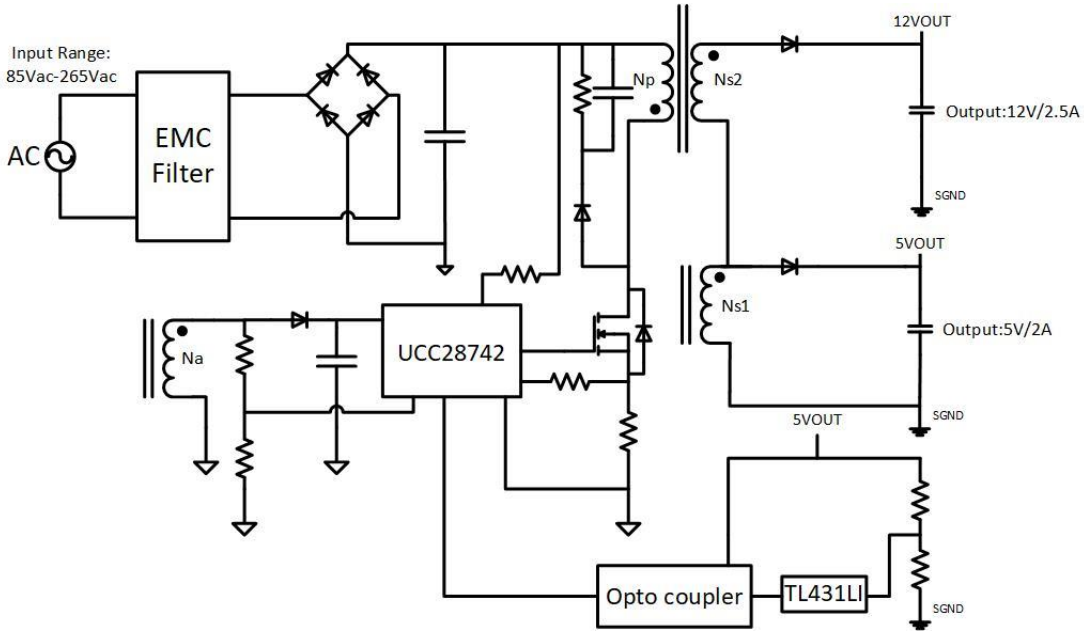
Test Report: PMP40508

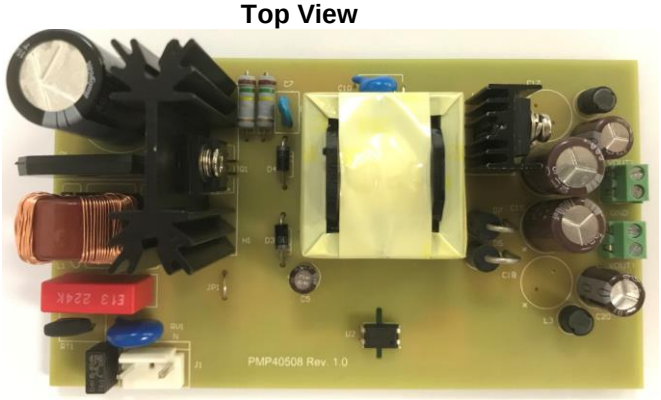
AC Input, 5-V/2-A and 12-V/2.5-A Dual-Output Flyback Converter Reference Design

Description

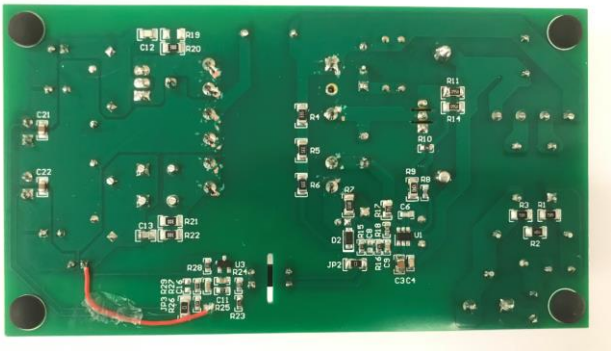
This reference design is a 40-W dual-output offline converter using UCC28742, a secondary side regulator. A 5-V rail is regulated to within ±1% precision and cross regulation of 12-V rail is within -8%~+14% at 25% to 100% load. The design adopts a single-layer PCB for cost optimization. The peak efficiency is 82.68% at 115 V/60 Hz and 84.03% at 230 V/50 Hz. Power consumption at standby mode is 32.7 mW at 115 V/60 Hz and 57.51 mW at 230 V/50 Hz.



Top View



Bottom View



1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	85~265Vac
AC frequency	47~63Hz
Output-1 Voltage	5V
Maximum Output-1 Current	2A
Output-2 Voltage	12V
Maximum Output-2 Current	2.5A

