

<b>标题</b>	<b>基于uP2535/uP2536 的5V1A 充电器电源应用方案</b>
<b>规格</b>	<b>输入电压: 90~264Vac</b> <b>输出功率: 5W</b> <b>输出特性: 5V/1.0A</b>
<b>应用范围</b>	<b>充电器电源产品</b>
<b>文件编号</b>	<b>AN-uP2535 V1.1</b>
<b>编写时间</b>	<b>2014.02.17</b>
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<b>版本号</b>	<b>REV1.1</b>

#### 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: <100mW(230VAC)
- 拥有可输出短路保护, 输出过流保护, VDD 过压保护, INV 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

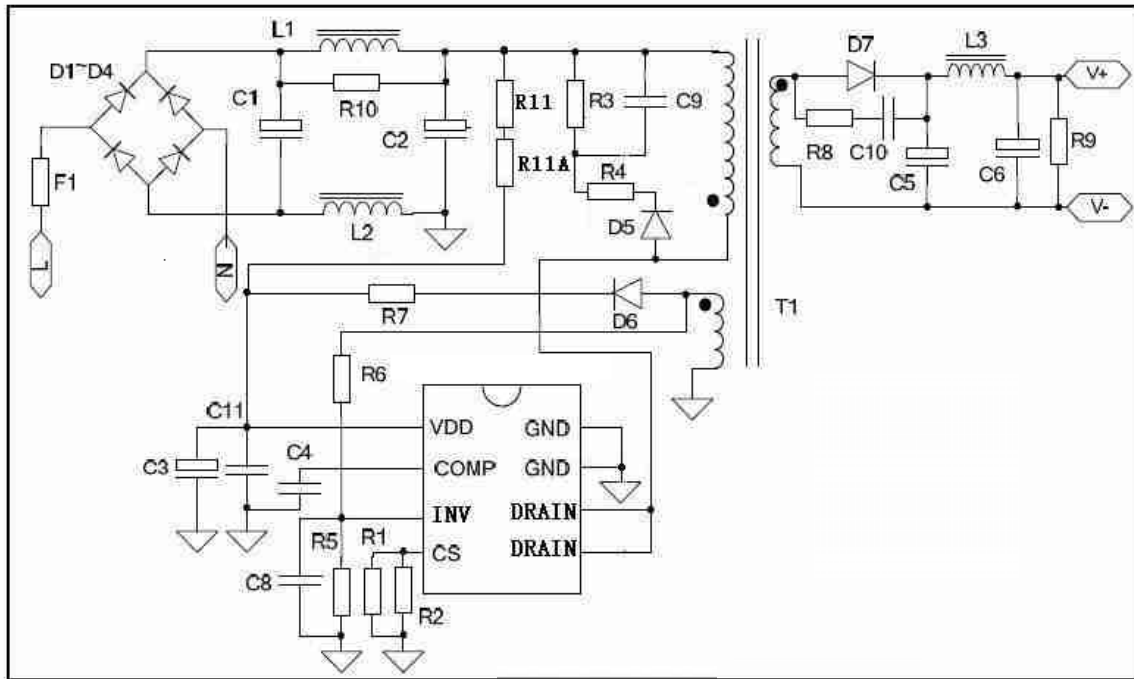
该报告提供了一种基于uP2535/uP2536 设计输出5V/1A 的开关电源。该报告包含了原理图，电源输入输出规格，BOM 表和变压器参数以及安规和EMI 测试数据等资料。下为 uP2535的实物图片：



## 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			100	mW	Io=0A
平均效率	$\eta$	70			%	115V,230V 输出线端1.5m24AWG
工作环境	Tamb	0	25	40	°C	外部环境

### 3. 电源原理图



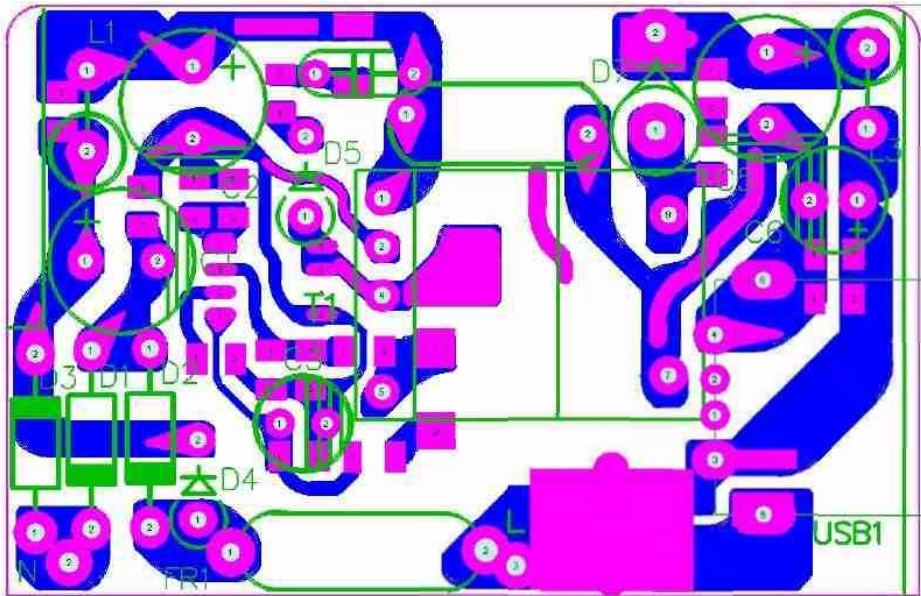
### 4. 电路描述

- 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uP2535 内部）漏源端尖峰 电压。
- uP2535 内置高压启动功能，可以在200mS 以内完全启动；
- 当uP2535 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INV 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 $\pi$  型滤波，以改善EMI 性能。

