Test Report

10W/5V/2A AC/DC Adapter

Reference Design Using UCC28700

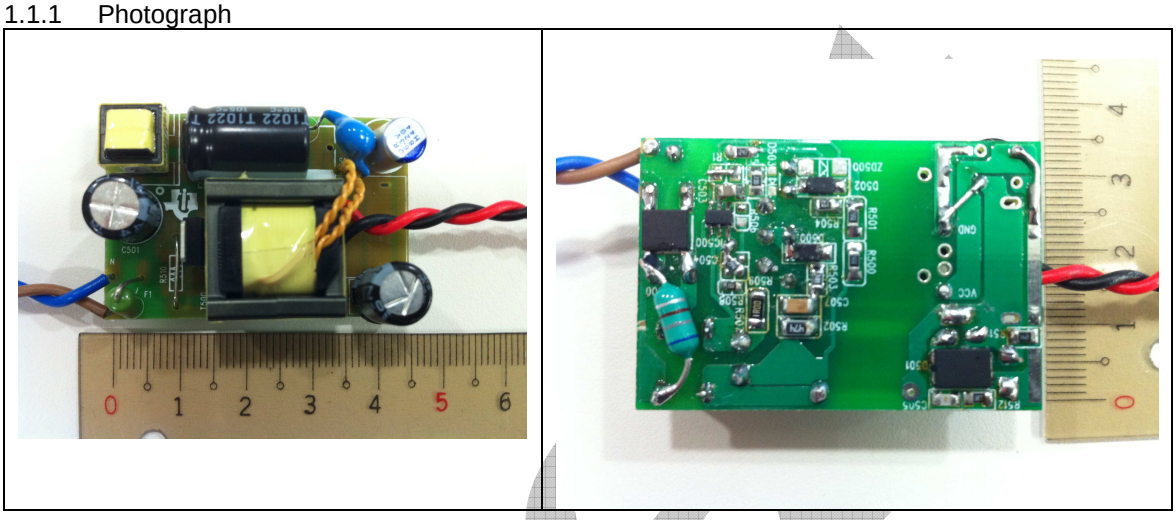
Table of Content

1 Introduction

This reference design is a 10W USB charger driver using UCC28700. The design works with AC mains from 90Vrms to 264Vrms and provides a 5V/2A output.

The PCB dimensions: 45mm(L) x 30mm(W) x 15mm(H, with PCB 1.2mm), PCB material: FR406 or compatible, single layer and 2-oz copper.

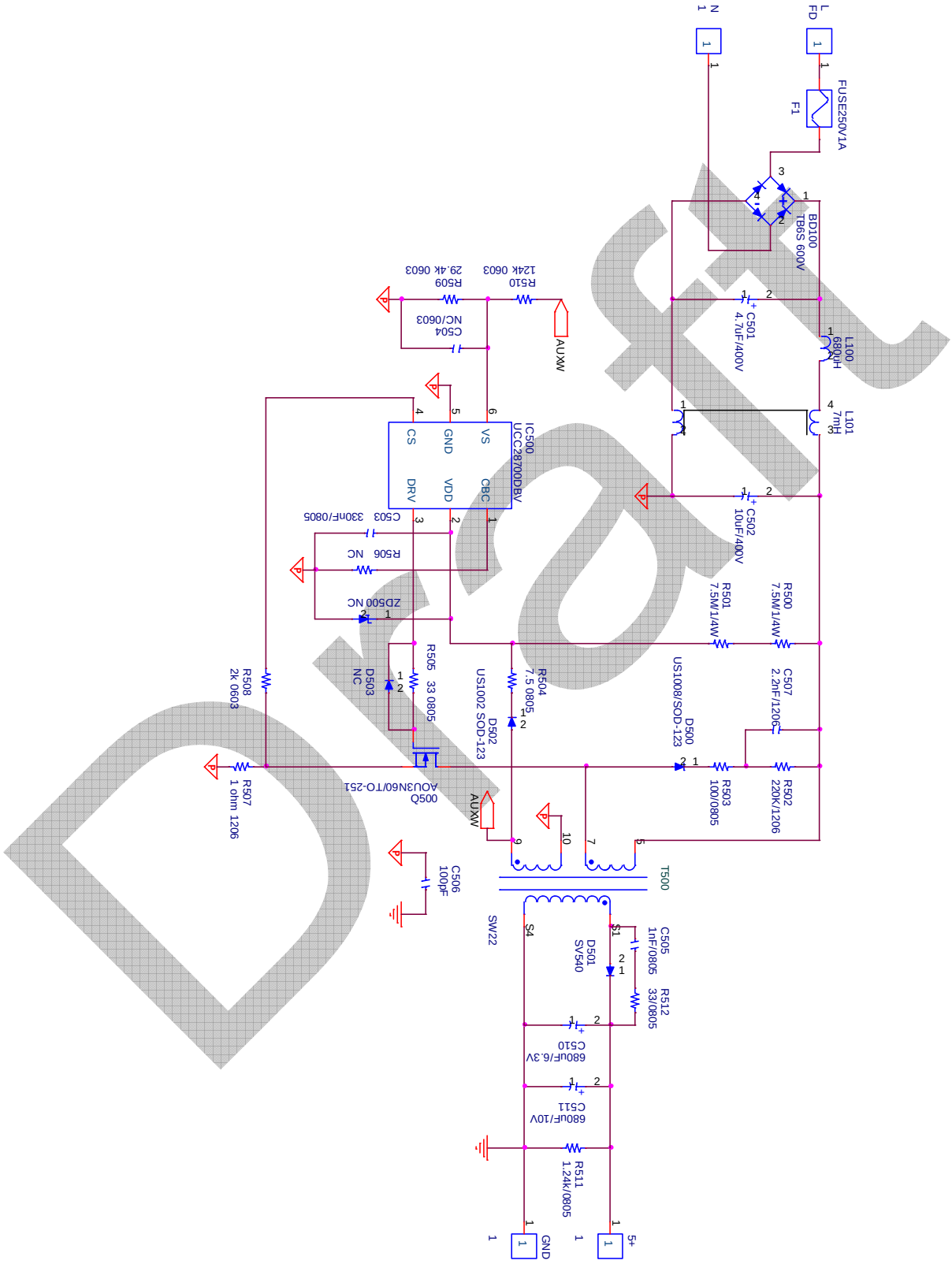
1.1.1 Photograph



2 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range		90		264	Vrms
Frequency		47		63	Hz
Start up time				1000	ms
Output Characteristics					
Output voltage, Vout		4.75	5	5.25	V
Output load current, Iout				2	A
Output Power				10.5	Watt
Output voltage ripple/noise				150	mVpp
Output rise time				30	ms
Protection Characteristics					
Over voltage protection			5.8		V
Over current protection			2.1		A
Systems Characteristics					
Efficiency (Peak)	Test in board end			78	%

3 Schematic



4 Function Test Report

4.1 Test Equipment

Instrument	Manufacturer	Model No.
AC Source	Chroma	6530
Power Analyzer	Chroma	6630
Multimeter	Fluke	189 Multimeter
Electronic Load	Chroma	63030
Oscilloscope	Tektronix	TDS 3014B
Differential Probe	Tektronix	P5205
Current Amplifier	Tektronix	TCPA300 + 12-1605
Voltage Probe	Tektronix	P6139A

4.2 Efficiency

4.2.1 Test Board End

Vac	Pi	Iin	Vo	Io	Load	Eff	Average Eff
115	3.257W	63.9mA	5.094V	0.50A	25%	78.20%	77.99%
	6.499W	110.2mA	5.101V	1.00A	50%	78.48%	
	9.878W	154.2mA	5.118V	1.50A	75%	77.71%	
	13.277W	197.7mA	5.152V	2.00A	100%	77.59%	
230	3.385W	42.9mA	5.098 V	0.50A	25%	75.30%	77.53%
	6.554W	73.7mA	5.113 V	1.00A	50%	78.01%	
	9.833W	101.9mA	5.133 V	1.50A	75%	78.30%	
	13.145W	128.1mA	5.161V	2.00A	100%	78.52%	

