標題	***採用 LYTSwitch™-0 LYT0006D 之 7 W 非調光、非隔離降壓式 LED 驅動器的參考設計報告***
規格	190 VAC – 265 VAC 輸入；85 V、82 mA 輸出
應用	A17/A19 LED 驅動器替換燈泡
作者	應用工程部門
文件編號	RDR-378
日期	2013 年 10 月 4 日
修訂	1.0

摘要與功能

- Single-stage 功率因數修正 (PFC) (在 230 V 條件下大於 0.5) 與精準的定電流 (CC) 輸出
- 所需元件極少且 PCB 佔位面積小的低成本解決方案
- 高度節能，在整個 VAC 輸入範圍內效率爲 91%
- 快速啓動 (小於 100 ms) – 無可感延遲
- 整合式保護與信賴度特性
    - 單擊 (Single shot) 無負載保護
    - 藉由自動恢復功能提供輸出短路保護
    - 具有高磁滯時間的自動恢復回復過溫保護，同時保護元件和 PCB
    - 在電壓關閉情況下，不會發生任何損壞
- 符合 IEC 振盪波、線差動電壓突波和 EN55015 傳導性 EMI 規定

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目錄

重要事項：
雖然此電路板的設計符合安全隔離要求，但工程原型尚未取得相關機構之認證。因此，執行所有測試應使用隔離變壓器才能提供 AC 輸入給原型板。

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1 簡介

本文件說明採用 LYTSwitch™-0 系列 (LYT0006D) 且具有極輕薄小巧型降壓式架構的成本效益型電源供應器。

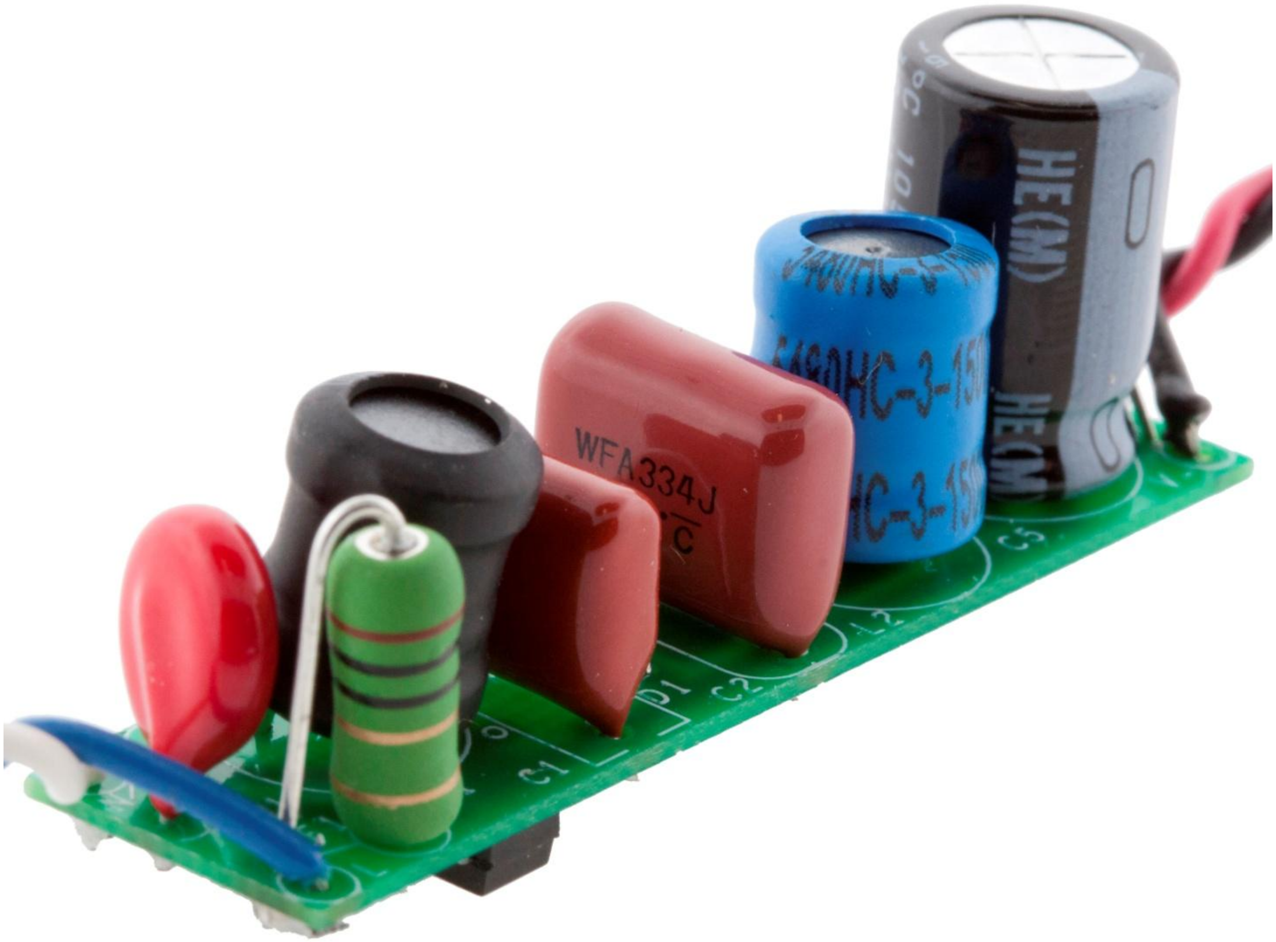

Figure 1 – Populated Circuit Board

此電源供應器在 190 VAC 至 265 VAC 的輸入電壓範圍內運作。使用降壓式架構時，DC 匯流排電壓足夠高，可支援 85 V 輸出 - 在降壓式轉換器中，輸出電壓必須始終低於輸入電壓。輸出電壓還受到 LYTSwitch-0 最大工作週期的限制，此裝置也要求輸入電壓必須大於輸出電壓。

參考設計並不限於改良式燈具應用；設計佈局可輕鬆進行修改以用於 LED 燈管或電子安定器應用。

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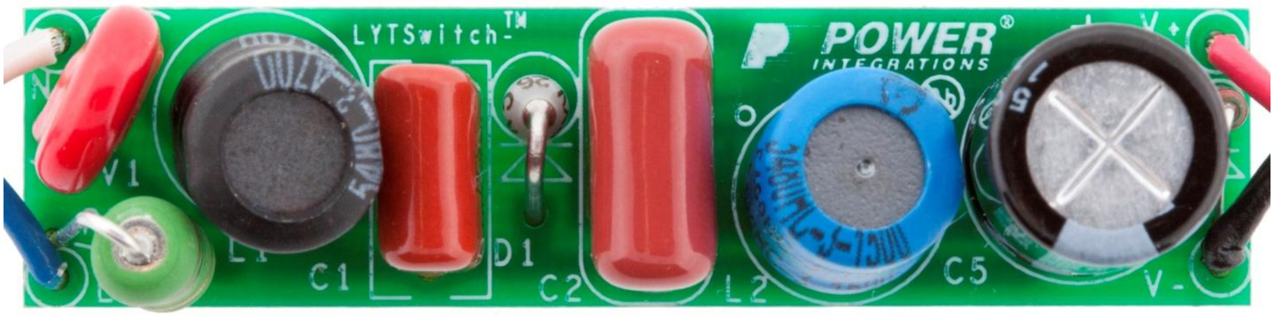

Figure 2 – Populated Circuit Board, Top View.

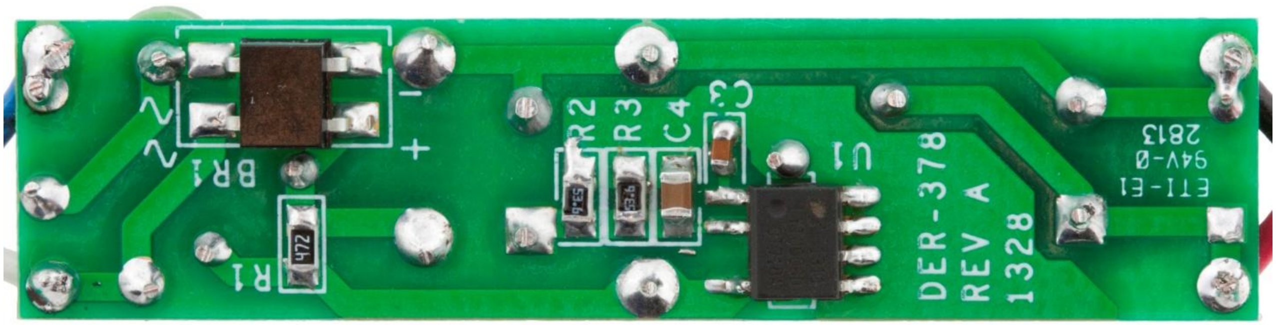

Figure 3 – Populated Circuit Board, Bottom View.

2 電源供應器規格

下表展示設計的最低可接受效能。實際效能列在結果部分。

說明	符號	最小值	典型值	最大值	單位	註解
輸入						
電壓操作	V_{IN}	190		265	VAC	雙線 – 無 P.E.
頻率	f_{LINE}	47	50/60		Hz	工作頻率不受限制。如果是針對 400 Hz 的線電壓頻率，請調整感測電阻器。
輸出						
輸出電壓	V_{OUT}	83	85	88	V	在 200 VAC - 240 VAC 條件下 ±4%
輸出電流	I_{OUT}		82		mA	
總輸出功率						
連續輸出功率	P_{OUT}		7		W	
效率						
240 VAC；85 V LED	η	91			%	於 P_{OUT}、25 °C 條件下測量
功率因數 (PF)						
240 VAC；85 V LED	功率因數 (PF)	0.5				於 P_{OUT}、25 °C 條件下測量
環境						
傳導性 EMI		符合 CISPR22B / EN55015B 標準				
線電壓突波 差模 (L1-L2)			0.5		kV	1.2/50 µs 突波，IEC 1000-4-5，串聯阻抗： 差模： 2 Ω
振盪波 (100 kHz) 差模 (L1-L2)			2.5		kV	500 A 短路 串聯阻抗： 差模： 2 Ω
環境溫度	T_{AMB}	-10	25		°C	自然對流，海平面

