設計範例報告

標題	***採用 LYTSwitch™-4 LYT4322E 的 12 W 高功率因數 (PF) 非隔離升降壓式可調光雙向閘流器 (TRIAC) LED 驅動器***
規格	190 VAC – 265 VAC 輸入； 120 V_{TYP}，100 mA 輸出
應用	A19 LED 驅動器
作者	應用工程部門
文件編號	DER-412
日期	2014 年 6 月 9 日
修訂	1.0

摘要與功能

- Single-stage 功率因數修正 (PFC) 結合定電流 (CC) 輸出
- 可調光雙向閘流器 (TRIAC)
  - 可選擇使用廣泛的雙向閘流器 (TRIAC) 調光器 (300 W 至 1200 W)
  - 快速啓動 (小於 200 ms) – 無可感延遲
- 整合式保護與信賴度特性
  - 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
  - 在電壓關閉情況下，不會發生任何損壞
- 230 VAC 時功率因數 (PF) 大於 0.9
- 符合振盪波、線電壓高壓突波和 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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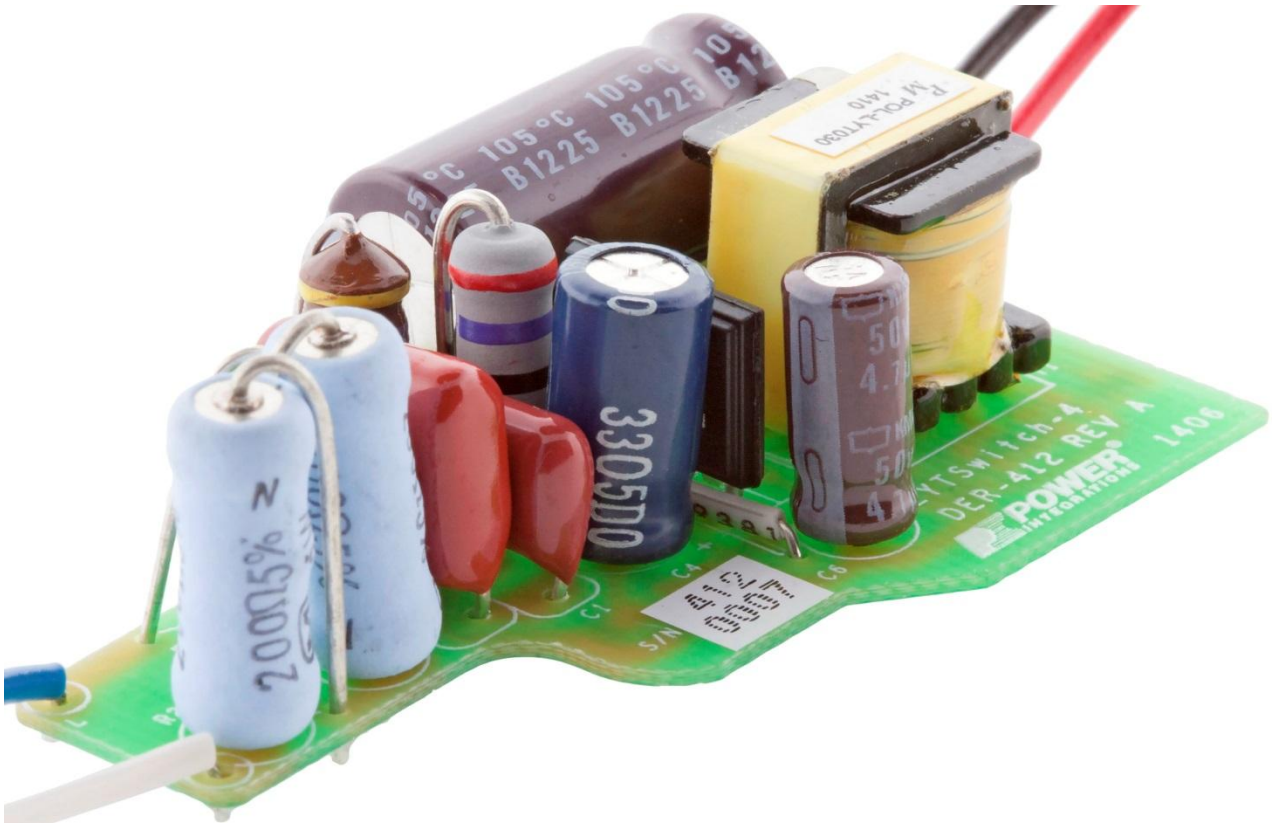
1 簡介

本文件說明非隔離式高功率因數 (PF) 可調光雙向閘流器 (TRIAC) LED 驅動器，其設計爲輸入電壓範圍爲 190 VAC 至 265 VAC (典型值 50 Hz) 時，於 100 mA 下驅動 120 V 的標準 LED 串電壓。此 LED 驅動器採用 LYTSwitch-4 IC 系列中的 LYT4322E。

此設計使用 Single-stage 非隔離升降壓式架構，以符合此設計的高功率因數 (PF)、定電流調節和調光要求。

本文件包含 LED 驅動器規格、電路圖、PCB 詳情、物料清單、變壓器文件及典型效能特性。



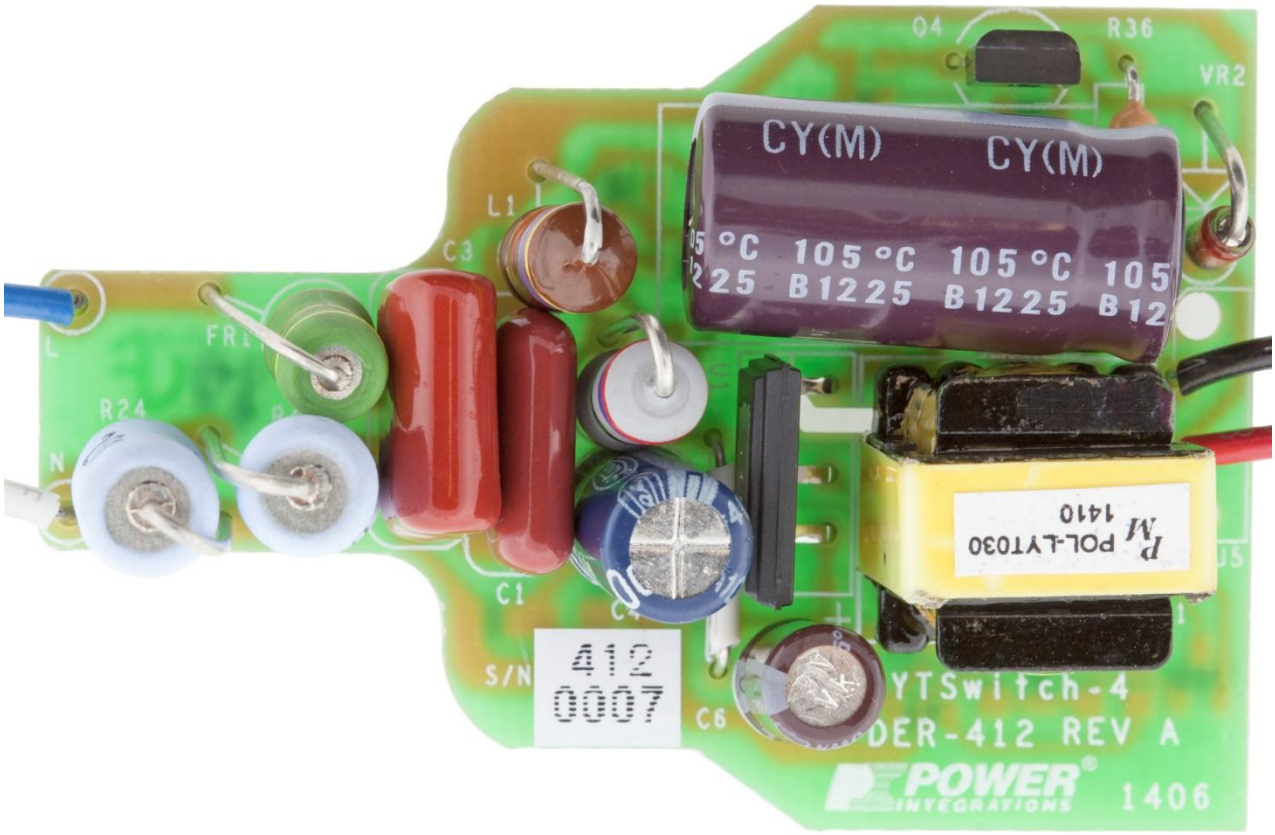


Figure 1 – Populated Circuit Board, Top View.

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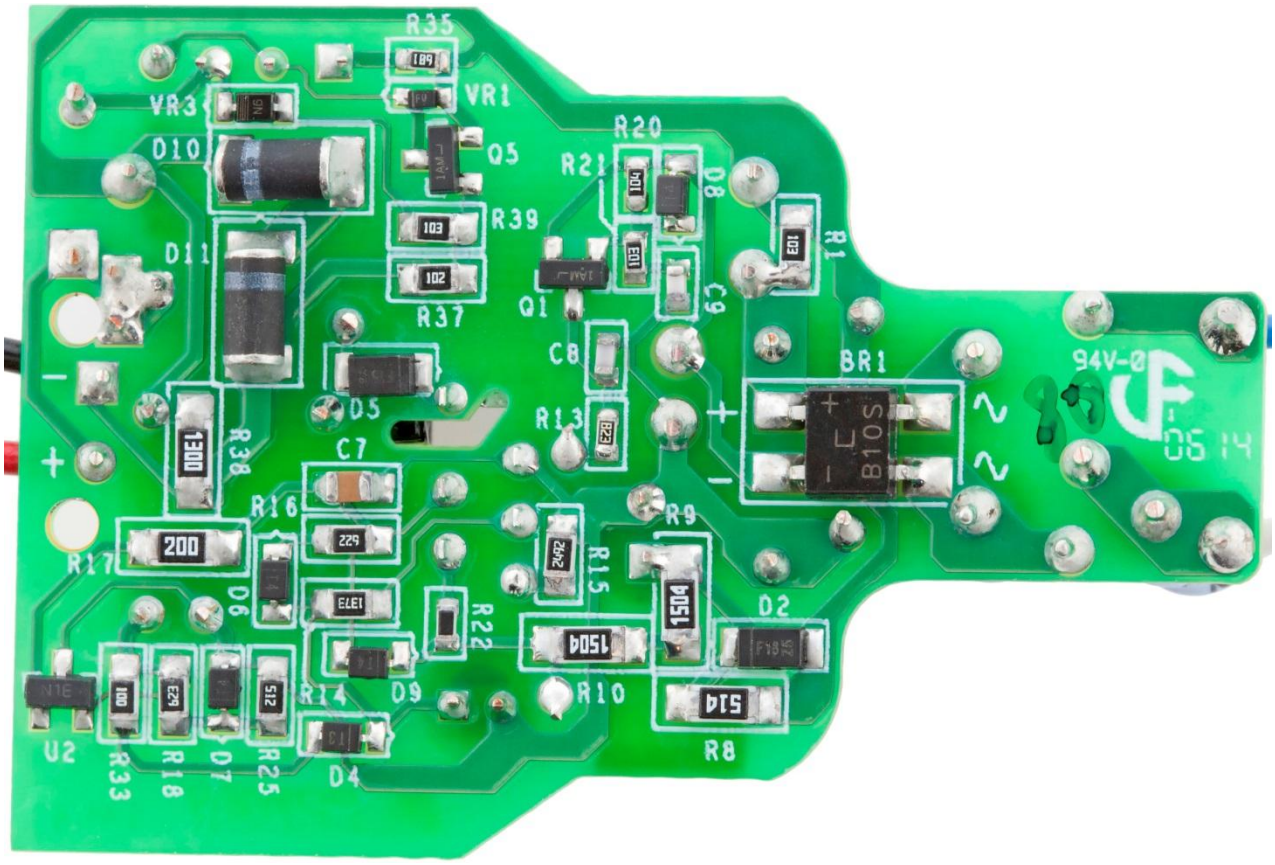

Figure 2 – Populated Circuit Board, Bottom View.

2 電源供應器規格

下表列出此設計可接受的最低效能。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	V_{IN}	190	230	265	VAC	雙線 – 無 P.E.
頻率	f_{LINE}		50		Hz	
輸出						
輸出電壓	V_{OUT}		120		V	
輸出電流	I_{OUT}	93	100	107	mA	V_{OUT} = 120 V，V_{IN} = 230 VAC，25°C
總輸出功率						
連續輸出功率	P_{OUT}		12		W	
效率						
滿載	η	84	85		%	在 P_{OUT} 25°C、無調光器、230 VAC 輸入條件下測量
環境						
傳導性 EMI		CISPR 15B / EN55015B				
安全		非隔離式				
振盪波 (100 kHz)						
差模 (L1-L2)			2.5		kV	
差模突波			500		V	
功率因數 (PF)			0.9			在 $V_{OUT(TYP)}$、$I_{OUT(TYP)}$ 及 230 VAC、50 Hz 條件下測量
環境溫度	T_{AMB}		40		°C	自然對流，開放式架構 *最後組裝時需考慮環氧灌注，以增加工作溫度並減少阻尼器 R24 和 R40 上的熱應力

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3 電路圖

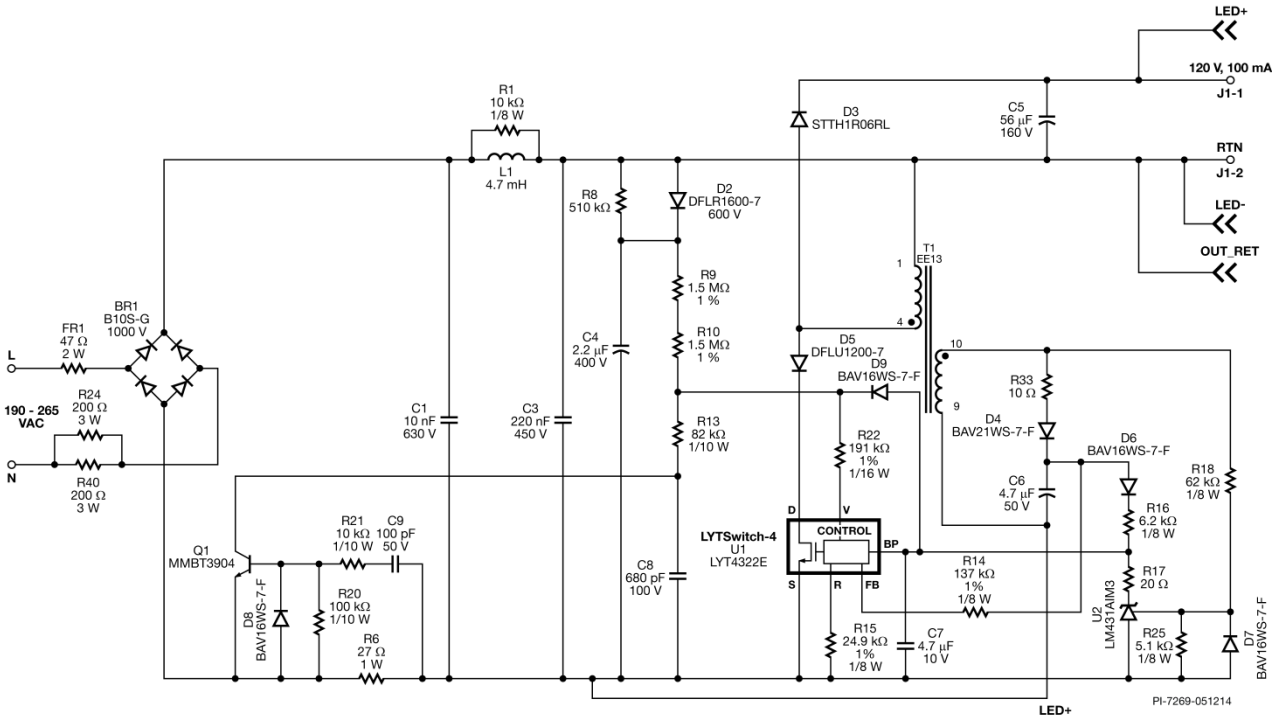

Figure 3 – Schematic.

