

DL7023M

12W Adapter Module Using DL7023

Subject
DL7023

Demo Board Manual

Board Model: DL7023M

Doc. No.:



Key features:

- Low component count
- Standby Power<0.3W
- Audio noise free operation
- OCP with line compensation

Revision History

Revise Date	Version	Reason/Issue
2007-09-26	A3	Whole manual format revised

This demo board is compatible for DL7023

} device. All data in this manual is test with DL7023

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

1.6. Dielectric withstand (Hi-pot) test

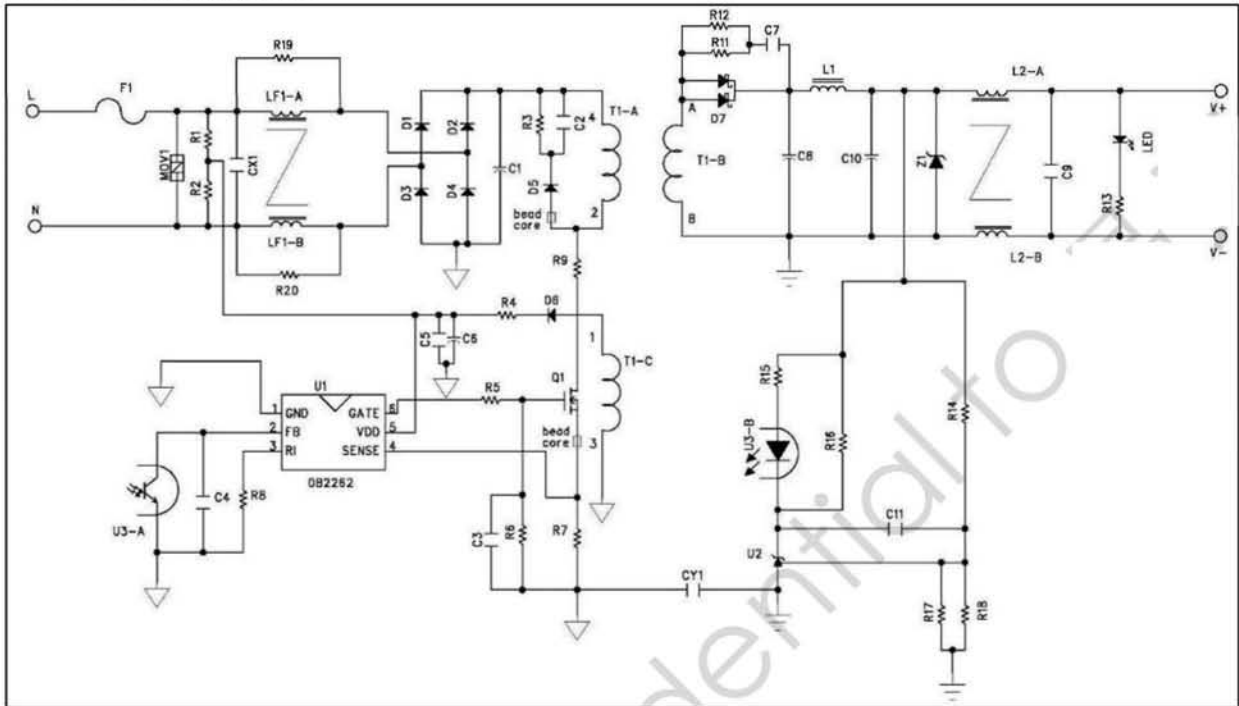
- Input to Output 3000Vac 1 minute.

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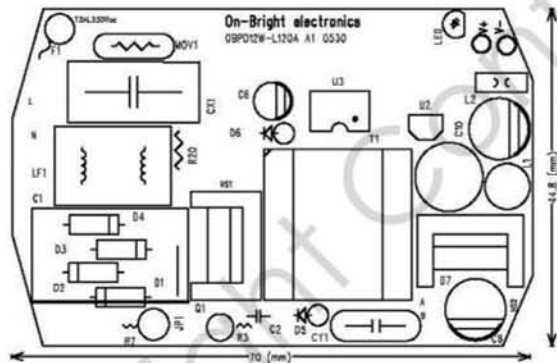
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2. Adaptor Module Information

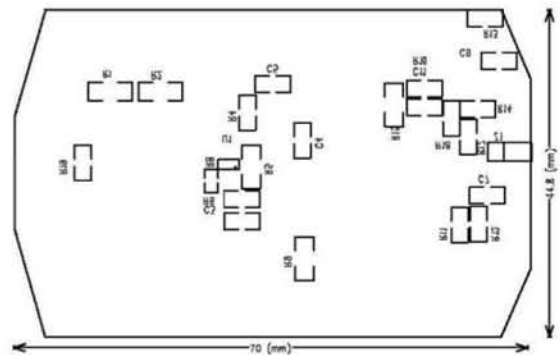
2.1. Schematic



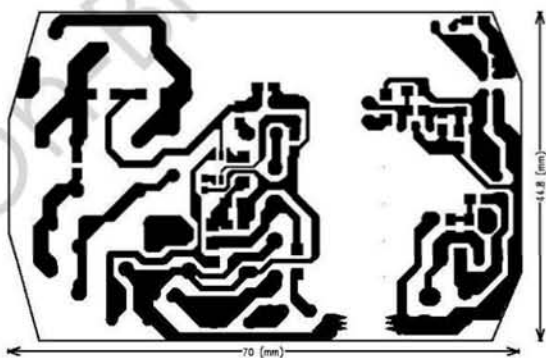
2.2. PCB Garber File



Top silk layer



Bottom silk layer



Bottom copper path

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2.3. 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°C 5*11mm	1	
34	C7	SMD C.C 102P 100V 0805	1	
35	C8	C.E 470uF/16V Low ESR 105°C D8	1	
36	C10	C.E 220uF/16V Low ESR 105°C D8	1	
37	C11	SMD C.C 472P 25V 0805	1	
38	U1	SMD PWM controller OB2262 SOT23-6	1	
39	U2	Shunt regulator TL431 ±1%	1	
40	U3	Photocoupler PC817C	1	
41	T1	Transformer EF20 OBPD12W-L120A	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	OBPD12W-L120A A1 0530	1	
50	LABEL	LABEL 100uM PVC+25uM OPP MODEL:OBPD15W-L120A	1	
51	V+, V-	Cable AWG18# 1200mm	1	

