标题	***参考设计报告：使用LinkSwitch™-HP LNK6766E设计的30 W单路输出反激式转换器***
规格	90 VAC – 265 VAC输入；12 V，2.5 A输出
应用	适配器
作者	应用工程部
文档编号	RDR-313
日期	2012年9月14日
修订版本	1.2

特色概述

- 调整精度为±5%的初级侧稳压隔离反激式转换器。
- 132 kHz开关频率可减小变压器及输出滤波器的尺寸。
- 满载连续导通模式工作可提高效率并降低输出电容纹波电流
- 多模式工作可提高整个负载范围内的效率
- 在230 VAC下功耗低于30 mW。
- 采用全面的保护功能，包括过压保护(OVP)、过热保护(OTP)、电压缓升/跌落保护、输入过压关断保护以及失稳压保护（自动重启动）
- 满足EN-550022和CISPR-22 Class B传导EMI要求，EMI裕量>5 dB。
- 满足IEC61000-4-5的1 kV / 2 kV浪涌电压要求。

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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

这份报告介绍的是一款采用LinkSwitch-HP系列IC器件LNK6766E设计的通用输入、12 V、30 W隔离反激式转换器。它包含完整的电源规格、详细的电路原理图、构建电源所需的完整物料清单、详尽的电源变压器文档，以及测试数据和最重要的电气波形的波形图。

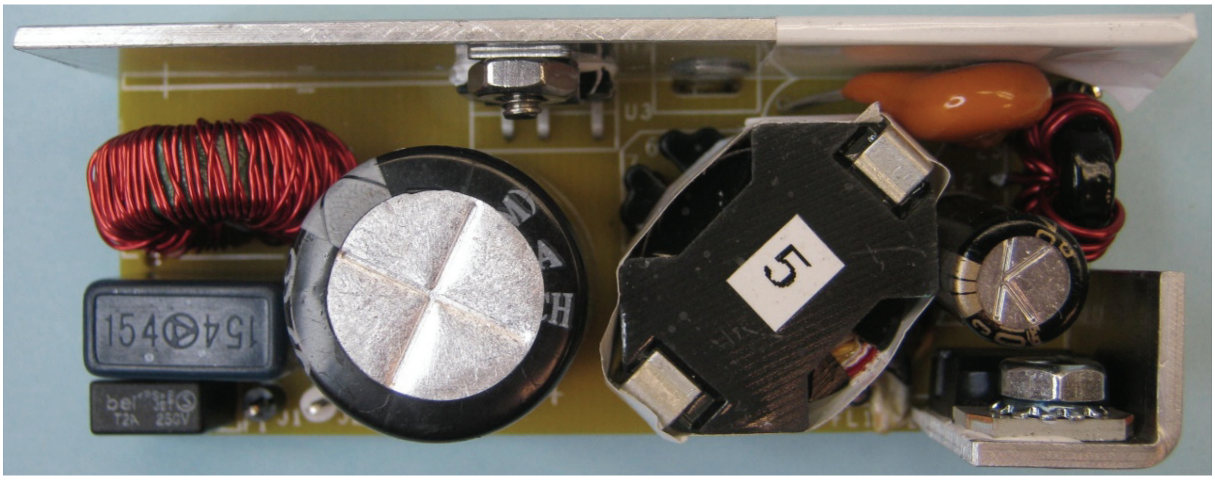

Figure 1 – Prototype Top View.

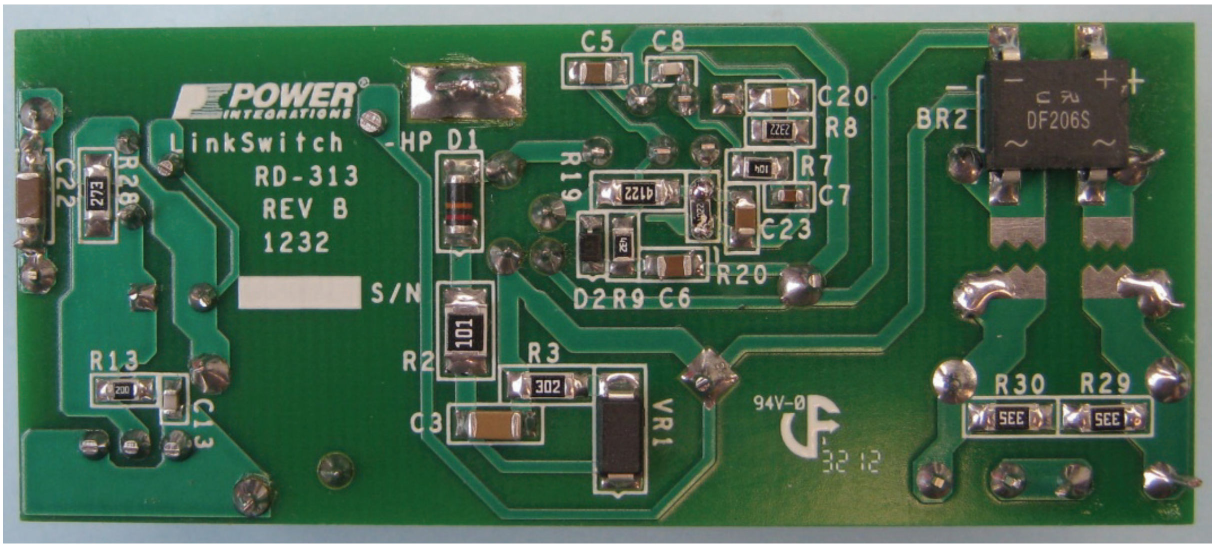

Figure 2 – Prototype Bottom View.

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		265	VAC	双导线 – 无P.E.
频率	f_{LINE}	47	50/60	64	Hz	
待机模式机输入功率				30	mW	230 VAC
输出						
输出电压	V_{OUT}	11.4	12	12.6	V	
输出纹波电压	V_{RIPPLE}			120	mVpp	20 MHz带宽，稳态负载
输出电流	I_{OUT}	0.0		2.5	A	
过冲电压	$V_{OVERSHOOT}$			18	V	待机负载和AC输入循环
总输出功率						
连续输出功率	P_{OUT}	0		30	W	
效率						
满载效率	η	85			%	90 VAC且满载
环境						
传导EMI		满足EN55022B				5dB裕量
安全		其设计符合IEC950、UL1950 II类要求				
浪涌	DM	1			kV	1.2/50 μs浪涌，IEC 1000-4-5，串联电阻：差模：2 Ω 共模： 12 Ω
	CM	2				
ESD	Air	-15		15	kV	空气放电至输出连接器
	Contact	-8		8	kV	接触放电至输出连接器
环境温度	T_{AMB}	0		40	°C	自然对流，海平面

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3 电路原理图

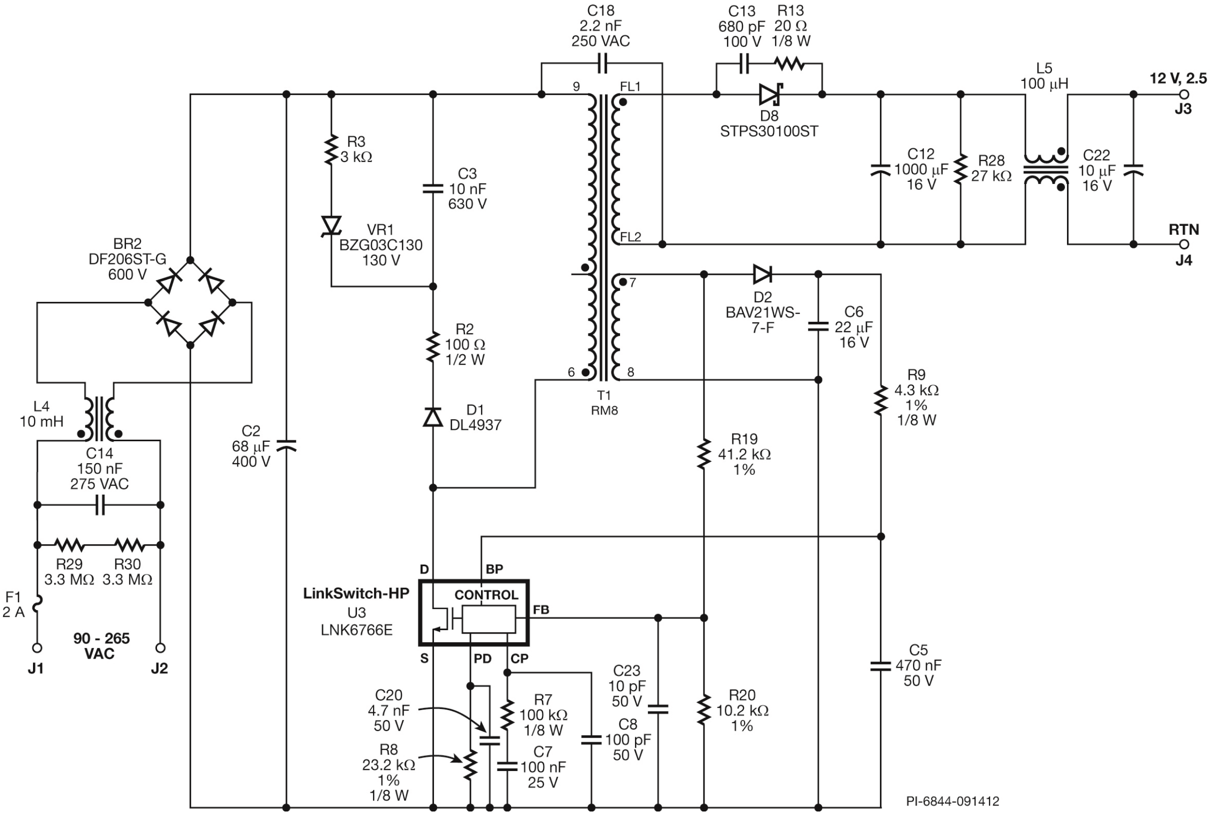

Figure 3 – Schematic.

4 电路描述

4.1 输入整流和滤波

桥式整流管BR1对AC输入进行整流，C2对AC输入进行滤波。电感L4、C14和C2用于衰减差模和共模传导EMI。在构建变压器T1时采用了屏蔽技术，以降低共模EMI位移电流。这种滤波器设计、屏蔽技术加上IC的频率抖动功能，为这种采用Y电容和初级侧RZCD箝位电路的解决方案提供了出色的EMI性能。

4.2 LinkSwitch-HP初级

LNK6766E器件(U3)将振荡器、误差放大器和多模式控制电路、启动和保护电路以及高压功率MOSFET全部集成到了一个单片IC中。

电源变压器的一端连接到高压总线，另一端连接到U3的漏极(D)引脚。在开关周期开始时，控制器将功率MOSFET导通，初级绕组中的电流不断增大，从而将能量存储在变压器磁芯中。当该电流达到内部误差放大器（补偿(CP)引脚电压）设定的流限阈值时，控制器会关断功率MOSFET。由于变压器绕组需要调整相位和输出二极管需要调整方向，所存储的能量会在次级绕组中产生一个电压，这会对输出二极管进行正向偏置，然后将存储的能量传送到输出电容。

连接到旁路(BP)引脚的电容C5 (0.47 μF)将过压保护(OVP)和过热保护(OTP)设置为锁存和失稳压保护，以便在给定关断期间（典型值为1500 ms）后尝试自动重启动。

4.3 初级侧RZCD箝位

二极管D1、VR1、C3、R2和R3形成RZCD缓冲电路，用于限制LinkSwitch-HP上的电压应力。峰值漏极电压在265VAC输入时可以控制在540V之下，对650V耐压(BV_{DSS})的MOSFET管来说有非常大的裕量。齐纳二极管VR1可防止电容C3在每个开关周期完全放电，从而降低待机工作时的功耗。

二极管D1、R2、VR1、C3、R5和R6形成RCD缓冲电路，用于限制LinkSwitch-HP上的电压应力。峰值漏极电压在265VAC输入时可以控制在580V之下，对700V耐压(BV_{DSS})的MOSFET管来说有非常大的裕量。

4.4 输出整流

对12 V输出的输出整流由二极管D8提供，滤波则由电容C12、C21和电感L5和C22提供。由R13和C13构成的缓冲电路提供高频率抖动，以提高EMI性能。

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4.5 外部电流限流点设置

最大逐周期限流点由连接到编程(PD)引脚的电阻R8设定。本设计中采用了一个23.2 kΩ电阻，可将最大限流点设置到LNK6766E的默认限流点的60%。

4.6 反馈及补偿网络

输出电压通过偏置绕组和电阻分压器（R19和R20）在反激期间进行检测。检测到输出电压通过与反馈(FB)引脚阈值进行比较来调整输出，或者在检测到过压时停止开关(OVP)。这种初级侧调节解决方案不仅能降低系统成本，还能延长系统的使用寿命，因为采用LinkSwitch-HP设计的电源无需使用光耦器（该元件可明显降低电源的寿命）。

分压器R19和R20还用于在集成的功率MOSFET导通期间间接监测总线电压。启动时，IC只会在总线电压通常达到100 V（电压缓升阈值）的情况下才开始开关。例如，当总线电压在电压跌落情况下降到40 V典型值以下时，器件将停止开关（电压跌落保护）。一旦总线电压达到过高水平（例如，由输入浪涌造成），器件将停止开关。此外，逐周期限流点还会在不同电压下得到补偿，以限制可用的过载功率。有关详细信息，请参见器件数据手册。

在FB引脚检测到的电压会在CP引脚产生控制电压。电阻R7以及电容C7和C8用于控制环路补偿。工作峰值初级电流和工作开关频率由CP引脚电压决定。

5 PCB布局

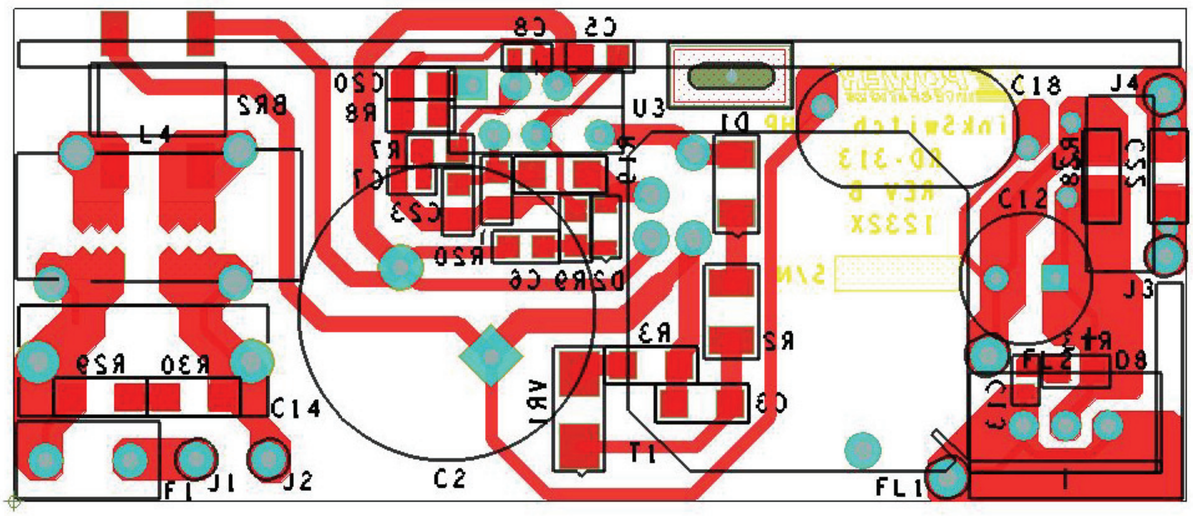

Figure 4 – PCB Top/Bottom Side 2.76” (70.1 mm) x 1.16” (29.4 mm).