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3 電路圖

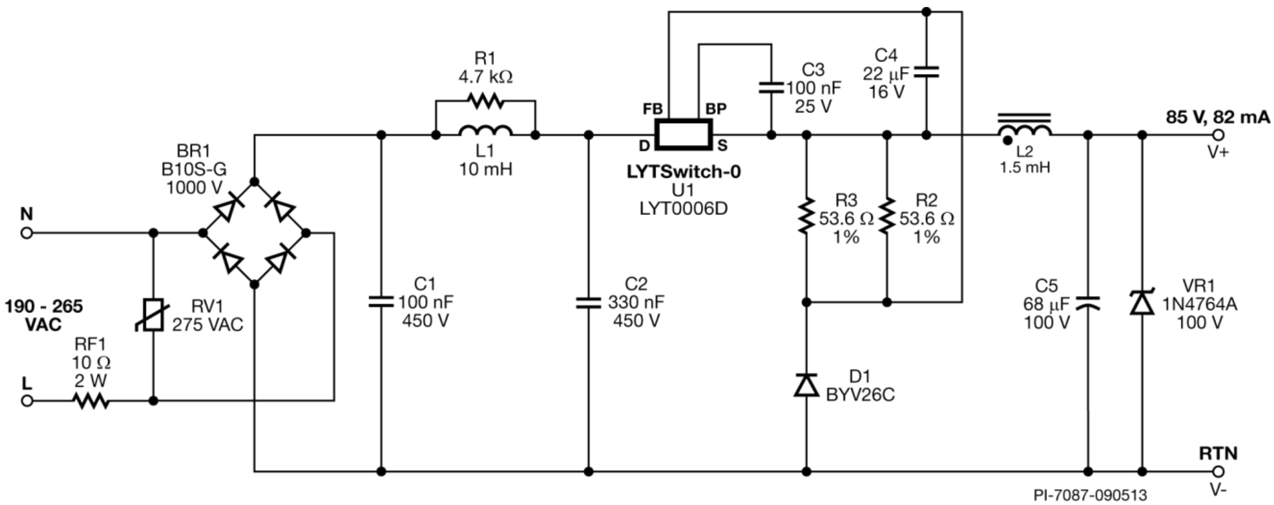

Figure 4 – Schematic.Zener Diode VR1 is Optional, Providing One-time No-load Protection. Refer to AN-60 for Additional OVP Options.

4 電路說明

圖 3 中所示的電源供應器採用高壓降壓式結構的 LYT0006D (U1)，可在 85 VDC 輸出電壓下提供恆定的 82 mA 電流。該電源供應器專用於驅動 LED，而 LED 應始終透過定電流 (CC) 驅動。

4.1 輸入 EMI 濾波

保險絲 RF1 提供短路保護。橋式整流器 BR1 提供全波整流，以實現良好的功率因數 (PF)。電容器 C1 和 C2 及共模電感器 L1 構成 π 濾波器，以符合傳導性 EMI 標準。電容器 C1 和 C2 還用於能量儲存，以減少線間噪音並防止線電壓突波。

4.2 LYTSwitch-0

LYTSwitch-0 系列已經過全面最佳化，使得 LED 驅動器簡單易用、具有成本效益，且在 0 至 100 ºC (LYTSwitch-0 外殼溫度) 內提供良好的線間電壓與溫度調節。PIXls 試算表用於最佳化功率電感器和感測電阻器的選擇，進而實現最佳線間電壓調節。最佳化總輸入電容，以設計出儘可能最高功率因數 (PF) 和線間負載調節。

LYTSwitch-0 系列具有內建過熱限制，可在溫度上升至超過適當的運作等級時保護電源供應器。

降壓式轉換器階段由 LYT0006D (U1) 內的整合式功率 MOSFET 切換開關、飛輪二極體 (D1)、感測電阻器 (R2、R3)、功率電感器 L2 和輸出電容器 (C5) 組成。該轉換器通常在不連續模式 (DCM) 下運作，以限制反向電流的週期。選用了快速飛輪二極體以將切換損失降至最低。

電源轉換器中使用現成的標準電感器，以降低成本。

4.3 輸出整流

快速輸出二極體 (D1) 用於實現良好效率和散熱管理。通常在 LED 應用中，環境溫度高於 70 ºC。建議使用 t_{RR} 較低 (小於 35 ns) 的裝置。

4.4 輸出回授

透過跳離切換週期來維持調節。當輸出電流上升時，流入回授 (FB) 接腳的電壓也會上升。如果此電壓超過 V_{FB}，則將跳離後續切換週期，直到電壓降至低於 V_{FB}。電流透過 R2 和 R3 進行感測並由 C4 進行濾波，然後饋送至 FB 接腳進行精確調節。實現良好線電壓調節的關鍵在於，計算出最低電感後平衡功率電感器和感測電阻器的值。

BYPASS 電容器 (C4) 連接 FB 接腳和源極 (S) 接腳，有助於降低輸出電流感測期間的功率損失。該電容器用於對 FB 接腳的回授電流資訊進行取樣與保持。FB 接腳與 C4 之間無需限制電阻器，因爲峰值電壓不會超過裝置的最大額定值。

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4.5 無負載保護

此設計整合了選用的單擊無負載保護電路。發生意外的無負載運作時，輸出電容器會受到 VR1 的保護。發生故障後需要更換積納二極體 VR1。請參閱 AN-60 以瞭解其他的 OVP 設計選項。

在運作中 (LED 改良式燈具)，負載始終是接通的，因此可移除 VR1 以節省成本。使用此選項後，若要在電路板等級測試 (製造中) 期間提供保護，可對輸入端施加 70 VAC 電壓；如果未測量輸出電流，則不會接通負載。此測試可讓電路板安全無損地進行初始通電，而無需使用 OV 保護電路。

5 PCB 佈局

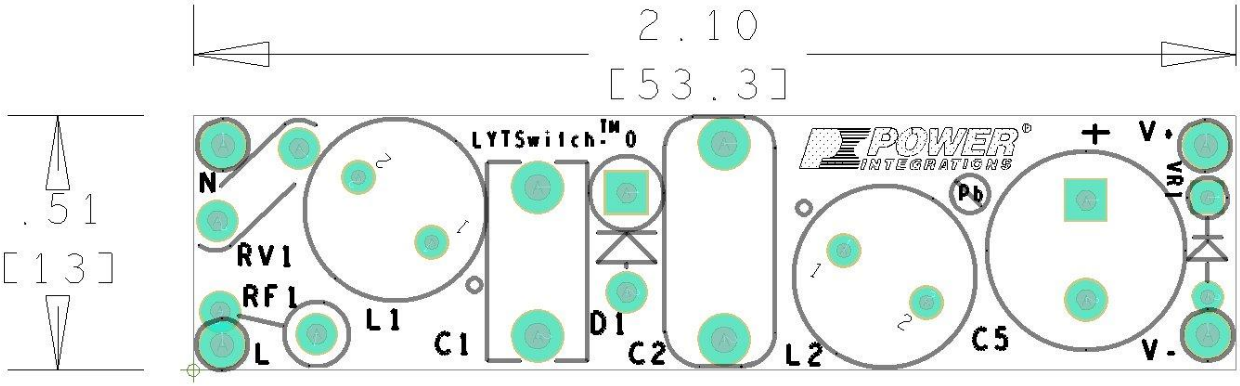

Figure 5 – Printed Circuit Layout, Top View.

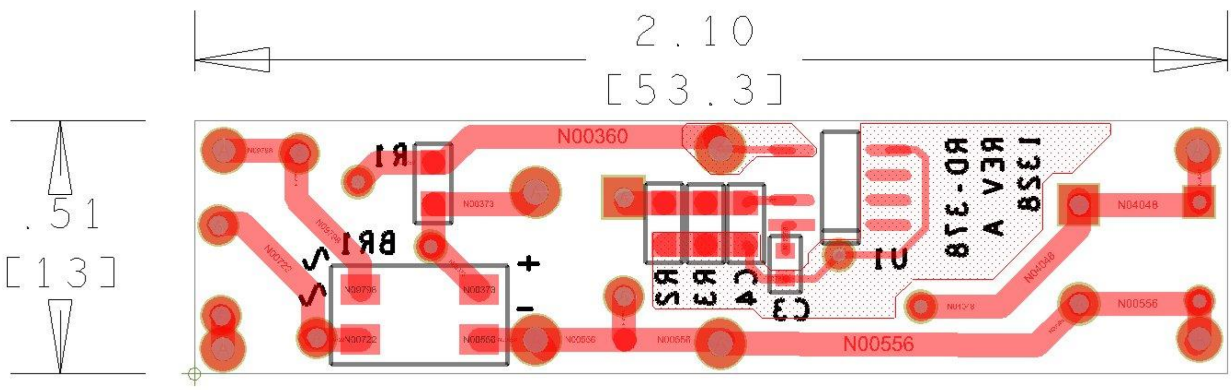

Figure 6 – Printed Circuit Layout, Bottom View.

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6 物料清單

Item	Qty	Ref Des	說明	Manufacturer P/N	Manufacturer
Electrical					
1	1	BR1	1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC	B10S-G	Comchip Technology
2	1	C1	100 nF, 450 V, Film	MEXXD31004JJ1	Duratech
3	1	C2	330 nF, 450 V, METALPOLYPRO	ECW-F2W334JAQ	Panasonic
4	1	C3	100 nF, 25 V, Ceramic, X7R, 0603	VJ0603Y104KNXAO	Vishay
5	1	C4	22 μF, 16 V, Ceramic, X7R, 0805	C2012X5R1C226K	TDK
6	1	C5	68 μF, 100 V, Electrolytic, Gen. Purpose, (10 x 16)	UHE2A680MPD	Nichicon
7	1	D1	600 V, 1 A, Ultrafast Recovery, 30 ns, SOD57	BYV26C	Philips
8	1	L1	10 mH, 0.076 A, 20%	RL-5480-3-10000	Renco Elect
9	1	L2	1.5 mH, 0.250 A, 10%	RL-5480HC-3-1500	Renco Elect
10	1	R1	4.7 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ472V	Panasonic
11	2	R2 R3	53.6 Ω, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF53R6V	Panasonic
12	1	RF1	10 Ω, 5%, 2 W, Wirewound, Fusible	FW20A10R0JA	Bourns
13	1	RV1	275 V, 23 J, 7 mm, RADIAL	V275LA4P	Littlefuse
14	1	U1	LYTSwitch-0, SMD-8C	LYT0006D	Power Integrations
15	1	VR1	100 V, 5%, 1 W, DO-41	1N4764A-TAP	Vishay
Mechanical					
16	1	WIRE(V-)	Wire, UL1007,# 24 AWG, Blk, PVC, 4"	1007-24/7-0	Anixter
17	1	WIRE (L)	Wire, UL1007, #24 AWG, Blu, PVC, 4"	1007-24/7-6	Anixter
18	1	WIRE(V+)	Wire, UL1007, #24 AWG, Red, PVC, 4"	1007-24/7-2	Anixter
19	1	WIRE(N)	Wire, UL1007, #24 AWG, Wht, PVC, 4"	1007-24/7-9	Anixter
20	1	PCB	FR4, 0.31, 1 Oz Cu (0.51" X 2.1")		

