设计范例报告

标题	***使用LYTSwitch™LYT4311E设计的14.35 W 高效率、可控硅调光的、非隔离、抽头降压式LED驱动器***
规格	190 VAC – 265 VAC输入； 41V$_{TYP}$,350mA输出
应用	PAR30 LED驱动器
作者	应用工程部
文档编号	DER-365
日期	2013年5月15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
- 在230 VAC下效率约为89%
- 可控硅调光
  - 可兼容各种可控硅调光器
- 低成本、元件数量少、印刷电路板(PCB)占用面积小
- 快速启动时间(<300 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 > 0.95
- 在230 VAC下，A-THD <15%
- 满足EN55015传导EMI要求

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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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)、高效率、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41V、额定电流350 mA的驱动。

所采用的拓扑结构是单级、非隔离、抽头降压式拓扑结构，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。

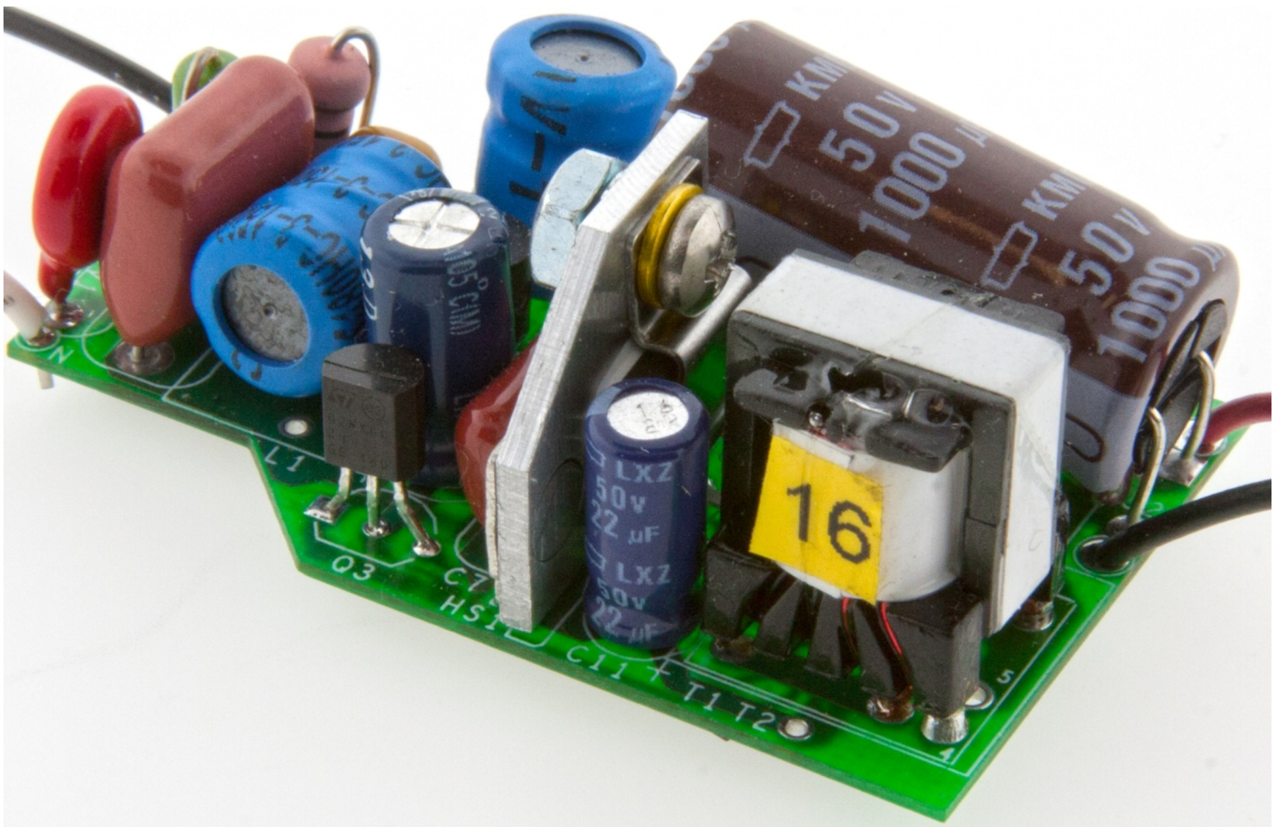

Figure 1 – Populated Circuit Board, Angle View.

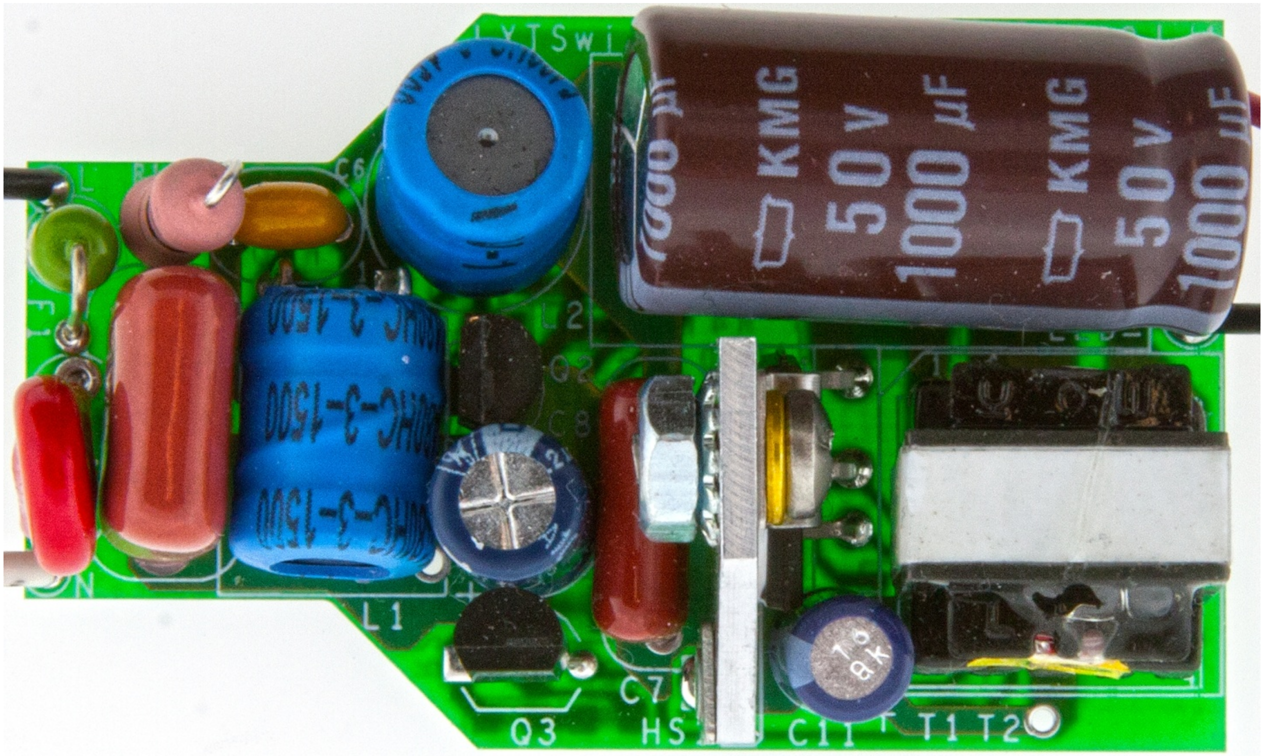

Figure 2 – Populated Circuit Board, Top View.

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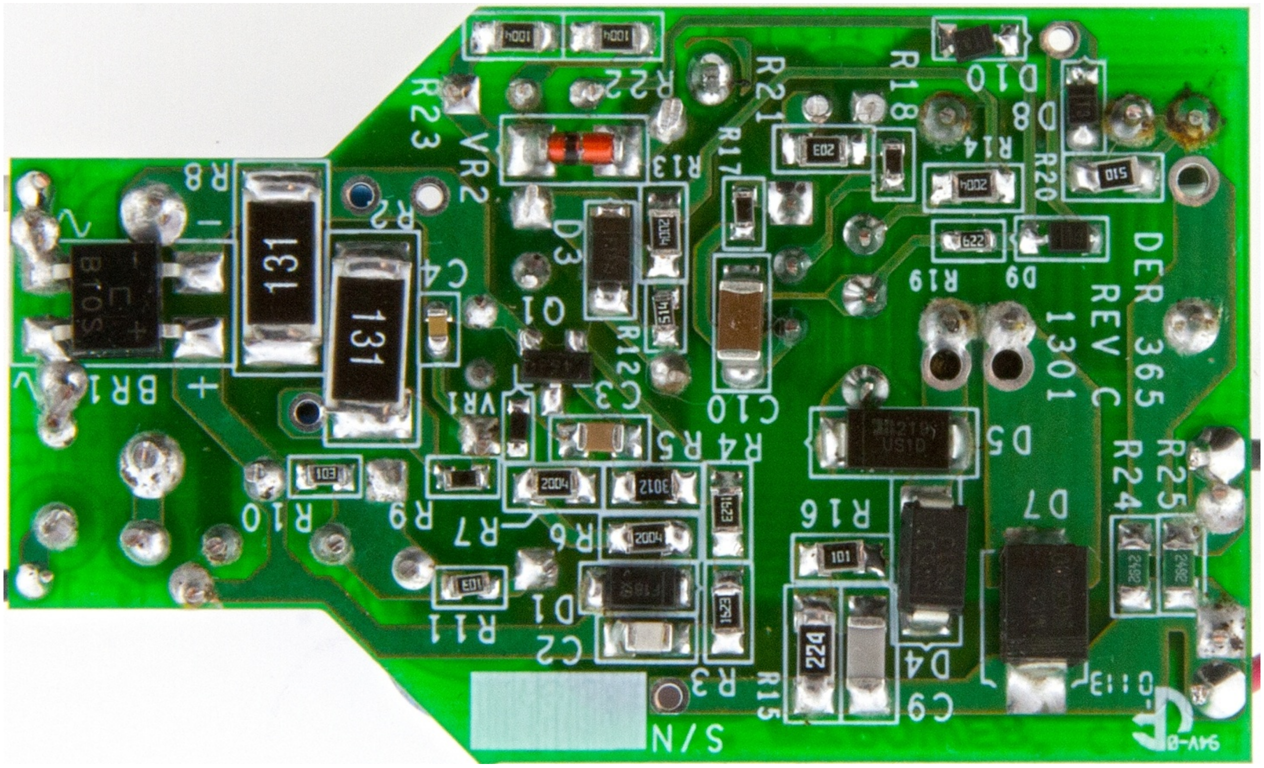

Figure 3 – Populated Circuit Board, Bottom View.

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}		50/60		Hz	
输出						
输出电压	V_{OUT}	38	41	44	V	V_{OUT} = 41V，V_{IN} = 230 VAC，25°C
输出电流	I_{OUT}		350		mA	
总输出功率						
连续输出功率	P_{OUT}		14.35		W	
效率						
满载	η	88	89		%	在P_{OUT} 25 °C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	
共模(L1/L2-PE)						
差模浪涌			500		V	
功率因数		0.95				在$V_{OUT(TYP)}$、$I_{OUT(TYP)}$ 以及230 VAC、50Hz条件下测得
谐波电流		EN 61000-3-2 Class C				
环境温度	T_{AMB}				°C	

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3 电路原理图

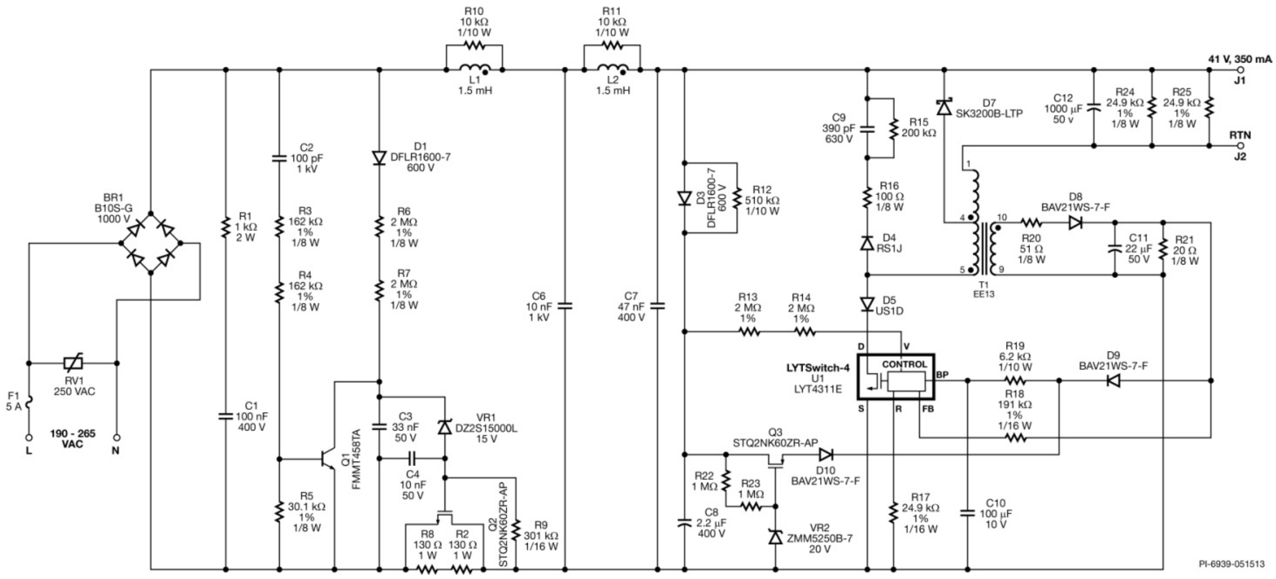

Figure 4 – Schematic.

4 电路描述

LYT4311E (U1)是一款适用于LED驱动器应用的高集成度初级侧芯片控制器。它能够在单级转换级中提供高功率因数，同时对特定输入电压(190 VAC - 265 VAC)电压条件下的输出电流进行调节。所有提供这些功能的控制电路以及高压功率MOSFET都集成在IC中。

4.1 输入EMI滤波

保险丝F1在元件发生故障时提供保护，而RV1用来对差模浪涌测试期间可能产生的最大电压进行箝位。桥式整流器BR1对AC输入电压进行整流。

EMI滤波由电感L1、L2以及电容C6和C7提供。L1和L2上的电阻R10和R11可抑制电感的自谐振，避免以其谐振频率在传导EMI图上出现噪声峰值。

由于所选的电感未采用磁屏蔽设计，它们串联在一起且彼此相邻，因此L1与L2之间的磁耦合效应在布局时经过认真考虑，以便提供一致的EMI性能。在本设计中，L1垂直于L2安装，绕组的起始端和结束端受到良好控制，在电路原理图和PCB上用点表示。（请参阅电感厂商的数据手册，了解起始绕组和结束绕组的信息。）

4.2 功率电路

本设计所采用的拓扑结构为低压端抽头降压式配置，可在190 VAC至265 VAC的输入电压范围内提供低THD、高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D7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，从而实现更具成本效益的设计。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4:1（初级绕组与次级绕组匝数比）后，可使用一个200V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D7每当U1关断时就会导通，将能量传输至负载。在C7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。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D4、电容C9以及电阻R15和R16组成。

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选用电容C12来降低输出纹波(<30%)。当AC断电并确保灯完全熄灭时（而不是在AC断电后微弱发光数秒钟），假负载电阻R24和R25可使输出快速放电至LED灯串电压以下。

为向U1提供峰值输入电压信息，经整流AC的输入峰值经由D3对C8充电。然后电流经过R13和R14，注入U1的电压监测(V)引脚。电阻R12提供放电通路，以使C8的电压跟踪AC输入的变化。

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C10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，C10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。电容C10的选取值为100 μF，使器件能够在深度调光模式下具有更好工作性能，否则可以使用4.7 uF的取值，因为LYT4311只有一种功率模式。

U1的参考(R)引脚通过电阻R17接地（源极）。24.9 kΩ值用来提供精确的恒流调整。

4.3 偏置电源和输出反馈

T1上的偏置绕组用于为IC提供反馈和供电。偏置绕组的反馈电压由D8进行整流并由C11进行滤波，以平滑电压和R20，从而降低耦合自漏感能量的过高电压。反馈电流然后经由电阻R18馈入反馈(FB)引脚。二极管D9和R19将BP引脚链路至偏置绕组。有必要采用二极管D9在启动时将C10与C11隔离，电阻R19用于限制从偏置绕组提供给BP引脚的电流。R21对偏置电源提供负载，以加快C11在AC周期内的放电，同时有助于提高调光比。

