

設計範例報告

標題	使用 LYTSwitch™ LYT4311E 的 14.35 W 高效率、可調光雙向閘流器 (TRIAC)、非隔離 Tapped-Buck LED 驅動器
規格	190 VAC – 265 VAC 輸入； 41 V _{TYP} ，350 mA 輸出
應用	PAR30 LED 驅動器
作者	應用工程部門
文件編號	DER-365
日期	2013 年 5 月 15 日
修訂	1.0

摘要與功能

- Single-stage 功率因數修正 (PFC) 與定電流 (CC) 輸出相結合
- 在 230 VAC 條件下，效率約 89%
- 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
- 低成本、少元件、PCB 佔位面積小
- 快速啟動 (小於 300 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 0.95
- 230 VAC 時 A-THD 小於 15%
- 符合 EN55015 傳導性 EMI

Power Integrations

5245 Hellyer Avenue, San Jose, CA 95138 USA.

Tel: +1 408 414 9200 Fax: +1 408 414 9201

www.powerint.com

專利資訊

Power Integrations 的一項或多項美國及國外專利 (或可能正在申請的美國及國外專利) 可能涵蓋本文件中所示的產品和應用 (包括產品外部的變壓器結構和電路)。www.powerint.com 上提供了 Power Integrations 專利的完整清單。Power Integrations 授予其客戶某些特定專利權的授權，詳情請參閱 <<http://www.powerint.com/ip.htm>>。



目錄

1	簡介.....	5
2	電源供應器規格.....	8
3	電路圖.....	9
4	電路說明.....	10
4.1	輸入 EMI 濾波.....	10
4.2	電源電路.....	10
4.3	偏壓電源供應器和輸出回饋.....	11
4.4	TRIAC 相位調光控制相容性.....	11
5	PCB 佈局.....	13
6	物料清單.....	14
7	電感器規格.....	15
7.1	電氣圖.....	15
7.2	電氣規格.....	15
7.3	材料.....	15
7.4	電感建構圖.....	16
7.5	電感器結構.....	16
8	U1 散熱片.....	17
8.1	U1 散熱片製造圖.....	17
8.2	U1 散熱片組裝圖.....	18
8.3	散熱片和 U1 組裝圖.....	19
9	效能資料.....	20
9.1	效率.....	20
9.2	線電壓與負載穩定度關係圖.....	21
9.3	功率因數 (PF).....	23
9.4	A-THD.....	24
9.5	諧波.....	25
9.6	測試資料.....	26
9.6.1	測試資料, 38 V LED 負載.....	26
9.6.2	測試資料, 41 V LED 負載.....	26
9.6.3	測試資料, 44 V LED 負載.....	26
10	調光效能資料.....	27
10.1	使用前緣調光器的調光曲線.....	27
10.2	調光器相容性清單.....	28
11	散熱效能.....	29
11.1	非調光 $V_{IN} = 190$ VAC, 50 Hz, 41 V LED 負載.....	29
11.2	非調光 $V_{IN} = 265$ VAC, 50 Hz, 41 V LED 負載.....	30
11.3	Dimming $V_{IN} = 230$ VAC, 50 Hz, 41 V LED 負載、REV300 調光器.....	31
12	非調光波形.....	32
12.1	輸入電壓和輸入電流波形.....	32



12.2	正常運作下的輸出電流和輸出電壓	32
12.3	啓動時的輸入電壓和輸出電流波形	33
12.4	正常運作下的汲極電壓和電流	33
12.5	啓動汲極電壓和電流.....	35
12.6	輸出短路情況下的汲極電流和汲極電壓	36
12.7	輸出二極體電流和電壓波形.....	37
12.8	輸出二極體電流和電壓啓動波形.....	38
12.9	輸出二極體電流和電壓短路波形.....	38
12.10	關閉.....	39
12.11	線間暫態	40
13	調光波形.....	41
13.1	輸入電壓和輸入電流波形	41
13.2	輸出電流波形	42
14	傳導性 EMI.....	43
14.1	測試裝置	43
14.2	測試結果	44
15	線電壓突波測試.....	45
16	修訂記錄.....	47

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。



1 簡介

本文件說明非隔離式、高功率因數 (PF)、高效率、雙向閘流器 (TRIAC) 調光 LED 驅動器，其設計為輸入電壓範圍為 190 VAC 至 265 VAC (典型值 50 Hz) 時，於 350 mA 下驅動 41 V 的標準 LED 串電壓。

此設計使用 Single-stage 非隔離 Tapped Buck，以符合此設計的高功率因數、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。

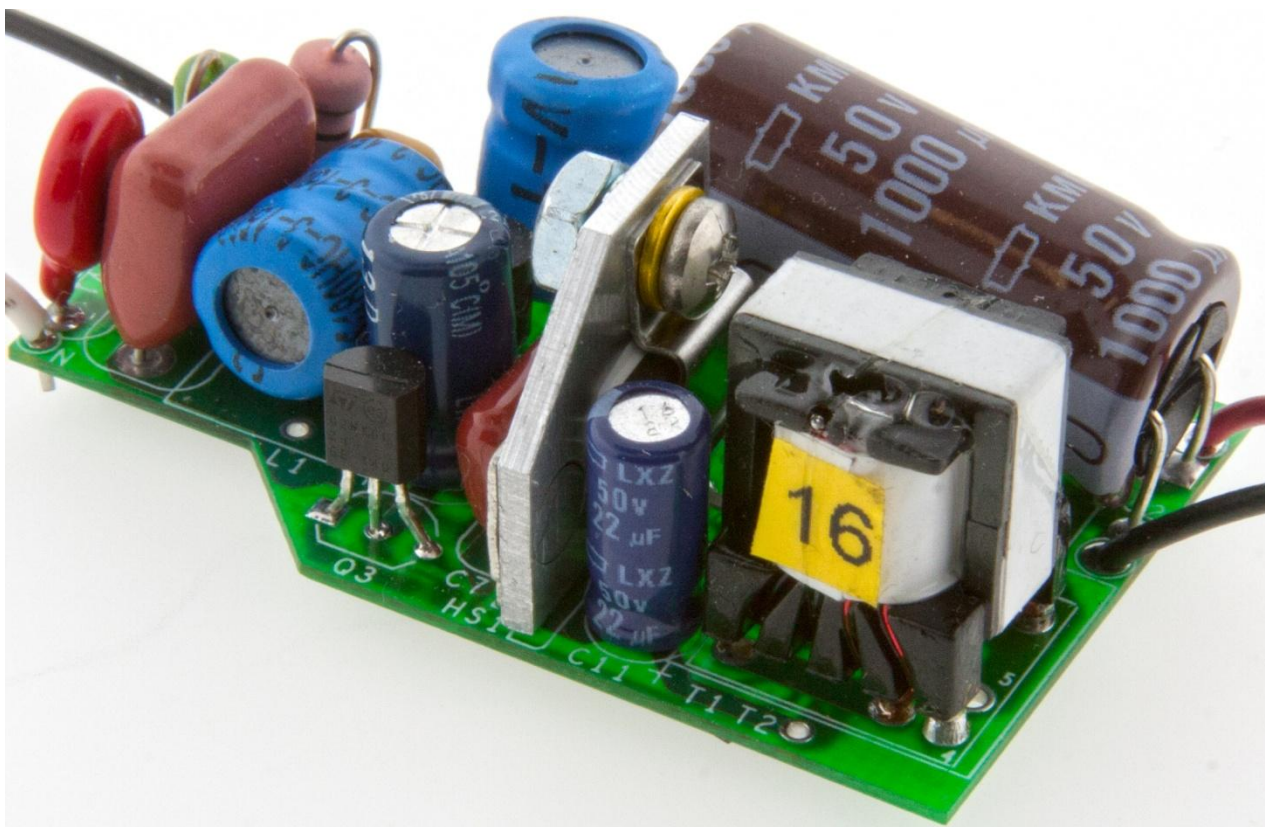


Figure 1 – Populated Circuit Board, Angle View.

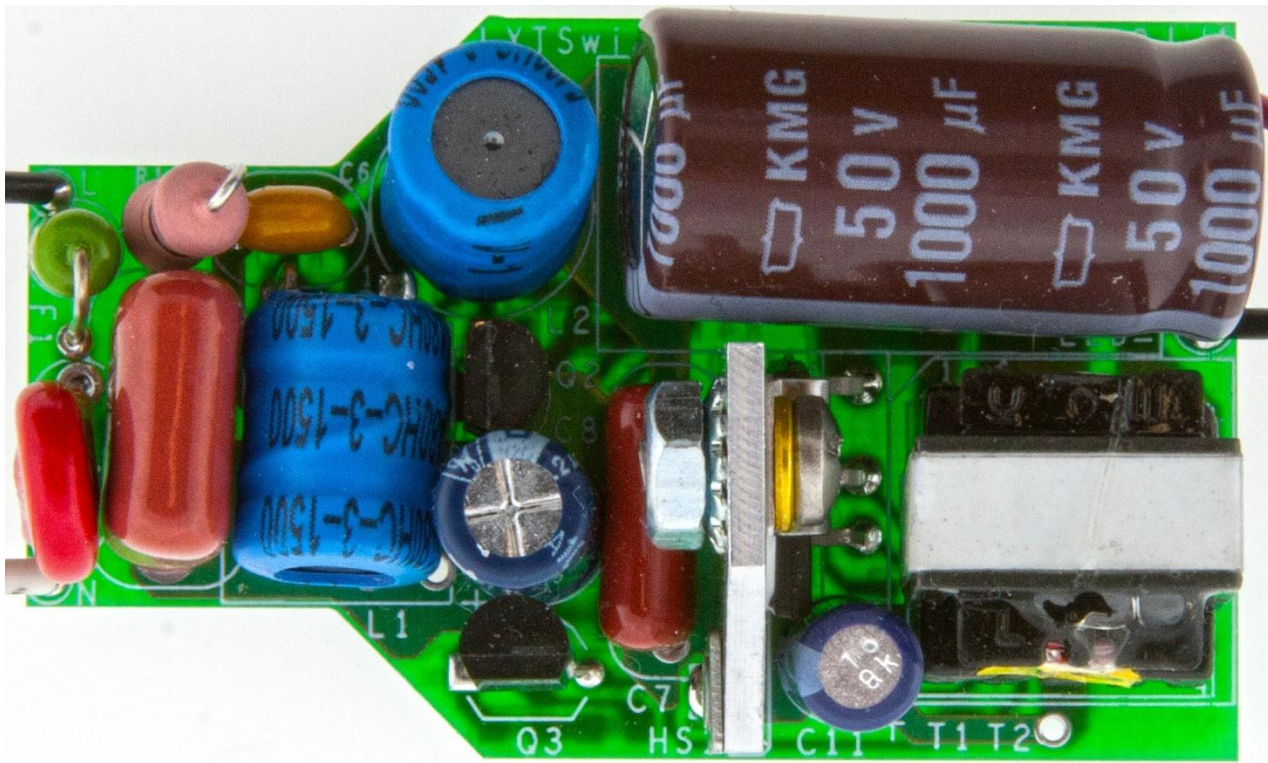


Figure 2 – Populated Circuit Board, Top View.

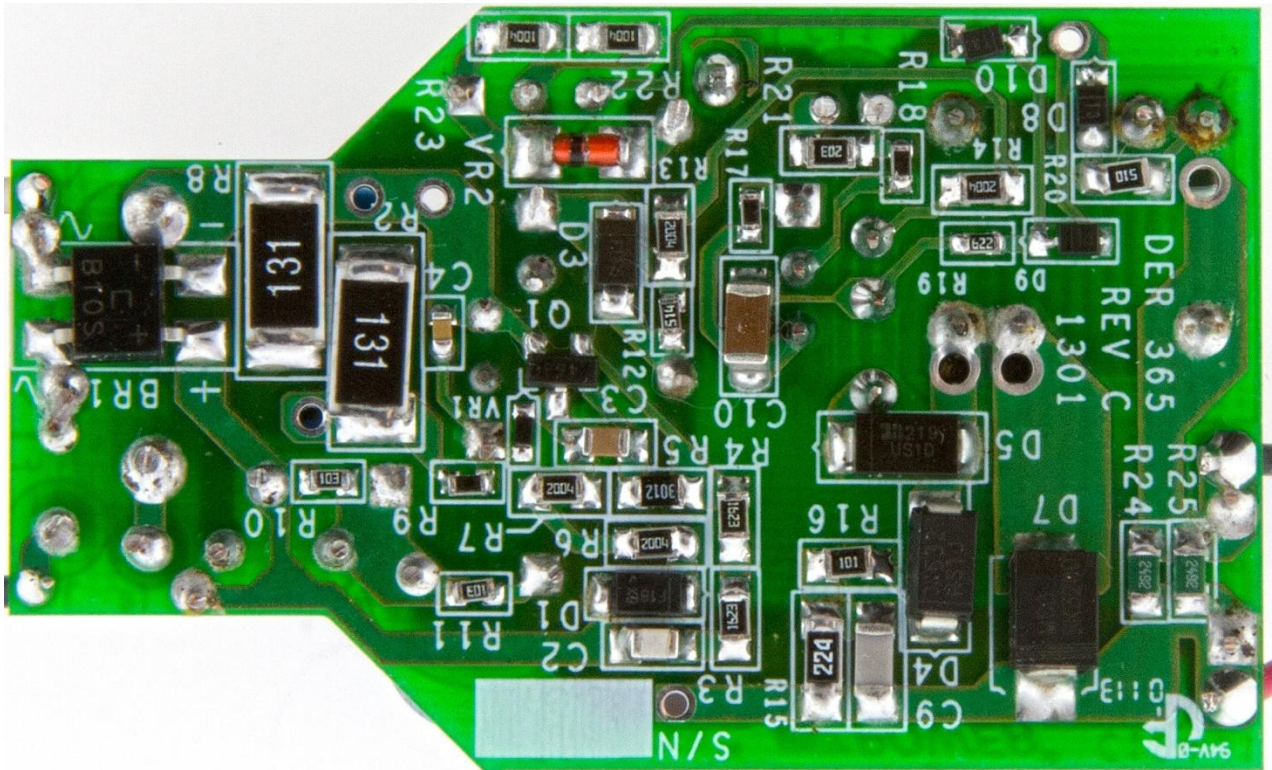


Figure 3 – Populated Circuit Board, Bottom View.