Note: JP1 is 0 Ω 1206 smd resistor in R38 location if optional turn-off circuit is not used.

4 電路說明

LYTSwitch-4 LYT4322E 裝置是採用整合式 725 V 功率 MOSFET 的控制器，適用於 LED 驅動器應用。LYTSwitch-4 LYT4322E 設定用於Single-stage 升降壓式架構，可提供已調整的一次側定電流輸出，同時保持 AC 輸入端的高功率因數 (PF)。

4.1 輸入 EMI 濾波

可熔電阻器 FR1 可在異常狀況下防止元件發生故障。橋式整流器 BR1 可利用電容器 C3 對 AC 線間電壓進行整流，來爲一次側切換電流提供低阻抗路徑 (去耦合)。爲保持功率因數 (PF) 大於 0.9，需要使用小輸入電容值 (C1 與 C3 之和)。EMI 濾波由電感器 L1 以及電容器 C1 和 C3 提供。

4.2 電源電路

此設計選用了低壓側切換升降壓式架構，設定爲在 190 VAC 至 265 VAC 輸入電壓範圍內提供高功率因數 (PF) 和定電流輸出。

每當 U1 關閉時，輸出二極體 D3 就會傳導，並將能量輸送到負載。需要使用二極體 D5，才能在 C3 上的電壓 (整流後的輸入 AC) 降到低於輸出電壓時防止反向電流流經 U1。

爲了提供峰值線電壓資訊給 U1，輸入整流 AC 峰值電壓會透過 D2 爲 C4 充電。然後，該電壓將以透過 R9 和 R10 的電流形式饋送至 U1 的電壓監測器 (V) 接腳。選擇電阻器 R9 和 R10，可在 230 VAC 輸入時提供大約 100 µA 的 I_V (請見 PIXls 試算表)。

線電壓過壓關機功能 (透過 V 接腳電流感測) 可讓整流後的線電壓耐受度 (在突波和線間陡昇期間) 提高至內部功率 MOSFET 的 725 BV_{DSS} 額定值。

電容器 C7 會爲 U1 的 BP 接腳 (內部控制器的供電接腳) 提供本機去耦合。在啓動期間，會從 U1 的 D 接腳連接的內部高壓電流源將 C7 充電至約 6 V。

U1 的參考接腳透過 24.9 kΩ 電阻器 R15 接地 (源極)。

4.3 輸出回授

從偏壓繞組衍生的回授訊號，會由二極體 D4 和電容器 C6 組成的網路進行整流和濾波。電容器 C6 產生的輸出電壓資訊會由電阻器 R14 轉換爲回授電流。LYT4322E 使用此電流來調節轉換器的輸出電流。

4.4 TRIAC 相位調光控制相容性

爲了提供低成本的輸出調光功能，採用 TRIAC 的前緣觸發和後緣觸發相位調光器在設計時有些取捨。

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由於 LED 照明所消耗的功率小得多，因此，整體燈泡所汲取的電流會低於許多調光器內 TRIAC 的保持電流 (holding current)。這可能會導致不良狀況，如調光範圍受限和/或閃爍。由於 LED 驅動器無法抑制調光器內部及 EMI 通常所需之驅動器內部 LC 網路的回應，LED 提供給線間和調光器的較大阻抗會導致大幅振盪。這個效應會導致發生類似的不良情況，因爲振盪可能導致 TRIAC 電流降至零並關閉。

爲了解決這些問題，採用了被動阻尼器和無功損主動洩放器。

電阻器 R24 和 R40 用於抑制 TRIAC 調光期間的輸入網路。

透過增加在 AC 輸入的上升邊緣部分期間處理的功率，提供額外的阻尼。此方法可模擬被動 RC 洩放器的行爲，但在調光時不會有相關的功損及缺點。

4.5 無負載/開路負載保護

偏壓繞組上的輸出電壓是透過主繞組和偏壓繞組的圈數比來偵測的。電壓調整器 U2 會在自動重新啓動時強制 BP 接腳調節輸出電壓。分壓器 R25 和 R18 會設定偵測臨界值。當偏壓繞組上的電壓在開啓期間倒轉時，二極體 D7 會防止反向電流流經 U2。R17 用於限制流入 U2 的最大電流。

4.6 選用關閉電路

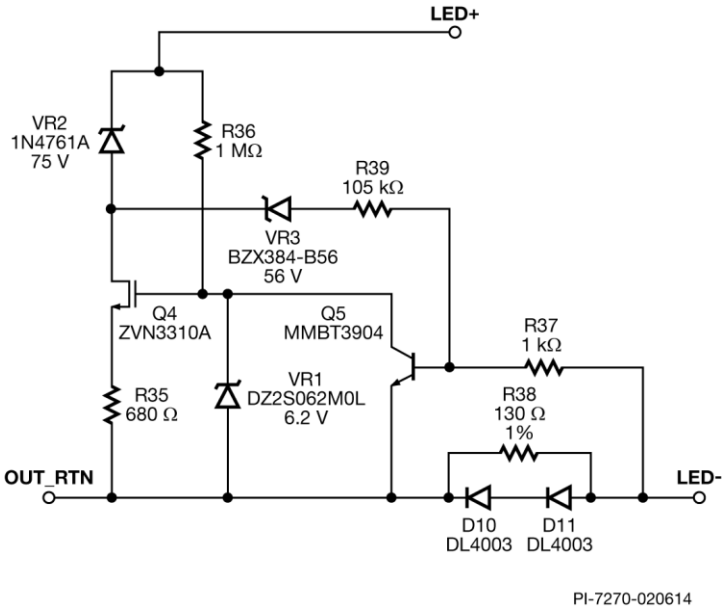

Figure 4 – Turn-off Circuit.

此設計中還融入了用於關閉深度調光期間 LED 電流的主動預載電路。這種關閉電路用於避免在驅動器搭配使用導通角小於 30^0 的調光器時發生輸出光線閃爍。導通角小於或等於 30^0 時，由於存在線間噪音且驅動器處理的功率太低而無法滿足調光器保持電流 (holding current)，調光器導通角更容易發生變化。這會導致照明輸出在極低導通角下發生閃爍。爲避免這一行爲，在輸出電流降至約 5 mA 時會終止 LED 的輸出電流。這個輸出電流臨界值由電阻器 R38 設定。如果 R38 上的壓降降至 0.65 V ($Q5_{Vbe}$) 以下，Q5 會關閉，Q4 會開啓。當 Q4 開啓時，輸出會分流爲 VR2 + $Q4_{VDS}$ + 約 4 V。在這一水平，LED 應關閉且所有輸出電流會分流至 Q4 分支。選用了電阻器 R35，以允許 Q4 分支汲取 4 V / R35 的電流。此電流略高於 5 mA 臨界值，以避免 Q4 分支與輸出端之間的回跳。R35 電壓由 Q4VGT – VR1 限制。此配置還會限制 Q4 分支上的最大功耗。

採用了二極體 D10 和 D11，以便將 R38 上的壓降限制爲兩個二極體壓降，從而確保 R38 在輸出短路情況下的效率和安全。VR3 和 R39 用於在開路負載狀況下關閉預載。選用了積納二極體 VR3，使得 VR2 + VR3 大於 LED 最大電壓。在 Q5 關閉時，電阻器 R36 會向 Q4 施加偏壓。

然而，輸出電流可在小於 1 mA 的範圍內。當調光器在最小調光器位置啓動時會發生此情況。當預載爲主動式並汲取 4 V / R35 的電流時會發生此情況。阻尼器應設計爲在 I_{OUT} 大於 4 V / R35 時不會閃爍，以避免閃爍。

如果驅動器搭配使用在 230 VAC、50 Hz 線電壓條件下最小導通角爲 45 度或更高的調光器，則可以省略關閉電路，使用跳線電阻器來取代 R38。

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5 PCB 佈局

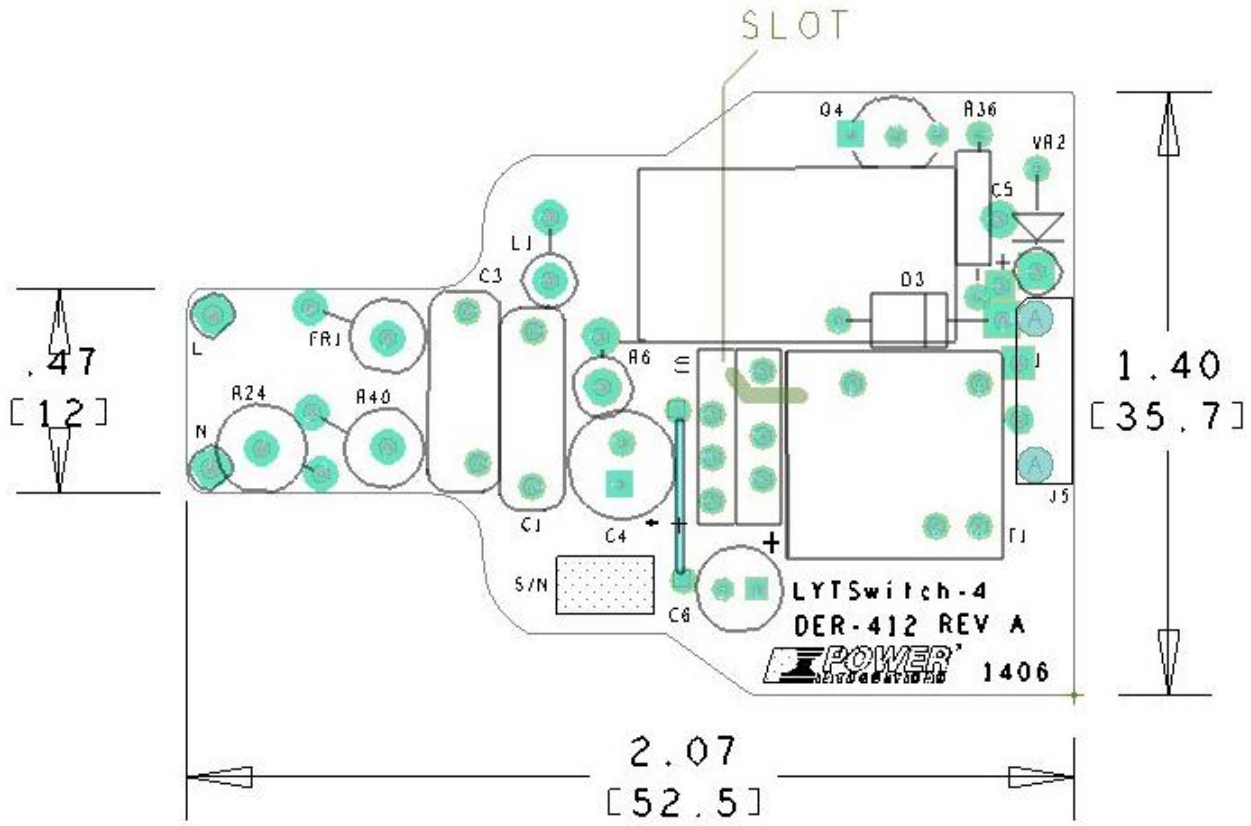

Figure 5 – Top Side.

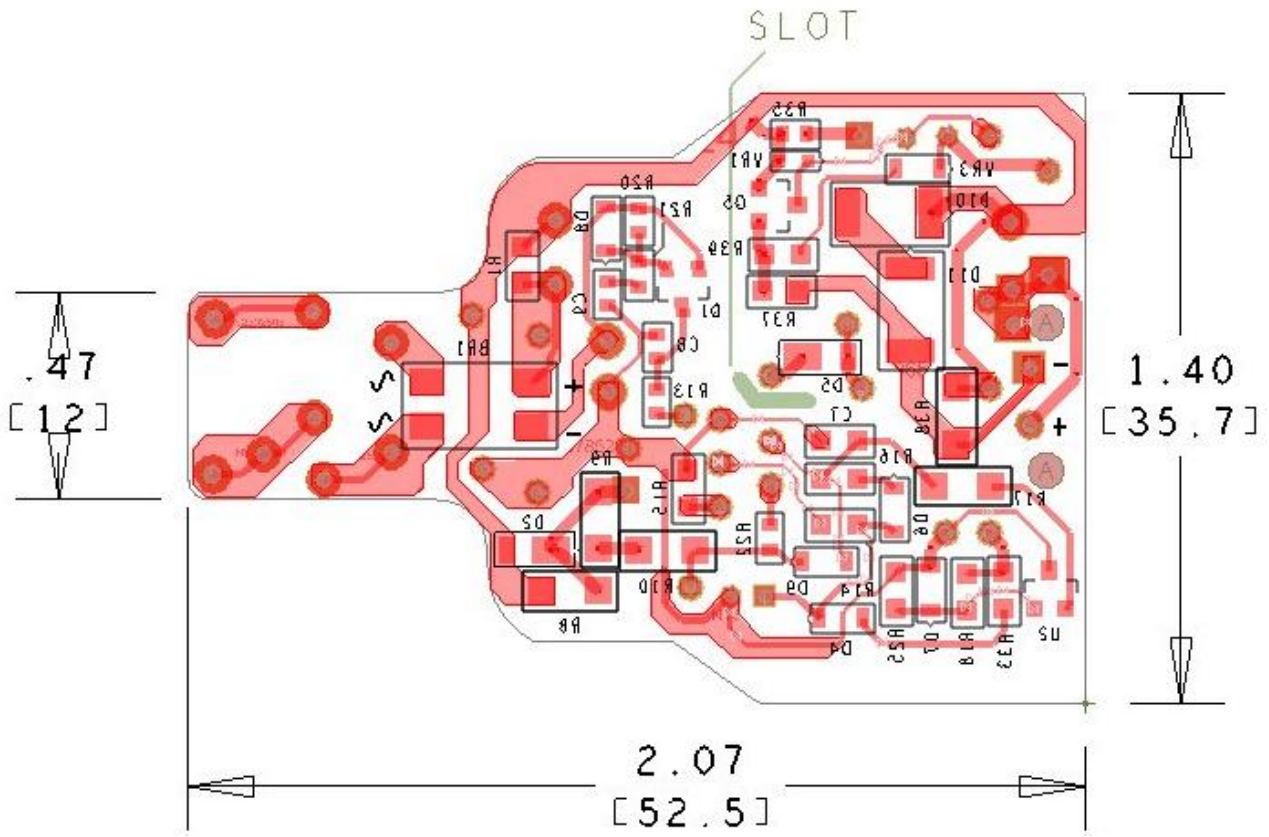

Figure 6 – Bottom Side.