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及后沿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，灯吸收的电流要小于许多应用中可控硅的维持电流。这样会因为可控硅触发不一致而产生某些不良情况，比如调光范围受限和/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。这种效应会造成闪烁，因为振荡会使可控硅电流降至零并关断。

本设计中所采用的衰减电路、泄放电路和线性稳压电路能够克服这些问题，并且对驱动器效率的影响保持在最小限度。

电阻R2和R8提供无源衰减，由D1、R6、R7、C3、VR1、C4、Q2和R9构成的外围电路可在可控硅导通约2毫秒后以线性模式操作Q2，从而降低R2和R8的功耗。电容C2、R3、R4、R5和Q1提供放电通路，以便在下一个可控硅开关周期开始时首先关断Q2。相关值也已选取，这样当无可控硅连接时，Q2将永久导通，这有助于提高非调光模式下的效率。

无源泄放网络由电容C1和电阻R1构成。该网络可以抑制输入网络，同时为可控硅调光器提供要求的锁存和维持电流。

本设计增加了线性稳压电路R22、R23、VR2、Q3和D10，以使IC的供电（BP引脚）保持恒定 – 使它能够在极低导通角下或以极低输入电压进行正常工作，并且使IC充当一个负载（这对具有高漏电流的可控硅特别重要）。大多数具有高功率额定值(>600 W)的可控硅调光器都有一个LC输入滤波器。如果电容足够大，能够提供能量为LED驱动器的输入级进行充电，那么LED可能会在LED负载加电时导通，直到输入放电为止。然后该周期重复发生，即使在可控硅关断时也会导致LED负载闪烁。

当偏置电压高于Vz_{VR2} +Vt_{Q3} + Vf_{D10}时，线性稳压器不会激活。本设计选择使用电压稳压器VR2，以便线性稳压器仅在偏置电压足够低时的深度调光期间工作，从而降低Q3的功耗。MOSFET Q3可替换为BJT (400V)以降低成本，电阻R22和R23必须进行相应调整以便能提供足够的驱动，这在深度调光期间输入电压较低时特别有用。

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5 PCB布局

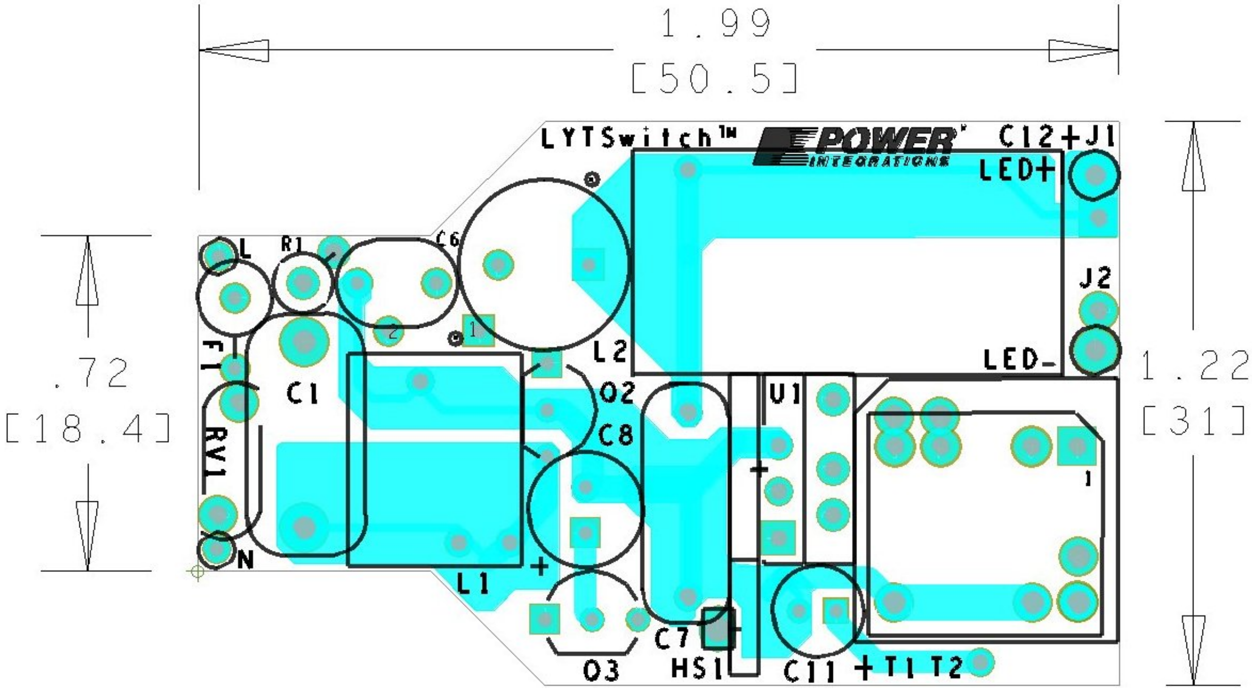

Figure 5 – Top Side.

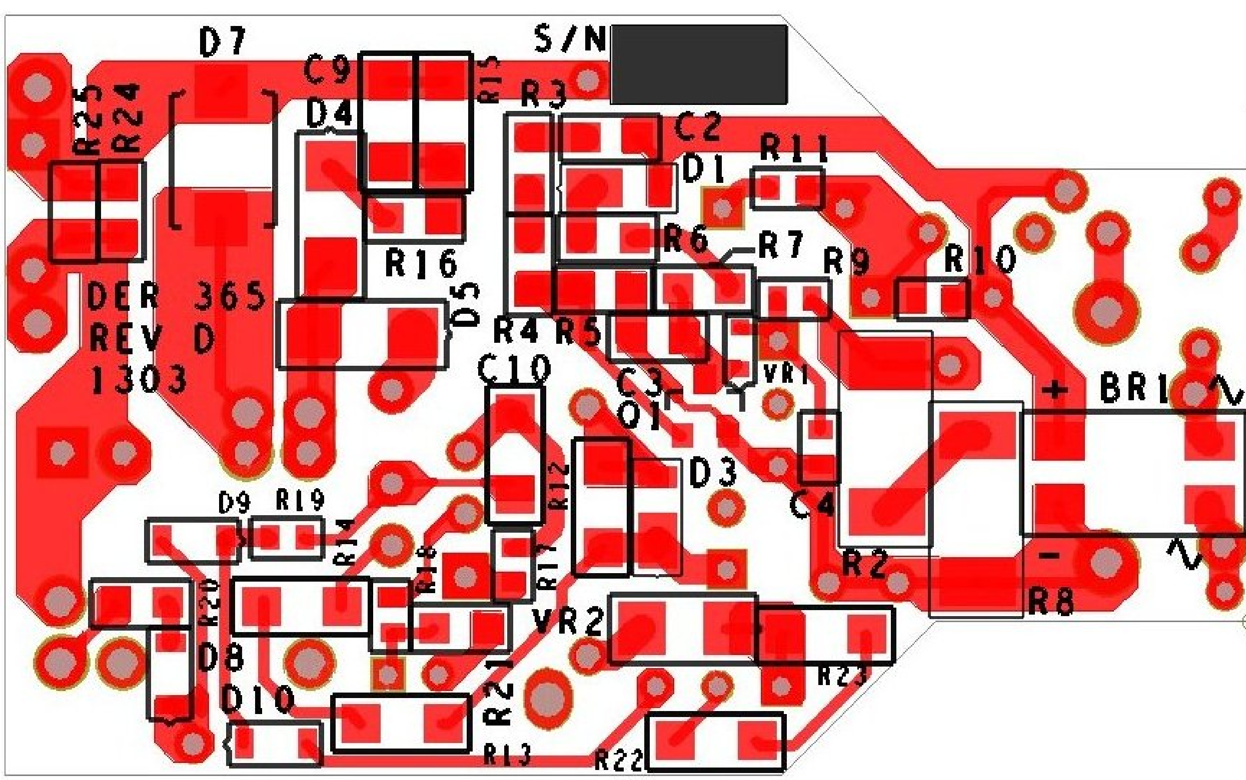

Figure 6 – Bottom Side.

6 物料清单(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 Technology
2	1	C1	100 nF, 400 V, Film	ECQ-E4104KF	Panasonic
3	1	C2	100 pF, 1000 V, Ceramic, NPO, 0805	C0805C101MDGACTU	Kemet
4	1	C3	33 nF, 50 V, Ceramic, X7R, 0805	CC0805KRX7R9BB333	Yageo
5	1	C4	10 nF 50 V, Ceramic, X7R, 0603	C0603C103K5RACTU	Kemet
6	1	C6	10 nF, 1 kV, Disc Ceramic, X7R	SV01AC103KAR	AVX
7	1	C7	47 nF, 400 V, Film	ECQ-E4473KF	Panasonic
8	1	C8	2.2 μF, 400 V, Electrolytic, (6.3 x 11)	TAB2GM2R2E110	Ltec
9	1	C9	390 pF, 630 V, Ceramic, NPO, 1206	C3216C0G2J391J	TDK
10	1	C10	100 μF, 10 V, Ceramic, X5R, 1206	C3216X5R1A107M	TDK
11	1	C11	22 μF, 50 V, Electrolytic, (5 x 11)	UPW1H220MDD	Nichicon
12	1	C12	1000 μF, 50 V, Electrolytic, Gen. Purpose, (12.5 x 25)	EKMG500ELL102MK25S	Nippon Chemi-Con
13	2	D1 D3	600 V, 1 A, Rectifier, Glass Passivated, POWERDI123	DFLR1600-7	Diodes, Inc.
14	1	D4	600 V, 1 A, Fast Recovery, 250 ns, SMA	RS1J-13-F	Diodes, Inc.
15	1	D5	Diode ULTRA FAST, SW, 200V, 1A, SMA	US1D-13-F	Diodes, Inc.
16	1	D7	200 V, 3 A, DIODE SCHOTTKY 1A 200V, SMB	SK3200B-LTP	Micro Commercial
17	3	D8 D9 D10	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
18	1	F1	5 A, 250V, Fast, Microfuse, Axial	0263005.MXL	Littlefuse
19	2	L1 L2	1.5 mH, 0.250 A, 10%	RL-5480HC-3-1500	Renco
20	1	Q1	NPN, HP, 400V, 225Ma, SOT23-3	FMMT458TA	Diodes, Inc.
21	2	Q2 Q3	600 V, 0.4 A, 8 Ω, N-Channel, TO-92	STQ2NK60ZR-AP	STMicro
22	1	R1	1 kΩ, 5%, 2 W, Metal Film	FMP200JR-52-1K	Yageo
23	2	R2 R8	130Ω, 5%, 1 W, Thick Film, 2512	ERJ-1TYJ131U	Panasonic
24	2	R3 R4	162 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF1623V	Panasonic
25	1	R5	30.1 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF3012V	Panasonic
26	2	R6 R7	2 MΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2004V	Panasonic
27	1	R9	301 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF3013V	Panasonic
28	2	R10 R11	10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
29	1	R12	510 kΩ, 5%, 1/10 W, Thick Film, 1206	ERJ-8GEYJ514V	Panasonic
30	2	R13 R14	2.00 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF2004V	Panasonic
31	1	R15	200 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ204V	Panasonic
32	1	R16	100 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ101V	Panasonic
33	1	R17	24.9 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF2492V	Panasonic
34	1	R18	191 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1913V	Panasonic
35	1	R19	6.2 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ622V	Panasonic
36	1	R20	51 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ510V	Panasonic
37	1	R21	20 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ203V	Panasonic
38	2	R22 R23	1 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ105V	Panasonic
39	2	R24 R25	24.9 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2492V	Panasonic
40	1	RV1	250 V, 21 J, 7 mm, RADIAL LA	V250LA4P	Littlefuse
41	1	T1	Custom	TSD-3192	Premier Magnetics
42	1	U1	LYTSwitch, eSIP-7C	LYT4311E	Power Integrations
43	1	VR1	15 V, 5%, 150 mW, SSMINI-2	DZ2S15000L	Panasonic-SSG
44	1	VR2	20 V, 5%, 500 mW, DO-213AA (MELF)	ZMM5250B-7	Diodes, Inc.

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7 电感规格

7.1 电气原理图

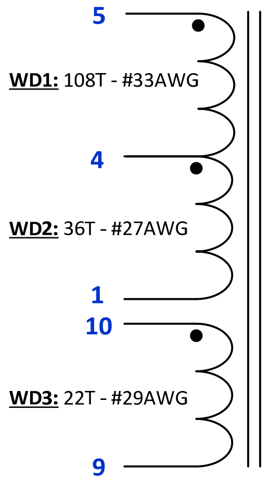

Figure 7 – Inductor Electrical Diagram.

7.2 电气规格

Primary Inductance	Pins 1-5, all other windings open, measured at 100kHz, 0.4 RMS.	2 mH ±3%
Resonant Frequency	Pins 1-5, all other windings open.	800 kHz (Min.)

7.3 材料

Item	Description
[1]	Core: EE13, NC2H.
[2]	Bobbin: EE13-Vertical, 10pins (5/5). Yih-Hwa Enterprises P/N: YW-538-02B.
[3]	Magnet wire: #33AWG - Double coated.
[4]	Magnet wire: #27AWG - Double coated.
[5]	Magnet wire: #29AWG - Double coated.
[6]	Tape: 3M 1298 Polyester Film, 7.5mm wide, 2.0 mils thick, or equivalent.
[7]	Varnish: Dolph BC-359 or equivalent.

7.4 电感结构图

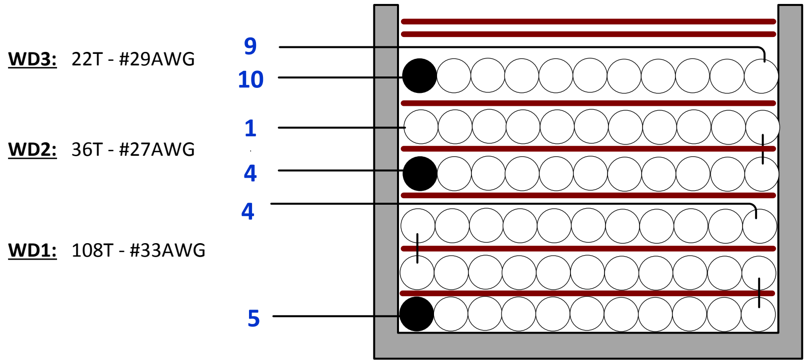

Figure 8 – Inductor Build Diagram.

7.5 电感构造

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 5, wind 36 turns of wire item [3] from left to right, place 1 layer tape item [6], then continue wind another 36 turns from right to left, place 1 layer tape item [6], then continue wind another 36 turns from left to right, and end at pin 4.
Insulation	Place 1 layer of tape item [6].
WD2	Start at pin 4, wind 18 turns of wire item [4] from left to right, place 1 layer tape item [6], then continue wind another 18 turns from right to left, and end at pin 1.
Insulation	Place 1 layer of tape item [6].
WD3	Start at pin 10, wind 22 turns of wire item [5] from left to right in 1 layer. At the last turn bring the wire back to the left and end at pin 9.
Insulation	Place 2 layers of tape item [6].
Final Assembly	Grind, assemble, and secure core halves with tape.Varnish with item [7].