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}		50/60		Hz	
輸出 輸出電壓	V_{OUT}	38	41	44	V	$V_{OUT} = 41\text{ V}$, $V_{IN} = 230\text{ VAC}$, $25\text{ }^{\circ}\text{C}$
輸出電流	I_{OUT}		350		mA	
總輸出功率			14.35		W	
連續輸出功率	P_{OUT}					
效率 滿載	η	88	89		%	在 P_{OUT} $25\text{ }^{\circ}\text{C}$ 時測量
環境 傳導性 EMI 安全 振盪波 (100 kHz) 差模 (L1-L2) 共模 (L1/L2-PE) 差模突波			CISPR 15B / EN55015B 非隔離式			
			2.5		kV	
			500		V	
功率因數 (PF)		0.95				於 $V_{OUT(TYP)}$ 、 $I_{OUT(TYP)}$ 及 230 VAC、50 Hz 條件下測量
諧波電流		EN 61000-3-2 C 級				
環境溫度	T_{AMB}				$^{\circ}\text{C}$	



3 電路圖

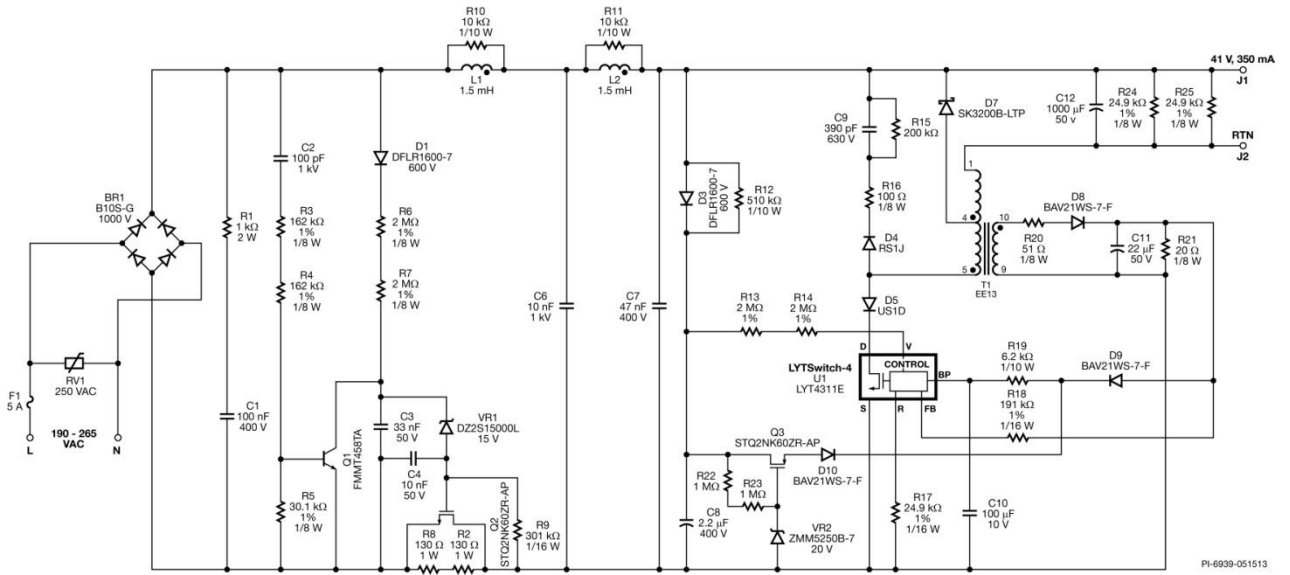


Figure 4 – Schematic.

4 電路說明

LYT4311E (U1) 是一個高度整合的一次側控制器，主要用於 LED 驅動器應用。它可以 Single-stage 轉換提供高功率因數 (PF)，同時還能在廣泛的輸入範圍 (190 VAC 至 265 VAC) 內調節輸出電流。所有負責這些功能的控制電路，加上高電壓功率 MOSFET 都整合到 IC 內。

4.1 輸入 EMI 濾波

保險絲 F1 可在發生元件故障時提供保護，而 RV1 可在發生差模線電壓突波活動期間進行箝制，以限制最大電壓。橋式整流器 BR1 可對 AC 線電壓進行整流。

EMI 濾波由電感器 L1 和 L2，以及電容器 C6 和 C7 提供。在 L1 和 L2 上的電阻器 R10 和 R11 會抑制電感器自身的諧振，以避免傳導性 EMI 圖中的雜訊在這些電感器的諧振頻率下達到峰值。

由於選用的電感器不防磁，且彼此相鄰串聯連接，所以在佈局中，謹慎考量了 L1 與 L2 之間磁耦合的影響，以產出一致的 EMI 反應。在此設計中，L1 與 L2 垂直接合，且良好控制了繞組的起始和終止，並在電路圖和 PCB 中以圓點表示。(如需起始和終止繞組的相關資訊，請參閱電感器製造商產品規格型錄)

4.2 電源電路

此設計選用了低端 Tapped Buck，設定為在 190 VAC 至 265 VAC 輸入電壓範圍內提供低 THD、高功率因數 (PF) 和定電流輸出。

Tapped-Buck 轉換器具有下列優勢：減小磁性元件的尺寸、主電源切換開關 U1 上的電流應力以及輸出二極體 D7 上的電壓應力。主電源切換開關上的電流應力減小後，便可使用較小的切換裝置，以提供更具成本效益的設計。輸出二極體上的電壓應力減小後，便可使用低 V_F (蕭特基)，以提高效率。

電感器 T1 是降壓式轉換器的主要電感器。其包含三組繞組，即一次側繞組、二次側繞組和偏壓繞組。一次側與二次側圈數比選為 4:1，這樣便可使用 200 V 輸出二極體，同時保持 U1 LYT4311E 的最大電壓遠低於其最大值。

每當 U1 關閉時，輸出二極體 D7 就會傳導，並將能量輸送到負載。需要使用二極體 D5，才能在 C7 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。還增加了電壓箝位電路，以限制由 T1 漏電感引起的電壓突波。電壓箝位網路由二極體 D4、電容器 C9 及電阻器 R15 和 R16 構成。

選用了輸出電容器 C12 以將輸出漣波降至最低 (低於 30%)。預載電阻器 R24 和 R25 會在移除 AC 時將輸出端快速放電至 LED 串電壓以下，並確保燈具完全熄滅，而不是在移除 AC 後微弱地發光數秒鐘。



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 D3 爲 C8 充電。然後，該電壓將以透過 R13 和 R14 的電流形式饋送至 U1 的電壓監測器 (V) 接腳。電阻器 R12 提供放電路徑，可讓 C8 上的電壓追蹤輸入 AC 的變化。

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 V_{DSS} 額定值。

電容器 C10 會爲 U1 的 BYPASS (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 汲極 (D) 接腳連接的內部高電壓電流源將 C10 充電至約 6 V。選擇的電容器 C10 爲 100 μF ，可讓裝置在深度調光模式下更好地操作，否則，可使用 4.7 μF ，因爲 LYT4311 只有一種功率模式。

U1 的參考 (R) 接腳透過電阻器 R17 接地 (源極)。使用 24.9 $\text{k}\Omega$ 值以提供嚴格的定電流調節。

4.3 偏壓電源供應器和輸出回饋

T1 的偏壓繞組用於提供回饋和供電給 IC。偏壓繞組上的返馳式電壓會使用 D8 進行整流、C11 進行濾波，以使電壓平順，並使用 R20 減少從漏電感能量耦合的過量電壓。然後回饋電流會透過電阻器 R18 回饋到回饋 (FB) 接腳。二極體 D9 和 R19 會將 BP 接腳連結到偏壓繞組。啓動期間需要使用二極體 D9 來隔離 C10 與 C11，電阻器 R19 則限制從偏壓繞組供應給 BP 接腳的電流。R21 提供偏壓供電的負載，以加快 C11 在 AC 週期期間的放電，並有助於實現較高的調光比。

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 的前緣和後緣相位調光器在設計時有許多取舍。

由於 LED 照明所消耗的功率小得多，因此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)。這會導致發生不良情況，例如調光範圍受限及 (或) 在 TRIAC 啓動時不一致地閃爍。開啓 TRIAC 時，LED 燈相對較大的阻抗會因對輸入電容充電的突波電流 (inrush current) 而導致大幅振盪。這個效應會導致發生閃爍，因爲振盪可能導致 TRIAC 電流降至零並關閉。

在設計中整合阻尼器、洩放器和線性調節器電路可以克服這些問題，而且幾乎不影響驅動器的效率。

電阻器 R2 和 R8 提供被動阻尼以及由 D1、R6、R7、C3、VR1、C4、Q2 和 R9 組成的包覆電路，並藉由在 TRIAC 導通後於線性模式下操作 Q2 約 2 ms，將 R2 和 R8 的功耗降至最低。電容器 C2、R3、R4、R5 和 Q1 提供放電路徑，如此一來，當下一個 TRIAC 切換週期開始時，Q2 一開始就會關閉。所以會選取這些值，以便在未連接 TRIAC 時，使 Q2 永久開啓，以協助提升非調光操作期間的效率。



被動洩放器網路由電容器 C1 和 R1 構成。這個網路會減弱輸入網路，但也會為雙向閘流器 (TRIAC) 調光器提供所需的鎖定和保持電流。

新增的線性調節器電路 R22、R23、VR2、Q3 和 D10 可持續為 IC (BP 接腳) 穩定供電，可讓此 IC 在非常低的導通角或極低的輸入電壓下正常運作，並使該 IC 作為負載 (尤其是具有高漏電流的 TRIAC)。大多數高額定功率 (大於 600 W) 雙向閘流器 (TRIAC) 調光器均具有 LC 輸入濾波器。如 C 大到足以提供能量來為 LED 驅動器的輸入階段充電，當 LED 負載通電時，LED 便會開啓，直到輸入放電。然後會重覆此循環，並導致 LED 負載閃爍，即使關閉了雙向閘流器 (TRIAC) 也是一樣。

當偏壓電壓高於 $V_{ZVR2} + V_{tQ3} + V_{fD10}$ 時，將不會啓動線性調節器。選擇電壓調節器 VR2 可讓線性調節器僅在偏壓電壓夠低情況下進行深度調光期間運作，將 Q3 功率消耗降至最低。MOSFET Q3 可換成 BJT (400V) 以降低成本，而電阻器 R22 和 R23 則必須隨之調整，以提供充沛動力，尤其輸入電壓在深度調光情況下偏低時。



5 PCB 佈局

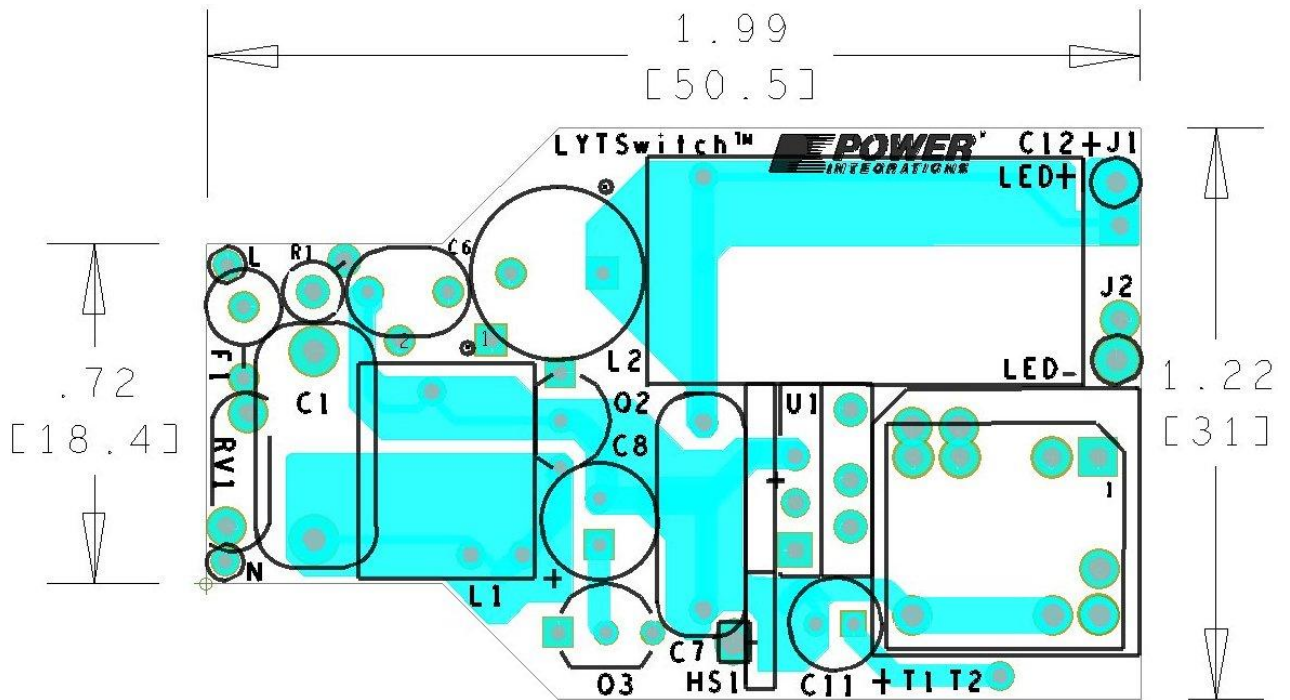


Figure 5 – Top Side.

