2012/08/16

Test Report

5W/5V/1A AC/DC Adapter

Reference Design Using UCC28700

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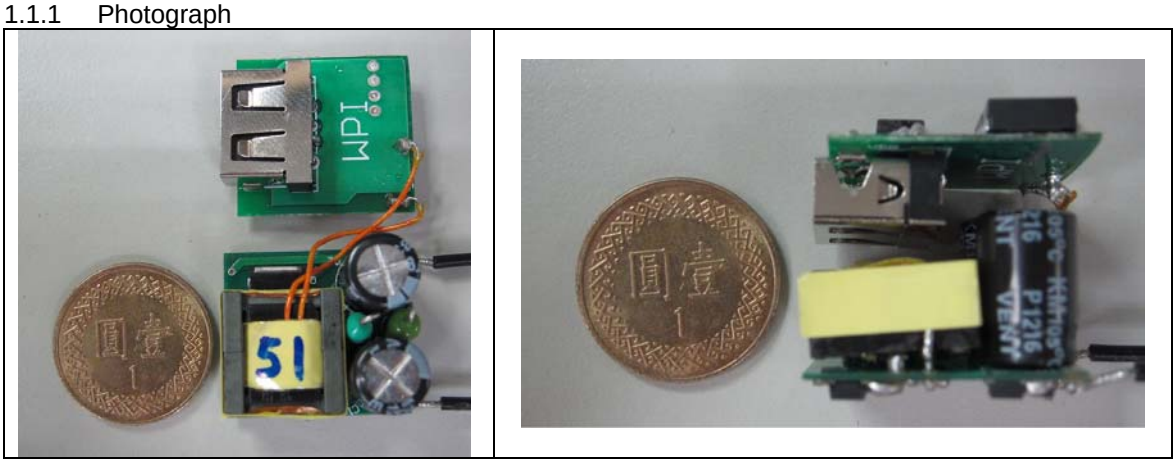
1 Introduction

This reference design is a 5W USB charger driver using UCC28700. The design works with AC mains from 90Vrms to 264Vrms and provides a 5V/1A output.

The PCB dimensions: 22.5mm(L) x 20mm(W) x 20mm(H, with PCB 0.6mm), PCB material: FR406 or compatible, two layers and 2-oz copper.

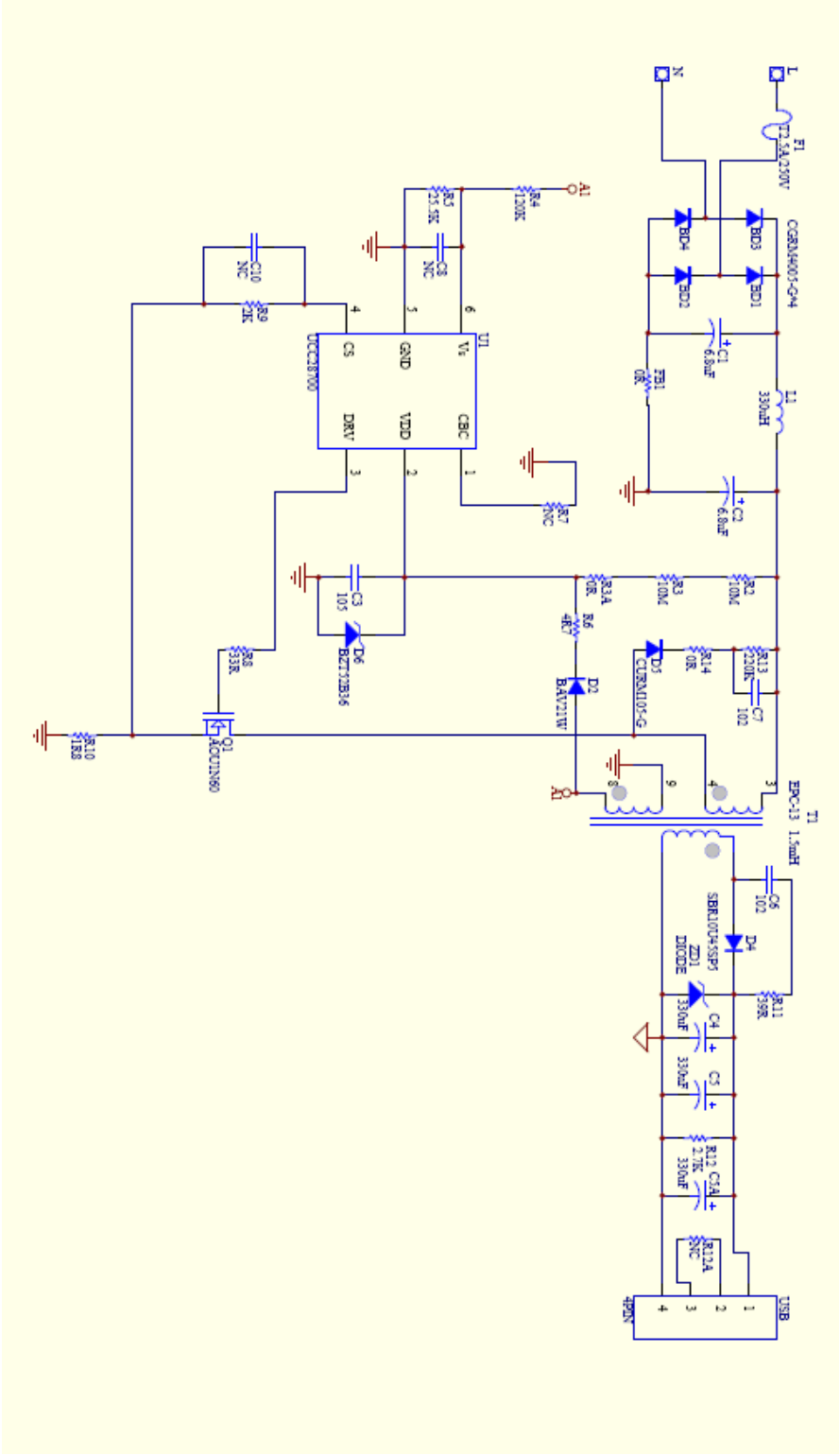
1.1.1 Photograph



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				1700	ms
Output Characteristics					
Output voltage, Vout		4.75	5	5.25	V
Output load current, Iout				1	A
Output Power				5.25	Watt
Output voltage ripple/noise				80	mVpp
Output rise time				15	ms
Protection Characteristics					
Over voltage protection			5.9		V
Over current protection				1.2	A
Systems Characteristics					
Efficiency	Test in board end	77		78	%

3 Schematic


L
N
F1
T2.5A,250V
BD4
BD3
BD2
BD1
CGRBM4001-G-F4
C1
6.8uF
FB1
0R
L1
330uH
C2
6.8uF
R1
510M
R2
510M
R3
510M
R34
0R
R6
4R7
R13
220K
C7
102
R14
0R
D5
CURM105-G
D2
BAV21W
R7
NC
R4
120K
R5
25.5K
C3
NC
C10
NC
R9
1K
U1
UCC28700
CS
GND
Vs
DRV
VDD
CBC
C3
105
D6
BZT52B36
R8
33R
Q1
4CU15N60
R10
1R8
A1
A2
T1
EPC-13 1.5mH
C6
102
D4
SBR10U45SP1
ZD1
DIODE
R11
39R
C4
330uF
C5
330uF
R12
2.7K
C34
330uF
R12A
NC
USB
4PDN

4 Function Test Report

4.1 Test Equipment

Instrument	Manufacturer	Model No.
AC Source	Chroma	61502
Power Analyzer	Chroma	66202
Multimeter	Fluke	187 Multimeter
Electronic Load	Chroma	63103A
Oscilloscope	Tektronix	TDS3054B
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(W)	Iin(mA)	Vo(V)	Io(A)	Load	Eff	Average Eff
115	1.646	37.34	5.102	0.25	25%	77.49%	78.44%
	3.225	62.57	5.101	0.50	50%	79.08%	
	4.873	86.36	5.109	0.75	75%	78.64%	
	6.522	108.66	5.124	1.00	100%	78.56%	
230	1.735	28.55	5.097	0.25	25%	73.44%	77.64%
	3.263	44.21	5.101	0.50	50%	78.16%	
	4.834	58.78	5.105	0.75	75%	79.21%	
	6.416	72.55	5.117	1.00	100%	79.75%	

