

Design Example Report

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标题	基于 PN8355 的 5V1A 充电器电源应用方案
规格	输入电压：90~264Vac 输出功率：5W 输出特性：5V/1.0A
应用范围	充电器电源产品
文件编号	DER-8355-13-P069
编写时间	2014-01-20
编写部门	应用二部
版本号	V1.0

特性概述：

- 单面板设计，双面元器件，尺寸：51.0mm*33mm；
- 输入电压：90~264Vac；
- 输出功率：**5W(5V1A)**；
- 待机功耗：<75mW
- 拥有可输出短路保护，输出过流保护，VDD 过压保护，FB 分压电阻开路短路保护，以及电流检测电阻 Rcs 短路保护，过温保护；
- 平均效率：≥68.2% (**输出线端 1.5m AWG 24**)；

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1. 电源介绍

该报告提供了一种基于 PN8355 设计输出 5V/1A 的开关电源。

该报告包含了原理图，电源输入输出规格，BOM 表和变压器参数以及安规和 EMI 测试数据等资料。

以下为该电源的实物图片：



2. 电源规格明细

项目描述	标号	Min	Typ	Max	Unit	备注
输入	Vin	90	230	264	V	
输出	Vo	4.75	5.0	5.25	V	
	Io		1.0	1.2	A	
输出功率	Pout		5		W	
待机功耗	Pin			75	mW	Io=0A
平均效率	η	70			%	115V,230V 输出线端 1.5m 24AWG

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工作环境	Tamb	0	25	40	°C	外部环境
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4. 电路描述

该电路图中R5、R6为反馈分压电阻，通过辅助绕组检测次级的电压，使输出电压维持在5V。

C4为环路补偿电容，空载时电压接近0V，最大负载时电压接近2V；

D5，R4，以及 R3，C9 组成 RCD 箝位电路，用于吸收功率 Mos（集成于 PN8355 内部）漏源端尖峰电压。

PN8355 内置高压启动功能，可以在 200mS 以内完全启动；

当 PN8355 本体温度太高时，其内置的 OTP 保护功能会及时动作，关闭 IC，以保护整个系统，温度下降之后在自动重启；

电路具有输出短路保护，输出过流保护，开环保护，VDD 过压保护等功能，以提高整个系统的可靠性；

当反馈脚 FB 的分压电阻开路或短路时，系统都会进入保护状态；

当 CS 脚短路（或 Rcs 短路）时系统会发生保护并进入 Latch 状态，以确保系统不会被损坏；

C1，L1，C2 组成 π 性滤波，以改善 EMI 性能；

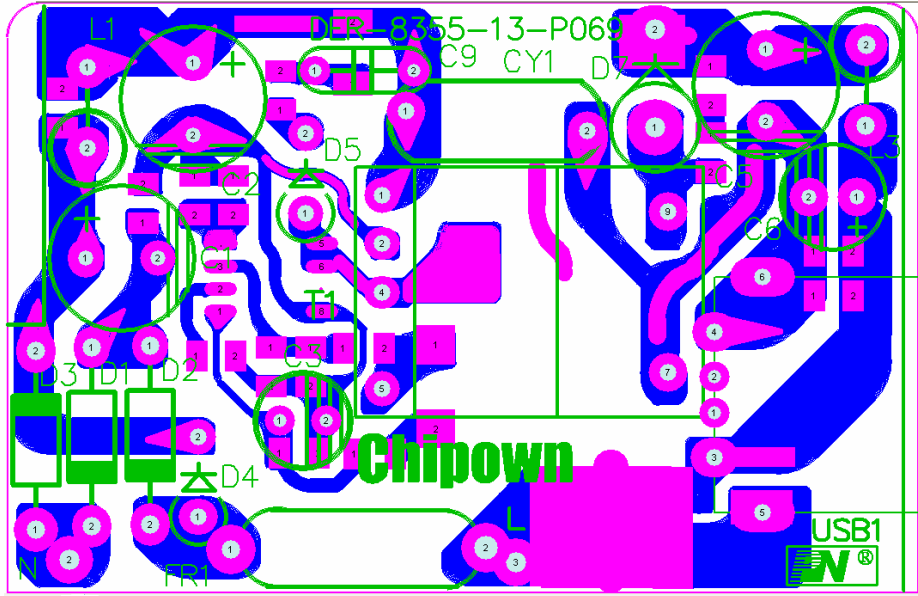
5. PCB LAYOUT

PCB 为普通单面板工艺，双面元器件，铜厚 1OZ，基材为 FR-4。PCB 长 51mm，宽 33mm，厚 1mm。

污染等级符合 CLASS2。

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6. 元件清单

序号	元件标号	元件名称	元件型号	封装尺寸	数量	备注
1	C1	电解电容	4.7uF/400V,Low ESR	E/C8.0	1	
2	C2	电解电容	4.7uF/400V,Low ESR	E/C8.0	1	
3	C3	电解电容	10uF/35V	E/C5.0	1	
4	C4	贴片电容	100nF/25V	SMD0805	1	
5	C5	电解电容	680uF/10V,Low ESR	E/C8.0	1	
6	C6	电解电容	470uF/10V,Low ESR	E/C6.0	1	
7	C8	贴片电容	10pF/25V	SMD0805	1	
8	C9	薄膜电容	1nF/1000V		1	
9	C10	贴片电容	1nF/50V	SMD0805	1	
10	C11	贴片电容	100nF/35V	SMD0805	1	
11	D1	二极管	1N4007		1	
12	D2	二极管	1N4007		1	
13	D3	二极管	1N4007		1	
14	D4	二极管	1N4007		1	
15	D5	二极管	1N4007		1	
16	D6	二极管	RS1M	SMD	1	
17	D7	肖特基	SR240		1	
18	F1	线绕电阻	10R , 1W , 线绕		1	

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19	L1	色环电感	1mH	0510	1	
20	L2	Bead	LQM21FN4R7M80(MURATA)	SMD	1	
21	L3	Bead	Φ 3.5*9mm, 穿芯电感		1	
22	R1	贴片电阻	2.7R , 1%	SMD0805	1	
23	R2	贴片电阻	3.0R , 1%	SMD0805	1	
24	R3	贴片电阻	220K , 5%	SMD1206	1	
25	R4	贴片电阻	150R , 5%	SMD0805	1	
26	R5	贴片电阻	3K , 1%	SMD0805	1	
27	R6	贴片电阻	23.5K , 1%	SMD0805	1	
28	R7	贴片电阻	6.8R , 5%	SMD0805	1	
29	R8	贴片电阻	33R , 5%	SMD0805	1	
30	R9	贴片电阻	1.2K , 5%	SMD0805	1	
31	R10	贴片电阻	4.7K , 5%	SMD0805	1	
32	T1	变压器	EE-13 卧式加长 5+2 , 1.75mH		1	
33	U1	IC	PN8355, SOP-8		1	