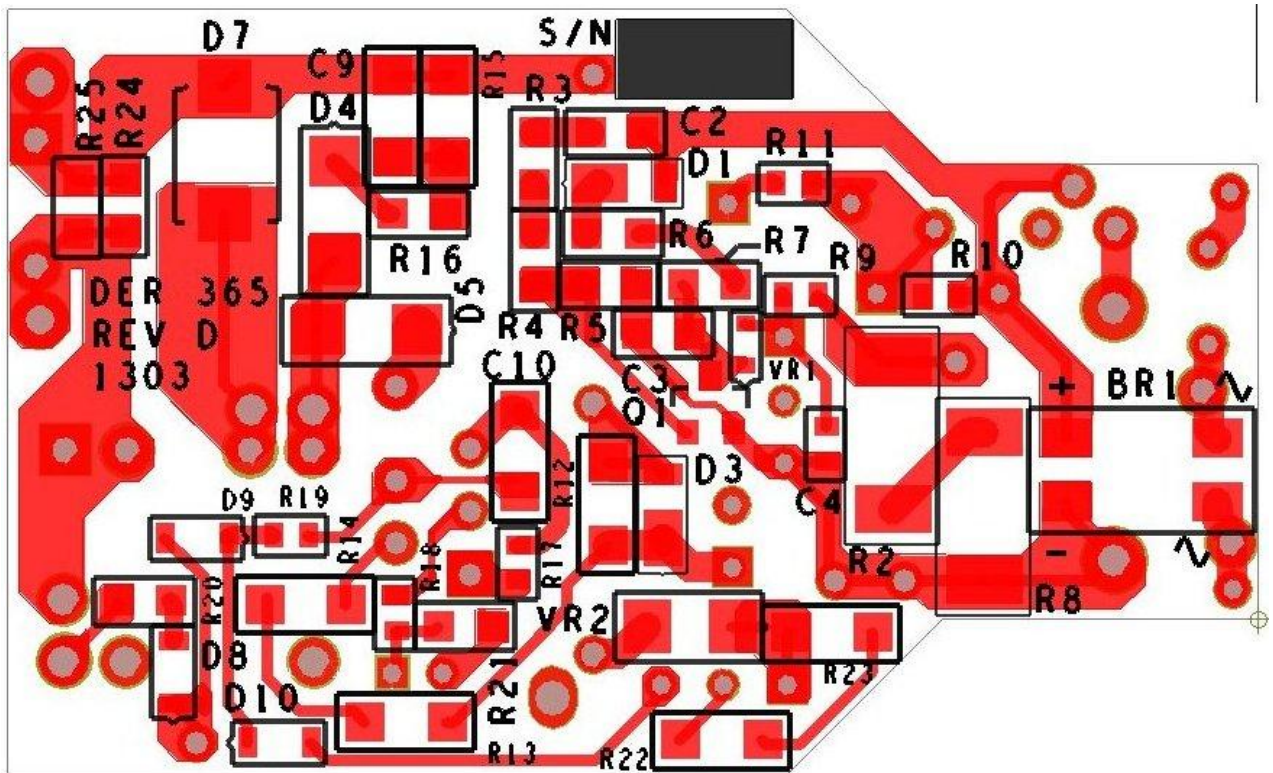


Figure 6 – Bottom Side.



6 物料清單

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR1	1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC	B10S-G	Comchip Technology
2	1	C1	100 nF, 400 V, Film	ECQ-E4104KF	Panasonic
3	1	C2	100 pF, 1000 V, Ceramic, NPO, 0805	C0805C101MDGACTU	Kemet
4	1	C3	33 nF, 50 V, Ceramic, X7R, 0805	CC0805KRX7R9BB333	Yageo
5	1	C4	10 nF 50 V, Ceramic, X7R, 0603	C0603C103K5RACTU	Kemet
6	1	C6	10 nF, 1 kV, Disc Ceramic, X7R	SV01AC103KAR	AVX
7	1	C7	47 nF, 400 V, Film	ECQ-E4473KF	Panasonic
8	1	C8	2.2 μ F, 400 V, Electrolytic, (6.3 x 11)	TAB2GM2R2E110	Ltec
9	1	C9	390 pF, 630 V, Ceramic, NPO, 1206	C3216C0G2J391J	TDK
10	1	C10	100 μ F, 10 V, Ceramic, X5R, 1206	C3216X5R1A107M	TDK
11	1	C11	22 μ F, 50 V, Electrolytic, (5 x 11)	UPW1H220MDD	Nichicon
12	1	C12	1000 μ F, 50 V, Electrolytic, Gen. Purpose, (12.5 x 25)	EKMG500ELL102MK25S	Nippon Chemi-Con
13	2	D1 D3	600 V, 1 A, Rectifier, Glass Passivated, POWERD1123	DFLR1600-7	Diodes, Inc.
14	1	D4	600 V, 1 A, Fast Recovery, 250 ns, SMA	RS1J-13-F	Diodes, Inc.
15	1	D5	Diode ULTRA FAST, SW, 200 V, 1 A, SMA	US1D-13-F	Diodes, Inc.
16	1	D7	200 V, 3 A, DIODE SCHOTTKY 1 A 200 V, SMB	SK3200B-LTP	Micro Commercial
17	3	D8 D9 D10	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
18	1	F1	5 A, 250 V, Fast, Microfuse, Axial	0263005.MXL	Littlefuse
19	2	L1 L2	1.5 mH, 0.250 A, 10%	RL-5480HC-3-1500	Renco
20	1	Q1	NPN, HP, 400 V, 225Ma, SOT23-3	FMMT458TA	Diodes, Inc.
21	2	Q2 Q3	600 V, 0.4 A, 8 Ω , N-Channel, TO-92	STQ2NK60ZR-AP	ST Micro
22	1	R1	1 k Ω , 5%, 2 W, Metal Film	FMP200JR-52-1K	Yageo
23	2	R2 R8	130 Ω , 5%, 1 W, Thick Film, 2512	ERJ-1TYJ131U	Panasonic
24	2	R3 R4	162 k Ω , 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF1623V	Panasonic
25	1	R5	30.1 k Ω , 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF3012V	Panasonic
26	2	R6 R7	2 M Ω , 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2004V	Panasonic
27	1	R9	301 k Ω , 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF3013V	Panasonic
28	2	R10 R11	10 k Ω , 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
29	1	R12	510 k Ω , 5%, 1/10 W, Thick Film, 1206	ERJ-8GEYJ514V	Panasonic
30	2	R13 R14	2.00 M Ω , 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF2004V	Panasonic
31	1	R15	200 k Ω , 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ204V	Panasonic
32	1	R16	100 Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ101V	Panasonic
33	1	R17	24.9 k Ω , 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF2492V	Panasonic
34	1	R18	191 k Ω , 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1913V	Panasonic
35	1	R19	6.2 k Ω , 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ622V	Panasonic
36	1	R20	51 Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ510V	Panasonic
37	1	R21	20 k Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ203V	Panasonic
38	2	R22 R23	1 M Ω , 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ105V	Panasonic
39	2	R24 R25	24.9 k Ω , 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2492V	Panasonic
40	1	RV1	250 V, 21 J, 7 mm, RADIAL LA	V250LA4P	Littlefuse
41	1	T1	Custom	TSD-3192	Premier Magnetics
42	1	U1	LYTSwitch, eSIP-7C	LYT4311E	Power Integrations
43	1	VR1	15 V, 5%, 150 mW, SSMINI-2	DZ2S15000L	Panasonic-SSG
44	1	VR2	20 V, 5%, 500 mW, DO-213AA (MELF)	ZMM5250B-7	Diodes, Inc.



7 電感器規格

7.1 電氣圖

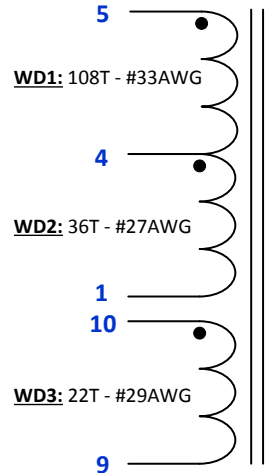


Figure 7 – Inductor Electrical Diagram.

7.2 電氣規格

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

7.3 材料

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

7.4 電感建構圖

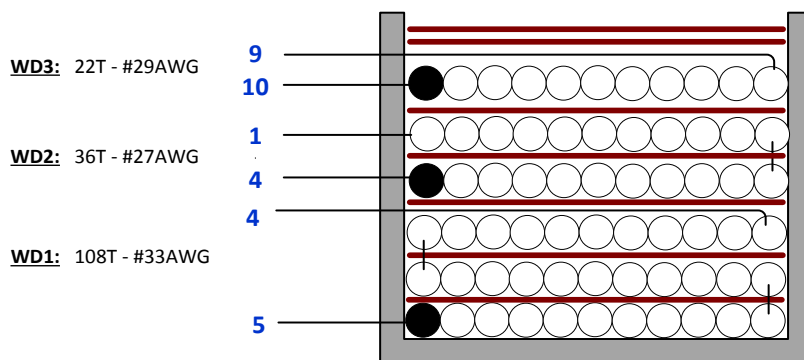


Figure 8 – Inductor Build Diagram.

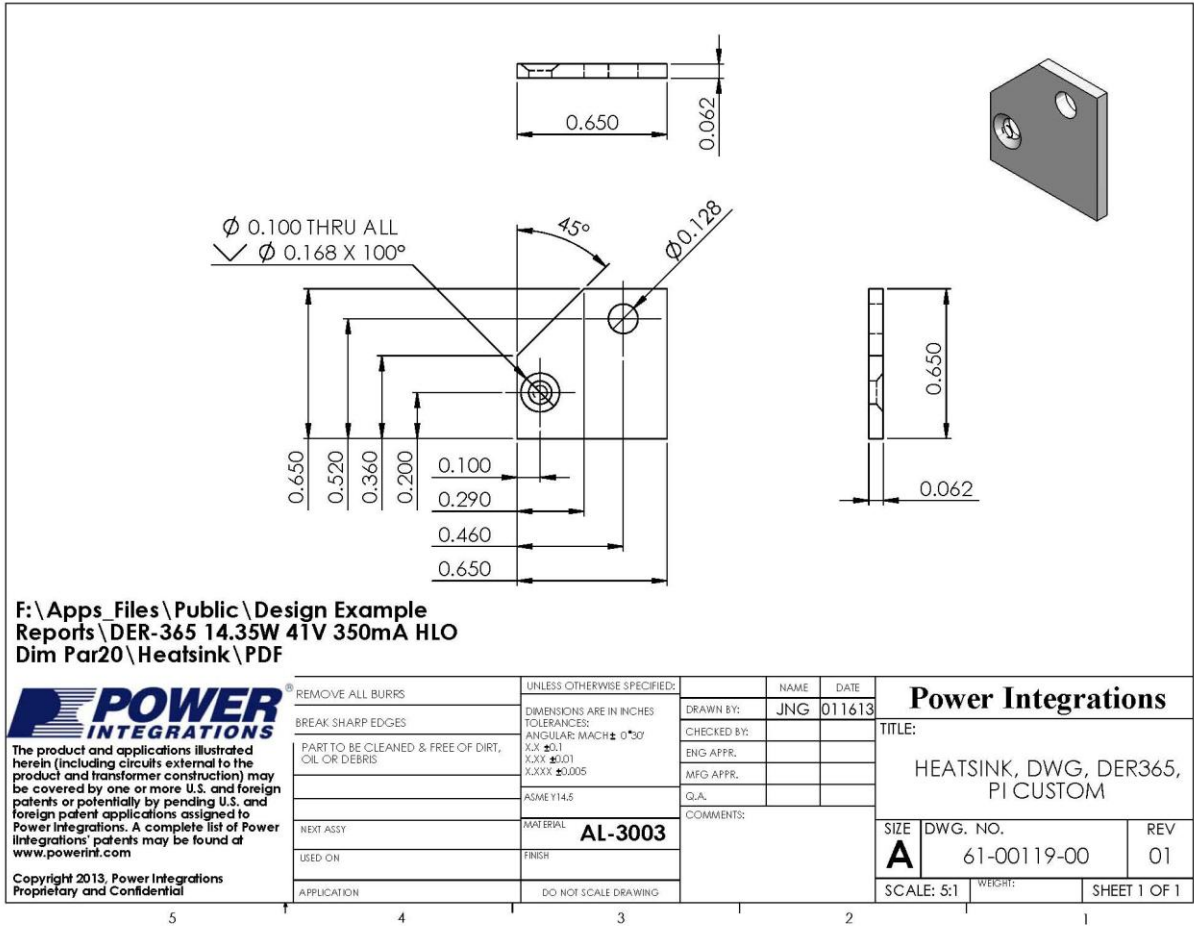
7.5 電感器結構

Winding Preparation	Place the bobbin on the mandrel with the pin side is on the left side. Winding direction is clockwise direction.
WD1	Start at pin 5, wind 36 turns of wire item [3] from left to right, place 1 layer tape item [6], then continue wind another 36 turns from right to left, place 1 layer tape item [6], then continue wind another 36 turns from left to right, and end at pin 4.
Insulation	Place 1 layer of tape item [6].
WD2	Start at pin 4, wind 18 turns of wire item [4] from left to right, place 1 layer tape item [6], then continue wind another 18 turns from right to left, and end at pin 1.
Insulation	Place 1 layer of tape item [6].
WD3	Start at pin 10, wind 22 turns of wire item [5] from left to right in 1 layer. At the last turn bring the wire back to the left and end at pin 9.
Insulation	Place 2 layers of tape item [6].
Final Assembly	Grind, assemble, and secure core halves with tape. Varnish with item [7].



