

Design Example Report

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| | |
|------|--|
| 标题 | 基于 PN8316 的 22.4W LED 应用方案 80V280mA |
| 规格 | 输入电压：176~264V 输出功率：22.4W 输出电压：80V 输出电流：280mA±3% |
| 应用范围 | 照明类电源产品，吸顶灯等 |
| 文件编号 | DER-8316-13-P058 |
| 编写时间 | 2014-1-1 |
| 编写部门 | 工程部 |
| 版本号 | V1.2 |

特性概述：

- 单面板设计，单面元器件，面积：55mm*32mm；
- 输入电压：176~264Vac；
- 输出功率：≤22.4W；
- 拥有 LED 灯开路、短路、过温保护、外接元器件开短路保护等功能；
- 拥有电流采样电阻短路保护；
- 24W 输出效率：≥88%；

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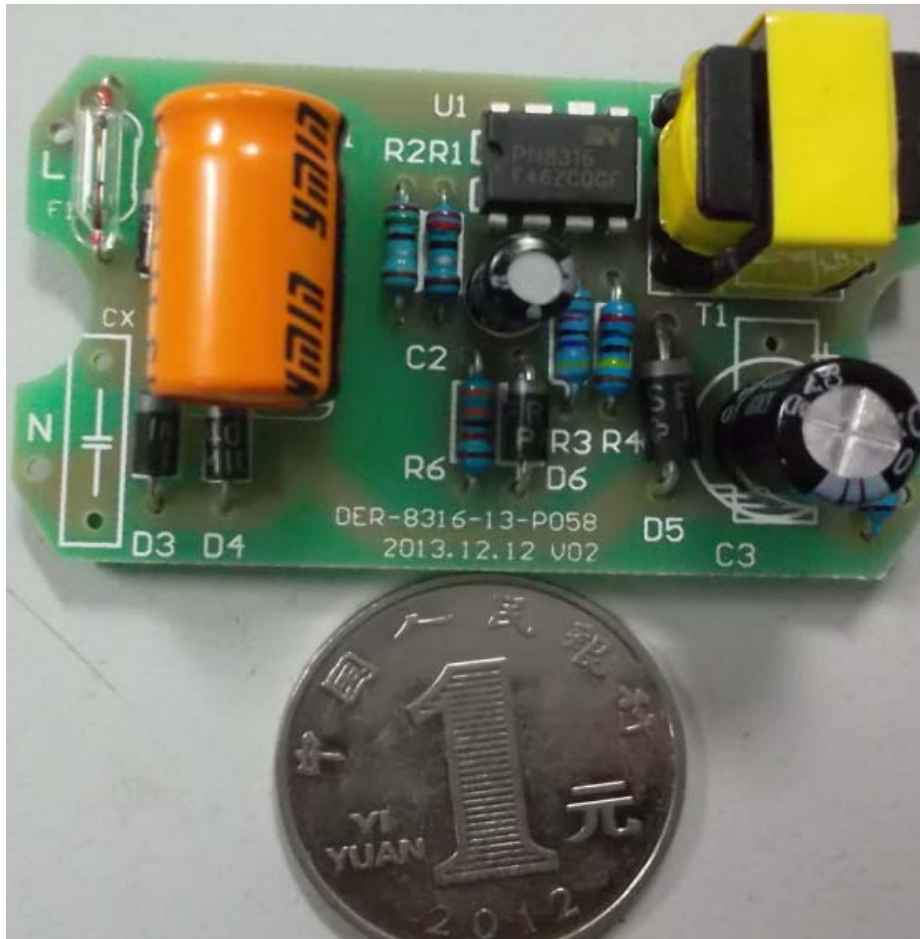
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1. 电源介绍

该报告提供了一种基于 PN8316 80V/280mA 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

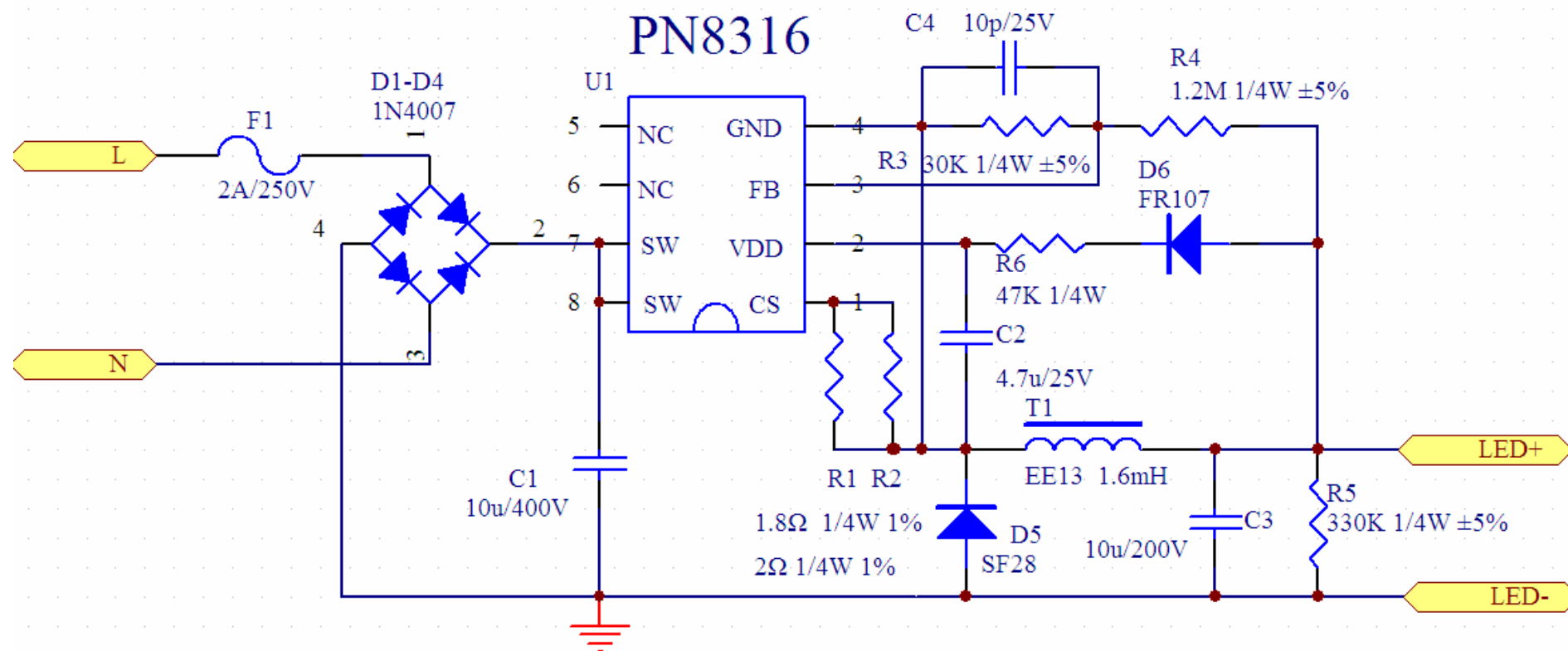
最大输入输出电气特性：

| 项目描述 | 标号 | Min | Typ | Max | Unit | 备注 |
|------|--------|-----|------|-----|------|--------|
| 输入电压 | Vin | 176 | 230 | 264 | Vac | 60Hz |
| 输出电压 | Vout | 28 | 80 | 84 | V | |
| 输出电流 | Iout | 270 | 280 | 290 | mA | |
| 输出功率 | Pout | | 22.4 | | W | |
| 效率 | η | 88 | | | % | CV=80V |
| 工作环境 | Tamb | 0 | 25 | 80 | °C | |