7 電感器設計試算表

ACDC_LYTSwitchZero_052813; Rev.0.8; Copyright Power Integrations 2013	INPUT	INFO	OUTPUT	UNIT	LYTSwitchZero_Rev_0-8.xls:LYTSwitchZero Design Spreadsheet
INPUT VARIABLES					
VACMIN	190		190	Volts	Minimum AC Input Voltage
VACNOM	230		230		
VACMAX	265		265	Volts	Maximum AC Input Voltage
FL	50		50	Hertz	Line Frequency
VO	85		85	Volts	輸出電壓
IO	82		82	mA	輸出電流
Pout			6.97	W	
EFFICIENCY	0.91		0.91		Overall Efficiency Estimate (Adjust to match Calculated, or enter Measured Efficiency)
CIN	0.43		0.43	uF	Input Filter Capacitor
Input Stage Resistance	4.7		4.7	ohms	Input Stage Resistance, Fuse & Filtering
Switching Topology			Buck		Type of Switching topology
DC INPUT VARIABLES					
VMIN			85	Volts	Minimum DC Bus Voltage
VMAX			374.766594	Volts	
LYTSwitchZero					
LYTSwitchZero	LYT0006		LYT0006		
ILIMIT			0.375	Amps	Typical Current Limit
ILIMIT_MIN			0.33275	Amps	Minimum Current Limit
ILIMIT_MAX			0.401	Amps	Maximum Current Limit
FSMIN			62000	Hertz	Minimum Switching Frequency
IRMS			85.25298	mA	Expected RMS current through LYTSwitch
VDS			4.8375	Volts	Maximum On-State Drain To Source Voltage drop
DIODE					
VD			0.7	Volts	Freewheeling Diode Forward Voltage Drop
VRR			600	Volts	Recommended PIV rating of Freewheeling Diode
IF			1	Amps	Recommended Diode Continuous Current Rating
Diode Recommendation			BYV26C		Suggested Freewheeling Diode
OUTPUT INDUCTOR					
Core type	Off-the-Shelf		Off-the-Shelf		Select core type between Ferrite and Off-the-Shelf
Core size					Select core size
Custom Core					Enter custom core description (if used)
AE			N/A	mm^2	Core Effective Cross Sectional Area
LE			N/A	mm	Core Effective Path Length
AL			N/A	nH/T^2	Ungapped Core Effective Inductance
BW			N/A	mm	Bobbin Physical Winding Width
NL			N/A		Number of turns on inductor
BP			N/A	Gauss	Peak flux density
LG			N/A	mm	Gap length
OD			N/A		Maximum Primary Wire Diameter including insulation

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INS			N/A		Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			N/A		Bare conductor diameter
AWG			N/A		Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			N/A		Bare conductor effective area in circular mils
CMA			N/A		!!! INCREASE CMA > 200 (increase L(primary layers),decrease NS, use larger Core)
L			N/A		
LP	1350		1350	uH	Output Inductor, Recommended Standard Value
IO_Average			82.52548	mA	Average output current
ILRMS			176.4503	mA	Estimated RMS inductor current (at VMAX)
FEEDBACK COMPONENTS					
RFB	26.8		26.8	Ohms	Feedback Resistor.Use closest standard 1% value
CFB			22	uF	Feedback Capacitor
OUTPUT REGULATION					
IO_VACMIN			82.52548	mA	Output Current at VACMIN
IO_VACNOM			80.51328	mA	Output Current at VACNOM
IO_VACMAX			79.12785	mA	Output Current at VACMAX

8 效能資料

All measurements performed at room temperature (≈25 ºC) unless otherwise specified.

輸入		Input Measurement				LED Load Measurement			Efficiency (%)	Regulation (%)
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	功率因數 (PF)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)		
190	50	190.20	54.85	7.449	0.714	81.4500	83.680	6.832	91.72	2.05
200	50	220.35	53.19	7.388	0.630	81.4400	82.620	6.740	91.23	0.76
220	50	230.22	52.27	7.332	0.609	81.4400	82.000	6.688	91.22	0.00
230	50	240.23	51.60	7.279	0.587	81.4300	81.390	6.637	91.18	-0.74
265	50	265.25	50.39	7.100	0.531	81.4000	79.050	6.442	90.73	-3.60
190	50	190.16	55.32	7.669	0.729	84.4900	83.260	7.052	91.95	1.54
200	50	220.35	52.81	7.598	0.653	84.4800	82.290	6.964	91.66	0.35
220	50	230.21	52.40	7.570	0.628	84.4800	81.840	6.925	91.48	-0.20
230	50	240.23	52.08	7.545	0.603	84.4700	81.390	6.885	91.25	-0.74
265	50	265.28	52.16	7.473	0.540	84.4600	80.300	6.790	90.86	-2.07
190	50	190.17	55.92	7.937	0.746	87.5700	83.230	7.306	92.05	1.50
200	50	220.35	53.01	7.833	0.671	87.5500	81.780	7.173	91.57	-0.27
220	50	230.22	52.54	7.798	0.645	87.5400	81.480	7.144	91.61	-0.63
230	50	240.34	52.22	7.773	0.619	87.5400	81.180	7.117	91.56	-1.00
265	50	265.26	51.80	7.719	0.562	87.5300	80.430	7.048	91.31	-1.91

Table 1 – Raw Data of Unit.

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8.1 工作模式效率

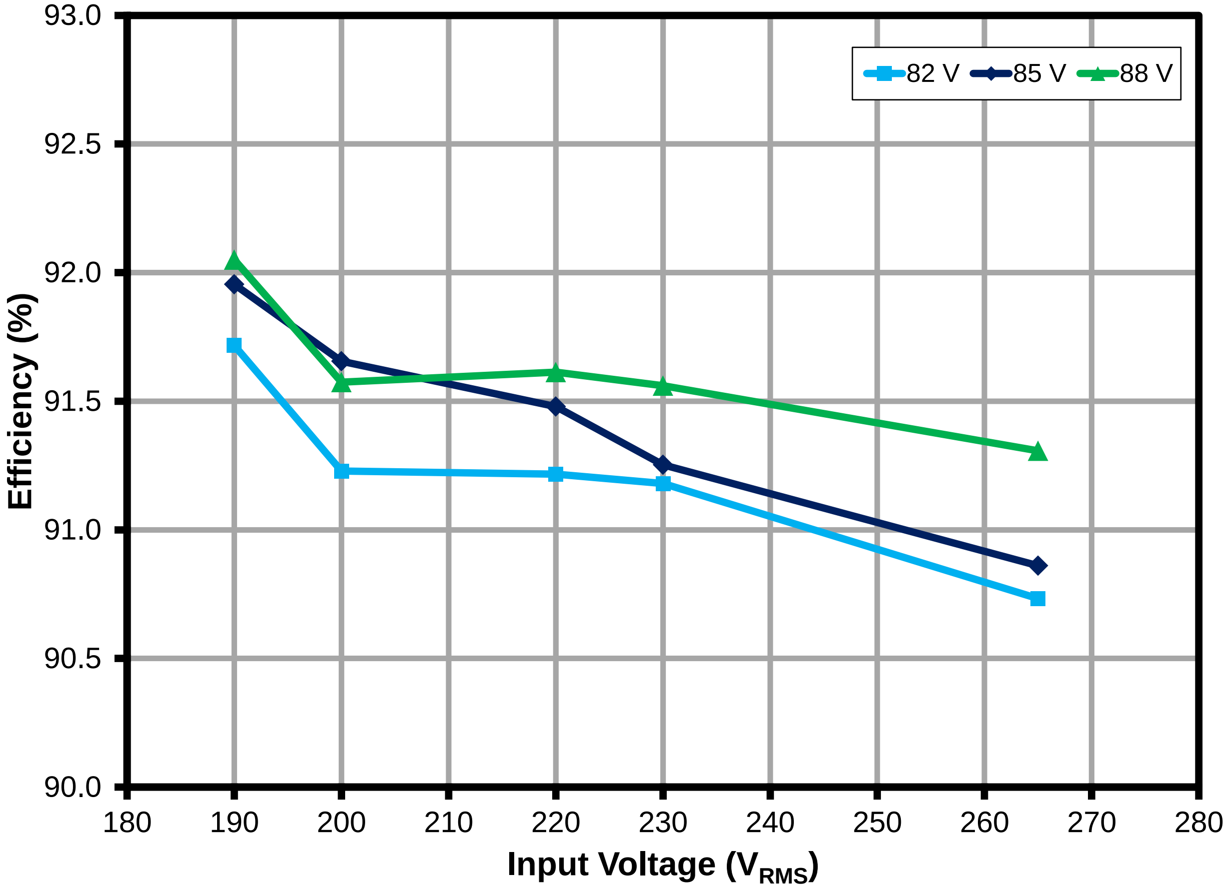

Figure 7 – Efficiency with Respect to AC Input Voltage, 190-265 VAC (60 Hz) Input.

