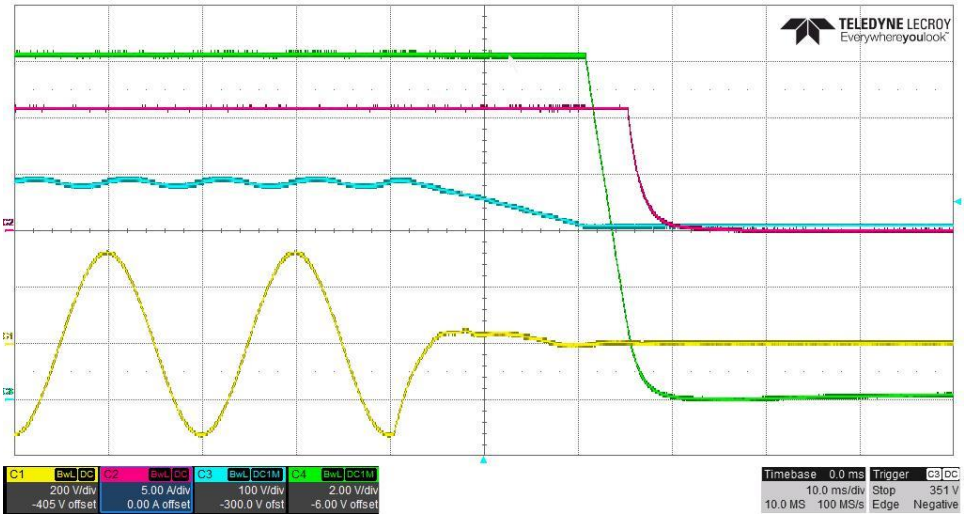
6.1 100V_{AC}/60Hz –12V/10.8A



6.2 115V_{AC}/60Hz –12V/10.8A



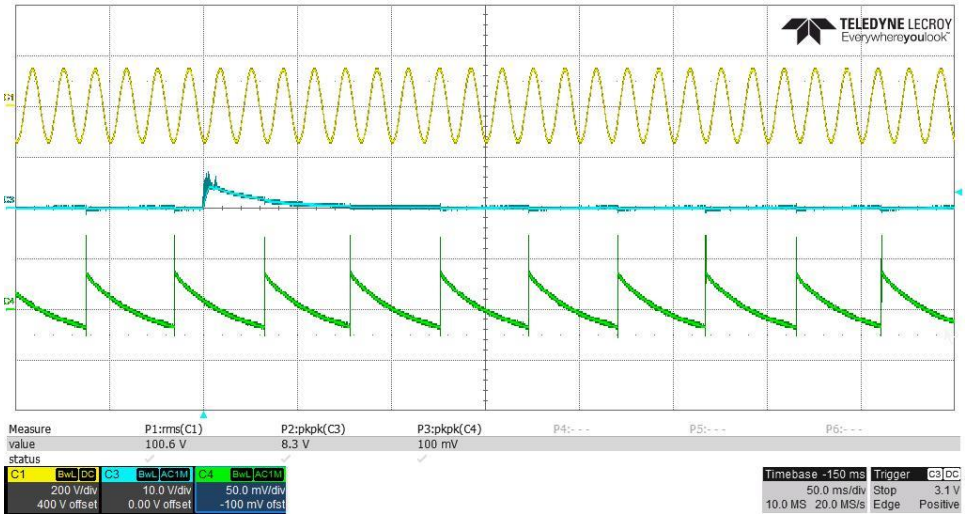
6.3 $230V_{AC}$/50Hz – 12V/10.8A



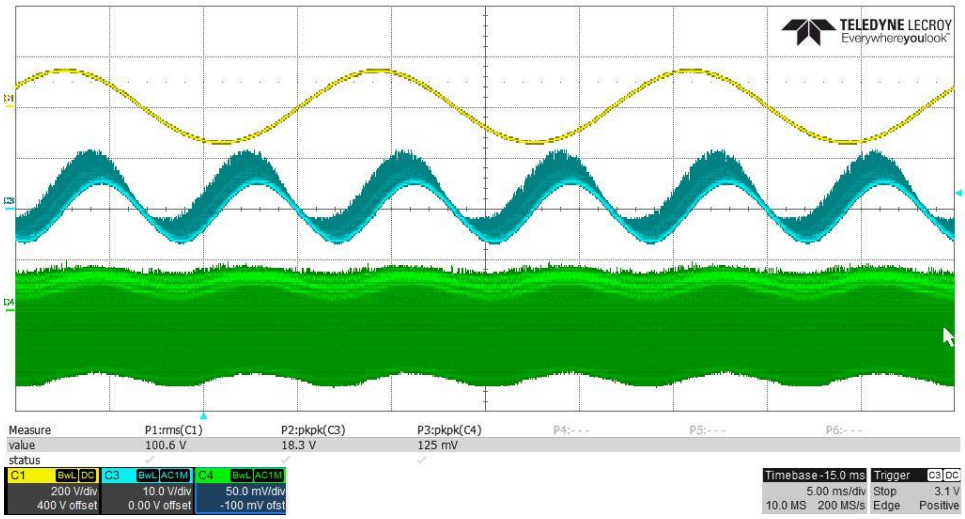
7 Ripple Voltages

Ripple voltages are shown in the images below, where Channel 1 is the input voltage, Channel 3 is HV to GND voltage in AC level, and Channel 4 is output voltage in AC level.