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6 物料清單

6.1 無關閉電路時的 BOM

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR1	1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC	B10S-G	Comchip
2	1	C1	10 nF, 630 V, Film	ECQ-E6103KF	Panasonic
3	1	C3	220 nF, 450 V, Film	MEXXF32204JJ	Duratech
4	1	C4	2.2 µF, 400 V, Electrolytic, (6.3 x 11)	TAB2GM2R2E110	Ltec
5	1	C5	56 µF, 160 V, Electrolytic, Gen. Purpose, (10 x 20)	UCY2C560MPD1TD	Nichicon
6	1	C6	4.7 µF, 50 V, Electrolytic, Gen. Purpose, (5 x 11)	EKMG500ELL4R7ME11D	Nippon Chemi-Con
7	1	C7	4.7 µF, 10 V, Ceramic, X7R, 0805	CL21A475KBQNNNE	Samsung
8	1	C8	680 pF 100 V, Ceramic, NPO, 0603	CGA3E2C0G2A681J	TDK
9	1	C9	100 pF 50 V, Ceramic, NPO, 0603	CC0603JRNPO9BN101	Yageo
10	1	D2	600 V, 1 A, Rectifier, Glass Passivated, POWERDI123	DFLR1600-7	Diodes, Inc.
11	1	D3	600 V, 1 A, Ultrafast Recovery, DO-41	STTH1R06RL	ST Micro
12	1	D4	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
13	1	D5	DIODE, UFAST, 200 V, 1 A, POWERDI123	DFLU1200-7	Diodes, Inc.
14	1	D6	75 V, 0.15 A, Switching,SOD-323	BAV16WS-7-F	Diodes, Inc.
15	1	D7	75 V, 0.15 A, Switching,SOD-323	BAV16WS-7-F	Diodes, Inc.
16	1	D8	75 V, 0.15 A, Switching,SOD-323	BAV16WS-7-F	Diodes, Inc.
17	1	D9	75 V, 0.15 A, Switching,SOD-323	BAV16WS-7-F	Diodes, Inc.
18	1	FR1	47 Ω, 5%, 2 W, Wirewound, Fusible	FW20A47R0JA	Bourns
19	1	R38	0 Ω, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEY0R00V	Panasonic
20	1	L1	4.7 mH, 90 mA, 20 Ohm, RF Inductor	B82144A2475J	Epcos
21	1	Q1	NPN, Small Signal BJT, 40 V, 0.2 A, SOT-23	MMBT3904LT1G	On Semi
22	1	R1	10 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ103V	Panasonic
23	1	R6	27 Ω, 5%, 1 W, Metal Oxide	RSF100JB-27R	Yageo
24	1	R8	510 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ514V	Panasonic
25	1	R9	1.50 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF1504V	Panasonic
26	1	R10	1.50 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF1504V	Panasonic
27	1	R13	82 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ823V	Panasonic
28	1	R14	137 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF1373V	Panasonic
29	1	R15	24.9 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2492V	Panasonic
30	1	R16	6.2 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ622V	Panasonic
31	1	R17	20 R, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ200V	Panasonic
32	1	R18	62 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ623V	Panasonic
33	1	R20	100 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ104V	Panasonic
34	1	R21	10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
35	1	R22	191 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1913V	Panasonic
36	1	R24	200 Ω, 5%, 3 W, Metal Oxide	ERG-3SJ201	Panasonic
37	1	R25	5.1 k, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ512V	Panasonic
38	1	R33	10 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ100V	Panasonic
39	1	R40	200 Ω, 5%, 3 W, Metal Oxide	ERG-3SJ201	Panasonic
40	1	T1	Bobbin, EE13, Vertical, 10 pins Transformer Transformer	P-1302-2 SNX-R1731 POL-LYT030	Pin Shine Santronics Premier Magnetics
41	1	U1	LYTSwitch-4, eSIP-7C	LYT4322E	Power Integrations
42	1	U2	IC, REG ZENER SHUNT ADJ SOT-23	LM431AIM3/NOPB	National Semi
43	1	WIRE 24AWG	Wire, UL1007, #24 AWG, Red, PVC, 3 in	1007-24/7-2	Anixter

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

6.2 有關閉電路時的 BOM

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR1	1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC	B10S-G	Comchip
2	1	C1	10 nF, 630 V, Film	ECQ-E6103KF	Panasonic
3	1	C3	220 nF, 450 V, Film	MEXXF32204JJ	Duratech
4	1	C4	2.2 μF, 400 V, Electrolytic, (6.3 x 11)	TAB2GM2R2E110	Ltec
5	1	C5	56 μF, 160 V, Electrolytic, Gen. Purpose, (10 x 20)	UCY2C560MPD1TD	Nichicon
6	1	C6	4.7 μF, 50 V, Electrolytic, Gen. Purpose, (5 x 11)	EKMG500ELL4R7ME11D	Nippon Chemi-Con
7	1	C7	4.7 μF, 10 V, Ceramic, X7R, 0805	CL21A475KBQNNNE	Samsung
8	1	C8	680 pF 100 V, Ceramic, NPO, 0603	CGA3E2C0G2A681J	TDK
9	1	C9	100 pF 50 V, Ceramic, NPO, 0603	CC0603JRNPO9BN101	Yageo
10	1	D2	600 V, 1 A, Rectifier, Glass Passivated, POWERDI123	DFLR1600-7	Diodes, Inc.
11	1	D3	600 V, 1 A, Ultrafast Recovery, DO-41	STTH1R06RL	ST Micro
12	1	D4	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
13	1	D5	DIODE, UFAST, 200 V, 1 A, POWERDI123	DFLU1200-7	Diodes, Inc.
14	4	D6 D7 D8 D9	75 V, 0.15 A, Switching, SOD-323	BAV16WS-7-F	Diodes, Inc.
15	2	D10 D11	200 V, 1 A, Rectifier, Glass Passivated, DO-213AA (MELF)	DL4003-13-F	Diodes, Inc.
16	1	FR1	47 R, 5%, 2 W, Wirewound, Fusible	FW20A47R0JA	Bourns
17	1	L1	4.7 mH, 90 mA, 20 Ω, RF Inductor	B82144A2475J	Epcos
18	2	Q1 Q5	NPN, Small Signal BJT, 40 V, 0.2 A, SOT-23	MMBT3904LT1G	On Semi
19	1	Q4	100 V, 0.2 A, 10 Ω, N-Channel, TO-92	ZVN3310A	Diodes, Inc.
20	2	R1 R39	10 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ103V	Panasonic
21	1	R6	27 Ω, 5%, 1 W, Metal Oxide	RSF100JB-27R	Yageo
22	1	R8	510 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ514V	Panasonic
23	2	R9 R10	1.50 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF1504V	Panasonic
24	1	R13	82 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ823V	Panasonic
25	1	R14	137 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF1373V	Panasonic
26	1	R15	24.9 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2492V	Panasonic
27	1	R16	6.2 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ622V	Panasonic
28	1	R17	20 Ω, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ200V	Panasonic
29	1	R18	62 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ623V	Panasonic
30	1	R20	100 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ104V	Panasonic
31	1	R21	10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
32	1	R22	191 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1913V	Panasonic
33	2	R24 R40	200 Ω, 5%, 3 W, Metal Oxide	ERG-3SJ201	Panasonic
34	1	R25	5.1 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ512V	Panasonic
35	1	R33	10 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ100V	Panasonic
36	1	R35	680 Ω, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ681V	Panasonic

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

7 電感器設計試算表

ACDC_LYTSwitch-4_HL_012114; Rev.1.2; Copyright Power Integrations 2014	INPUT	INFO	OUTPUT	UNIT	LYTSwitch-4_HL_012114: Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES					
Dimming required	YES		YES		Select 'YES' option if dimming is required. Otherwise select 'NO'.
VACMIN	190		190	V	Minimum AC Input Voltage
VACMAX			265	V	Maximum AC input voltage
fL			50	Hz	AC Mains Frequency
VO	120		120	V	Typical output voltage of LED string at full load
VO_MAX			132.00	V	Maximum expected LED string Voltage.
VO_MIN			108.00	V	Minimum expected LED string Voltage.
V_OVP			142.37	V	Over-voltage protection setpoint
IO	0.1		0.10	A	Typical full load LED current
PO			12.0	W	Output Power
n	0.85		0.85		Estimated efficiency of operation
VB			25	V	Bias Voltage
ENTER LYTSwitch VARIABLES					
LYTSwitch	LYT4322		LYT4322		Selected LYTSwitch
Current Limit Mode	FULL		FULL		Select "RED" for reduced Current Limit mode or "FULL" for Full current limit mode
ILIMITMIN			0.79	A	Minimum current limit
ILIMITMAX			0.92	A	Maximum current limit
fS			132000	Hz	Switching Frequency
fSmin			124000	Hz	Minimum Switching Frequency
fSmax			140000	Hz	Maximum Switching Frequency
IV			100.7	uA	V pin current
RV	3.2		3.2	M-ohms	Upper V pin resistor
RV2			1000000000000	M-ohms	Lower V pin resistor
IFB	177		177.0	uA	FB pin current (85 uA < IFB < 210 uA)
RFB1			124.3	k-ohms	FB pin resistor
VDS			10	V	LYTSwitch on-state Drain to Source Voltage
VD			0.50	V	Output Winding Diode Forward Voltage Drop (0.5 V for Schottky and 0.8 V for PN diode)
VDB			0.70	V	Bias Winding Diode Forward Voltage Drop
Key Design Parameters					
KP	1.18		1.18		Ripple to Peak Current Ratio (For PF0.9，0.4 < KP < 0.9)/>
LP			960	uH	Primary Inductance
VOR	120.5		120.5	V	Reflected Output Voltage.
Expected IO (average)			0.10	A	Expected Average Output Current
KP_VNOM		Info	1.00		!!! Info. PF at high line may be less than 0.9. Decrease KP for higher PF
TON_MIN			1.84	us	Minimum on time at maximum AC input voltage
PCLAMP			0.09	W	Estimated dissipation in primary clamp
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	EE13		EE13		Select Core Size
Custom Core					Enter Custom core part number (if

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					applicable)
AE			0.171	cm^2	Core Effective Cross Sectional Area
LE			3.02	cm	Core Effective Path Length
AL			1130	nH/T^2	Ungapped Core Effective Inductance
BW			7.4	mm	Bobbin Physical Winding Width
M			0	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	4		4		Number of Primary Layers
NS	150		150		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			269	V	Peak input voltage at VACMIN
VMAX			375	V	Peak input voltage at VACMAX
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.28		Minimum duty cycle at peak of VACMIN
IAVG			0.07	A	Average Primary Current
IP			0.60	A	Peak Primary Current (calculated at minimum input voltage VACMIN)
IRMS			0.15	A	Primary RMS Current (calculated at minimum input voltage VACMIN)
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			960	uH	Primary Inductance
LP_TOL			10		Tolerance of primary inductance
NP			150		Primary Winding Number of Turns
NB			32		Bias Winding Number of Turns
ALG			43	nH/T^2	Gapped Core Effective Inductance
BM			2256	Gauss	Maximum Flux Density at PO, VMIN (BM<3100)
BP			3444	Gauss	Peak Flux Density (BP<3700)
BAC			1128	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1588		Relative Permeability of Ungapped Core
LG			0.48	mm	Gap Length (Lg0.1 mm)/>
BWE			29.6	mm	Effective Bobbin Width
OD			0.20	mm	Maximum Primary Wire Diameter including insulation
INS			0.04	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.16	mm	Bare conductor diameter
AWG			35	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			32	Cmils	Bare conductor effective area in circular mils
CMA			210	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 600)
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT)					
Lumped parameters					
ISP			0.60	A	Peak Secondary Current
ISRMS			0.22	A	Secondary RMS Current
IRIPPLE			0.20	A	Output Capacitor RMS Ripple Current (based on Expected IO)
CMS			44	Cmils	Secondary Bare Conductor minimum circular mils
AWGS			33	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS			0.18	mm	Secondary Minimum Bare Conductor Diameter
ODS			0.05	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire

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

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8 電感器規格

8.1 電氣圖

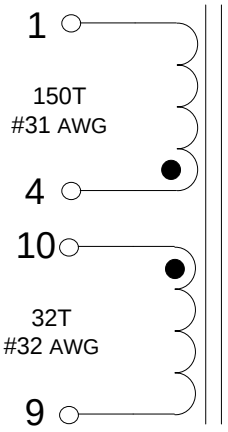

Figure 7 – Inductor Electrical Diagram.

8.2 電氣規格

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

8.3 材料

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

8.4 電感器建置圖

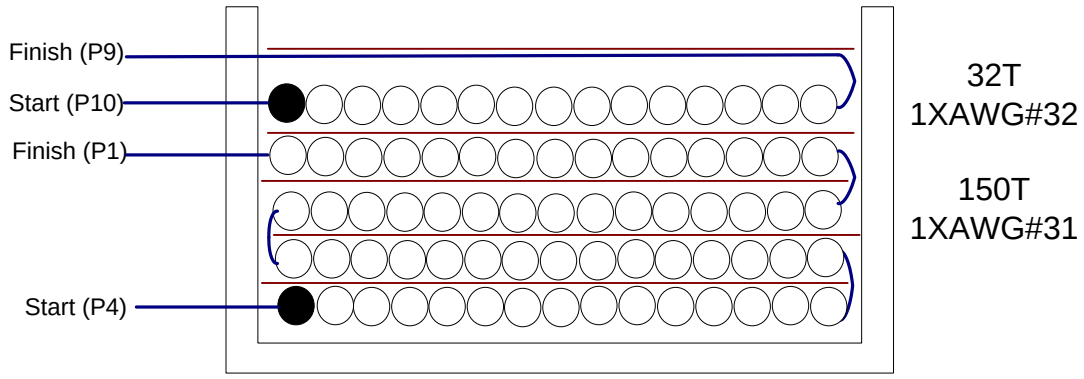

Figure 8 – Inductor Build Diagram.

8.5 電感器構造

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

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9 效能資料

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

9.1 效率

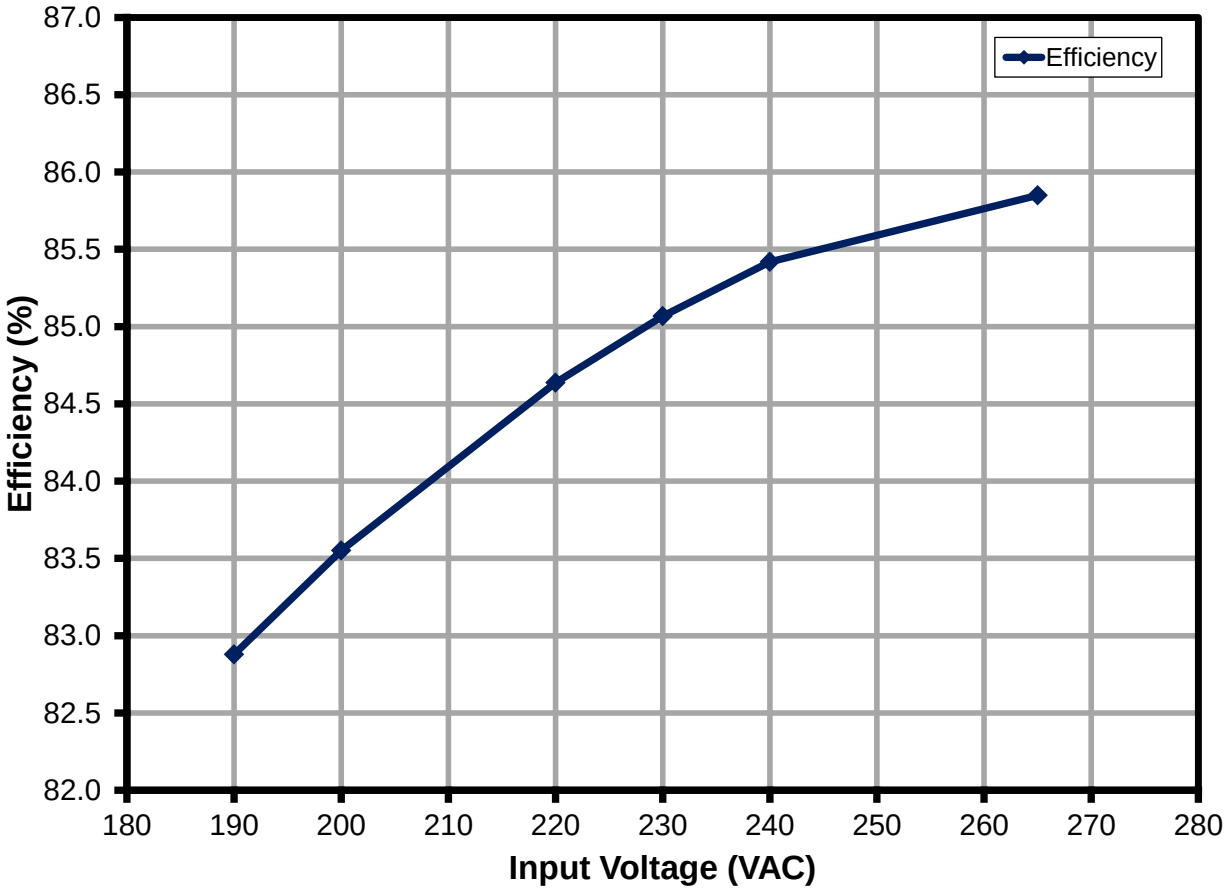

Figure 9 – Efficiency vs. Line.