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2.4. Transformer Design

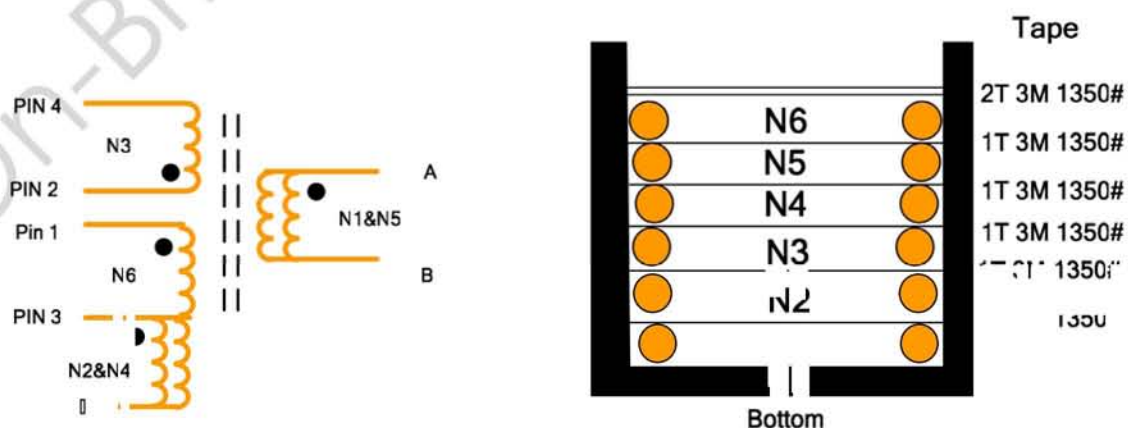
2.4.1. Specification

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

2.4.2. 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		

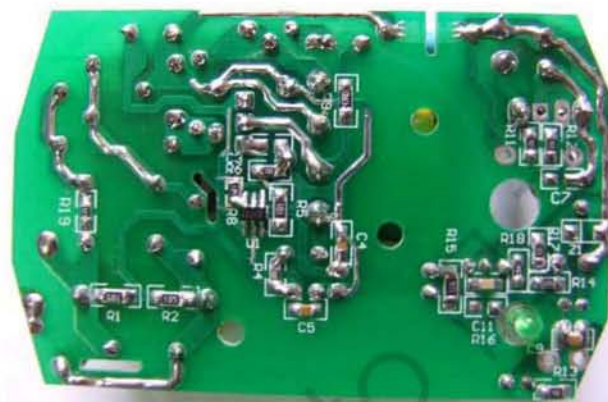
2.4.3. Configuration



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2.5. Adaptor Module Snapshot



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3. Performance Evaluation

This session presents the test results of 12W-L120A module up to date. Results on inrush current and leakage current test data are not included and will be added when they become available.

Overall, the module meets design specifications.

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	0.45A Max.	0.282A
Standby power (264Vac;no LED)	<0.3W	0.197W
Standby power (264Vac,with LED)	<0.3W	0.242W (LED current 4mA)
Efficiency	>75%	80%
2. Output characteristic		
Line regulation& Load regulation	±1% ±5%	0.008% 0.041%
Ripple & noise	100mV Max	38mV
Over shoot & Under shoot	600mV Max	445mV
Dynamic load voltage	±600mV Max	317mV
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		1.18-1.25A
Short Circuit protection		Pass
5. Brownout/Brownout recovery		
		Pass

Test Equipments

Item	Vender	Module
AC Source	APE	AFR-105W
Digital Power Meter	Prodigit	4012A
Electrical Load	Prodigit	3310C
Oscilloscope	LeCroy	WS424

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	I _{rms} (A)	P _{in} (W)	V _o (V)	I _o (A)	η	Specification	Test result
90V/63Hz	0.282	15.30	12.202	1	80%	>75%	Pass
115V/60Hz	0.237	15.03	12.202	1	81%		
230V/50Hz	0.161	15.18	12.202	1	80%		
264V/47Hz	0.149	15.11	12.202	1	81%		

Table 2 : Standby power at no load

Input voltage	V _o (V)	Input Pin(W)	Specification	Test result
90V/63Hz	12.202	0.104	<0.3W	Pass
115V/60Hz	12.202	0.107		
240V/50Hz	12.202	0.169		
264V/47Hz	12.202	0.197		

Table 3 : Standby power at no load with output LED

Input voltage	V _o (V)	Input Pin(W)	Specification	Test result
90V/63Hz	12.202	0.174	<0.3W	Pass
115V/60Hz	12.202	0.167		
240V/50Hz	12.202	0.221		
264V/47Hz	12.202	0.242		

Note: 1. 264VAC/50HZ measurement data is only for RD reference.
2. All data was measured at PCB end if not otherwise noted.

3.2. Output Characteristics

3.2.1. Line Regulation & Load Regulation

Table 4: Line Regulation & Load Regulation

Input voltage	No load	Half load	Full load	Specification	Test result
90Vac/60HZ	12.197	12.189	12.182	<1%	Pass
115Vac/60HZ	12.198	12.190	12.182		
132Vac/60HZ	12.197	12.189	12.182		
180Vac/50HZ	12.197	12.190	12.182		
230Vac/50HZ	12.198	12.190	12.182		
264Vac/50HZ	12.198	12.190	12.182		
Line Regulation	0.008%				
Load Regulation	0.042%			<5%	Pass

Note: All data was measured at PCB end.

3.2.2. Ripple & Noise

Table 5 : Ripple & Noise measure results

Input voltage	No load	Full load	Spec.	Test result	Remark
90Vac/60HZ	26.9 mV	25.0 mV	100mV	Pass	
115Vac/60HZ	29.4 mV	19.4 mV		Pass	
230Vac/50HZ	35.6 mV	18.1 mV		Pass	
264Vac/50HZ	38.1 mV	17.5 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.