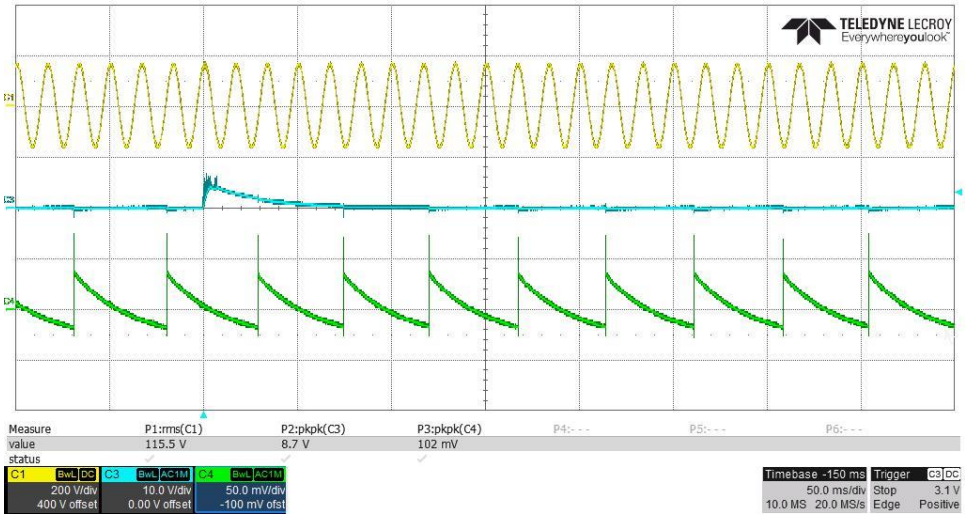
7.1 100V_{AC}/60Hz –12V/0A



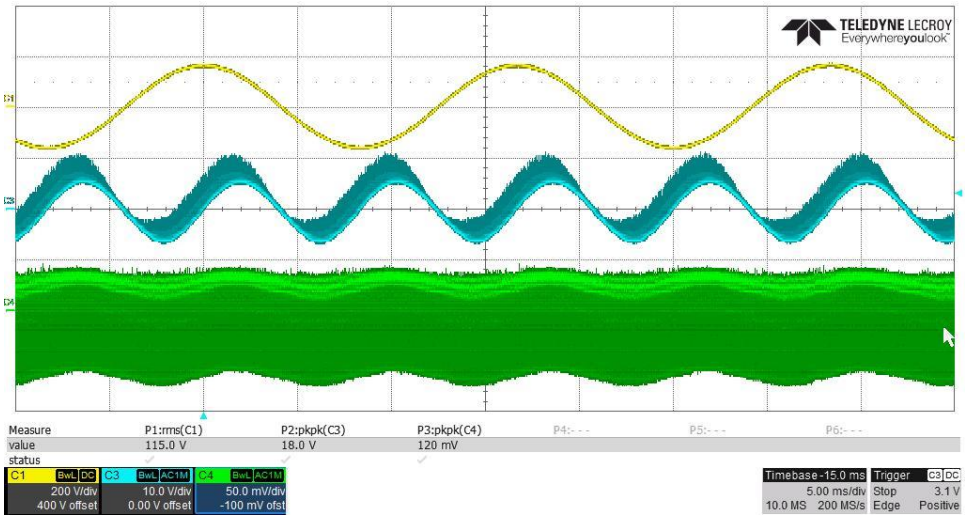
7.2 100V_{AC}/60Hz –12V/10.8A



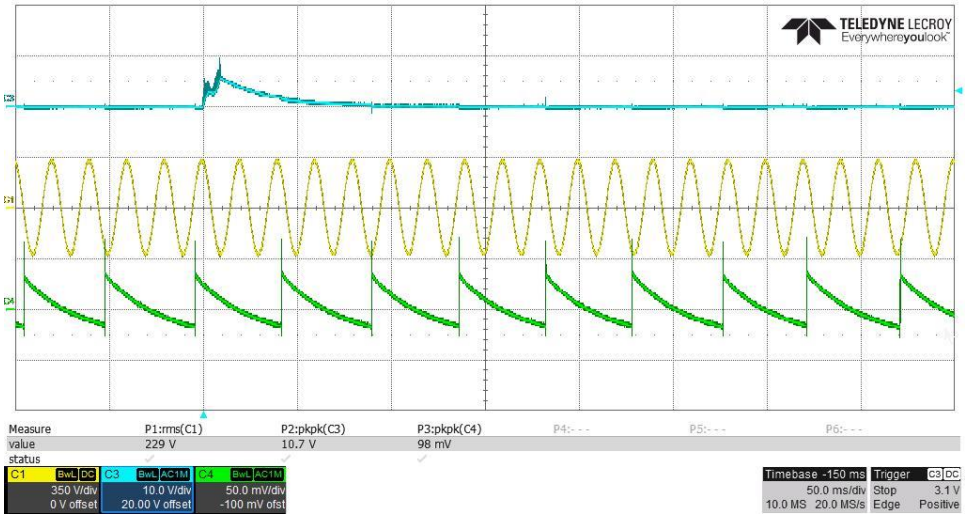