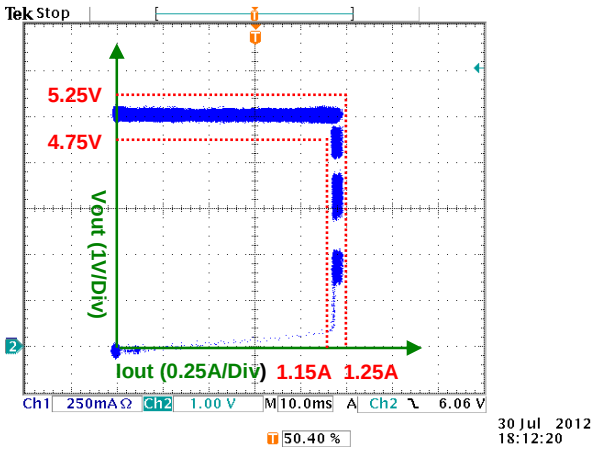
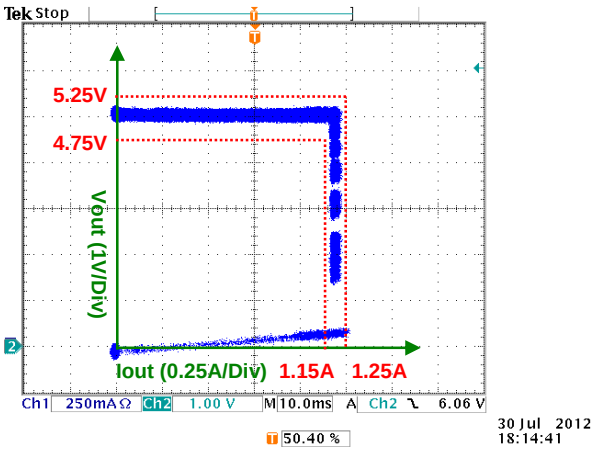
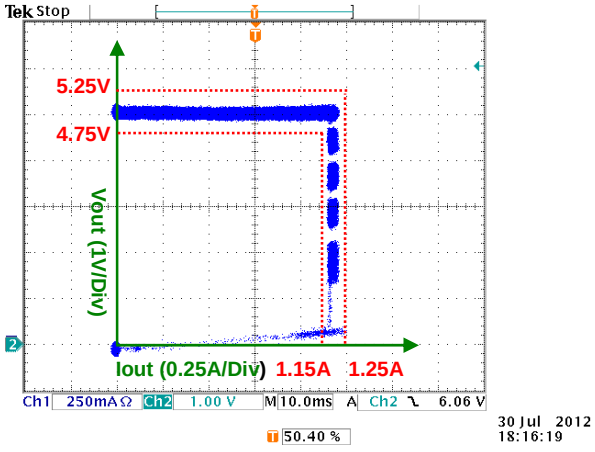
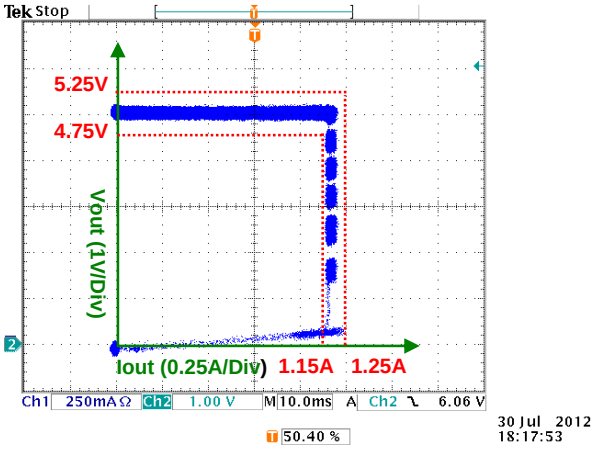
4.2.2 Output No-Load Condition

Vac	Input Power	Vo
115	20.55mW	5.156V
230	26.27mW	5.136V

4.3 Output V-I Characteristics

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

4.3.1 Test Waveform

90Vac	115Vac
	
230Vac	**264Vac**
	

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%.

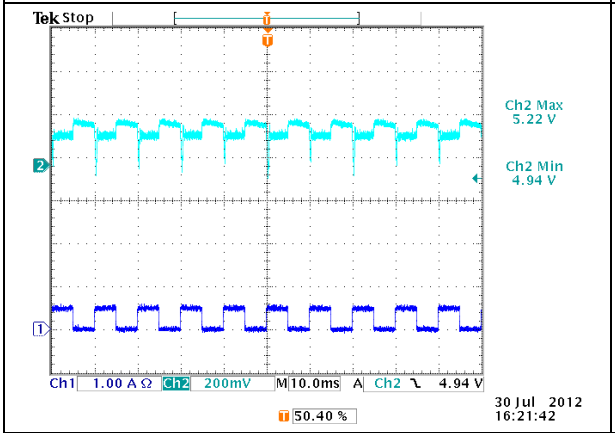
4.4.1 100Hz Test Result with transient load 0 ~ 0.5A

AC Input	Vo at 0 ~ 0.5A	
	max	min
90	5.22	4.94
115	5.22	4.92
230	5.22	4.90
264	5.22	4.92

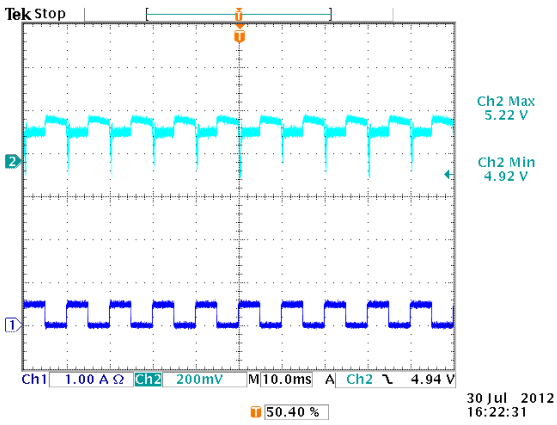
4.4.2 100Hz Test Waveform

CH1: Output current, CH2: Output voltage

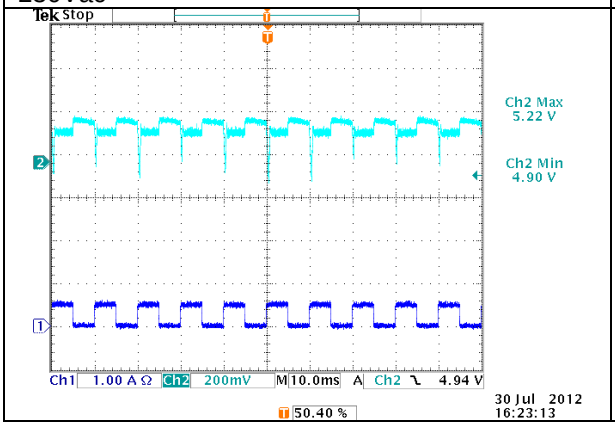
90Vac



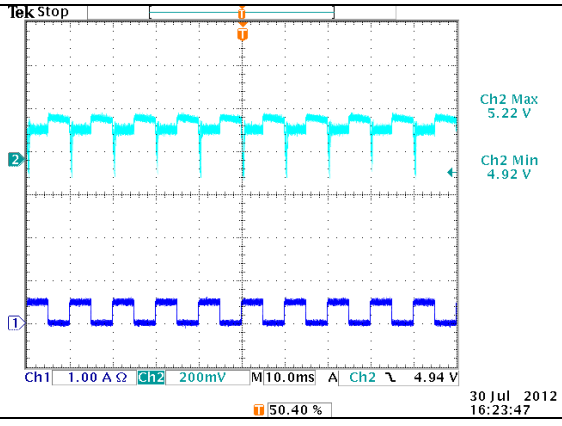
115Vac



230Vac



264Vac



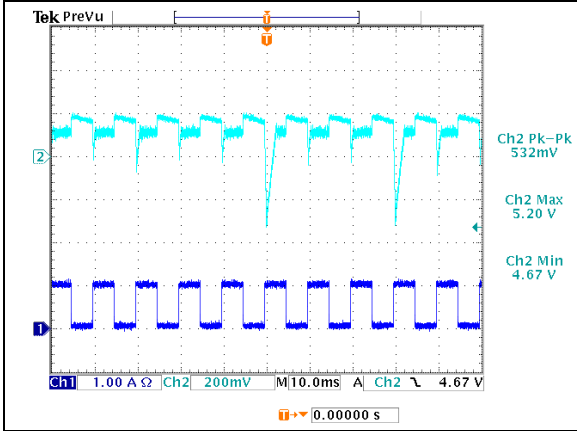
4.4.3 100Hz Test Result with transient load 0 ~ 1A

