PL3563 Demo Board Manual

Board Model: 12W

Doc. No.: A0

Highlights:

- Low component count
- Standby Power<0.3W
- Audio noise free operation
- OCP with line compensation
- Frequency jitter to improve EMC

Revision History

Revise Date	Version	Reason/Issue
09.6	A0	

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1. Adaptor Module Specification

1.1. Input Characteristic

AC input voltage rating	100VAC to 240VAC
AC input voltage range	90VAC to 264VAC
AC input frequency	47HZ to 63HZ
Input Current	0.45A (rms) max. @ full load, 100VAC/60HZ 0.23A (rms) max. @ full load, 240VAC/50HZ

1.2. Output Characteristic

Output Voltage	+12.0V
Output Tolerance	+/-0.6V
Min. load current	0A
Max. load current	1.0A
Line Regulation	±1%
Load Regulation	±5%
Ripple & Noise	100 mV

Note: Ripple & Noise is measured with 20MHZ bandwidth limited (peak to peak value) at the end of a 1.2m twisted wire terminated with a 10uF capacitor in parallel with a 0.1uF ceramic capacitor.

1.3. Performance Specifications

Total Output Power	12W Typical
Standby Power	< 0.3W @ 240Vac/50HZ, no load.
Efficiency	75% min. @ 90Vac/60HZ with full load
Hold up Time	10m sec. min. @ 100Vac/60HZ with full load
Turn on Delay Time	1 sec. max. @ 100Vac/60HZ with full load

1.4. Protection Features

Short circuit Protection	Output shut down (Auto recovery)
Over Voltage Protection	Output shut down when output voltage exceeds 15V
Over Current Protection	Output shut down (Auto recovery)

1.5. Environmental

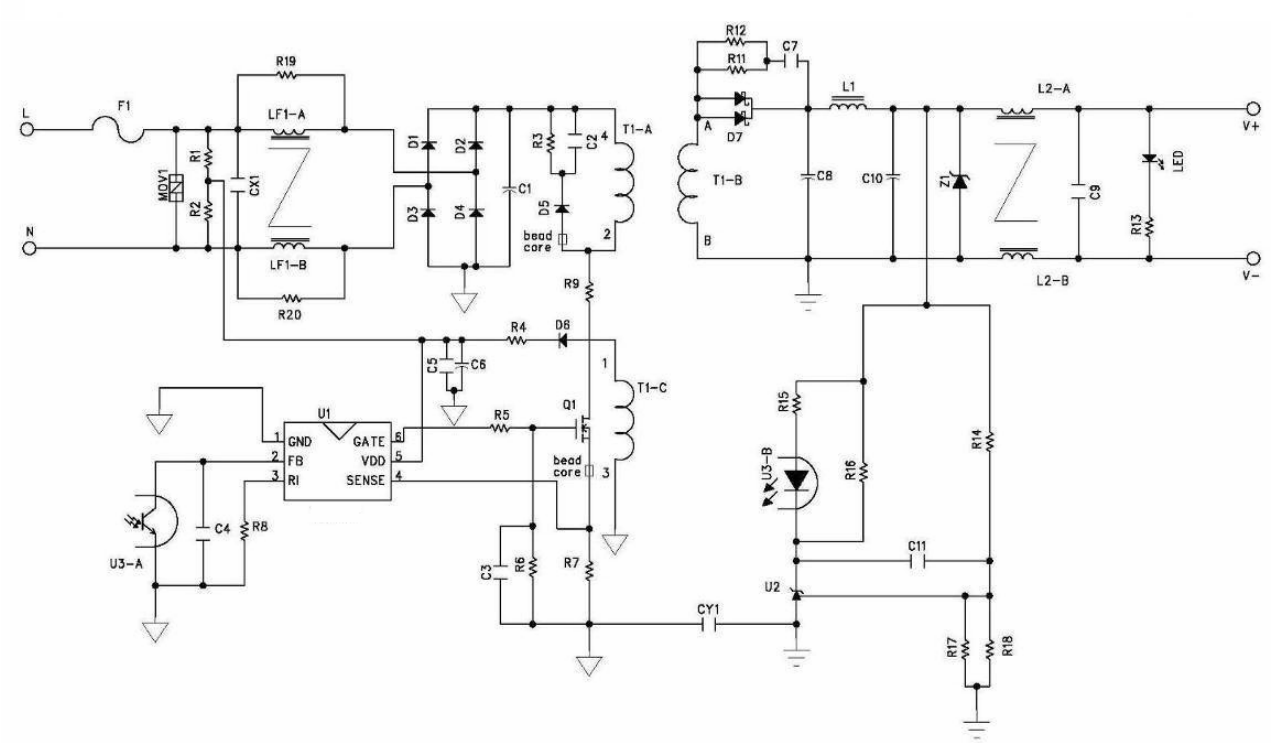
Operating Temperature	0℃ to + 40℃
Operating Humidity	20 % to 90 % R. H.
Storage Temperature	-40 ℃ to 85 ℃
Storage Humidity	0 % to + 90 % R. H.

1.6. Dielectric withstand (Hi-pot) test

Input to Output	3000Vac 1 minute.

2. Adaptor Module Information

2.1. Schematic



2.2. Bill of material

No.	Position	Description	Quantity	Remark
1	R1,R2	SMD Resistor 1M 1206 ±5%	2	
2	R3	MOFR 47K 1W ±5%	1	
3	R4	SMD Resistor 0R 0805 ±5%	1	
4	R5	SMD Resistor 100R 1206 ±5%	1	
5	R6	SMD Resistor 10K 0805 ±5%	1	
6	R7	MOFR 1.5R 1W ±5%	1	
7	R8	SMD Resistor 130K 0603 ±1%	1	
8	R9	SMD Resistor 47R 1206 ±5%	1	
9	R11,R12	SMD Resistor 100R 0805 ±5%	2	
10	R13	SMD Resistor 4.3K 0805 ±5%	1	
11	R14	SMD Resistor 43K 0805 ±1%	1	
12	R15	SMD Resistor 510R 1206 ±5%	1	
13	R16	NC	0	
14	R17	SMD Resistor 12K 0805 ±1%	1	
15	R18	SMD Resistor 150K 0805 ±5%	1	
16	R19	SMD Resistor 33K 0805 ±5%	1	
17	R20	C.R 33K 1/8W ±5%	1	
18	MOV1	V.R 07D471K	1	
19	F1	Fuse 2A/250V Time lag	1	
20	JP1	Jumper 0.6*8mm	1	
21	D1,D2,D3,D4,D5	Diode 1N4007 1A 1000V DO-41	5	
22	D6	Diode PG102R DO-41	1	
23	D7	Shottky diode SB5100	1	
24	Z1	NC	0	
25	LED	LED green	1	
26	CX1	Xcap 0.22uF X2	1	
27	CY1	Ycap 102P Y1	1	
28	C1	C.E 22uF/400V +/-20% 13*20mm	1	
29	C2	Cap MPP 103P 630V	1	
30	C3	NC	0	
31	C4	SMD C.C 102P 25V 0805	1	
32	C5,C9	SMD C.C 104P 25V 0805	2	
33	C6	C.E 4.7uF/50V 105℃ 5*11mm	1	
34	C7	SMD C.C 102P 100V 0805	1	
35	C8	C.E 470uF/16V Low ESR 105℃ D8	1	
36	C10	C.E 220uF/16V Low ESR 105℃ D8	1	
37	C11	SMD C.C 472P 25V 0805	1	
38	U1	PWM controller PL3563	1	
39	U2	Shunt regulator TL431 ±1%	1	
40	U3	Photocoupler PC817C	1	
41	T1	Transformer EF20	1	
42	LF1	EMI filter UU9.8 20mH Min	1	
43	L1	Inductor D4*15 10uH	1	
44	L2	Common chock 5.85D*1.55W 60uH	1	
45	For D7, Q1	Bead core	2	
46	Q1	MOSFET SSS4N60	1	
47	HS1	Heat sink 10*15*20mm AL	1	
48	For Q1	Screw 3*6mm	1	
49	PCB		1	
50	LABEL		1	
51	V+, V-	Cable AWG18# 1200mm	1	