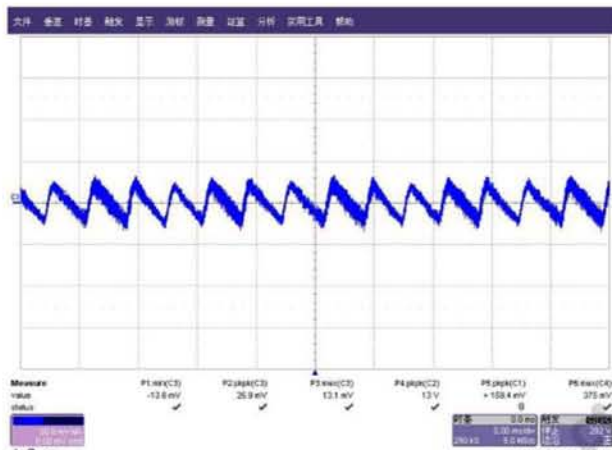


Figure 1: Measured ripple & noise waveform @90Vac/60HZ, no load

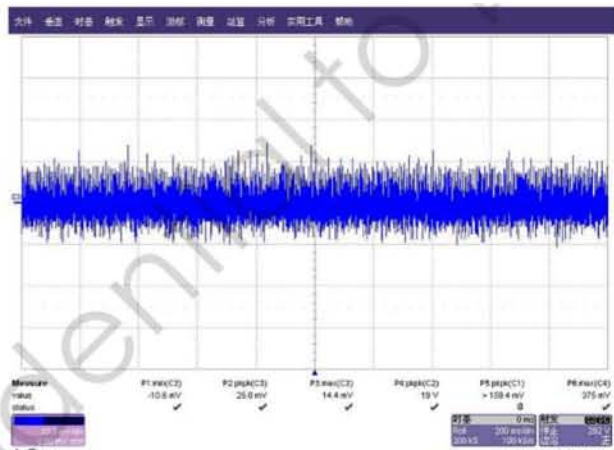


Figure 2: Measured ripple & noise waveform @90Vac/60HZ, full load

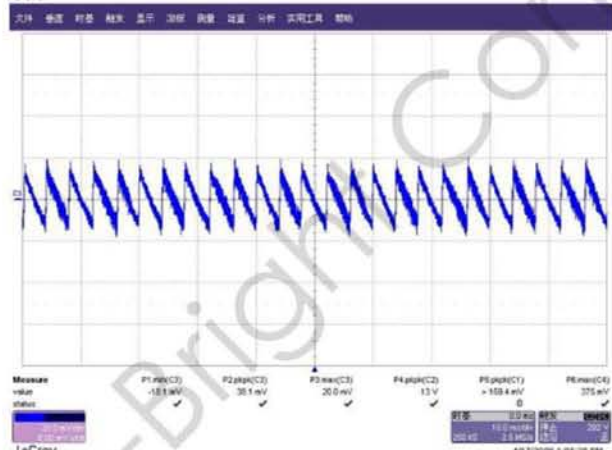


Figure 3: Measured ripple & noise waveform @264Vac/50HZ, no load

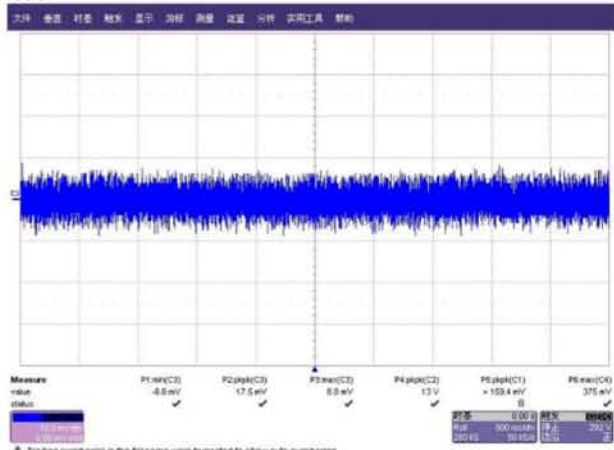


Figure 4: Measured ripple & noise waveform @264Vac/50HZ, full load

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3.2.3.Over shoot & Under shoot

Over shoot/under shoot were measured under below conditions.

1. AC input switches ON for over shoot and OFF for under shoot.
2. Input voltage ranges from 90Vac/60HZ~264Vac/50HZ.

Measurement data is listed in below table.

Table 6 : Over shoot/under shoot measurement results

Input Voltage	load	Meas. Data	Spec.	Test result	Remark
90V/60HZ	Full load	over shoot	282.6mV	600mV Max	Pass
		under shoot	0mV		Pass
	No load	over shoot	445mV		Pass
		under shoot	0mV		Pass
264V/50HZ	Full load	over shoot	285.3mV		Pass
		under shoot	0mV		Pass
	No load	over shoot	378mV		Pass
		under shoot	0mV		Pass

Note: All data was measured at PCB end.

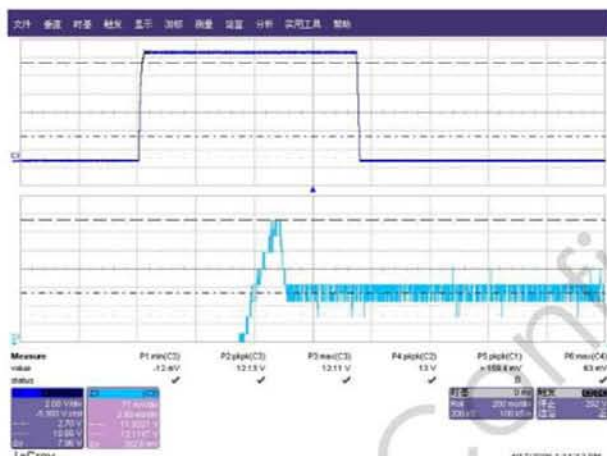


Figure 5: Measured overshoot waveform@90Vac/60HZ, full load

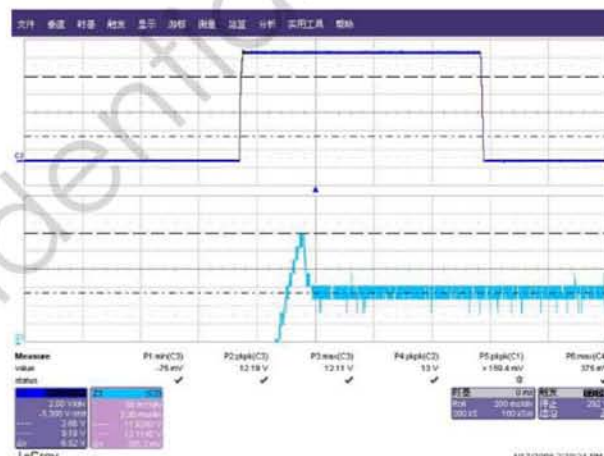


Figure 6: Measured overshoot waveform@264Vac/50HZ, full load

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.

Measurement was taken at a 1.2m/18AWG DC cord end with data listed in below Table .

