# 设计范例报告

| | |
|---|---|
| **标题** | ***使用LYTSwitch™-4 LYT4322E设计的12 W高功率因数．非隔离．降压-升压式．可控硅调光的LED驱动器*** |
| **规格** | 190 VAC – 265 VAC输入；<br>120V$_{TYP}$，100mA输出 |
| **应用** | A19 LED驱动器 |
| **作者** | 应用工程部 |
| **文档编号** | DER-412 |
| **日期** | 2014年6月9日 |
| **修订版本** | 1.0 |

**特色概述**

- 单级功率因数校正(PFC)与精确恒流(CC)输出相结合
- 可控硅调光
  - 可兼容300 W至1200 W的各种可控硅调光器
  - 快速启动时间(<200 ms) – 无可见延迟
- 集成的保护及可靠性能
  - 输出短路保护，带自动恢复功能
  - 带更大迟滞的自动恢复热关断
  - 在AC电压跌落期间不会造成任何损坏
- 在230 VAC下，PF > 0.9
- 满足振铃波、差模输入浪涌和EN55015传导EMI要求



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# 目录

**重要说明**：虽然本电路板的设计满足安全隔离要求，但工程原型尚未获得机构认证。因此，必须使用隔离变压器向原型板提供AC输入，以执行所有测试。



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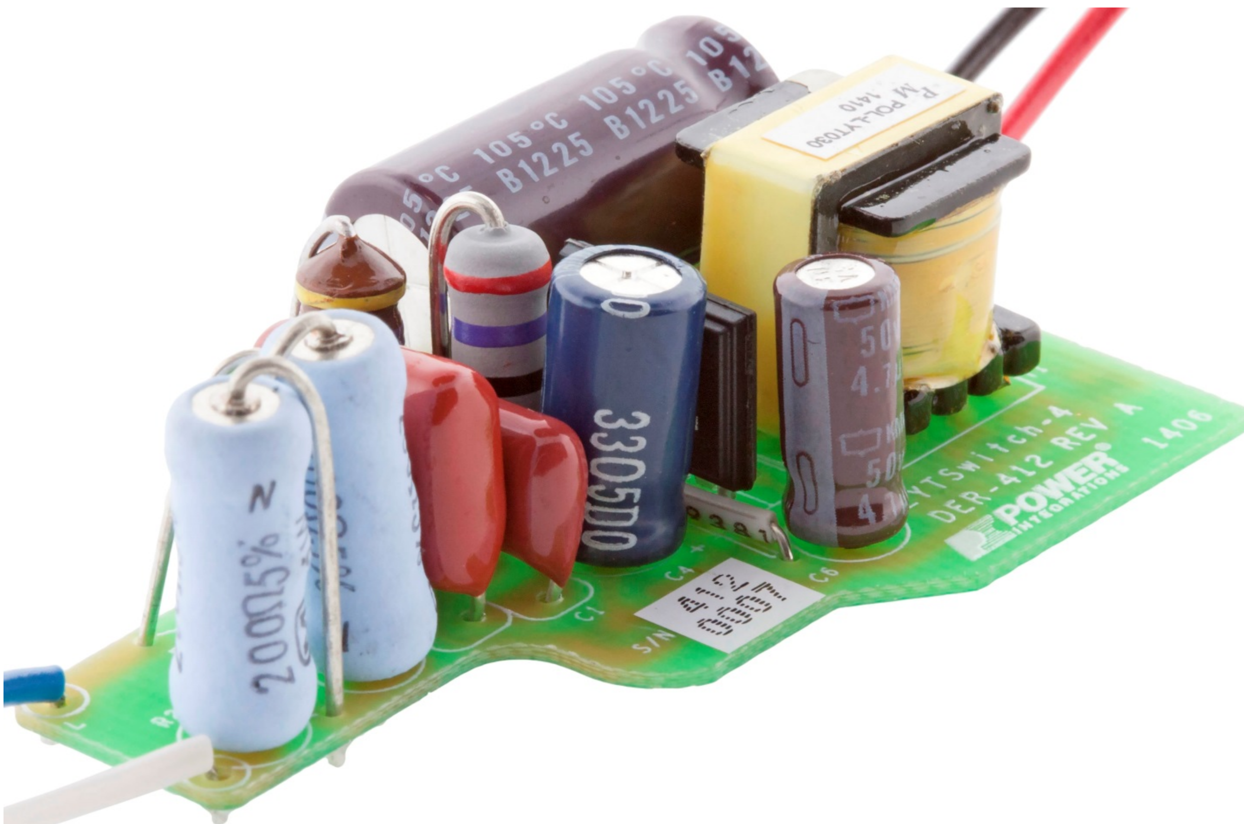
# 1 简介

本文档介绍的是一款非隔离、高功率因数(PF)、可控硅调光的LED驱动器，它可以在190 VAC至265 VAC（典型值为50Hz）的输入电压范围内为LED灯串提供额定电压120V、额定电流100 mA的驱动。该LED驱动器采用了LYTSwitch-4系列IC中的LYT4322E器件。

所采用的拓扑结构是单级、非隔离、降压-升压式拓扑结构，可满足本设计的高功率因数、恒流调整和调光要求。

本文档包含LED驱动器规格、电路原理图、PCB设计细节、物料清单、变压器规格文件和典型性能特征。



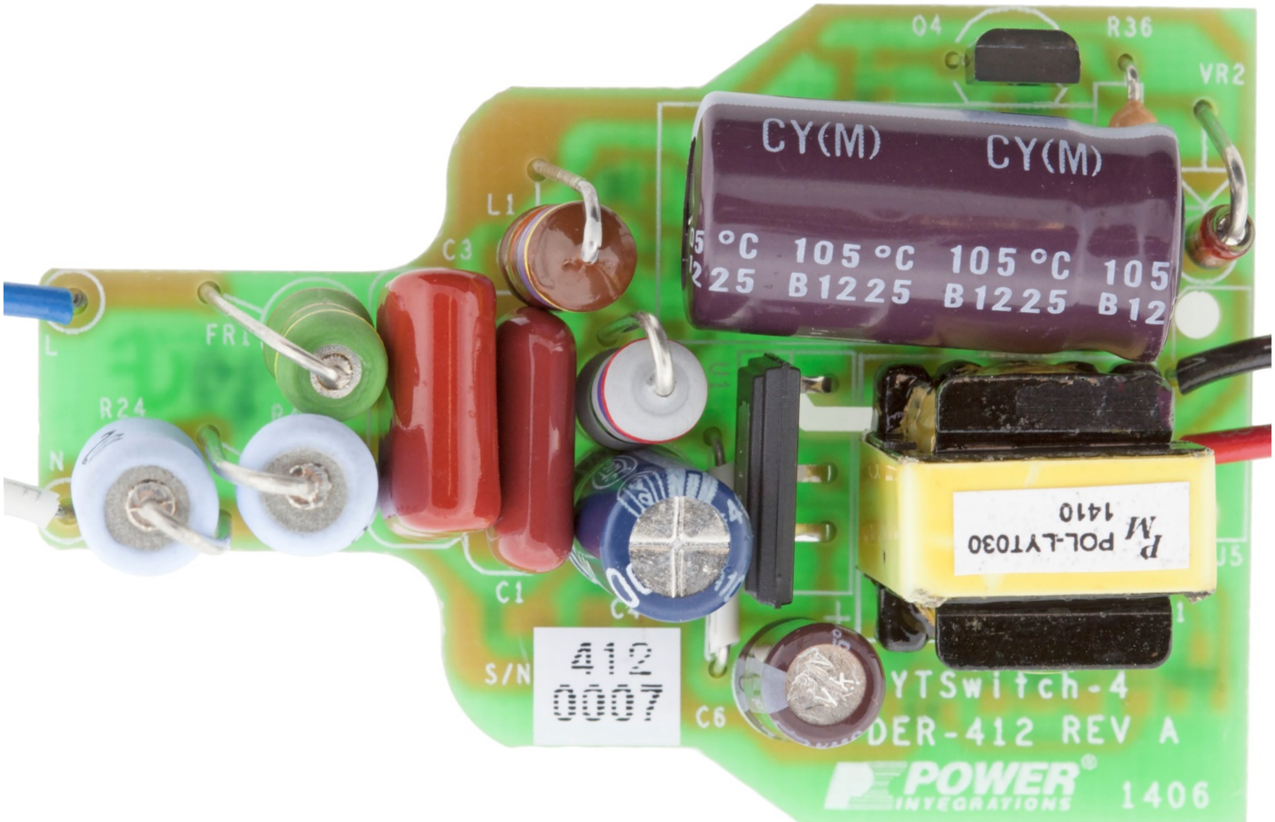



**Figure 1 –** Populated Circuit Board, Top View.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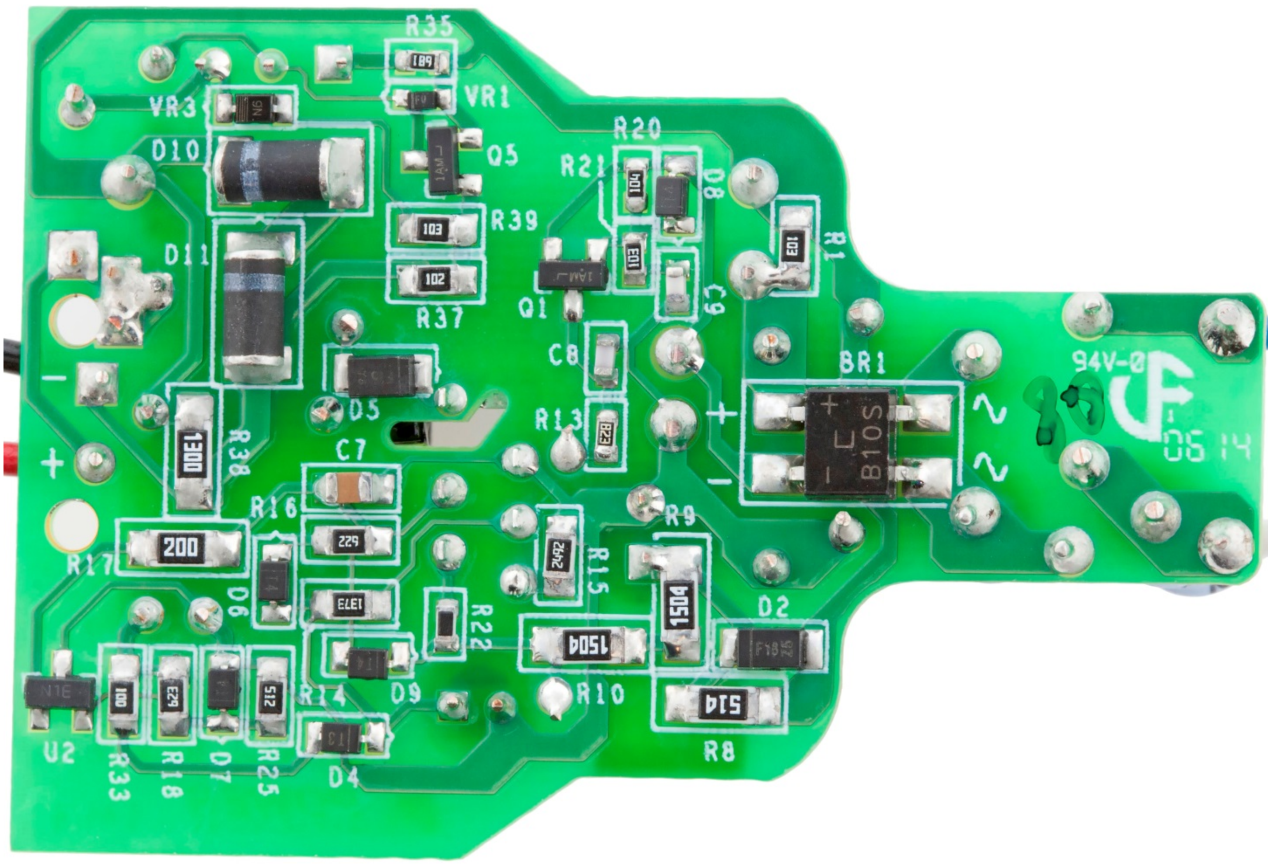


**Figure 2 –** Populated Circuit Board, Bottom View.

## 2　电源规格

下表所列为设计的最低可接受性能。实际性能可参考测量结果部分。

| 说明 | 符号 | 最小值 | 典型值 | 最大值 | 单位 | 备注 |
|---|---|---|---|---|---|---|
| **输入** | | | | | | |
| 电压 | $V_{IN}$ | 190 | 230 | 265 | VAC | 双导线 – 无P.E. |
| 频率 | $f_{LINE}$ | | 50 | | Hz | |
| **输出** | | | | | | |
| 输出电压 | $V_{OUT}$ | | 120 | | V | |
| 输出电流 | $I_{OUT}$ | 93 | 100 | 107 | mA | $V_{OUT}$ = 120V, $V_{IN}$ = 230 VAC, 25°C |
| **总输出功率** | | | | | | |
| 连续输出功率 | $P_{OUT}$ | | 12 | | W | |
| **效率** | | | | | | |
| 满载 | η | 84 | 85 | | % | 在$P_{OUT}$ 25°C、无调光器、230VAC的条件下测得 |
| **环境** | | | | | | |
| 传导EMI | | | CISPR 15B / EN55015B | | | |
| 安全 | | | 非隔离 | | | |
| 振铃波(100 kHz) | | | | | | |
| 　差模(L1-L2) | | | 2.5 | | kV | |
| 差模浪涌 | | | 500 | | V | |
| 功率因数 | | | 0.9 | | | 在$V_{OUT(TYP)}$、$I_{OUT(TYP)}$以及230 VAC、50Hz条件下测得 |
| 环境温度 | $T_{AMB}$ | | 40 | | °C | 自然对流，敞开式<br>*在最终装配时应考虑采用灌封，用以提高工作温度以及降低衰减电路R24和R40上的热应力。 |


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## 3 电路原理图

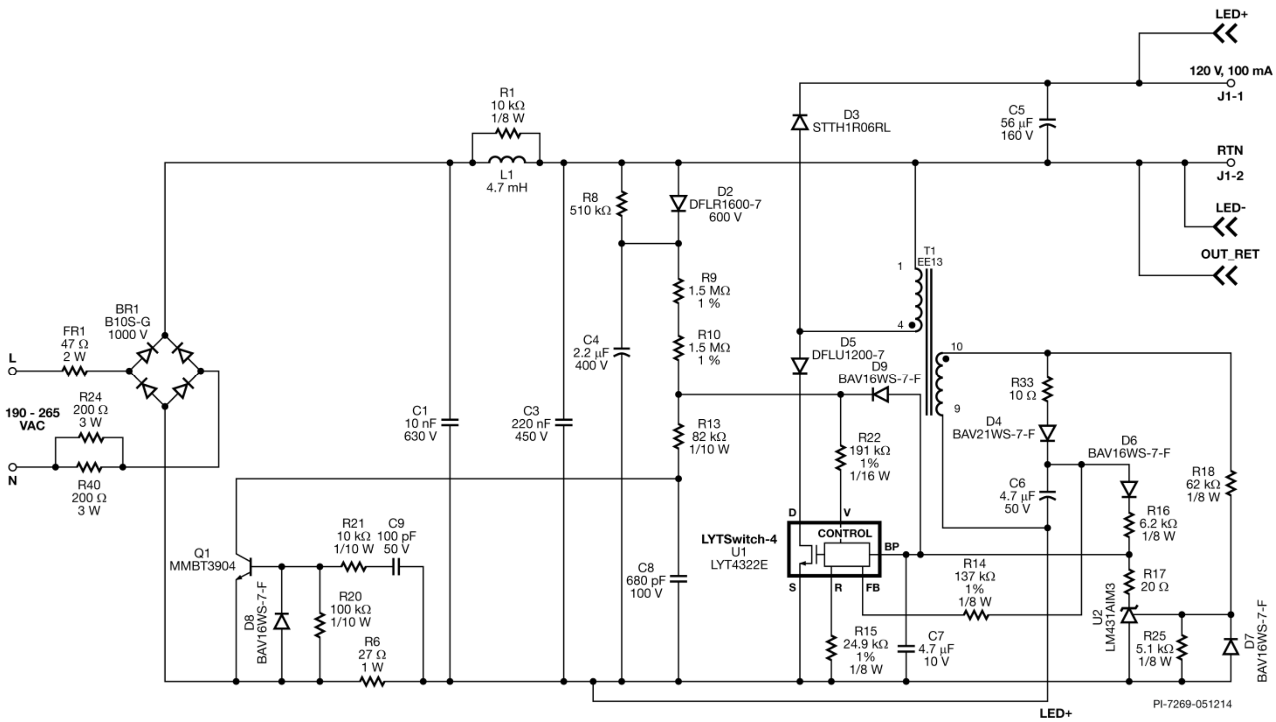


**Figure 3 –** Schematic.

Note: JP1 is 0Ω1206 smd resistor in R38 location if optional turn-off circuit is not used.