8.2 輸出電流調節

8.2.1 線間電壓與負載範圍內的輸出電流調節

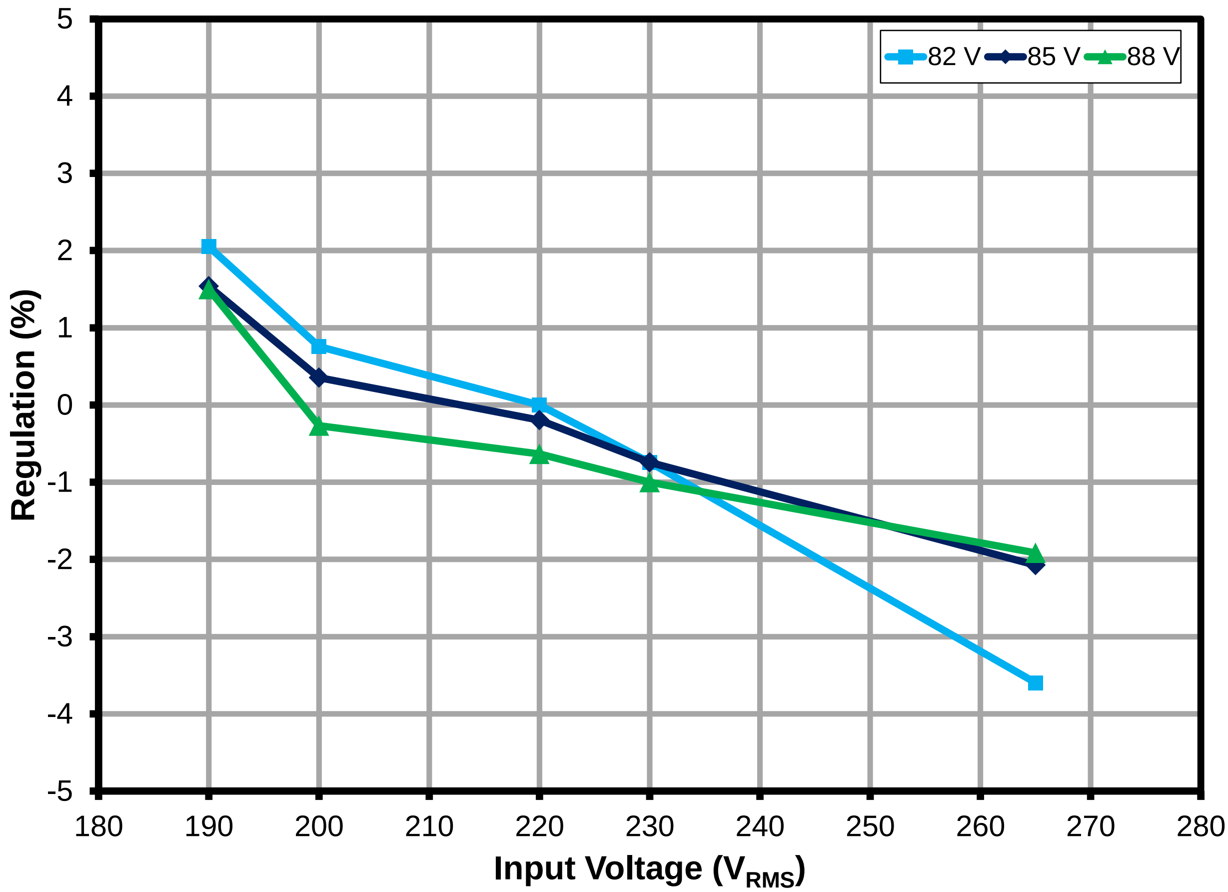

Figure 8 – Load Regulation, Room Temperature.

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9 散熱效能

9.1 使用設備

Chamber:	Tenney Environmental Chamber Model No:TJR-17 942	Wattmeter:	Yokogawa Power Meter Model No:WT2000
AC Source:	Chroma Programmable AC Source Model No: 6415	Data Logger:	Agilent

Figure 9 – Thermal Chamber Set-up Showing Box Used to Prevent Airflow Over UUT.Open Frame Set-up Measurement.

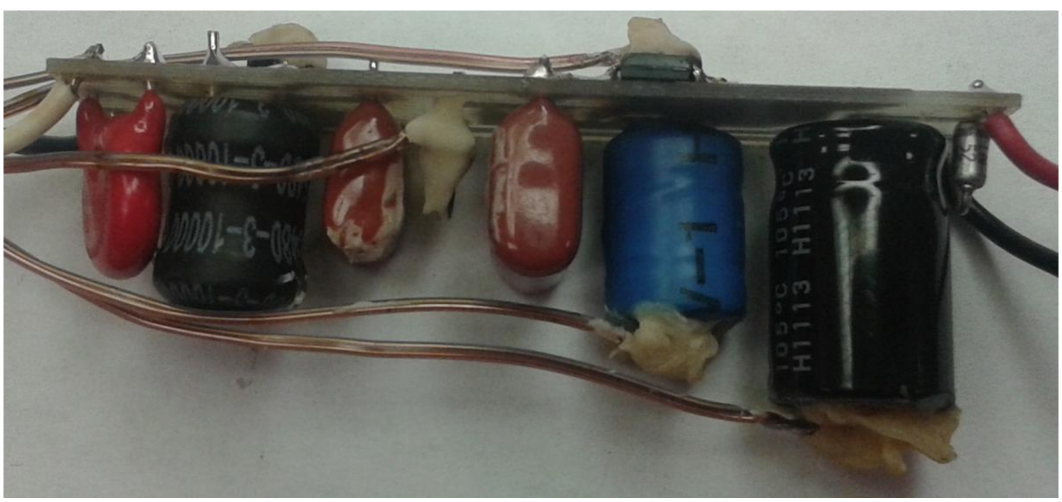

Figure 10 – Thermal Measurement, Thermocouple Set-up.

Figure 11 – Enclosed Thermal Measurement Set-up.

Note: Typical A19 enclosure is used in the test; the housing may be identical to lamps available in the market but it does not limit its application.It is up to the end customer to enclose the driver and design the housing.

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9.2 散熱成效

9.2.1 負載：85 V/82 m A LED 負載。

Remarks	Internal Ambient °C	BR °C	LYT0006D °C	L2;Power Inductor °C	Output Capacitor °C	Output Diode °C
Normal Operation Open Frame in the Thermal Chamber 190 V / 50 Hz	-10	-5.77	4.91	-2.24	-10.24	-0.15
	0	3.92	14.36	6.81	-0.98	9.28
	10	13.39	23.80	15.71	8.23	18.29
	20	23.10	33.37	25.10	17.89	28.07
	30	32.95	43.09	34.45	27.58	37.70
	40	42.64	52.69	43.71	37.16	47.12
	50	52.30	62.33	53.12	46.80	56.79
	60	61.92	71.65	61.98	55.77	66.10
	70	71.69	81.40	71.32	65.44	75.87
	80	81.52	91.33	80.89	75.19	85.60
	90	91.01	101.09	90.23	85.05	95.59
	100	101.31	110.97	99.85	94.78	105.34
	110	111.48	121.03	109.71	105.11	115.51
OTP; 190 V / 50 Hz	117	119.28	129.15	117.55	112.42	123.19
Recovery; 190 V / 50 Hz	53	58.08	62.83	65.18	61.33	61.86
190 V / 50 Hz Enclosed (30 °C External Ambient)	64	54.28	78.39	74.10	70.15	67.79
265 V / 50 Hz Enclosed (30 °C External Ambient)	65	54.30	81.11	76.26	71.11	69.66

Table 2 – Thermal Measurement.

9.3 感熱掃描

Open-frame thermal measurement at 25°C ambient.UUT was soaked for 1 hour to achieve steady-state before the measurements were made.

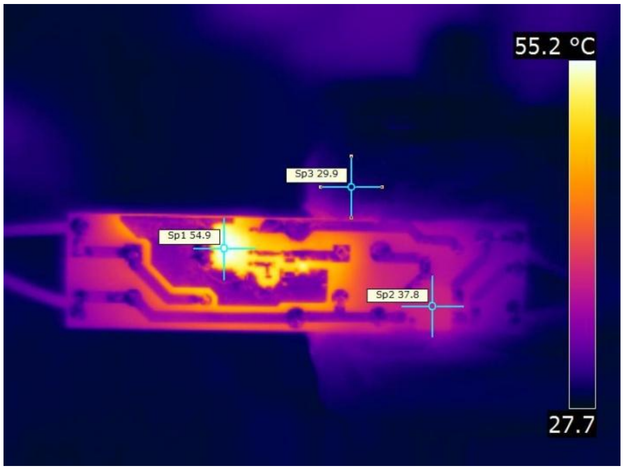

Figure 12 – Temperature (°C) at Bottom Side of PCB.SP1 – U1, LYT0006D.SP2 – BR1, Bridge Rectifier.SP3 – Ambient.

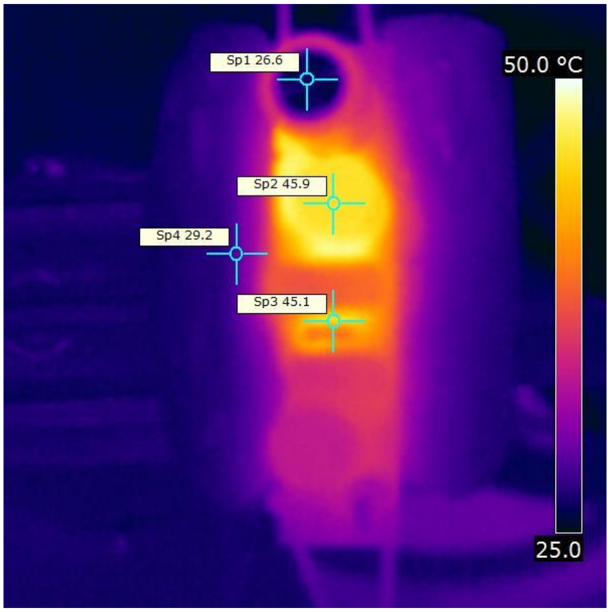

Figure 13 – Temperature (°C) at Top Side of PCB.SP1 – Output Capacitor.SP2 – L2, Power inductor.SP3 – D1, Freewheeling Diode.SP4 – Ambient.

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10 波形

10.1 正常運作下的汲極電壓和電流

Missing pulses are normal and are used to regulate the output current.These missing pulses are present every time the sense resistors (R2, R3) voltage-drop reaches 1.65 V. The unit will enter into auto-restart if there is not at least one missing pulse within a 50 ms period.For some designs where the power inductance is high and the circuit is operating (mostly) in CCM, a period of reverse current may be present.This can be avoided by increasing the device size or increase input capacitance or adding a drain blocking diode.See AN-60 for additional information.

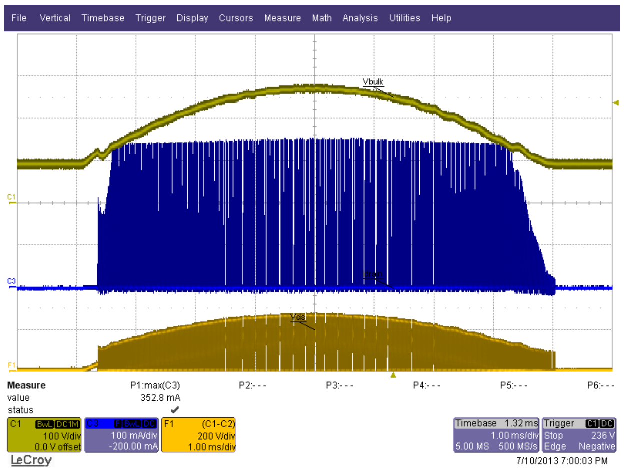

Figure 14 – 190 VAC, 50 Hz, Nominal V_{LED} Load.
F1 (Orange):V_{D-S}, 200 V / div.
Ch1 (Yellow):V_{D-G}, 100 V / div.
Ch3 (Blue):I_{DRAIN}, 100 mA / div.
Time Scale:1 ms / div.