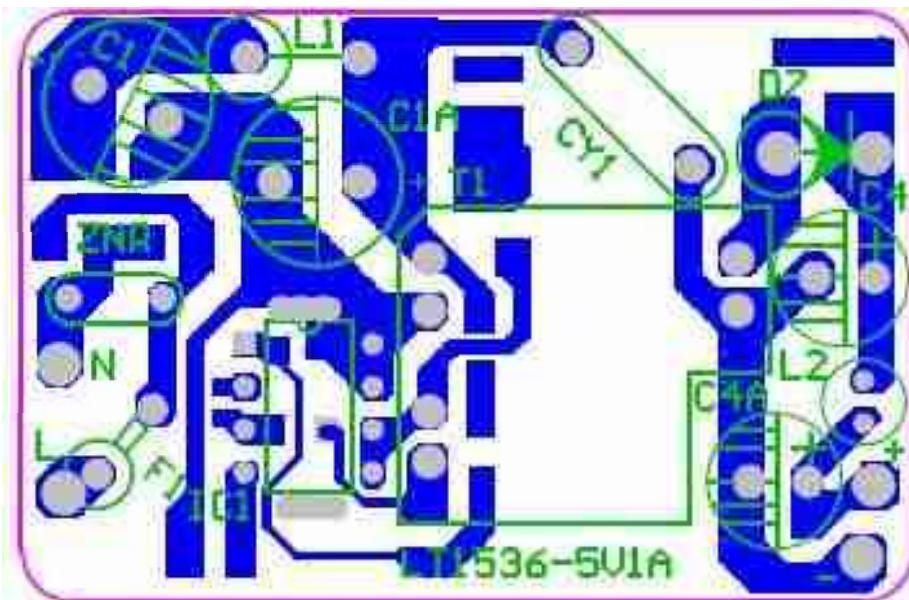
**5. PCB LAYOUT**

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。

uP2535PCB



uP2536PCB



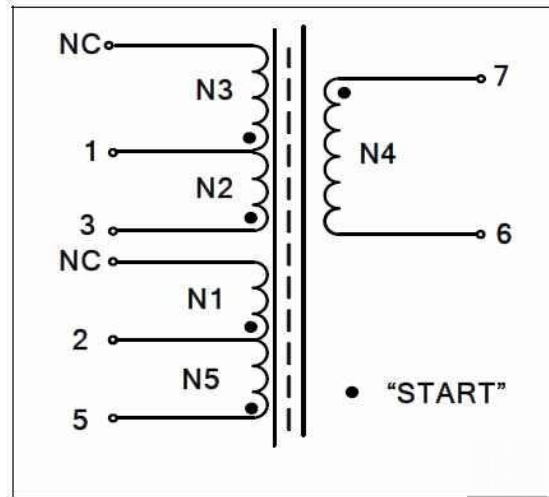
## 6. 元件清单

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	
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%	SMD1206	1	
23	R2	贴片电阻	3.0R, 1%	SMD1206	1	
24	R3	贴片电阻	220K, 5%	SMD1206	1	
25	R4	贴片电阻	150R, 5%	SMD1206	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%	SMD1206	1	
29	R8	贴片电阻	33R, 5%	SMD1206	1	
30	R9	贴片电阻	1.2K, 5%	SMD0805	1	
31	R10	贴片电阻	4.7K, 5%	SMD0805	1	
32	R11	贴片电阻	1M, 5%	SMD1206	1	
33	R11A	贴片电阻	1M, 5%	SMD1206	1	
34	T1	变压器	EE-13 卧式加长 5+2, 1.75mH		1	
35	IC1	IC	uP2535	SO-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



### 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:

7.2.1 采用 TDK PC40 或相当材质的磁芯; 剪掉 4 脚;

7.2.2 1脚到3脚电感量: 1.75mH (50KHz,1V); 漏感: 小于 100uH(50KHz,1V);

7.2.3 输入输出耐压 AC3000V,5mA,1min;

7.2.4 气隙一定要磨磁芯中柱, 不能垫气隙;

7.2.5 请勿改动圈数, 绕制尽量平整;

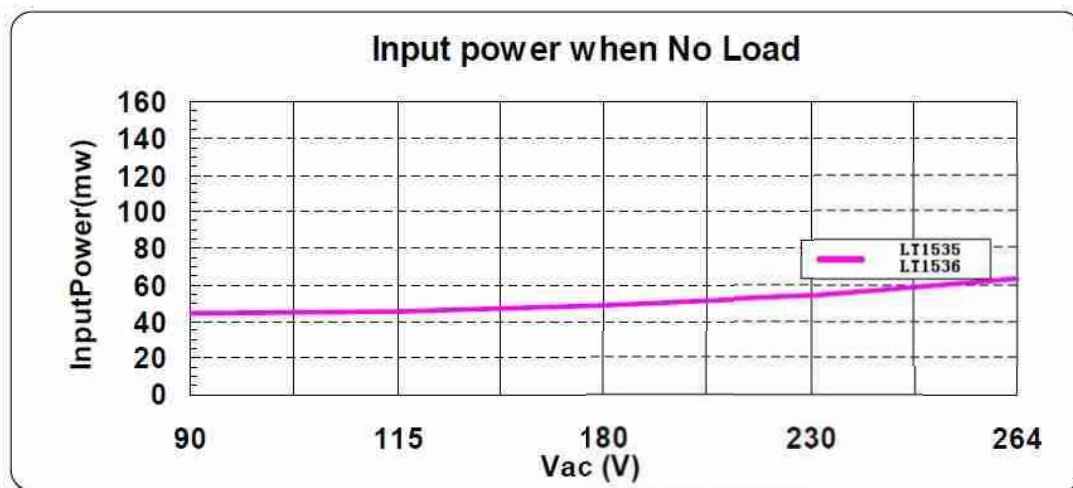
7.2.6 浸漆;