## 4 电路描述

LYTSwitch-4 LYT4322E器件是一种将控制器和725 V功率MOSFET集成在一起的器件，用于LED驱动器应用。LYTSwitch-4 LYT4322E可用于单级降压-升压式拓扑结构，提供调节的恒流隔离输出，同时使AC输入保持高功率因数。

### *4.1 输入EMI滤波*

可熔电阻FR1在异常工作情况下提供元件故障保护。二极管桥堆BR1对AC线电压进行整流，电容C3为初级开关电流提供低阻抗通路（去耦）。为使功率因数保持在0.9以上，需要确保较低的输入电容（C1与C3之和）值。EMI滤波由电感L1以及电容C1和C3提供。

### *4.2 功率电路*

本设计所采用的拓扑结构为低压端开关降压-升压式配置，可在190 VAC至265 VAC的输入电压范围内提供高功率因数和恒流输出。

输出二极管D3每当U1关断时就会导通，将能量传输至负载。在C3上的电压（整流后的输入AC）降到输出电压以下时，需要使用二极管D5来防止反向电流流经U1。

为向U1提供峰值输入电压信息，经整流AC的输入峰值经由D2对C4充电。然后电流经过R9和R10，注入U1的电压监测(V)引脚。电阻R9和R10所选取的值可以在230 VAC输入下提供~100μA的$I_V$（来自PIXls设计表格）。

输入过压关断功能（通过V引脚电流检测）可使整流后的线电压承受能力（在浪涌和线电压陡升期间）达到内部功率MOSFET的额定725 $BV_{DSS}$。

电容C7对U1的BP引脚进行局部去耦，该引脚是内部控制器的供电引脚。在启动期间，C7从与U1的D引脚相连的内部高压电流源被充电至约6 V。

U1的参考引脚通过24.9k 电阻R15接地（源极）。

### *4.3 输出反馈*

反馈信号来自由二极管D4和电容C6组成的网络所整流和滤波的偏置绕组。从电容C6产生的输出电压信息被电阻R14转换为反馈电流。该电流被LYT4322E用来调节转换器的输出电流。


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### *4.4 可控硅相位调光控制兼容性*

对于用低成本的可控硅前沿及后沿相控调光器提供输出调光的要求，我们需要在设计时进行一些权衡。

由于LED照明的功耗非常低，整灯吸收的电流要小于许多应用中可控硅的维持电流。这样会产生调光范围受限和/或闪烁等不良情况。LED灯对线路和调光器形成相对较大的阻抗，加上LED驱动器无法衰减调光器和驱动器内通常用来提高EMI性能的LC网络的响应，就会出现很严重的振铃。这种效应会造成类似不良情况，因为振荡会使可控硅电流降至零并关断。

要克服这些问题，需增加无源衰减电路和无损耗的有源泄放电路。

电阻R24和R40用于在可控硅调光期间衰减输入网络。

额外的衰减通过在AC输入的前沿部分增大处理功率来提供。这种方法是在仿真无源RC泄放电路的行为，但不会产生相关的损耗和调光缺点。

### *4.5 空载/开路负载保护*

输出电压通过主绕组与偏置绕组的匝数比在偏置绕组上进行检测。电压稳压器U2将强制BP引脚进入自动重启动模式，以调整输出电压。分压器R25和R18设置检测阈值。当导通期间偏置绕组上的电压发生反向时，二极管D7可防止U2产生反向电流。R17用于限制流入U2的最大电流。

### *4.6 可选关断电路*

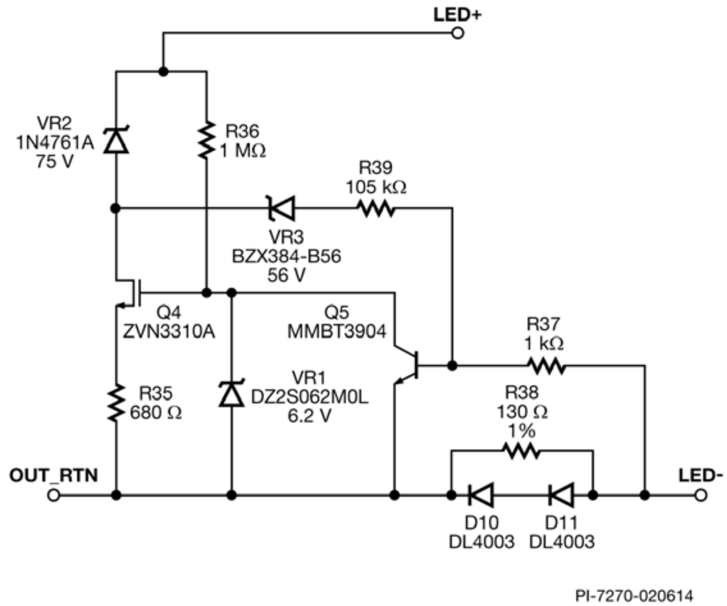


**Figure 4 –** Turn-off Circuit.

在深度调光期间关断LED的有源假负载也集成在本设计中。当驱动器与导通角低于30º的调光器一起使用时，该关断电路用于避免输出光闪烁。当导通角≤30º时，调光器导通角更易于出现变化，因为存在线路噪声并且驱动器处理的功率将变得过低而无法满足调光器维持电流。这可以导致在极低导通角下光输出出现闪烁。为避免此情况，当输出电流降至~5mA时，流入LED的输出电流终止。该输出电流阈值由电阻R38设置。如果R38上的电压降降至0.65V ($Q5_{Vbe}$)以下，Q5将关断，Q4导通。Q4导通时，输出分流到VR2 + $Q4_{VDS}$ + ~4V。此时，LED应关断并且所有输出电流转移到Q4分支。选用电阻R35使Q4分支吸收4V/R35电流。该电流稍高于5mA阈值，以避免Q4分支和输出之间出现反弹。R35电压由Q4VGT – VR1限制。这种配置还可限制Q4分支上的最大耗散。

二极管D10和D11用于将R38上的电压降限制到两个二极管压降，以提高效率并在输出短路时为R38提供保护。VR3和R39用于在开路负载时关断假负载。选用齐纳二极管VR3以使VR2 + VR3大于最大LED电压。电阻R36在Q5关断时对Q4进行偏置。

然而，输出电流可以处于<1mA的范围内。当调光器在最小调光器位置下启动时会发生这种情况。当假负载激活且吸收4V/R35电流时会发生这种情况。应将衰减电路设计为不在 $I_{OUT}$ of > 4V/R35下闪烁，以免出现闪烁。

如果驱动器与在230VAC、50Hz频率下最小导通角为45度或更高的调光器一起使用，则可省去关断电路，用跳线电阻替换R38。


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# 5 PCB布局

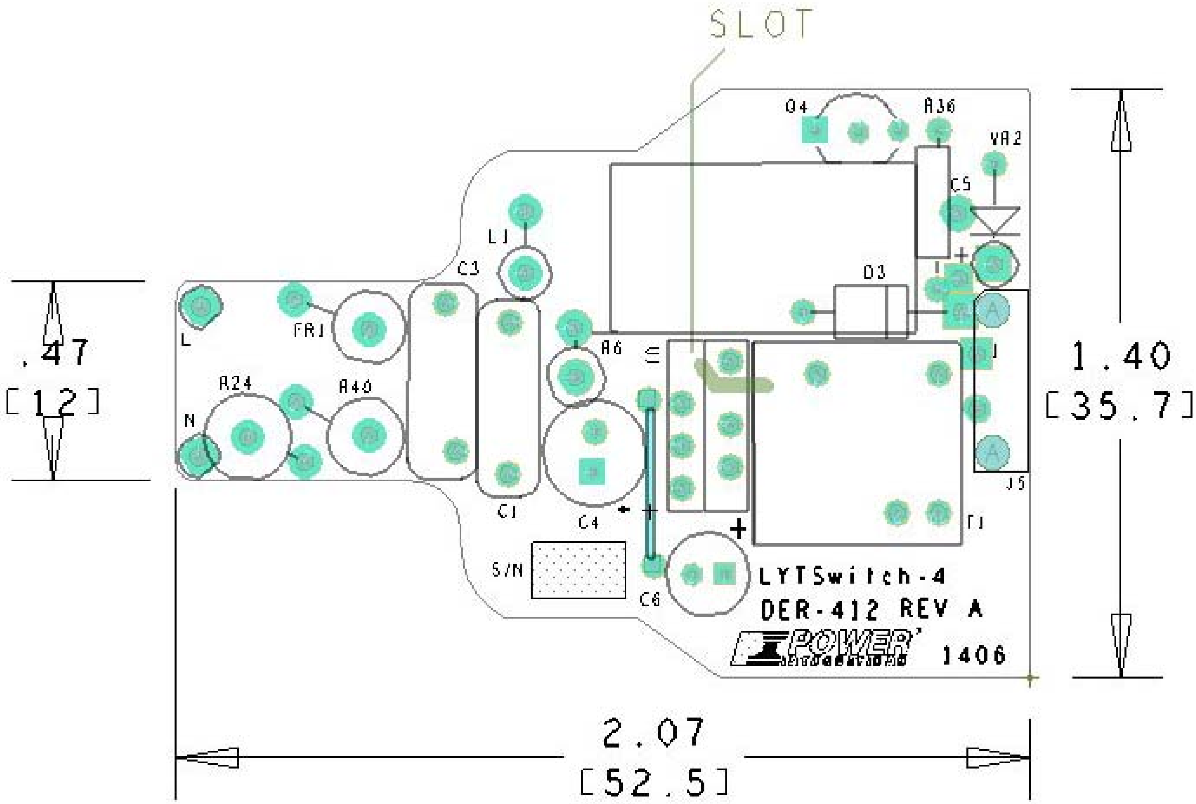


**Figure 5 –** Top Side.

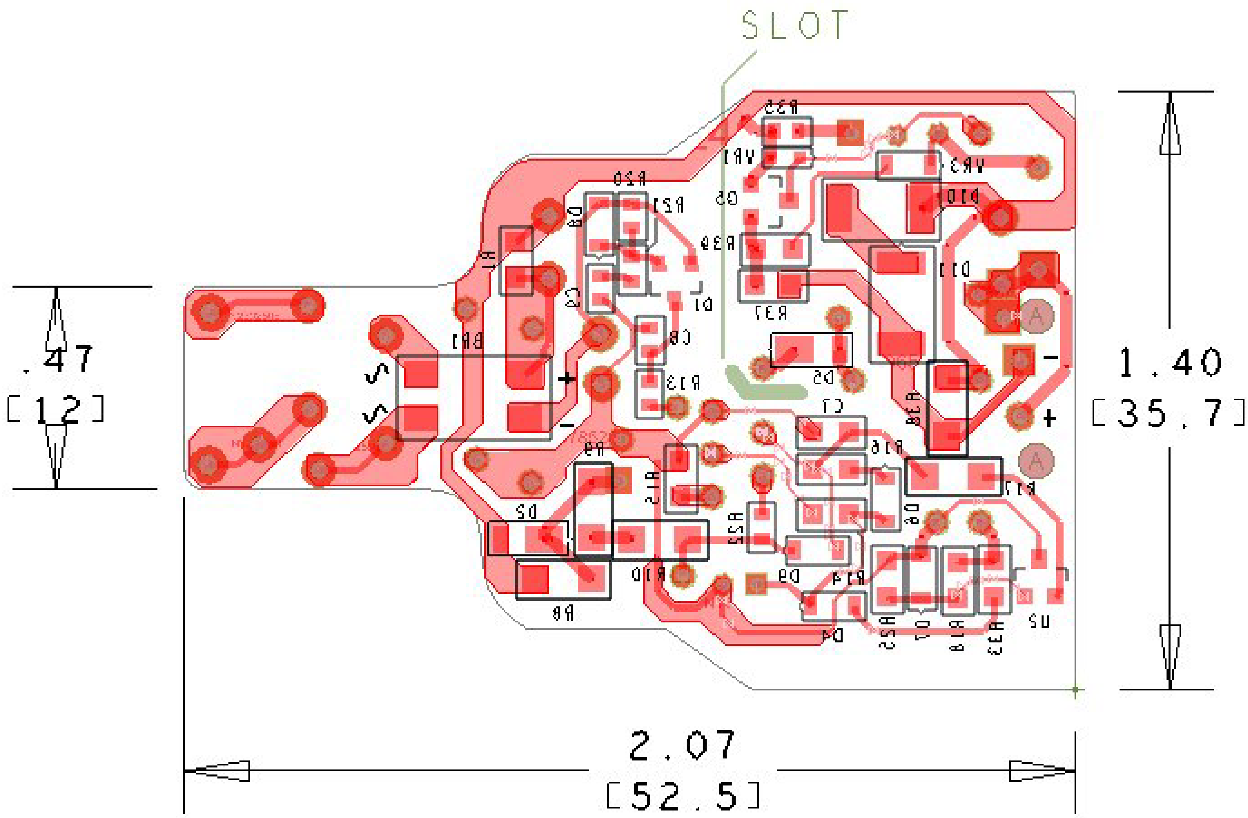


**Figure 6 –** Bottom Side.


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# 6 物料清单(BOM)

## *6.1 不含关断电路的BOM*

| Item | Qty | Ref Des | Description | Mfg Part Number | Mfg |
|---|---|---|---|---|---|
| 1 | 1 | BR1 | 1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC | B10S-G | Comchip |
| 2 | 1 | C1 | 10 nF, 630 V, Film | ECQ-E6103KF | Panasonic |
| 3 | 1 | C3 | 220 nF, 450 V, Film | MEXXF32204JJ | Duratech |
| 4 | 1 | C4 | 2.2 μF, 400 V, Electrolytic, (6.3 x 11) | TAB2GM2R2E110 | Ltec |
| 5 | 1 | C5 | 56 μF, 160 V, Electrolytic, Gen. Purpose, (10 x 20) | UCY2C560MPD1TD | Nichicon |
| 6 | 1 | C6 | 4.7 μF, 50 V, Electrolytic, Gen. Purpose, (5 x 11) | EKMG500ELL4R7ME11D | Nippon Chemi-Con |
| 7 | 1 | C7 | 4.7 μF, 10 V, Ceramic, X7R, 0805 | CL21A475KBQNNNE | Samsung |
| 8 | 1 | C8 | 680 pF 100 V, Ceramic, NPO, 0603 | CGA3E2C0G2A681J | TDK |
| 9 | 1 | C9 | 100 pF 50 V, Ceramic, NPO, 0603 | CC0603JRNPO9BN101 | Yageo |
| 10 | 1 | D2 | 600 V, 1 A, Rectifier, Glass Passivated, POWERDI123 | DFLR1600-7 | Diodes, Inc. |
| 11 | 1 | D3 | 600 V, 1 A, Ultrafast Recovery, DO-41 | STTH1R06RL | ST Micro |
| 12 | 1 | D4 | 250 V, 0.2 A, Fast Switching, 50 ns, SOD-323 | BAV21WS-7-F | Diodes, Inc. |
| 13 | 1 | D5 | DIODE, UFAST, 200V, 1A, POWERDI123 | DFLU1200-7 | Diodes, Inc. |
| 14 | 1 | D6 | 75 V, 0.15 A, Switching,SOD-323 | BAV16WS-7-F | Diodes, Inc. |
| 15 | 1 | D7 | 75 V, 0.15 A, Switching,SOD-323 | BAV16WS-7-F | Diodes, Inc. |
| 16 | 1 | D8 | 75 V, 0.15 A, Switching,SOD-323 | BAV16WS-7-F | Diodes, Inc. |
| 17 | 1 | D9 | 75 V, 0.15 A, Switching,SOD-323 | BAV16WS-7-F | Diodes, Inc. |
| 18 | 1 | FR1 | 47 Ω, 5%, 2 W, Wirewound, Fusible | FW20A47R0JA | Bourns |
| 19 | 1 | R38 | 0 Ω, 5%, 1/4 W, Thick Film, 1206 | ERJ-8GEY0R00V | Panasonic |
| 20 | 1 | L1 | 4.7 mH, 90 mA, 20 Ohm, RF Inductor | B82144A2475J | Epcos |
| 21 | 1 | Q1 | NPN, Small Signal BJT, 40 V, 0.2 A, SOT-23 | MMBT3904LT1G | On Semi |
| 22 | 1 | R1 | 10 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ103V | Panasonic |
| 23 | 1 | R6 | 27 Ω, 5%, 1 W, Metal Oxide | RSF100JB-27R | Yageo |
| 24 | 1 | R8 | 510 kΩ, 5%, 1/4 W, Thick Film, 1206 | ERJ-8GEYJ514V | Panasonic |
| 25 | 1 | R9 | 1.50 MΩ, 1%, 1/4 W, Thick Film, 1206 | ERJ-8ENF1504V | Panasonic |
| 26 | 1 | R10 | 1.50 MΩ, 1%, 1/4 W, Thick Film, 1206 | ERJ-8ENF1504V | Panasonic |
| 27 | 1 | R13 | 82 kΩ, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ823V | Panasonic |
| 28 | 1 | R14 | 137 kΩ, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF1373V | Panasonic |
| 29 | 1 | R15 | 24.9 kΩ, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF2492V | Panasonic |
| 30 | 1 | R16 | 6.2 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ622V | Panasonic |
| 31 | 1 | R17 | 20 R, 5%, 1/4 W, Thick Film, 1206 | ERJ-8GEYJ200V | Panasonic |
| 32 | 1 | R18 | 62 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ623V | Panasonic |
| 33 | 1 | R20 | 100 kΩ, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ104V | Panasonic |
| 34 | 1 | R21 | 10 kΩ, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ103V | Panasonic |
| 35 | 1 | R22 | 191 kΩ, 1%, 1/16 W, Thick Film, 0603 | ERJ-3EKF1913V | Panasonic |
| 36 | 1 | R24 | 200 Ω, 5%, 3 W, Metal Oxide | ERG-3SJ201 | Panasonic |
| 37 | 1 | R25 | 5.1 k, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ512V | Panasonic |
| 38 | 1 | R33 | 10 Ω, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ100V | Panasonic |
| 39 | 1 | R40 | 200 Ω, 5%, 3 W, Metal Oxide | ERG-3SJ201 | Panasonic |
| 40 | 1 | T1 | Bobbin, EE13, Vertical, 10 pins<br>Transformer<br>Transformer | P-1302-2<br>SNX-R1731<br>POL-LYT030 | Pin Shine<br>Santronics<br>Premier Magnetics |
| 41 | 1 | U1 | LYTSwitch-4, eSIP-7C | LYT4322E | Power Integrations |
| 42 | 1 | U2 | IC, REG ZENER SHUNT ADJ SOT-23 | LM431AIM3/NOPB | National Semi |

| | | | | | |
|---|---|---|---|---|---|
| 43 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Red, PVC, 3 in | 1007-24/7-2 | Anixter |
| 44 | 1 | WIRE 24AWG | Wire, UL1007, 24AWG, Blk, PVC, 3 in | 1007-24/7-0 | Anixter |
| 45 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Blu, PVC, 3 in | 1007-24/7-6 | Anixter |
| 46 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Wht, PVC, 3in | 1007-24/7-9 | Anixter |