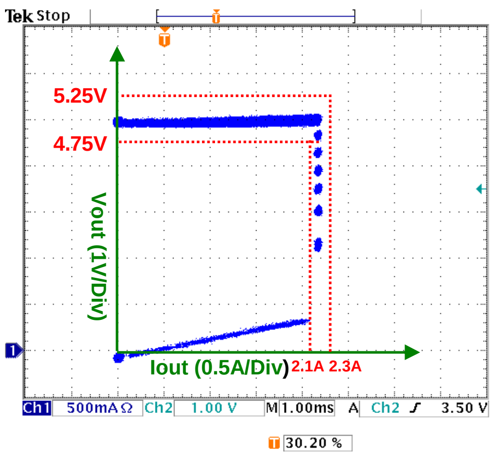
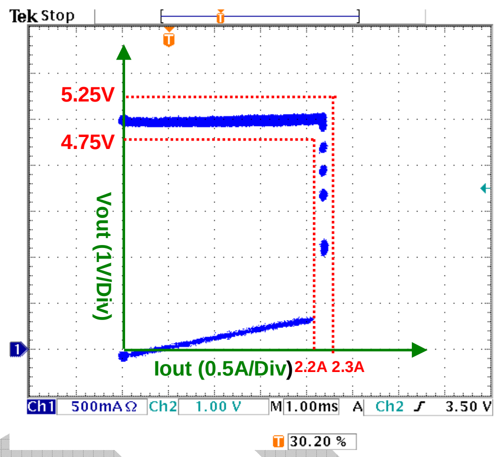
4.2.2 Output No-Load Condition

Vac	Input Power	Vo
115	42mW	5.117V
230	63mW	5.116V

4.3 *Output V-I Characteristics*

Measure the output of constant voltage (CV) curve and constant current (CC) curve.

4.3.1 Test Waveform

<table>
<tr><td>90Vac</td><td>115Vac</td></tr>
<tr><td> 
</td><td> 
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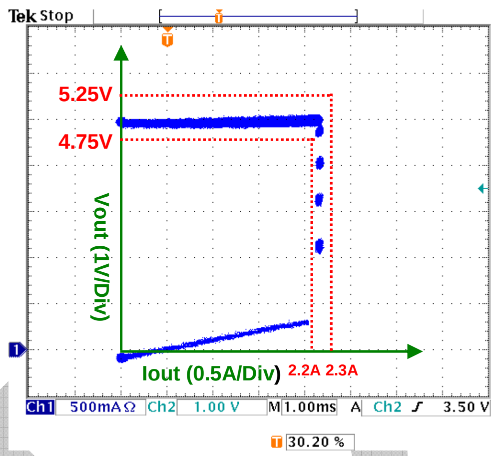
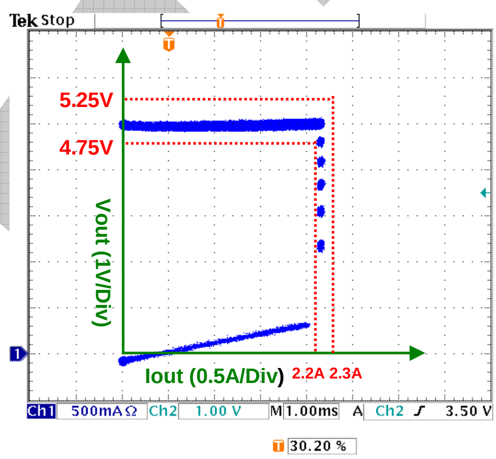
<tr><td>230Vac</td><td>264Vac</td></tr>
<tr><td> 
</td><td> 
</td></tr>
</table>

4.4 *Output Transient Response (Dynamic Loading)*

The output voltage will remain within their regulation limits specified for the load steps. The load slew rate will not exceed 2.5A/uS. Frequency of the dynamic load will be 100Hz and 1KHz with a duty cycle of 50%.

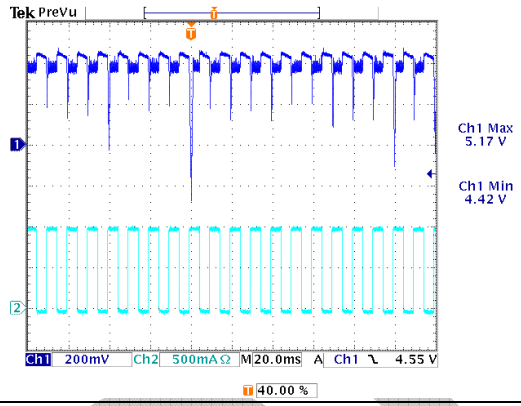
4.4.1 100Hz Test Result

AC Input	Vo at 0 ~ 1A	
	max	min
90	5.17	4.42
115	5.18	4.47
230	5.15	4.46
264	5.15	4.44

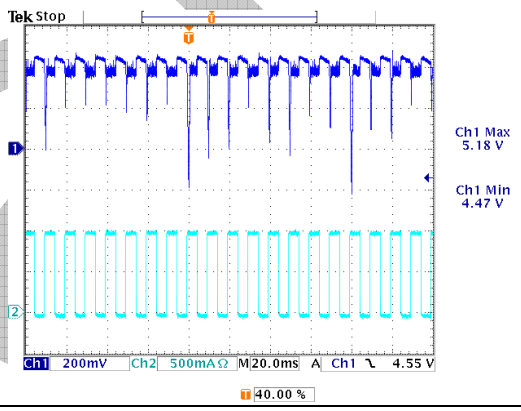
4.4.2 100Hz Test Waveform

CH1: Output voltage, CH2: Output current

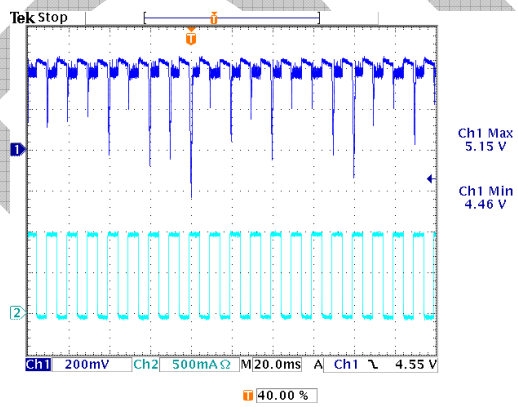
90Vac



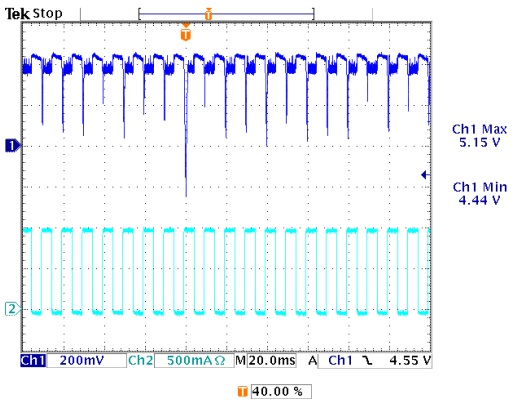
115Vac



230Vac



264Vac



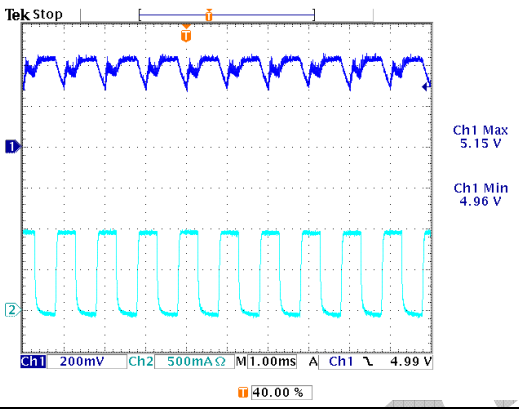
4.4.3 1kHz Test Result

AC Input	Vo at 0 ~ 1A, 1kHz	
	max	min
90	5.15	4.96
115	5.16	4.97
230	5.16	4.97
264	5.16	4.97