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；

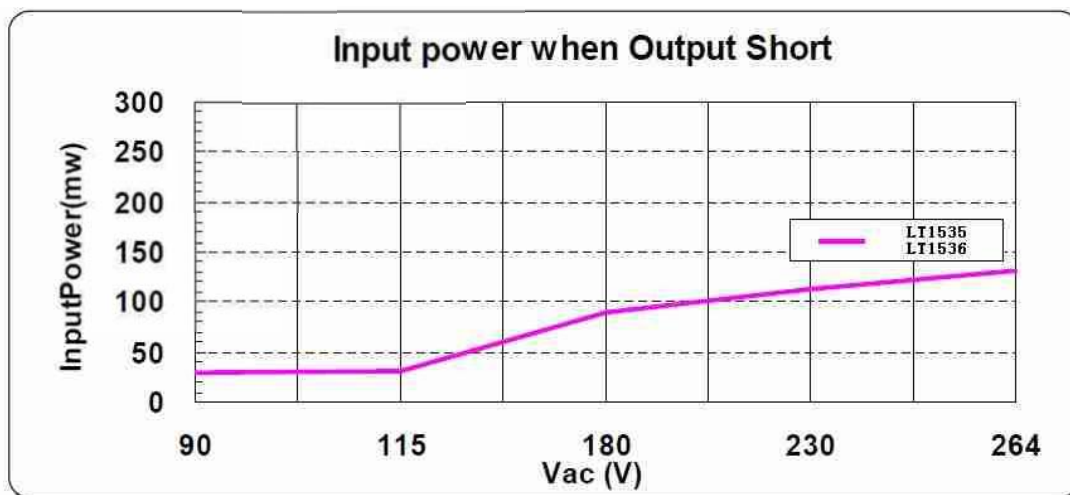
8.1 Input power when standby

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



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

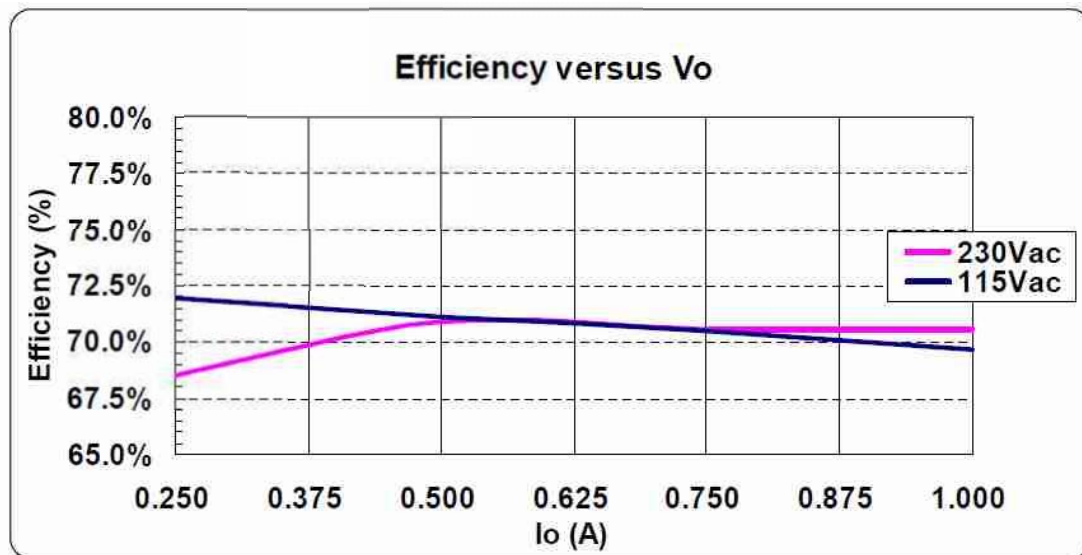




**8.3 Efficiency**

Note:1.5m 24AWG线端

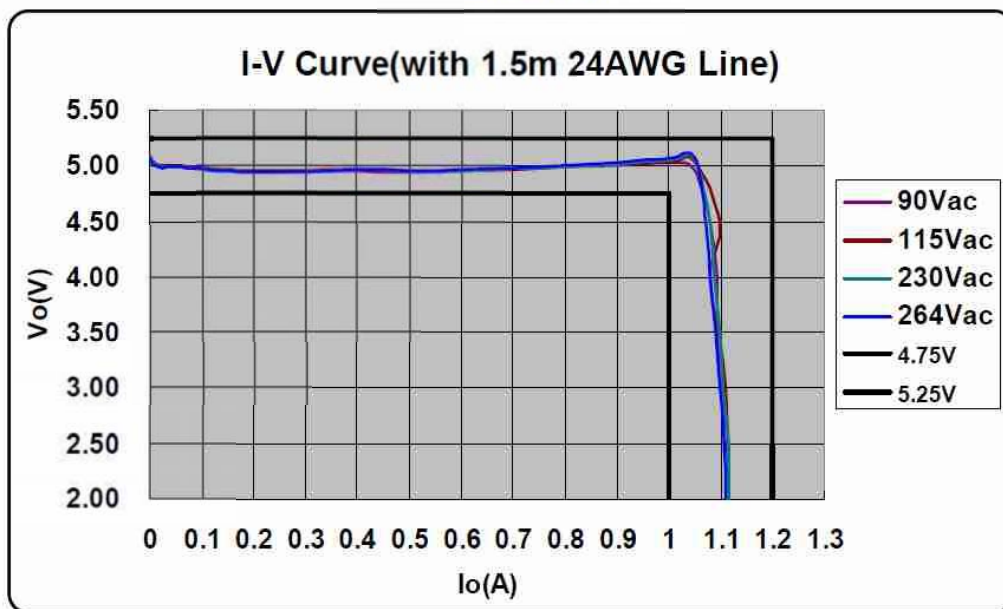
	Io(A)	Vo(V)	Po (W)	Pin (W)	Efficiency (%)	AVG. Efficiency (%)