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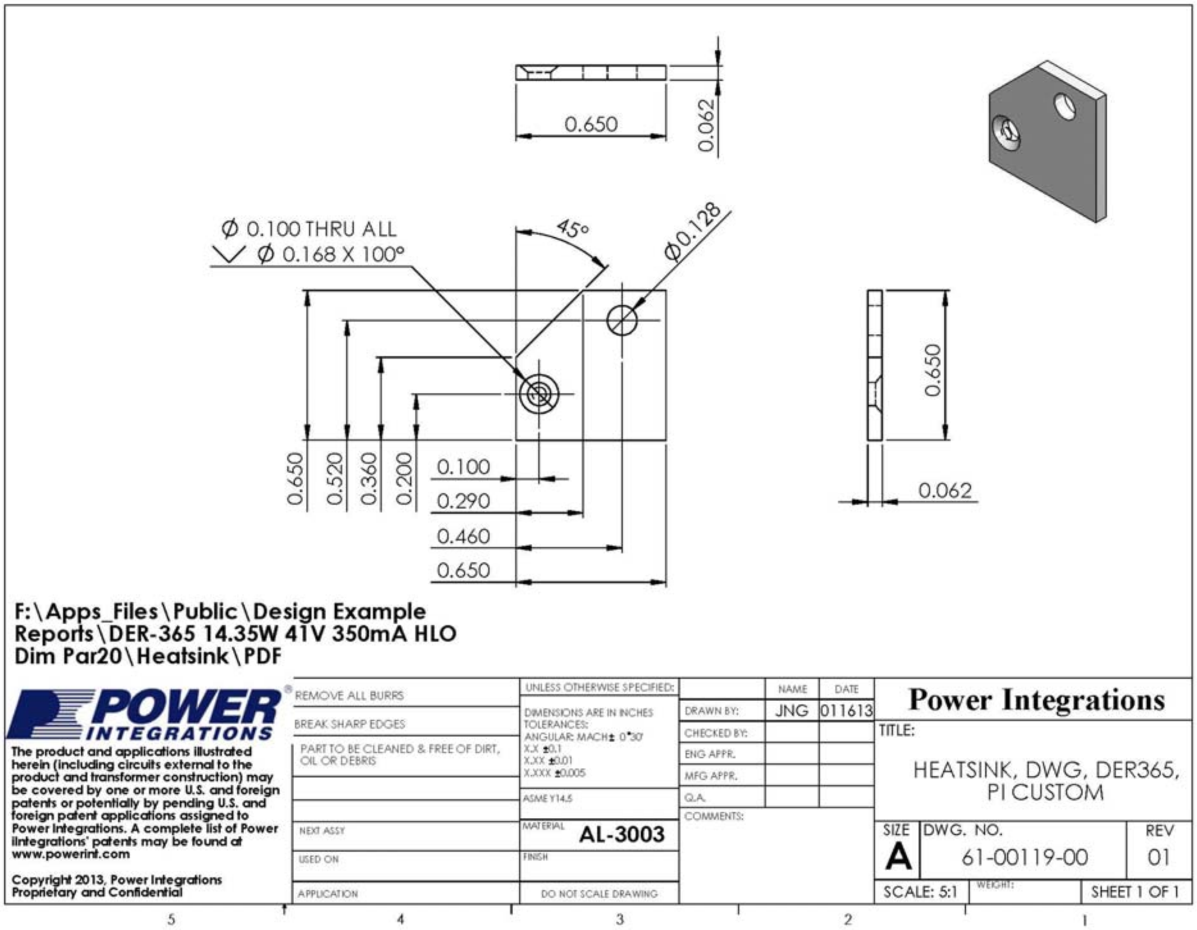
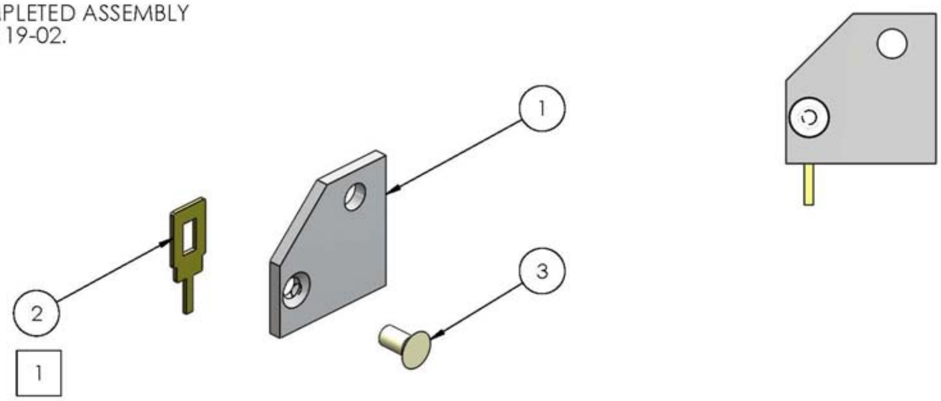
8 U1散热片

8.1 U1散热片加工图



8.2　U1散热片装配图

1 FOR COMPLETED ASSEMBLY SEE 61-00119-02.



F:\Apps_Files\Public\Design Example Reports\DER-365 14.35W 41V 350mA HLO Dim Par20\Heatsink\PDF

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-001197-00	HEATSINK,AL,3003,DER365,PI CUSTOM	1
2	60-00051-00	POST,HEATSINK,SS,NICKEL PLATED,5mm W x 9.1 mm T	1
3	75-00084-00	RIVET,AI,.093 DIA x 0.187 C'sunk	1

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The product and applications illustrated herein (including circuits external to the product and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at www.powerint.com

REMOVE ALL BURRS
BREAK SHARP EDGES
PART TO BE CLEANED & FREE OF DIRT, OIL OR DEBRIS
NEXT ASSY
USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
ANGULAR: MACH± 0°30'
X.X ±0.1
X.XX ±0.01
X.XXX ±0.005
ASME Y14.5
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN BY:	JNG	013013
CHECKED BY:		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

Power Integrations

TITLE: HEATSINK, DWG, DER365, PI CUSTOM

SIZE A　DWG. NO. 61-00119-01　REV 01

SCALE: 2:1　WEIGHT:　SHEET 1 OF 1

5　4　3　2　1

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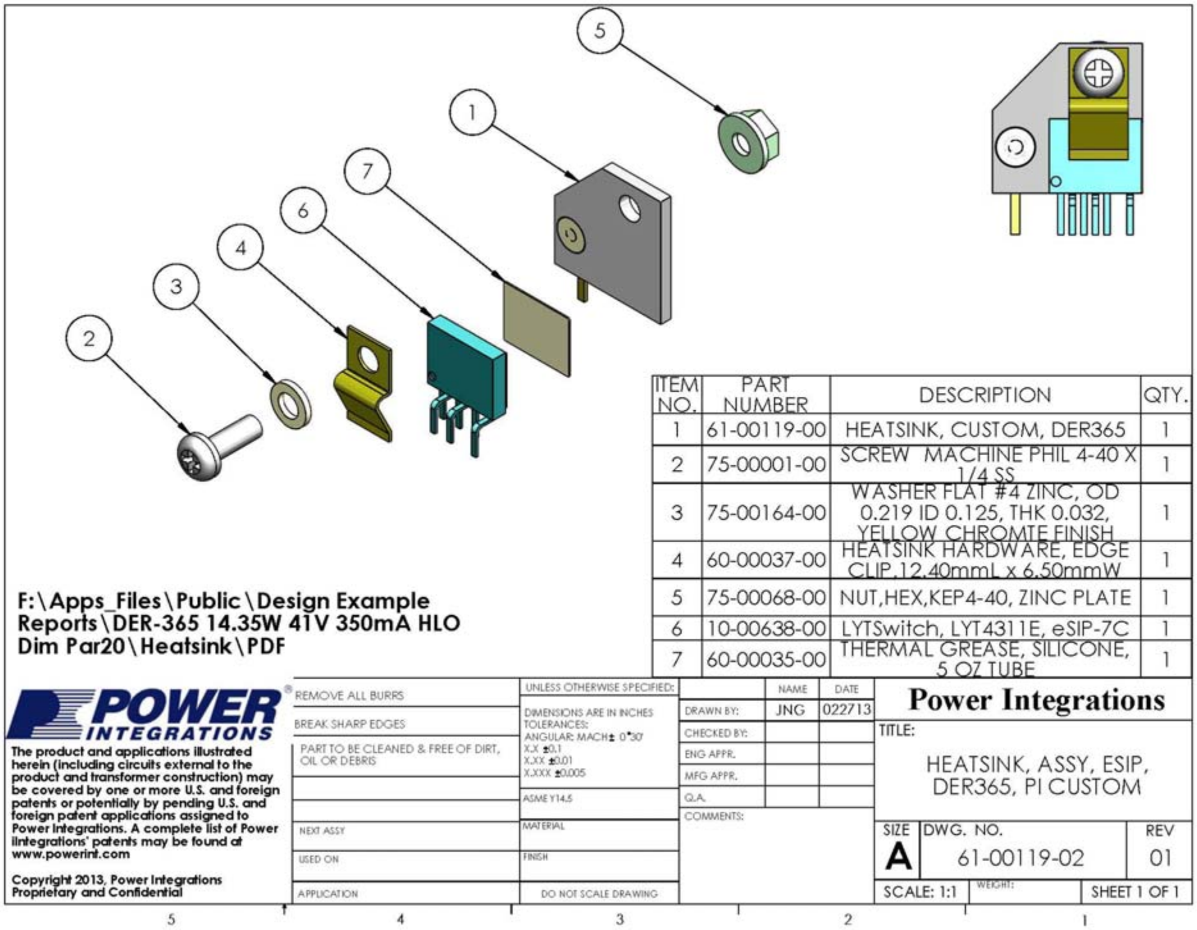
8.3 散热片和U1装配图



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00119-00	HEATSINK, CUSTOM, DER365	1
2	75-00001-00	SCREW MACHINE PHIL 4-40 X 1/4 SS	1
3	75-00164-00	WASHER FLAT #4 ZINC, OD 0.219 ID 0.125, THK 0.032, YELLOW CHROMTE FINISH	1
4	60-00037-00	HEATSINK HARDWARE, EDGE CLIP, 12.40mmL x 6.50mmW	1
5	75-00068-00	NUT,HEX,KEP4-40, ZINC PLATE	1
6	10-00638-00	LYTSwitch, LYT4311E, eSIP-7C	1
7	60-00035-00	THERMAL GREASE, SILICONE, 5 OZ TUBE	1

9　性能数据

All measurements performed at room temperature using an LED load.The following data was taken measured using 3 sets of loads representinga load range of 38Vto44V (output voltage). Refer to the table on Section 9.6 for complete test data values.

9.1　效率

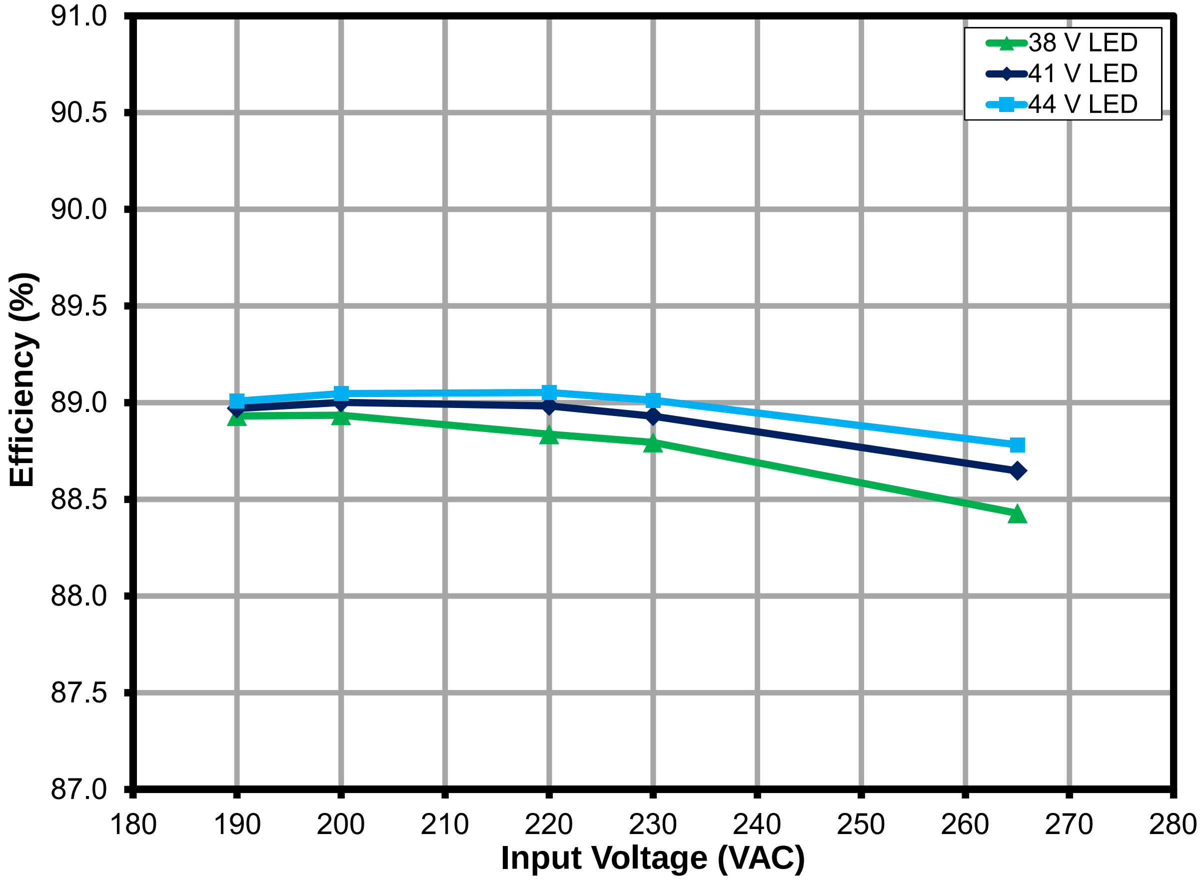


Figure 9 – Efficiency vs. Line and Load.

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9.2 输入电压调整率和负载调整率

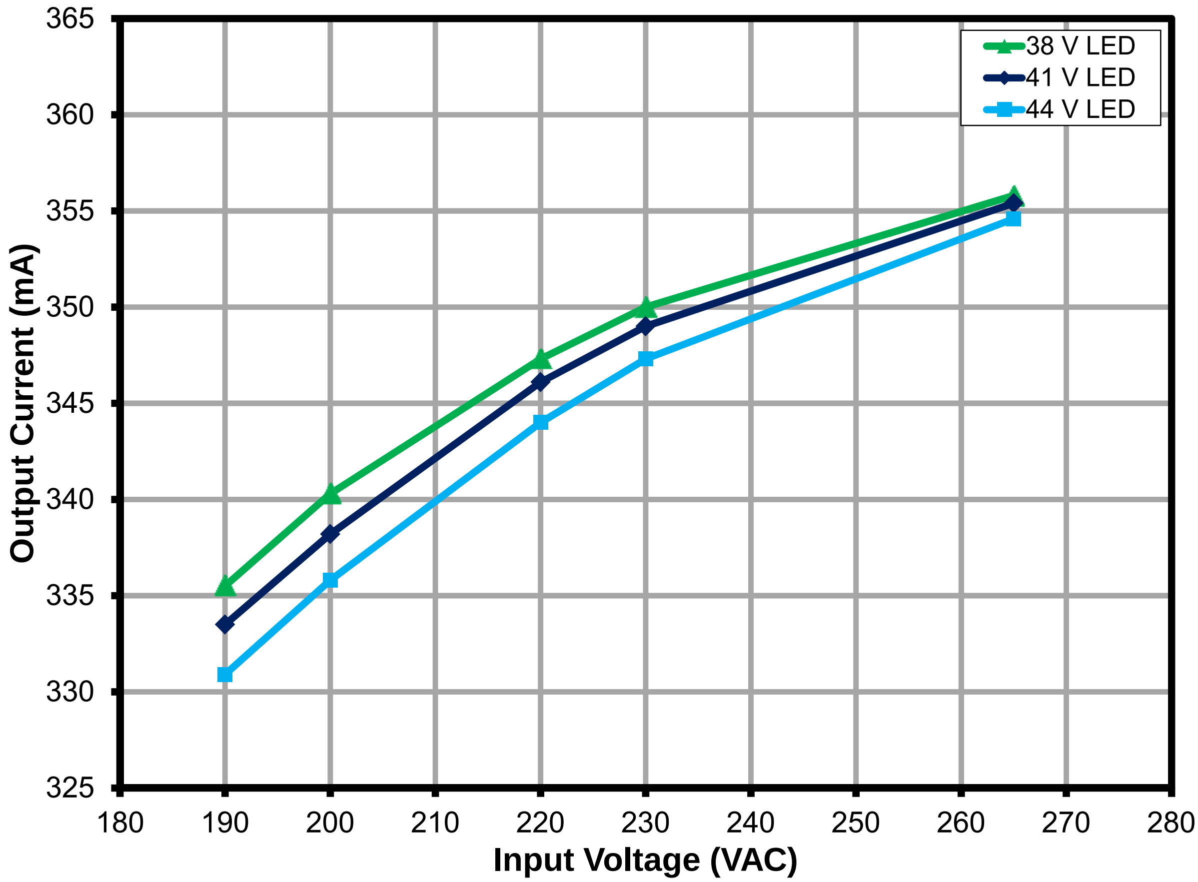

Figure 10 – Regulation vs. Line and Load.