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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

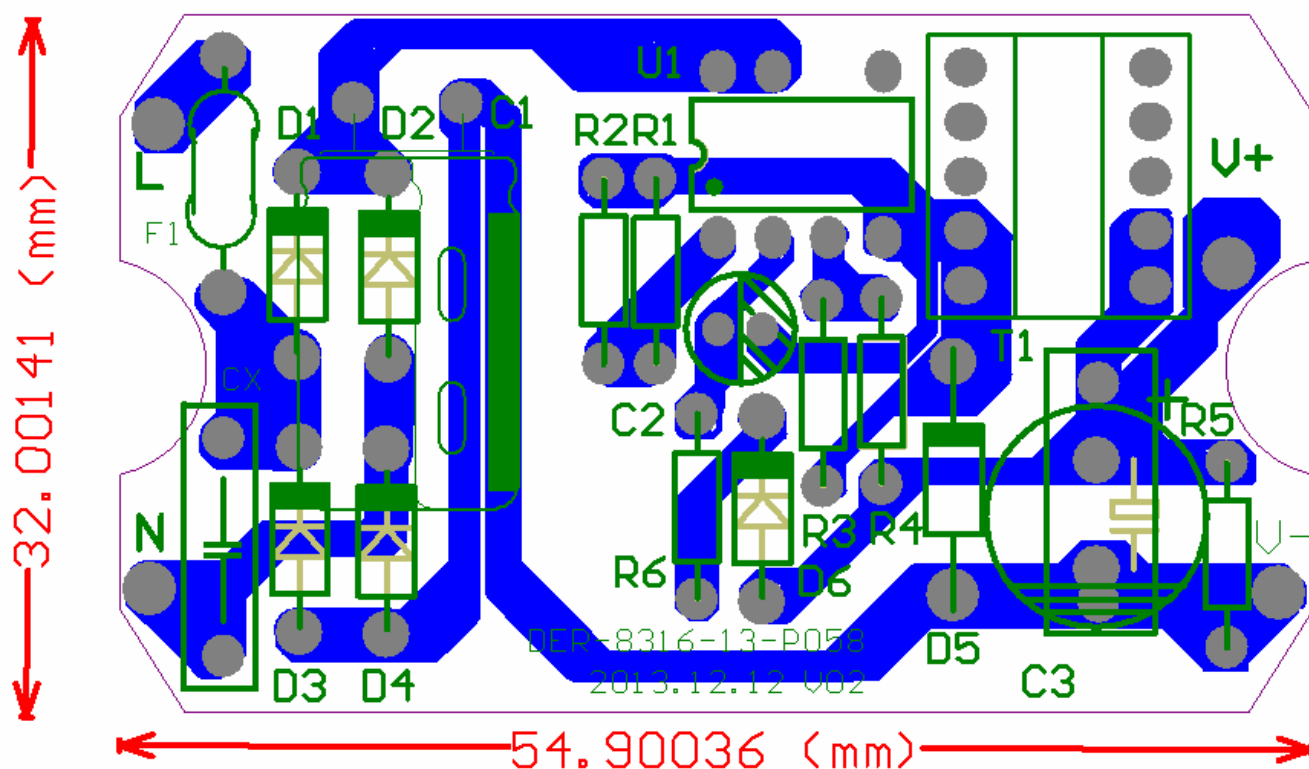
电路图中R3、R4为FB分压电阻，可通过辅助绕组采样出的电压，等比例调节R3、R4可实现LED输出开环电压值,FB过电压保护点约为3.3V.

当PN8316 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 为普通单面板工艺，单面元器件，铜厚 1OZ，基材为 FR-4。PCB 长 55mm，宽 32mm，厚 1.6mm。污染等级符合 CLASS2。