<b>90V</b>	0.25	4.921	1.230	<b>1.716</b>	<b>71.69%</b>	<b>69.42%</b>
	0.50	4.926	2.463	<b>3.525</b>	<b>69.87%</b>	
	0.75	4.952	3.714	<b>5.399</b>	<b>68.79%</b>	
	1.00	5.031	5.031	<b>7.475</b>	<b>67.30%</b>	
<b>115V</b>	0.25	4.920	1.230	<b>1.709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



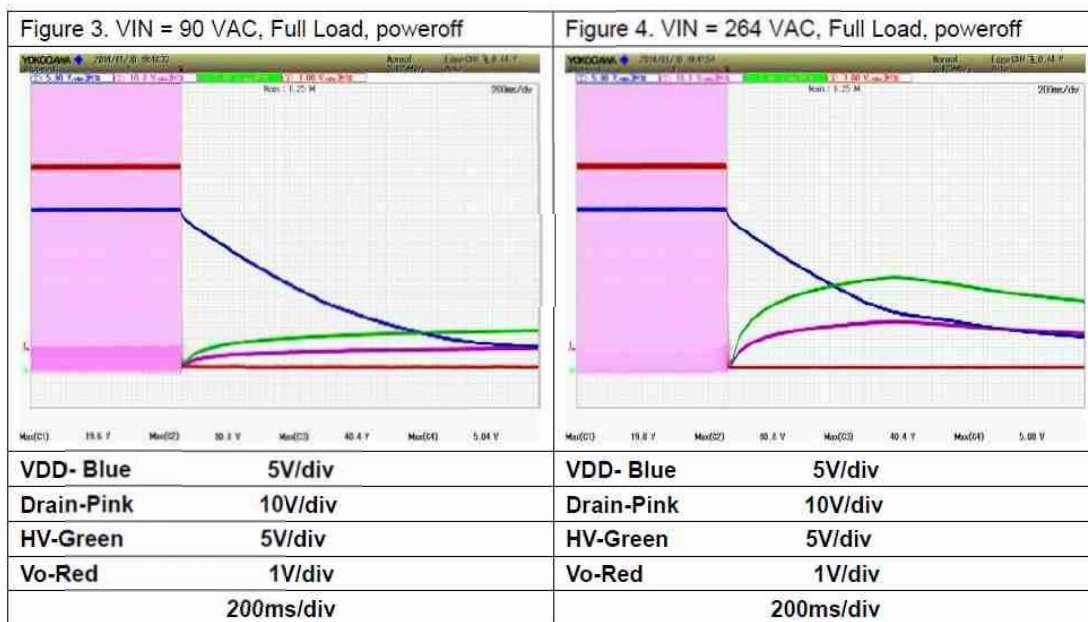
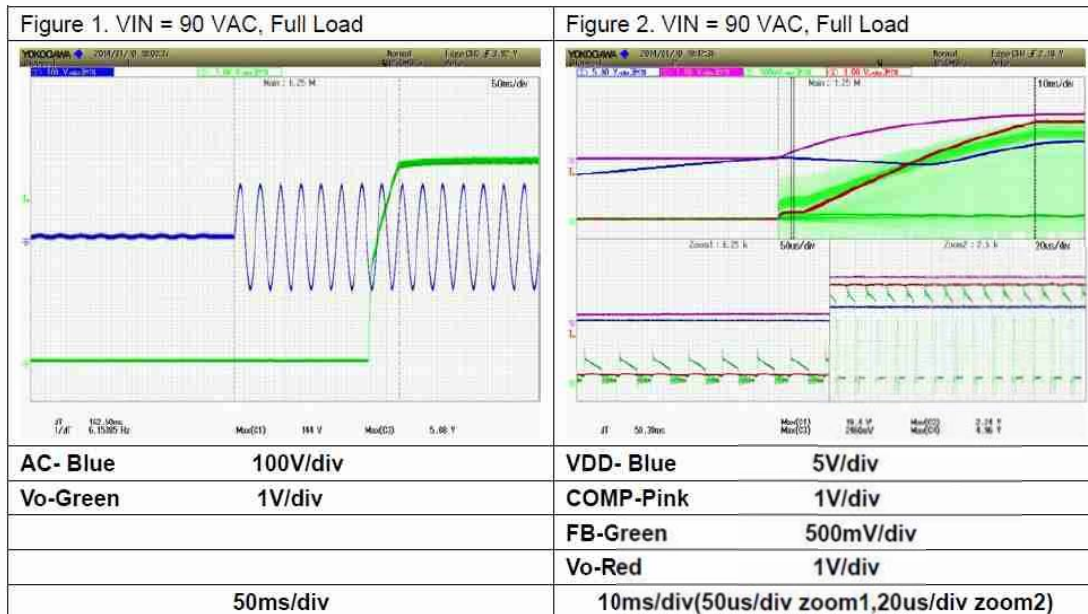
**8.4 CC-CV 特性**