6 物料清单(BOM)

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR2	600 V, 2 A, Bridge Rectifier, SMD, DFS	DF206ST-G	Comchip Technology
2	1	C2	68 μF, 400 V, Electrolytic, (18 x 20)	ERT686M2GL20RR	Samxon
3	1	C3	10 nF, 630 V, Ceramic, X7R, 1206	C1206C103KBRACTU	Kemet
4	1	C5	470 nF, 50 V, Ceramic, X7R, 0805	GRM21BR71H474KA88L	Murata
5	1	C6	22 μF, 16 V, Ceramic, X7R, 0805	C2012X5R1C226K	TDK
6	1	C7	100 nF, 25 V, Ceramic, X7R, 0603	VJ0603Y104KNXAO	Vishay
7	1	C8	100 pF 50 V, Ceramic, NPO, 0603	CC0603JRNPO9BN101	Yageo
8	1	C12	1000 μF, 16 V, Electrolytic, Low ESR, 8 x 20)	16MCZ100M8X20	Rubycon
9	1	C13	680 pF 100 V, Ceramic, NPO, 0603	CGA3E2C0G2A681J	TDK
10	1	C14	150 nF, 275 VAC, Film, X2	LE154-M	OKAYA
11	1	C18	2.2 nF, Ceramic, Y1	440LD22-R	Vishay
12	1	C20	4.7 nF, 50 V, Ceramic, X7R, 0805	08055C472KAT2A	AVX
13	1	C22	10 μF, 16 V, Ceramic, X7R, 1206	C3216X7R1C106M	TDK
14	1	C23	10 pF, 50 V, Ceramic, NPO, 0805	C0805C100J5GACTU	Kemet
15	1	D1	600 V, 1 A, Rectifier, Fast Recovery, MELF (DL-41)	DL4937-13-F	Diodes, Inc.
16	1	D2	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
17	1	D8	100 V, 30 A, Schottky, TO-220AB	STPS30100ST	ST Micro
18	1	F1	2 A, 250 V, Slow, Long Time Lag, RST	RST 2	Belfuse
19	2	FL1 FL2	PCB Terminal Hole, #22 AWG	N/A	N/A
20	2	J1 J3	Test Point, RED, Miniature THRU-HOLE MOUNT	5000	Keystone
21	2	J2 J4	Test Point, BLK, Miniature THRU-HOLE MOUNT	5001	Keystone
22	1	L4	Common Mode Choke Toroidal	P/N T22148-902S	Fontaine Tech
23	1	L5	Core, K5, Toroidal, 10 mm O.D. x 4 mm Th x 6 mm I.D.	K5B T 10*4*6	Kingcore Taiwan
24	1	R2	100 Ω, 5%, 1/2 W, Thick Film, 1210	ERJ-14YJ101U	Panasonic
25	1	R3	3 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ302V	Panasonic
26	1	R7	100 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ104V	Panasonic
27	1	R8	23.2 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2322V	Panasonic
28	1	R9	4.3 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ432V	Panasonic
29	1	R13	20 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ200V	Panasonic
30	1	R19	41.2 kΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF4122V	Panasonic
31	1	R20	10.2 kΩ, 1%, 1/4 W, Thick Film, 0805	ERJ-6ENF1022V	Panasonic
32	1	R28	27 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ273V	Panasonic
33	2	R29 R30	3.3 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ335V	Panasonic
34	1	T1	Bobbin, RM8, Vertical, 12 pins	RM8/12/1	Schwartzpunkt
35	1	TE1	Terminal, Eyelet, Tin Plated Brass, Zierick PN 190	190	Zierick
36	1	U3	LinkSwitch-HP, eSIP-7F	LNK6766E	Power Integrations
37	1	VR1	130 V, 1.25 W, 5%, DO214AC (SMA)	BZG03C130TR	Vishay

7 变压器设计表格

ACDC_LinkSwitch-HP_051612; Rev.0.13; Copyright Power Integrations 2012	INPUT	OUTPUT	UNIT	LinkSwitch-HP Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES				
VACMIN	90	90	V	Minimum AC Input Voltage
VACMAX	265	265	V	Maximum AC Input Voltage
fL	50	50	Hz	AC Mains Frequency
VO	12	12	V	Output Voltage (main)
PO	30	30	W	Output Power
n	0.84	0.84		Efficiency Estimate
Z	0.50	0.50		Loss Allocation Factor
VB	10	10	V	Bias Voltage
tC	3	3	ms	Bridge Rectifier Conduction Time Estimate
CIN	68	68	uF	Input Filter Capacitor
ENTER LINKSWITCH-HP VARIABLES				
LinkSwitch-HP	**LNK6766E**	**LNK6766E**		Selected LinkSwitch-HP
ILIMITMIN		1.814	A	Minimum Current limit
ILIMITMAX		2.087	A	Maximum current limit
KI	0.60	0.600	A	Current limit reduction factor
ILIMITMIN_EXT		1.088	A	External Minimum Current limit
ILIMITMAX_EXT		1.252	A	External Maximum current limit
fS		132000	Hz	LinkSwitch-HP Switching Frequency: Choose between 132 kHz and 66 kHz
fSmin		124000	Hz	LinkSwitch-HP Minimum Switching Frequency
fSmax		140000	Hz	LinkSwitch-HP Maximum Switching Frequency
KP	0.59	0.59		Ripple to Peak Current Ratio (0.4 < KP < 6.0)
VOR	100	100.00	V	Reflected Output Voltage
Voltage Sense				
VUVON	100	100.00	V	Undervoltage turn on
VUVOFF		42.14	V	Undervoltage turn off
VOV		446.44	V	Overvoltage threshold
FMAX_FULL_LOAD		139135	Hz	Maximum switching frequency at full load
FMIN_FULL_LOAD		123234	Hz	Minimum switching frequency at full load
TSAMPLE_FULL_LOAD		3.51	us	Minimum available Diode conduction time at full load. This should be greater than 2.5 us
TSAMPLE_LIGHT_LOAD		1.76	us	Minimum available Diode conduction time at light load. This should be greater than 1.11 us
Rpd		23.20	k-ohm	Program delay Resistor
Cpd	4.7	4.70	nF	Program delay Capacitor
Total programmed delay		0.03	sec	Total program delay
VDS	3.64	3.64	V	LinkSwitch-HP on-state Drain to Source Voltage
VD	0.5	0.50	V	Output Winding Diode Forward Voltage Drop
VDB	0.70	0.70	V	Bias Winding Diode Forward Voltage Drop
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES				
Core Type	RM8			
Core		#N/A		Selected Core
Custom Core				Enter name of custom core is applicable
AE	0.5200	0.52	cm^2	Core Effective Cross Sectional Area
LE	3.3500	3.35	cm	Core Effective Path Length
AL	2600.0	2600	nH/T^2	Ungapped Core Effective Inductance
BW	9.0	9	mm	Bobbin Physical Winding Width
M	2.00	2.00	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	3.00	3		Number of Primary Layers

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NS	7.00	7		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS				
VMIN	100	100	V	Minimum DC Input Voltage
VMAX	375	375	V	Maximum DC Input Voltage
CURRENT WAVEFORM SHAPE PARAMETERS				
DMAX		0.51		Maximum Duty Cycle
IAVG		0.36	A	Average Primary Current
IP		0.99	A	Peak Primary Current
IR		0.59	A	Primary Ripple Current
IRMS		0.51	A	Primary RMS Current
TRANSFORMER PRIMARY DESIGN PARAMETERS				
LP_TYP		693	uH	Typical Primary Inductance
LP_TOL	7	7	%	Primary inductance Tolerance
NP		56		Primary Winding Number of Turns
NB		6		Bias Winding Number of Turns
ALG		221	nH/T^2	Gapped Core Effective Inductance
BM		2368	Gauss	Maximum Flux Density at PO, VMIN (BM<3000)
BP		3189	Gauss	Peak Flux Density (BP<3700)
BAC		699	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur		1333		Relative Permeability of Ungapped Core
LG		0.27	mm	Gap Length (Lg > 0.1 mm)
BWE		15	mm	Effective Bobbin Width
OD	0.40	0.40	mm	Maximum Primary Wire Diameter including insulation
INS		0.06	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA		0.34	mm	Bare conductor diameter
AWG		28	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM		161	Cmils	Bare conductor effective area in circular mils
CMA		313	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)
FEEDBACK SENSING SECTION				
RFB1		41.20	k-ohms	Feedback divider upper resistor
RFB2		9.53	k-ohms	Feedback divider lowerr resistor
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT)				
Lumped parameters				
ISP		7.96	A	Peak Secondary Current
ISRMS		4.04	A	Secondary RMS Current
IO		2.50	A	Power Supply Output Current
IRIPPLE		3.18	A	Output Capacitor RMS Ripple Current
CMS		809	Cmils	Secondary Bare Conductor minimum circular mils
AWGS		21	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS		0.73	mm	Secondary Minimum Bare Conductor Diameter
ODS		0.71	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
INSS		-0.01	mm	Maximum Secondary Insulation Wall Thickness
VOLTAGE STRESS PARAMETERS				
VDRAIN		605	V	Peak voltage acoss drain to source of Linkswitch-HP
PIVS		59	V	Output Rectifier Maximum Peak Inverse Voltage
PIVB		50	V	Bias Rectifier Maximum Peak Inverse Voltage
TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)				
1st output				
VO1		12	V	Output Voltage
IO1		2.50	A	Output DC Current
PO1		30.00	W	Output Power
VD1		0.5	V	Output Diode Forward Voltage Drop
NS1		7.00		Output Winding Number of Turns
ISRMS1		4.043	A	Output Winding RMS Current

IRIPPLE1		3.18	A	Output Capacitor RMS Ripple Current
PIVS1		59	V	Output Rectifier Maximum Peak Inverse Voltage
CMS1		809	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS1		21	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS1		0.73	mm	Minimum Bare Conductor Diameter
ODS1		0.71	mm	Maximum Outside Diameter for Triple Insulated Wire

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8 变压器规格

8.1 电气原理图

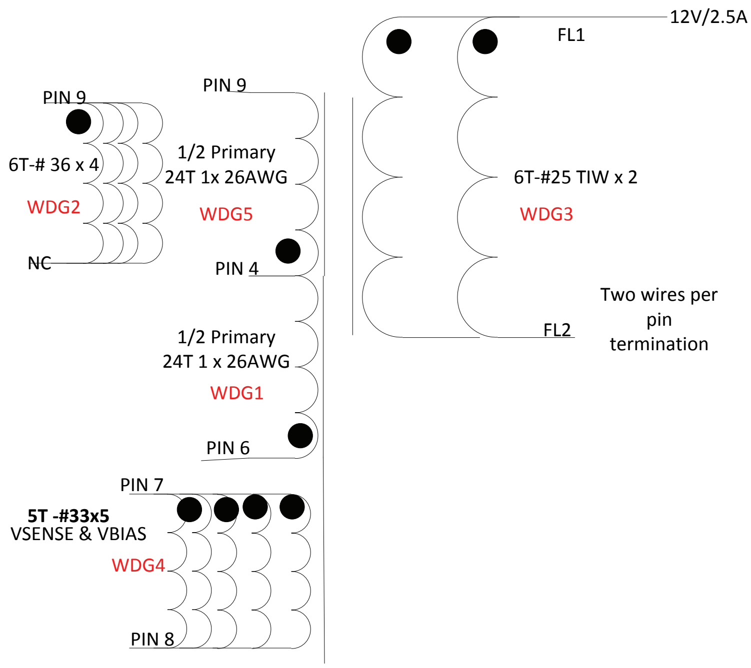


Figure 5 – Transformer Electrical Diagram.

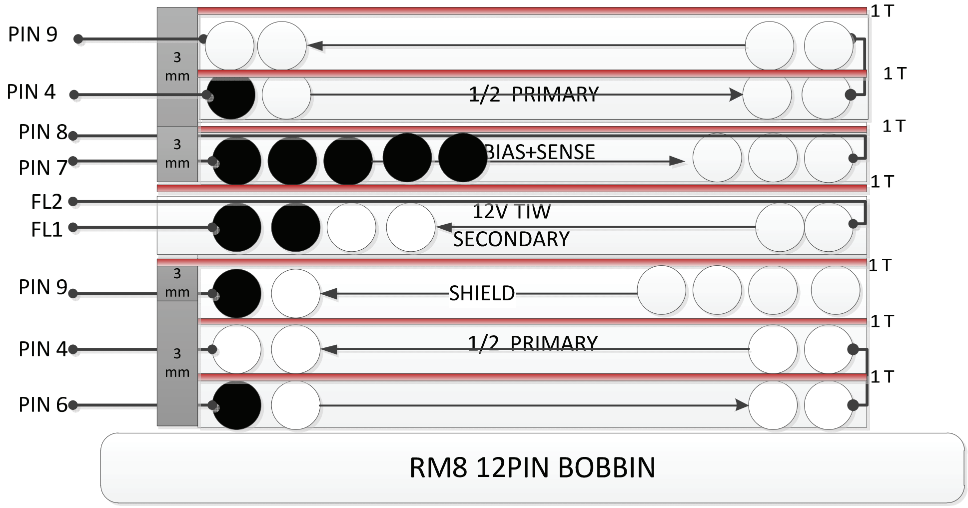
8.2 电气规格

Electrical Strength	1 second, 60 Hz, from pins 1-3 to pins 6-10.	3000 VAC
Primary Inductance	Pins 6-9, all other windings open, measured at 100 kHz, 0.4 V_{RMS}.	0.693 mH, ±7%
Resonant Frequency	Pins 6-9, all other windings open.	1400 kHz (Min.)
Primary Leakage Inductance	Pins 6-9, with all other pins shorted, measured at 100 kHz, 0.4 V_{RMS}.	15 µH (Max.)

