设计范例报告

标题	***使用LYTSwitch™-4 LYT4311E设计的7.5 W 非隔离抽头降压式、可控硅调光、带功率因数校正(>.095)的LED驱动器***
规格	90 VAC – 132 VAC输入；15 V，500 mA输出
应用	PAR20 LED驱动器
作者	应用工程部
文档编号	DER-360
日期	2013年6月10日
修订版本	1.0

特色概述

- 在120 VAC输入下，效率极高(≥85%)
- 具有非常宽的调光器兼容性（满足NEMA SSL6调光曲线要求），可兼容广泛的美国可控硅调光器
  - 高调光比(1000:1)
- 增强的用户体验
  - 无闪烁的单向调光
  - 快速单向启动(<200 ms) – 无可见延迟
  - 以几乎相同的调光角度导通和关断 – 不存在突然变亮现象或死区时间
- 成本低
  - 单级集成式PFC与精确初级侧调节的恒流输出
- 集成的保护及可靠性能
  - 输出开路/输出短路保护，带自动恢复功能
  - 快速反应的输入过压关断可扩展输入故障时的电压耐受范围
    - 耐受±2500 V振铃波和±500 V差模浪涌（无MOV）
  - 更大迟滞的自动恢复热关断可同时保护元件和印刷电路板
- 满足IEC 61000-4-5振铃波、IEC 61000-3-2 C THD和IEC CISPR 15 / EN55015 B传导EMI要求

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专利信息

此处介绍的产品和应用（包括产品之外的变压器结构和电路）可能包含一项或多项美国及国外专利，或正在申请的美国或国外专利。有关Power Integrations专利的完整列表，请参见www.powerint.com。Power Integrations按照在http://www.powerint.com/ip.htm中所述规定，向客户授予特定专利权利的许可。

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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。

1 简介

本文档介绍的是一款隔离式高功率因数(PF)、可控硅调光的LED驱动器，它可以在90 VAC至132 VAC的输入电压范围内为LED灯串提供额定电压15 V、额定电流500 mA的驱动。该LED驱动器采用了LYTSwitch-4系列IC中的LYT4311E 器件。

所采用的拓扑结构为低元件件数、单级、带功率因数校正的抽头降压式拓扑结构，可提供高效率、高功率因数以及低THD。

LYTSwitch-4 IC还可提供各种复杂的保护功能，包括环路开环或输出短路条件下自动重启动等，利用该器件可实现高功率因数和低THD。输入过压关断可提供增强的抗输入故障和浪涌能力，精确的迟滞热关断可确保在所有条件下平均PCB温度都处于安全范围内。

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

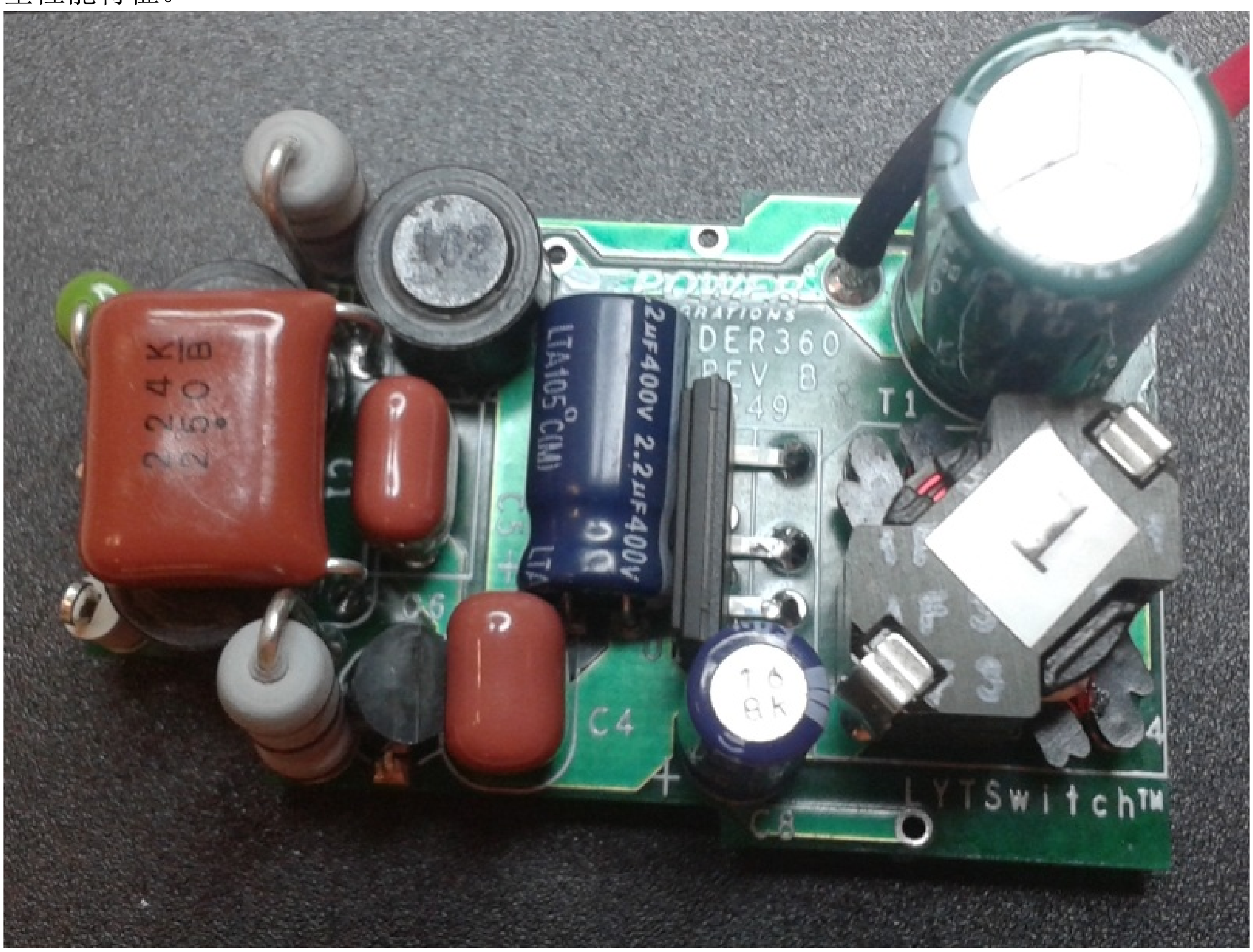

Figure 1 – Populated Circuit Board Photograph.

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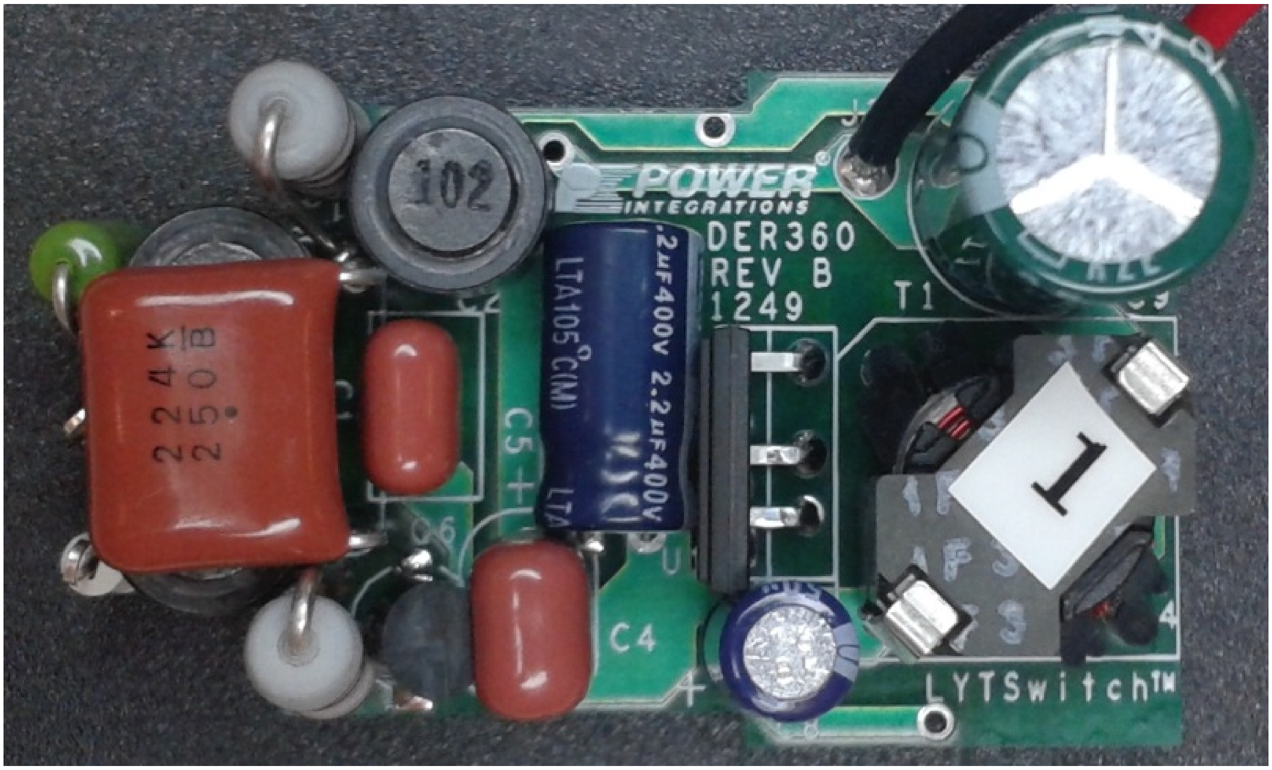

Figure 2 – Populated Circuit Board Photograph (Top View).

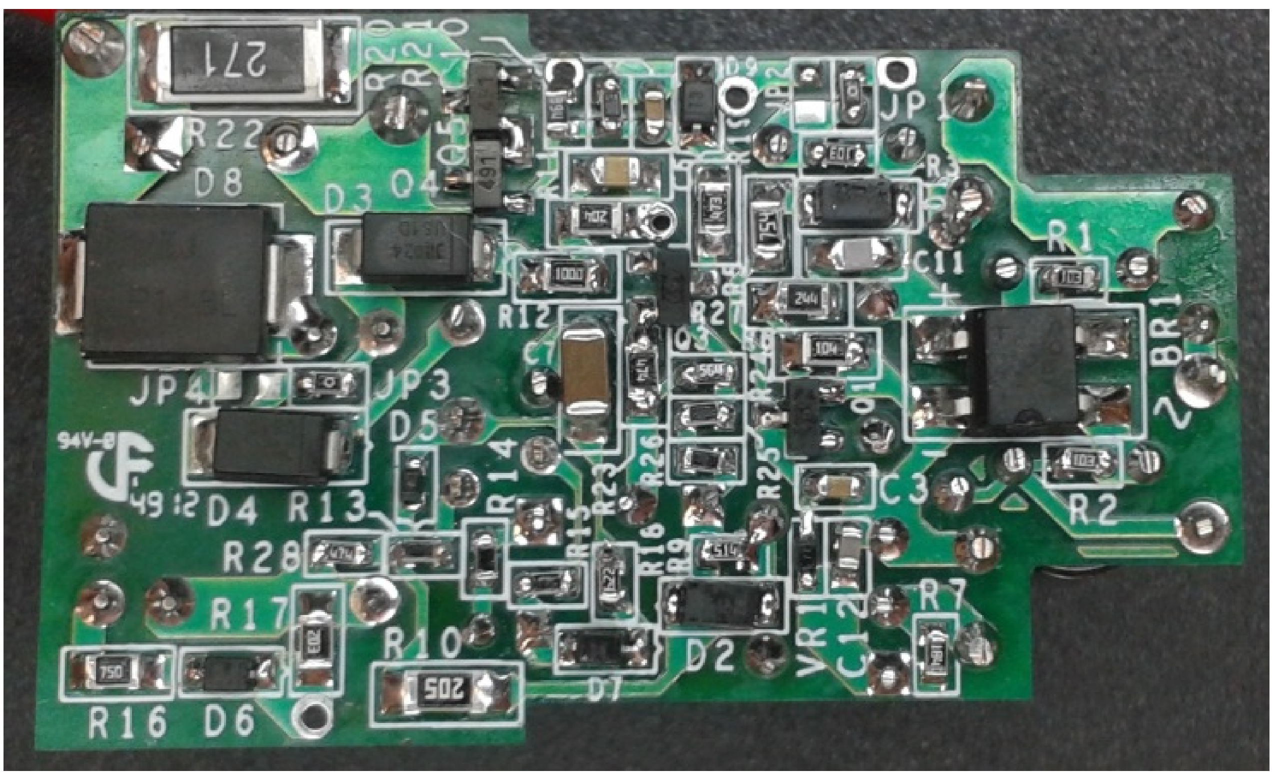

Figure 3 – Populated Circuit Board Photograph (Bottom View).