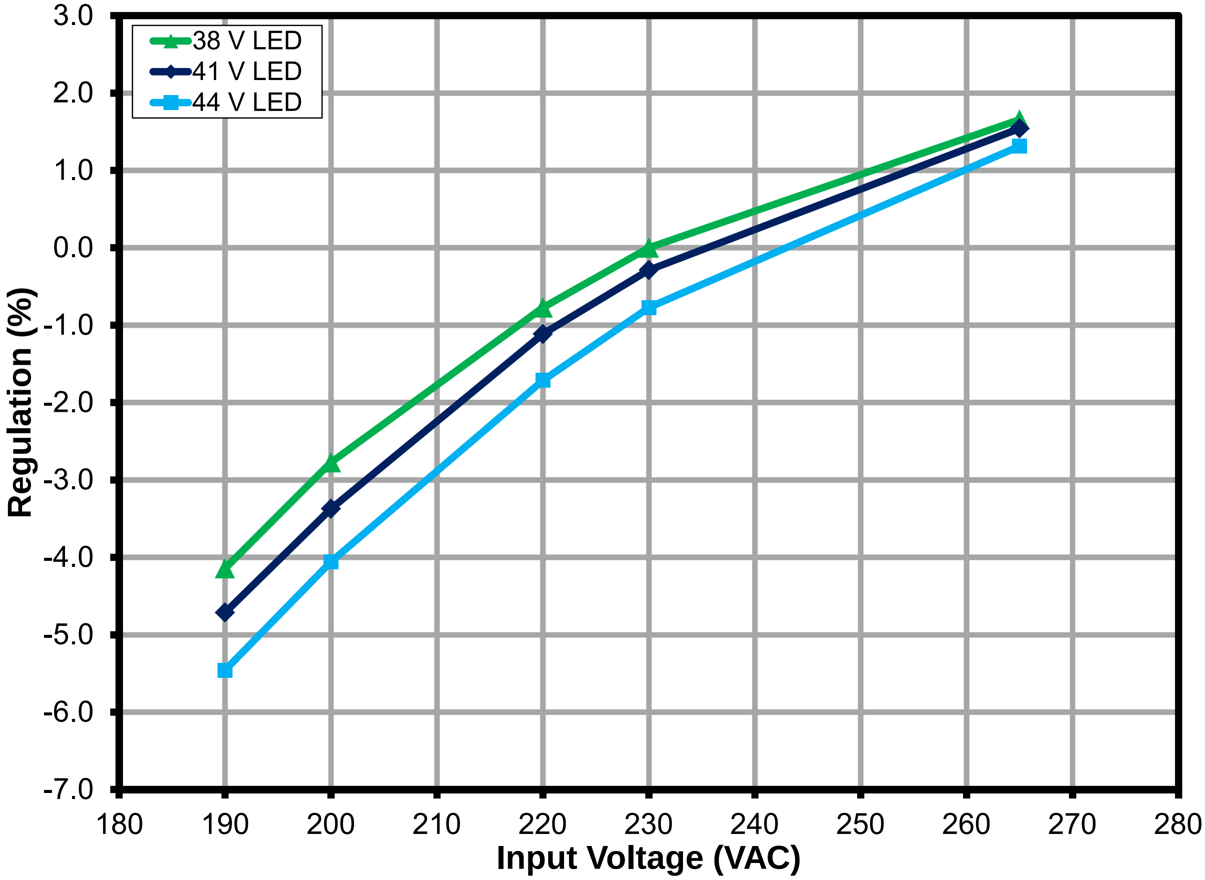

Figure 11 – % Regulation vs. Line and Load.

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9.3 功率因数

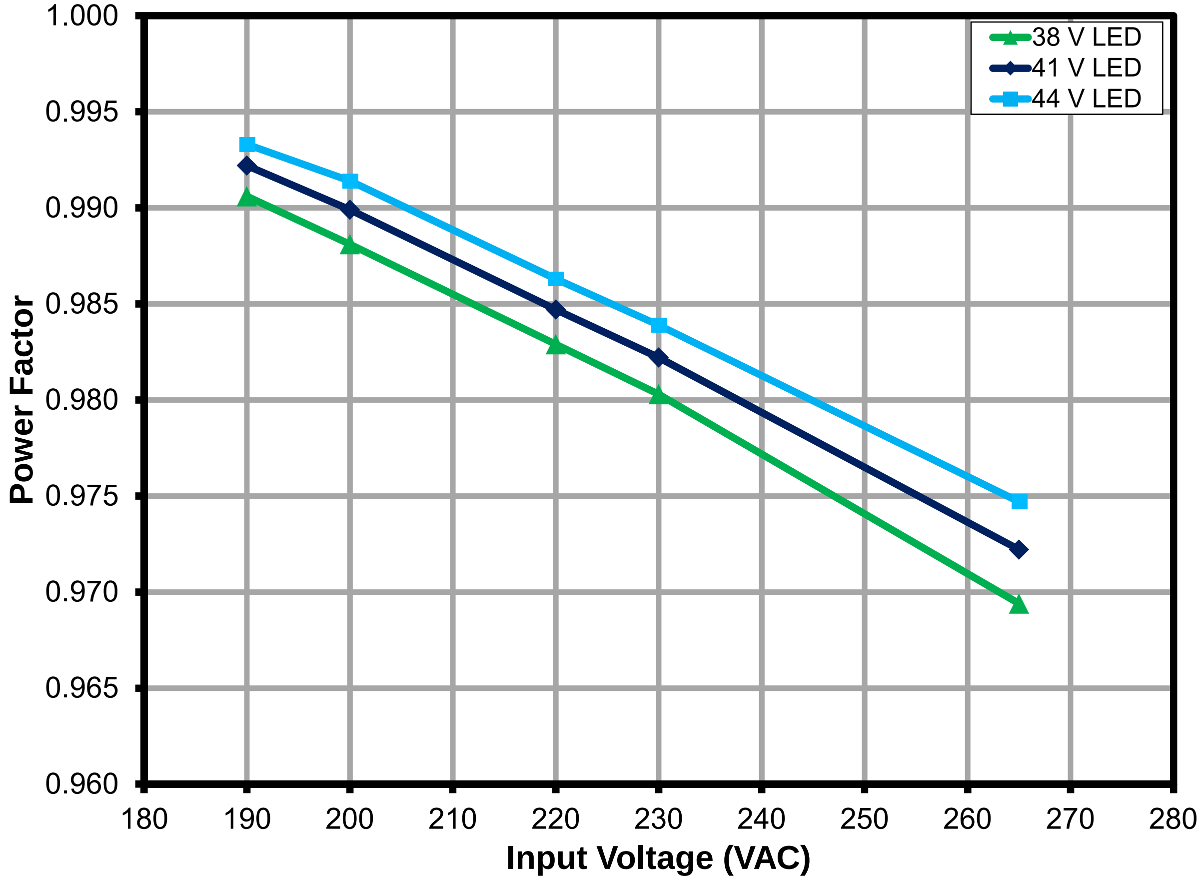

Figure 12 – Power Factor vs. Line and Load.

9.4 A-THD

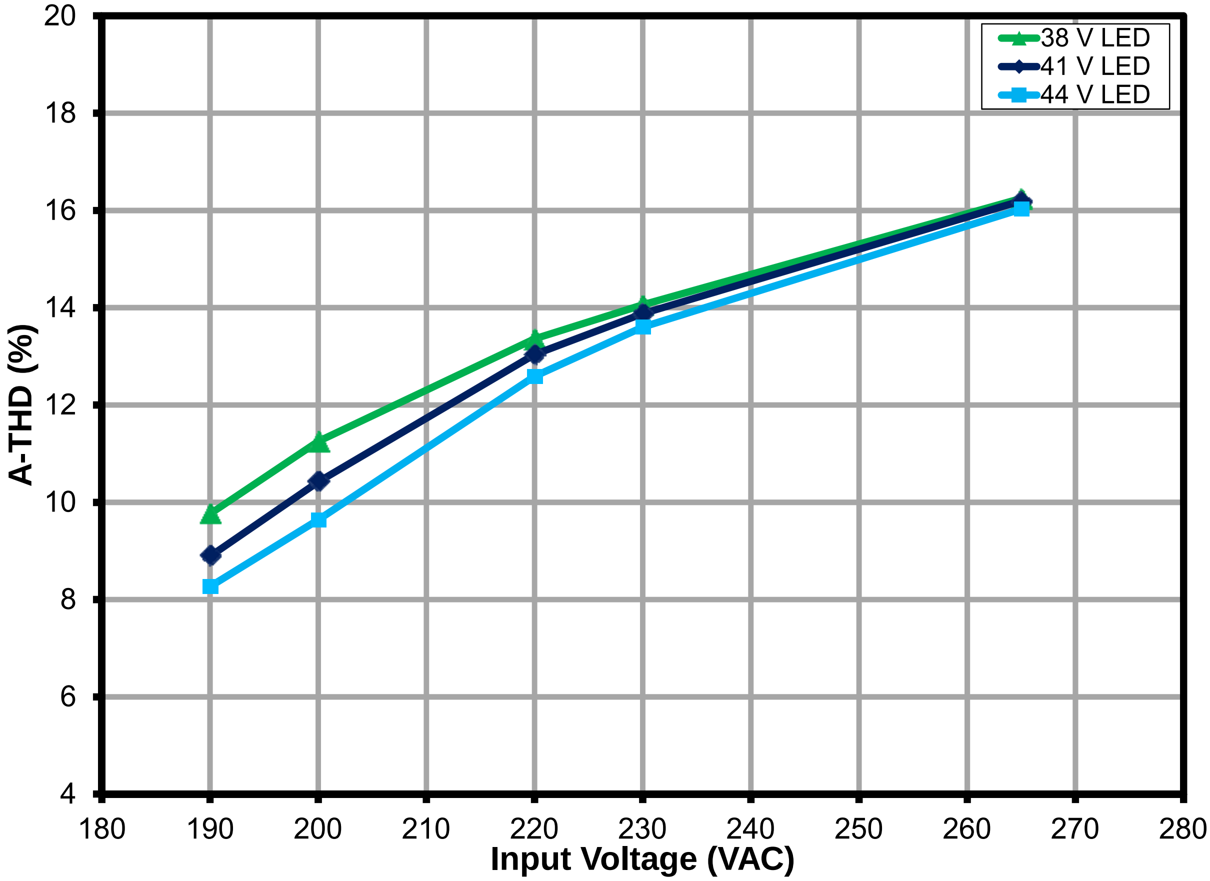

Figure 13 – A-THD vs. Line and Load.

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9.5 谐波

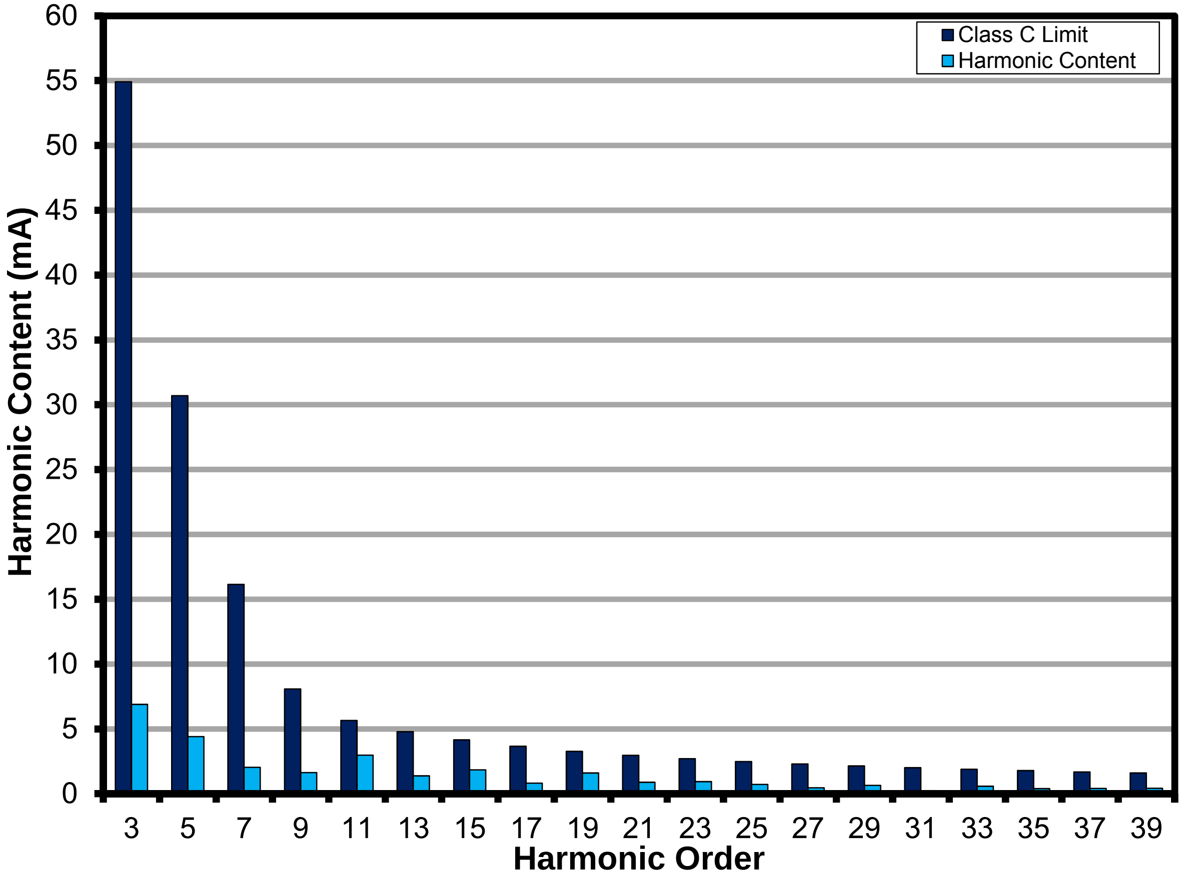

Figure 14 – 41V LED Load Input Current Harmonics at 230VAC, 50Hz.

9.6 测试数据

All measurements were taken with the board at open frame, 25 ºC ambient, and 50Hz line frequency.

9.6.1 测试数据，38V LED负载

Input		Input Measurement					Load Measurement				
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	PF	%ATHD	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)	% Reg
190	50	190.33	76.15	14.357	0.991	9.76	37.9830	335.500	12.768	88.93	-4.14
200	50	200.34	73.59	14.569	0.988	11.25	38.0080	340.300	12.957	88.94	-2.77
220	50	220.38	68.78	14.898	0.983	13.36	38.0430	347.300	13.235	88.84	-0.77
230	50	230.37	66.55	15.029	0.980	14.06	38.0620	350.000	13.345	88.79	0.00
265	50	265.48	59.64	15.348	0.969	16.25	38.0850	355.800	13.572	88.43	1.66

9.6.2 测试数据，41V LED负载

Input		Input Measurement					Load Measurement				
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	PF	%ATHD	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)	% Reg
190	50	190.31	81.53	15.395	0.992	8.89	41.0100	333.500	13.697	88.97	-4.71
200	50	200.33	78.77	15.621	0.990	10.42	41.0400	338.200	13.903	89.00	-3.37
220	50	220.35	73.75	16.003	0.985	13.04	41.0850	346.100	14.240	88.98	-1.11
230	50	230.41	71.37	16.152	0.982	13.88	41.0990	349.000	14.364	88.93	-0.29
265	50	265.48	64.00	16.517	0.972	16.2	41.1390	355.400	14.642	88.65	1.54

9.6.3 测试数据，44V LED负载

Input		Input Measurement					Load Measurement				
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	PF	%ATHD	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)	% Reg
190	50	190.33	86.67	16.385	0.993	8.27	44.0050	330.900	14.584	89.01	-5.46
200	50	200.33	83.71	16.625	0.991	9.64	44.0310	335.800	14.804	89.05	-4.06
220	50	220.39	78.45	17.054	0.986	12.59	44.0860	344.000	15.187	89.05	-1.71
230	50	230.41	76.01	17.230	0.984	13.6	44.1070	347.300	15.337	89.01	-0.77
265	50	265.47	68.25	17.660	0.975	16.03	44.1540	354.600	15.679	88.78	1.31

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10 调光性能数据

TRIAC dimming results were taken with input voltage of 230VAC, 50Hz line frequency, room temperature, and nominal 41V LED load.