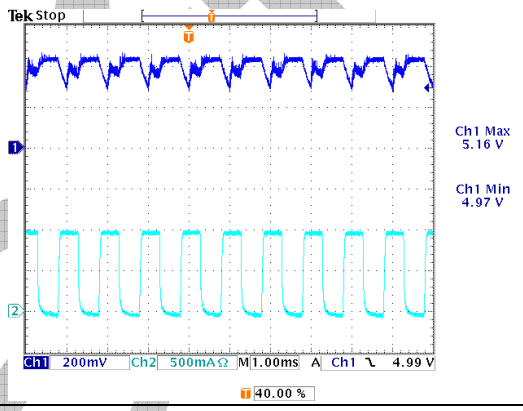
4.4.4 1kHz Test Waveform

CH1: Output voltage, CH2: Output current

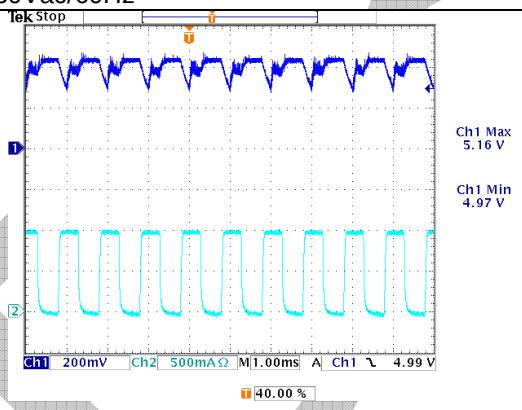
90Vac/60Hz



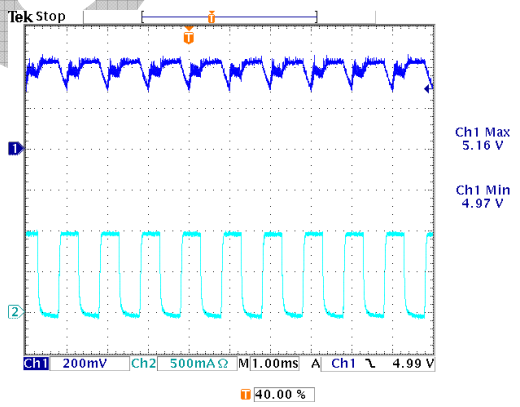
115Vac/60H



230Vac/60Hz



264Vac/60Hz



4.5 *Output Ripple/Noise*

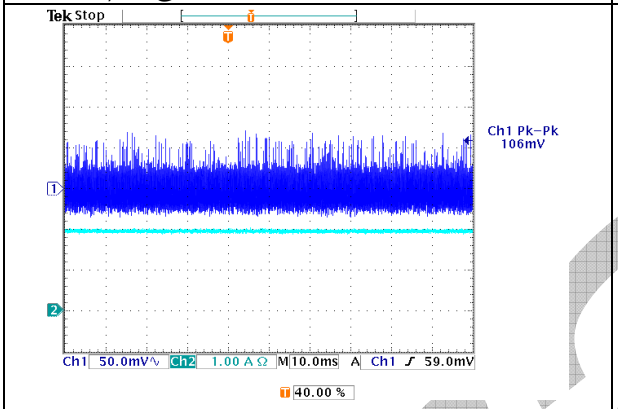
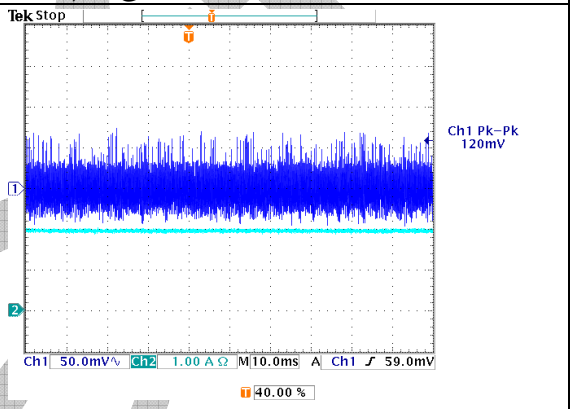
Measurements will be made with an oscilloscope set to 20MHz bandwidth limit. Output will be tested with 10uF aluminum electrolytic capacitor and 0.1uF ceramic capacitor in parallel.

4.5.1 Test Result

AC Input	Vout (mVp-p)
115	106
230	120

4.5.2 Test Waveform

CH1: Output voltage, CH2: Output current

115Vac, 5V@2A	230Vac, 5V@2A
	

4.6 *Output Rise Time*

The output load set at maximum loading and no loading. Measure the time interval between 10% to 90% output voltage during startup.

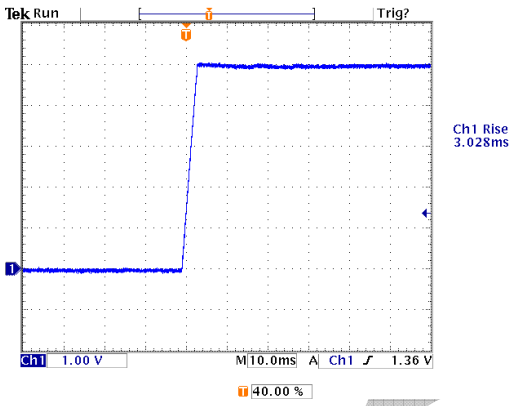
4.6.1 Test Result

AC Input	No Load	Max. Load
115	3.02ms	27.18ms
230	3.03ms	29.06ms

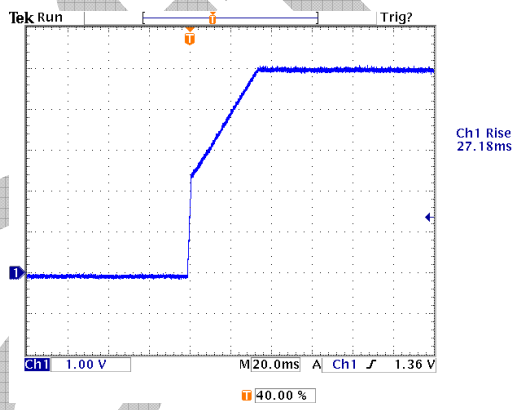
4.6.2 Test Waveform

CH1: Output voltage

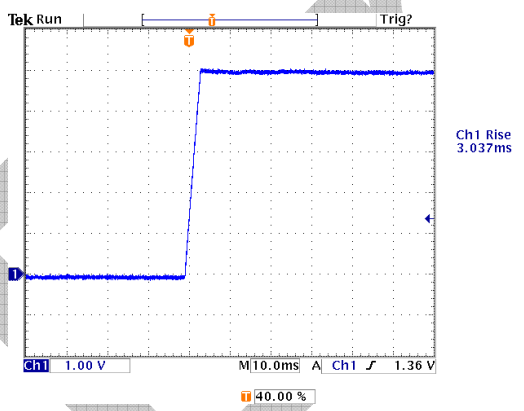
115Vac/No load



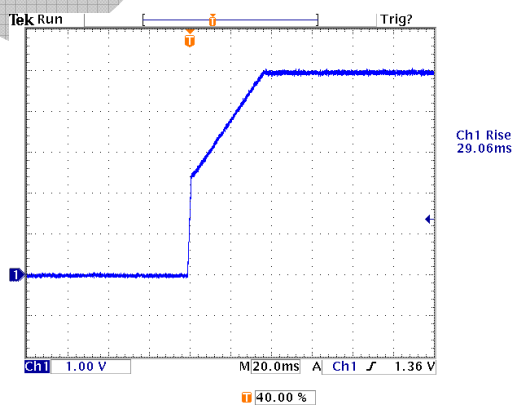
115Vac/Maximum load



230Vac/No load



230Vac/Maximum load



4.7 *Start Up Time*

The output load set at maximum loading. Measure the time interval between 90VAC power up and stable of output voltage.