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

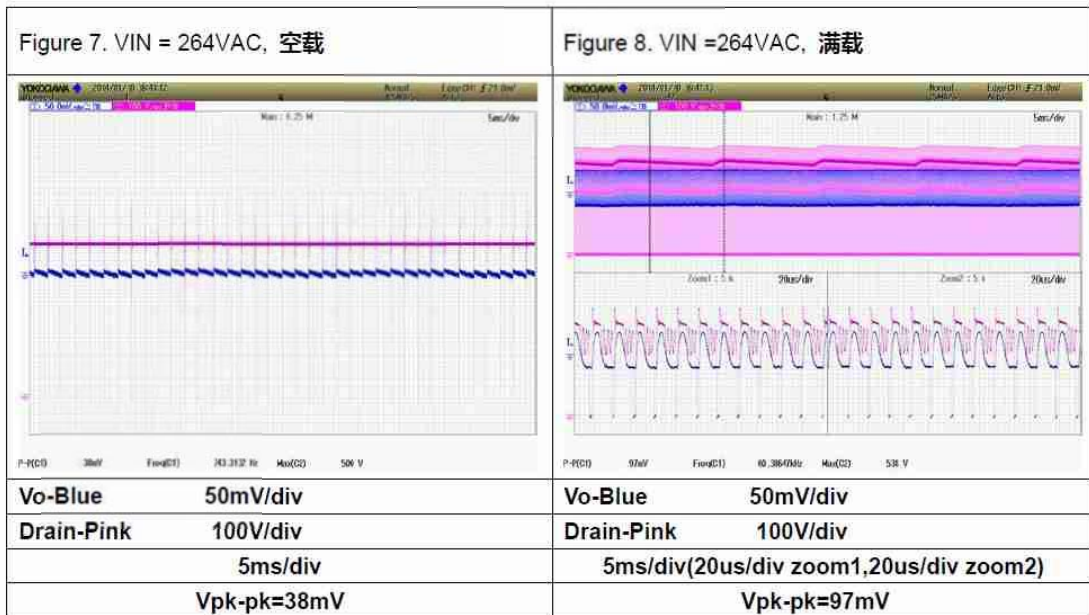
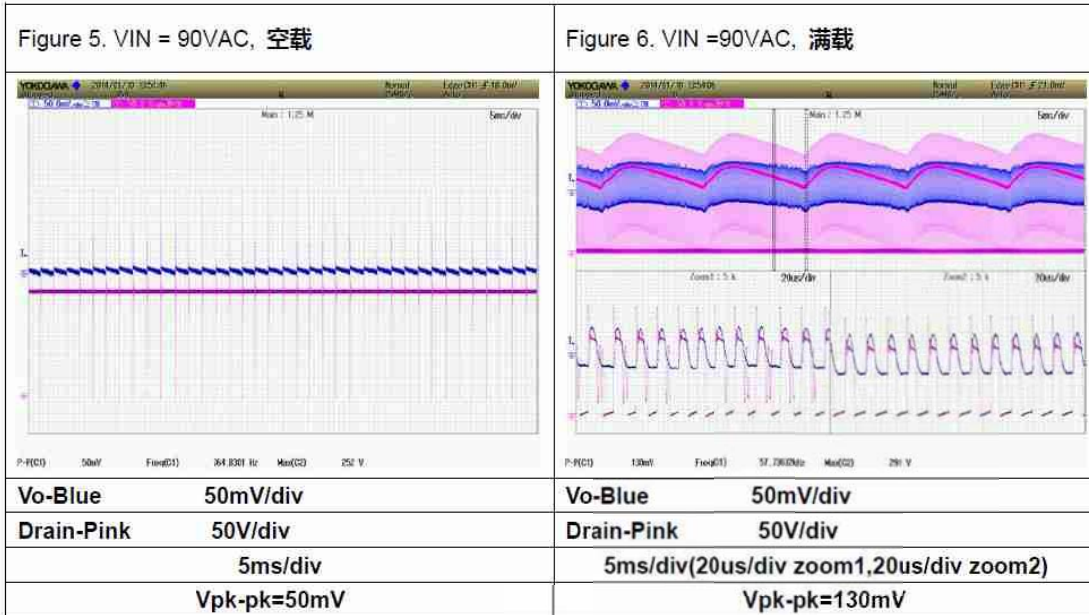
**CV:±1.41% CC:±2.2%**



