

Design Example Report

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标题	基于 PN8313 的 3W 灯丝灯应用方案 150V20mA
规格	输入电压: 176~264V 全电压 输出功率: 3W 输出电压: 150V 输出电流: 21mA±5%
应用范围	照明类电源产品
文件编号	DER-8313-14-022
编写时间	2014-3-27
编写部门	FAE
版本号	V1.0

特性概述:

- 双面板设计, 双面元器件, 面积: 直径 20mm;
- 输入电压: 176~264Vac 电压范围;
- 输出功率: ≤3W;
- 拥有 LED 灯开路、短路、过温保护等功能;
- 拥有电流采样电阻短路保护;
- 3W 输出平均效率: ≥88%;

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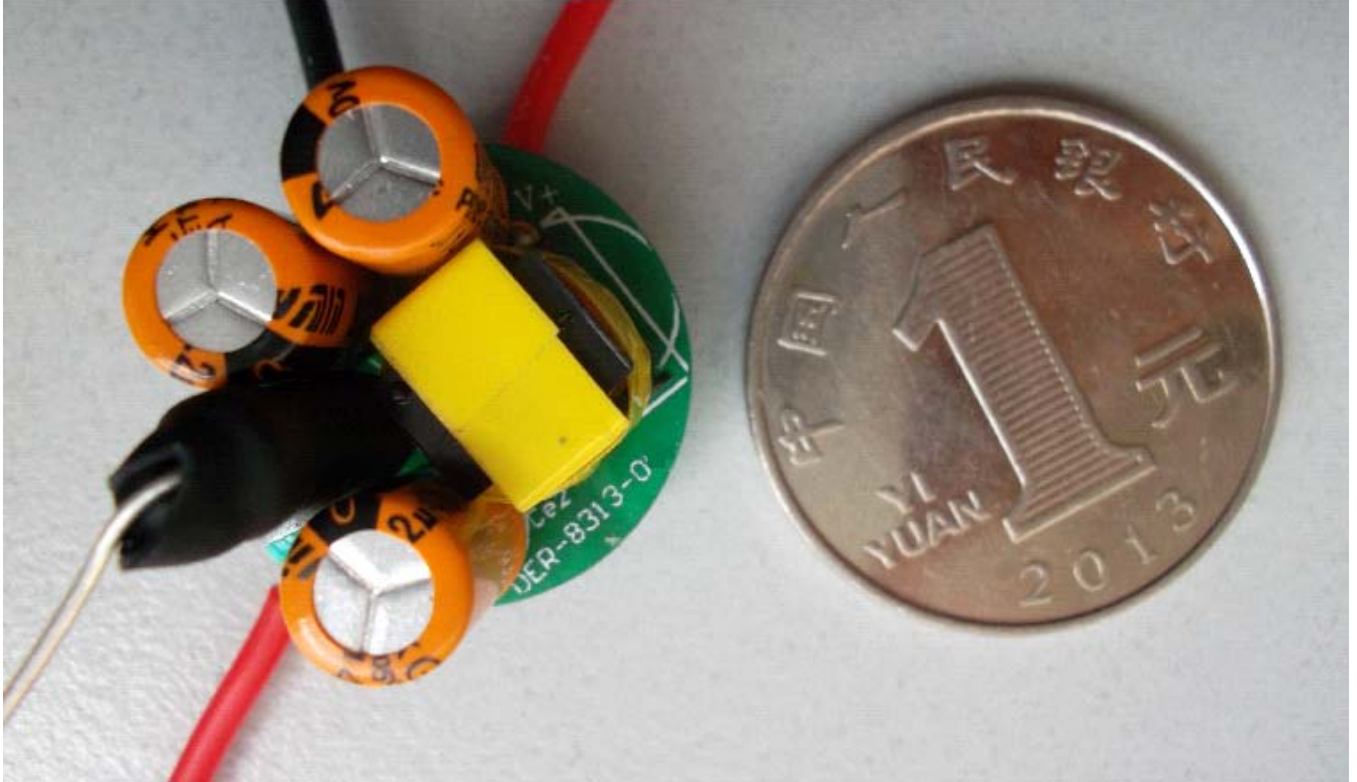
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1. 电源介绍

该报告提供了一种基于 PN8313 150V/20mA 单路输出开关电源。系统工作在准谐振模式来实现高效率 and 低 EMI 的应用。芯片集成度高, BOM 器件个数少, 具有 LED 灯开路、短路、过温保护等功能;

该报告包含了原理图, 电源输入输出规格, BOM 表, 变压器参数和 PCB LAYOUT 等数据表单。

以下为该电源的实物图片:



2. 电源规格明细

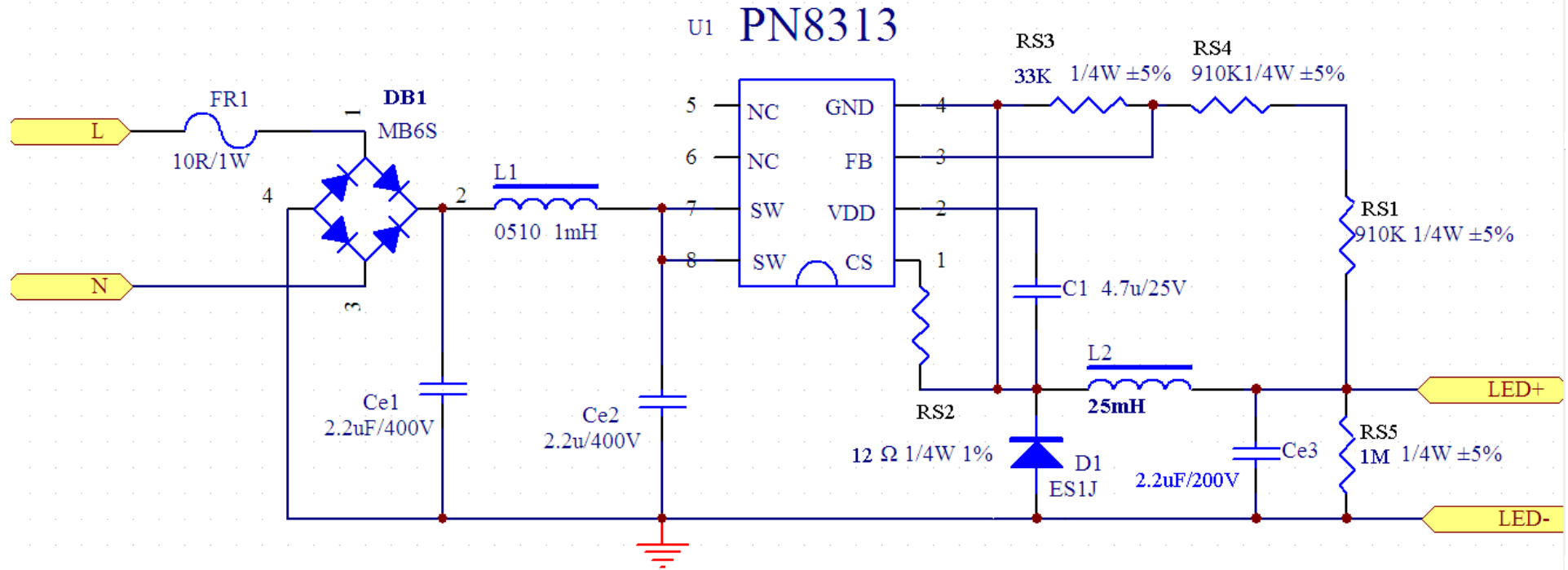
最大输入输出电气特性:

项目描述	标号	Min	Typ	Max	Unit	备注
输入电压	Vin	176	230	264	V	50Hz
输出电压	Vout			150	V	
输出电流	Iout	19.95	21	22.05	mA	
输出功率	Pout		3		W	
效率	η	88			%	CV=150V
工作环境	Tamb	0	25	80	°C	外部环境

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3. 电源原理图:



Note: 具体参数以 BOM 为准

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4. 电路描述

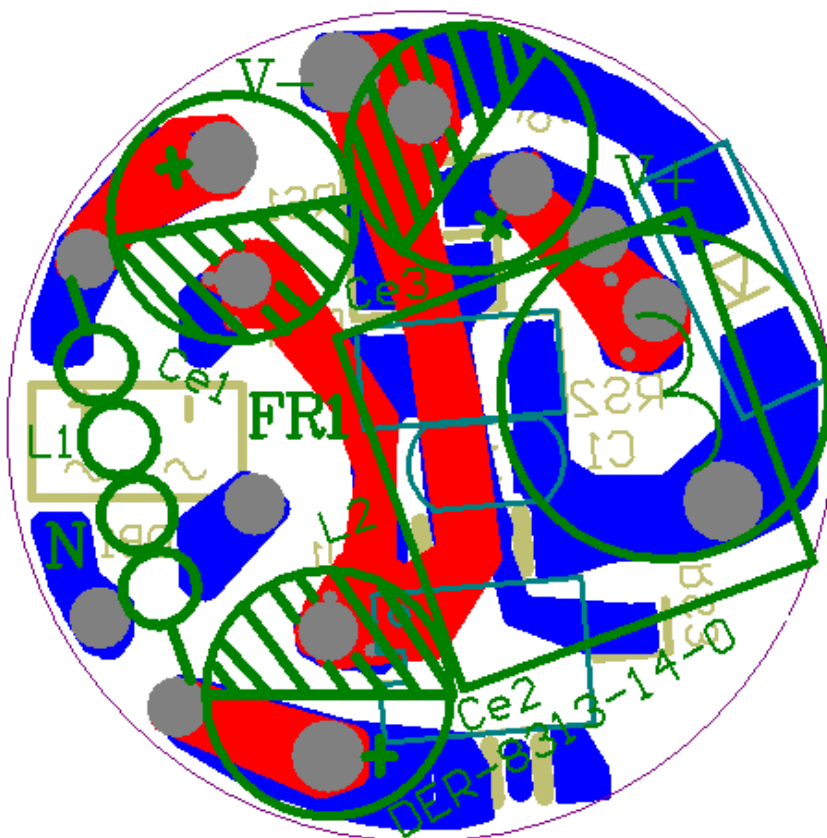
电路图中RS1、RS3, RS3为ZCS分压电阻，可通过辅助绕组采样出的电压，LED开路时，输出电压会很高，调整RS1、RS3的比例，可调节LED开路时的输出电压，ZCS过电压保护点约为3V；等比例调节RS1、RS3可改善Io的线性调整率；

当PN8313本体温度太高时，其内置的OTP保护功能会及时启动，以保护整个系统；

该驱动具有LED短路、开路保护功能，当LED发生短路或开路时，系统将进入打嗝模式直到短路状态消除。

5. PCB LAYOUT

PCB为普通双面板工艺，双面元器件，铜厚1OZ，基材为FR-4。PCB直径20mm，厚1mm。污染等级符合CLASS2。



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6. Bill of Materials

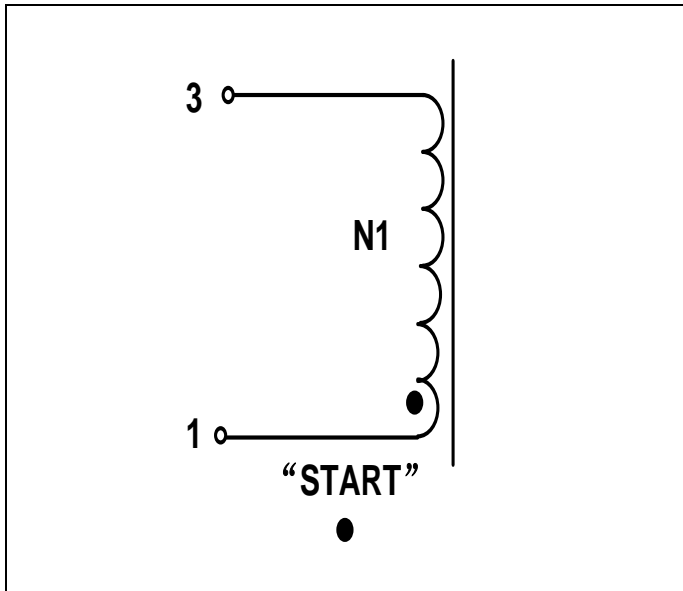
序号	元件标号	元件名称	元件型号	封装尺寸	数量	备注
1	Ce1	电解电容	400V/2.2UF	6*12	1	
2	Ce2	电解电容	400V/2.2UF	6*12	1	
3	C1	贴片电容	4.7uF/25V	1206	1	
4	Ce3	电解电容	200V/2.2uF	6*12	1	
5	D1	快速二极管	ES1J	SMD	1	
6	FR1	保险丝/线绕电阻	10R/1W	1W	1	
7	BD1	贴片桥堆	MB6S	SMD	1	
8	Rs1	贴片电阻	910K 1%	0805	1	
9	Rs2	贴片电阻	12R 1%	1206	1	
10	Rs3	贴片电阻	33K 1%	0805	1	
11	Rs4	贴片电阻	910K 1%	0805	1	
12	Rs5	贴片电阻	1M 5%	0805	1	
13	L2	电感	EE8.3 25mH	3+3	1	
14	L1	色环电感	1mH	0510	1	
15	U1	IC	PN8313	SOP8	1	