AC Input	Vo at 0 ~ 1A	
	max	min
90	5.20	4.67
115	5.20	4.70
230	5.20	4.60
264	5.20	4.61

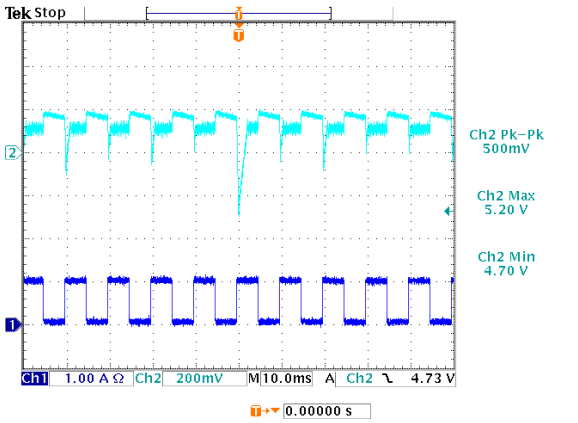
4.4.4 100Hz Test Waveform

CH1: Output current, CH2: Output voltage

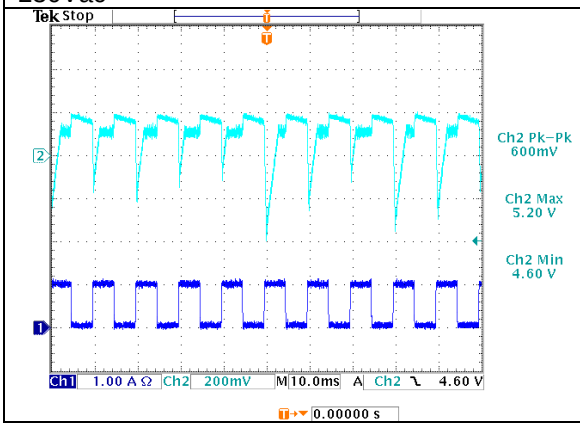
90Vac



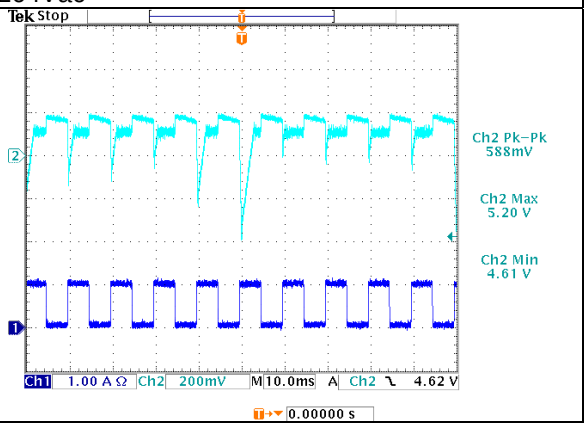
115Vac



230Vac



264Vac



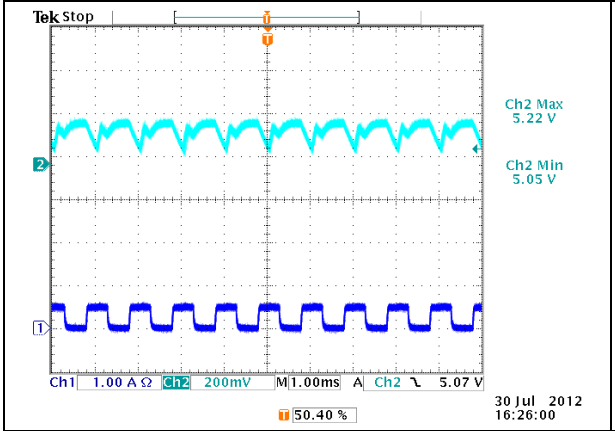
4.4.5 1kHz Test Result with transient load 0 ~ 0.5A

AC Input	Vo at 0 ~ 0.5A, 1kHz	
	max	min
90	5.22	5.05
115	5.22	5.05
230	5.21	5.04
264	5.22	5.04

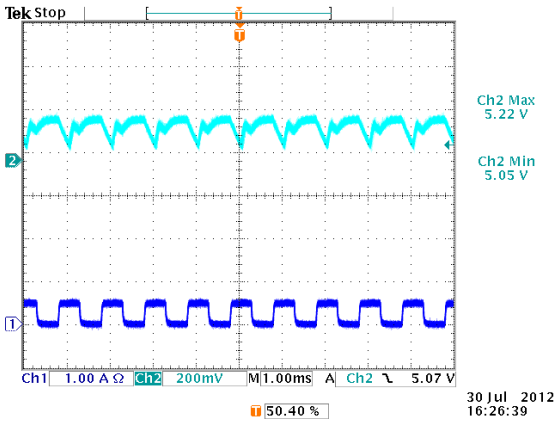
4.4.6 1kHz Test Waveform

CH1: Output current, CH2: Output voltage

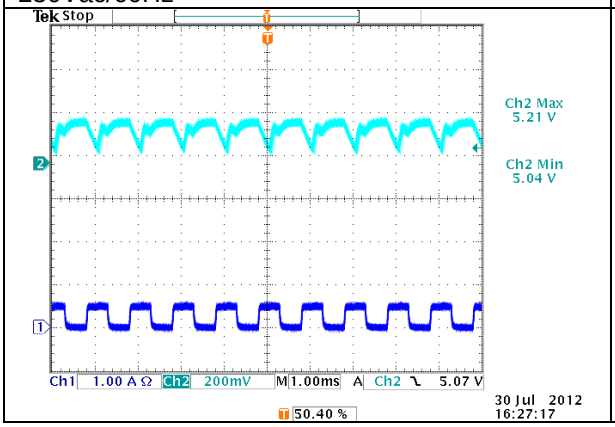
90Vac/60Hz



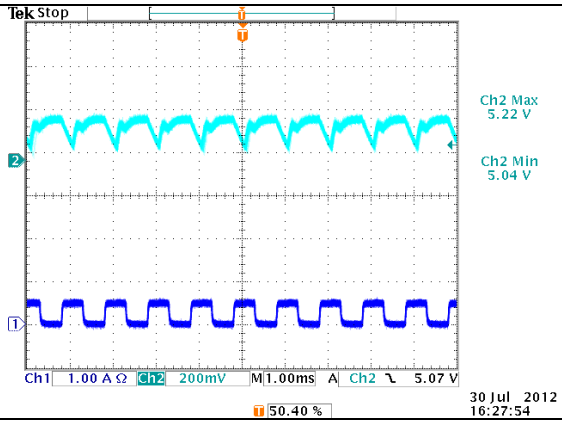
115Vac/60H



230Vac/60Hz



264Vac/60Hz



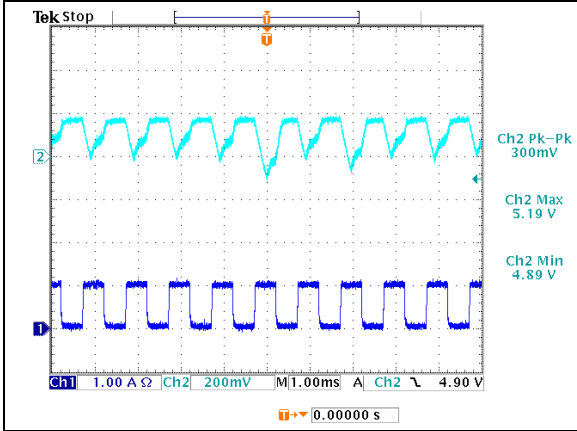
4.4.7 1kHz Test Result with transient load 0 ~ 1A

AC Input	Vo at 0 ~ 0.5A, 1kHz	
	max	min
90	5.19	4.89
115	5.19	4.89
230	5.19	4.87
264	5.19	4.88