2.3. Transformer Design

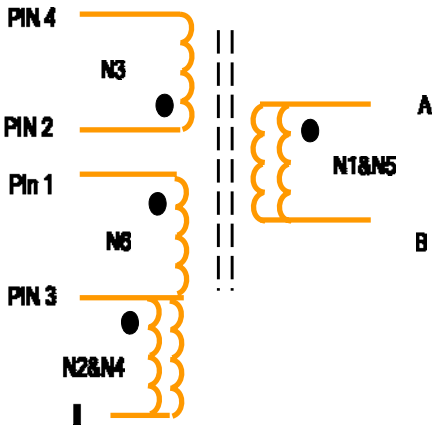
2.3.1. Specification

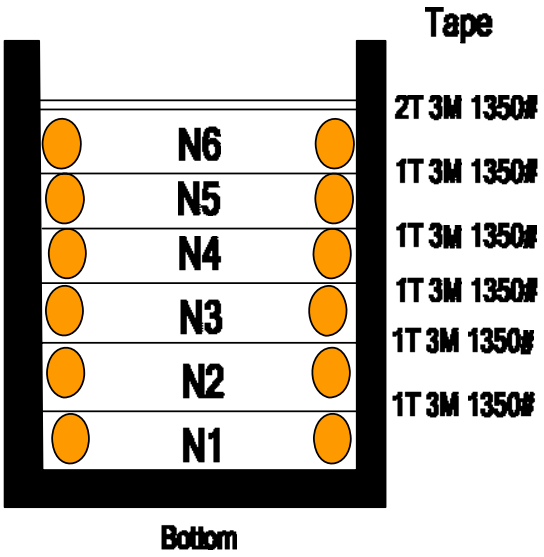
1) Bobbin: EF20(8Pin), Pin 5 to Pin 8 cut off
2) Core material: PC40 (TDK).
3) L(1-3) = 1.6mH±3% (1KHZ,0.3V,25℃)
4) HI-POT: (60Hz/5mA/3Sec).
*Pri. to Sec. 3750 Vac; Sec. to core 3750Vac.

2.3.2. Winding data

Step	Winding	Material	Start	Turns	Finish	Remark
1	N1	Triple insulation, 0.55Φ*1	A	18	B	N2,N3,N4,N6 with TEFLON Tube.
2	TAPE	TAPE W=11.4mm (Y)		1		
3	N2	0.1Φ*3 2UEW	空	23	3	
4	TAPE	TAPE W=11.4mm (Y)		1		
5	N3	0.25Φ*1 2UEW	2	108	4	
6	TAPE	TAPE W=11.4mm (Y)		1		
7	N4	0.1Φ*3 2UEW	空	23	3	
8	TAPE	TAPE W=11.4mm (Y)		1		
9	N5	Triple insulation, 0.55Φ*1	A	18	B	
10	TAPE	TAPE W=11.4mm (Y)		1		
11	N6	0.1Φ*3 2UEW	1	23	3	
12	TAPE	TAPE W=11.4mm (Y)		2		

2.3.3. Configuration





3. Performance Evaluation

Performance Highlights

- The efficiency over 90Vac ~264Vac is >75%.
- The standby power is < 0.3W at 240Vac/50HZ at no load condition.

Characterization Results Summary

Test Item	Specification	Test result
1. Input characteristic		
Input current Standby power (264Vac,with LED) Efficiency	0.45A Max. <0.3W >75%	0.277A 0.211W (LED current 4mA) 80.95%
2 .Output characteristic		
Line regulation& Load regulation	±1% ±5%	0.008% 0.019%
Ripple & noise	100mV Max	52mV
Over shoot & Under shoot	600mV Max	63mV
Dynamic load voltage	±600mV Max	228mV
3. Time sequence		
Turn on delay time	<1S	655mS
Hold up time	>10mS	10.15mS
Rise time		12mS
Fall time		8mS
4. Protection		
Over voltage protection		Pass
Over current protection		1.1504-1.2544A
Short Circuit protection		Pass
5. Brownout/Brownout recovery		Pass

Test Equipments

Item	Vender
AC Source	APE
Digital Power Meter	Prodigit
Electrical Load	Prodigit
Oscilloscope	LeCroy

3.1. Input Characteristics

The module was tested at different input voltages (from 90Vac to 264Vac) and different load conditions (full load and no load). Efficiency and standby power were measured and listed in below table .

Table 1: Input characteristic at full load

Input voltage	Irms (A)	Pin(W)	Vo(V)	Io(A)	η	Specification	Test result
90V/63Hz	0.277	15.066	12.196	1	80.95%	>75%	Pass
115V/60Hz	0.229	14.764	12.197	1	82.61%		
230V/50Hz	0.156	14.94	12.198	1	81.65%		
264V/47Hz	0.144	14.97	12.199	1	81.49%		

Table 2 : Standby power at no load with output LED

Input voltage	Vo(V)	Input Pin(W)	Specification	Test result
90V/63Hz	12.221	0.167	<0.3W	Pass
115V/60Hz	12.221	0.1603		
240V/50Hz	12.221	0.191		
264V/47Hz	12.221	0.211		

Note: All data was measured at PCB end if not otherwise noted.

3.2. Output Characteristics

3.2.1. Line Regulation & Load Regulation

Table 3: Line Regulation & Load Regulation

Input voltage	No load	Half load	Full load	Specification	Test result
90Vac/60HZ	12.22	12.209	12.197		
115Vac/60HZ	12.22	12.209	12.197		
132Vac/60HZ	12.22	12.209	12.198		
180Vac/50HZ	12.22	12.209	12.198		
230Vac/50HZ	12.22	12.209	12.198		
264Vac/50HZ	12.22	12.209	12.198		
Line Regulation	0.008%			<1%	Pass
Load Regulation	0.019%			<5%	Pass

Note: All data was measured at PCB end.

3.2.2. Ripple & Noise

Table 4 : Ripple &Noise measure results

Input voltage	No load	Full load	Spec.	Test result	Remark
90Vac/60HZ	12.5 mV	52 mV	100mV	Pass	
115Vac/60HZ	17 mV	52 mV		Pass	
230Vac/50HZ	22 mV	50 mV		Pass	
264Vac/50HZ	15 mV	52 mV		Pass	

Note: Ripple& noise was measured at DC cord end(1.2m/18AWG) with a 0.1uF/100V ceramic cap connected in parallel with a 10uF/50V Electrolytic cap. Bandwidth was limited to 20MHz.