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6. Bill of Materials

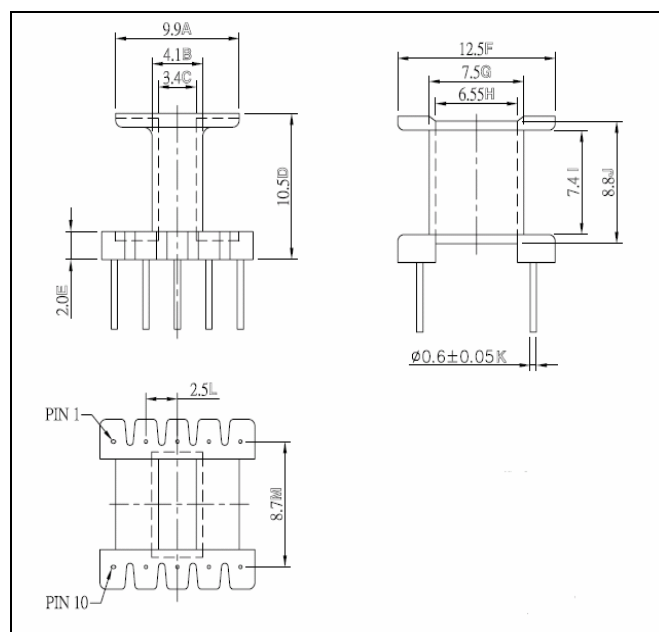
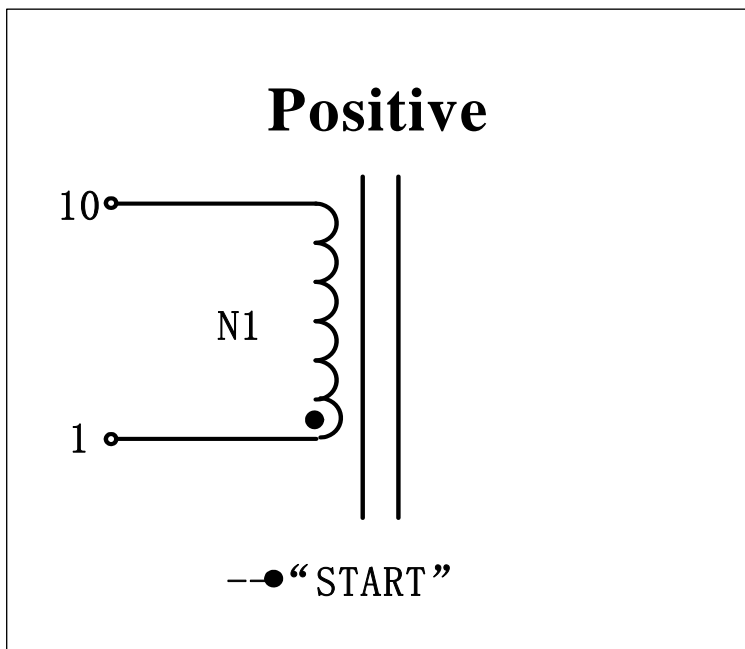
| 序号 | 元件标号 | 元件名称 | 元件型号 | 封装尺寸 | 数量 | 备注 |
|----|------|-------|-------------------|---------|----|----|
| 1 | C1 | 电解电容 | 10uF/400V | 10*20mm | 1 | |
| 2 | C2 | 电解电容 | 4.7uF/50V | 6*11mm | 1 | |
| 3 | C3 | 电解电容 | 10uF/200V | 8*11mm | 1 | |
| 4 | C4 | 瓷片电容 | 10pF/25V | P=5mm | 1 | |
| 5 | D1 | 普通二极管 | 1N4007 | DO-15 | 1 | |
| 6 | D2 | 普通二极管 | 1N4007 | DO-15 | 1 | |
| 7 | D3 | 普通二极管 | 1N4007 | DO-15 | 1 | |
| 8 | D4 | 普通二极管 | 1N4007 | DO-15 | 1 | |
| 9 | D5 | 快速二极管 | SF28 | DO-15 | 1 | |
| 10 | D6 | 快速二极管 | FR107 | DO-15 | 1 | |
| 11 | F1 | 保险丝 | 2A/250V | P=10mm | 1 | |
| 12 | R1 | 插件电阻 | 1.8R 1% | 1/4W | 1 | |
| 13 | R2 | 插件电阻 | 2R 1% | 1/4W | 1 | |
| 14 | R3 | 插件电阻 | 30K | 1/4W | 1 | |
| 15 | R4 | 插件电阻 | 1.2M | 1/4W | 1 | |
| 16 | R5 | 插件电阻 | 330K | 1/4W | 1 | |
| 17 | R6 | 插件电阻 | 47K | 1/4W | 1 | |
| 18 | T1 | 变压器 | EE13 式 5+5, 1.7mH | EE-13 | 1 | |
| 19 | U1 | IC | PN8316 | DIP-7 | 1 | |

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7. 变压器规格

一, 绕线结构及视图 (磁芯: EE13; 材质: PC40) 骨架图 立式 5+5



二、线包制作工序

| 工序 | 漆包线规格 | 圈数 | 起点—终点 | 绕法 | 绝缘胶带 |
|----|--|-------|-------|--------|------|
| N1 | $\Phi 0.25\text{mm} \times 1\text{P}$ 2UEW-N | 210Ts | 1—10 | 密绕 8 层 | 2Ts |

备注:

- 1) 浸漆。
- 2) Pin1 到 Pin10 间的感量为 $1.7\text{mH} \pm 7\%$ (1KHz, 1V);
- 3) 气隙一定要磨磁芯中柱, 不能垫气隙。

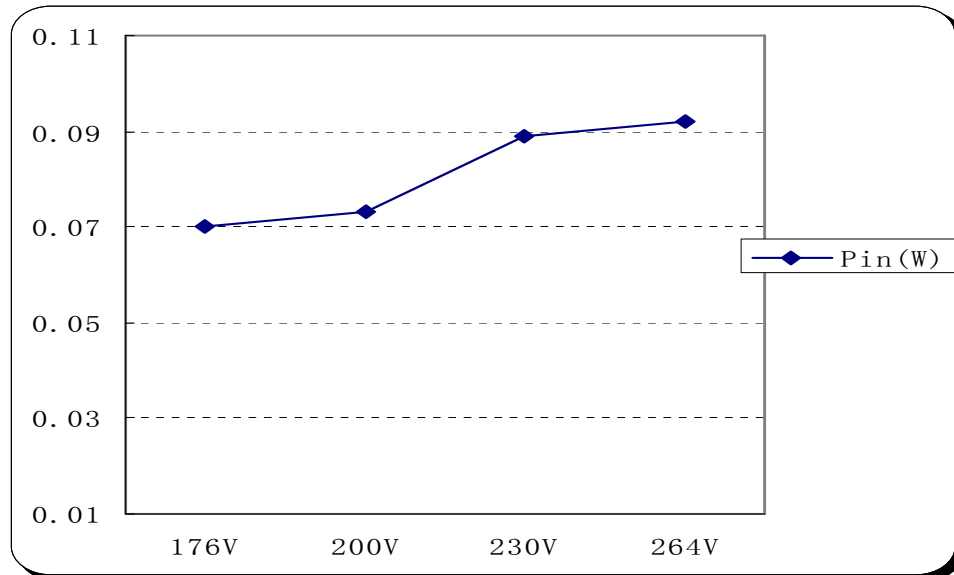
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8. 电源输入输出特性和工作波形

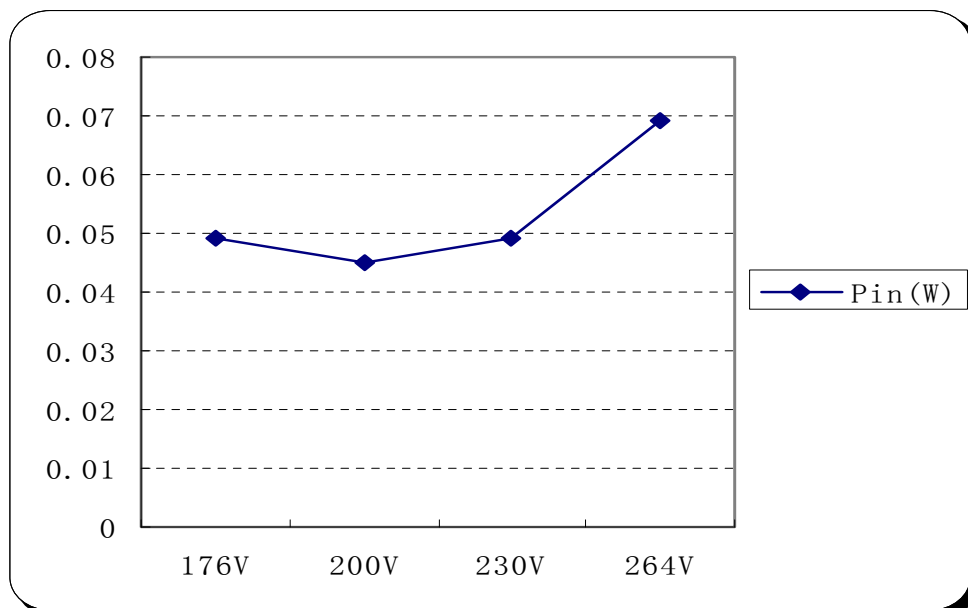
1) Input power when LED open

| Input Power | 176V | 200V | 230V | 264V |
|-------------|------|-------|-------|-------|
| Pin(W) | 0.07 | 0.073 | 0.089 | 0.092 |