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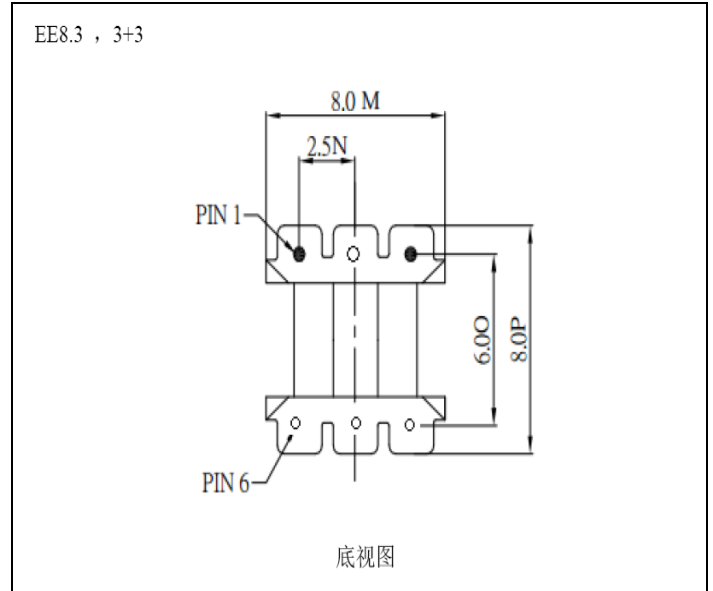
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7. 变压器规格

绕法示意图



骨架 EE8 .3 立式 3+3



绕组顺序

绕组	起绕点	结束脚	线型	线径	圈数	外围胶带	绕法
N1	1	3	漆包线	0.1mm	504	2TS	密绕 12 层

备注:

- 1) 2, 4, 5, 6 脚剪掉;
- 2) 1 脚到 3 脚电感量: $25\text{mH} \pm 4\%$ (10KHz, 1V);
- 3) 气隙一定要磨磁芯中柱, 不能垫气隙;
- 4) 需要真空浸漆。

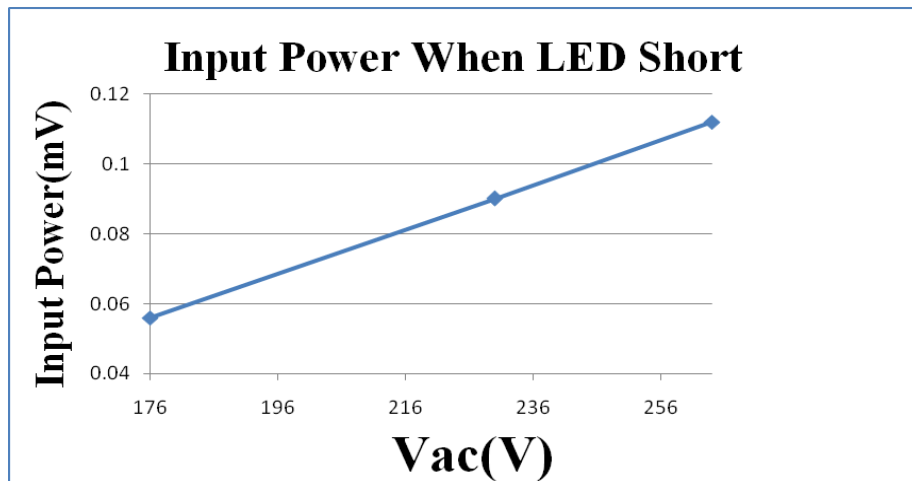
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8. 电源输入输出特性和工作波形