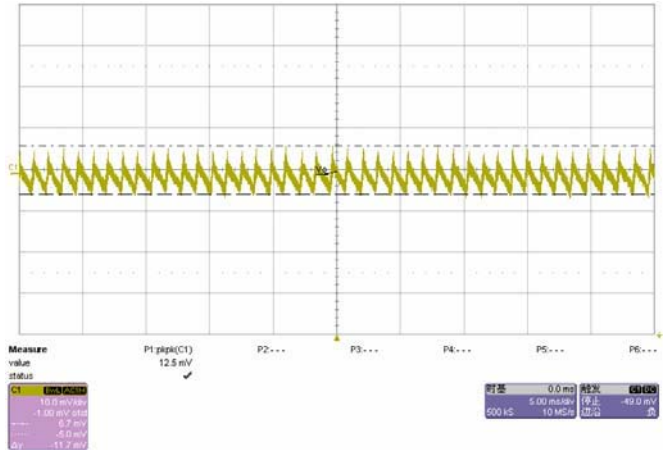


Figure 1: Measured ripple& noise waveform@90Vac/60HZ, no load

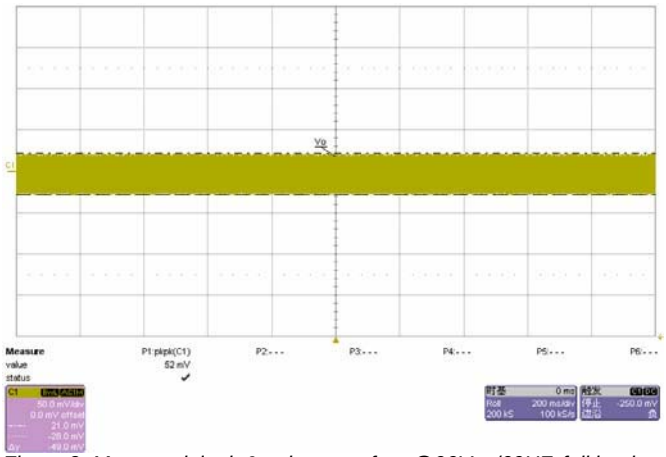


Figure 2: Measured ripple& noise waveform@90Vac/60HZ, full load

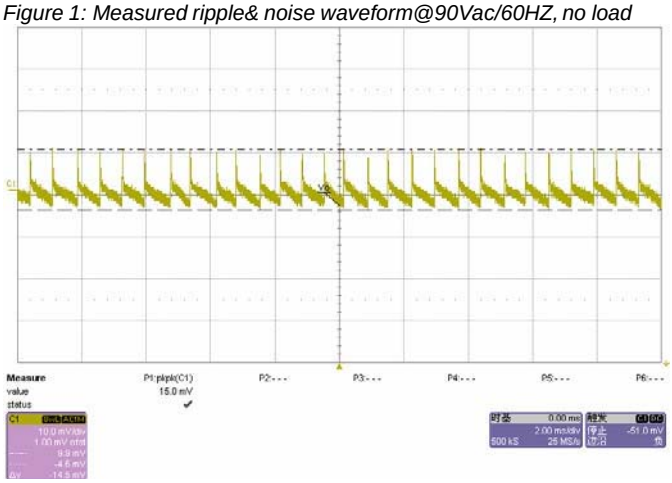


Figure 3: Measured ripple& noise waveform@264Vac/50HZ, no load

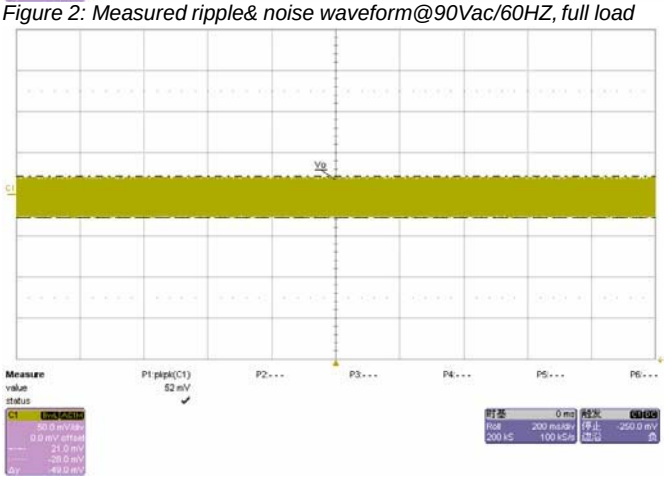


Figure 4 : Measured ripple& noise waveform@264Vac/50HZ, full load

3.2.3. Over shoot & Under shoot

Table 5 : Over shoot/under shoot measurement results

Input Voltage	load		Meas. Data	Spec.	Test result	Remark
90V/60HZ	Full load	over shoot	63mV	600mV Max	Pass	
		under shoot	0mV		Pass	
	No load	over shoot	50mV		Pass	
		under shoot	0mV		Pass	
264V/50HZ	Full load	over shoot	52mV		Pass	
		under shoot	0mV		Pass	
	No load	over shoot	63mV		Pass	
		under shoot	0mV		Pass	

Note: All data was measured at PCB end.

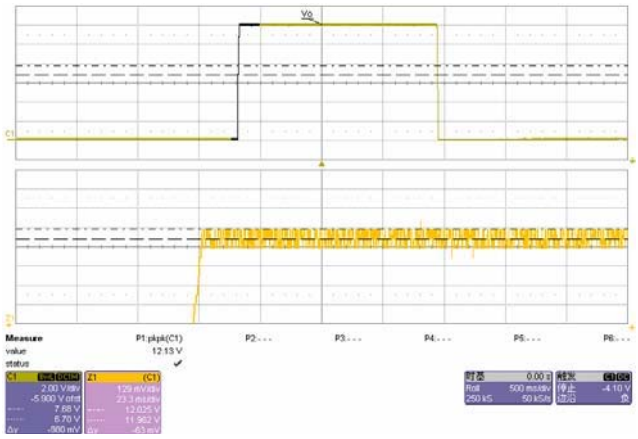


Figure 5: Measured overshoot waveform@90Vac/60HZ, full load

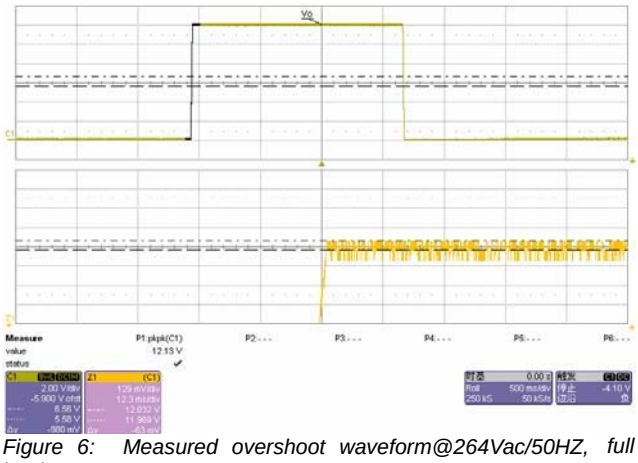


Figure 6: Measured overshoot waveform@264Vac/50HZ, full load

3.2.4. Dynamic Test

A dynamic load with low set at 0.1A lasting for 50ms and high set at 1A lasting for 50mS is added to output. The ramp is set at 0.125A/us at transient.

Table 6 : Output voltage under dynamic test

Input voltage	Output voltage	Test Specifications	Test result	Remark
264V/50HZ	12V±228mV	12V±600mV	Pass	
230V/50HZ	12V±228mV		Pass	
115V/60HZ	12V±228mV		Pass	
90V/60HZ	12V±228mV		Pass	