2) Input power when LED short

| Input Power | 176V | 200V | 230V | 264V |
|-------------|-------|-------|-------|-------|
| Pin(W) | 0.049 | 0.045 | 0.049 | 0.069 |

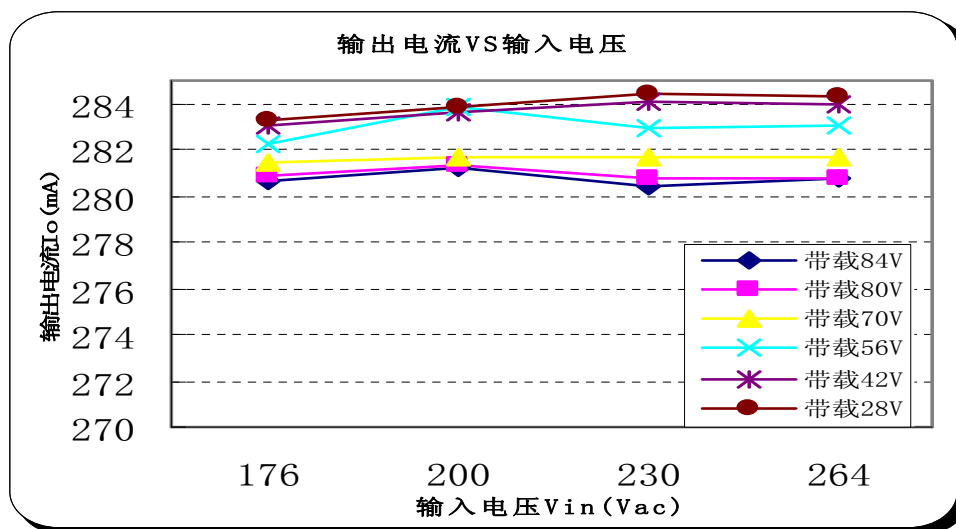
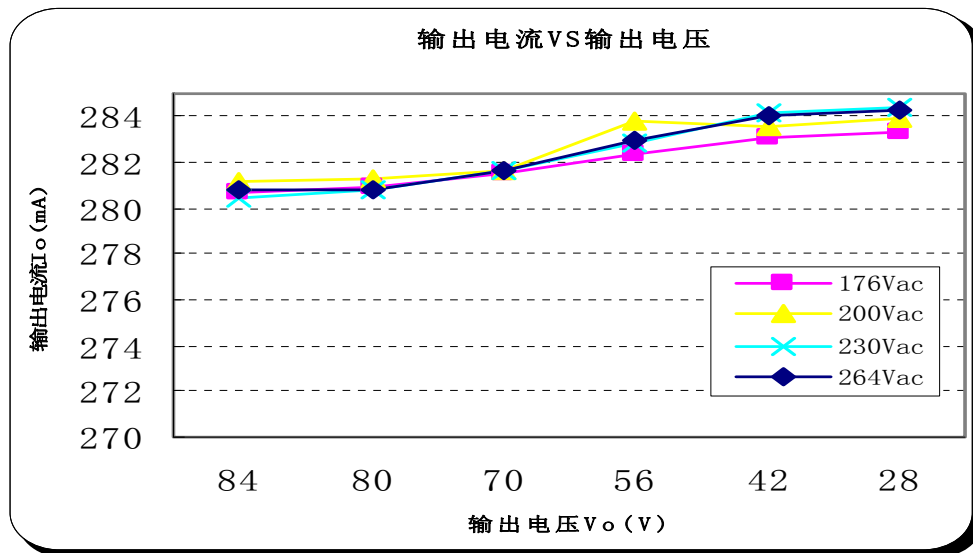


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3) 线性调整率&负载调整率

| 带载 (Vo) | 输出电流 (mA) | | | | 线性调整率 |
|---------|-----------|--------|--------|--------|--------|
| | 176Vac | 200Vac | 230Vac | 264Vac | |
| 84 | 280.7 | 281.2 | 280.4 | 280.8 | ±0.14% |
| 80 | 280.9 | 281.3 | 280.8 | 280.8 | ±0.08% |
| 70 | 281.5 | 281.7 | 281.7 | 281.7 | ±0.03% |
| 56 | 282.3 | 283.8 | 282.9 | 283 | ±0.26% |
| 42 | 283.1 | 283.6 | 284.1 | 284 | ±0.17% |
| 28 | 283.3 | 283.9 | 284.4 | 284.3 | ±0.19% |
| 负载调整率 | ±0.46% | ±0.47% | ±0.70% | ±0.61% | |



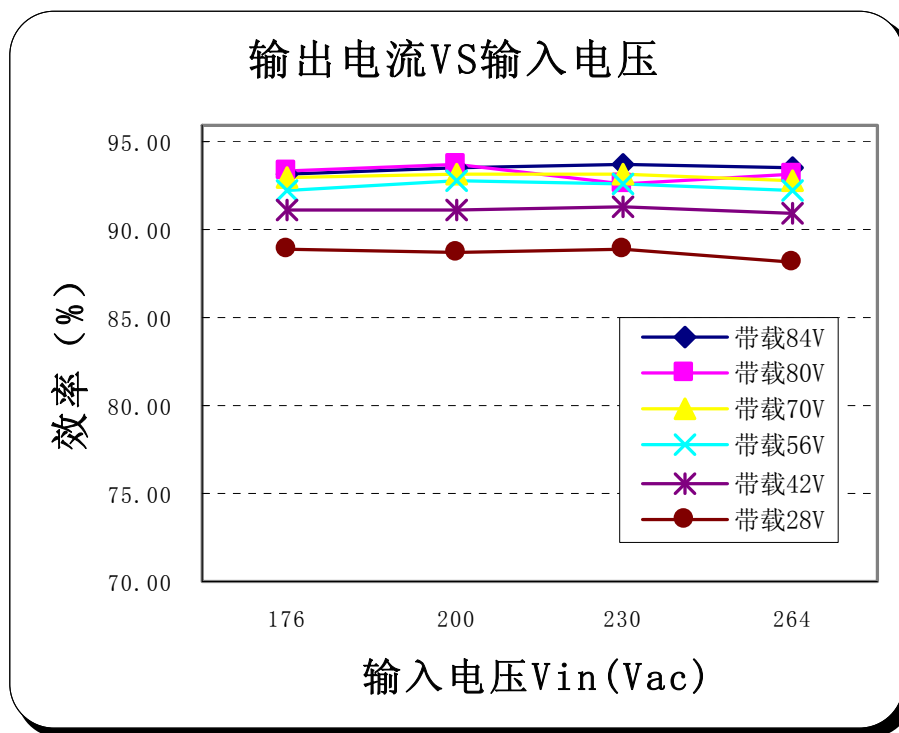
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4) 效率