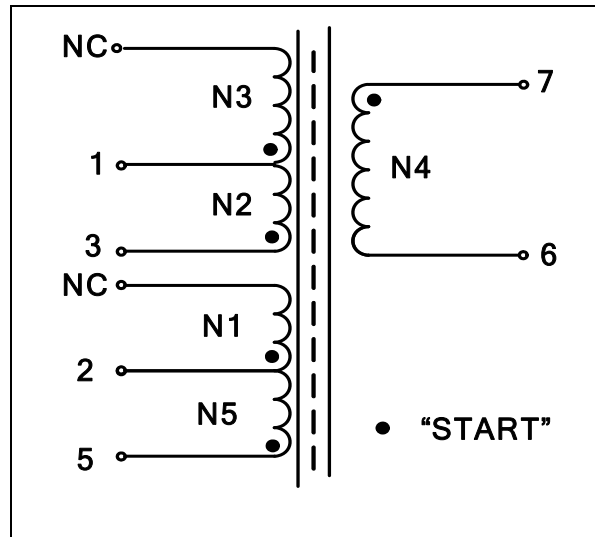
7. 变压器规格

7.1 绕法示意图

骨架 EE-13 卧式加长 5+2

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7.2 绕线结构

绕组	起绕点	结束脚	线型	线径	圈数	外围胶带	绕法
N1	2	NC	漆包线	0.18mm	37	1TS	密绕
N2	3	1	漆包线	0.13mm	135	2TS	分3层密绕
N3	1	NC	漆包线	0.2mm*2	17	2TS	密绕
N4	7	6	三重绝缘线	0.5mm	9	2TS	密绕
N5	5	2	漆包线	0.18mm	29	3TS	密绕

备注：

- 1) 采用 TDK PC40 或相当材质的磁芯；剪掉 4 脚
- 2) 1 脚到 3 脚电感量：1.75mH (50KHz,1V); 漏感：小于 100uH(50KHz,1V);
- 3) 输入输出耐压 AC3000V,5mA,1min;
- 4) 气隙一定要磨磁芯中柱，不能垫气隙；

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5) 请勿改动圈数，绕制尽量平整；

6) 浸漆；

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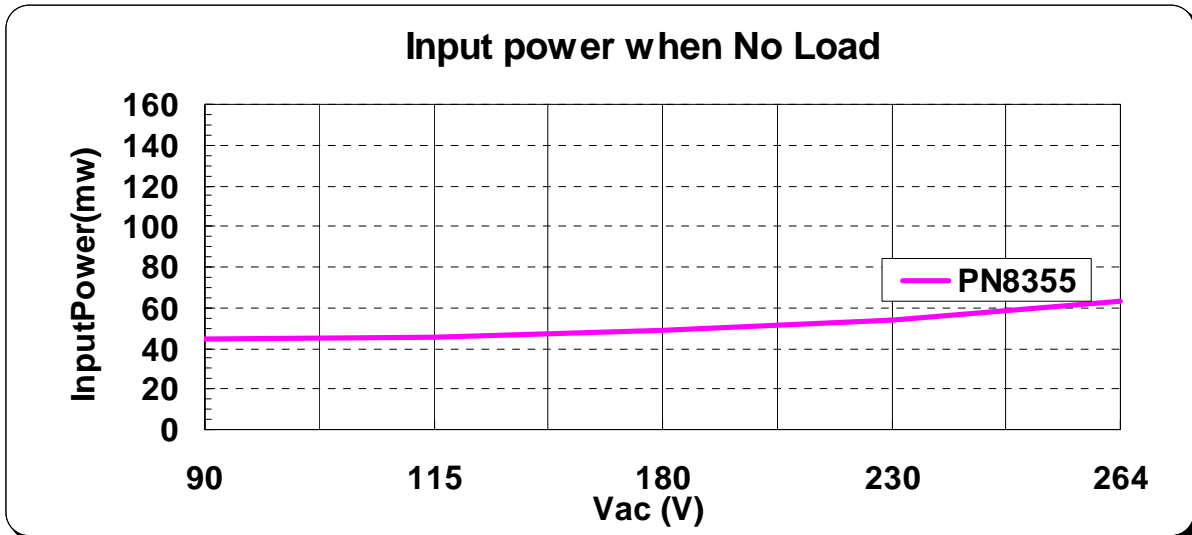
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8. 电源输入输出特性和工作波形