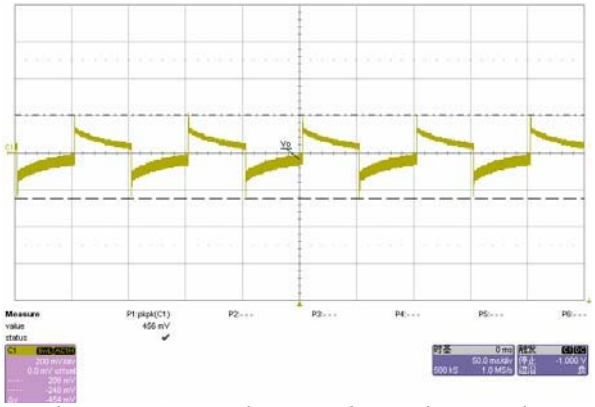


Figure 7 : Output voltage waveform under Dynamic test @264Vac/50Hz,full load

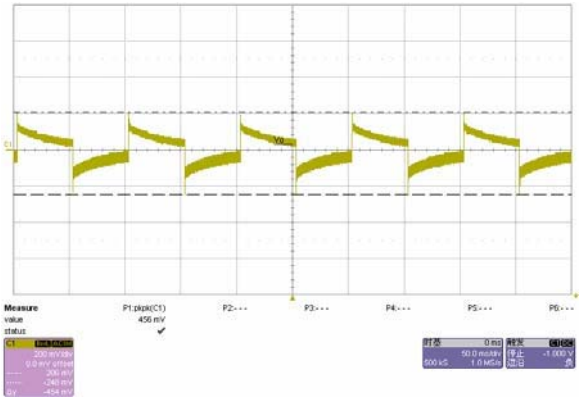


Figure 8 : Output voltage waveform under Dynamic test @90Vac/60Hz with full load

3.2.5. Time Sequence

Table 7 : Turn-on delay /hold-up/Rise/Fall time measurement results

Item	Input voltage	Meas. Data	Test spec.	Test results	Remark
Turn-on delay time	90V/60HZ	0.655 Sec	<1s	**Pass**	Figure 9
	240V/50HZ	0.217 Sec		**Pass**	Figure 9
Hold-up time	100V/60HZ	10.15 ms	>10ms	**Pass**	Figure 10
	240V/50HZ	N.A.			
Rise Time	100V/60HZ	12.30ms		**Pass**	Figure 11
	240V/50HZ	9.45ms		**Pass**	Figure 12
Fall Time	100V/60HZ	8.42ms		**Pass**	Figure 13
	240V/50HZ	8.38ms		**Pass**	Figure 14

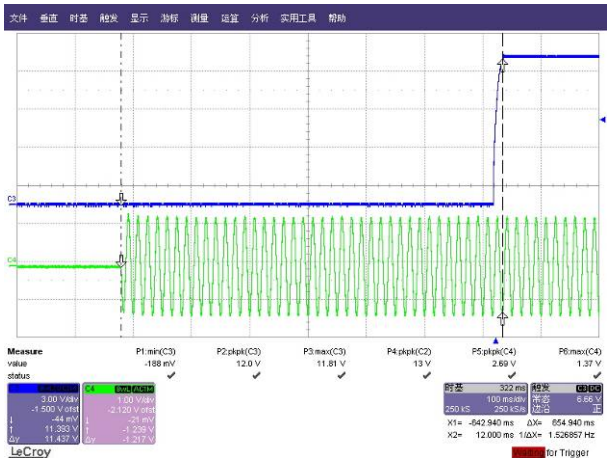


Figure 9: Turn on delay time measured waveform@90Vac/60HZ,full load

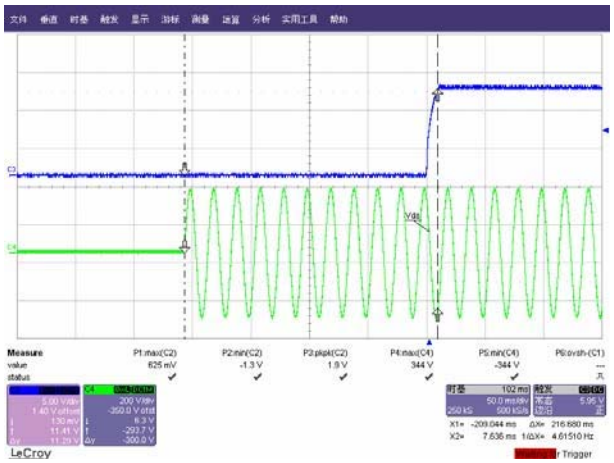


Figure 10 : Turn on delay time measured waveform@240Vac/50HZ,full load

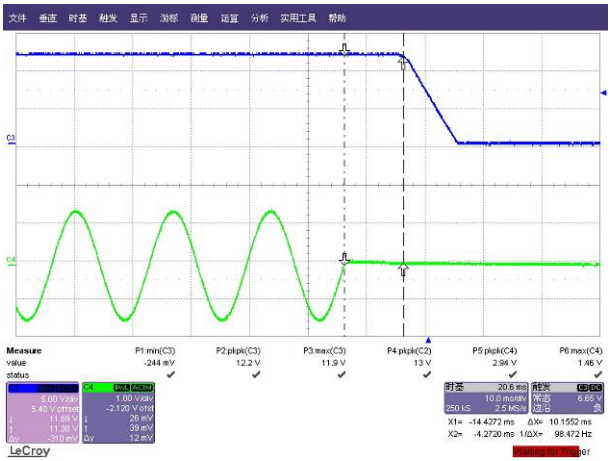


Figure 11: Hold up time measured waveform@100Vac/60HZ,full load

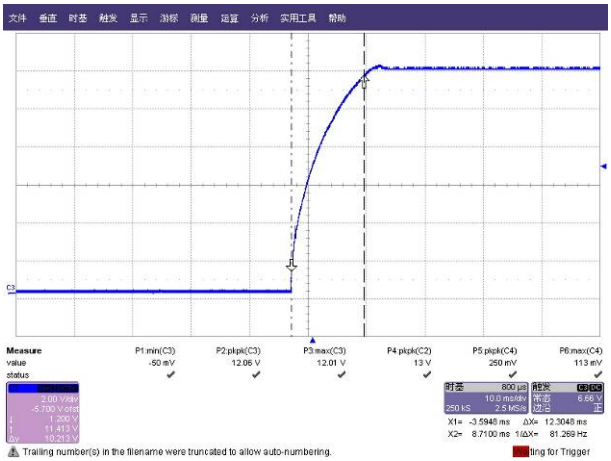


Figure 12: Rise time measured waveform@100Vac/60HZ,full load

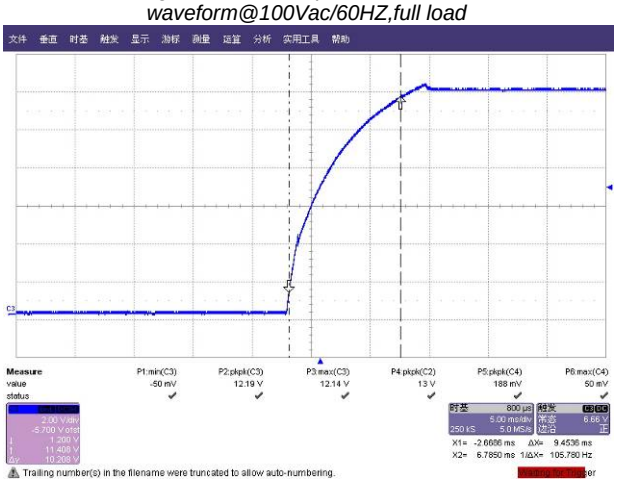


Figure 13: Rise time measured waveform@240Vac/50HZ,full load

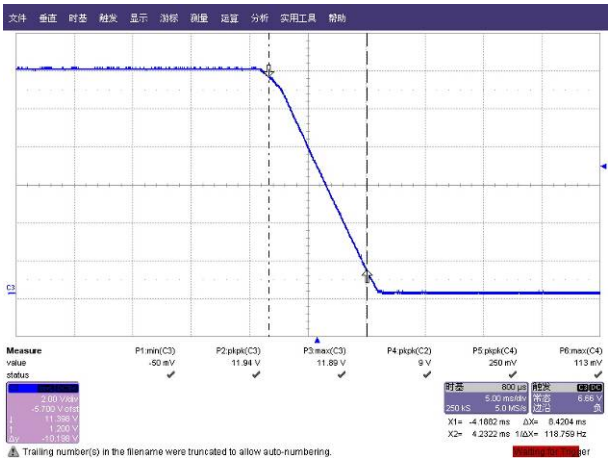


Figure 14: Fall time measured waveform@100Vac/60HZ,full load

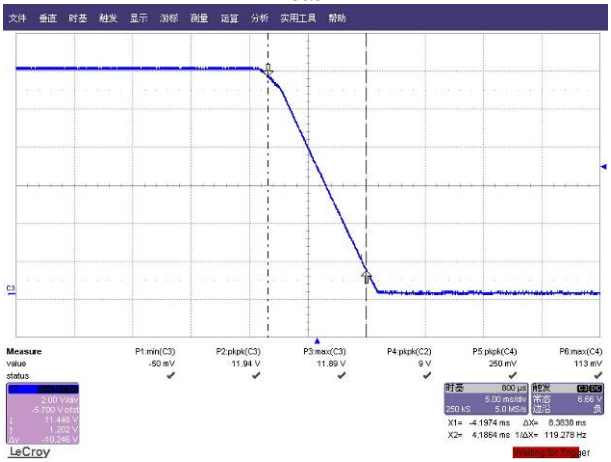


Figure 15 : Fall time measured waveform@240Vac/50HZ,full load

3.3. Protections

3.3.1. Over Current Protection (OCP)

The OCP was tested at 90Vac/60Hz to 264Vac/50Hz input voltage. The results are listed in below table