## 6.2 BOM WithTurn-off Circuit

| Item | Qty | Ref Des | Description | Mfg Part Number | Mfg |
|---|---|---|---|---|---|
| 1 | 1 | BR1 | 1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC | B10S-G | Comchip |
| 2 | 1 | C1 | 10 nF, 630 V, Film | ECQ-E6103KF | Panasonic |
| 3 | 1 | C3 | 220 nF, 450 V, Film | MEXXF32204JJ | Duratech |
| 4 | 1 | C4 | 2.2 μF, 400 V, Electrolytic, (6.3 x 11) | TAB2GM2R2E110 | Ltec |
| 5 | 1 | C5 | 56 μF, 160 V, Electrolytic, Gen. Purpose, (10 x 20) | UCY2C560MPD1TD | Nichicon |
| 6 | 1 | C6 | 4.7 μF, 50 V, Electrolytic, Gen. Purpose, (5 x 11) | EKMG500ELL4R7ME11D | Nippon Chemi-Con |
| 7 | 1 | C7 | 4.7 μF, 10 V, Ceramic, X7R, 0805 | CL21A475KBQNNNE | Samsung |
| 8 | 1 | C8 | 680 pF 100 V, Ceramic, NPO, 0603 | CGA3E2C0G2A681J | TDK |
| 9 | 1 | C9 | 100 pF 50 V, Ceramic, NPO, 0603 | CC0603JRNPO9BN101 | Yageo |
| 10 | 1 | D2 | 600 V, 1 A, Rectifier, Glass Passivated, POWERDI123 | DFLR1600-7 | Diodes, Inc. |
| 11 | 1 | D3 | 600 V, 1 A, Ultrafast Recovery, DO-41 | STTH1R06RL | ST Micro |
| 12 | 1 | D4 | 250 V, 0.2 A, Fast Switching, 50 ns, SOD-323 | BAV21WS-7-F | Diodes, Inc. |
| 13 | 1 | D5 | DIODE, UFAST, 200V, 1A, POWERDI123 | DFLU1200-7 | Diodes, Inc. |
| 14 | 4 | D6 D7 D8 D9 | 75 V, 0.15 A, Switching,SOD-323 | BAV16WS-7-F | Diodes, Inc. |
| 15 | 2 | D10 D11 | 200 V, 1 A, Rectifier, Glass Passivated, DO-213AA (MELF) | DL4003-13-F | Diodes, Inc. |
| 16 | 1 | FR1 | 47 R, 5%, 2 W, Wirewound, Fusible | FW20A47R0JA | Bourns |
| 17 | 1 | L1 | 4.7 mH, 90 mA, 20 Ω, RF Inductor | B82144A2475J | Epcos |
| 18 | 2 | Q1 Q5 | NPN, Small Signal BJT, 40 V, 0.2 A, SOT-23 | MMBT3904LT1G | On Semi |
| 19 | 1 | Q4 | 100 V, 0.2 A, 10 Ω, N-Channel, TO-92 | ZVN3310A | Diodes, Inc. |
| 20 | 2 | R1 R39 | 10 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ103V | Panasonic |
| 21 | 1 | R6 | 27 Ω, 5%, 1 W, Metal Oxide | RSF100JB-27R | Yageo |
| 22 | 1 | R8 | 510 kΩ, 5%, 1/4 W, Thick Film, 1206 | ERJ-8GEYJ514V | Panasonic |
| 23 | 2 | R9 R10 | 1.50 MΩ, 1%, 1/4 W, Thick Film, 1206 | ERJ-8ENF1504V | Panasonic |
| 24 | 1 | R13 | 82 kΩ, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ823V | Panasonic |
| 25 | 1 | R14 | 137 kΩ, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF1373V | Panasonic |
| 26 | 1 | R15 | 24.9 kΩ, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF2492V | Panasonic |
| 27 | 1 | R16 | 6.2 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ622V | Panasonic |
| 28 | 1 | R17 | 20 Ω, 5%, 1/4 W, Thick Film, 1206 | ERJ-8GEYJ200V | Panasonic |
| 29 | 1 | R18 | 62 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ623V | Panasonic |
| 30 | 1 | R20 | 100 kΩ, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ104V | Panasonic |
| 31 | 1 | R21 | 10 kΩ, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ103V | Panasonic |
| 32 | 1 | R22 | 191 kΩ, 1%, 1/16 W, Thick Film, 0603 | ERJ-3EKF1913V | Panasonic |
| 33 | 2 | R24 R40 | 200 Ω, 5%, 3 W, Metal Oxide | ERG-3SJ201 | Panasonic |
| 34 | 1 | R25 | 5.1 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ512V | Panasonic |


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| | | | | | |
|---|---|---|---|---|---|
| 35 | 1 | R33 | 10 Ω, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ100V | Panasonic |
| 36 | 1 | R35 | 680 Ω, 5%, 1/10 W, Thick Film, 0603 | ERJ-3GEYJ681V | Panasonic |
| 37 | 1 | R36 | 1 MΩ, 5%, 1/4 W, Carbon Film | CFR-25JB-1M0 | Yageo |
| 38 | 1 | R37 | 1 kΩ, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ102V | Panasonic |
| 39 | 1 | R38 | 130 Ω, 1%, 1/4 W, Thick Film, 1206 | ERJ-8ENF1300V | Panasonic |
| 40 | 1 | T1 | Bobbin, EE13, Vertical, 10 pins<br>Transformer<br>Transformer | P-1302-2<br>SNX-R1731<br>POL-LYT030 | Pin Shine<br>Santronics<br>Premier Magnetics |
| 41 | 1 | U1 | LYTSwitch-4, eSIP-7C | LYT4322E | Power Integrations |
| 42 | 1 | U2 | IC, REG ZENER SHUNT ADJ SOT-23 | LM431AIM3/NOPB | National Semi |
| 43 | 1 | VR1 | 6.2 V, 5%, 150 mW, SSMINI-2 | DZ2S062M0L | Panasonic |
| 44 | 1 | VR2 | 75 V, 5%, 1 W, DO-41 | 1N4761A-TR | Vishay |
| 45 | 1 | VR3 | 56 V, 2%, 300 mW, SOD323 | BZX384-B56,115 | NXP Semi |
| 46 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Red, PVC, 3 in | 1007-24/7-2 | Anixter |
| 47 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Blk, PVC, 3 in | 1007-24/7-0 | Anixter |
| 48 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Blu, PVC, 3 in | 1007-24/7-6 | Anixter |
| 49 | 1 | WIRE 24AWG | Wire, UL1007, #24AWG, Wht, PVC, 3 in | 1007-24/7-9 | Anixter |

# 7 电感设计表格

| ACDC_LYTSwitch-4_HL_012114; Rev.1.2; Copyright Power Integrations 2014 | INPUT | INFO | OUTPUT | UNIT | LYTSwitch-4_HL_012114: Flyback Transformer Design Spreadsheet |
|---|---|---|---|---|---|
| **ENTER APPLICATION VARIABLES** | | | | | |
| Dimming required | YES | | YES | | Select 'YES' option if dimming is required. Otherwise select 'NO'. |
| VACMIN | 190 | | 190 | V | Minimum AC Input Voltage |
| VACMAX | | | 265 | V | Maximum AC input voltage |
| fL | | | 50 | Hz | AC Mains Frequency |
| VO | 120 | | 120 | V | Typical output voltage of LED string at full load |
| VO_MAX | | | 132.00 | V | Maximum expected LED string Voltage. |
| VO_MIN | | | 108.00 | V | Minimum expected LED string Voltage. |
| V_OVP | | | 142.37 | V | Over-voltage protection setpoint |
| IO | 0.1 | | 0.10 | A | Typical full load LED current |
| PO | | | 12.0 | W | Output Power |
| n | 0.85 | | 0.85 | | Estimated efficiency of operation |
| VB | | | 25 | V | Bias Voltage |
| **ENTER LYTSwitch VARIABLES** | | | | | |
| LYTSwitch | LYT4322 | | LYT4322 | | Selected LYTSwitch |
| Current Limit Mode | FULL | | FULL | | Select "RED" for reduced Current Limit mode or "FULL" for Full current limit mode |
| ILIMITMIN | | | 0.79 | A | Minimum current limit |
| ILIMITMAX | | | 0.92 | A | Maximum current limit |
| fS | | | 132000 | Hz | Switching Frequency |
| fSmin | | | 124000 | Hz | Minimum Switching Frequency |
| fSmax | | | 140000 | Hz | Maximum Switching Frequency |
| IV | | | 100.7 | uA | V pin current |
| RV | 3.2 | | 3.2 | M-ohms | Upper V pin resistor |
| RV2 | | | 1000000000000 | M-ohms | Lower V pin resistor |
| IFB | 177 | | 177.0 | uA | FB pin current (85 uA< IFB < 210 uA) |
| RFB1 | | | 124.3 | k-ohms | FB pin resistor |
| VDS | | | 10 | V | LYTSwitch on-state Drain to Source Voltage |
| VD | | | 0.50 | V | Output Winding Diode Forward Voltage Drop (0.5 V for Schottky and 0.8 V for PN diode) |
| VDB | | | 0.70 | V | Bias Winding Diode Forward Voltage Drop |
| **Key Design Parameters** | | | | | |
| KP | 1.18 | | 1.18 | | Ripple to Peak Current Ratio (For PF > 0.9, 0.4 < KP < 0.9) |
| LP | | | 960 | uH | Primary Inductance |
| VOR | 120.5 | | 120.5 | V | Reflected Output Voltage. |
| Expected IO (average) | | | 0.10 | A | Expected Average Output Current |
| KP_VNOM | | Info | 1.00 | | !!! Info. PF at high line may be less than 0.9. Decrease KP for higher PF |
| TON_MIN | | | 1.84 | us | Minimum on time at maximum AC input voltage |
| PCLAMP | | | 0.09 | W | Estimated dissipation in primary clamp |


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| | | | | | |
|---|---|---|---|---|---|
| **ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES** | | | | | |
| Core Type | EE13 | | EE13 | | Select Core Size |
| Custom Core | | | | | Enter Custom core part number (if applicable) |
| AE | | | 0.171 | cm^2 | Core Effective Cross Sectional Area |
| LE | | | 3.02 | cm | Core Effective Path Length |
| AL | | | 1130 | nH/T^2 | Ungapped Core Effective Inductance |
| BW | | | 7.4 | mm | Bobbin Physical Winding Width |
| M | | | 0 | mm | Safety Margin Width (Half the Primary to Secondary Creepage Distance) |
| L | 4 | | 4 | | Number of Primary Layers |
| NS | 150 | | 150 | | Number of Secondary Turns |
| **DC INPUT VOLTAGE PARAMETERS** | | | | | |
| VMIN | | | 269 | V | Peak input voltage at VACMIN |
| VMAX | | | 375 | V | Peak input voltage at VACMAX |
| **CURRENT WAVEFORM SHAPE PARAMETERS** | | | | | |
| DMAX | | | 0.28 | | Minimum duty cycle at peak of VACMIN |
| IAVG | | | 0.07 | A | Average Primary Current |
| IP | | | 0.60 | A | Peak Primary Current (calculated at minimum input voltage VACMIN) |
| IRMS | | | 0.15 | A | Primary RMS Current (calculated at minimum input voltage VACMIN) |
| **TRANSFORMER PRIMARY DESIGN PARAMETERS** | | | | | |
| LP | | | 960 | uH | Primary Inductance |
| LP_TOL | | | 10 | | Tolerance of primary inductance |
| NP | | | 150 | | Primary Winding Number of Turns |
| NB | | | 32 | | Bias Winding Number of Turns |
| ALG | | | 43 | nH/T^2 | Gapped Core Effective Inductance |
| BM | | | 2256 | Gauss | Maximum Flux Density at PO, VMIN (BM<3100) |
| BP | | | 3444 | Gauss | Peak Flux Density (BP<3700) |
| BAC | | | 1128 | Gauss | AC Flux Density for Core Loss Curves (0.5 X Peak to Peak) |
| ur | | | 1588 | | Relative Permeability of Ungapped Core |
| LG | | | 0.48 | mm | Gap Length (Lg> 0.1 mm) |
| BWE | | | 29.6 | mm | Effective Bobbin Width |
| OD | | | 0.20 | mm | Maximum Primary Wire Diameter including insulation |
| INS | | | 0.04 | mm | Estimated Total Insulation Thickness (= 2 * film thickness) |
| DIA | | | 0.16 | mm | Bare conductor diameter |
| AWG | | | 35 | AWG | Primary Wire Gauge (Rounded to next smaller standard AWG value) |
| CM | | | 32 | Cmils | Bare conductor effective area in circular mils |
| CMA | | | 210 | Cmils/Amp | Primary Winding Current Capacity (200 < CMA < 600) |
| **TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT)** | | | | | |
| **Lumped parameters** | | | | | |
| ISP | | | 0.60 | A | Peak Secondary Current |
| ISRMS | | | 0.22 | A | Secondary RMS Current |
| IRIPPLE | | | 0.20 | A | Output Capacitor RMS Ripple Current (based on Expected IO) |
| CMS | | | 44 | Cmils | Secondary Bare Conductor minimum circular mils |
| AWGS | | | 33 | AWG | Secondary Wire Gauge (Rounded up to next larger standard AWG value) |
| DIAS | | | 0.18 | mm | Secondary Minimum Bare Conductor |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Diameter |
| ODS | | | 0.05 | mm | Secondary Maximum Outside Diameter for Triple Insulated Wire |
| **VOLTAGE STRESS PARAMETERS** | | | | | |
| VDRAIN | | | 620 | V | Estimated Maximum Drain Voltage assuming maximum LED string voltage (Includes Effect of Leakage Inductance) |
| PIVS | | | 517 | V | Output Rectifier Maximum Peak Inverse Voltage (calculated at VOVP, excludes leakage inductance spike) |
| PIVB | | | 110 | V | Bias Rectifier Maximum Peak Inverse Voltage (calculated at VOVP, excludes leakage inductance spike) |
| **FINE TUNING (Enter measured values from prototype)** | | | | | |
| **V pin Resistor Fine Tuning** | | | | | |
| RV1 | | | 3.20 | M-ohms | Upper V Pin Resistor Value |
| RV2 | | | 1000000000000 | M-ohms | Lower V Pin Resistor Value |
| VAC1 | | | 115.0 | V | Test Input Voltage Condition1 |
| VAC2 | | | 230.0 | V | Test Input Voltage Condition2 |
| IO_VAC1 | | | 0.10 | A | Measured Output Current at VAC1 |
| IO_VAC2 | | | 0.10 | A | Measured Output Current at VAC2 |
| RV1 (new) | | | 3.20 | M-ohms | New RV1 |
| RV2 (new) | | | 16729.30 | M-ohms | New RV2 |
| V_OV | | | 256.2 | V | Typical AC input voltage at which OV shutdown will be triggered |
| V_UV | | | 53.6 | V | Typical AC input voltage beyond which power supply can startup |
| **FB pin resistor Fine Tuning** | | | | | |
| RFB1 | | | 124 | k-ohms | Upper FB Pin Resistor Value |
| RFB2 | | | 1000000000000 | k-ohms | Lower FB Pin Resistor Value |
| VB1 | | | 22.4 | V | Test Bias Voltage Condition1 |
| VB2 | | | 27.6 | V | Test Bias Voltage Condition2 |
| IO1 | | | 0.10 | A | Measured Output Current at Vb1 |
| IO2 | | | 0.10 | A | Measured Output Current at Vb2 |
| RFB1 (new) | | | 124.3 | k-ohms | New RFB1 |
| RFB2(new) | | | 1000000000000 | k-ohms | New RFB2 |
| **Input Current Harmonic Analysis** | | | | | |
| Harmonic | | | Max Current (mA) | Limit (mA) | |
| 1st Harmonic | | | 62.70 | N/A | Fundamental (mA) |
| 3rd Harmonic | | | 16.03 | 48.00 | PASS. 3rd Harmonic current content is lower than the limit |
| 5th Harmonic | | | 8.1 | 26.82 | PASS. 5th Harmonic current content is lower than the limit |
| 7th Harmonic | | | 5.0 | 14.12 | PASS. 7th Harmonic current content is lower than the limit |
| 9th Harmonic | | | 3.44 | 7.06 | PASS. 9th Harmonic current content is lower than the limit |
| 11th Harmonic | | | 2.53 | 4.94 | PASS. 11th Harmonic current content is lower than the limit |
| 13th Harmonic | | | 1.93 | 4.18 | PASS. 13th Harmonic current content is lower than the limit |
| 15th Harmonic | | | 1.53 | 3.62 | PASS. 15th Harmonic current content is lower than the limit |
| THD | | | 29.6 | % | Estimated total Harmonic Distortion (THD) |


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# 8 电感规格

## 8.1 电气原理图

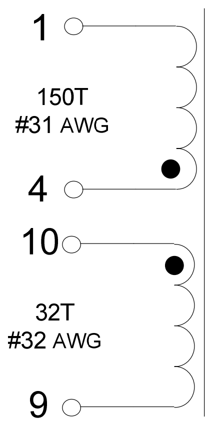


**Figure 7 –** Inductor Electrical Diagram.

## 8.2 电气规格

| | | |
|---|---|---|
| **Primary Inductance** | Pins 1-4, all other windings open, measured at 100kHz, 0.4 $V_{RMS}$AL = 42.667 nH/$n^2$ | 960μH ±5% |