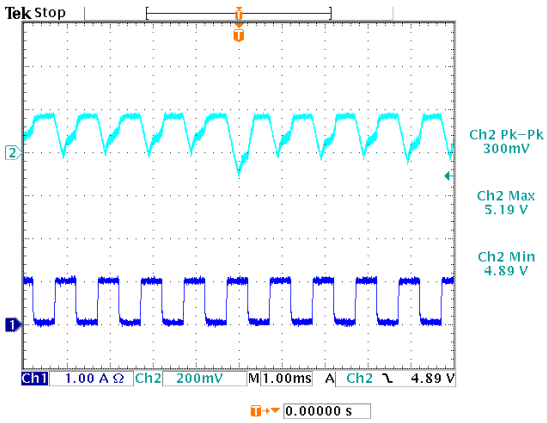
4.4.8 1kHz Test Waveform

CH1: Output current, CH2: Output voltage

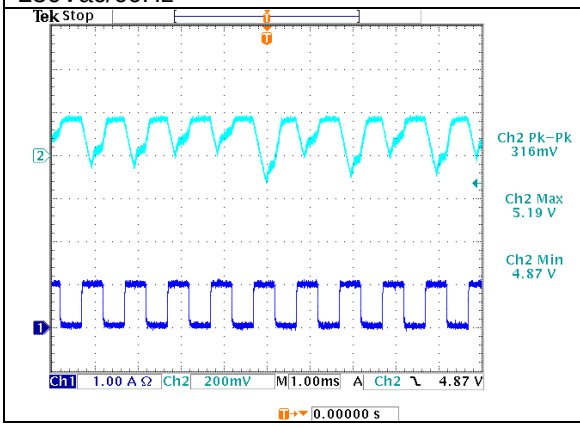
90Vac/60Hz



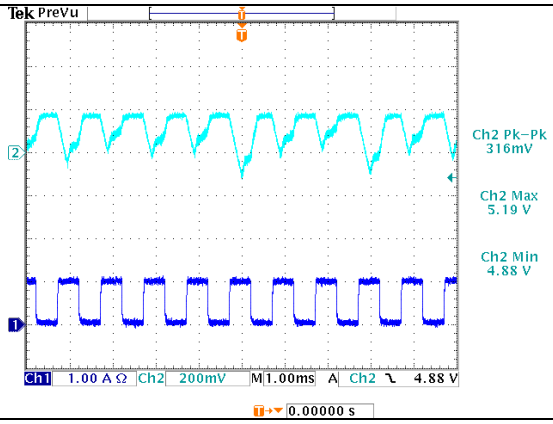
115Vac/60H



230Vac/60Hz



264Vac/60Hz



4.5 Output Ripple/Noise

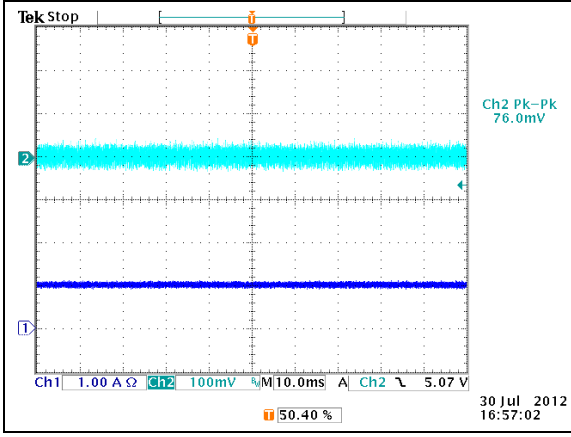
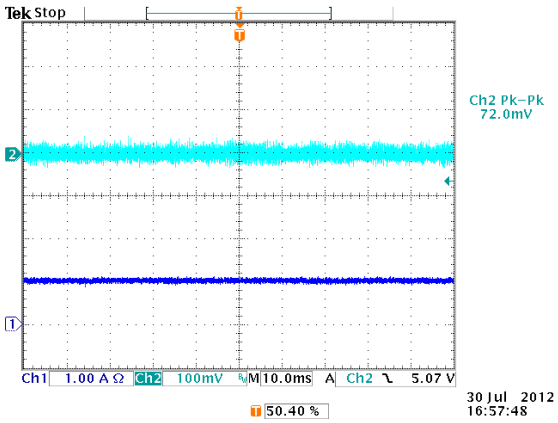
Measurements will be made with an oscilloscope set to 20MHz bandwidth limit. Output will be tested with 10uF aluminum electrolytic capacitor and 0.1uF ceramic capacitor in parallel.

4.5.1 Test Result

AC Input	Vout (mVp-p)
115	76
230	72

4.5.2 Test Waveform

CH1: Output current, CH2: Output voltage

115Vac, 5V@1A	230Vac, 5V@1A
	

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.