Table 8 : OCP value vs. input voltage

Input voltage	Input current	OCP	Remark
90Vac/60HZ	0.308A	1.1504A	1.1504times of rated output current
105Vac/60Hz	0.282A	1.1872A	1.1872times of rated output current
120Vac/60Hz	0.123A	1.2112A	1.2112times of rated output current
132Vac/60Hz	0.103A	1.2272A	1.2272imes of rated output current
180Vac/50Hz	0.09A	1.2096A	1.2096times of rated output current
200Vac/50Hz	0.087A	1.2112A	1.2112times of rated output current
230Vac/50Hz	0.083A	1.2352A	1.2352times of rated output current
264Vac/50HZ	0.081A	1.2544A	1.2544times of rated output current

3.3.2. Over Voltage Protection (OVP)

System was observed shutdown when output voltage exceeds 15V. No abnormal damage occurred 24 hours after OVP test at power on. The module passed OVP test.

3.3.3. Short Circuit Protection

The system is protected during output short circuit condition and recovered when short circuit condition is removed. The module passed SCP test.

3.4. Brownout/Brownout recovery test

3.4.1. Brownout test

The power supply meets specification while the line voltage is reduced from 90Vac to 0Vac in 5V decrement every 10 minutes. Full load is connected at output during test.

3.4.2. Brownout recovery test

The power supply meets specification while the line voltage is increased from 0Vac to 90Vac in 5V increment every 10 minutes. Full load is connected at output during test.
The Brownout/Brownout recovery test results are listed in below table.
The module passes Brownout/Brownout recovery test.

Table 9: Brownout/Brownout recovery test results

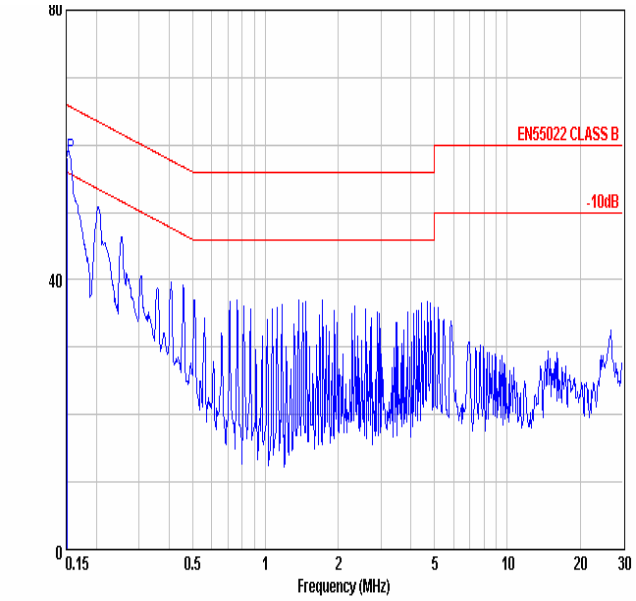
Brownout test		Brownout recovery test	
Input voltage	**Input power (90Vac to 0Vac)**	**Input voltage**	**Input power (0Vac to 90Vac)**
90Vac/60HZ	15.14W	0Vac~45Vac/60HZ	0
85Vac/60HZ	15.218W	50Vac/60HZ	0
80Vac/60HZ	15.295W	55Vac/60HZ	0
75Vac/60HZ	15.284W	60Vac/60HZ	0
70Vac/60HZ	14.95W	65Vac/60HZ	0W
65Vac/60HZ	0W	70Vac/60HZ	15.24W
60Vac/60HZ	0	75Vac/60HZ	15.277W
55Vac/60HZ	0	80Vac/60HZ	15.266W
50Vac/60HZ	0	85Vac/60HZ	15.172W
0Vac~45Vac/60HZ	0	90Vac/60HZ	15.072W

3.5. EMI Test

The Power supply passed EN55022 Class B and FCC Class B EMI requirement with more than 6dB margin

3.5.1. Conduct testa

3.5.1.1. EN55022 CLASS B @ full load report



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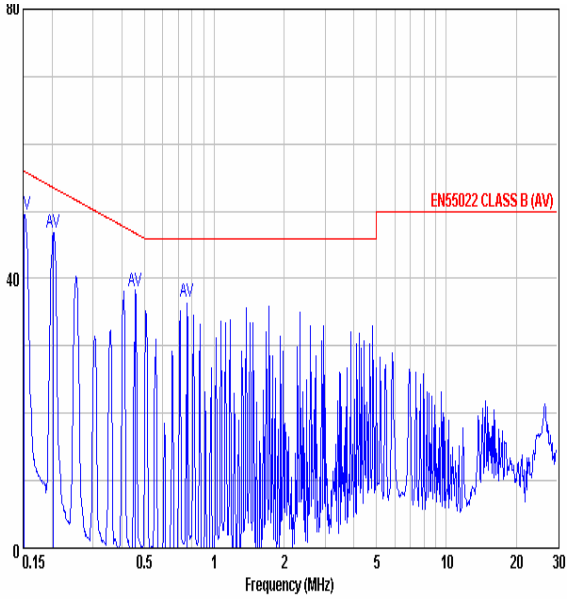
Condition : EN55022 CLASS B ESH2-Z5-05.04.13 NEUTRAL



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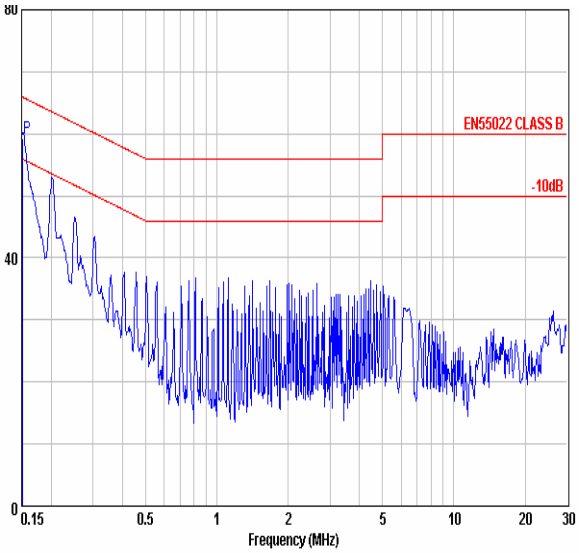