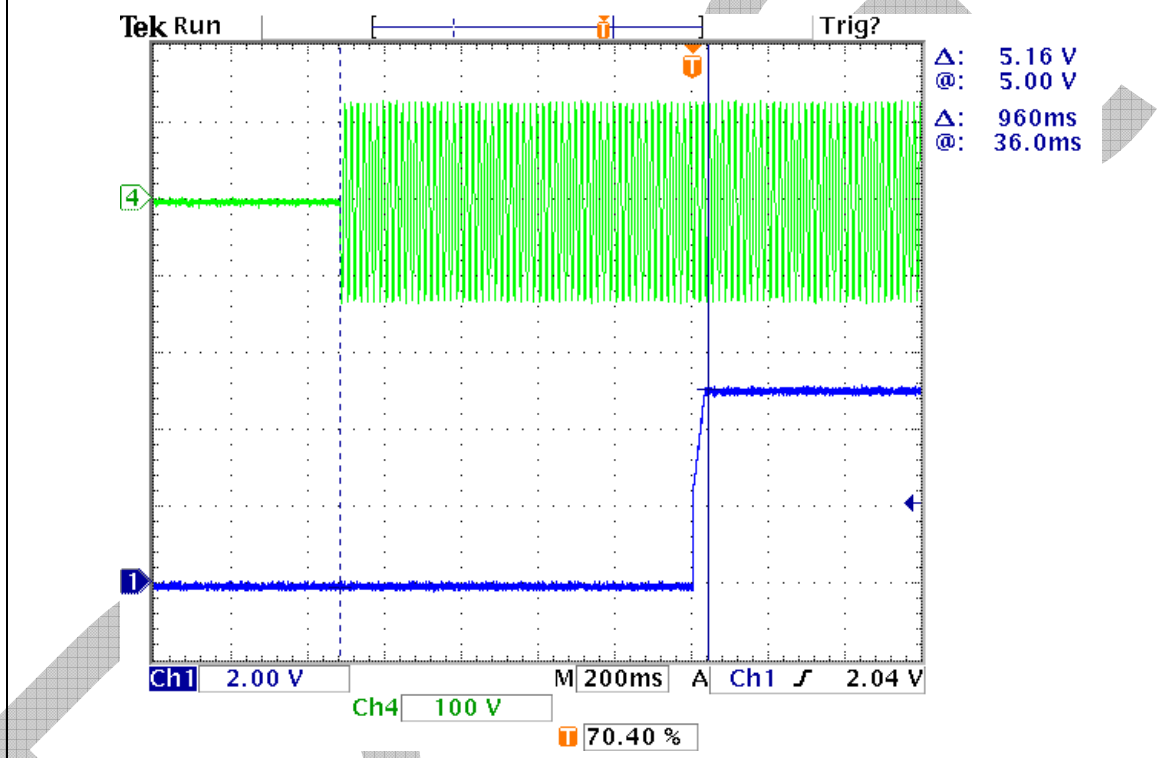
4.7.1 Test Result

AC Input	Delay Time
90	960ms

4.7.2 Test Waveform

CH1: Output voltage, CH4: AC input

90Vac/No load



4.8 *Hold Up Time*

The output load set at maximum loading. Measure the time interval between 115VAC turn off at zero degree and the output voltage falling to out of regulation.

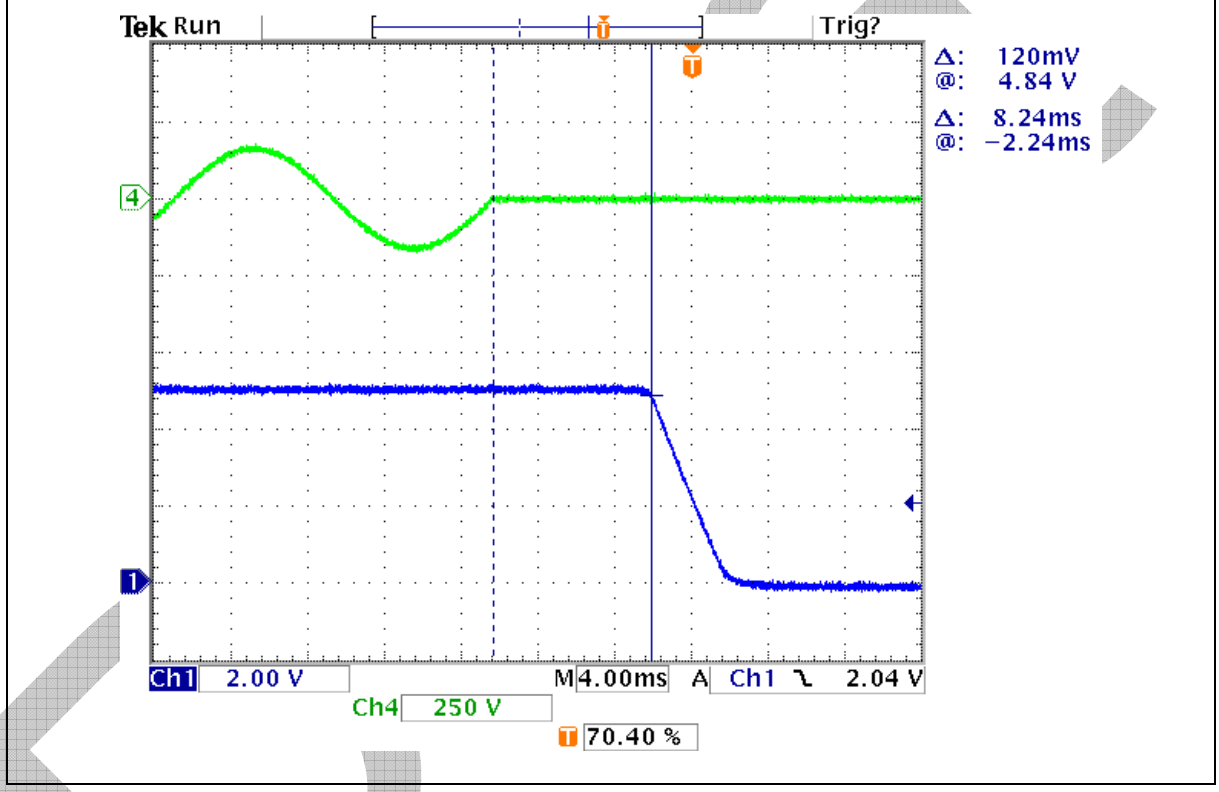
4.8.1 Test Result

AC Input	Hold up Time
115	8.24ms

4.8.2 Test Waveform

CH1: Output voltage, CH4: AC input

115ac/Maximum load



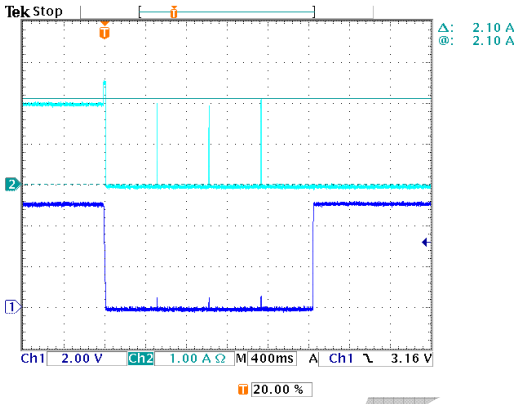
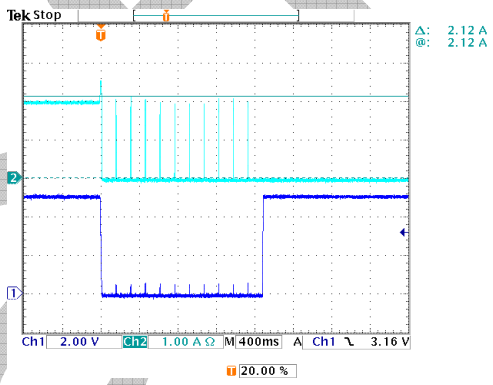
4.9 *Over Current Protection*

The output current ramp starts from full load. Measure the maximum output current when the output voltage going to hiccup mode.