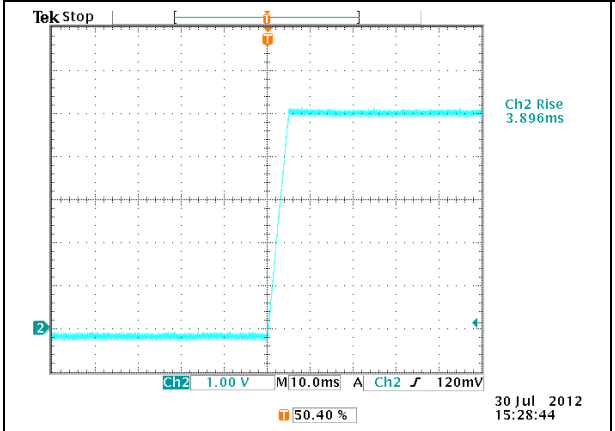
4.6.1 Test Result

AC Input	No Load	Max. Load
115	3.89ms	9.44ms
230	3.85ms	9.82ms

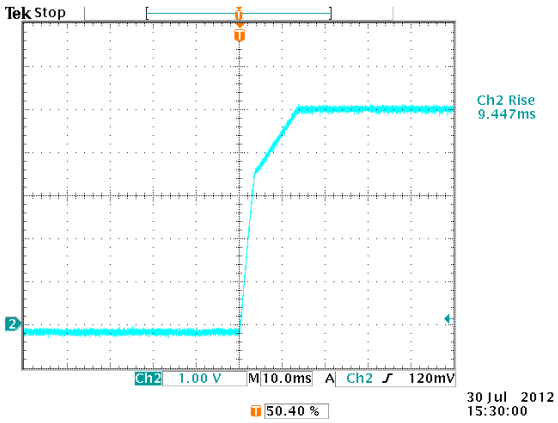
4.6.2 Test Waveform

CH2: Output voltage

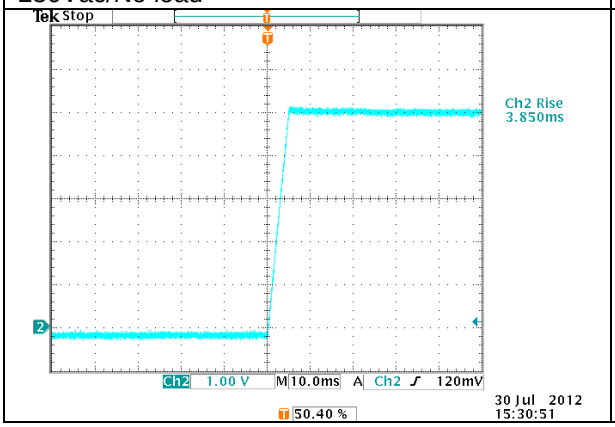
115Vac/No load



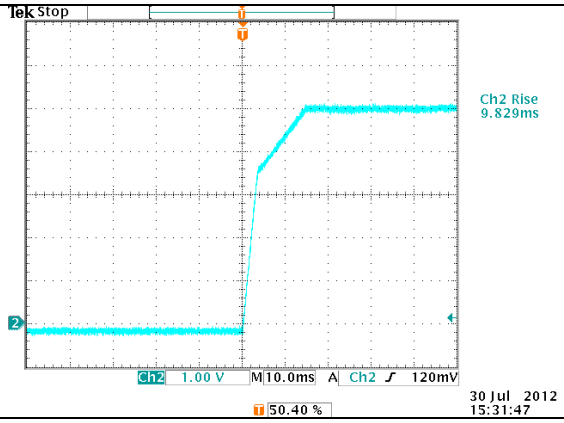
115Vac/Maximum load



230Vac/No load



230Vac/Maximum load



4.7 Start Up Time

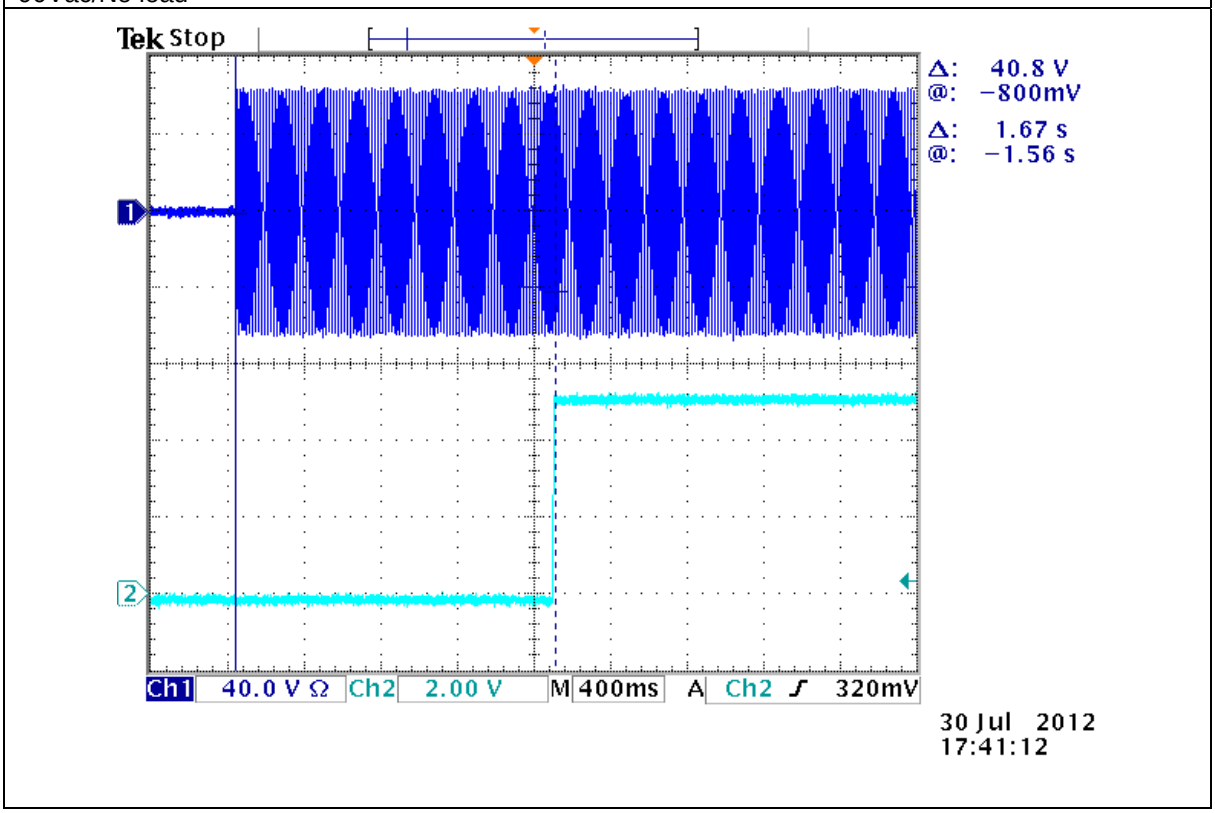
The output load set at maximum loading. Measure the time interval between 90VAC power up and stable of output voltage.

4.7.1 Test Result

AC Input	Delay Time
90	1670ms

4.7.2 Test Waveform

CH1: AC input, CH2: Output voltage
90Vac/No load



4.8 Hold Up Time

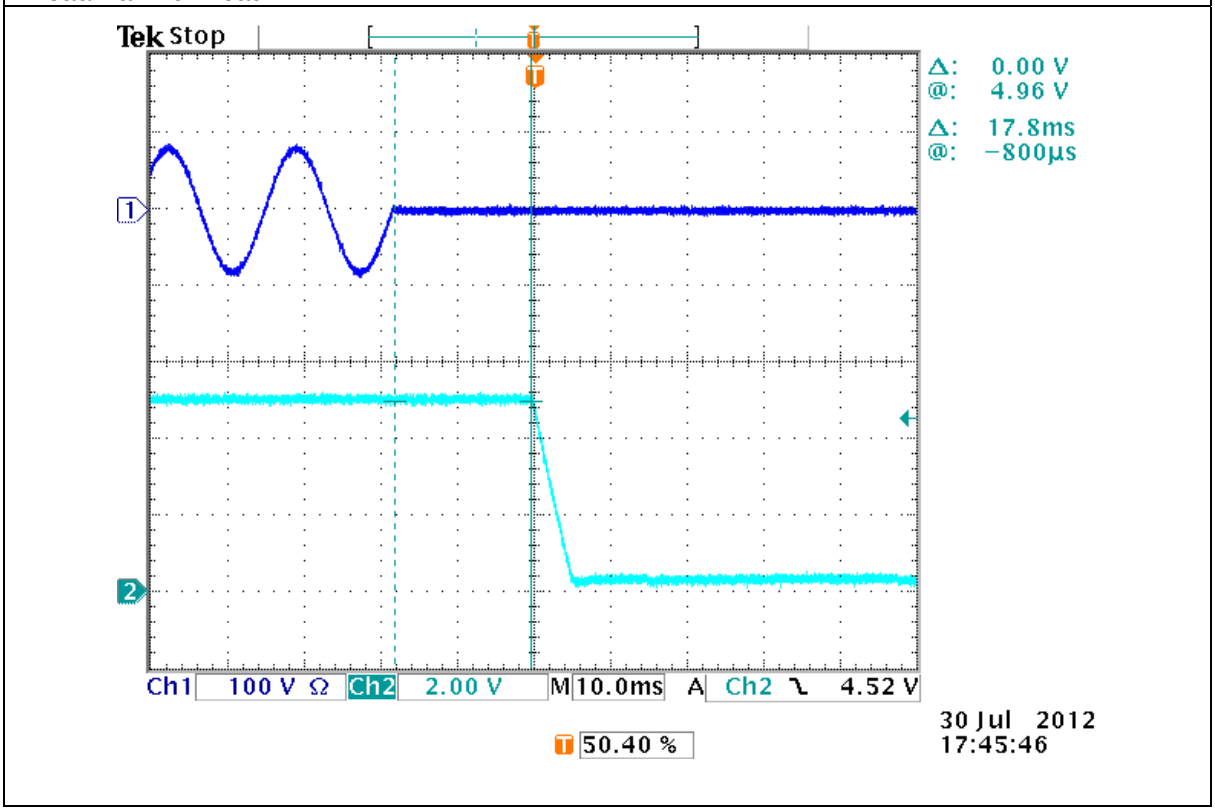
The output load set at maximum loading. Measure the time interval between 115VAC turn off at zero degree and the output voltage falling to out of regulation.

4.8.1 Test Result

AC Input	Hold up Time
115	17.8ms

4.8.2 Test Waveform

CH1: AC input, CH2: Output voltage
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.

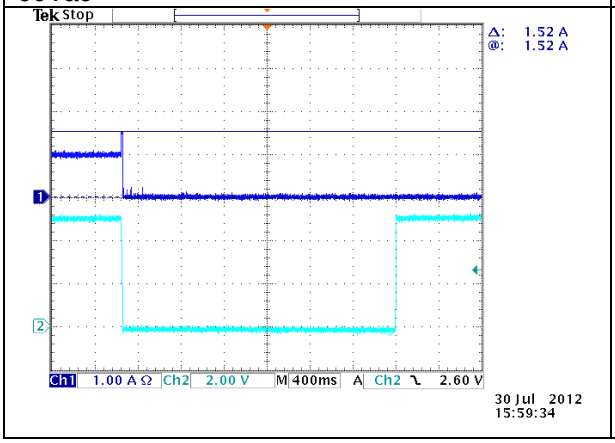
4.9.1 Test Result

Vac	OCP
90	1.52A
264	1.54A

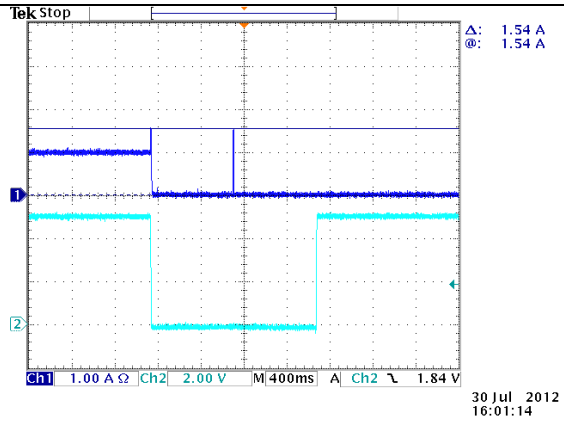
4.9.2 Test Waveform

CH1: Output Current, CH2: Vds voltage

90Vac



264Vac



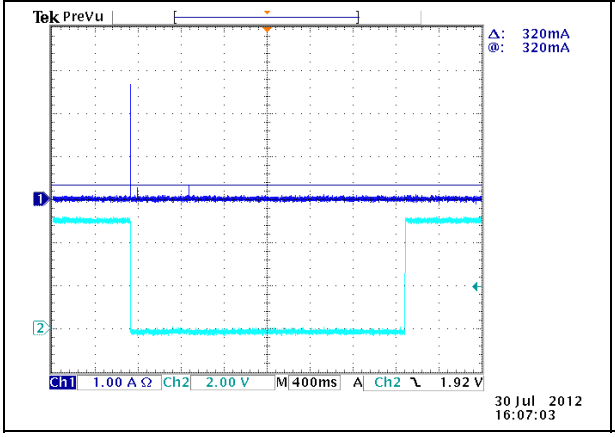
4.10 *Short Circuit Protection*

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.