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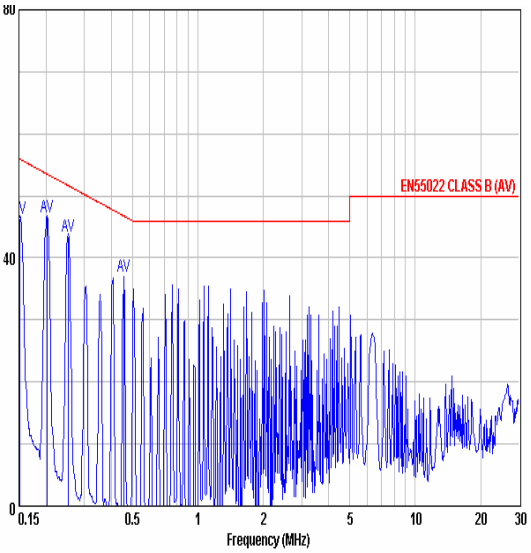
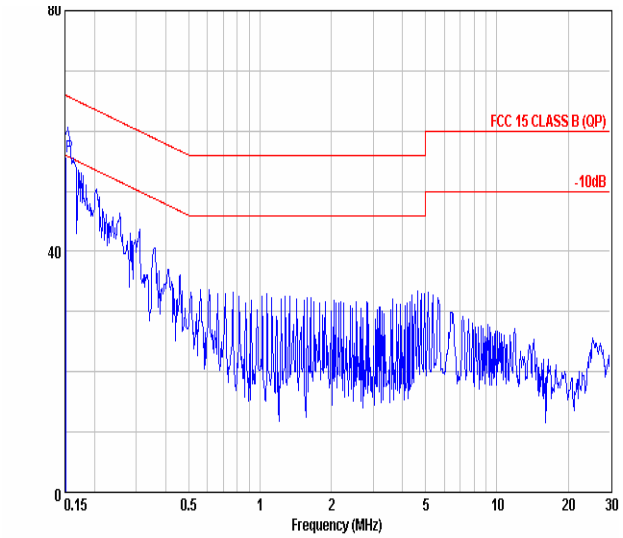
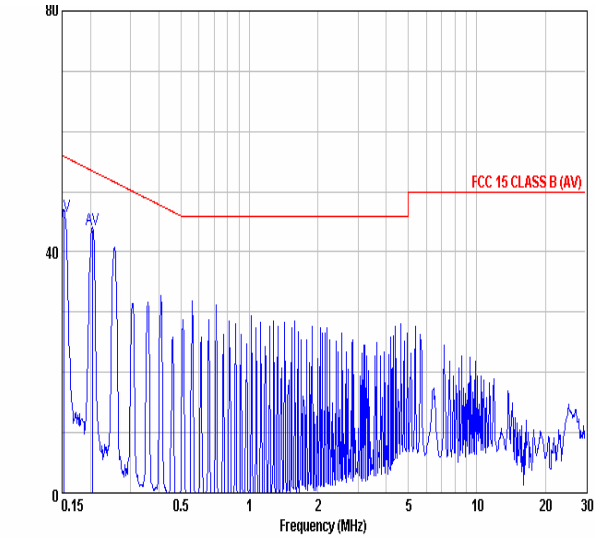


Site : Audix ACI(Conducted Emission)
Condition : EN55022 CLASS B (AV) ESH2-Z5-05.04.13 LINE

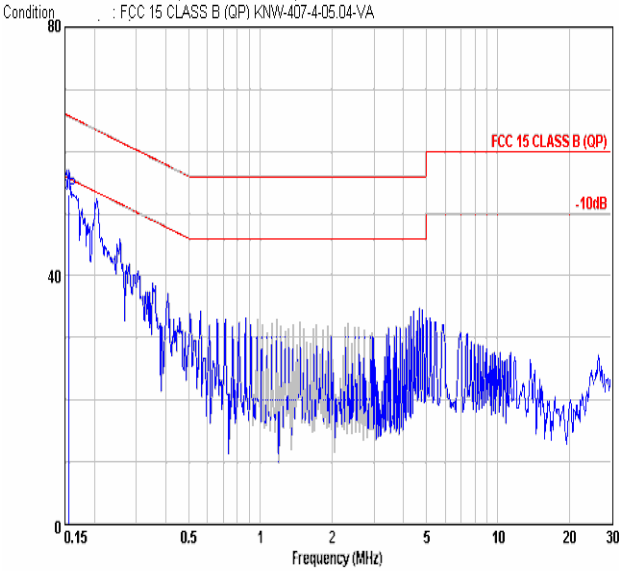
3.5.1.2. FCC CLASS B @ full load report



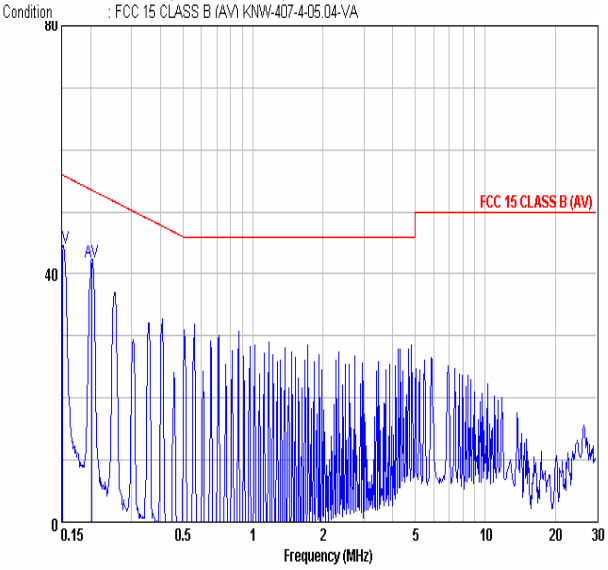
Site : Audix ACI(Conducted Emission)
Condition : FCC 15 CLASS B (QP) KNW-407-4-05.04-VA



Site : Audix ACI(Conducted Emission)
Condition : FCC 15 CLASS B (AV) KNW-407-4-05.04-VA



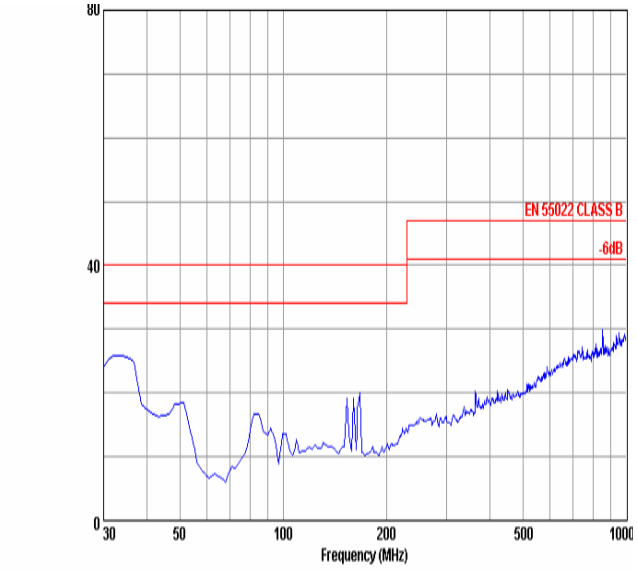
Site : Audix ACI(Conducted Emission)
Condition : FCC 15 CLASS B (QP) KNW-407-4-05.04-VB



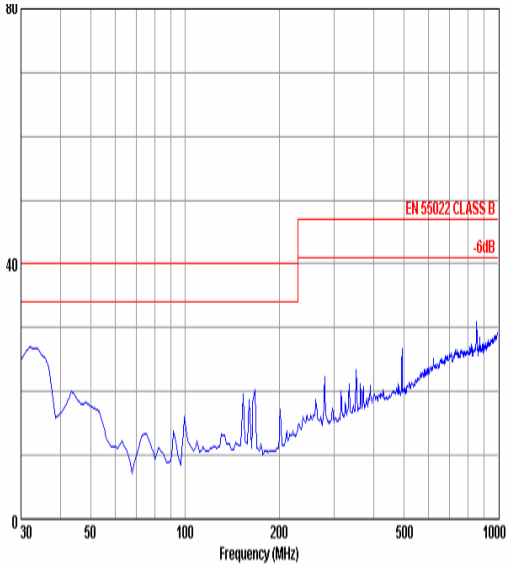
Site : Audix ACI(Conducted Emission)
Condition : FCC 15 CLASS B (AV) KNW-407-4-05.04-VB