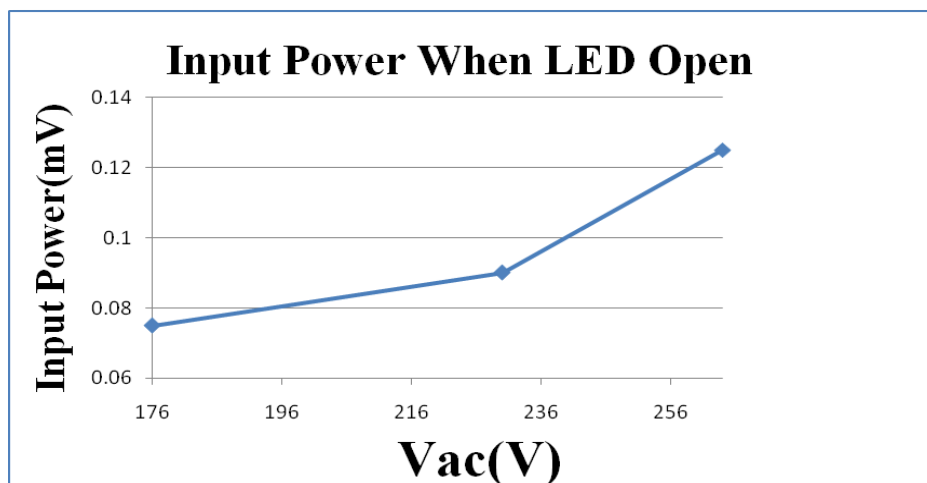
1) Input power when LED short

Input Power	176V	230V	264V
Pin(W)	0.056	0.090	0.112



2) Input power when LED open

Input Power	176V	230V	264V
Pin(W)	0.075	0.090	0.125



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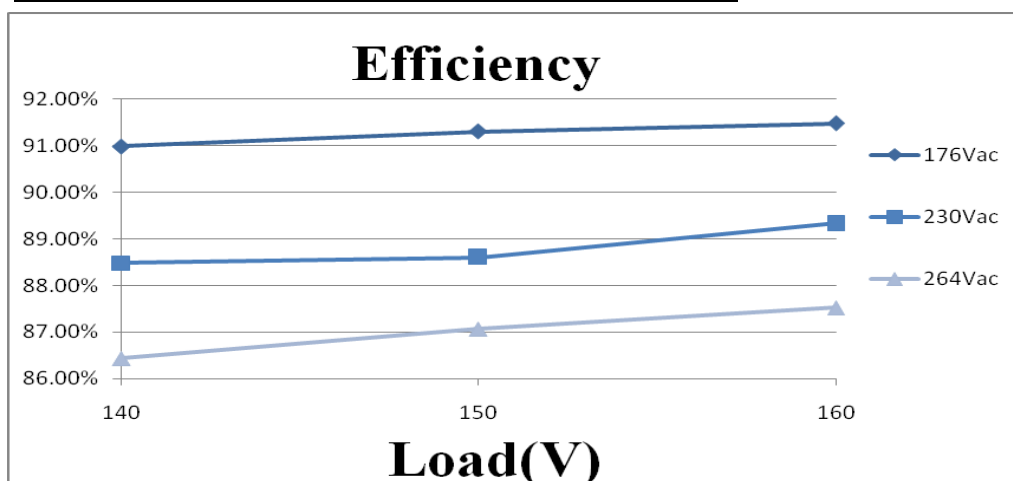
3) 线性调整率与负载调整率

带载 (Vo)	输出电流(mA)			Max.-Min.	线性调整率
	176Vac	230Vac	264Vac		
150	21.766	21.24	21.25	0.516	±1.2%
140	21.64	21.33	21.35	0.29	±0.65%
120	21.677	21.492	21.54	0.137	±0.32%
100	21.82	21.676	21.749	0.071	±0.17%
Max.-Min.	0.348	0.506	0.589		
负载调整率	±0.43%	±1.04%	±1.19%		

4) Efficiency

Note: 用电子负载CV模式模拟LED负载

带载 (Vo)	效率(%)		
	176Vac	230Vac	264Vac
160	91.47%	89.32%	87.53%
150	91.30%	88.60%	87.07%
140	90.98%	88.48%	86.44%



5) Startup



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Figure 1. VIN = 176VAC, startup



Drain- CH1	100V/div
VDD-CH2	10V/div
Vo-CH3	50V/div
5ms/div(10us/div zoom1)	

Figure 2. VIN = 264VAC, startup



Drain- CH1	100V/div
VDD-CH2	10V/div
Vo-CH3	50V/div
5ms/div(10us/div zoom1)	

6) Power off

Figure 3. VIN = 176VAC, power off



Drain- CH1	100V/div
VDD-CH2	10V/div
Vo-CH3	50V/div
100ms/div(5ms/div zoom1)	

Figure 4. VIN = 264VAC, power off



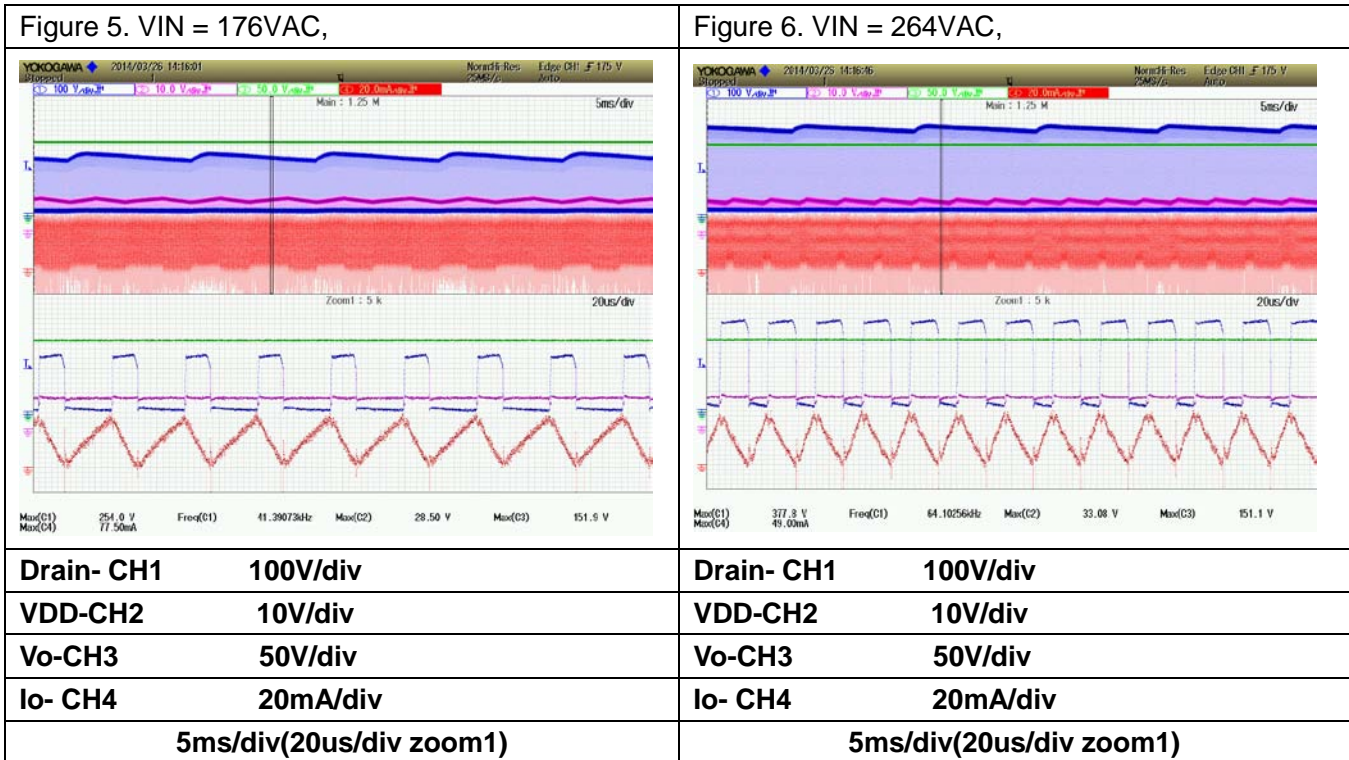
Drain- CH1	100V/div
VDD-CH2	10V/div
Vo-CH3	50V/div
100ms/div(10ms/div zoom1)	