## 8.3 材料

| Item | Description |
|---|---|
| [1] | Core: EE13 NC2H or equivalent. |
| [2] | Bobbin:EE13;5/5 pinvertical.PI PN: 25-01023-00 |
| [3] | Magnet Wire: #31 AWG. |
| [4] | Magnet Wire: #32 AWG. |
| [5] | Tape, Polyester film, 3M 1350F-1 or equivalent, 7.4 mm wide. |
| [6] | Dolph BC-359 or equivalent. |

### 8.4 电感结构图

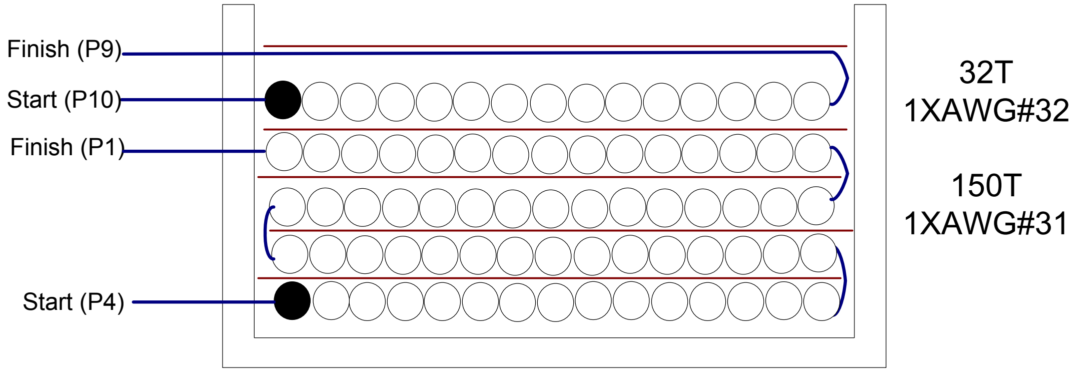


**Figure 8 –** Inductor Build Diagram.

### 8.5 电感构造

| | |
|---|---|
| **Bobbin Preparation** | Place the bobbin item [2] on the mandrel with pin side on the left and winding direction is clockwise direction. |
| **Winding1** | Use wire item [3], start at pin 4 wind 150 turns in ~4 layers and at the last turn terminate the wire at pin 1. Apply 1 layer of tape item [5] between layers |
| **Winding2** | Use wire item [4], start at pin 10 wind 32 turns in ~1 layer, and at the last turn terminate the wire at pin 9. Apply 1 layer of tape item [5] between layers |
| **Finish** | Grind core to get 960μH inductance, secure the core with tape. Dip impregnate using varnish item[6] |
| **Pins** | Cut pins 2, 3, 5, 6, 7, 8. |


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## 9 性能数据

All measurements performed at room temperature using an LED load.The following data were measured using customerLED load of ~120V output voltage. Refer to the table on Section 9.4 for the complete set of test data values.

### *9.1 效率*

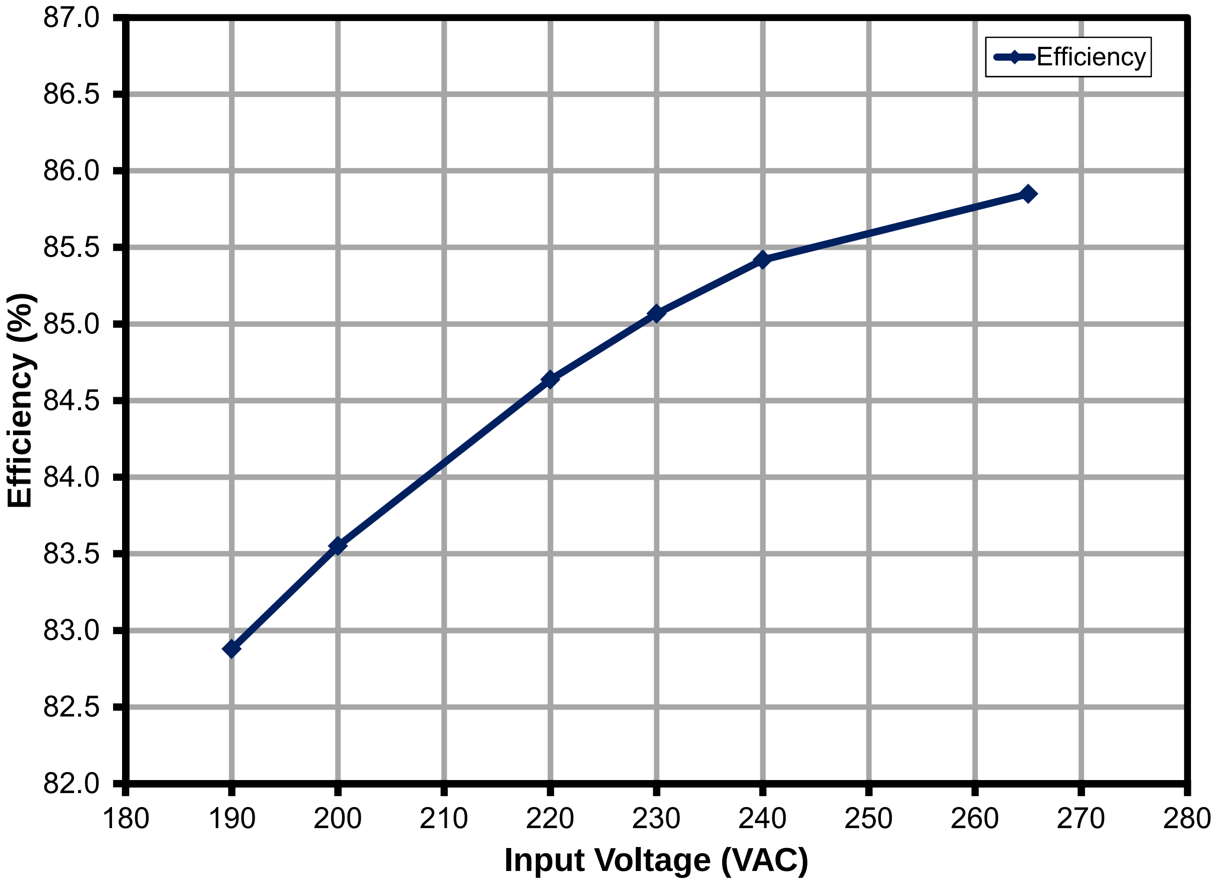


**Figure 9 –** Efficiency vs. Line.

### *9.2 线电压调整*

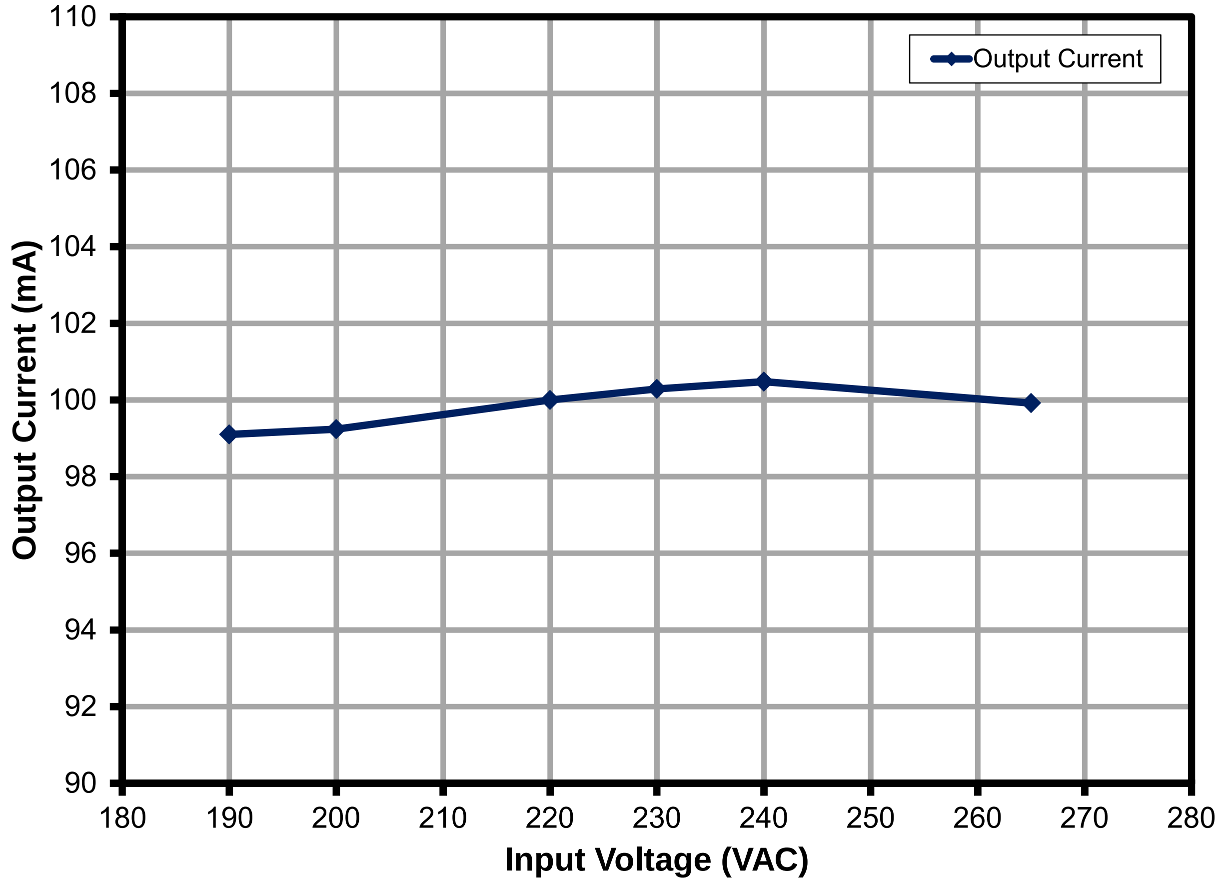


**Figure 10 –** Regulation vs. Line.


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### *9.3 功率因数*

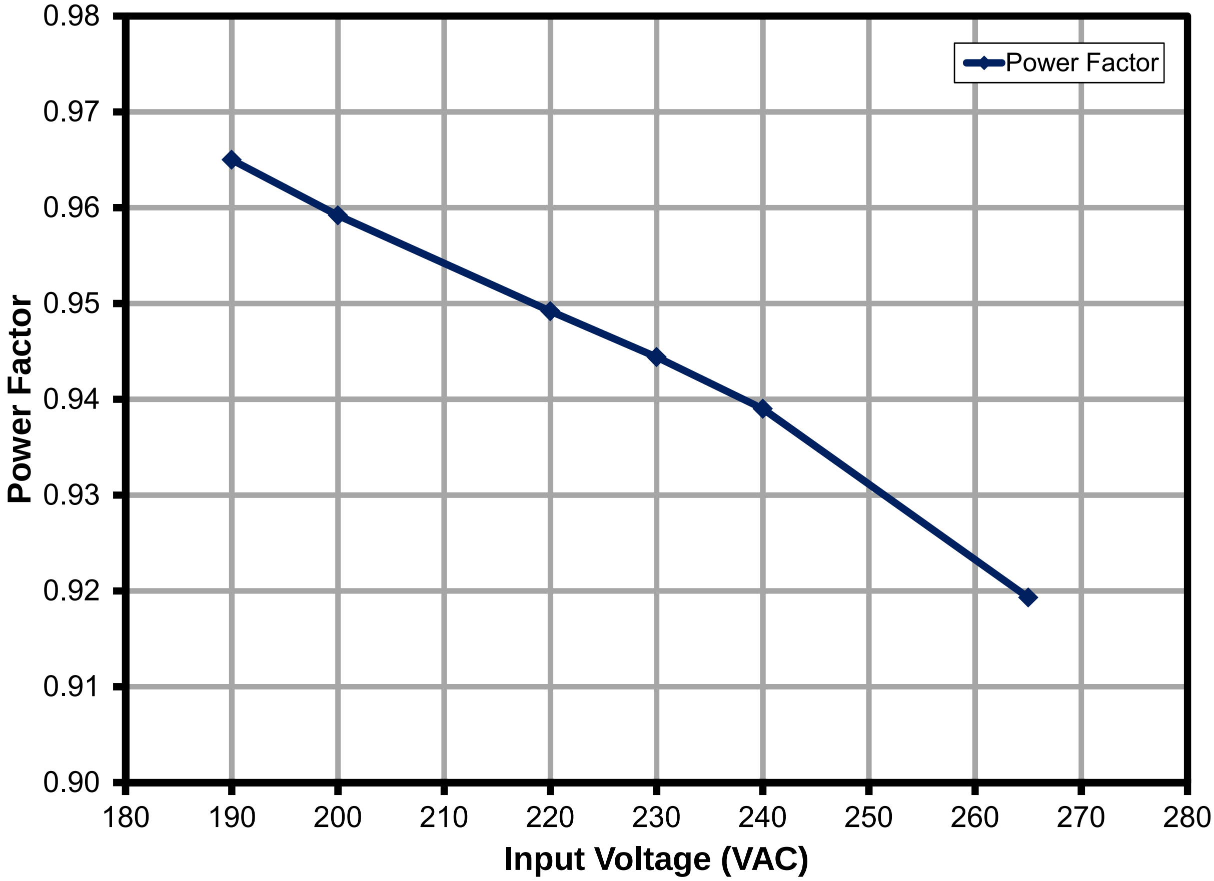


**Figure 11 –** Power Factor vs. Line.

### *9.4 测试数据*

All measurements were taken with the board at open frame, 25 ºC ambient, 50Hz line frequency, and customer supplied LED load

| Input Measurement | | | | | Load Measurement | | | Calculation | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_{IN}$ ($V_{RMS}$) | $I_{IN}$ ($mA_{RMS}$) | $P_{IN}$ (W) | PF | %ATHD | $V_{OUT}$ ($V_{DC}$) | $I_{OUT}$ ($mA_{DC}$) | $P_{OUT}$ (W) | $P_{CAL}$ (W) | Efficiency (%) | Loss (W) |
| 190.11 | 76.22 | 13.983 | 0.965 | 22.45 | 116.7400 | 99.100 | 11.589 | 11.57 | 82.88 | 2.39 |
| 200.08 | 72.16 | 13.849 | 0.959 | 23.58 | 116.3900 | 99.240 | 11.571 | 11.55 | 83.55 | 2.28 |
| 220.11 | 65.86 | 13.760 | 0.949 | 24.43 | 116.2500 | 100.000 | 11.646 | 11.63 | 84.64 | 2.11 |
| 230.16 | 63.10 | 13.715 | 0.944 | 24.31 | 116.1300 | 100.290 | 11.667 | 11.65 | 85.07 | 2.05 |
| 240.13 | 60.65 | 13.675 | 0.939 | 24.05 | 116.0400 | 100.480 | 11.681 | 11.66 | 85.42 | 1.99 |
| 265.15 | 55.44 | 13.512 | 0.919 | 24.63 | 115.9000 | 99.920 | 11.600 | 11.58 | 85.85 | 1.91 |


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## 10 调光性能数据

TRIAC dimming results were taken with input voltage of 230VAC, 60Hz line frequency, room temperature, and nominal ~120V LED load.

### *10.1 调光曲线*

Taken using a programmable AC source providing the leading edge chopped AC input.

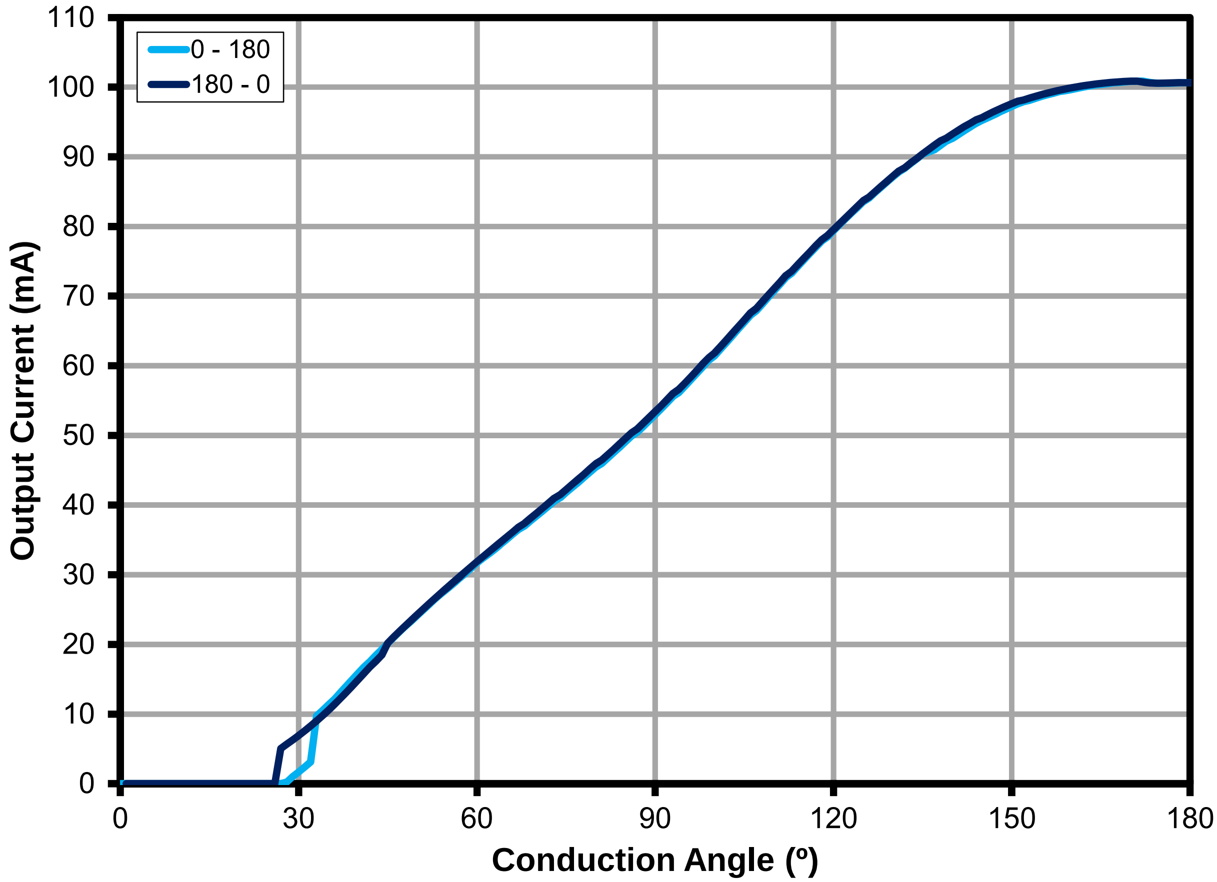


**Figure 12 –** Leading Edge Dimming Characteristics.

### *10.2 调光效率*

Measured using a programmable AC source providing the leading edge chopped AC input.Note that dimming efficiency varies with the dimmer used.