8 U1 散熱片

8.1 U1 散熱片製造圖



8.2 U1 散熱片組裝圖

1 FOR COMPLETED ASSEMBLY
SEE 61-00119-02.

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

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

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

Copyright 2013, Power Integrations
Proprietary and Confidential

REMOVE ALL BURRS	UNLESS OTHERWISE SPECIFIED:	NAME	DATE	Power Integrations
BREAK SHARP EDGES	DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: MACH ± 0°30' X.X ±0.1 X.XX ±0.01 X.XXX ±0.005	DRAWN BY: JNG	013013	
PART TO BE CLEANED & FREE OF DIRT, OIL OR DEBRIS	ASM EY14.5	CHECKED BY:		TITLE: HEATSINK, DWG, DER365, PI CUSTOM
NEXT ASSY	MATERIAL	ENG APPR.		
USED ON	FINISH	MFG APPR.		SIZE DWG. NO. REV A 61-00119-01 01
APPLICATION	DO NOT SCALE DRAWING	COMMENTS:		

5
4
3
2
1



8.3 散熱片和 U1 組裝圖

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

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

<p>REMOVE ALL BURRS</p> <p>BREAK SHARP EDGES</p> <p>PART TO BE CLEANED & FREE OF DIRT, OIL OR DEBRIS</p> <p>NEXT ASSY</p> <p>USED ON</p> <p>APPLICATION</p>	UNLESS OTHERWISE SPECIFIED:	DIMENSIONS ARE IN INCHES	TOLERANCES:	ANGULAR: MACH ± 0°30'	X.X ±0.1	X.XX ±0.01	X.XXX ±0.005	ASM EY14.5	MATERIAL	FINISH	DO NOT SCALE DRAWING
	DRAWN BY: JNG	DATE: 022713	<p>Power Integrations</p> <p>TITLE: HEATSINK, ASSY, ESIP, DER365, PI CUSTOM</p> <p>SIZE: A DWG. NO.: 61-00119-02 REV: 01</p> <p>SCALE: 1:1 WEIGHT: SHEET 1 OF 1</p>								
	CHECKED BY:	ENG APPR:	MFG APPR:	Q/A:	COMMENTS:						
	<p>The product and applications illustrated herein (including circuits external to the product and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at www.powerint.com</p> <p>Copyright 2013, Power Integrations Proprietary and Confidential</p>										
	<p>5 4 3 2 1</p>										

9 效能資料

All measurements performed at room temperature using an LED load. The following data was taken measured using 3 sets of loads representing a load range of 38 V to 44 V (output voltage). Refer to the table on Section 9.6 for complete test data values.

9.1 效率

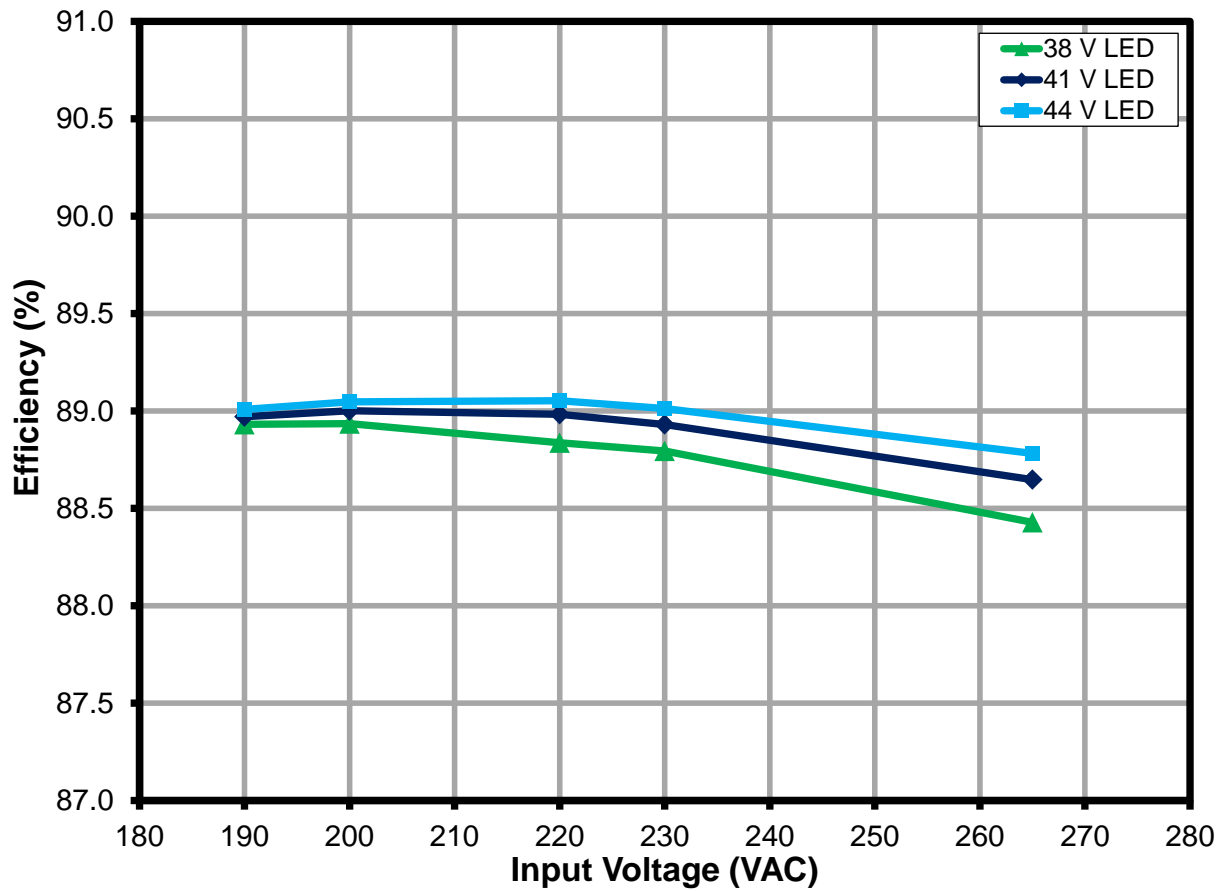


Figure 9 – Efficiency vs. Line and Load.



9.2 線電壓與負載穩定度關係圖

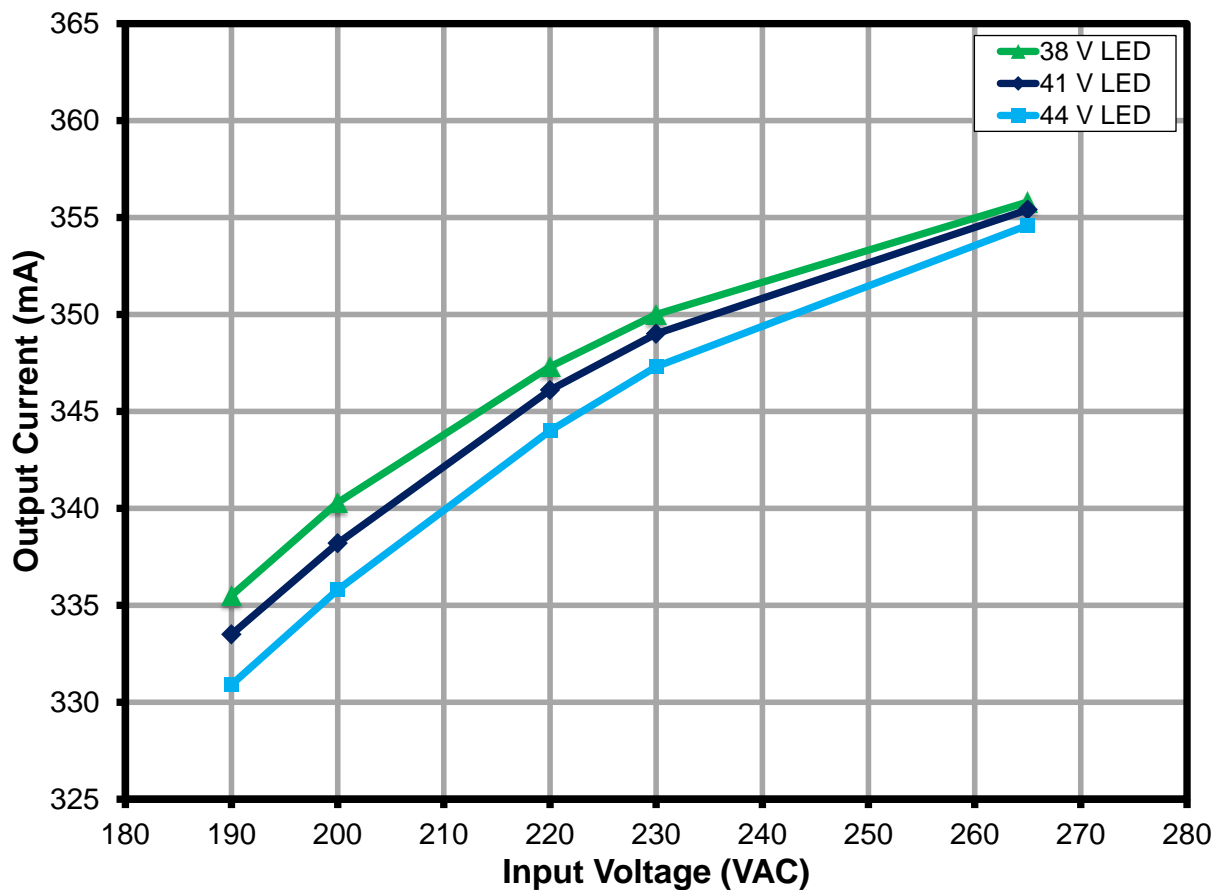


Figure 10 – Regulation vs. Line and Load.



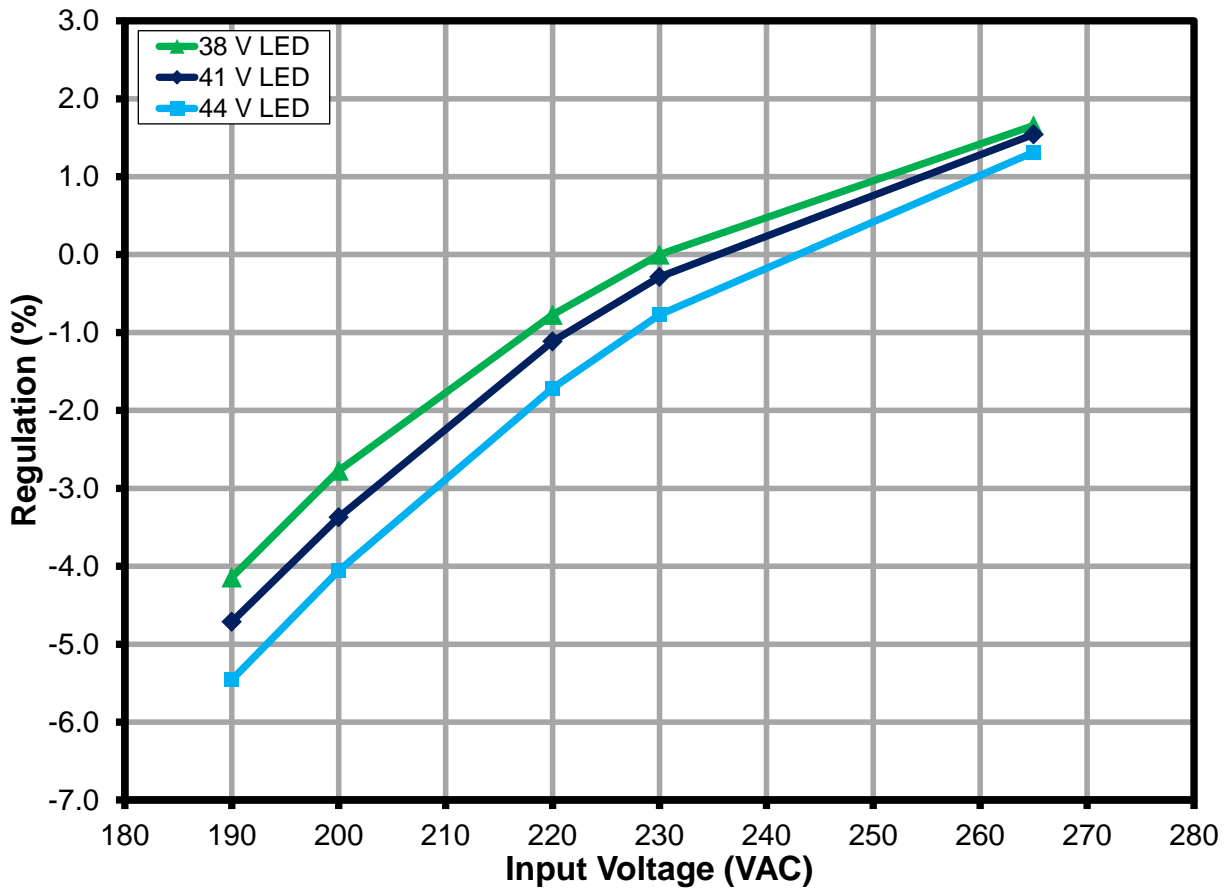


Figure 11 – % Regulation vs. Line and Load.