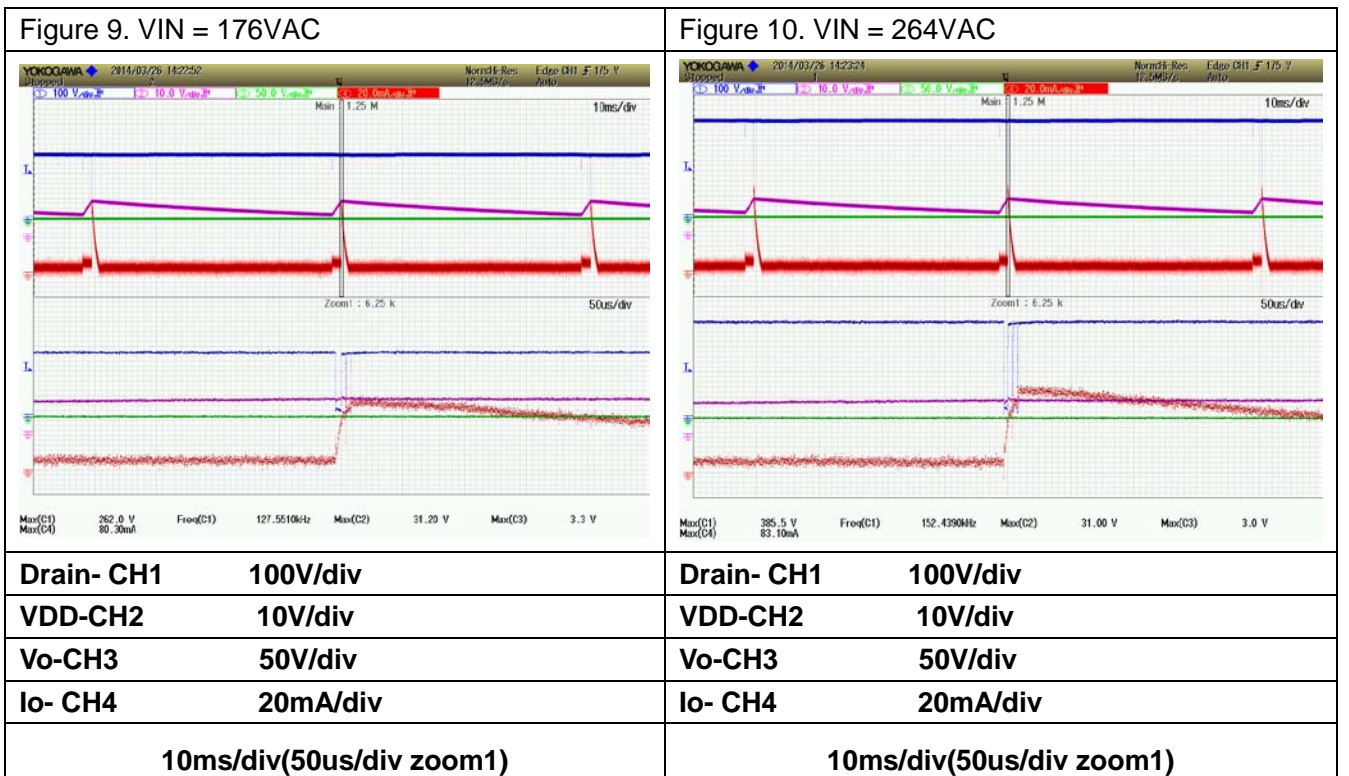
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7) Operating waveforms