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}	90	120	132	VAC	
频率	f_{LINE}		60		Hz	
输出						
输出电压	V_{OUT}	12	15	18	V	
输出电流	I_{OUT}		500		mA	
总输出功率						
连续输出功率	P_{OUT}		7.5		W	
效率						
满载	η		85		%	V_{OUT} = 15，V_{IN} = 120 VAC，25 °C环境温度
环境						
传导EMI		CISPR 15B / EN55015B				
安全		隔离式				
振铃波(100 kHz)						
差模(L1-L2)			2.5		kV	
共模(L1/L2-PE)						
差模浪涌(1.2 / 50 μs)			500		V	
功率因数			0.95			在$V_{OUT(TYP)}$、$I_{OUT(TYP)}$以及120 VAC、60 Hz条件下测得
谐波电流		EN 61000-3-2 Class D (C)				当 P_{IN} <25 W，Class C指定Class D限值
环境温度	T_{AMB}		40		°C	自然对流，海平面

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3 电路原理图

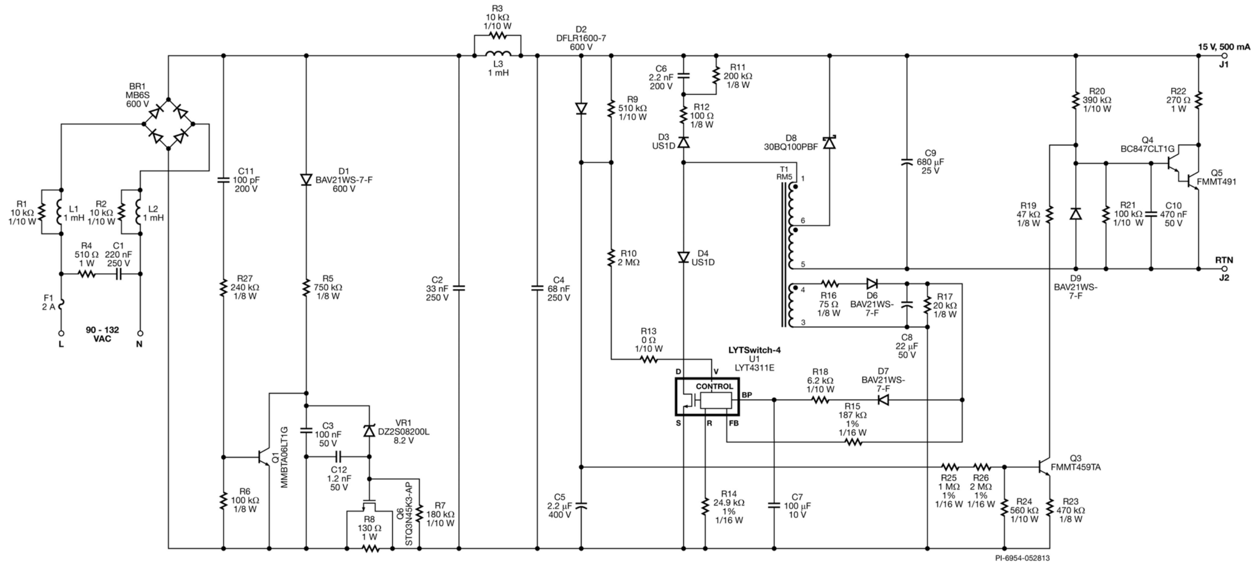

Figure 4 – Schematic.

4 电路描述

LYTSwitch-4 器件是一种将控制器和650 V功率MOSFET集成在一起的器件，用于LED驱动器应用。LYTSwitch-4 IC可用于单级、抽头降压式拓扑结构，提供初级侧调节的恒流隔离输出，同时使AC输入保持高功率因数。

4.1 输入滤波

保险丝F1提供元件故障保护。本电路选用了相对较高的电流额定值，以防止在差模(1.2 μs / 50 μs)输入浪涌期间出现故障。LYTSwitch-4 IC的快速反应输入过压检测与D2和C5峰值检测电容一起提供箝位功能，用以限制在IC的MOSFET上出现最大电压应力。C5取值2.2 μF可以耐受500 V的浪涌，而取值4.7 μF可耐受1 kV的浪涌。可选的额定输入电压为140 VAC的额外MOV（金属氧化物压敏电阻）RV1可用来满足>1000 V的差模输入电压浪涌要求。二极管桥堆BR1对AC线电压进行整流，电容C4为初级开关电流提供低阻抗通路（去耦）。

EMI滤波由电感L1、L2和L3以及电容C2和C4提供。L1、L2和L3上的电阻R1、R2和R3可分别抑制由滤波元件和AC输入阻抗所产生的任何共振，不然会导致传导EMI测量值增大。

4.2 LYTSwitch-4初级

本设计所采用的拓扑结构为低压端抽头降压式配置，可在90 VAC至132 VAC的输入电压范围内提供低THD、整功率因数和恒流输出。

抽头降压式转换器具有诸多优势，包括可减小磁芯元件的尺寸、降低主开关U1上的电流应力以及降低输出二极管D8上的电压应力。主开关上的电流应力降低后，可使用较小的开关器件，从而提高设计的成本效益。输出二极管上的电压应力降低后，可使用V_F值较低的（肖特基）器件，从而提高效率。

电感T1是降压转换器的主电感，它由初级绕组、次级绕组和偏置绕组这三个绕组组成。将匝数比选定为5:1（初级绕组与次级绕组匝数比）后，可使用一个100 V输出二极管，同时仍使U1 LYT4311E的最大电压远低于其最大值。

输出二极管D8每当U1关断时就会导通，将能量传输至负载。在C4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D4来防止反向电流流经U1。此外，还添加了一个电压箝位电路来限制由T1的漏感所产生的电压尖峰。电压箝位网络由二极管D3、电容C6以及电阻R11和R12组成。

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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C5充电。然后电流经过R10，注入U1的电压监测(V)引脚。当出现电压跌落时，电阻R9就是C5的放电通路，使V引脚在降低功率方面作出快速响应。

输入过压关断功能（通过 V引脚检测）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650 BV_{DSS}。LYTSwitch-4 IC的快速反应输入过压检测与D2和C5峰值检测电容一起提供箝位功能，用以限制在IC的MOSFET上出现最大电压应力。C5取值2.2 µF可以耐受500 V的浪涌，而取值4.7 µF可耐受1 kV的浪涌。可选的额定输入电压为140 VAC的额外MOV（金属氧化物压敏电阻）RV1可用来满足>1000 V的差模输入电压浪涌要求。

电容C7对U1的旁路(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的漏极(D)引脚相连的内部高压电流源被充电至约6 V。作为系列内功耗最低的器件，LYT4311E具有固定功率模式。不过，将电容C8取值100 µF可使器件在调光时以低导通角进行操作。建议使用外部偏置供电（通过D7和R18）以实现最低的器件功耗，并在深度调光情况下向U1提供足够的电源。二极管D7用于在启动时将C7与C8隔离，电阻R18用于限制从偏置绕组提供给BP引脚的电流。

V引脚电流和反馈(FB)引脚电流在内部用来控制LED平均输出电流。对于相位角调光应用，可在参考(R)引脚(R14)和V引脚上分别使用49.9 kΩ电阻和2 MΩ (R10)电阻，使输入电压和输出电流保持线性关系。这样可在配合可控硅调光器使用时扩大调光范围。但在本设计中，24.99 kΩ用于提高恒流调节精确度。在输出上使用有源假负载可以实现高调光比。

4.3 反馈

偏置绕组电压用来间接地反映输出电压的高低，而无需使用次级侧反馈元件。偏置绕组上的电压与输出电压成比例（由偏置绕组与次级绕组之间的匝数比决定）的。偏置绕组的反馈电压由D6进行整流并由R16和C8进行滤波。电阻R15将偏置电压转换为电流，馈入U1的FB引脚。U1中的内部引擎综合FB引脚电流、V测引脚电流和内部漏极电流信息，提供恒定的输出电流，同时保持较高的输入功率因数。

4.4 输出整流

变压器次级绕组由D8进行整流，由电容C9进行滤波。对于要求采用低纹波的设计，可提高输出电容值。

4.5 可控硅相位调光控制兼容性

对于用低成本的可控硅前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全面权衡。

由于LED照明的功耗非常低，灯具所消耗的电流要小于调光器内可控硅的维持电流。这样会因为可控硅触发不一致而产生某些不良情况，比如灯具在调光器控制范围结束时关闭和/或闪烁。由于LED灯的阻抗相对较大，因此在可控硅导通时，浪涌电流会对输入电容进行充电，产生很严重的振铃。这同样会造成类似的不良情况，因为振铃会使可控硅电流降至零。

要克服这些问题，需要增加有源衰减电路和无源泄放电路。这些电路的缺点是会增大功耗，进而降低电源的效率。对于非调光应用，可以省略这些元件。

PI独特的最新有源衰减电路由主要元件Q6和R8组成。当无可控硅连接时，Q6将完全导通，然后旁路R8，将使功耗保持低水平，从而保持较高的系统效率。可控硅的检测通过C11、R27和R6执行，这样可瞬间将Q1导通，使C3接地，并使Q6降低，从而使R8与可控硅串联以充当衰减元件，在可控硅每次导通时衰减电流振铃。

无源泄放电路由C1和R4构成。这样可以使输入电流始终大于可控硅的维持电流，而驱动器的输入电流将在每个AC半周期内增大，防止每个导通期间的起始阶段出现可控硅开关振荡。

4.6 有源假负载

PI在此驱动器中新增的独特的有源假负载电路用于形成调光曲线和提高调光比，同时在正常工作期间维持高效率。该电路还可用于降压式、降压-升压式和抽头降压式等非隔离转换器。

有源假负载电路经由分压器R25、R26和R24检测来自C5的输入峰值电压，该电压与调光器的导通角成正比；信息经由Q3、R23、R19和C10进行处理后给出平均信号，用于对达林顿晶体管（Q4、Q5）进行线性驱动，从而经由一个电阻(R22)向输出加载。

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在非调光工作（全导通）期间，有源泄放电路未跨接输出，因此可维持高效率工作。泄放电路在设定调光角（调光角度约<70º）下进行导通。有源泄放电路将被线性偏置，并降至可控硅可以工作的最小导通角，从而提高调光比。

该电路还可以充当有泄漏的可控硅的一个泄放电路，因为达林顿晶体管将经由R20被偏置，并在输出的电压因来自可控硅的少量泄漏而升高时向R22加载。

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5 PCB布局

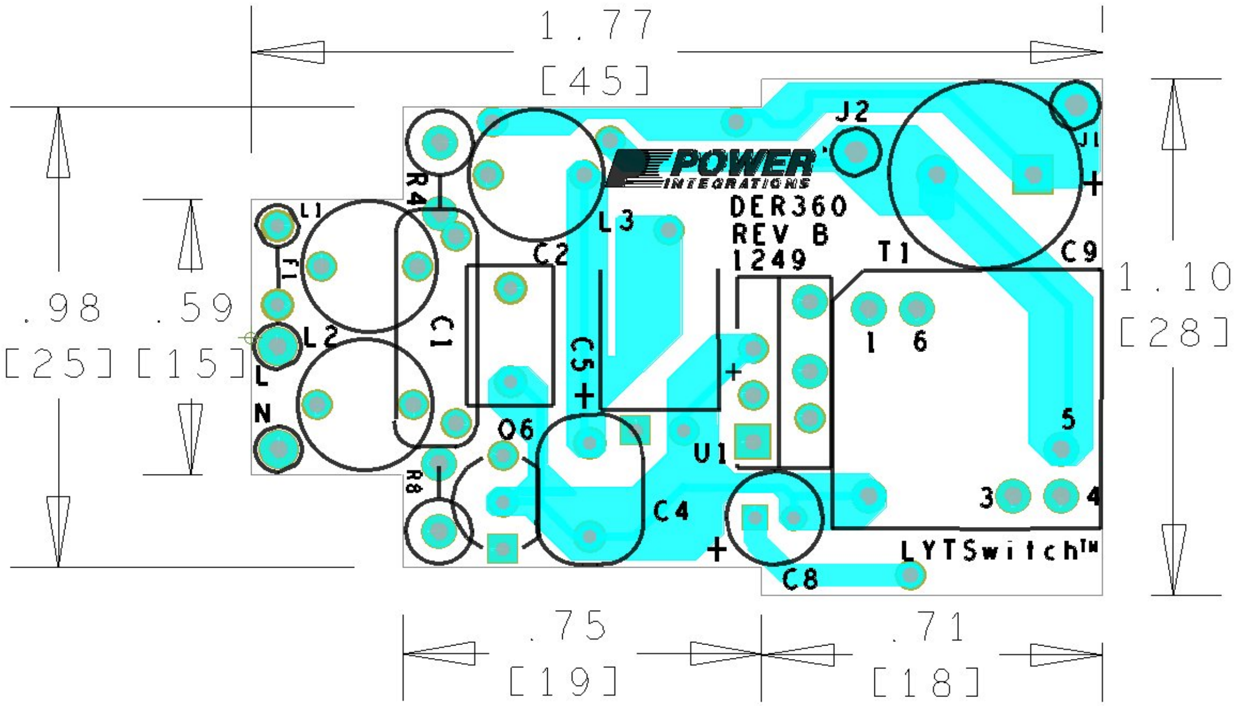

Figure 5 – Top Side.

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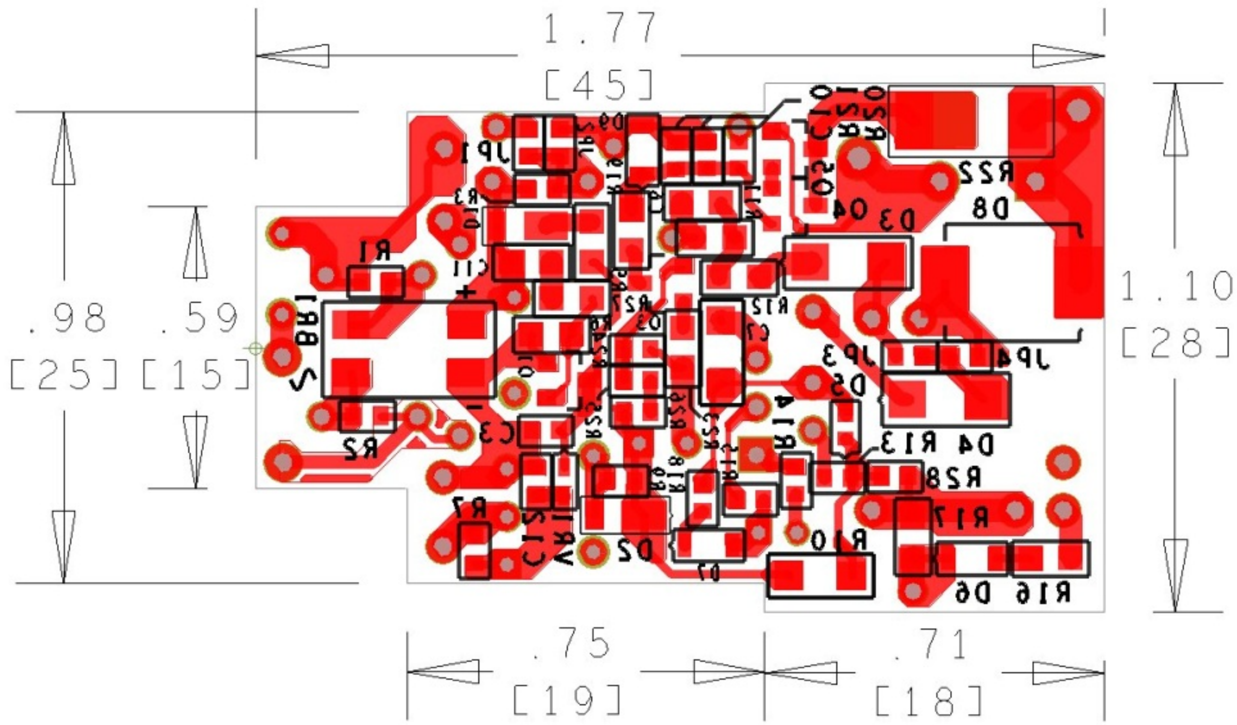

Figure 6 – Bottom Side.