9.2 線電壓調節

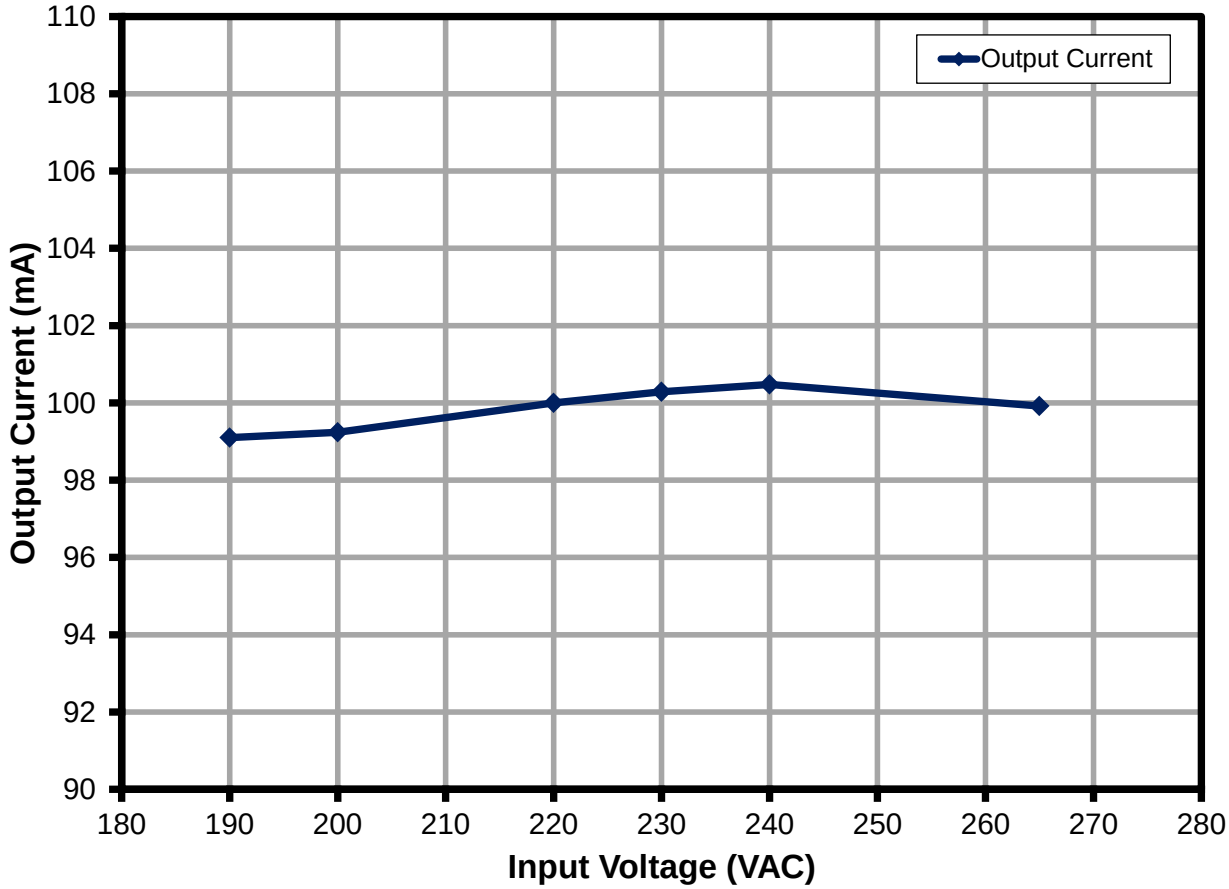

Figure 10 – Regulation vs. Line.

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9.3 功率因數 (PF)

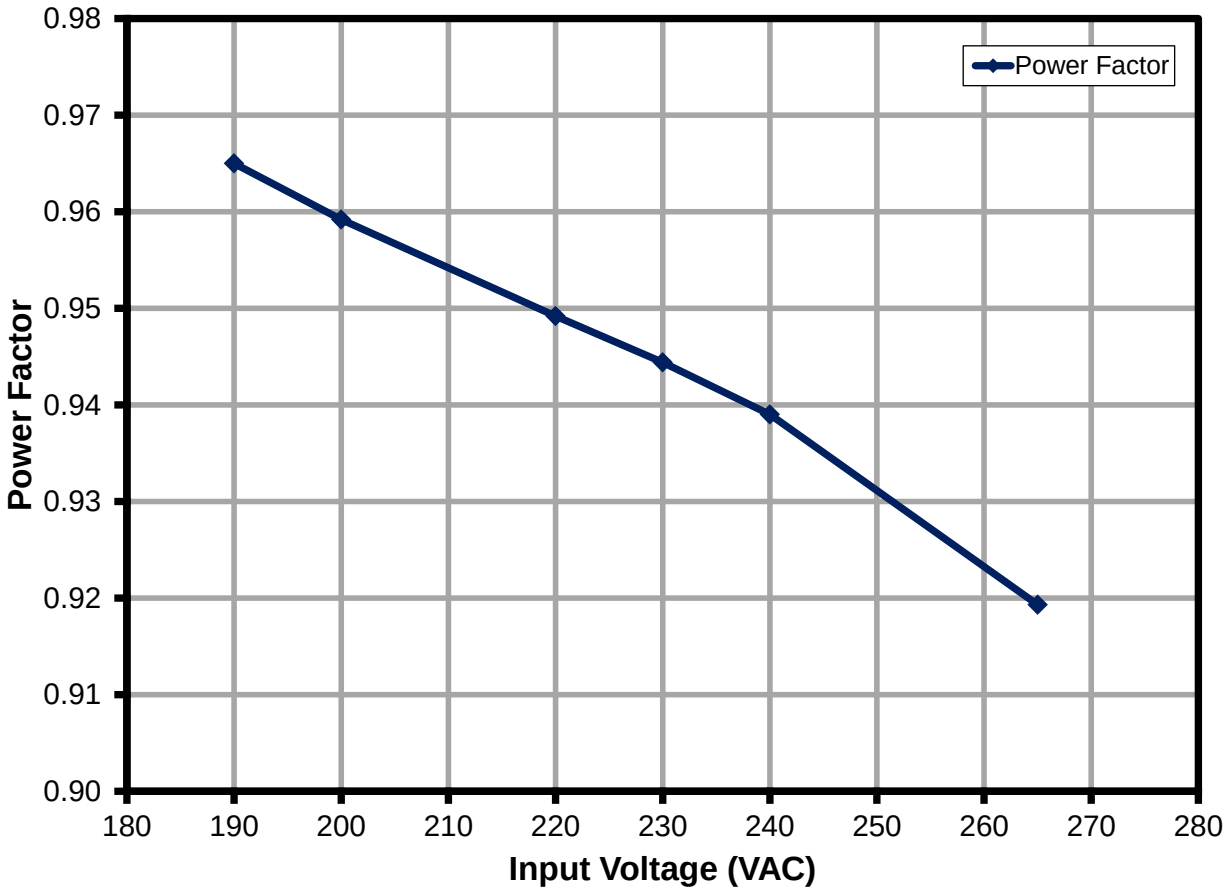

Figure 11 – Power Factor vs. Line.

9.4 測試資料

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

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

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10 調光效能資料

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

10.1 調光曲線

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

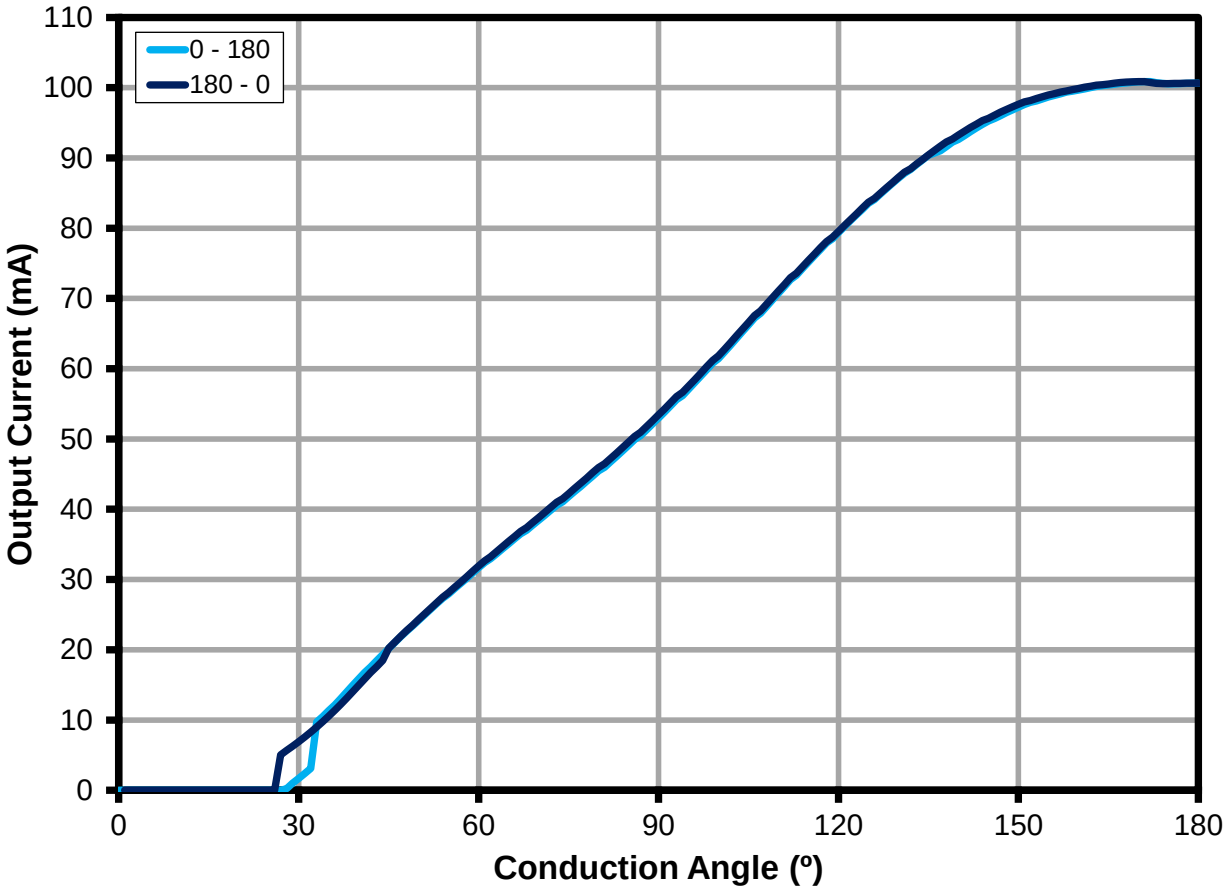

Figure 12 – Leading Edge Dimming Characteristics.

10.2 調光效率

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

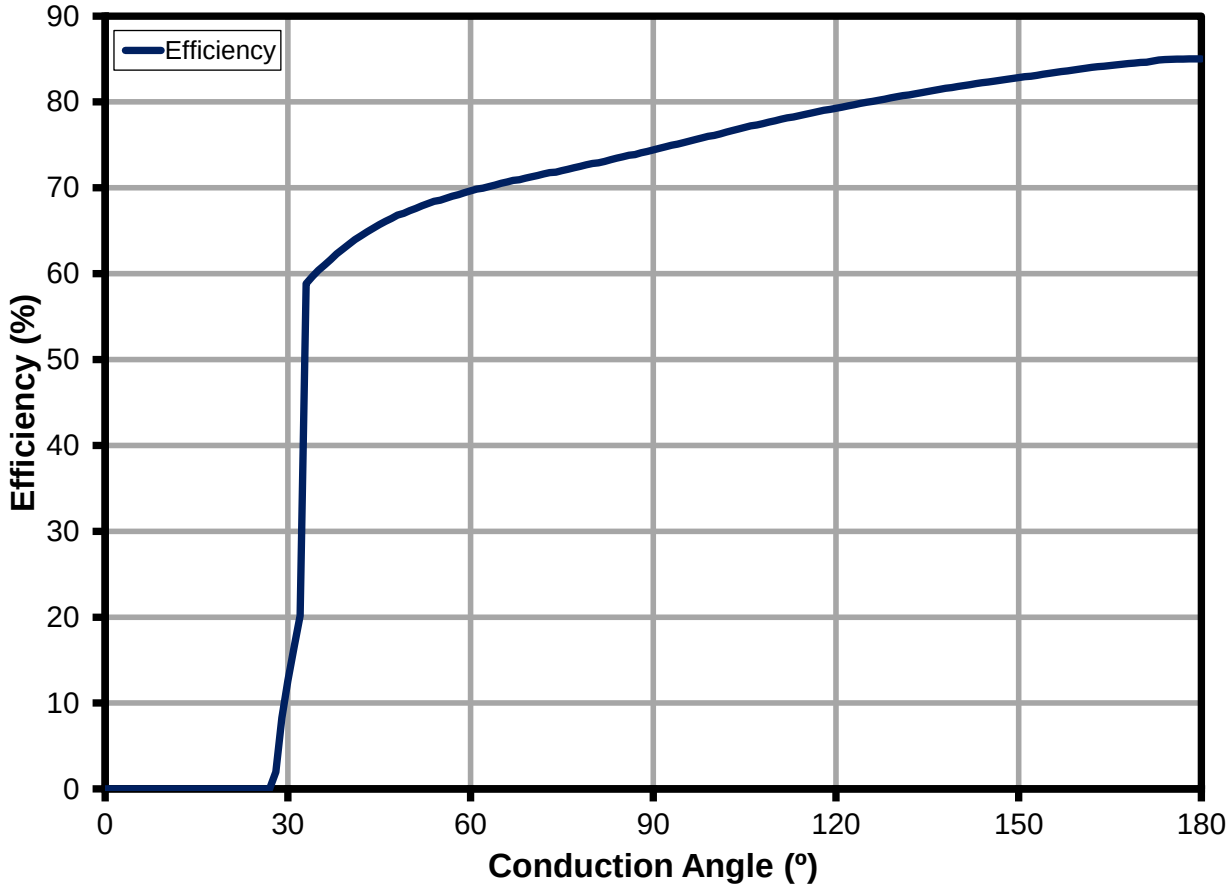

Figure 13 – Driver Efficiency as a function of Conduction Angle.

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10.3 調光時的驅動器功率損失

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

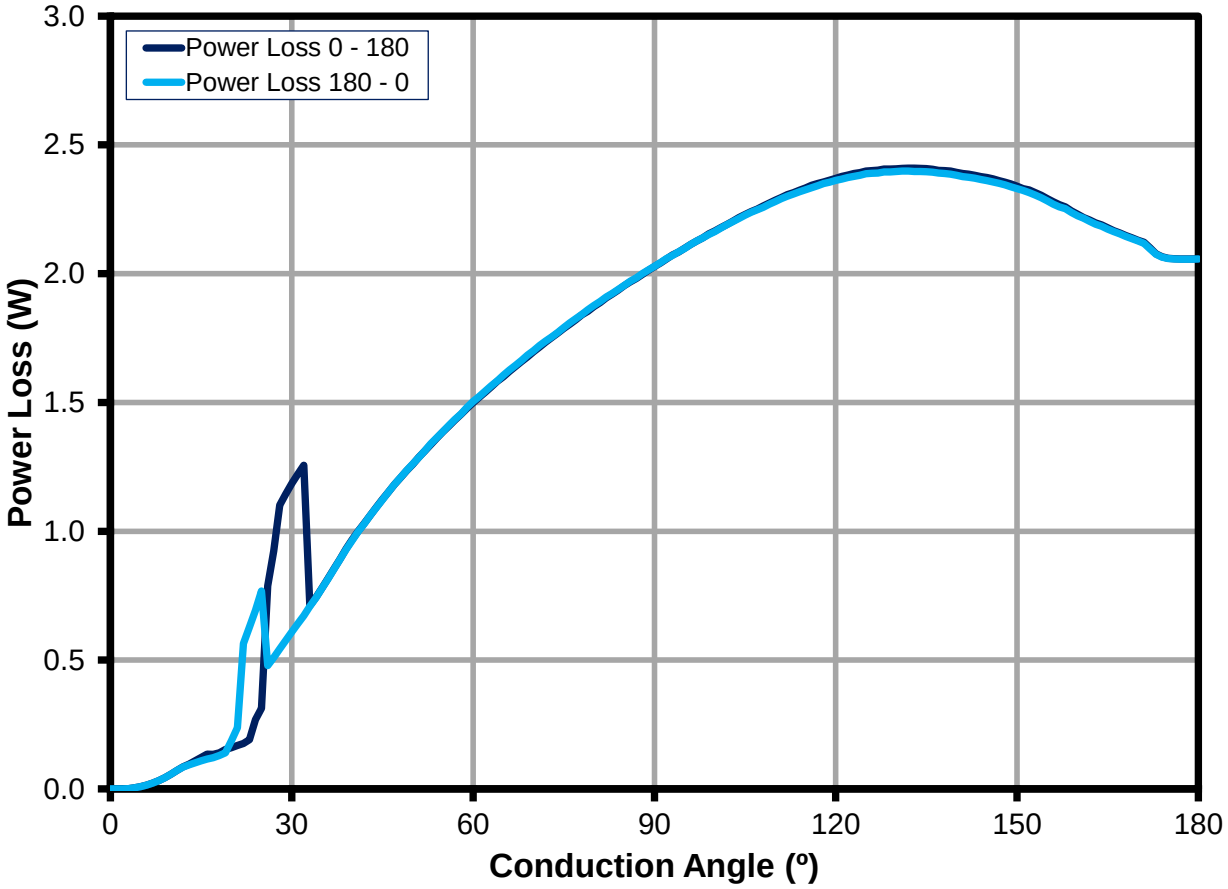

Figure 14 – Driver Power Loss as a function of Conduction Angle.