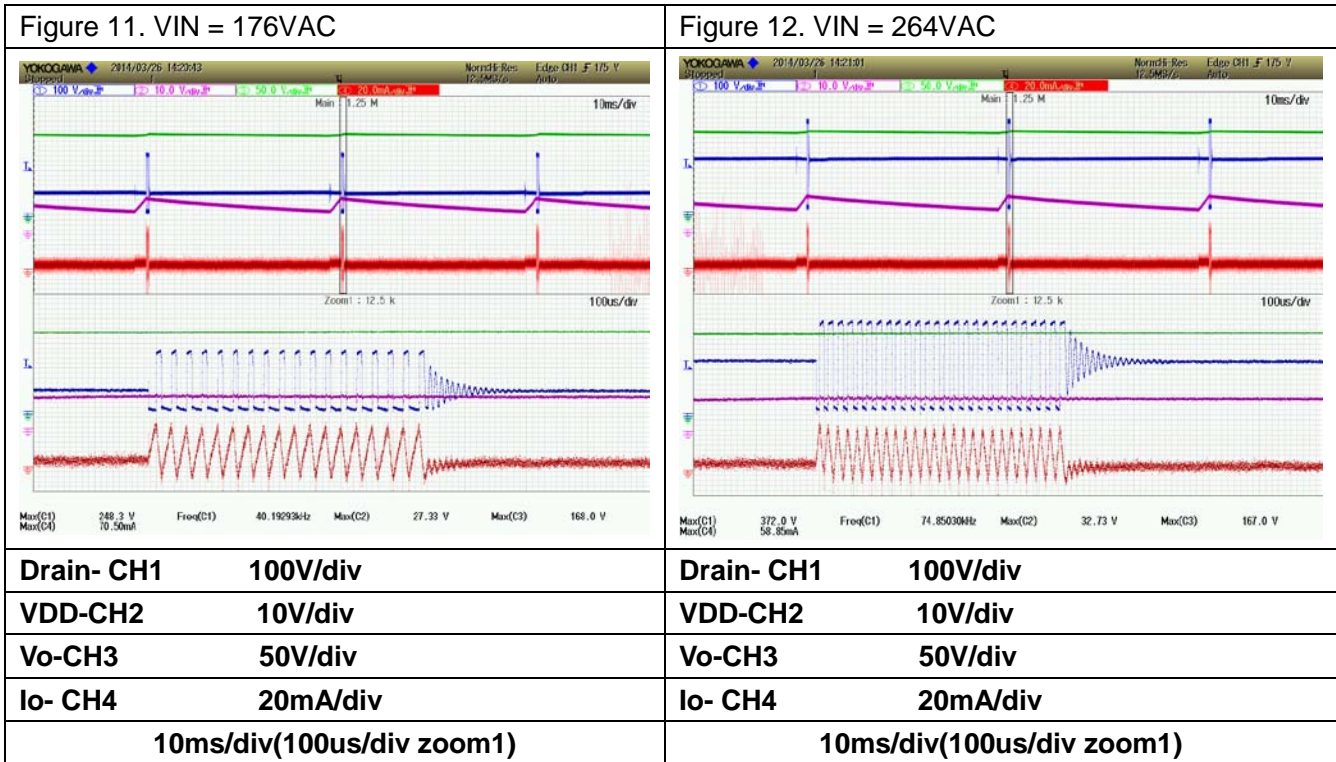
8) LED Short Protection



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9) LED Open Protection



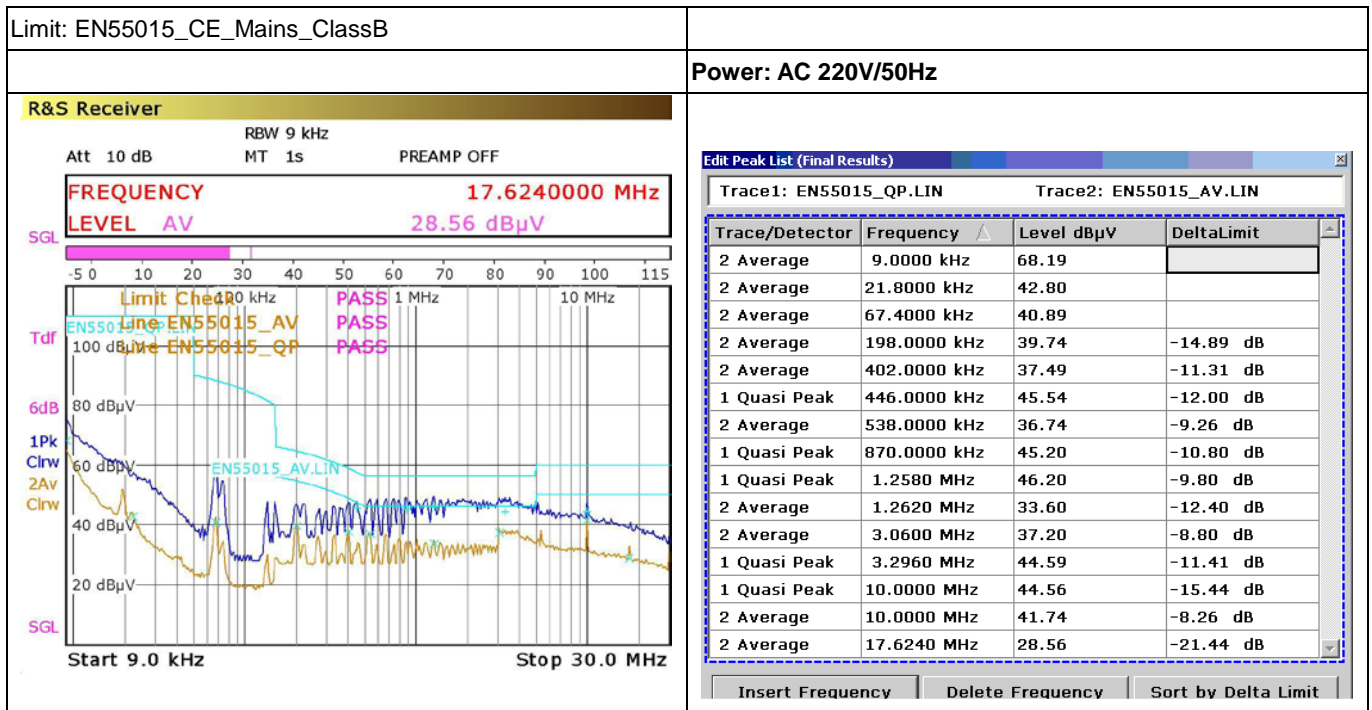
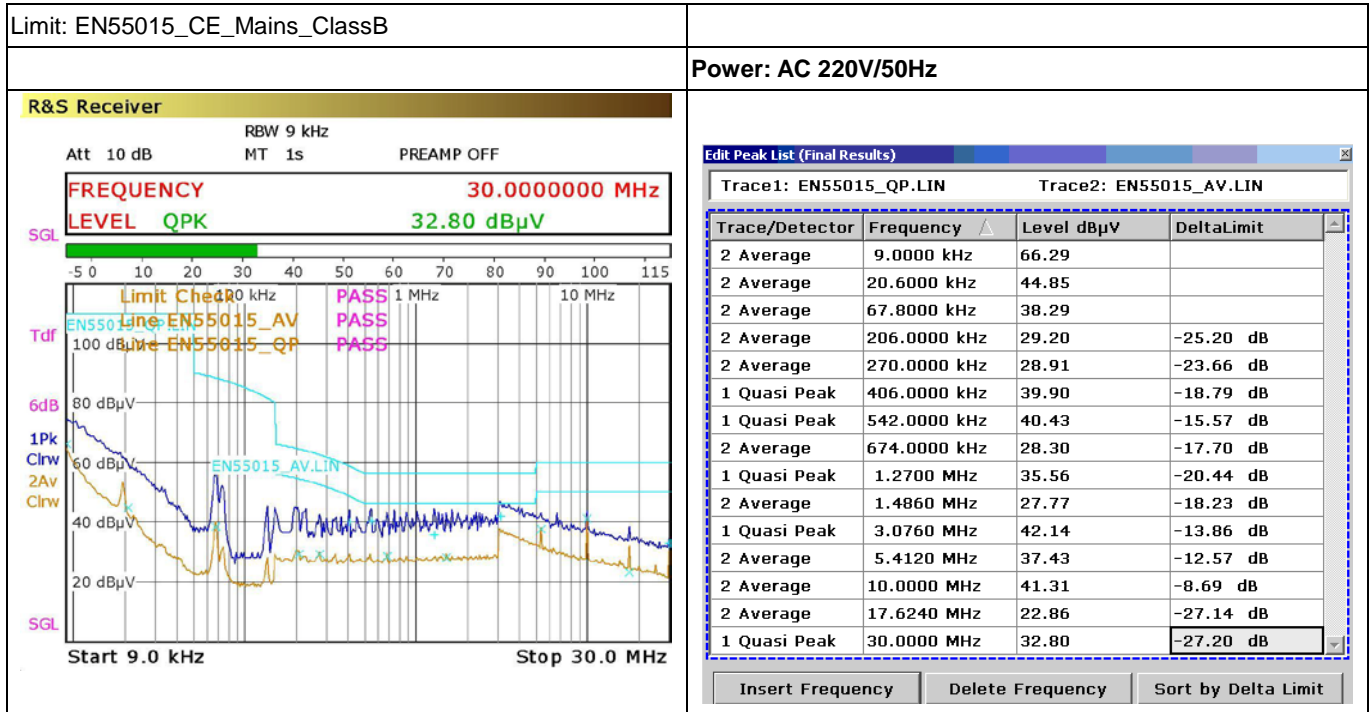
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9. 电源 EMI 测试