8.3 材料

Item	Description
[1]	Core: RM8, NC-2H (Nicera) or Equivalent, gapped for ALG of 219 nH/t².
[2]	Bobbin: Vertical 12 pin.
[3]	Magnet Wire: #26 AWG.
[4]	Magnet Wire: #33, #36 AWG.
[5]	TIW Wire: #25 AWG.
[5]	Tape: 3M 1298 Polyester Film, 2.0 mils thick, 9.8 mm wide.

8.4 变压器结构图



Electrical Test Specifications

Parameter	Condition	Spec
Electrical Strength, VAC	60 Hz 1 second, from pins 5-9 to pins 1,2,3,4,10-12.	3000
Nominal Primary Inductance, µH	Measured at 1 V pk-pk, typical switching frequency, between pin 6 to pin 9, with all other Windings open.	693
Tolerance, ±%	Tolerance of Primary Inductance	10.0
Maximum Primary Leakage, µH	Measured between Pin 6 to Pin 9, with all other Windings shorted.	15

Figure 6 – Transformer Build Diagram.

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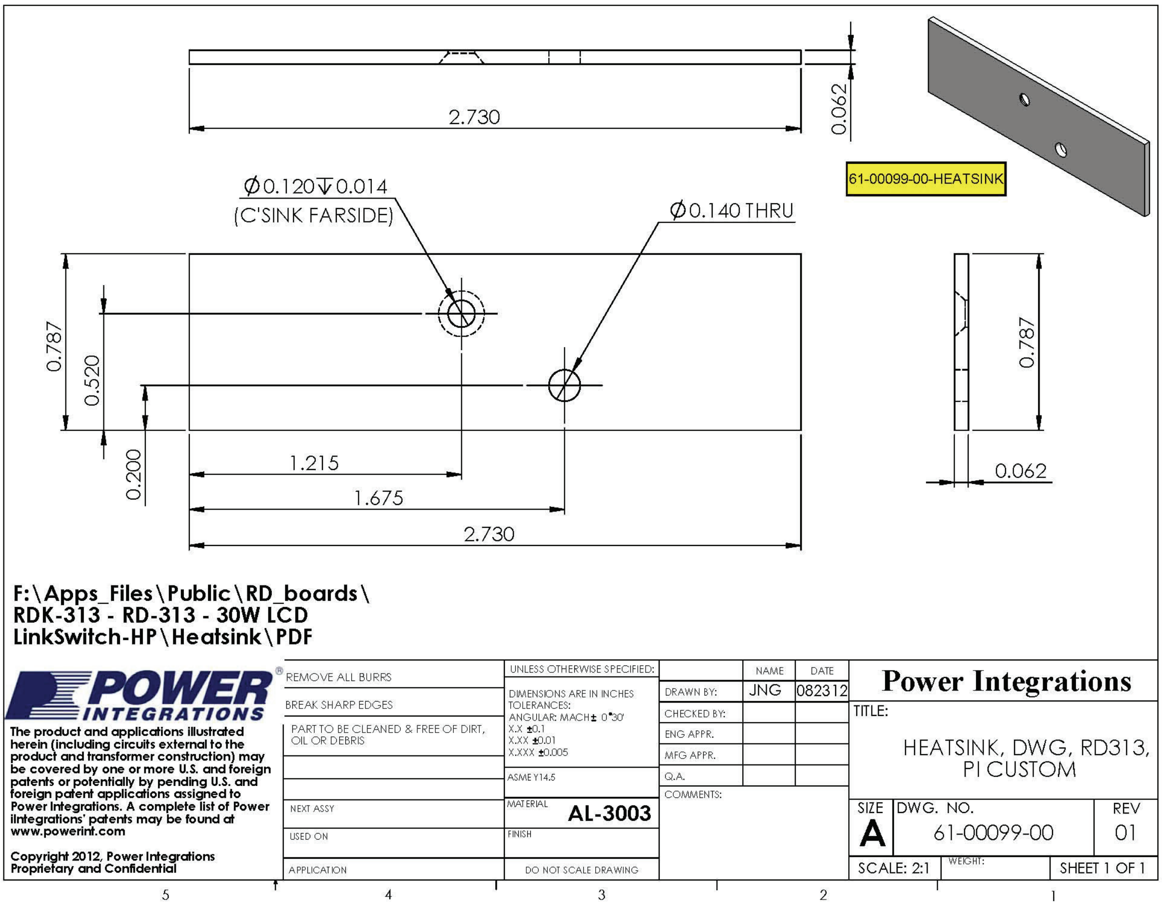
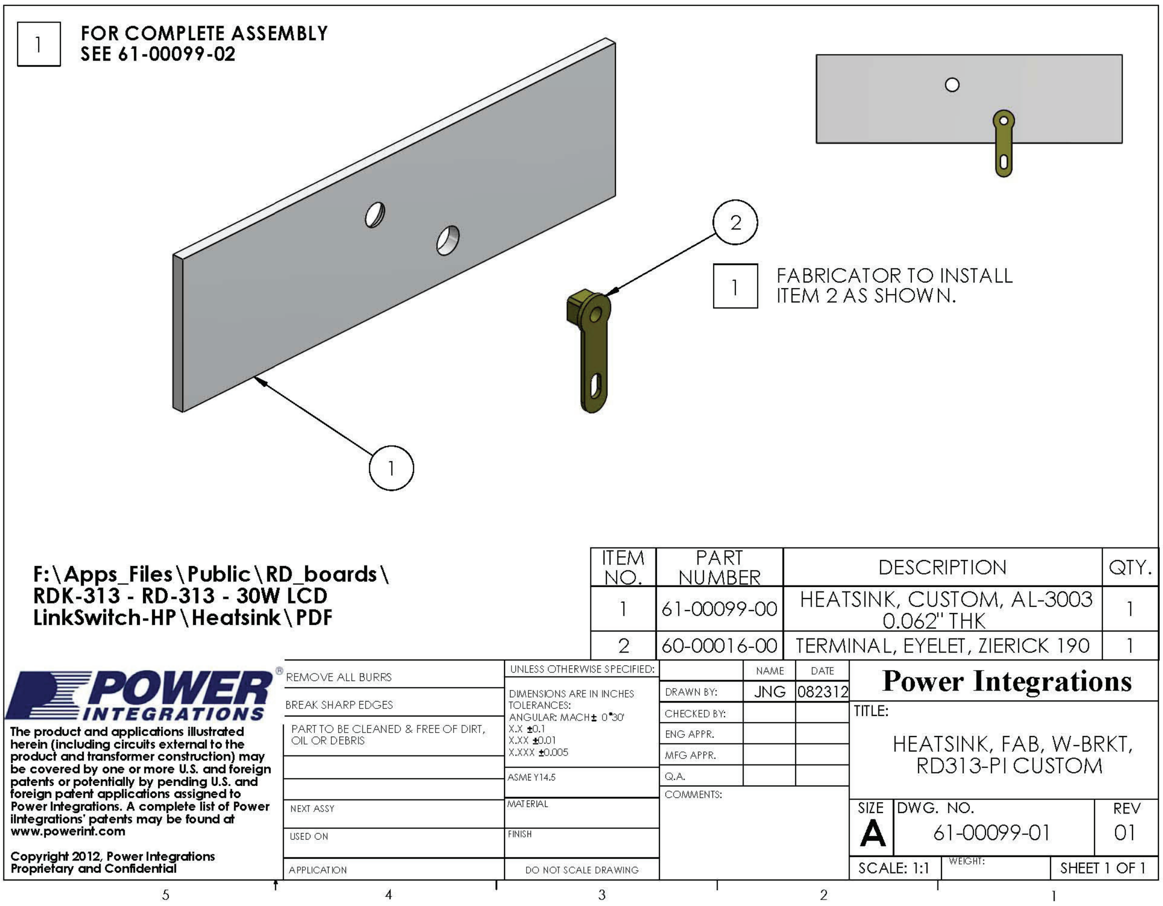
9 散热片组件