Note: 用电子负载CV模式模拟LED负载

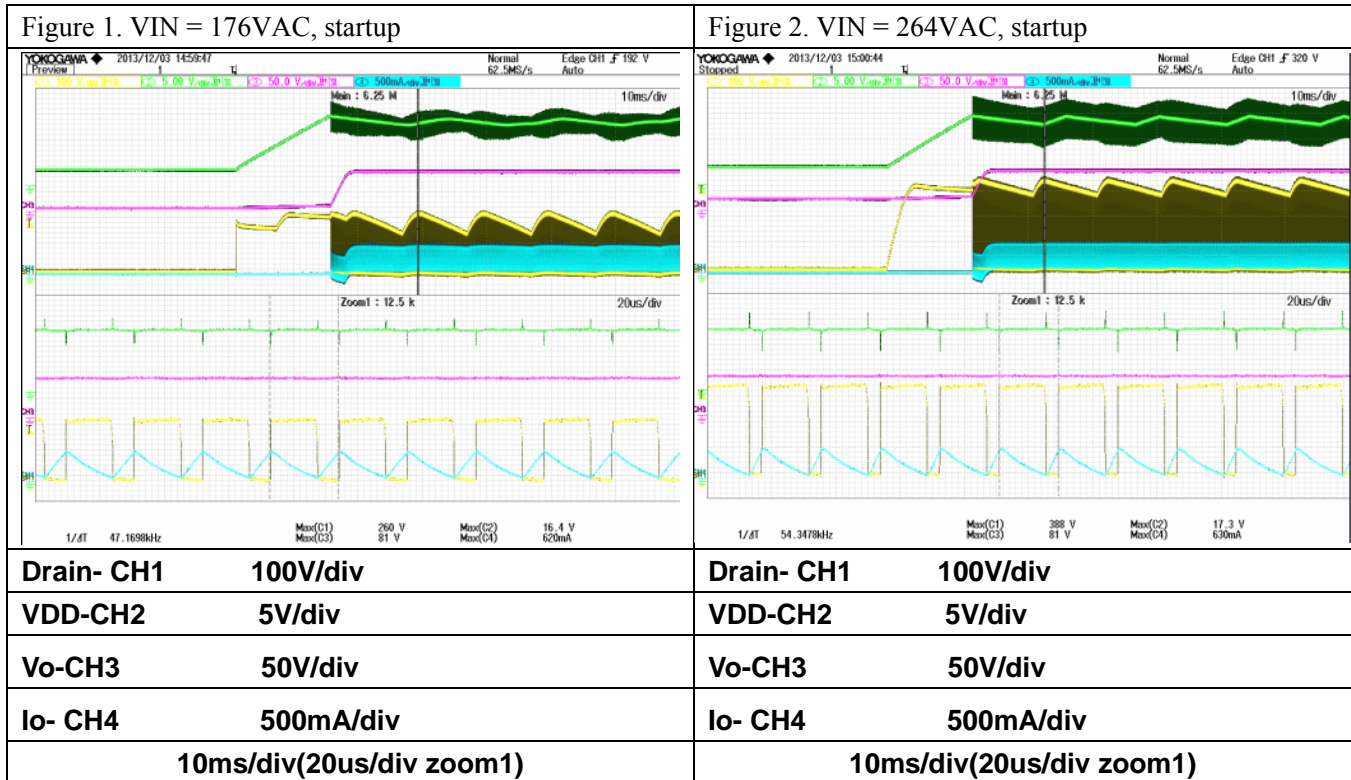
| 带载 (Vo) | 效率 (%) | | | |
|---------|--------|--------|--------|--------|
| | 176Vac | 200Vac | 230Vac | 264Vac |
| 84 | 93.23 | 93.62 | 93.84 | 93.64 |
| 80 | 93.32 | 93.77 | 92.75 | 93.29 |
| 70 | 93.08 | 93.23 | 93.19 | 92.84 |
| 56 | 92.29 | 92.89 | 92.59 | 92.19 |
| 42 | 91.11 | 91.20 | 91.29 | 91.05 |
| 28 | 89.03 | 88.72 | 88.97 | 88.16 |



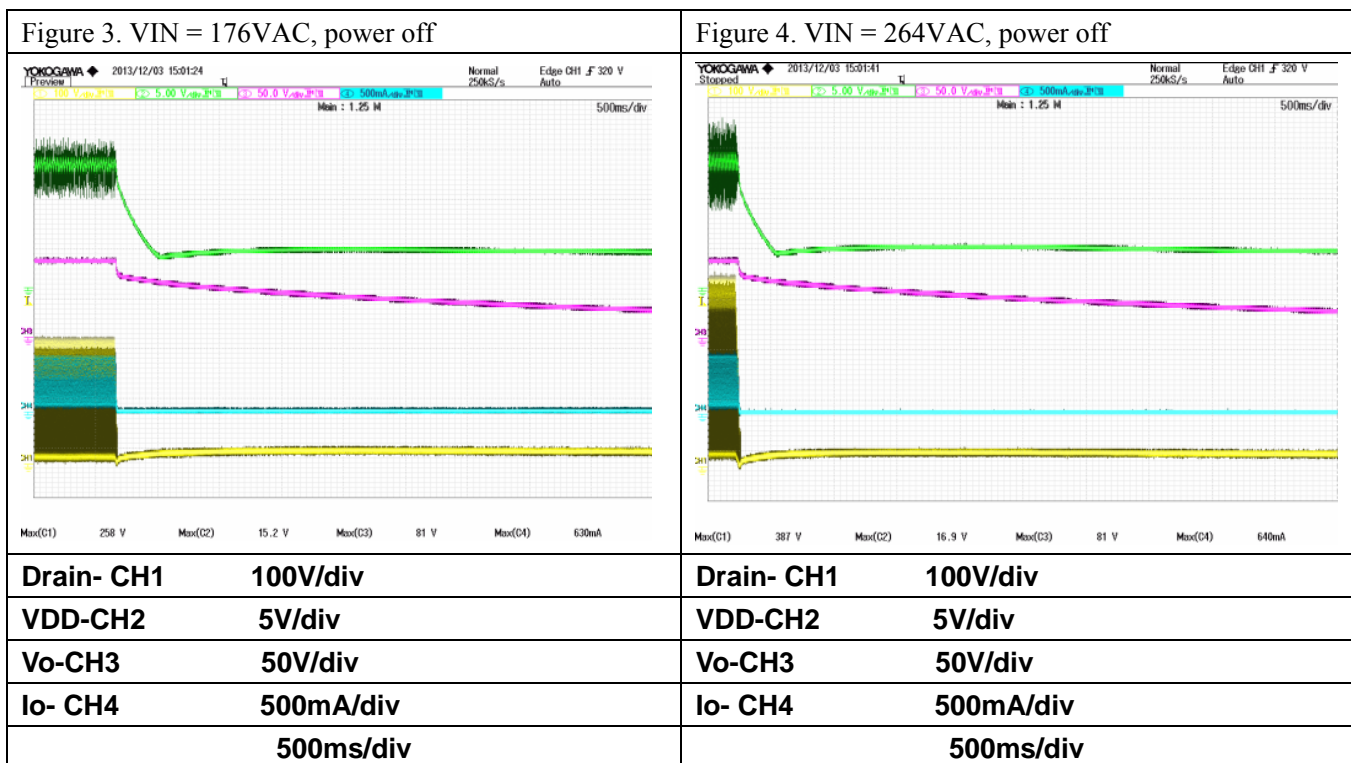
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5) Startup