所有测试，包括电气特性和安规，输出线都采用 1.5m 24AWG；

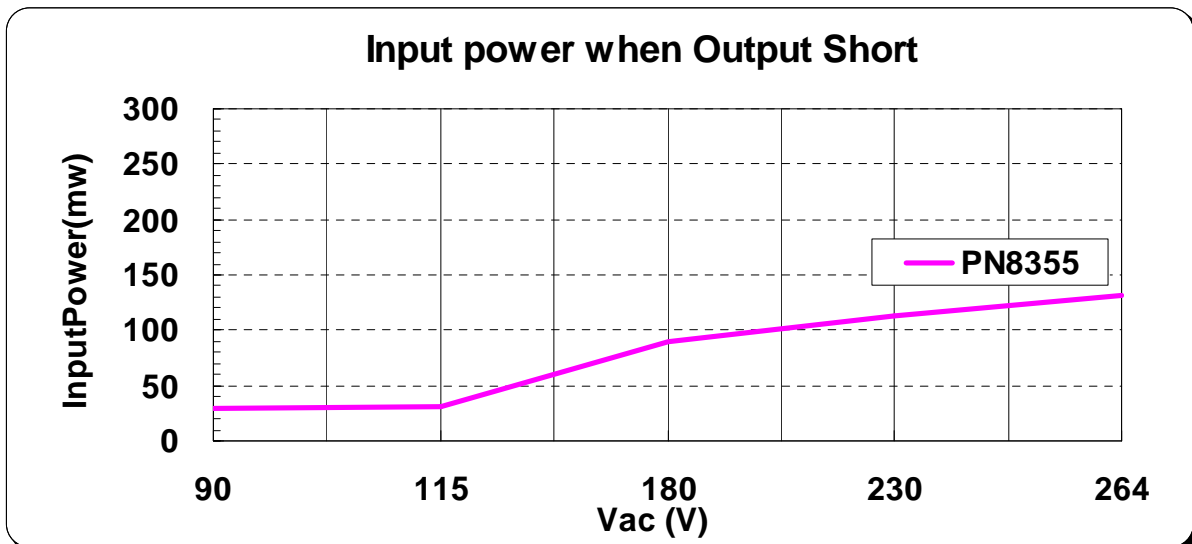
1) Input power when standby

Input Power	90	115	180	230	264
Pin(mW)	44.6	45.2	48.8	53.5	62.8



2) Input power when Output short

Input Power	90	115	180	230	264
Pin(mW)	29.2	31.3	90.3	112.3	131.2



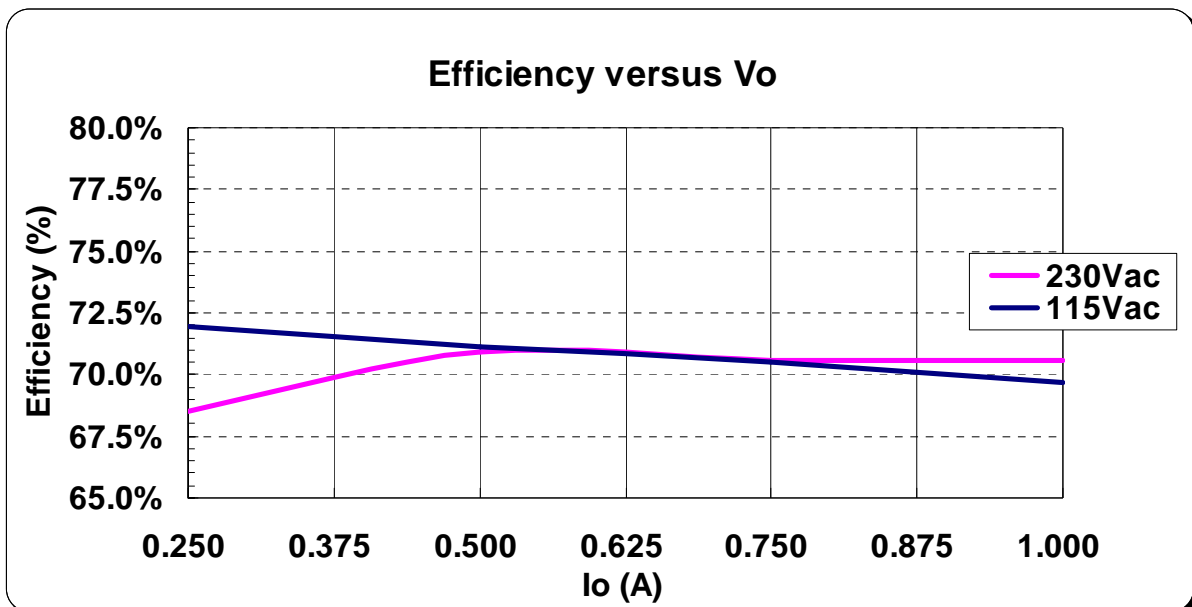
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3) Efficiency

Note:1.5m 24AWG线端

	Io(A)	Vo(V)	Po (W)	Pin (W)	Efficiency	AVG. Efficiency
90V	0.25	4.921	1.230	1.716	71.69%	69.42%
	0.50	4.926	2.463	3.525	69.87%	
	0.75	4.952	3.714	5.399	68.79%	
	1.00	5.031	5.031	7.475	67.30%	
115V	0.25	4.920	1.230	1.709	71.97%	70.82%
	0.50	4.934	2.467	3.468	71.14%	
	0.75	4.961	3.721	5.278	70.50%	
	1.00	5.027	5.027	7.213	69.69%	
230V	0.25	4.918	1.230	1.794	68.53%	70.15%
	0.50	4.933	2.467	3.477	70.94%	
	0.75	4.973	3.730	5.287	70.55%	
	1.00	5.039	5.039	7.138	70.59%	
264V	0.25	4.917	1.229	1.833	67.06%	69.35%
	0.50	4.937	2.469	3.518	70.17%	
	0.75	4.983	3.737	5.345	69.92%	
	1.00	5.049	5.049	7.187	70.25%	



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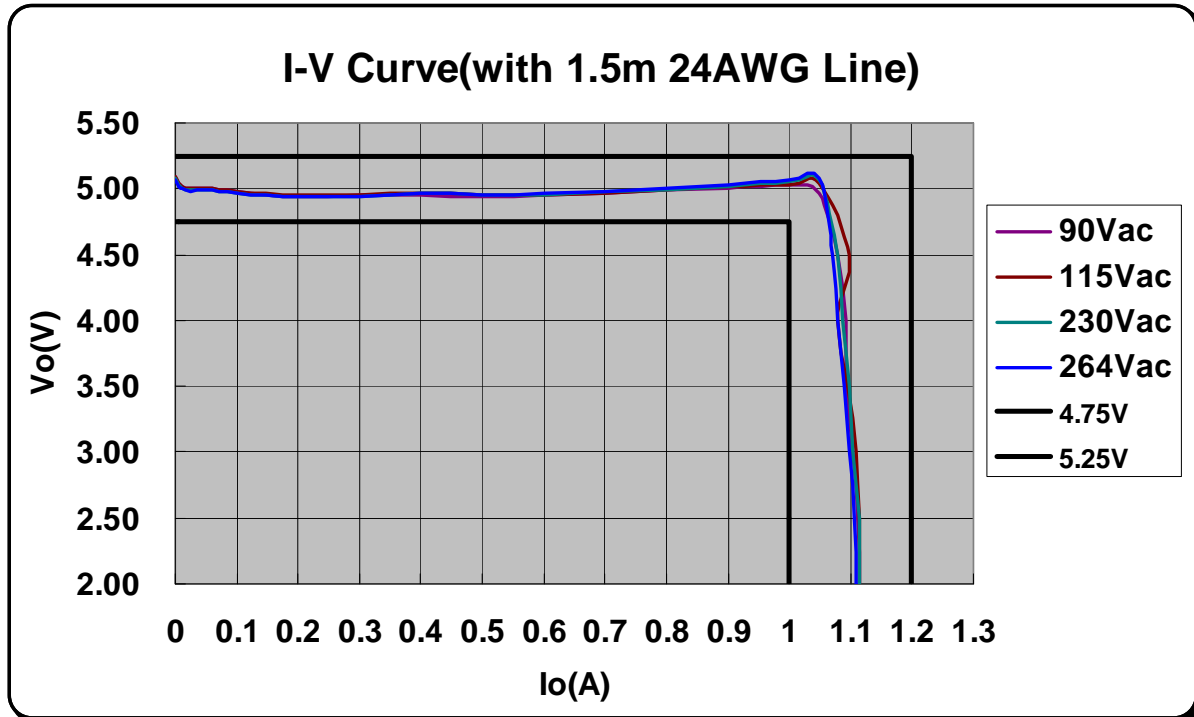
4) CC-CV 特性