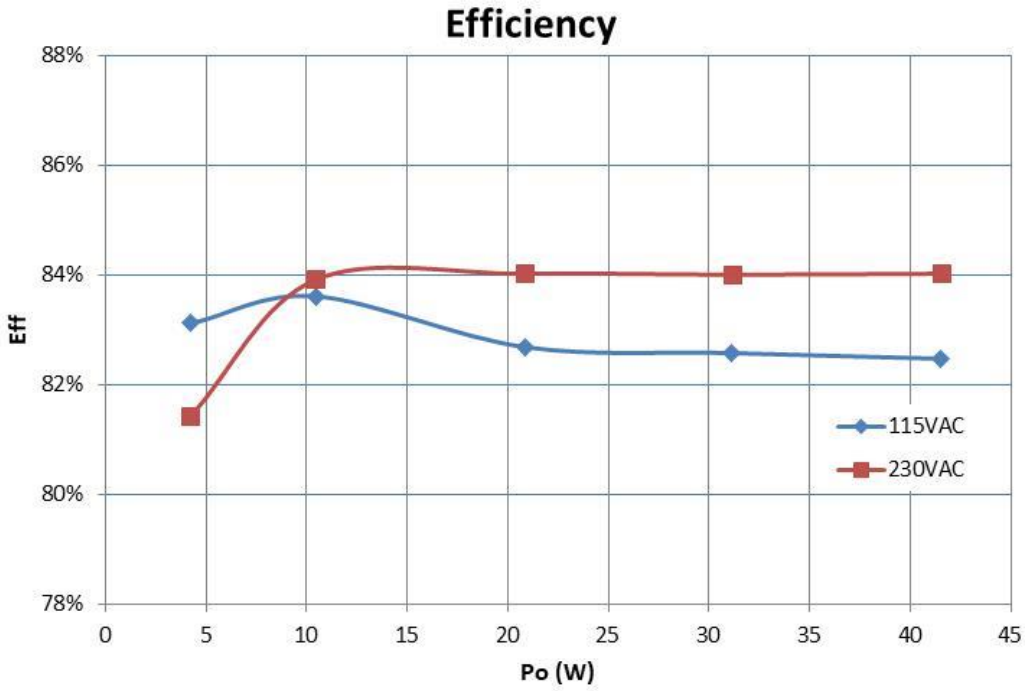
1.2 Required Equipment

- Chroma AC Source MODEL 61603
- Chroma DC E-load MODEL 6314A
- Single Phase Power Meter WT210
- Tektronix DPO 3054
- Multi-meter (current): Fluke 287C
- Multi-meter (voltage): Fluke 287C
- Electrical Thermography: Fluke TiS55
- EMI Test Receiver: KH3939

2 Testing and Results

2.1 Efficiency Data

4-point average efficiency: 82.84%@115VAC/60Hz and 83.99%@230VAC/50Hz.



2.1.1 115V_{AC}/60Hz Efficiency Measurement

P_{IN}/W	V_{O1}/V	I_{O1}/A	V_{O2}/V	I_{O2}/A	P_{OUT}/W	Loss/W	Eff
5.070	5.0060	0.200	12.472	0.258	4.214	0.856	**83.12%**
12.480	5.0051	0.500	12.533	0.633	10.435	2.045	**83.61%**
25.260	5.0035	1.001	12.600	1.260	20.886	4.374	**82.68%**
37.710	5.0022	1.501	12.597	1.876	31.140	6.570	**82.58%**
50.350	5.0006	2.001	12.583	2.505	41.526	8.824	**82.47%**

2.1.2 230V_{AC}/50Hz Efficiency Measurement

P_{IN}/W	V_{O1}/V	I_{O1}/A	V_{O2}/V	I_{O2}/A	P_{OUT}/W	Loss/W	Eff
5.170	5.0058	0.2009	12.426	0.2578	4.209088	0.960912	**81.41%**
12.440	5.005	0.5009	12.535	0.6328	10.43915	2.000848	**83.92%**
24.860	5.0033	1.0001	12.598	1.2609	20.88862	3.971381	**84.03%**
37.090	5.002	1.5012	12.607	1.8759	31.15847	5.931526	**84.01%**
49.470	5.0004	2.001	12.595	2.5059	41.56761	7.902389	**84.03%**

2.2 Cross Regulation

2.2.1 115VAC/60Hz

V_{OUT1}

I_{O1} \ I_{O2}	0A	0.1A	0.625A	1.25A	1.875A	2.5A
0A	5.0071	5.0066	\	\	\	\
0.1A	5.0063	5.0062	5.006	5.0057	5.0056	5.0055
0.5A	\	5.0051	5.0051	5.0046	5.0046	5.0045
1A	\	5.0037	5.0036	5.0035	5.0034	5.0032
1.5A	\	5.0024	5.0023	5.0022	5.0022	5.0018
2A	\	5.0012	5.0010	5.0009	5.0008	5.0006

V_{OUT2}

I_{O1} \ I_{O2}	0A	0.1A	0.625A	1.25A	1.875A	2.5A
0A	16.574	9.178	\	\	\	\
0.1A	22.530	12.506	11.537	10.698	10.010	9.405
0.5A	\	14.568	12.533	12.163	11.941	11.707
1A	\	16.992	13.167	12.600	12.337	12.174
1.5A	\	19.73	13.718	12.917	12.597	12.398
2A	\	21.624	14.236	13.226	12.818	12.583

2.2.2 230VAC/50Hz

V_{OUT1}

I_{O1} \ I_{O2}	0A	0.1A	0.625A	1.25A	1.875A	2.5A
0A	5.0072	5.0063	\	\	\	\
0.1A		5.0060	5.0059	5.0057	5.0054	5.0051
0.5A	\	5.0050	5.0049	5.0045	5.0045	5.0043
1A	\	5.0036	5.0035	5.0033	5.0032	5.0030
1.5A	\	5.0023	5.0022	5.0021	5.002	5.0018
2A	\	5.0010	5.0009	5.0007	5.0006	5.0004

V_{OUT2}

I_{O1} \ I_{O2}	0A	0.1A	0.625A	1.25A	1.875A	2.5A
0A	16.910	9.012	\	\	\	\
0.1A	23.140	12.436	11.528	10.758	10.068	9.474
0.5A	\	14.490	12.535	12.164	11.938	11.728
1A	\	17.004	13.129	12.598	12.346	12.188
1.5A	\	19.854	13.747	12.934	12.607	12.402
2A	\	21.956	14.274	13.254	12.840	12.595