10.4 調光器相容性清單

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

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

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11 散熱效能

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

11.1 230 VAC、50 Hz：調光器未連接

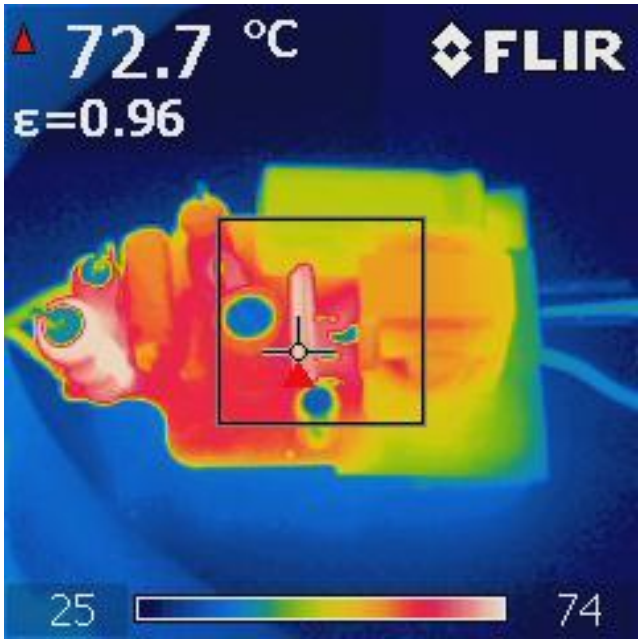

Figure 15 – U1: LYT4322E**.**

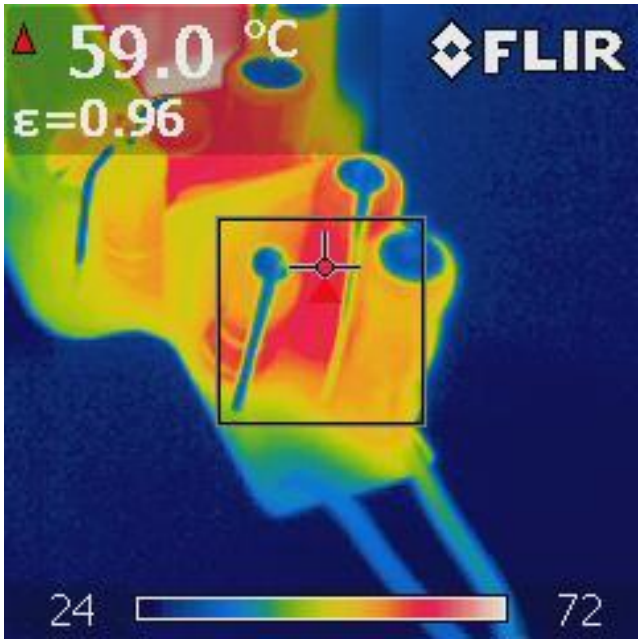

Figure 16 – R24: Damper Resistor.

11.2 230 VAC、50 Hz：調光器已連接，90⁰導通角

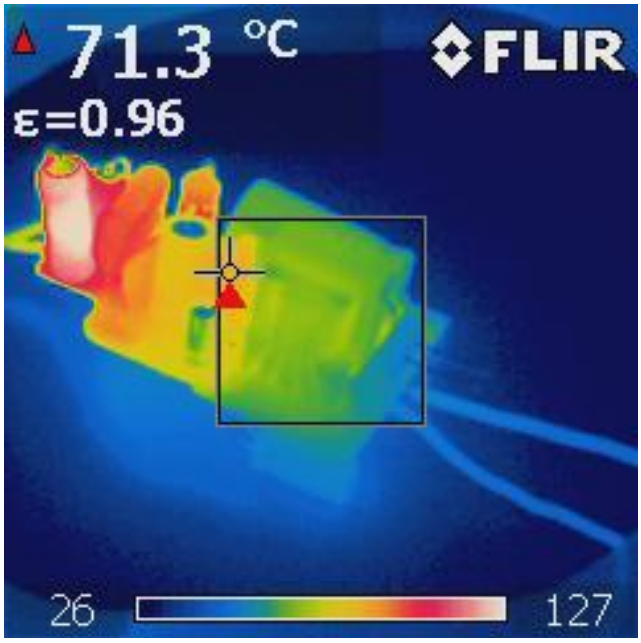

Figure 17 – U1: LYT4322E.

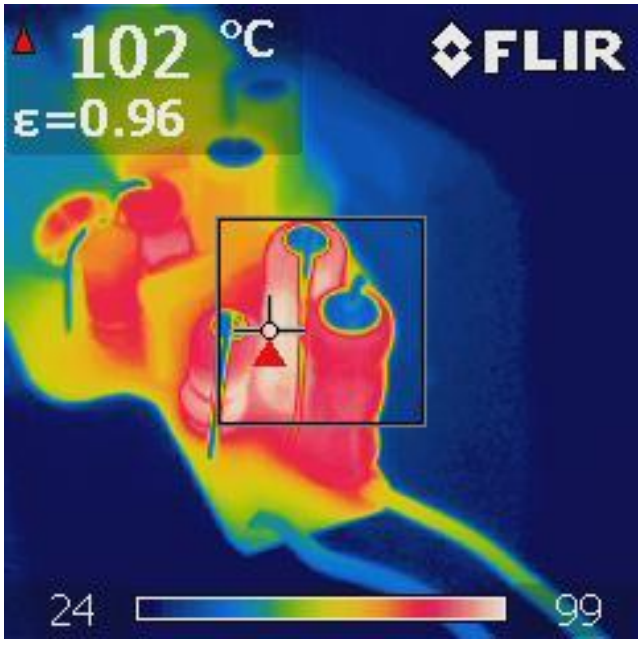

Figure 18 – R24: Damper Resistor.

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12 非調光 (調光器未連接) 波形

12.1 輸入電壓和輸入電流波形

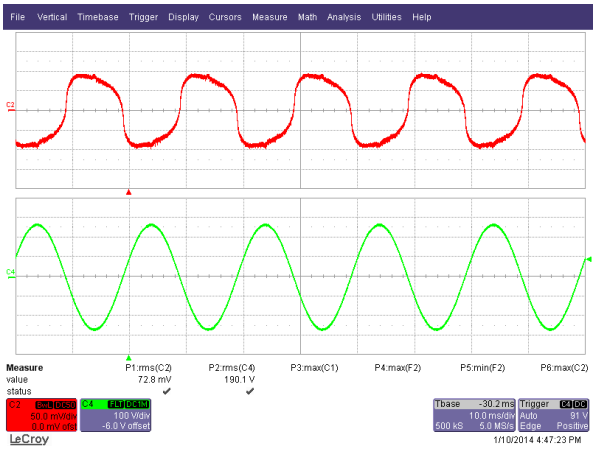

Figure 19 – 190 VAC, Full Load.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 10 ms / div.

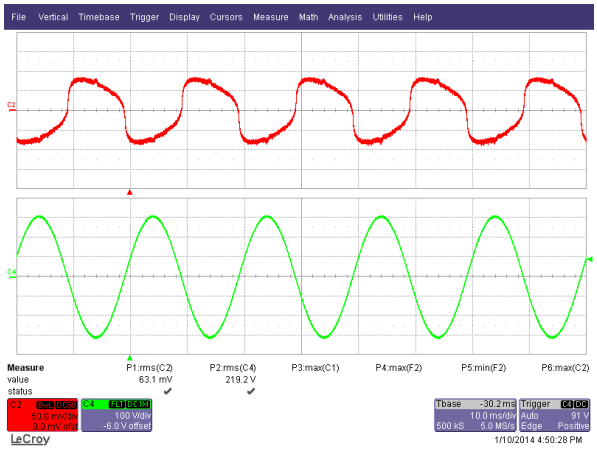

Figure 20 – 220 VAC, Full Load.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 10 ms / div.

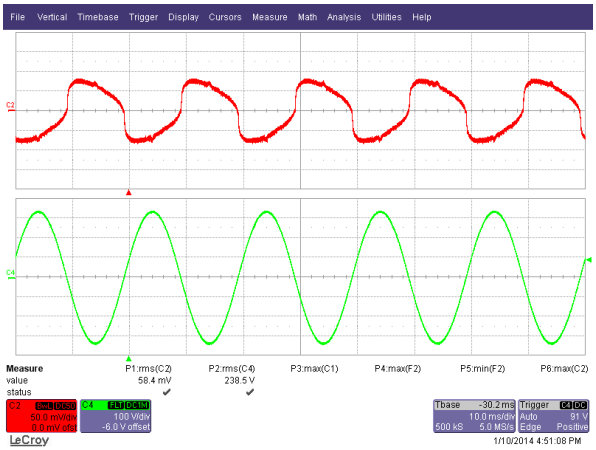

Figure 21 – 240 VAC, Full Load.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 10 ms / div.

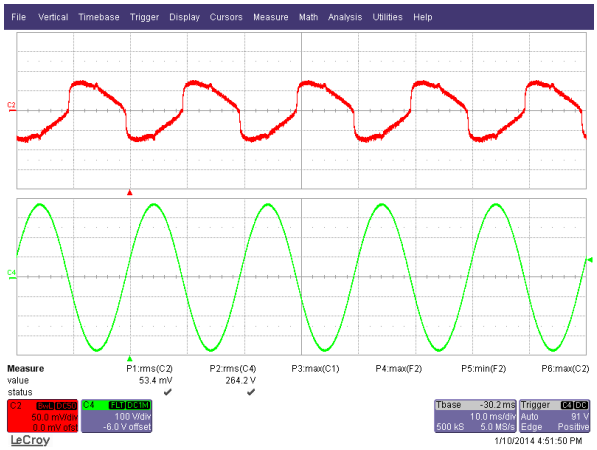

Figure 22 – 265 VAC, Full Load.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 10 ms / div.

12.2 正常運作下的輸出電流和輸出電壓

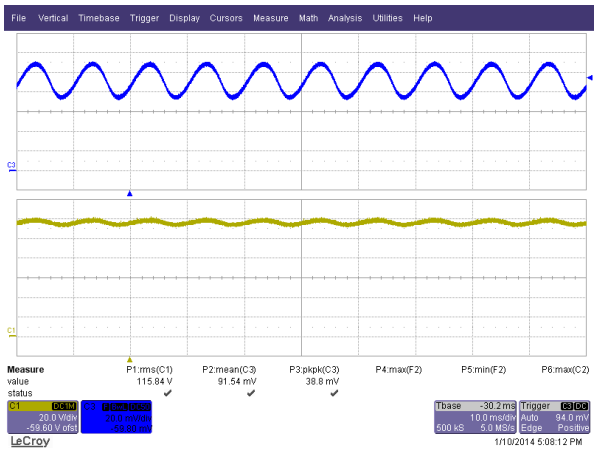

Figure 23 – 190 VAC, 50 Hz. Full Load.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{OUT}, 20 V, 10 ms / div.

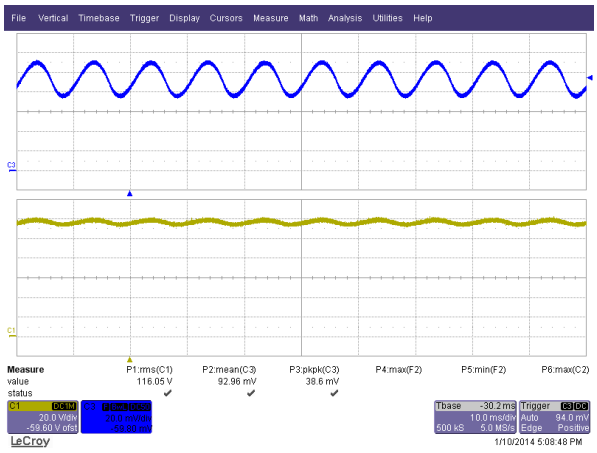

Figure 24 – 220 VAC, 50 Hz. Full Load.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{OUT}, 20 V, 10 ms / div.

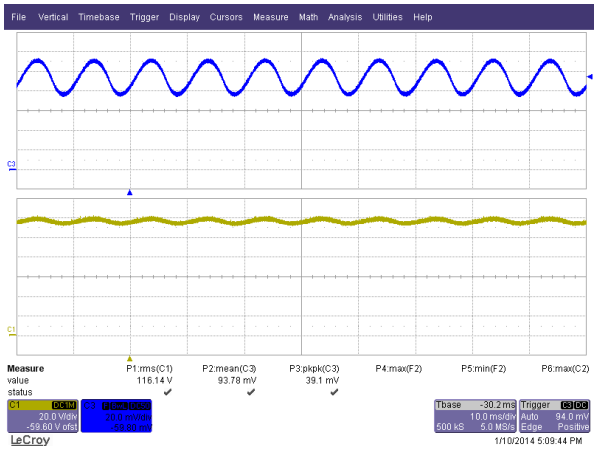

Figure 25 – 240 VAC, 50 Hz. Full Load.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{OUT}, 20 V, 10 ms / div.

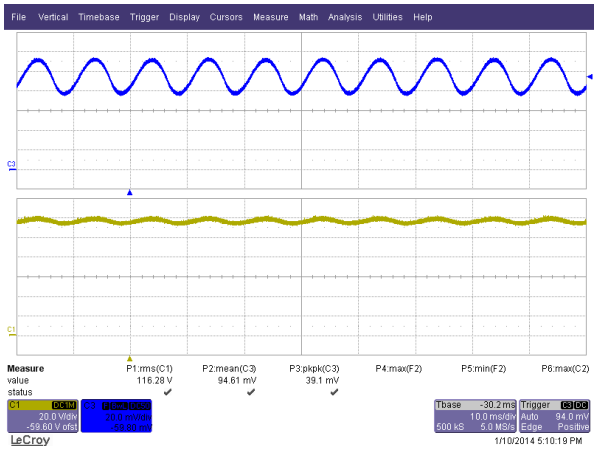

Figure 26 – 265 VAC, 50 Hz. Full Load.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{OUT}, 20 V, 10 ms / div.

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12.3 輸出電流上升及下降

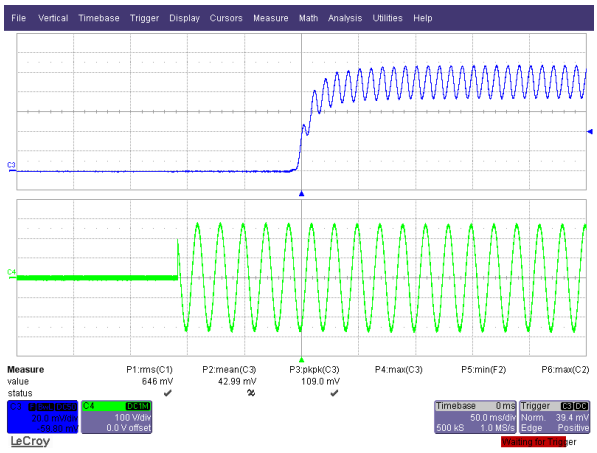

Figure 27 – 190 VAC Output Rise.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 50 ms / div.