Io(A)	90Vac	Io(A)	115Vac	Io(A)	230Vac	Io(A)	264Vac
0	5.088	0	5.090	0	5.077	0	5.073
0.005	5.038	0.005	5.039	0.005	5.024	0.005	5.021
0.01	5.020	0.01	5.021	0.01	5.004	0.01	5.002
0.025	5.008	0.025	5.008	0.025	4.985	0.025	4.983
0.05	5.005	0.05	5.006	0.05	4.993	0.05	4.991
0.1	4.978	0.1	4.978	0.1	4.963	0.1	4.961
0.2	4.945	0.2	4.948	0.2	4.941	0.2	4.938
0.3	4.947	0.3	4.949	0.3	4.943	0.3	4.942
0.4	4.955	0.4	4.961	0.4	4.963	0.4	4.967
0.5	4.943	0.5	4.950	0.5	4.955	0.5	4.959
0.6	4.947	0.6	4.955	0.6	4.959	0.6	4.966
0.7	4.966	0.7	4.970	0.7	4.975	0.7	4.983
0.8	4.986	0.8	4.992	0.8	4.995	0.8	5.007
0.9	5.006	0.9	5.012	0.9	5.019	0.9	5.033
1	5.025	1	5.033	1	5.053	1	5.064
1.05	4.961	1.05	5.042	1.05	5.067	1.05	5.079
1.080	4.500	1.097	4.500	1.078	4.500	1.070	4.500
1.093	4.000	1.079	4.000	1.087	4.000	1.078	4.000
1.092	3.500	1.095	3.500	1.098	3.500	1.089	3.500
1.104	3.000	1.110	3.000	1.104	3.000	1.097	3.000
1.111	2.500	1.114	2.500	1.113	2.500	1.107	2.500
1.114	2.000	1.115	2.000	1.115	2.000	1.110	2.000

CV:±1.41% CC:±2.2%

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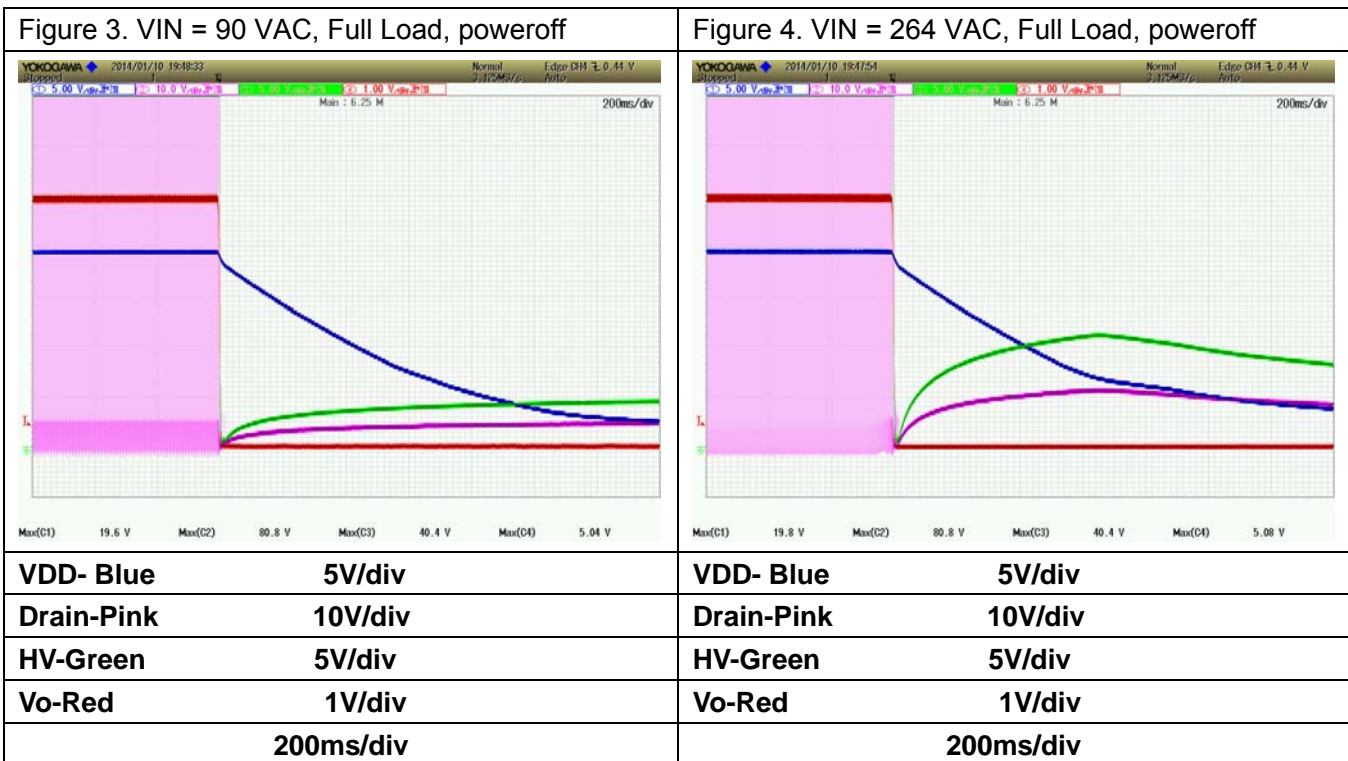
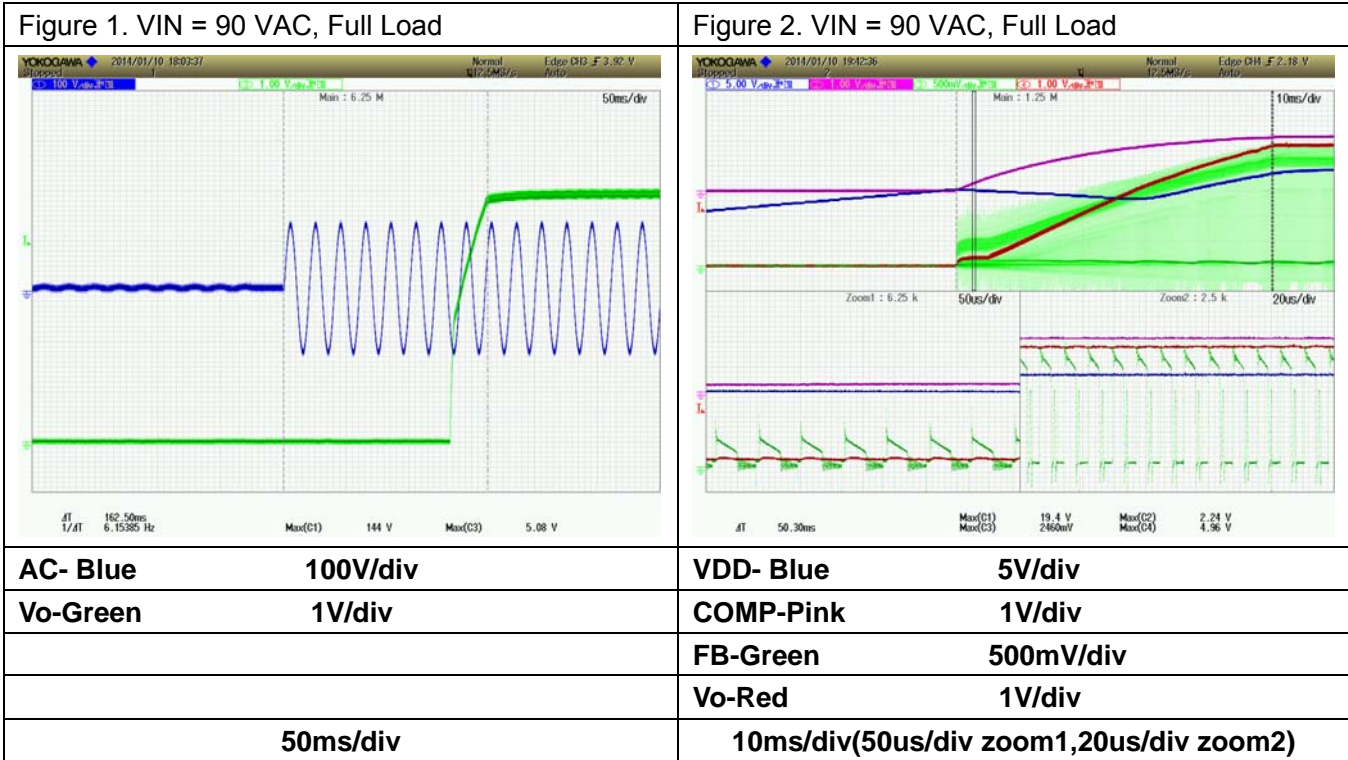
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5) Startup and Power off