Table 7 : Output voltage under dynamic test

Input voltage	Output voltage	Test Specifications	Test result	Remark
264V/50HZ	12V±317mV	12V±600mV	Pass	
230V/50HZ	12V±317mV		Pass	
115V/60HZ	12V±317mV		Pass	
90V/60HZ	12V±317mV		Pass	

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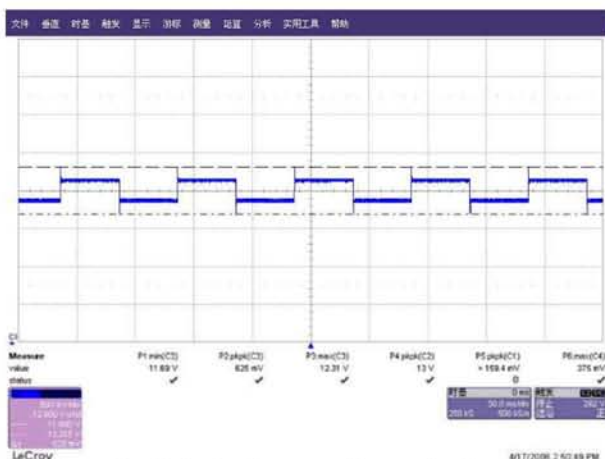


Figure 7 : Output voltage waveform under Dynamic test @264Vac/50Hz,full load

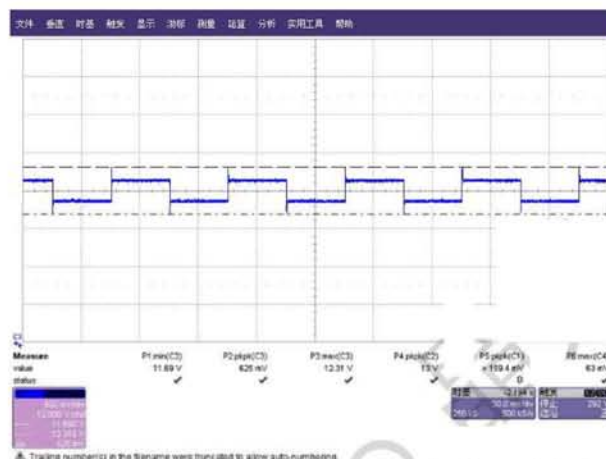


Figure 8 : Output voltage waveform under Dynamic test @90Vac/60Hz with full load

3.2.5. Time Sequence

Time sequence parameters were measured with DSO.

Table 8 : 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

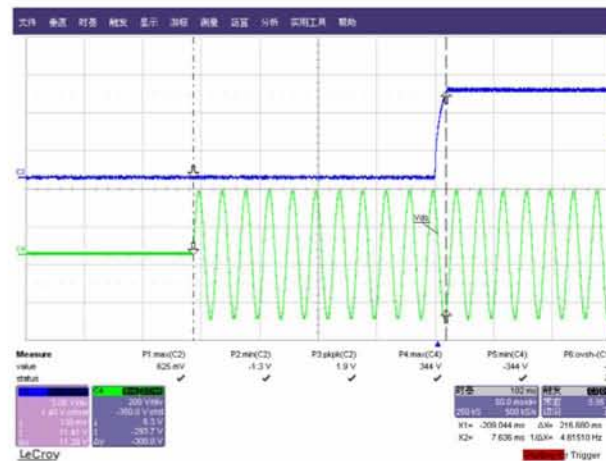


Figure 10 : Turn on delay time measured waveform@240Vac/50Hz,full load

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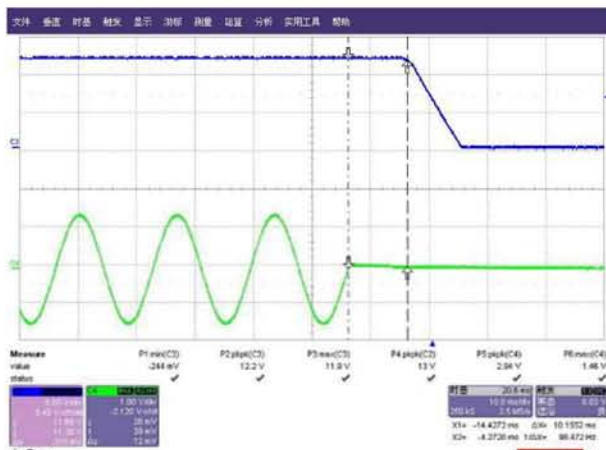