Note: PCB can be configured to buck, buck-boost or tapped-buck topology. See jumper configuration.

CONFIGURATION:

BUCK: JP1=C; JP2=O; JP3=O; JP4=C

BUCK-BOOST : JP1=O; JP2=C; JP3=O; JP4=C

TAPPED-BUCK: JP1=C; JP2=O; JP3=C; JP4=O

NOTE: For Buck and Buck-Boost configuration do not install D12, R41, R4, C13

6 物料清单(BOM)

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR1	600 V, 0.5 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC	MB6S-TP	Micro Commercial
2	1	C1	220 nF, 250 V, Film	ECQ-E2224KF	Panasonic
3	1	C2	33 nF, 250 V, Film	ECQ-E2333KB	Panasonic
4	1	C3	100 nF 50 V, Ceramic, X7R, 0603	C1608X7R1H104K	TDK
5	1	C4	68 nF, 250 V, Polyester Film	ECQ-E2683KB	Panasonic
6	1	C5	2.2 μF, 400 V, Electrolytic, (6.3 x 11)	TAB2GM2R2E110	Ltec
7	1	C6	2.2 nF, 200 V, Ceramic, X7R, 0805	08052C222KAT2A	AVX
8	1	C7	100 μF, 10 V, Ceramic, X5R, 1206	C3216X5R1A107M	TDK
9	1	C8	22 μF, 50 V, Electrolytic, (5 x 11)	UPW1H220MDD	Nichicon
10	1	C9	680 μF, 25 V, Electrolytic, Low ESR, 52 mΩ, (10 x 20)	ZGD1EM681G160	Ltec
11	1	C10	470 nF, 50 V, Ceramic, X7R, 0603	UMK107B7474KA-TR	Taiyo Yuden
12	1	C11	100 pF, 200 V, Ceramic, COG, 0805	08052A101JAT2A	AVX
13	1	C12	1.2 nF 50 V, Ceramic, NPO, 0603	CGJ3E2C0G1H122J	TDK
14	1	D1	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
15	1	D2	600 V, 1 A, Rectifier, Glass Passivated, POWERDI123	DFLR1600-7	Diodes, Inc.
16	1	D3	Diode ULTRA FAST, SW, 200 V, 1 A, SMA	US1D-13-F	Diodes, Inc.
17	1	D4	Diode ULTRA FAST, SW, 200 V, 1 A, SMA	US1D-13-F	Diodes, Inc.
18	1	D6	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diode Inc.
19	1	D7	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
20	1	D8	100 V, 3 A, Schottky, SMC	30BQ100PBF	Vishay
21	1	D9	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
22	1	F1	Fuse, Pico, 2 A, 250 V, Fast, Axial	0263002.MXL	Littlefuse
23	1	JP1	0 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEY0R00V	Panasonic
24	1	JP3	0 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEY0R00V	Panasonic
25	1	L1	1 mH, 0.23 A, Ferrite Core	CTSCH875DF-102K	CT Parts
26	1	L2	1 mH, 0.23 A, Ferrite Core	CTSCH875DF-102K	CT Parts
27	1	L3	1 mH, 0.23 A, Ferrite Core	CTSCH875DF-102K	CT Parts
28	1	Q1	NPN, Small Signal BJT, 80 V, 0.15 A,SOT-23	MMBTA06LT1G	Diodes, Inc.
29	1	Q3	NPN, Small Signal BJT, 450 V, 0.5 A,SOT-23	FMMT459TA	Diodes, Inc.
30	1	Q4	NPN, Small Signal BJT, 45 V, 0.1 A, SOT-23	BC847CLT1G	On Semi
31	1	Q5	NPN,60 V 1000 MA, SOT-23	FMMT491TA	Zetex
32	1	Q6	450 V, 0.6 A, 3.8 Ω, N-Channel, TO-92	STQ3N45K3-AP	ST Micro
33	1	R1	10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
34	1	R2	10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
35	1	R3	10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
36	1	R4	510 Ω, 5%, 1 W, Metal Oxide	RSF100JB-510R	Yageo
37	1	R5	750 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ754V	Panasonic
38	1	R6	100 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ104V	Panasonic
39	1	R7	180 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ184V	Panasonic
40	1	R8	130 Ω, 5%, 1 W, Metal Oxide	RSF100JB-130R	Yageo
41	1	R9	510 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ514V	Panasonic
42	1	R10	2 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ205V	Panasonic
43	1	R11	200 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ204V	Panasonic
44	1	R12	100 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ101V	Panasonic
45	1	R13	0 Ω, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEY0R00V	Panasonic
46	1	R14	24.9 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF2492V	Panasonic

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47	1	R15	187 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1873V	Panasonic
48	1	R16	75 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ750V	Panasonic
49	1	R17	20 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ203V	Panasonic
50	1	R18	6.2 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ622V	Panasonic
51	1	R19	47 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ473V	Panasonic
52	1	R20	390 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ394V	Panasonic
53	1	R21	100 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ104V	Panasonic
54	1	R22	270 Ω, 5%, 1 W, Thick Film, 2512	ERJ-1TYJ271U	Panasonic
55	1	R23	470 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ474V	Panasonic
56	1	R24	560 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ564V	Panasonic
57	1	R25	1.00 MΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1004V	Panasonic
58	1	R26	2.00 MΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF2004V	Panasonic
59	1	R27	240 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ244V	Panasonic
60	1	T1	Bobbin, RM5, Vertical, 6 pins	P-501	Pin Shine
61	1	U1	LYTSwitch-4, eSIP-7C	LYT4311E	Power Integrations
62	1	VR1	8.2 V, 5%, 150 mW, SSMINI-2	DZ2S08200L	Panasonic

7 变压器规格

7.1 电气原理图

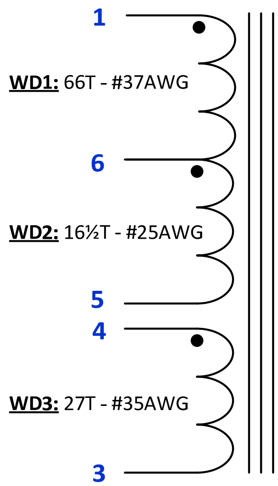

Figure 7 – Transformer Electrical Diagram.

7.2 电气规格

Inductance	Pins 1-5, all other windings open, measured at 100 kHz, 0.4 RMS.	1.2 mH ±5%
Resonant Frequency	Pins 1-5, all other windings open.	1,200 kHz (Min.)

7.3 材料

Item	Description
[1]	Core: RM5/I-3F3 PIN SHINE.
[2]	Bobbin: RM5-Vertical, 6 pins (3/3). AllStar Magnetics P/N: P501.
[3]	Clip: AllStar Magnetics P/N: CLI/P-RM4/5/I.
[4]	Magnet wire: #37 AWG - Double coated.
[5]	Magnet wire: #25 AWG - Double coated.
[6]	Magnet wire: #35 AWG - Double coated.
[7]	Tape: 3M 1298 Polyester Film, 4.5 mm wide, 2.0 mils thick, or equivalent.
[8]	Varnish: Dolph BC-359 or equivalent.

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7.4 变压器结构图

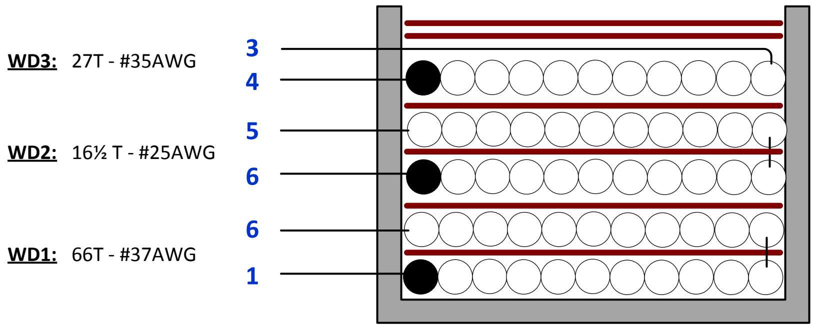

Figure 8 – Transformer Build Diagram.

7.5 变压器构造

Winding Preparation	Place the bobbin on the mandrel with the pin side is on the left side. Winding direction is clockwise direction.
WD1	Start at pin 1, wind 33 turns of wire item [4] from left to right, place 1 layer tape item [7], then continue wind another 33 turns from right to left, and end at pin 6.
Insulation	Place 1 layer of tape item [7].
WD2	Start at pin 6, wind 8 turns of wire item [5] from left to right, place 1 layer tape item [7], then continue wind another 8 ½ turns from right to left, and end at pin 5.
Insulation	Place 1 layer of tape item [7].
WD3	Start at pin 4, wind 27 turns of wire item [6] from left to right in 1 layer. At the last turn bring the wire back to the left and end at pin 3.
Final Assembly	Grind, assemble, and secure core halves with clips item [3]. Varnish with item [8].

8 变压器设计表格

ACDC_LYTSwitch_Tapped Buck_110112; Rev.0.3; Copyright Power Integrations 2012	INPUT	INFO	OUTPUT	UNIT	ACDC_LYTSwitch_110112: LYTSwitch Tapped Buck Design Spreadsheet
ENTER APPLICATION VARIABLES					
Dimming required	**YES**		**YES**		Select "YES" option if dimming is required. Otherwise select "NO".
VACMIN	90		90	V	Minimum AC Input Voltage
VACMAX	132		132	V	Maximum AC input voltage
fL			50	Hz	AC Mains Frequency
VO	15.00			V	Typical output voltage of LED string at full load
VO_MAX			18.75	V	Maximum LED string Voltage. Ensure that the maximum LED string voltage is below VO_MAX
VO_MIN			11.25	V	Minimum LED string Voltage. Ensure that the minimum LED string voltage is above VO_MIN
V_OVP			20.63	V	Over-voltage setpoint
IO	0.50				Typical full load LED current
PO			7.5	Watts	!!! For 115/230V INPUT : REDUCE PO<2.5W (larger LYTSwitch)
n	0.86		0.86		Estimated efficiency of operation
ENTER LYTSwitch VARIABLES					
LYTSWITCH	**LYT4311E**				Selected LYTSwitch device. If Dimming is required, select device from LNK40X family, Otherwise select device from LNK41X family
Current Limit Mode	**RED**		RED		Select "RED" for reduced Current Limit mode or "FULL" for Full current limit mode
ILIMITMIN			0.750	A	Minimum current limit
ILIMITMAX			0.940	A	Maximum current limit
fS			132000	Hz	Switching Frequency
fSmin			124000	Hz	Minimum Switching Frequency
fSmax			140000	Hz	Maximum Switching Frequency
IV			79.82	uA	V pin current
Rv			2	M-ohms	Upper V pin resistor
IFB			114.22	uA	FB pin current (75 uA < IFB < 250 uA)
R7			36.77	k-ohms	IFB setting resistor (See RDR254 schematic)
R8			35.35	k-ohms	Upper resistor in base divider (See RDR254 schematic)
R9			90.90	k-ohms	Lower resistor in base divider (See RDR254 schematic)
VDS			10	V	LYTSwitch on-state Drain to Source Voltage
VD	0.60			V	Output Winding Diode Forward Voltage Drop
VDB	0.70			V	Bias Winding Diode Forward Voltage Drop
Key Design Parameters					
KP			0.95		Ripple to Peak Current Ratio (0.4 < KRP < 1.3)
LP			1200	uH	Primary Inductance
KP Expected			0.81		Ripple to Peak Current Ratio (0.4 < KRP < 1.3)
Expected IO (average)			0.500	A	Expected Average Output Current
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	**RM5**		**RM5**		Selected Core for inductor
Core		#N/A		*P/N:*	#N/A
Bobbin		#N/A		*P/N:*	#N/A
AE	0.23		0.23	cm^2	Core Effective Cross Sectional Area
LE	0.21		0.21	cm	Core Effective Path Length
AL	1450.00		1450	nH/T^2	Ungapped Core Effective Inductance
BW	4.50		4.5	mm	Bobbin Physical Winding Width
M			0	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	6.00		6		Number of Primary Layers

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DC INPUT VOLTAGE PARAMETERS					
VMIN			127	V	Peak input voltage at VACMIN
VMAX			187	V	Peak input voltage at VACMAX
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.12		Minimum duty cycle at peak of VACMIN
IAVG			0.50	A	Average Primary Current
IP			0.39	A	Peak Primary Current (calculated at minimum input voltage VACMIN)
ISP			1.96	A	Peak Secondary Current (calculated at minimum input voltage VACMIN)
IRMS			0.50	A	Primary RMS Current (calculated at minimum input voltage VACMIN)
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP	1200.00		1200	uH	Primary Inductance
N_RATIO	5.00		5		Turns Ratio
NP	83.00		83		Total Number of Turns in the winding
NS			17		Secondary winidng turns
ALG			174	nH/T^2	Gapped Core Effective Inductance
BM			2459	Gauss	Maximum Flux Density at PO, VMIN (BM<3000)
BP			3381	Gauss	Peak Flux Density (BP<4200)
BAC			1168	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			105		Relative Permeability of Ungapped Core
LG			0.15	mm	Gap Length (Lg > 0.1 mm)
BWE			27	mm	Effective Bobbin Width
OD			0.33	mm	Maximum Primary Wire Diameter including insulation
INS			0.05	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.27	mm	Bare conductor diameter
AWG			30	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			102	Cmils	Bare conductor effective area in circular mils
CMA			203	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)

9 性能数据

All measurements were performed at room temperature using an LED e-load. The table in Section 9.5 shows complete test data values.