9.1 eSIP散热片

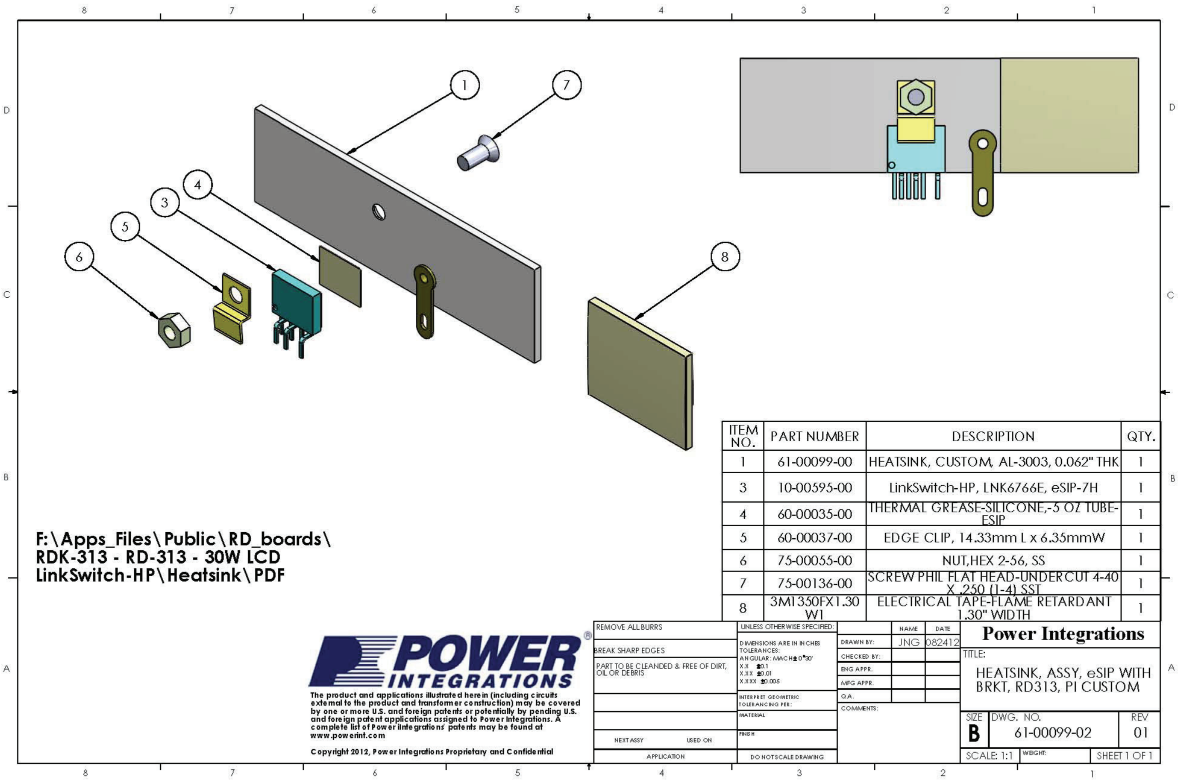
9.1.1 eSIP散热片加工图



9.1.2 eSIP散热片装配图

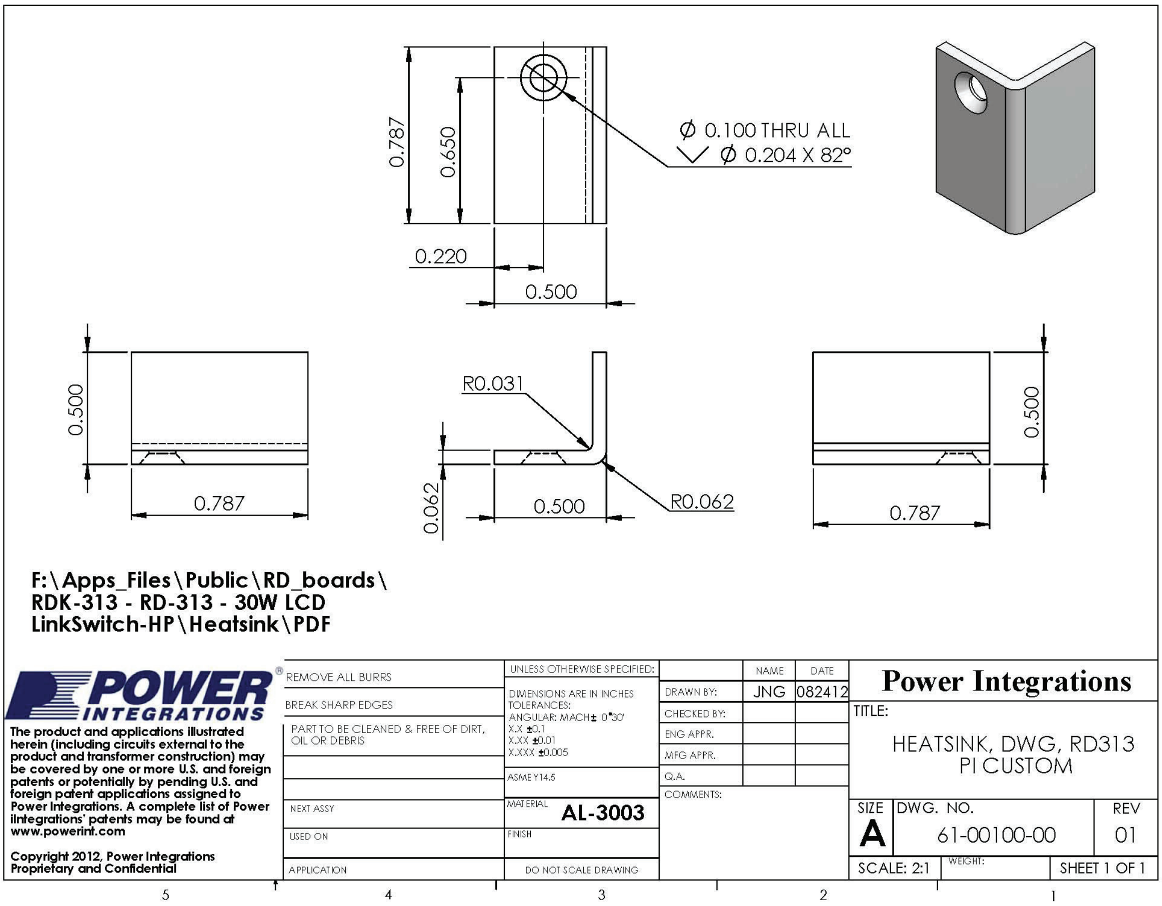


9.1.3 eSIP和散热片装配图



9.2 二极管散热片

9.2.1 二极管散热片加工图



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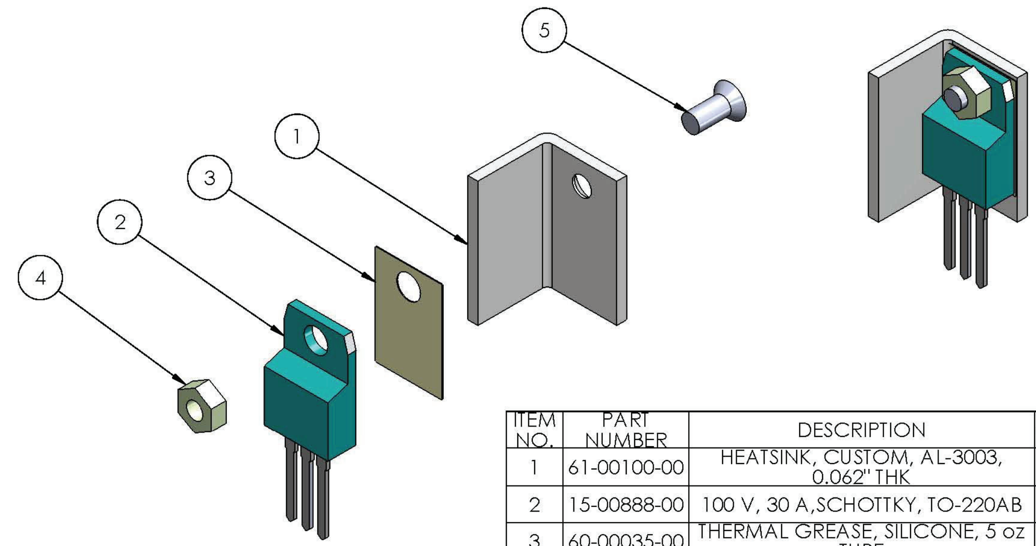
9.2.2 二极管和散热片装配图



F:\Apps_Files\Public\RD_boards\RDK-313 - RD-313 - 30W LCD LinkSwitch-HP\Heatsink\PDF

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00100-00	HEATSINK, CUSTOM, AL-3003, 0.062" THK	1
2	15-00888-00	100 V, 30 A,SCHOTTKY, TO-220AB	1
3	60-00035-00	THERMAL GREASE, SILICONE, 5 oz TUBE	1
4	75-00055-00	NUT,HEX 2-56, SS	1
5	75-00136-00	SCREW PHIL FLAT HEAD-UNDERCUT 4-40 X .250 (1-4) SST	1

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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	082412
CHECKED BY:		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

Power Integrations

TITLE:
HEATSINK, ASSY, DIODE, RD313, PI CUSTOM

SIZE	DWG. NO.	REV
A	61-00100-02	01

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

10 性能数据

除非另有说明，所有测量均在室温和50 Hz线电压频率下进行。对于所有测试，满载为2.5 A。

10.1 带载模式效率

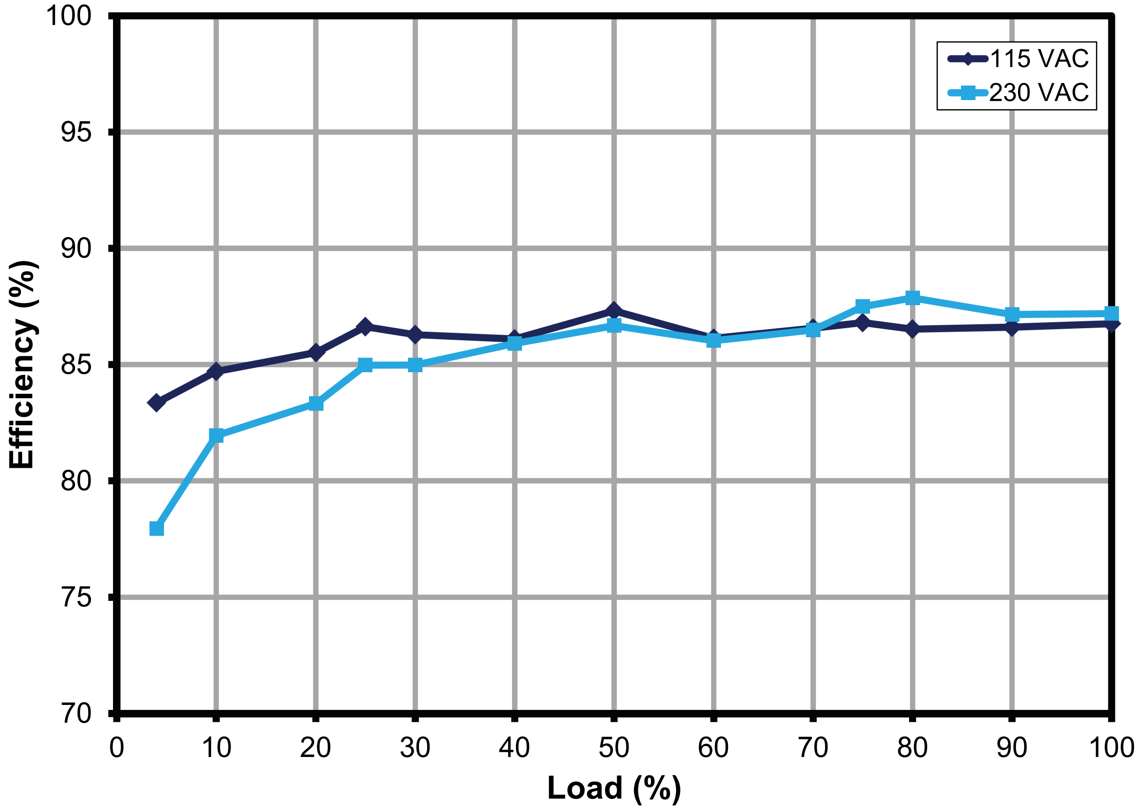

Figure 7– Active mode Efficiency, Room Temperature

115 VAC				230 VAC			
V_{OUT} (V)	I_{OUT} (A)	P_{IN} (W)	η	V_{OUT} (V)	I_{OUT} (A)	P_{IN} (W)	η
12.1	0.625	8.73	86.63%	12.1	0.625	8.9	84.97%
12	1.251	17.18	87.3%	12.01	1.251	17.32	86.7%
11.94	1.875	25.79	86.8%	11.97	1.875	25.65	87.5%
11.91	2.5	34.32	86.76%	11.94	2.5	34.25	87.19%
		Avg	86.88%			Avg	86.58%

Table 1 – Four Point Average Efficiency (25%, 50%, 75% and 100%), Room Temperature.

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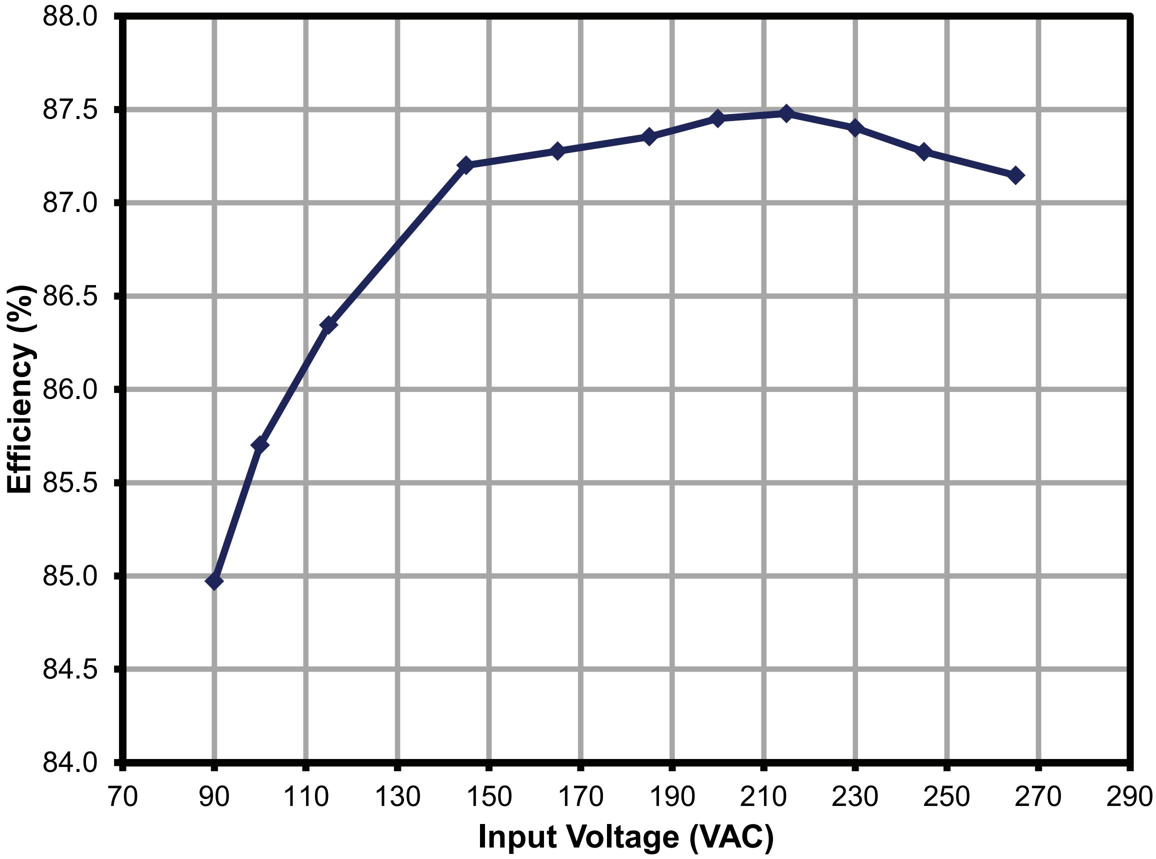

Figure 8 – Full Load Efficiency vs. Input Voltage, Room Temperature.

10.2 空载输入功率

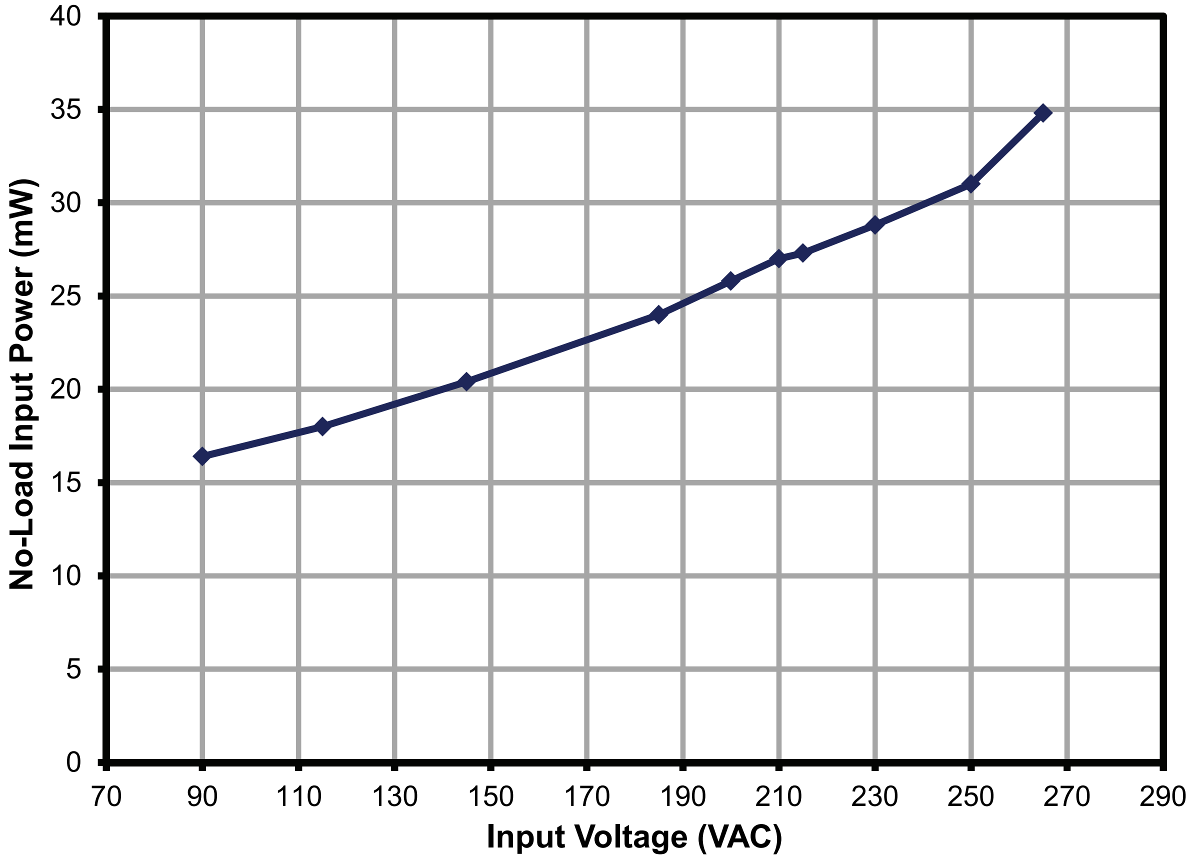

Figure 9 – No-Load Input Power vs. Input Line Voltage, Room Temperature.