Figure 11: Hold up time measured waveform@100Vac/60HZ,full load



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

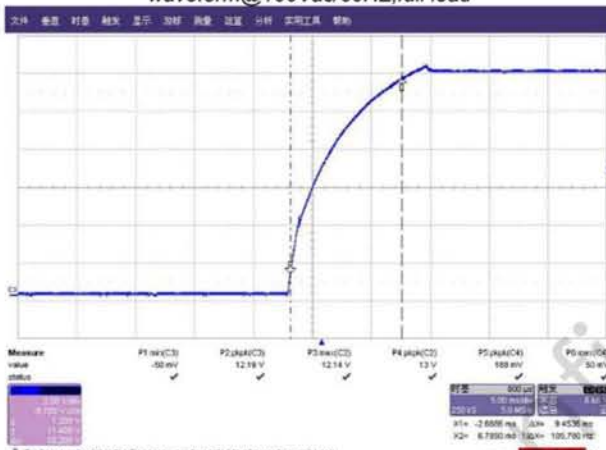


Figure 13: Rise time measured waveform@240Vac/50HZ,full load



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



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

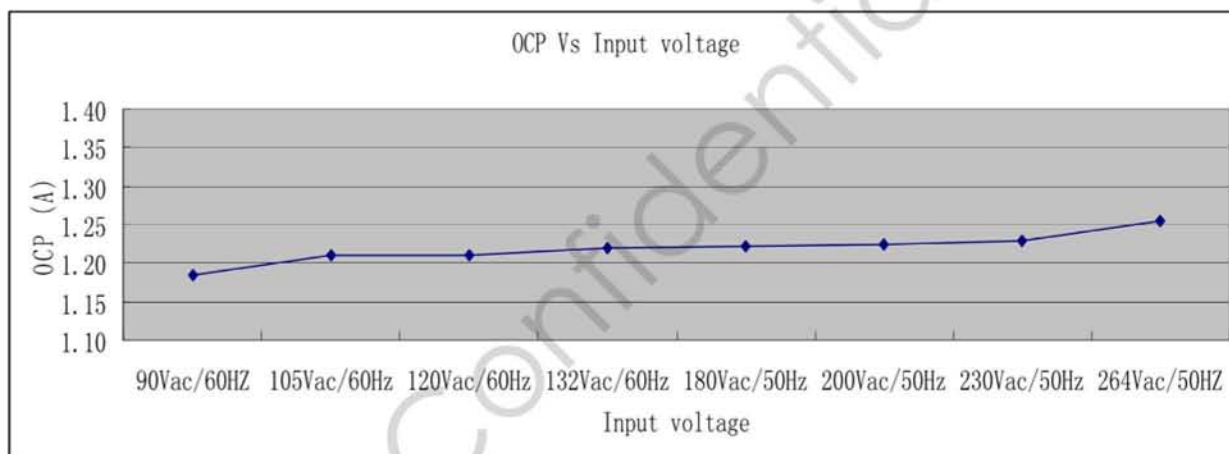
3.3. Protections

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 9 : OCP value vs. input voltage

Input voltage	Input current	OCP	Remark
90Vac/60HZ	0.327A	1.185A	1.185times of rated output current
105Vac/60Hz	0.298A	1.211A	1.211times of rated output current
120Vac/60Hz	0.272A	1.211A	1.211times of rated output current
132Vac/60Hz	0.254A	1.219A	1.219imes of rated output current
180Vac/50Hz	0.208A	1.221A	1.221times of rated output current
200Vac/50Hz	0.193A	1.225A	1.225times of rated output current
230Vac/50Hz	0.189A	1.230A	1.230times of rated output current
264Vac/50HZ	0.181A	1.254A	1.254times of rated output current



OCP curve

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.

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Table 10 : Brownout/Brownout recovery test results

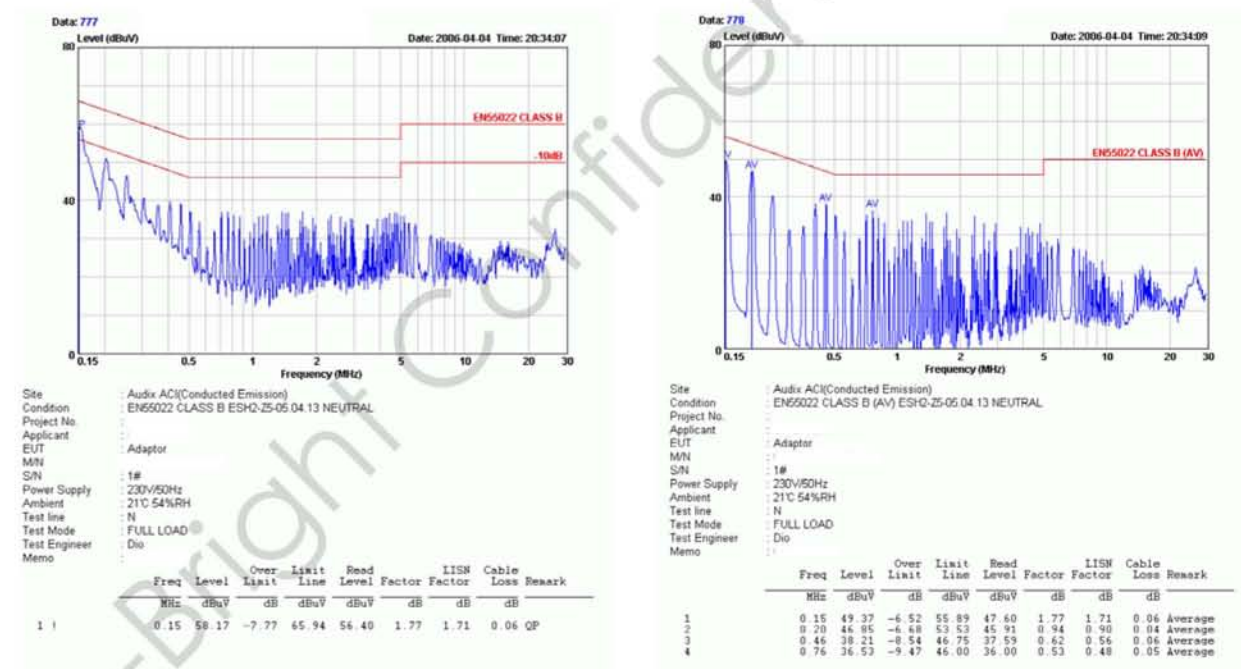
Brownout test		Brownout recovery test	
Input voltage	Input power (90Vac to 0Vac)	Input voltage	Input power (0Vac to 90Vac)
90Vac/60HZ	15.27W	0Vac~45Vac/60HZ	0
85Vac/60HZ	15.34W	50Vac/60HZ	0
80Vac/60HZ	15.45W	55Vac/60HZ	0
75Vac/60HZ	15.61W	60Vac/60HZ	0
70Vac/60HZ	15.81W	65Vac/60HZ	0W
65Vac/60HZ	0W	70Vac/60HZ	15.81W
60Vac/60HZ	0	75Vac/60HZ	15.61W
55Vac/60HZ	0	80Vac/60HZ	15.45W
50Vac/60HZ	0	85Vac/60HZ	15.34W
0Vac~45Vac/60HZ	0	90Vac/60HZ	15.27W