4.9.1 Test Result

Vac	OCP
90	2.10A
265	2.12A

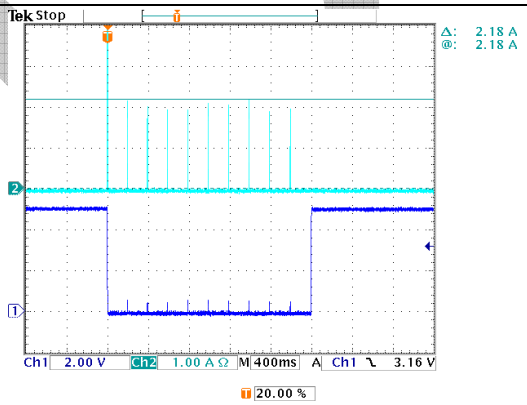
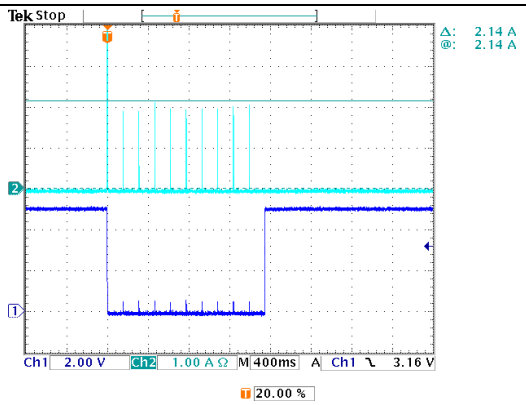
4.9.2 Test Waveform

CH1: Output voltage, CH2: Output Current	
90Vac	264Vac
	

4.10 *Short Circuit Protection*

A short circuit, which is defined as an impedance of 0.1 ohms or less, applied to any output start-up or while running will not cause any damage to the power supply. The output voltage will be restart when the short circuit is removed.

4.10.1 Test Waveform

CH1: Output voltage, CH2: Output current	
90Vac	264Vac
	

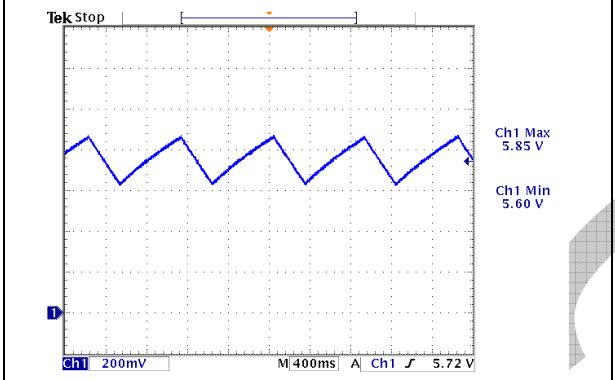
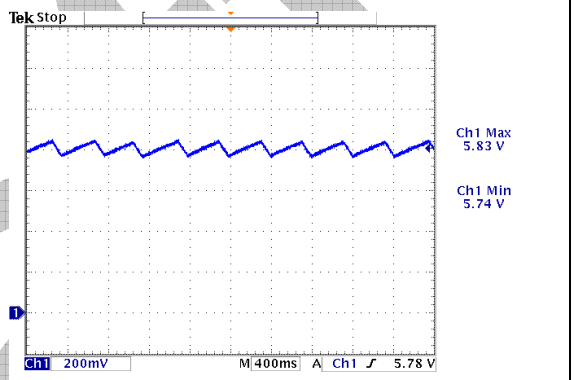
4.11 *Over Voltage Protection*

The output load set at minimum loading. Measure the maximum output voltage. After over voltage protection, the output voltage will go to non-latch mode.

4.11.1 Test Result

AC Input	No Load
90	5.85V
265	5.83V

4.11.2 Test Waveform

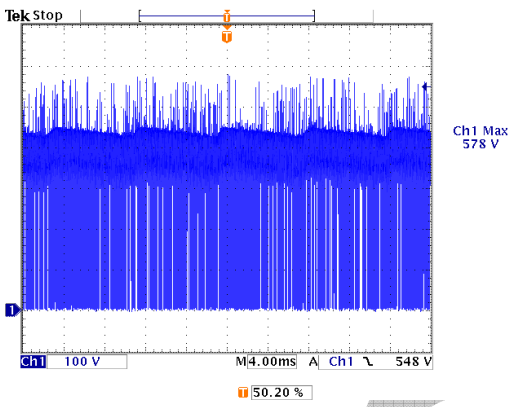
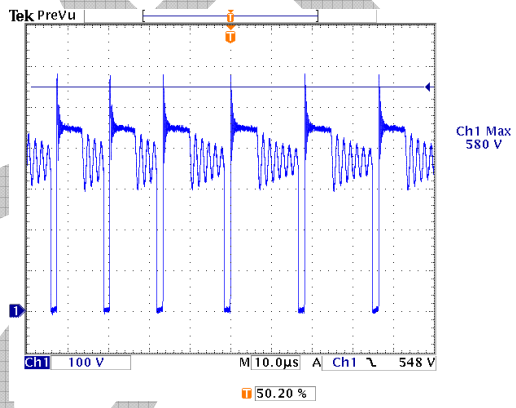
CH1: Output voltage	
90Vac	2640Vac
	

4.12 *Key Component Stress*

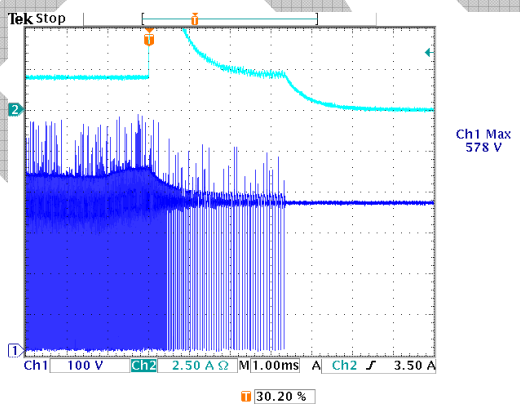
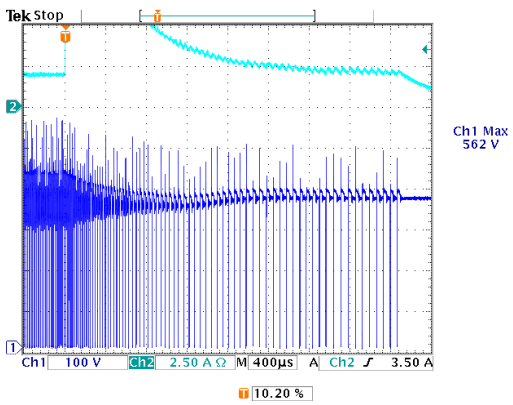
4.12.1 Test Result