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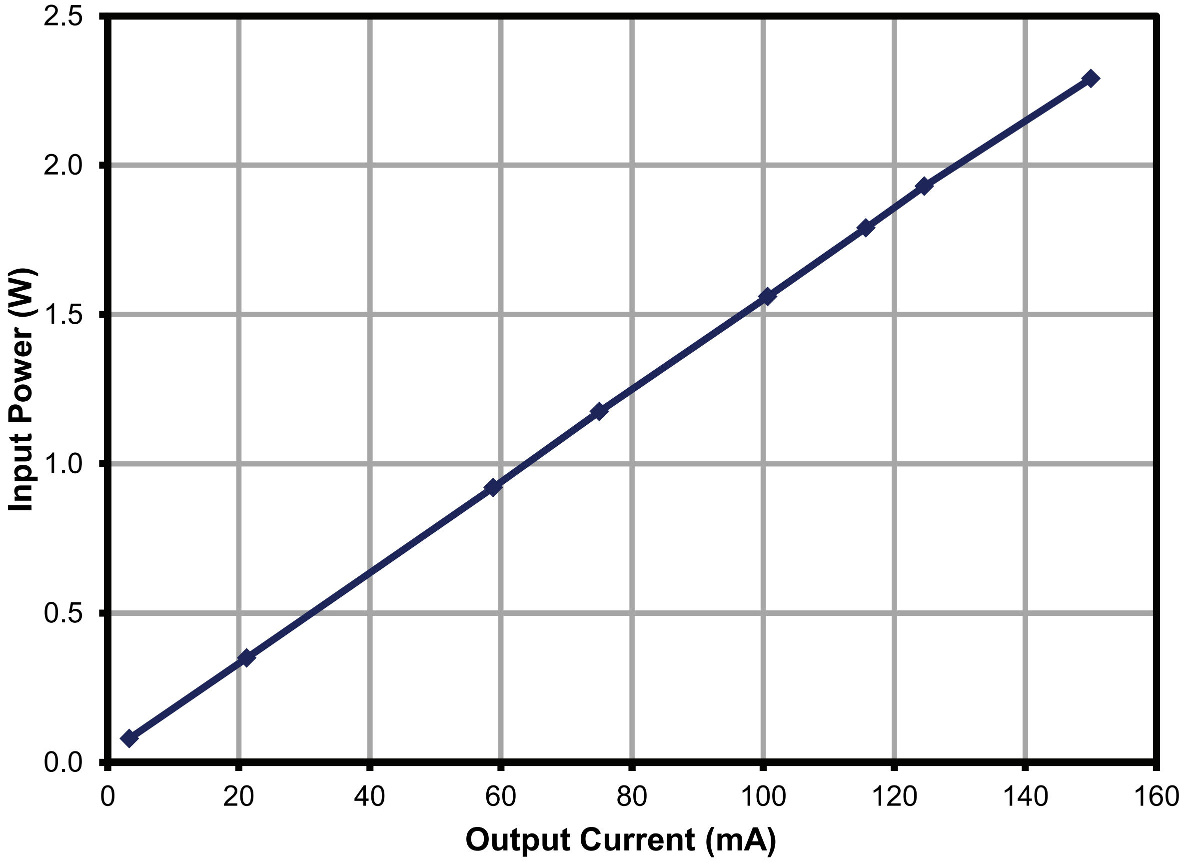

Figure 10 – Standby Performance at 230 VAC, Room Temperature.

10.3 线电压调整

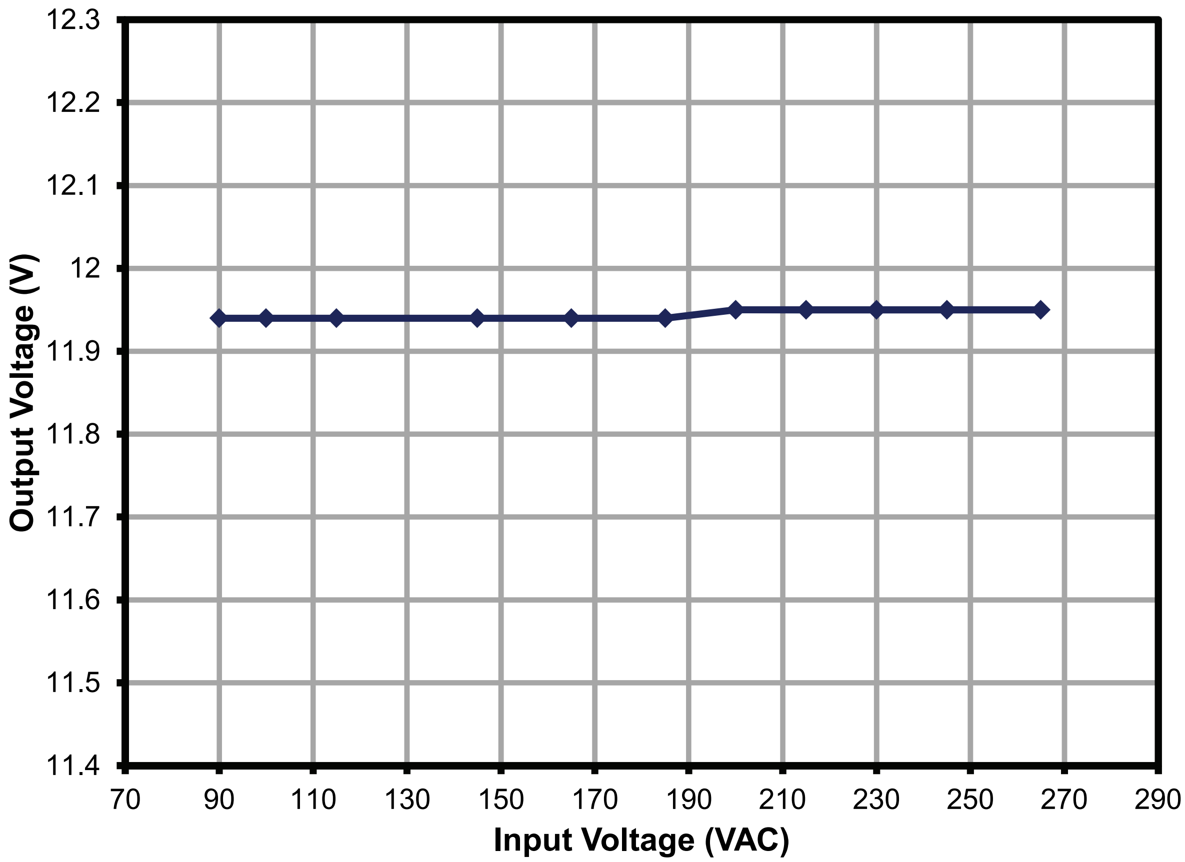

Figure 11 – Line Regulation under Full Load, Room Temperature.

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10.4 负载调整

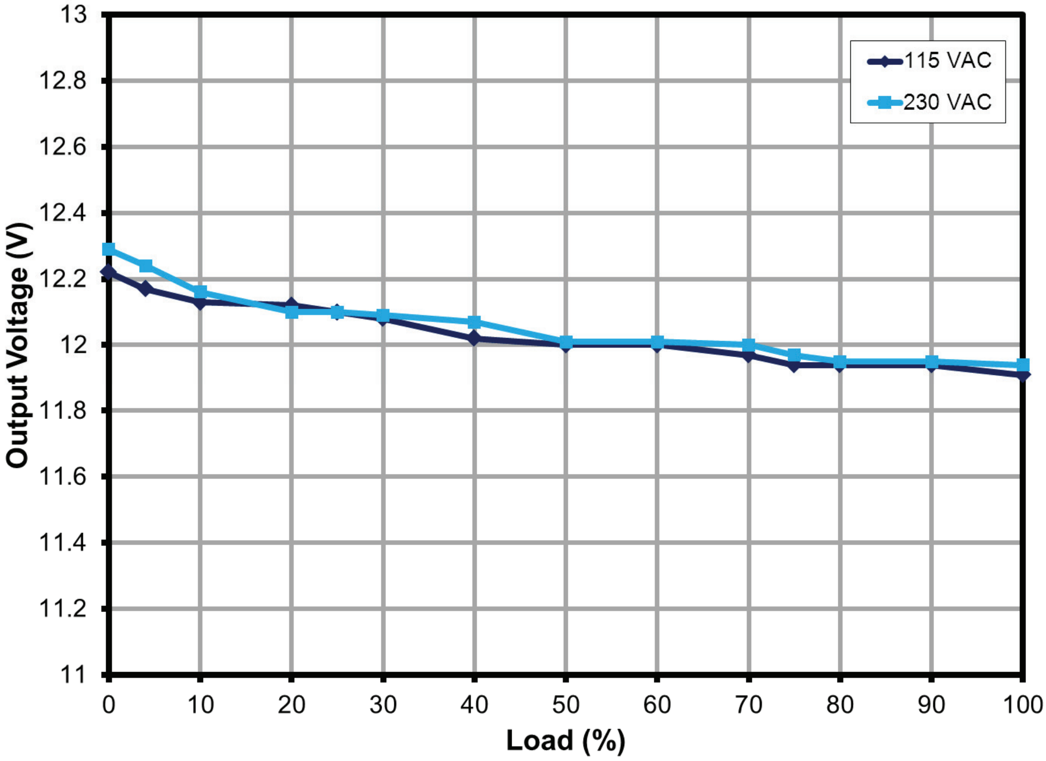

Figure 12 – Load Regulation, Room Temperature.

10.5 功率限制

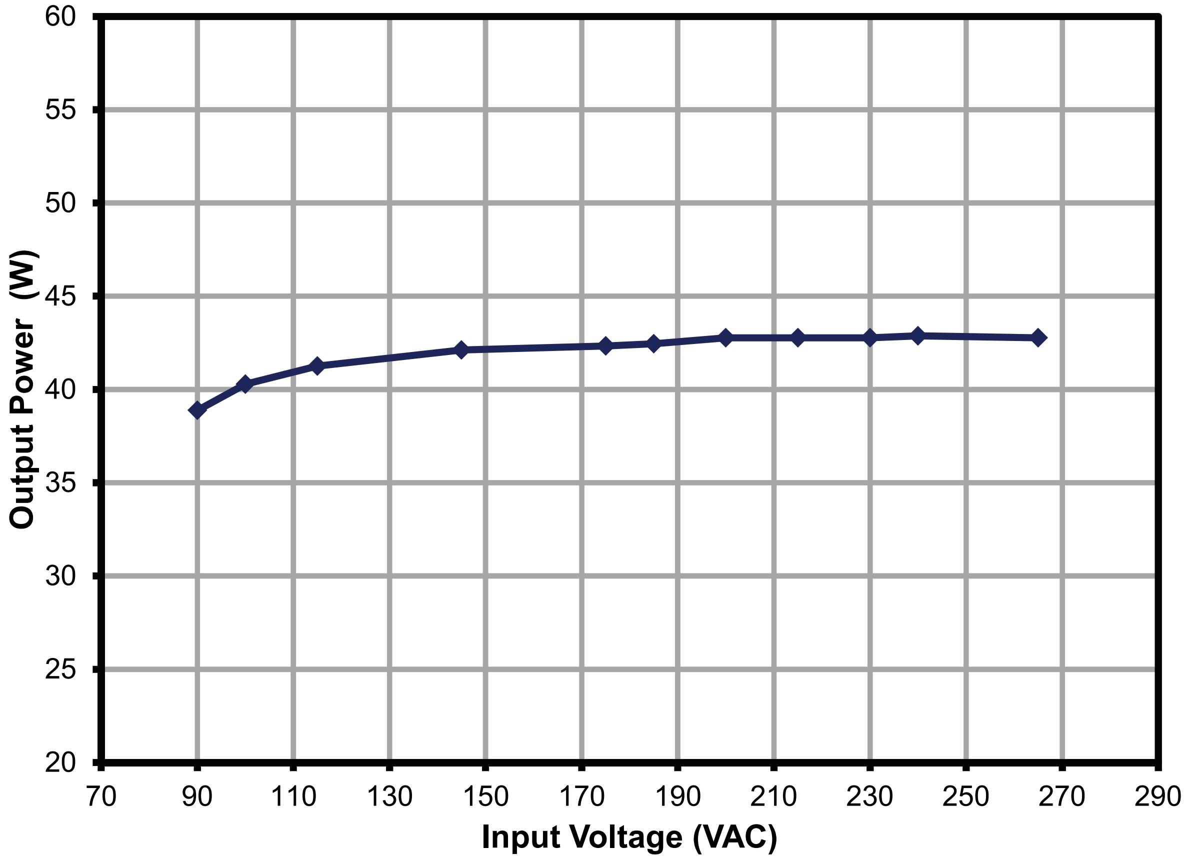

Figure 13 – Overload Power vs. Line Voltage.

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11 波形

11.1 漏极电压和电流，正常工作

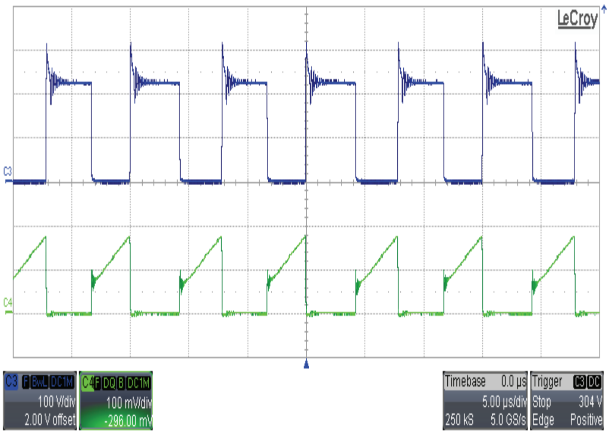

Figure 14 – 90 VAC, Full Load.
Upper: V_{DRAIN}, 100 V / div.
Lower: I_{DRAIN}, 0.5 A / div., 10 µs / div.

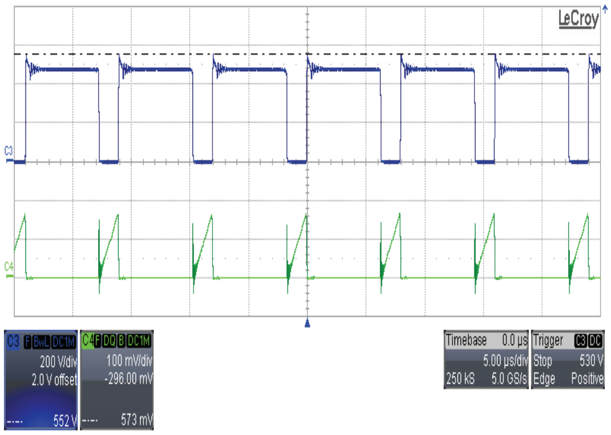

Figure 15 – 265 VAC, Full Load.
Upper: V_{DRAIN}, 200 V / div.
Lower: I_{DRAIN}, 0.5 A / div., 10 µs / div.