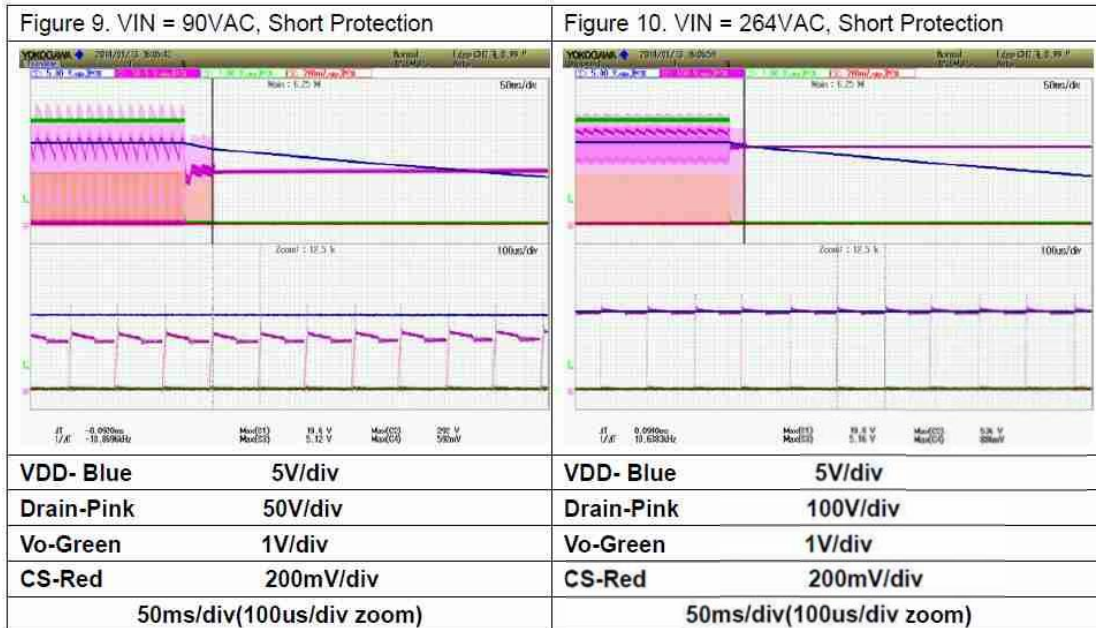
**8.5 Startup and Power off**



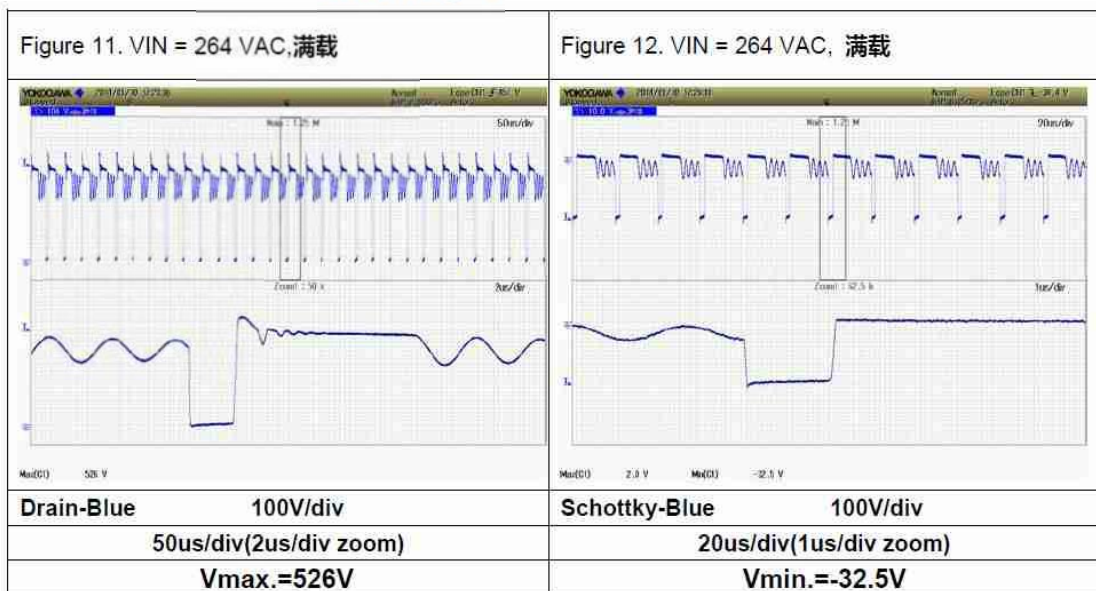
**8.6 Ripple**



### 8.7 Output Short Protection



### 8.8 Drain and Schottky Voltage



## 9. EFT Test

### Electrical Fast Transient/Burst Measurement Results

<b>Test Site</b>	TR2		<b>Temperature</b>	26 °C				
<b>EUT:</b>	uP2535 5V1A Charger		<b>Humidity :</b>	48%RH				
<b>M/N:</b>			<b>Barometric Pressure</b>	101.3kPa				
<b>S/N:</b>			<b>Input Voltage:</b>	220V,50Hz				
<b>Test Mode:</b>	Normal operation							
<b>Standard:</b>	EN 55024: 1998+A1: 2001+A2: 2003, IEC 61000-4-4: 2004							
<b>Measurement Equipment:</b>	<input checked="" type="checkbox"/> Immunity Test System (M/N: EMCPro) (Cali. Due Date: 2014.1.24) <input type="checkbox"/> CCL (M/N: CCL) (Cali. Due Date: 2014.1.24)							
Input a.c. power ports (Tr/Th: 5/50ns, Repetition Frequency: 5kHz)								
<b>Inject Line</b>	<b>Polarity</b>	<b>Test Level (kV)</b>	<b>Test Duration (second)</b>	<b>Inject Line</b>	<b>Polarity</b>	<b>Test Level (kV)</b>	<b>Test Duration (second)</b>	<b>Inject Line</b>
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.