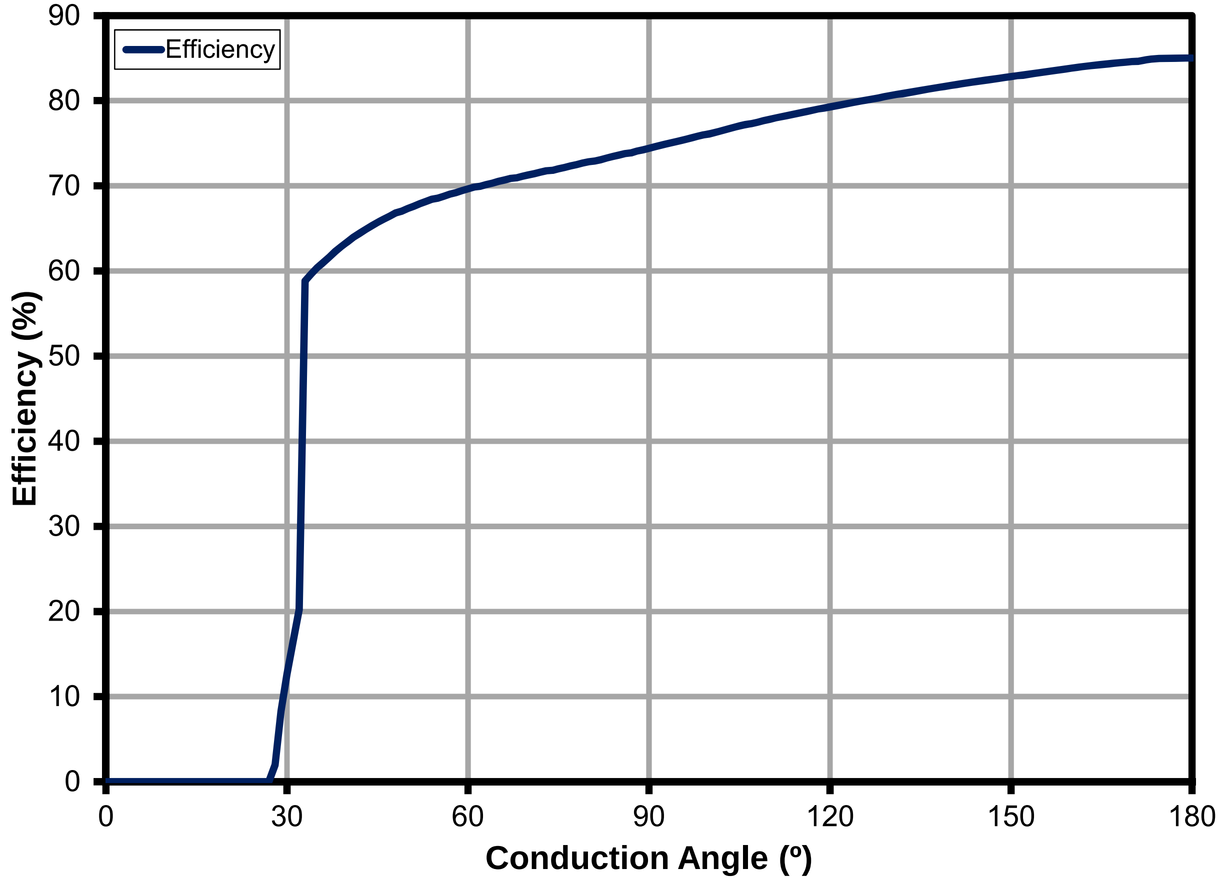


**Figure 13 –** Driver Efficiency as a function of Conduction Angle.


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### *10.3 调光期间的驱动器功耗*

Measured using a programmable AC source providing the leading edge chopped AC input. Note the increase in power loss at ~30 due to turn-off circuit.

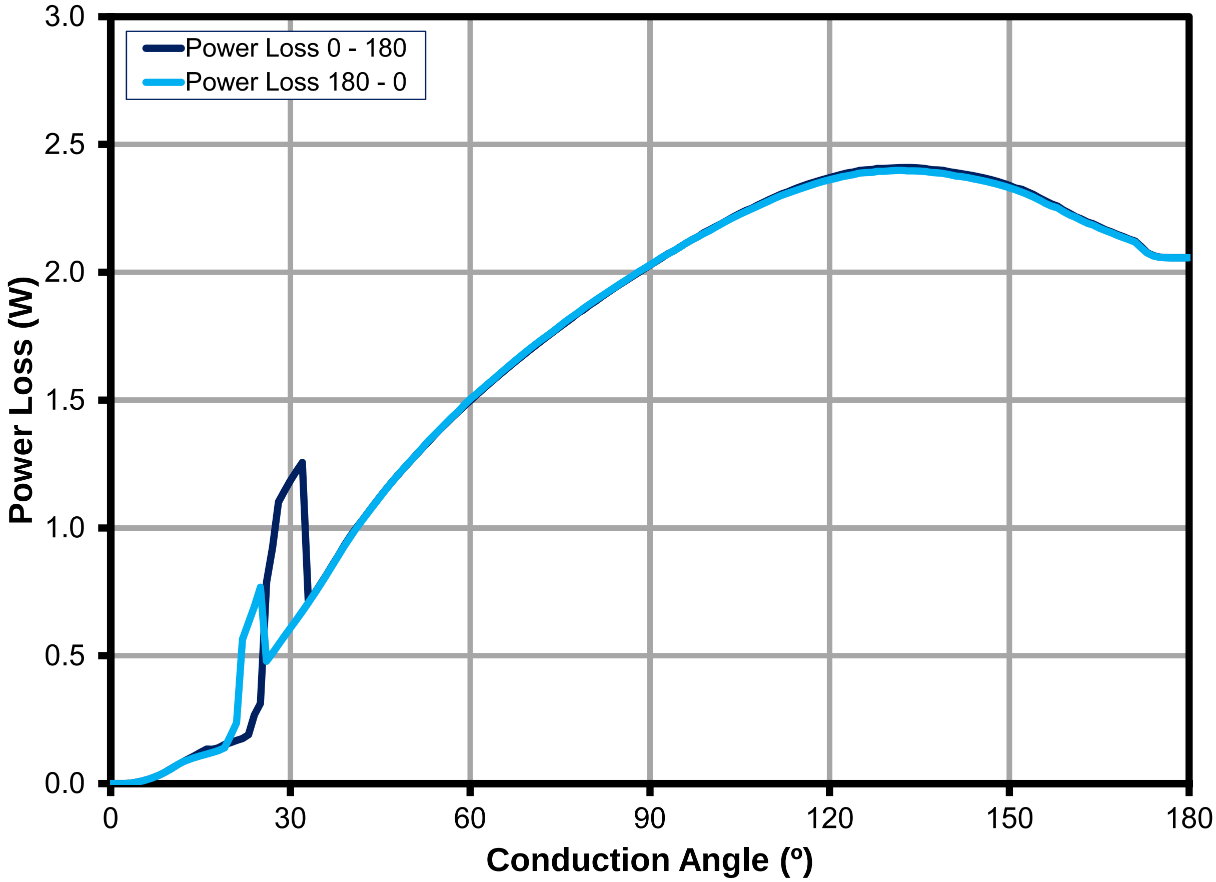


**Figure 14 –** Driver Power Loss as a function of Conduction Angle.

### *10.4 调光器兼容性列表*

The unit was tested with the following high-linedimmers at 230VAC, 50 Hz input and ~120V LED load.

| Dimmers | Type | $I_{OUT}$ (mA) | | DR |
|---|---|---|---|---|
| | | Max | Min | |
| BERKER 2830 10 | LE | 97 | 28 | 3.46 |
| JUNG 225 NV DE | LE | 95 | 19 | 5.00 |
| JUNG 254 UDIE 1 | TE | 95 | 20 | 4.75 |
| JUNG 266 G DE | LE | 97 | 23 | 4.22 |
| BUSCH 2200 UJ-212 | LE | 97 | 33 | 2.94 |
| BUSCH 2250 U | LE | 98 | 19 | 5.16 |
| BUSCH 2247 U | LE | 97 | 28 | 3.46 |
| GIRA 2262 00 / IO1 | LE | 97 | 15 | 6.47 |
| GIRA 0300 00 / IO1 | LE | 97 | 32 | 3.03 |
| GIRA 0302 00 / IO1 | LE | 98 | 24 | 4.08 |
| GIRA 1176 00/I03 | TE | 95 | 26 | 3.65 |
| 310-013 | LE | 99 | 27.5 | 3.60 |
| 310-017 | TE | 92 | 29 | 3.17 |
| 310-014 | LE | 99 | 33 | 3.00 |
| 310-016 | LE | 99 | 30 | 3.30 |
| KOPP 8033 | LE | 93 | 25 | 3.72 |
| BUSCH 691 U-101 | ELEC | 92 | 21 | 4.38 |
| BUSCH 6513 U-102 | TE | 97 | 22 | 4.41 |
| PEHA 433HAB | TE | 93 | 31 | 3.00 |
| PEHA 433HAB Oa | TE | 86 | 21 | 4.10 |
| REV 300W | LE | 97 | 1 | 97.00 |
| 2250 | LE | 98 | 21 | 4.67 |
| 400W | LE | 93 | 6 | 15.50 |
| 572499 | LE | 99 | 16 | 6.19 |
| 6513 | TE | 97 | 23 | 4.22 |
| 2875 | LE | 97 | 23 | 4.22 |
| TCL | LE | 100 | 21 | 4.76 |
| SEN BO LANG | LE | 100 | 35 | 2.86 |
| EBA HUANG | LE | 100 | 1 | 100.00 |
| SB ELECT | LE | 99 | 1 | 99.00 |
| MYONGBO | LE | 100 | 34 | 2.94 |
| KBE | LE | 100 | 5 | 20.00 |
| CLIPMEI | LE | 100 | 22 | 4.55 |
| MANK | LE | 100 | 37 | 2.70 |
| 32E450LM | LE | 94 | 22 | 4.27 |
| 32E450TM | TE | 92 | 20 | 4.60 |
| 32E2CFLDM | TE | 91 | 20 | 4.55 |
| 32E450UDM | TE | 95 | 24 | 3.96 |
| SED200LRS | LE | 99 | 1 | 99.0 |
| WDE200L-1 | LE | 99 | 1 | 99.0 |
| SED300FHS | LE | 97 | 6 | 16.2 |
| EED100PRS | LE | 99 | 1 | 99.0 |
| E0902 DIM | LE | 97 | 17 | 5.7 |
| WDE300F-1 | LE | 99 | 1 | 99.0 |