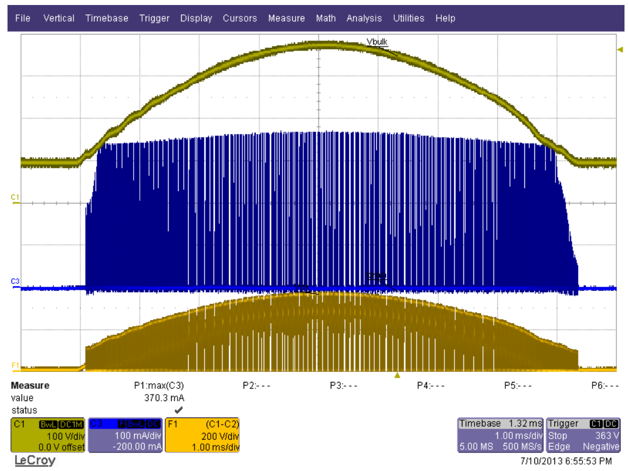

Figure 15 – 265 VAC, 50 Hz, Nominal V_{LED} Load.
F1 (Orange):V_{D-S}, 200 V / div.
Ch1 (Yellow):V_{D-G}, 100 V / div.
Ch3 (Blue):I_{DRAIN}, 100 mA / div.
Time Scale:1 ms / div.

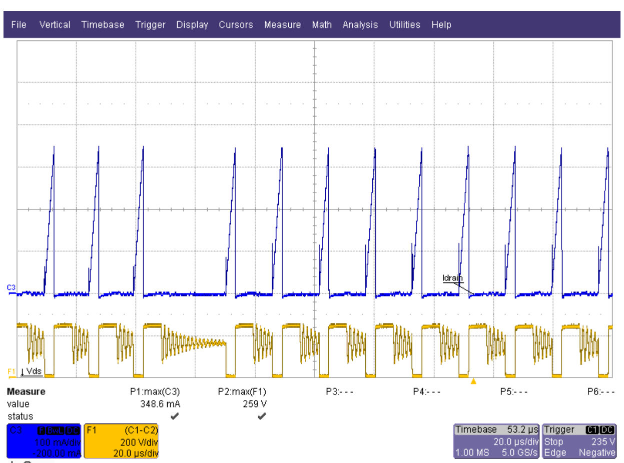

Figure 16 – 190 VAC, 50 Hz, Nominal V_{LED} Load.
F1 (Orange):V_{D-S}, 200 V / div. Ch3 (Blue):I_{DRAIN}, 100 mA / div.
Time Scale:20 µs / div.

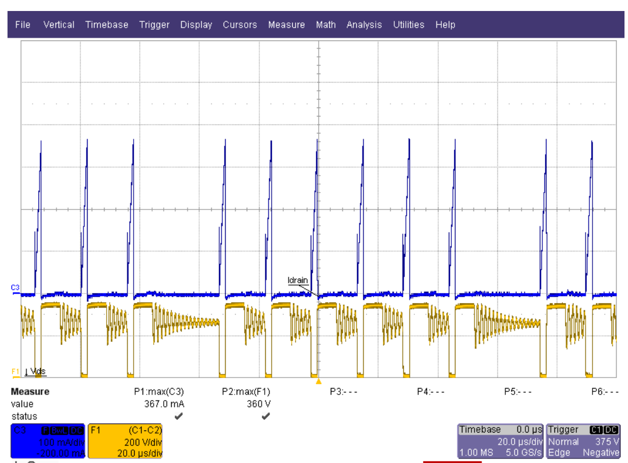

Figure 17 – 265 VAC, 50 Hz, Nominal V_{LED} Load.
F1 (Orange):V_{D-S}, 200 V / div. Ch3 (Blue):I_{DRAIN}, 100 mA / div.
Time Scale:20 µs / div.

10.2 輸出短路時的汲極電壓和電流

Device is operating within range, no inductor saturation was observed.

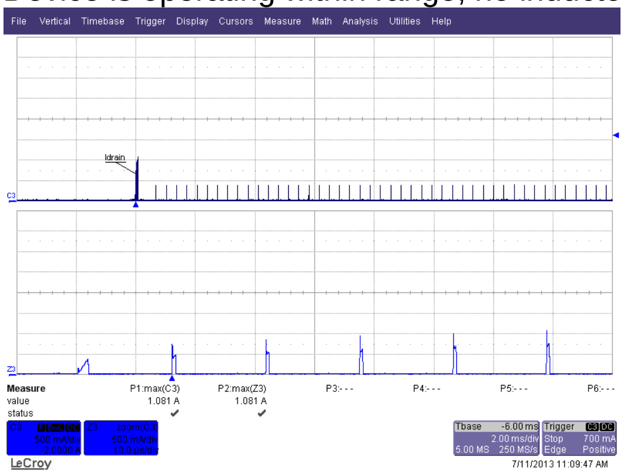

Figure 18 – LYT0006D Output Short.265 VAC.
Ch3:I_{DRAIN}, 0.5 A / div.
Time Scale:2 ms / div.
Z4:V_{D-S}, 0.5 A / div.
Zoom Time Scale:10 µs / div.

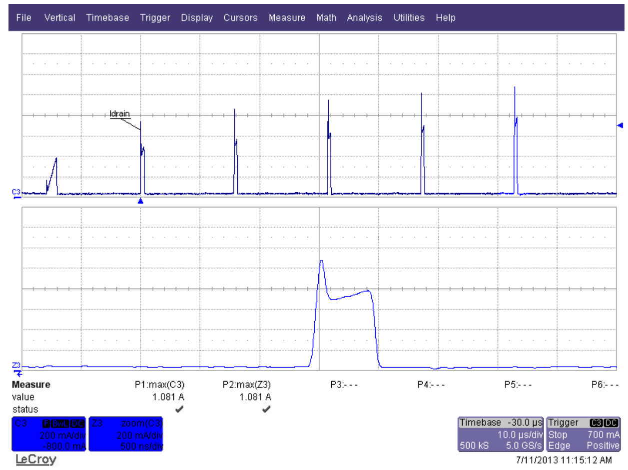

Figure 19 – LYT0006D Output Short.265 VAC.
Ch4:I_{DRAIN}, 0.2 A / div.
Time Scale:10 µs / div.
Z4:V_{D-S}, 0.2 A / div.
Zoom Time Scale:500 ns / div.

10.3 汲極電壓和電流啓動分析

Device is operating within range, no inductor saturation was observed.

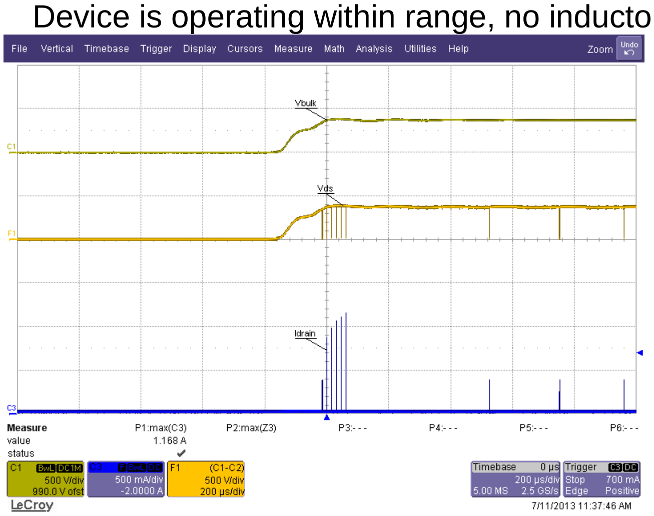

Figure 20 – 265 VAC / 50 Hz Start-up.
Ch1:Bulk Input, 500 V / div.
Ch3:Z4:I_{DRAIN}, 0.5 A / div.
Time Scale:200 µs / div.
F1:V_{D-S}, 500 V / div.
Zoom Time Scale:200 µs / div.

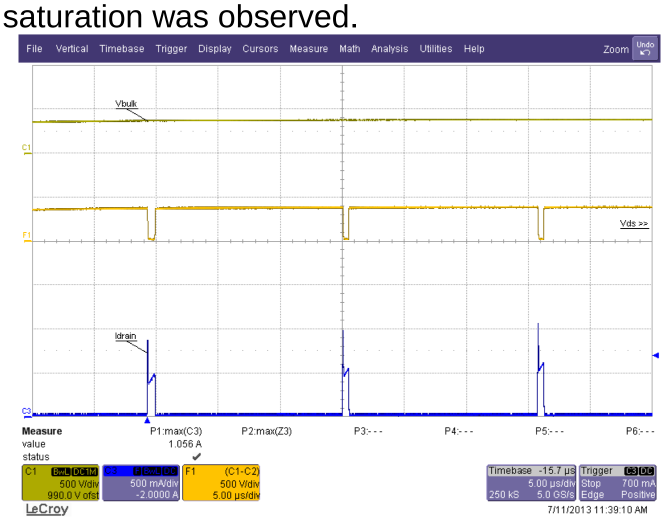

Figure 21 – 265 VAC / 50 Hz Start-up.
Ch1:Bulk Input, 500 V / div.
Ch3:Z4:I_{DRAIN}, 0.5 A / div.
Time Scale:200 µs / div.
F1:V_{D-S}, 500 V / div.
Zoom Time Scale:200 µs / div.

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10.4 輸出電流啓動分析

Output current/light is present within one AC cycle (<100 ms).

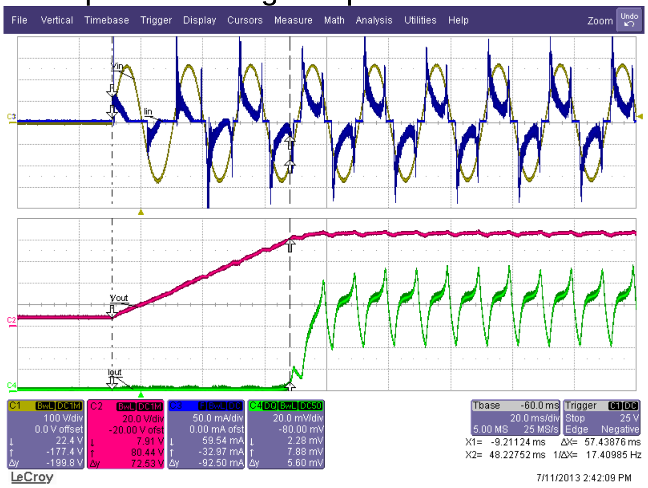

Figure 22 – 190 VAC, 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 20 ms / div.