10.1 前沿调光器的调光曲线

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

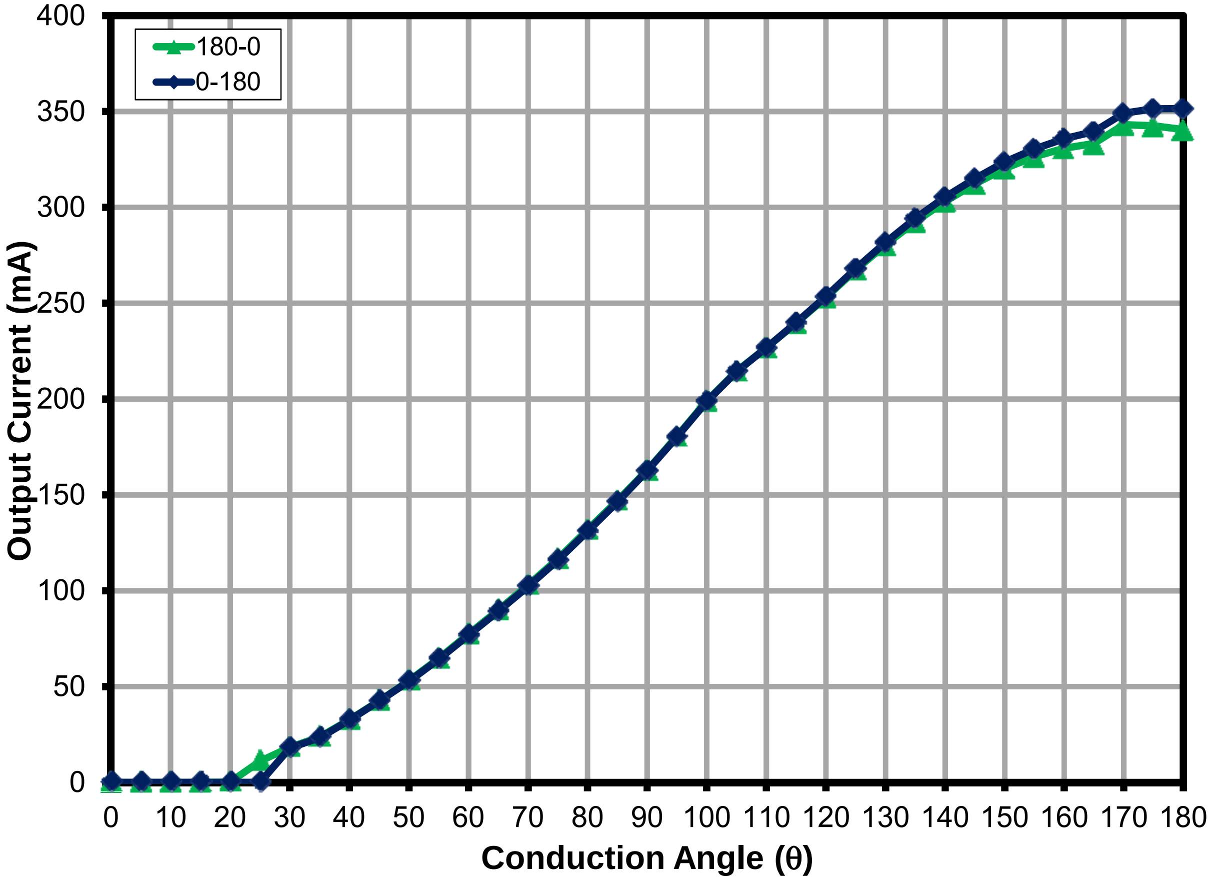

Figure 15 – Leading Edge Dimming Characteristics.

10.2 调光器兼容性列表

The unit was tested with the following high-line dimmers at 230VAC, 50 Hz input and 41V LED load and using Agilent 6812B AC source.

Chinese Dimmers	Type	Maximum Setting I_{OUT} (mA)	Minimum Setting I_{OUT} (mA)	Dim Ratio
TCL 630W	L	334	15	22
EBA HUANG	L	337	1	337
SB ELECT 600W	L	326	2	163
MYONGBO	L	336	40	8
CLIPMEI	L	333	3	111
MANK 200W	L	334	54	6

German Dimmers	Type	Maximum Setting I_{OUT} (mA)	Minimum Setting I_{OUT} (mA)	Dim Ratio
REV 300W	L	317	1	317
BUSCH 2250	L	320	25	13
MERTEN 572499	L	331	15	22
BERKER 2875 600W	L	317	30	11
KOPP 8033	L	293	25.9	11

Korean Dimmers	Type	Maximum Setting I_{OUT} (mA)	Minimum Setting I_{OUT} (mA)	Dim Ratio
ANAM 500W	L	332	90	4
SHIN SUNG 500W	L	336	66	5
FANTASIA 500W	L	337	44	8

EU Dimmers	Type	Maximum Setting I_{OUT} (mA)	Minimum Setting I_{OUT} (mA)	Dim Ratio
BERKER 2830 10	L	317	37	9
JUNG 225 NV DE	L	310	24.6	13
JUNG 266 G DE	L	318	32	10
BUSCH 2200 UJ-212	L	317	44	7
BUSCH 2250 U	L	326	4.3	76
BUSCH 2247 U	L	317	43.7	7
GIRA 2262 00 / IO1	L	318	16	20
GIRA 0300 00 / IO1	L	315	43	7
GIRA 0302 00 / IO1	L	318	33	10

Trailing Edge Dimmers	Type	Maximum Setting I_{OUT} (mA)	Minimum Setting I_{OUT} (mA)	Dim Ratio
PEHA 433HAB	T	311	78	4
PEHA 433HAB oA	T	274	48	6
BUSCH 6513	T	341	89	4
JUNG 254 UDIE 1	T	315	97	3

Figure 16 – Compatibility List.

11 热性能

Images captured after running for >30 minutes at room temperature (25 °C), open frame for the conditions specified.

NOTE: Potting the board or placing heat sink on U1 may be necessary when used at high ambient conditions.

11.1 非调光V_{IN} = 190 VAC，50Hz，41V LED负载

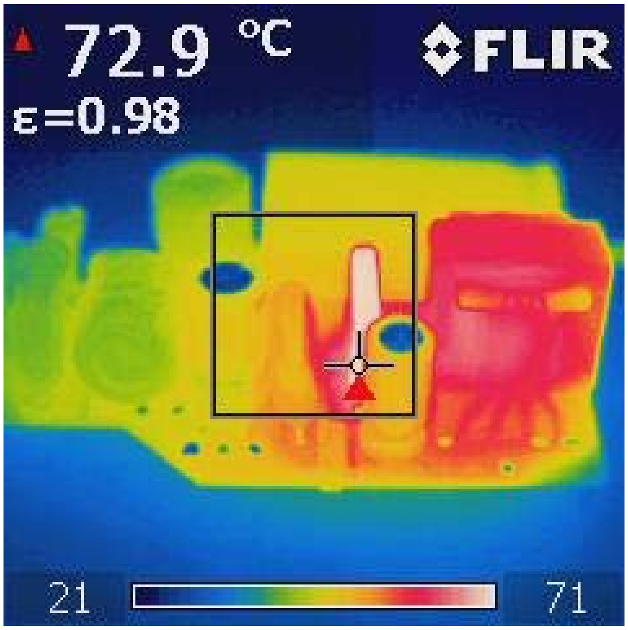

Figure 17 – Top Side.
U1-LYT4311E: 72.9 ºC.

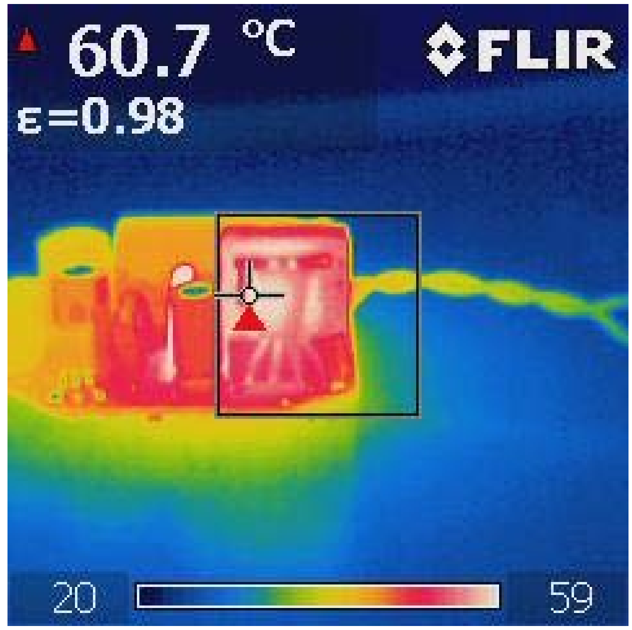

Figure 18 – Top Side.
T1: 60.7 ºC.

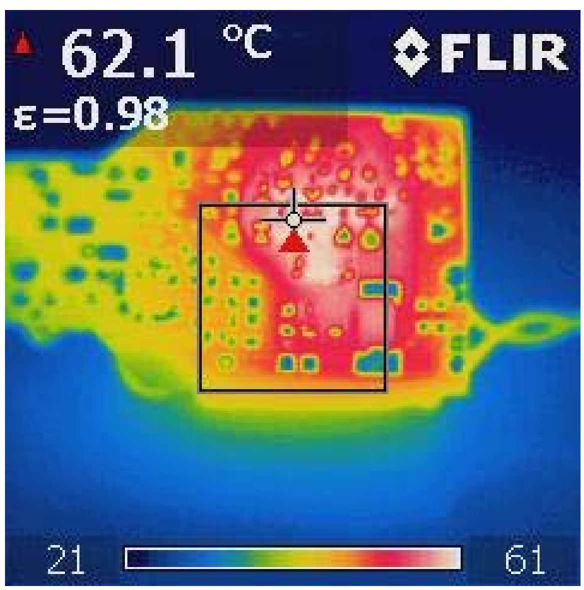

Figure 19 – Bottom Side.
PCB: 62.1 ºC.

11.2 非调光V_{IN} = 265 VAC，50 Hz，41 V LED负载

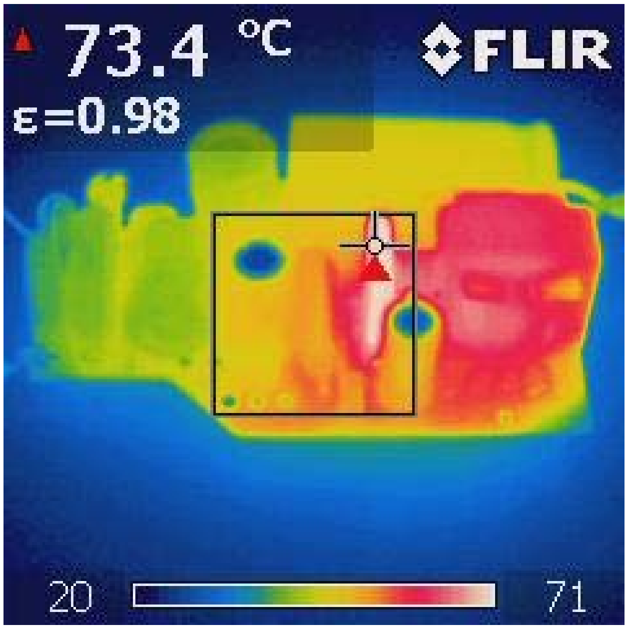

Figure 20 – Top Side.
U1-LYT4311E: 73.4ºC.

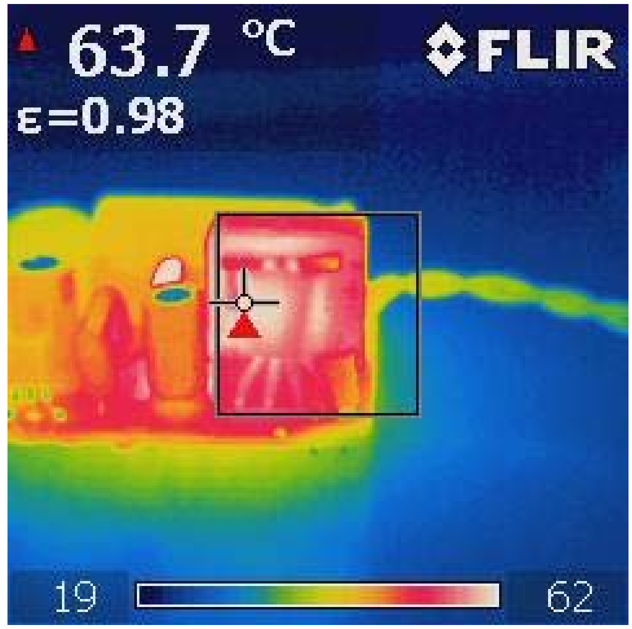

Figure 21 – Top Side, Inductor.
T1: 63.7 ºC.

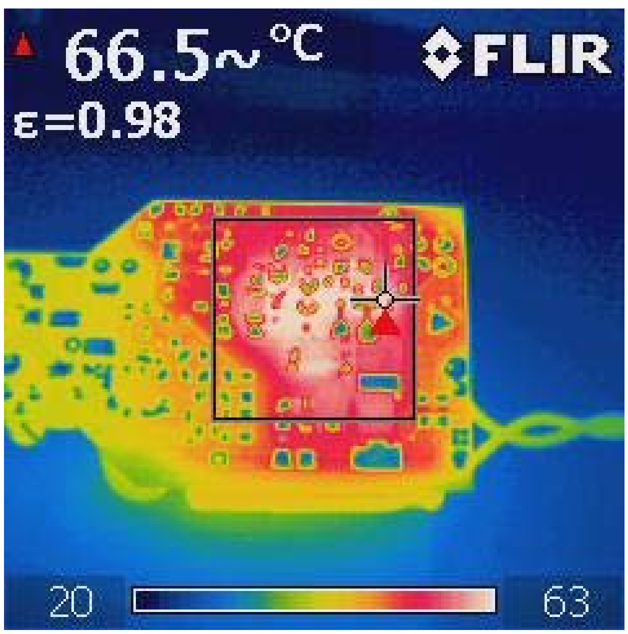

Figure 22 – Bottom Side.
PCB: 66.5 ºC.

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11.3 调光V_{IN} = 230 VAC，50 Hz，41 V LED负载，REV300调光器

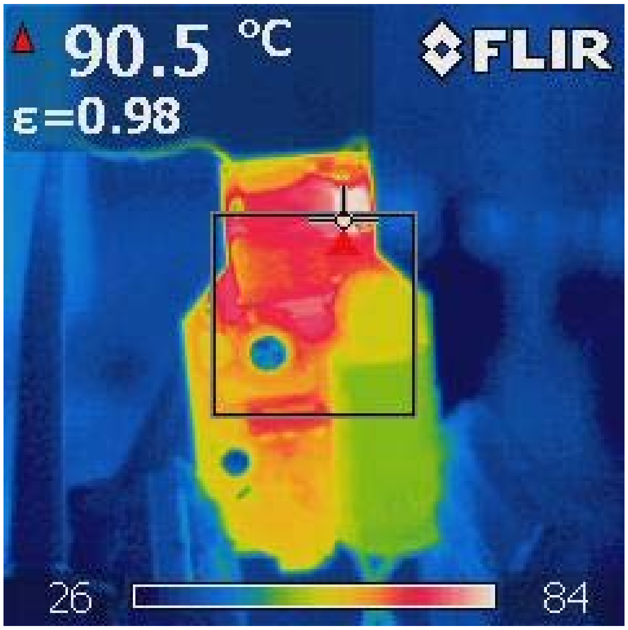

Figure 23 – 90º Conduction Angle.
R26: 90.5ºC.

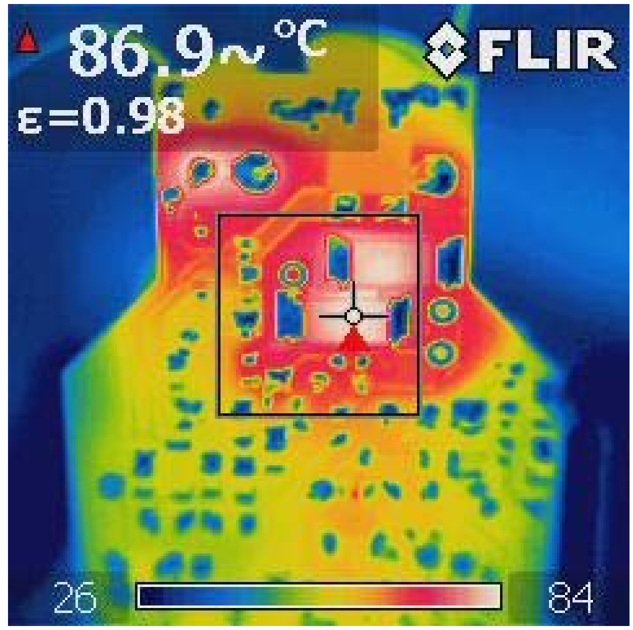

Figure 24 – 90º Conduction Angle.
R2: 86.9 ºC.