## 10. Surge Test

### Surge Immunity Test Results

<b>Test Site</b>	TR2		<b>Temperature</b>	24 °C				
<b>EUT:</b>	uP2535 5V1A Charger		<b>Humidity :</b>	42%RH				
<b>M/N:</b>			<b>Barometric Pressure</b>	101kPa				
<b>S/N:</b>			<b>Input Voltage:</b>	230 V, 50 Hz				
<b>Standard:</b>	EN 55024:2010; IEC 61000-4-5:2005							
<b>Measurement Equipment:</b>	<input checked="" type="checkbox"/> Immunity Test System (M/N: EMCPro) (Cali. Due Date: 2014.1.24) <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)]								
<b>Inject Line</b>	<b>Polarity</b>	<b>Angle (degree)</b>	<b>Test Level (kV)</b>	<b>Test Interval (second)</b>	<b>Performance criterion</b>	<b>Test Result criterion</b>	<b>Result</b>	<b>Observation</b>
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

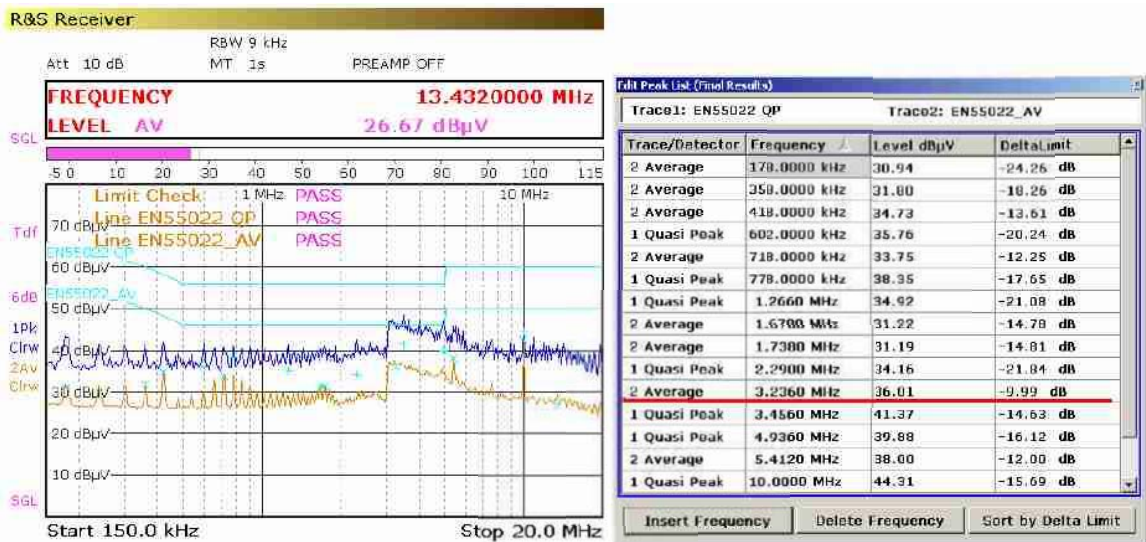
Note1: There was no change operated with initial operating during the test.

## 11. 电源CE和RE测试

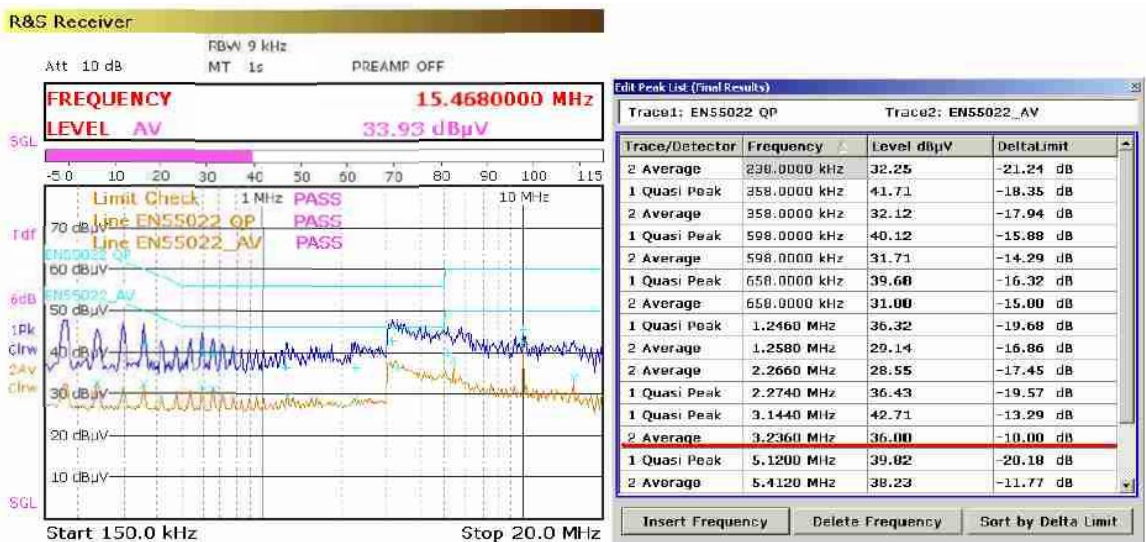
### 11.1 CE Test

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: <b>Line -9.99dB</b>
EUT: uP2535 5V1A Charger	Power: AC 230V/50Hz