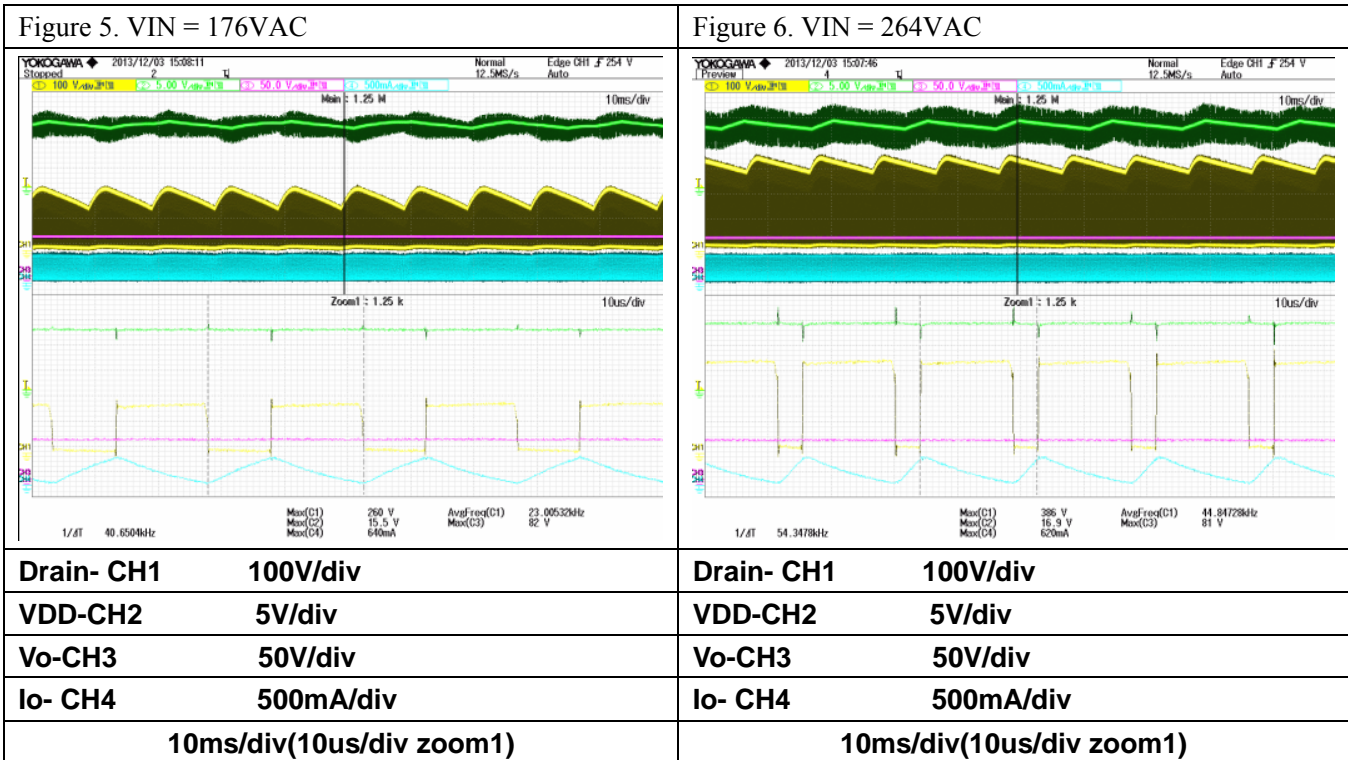
6) Power off



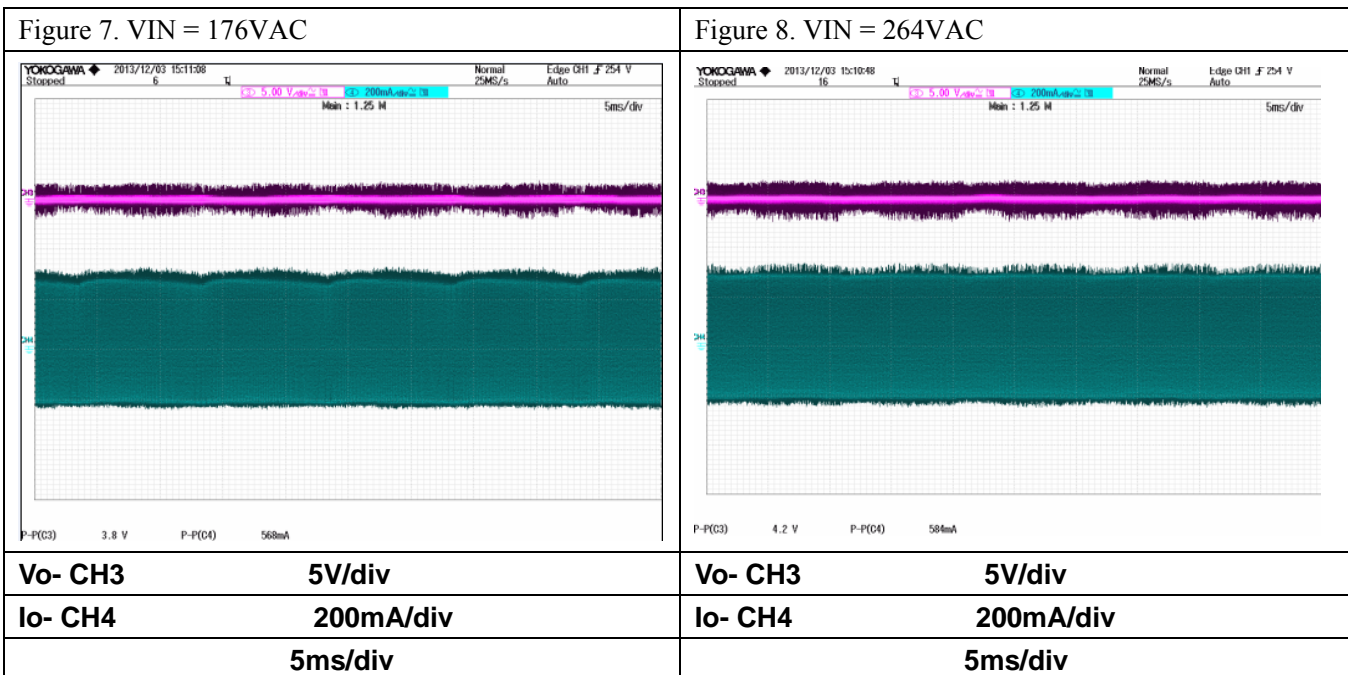
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7) Operating waveforms