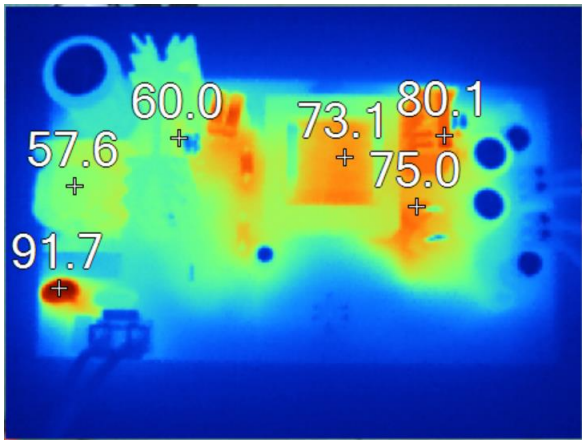
2.3 No-load Power Consumption

VIN	85VAC/60Hz	115VAC/60Hz	230VAC/50Hz	265VAC/50Hz
P_{IN}/mW	29.56	32.7	57.51	74.68

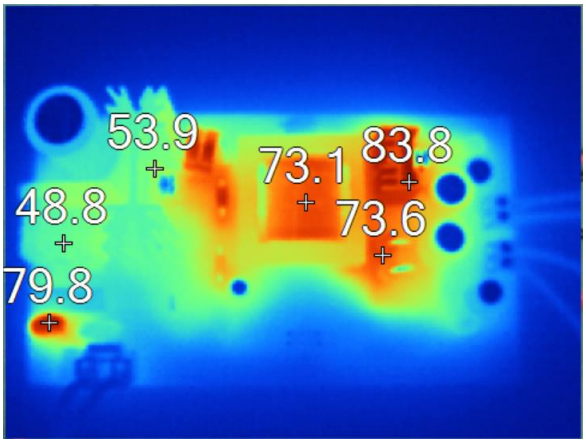
2.4 Thermal Images

The thermal images below show a top view of the board because all the power components are on the top layer. The output load is 5V2A and 12V2.5A and runs 30mins. The ambient temperature was 22.5ºC, open frame.

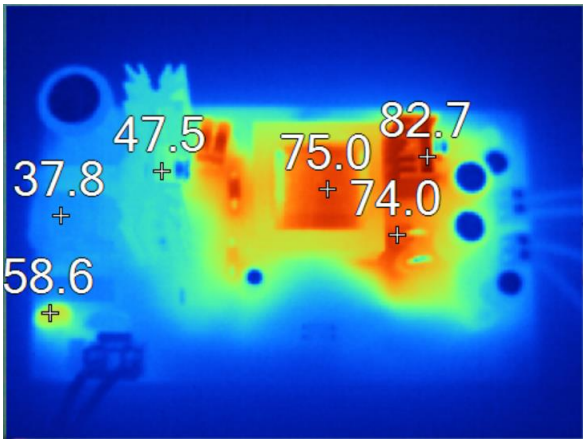
2.4.1 85V_{AC}/60Hz



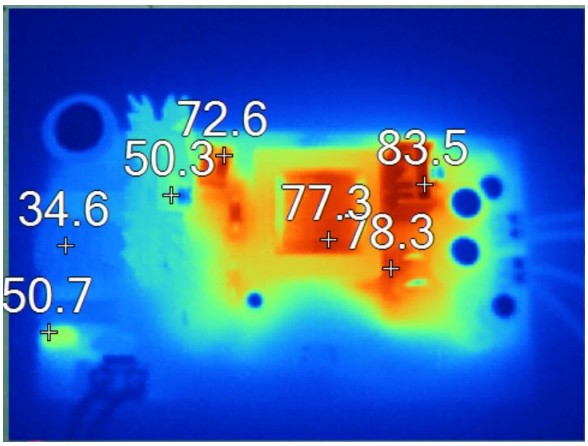
2.4.2 115V_{AC}/60Hz



2.4.3 230V_{AC}/50Hz

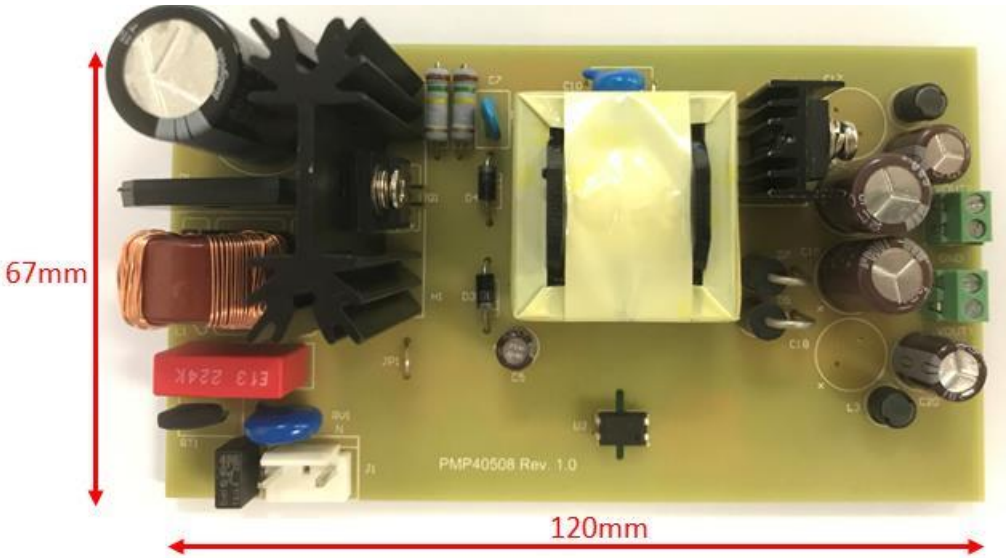


2.4.4 265V_{AC}/50Hz



2.5 Dimensions

The dimension of this board is 120mm (length)*67mm (width)*38mm (height).