3.5.2. Radiation Test

3.5.2.1. EN55022 CLASS B @ full load report

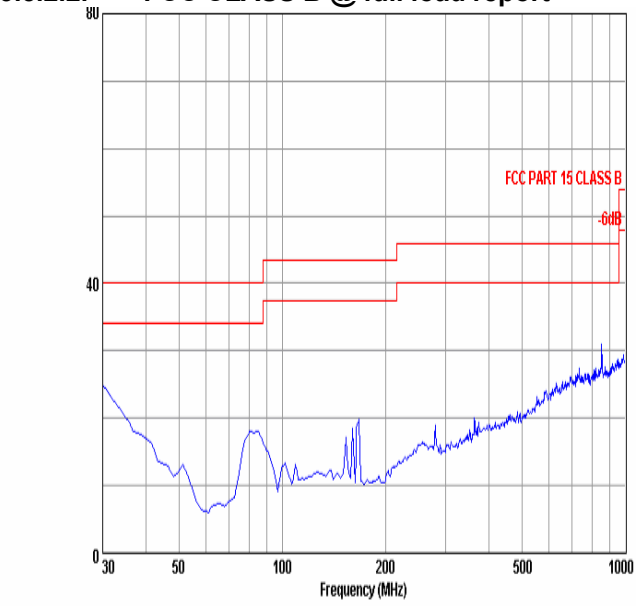


Site : Chamber 3
Condition : EN 55022 CLASS B 3m HORIZONTAL

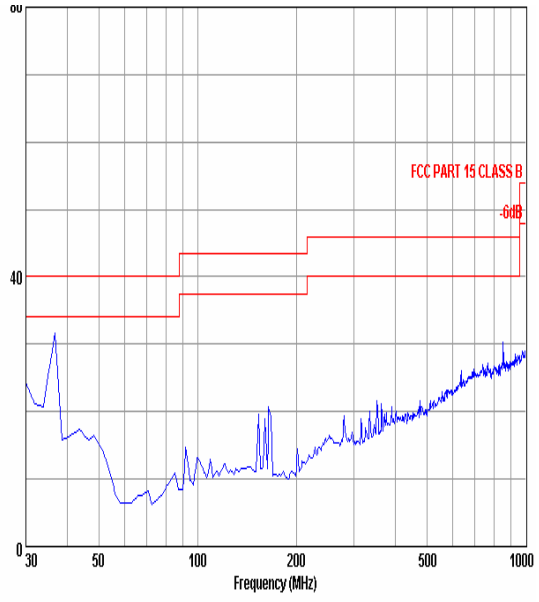


Site : Chamber 3
Condition : EN 55022 CLASS B 3m VERTICAL

3.5.2.2. FCC CLASS B @ full load report



Site : Chamber 3
Condition : FCC PART 15 CLASS B 3m HORIZONTAL



Site : Chamber 3
Condition : FCC PART 15 CLASS B 3m VERTICAL

3.6. ESD Test

Demo board passed 15KV air discharge and 8KV contact discharge ESD test.
Test condition listed as below.
1, Input: 230V/50Hz
2, Load: Full load
3, Air Discharge: 15KV
4, Contact Discharge: 8KV

Table 20: ESD test result

Location	Points	Kind: A-Air; C-Contact
Around the EUT (HCP)	4	C
Around the EUT (VCP)	4	C
Slots	4	A
AC Input	2	A
DC Output	2	A

3.7. Lighting Test

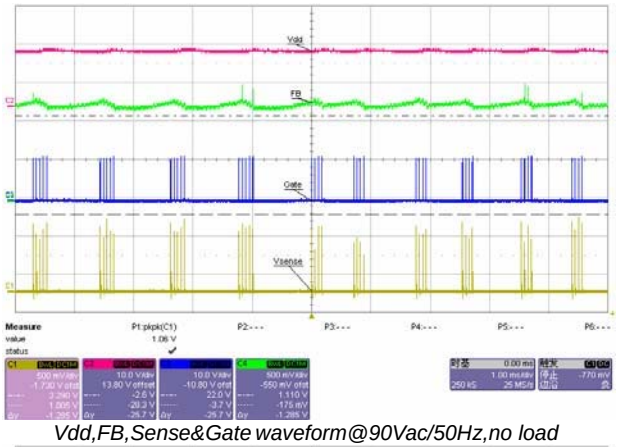
Demo board passed 4KV Lighting test.
Test condition listed as below
1, Input: 230V/50Hz
2, Load: Full load
3, Repetition: 5 times per test
4, Interval: 60 seconds

Table 31: Lighting test result

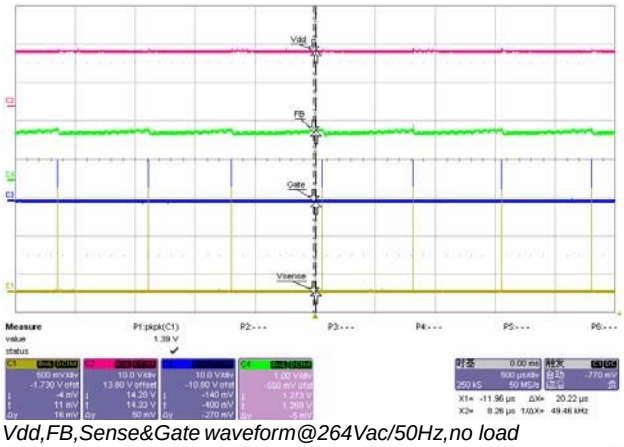
Phase	Conductor		
	L1-PE	L2-PE	L1-L2
0°	4KV	4KV	4KV
90°	4KV	4KV	4KV
180°	4KV	4KV	4KV
270°	4KV	4KV	4KV

4. Other Waveform

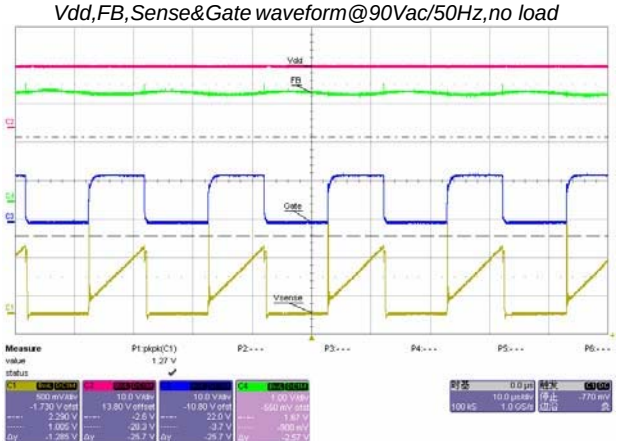
4.1 Vdd, FB, Sense& Gate waveform at no load/full load.