Item	264Vac
Q1	580V
Q1@SCP	578V

4.12.2 Q1 (AOU3N60) Voltage Stress

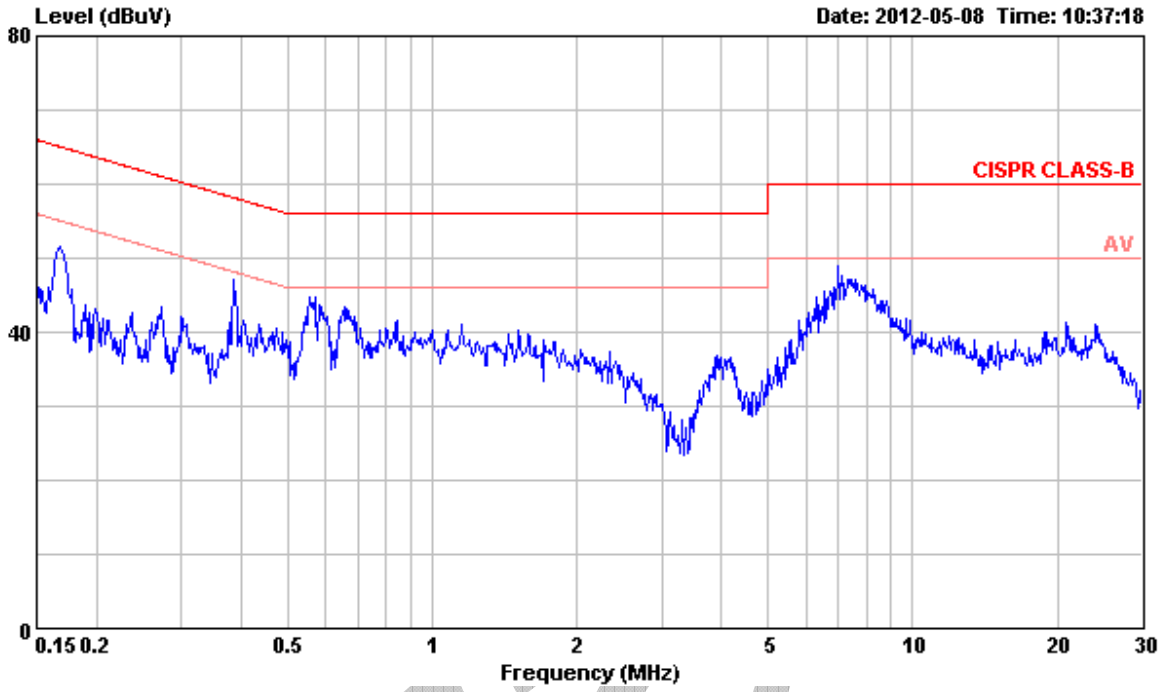
CH1: Vds voltage	
264Vac	
	

4.12.3 Q1 (AOU3N60) Voltage Stress when SCP

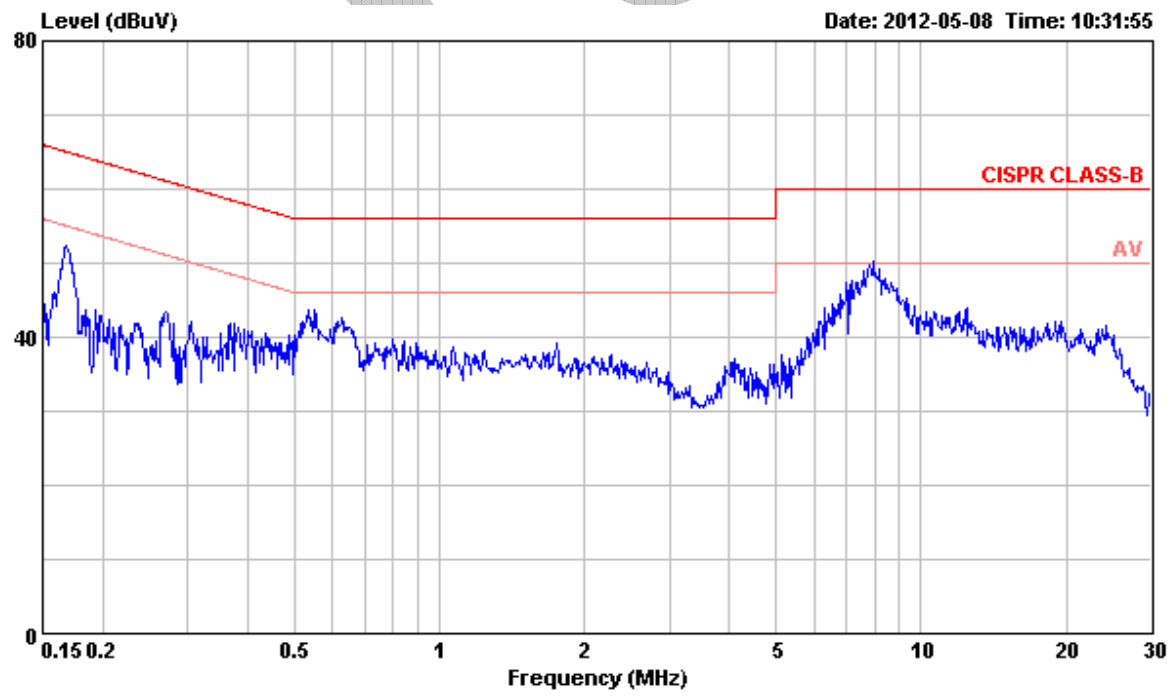
CH1: Vds voltage CH2: Output Current	
264Vac	
	