9.1 效率

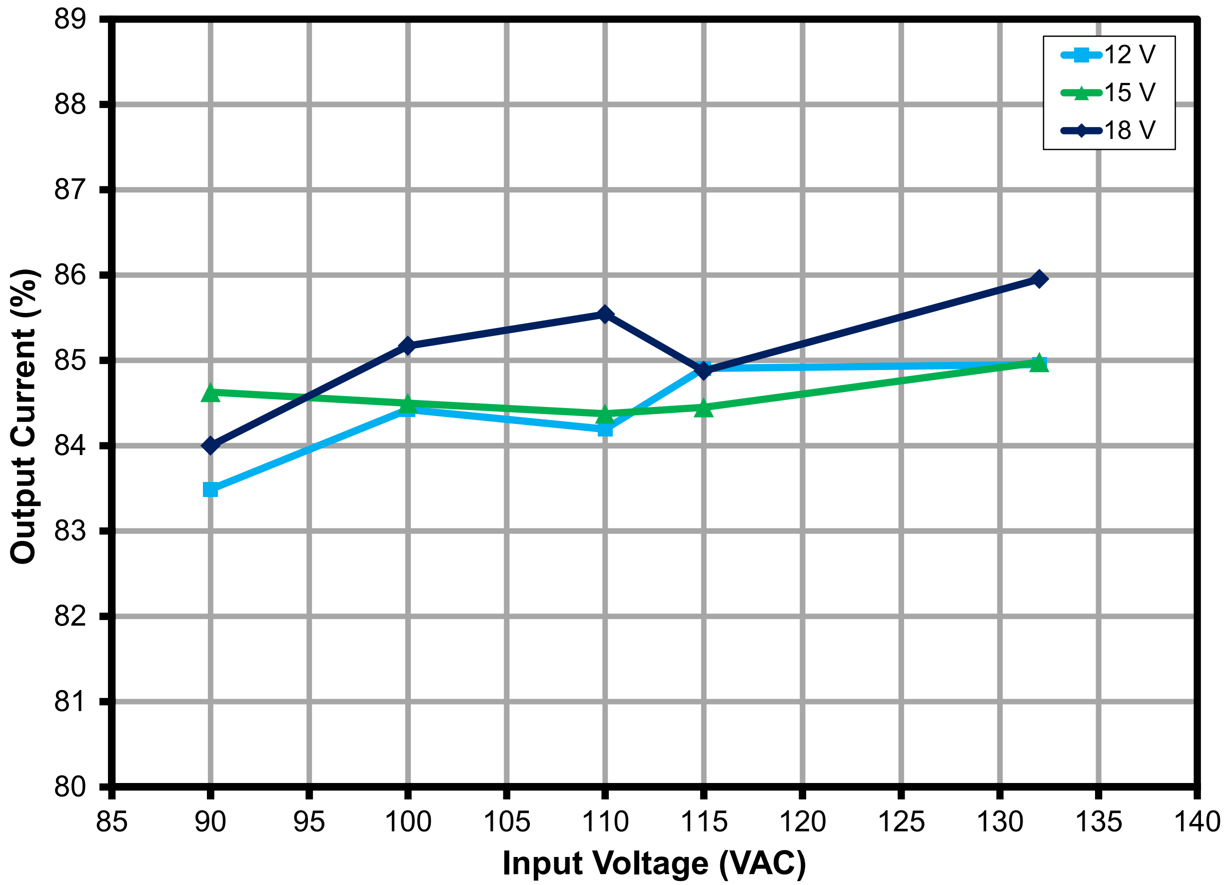

Figure 9 – Efficiency vs. Line.

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9.2 输入电压调整率和负载调整率

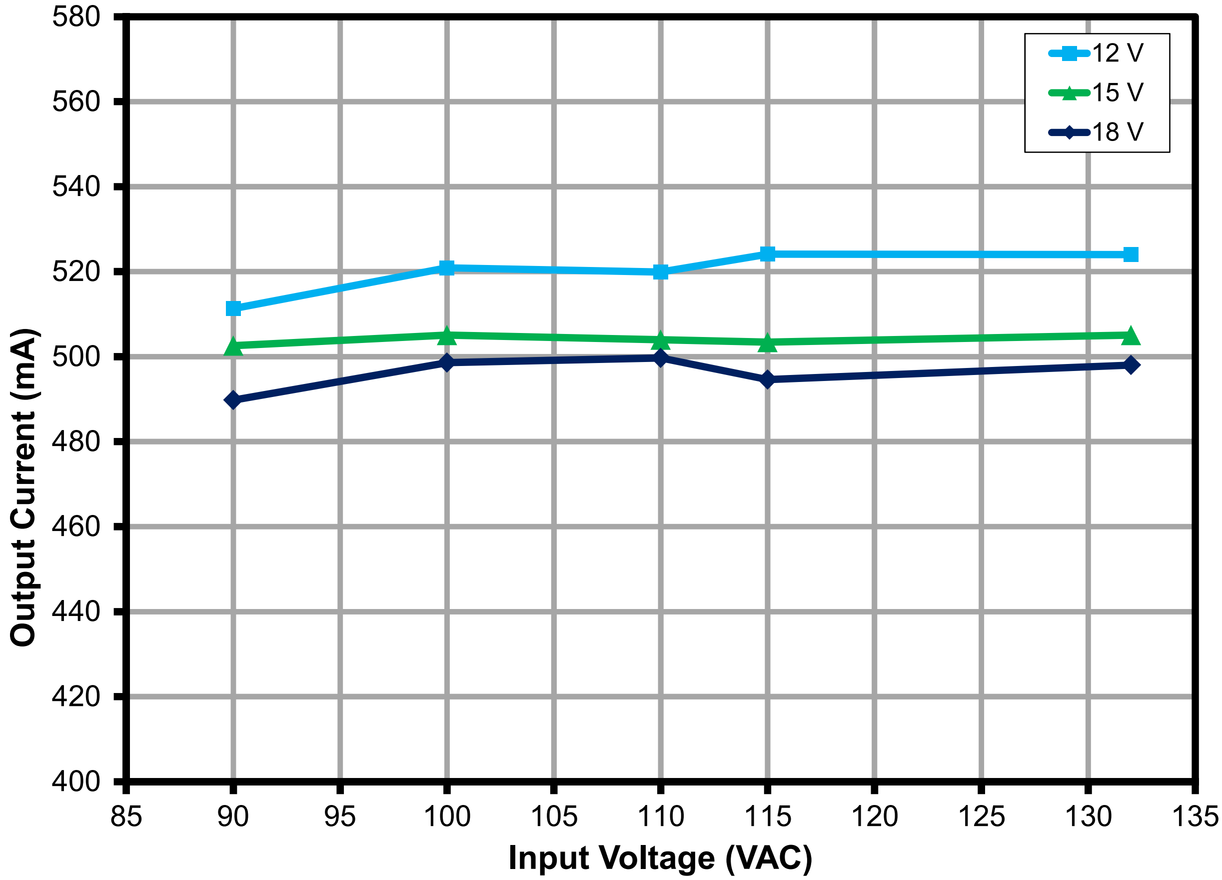

Figure 10 – Regulation vs. Line and Load.

9.3 功率因数

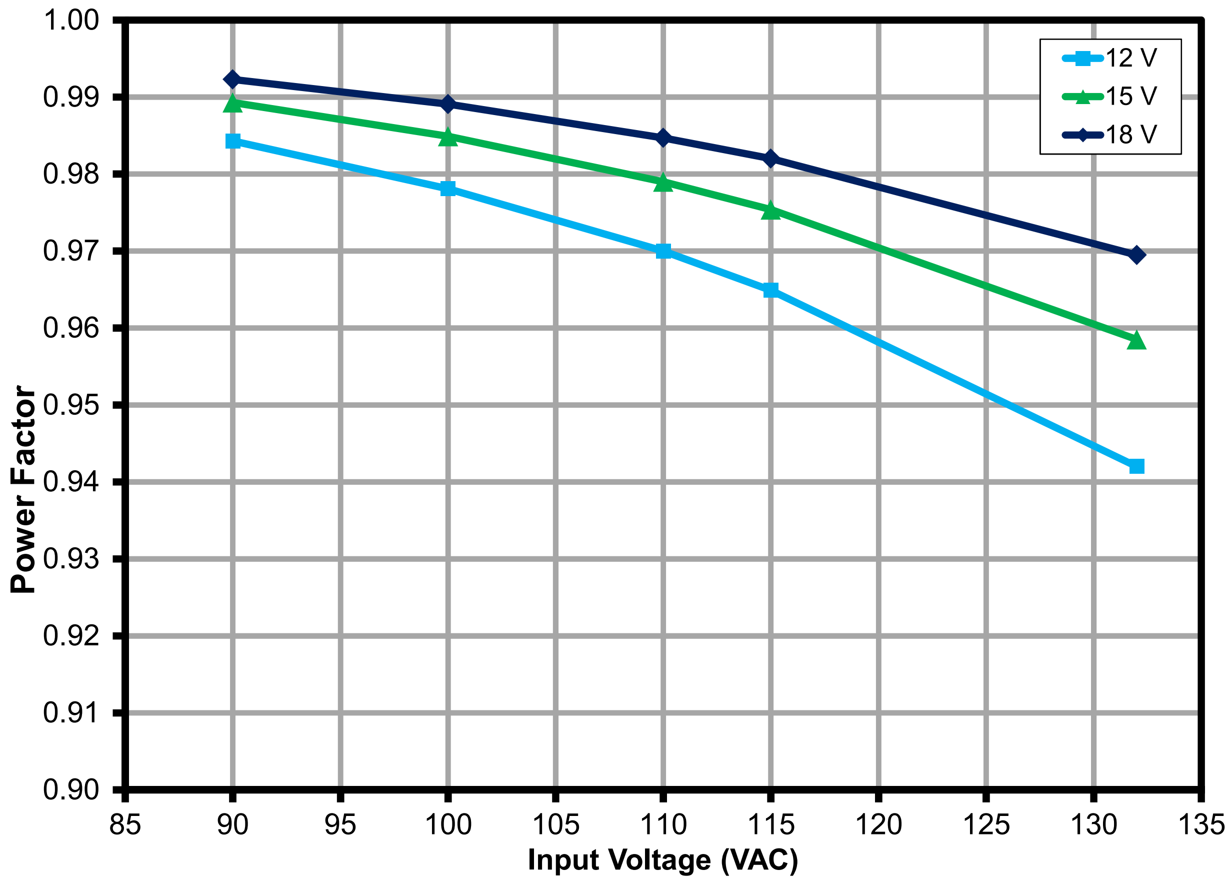

Figure 11 – Power Factor vs. Line and Load

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9.4 A-THD

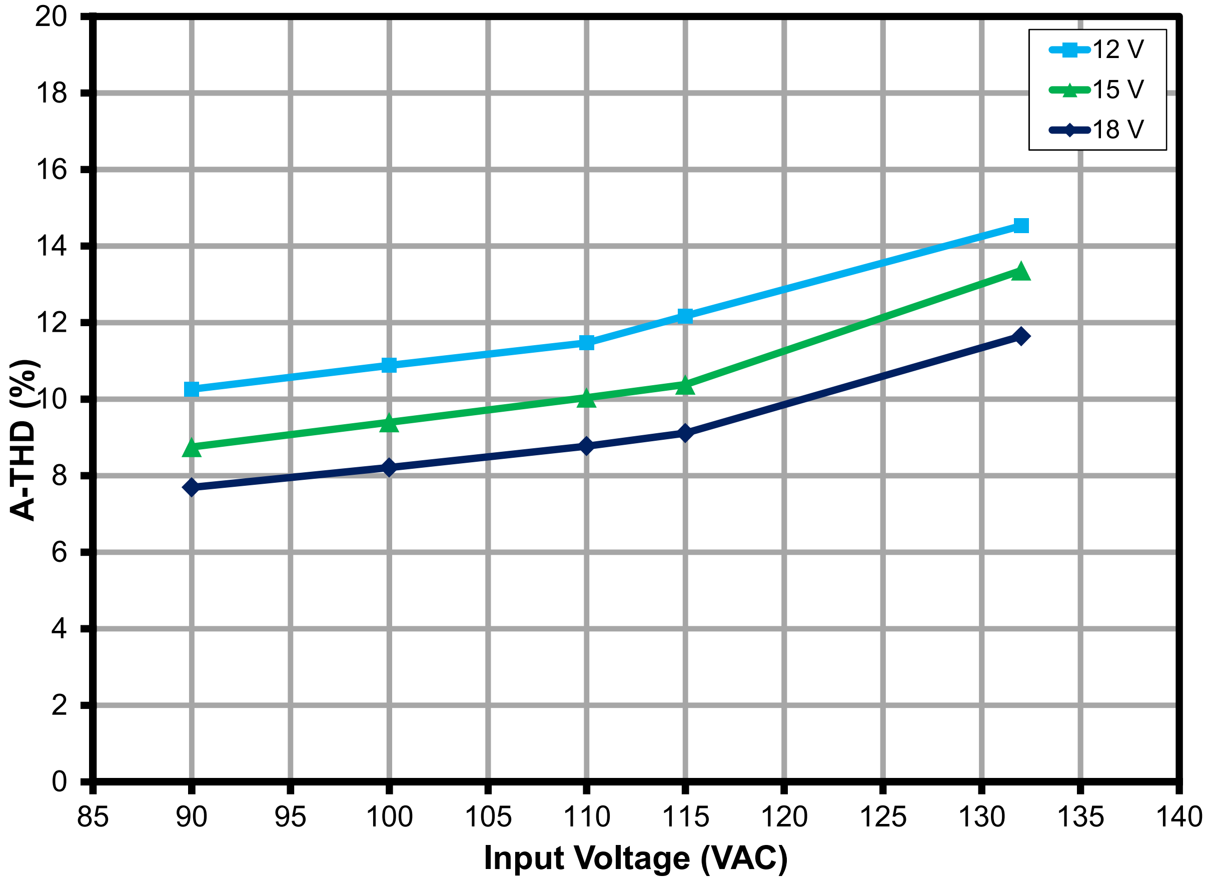

Figure 12 – A-THD vs. Line and Load.

9.5 测试数据

All measurements were taken with the board at open frame, 25 °C ambient, and 60 Hz line frequency.