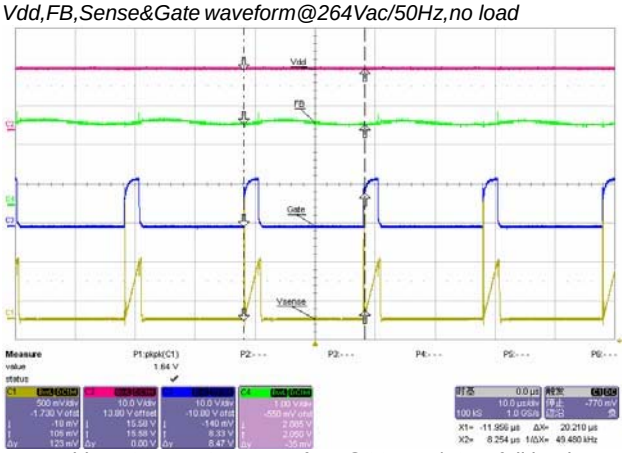
Vdd,FB,Sense&Gate waveform@90Vac/50Hz,no load



Vdd,FB,Sense&Gate waveform@264Vac/50Hz,no load

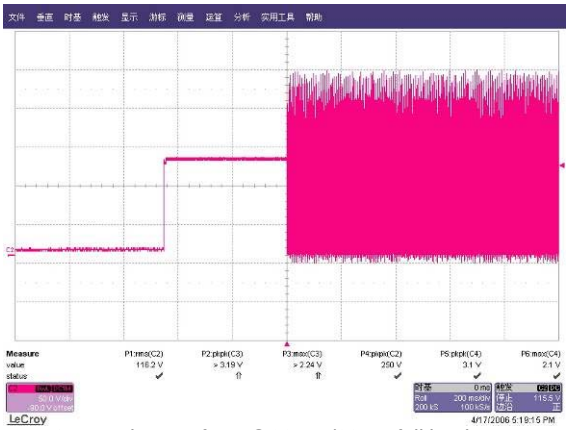


Vdd,FB,Sense&Gate waveform@90Vac/50Hz,full load

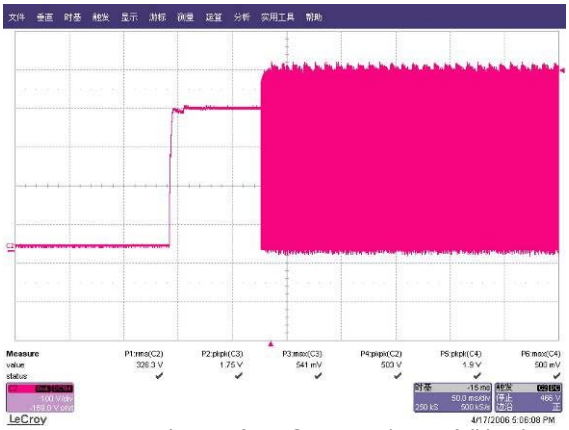


Vdd,FB,Sense&Gate waveform@264Vac/50Hz,full load

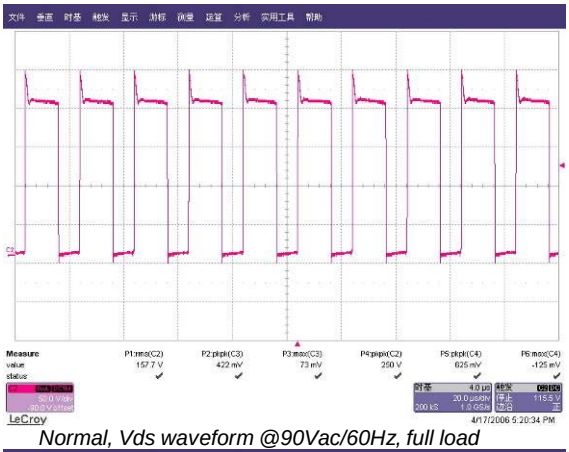
4.2 MOSFET V_{DS} waveform@90Vac/264Vac,start/normal/output short



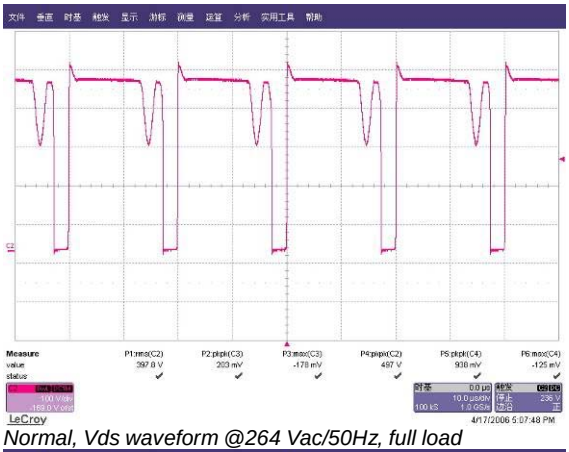
Start, Vds waveform @90Vac/60Hz, full load



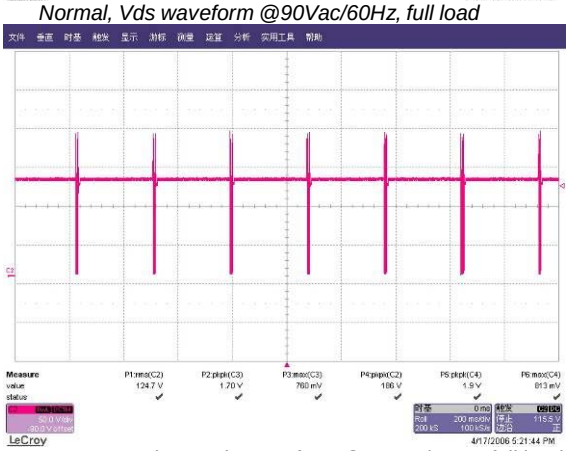
Start, Vds waveform @264 Vac/50Hz, full load



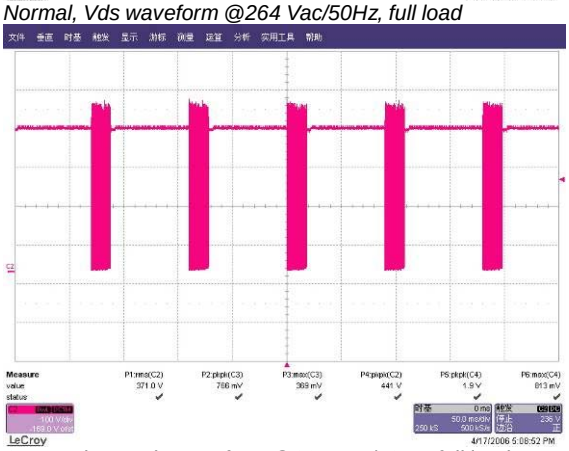
Normal, Vds waveform @90Vac/60Hz, full load



Normal, Vds waveform @264 Vac/50Hz, full load



Output short, Vds waveform @90Vac/60Hz, full load



Output short, Vds waveform @264 Vac/50Hz, full load

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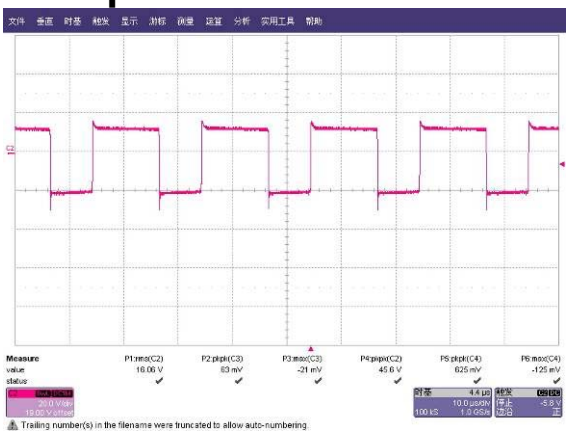
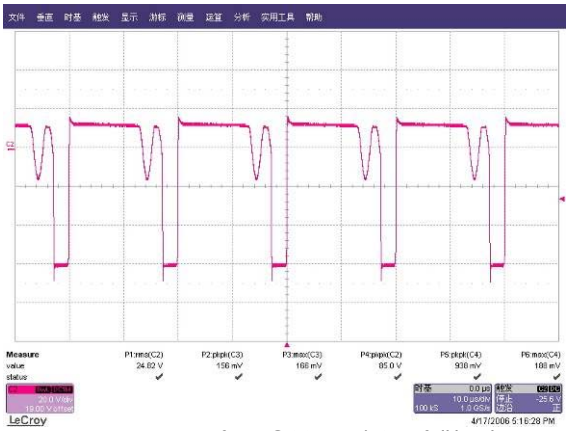
4.3 Output rectifier VAK waveform at full load



VAK waveform @90Vac/60Hz,full load



VAK waveform @264Vac/50Hz,full load