7.3 $115V_{AC}$/60Hz –12V/0A



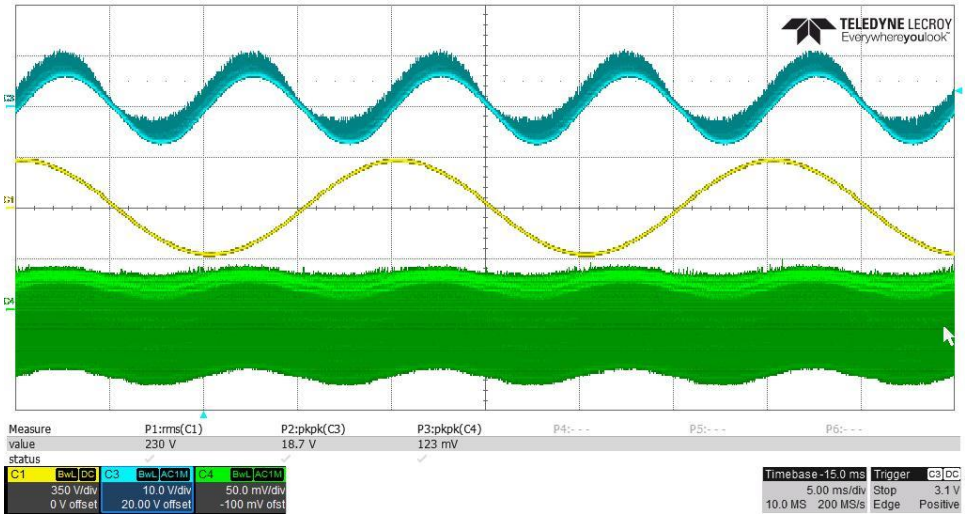
7.4 $115V_{AC}$/60Hz –12V/10.8A



7.5 230V_{AC}/50Hz – 12V/0A



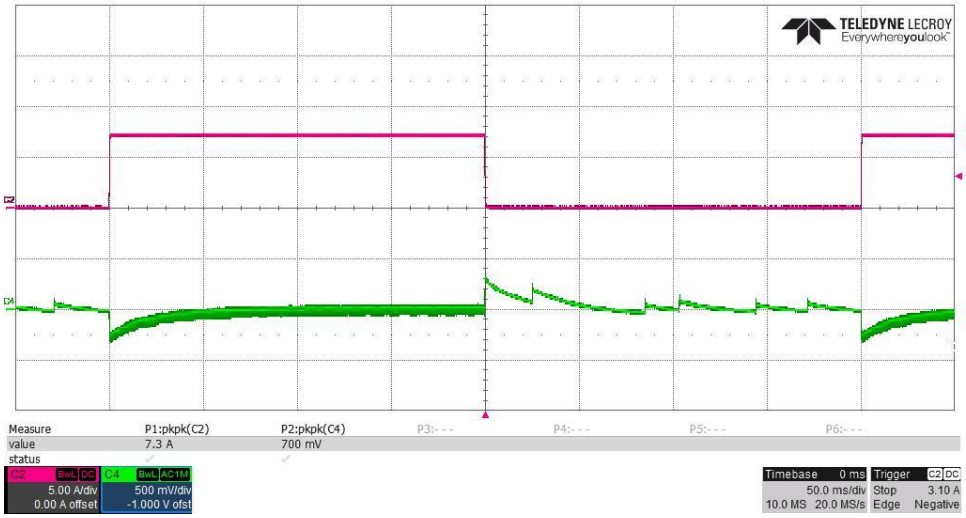
7.6 230V_{AC}/50Hz – 12V/10.8A