4.13 EMI Conduction Test without FG-GND

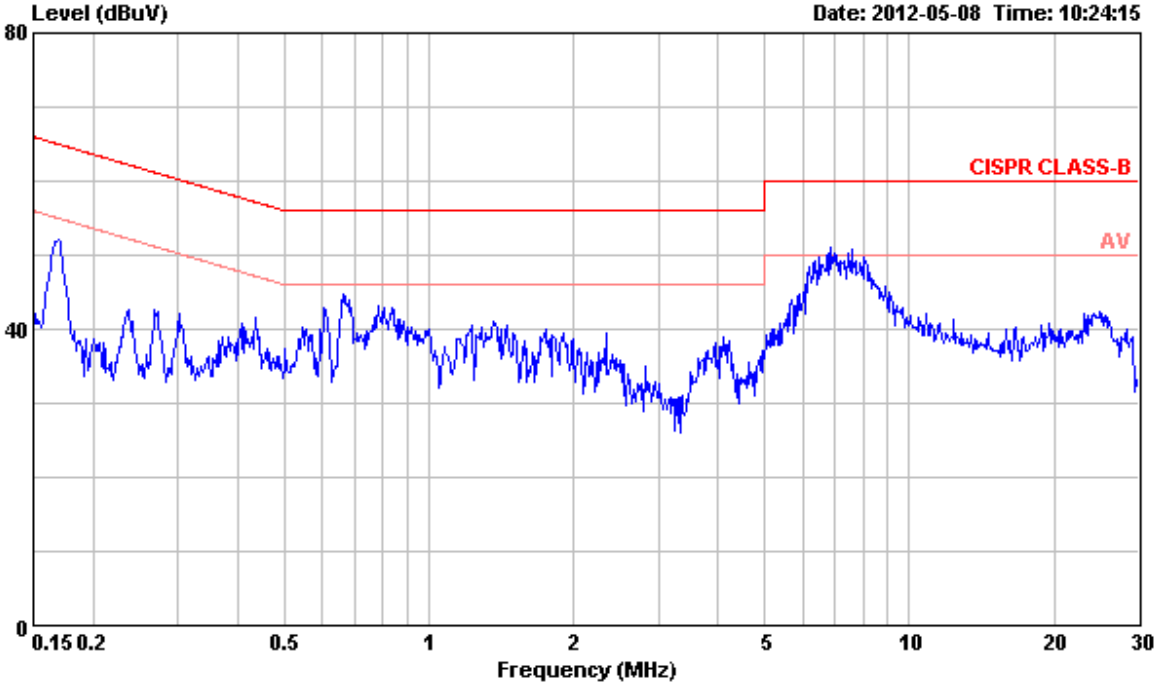
4.13.1 110Vac Line



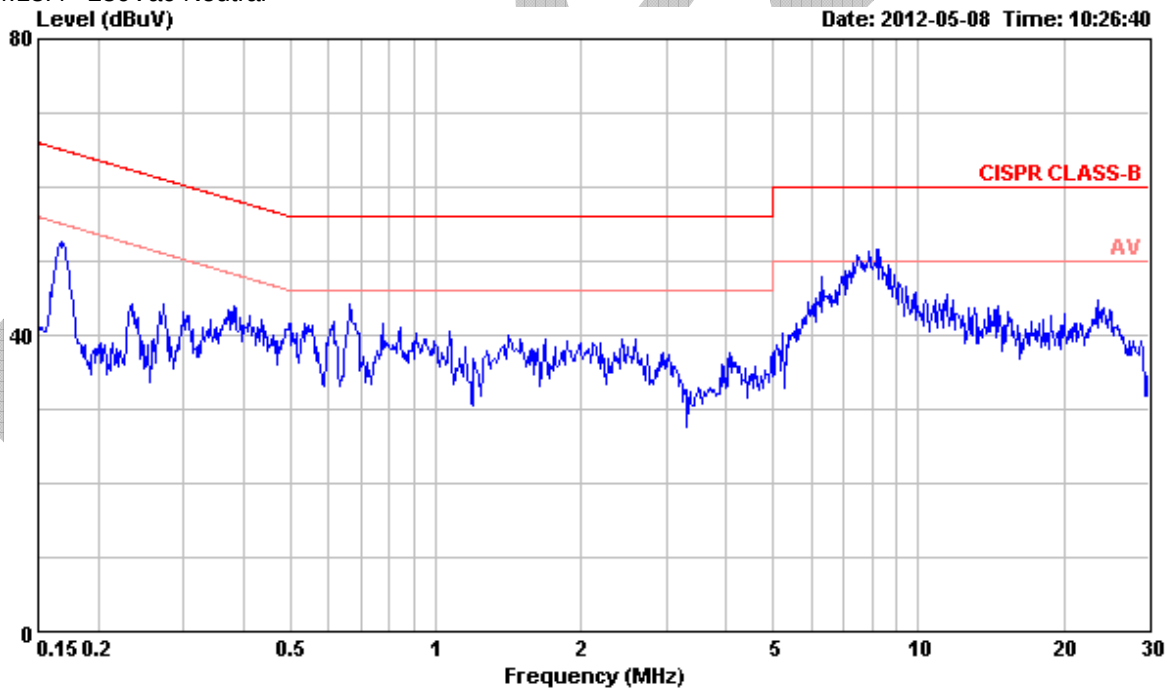
4.13.2 110Vac Neutral



4.13.3 230Vac Line

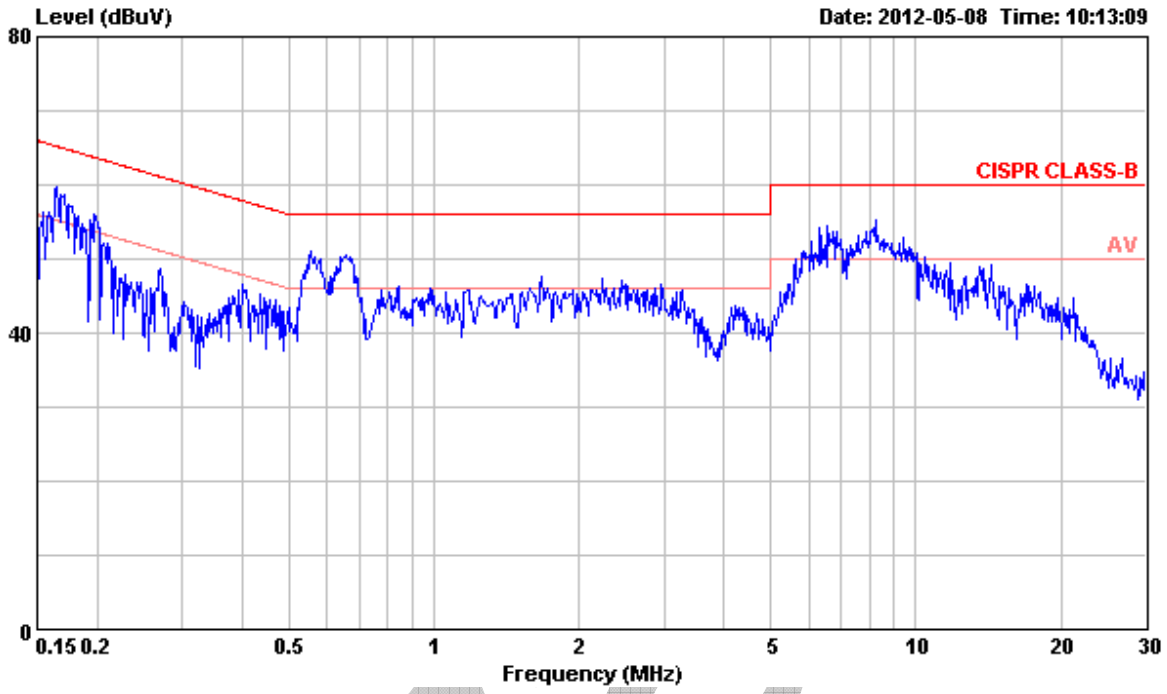


4.13.4 230Vac Neutral

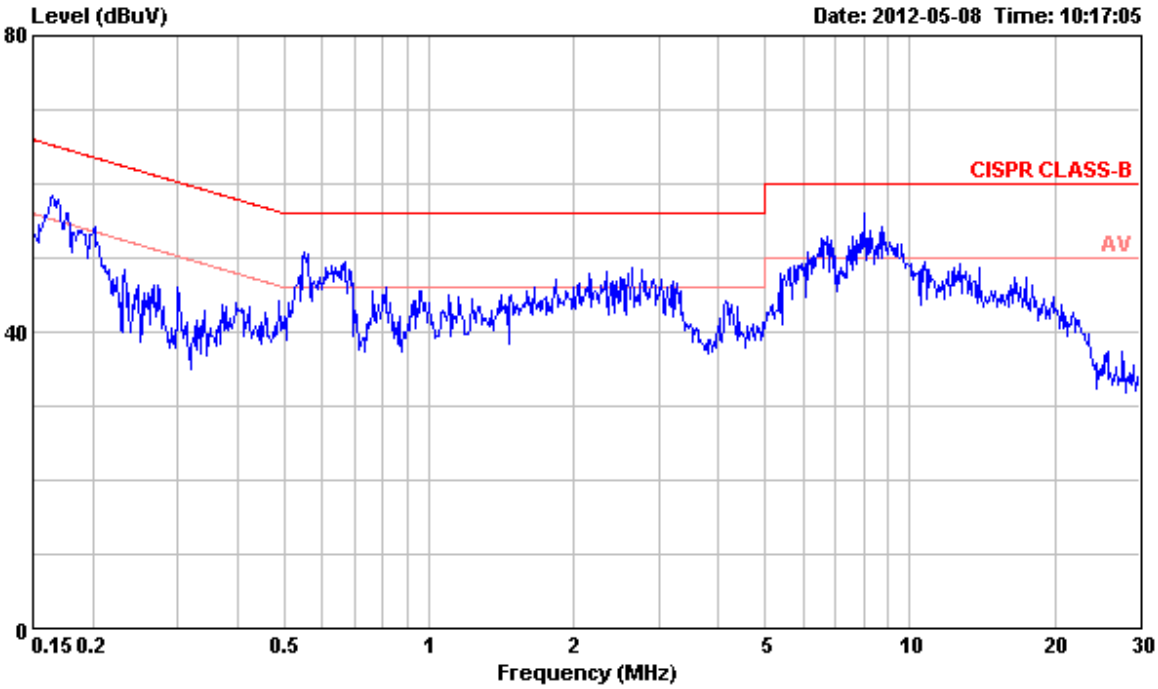


4.14 *EMI Conduction Test with FG-GND*

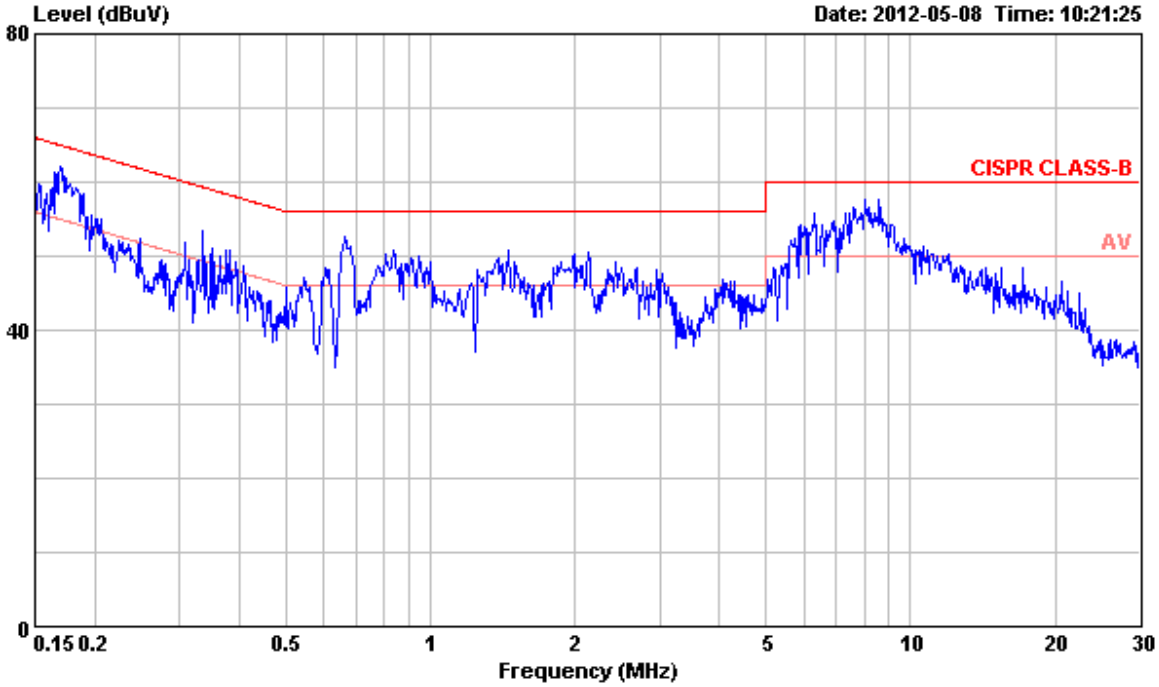
4.14.1 110Vac Line



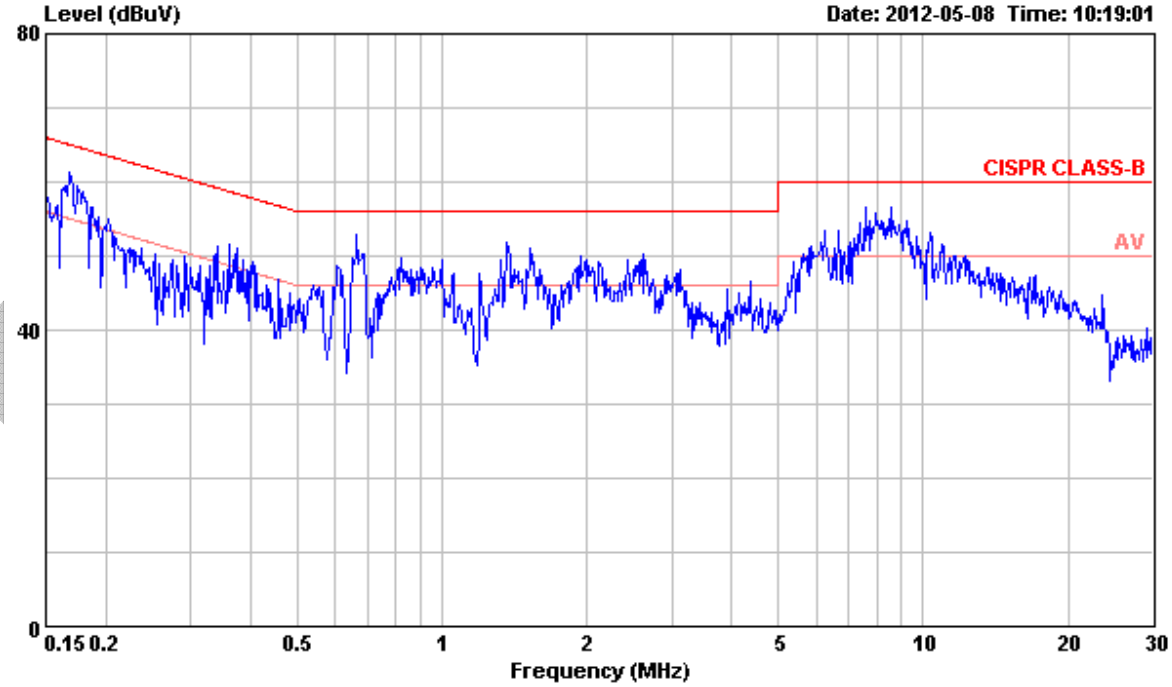
4.14.2 110Vac Neutral



4.14.3 230Vac Line

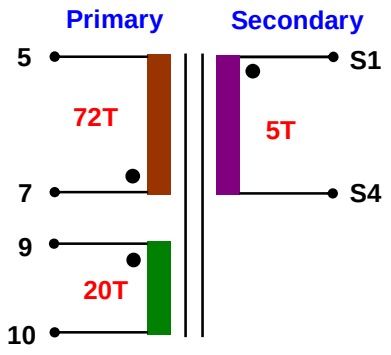


4.14.4 230Vac Neutral



5 Transformer Construction

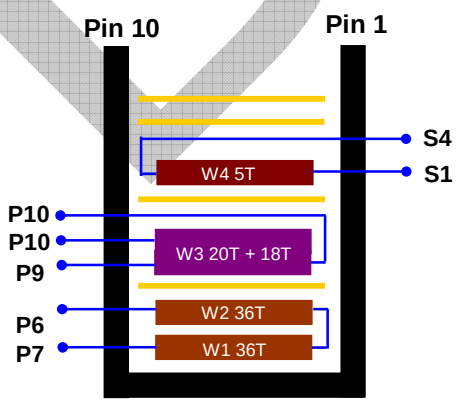
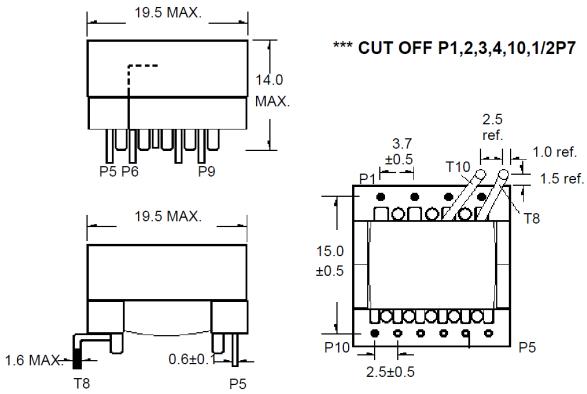
5.1 *Schematic and Specifications*

Schematic	Specifications
	**Electrical:** 1. Primary Inductance = 700uH+/-10% at 100KHz 1V 2. Primary Leakage Inductance = 40uH Maximum 3. D.C.R Measure at 25Deg. C P7-5: 580m ohm Maximum P9-10: 120m ohm Maximum S1-S4: 10m ohm Maximum **Materials:** 4. Core: EPC-17 (Ferrite Mn-Zn Material TDK PC40 or Equivalent) 5. Bobbin: EPC-17 Horizontal 6. Wires: Primary for Type 2-UEW, Secondary for Triple Insulated Wires 7. Layer Insulation Tape: 3M1350F1 or Equivalent

5.2 *Winding Table*

Winding#	Start Pin	Finish Pin	Turns	Wire Size & Type	Note