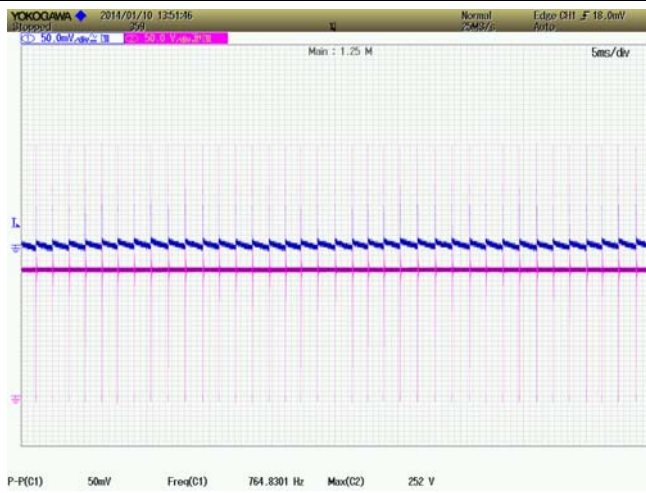


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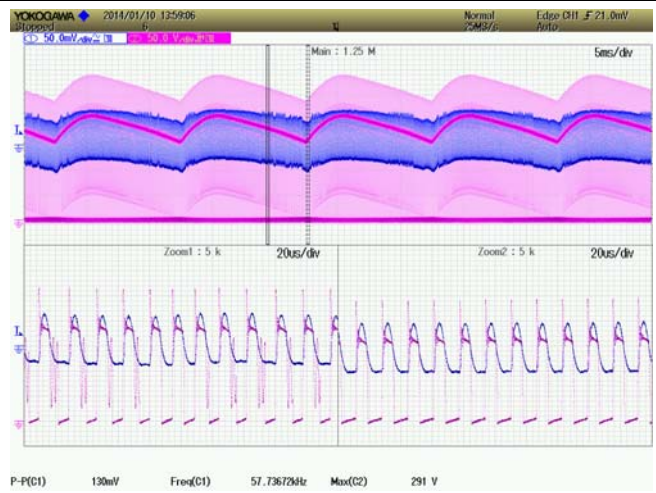
6) Ripple

Figure 5. VIN = 90VAC, 空载



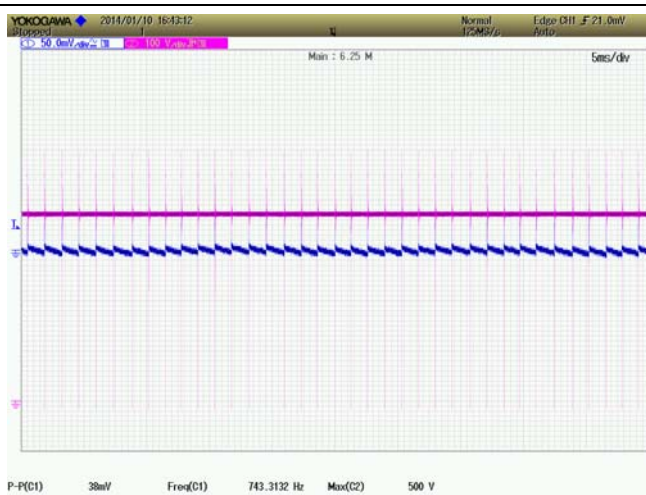
Vo-Blue	50mV/div
Drain-Pink	50V/div
	5ms/div
	Vpk-pk=50mV

Figure 6. VIN =90VAC, 满载



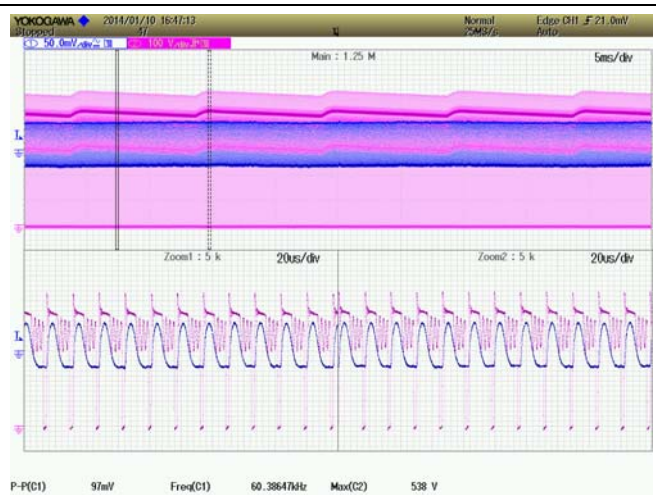
Vo-Blue	50mV/div
Drain-Pink	50V/div
	5ms/div(20us/div zoom1,20us/div zoom2)
	Vpk-pk=130mV