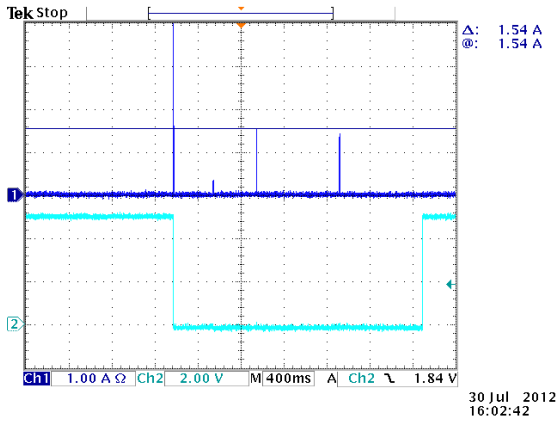
4.10.1 Test Waveform

CH1: Output Current, CH2: Vds voltage

90Vac



264Vac



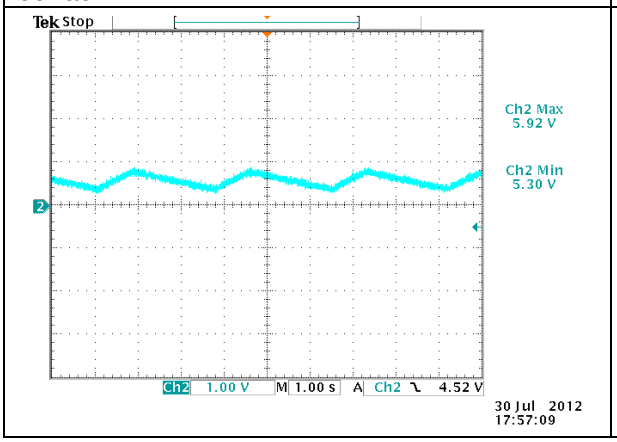
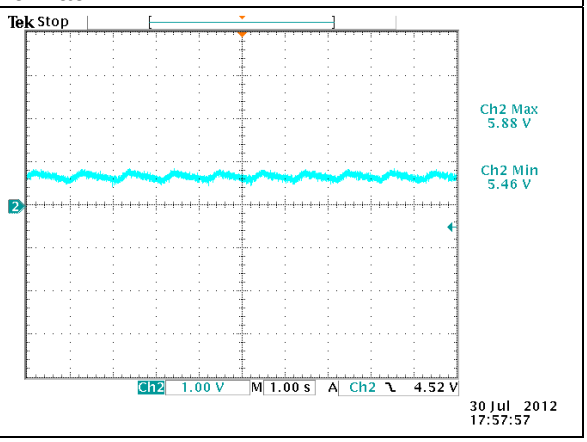
4.11 Over Voltage Protection