9.3 功率因數 (PF)

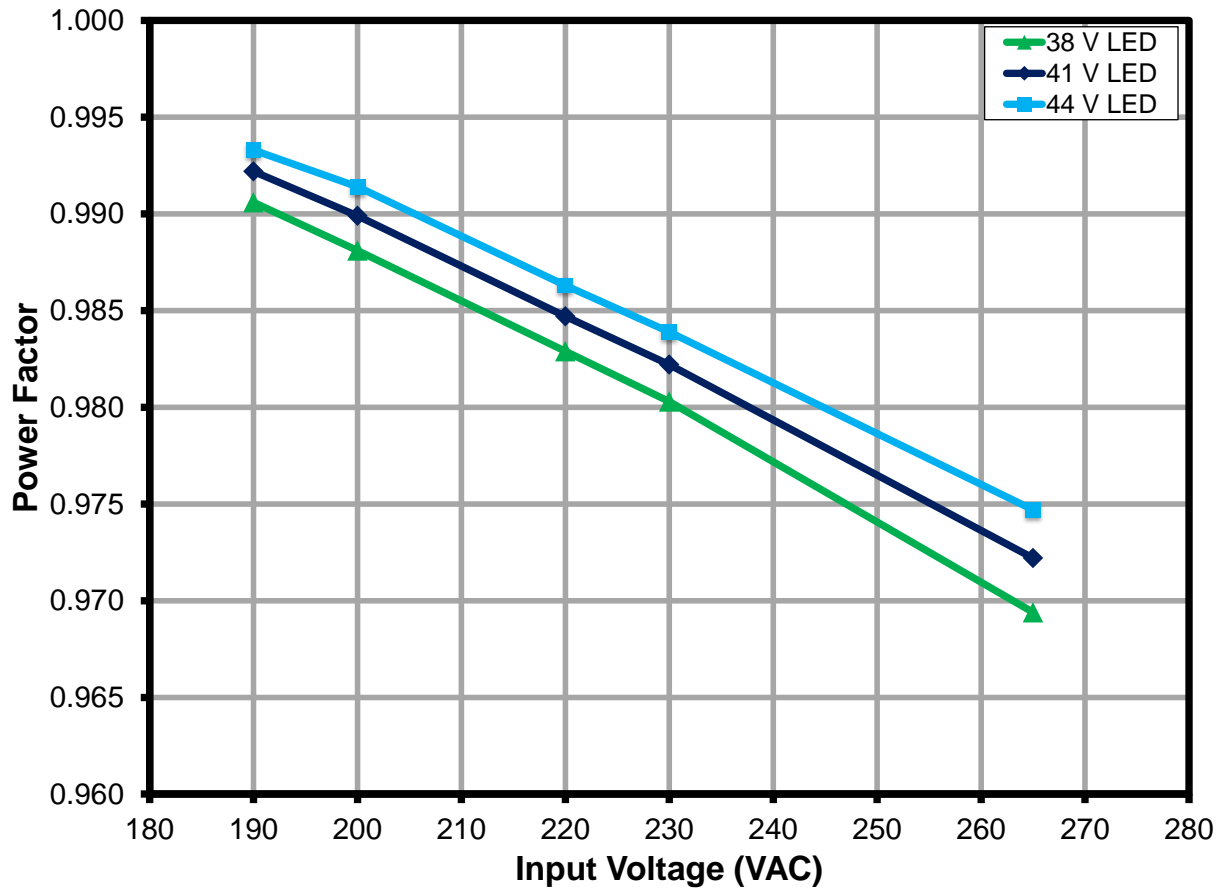


Figure 12 – Power Factor vs. Line and Load.



9.4 A-THD

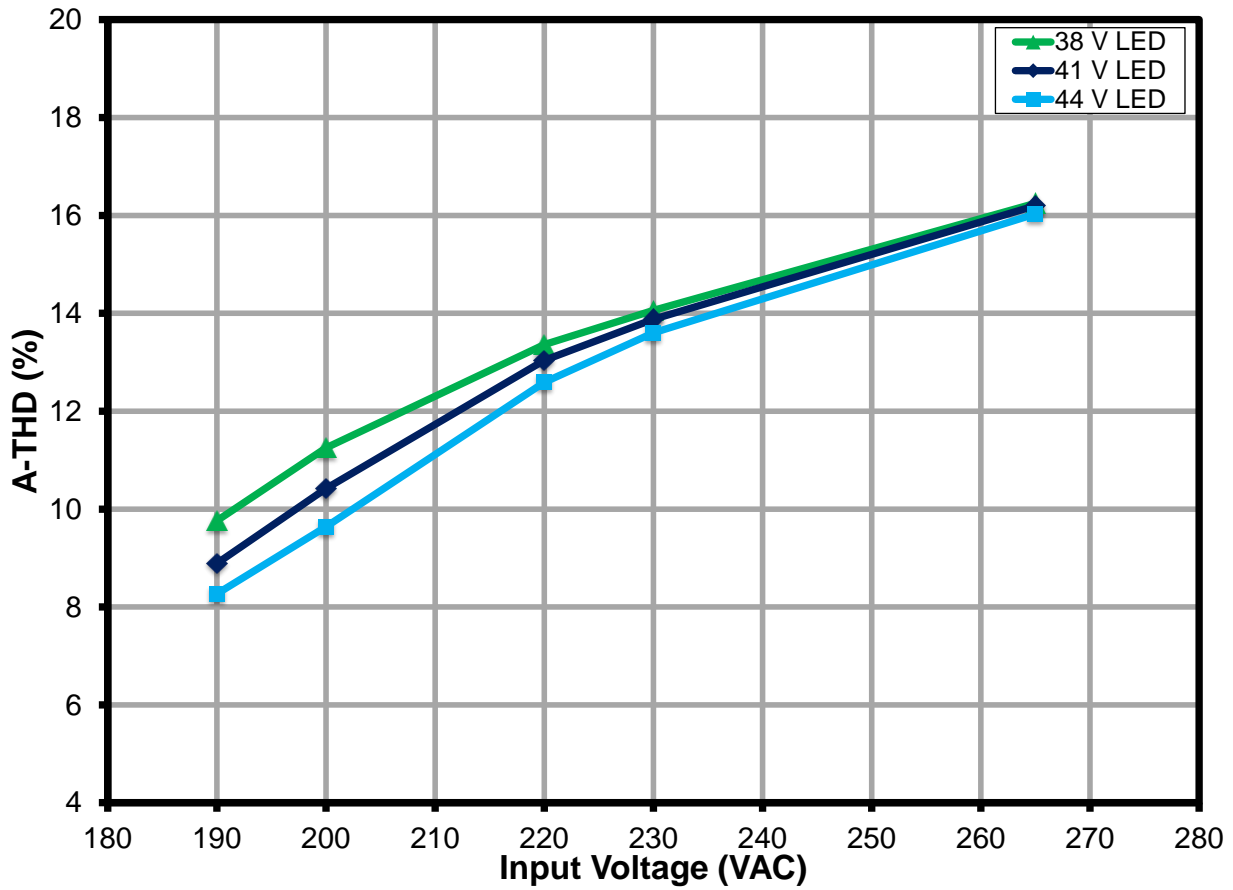


Figure 13 – A-THD vs. Line and Load.



9.5 諧波

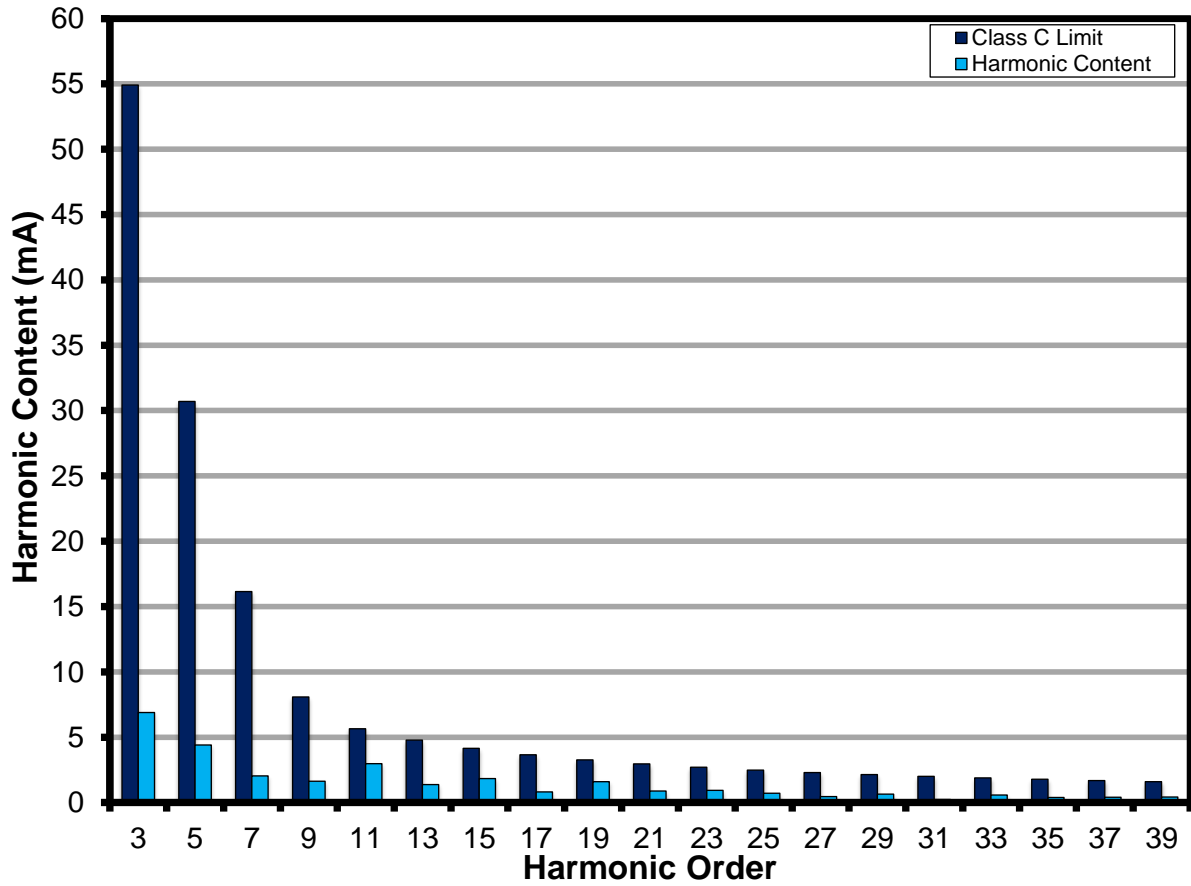


Figure 14 – 41 V LED Load Input Current Harmonics at 230 VAC, 50 Hz.



9.6 測試資料

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

9.6.1 測試資料，38 V LED 負載

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

9.6.2 測試資料，41 V LED 負載

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

9.6.3 測試資料，44 V LED 負載

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



10 調光效能資料

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

10.1 使用前緣調光器的調光曲線

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

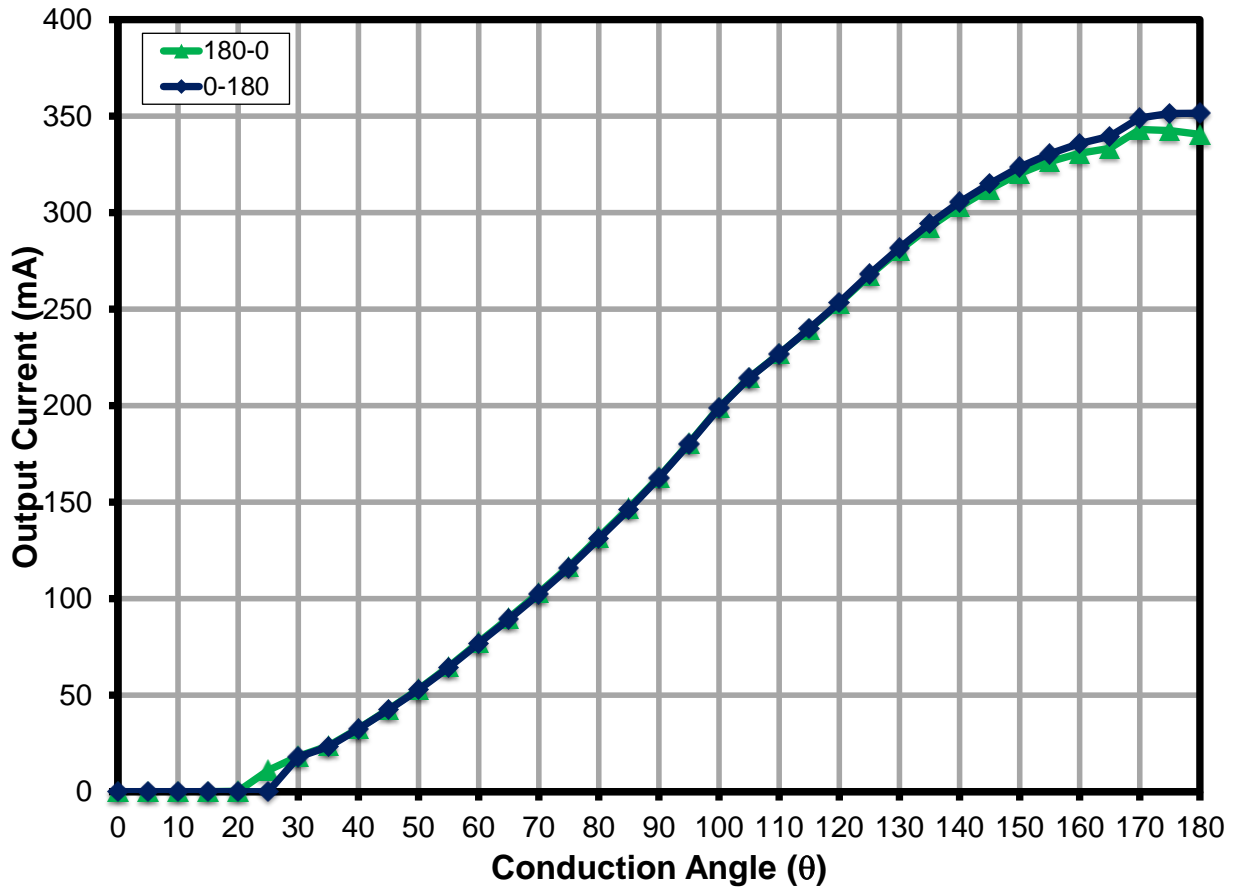


Figure 15 – Leading Edge Dimming Characteristics.

10.2 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 41 V LED load and using Agilent 6812B AC source.

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

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

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

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

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

Figure 16 – Compatibility List.



11 散熱效能

Images captured after running for 於室溫 (25 °C) 下 30 分鐘以上(°C), open frame for the conditions specified.

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

11.1 非調光 $V_{IN} = 190 \text{ VAC}$, 50 Hz , 41 V LED 負載

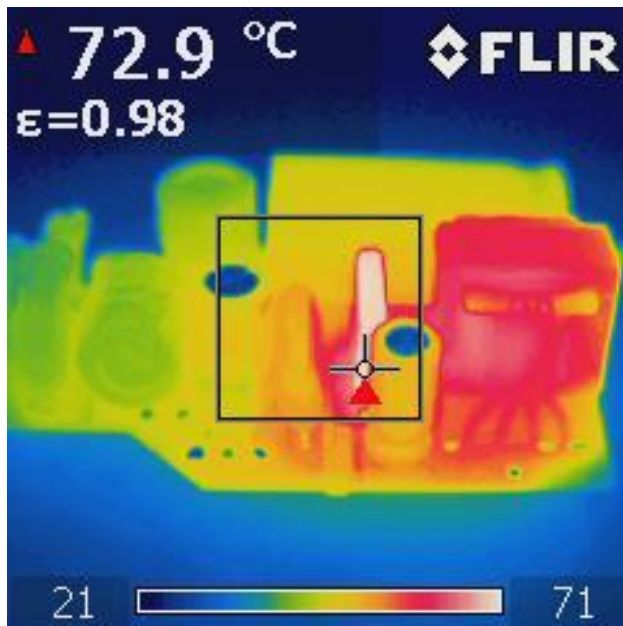


Figure 17 – Top Side.
 U1-LYT4311E: 72.9 °C.