9.5.1 测试数据，12 V LED负载

Input		Input Measurement					Load Measurement			
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (A_{RMS})	P_{IN} (W)	PF	%ATHD	V_{OUT} (V_{DC})	I_{OUT} (A_{DC})	P_{OUT} (W)	Efficiency (%)
90	60	89.94	84.34	7.467	0.984	10.26	12.0030	511.300	6.234	83.49
100	60	99.94	77.03	7.530	0.978	10.88	12.0150	520.900	6.357	84.42
110	60	109.94	70.66	7.535	0.970	11.47	12.0140	519.900	6.344	84.19
115	60	114.94	67.92	7.533	0.965	12.17	12.0200	524.100	6.396	84.91
132	60	131.93	60.53	7.522	0.942	14.53	12.0180	524.000	6.390	84.95

9.5.2 测试数据，15 V LED负载

Input		Input Measurement					Load Measurement			
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (A_{RMS})	P_{IN} (W)	PF	%ATHD	V_{OUT} (V_{DC})	I_{OUT} (A_{DC})	P_{OUT} (W)	Efficiency (%)
90	60	89.94	101.68	9.048	0.989	8.75	15.0100	502.600	7.657	84.63
100	60	99.94	92.53	9.108	0.985	9.39	15.0120	505.100	7.696	84.50
110	60	109.94	84.54	9.100	0.979	10.04	15.0110	504.000	7.678	84.37
120	60	114.94	80.98	9.079	0.975	10.38	15.0100	503.400	7.667	84.45
132	60	131.92	71.55	9.047	0.959	13.36	15.0130	505.100	7.688	84.98

9.5.3 测试数据，18 V LED负载

Input		Input Measurement					Load Measurement			
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (A_{RMS})	P_{IN} (W)	PF	%ATHD	V_{OUT} (V_{DC})	I_{OUT} (A_{DC})	P_{OUT} (W)	Efficiency (%)
90	60	89.94	119.19	10.637	0.992	7.69	17.9890	489.800	8.935	84.00
100	60	99.93	108.13	10.688	0.989	8.21	18.0060	498.600	9.103	85.17
110	60	109.95	98.49	10.664	0.985	8.77	18.0070	499.700	9.122	85.54
120	60	114.93	94.20	10.632	0.982	9.11	17.9980	494.600	9.024	84.88
132	60	131.92	82.61	10.565	0.970	11.64	18.0040	498.000	9.081	85.95

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10 调光性能数据

TRIAC dimming results were taken at an input voltage of 120 VAC, 60 Hz line frequency, room temperature, and a nominal 15 V LED load.

The output current High Limit I_{OUT} (HL) and Low Limit I_{OUT} (LL) were incorporated based on the USA NEMA publication SSL6-2010 section 4 page 9 for dimming performance system requirements for reference. The standard however refers to 120 VAC operating input voltage and pertains to the limits as relative light output. The limits incorporated on the succeeding graphs assumes that 100% relative light output falls on the maximum operating output current of 500 mA and 0 mA as 0% light output, and input line of 120 VAC, 60 Hz.

10.1 模拟（使用Agilent 6812B交流电源供应器）前沿调光器的调光曲线

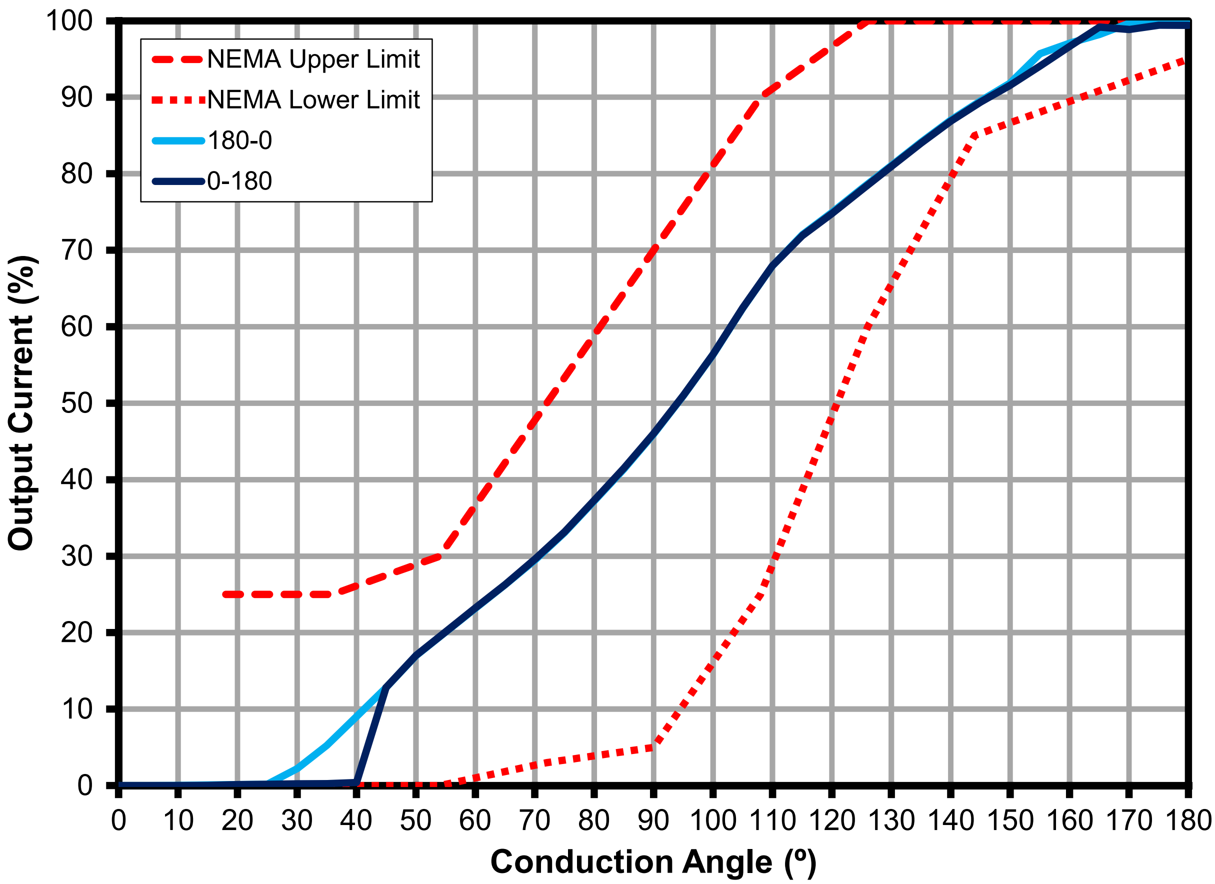

Figure 13 – Dimming Curve at 120 VAC, 60 Hz Input.

10.2 快速启动(<200 ms) – 采用可控硅调光器

A TRIAC-based U.S. dimmer model DVWCL-153-PLH (Lutron) was used with the thumb-wheel adjust set to minimum turn-on (i.e. <30 degrees) which guarantees the LED driver is off when it is switched to ON position. The test was made by turning/sliding the dimmer knob as quickly as possible from minimum to maximum position then measuring the time from the point the dimmer started conducting to the point the output current started rising.

Input voltage: 120 VAC / 60 Hz

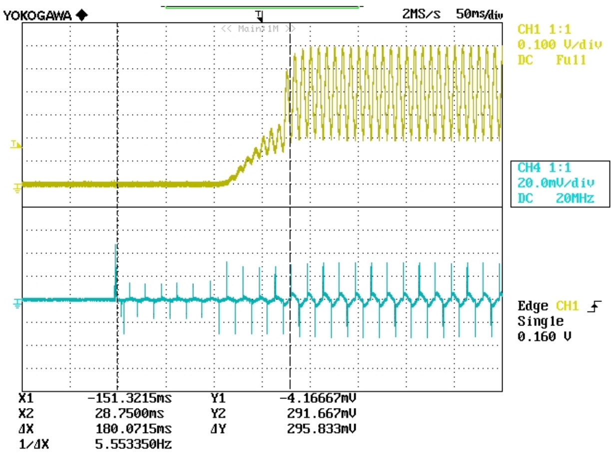

Figure 14 – Measured Start-up Time 180 ms.
Flicking the Switch ON, Dimmer at Full Conduction.
Upper: I_{OUT}, 100 mA / div.
Lower: I_{IN}, 20 mA, 50 ms / div.

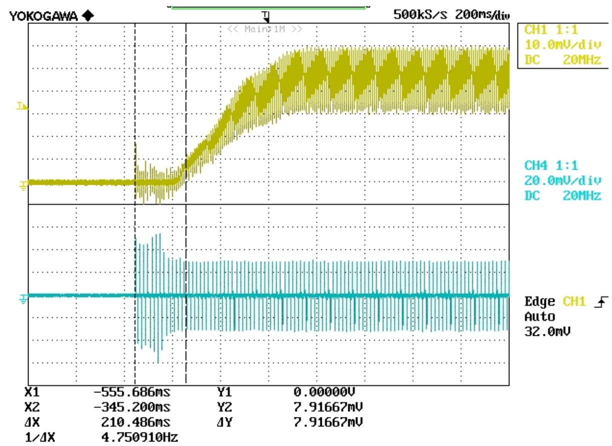

Figure 15 – Measured Start-up Time 210 ms.
Flicking the Switch ON, Dimmer at 10% Load.
Upper: I_{OUT}, 10 mA / div.
Lower: I_{IN}, 20 mA, 200 ms / div.

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10.3 可控硅调光器的突然变亮点

Pop-on per NEMA SSL-6 definition is the lowest dimmer setting above minimum at which the lamp transitions from off to dimmed.

This particular test was conducted using 120 V / 60 Hz TRIAC dimmer model SLV-603P (Lutron U.S. dimmer).

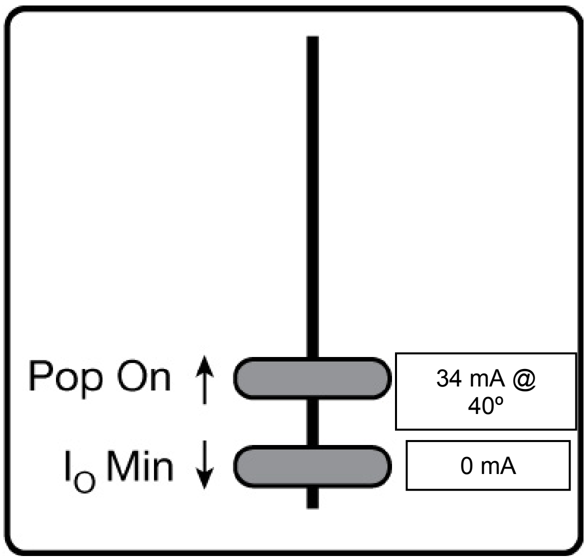

Figure 16 – 40º Conduction Angle was Measured at Pop-on Point.

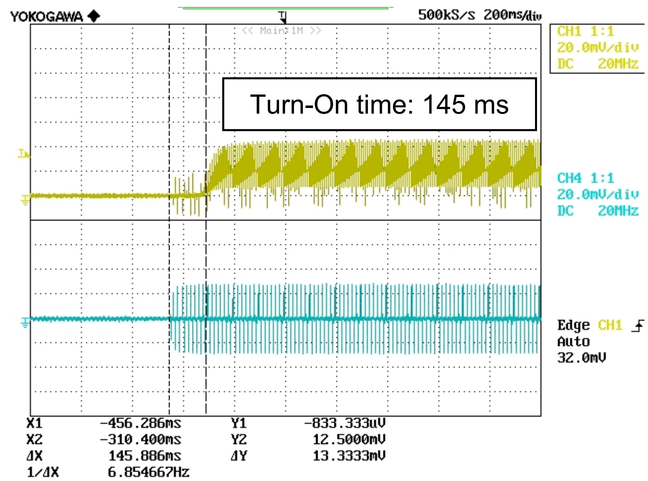

Figure 17 – 40º Conduction Turn-on Time 145 ms.
Upper: I_{OUT}, 20 mA / div.
Lower: I_{IN}, 100 mA / div., 200 ms / div.

10.4 使用调光器时的输出电流和输入电流波形

Input: 120 VAC, 60 Hz Programmable AC source
Output: 15 V LED Load
Dimmer: LUTRON GL-600WH

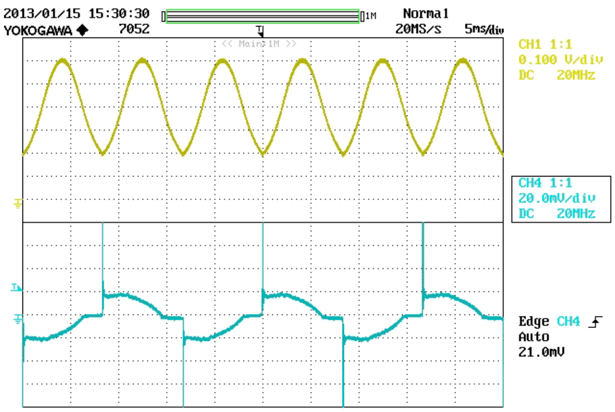

Figure 18 – Maximum Conduction Angle (147º).
Upper: I_{OUT}, 100 mA / div.
Lower: I_{IN}, 200 mA, 5 ms / div.

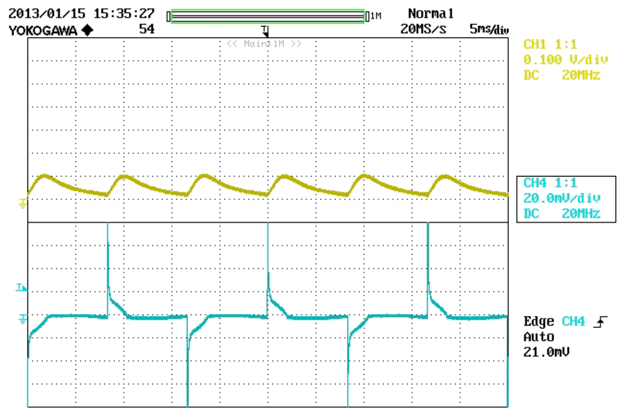

Figure 19 – Minimum Conduction Angle (40º).
Upper: I_{OUT}, 100 mA / div.
Lower: I_{IN}, 200 mA, 5 ms / div.