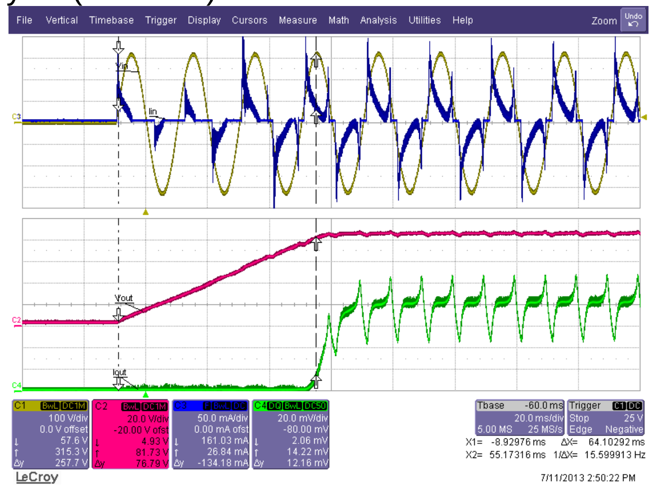

Figure 23 – 230 VAC, 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 20 ms / div.

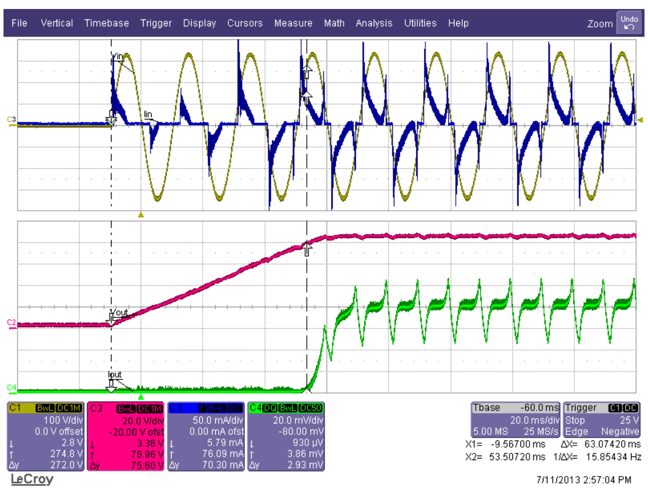

Figure 24 – 240 VAC, 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 20 ms / div.

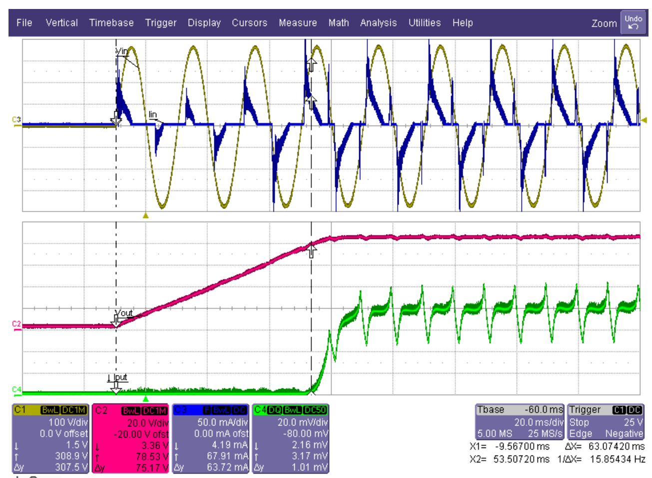

Figure 25 – 265 VAC, 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 20 ms / div.

10.5 輸入-輸出分析

There is no limitation to the amount of output capacitance that can be added.If the application requires less output current ripple then increasing the output capacitance is straightforward.Note that the output current waveform below will change depending on LED load impedance which varies according to LED type.

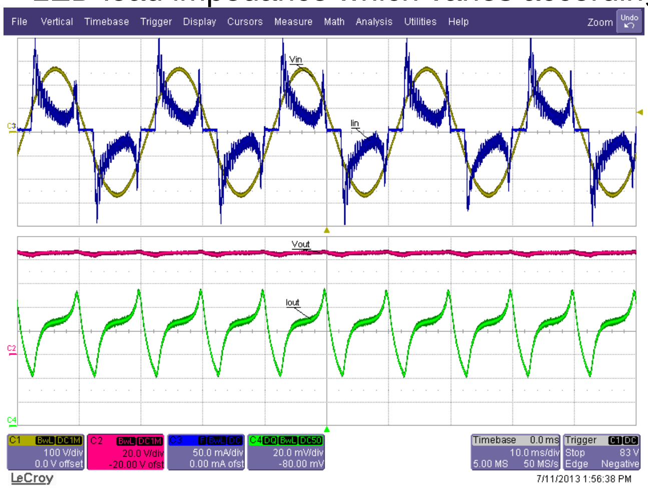

Figure 26 – 190 VAC / 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 10 ms / div.

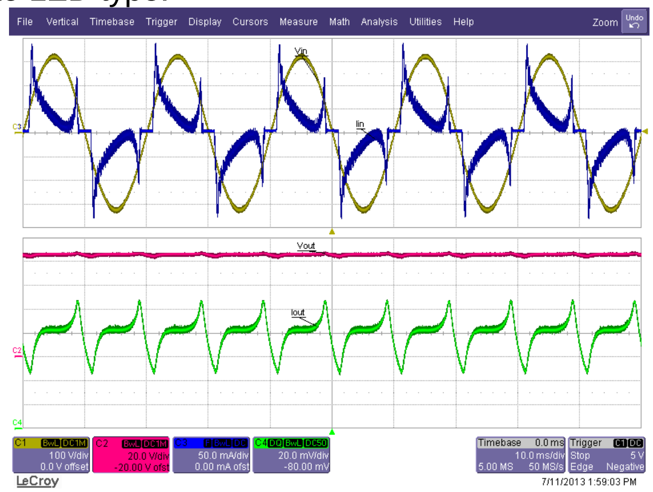

Figure 27 – 230 VAC / 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 10 ms / div.

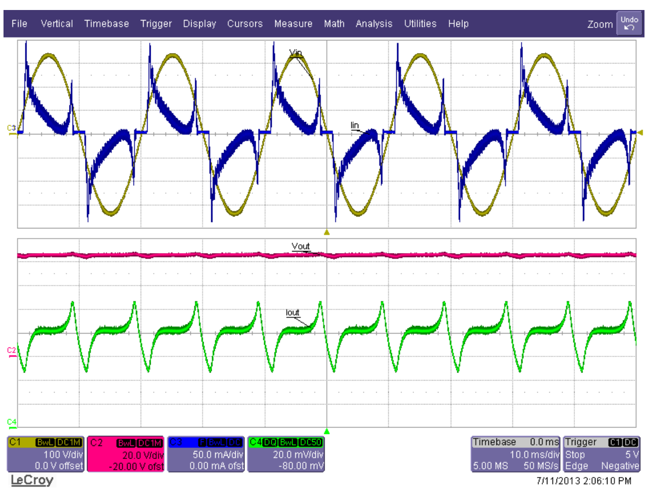

Figure 28 – 240 VAC / 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 10 ms / div.

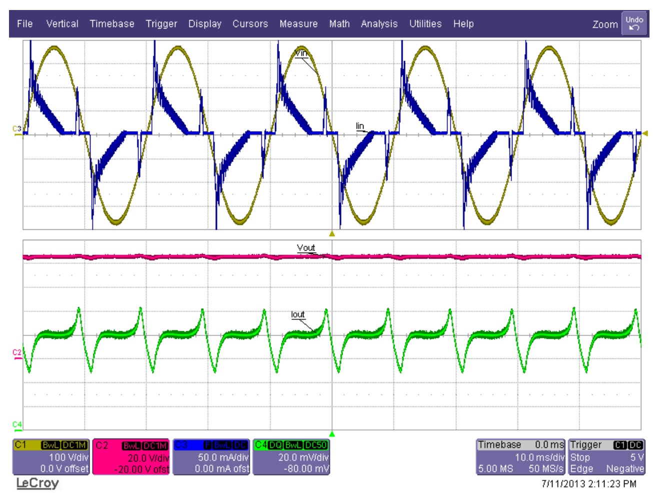

Figure 29 – 265 VAC / 50 Hz, Nominal V_{LED} Load.
Ch1 (Yellow):V_{IN}, 100 V / div.
Ch2 (Red):V_{OUT}, 20 V.
Ch3 (Blue):I_{IN}, 50 mA / div.
Ch4 (Green):I_{OUT}, 20 mA / div, 10 ms / div.

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10.6 線電壓弛波和突波

An inherent advantage of the buck converter implemented with the LYTSwitch-0 family is the imperceptible start-up delay, the driver will turn-on within 100 ms as shown below.No failure of any component occurred during line fluctuation tests.

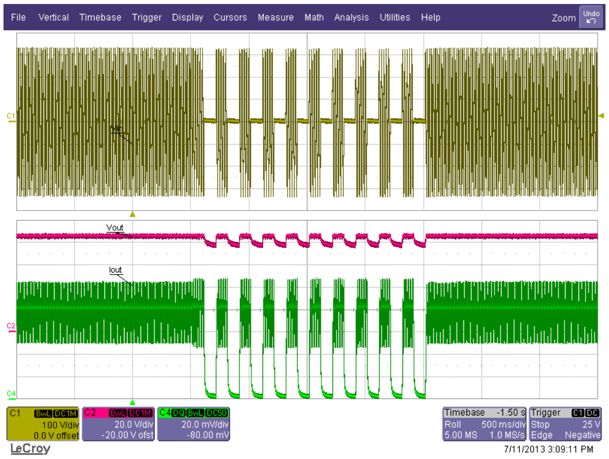

Figure 30 – Line Sag Test at 230 - 0 V at 0.1 Second Interval.
Ch1:V_{IN}, 100 V / div.
Ch2:V_{OUT}, 20 V / div.
Ch4:I_{OUT}, 50 mA / div.
Time Scale:500 ms / div.