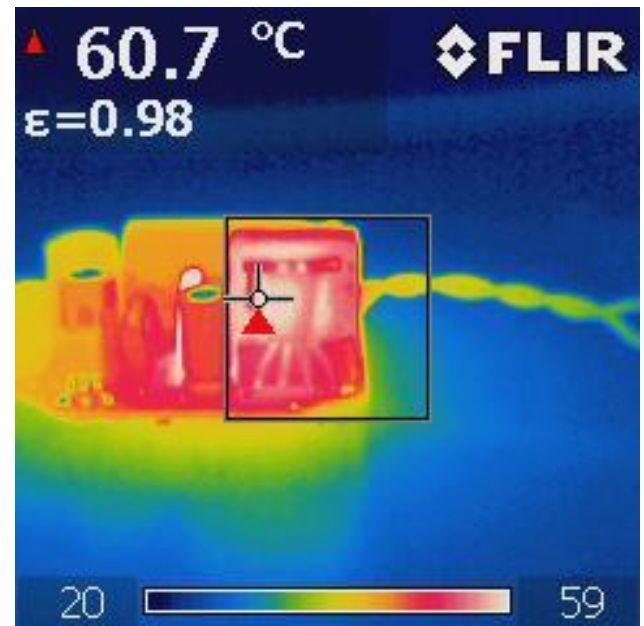


Figure 18 – Top Side.
 T1: 60.7 °C.

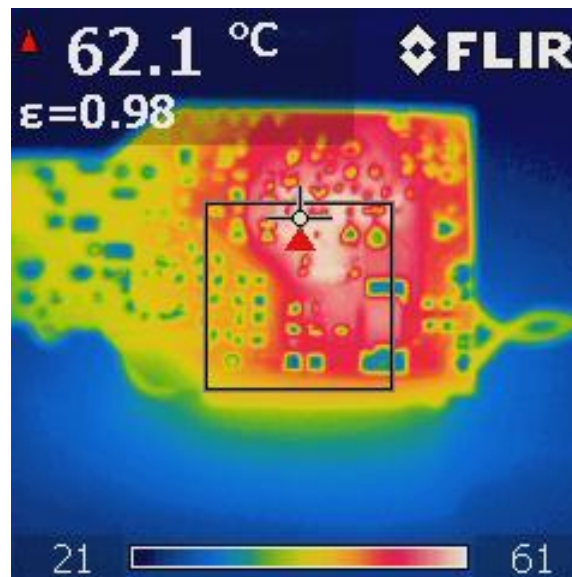


Figure 19 – Bottom Side.
 PCB: 62.1 °C.

11.2 非調光 $V_{IN} = 265 \text{ VAC}$, 50 Hz , 41 V LED 負載

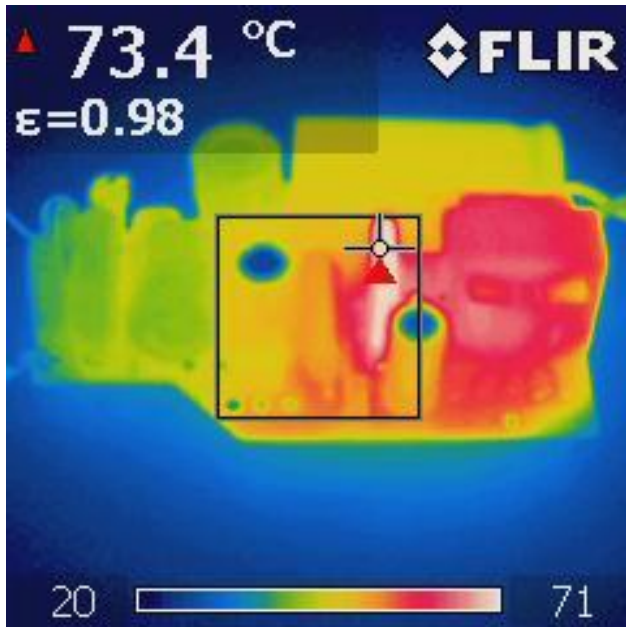


Figure 20 – Top Side.
U1-LYT4311E: 73.4 °C.

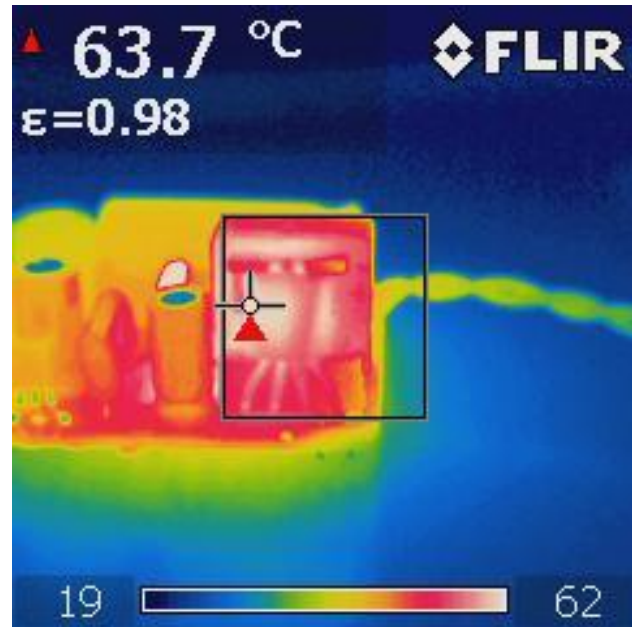


Figure 21 – Top Side, Inductor.
T1: 63.7 °C.

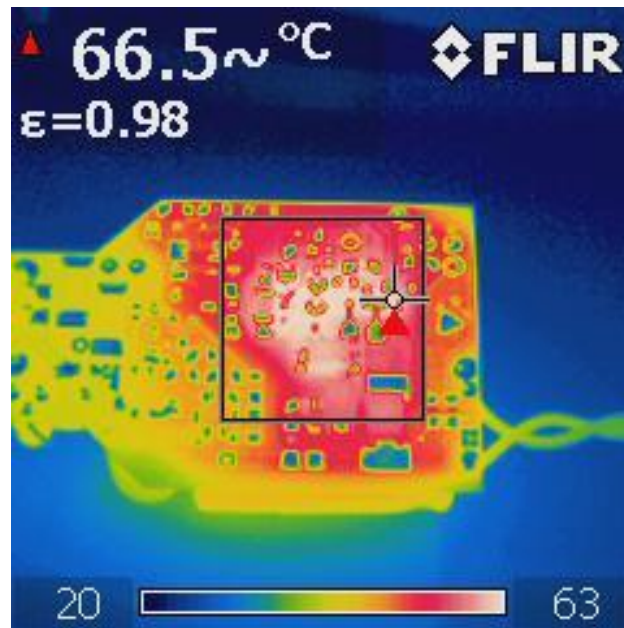


Figure 22 – Bottom Side.
PCB: 66.5 °C.

11.3 Dimming $V_{IN} = 230 \text{ VAC}$, 50 Hz , 41 V LED 負載、REV300 調光器

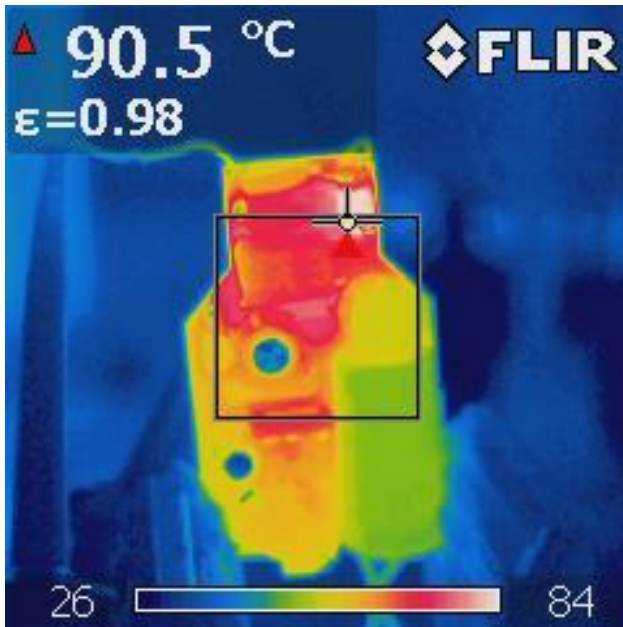


Figure 23 – 90° Conduction Angle.
R26: 90.5 °C.

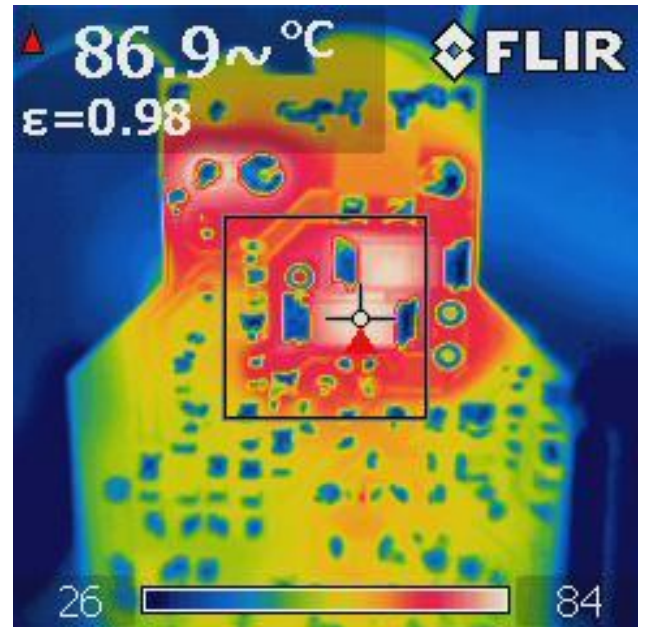


Figure 24 – 90° Conduction Angle.
R2: 86.9 °C.



12 非調光波形

12.1 輸入電壓和輸入電流波形

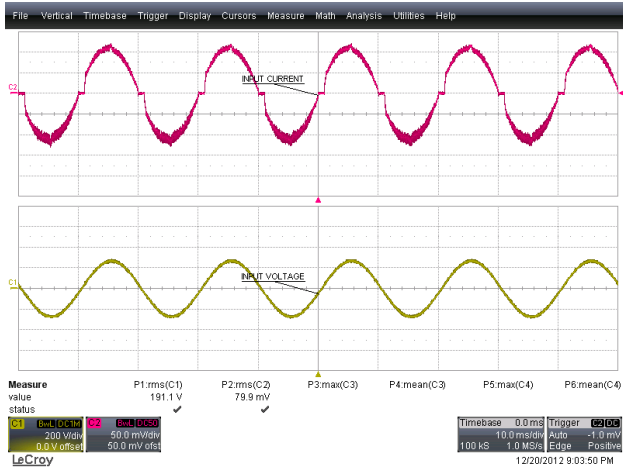


Figure 25 – 190 VAC, Full Load.
 Upper: I_{IN} , 50 mA / div.
 Lower: V_{IN} , 200 V, 10 ms / div.

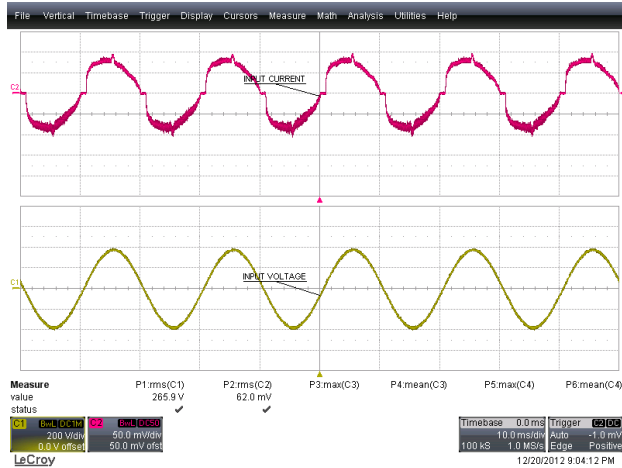


Figure 26 – 265 VAC, Full Load.
 Upper: I_{IN} , 50 mA / div.
 Lower: V_{IN} , 200 V, 10 ms / div.

12.2 正常運作下的輸出電流和輸出電壓

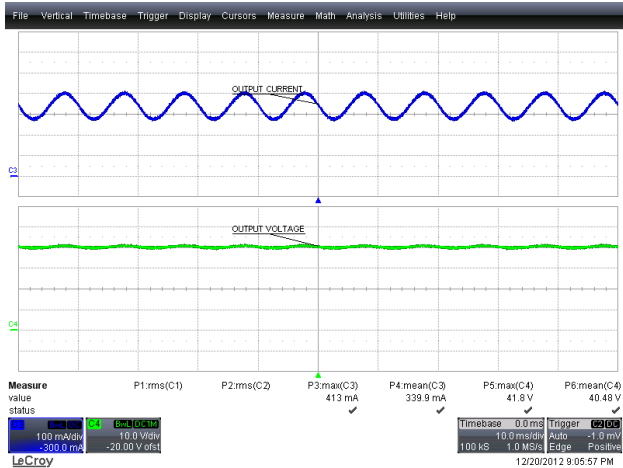


Figure 27 – 190 VAC, 50 Hz Full Load.
 Upper: I_{OUT} , 100 mA / div.
 Lower: V_{OUT} , 10 V, 10 ms / div.