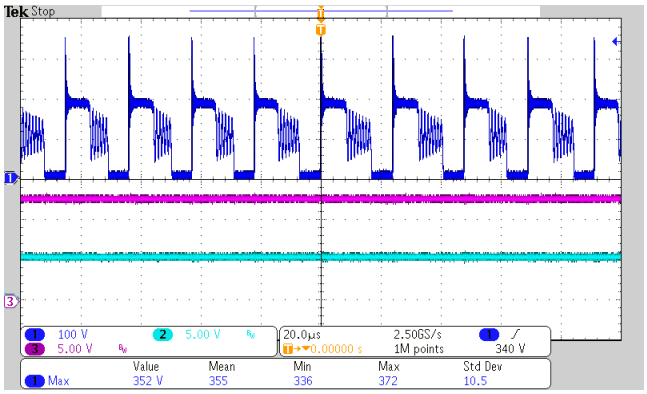


3 Waveforms

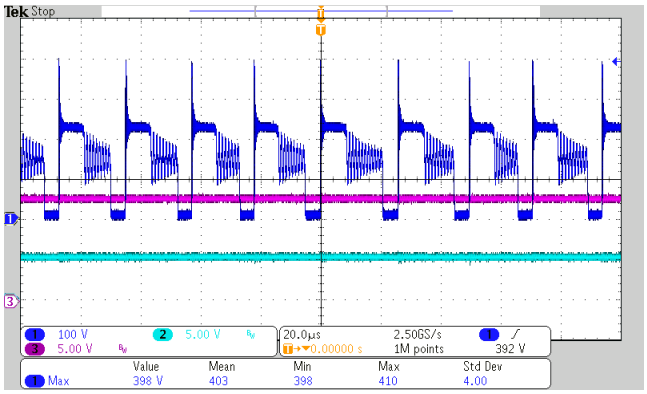
3.1 Normal Operation

The waveforms of V_{DS} are shown in the images below, where Channel 1 is the drain-source voltage, Channel 2 is the output 1 voltage, Channel 3 is the output 2 voltage.

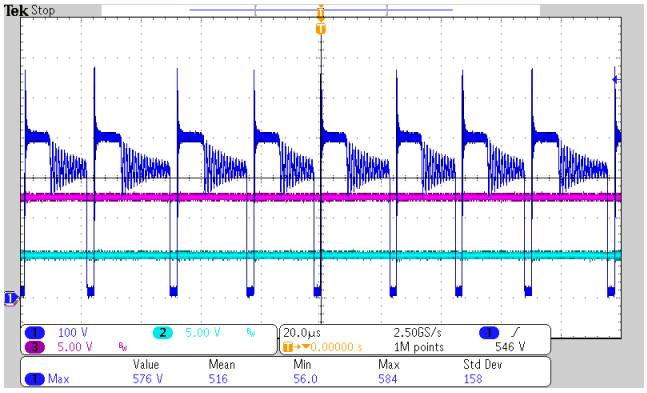
3.1.1 85V_{AC}/60Hz- Full Load



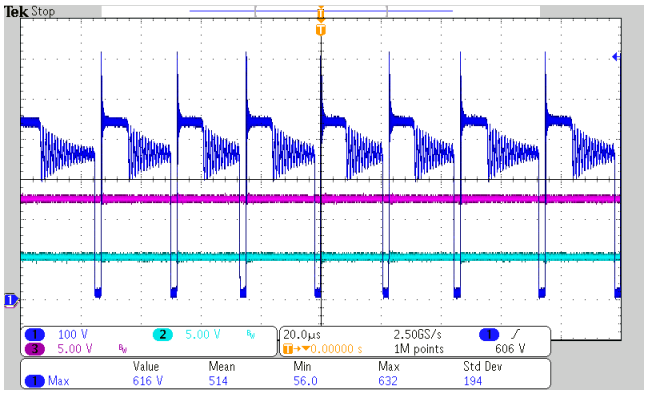
3.1.2 115V_{AC}/60Hz- Full Load



3.1.3 230V_{AC}/50Hz- Full Load



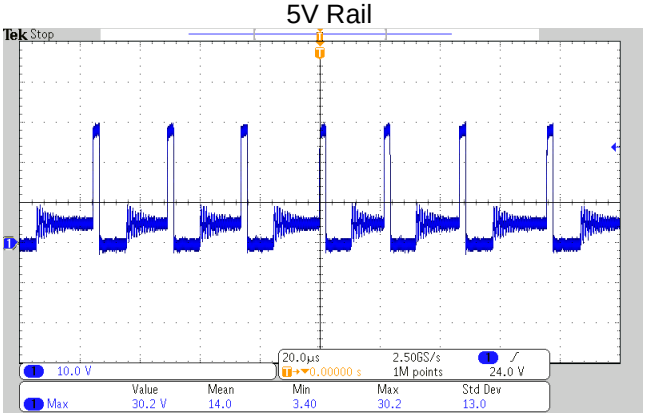
3.1.4 265V_{AC}/50Hz- Full Load



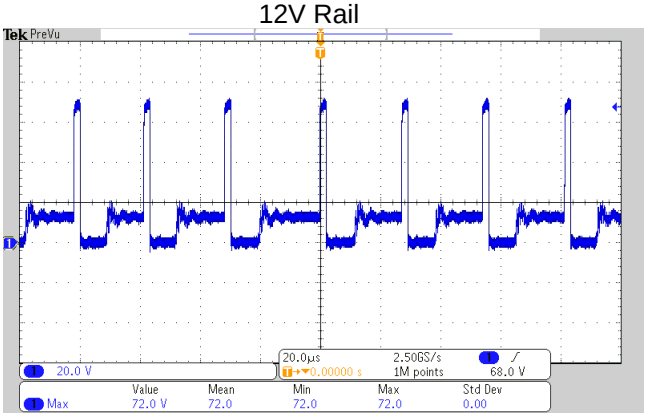
3.2 Rectifier Diode Stress

The waveforms of rectifier diodes V_{DD} at 265VAC/50Hz input are shown in the images below, where Channel 1 is the A-K voltage.