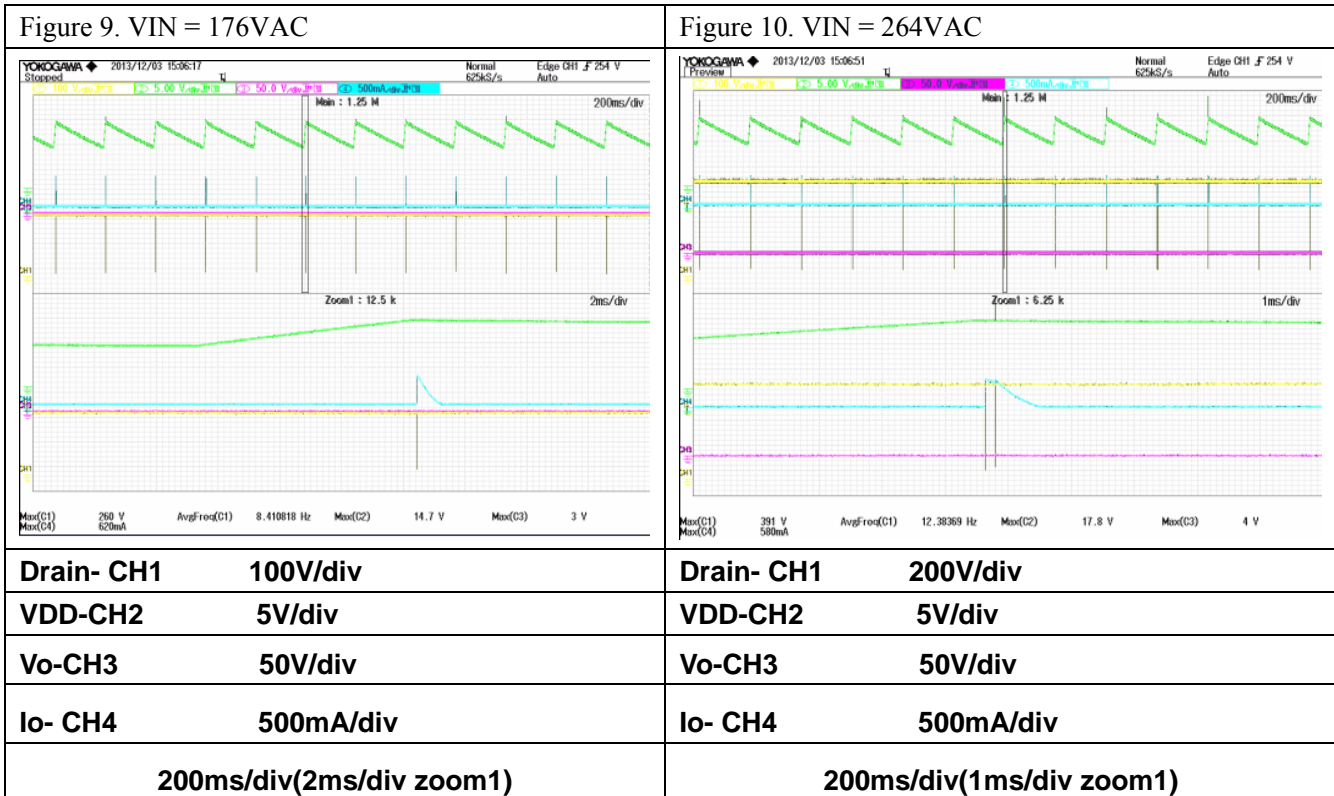
8) Ripple & Noise



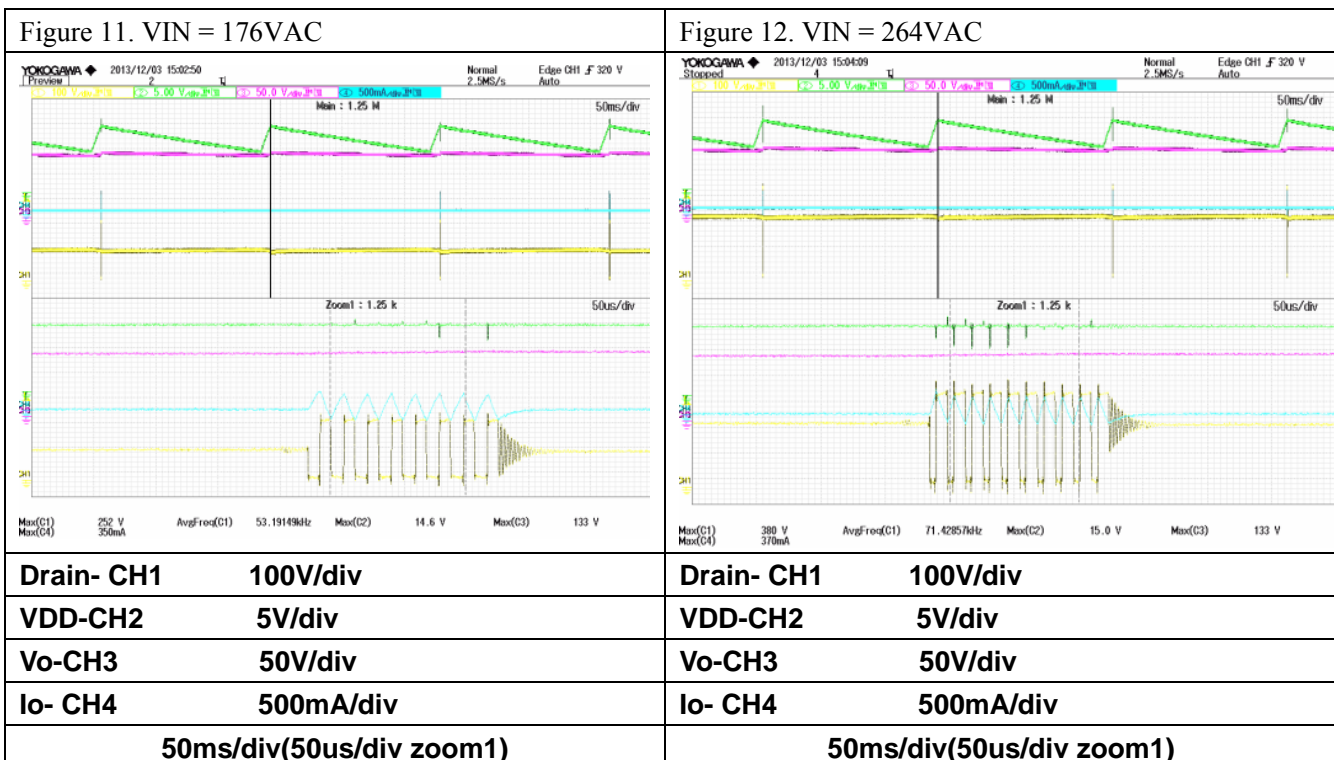
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9) LED Short Protection