3.5. EMI Test

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

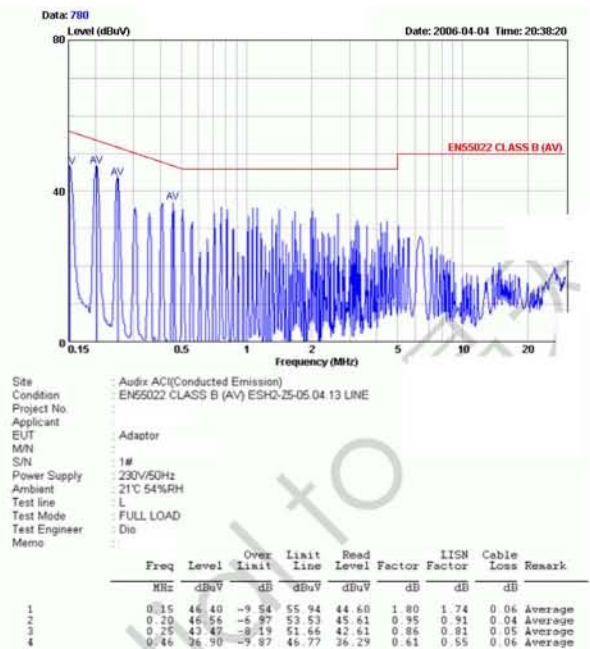
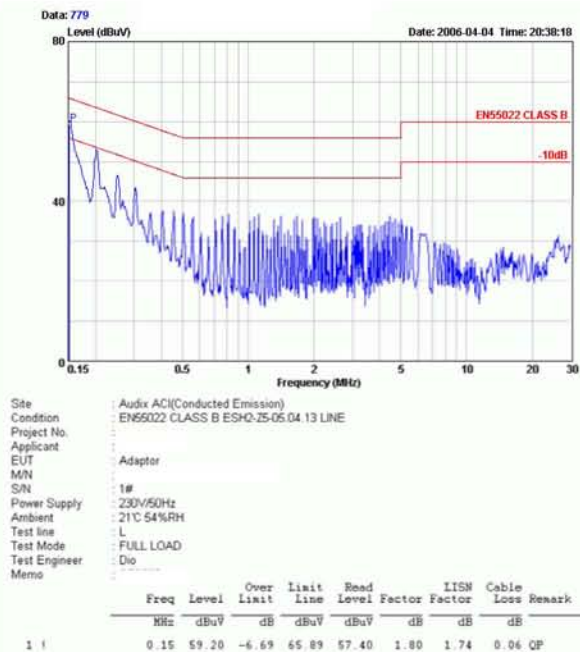
3.5.1. Conduct testa

3.5.1.1. EN55022 CLASS B @ full load report

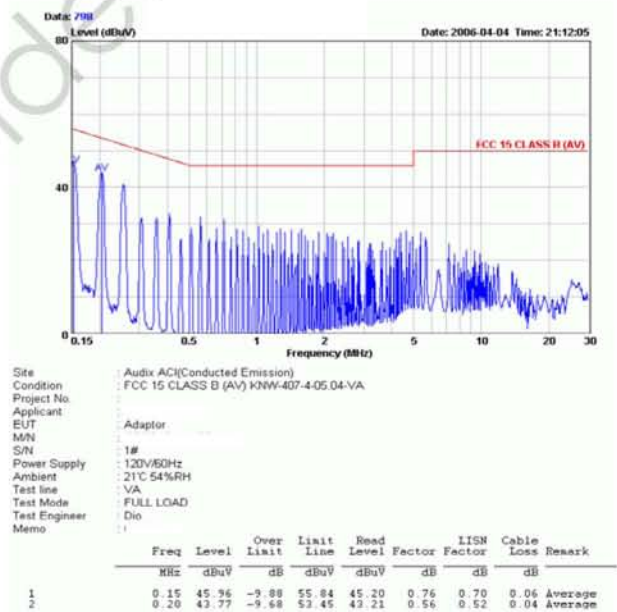
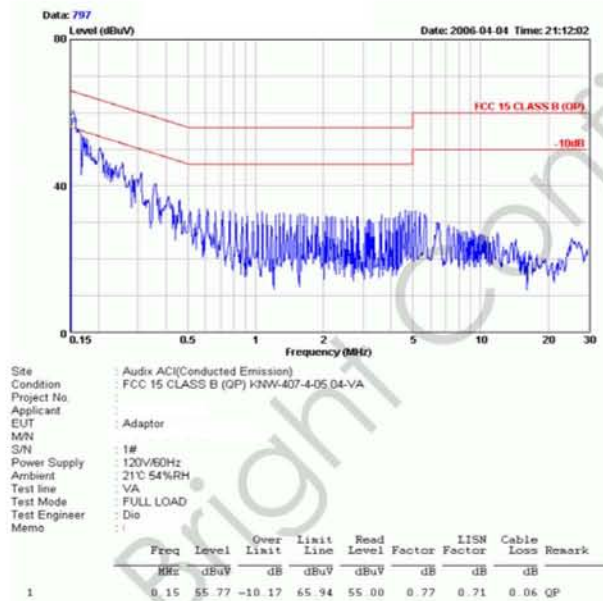


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12W Adapter Module Using DL7023

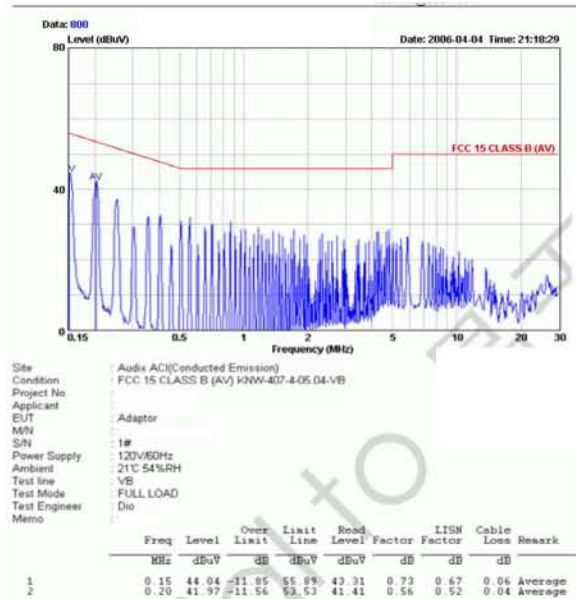
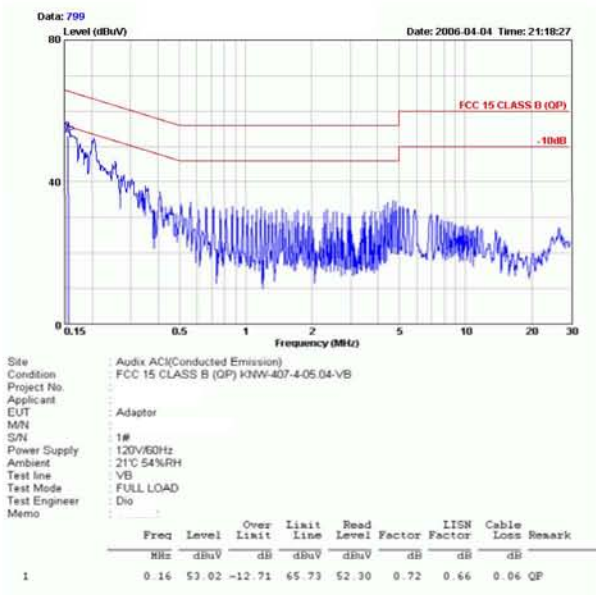