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	5.92V
264	5.88V

4.11.2 Test Waveform

CH2: Output voltage	
90Vac	264Vac
	

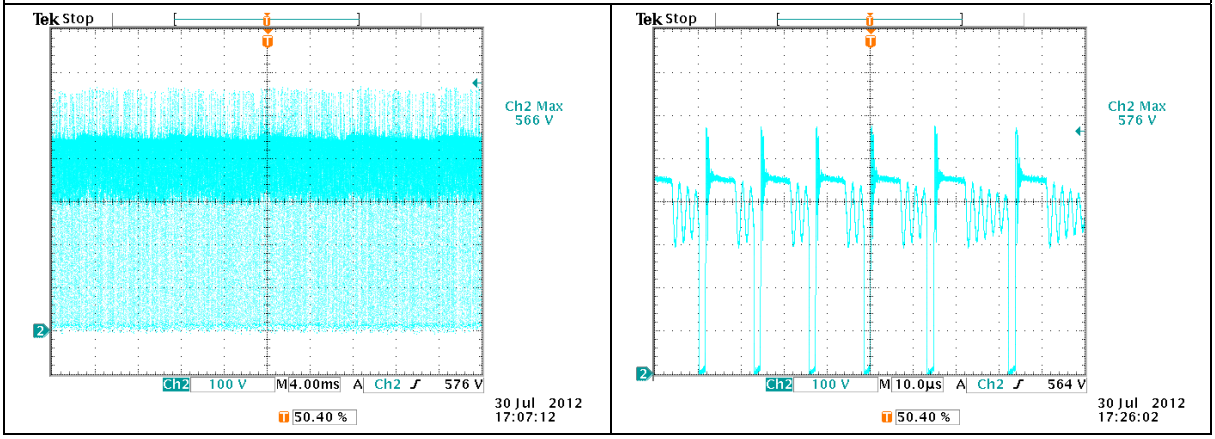
4.12 Key Component Stress

4.12.1 Test Result

Item	264Vac
Q1	576V
Q1@SCP	572V

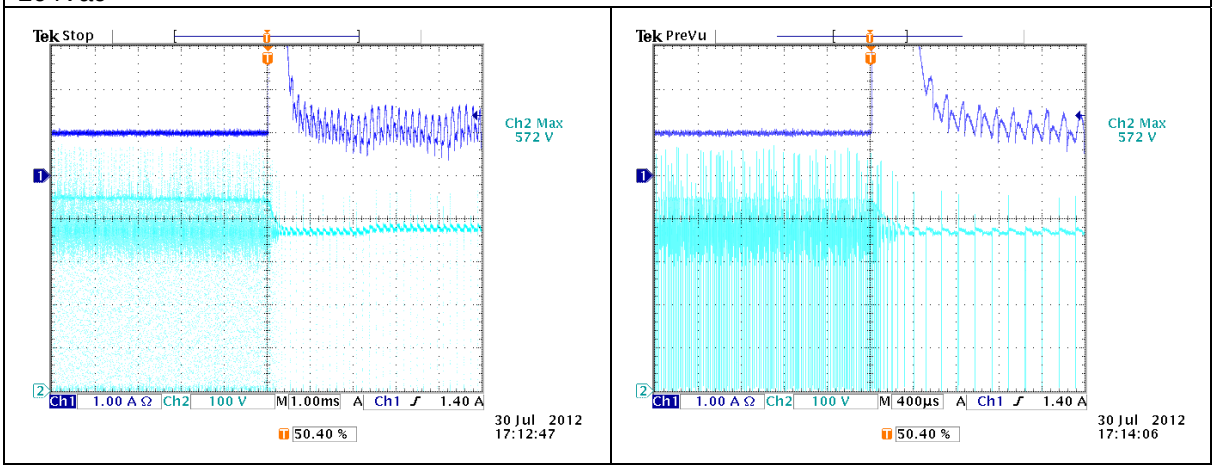
4.12.2 Q1 (P0165A) Voltage Stress

CH2: Vds voltage
264Vac



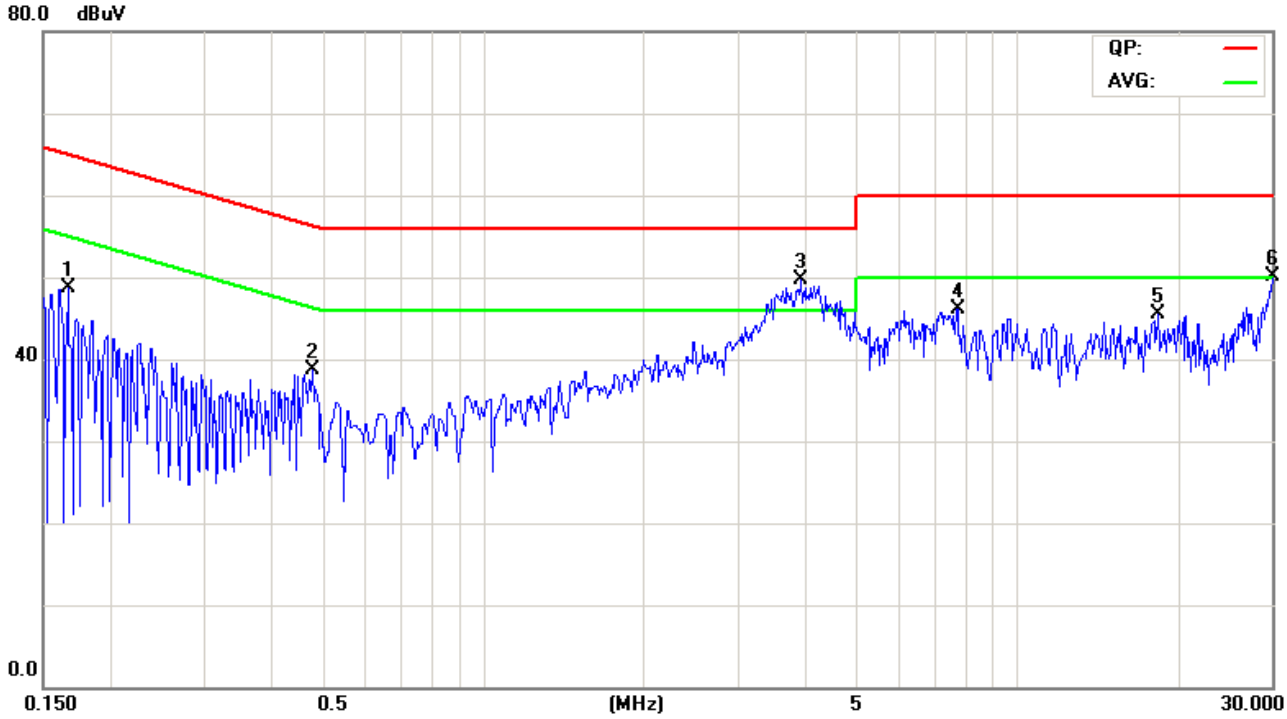
4.12.3 Q1 (P0165A) Voltage Stress when SCP

CH1: Output Current, CH2: Vds voltage
264Vac



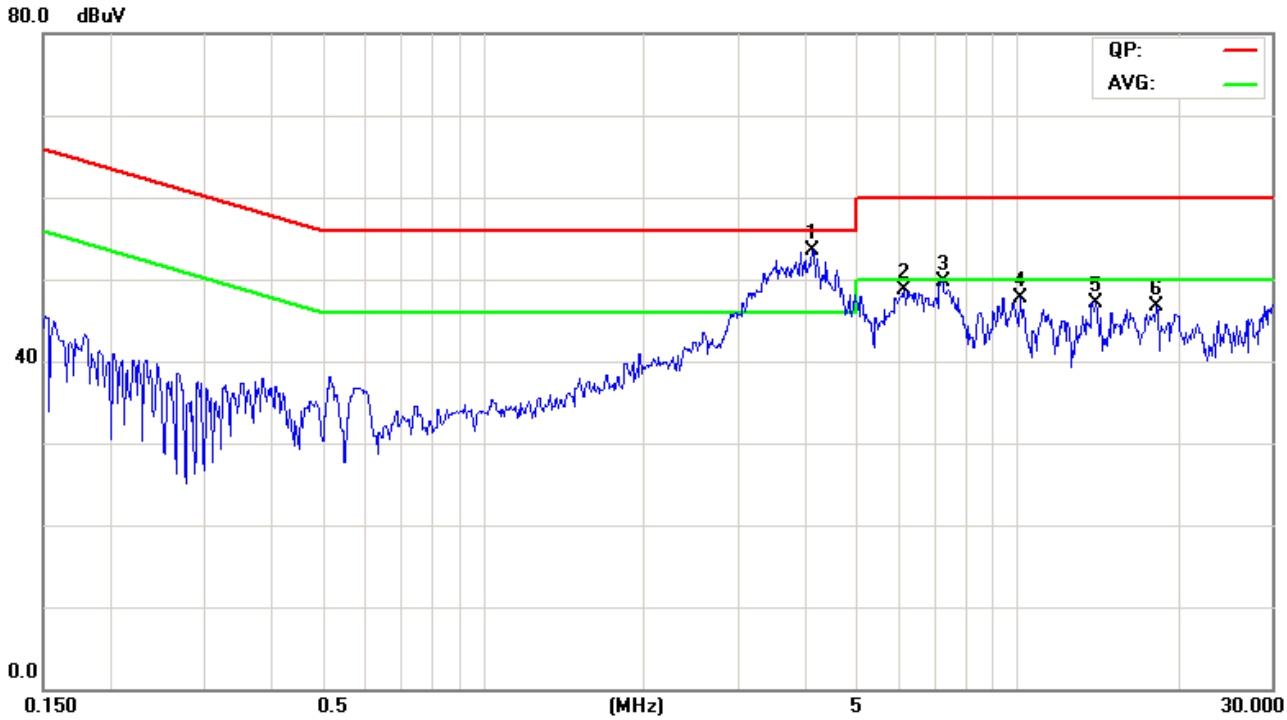
4.13 EMI Conduction Test without Y-Cap

4.13.1 110Vac Line



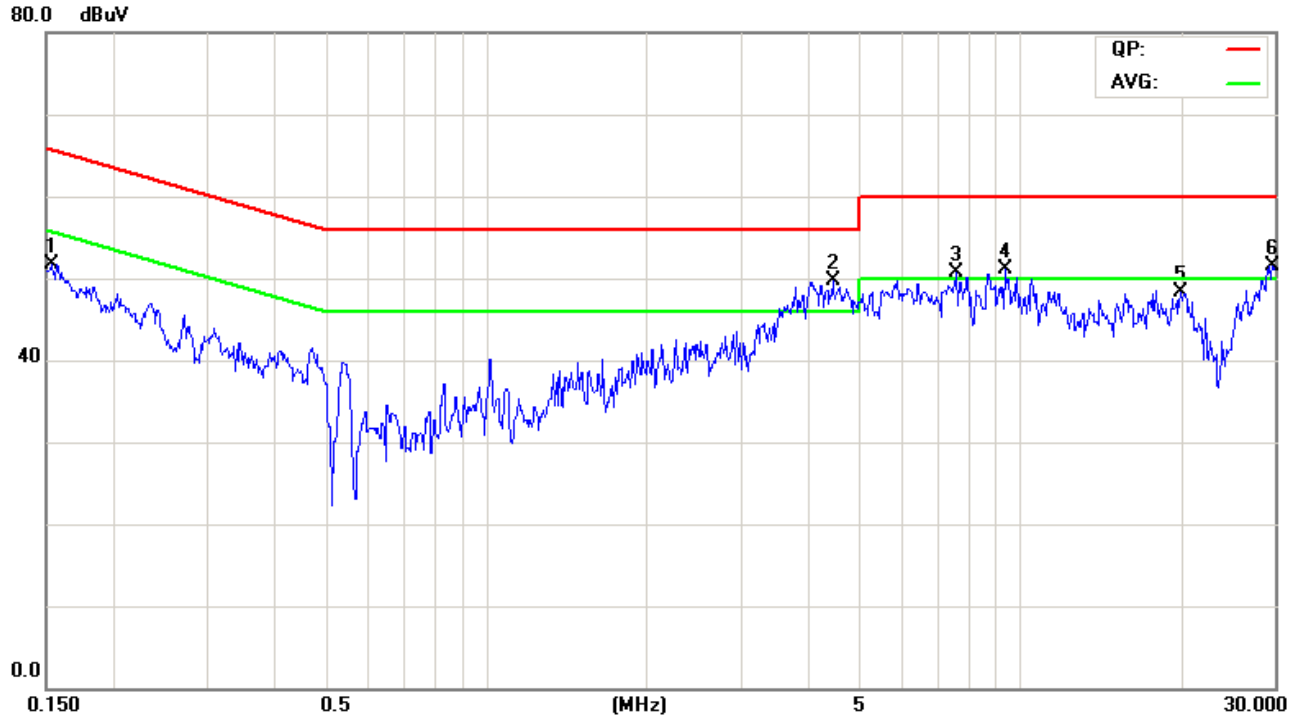
No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1	0.1664	48.58	48.58	0.09	48.67	48.67	65.14	55.14	-16.47	-6.47	Pass
2	0.4724	32.05	22.19	0.10	32.15	22.29	56.47	46.47	-24.32	-24.18	Pass
3	3.9223	44.13	36.02	0.20	44.33	36.22	56.00	46.00	-11.67	-9.78	Pass
4	7.7087	37.99	28.42	0.33	38.32	28.75	60.00	50.00	-21.68	-21.25	Pass
5	18.2377	35.70	28.34	0.78	36.48	29.12	60.00	50.00	-23.52	-20.88	Pass
6	29.9982	41.72	34.25	1.04	42.76	35.29	60.00	50.00	-17.24	-14.71	Pass