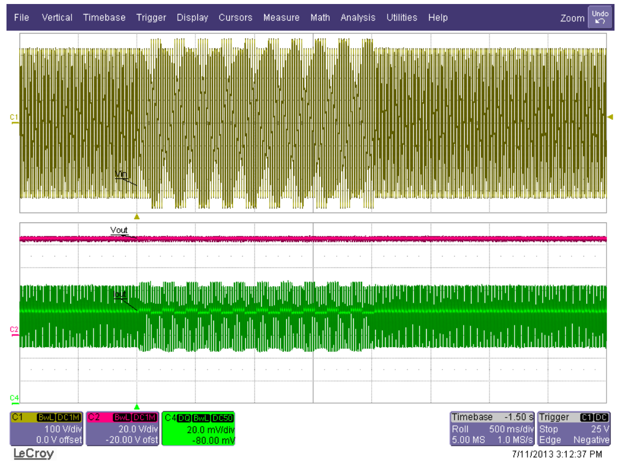

Figure 31 – Line Surge Test at 230 - 265 V at 0.1 Second Interval.
Ch1:V_{IN}, 100 V / div.
Ch2:V_{OUT}, 20 V / div.
Ch4:I_{OUT}, 50 mA / div.
Time Scale:500 ms / div.

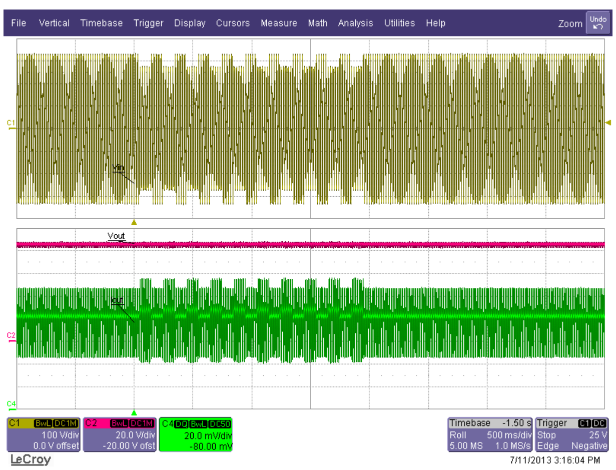

Figure 32 – Line Surge Test at 230 - 190 V at 0.1 Second Interval.
Ch1:V_{IN}, 100 V / div.
Ch2:V_{OUT}, 20 V / div.
Ch4:I_{OUT}, 50 mA / div.
Time Scale:500 ms / div.

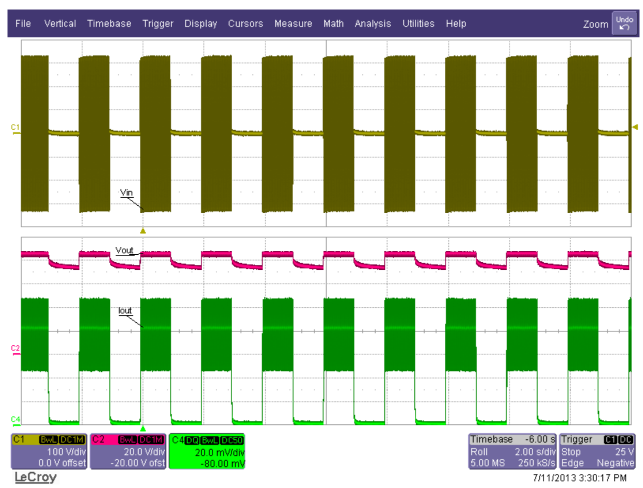

Figure 33 – Line Sag Test at 230 - 0 V at 1 Second Interval.
Ch1:V_{IN}, 100 V / div.
Ch2:V_{OUT}, 20 V / div.
Ch4:I_{OUT}, 50 mA / div.
Time Scale:2 s / div.

10.7 單擊無負載保護

The reference design is protected with one shot no-load protection.Zener diode VR1 will need to be replaced after the fault.

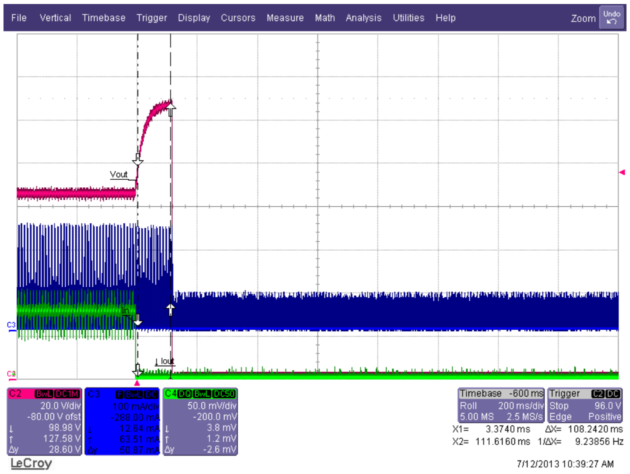

Figure 34 – No-Load Protection When Load is Disconnected.265 V / 50 Hz.Ch2:V_{OUT}, 20 V / div. Ch3:I_{DRAIN}, 100 mA / div. Ch3:I_{OUT}**,** 50 mA / div. Time Scale:200 ms / div.

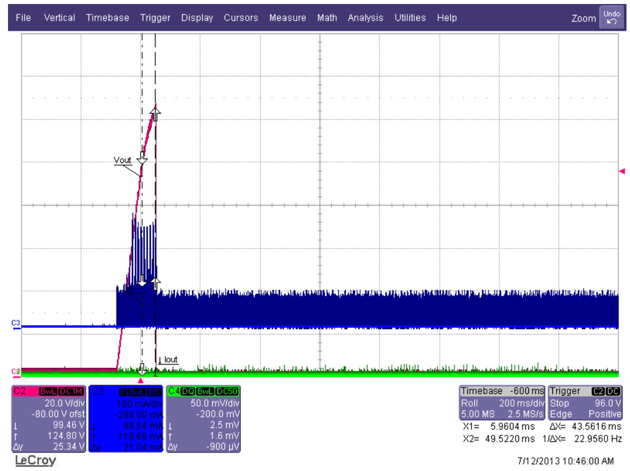

Figure 35 – No-Load Start-Up.265 V / 50 Hz.Ch2:V_{OUT}, 20 V / div. Ch3:I_{DRAIN}, 100 mA / div. Ch3:I_{OUT}, 50 mA / div. Time Scale:200 ms / div.

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10.8 電壓關閉/電壓啓動

No failure of any component during brownout test of 1 V / sec and 10 V / sec AC cut-in and cut-off.Consider the peak current at 132 mApk with an average of 75 mA_{AVG} during brown-out for LED absolute maximum rating.

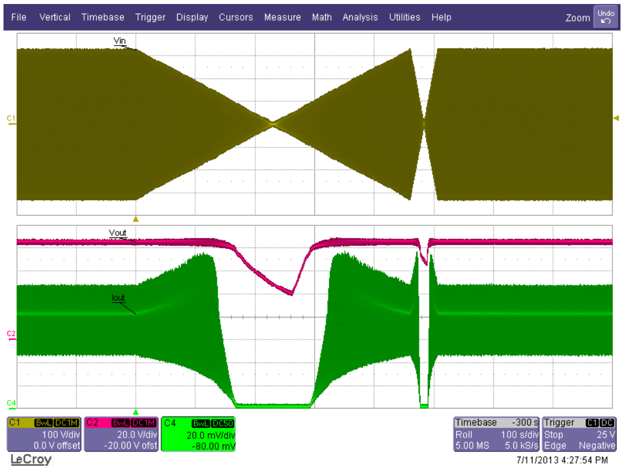

Figure 36 – Brown-out Test at 1 V / s and 10 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.230 V - 0 - 230 V
Ch1:V_{IN}, 100 V / div.
Ch1:V_{OUT}, 20 V / div.
Ch3:I_{OUT}, 20 mA / div.
Time Scale:100 s / div.

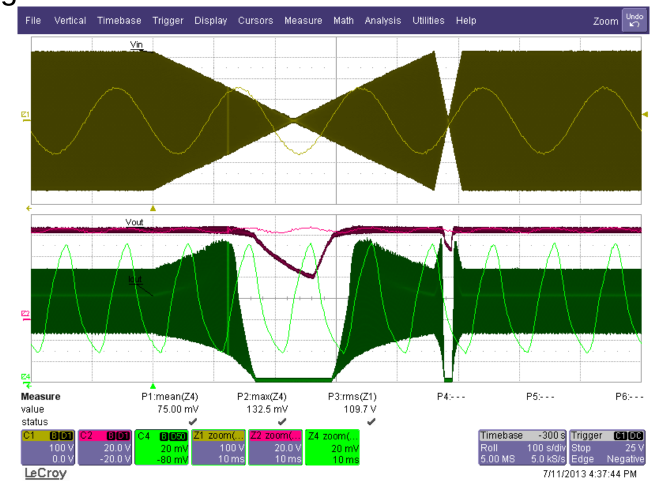

Figure 37 – Brown-out Test at 1 V / s and 10 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.230 V - 0 - 230 V
Ch1:V_{IN}, 100 V / div.
Ch1:V_{OUT}, 20 V / div.
Ch3:I_{OUT}, 20 mA / div.
Time Scale:100 s / div.

11 線電壓突波

Differential input line 500V / 50 μs surge testing was completed on a single test unit following the test method described in IEC61000-4-5. Input voltage was set at 230 VAC / 60 Hz.Full output load applied and operation was verified following each surge event.

Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
+500	230	L to N	90	Pass
-500	230	L to N	90	Pass
+500	230	L to N	270	Pass
-500	230	L to N	270	Pass
+500	230	L to N	0	Pass
-500	230	L to N	0	Pass

Unit passed testing under all conditions.

Differential ring input line surge testing was completed on a single test unit following the test method described in IEC61000-4-5. Input voltage was set at 230 VAC / 60 Hz.Full output load was applied and operation was verified following each surge event.

Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
+2500	230	L to N	90	Pass
-2500	230	L to N	90	Pass
+2500	230	L to N	270	Pass
-2500	230	L to N	270	Pass
+2500	230	L to N	0	Pass
-2500	230	L to N	0	Pass

Unit passed testing under all conditions.