11.2 漏极电压和电流，过载功率

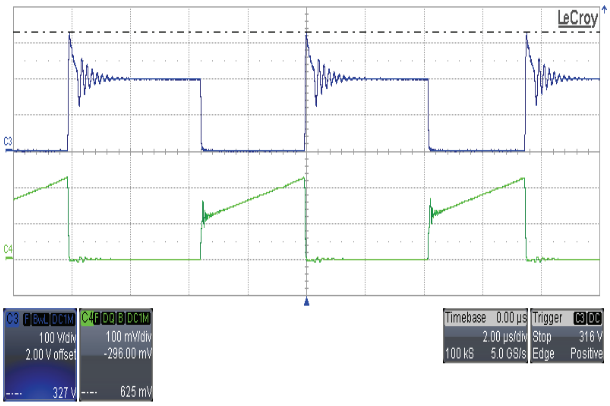

Figure 16 – 90 VAC, 38.8 W Overload Power.
Upper: V_{DRAIN}, 100 V / div.
Lower: I_{DRAIN}, 0.5 A / div., 10 µs / div.

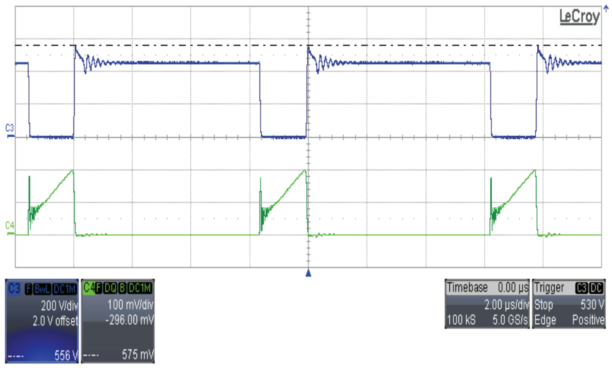

Figure 17 – 265 VAC, 42.78 W Overload Power.
Upper: V_{DRAIN}, 200 V / div.
Lower: I_{DRAIN}, 0.5 A / div., 10 µs / div.

11.3 电压应力，过载功率

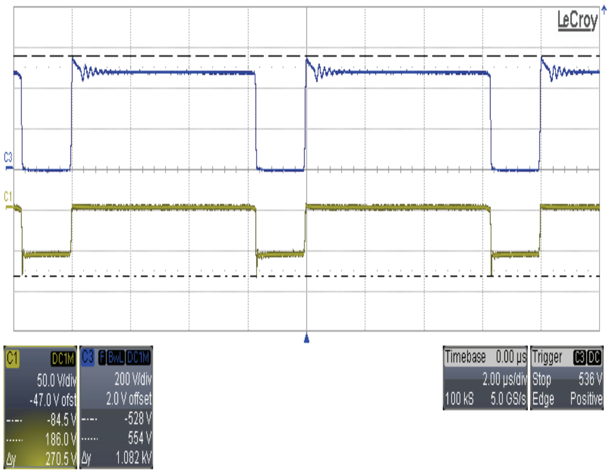

Figure 18 – 265 VAC, Overload Power.
Upper: V_{DRAIN}, 200 V / div.
Lower: PIV_{DIODE}, 50 V / div., 2.0 μs / div.

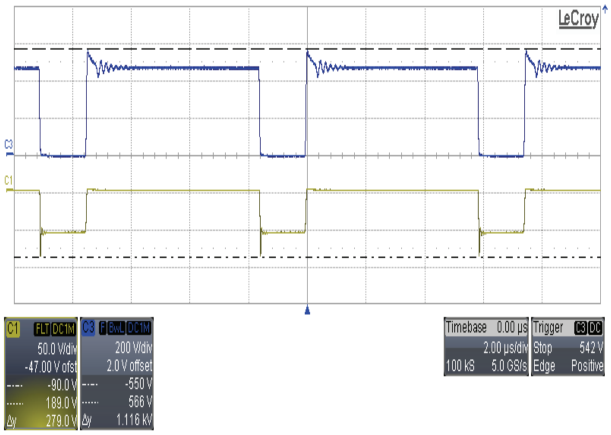

Figure 19 – 265 VAC, Overload Power.
Upper: V_{DRAIN}, 200 V / div.
Lower: PIV_{DIODE}, 50 V / div., 2.0 μs / div.

11.4 漏极电压和电流启动特征

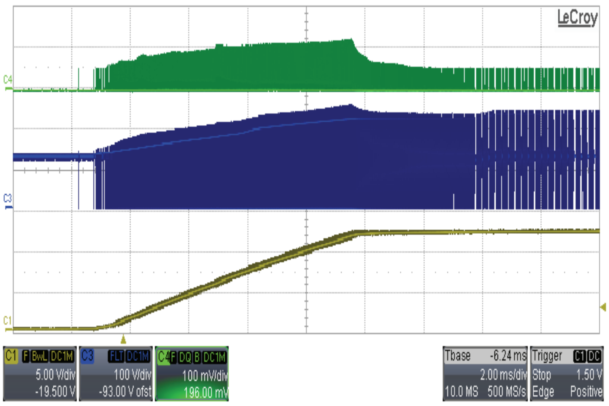

Figure 20 – 90 VAC, No-Load.
Upper: I_{DRAIN}, 0.5 A, 2 ms / div.
Middle: V_{DRAIN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.

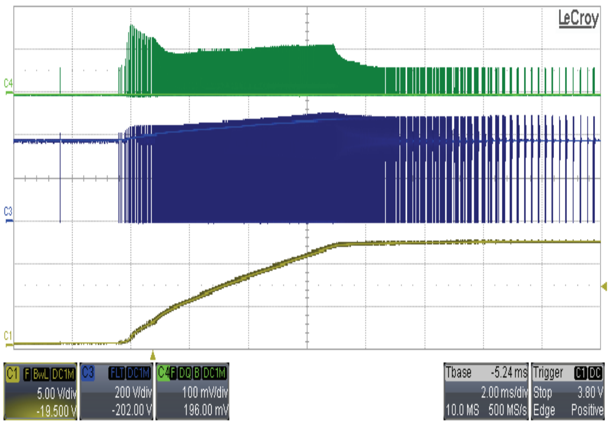

Figure 21 – 265 VAC, No-Load.
Upper: I_{DRAIN}, 0.5 A, 2 ms / div.
Middle: V_{DRAIN}, 200 V / div.
Lower: V_{OUT}, 5 V / div.

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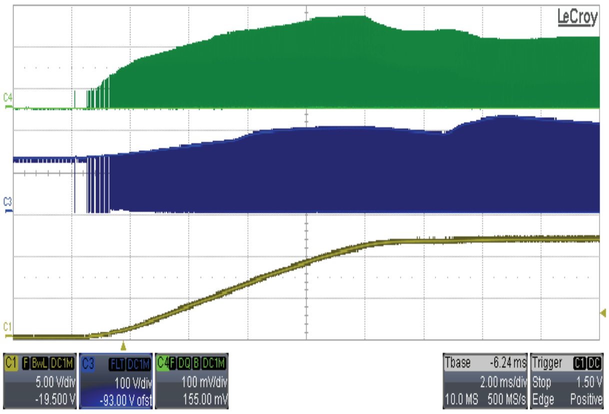

Figure 22 – 90 VAC, Full Load.
Upper: I_{DRAIN}, 0.5 A, 2 ms / div
Middle: V_{DRAIN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.

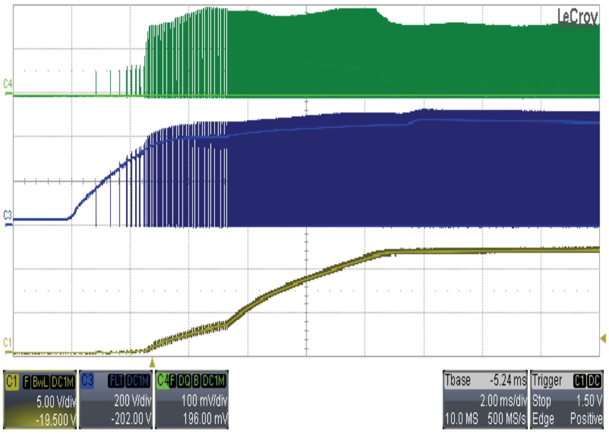

Figure 23 – 265 VAC, Full Load.
Upper: I_{DRAIN}, 0.5 A, 2 ms / div
Middle: V_{DRAIN}, 200 V / div.
Lower: V_{OUT}, 5 V / div.

11.5 负载瞬态响应

In the figures shown below, the output was AC coupled to view the load transient response. The oscilloscope was triggered using the load current step as a trigger source.

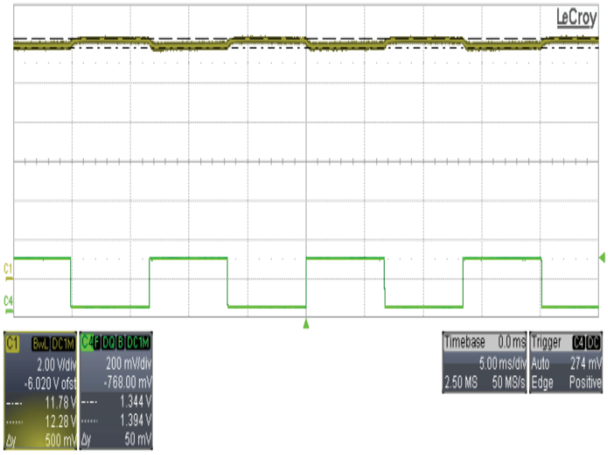

Figure 24 – Transient Response, 115 VAC,
5%<-->55% Step Load.
Upper: V_{OUT}, 2 V / div.
Lower: I_{OUT}, 1 A / div., 5 ms / div.

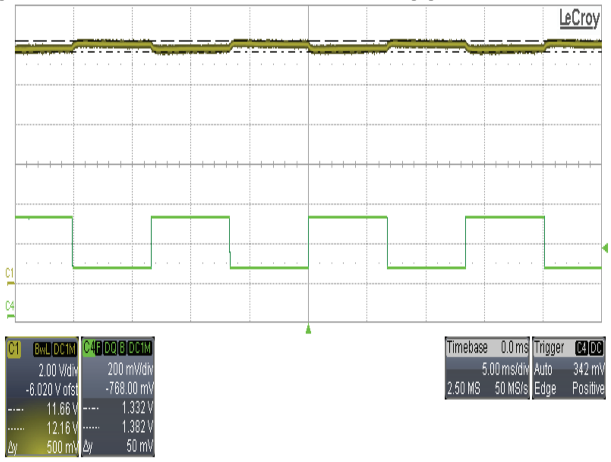

Figure 25 – Transient Response, 115 VAC,
50%<-->100% Step Load.
Upper: V_{OUT}, 2 V / div.
Lower: I_{OUT}, 1 A / div., 5 ms / div.

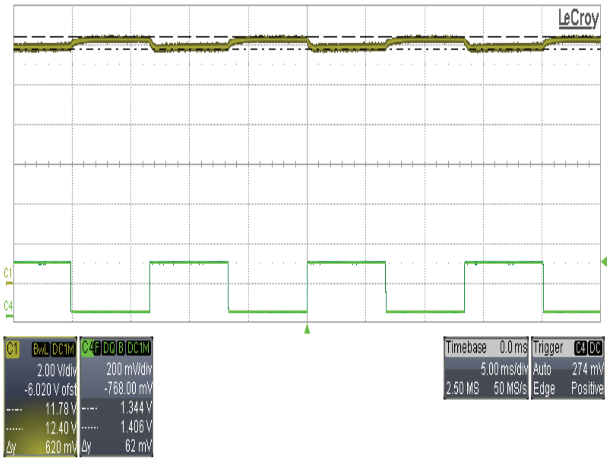

Figure 26 – Transient Response, 230 VAC,
5%<-->55% Step Load.
Upper: V_{OUT}, 2.0 V / div.
Lower: I_{OUT}, 1 A / div., 5 ms / div.

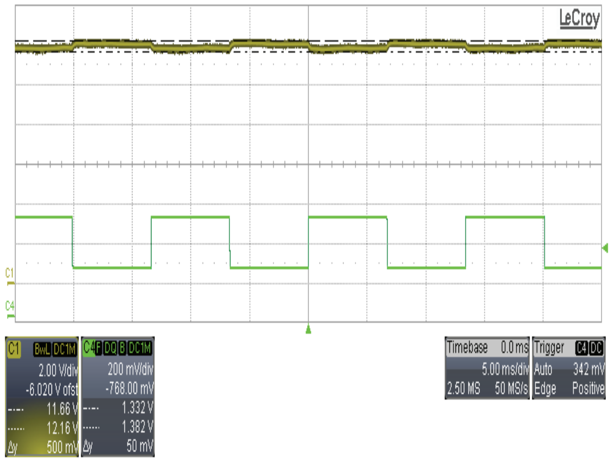

Figure 27 – Transient Response, 230 VAC,
50%<-->100% Step Load.
Upper: V_{OUT}, 2.0 V / div.
Lower: I_{OUT}, 1 A / div., 5 ms / div.

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11.6 输出纹波和噪声测量

11.6.1 纹波测量技巧

For DC output ripple measurements, a modified oscilloscope test probe must be utilized in order to reduce spurious signals due to pick-up. Details of the probe modification are provided in the figures below.

The 5125BA probe adapter is affixed with two capacitors tied in parallel across the probe tip. The capacitors include one (1) 0.1 μF / 50 V ceramic type and one (1) 4.7 μF / 50 V aluminum electrolytic. The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).

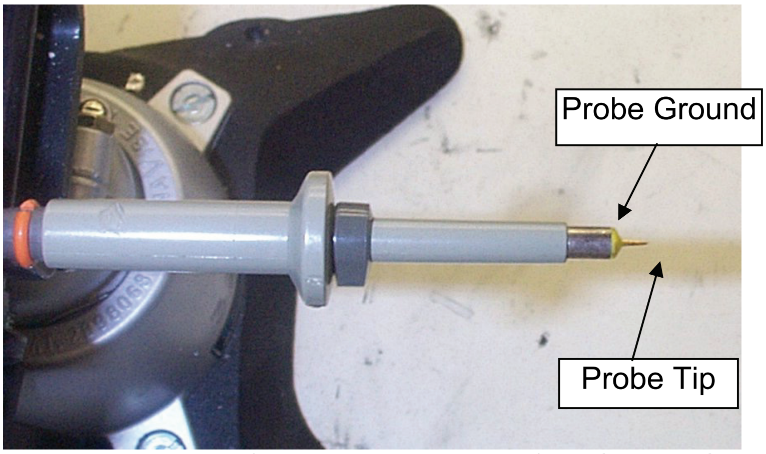

Figure 28 – Oscilloscope Probe Prepared for Ripple Measurement (End Cap and Ground Lead Removed).