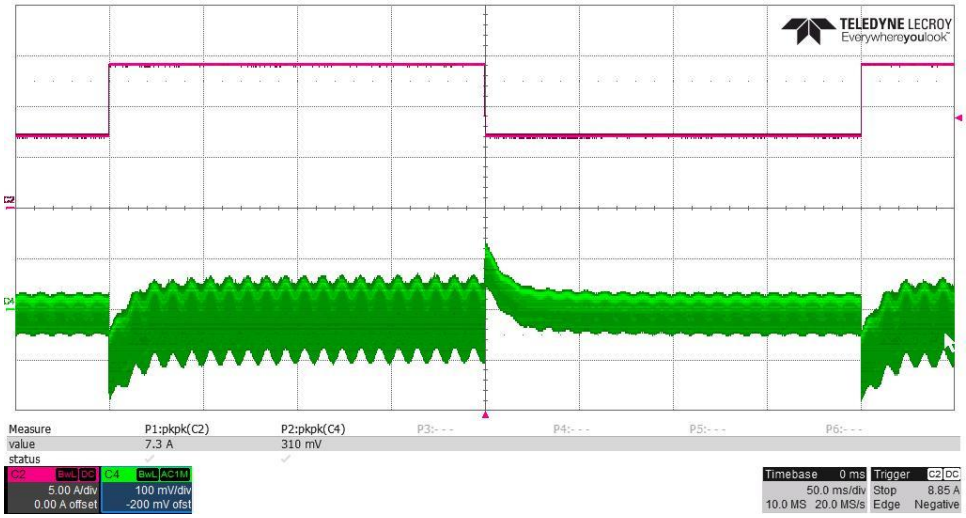
8 Load Response

Load response is tested at 230V_{AC}/50Hz input, where Channel 2 is the output current, and Channel 4 is output voltage in AC level.