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## 11 热性能

The following reading were taken at open frame, room temperature condition

### *11.1 230VAC，50Hz：未连接调光器*

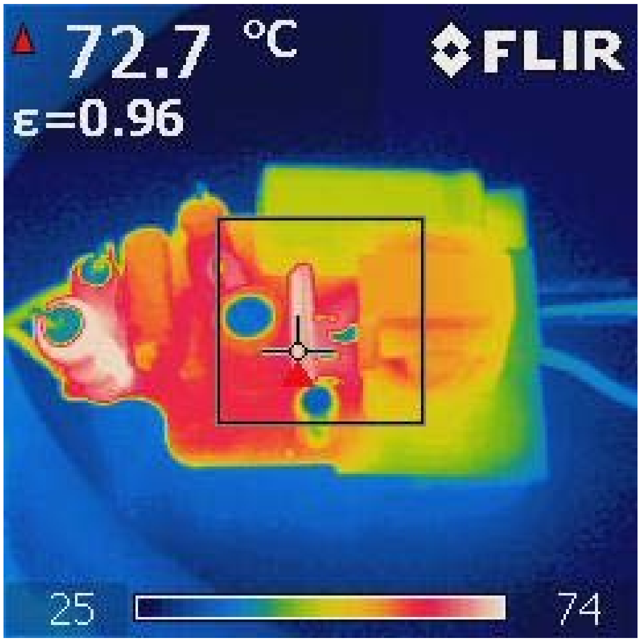


**Figure 15 –** U1: LYT4322E.

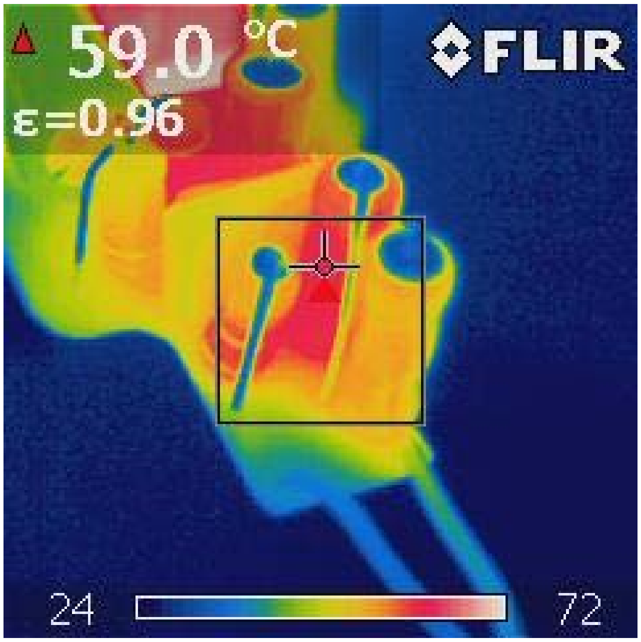


**Figure 16 –** R24: Damper Resistor.

### *11.2 230VAC，50Hz：连接调光器，90º导通角*

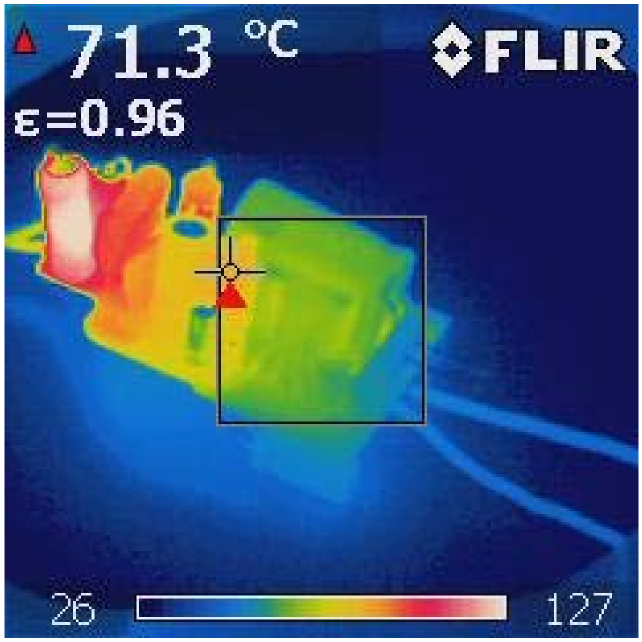


**Figure 17 –** U1:LYT4322E.

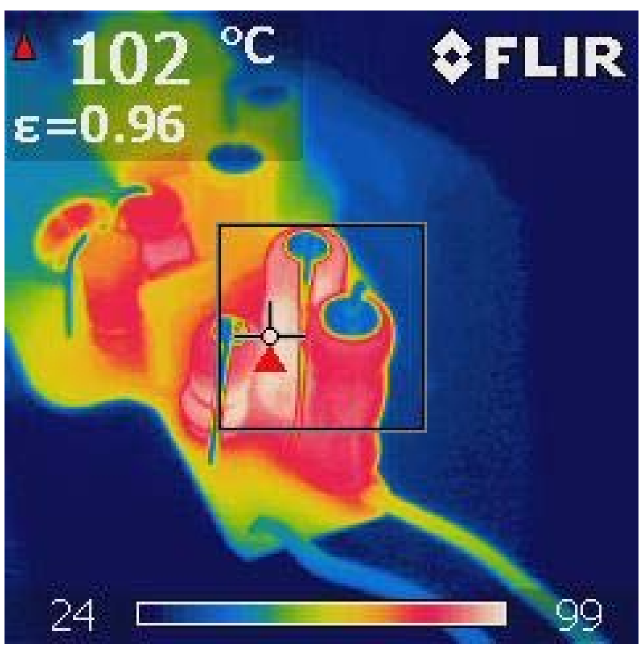


**Figure 18 –** R24: Damper Resistor.


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# 12 非调光（未连接调光器）波形

## *12.1 输入电压和输入电流波形*

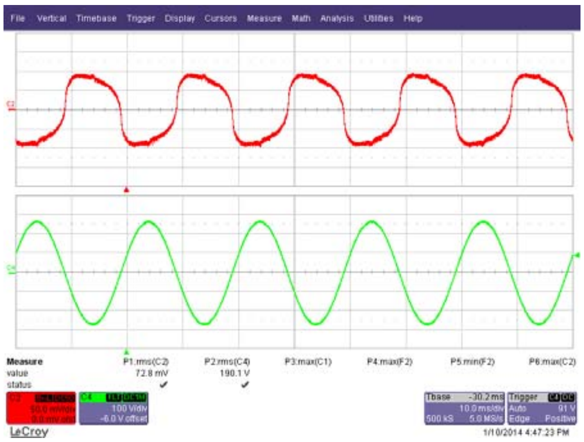

**Figure 19 –**190 VAC, Full Load.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 10 ms / div.

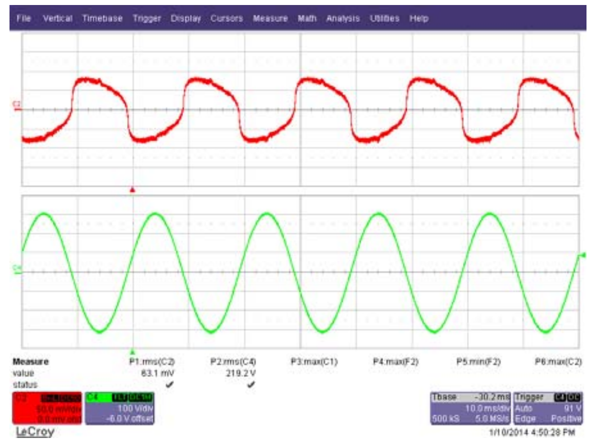

**Figure 20 –** 220 VAC, Full Load.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 10 ms / div.

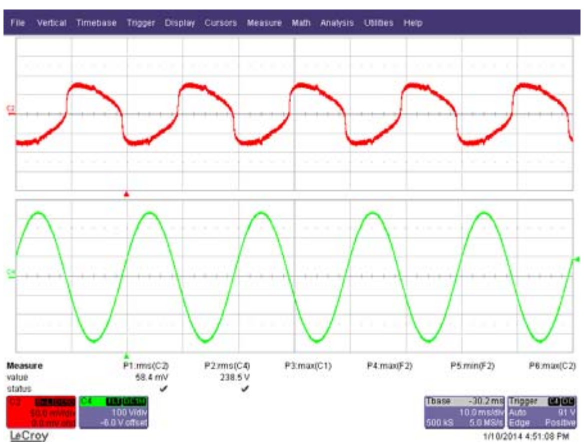

**Figure 21 –** 240 VAC, Full Load.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 10 ms / div.

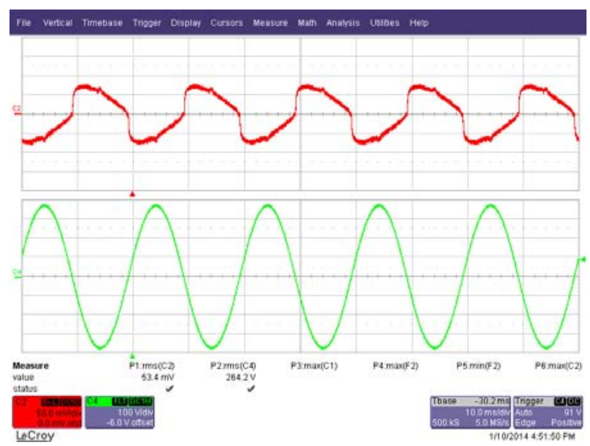

**Figure 22 –** 265 VAC, Full Load.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 10 ms / div.

## *12.2 正常工作时的输出电流和输出电压*

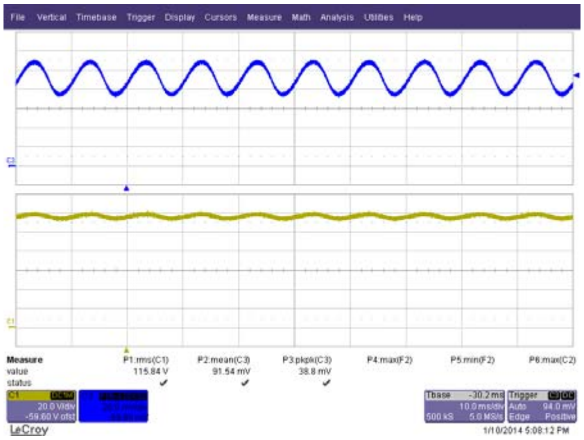

**Figure 23 –** 190 VAC, 50Hz.Full Load.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{OUT}$, 20 V, 10 ms / div.

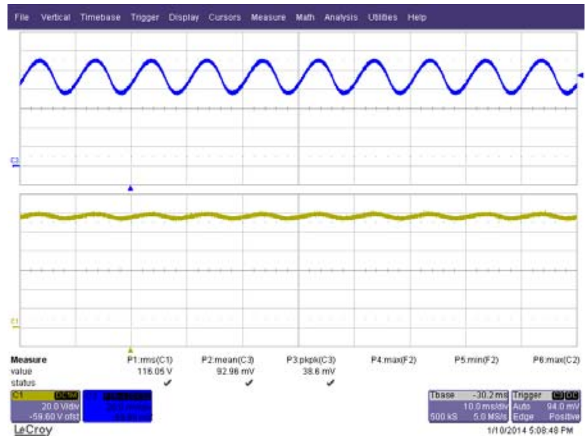

**Figure 24 –** 220 VAC, 50Hz. Full Load.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{OUT}$, 20 V, 10 ms / div.

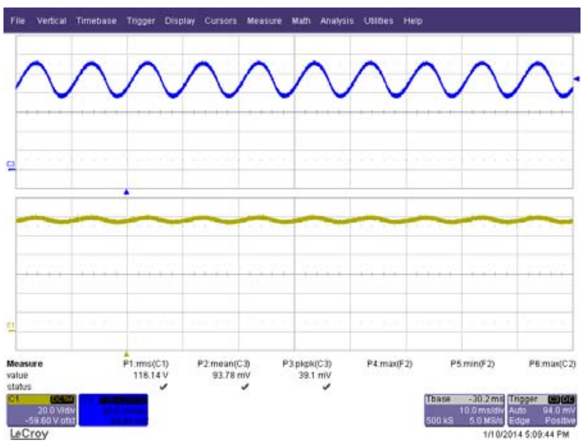

**Figure 25 –** 240 VAC, 50Hz.Full Load.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{OUT}$, 20 V, 10 ms / div.

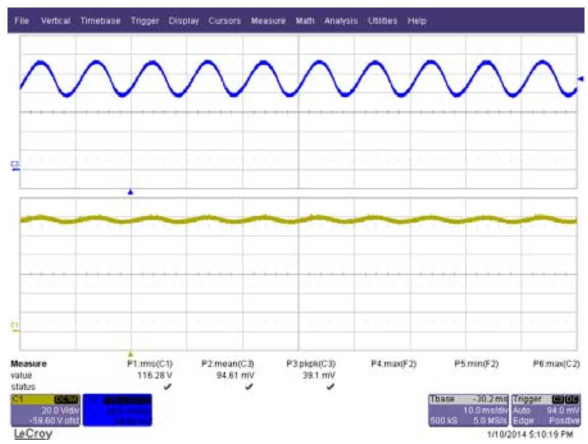

**Figure 26 –** 265 VAC, 50Hz. Full Load.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{OUT}$, 20 V, 10 ms / div.



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## *12.3 输出电流的升降*

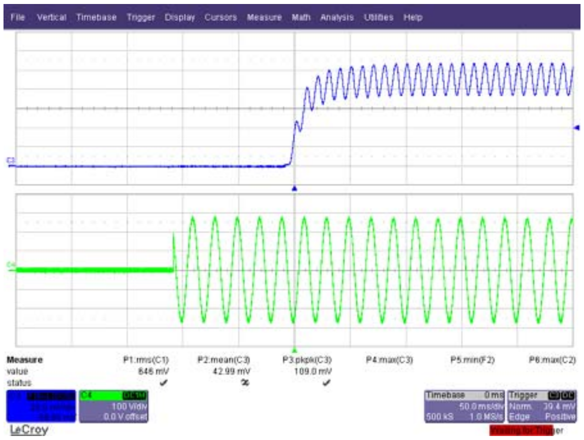

**Figure 27 –** 190 VAC Output Rise.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 50 ms / div.

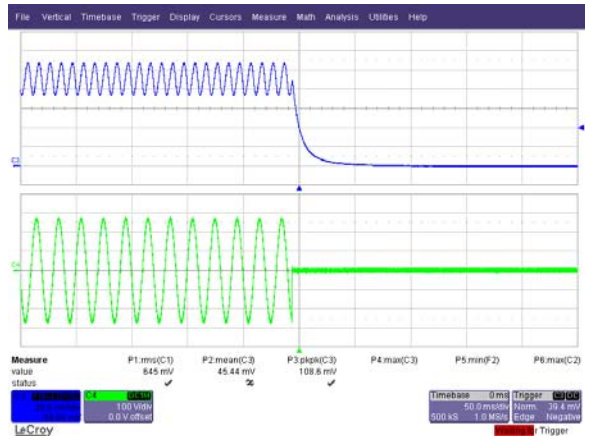

**Figure 28 –** 90 VAC Output Fall.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 200 V, 100 ms / div.

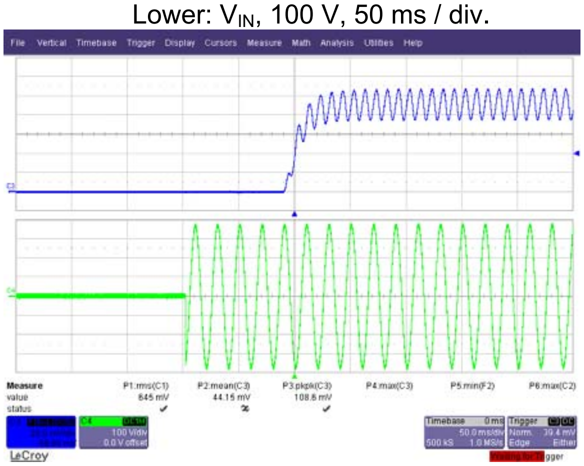

**Figure 29 –** 265 VAC Output Rise.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 50 ms / div.

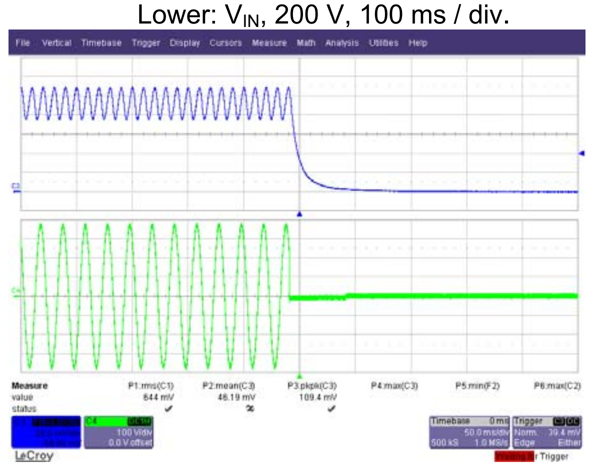

**Figure 30 –** 265 VAC Output Fall.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 50 ms / div.

### *12.4 正常工作时的漏极电压和电流*

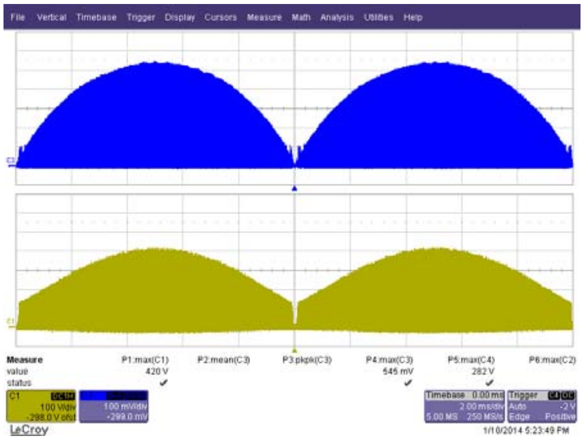

**Figure 31 –** 190 VAC, 50Hz.
Upper: $I_{DRAIN}$, 0.1 A / div.
Lower: $V_{DRAIN}$, 100 V,2ms / div.

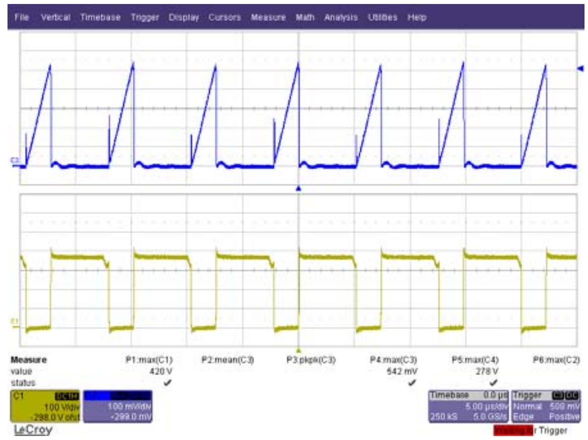

**Figure 32 –** 190 VAC, 50Hz.
Upper: $I_{DRAIN}$, 0.1 A / div.
Lower: $V_{DRAIN}$, 100 V / div., 5µs / div.

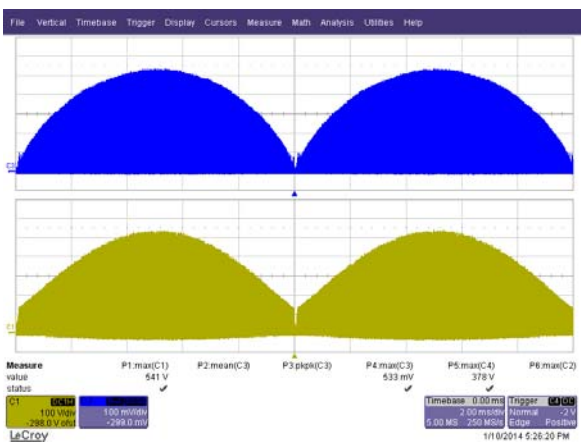

**Figure 33 –** 265 VAC, 50Hz.
Upper: $I_{DRAIN}$, 0.1 A / div.
Lower: $V_{DRAIN}$, 100 V,2ms / div.

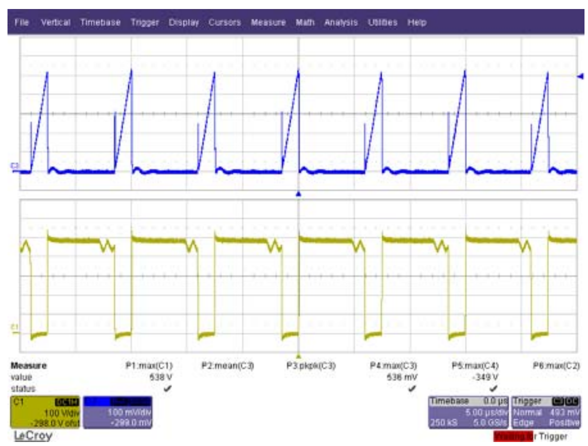

**Figure 34 –** 265 VAC, 50Hz.
Upper: $I_{DRAIN}$, 0.1 A / div.
Lower: $V_{DRAIN}$, 100 V / div., 5µs / div.


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## *12.5 启动时的漏极电压和电流*

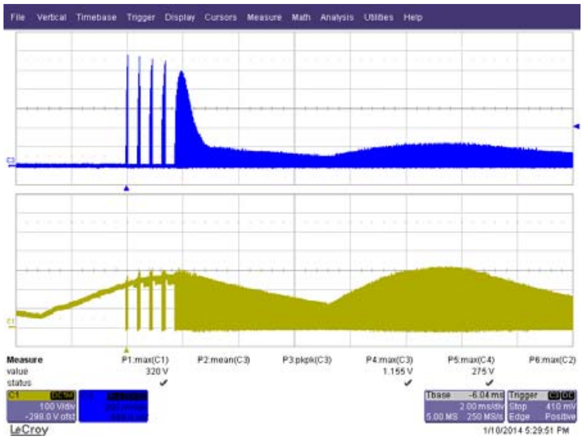

**Figure 35 –** 190 VAC, 50Hz Start-up.
Upper: $I_{DRAIN}$, 200mA / div.
Lower: $V_{DRAIN}$,100 V, 2 ms / div.

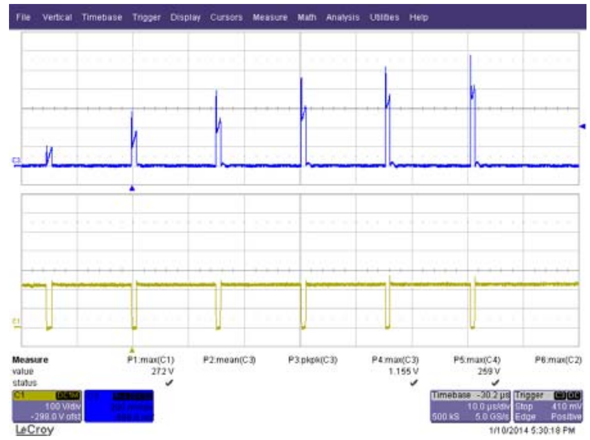

**Figure 36 –** 190 VAC, 50Hz Start-up.
Upper: $I_{DRAIN}$, 200mA / div.
Lower: $V_{DRAIN}$,100 V, 10µs / div.

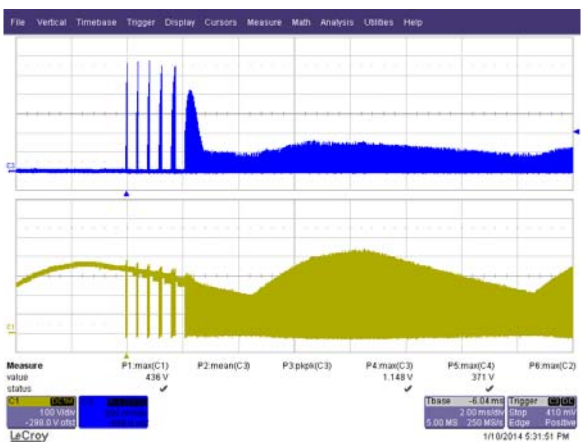

**Figure 37 –** 265 VAC, 50 Hz Start-up.
Upper: $I_{DRAIN}$, 200mA / div.
Lower: $V_{DRAIN}$,100 V, 2 ms / div.

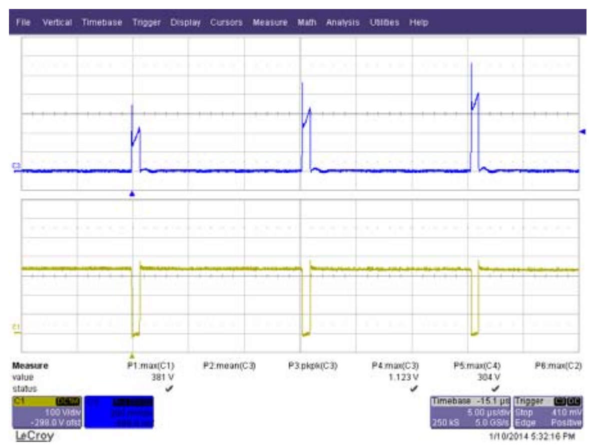

**Figure 38 –** 265 VAC, 50 Hz Start-up.
Upper: $I_{DRAIN}$, 200mA / div.
Lower: $V_{DRAIN}$,100 V, 5µs / div.

### *12.6 输出短路时的漏极电流和漏极电压*

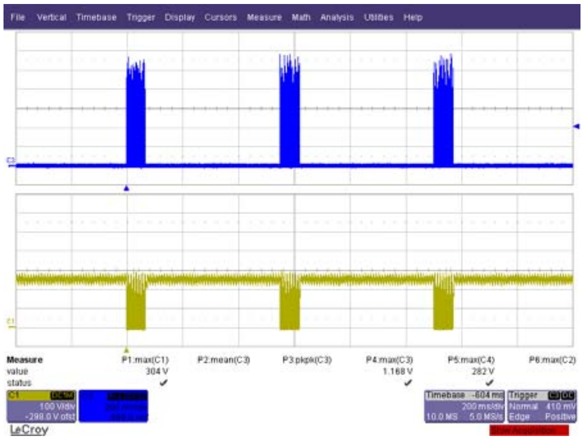

**Figure 39 –**190 VAC, 50Hz Output Short Condition.
Upper: $I_{DRAIN}$, 200mA / div.
Lower: $V_{DRAIN}$,100 V, 200ms / div.