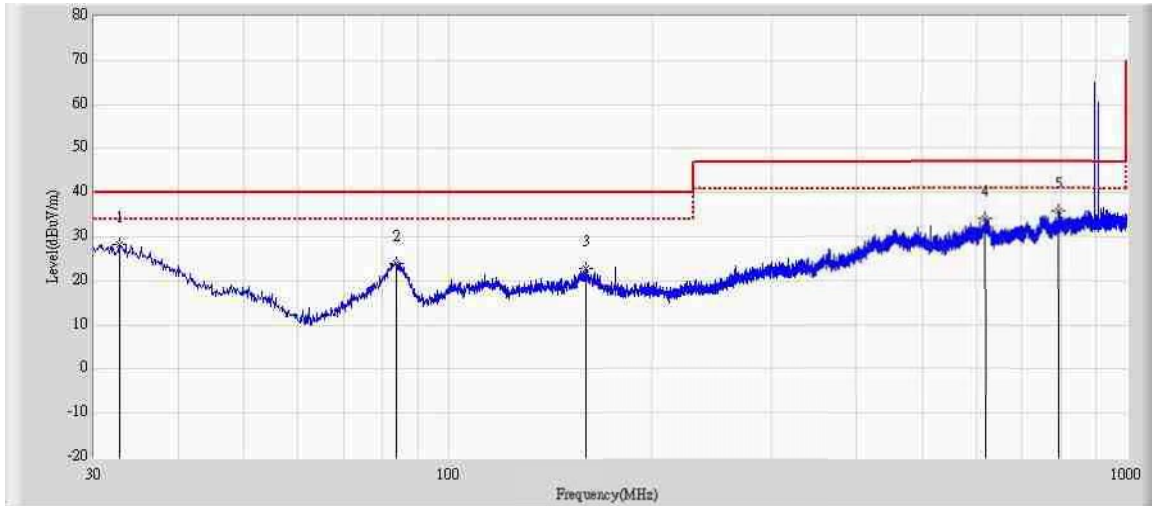


Limit: EN55022_CE_Mains_ClassB	Margin: <b>Neutral -10.0dB</b>
EUT: uP2535 5V1A Charger	Power: AC 230V/50Hz



**11.2 RE Test**

Limit: EN55022_RE(3m)_ClassB	Margin: <b>-11.17dB(PK)</b>
Probe: AC3_10m Comparison(30-1000MHz)	Polarity: Horizontal
EUT: <b>uP2535 5V1A Charger</b>	Power: AC 230V/50Hz



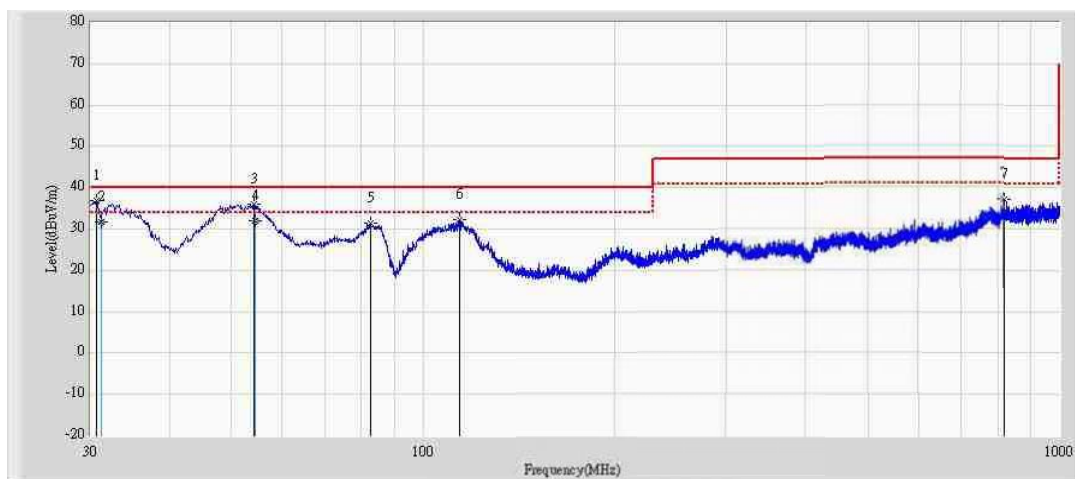
No	Mark	Frequency (MHz)	Measure Level (dBuV/m)	Reading Level (dBuV)	Over Limit (dB)	Limit (dBuV/m)	Probe (dB/m)	Cable (dB)	Amp (dB)	Ant Pos (cm)	Table Pos (deg)	Type
1		32.667	28.310	2.723	-11.690	40.000	19.114	6.473	0.000	0	0	PK
2		83.592	24.010	8.768	-15.990	40.000	8.480	6.762	0.000	0	0	PK
3		159.374	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).



Limit: EN55022_RE(3m)_ClassB	Margin: <b>-7.911dB(QP)</b>
Probe: AC3_10m Comparison(30-1000MHz)	Polarity: Vertical
EUT: <b>uP2535 5V1A Charger</b>	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).

**12. 附录****uP2535/uP2536 脚位配置图:**