10.5 兼容性列表

The following U.S. TRIAC-based dimmers were tested with programmable AC source (120 VAC, 60 Hz) and 15 V LED load.

Dimmer Brand	Type	Remarks	Power	Part Number	I_{MIN} (mA)	I_{MAX} (mA)	Dim Ratio	Remark
LUTRON	L	Lutron 600-Watt Slide Dimmer LG-600PH-LA	600W	LG-600PH-WH	0.40	430	1075	pass
LUTRON	L	Lutron Skylark Incandescent 600W 3-Way Preset Dimmer with On/Off	600W	S-603P-WH	0.40	440	1100	pass
LUTRON	T	Lutron SLV-600P-WH 600-Watt Skylark Magnetic Low-Voltage Single-Pole Dimmer	600W	SLV600P-WH	0.40	443	1108	pass
LUTRON	L	Slide-to-Off Single Pole Skylark Dimmer Switch (RFI suppression)	600W	S-600-WH	0.40	470	1175	pass
LUTRON	L	Lutron Skylark 5-Amp White Gloss Dimmer	600W	S-600PH-WH	0.40	440	1100	pass
LUTRON	L	Cfl&led Dimmer, Paddle/slide, 120V, 600W	600W	DVWCL-153-PLH-WH	0.40	432	1080	pass
LUTRON	L	600W Diva Dimmer, 3-Way - Ivory	600W	DV-603P-WH	0.40	430	1075	pass
LUTRON	L	Lutron Diva DV-600P-WH Incand 600 Watt Single Pole Light Dimmer in White	600W	DV-600P-WH	0.40	431	1078	pass
LUTRON	L	Ivry Toggle Dimmer 1p Preset	600W	TG-600PH-WH	4.70	448	95	pass
LUTRON	T	Lutron Ariadni AY-600P-WH Incand Preset 600 Watt Single Pole Light Dimmer in White	600W	AY-600P-WH	6.70	439	66	pass
LUTRON	L	Glyder Incandescent Single Pole 600 Watts Preset Dimmer, White	600W	GL-600P-WH	0.40	436	1090	pass
LEVITON	L	SureSlide 600W Incandescent Dimmer	600W	R62-06633-1LW	0.40	483	1208	pass
LEVITON	L	SureSlide 600W Incandescent Slide Dimmer, Single-Pol	600W	R62-06631-1LW	0.40	454	1135	pass
LEVITON	L	IllumaTech Incandescent Preset Slide Dimmer	600W	R60-IPI06-1LM	47.00	478	10	pass
LEVITON	L	IllumaTech Rotary Controls 120V AC 60Hz	600W	R52-RPI06-1LW	9.00	491	55	pass
LEVITON	L	Leviton 600-Watt 3-Way Lighted White/Ivory Push Dimmer	600W	R60-06684-1IW	0.40	485	1213	pass
LEVITON			600W	6683	0.40	471	1178	pass
LEVITON	L	SURESLIDE" MAGNETIC LOW VOLTAGE DIMMER *600VA, 120V AC, 60Hz	450W	R02-06613-PLW	0.40	479	1198	pass
COOPER				SLC03P-W-K-L	0.40	447	1118	pass
LUTRON	L	Lutron 15-Amp White Slide Dimmer	600W	GL-600-WH	0.40	465	1163	pass
LUTRON	L	Diva, Screw Base Compact Fluorescent Dimming with Philips® DIMMABLE Energy Saver CFL, Single Pole/3-Way, 200W, White	200W	DVPDC-203P-WH	117.00	467	4	pass
LUTRON	L	Lyneo Lx Single Pole Dimmer 600W	500W	LX-600PL-WH	22.50	458	20	pass
LUTRON	L	Single Pole - Incandescent - Push On/Off - 600 Watt - White	600W	D-600P-WH	0.40	422	1055	pass
LUTRON			600W	CTCL-153PDH	2.00	432	216	pass
LUTRON			600W	S-600P	0.40	436	1090	pass
LUTRON				TGLV-600P	0.40	448	1120	pass
LUTRON			450W	TGLV-600PR	0.40	441	1103	pass
LUTRON	L	Lutron Diva Satin 5-Amp Desert Stone Preset Dimmer	300W	TT-300NLH-WH	0.40	472	1180	pass
LUTRON	L	Lutron Credenza 300-Watt White Lamp	300W	TT-300H-WH	0.40	473	1183	pass

		Dimmer						
LUTRON	L	Nova, Slide-To-Off Dimmers, Magnetic Low Voltage, Neon/Cold Cathode, Single Pole, 1000VA, White	800W	NLV-1000-WH	0.40	455	1138	pass
LUTRON	L	Lutron 15-Amp White Slide Dimmer	600W	GL-600-WH	0.40	465	1163	pass
LUTRON		S-600P			0.40	434	1085	pass
LUTRON		S-600P			0.40	465	1163	pass
Cooper		S106P			0.40	457	1143	pass
LUTRON		Skylark, Dimmers with On/Off Switch, Incandescent/Halogen, 3-Way, 1000W, White	1000	S-103P-WH	44.00	451	10	pass
LUTRON		Skylark, Dimmers with On/Off Switch & Locator Light, Incandescent/Halogen, Single Pole, 600W, White	600	S-600PNLH-WH	0.40	441	1103	pass
LUTRON		Skylark, Dimmers with On/Off Switch & Locator Light, Incandescent/Halogen, 3-Way, 600W, White	600	S-603PNL-WH	0.40	441	1103	pass
LUTRON		Skylark, Dimmers with On/Off Switch, Magnetic Low Voltage, 3-Way, 600VA, White	600	SLV-603P-WH	0.40	438	1095	pass
LUTRON		Skylark, Slide-To-Off Dimmers, Incandescent/Halogen, Eco-Dim, Single Pole/3-Way, 600W, Clamshell Packing, White	600	S-603PGH-WH	0.40	309	773	pass
LUTRON		Ariadni, Dimmers, Magnetic Low Voltage, Single Pole, 600VA, White	600	AYLV-600P-WH	0.40	443	1108	pass
LUTRON		Ariadni, Dimmers, Magnetic Low Voltage, 3-Way, 600VA, White	600	AYLV-603P-WH	0.40	430	1075	pass
LUTRON		Ariadni, Dimmers with Locator Light, Incandescent/Halogen, 3-Way, 600W, White	600	AY-603PNL-WH	0.40	411	1028	pass
LUTRON		Ariadni, Dimmers, Incandescent/Halogen, Eco-dim, Single Pole/3-Way, 600W, White	600	AY-603PG-WH	1.00	270	270	pass
LUTRON		Ariadni, Dimmers, Incandescent/Halogen, 3-Way, 600W, White	600	AY-603P-WH	7.50	426	57	pass
LUTRON		Ariadni, Dimmers with Locator Light, Incandescent/Halogen, Single Pole, 600W, White	600	AY-600PNL-WH	1.70	438	258	pass
LUTRON		Diva, Dimmers with Locator Light, Electronic Low Voltage, Single Pole, 300W, White	300	DVELV-300P-WH	3.00	442	147	pass
LUTRON		Diva, Dimmers with Locator Light, Magnetic Low Voltage, Single Pole, 1000VA, White	1000	DVLV-10P-WH	0.50	423	846	pass
LUTRON		Diva, Dimmers with Locator Light, Magnetic Low Voltage, 3-Way, 1000VA, White	1000	DVLV-103P-WH	0.40	428	1070	pass
LUTRON		Diva, Dimmers with Locator Light, Magnetic Low Voltage, 3-Way, 600VA, White	600	DVLV-603P-WH	0.40	432	1080	pass
LUTRON		Skylark, Slide-To-Off Dimmers, Incandescent/Halogen, Single Pole, 1000W, White	1000	S-1000-WH	0.40	467	1168	pass
LUTRON		Skylark, Dimmers with On/Off Switch, Electronic Low Voltage, Single Pole, 300W, White	300	SELV-300P-WH	2.80	435	155	pass
LUTRON		Skylark, Dimmers with On/Off Switch, Incandescent/Halogen, Single Pole, 600W, White	600	S-600P-WH	0.40	433	1083	pass
LUTRON		Skylark, Dimmers with On/Off Switch & Locator Light, Incandescent/Halogen, 3-	1000	S-103PNL-WH	43.00	445	10	pass

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		Way,1000W, White						
LUTRON		Spacer System, Dimmers with IR Receiver, Magnetic Low Voltage, Single Location, 1000VA(800W), White		SPSLV-1000-WH	59.00	450	8	pass
LUTRON		Spacer System, Dimmers with IR Receiver, Magnetic Low Voltage, Single Location, 600VA(450W), White		SPSLV-600-WH	60.00	438	7	pass
LUTRON		Spacer System, Dimmer with IR Receiver, Electronic Low Voltage, Single Location, 600W, White		SPSELV-600-WH	32.00	450	14	pass
LUTRON		Glyder, Slide-To-Off Dimmers, Magnetic Low Voltage, Single Pole, 600W, White	600	GLV-600-WH	0.40	463	1158	pass

Figure 20 – U.S. TRIAC-Based Dimmers Compatibility List.

10.6 IR热特性曲线

These images were captured while the unit was running with 15 V LED load for more than 2 hours (25 °C). The unit was placed on bench without enclosure for the conditions specified.

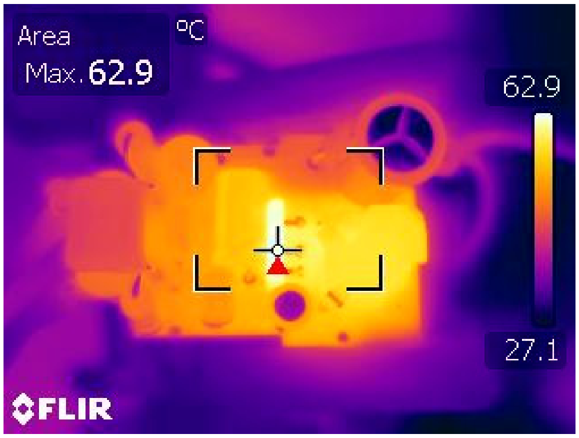

Figure 21 – Non-Dimming.
V_{IN} = 90 VAC, 60 Hz, 15 V LED Load.
U1 was Hottest Device.

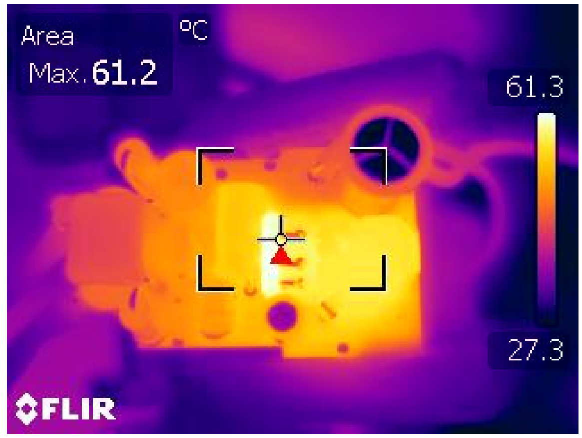

Figure 22 – Non-Dimming.
V_{IN} = 132 VAC, 60 Hz, 15 V LED Load.
U1 was Hottest Device.

Figure 23 – With TRIAC Dimmer Connected.
V_{IN} = 120 VAC, 60 Hz, 15 V LED.
Load at Full Conduction.
R4 was Hottest Device.

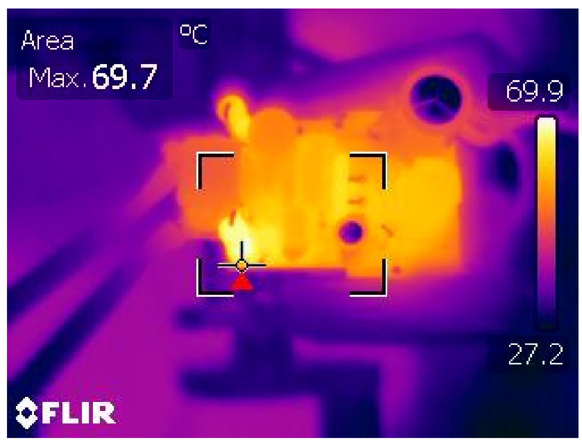

Figure 24 – With TRIAC Dimer Connected.
V_{IN} = 120 VAC, 60 Hz, 15 V LED.
Load at 90º Phase Conduction.
R4 Damper was Hottest Device.

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10.7 正常工作时的输出电流和输出电压波形

Input Condition	I_{OUT}, Mean (mA)	I_{OUT} Ripple: $(I_{MAX}-I_{MIN})/(I_{MAX}+I_{MIN})$*100%
90 VAC, 60 Hz	487	51%
120 VAC, 60 Hz	504	50%
132 VAC, 60 Hz	508	50%

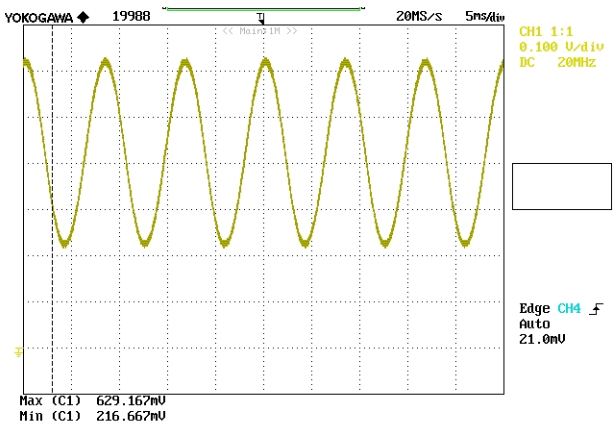

Figure 25 – 90 VAC, 60 Hz Full Load.
Ch1: I_{OUT}, 100 mA / div.