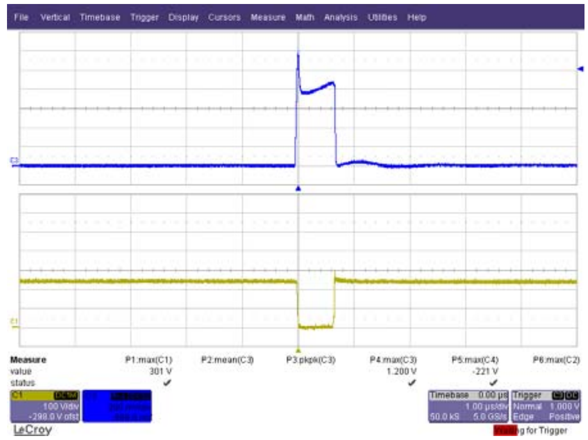

**Figure 40 –**190 VAC, 50Hz Output Short Condition.
Upper: $I_{DRAIN}$, 200 mA / div.
Lower: $V_{DRAIN}$, 100 V, 1µs / div.

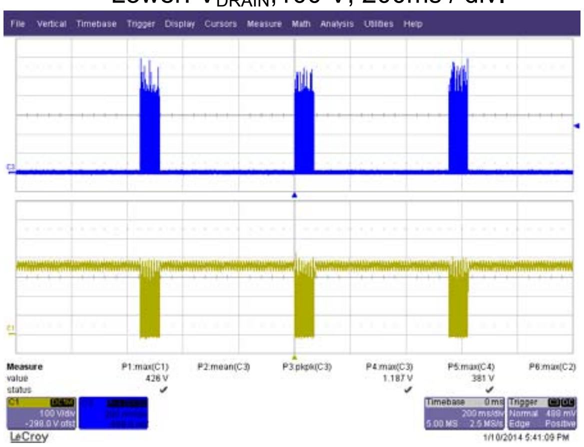

**Figure 41 –** 265 VAC, 50Hz Output Short Condition.
Upper: $I_{DRAIN}$, 200 mA / div.
Lower: $V_{DRAIN,}$ 100 V, 5ms / div.

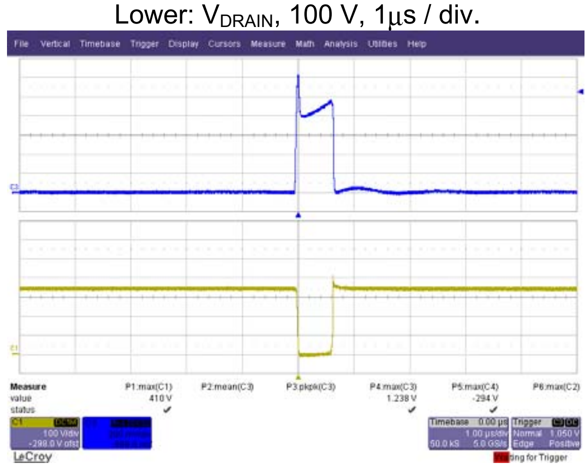

**Figure 42 –** 265 VAC, 50Hz Output Short Condition.
Upper: $I_{DRAIN}$, 200 mA / div.
Lower: $V_{DRAIN,}$ 100 V, 1µs / div.



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### *12.7 开路负载特性*

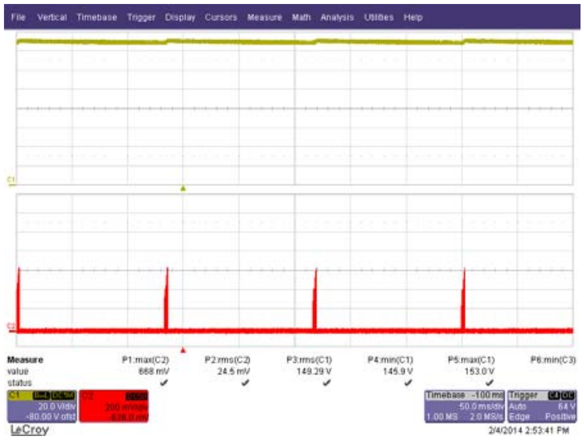

**Figure 43 –**190 VAC, 50Hz Open Load Condition.
Upper: $V_{OUT}$, 50 V / div.
Lower: $I_{DRAIN}$, 200 mA, 100ms / div.

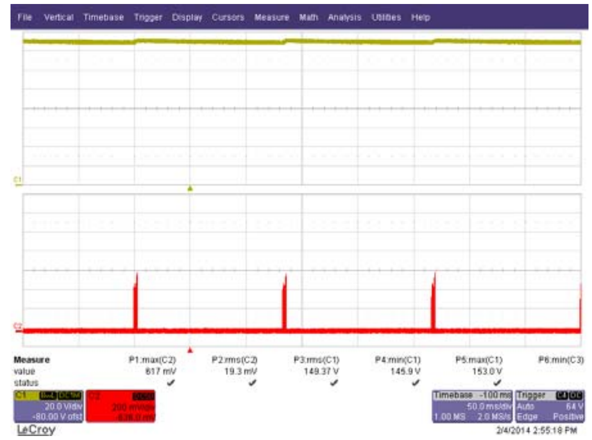

**Figure 44 –** 265 VAC, 50Hz Output Short Condition.
Upper: $V_{OUT}$, 50 V / div.
Lower: $I_{DRAIN}$, 200 mA, 200ms / div.

### *12.8 电压跌落/缓升*

No failure of any component during brownout test of 0.5 V / sec AC cut-in and cut-off.

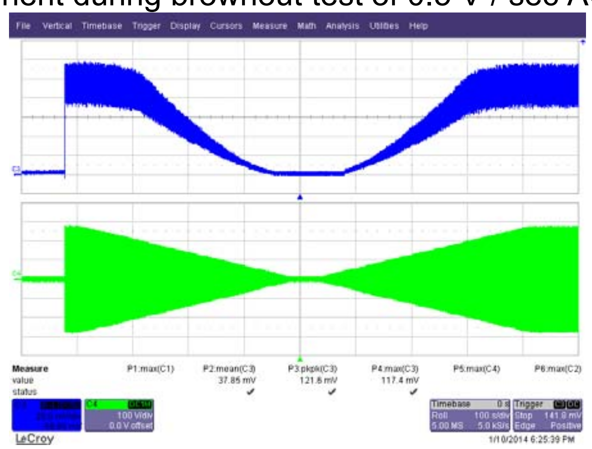

**Figure 45 –** Brown-out Test at 0.5V/ s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.Ch4: $V_{IN}$; 100V/ div.
Ch2: $I_{OUT}$; 20mA/ div.
Time Scale:100s/ div.