Figure 7. VIN = 264VAC, 空载



Vo-Blue	50mV/div
Drain-Pink	100V/div
	5ms/div
	Vpk-pk=38mV

Figure 8. VIN =264VAC, 满载



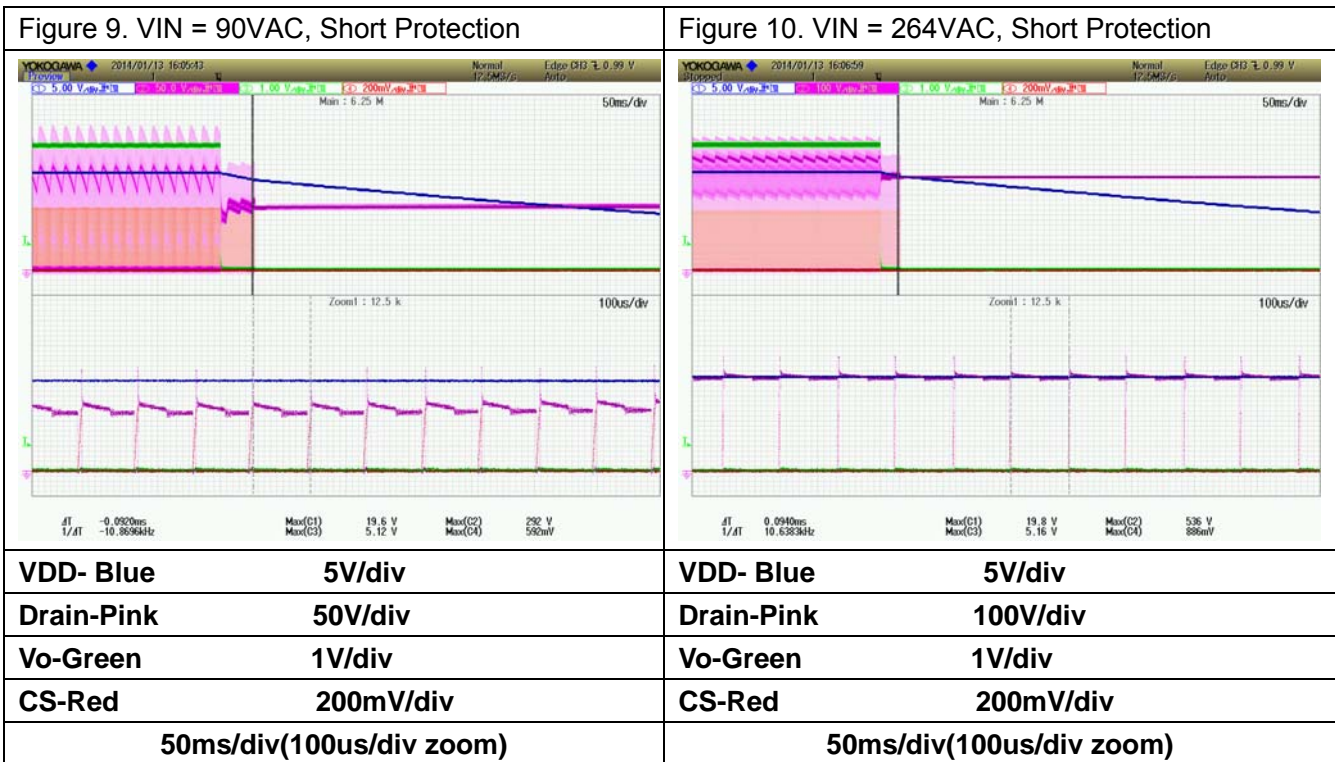
Vo-Blue	50mV/div
Drain-Pink	100V/div
	5ms/div(20us/div zoom1,20us/div zoom2)
	Vpk-pk=97mV



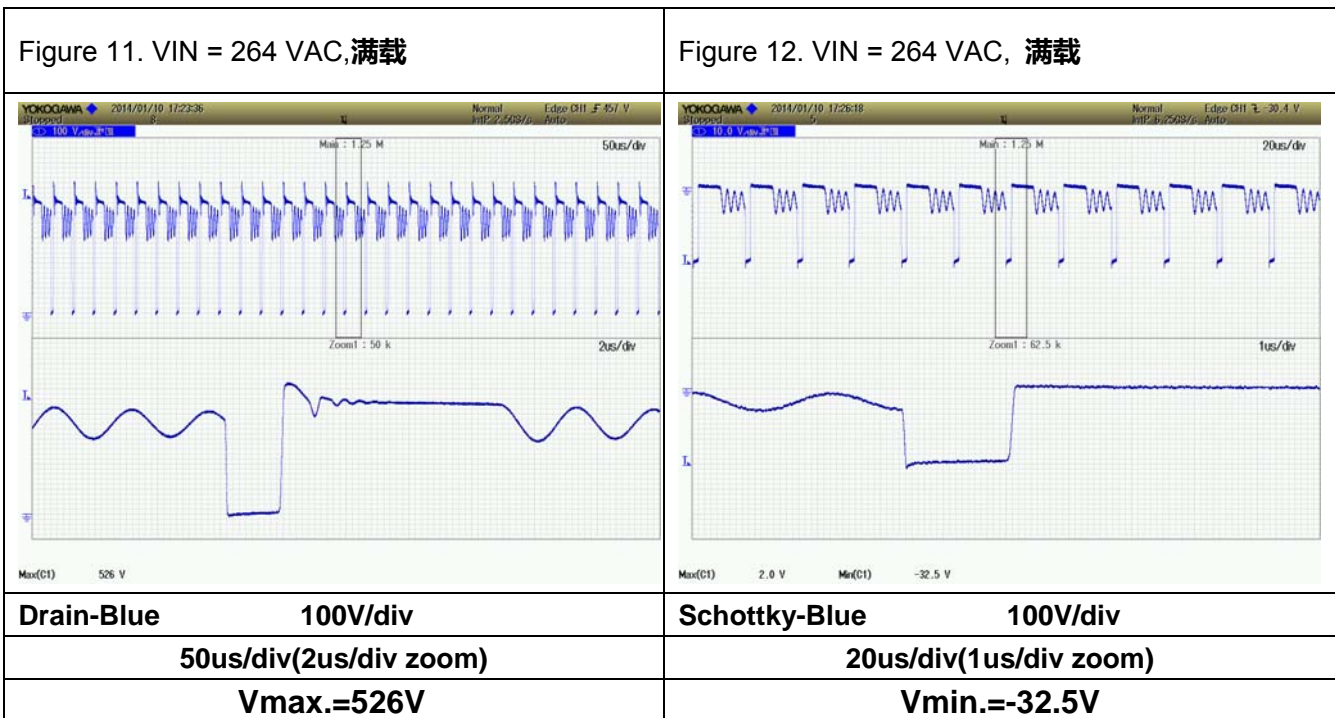
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7) Output Short Protection



8) Drain and Schottky Voltage



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9. EFT Test

Electrical Fast Transient/Burst Measurement Results

Test Site	TR2		Temperature	26°C				
EUT:	PN8355 5V1A Charger		Humidity :	48%RH				
M/N:			Barometric Pressure	101.3kPa				
S/N:			Input Voltage:	220V,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: EMCPPro) (Cali. Due Date: 2012.04.23) <input type="checkbox"/> CCL (M/N: CCL) (Cali. Due Date: 2012.04.23)							
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	+	1	60	Direct	B	A	Pass	Note
L	-	1	60	Direct	B	A	Pass	Note
N	+	1	60	Direct	B	A	Pass	Note
N	-	1	60	Direct	B	A	Pass	Note
L+N	+	1	60	Direct	B	A	Pass	Note
L+N	-	1	60	Direct	B	A	Pass	Note