8.1 Load step from 0A to 7A:

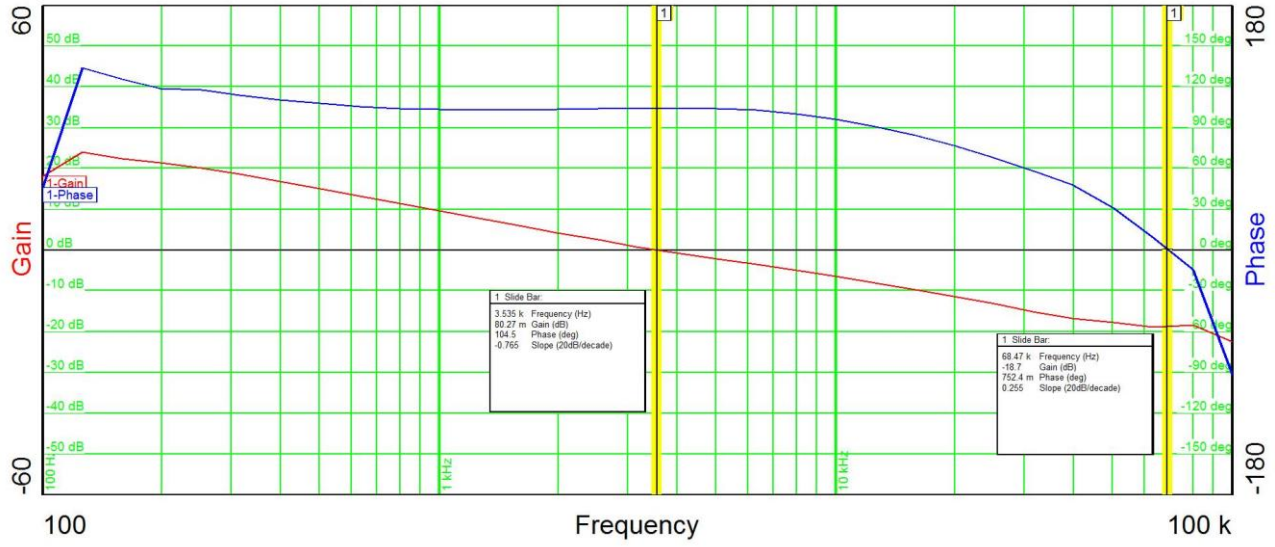


8.2 Load step from 7A to 14.2A:



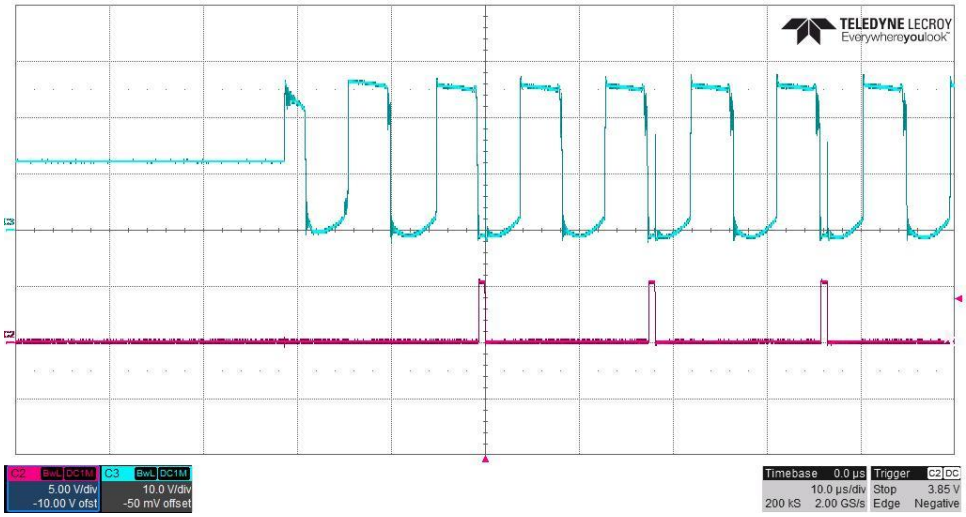
9 Frequency Response

Frequency response of the LLC-SRC stage is tested with 230V_{AC}/50Hz input and 12V/10.8A output. A 49.9ohm resistor is inserted in between node V_{out} and the load for signal injection.