12 非调光波形

12.1 输入电压和输入电流波形

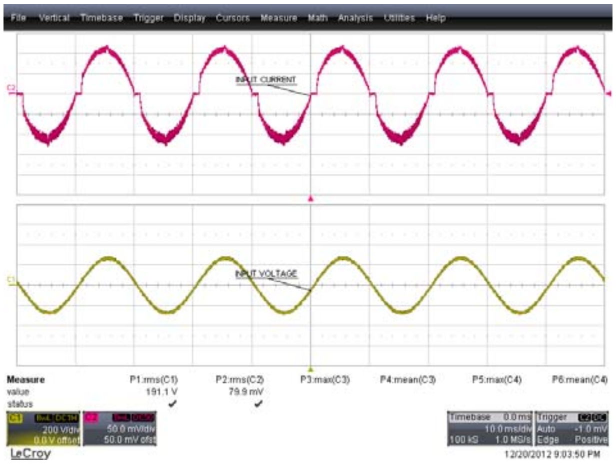

Figure 25 – 190 VAC, Full Load.
Upper: I_{IN}, 50mA / div.
Lower: V_{IN}, 200 V, 10 ms / div.

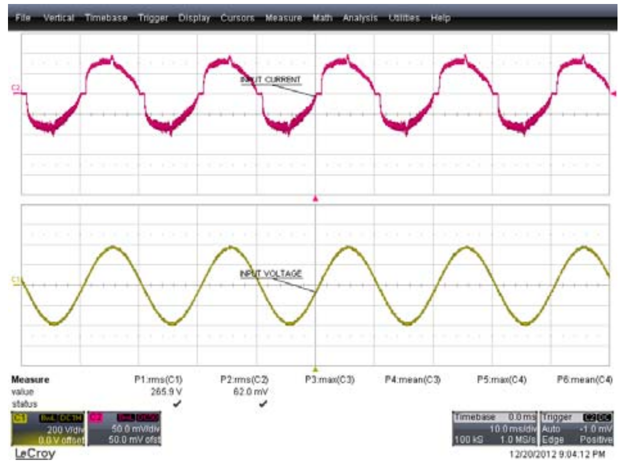

Figure 26 – 265 VAC, Full Load.
Upper: I_{IN}, 50mA / div.
Lower: V_{IN}, 200 V, 10 ms / div.

12.2 正常工作时的输出电流和输出电压

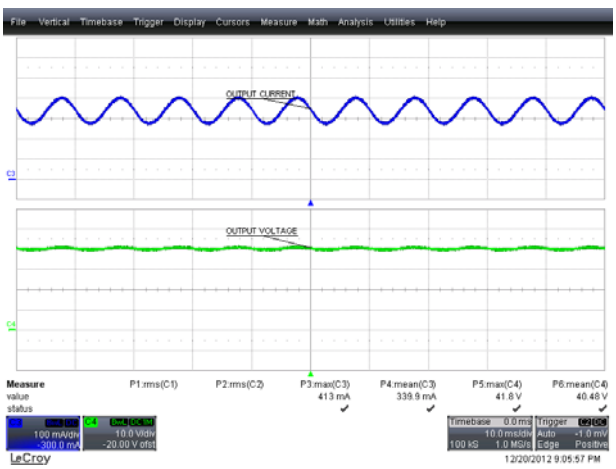

Figure 27 – 190 VAC, 50Hz Full Load.
Upper: I_{OUT},100mA / div.
Lower: V_{OUT}, 10 V, 10 ms / div.

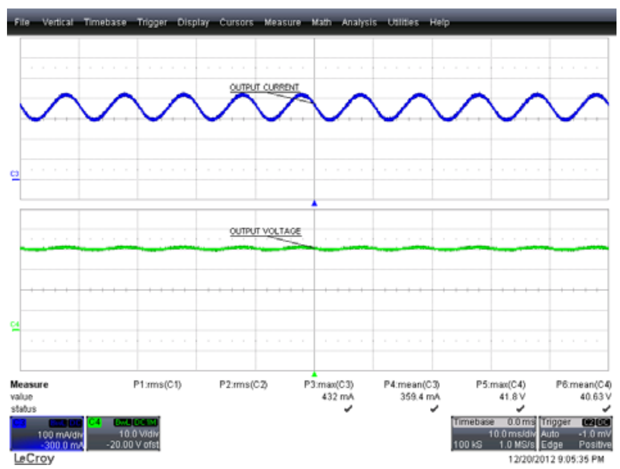

Figure 28 – 265 VAC, 50Hz Full Load.
Upper: I_{OUT},100mA / div.
Lower: V_{OUT}, 10 V, 10 ms / div.

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12.3 启动时的输入电压和输出电流波形

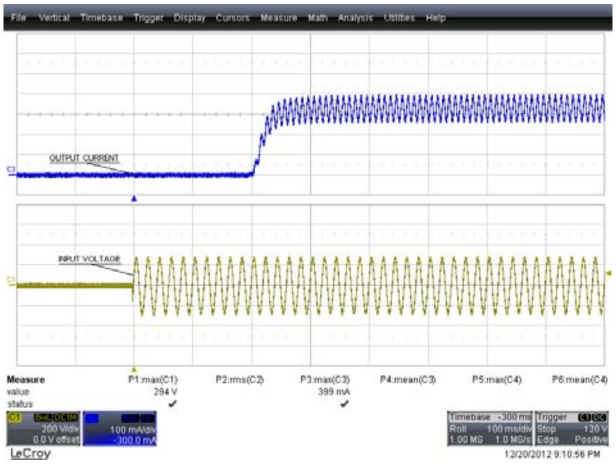

Figure 29 – 190 VAC, 50Hz.
Upper: I_{OUT}, 100mA / div.
Lower: V_{IN}, 200 V,100ms / div.

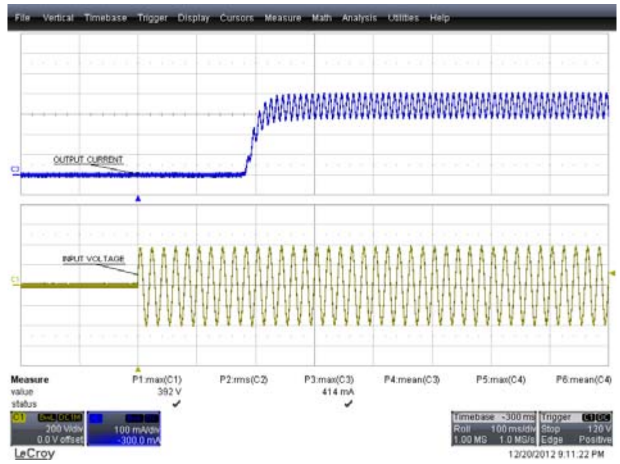

Figure 30 – 265 VAC, 50Hz.
Upper: I_{OUT}, 100m A / div.
Lower: V_{IN}, 200 V,100ms / div.

12.4 正常工作时的漏极电压和电流

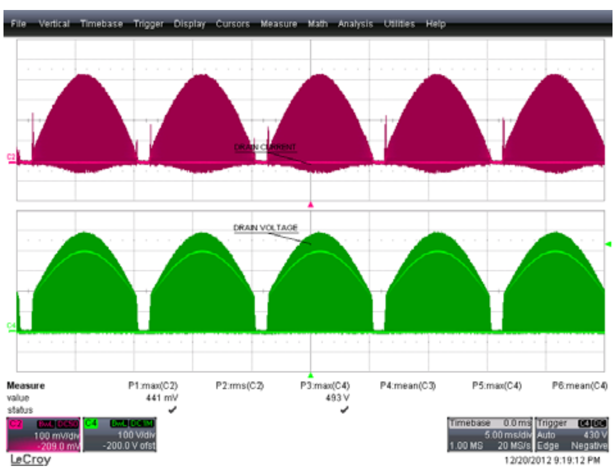

Figure 31 – 190 VAC, 50Hz.
Upper: I_{DRAIN}, 100 mA / div.
Lower: V_{DRAIN}, 100 V,5 ms / div.

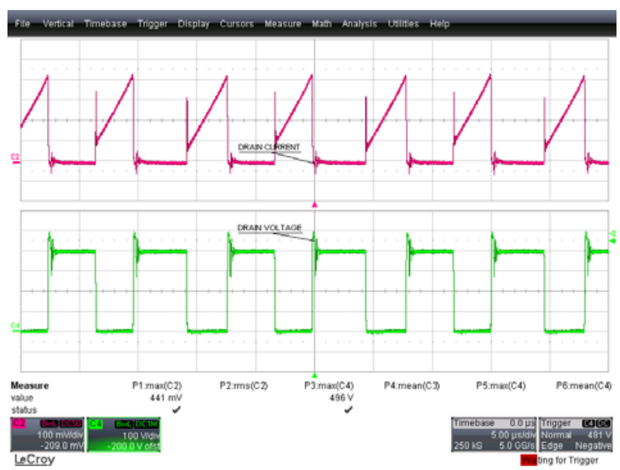

Figure 32 – 190 VAC, 50Hz.
Upper: I_{DRAIN}, 100 mA / div.
Lower: V_{DRAIN}, 100 V / div., 5 μs / div.

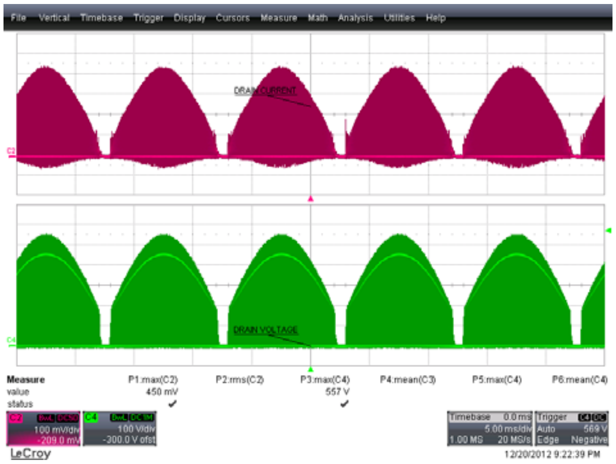

Figure 33 – 230 VAC, 50Hz.
Upper: I_{DRAIN}, 100 mA / div.
Lower: V_{DRAIN}, 100 V,5 ms / div.

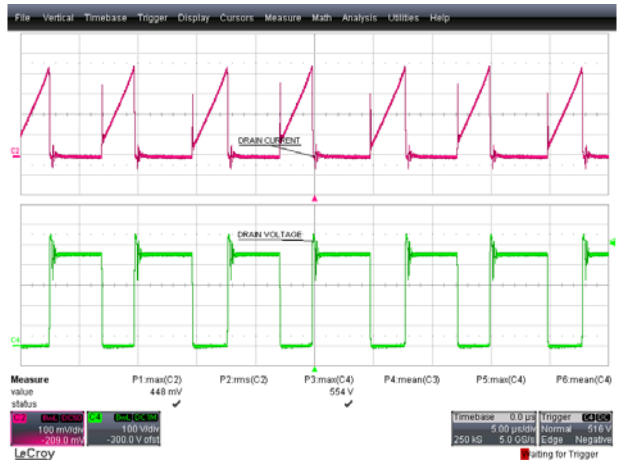

Figure 34 – 230 VAC, 50Hz.
Upper: I_{DRAIN}, 100 mA / div.
Lower: V_{DRAIN}, 100 V / div., 5µs / div.

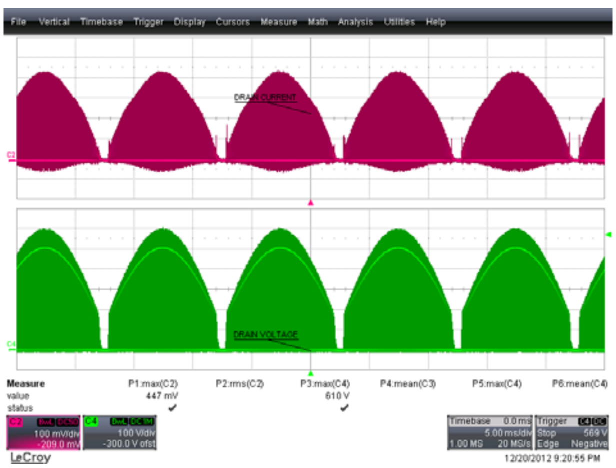

Figure 35 – 265 VAC, 50 Hz.
Upper: I_{DRAIN}, 100 mA / div.
Lower: V_{DRAIN}, 100 V,5 ms / div.

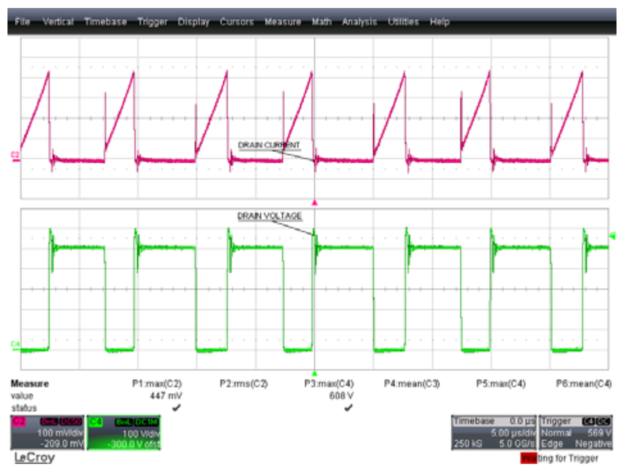

Figure 36 – 265 VAC, 50 Hz.
Upper: I_{DRAIN}, 100 mA / div.
Lower: V_{DRAIN}, 100 V / div., 5µs / div.

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12.5 启动时的漏极电压和电流

Figure 37 – 190 VAC, 50Hz Start-up.
Upper: I_{DRAIN}, 200mA / div.
Lower: V_{DRAIN},100 V, 2 ms / div.

Figure 38 – 190 VAC, 50Hz Start-up.
Upper: I_{DRAIN}, 200mA / div.
Lower: V_{DRAIN},100 V, 10µs / div.

Figure 39 – 265 VAC, 50 Hz Start-up.
Upper: I_{DRAIN}, 200mA / div.
Lower: V_{DRAIN},100 V, 2 ms / div.

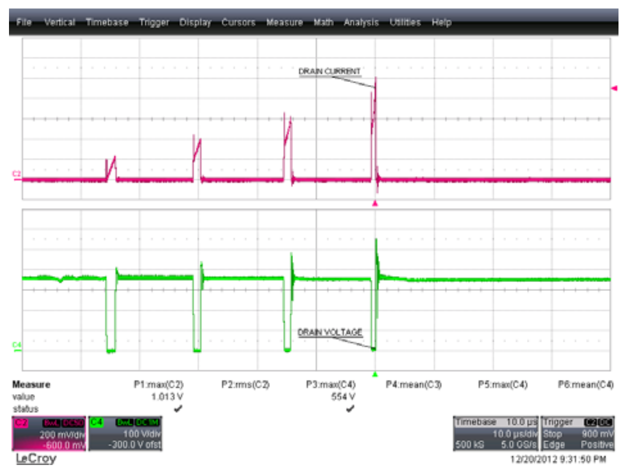

Figure 40 – 265 VAC, 50 Hz Start-up.
Upper: I_{DRAIN}, 200mA / div.
Lower: V_{DRAIN},100 V, 10µs / div.

12.6 输出短路时的漏极电流和漏极电压

Figure 41 – 190 VAC, 50Hz Output Short Condition.
Upper: I_{DRAIN}, 200mA / div.
Lower: V_{DRAIN},100 V, 200 ms / div.

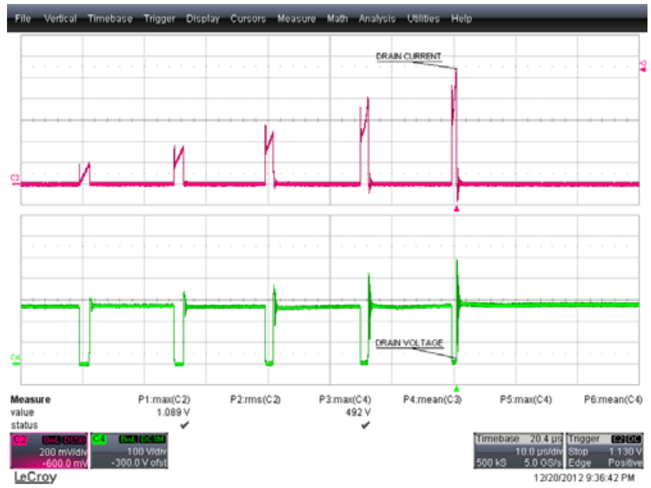

Figure 42 – 190 VAC, 50Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 10µs / div.