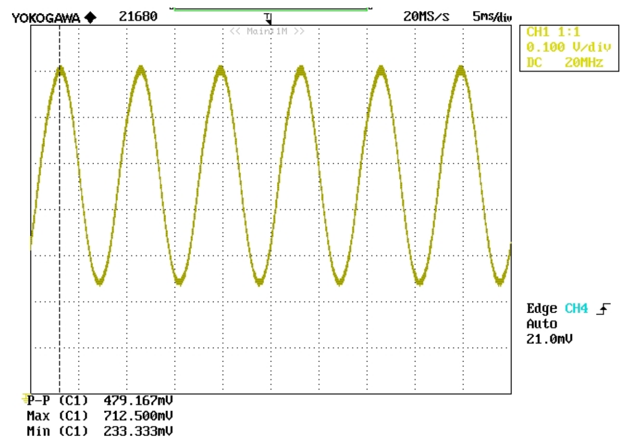

Figure 26 – 120 VAC, 60 Hz Full Load.
Ch1: I_{OUT}, 100 mA / div.

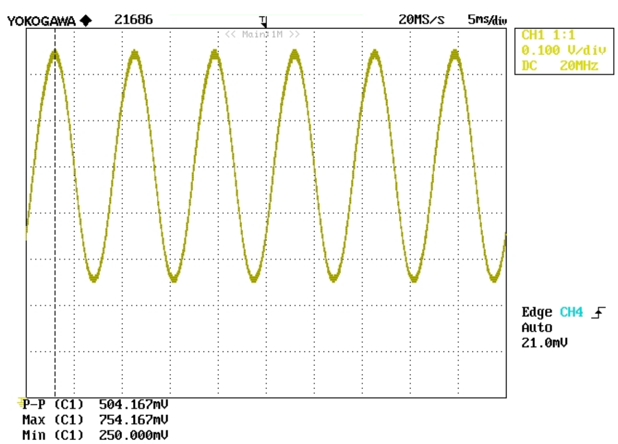

Figure 27 – 132 VAC, 60 Hz Full Load.
Ch1: I_{OUT}, 100 mA / div.

10.8 启动时的输出电压和输出电流波形

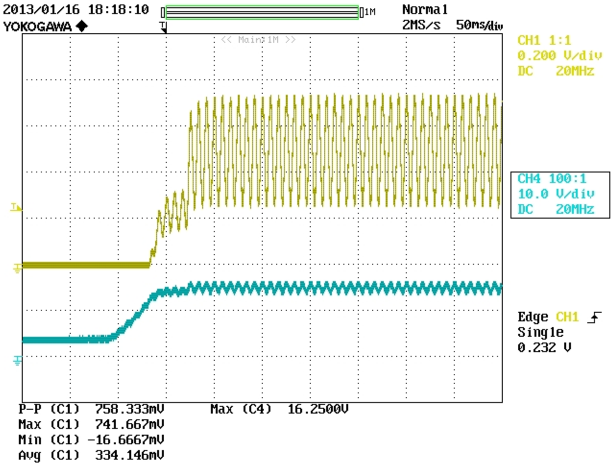

Figure 28 – 90 VAC, 60 Hz.
Upper: I_{OUT}, 200 mA / div.
Lower: V_{OUT}, 10 V, 50 ms / div.

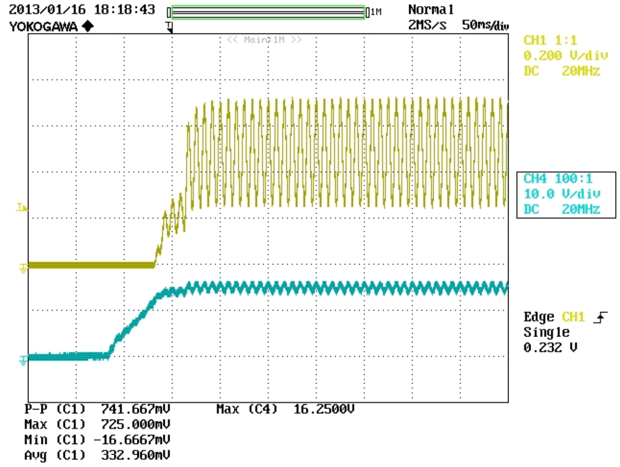

Figure 29 – 132 VAC, 60 Hz.
Upper: I_{OUT}, 200 mA / div.
Lower: V_{OUT}, 10 V, 50 ms / div.

10.9 正常工作时的漏极电压和电流

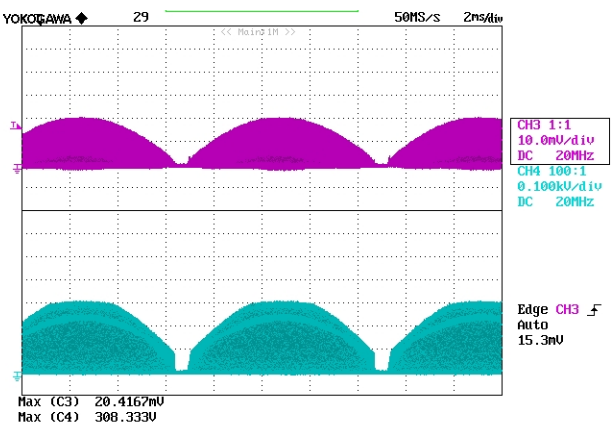

Figure 30 – 120 VAC, 60 Hz.
Upper: I_{DRAIN}, 0.5 A / div.
Lower: V_{DRAIN}, 100 V, 2 ms / div.

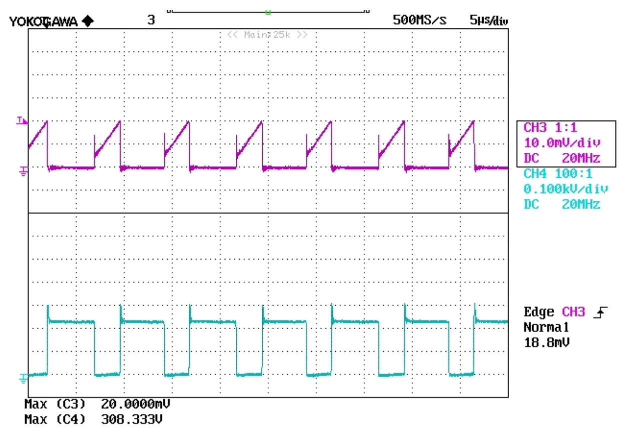

Figure 31 – 120 VAC, 60 Hz.
Upper: I_{DRAIN}, 0.5 A / div.
Lower: V_{DRAIN}, 100 V / div., 5 µs / div.

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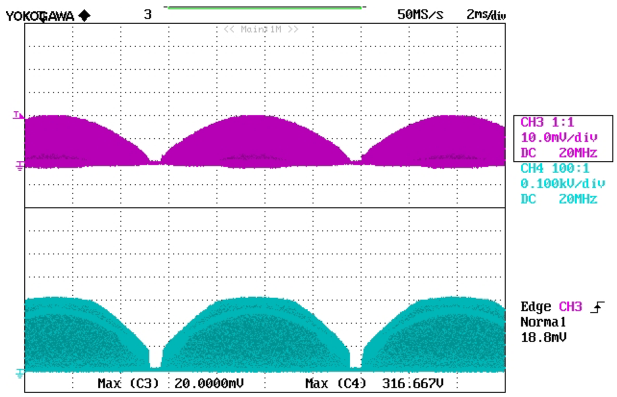

Figure 32 – 132 VAC, 60 Hz.
Upper: I_{DRAIN}, 0.5 A / div.
Lower: V_{DRAIN}, 100 V, 2 ms / div.

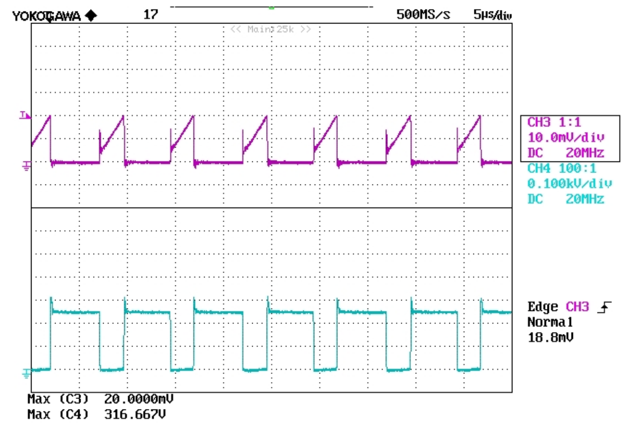

Figure 33 – 132 VAC, 60 Hz.
Upper: I_{DRAIN}, 0.5 A / div.
Lower: V_{DRAIN}, 100 V / div., 5 µs / div.

10.10 启动时的漏极电压和电流

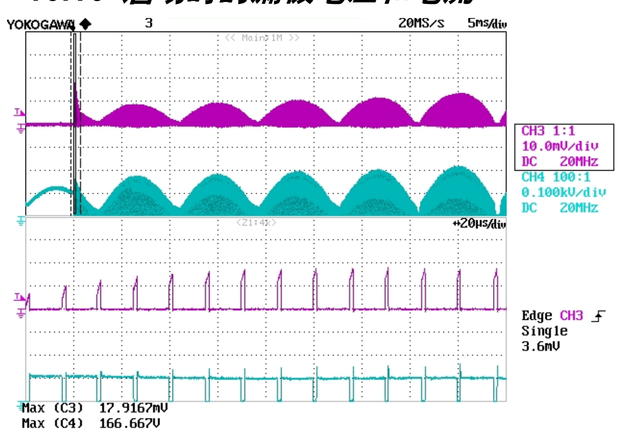

Figure 34 – 90 VAC, 60 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 5 ms / div.

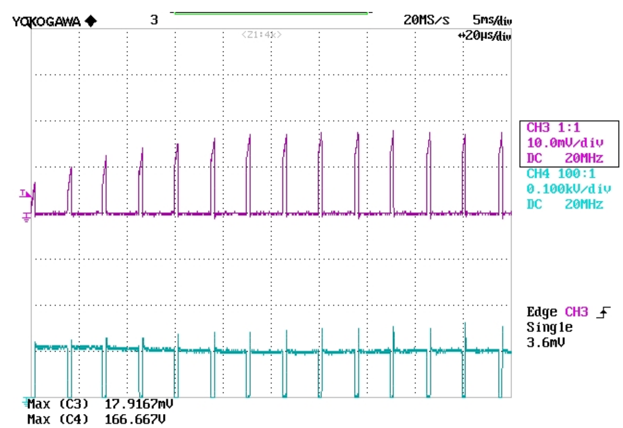

Figure 35 – 90 VAC, 60 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 10 µs / div.

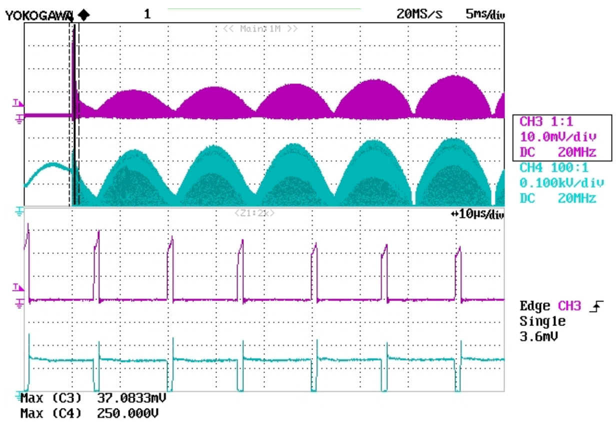

Figure 36 – 132 VAC, 60 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 5 ms / div.

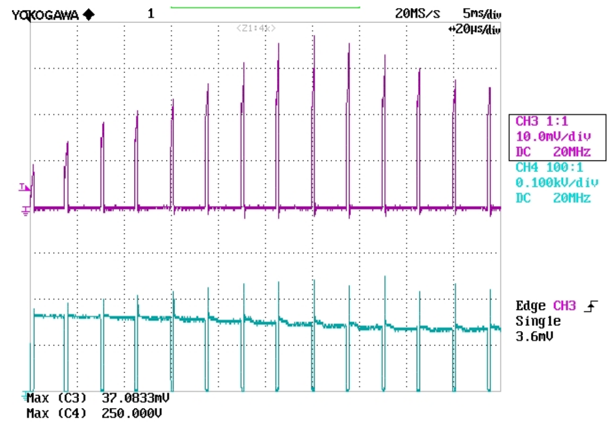

Figure 37 – 132 VAC, 60 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 20 μs / div.

10.11 输出短路条件下的漏极电压和电流

During output short condition, the I_{FB} current falls below the $I_{FB(AR)}$ threshold and enters the auto-restart condition. During this condition, to minimize power dissipation on the power components, the auto-restart circuit turns the power supply on and off at an auto-restart duty cycle of typically DC_{AR} for as long as the fault condition persists.

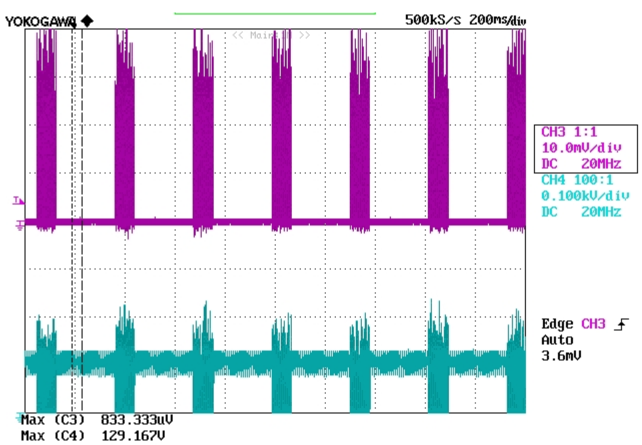

Figure 38 – 90 VAC, 60 Hz Output Short Condition.
Upper: I_{DRAIN}, 1 A / div.
Lower: V_{DRAIN}, 100 V, 200 ms / div.

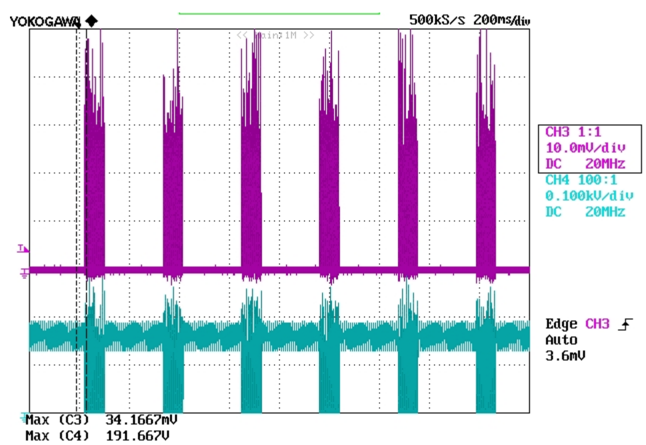

Figure 39 – 132 VAC, 60 Hz Output Short Condition.
Upper: I_{DRAIN}, 1 A / div.
Lower: V_{DRAIN}, 100 V, 200 ms / div.