5V Rail



12V Rail

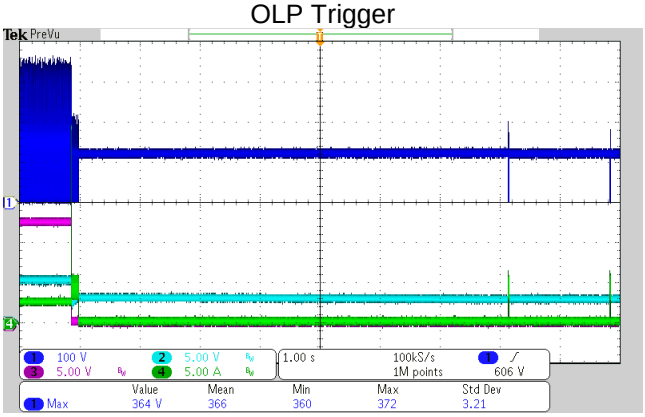


3.3 Output Over Load Protection

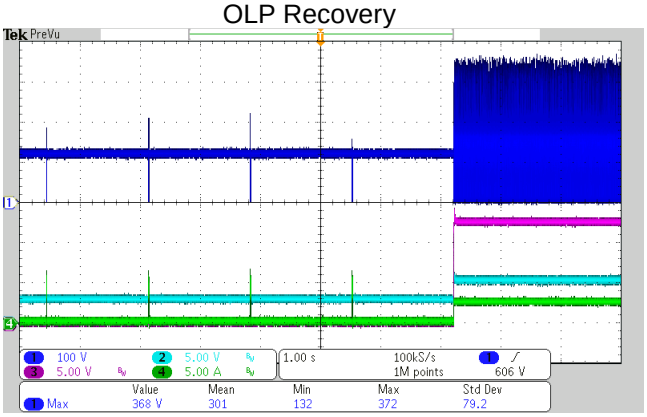
The waveforms of V_{DS} at output over-load are shown in the images below, where Channel 1 is the drain-source voltage, Channel 2 is the output 1 voltage, Channel 3 is the output 2 voltage, Channel 4 is the output 2 current.

3.3.1 85VAC/60Hz- Full Load

OLP Trigger

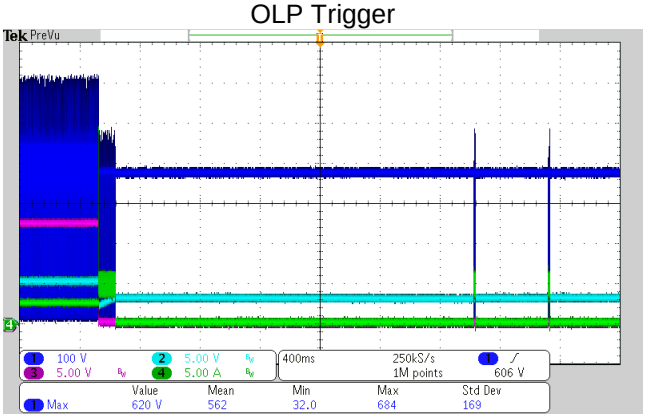


OLP Recovery

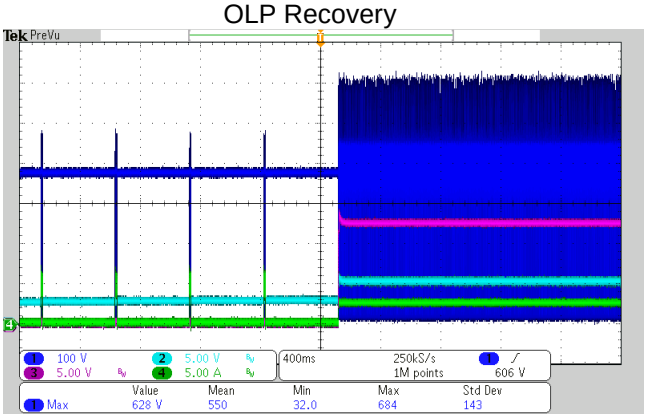


3.3.2 265VAC/50Hz- Full Load

OLP Trigger



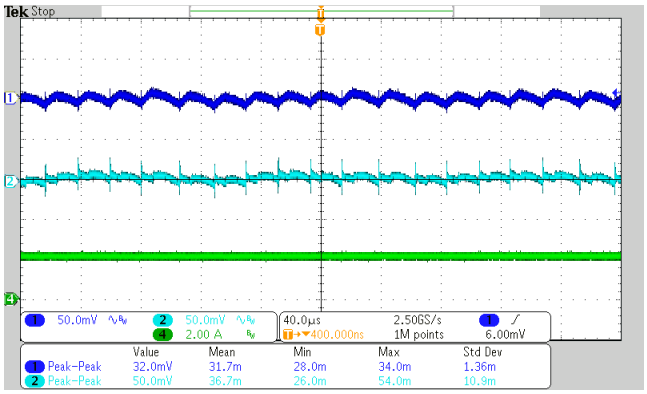
OLP Recovery



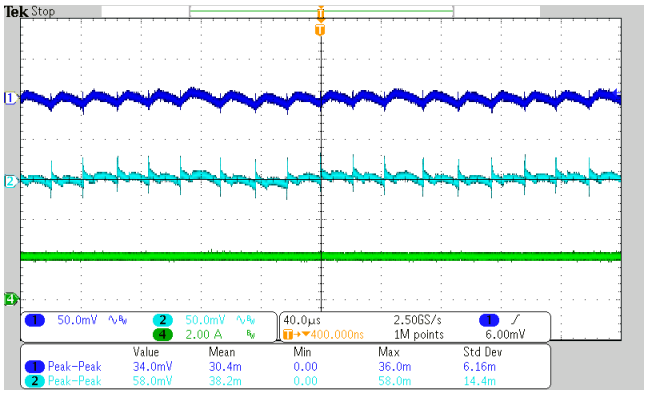
3.4 Output Voltage Ripple

The output voltage ripple are shown in the images below, where Channel 1 is the ripple voltage of output 1, Channel 2 is the ripple voltage of output 2, Channel 4 is the output 1 current.