# 13 调光波形

## *13.1 输入电压及输入电流波形 - 前沿调光器*

Input: 230VAC, 50Hz
Output: 120V LED Load
Dimmer: WDE300F-1

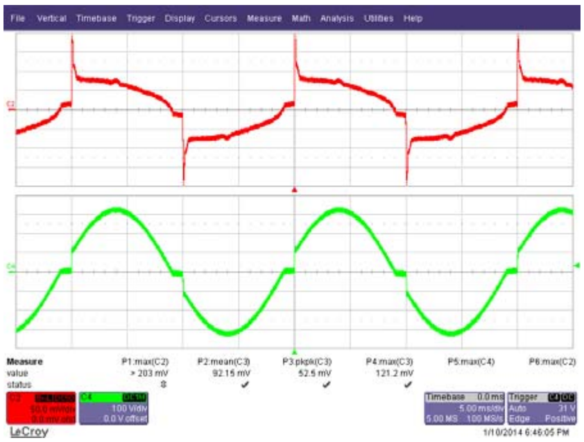

**Figure 46 –**162ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

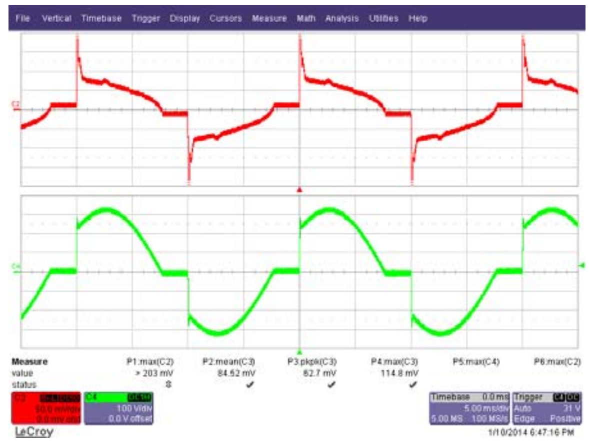

**Figure 47 –** 135ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

**Figure 48 –** 90ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

**Figure 49 –** 30ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

### *13.2 输出电流波形 – 前沿调光器*

Input: 230VAC, 50 Hz
Output: 120 V LED Load
Dimmer: WDE300F-1

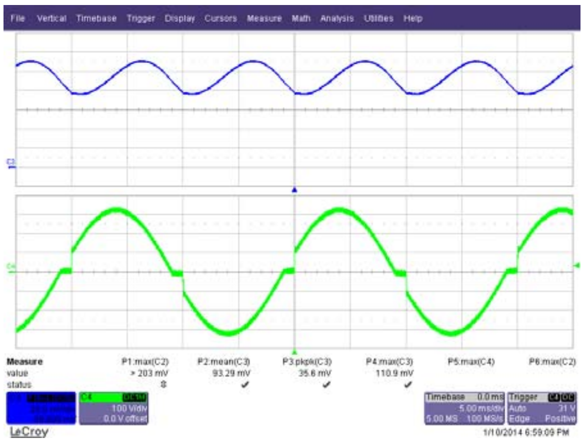

**Figure 50 –** 162ºConduction Angle.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

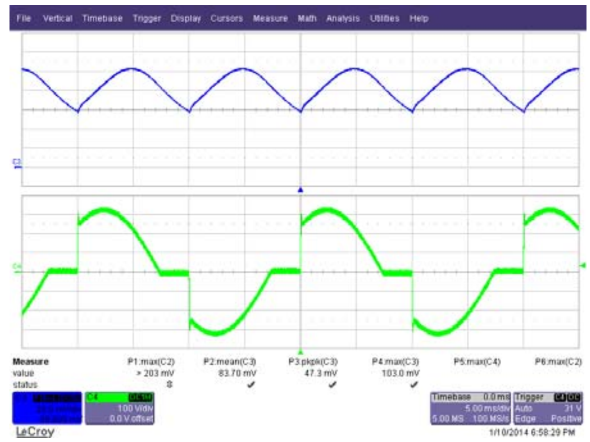

**Figure 51 –** 135ºConduction Angle.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

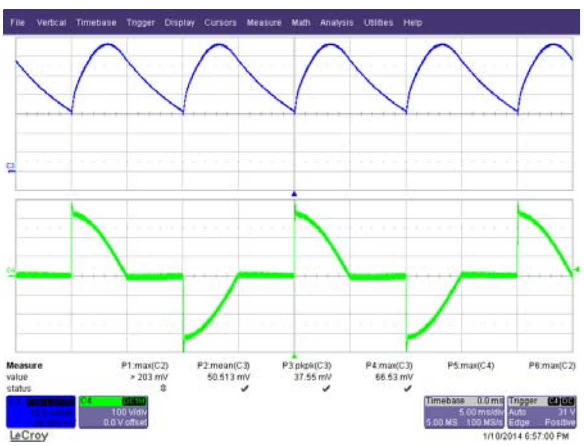

**Figure 52 –** 90ºConduction Angle.
Upper: $I_{OUT}$, 10mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

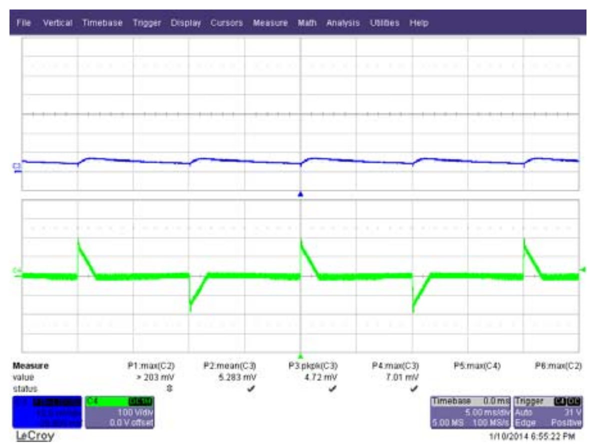

**Figure 53 –** 30ºConduction Angle.
Upper: $I_{OUT}$, 10mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

### *13.3 输入电压及输入电流波形 – 后沿调光器*

Input: 230VAC, 50 Hz
Output: 120 V LED Load
Dimmer: PEHA 433HAB

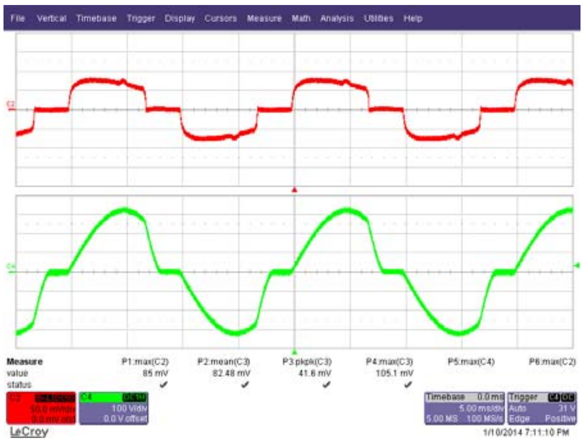

**Figure 54 –** 124ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

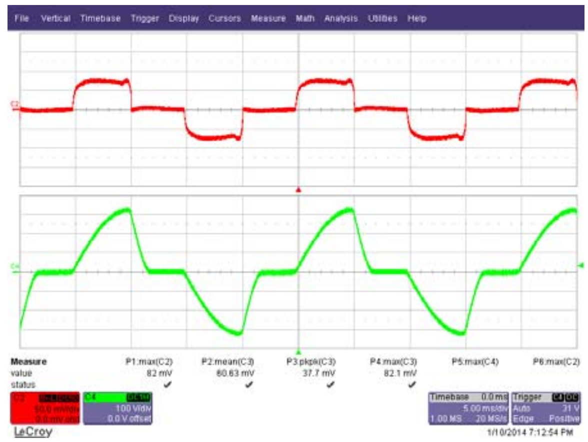

**Figure 55 –** 120ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

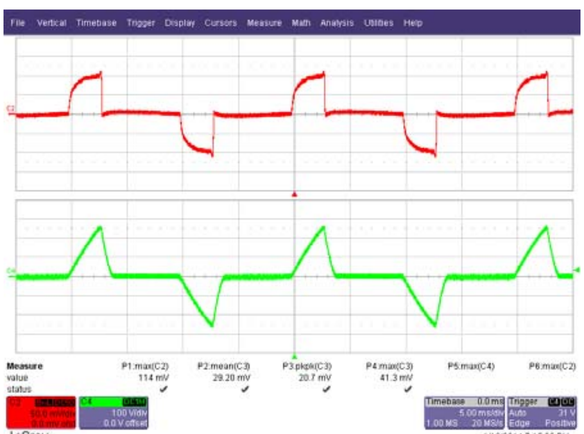

**Figure 56 –** 54ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

**Figure 57 –** 43ºConduction Angle.
Upper: $I_{IN}$, 50mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.



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### *13.4 输出电流波形 – 后沿调光器*

Input: 230VAC, 50 Hz
Output: 120 V LED Load
Dimmer: PEHA 433HAB

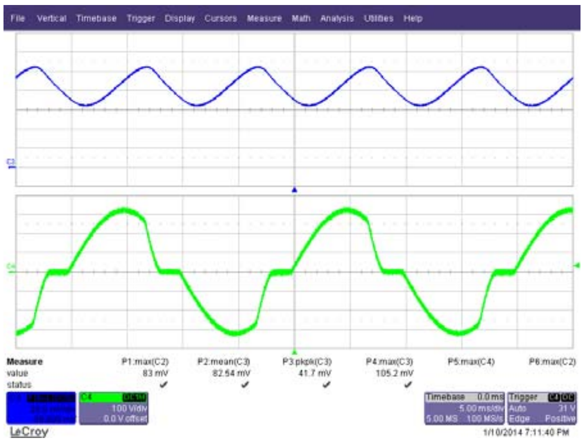

**Figure 58 –** 124ºConduction Angle.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

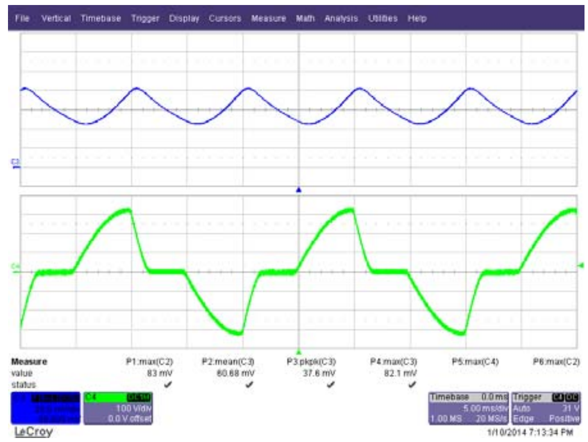

**Figure 59 –** 90ºConduction Angle.
Upper: $I_{OUT}$, 20mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

**Figure 60 –** 54ºConduction Angle.
Upper: $I_{OUT}$, 10mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

**Figure 61 –** 43ºConduction Angle.
Upper: $I_{OUT}$, 10mA / div.
Lower: $V_{IN}$, 100 V, 5 ms / div.

### *13.5 漏极电流波形 – 前沿调光器*

Input: 230VAC, 50 Hz
Output: 120 V LED Load
Dimmer: WDE300F-1

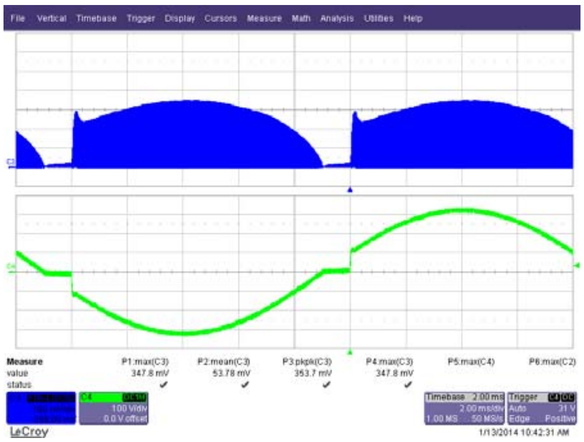

**Figure 62 –** 162ºConduction Angle.
Upper: U1 $I_{DS}$, 100mA / div.
Lower: $V_{IN}$, 100 V, 2 ms / div.

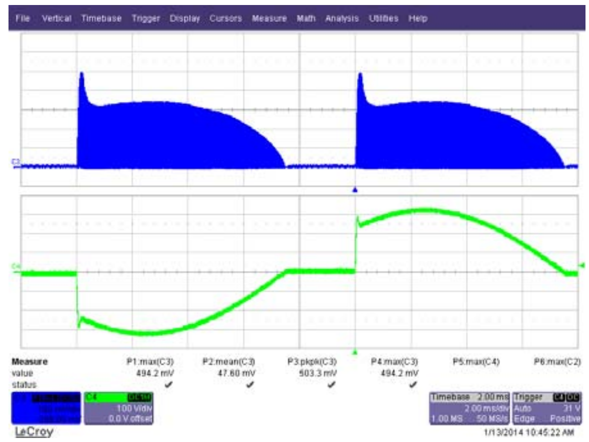

**Figure 63 –** 135ºConduction Angle.
Upper: U1 $I_{DS}$, 100mA / div.
Lower: $V_{IN}$, 100 V, 2 ms / div.

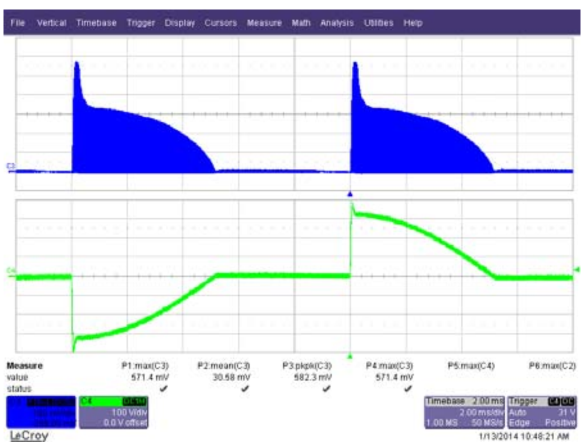

**Figure 64 –** 90ºConduction Angle.
Upper: U1 $I_{DS}$, 100mA / div.
Lower: $V_{IN}$, 100 V, 2 ms / div.

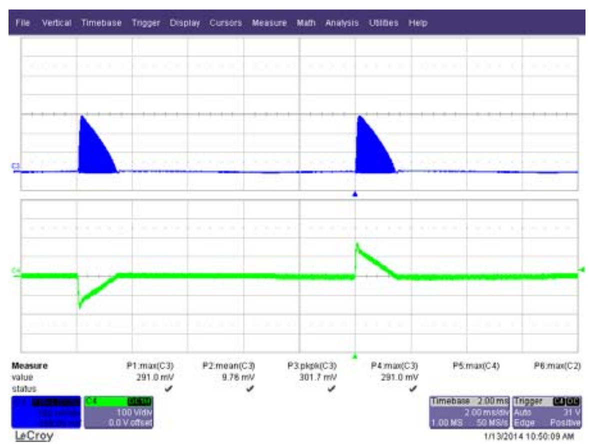

**Figure 65 –** 30ºConduction Angle.
Upper: U1 $I_{DS}$, 100mA / div.
Lower: $V_{IN}$, 100 V, 2 ms / div.



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# 14 传导EMI

## *14.1 测试设置*

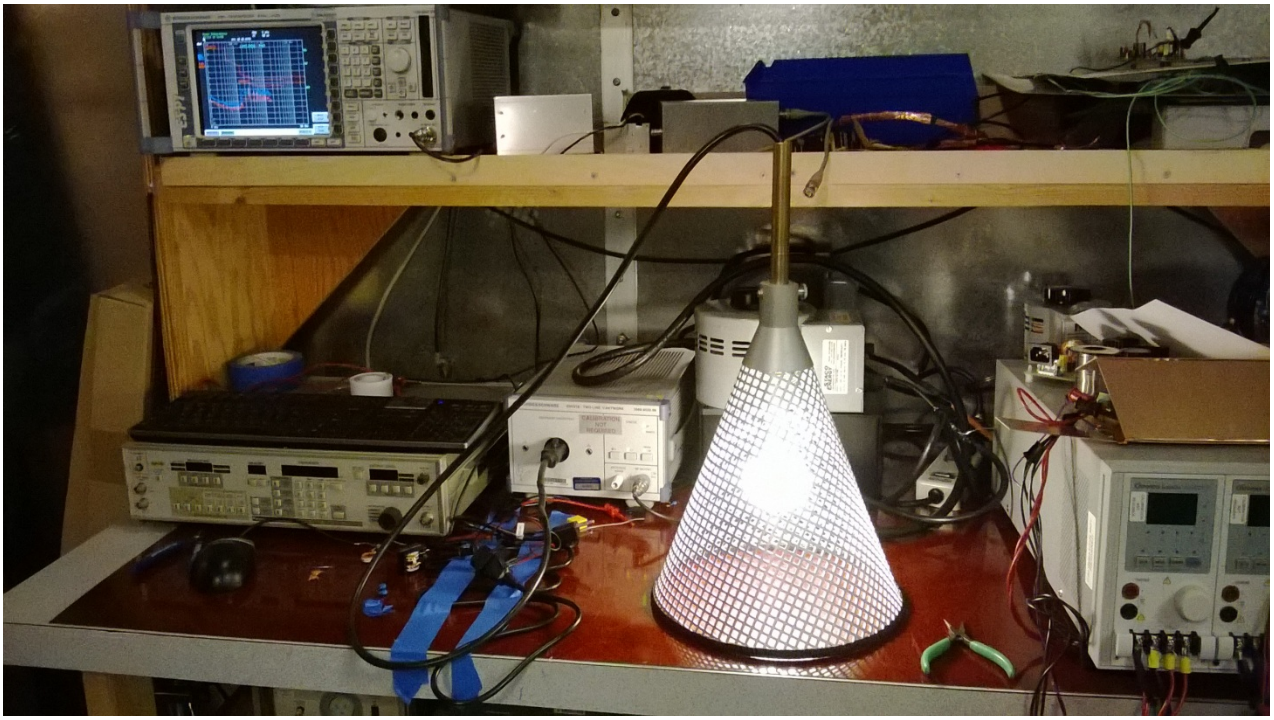

**Figure 66 –** Conducted EMI Test Set-up.

## *14.2 测试结果*

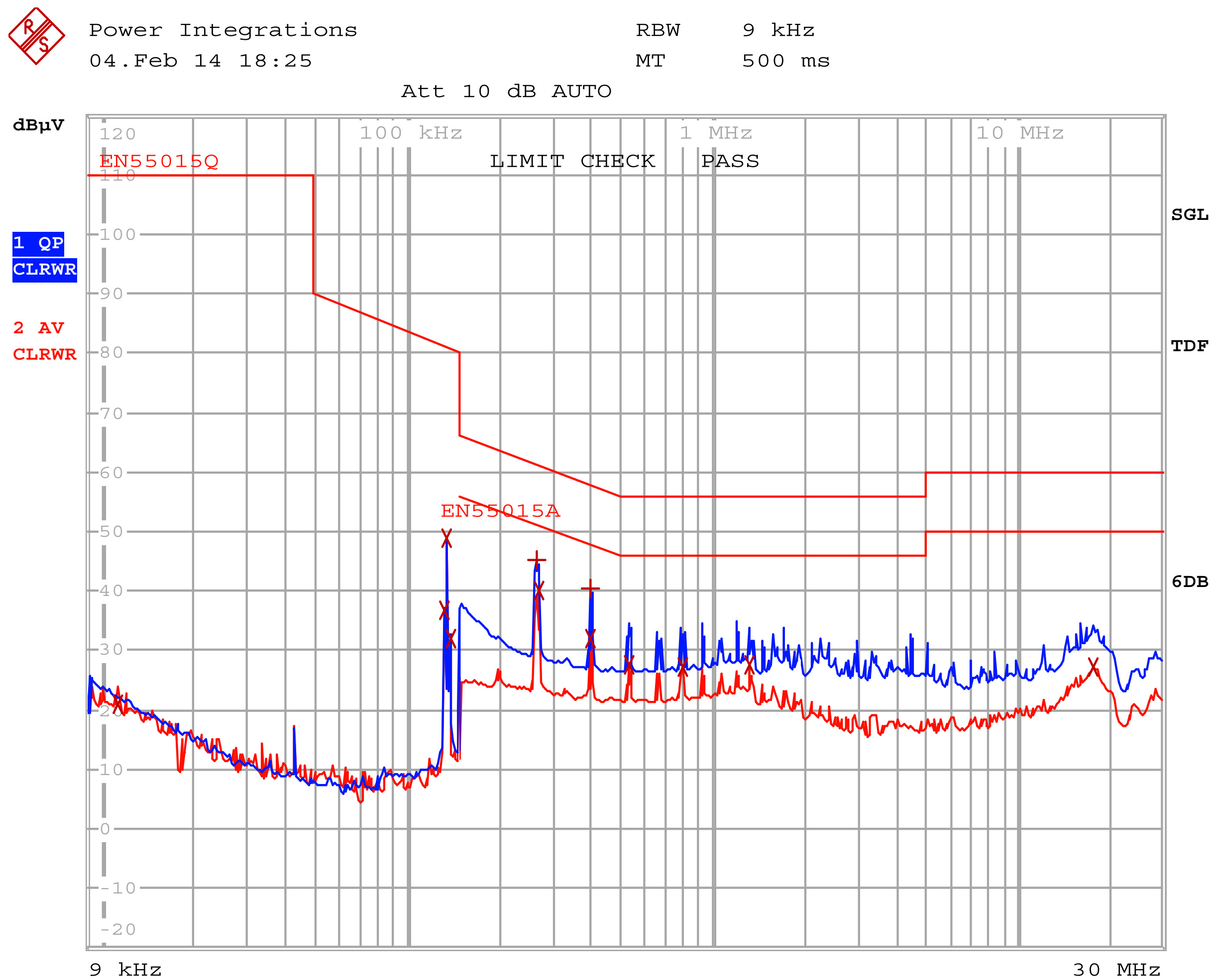


**Figure 67 –** Conducted EMI, ~120V LED Load, 230 VAC, 60 Hz, and EN55015 B Limits.


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| EDIT PEAK LIST (Final Measurement Results) | | | | | |
|---|---|---|---|---|---|
| Trace1: | | EN55015Q | | | |
| Trace2: | | EN55015A | | | |
| Trace3: | | --- | | | |
| | TRACE | FREQUENCY | LEVEL dBµV | | DELTA LIMIT dB |
| 2 | Average | 11.2024427378 kHz | 21.11 | N gnd | |
| 2 | Average | 130.825395691 kHz | 36.71 | L1 gnd | |
| 2 | Average | 133.454986145 kHz | 48.99 | N gnd | |
| 2 | Average | 137.49880568 kHz | 31.99 | L1 gnd | |
| 1 | Quasi Peak | 264.49018761 kHz | 45.08 | L1 gnd | -16.20 |
| 2 | Average | 267.135089486 kHz | 40.14 | L1 gnd | -11.06 |
| 1 | Quasi Peak | 397.727746704 kHz | 40.55 | L1 gnd | -17.34 |
| 2 | Average | 397.727746704 kHz | 32.14 | L1 gnd | -15.76 |
| 2 | Average | 530.769219795 kHz | 27.42 | L1 gnd | -18.57 |
| 2 | Average | 798.145472681 kHz | 27.29 | L1 gnd | -18.70 |
| 2 | Average | 1.32578199726 MHz | 27.47 | L1 gnd | -18.52 |
| 2 | Average | 17.7971587654 MHz | 27.14 | L1 gnd | -22.85 |

**Figure 68 –** Conducted EMI, Final Measurement Results.

## 15 输入浪涌

Differential input line 500V surge testing was completed on a single test unit to IEC61000-4-5. Input voltage was set at 230 VAC / 60 Hz.

| Surge Level (V) | Input Voltage (VAC) | Injection Location | Injection Phase (°) | Test Result (Pass/Fail) |
|---|---|---|---|---|
| +500 | 230 | L to N | 90 | Pass |
| -500 | 230 | L to N | 90 | Pass |
| +500 | 230 | L to N | 0 | Pass |
| -500 | 230 | L to N | 0 | Pass |

Differential ring input line surge testing was completed on a single test unit to IEC61000-4-5. Input voltage was set at 230 VAC / 60 Hz. Output was loaded at full load and operation was verified following each surge event.

| Surge Level (V) | Input Voltage (VAC) | Injection Location | Injection Phase (°) | Test Result (Pass/Fail) |
|---|---|---|---|---|
| +2500 | 230 | L to N | 90 | Pass |
| -2500 | 230 | L to N | 90 | Pass |
| +2500 | 230 | L to N | 0 | Pass |
| -2500 | 230 | L to N | 0 | Pass |

Unit passed under all test conditions.

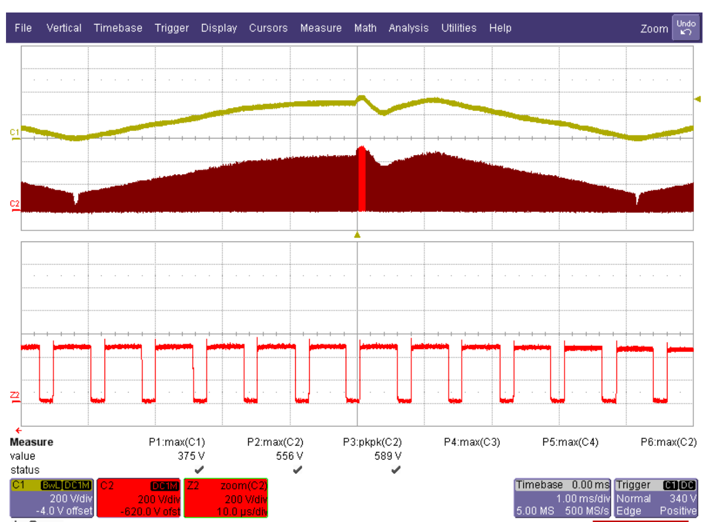


**Figure 69 –** 500V Differential Surge. 589V maximum VDS.


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## 16 版本历史

| Date | Author | Revision | Description andChanges | Reviewed |
|---|---|---|---|---|
| 9-Jun-14 | CA | 1.0 | Initial Release | Apps &Mktg |
| | | | | |
| | | | | |
| | | | | |

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