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10.12 正常工作时的输出二极管电压和电流波形

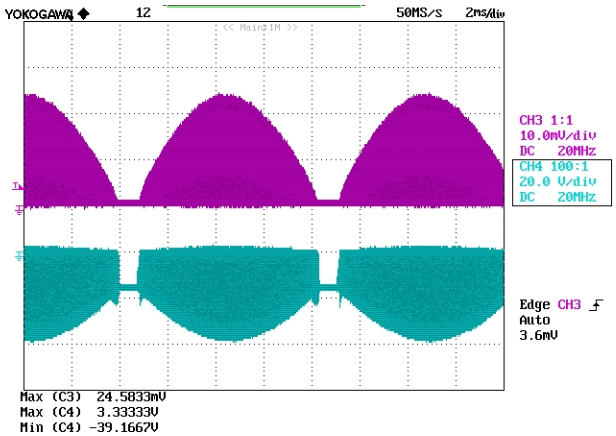

Figure 40 – 90 VAC, 60 Hz.
Upper: I_{D8}, 1 A / div.
Lower: V_{D8}, 20 V, 2 ms / div.

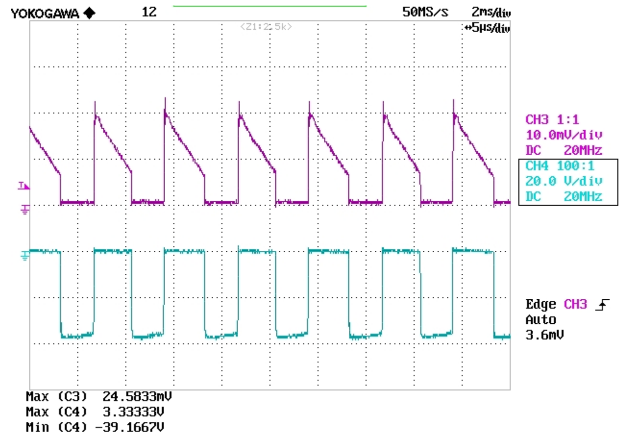

Figure 41 – 90 VAC, 60 Hz.
Upper: I_{D8}, 1 A / div.
Lower: V_{D8}, 100 V / div., 5 µs / div.

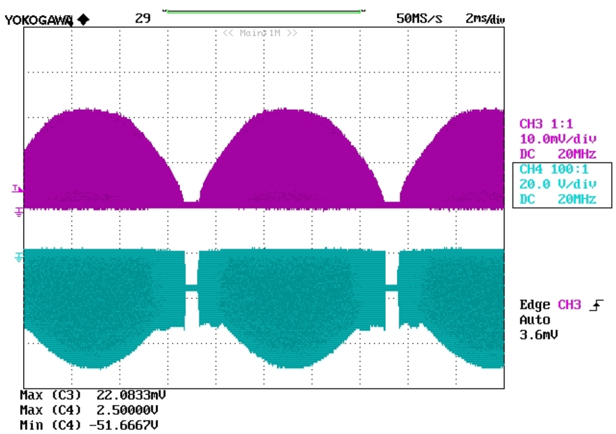

Figure 42 – 132 VAC, 60 Hz.
Upper: I_{D8}, 1 A / div.
Lower: V_{D8}, 20 V, 2 ms / div.

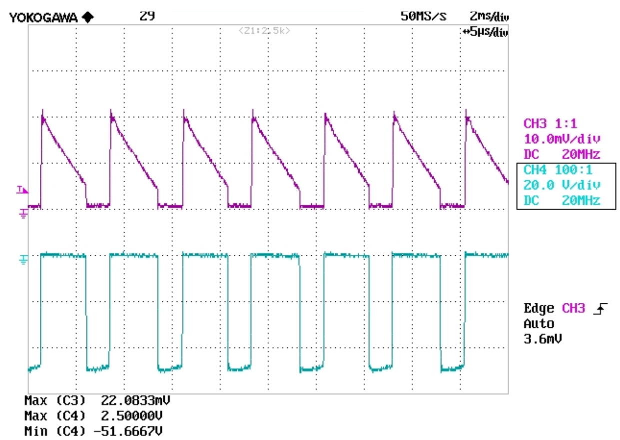

Figure 43 – 132 VAC, 60 Hz.
Upper: I_{D8}, 1 A / div.
Lower: V_{D8}, 20 V / div., 5 µs / div.

11 非调光波形

11.1 输出电流和输入电流波形

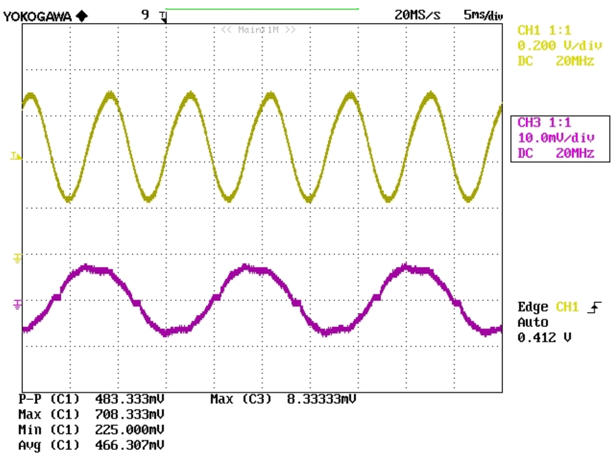

Figure 44 – 90 VAC, 15 V LED Load.
Upper: I_{OUT}, 200 mA / div.
Lower: I_{IN}, 200 mA, 5 ms / div.

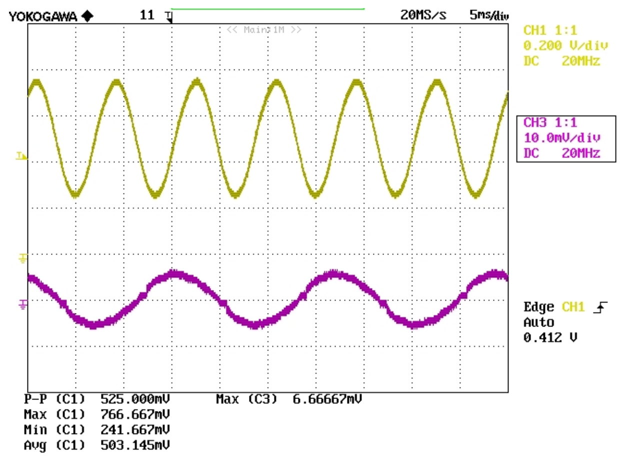

Figure 45 – 132 VAC, 15 V LED Load.
Upper: I_{OUT}, 200 mA / div.
Lower: I_{IN}, 200 mA, 5 ms / div.

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12 传导EMI

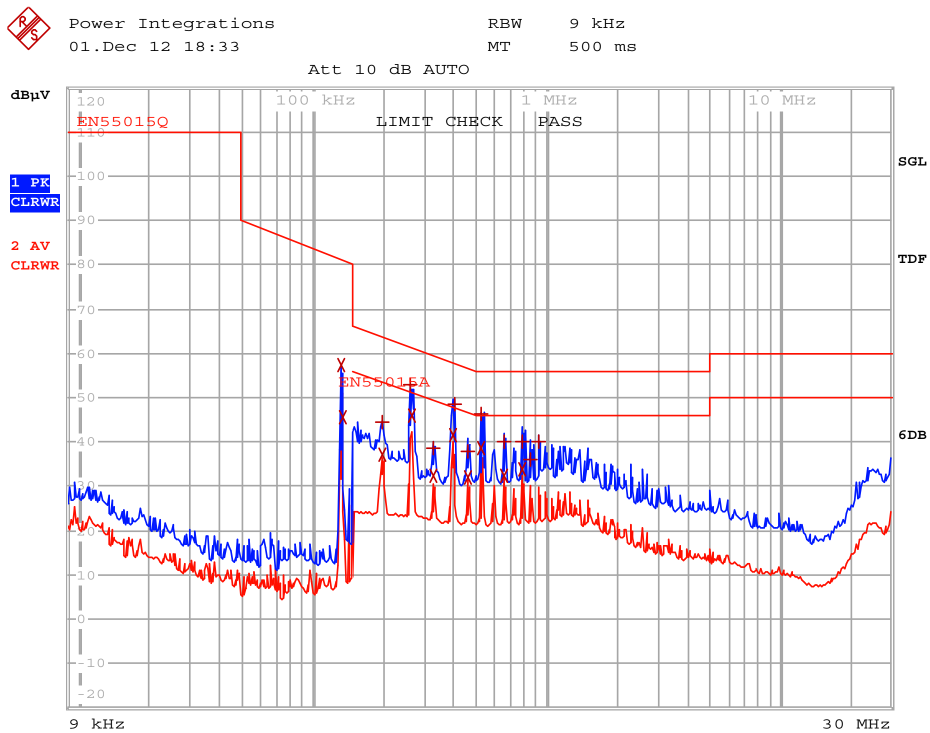
The design met the limits for conducted electromagnetic emission (EMI) with a frequency range of 9 kHz to 30 MHz as per described in the CISPR 15 / IEC: 2005 Standard.

12.1 测试设置

The unit was tested using a 15 V LED load at an input voltage of 120 VAC, 60 Hz at room temperature. The unit was placed inside a conical metal housing as shown in Figure 46.

Figure 46 – EMI Test Set-up with the Unit and LED Load Placed Inside a Conical Metal Housing as Described in CISPR 15 / IEC: 2005 Standard.

12.2 测试结果



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
2	Average	132.133649648 kHz	57.19	L1 gnd	
2	Average	134.789536006 kHz	45.68	L1 gnd	
1	Quasi Peak	196.231331718 kHz	44.44	N gnd	-19.32
2	Average	198.193645035 kHz	37.14	N gnd	-16.54
1	Quasi Peak	261.871472881 kHz	52.91	N gnd	-8.46
2	Average	264.49018761 kHz	45.80	N gnd	-5.48
1	Quasi Peak	329.215131266 kHz	38.61	N gnd	-20.85
2	Average	329.215131266 kHz	32.32	N gnd	-17.15
2	Average	397.727746704 kHz	41.44	N gnd	-6.45
1	Quasi Peak	401.705024172 kHz	48.70	N gnd	-9.11
1	Quasi Peak	457.177788726 kHz	37.94	N gnd	-18.79
2	Average	461.749566613 kHz	31.99	N gnd	-14.67
1	Quasi Peak	525.514079005 kHz	46.29	N gnd	-9.70
2	Average	525.514079005 kHz	38.77	N gnd	-7.22
1	Quasi Peak	654.11570866 kHz	40.21	N gnd	-15.79
2	Average	660.656865747 kHz	32.28	N gnd	-13.71
1	Quasi Peak	790.243042258 kHz	40.22	N gnd	-15.77
2	Average	790.243042258 kHz	33.82	N gnd	-12.17
1	Quasi Peak	855.719977385 kHz	36.08	N gnd	-19.91
1	Quasi Peak	917.447639259 kHz	40.04	N gnd	-15.95

Figure 47 – Conducted EMI, 15 V LED Load, 120 VAC, 60 Hz, and EN55015 B Limits.

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13 输入浪涌

The unit was subjected to ±2500 V 100 kHz ring wave and ±500 V differential surge at 120 VAC using 10 strikes at each condition. A test failure was defined as a non-recoverable interruption of output, requiring supply repair or recycling of input voltage.

The unit tested passed both ±2500 V 100 kHz ring wave and ±500 V differential surge with and without MOV.

Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Type	Test Result (Pass/Fail)
+2500	120	L1, L2	0	100 kHz Ring Wave (500 A)	Pass
-2500	120	L1, L2	0	100 kHz Ring Wave (500 A)	Pass
+2500	120	L1, L2	90	100 kHz Ring Wave (500 A)	Pass
-2500	120	L1, L2	90	100 kHz Ring Wave (500 A)	Pass

Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Type	Test Result (Pass/Fail)
+500	120	L1, L2	0	Surge (2 Ω)	Pass
-500	120	L1, L2	0	Surge (2 Ω)	Pass
+500	120	L1, L2	90	Surge (2 Ω)	Pass
-500	120	L1, L2	90	Surge (2 Ω)	Pass

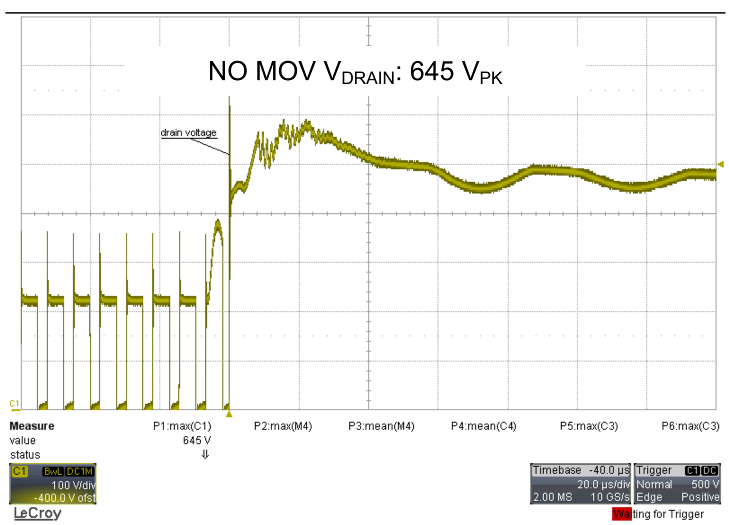

Figure 48 – No MOV +500 V 1.2 μs / 50 μs Differential Surge.

14 版本历史

Date	Author	Revision	Description and Changes	Reviewed
10-Jun-13	ME	1.0	Initial release	Apps & Mktg

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