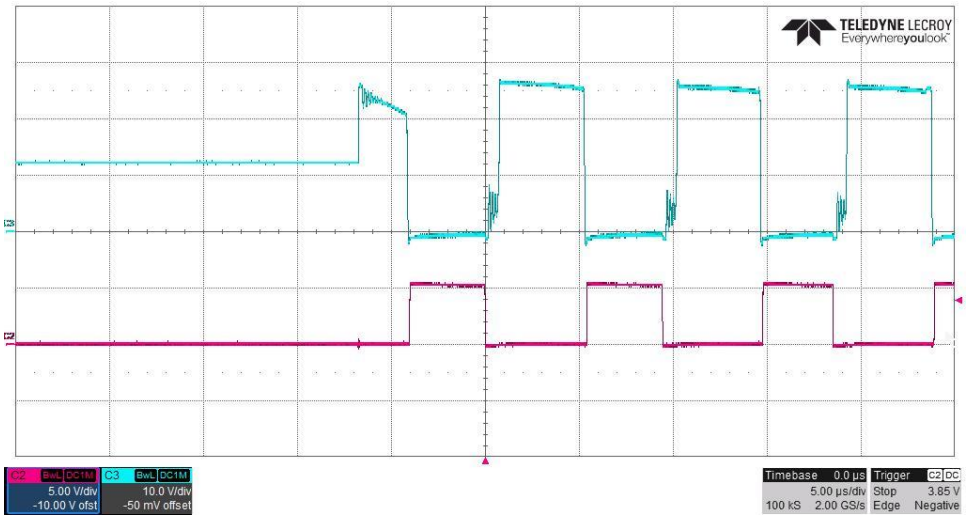


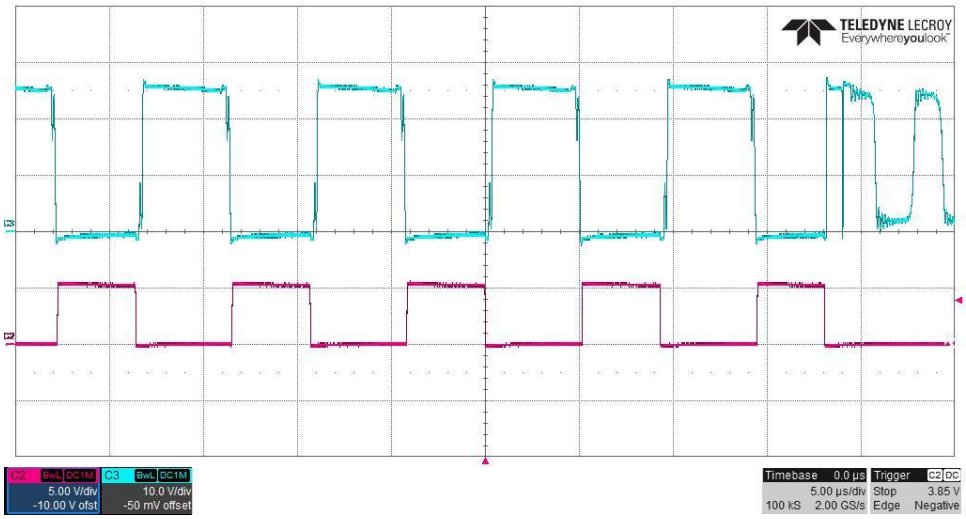
10 Key Waveforms

10.1 SR FET conduction at 100VAC/60Hz input, 12V/0A output: C2: Q203 V_{GS}, C3: Q203 V_{DS}.

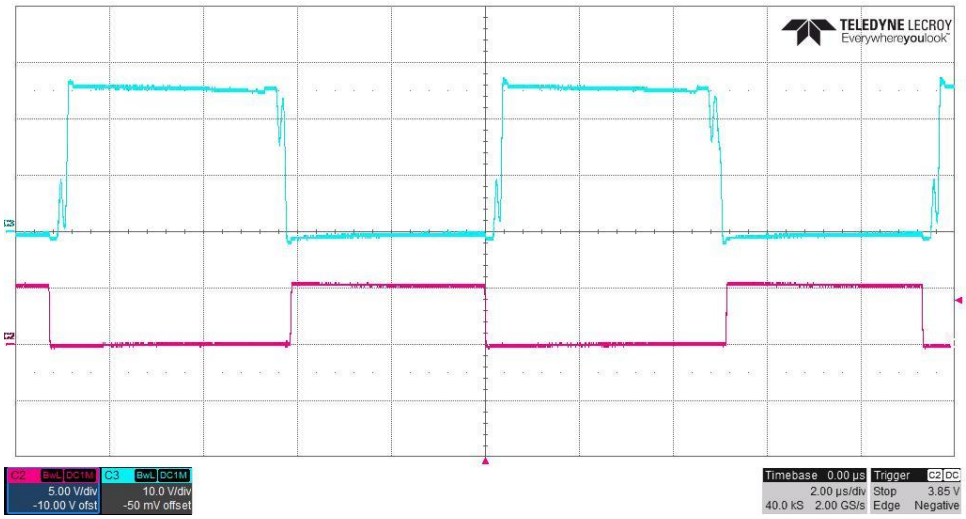


10.2 SR FET conduction at 100VAC/60Hz input, 12V/2.7A output: C2: Q203 V_{GS}, C3: Q203 V_{DS}.