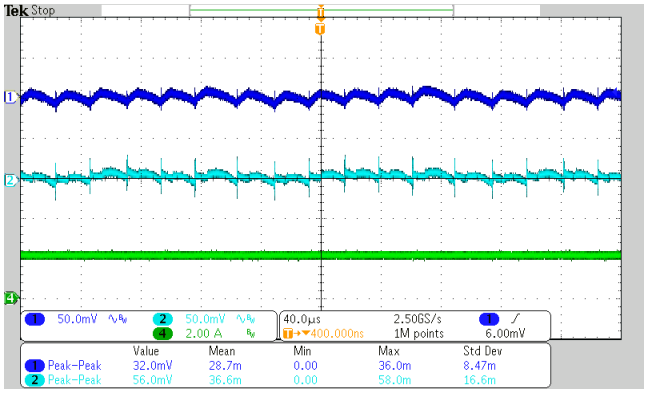
3.4.1 85V_{AC}/60Hz- Full Load



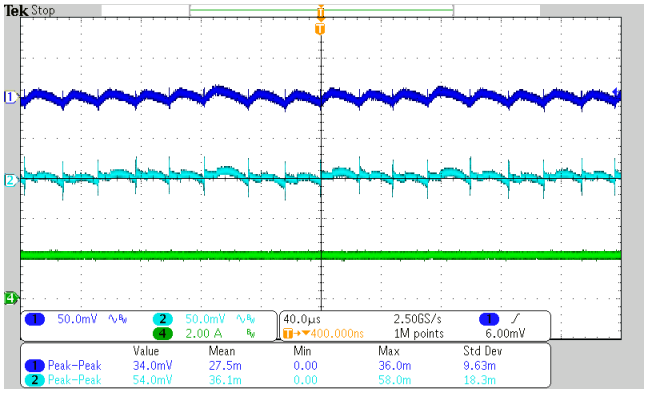
3.4.2 115V_{AC}/60Hz- Full Load



3.4.3 230V_{AC}/50Hz- Full Load



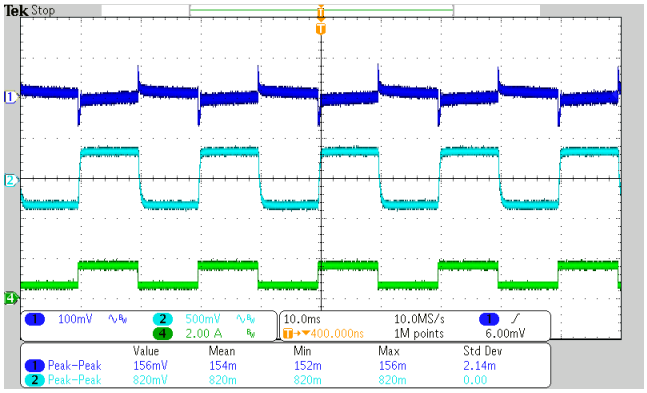
3.4.4 265V_{AC}/50Hz- Full Load



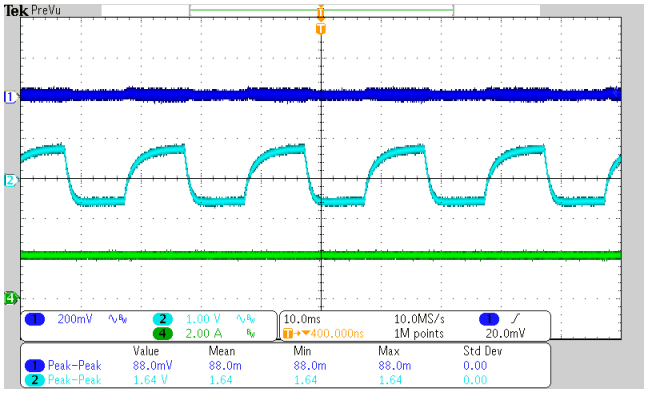
3.5 Load Transient

The output voltage ripple at load transient are shown in the images below, where Channel 1 is the output 1 voltage, Channel 2 is the output 2 voltage, Channel 4 is the output 1 current.
Test condition: one rail is full load, the other rail transient from ¼ load to ¾ load, high level keeps 10ms and low level keeps 10ms, with 0.1A/sec transient rate.

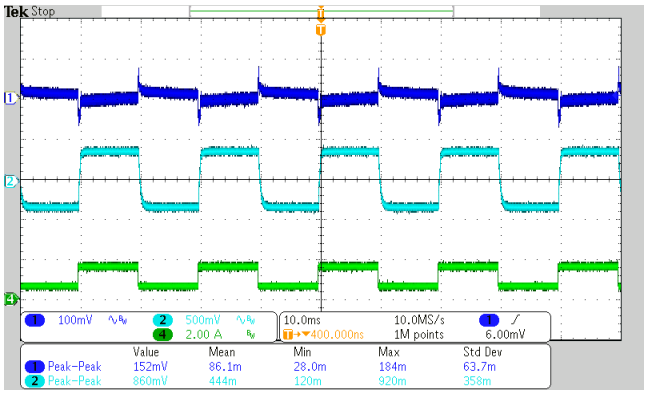
3.5.1 115VAC/60Hz- 5V0.5A->1.5A, 12V2.5A Output