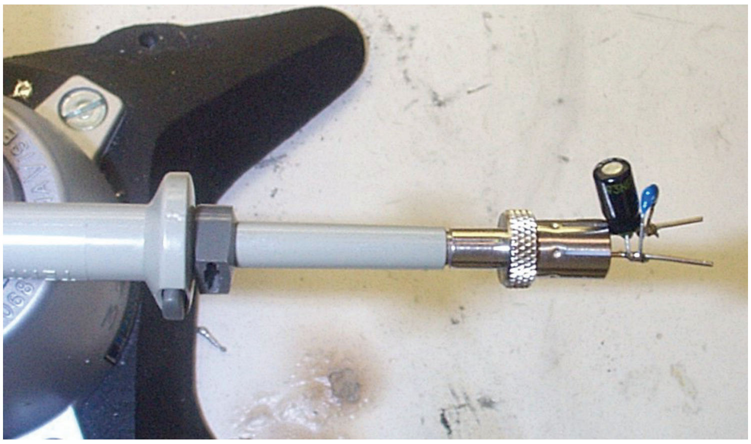

Figure 29 – Oscilloscope Probe with Probe Master 5125BA BNC Adapter (Modified with Wires for Probe Ground for Ripple Measurement, and Two Parallel Decoupling Capacitors Added).

11.6.2 纹波和噪声测量结果

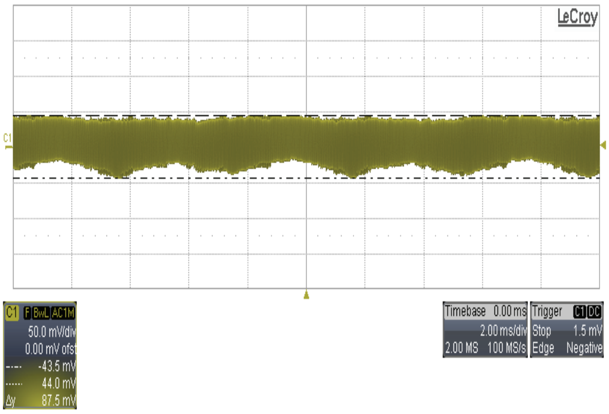

Figure 30 – Low Frequency Ripple, 115 VAC, Full Load.
V_{OUT}, 50 mV / div.

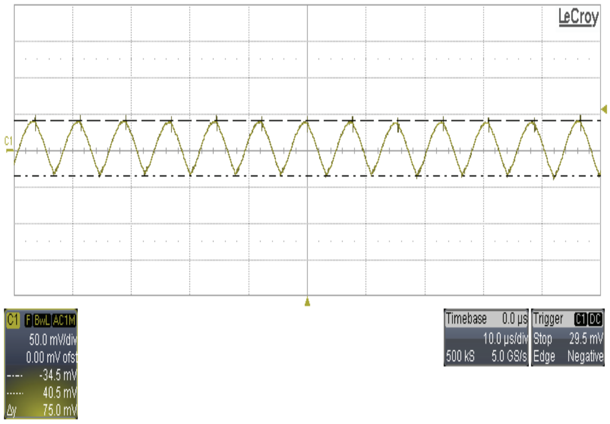

Figure 31 – Switching Noise, 115 VAC, Full Load.
V_{OUT}, 50 mV / div.

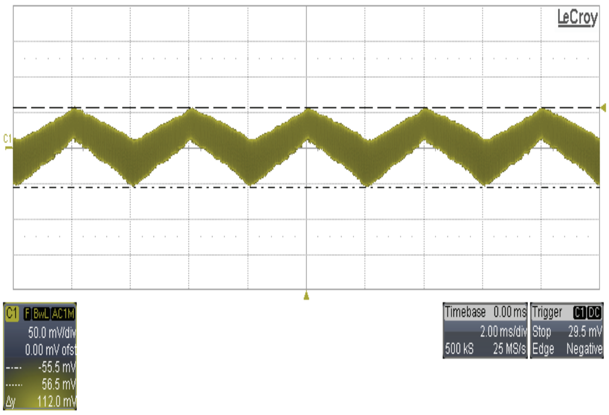

Figure 32 – Low Frequency Ripple, 230 VAC, Full Load.
V_{OUT}, 50 mV / div.

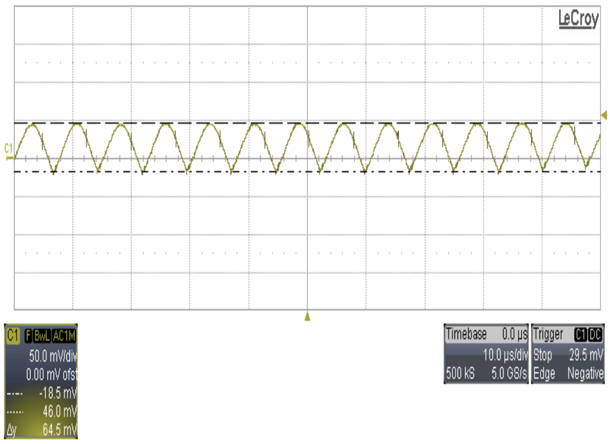

Figure 33 – Switching Noise, 230 VAC, Full Load.
V_{OUT}, 50 mV / div.

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12 保护功能

12.1 短路条件下的自动重启动

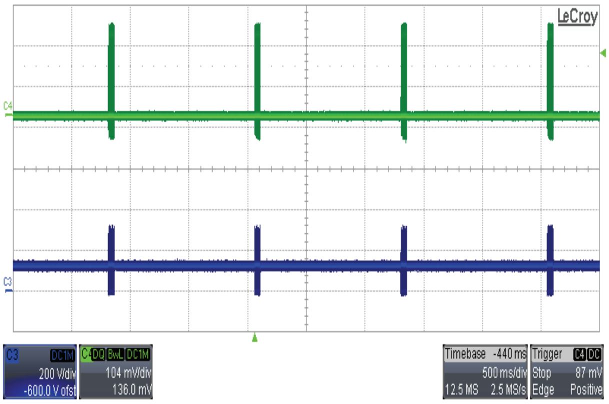

Figure 34 – Auto-restart Under Short-Circuit, 90 VAC.
Upper: I_{DRAIN}, 0.52 A / div., 500 ms / div.
Lower: V_{DRAIN}, 200 V / div.
Input Power = 1.38 W.

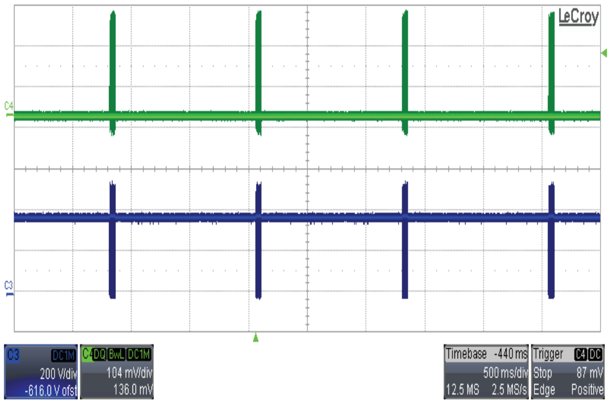

Figure 35 – Auto-restart Under Short-Circuit, 265 VAC.
Upper: I_{DRAIN}, 0.52 A / div., 500 ms / div.
Lower: V_{DRAIN}, 200 V / div.
Input Power = 1.41 W.

12.2 过压条件下的锁存保护（开环测试）

OVP is initiated by inserting a 100 kΩ between BP and CP pin during normal operation.

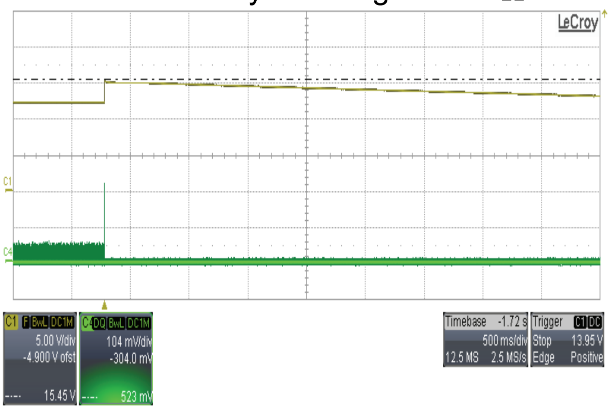

Figure 36 – OVP at 90 VAC, No-Load.
Upper: V_{OUT}, 5 V / div., 500 ms / div.
Lower: I_{DRAIN}, 0.52 A / div.
OVP Trip Point = 15.45 V.

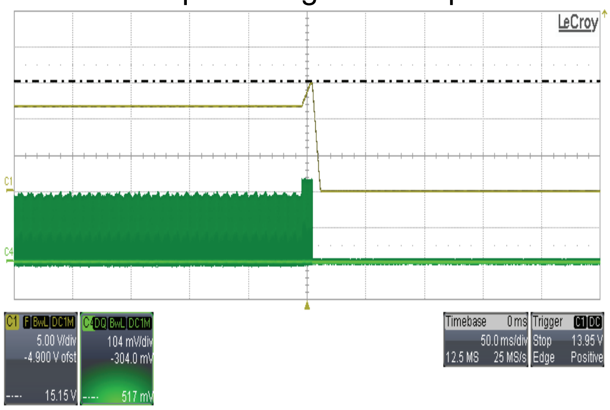

Figure 37 – OVP at 90 VAC, Full Load.
Upper: V_{OUT}, 5 V / div., 500 ms / div.
Lower: I_{DRAIN}, 0.52 A / div.
OVP Trip Point = 15.15 V.

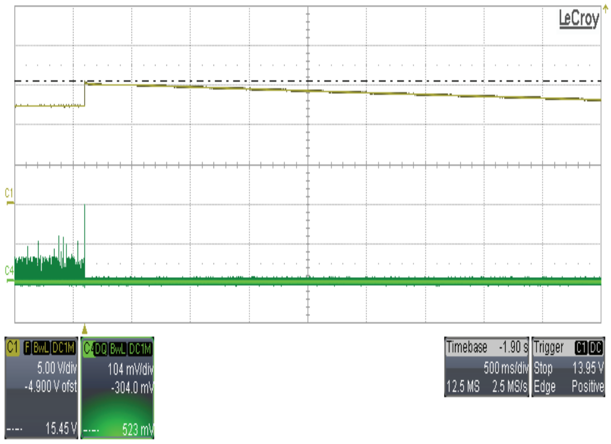

Figure 38 – OVP at 265 VAC, No-Load.
Upper: V_{OUT}, 5 V / div., 500 ms / div.
Lower: I_{DRAIN}, 0.52 A / div.
OVP Trip Point = 15.45 V.

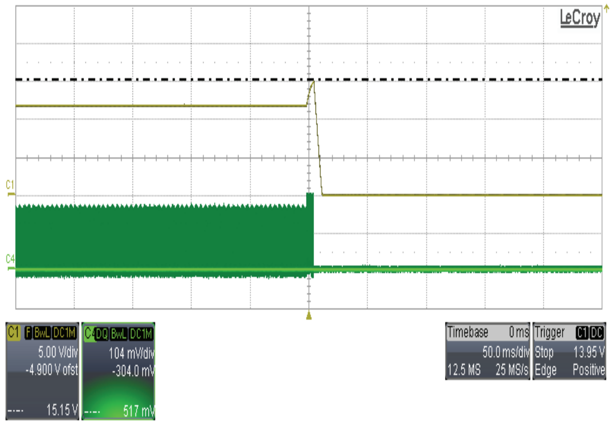

Figure 39 – OVP at 265 VAC, Full Load.
Upper: V_{OUT}, 5 V / div., 500 ms / div.
Lower: I_{DRAIN}, 0.52 A / div.
OVP Trip Point = 15.15 V.

12.3 电压缓升和电压跌落（使用DC输入电源进行测试）

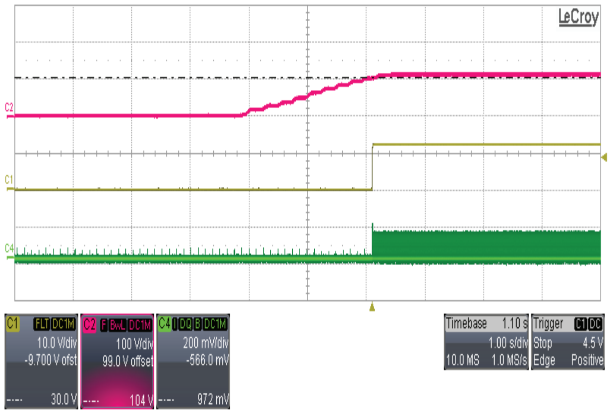

Figure 40 – Brown-in.
Upper: V_{IN}, 100 V / div., 1 s / div.
Middle: V_{OUT}, 10 V / div.
Lower: I_{DRAIN}, 1.0 A / div.

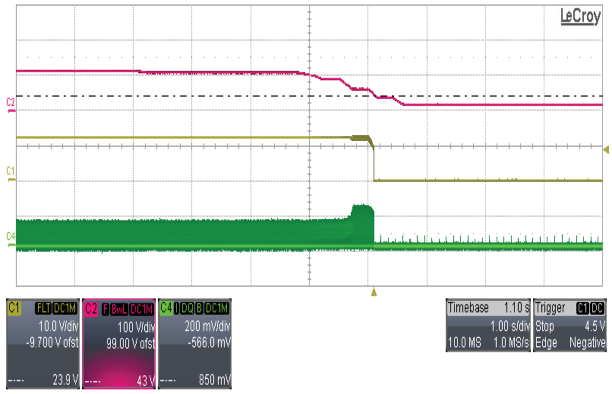

Figure 41 – Brown-out.
Upper: V_{IN}, 100 V / div., 1 s / div.
Middle: V_{OUT}, 10 V / div.
Lower: I_{DRAIN}, 1.0 A / div.