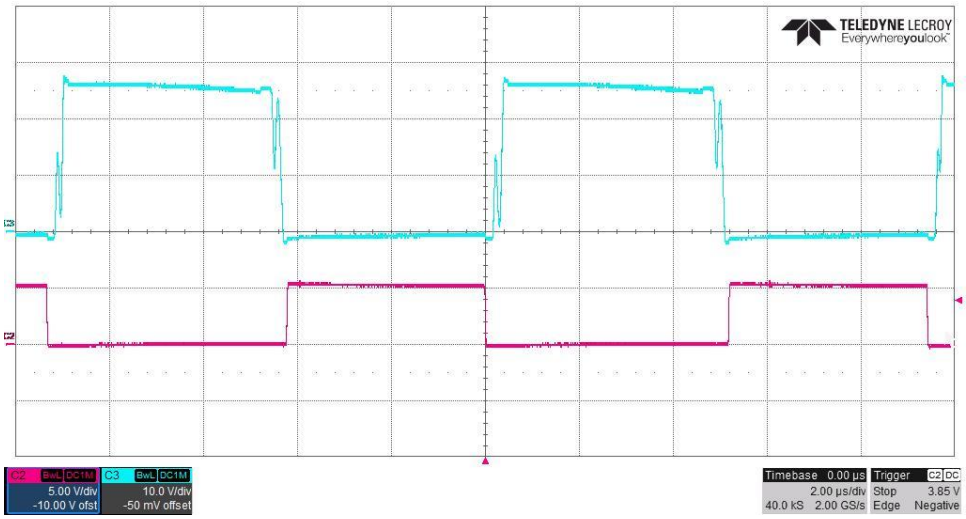




10.3 SR FET conduction at 100VAC/60Hz input, 12V/5.4A output: C2: Q203 V_{GS}, C3: Q203 V_{DS}.



10.4 SR FET conduction at 100VAC/60Hz input, 12V/10.8A output: C2: Q203 V_{GS}, C3: Q203 V_{DS}.



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