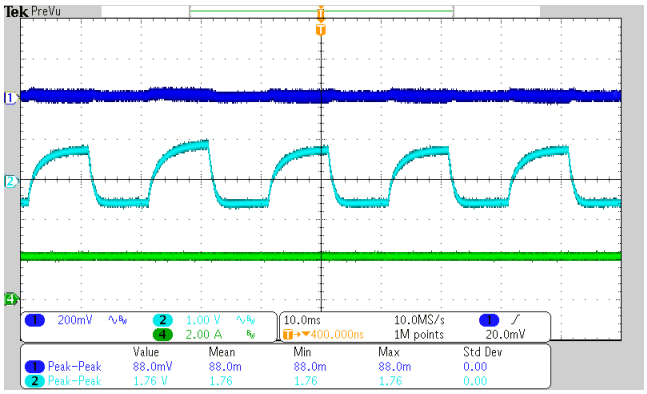
3.5.2 115VAC/60Hz- 5V2A, 12V0.6A->1.8A



3.5.3 230VAC/50Hz- 5V0.5A->1.5A, 12V2.5A Output



3.5.4 230VAC/50Hz- 5V2A, 12V0.6A->1.8A

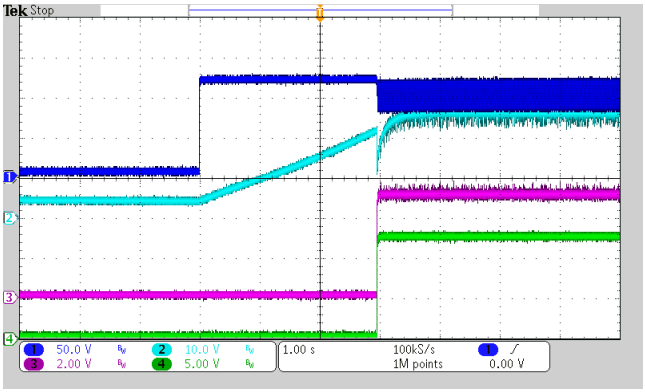


3.6 Power On and Off

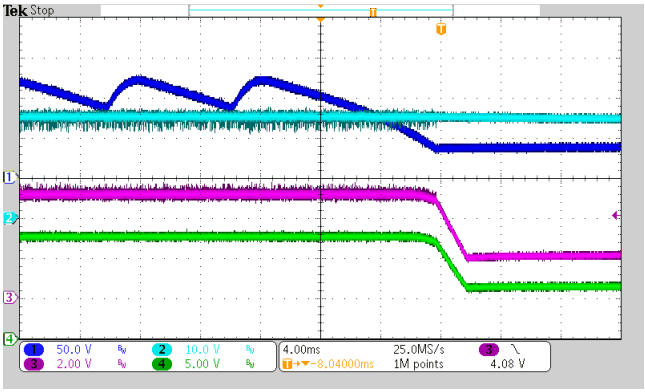
The power on and off are shown in the images below, where Channel 1 is the bus voltage, Channel 2 is the output 1 voltage, Channel 3 is the output 2 voltage.