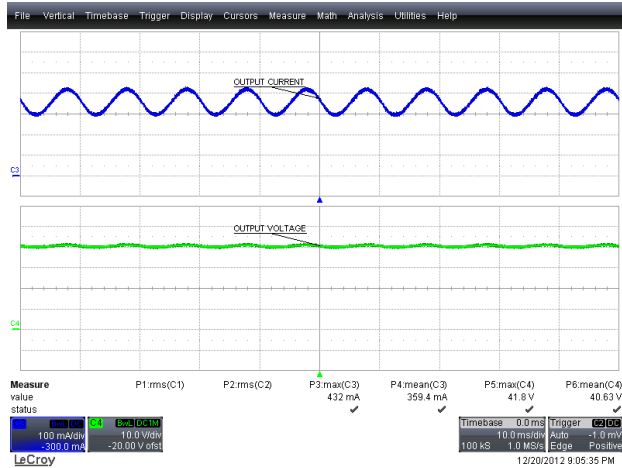


Figure 28 – 265 VAC, 50 Hz Full Load.
 Upper: I_{OUT} , 100 mA / div.
 Lower: V_{OUT} , 10 V, 10 ms / div.



12.3 啟動時的輸入電壓和輸出電流波形

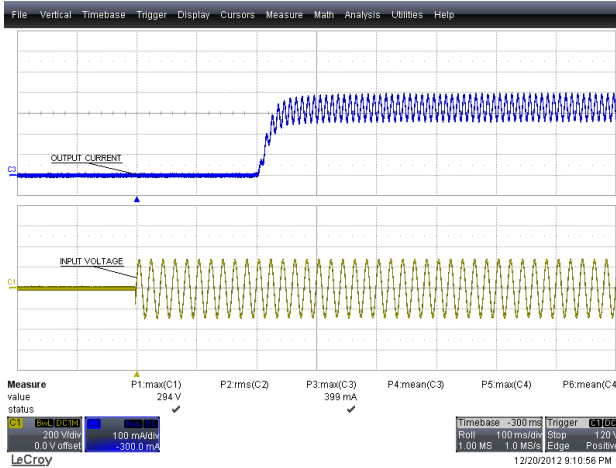


Figure 29 – 190 VAC, 50 Hz.
Upper: I_{OUT} , 100 mA / div.
Lower: V_{IN} , 200 V, 100 ms / div.

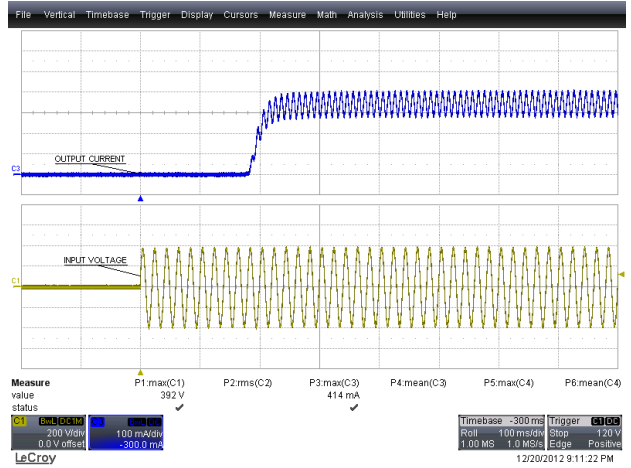


Figure 30 – 265 VAC, 50 Hz.
Upper: I_{OUT} , 100m A / div.
Lower: V_{IN} , 200 V, 100 ms / div.

12.4 正常運作下的汲極電壓和電流

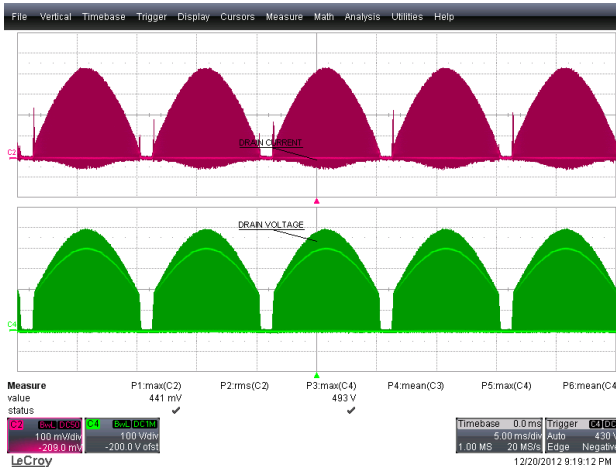


Figure 31 – 190 VAC, 50 Hz.
Upper: I_{DRAIN} , 100 mA / div.
Lower: V_{DRAIN} , 100 V, 5 ms / div.

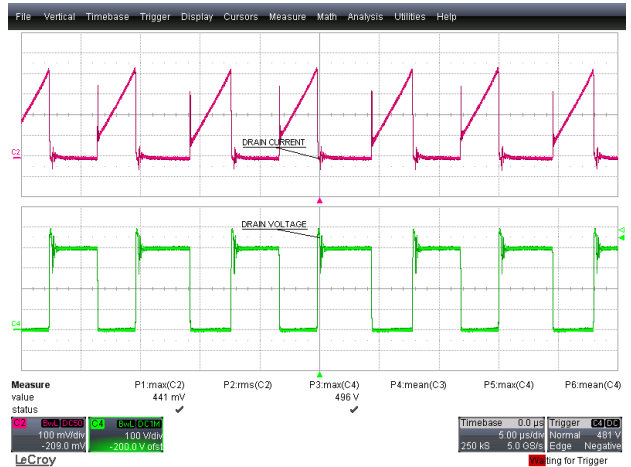


Figure 32 – 190 VAC, 50 Hz.
Upper: I_{DRAIN} , 100 mA / div.
Lower: V_{DRAIN} , 100 V / div., 5 μ s / div.



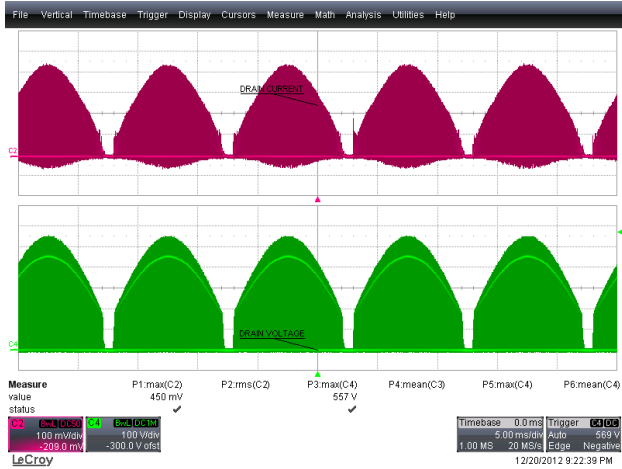


Figure 33 – 230 VAC, 50 Hz.
 Upper: I_{DRAIN} , 100 mA / div.
 Lower: V_{DRAIN} , 100 V, 5 ms / div.

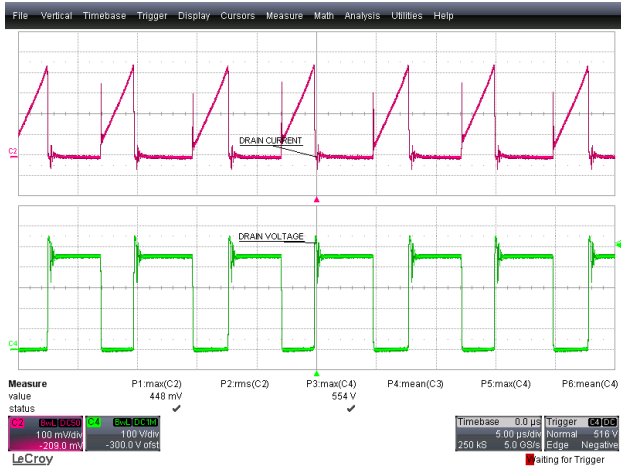


Figure 34 – 230 VAC, 50 Hz.
 Upper: I_{DRAIN} , 100 mA / div.
 Lower: V_{DRAIN} , 100 V / div., 5 μ s / div.

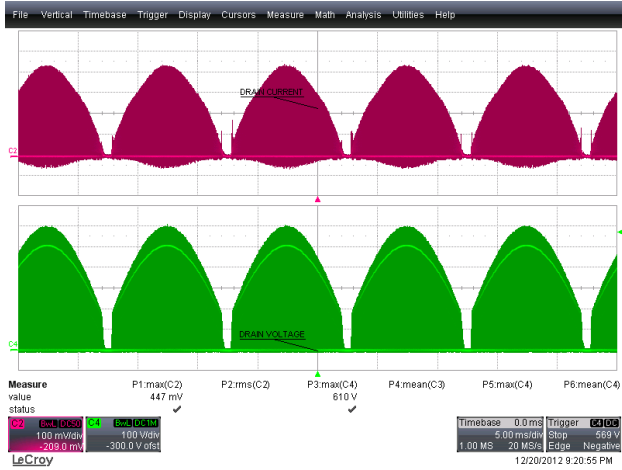


Figure 35 – 265 VAC, 50 Hz.
 Upper: I_{DRAIN} , 100 mA / div.
 Lower: V_{DRAIN} , 100 V, 5 ms / div.

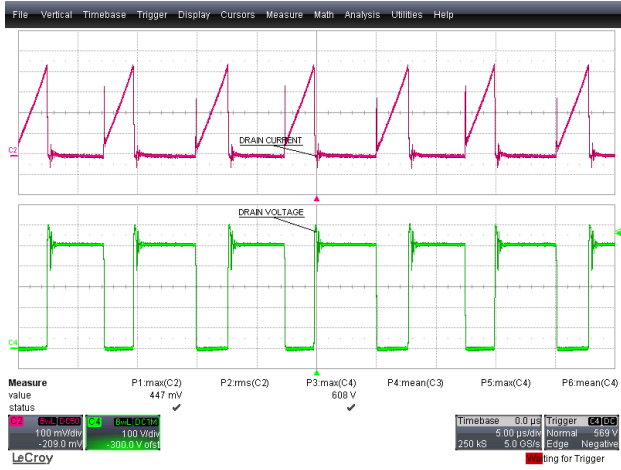


Figure 36 – 265 VAC, 50 Hz.
 Upper: I_{DRAIN} , 100 mA / div.
 Lower: V_{DRAIN} , 100 V / div., 5 μ s / div.



12.5 啓動及極電壓和電流

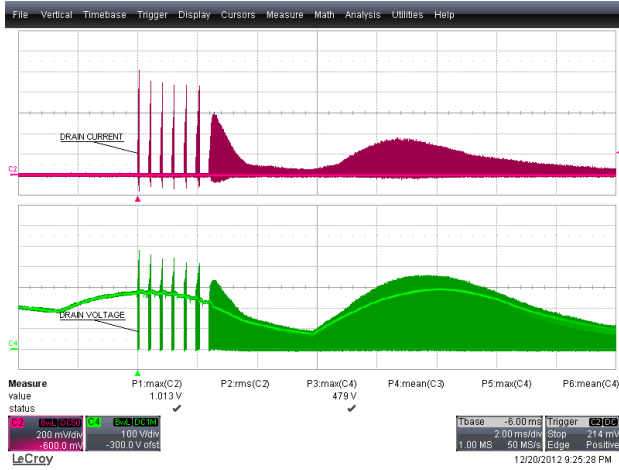


Figure 37 – 190 VAC, 50 Hz Start-up.
 Upper: I_{DRAIN} , 200 mA / div.
 Lower: V_{DRAIN} , 100 V, 2 ms / div.



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

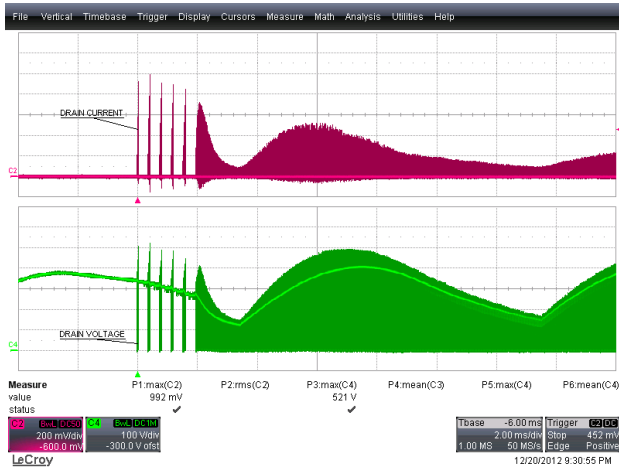


Figure 39 – 265 VAC, 50 Hz Start-up.
 Upper: I_{DRAIN} , 200 mA / div.
 Lower: V_{DRAIN} , 100 V, 2 ms / div.



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

12.6 輸出短路情況下的汲極電流和汲極電壓

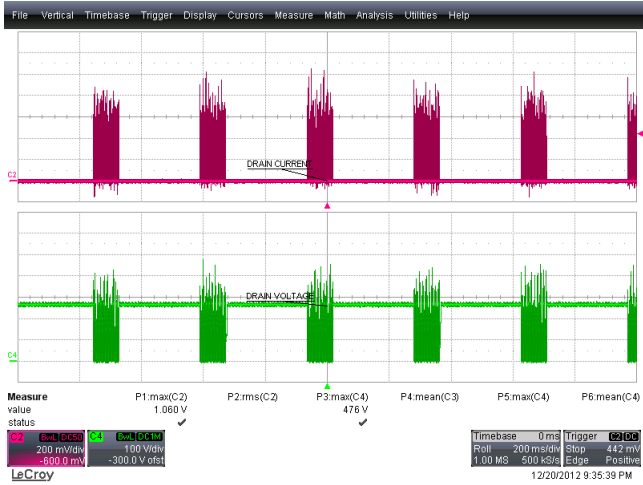


Figure 41 – 190 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN} , 200 mA / div.
Lower: V_{DRAIN} , 100 V, 200 ms / div.