W1	7		36	2UEW 0.23mm x 1	Clockwise
W2		5	36	2UEW 0.23mm x 1	Clockwise
W3	9	10	20	2UEW 0.23mm x 1	Clockwise
W3	10		18	2UEW 0.23mm x 1	Primary shielding
W4	S1	S4	5	Triple Insulated Wire 0.45mm(only copper) x 2	Anti-Clockwise

5.3 *Winding Instructions and Transformer Assembly*

Winding Instructions	Assembly Instructions
	

6 BOM List

Item Number	Part Number	Value	Description	Quantity
1	BD100	TB6S 600V	DIO 600V 0.5A	1
2	C501		CAP 4.7uF 400V 8x11.5 p3.5	1
3	C502		CAP 10uF 400V 8x20 p3.5	1
4	C503		CAP 330nF 25V X7R 0805	1
5	C505		CAP 1nF 50V NPO 0805	1
6	C506		CAP 100pF Y1	1
7	C507		CAP 2.2nF 1kV 1206	1
8	C510		CAP 680uF 6.3V	1
9	C511		CAP 680uF 10V	1
10	D500	US1008	DIO 800V 1A SOD-123	1
11	D501	SV540	DIO 40V 5A TO-277	1
12	D502	US1002	DIO 200V 1A SOD-123	1
13	F1	FUSE	FUSE 250VAC 2A	1
14	IC500	UCC28700DBV	IC CV/CC PWM with PSR	1
15	L100		Inductor DM 680uH	1
16	L101		Inductor CM 7mH	1
17	Q500	AOU3N60	MOS 600V 3A TO-251	1
18	R500		RES 7.5M 1206	1
19	R501		RES 7.5M 1206	1
20	R502		RES 220K 1206	1
21	R503		RES 100 0805	1
22	R504		RES 7.5 0805	1
23	R505		RES 33 0805	1
24	R506		RES 11k 0603	1
25	R507		RES 1 1206	1
26	R508		RES 2k 0603	1
27	R509		RES 29.4k 0603	1
28	R510		RES 124k 0603	1
29	R511		RES 1.24k 0805	1
30	R512		RES 33 0805	1
31	T500	SW22	Transformer EFD-17	1