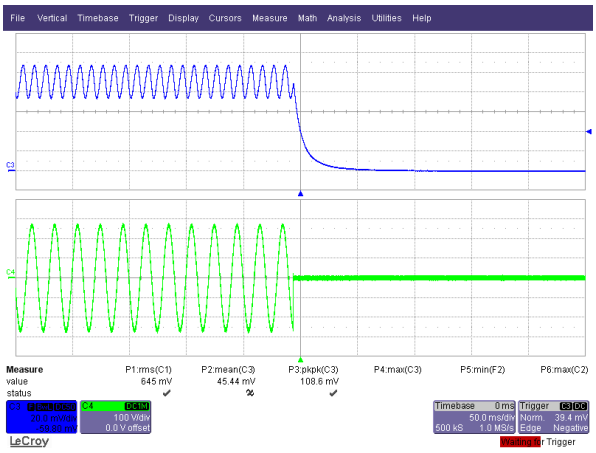

Figure 28 – 90 VAC Output Fall.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 200 V, 100 ms / div.

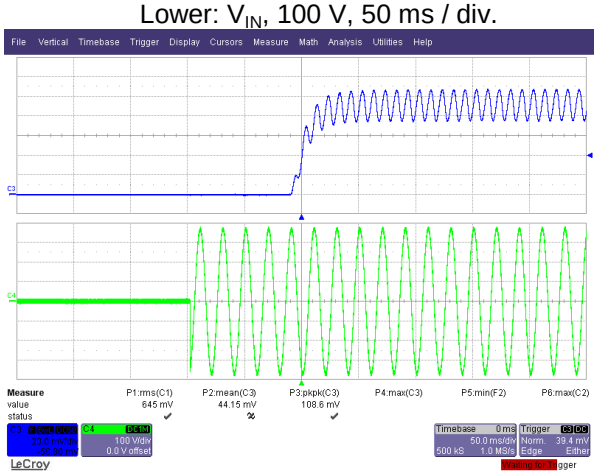

Figure 29 – 265 VAC Output Rise.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 50 ms / div.

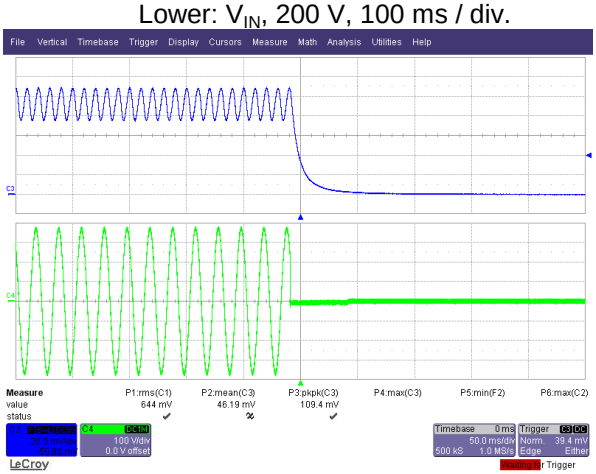

Figure 30 – 265 VAC Output Fall.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 50 ms / div.

12.4 正常運作下的汲極電壓和電流

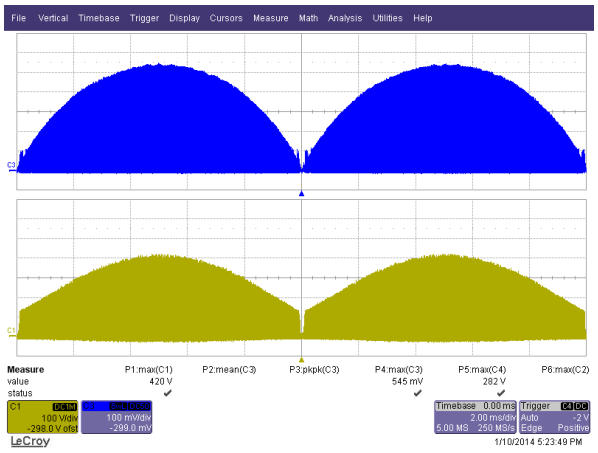

Figure 31 – 190 VAC, 50 Hz.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 100 V, 2 ms / div.

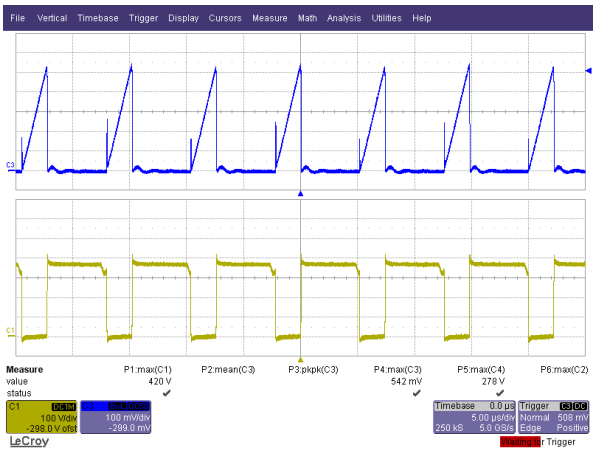

Figure 32 – 190 VAC, 50 Hz.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 100 V / div., 5 µs / div.

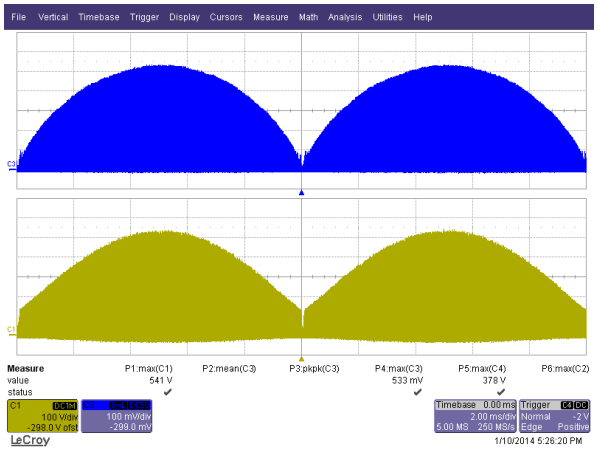

Figure 33 – 265 VAC, 50 Hz.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 100 V, 2 ms / div.

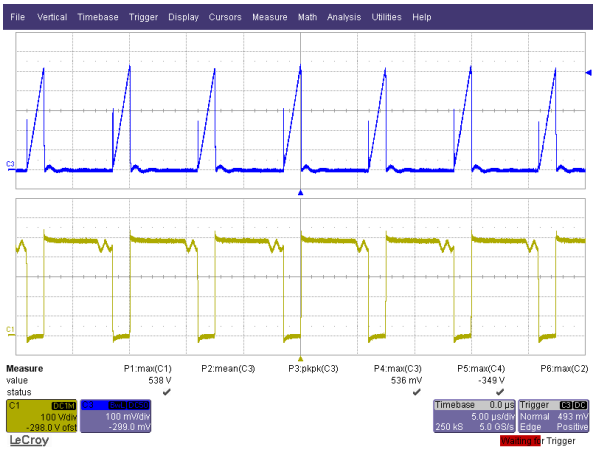

Figure 34 – 265 VAC, 50 Hz.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 100 V / div., 5 µs / div.

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12.5 啓動汲極電壓和電流

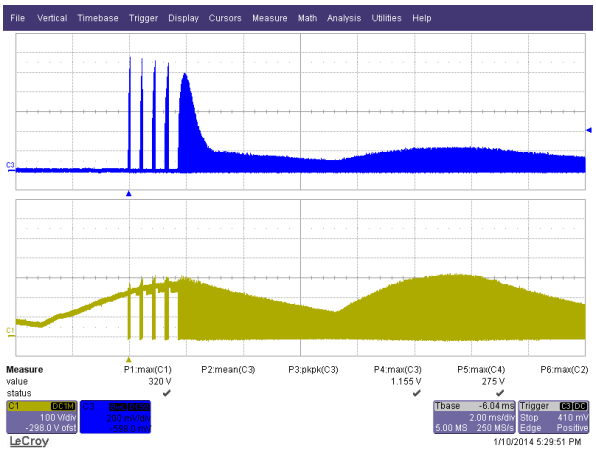

Figure 35 – 190 VAC, 50 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 2 ms / div.

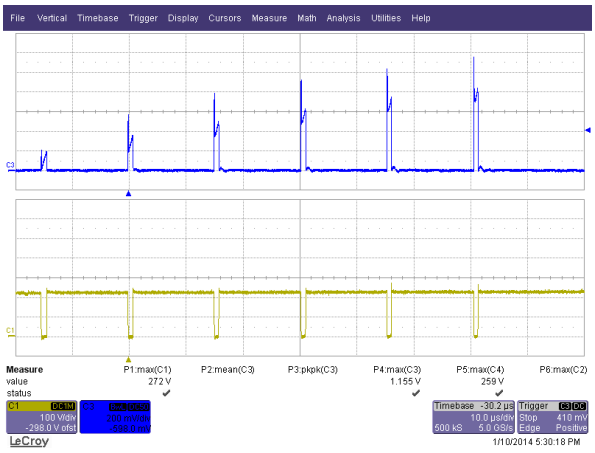

Figure 36 – 190 VAC, 50 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 10 µs / div.

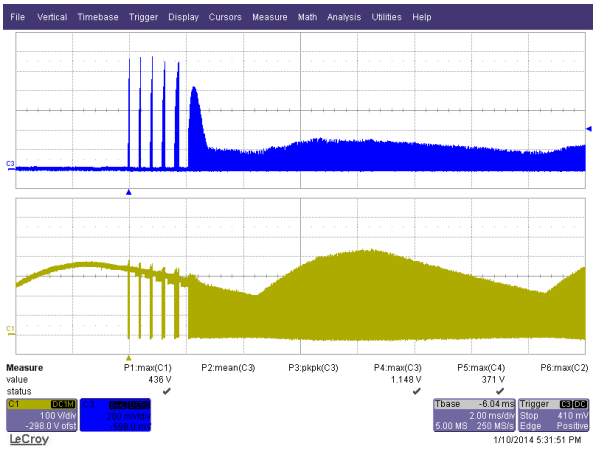

Figure 37 – 265 VAC, 50 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 2 ms / div.

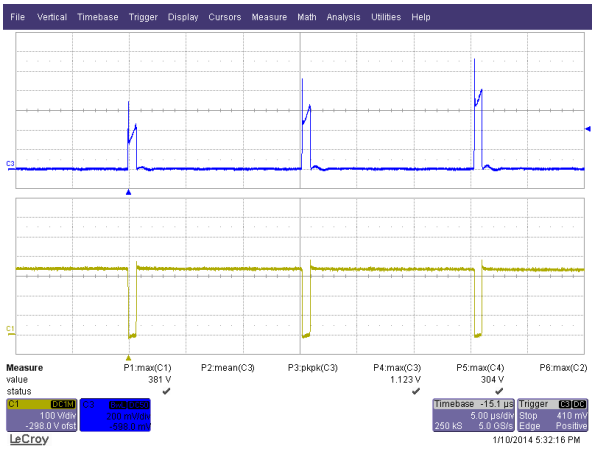

Figure 38 – 265 VAC, 50 Hz Start-up.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 5 µs / div.

12.6 輸出短路情況下的汲極電流和汲極電壓

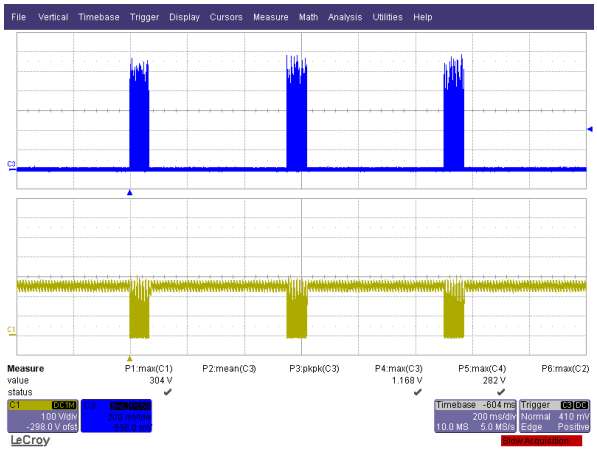

Figure 39 – 190 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 200ms / div.

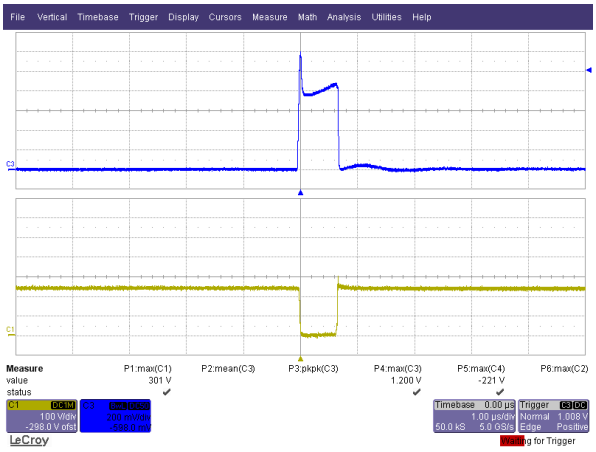

Figure 40 – 190 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: V_{DRAIN}, 100 V, 1 µs / div.

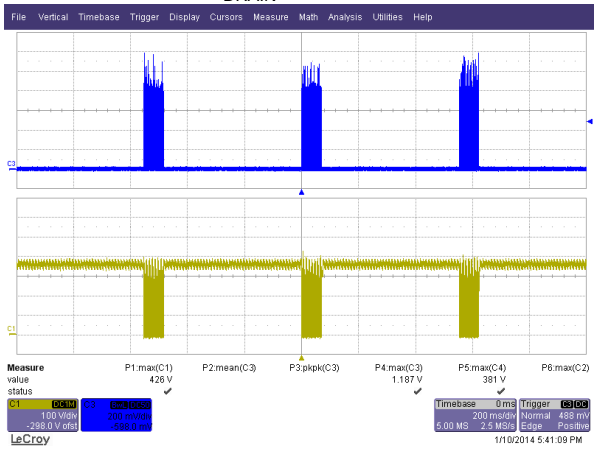

Figure 41 – 265 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: $V_{DRAIN,}$ 100 V, 5ms / div.

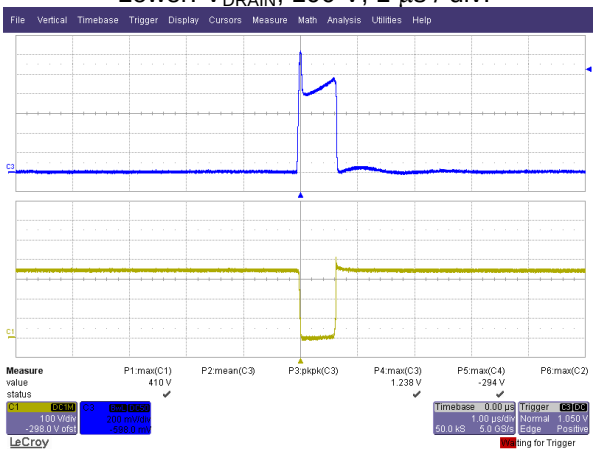

Figure 42 – 265 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN}, 200 mA / div.
Lower: $V_{DRAIN,}$ 100 V, 1 µs / div.

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12.7 開路負載特性

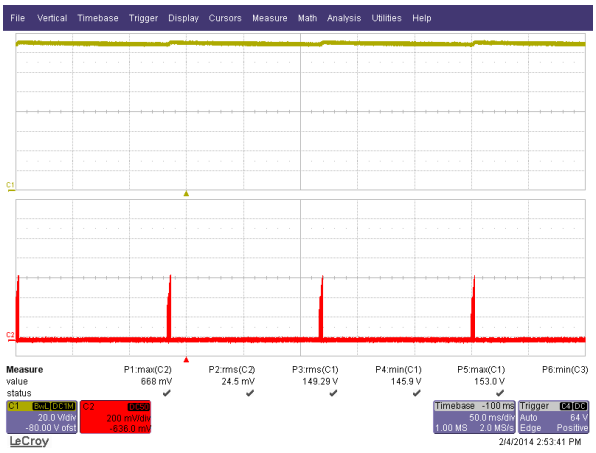

Figure 43 – 190 VAC, 50 Hz Open Load Condition.
Upper: V_{OUT}, 50 V / div.
Lower: I_{DRAIN}, 200 mA, 100ms / div.