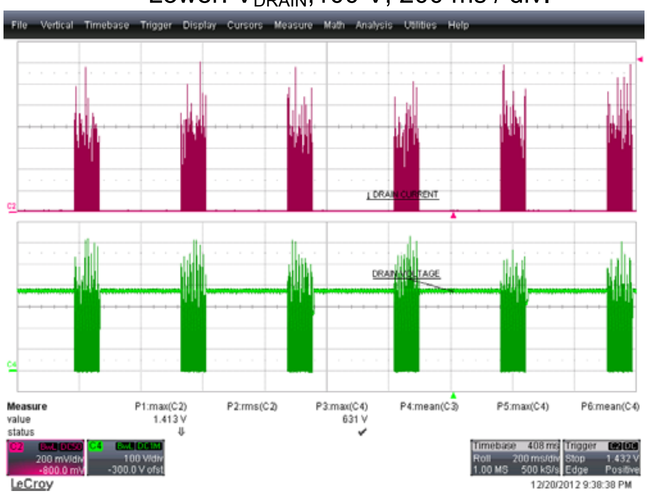

Figure 43 – 265 VAC, 50Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 200 ms / div.

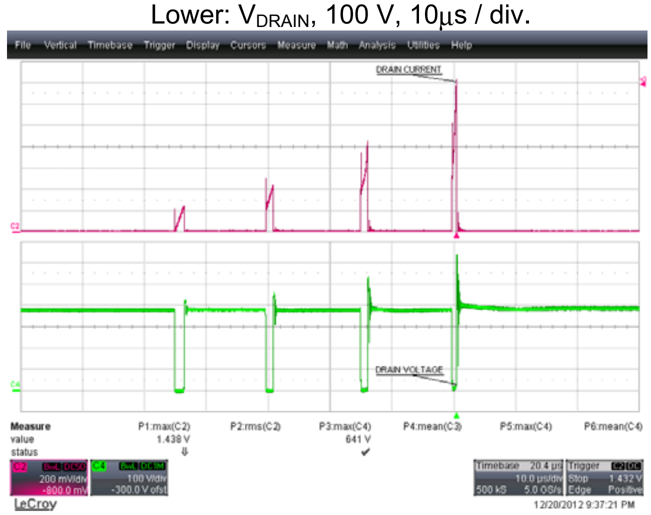

Figure 44 – 265 VAC, 50Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 10 µs / div.

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12.7 输出二极管电流和电压波形

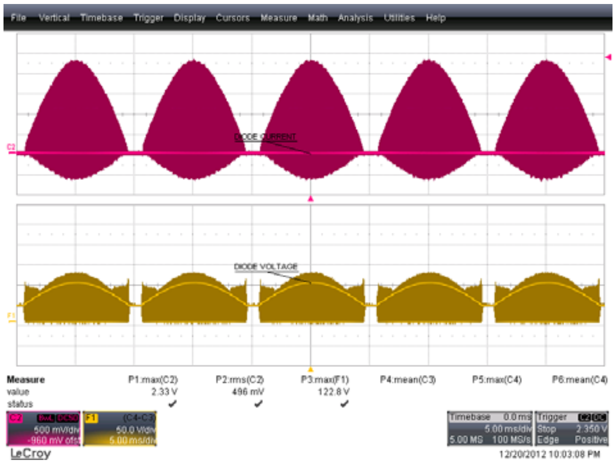

Figure 45 – 190 VAC, 50 Hz.
Upper: I_{D7}, 0.5 A / div.
Lower: V_{D7}, 50 V,5 ms / div.

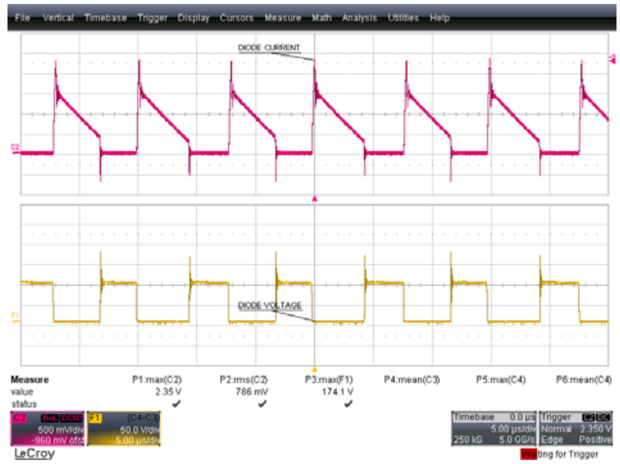

Figure 46 – 190 VAC, 50 Hz.
Upper: I_{D7}, 0.5 A / div.
Lower: V_{D7}, 50 V / div., 5µs / div.

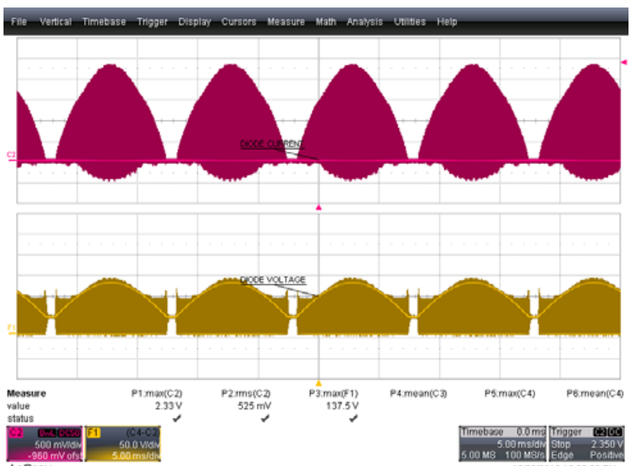

Figure 47 – 265VAC, 50 Hz.
Upper: I_{D7}, 0.5 A / div.
Lower: V_{D7}, 50 V,5 ms / div.

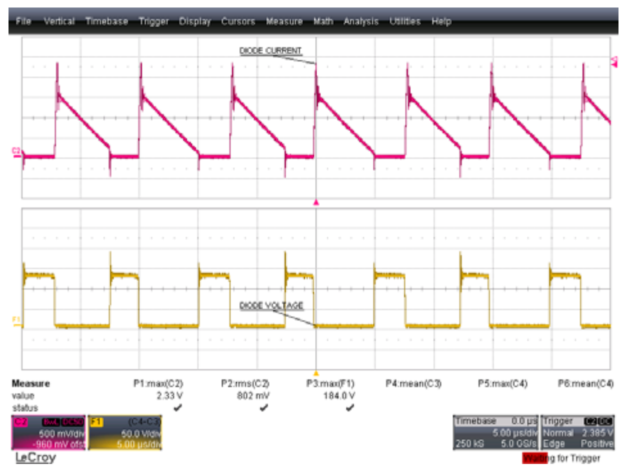

Figure 48 – 265 VAC, 50 Hz.
Upper: I_{D7}, 0.5A / div.
Lower: V_{D7}, 50 V / div., 5µs / div.

12.8 输出二极管电流和电压启动波形

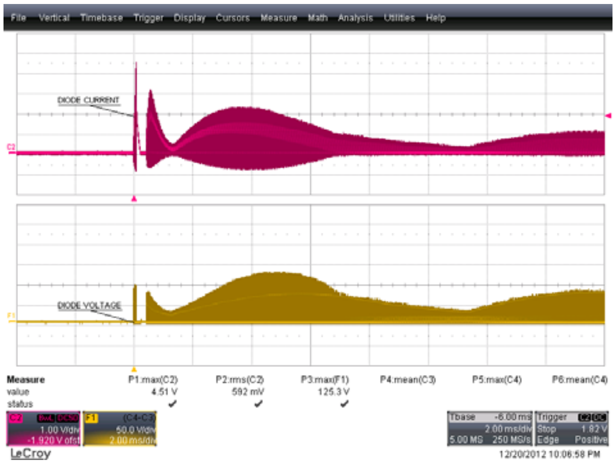

Figure 49 – 190 VAC, 50 Hz.
Upper: I_{D7}, 1 A / div.
Lower: V_{D7}, 50 V,2ms / div.

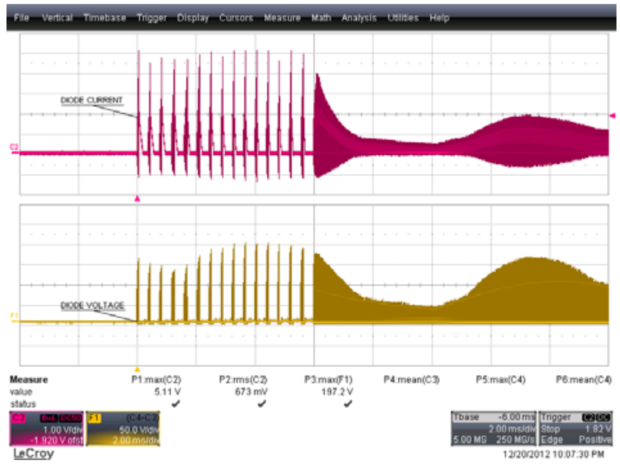

Figure 50 – 265 VAC, 50 Hz.
Upper: I_{D7}, 1 A / div.
Lower: V_{D7}, 50 V / div., 2 ms / div.

12.9 输出二极管电流和电压短路波形

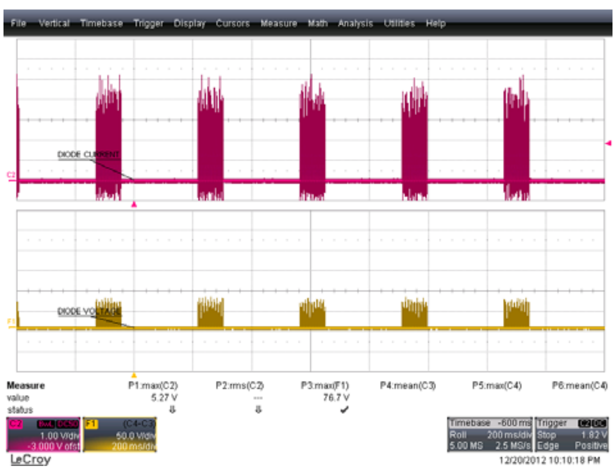

Figure 51 – 190 VAC, 50 Hz.
Upper: I_{D7}, 1 A / div.
Lower: V_{D7}, 50 V,200ms / div.

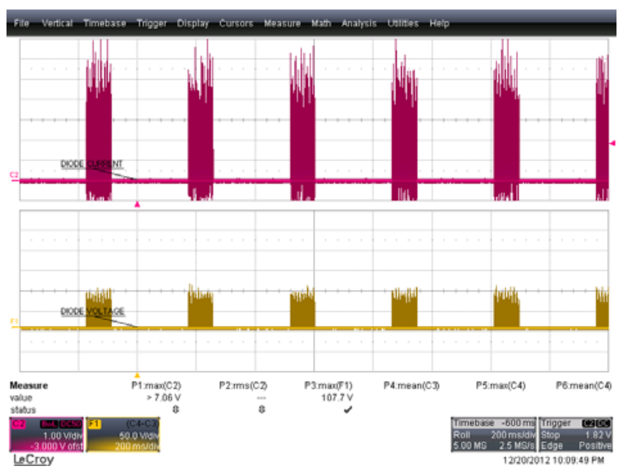

Figure 52 – 265 VAC, 50 Hz.
Upper: I_{D7}, 1 A / div.
Lower: V_{D7}, 50 V / div., 200 ms / div.

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12.10 电压跌落

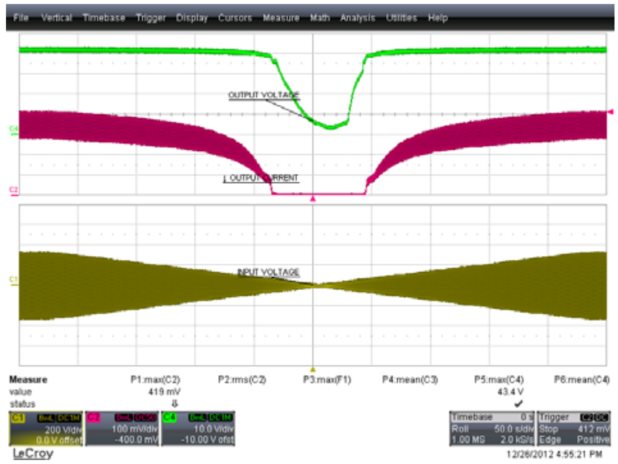

Figure 53 – 230 VAC, 50 Hz.
CH4: V_{OUT}, 10 V/div.
CH2: I_{OUT}, 100 mA/div.
CH1: V_{IN}, 200 V/div.

12.11 输入瞬态

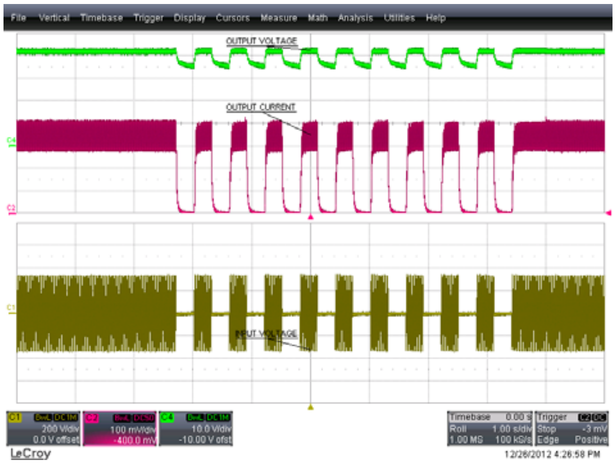

Figure 54 – 230VAC, 50 Hz.
300 ms ON, 300 ms OFF.
CH4: V_{OUT}, 10 V/div.
CH2: I_{OUT}, 100 mA/div.
CH1: V_{IN}, 200 V/div.

Figure 55 – 230VAC, 50 Hz.
20 ms ON, 20 ms OFF.
CH4: V_{OUT}, 10 V/div.
CH2: I_{OUT}, 100 mA/div.
CH1: V_{IN}, 200 V/div.

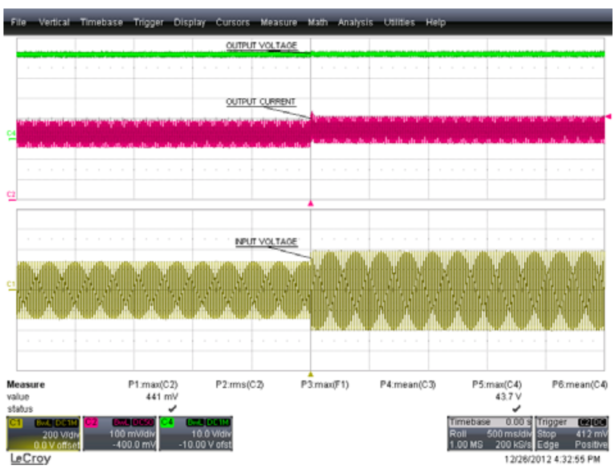

Figure 56 – 190V to 265V Step.
CH4: V_{OUT}, 10 V/div.
CH2: I_{OUT}, 100 mA/div.
CH1: V_{IN}, 200 V/div.