1) 传导测试

此电源产品传导性能能够满足 EN55015_CE_Mains_ClassB 的测试标准,

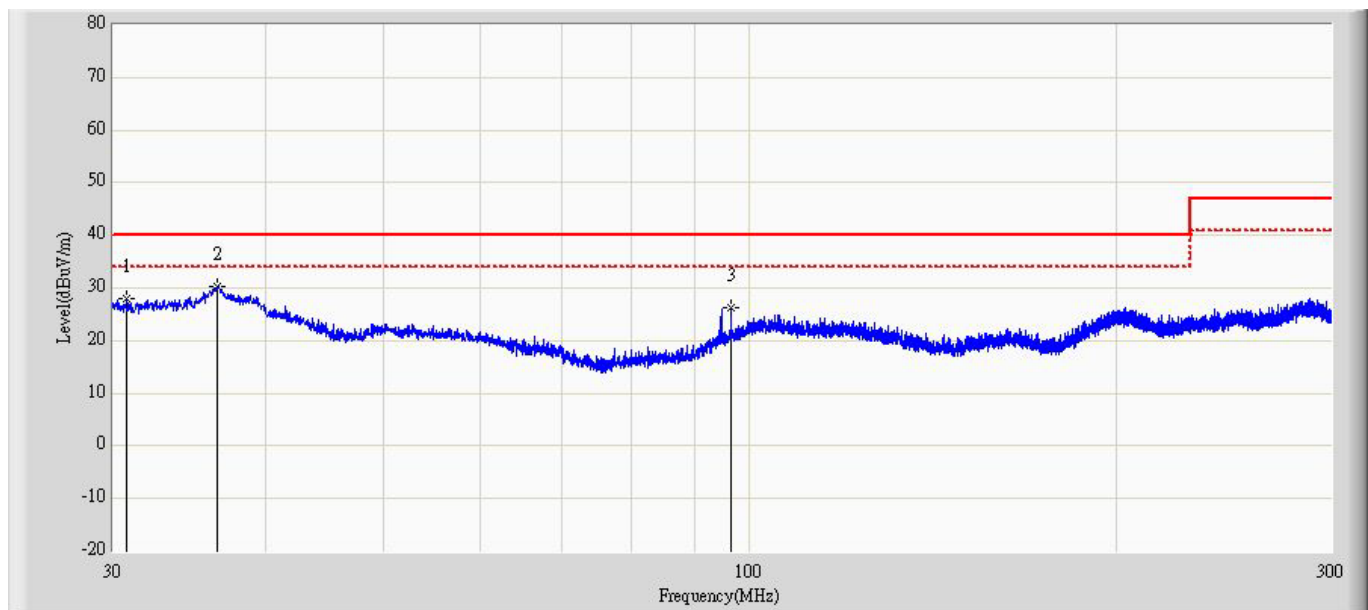


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2)RE Test

Profile: 2014.03.27	Page No.: 19
Engineer: Barlow	
Site: AC2	Time: 2014/03/27 - 11:40
Limit: CISPR15_RE(3m)	Margin: 6
Probe: AC2_10M(30-1000M)20130511	Polarity: Vertical
EUT:PN8313	Power: AC 230V/50Hz
Note: 1#	



No	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Probe (dB/m)	Cable (dB)	Amp (dB)	Ant Pos (cm)	Table Pos (deg)	Type
1		30.810	27.925	3.804	-12.075	40.000	17.662	6.459	0.000	0	0	PK
2	*	36.548	30.306	8.624	-9.694	40.000	15.182	6.500	0.000	0	0	PK
3		96.488	26.122	4.720	-13.878	40.000	14.581	6.821	0.000	0	0	PK