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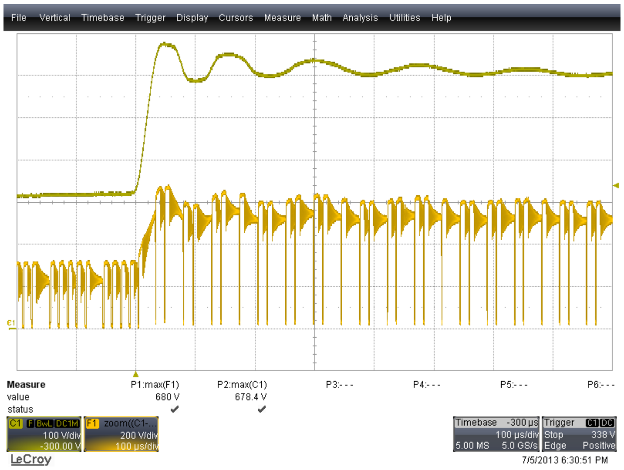

Figure 38 – Differential Line Surge at 500 V / 90°.Peak Drain Voltage Recorded is 680 V.
Ch1:V_{BULK}, 100 V / div.
F1:V_{DRAIN}, 200 V / div.
Time Scale:100 µs / div.

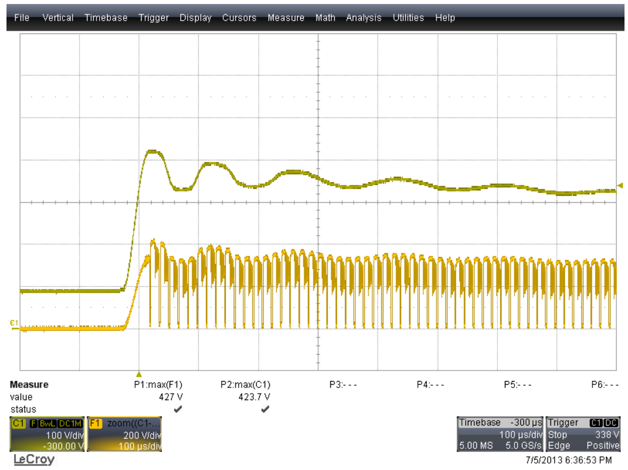

Figure 39 – Differential Line Surge at 500 V / 90°.Peak Drain Voltage Recorded is 427 V.
Ch1:V_{BULK}, 100 V / div.
F1:V_{DRAIN}, 200 V / div.
Time Scale:100 µs / div.

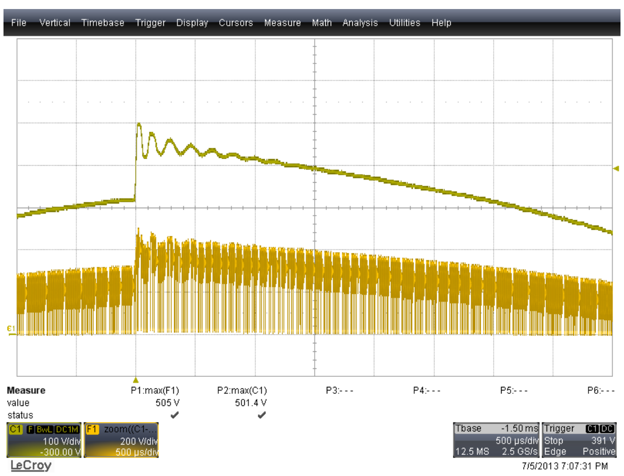

Figure 40 – Differential Ring Surge at 2500 V / 90°.Peak Drain Voltage Recorded is 505 V.
Ch1:V_{BULK}, 100 V / div.
F1:V_{DRAIN}, 200 V / div.
Time Scale:500 µs / div.

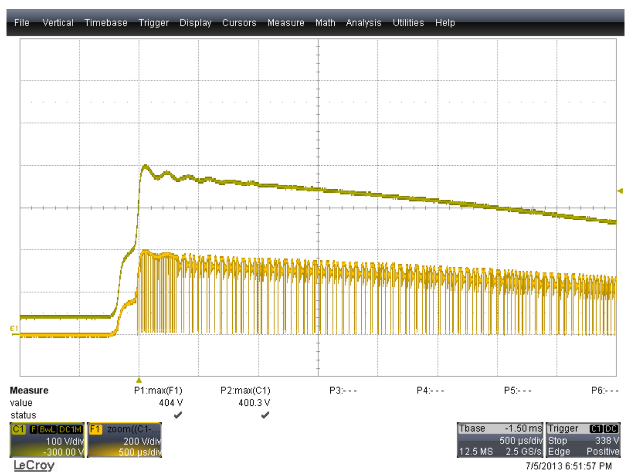

Figure 41 – Differential Ring Surge at 2500 V / 0°.Peak Drain Voltage Recorded is 404 V.
Ch1:V_{BULK}, 100 V / div.
F1:V_{DRAIN}, 200 V / div.
Time Scale:500 µs / div.

12 傳導性 EMI

Figure 42 – The Retrofit Lamp was Verified Inside a Conical Metal Cone as per EN55015.

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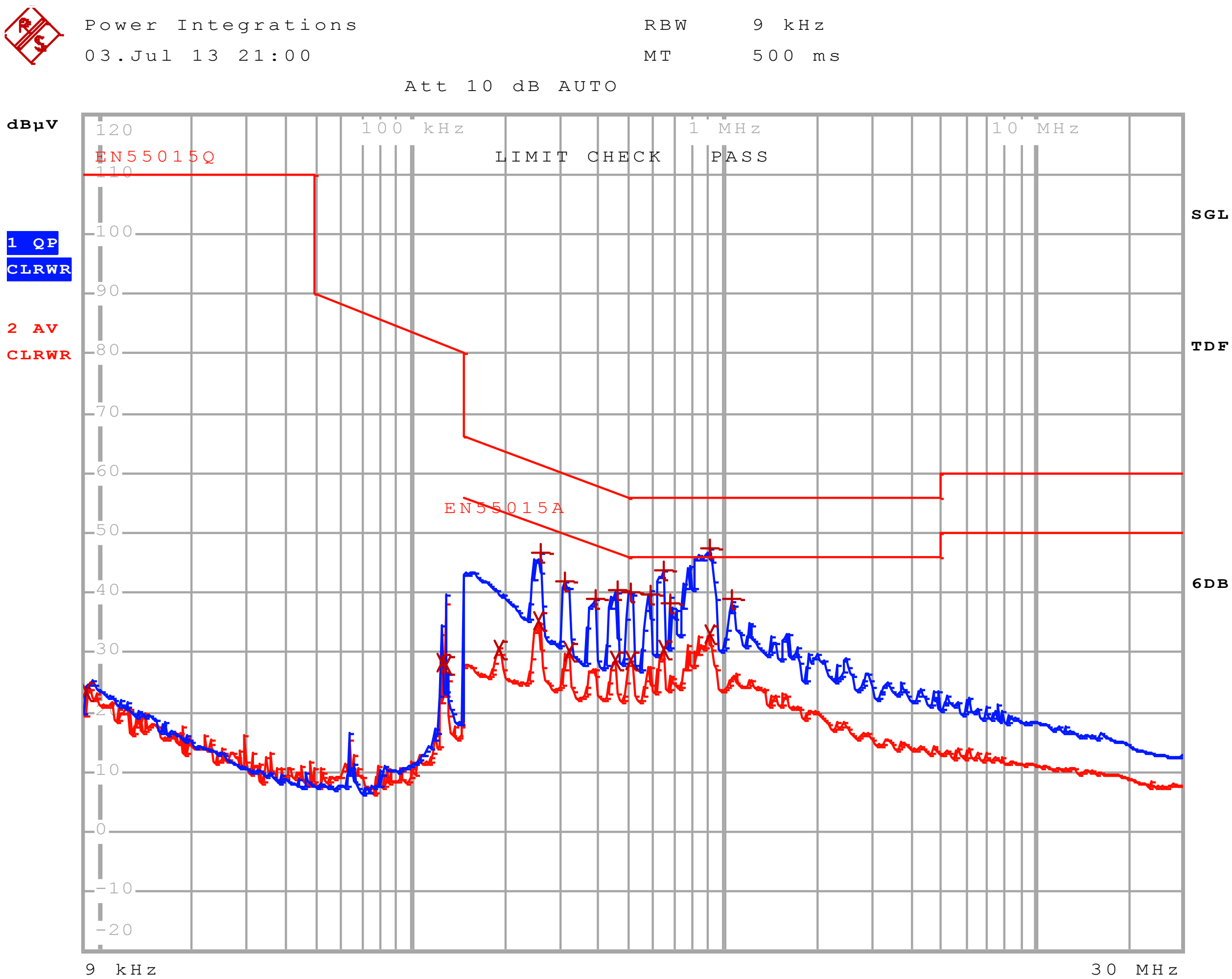

Figure 43 – Conducted EMI, Maximum Steady State Load, 230 VAC, 60 Hz, and EN55015 B Limits.Enclosed Unit in a Typical A19 Bulb Replacement Housing.

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
2	Average	9.09 kHz	23.57	N gnd	
2	Average	125.720633819 kHz	28.32	N gnd	
2	Average	129.530094744 kHz	27.83	L1 gnd	
2	Average	192.364799253 kHz	30.64	L1 gnd	-23.29
2	Average	256.711570318 kHz	35.38	N gnd	-16.15
1	Quasi Peak	259.278686021 kHz	46.59	L1 gnd	-14.85
1	Quasi Peak	310.135545783 kHz	42.05	L1 gnd	-17.90
2	Average	322.728292586 kHz	30.28	N gnd	-19.35
1	Quasi Peak	389.890938834 kHz	39.15	L1 gnd	-18.90
2	Average	452.651275966 kHz	28.63	N gnd	-18.19
1	Quasi Peak	457.177788726 kHz	40.31	N gnd	-16.42
1	Quasi Peak	505.008700673 kHz	40.18	L1 gnd	-15.81
2	Average	510.05878768 kHz	28.59	N gnd	-17.40
1	Quasi Peak	586.299423673 kHz	39.77	L1 gnd	-16.22
1	Quasi Peak	647.639315505 kHz	43.74	L1 gnd	-12.25
2	Average	647.639315505 kHz	30.70	N gnd	-15.29
1	Quasi Peak	680.675429436 kHz	38.42	L1 gnd	-17.57
1	Quasi Peak	908.363999266 kHz	47.31	L1 gnd	-8.68
2	Average	908.363999266 kHz	33.01	N gnd	-12.98
1	Quasi Peak	1.06512822736 MHz	39.04	L1 gnd	-16.95

Table 3 – Conducted EMI, Maximum Steady State Load, 230 VAC, 60 Hz, and EN55015 B Limits.Enclosed Unit in a Typical A19 Bulb Replacement Housing.

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13 修訂記錄

日期	作者	修訂	**Description & changes**	**Reviewed**
04-Oct-13	JDC	1.0	Initial Release	Apps & Mktg

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