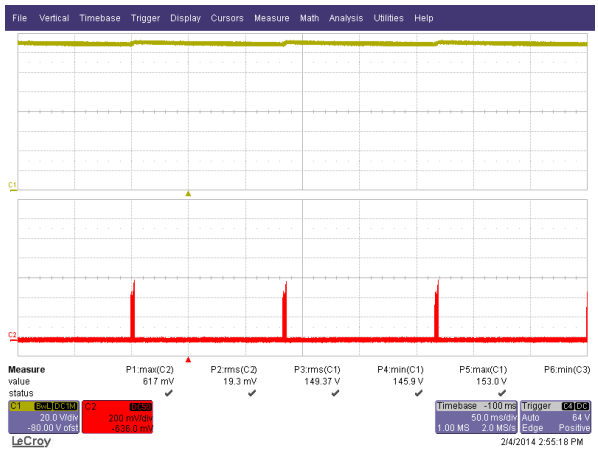

Figure 44 – 265 VAC, 50 Hz Output Short Condition.
Upper: V_{OUT}, 50 V / div.
Lower: I_{DRAIN}, 200 mA, 200ms / div.

12.8 電壓關閉/電壓啓動

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

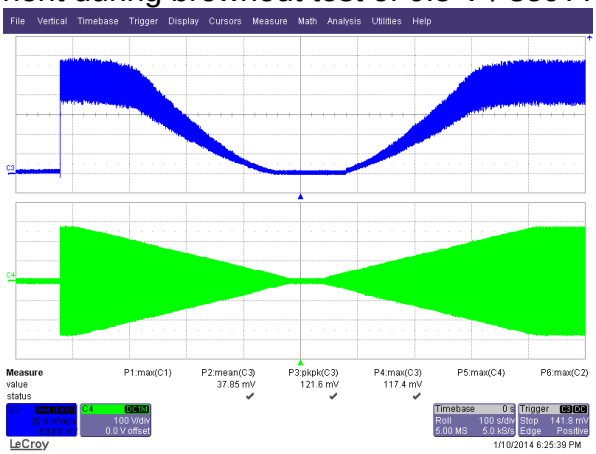

Figure 45 – Brown-out Test at 0.5 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.
Ch4: V_{IN}; 100 V / div.
Ch2: I_{OUT}; 20 mA / div.
Time Scale: 100 s / div.

13 調光波形

13.1 輸入電壓和輸入電流波形 – 前緣調光器

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

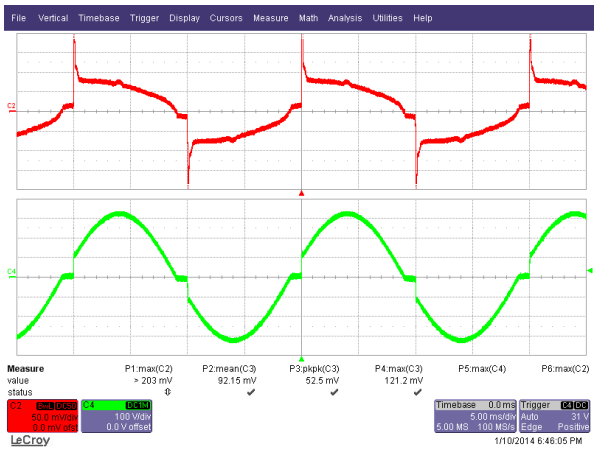

Figure 46 – 162º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

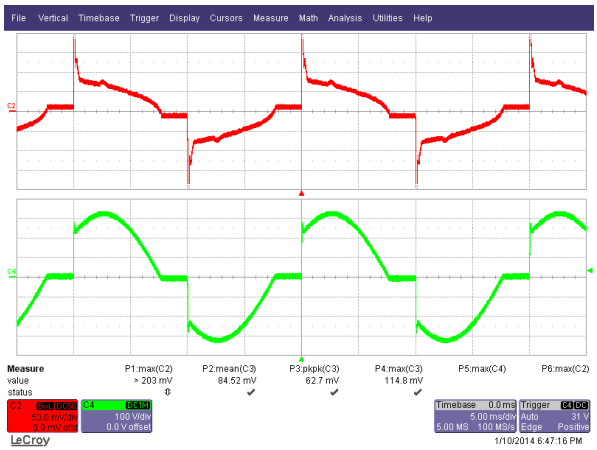

Figure 47 – 135º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

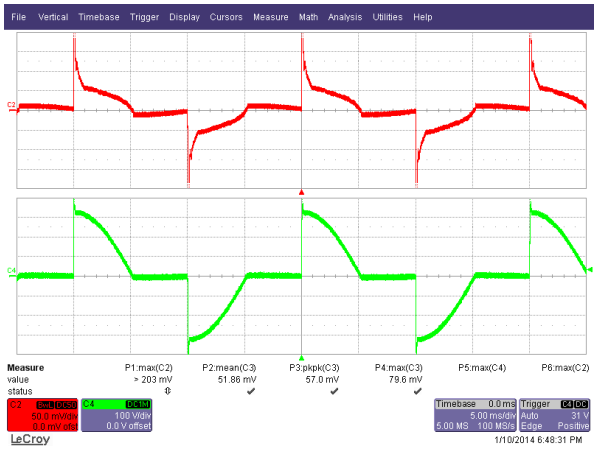

Figure 48 – 90º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

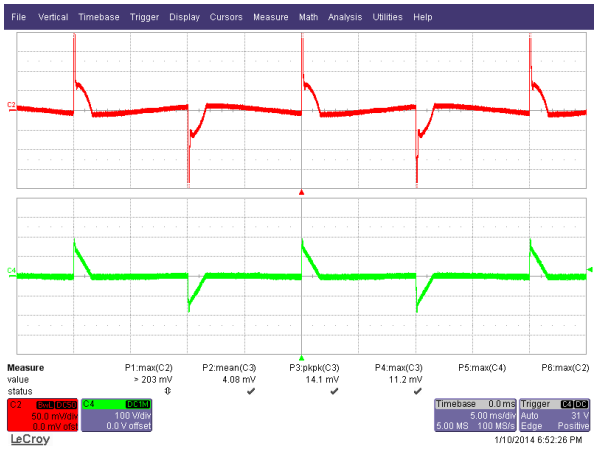

Figure 49 – 30º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

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13.2 輸出電流波形 – 前緣調光器

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

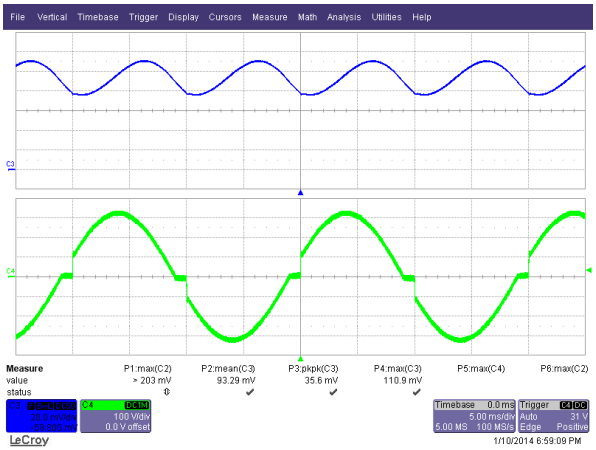

Figure 50 – 162º Conduction Angle.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

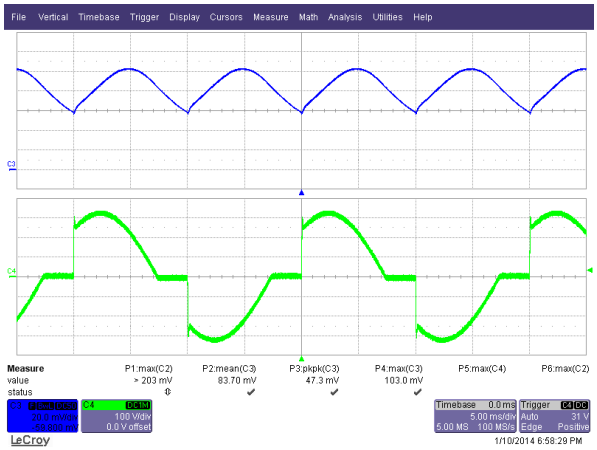

Figure 51 – 135º Conduction Angle.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

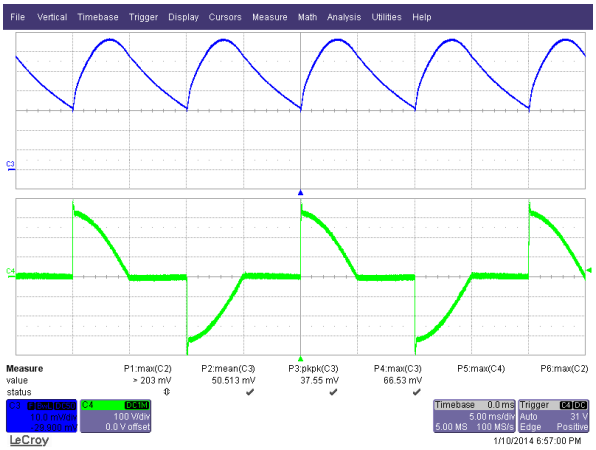

Figure 52 – 90º Conduction Angle.
Upper: I_{OUT}, 10 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

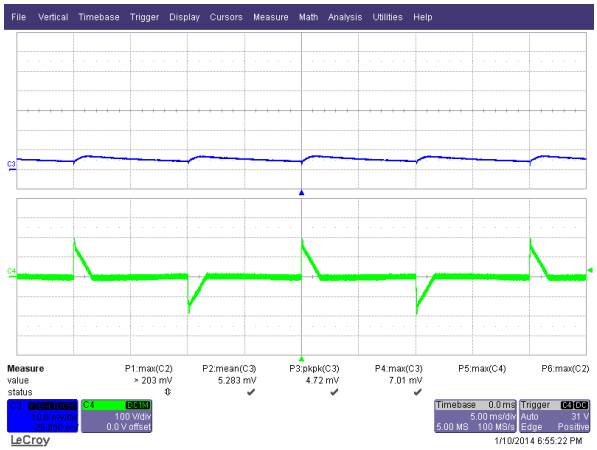

Figure 53 – 30º Conduction Angle.
Upper: I_{OUT}, 10 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

13.3 輸入電壓和輸入電流波形 – 後緣調光器

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

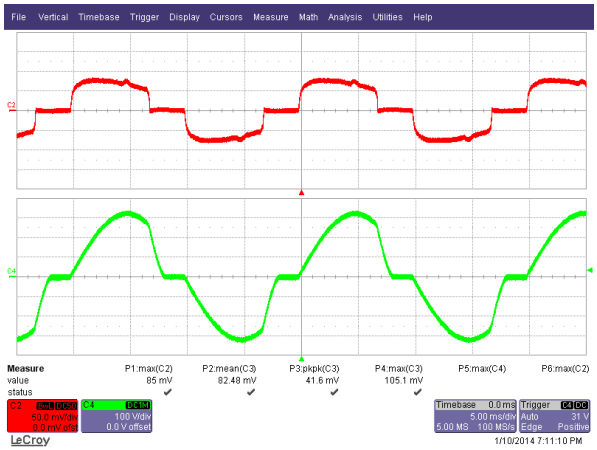

Figure 54 – 124º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

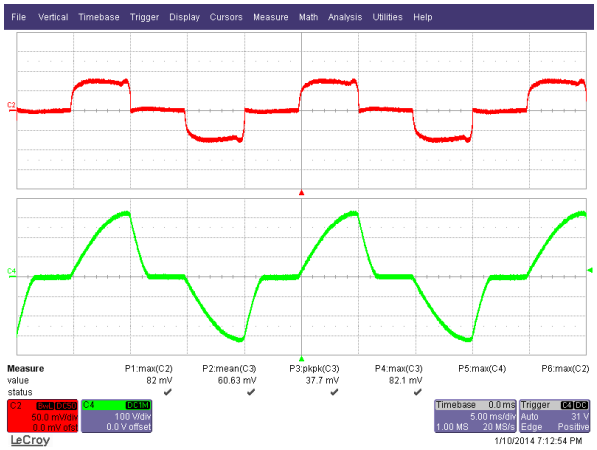

Figure 55 – 120º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

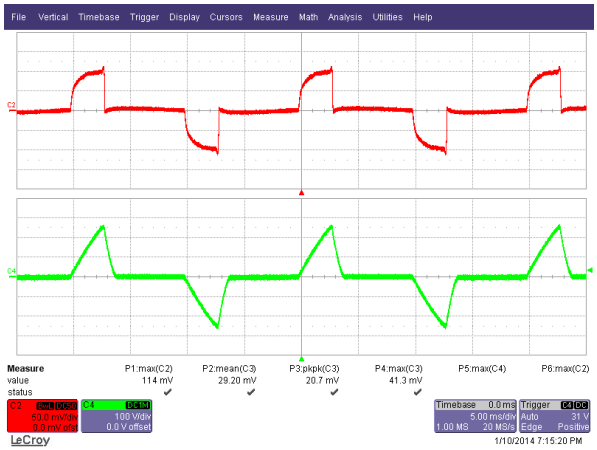

Figure 56 – 54º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

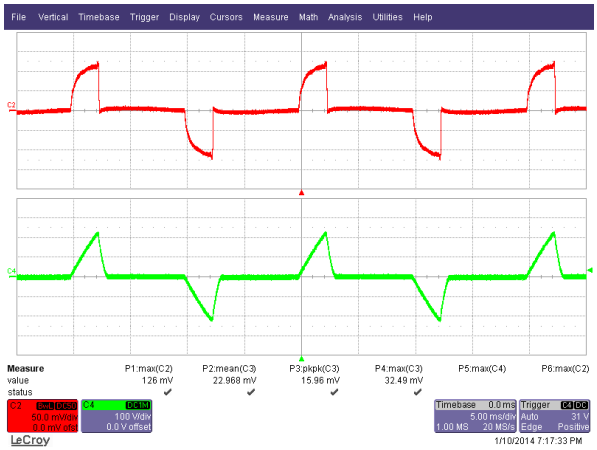

Figure 57 – 43º Conduction Angle.
Upper: I_{IN}, 50 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

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13.4 輸出電流波形 – 後緣調光器

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

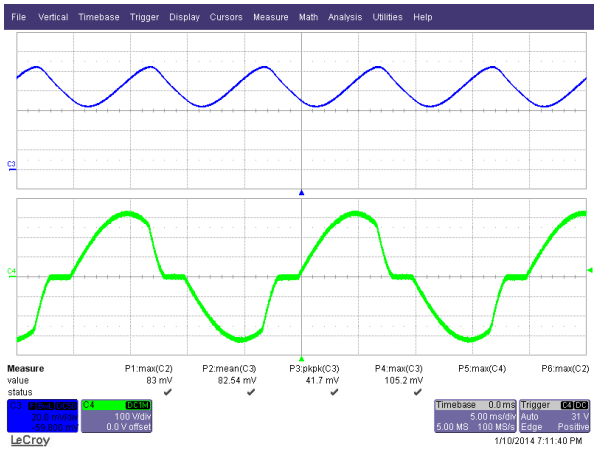

Figure 58 – 124º Conduction Angle.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

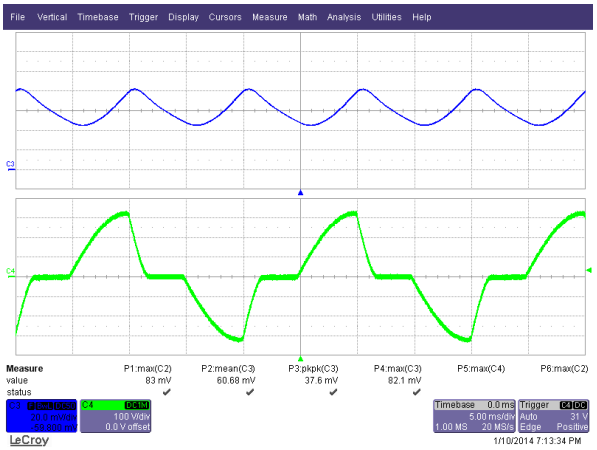

Figure 59 – 90º Conduction Angle.
Upper: I_{OUT}, 20 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

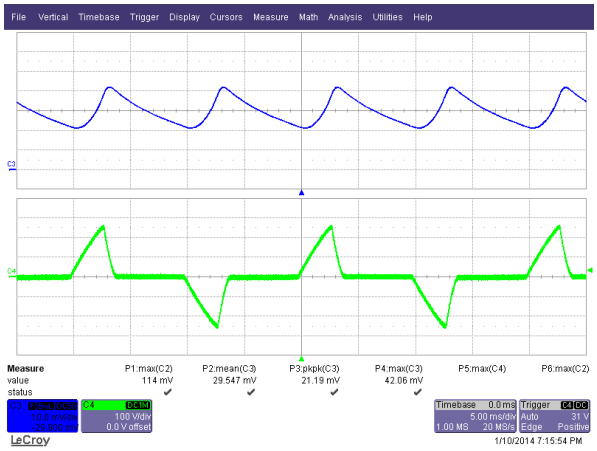

Figure 60 – 54º Conduction Angle.
Upper: I_{OUT}, 10 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

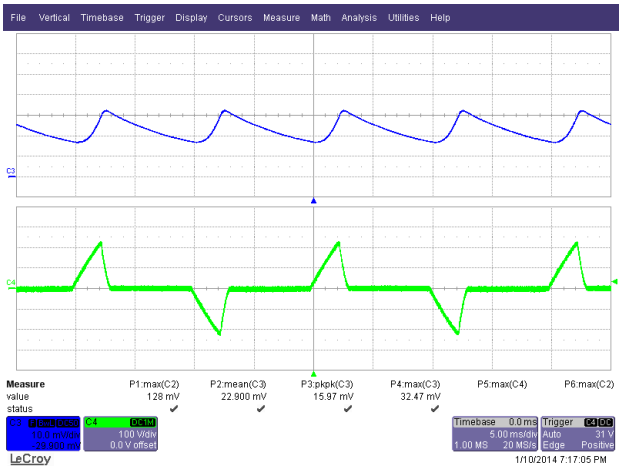

Figure 61 – 43º Conduction Angle.
Upper: I_{OUT}, 10 mA / div.
Lower: V_{IN}, 100 V, 5 ms / div.