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12.4 输入过压保护（使用DC输入电源进行测试）

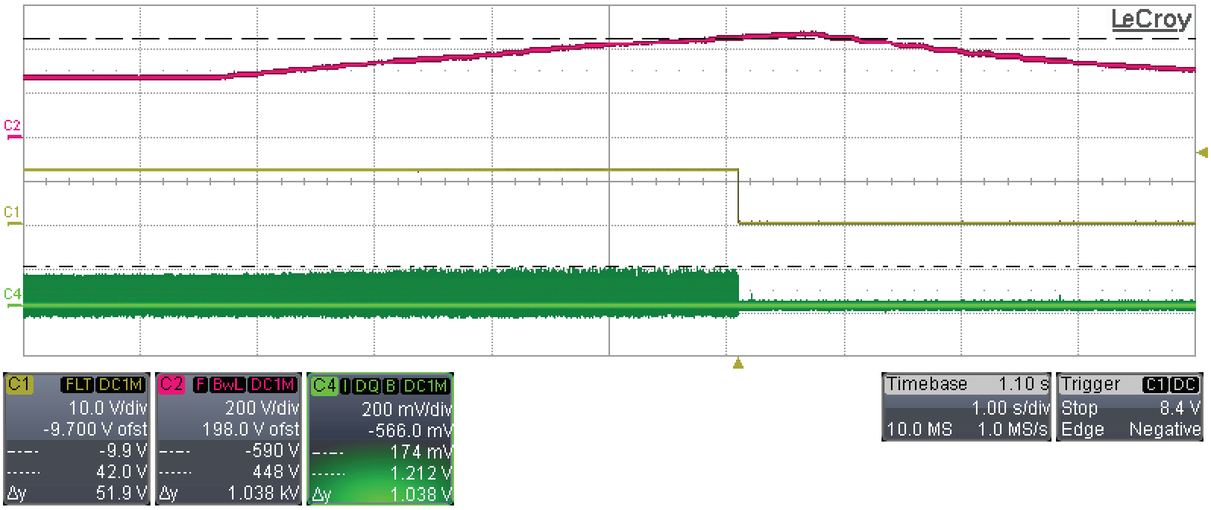


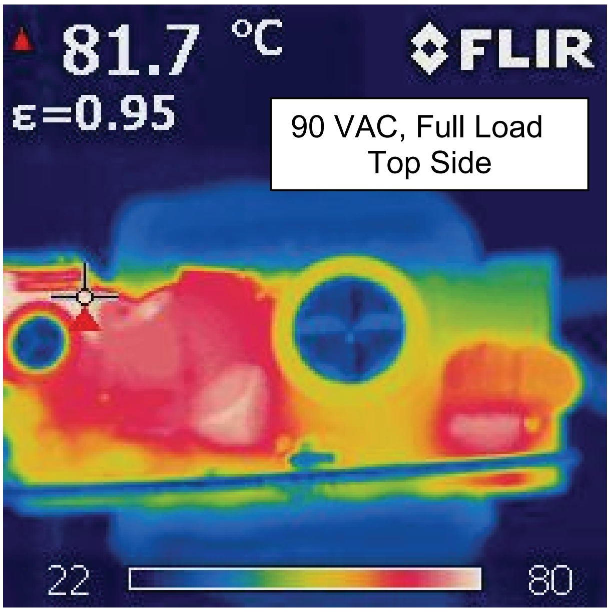
Figure 42 – Line Overvoltage Protection (Triggered at 448 V).
Upper: V_{IN}, 200 V / div., 1 s / div.
Middle: V_{OUT}, 10 V / div.
Lower: I_{DRAIN}, 1.0 A / div.

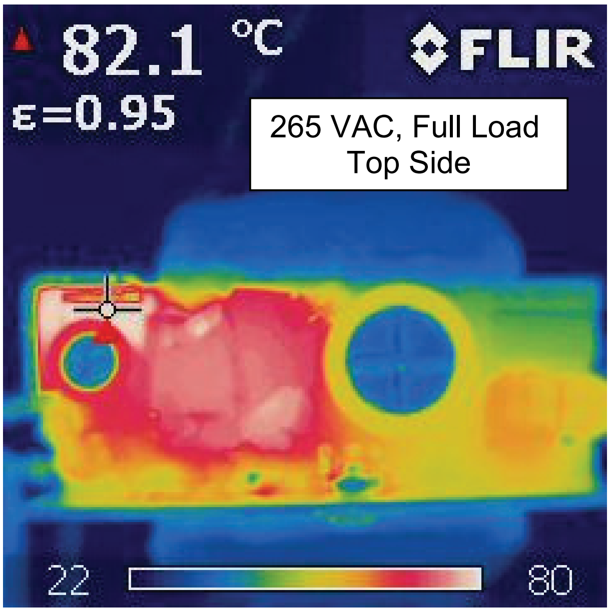
Note: Also programmed for latching under OTP conditions.

13 热性能($T_{AMBIENT}$ = 25 °C)

Thermal performance was measured at full load operation, open frame at ambient temperature of 25 °C. The transformer winding temperature was taken on the outermost layer.

Item	Description	90 VAC Full Load	265 VAC Full Load
1	Output Diode	81.7	82.1
2	LNK6766E	68	65
3	Transformer	73.3	75
4	Input Capacitor	58	43
5	Output CMC	62	55
6	Input CMC	61	35
7	Bridge Diode	77	52
8	Zener Clamp	73	63





14 AC浪涌（输出的电阻性满载）

Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Results (Pass/Fail # Strikes)
D.M.		**(2Ù source)**		**10 Strikes Each Level**
+1000	230	L1 to L2	90	Pass
-1000	230	L1 to L2	270	Pass
C.M.		**(12Ù source)**		
+2000	230	L1, L2 to PE	90	Pass
-2000	230	L1, L2 to PE	270	Pass

15 ESD（输出的电阻性满载）

Device	Discharge Type	Discharge Location	Voltage	# of Events (1/sec)	Remarks
LNK6766E	Contact	+ Output Terminal	+8 kV	10	PASS
			-8 kV	10	PASS
		- Output Terminal	+8 kV	10	PASS
			-8 kV	10	PASS
	Air	+ Output Terminal	+15 kV	10	PASS
			-15 kV	10	PASS
		- Output Terminal	+15 kV	10	PASS
			-15 kV	10	PASS

PASS = No output glitch or latch-off.

16 满载下的EMI测试

Conducted emissions tests were performed at 115 VAC and 230 VAC at full load. Composite EN55022B / CISPR22B conducted limits are shown. All the tests show excellent EMI performance.

16.1 EMI结果

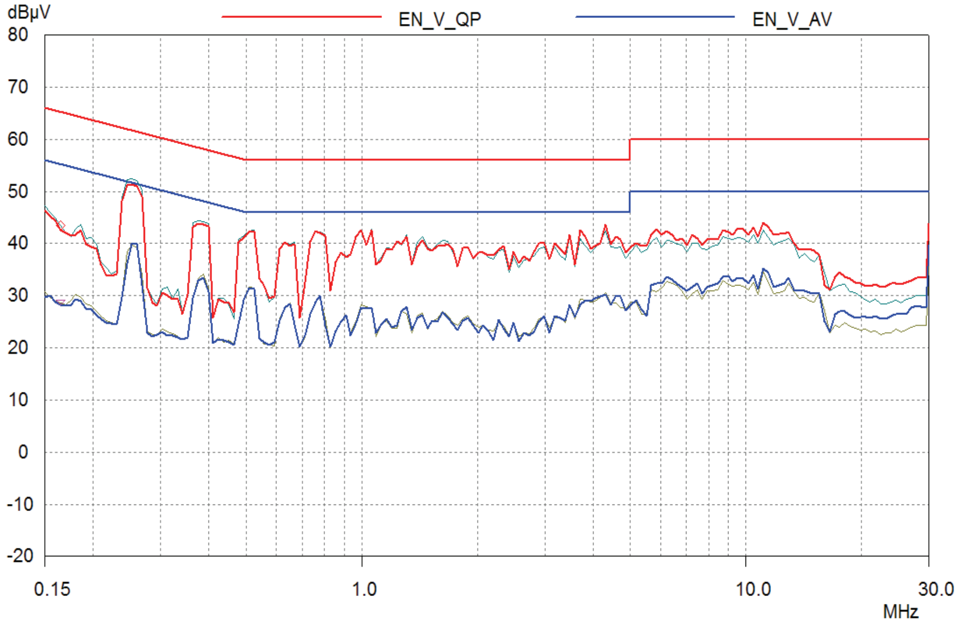


Figure 43 – Conducted EMI at 115 VAC 60 Hz, Full Load, and Output Return Connected to Ground.

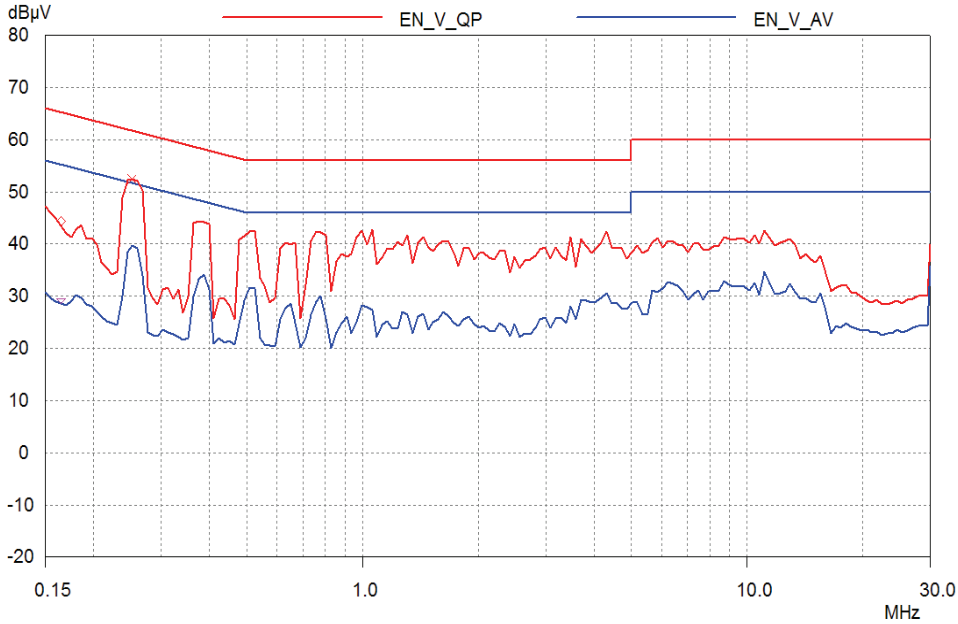


Figure 44 – Conducted EMI at 115 VAC 60 Hz, Full Load, and Output Return Connected to Artificial Hand.

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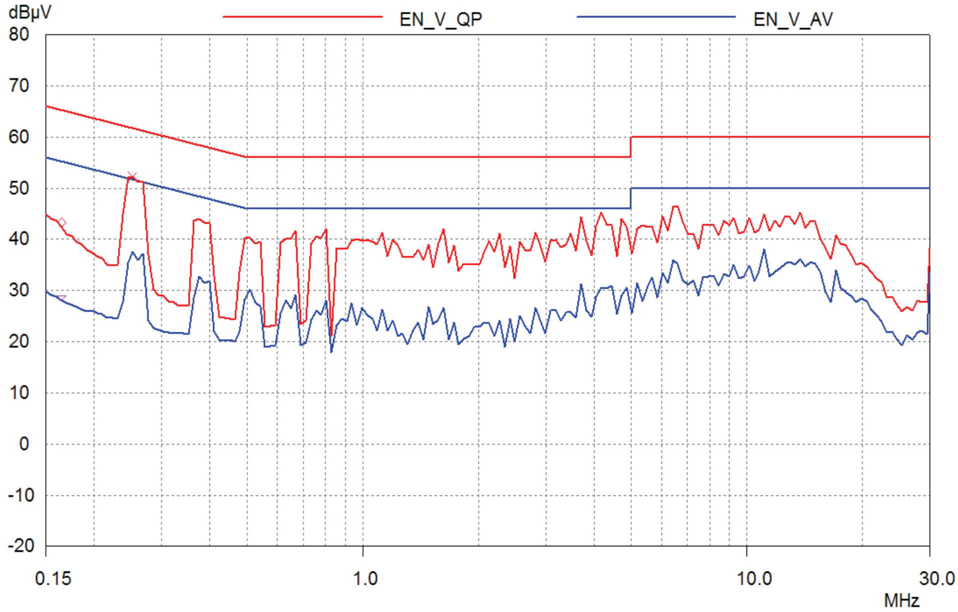

Figure 45 – Conducted EMI at 230 VAC 60 Hz, Full Load, and Output Return Connected to Ground.

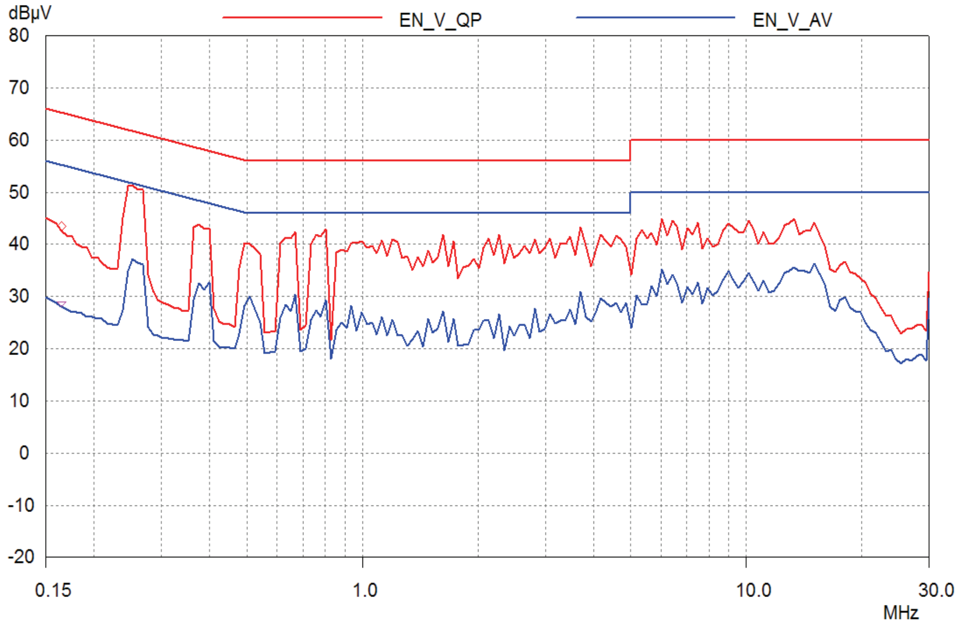

Figure 46 – Conducted EMI at 230 VAC 60 Hz, Full Load, and Output Return Connected to Artificial Hand.

17 版本历史

Date	Author	Revision	Description & changes	Reviewed
24-Jul-12	SS	1.0	Initial Release	Apps & Mktg
01-Aug-12	SS	1.1	Changed D8 to thru-hole. Improved heat sink for PI device and output diode. Changed BR2 and VR1 to SMD.	
14-Sep-12	KM	1.2	Updated schematic and format.	

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