3.5.1.2. FCC CLASS B @ full load report



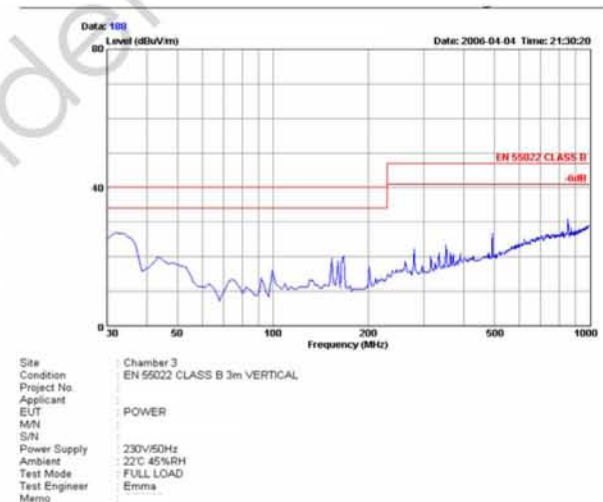
DL7023M

12W Adapter Module Using DL7023

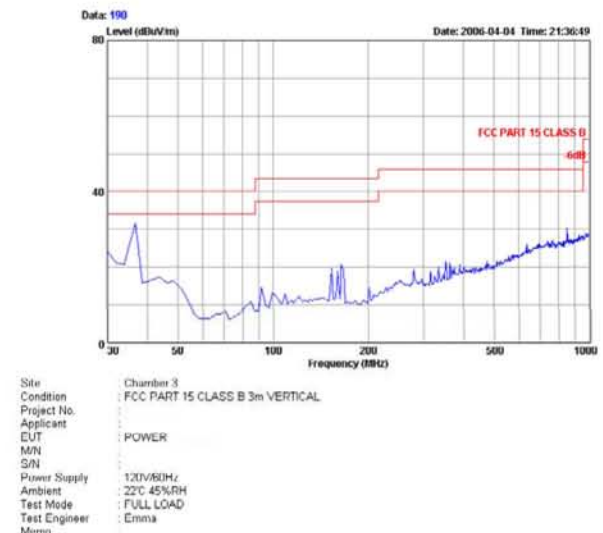
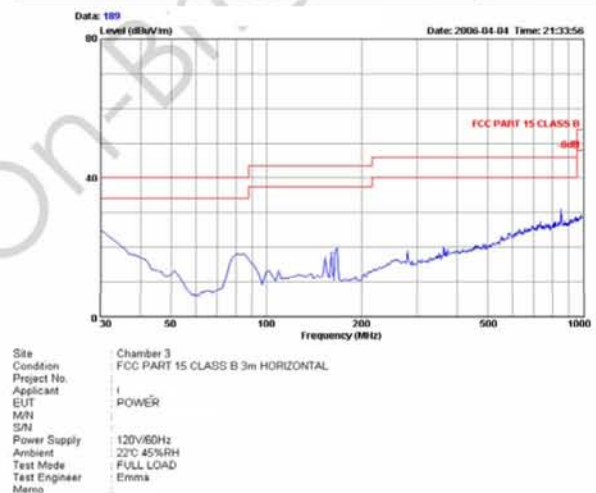


3.5.2. Radiation Test

3.5.2.1. EN55022 CLASS B @ full load report



3.5.2.2. FCC CLASS B @ full load report



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 11: 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

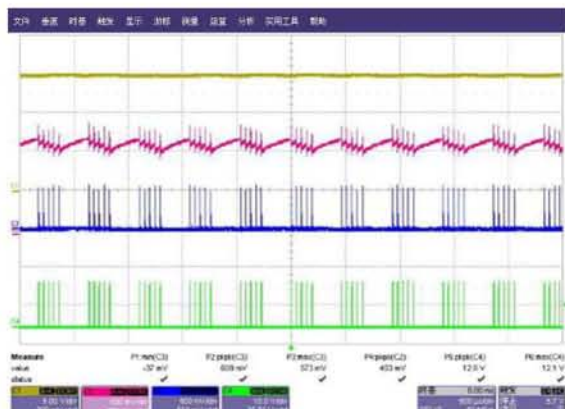
- 1, Input: 230V/50Hz
- 2, Load: Full load
- 3, Repetition: 5 times per test
- 4, Interval: 60 seconds

Table 12: 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

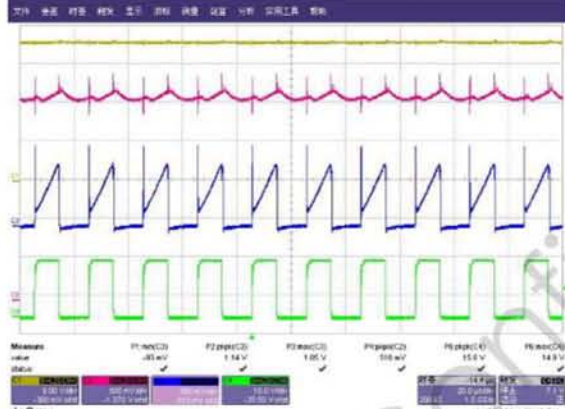
4.1 Vdd, FB, Sense & Gate waveform at no load/full load.



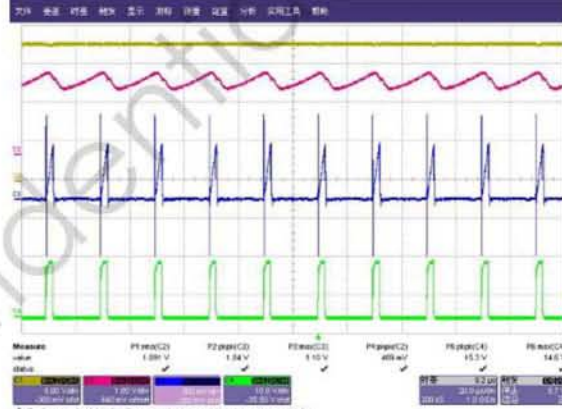
Vdd,FB,Sense&Gate waveform@90Vac/50Hz,no load