13.5 汲極電流波形 – 前緣調光器

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

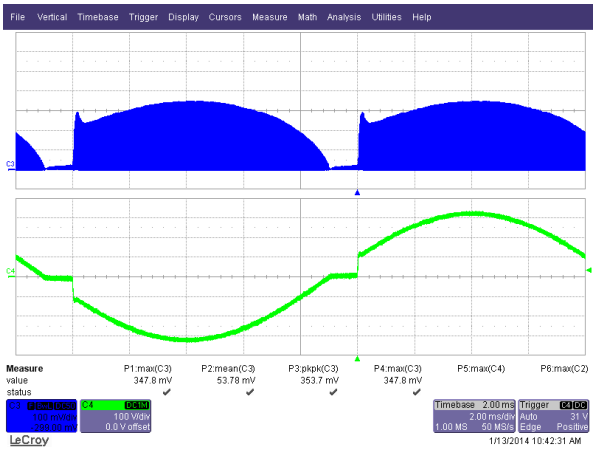

Figure 62 – 162º Conduction Angle.
Upper: U1 I_{DS}, 100 mA / div.
Lower: V_{IN}, 100 V, 2 ms / div.

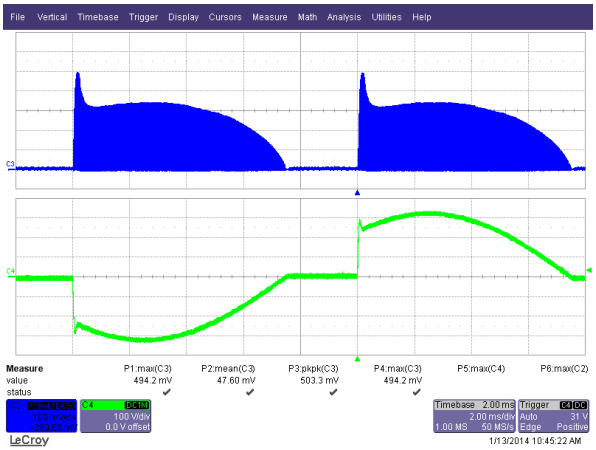

Figure 63 – 135º Conduction Angle.
Upper: U1 I_{DS}, 100 mA / div.
Lower: V_{IN}, 100 V, 2 ms / div.

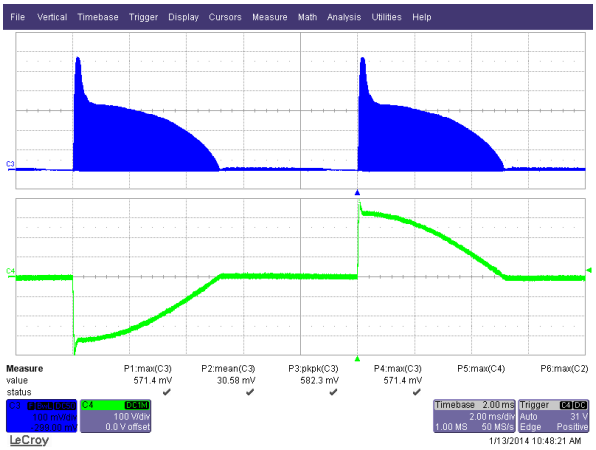

Figure 64 – 90º Conduction Angle.
Upper: U1 I_{DS}, 100 mA / div.
Lower: V_{IN}, 100 V, 2 ms / div.

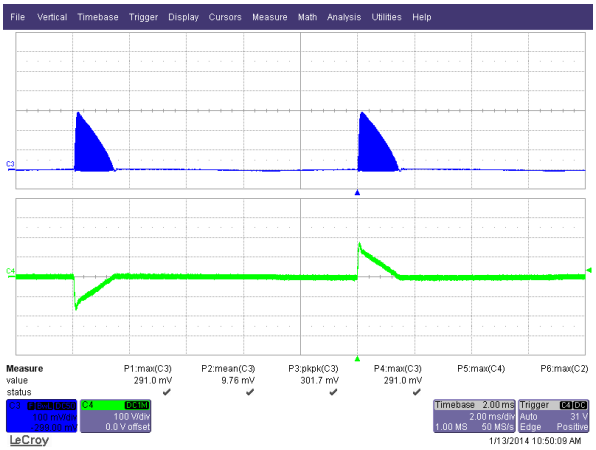

Figure 65 – 30º Conduction Angle.
Upper: U1 I_{DS}, 100 mA / div.
Lower: V_{IN}, 100 V, 2 ms / div.

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14 傳導性 EMI

14.1 測試裝置

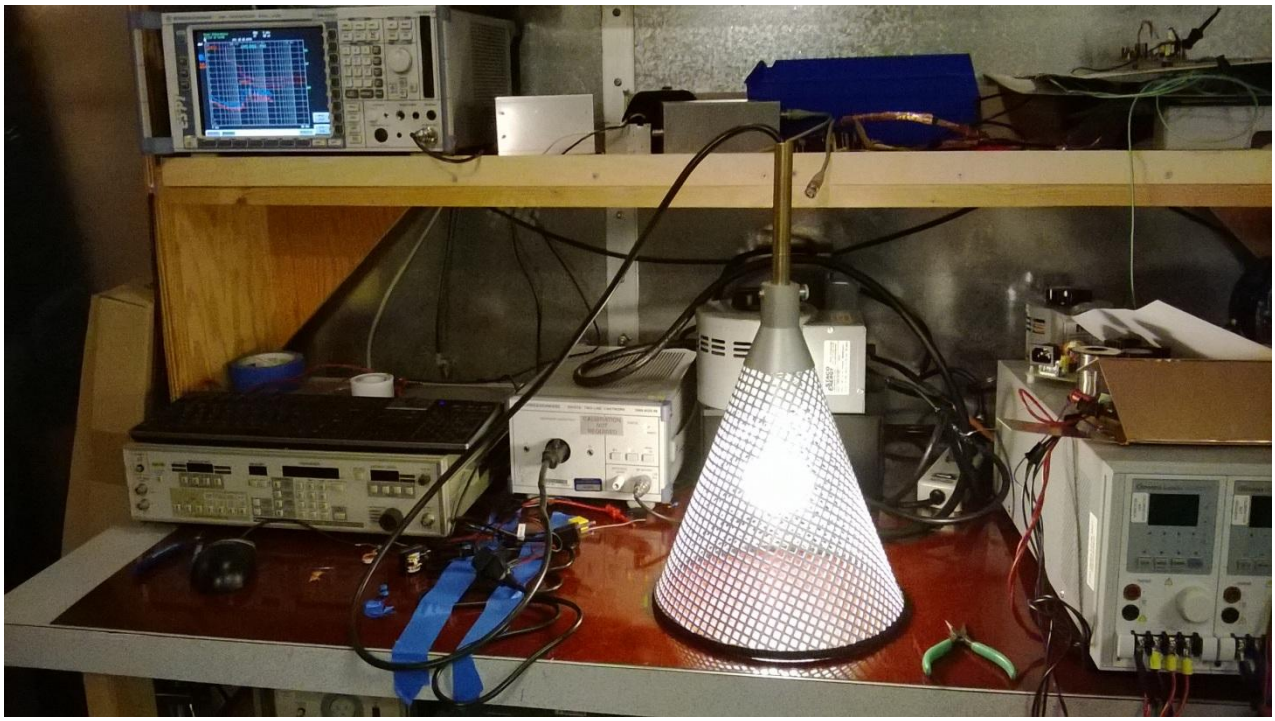

Figure 66 – Conducted EMI Test Set-up.

14.2 測試結果

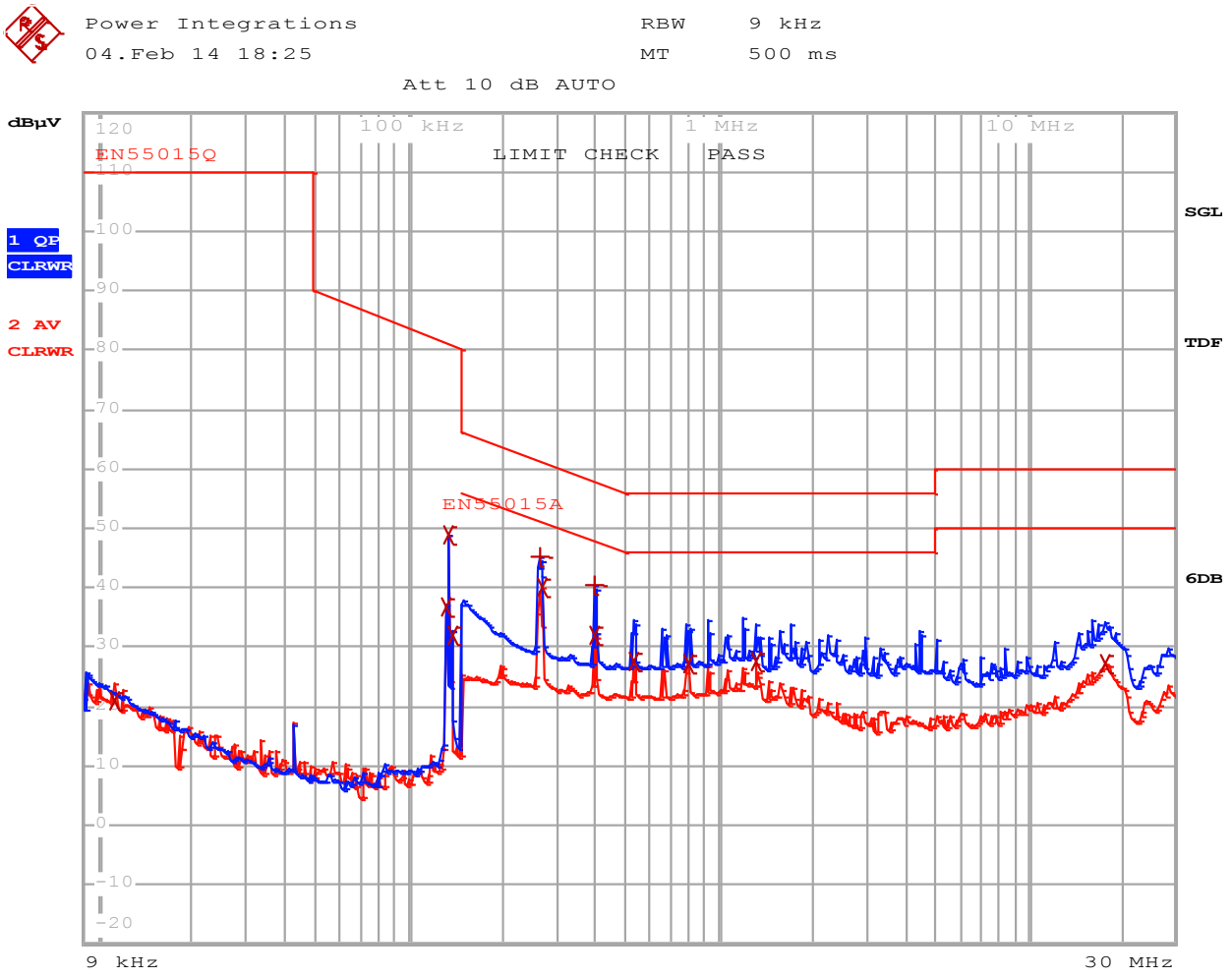

Figure 67 – Conducted EMI, ~120 V LED Load, 230 VAC, 60 Hz, and EN55015 B Limits.

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EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV			DELTA LIMIT dB
2	Average	11.2024427378 kHz	21.11	N	gnd	
2	Average	130.825395691 kHz	36.71	L1	gnd	
2	Average	133.454986145 kHz	48.99	N	gnd	
2	Average	137.49880568 kHz	31.99	L1	gnd	
1	Quasi Peak	264.49018761 kHz	45.08	L1	gnd	-16.20
2	Average	267.135089486 kHz	40.14	L1	gnd	-11.06
1	Quasi Peak	397.727746704 kHz	40.55	L1	gnd	-17.34
2	Average	397.727746704 kHz	32.14	L1	gnd	-15.76
2	Average	530.769219795 kHz	27.42	L1	gnd	-18.57
2	Average	798.145472681 kHz	27.29	L1	gnd	-18.70
2	Average	1.32578199726 MHz	27.47	L1	gnd	-18.52
2	Average	17.7971587654 MHz	27.14	L1	gnd	-22.85

Figure 68 – Conducted EMI, Final Measurement Results.

15 線電壓突波

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

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

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

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

Unit passed under all test conditions.

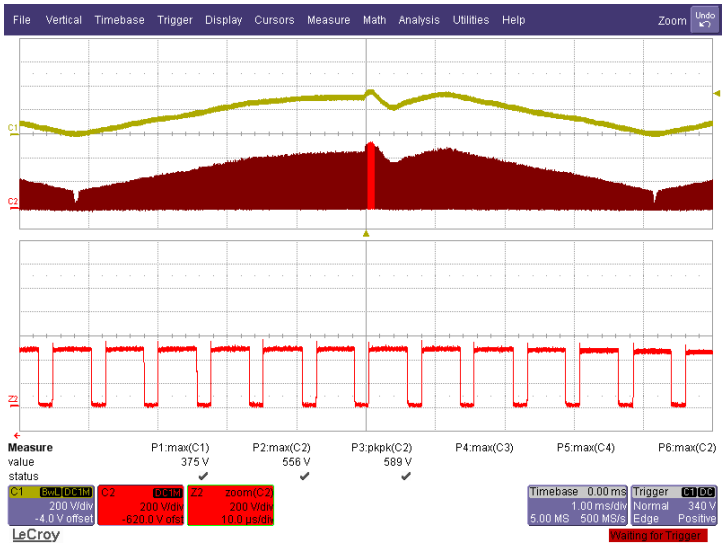

Figure 69 – 500 V Differential Surge. 589 V maximum VDS.

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16 修訂記錄

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

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