4.13.2 110Vac Neutral



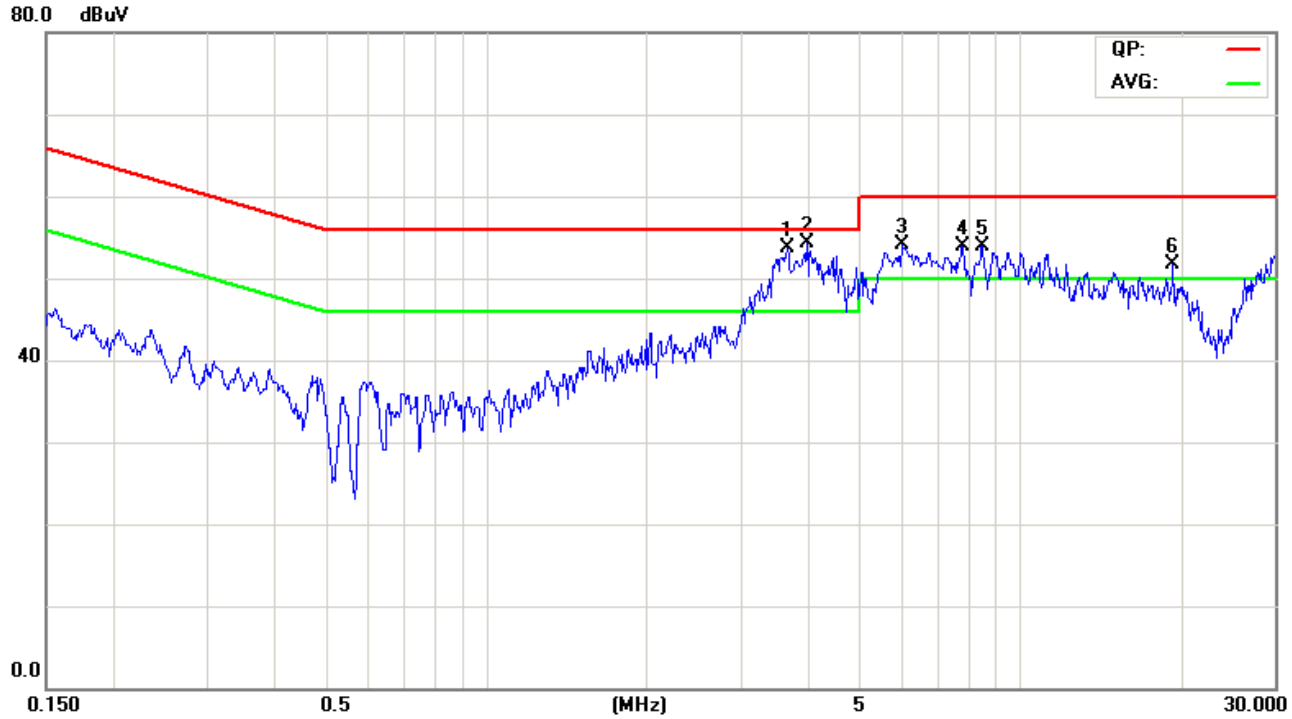
No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1	4.1589	44.56	36.30	0.17	44.73	36.47	56.00	46.00	-11.27	-9.53	Pass
2	6.1561	41.27	33.66	0.22	41.49	33.88	60.00	50.00	-18.51	-16.12	Pass
3	7.2363	43.32	32.40	0.25	43.57	32.65	60.00	50.00	-16.43	-17.35	Pass
4	10.1692	37.33	26.14	0.32	37.65	26.46	60.00	50.00	-22.35	-23.54	Pass
5	14.0157	39.52	29.73	0.44	39.96	30.17	60.00	50.00	-20.04	-19.83	Pass
6	18.1282	36.51	28.53	0.56	37.07	29.09	60.00	50.00	-22.93	-20.91	Pass

4.13.3 230Vac Line



No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1	0.1542	41.33	24.12	0.09	41.42	24.21	65.77	55.77	-24.35	-31.56	Pass
2	4.4351	40.23	32.81	0.22	40.45	33.03	56.00	46.00	-15.55	-12.97	Pass
3	7.5956	41.20	33.05	0.33	41.53	33.38	60.00	50.00	-18.47	-16.62	Pass
4	9.3197	41.93	33.87	0.39	42.32	34.26	60.00	50.00	-17.68	-15.74	Pass
5	19.9141	37.65	30.58	0.86	38.51	31.44	60.00	50.00	-21.49	-18.56	Pass
6	29.6326	44.29	36.99	1.03	45.32	38.02	60.00	50.00	-14.68	-11.98	Pass

4.13.4 230Vac Neutral



No.	Frequency	QuasiPeak reading	Average reading	Correction factor	QuasiPeak result	Average result	QuasiPeak limit	Average limit	QuasiPeak margin	Average margin	Remark
	(MHz)	(dBuV)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dBuV)	(dBuV)	(dB)	(dB)	
1	3.6591	45.12	36.88	0.16	45.28	37.04	56.00	46.00	-10.72	-8.96	Pass
2	3.9719	49.68	40.46	0.17	49.85	40.63	56.00	46.00	-6.15	-5.37	Pass
3	6.0584	46.49	36.79	0.22	46.71	37.01	60.00	50.00	-13.29	-12.99	Pass
4	7.7890	45.66	34.98	0.26	45.92	35.24	60.00	50.00	-14.08	-14.76	Pass
5	8.4898	47.33	35.53	0.28	47.61	35.81	60.00	50.00	-12.39	-14.19	Pass
6	19.2540	40.59	31.84	0.59	41.18	32.43	60.00	50.00	-18.82	-17.57	Pass

5. BOM List

Item Number	Part Number	Value	Description	Quantity
1	BD1,BD2, BD3,BD4	CGRM4005-G	1A/600V SUB SMA	4
2	D2	BAV21W	0.2A/200V SOD-123	1
3	D4	VS1045L-HF SBR10U45SP5	10A/45V	1
4	D5	CURM105-G	1A/600V SUB SMA	1
5	D6	MMSZ5258B BZT52B36	36V Zener SOD-123	1
6	L1		470uH	1
7	FB1,R3A	RTT050000FTP	0R 0805 1%	2
8	C1,C2	KM6R8M400F115A	6.8uF/400V 8Φ*12	2
9	C3		105/50V 0805 Y5V	1
10	C4,C5,C5A	6TPE330MIL	SANYO 330uF D3L	3
11	C6	CL21B102KBANNNC	102/50V 0805 X7R	1
12	C7	CL31B102KHFNNNE	102/630V 1206 X7R	1
13	R2,R3	RTT061005FTP	10M 1206 1%	2
14	R4	RTT051203FTP	120K 0805 1%	1
15	R5	RTT052552FTP	25.5K 0805 1%	1
16	R6	RTT054R70FTP	4R7 0805 1%	1
17	R8	RTT0533R0FTP	33R 0805 1%	1
18	R9	RTT032001FTP	2K 0603 1%	1
19	R10	RTT061R80FTP	1R8 1206 1%	1
20	R11	RTT0539R0FTP	39R 0805 1%	1
21	R12	RTT053651FTP	3.65K 0805 1%	1
22	R13	RTT062203FTP	220K 1206 1%	1
23	R14	RTT050000FTP	0R 0805 1%	1
24	Q1	P0165A AOU1N60	NIKO-SEM 1A/650V AO-SEM 1A/600V	1
25	U1	UCC28700	SOD-23 6PIN	1
26	T1		EPC-13 1.5mH	1
27	F1		250V/2A	1

6. Contact Window

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Contact WPI window for EVM order .

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