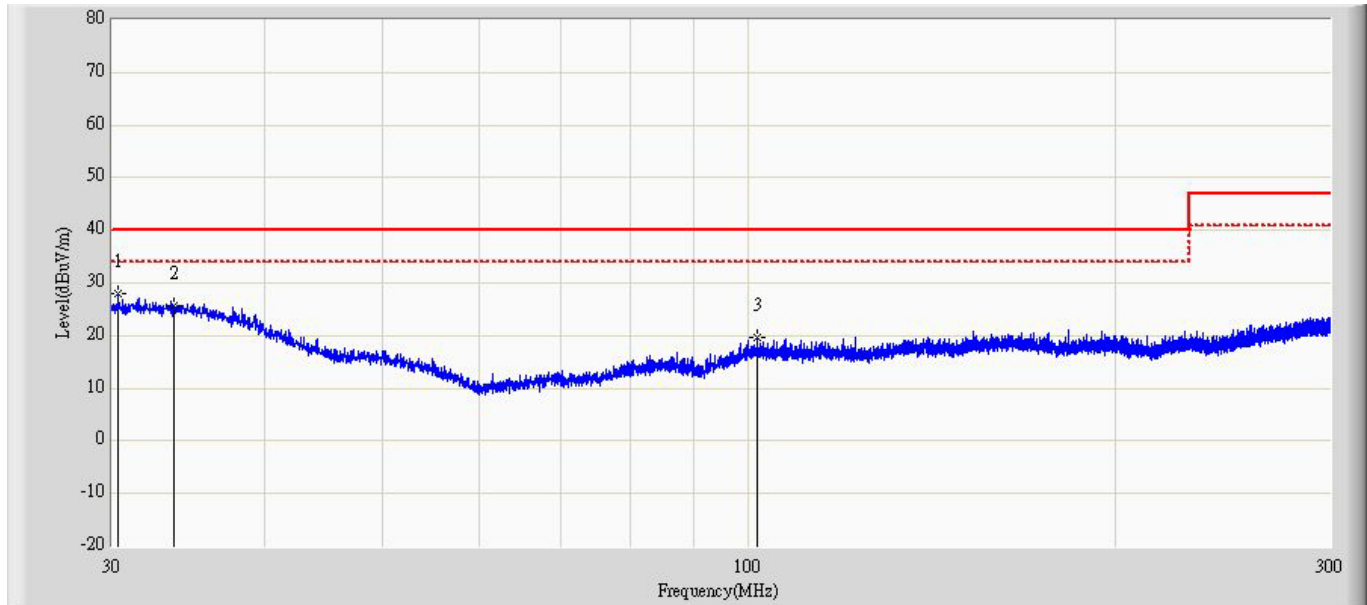
Note:

1. All Readings below 1GHz are Quasi-Peak, above are performed with peak and/or average measurements as necessary.
2. " * ", means this data is the worst emission level.
3. Measurement Level = Reading Level + Factor(Probe+Cable-Amp).

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Profile: 2014.03.27	Page No.: 20
Engineer: Barlow	
Site: AC2	Time: 2014/03/27 - 11:42
Limit: CISPR15_RE(3m)	Margin: 6
Probe: AC2_10M(30-1000M)20130511	Polarity: Horizontal
EUT: PN8313	Power: AC 230V/50Hz
Note: 1#	



No	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Probe (dB/m)	Cable (dB)	Amp (dB)	Ant Pos (cm)	Table Pos (deg)	Type
1	*	30.371	28.001	2.143	-11.999	40.000	19.403	6.455	0.000	0	0	PK
2		33.746	25.741	0.167	-14.259	40.000	19.093	6.481	0.000	0	0	PK
3		101.651	19.516	1.595	-20.484	40.000	11.076	6.845	0.000	0	0	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above are performed with peak and/or average measurements as necessary.
2. " * ", means this data is the worst emission level.
3. Measurement Level = Reading Level + Factor(Probe+Cable-Amp).

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3) EFT Test

Electrical Fast Transient/Burst Measurement Results

Test Site	TR2	Temperature	26°C
EUT:	PN8313 3W	Humidity :	48%RH
M/N:		Barometric Pressure	101.3kPa
S/N:		Input Voltage:	230V,50Hz
Test Mode:	Normal operation		
Standard:	EN 55024: 1998+A1: 2001+A2: 2003, IEC 61000-4-4: 2004		
Measurement Equipment:	<input checked="" type="checkbox"/> Immunity Test System (M/N: EMCPro) (Cali. Due Date: 2014.03.26) <input type="checkbox"/> CCL (M/N: CCL) (Cali. Due Date: 2014.03.26)		

Input a.c. power ports (Tr/Th: 5/50ns, Repetition Frequency: 5kHz)

Inject Line	Polarity	Test Level (kV)	Test Duration (second)	Inject Method	Performance criterion	Test Result criterion	Result	Observation
L	+	0.5	60	Direct	B	A	Pass	Note
L	-	0.5	60	Direct	B	A	Pass	Note
N	+	0.5	60	Direct	B	A	Pass	Note
N	-	0.5	60	Direct	B	A	Pass	Note
L+N	+	0.5	60	Direct	B	A	Pass	Note
L+N	-	0.5	60	Direct	B	A	Pass	Note

Input a.c. power ports (Tr/Th: 5/50ns, Repetition Frequency: 100kHz)

Inject Line	Polarity	Test Level (kV)	Test Duration (second)	Inject Method	Performance criterion	Test Result criterion	Result	Observation
L	+	0.5	60	Direct	B	A	Pass	Note
L	-	0.5	60	Direct	B	A	Pass	Note
N	+	0.5	60	Direct	B	A	Pass	Note
N	-	0.5	60	Direct	B	A	Pass	Note
L+N	+	0.5	60	Direct	B	A	Pass	Note
L+N	-	0.5	60	Direct	B	A	Pass	Note

Note: There was no change compared with initial operation during the test.



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4) Surge Test

Surge Immunity Test Results

Test Site	TR1	Temperature	26°C					
EUT:	PN8313 3W	Humidity :	48%RH					
M/N:		Barometric Pressure	101.3kPa					
S/N:		Input Voltage:	230 V, 50 Hz					
Standard:	EN 55024:2010; IEC 61000-4-5:2005							
Measurement Equipment:	<input checked="" type="checkbox"/> Immunity Test System (M/N: EMCPro) (Cali. Due Date: 2014.03.26) <input type="checkbox"/> Coupler/Decoupler Telecom Line (M/N: CM-TELCD) (Cali. Due Date: N/A) <input type="checkbox"/> Coupler/Decoupler Signal Line (M/N: CM-I/OCD) (Cali. Due Date: N/A)							
Input a.c. power ports [Tr/Th: 1.2/50us (8/20us)]								
Inject Line	Polarity	Angle (degree)	Test Level (kV)	Test Interval (second)	Performance criterion	Test Result criterion	Result	Observation
L+N	+	0	0.5	60	B	A	Pass	Note1
L+N	-	0	0.5	60	B	A	Pass	Note1
L+N	+	90	0.5	60	B	A	Pass	Note1
L+N	-	90	0.5	60	B	A	Pass	Note1
L+N	+	180	0.5	60	B	A	Pass	Note1
L+N	-	180	0.5	60	B	A	Pass	Note1
L+N	+	270	0.5	60	B	A	Pass	Note1
L+N	-	270	0.5	60	B	A	Pass	Note1

Note1: There was no change operated with initial operating during the test.