3.6.1 85V_{AC}/60Hz- Full Load

Power On

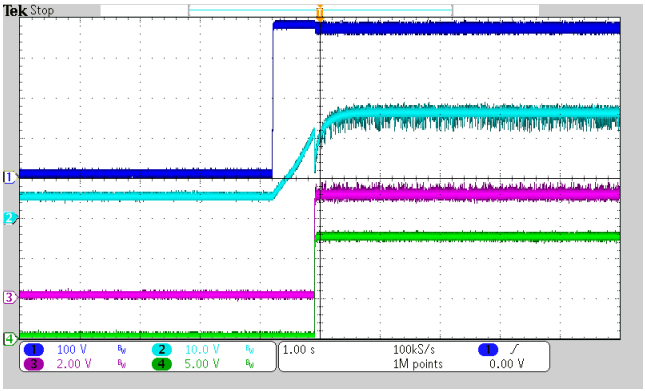


Power Off

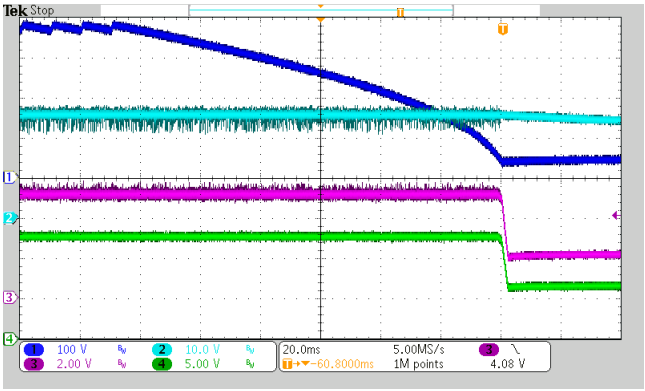


3.6.2 265V_{AC}/50Hz- Full Load

Power On



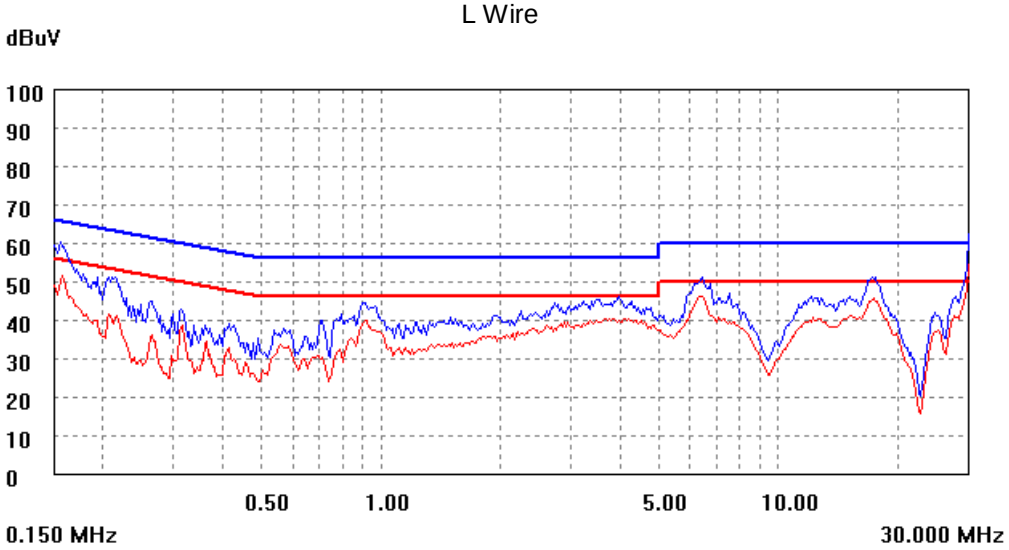
Power Off



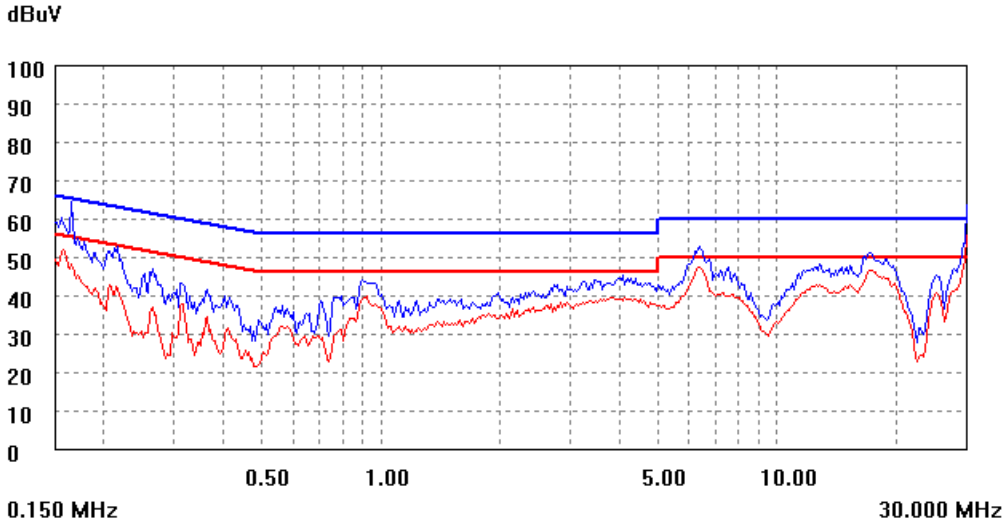
3.7 Conducted Emission (Standard: EN55022 Class B)

3.7.1 115VAC/60Hz- Full Load

L Wire

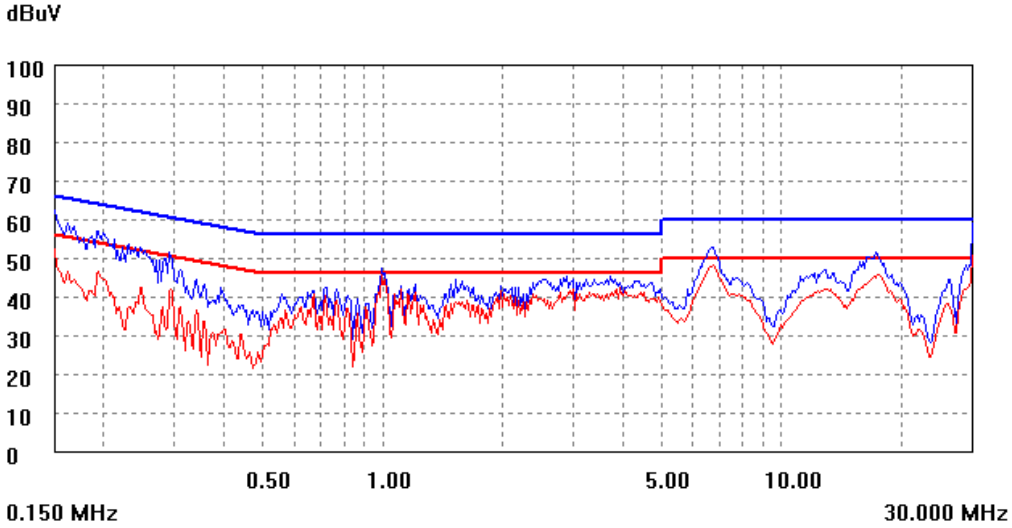


N Wire

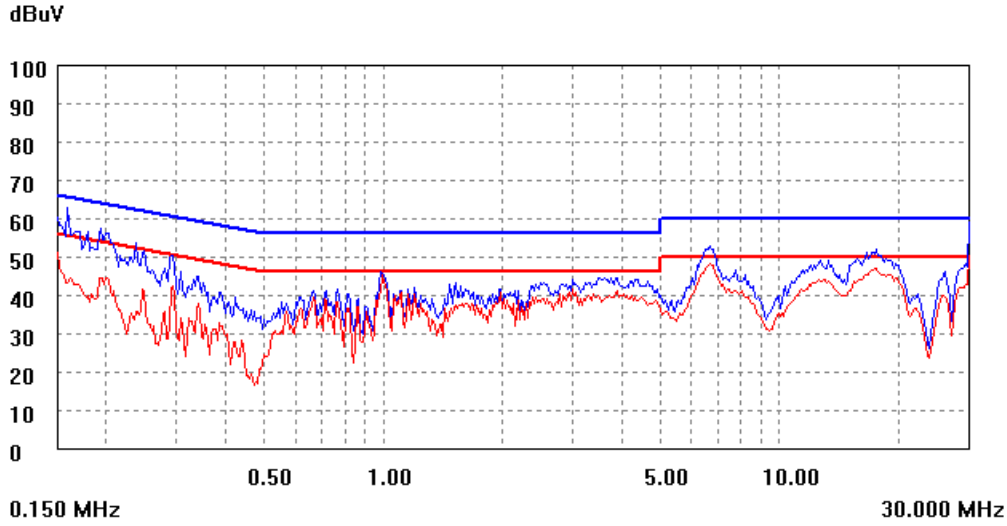


3.7.2 230VAC/50Hz- Full Load

L Wire



N Wire



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