10) LED Open Protection



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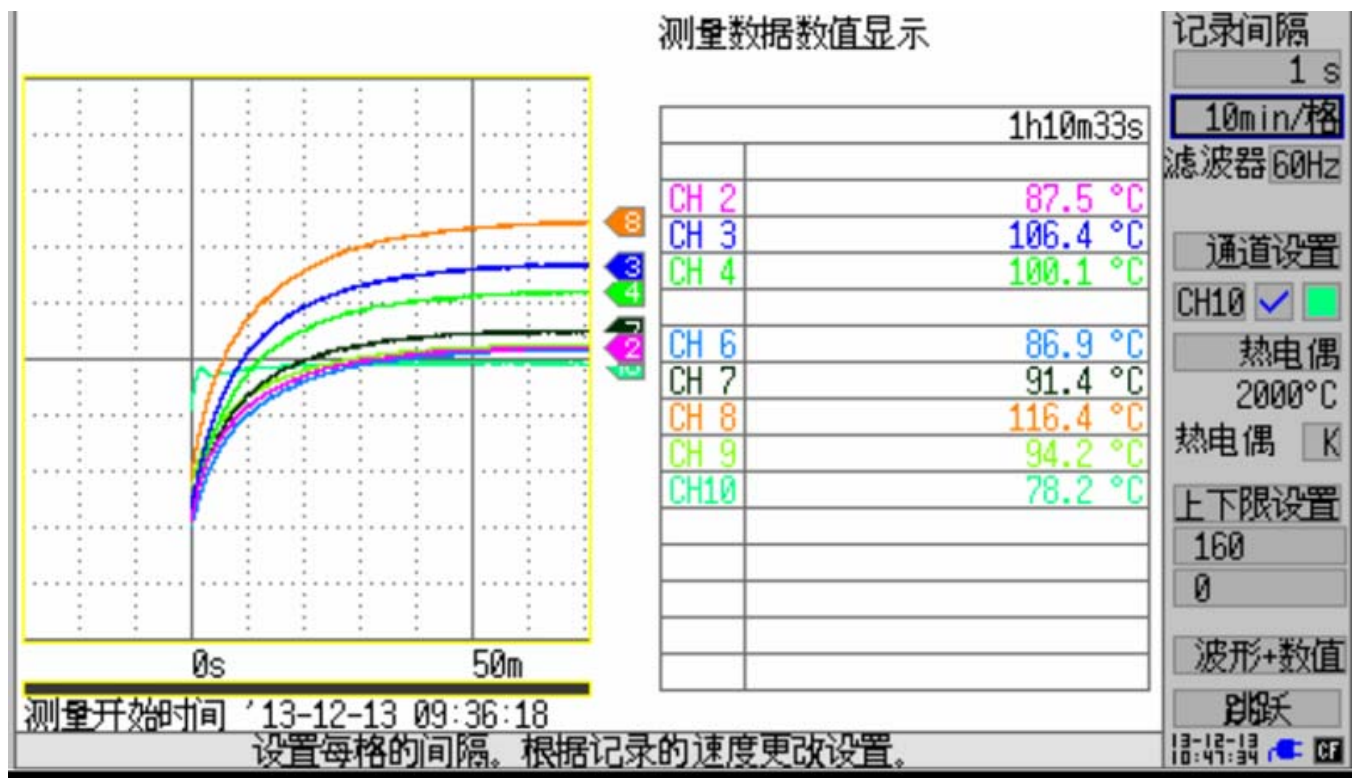
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9. 温度特性

测试条件: 176-264Vac 带 25 颗灯串联, 灯电压约 80V 280mA

| | CH2 | CH3 | CH4 | CH6 | CH7 | CH8 | CH9 | CH10 |
|------------|-----------|----------|-------|-----------|-----------|-------|----------|---------|
| 输入电压 (Vac) | PCB 温度 °C | 变压器线包 °C | 磁芯 °C | 输出电解电容 °C | 输入电解电容 °C | IC °C | 输出二极管 °C | 环境温度 °C |
| 176 | 87.5 | 106.4 | 101.1 | 86.9 | 91.4 | 116.4 | 94.2 | 78.2 |
| 200 | 87.3 | 107.9 | 101.5 | 87.4 | 90.4 | 114.6 | 95 | 78.5 |
| 230 | 87.2 | 109.9 | 103.1 | 88 | 89.3 | 113.6 | 95.9 | 78.4 |
| 264 | 87.6 | 112.2 | 104.7 | 88.5 | 89.5 | 113.7 | 96.9 | 78.8 |

176Vac 温升曲线



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10. 电源安规测试

1) EFT Test

Electrical Fast Transient/Burst Measurement Results

| Test Site | TR2 | | | Temperature | 26°C | | | |
|--|---|-----------------|------------------------|---------------------|-----------------------|-----------------------|--------|-------------|
| EUT: | 80V280mA | | | 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: 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 |
| 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 | + | 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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2) Surge Test

Surge Immunity Test Results

| Test Site | TR1 | Temperature | 26°C | | | | | |
|--|--|---------------------|-----------------|------------------------|-----------------------|-----------------------|--------|-------------|
| EUT: | 80V280mA | 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: 2012.04.23) <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.