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

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10. Surge Test

Surge Immunity Test Results

Test Site	TR2	Temperature	24°C					
EUT:	PN8355 5V1A Charger	Humidity :	42%RH					
M/N:		Barometric Pressure	101kPa					
S/N:		Input Voltage:	230 V, 50 Hz					
Standard:	EN 55024:2010; IEC 61000-4-5:2005							
Measurement	<input checked="" type="checkbox"/> Immunity Test System (M/N: EMCPro) (Cali. Due Date: 2012.04.23) <input type="checkbox"/> Coupler/Decoupler Telecom Line (M/N: CM-TELCD) (Cali. Due Date: N/A)							
Equipment:	<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	2	60	B	A	Pass	Note1
L+N	-	0	2	60	B	A	Pass	Note1
L+N	+	90	2	60	B	A	Pass	Note1
L+N	-	90	2	60	B	A	Pass	Note1
L+N	+	180	2	60	B	A	Pass	Note1
L+N	-	180	2	60	B	A	Pass	Note1
L+N	+	270	2	60	B	A	Pass	Note1
L+N	-	270	2	60	B	A	Pass	Note1

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

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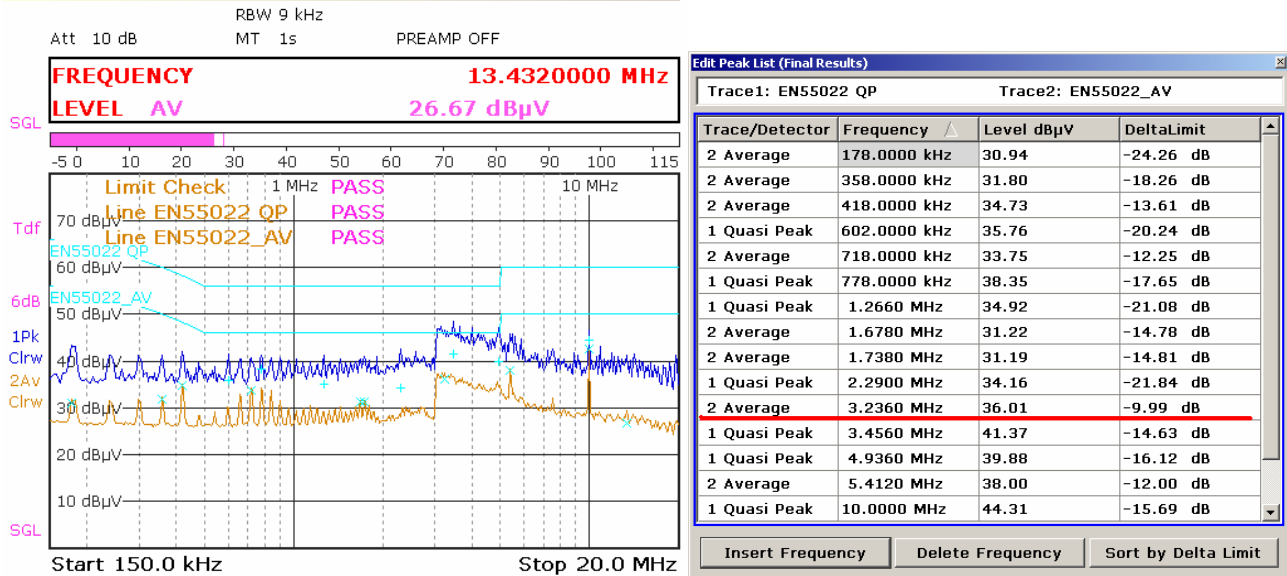
11. 电源 CE 和 RE 测试

1) CE Test

此电源产品传导性能能够满足 EN55022_CE_Mains_ClassB 的测试标准，CE 裕量大于 6.0dB。

Limit: EN55022_CE_Mains_ClassB	Margin: Line -9.99dB
EUT: PN8355 5V1A Charger	Power: AC 230V/50Hz

R&S Receiver



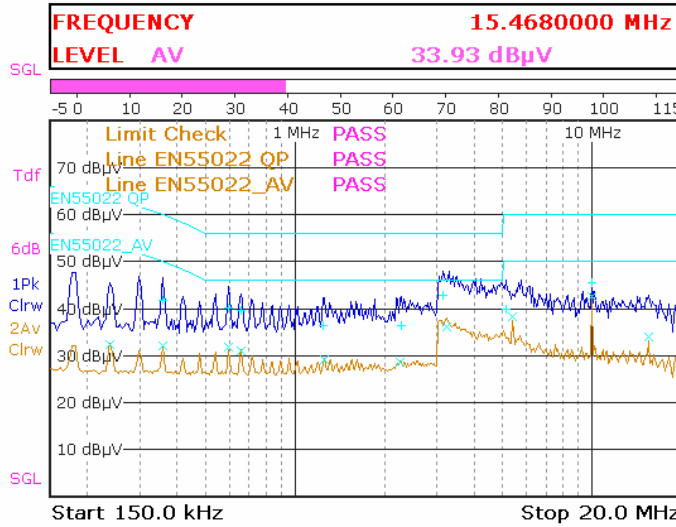
Limit: EN55022_CE_Mains_ClassB	Margin: Neutral -10.0dB
EUT: PN8355 5V1A Charger	Power: AC 230V/50Hz