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

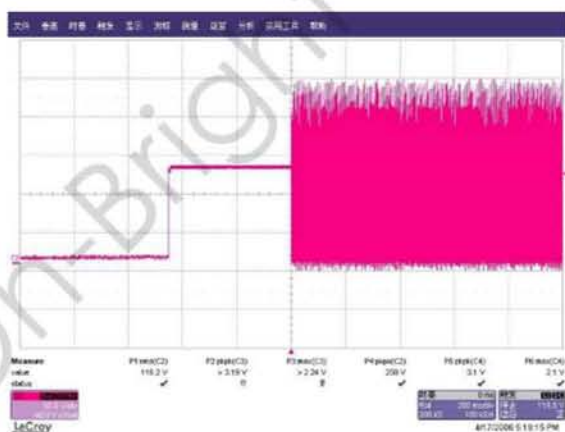


Vdd,FB,Sense&Gate waveform@90Vac/50Hz,full load

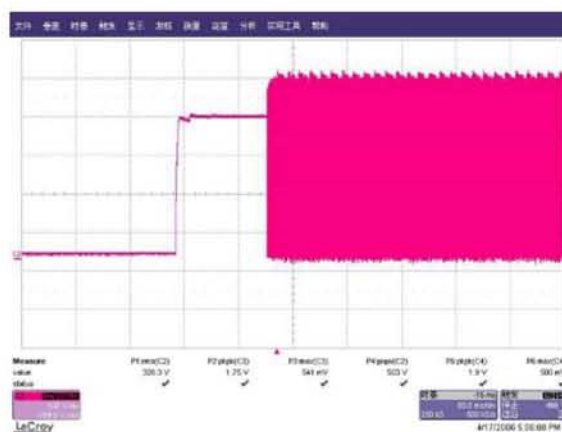


Vdd,FB,Sense&Gate waveform@264Vac/50Hz,full load

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



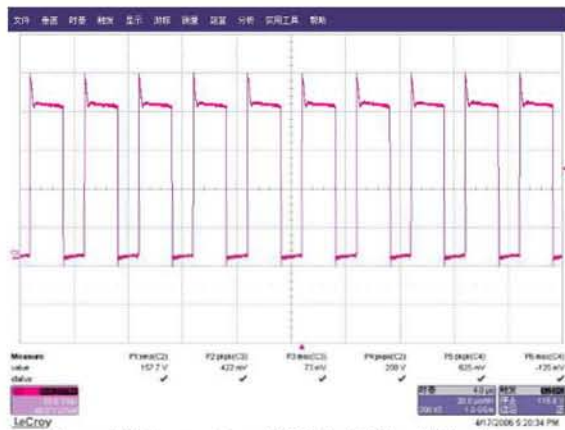
Start, Vds waveform @90Vac/60Hz, full load



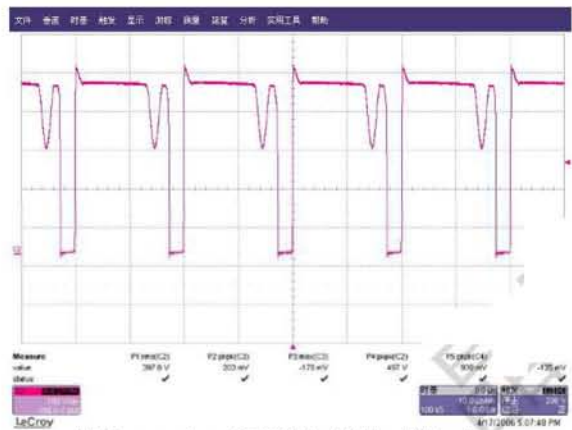
Start, Vds waveform @264 Vac/50Hz, full load

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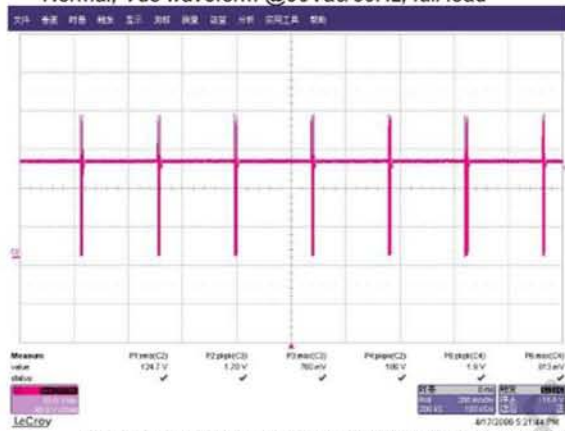
12W Adapter Module Using DL7023



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



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

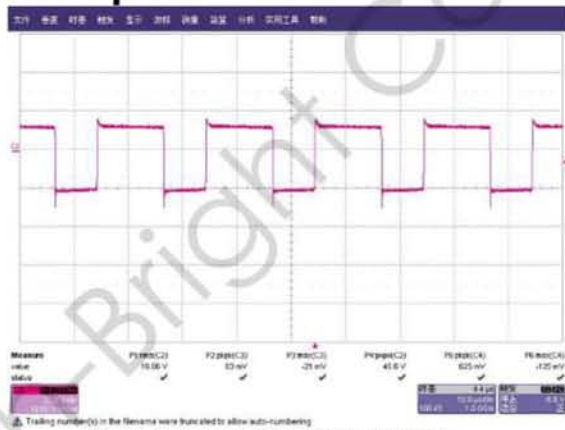


Output short, Vds waveform @90Vac/60Hz, full load

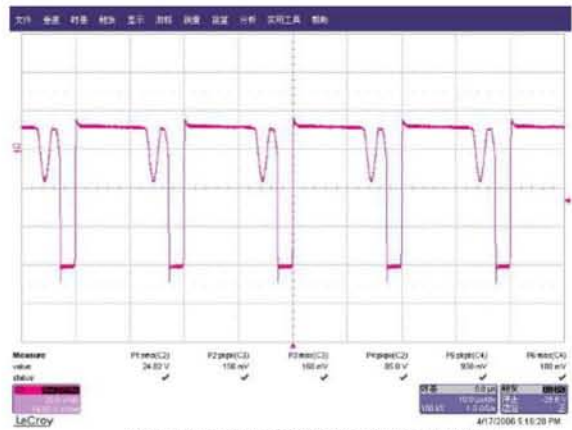


Output short, Vds waveform @264 Vac/50Hz, full load

4.3 Output rectifier VAK waveform at full load



VAK waveform @90Vac/60Hz, full load



VAK waveform @264Vac/50Hz, full load