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13 调光波形

13.1 输入电压和输入电流波形

Input: 230VAC, 50Hz
Output: 41V LED Load
Dimmer: MERTEN 572499 400W

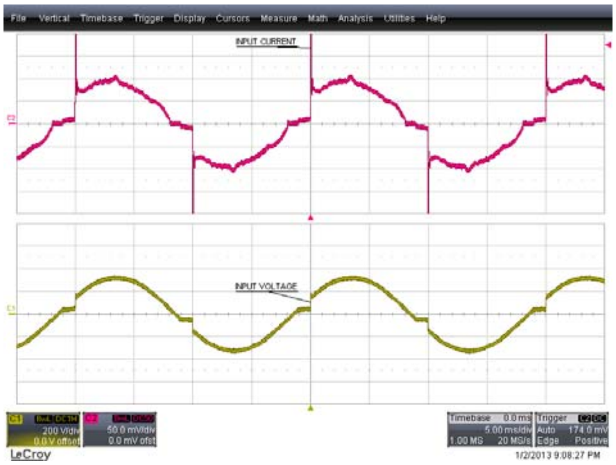

Figure 57 – 160ºConduction Angle.
Upper: I_{IN}, 50mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

Figure 58 – 90ºConduction Angle.
Upper: I_{IN}, 50mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

Figure 59 – 60ºConduction Angle.
Upper: I_{IN}, 50mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

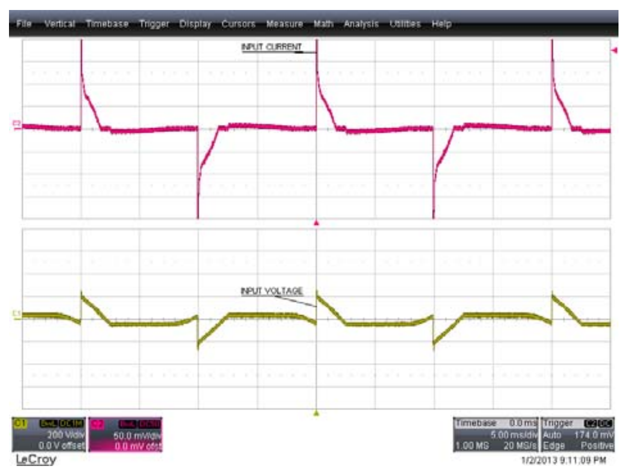

Figure 60 – 45ºConduction Angle.
Upper: I_{IN}, 50mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

13.2 输出电流波形

Input: 230 VAC, 50 Hz
Output: 41V LED Load
Dimmer: MERTEN 572499 400W

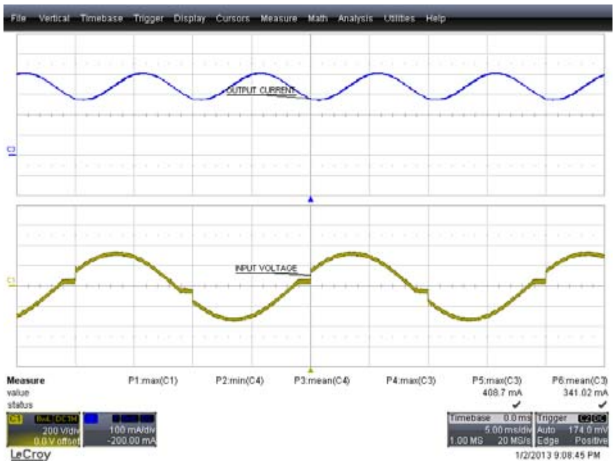

Figure 61 – 160ºConduction Angle.
Upper: I_{OUT}, 100mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

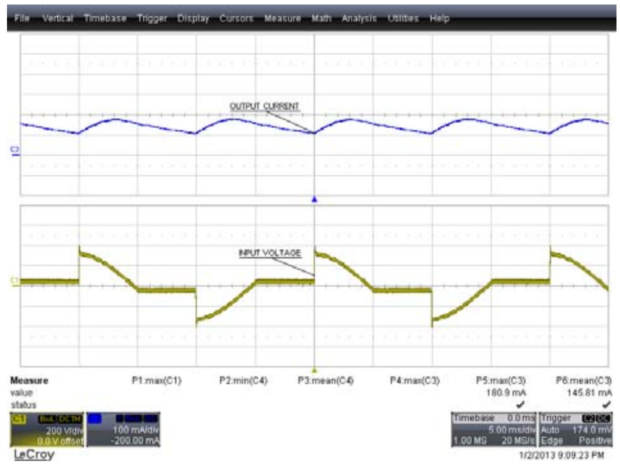

Figure 62 – 90ºConduction Angle.
Upper: I_{OUT}, 100mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

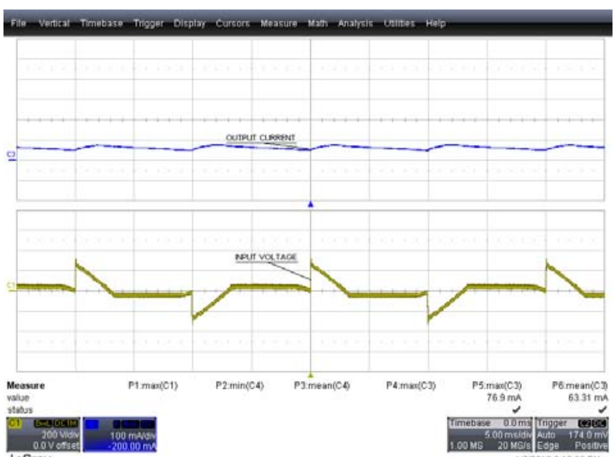

Figure 63 – 60ºConduction Angle.
Upper: I_{OUT}, 100mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

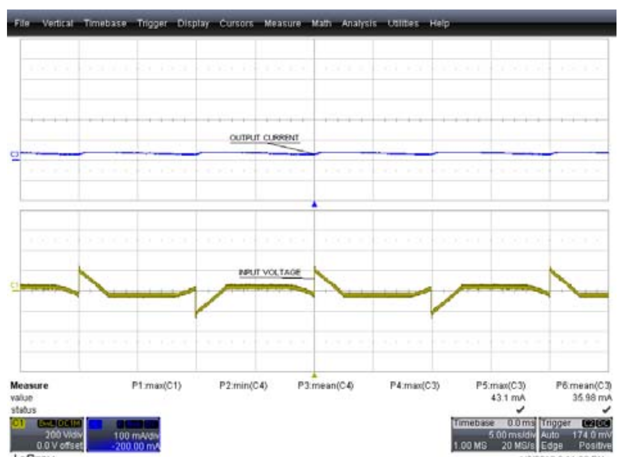

Figure 64 – 45ºConduction Angle.
Upper: I_{OUT}, 100mA / div.
Lower: V_{IN}, 200 V, 5 ms / div.

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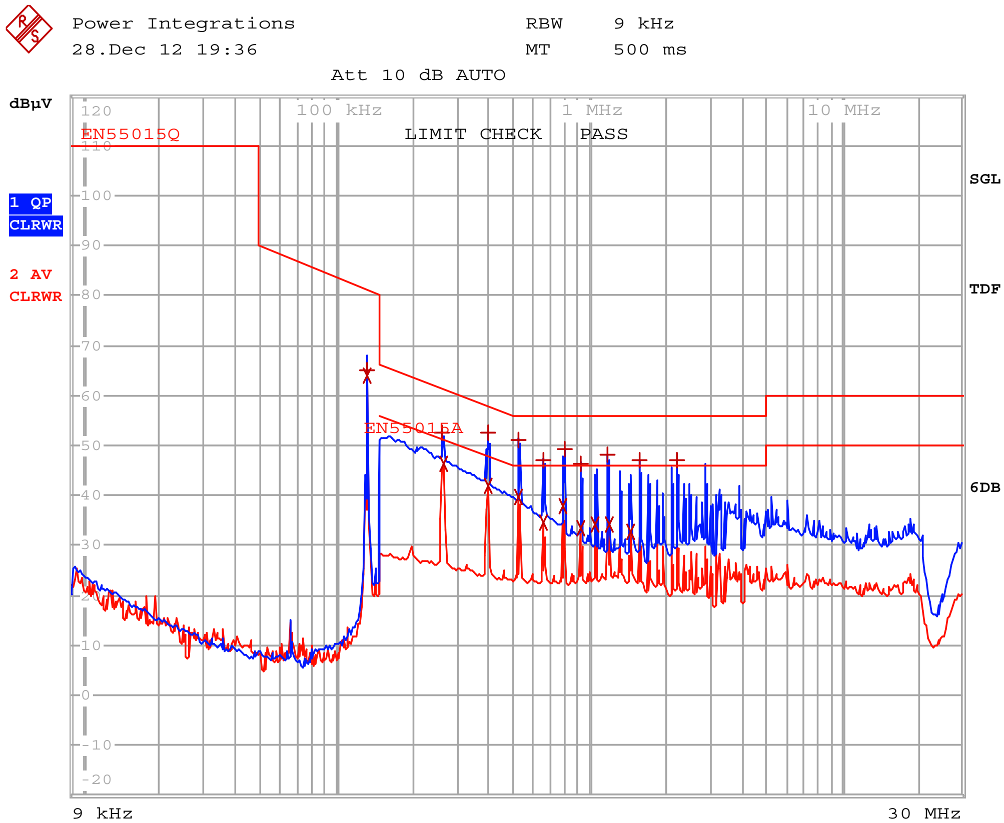
14 传导EMI

14.1 测试设置

The unit was tested using LED load (~41V V_{OUT}) with input voltage of 230VAC, 60Hz at room temperature.

Figure 65 – EMI Test Set-up with the Unit and LED Load Placed Inside the Cone.

14.2 测试结果



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
1	Quasi Peak	132.133649648 kHz	64.88	L1 gnd	-16.27
2	Average	132.133649648 kHz	64.05	N gnd	
1	Quasi Peak	261.871472881 kHz	52.59	N gnd	-8.77
2	Average	264.49018761 kHz	46.39	N gnd	-4.89
1	Quasi Peak	393.789848222 kHz	52.43	L1 gnd	-5.54
2	Average	397.727746704 kHz	41.86	L1 gnd	-6.03
1	Quasi Peak	525.514079005 kHz	51.18	L1 gnd	-4.81
2	Average	525.514079005 kHz	39.64	N gnd	-6.35
1	Quasi Peak	654.11570866 kHz	47.19	L1 gnd	-8.80
2	Average	660.656865747 kHz	34.39	N gnd	-11.60
2	Average	790.243042258 kHz	37.93	L1 gnd	-8.06
1	Quasi Peak	798.145472681 kHz	49.25	L1 gnd	-6.74
1	Quasi Peak	917.447639259 kHz	46.18	L1 gnd	-9.81
2	Average	917.447639259 kHz	33.50	N gnd	-12.49
2	Average	1.05458240332 MHz	34.23	L1 gnd	-11.76
1	Quasi Peak	1.17656420634 MHz	48.27	L1 gnd	-7.72
2	Average	1.1883298484 MHz	34.09	L1 gnd	-11.90
2	Average	1.44998824519 MHz	32.56	L1 gnd	-13.43
1	Quasi Peak	1.57012949439 MHz	47.22	L1 gnd	-8.77
1	Quasi Peak	2.22424976908 MHz	47.16	L1 gnd	-8.83

Figure 66 – Conducted EMI, 41V LED Load, 230 VAC, 60 Hz, and EN55015 B Limits.

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15 输入浪涌测试

The unit was subjected to ±2500 V, 100 kHz ring wave and ±500 V differential surge at 230 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.

Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Type	Test Result (Pass/Fail)
+2500	230	L1, L2	0	100 kHz Ring Wave (500A)	Pass
-2500	230	L1, L2	90	100 kHz Ring Wave (500A)	Pass
+2500	230	L1, L2	0	100 kHz Ring Wave (500A)	Pass
-2500	230	L1, L2	90	100 kHz Ring Wave (500A)	Pass

Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Type	Test Result (Pass/Fail)
+500	230	L1, L2	0	Surge (2Ω)	Pass
-500	230	L1, L2	90	Surge (2Ω)	Pass
+500	230	L1, L2	0	Surge (2Ω)	Pass
-500	230	L1, L2	90	Surge (2Ω)	Pass

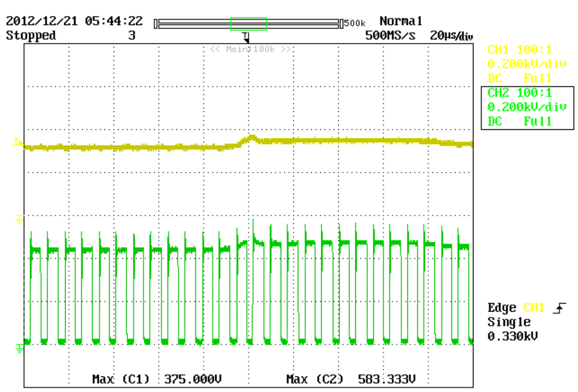

Figure 67 – (+)500V Differential Surge, 90º.
Upper: V_{BULK}, 200 V / div.
Lower: V_{DRAIN}, 200 V, 20 µs / div.

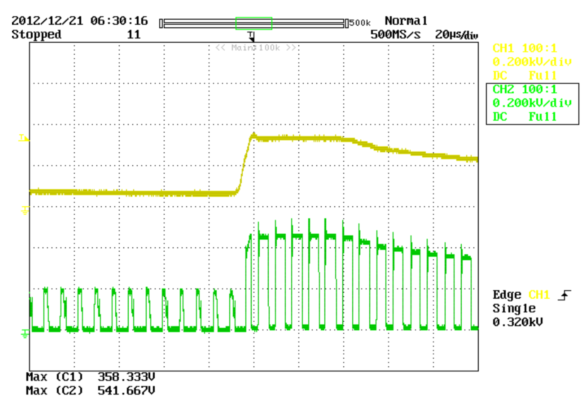

Figure 68 – (+)500V Differential Surge, 0º.
Upper: V_{BULK}, 200 V / div.
Lower: V_{DRAIN}, 200 V, 20 µs / div.

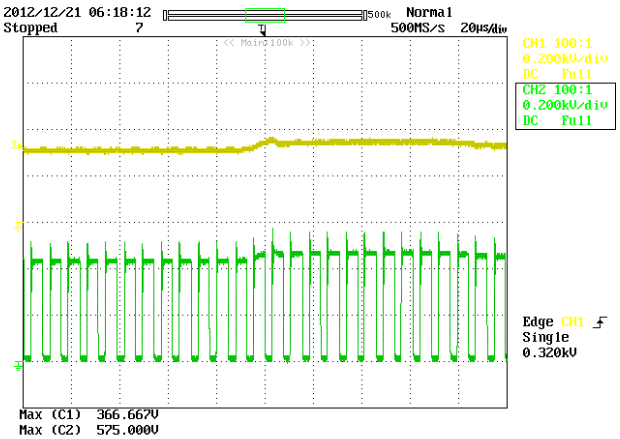

Figure 69 – (-)500V Differential Surge, 90º.
Upper: V_{BULK}, 200 V/ div.
Lower: V_{DRAIN}, 200 V, 20 μs / div.

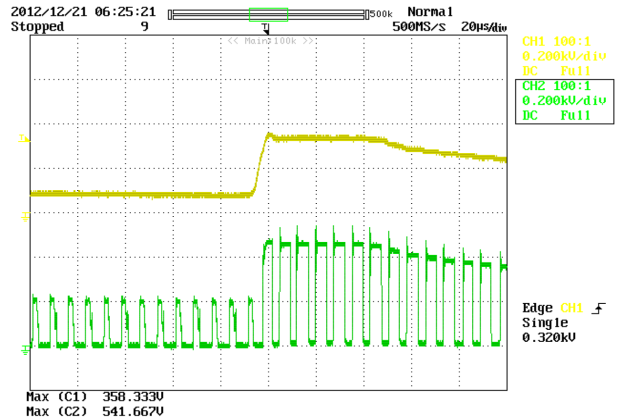

Figure 70 – (-)500V Differential Surge, 0º.
Upper: V_{BULK}, 200 V / div.
Lower: V_{DRAIN}, 200 V, 20 μs / div.

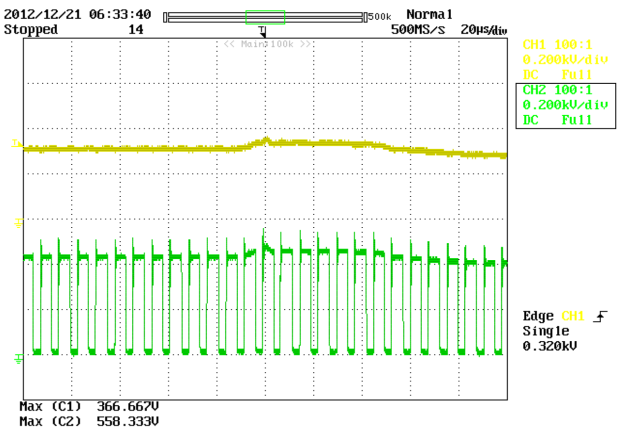

Figure 71–(+)2.5 kV Ring Wave, 90º.
Upper: V_{BULK}, 200 V/ div.
Lower: V_{DRAIN}, 200 V, 20 μs / div.

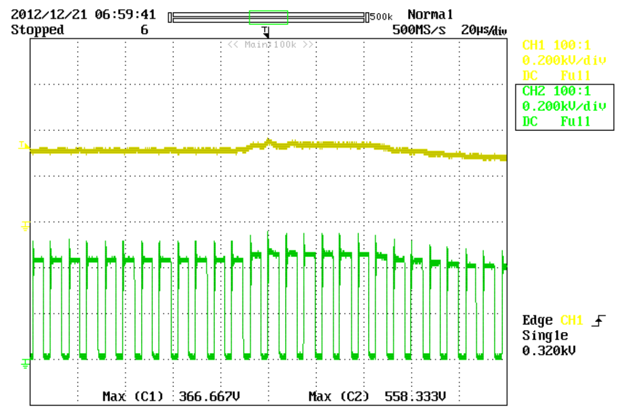

Figure 72–(-)2.5 kV Ring Wave, 90º.
Upper: V_{BULK}, 200 V/ div.
Lower: V_{DRAIN}, 200 V, 20 μs / div.

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16 版本历史

Date	Author	Revision	Description andChanges	Reviewed
15-May-13	DS	1.0	Initial Release	Apps &Mktg

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