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R&S Receiver

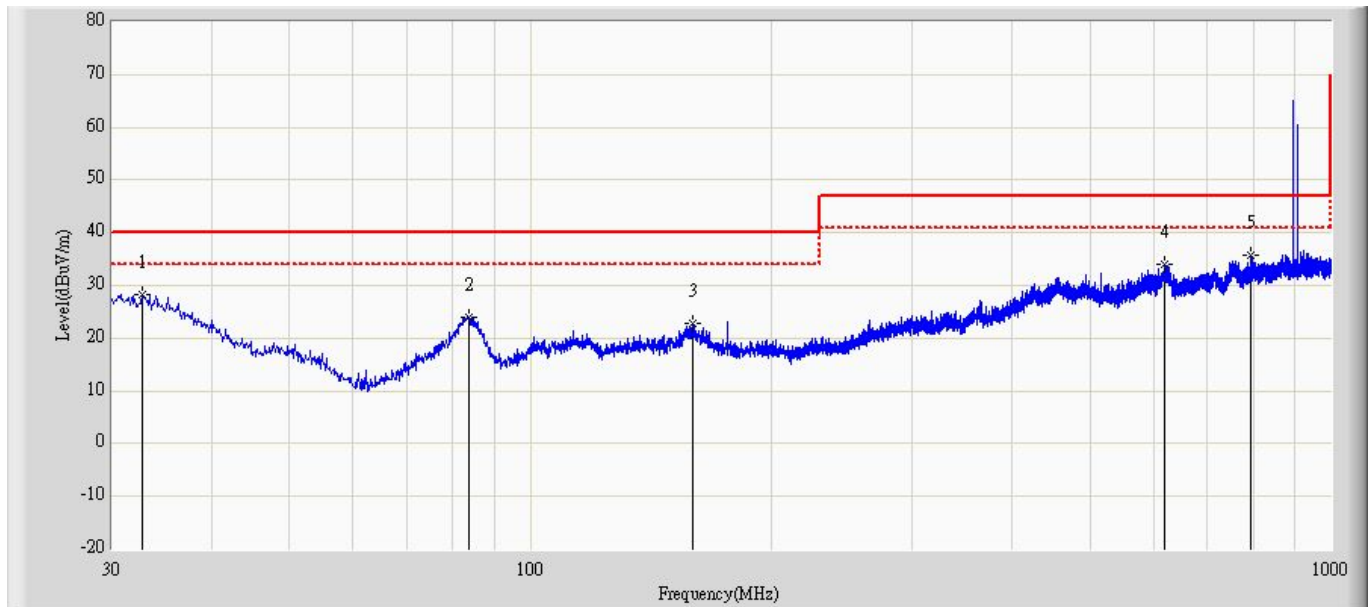
Att 10 dB RBW 9 kHz PREAMP OFF
 MT 1s



Trace/Detector	Frequency	Level dBµV	DeltaLimit
2 Average	238.0000 kHz	32.25	-21.24 dB
1 Quasi Peak	358.0000 kHz	41.71	-18.35 dB
2 Average	358.0000 kHz	32.12	-17.94 dB
1 Quasi Peak	598.0000 kHz	40.12	-15.88 dB
2 Average	598.0000 kHz	31.71	-14.29 dB
1 Quasi Peak	658.0000 kHz	39.68	-16.32 dB
2 Average	658.0000 kHz	31.00	-15.00 dB
1 Quasi Peak	1.2460 MHz	36.32	-19.68 dB
2 Average	1.2580 MHz	29.14	-16.86 dB
2 Average	2.2660 MHz	28.55	-17.45 dB
1 Quasi Peak	2.2740 MHz	36.43	-19.57 dB
1 Quasi Peak	3.1440 MHz	42.71	-13.29 dB
2 Average	3.2360 MHz	36.00	-10.00 dB
1 Quasi Peak	5.1200 MHz	39.82	-20.18 dB
2 Average	5.4120 MHz	38.23	-11.77 dB

2) RE Test

Limit: EN55022_RE(3m)_ClassB	Margin: -11.17dB(PK)
Probe: AC3_10m Comparison(30-1000MHz)	Polarity: Horizontal
EUT: PN8355 5V1A Charger	Power: AC 230V/50Hz



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		32.667	28.310	2.723	-11.690	40.000	19.114	6.473	0.000	0	0	PK



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2		83.592	24.010	8.768	-15.990	40.000	8.480	6.762	0.000	0	0	PK
3		159.374	22.760	4.252	-17.240	40.000	11.429	7.079	0.000	0	0	PK
4		618.790	34.091	1.720	-12.909	47.000	24.010	8.361	0.000	0	0	PK
5	*	794.966	35.832	3.406	-11.168	47.000	23.675	8.751	0.000	0	0	PK

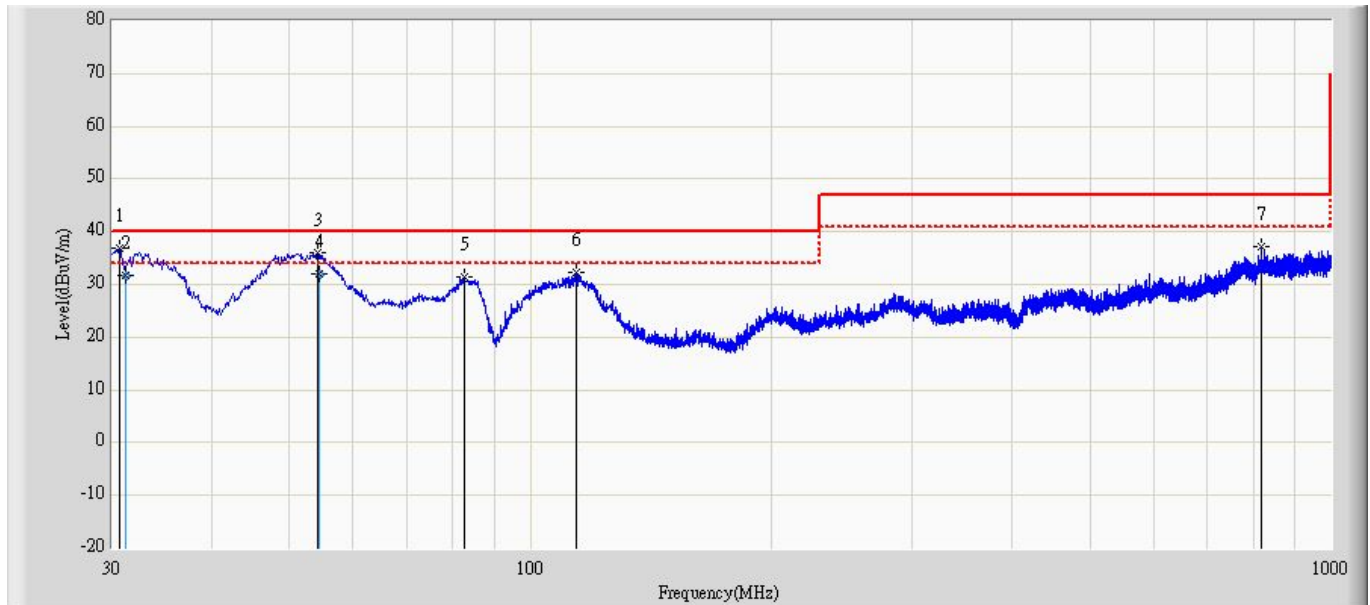
Note:

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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Limit: EN55022_RE(3m)_ClassB	Margin: -7.911dB(QP)
Probe: AC3_10m Comparison(30-1000MHz)	Polarity: Vertical
EUT: PN8355 5V1A Charger	Power: AC 230V/50Hz



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	*	30.606	36.916	12.714	-3.084	40.000	17.745	6.457	0.000	0	0	PK
2		31.224	31.755	7.800	-8.245	40.000	17.494	6.462	0.000	100	22	QP
3		54.129	35.924	17.974	-4.076	40.000	11.343	6.608	0.000	0	0	PK
4		54.460	32.089	14.200	-7.911	40.000	11.280	6.609	0.000	100	22	QP
5		82.501	31.434	14.892	-8.566	40.000	9.785	6.757	0.000	0	0	PK
6		113.905	32.422	9.570	-7.578	40.000	15.954	6.897	0.000	0	0	PK
7		818.731	37.079	3.430	-9.921	47.000	24.844	8.805	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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12. 附录

PN8355 封装和脚位配置图：