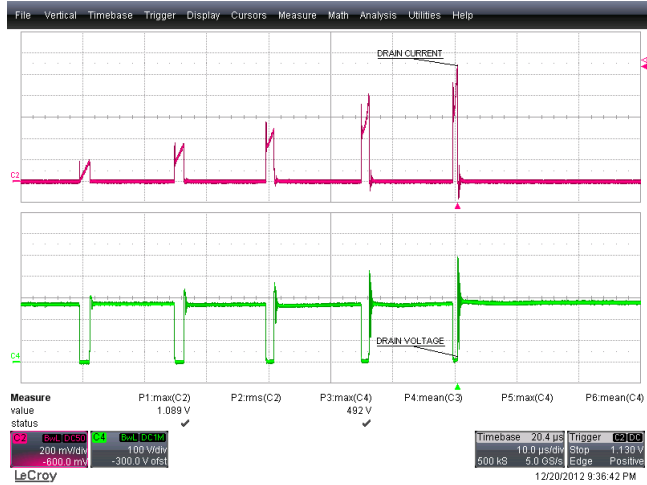


Figure 42 – 190 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN} , 200 mA / div.
Lower: V_{DRAIN} , 100 V, 10 μs / div.

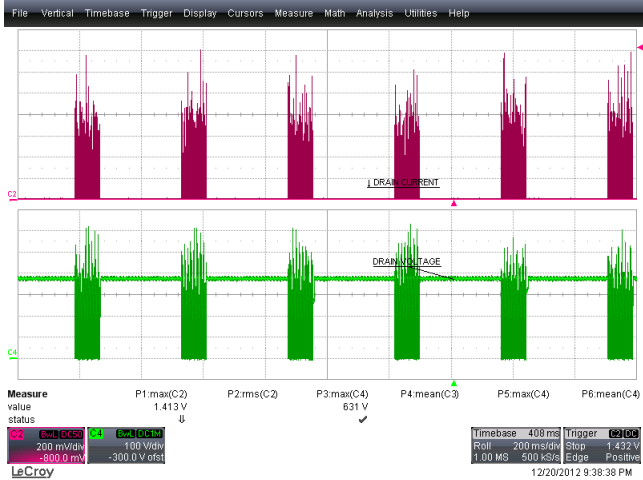


Figure 43 – 265 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN} , 200 mA / div.
Lower: V_{DRAIN} , 100 V, 200 ms / div.

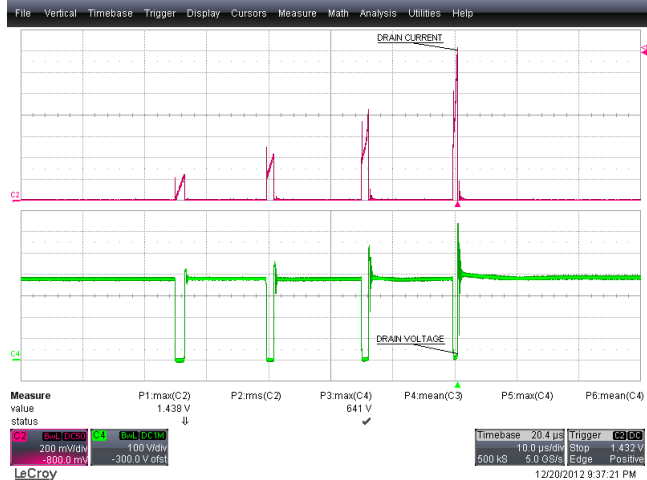


Figure 44 – 265 VAC, 50 Hz Output Short Condition.
Upper: I_{DRAIN} , 200 mA / div.
Lower: V_{DRAIN} , 100 V, 10 μs / div.



12.7 輸出二極體電流和電壓波形

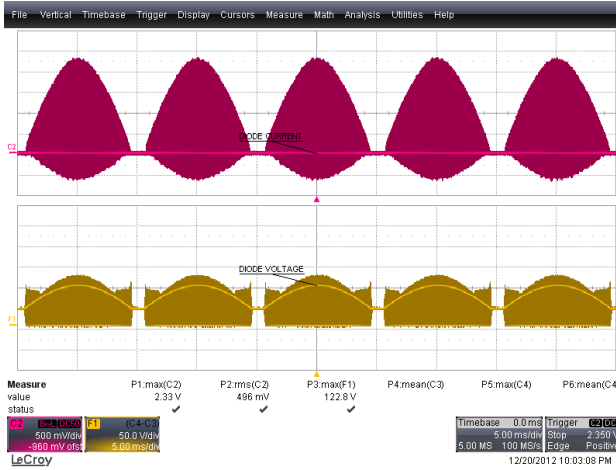


Figure 45 – 190 VAC, 50 Hz.
Upper: I_{D7} , 0.5 A / div.
Lower: V_{D7} , 50 V, 5 ms / div.

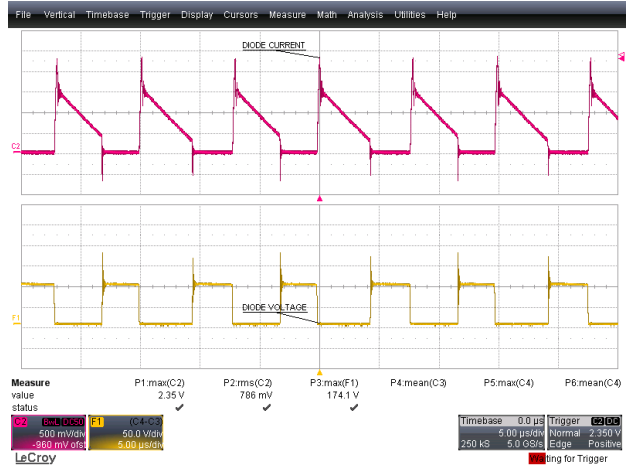


Figure 46 – 190 VAC, 50 Hz.
Upper: I_{D7} , 0.5 A / div.
Lower: V_{D7} , 50 V / div., 5 μ s / div.

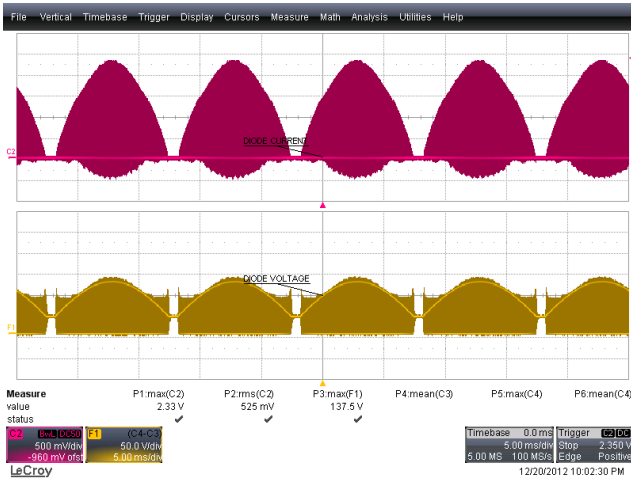


Figure 47 – 265 VAC, 50 Hz.
Upper: I_{D7} , 0.5 A / div.
Lower: V_{D7} , 50 V, 5 ms / div.

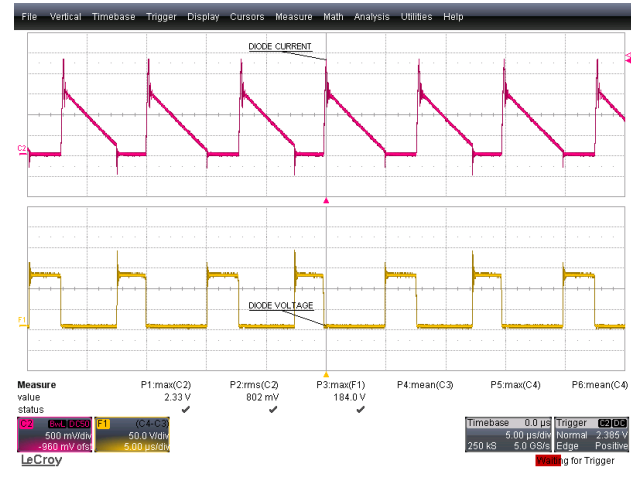


Figure 48 – 265 VAC, 50 Hz.
Upper: I_{D7} , 0.5 A / div.
Lower: V_{D7} , 50 V / div., 5 μ s / div.



12.8 輸出二極體電流和電壓啓動波形

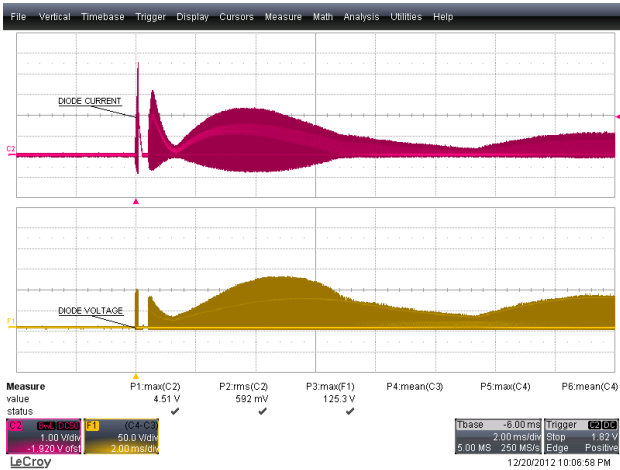


Figure 49 – 190 VAC, 50 Hz.
Upper: I_{D7} , 1 A / div.
Lower: V_{D7} , 50 V, 2 ms / div.

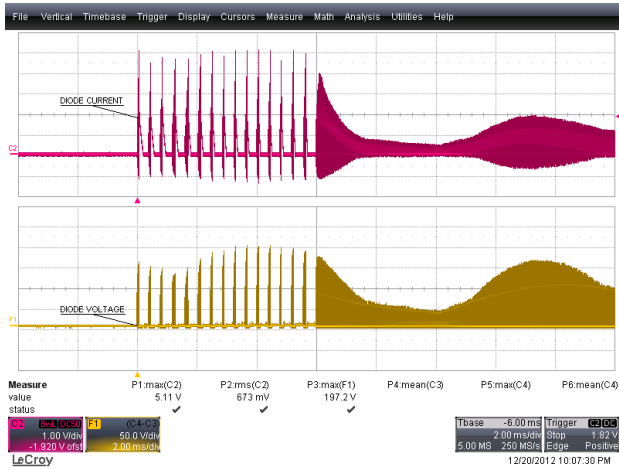


Figure 50 – 265 VAC, 50 Hz.
Upper: I_{D7} , 1 A / div.
Lower: V_{D7} , 50 V / div., 2 ms / div.

12.9 輸出二極體電流和電壓短路波形

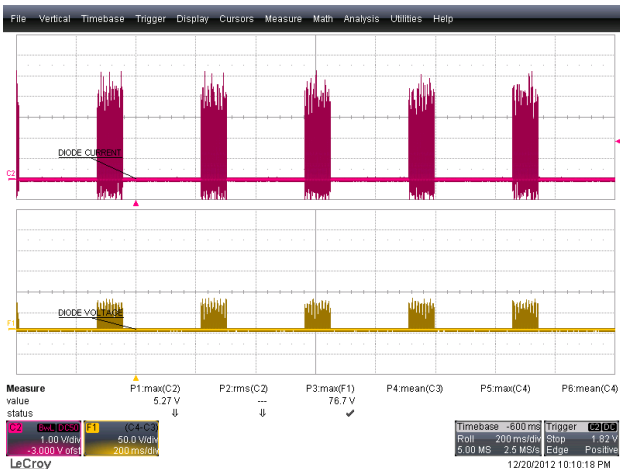


Figure 51 – 190 VAC, 50 Hz.
Upper: I_{D7} , 1 A / div.
Lower: V_{D7} , 50 V, 200 ms / div.

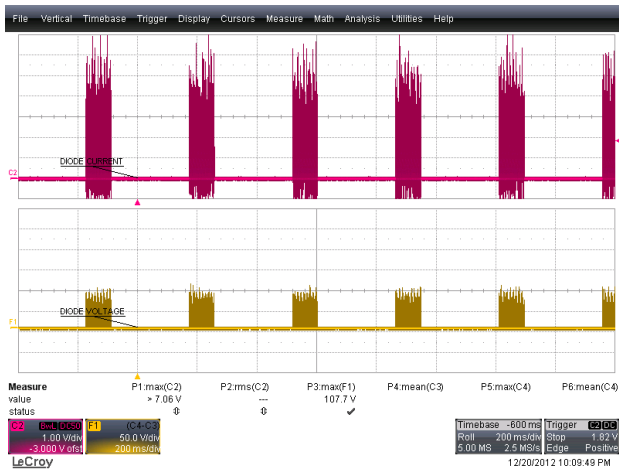


Figure 52 – 265 VAC, 50 Hz.
Upper: I_{D7} , 1 A / div.
Lower: V_{D7} , 50 V / div., 200 ms / div.



12.10 關閉

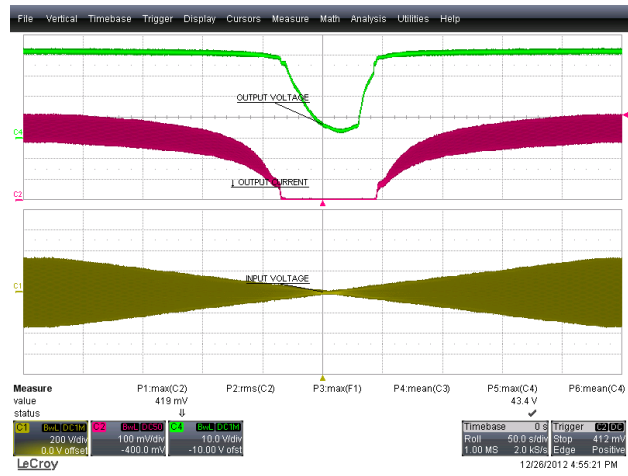


Figure 53 – 230 VAC, 50 Hz.
 CH4: V_{OUT} , 10 V / div.
 CH2: I_{OUT} , 100 mA / div.
 CH1: V_{IN} , 200 V / div.



12.11 線間暫態

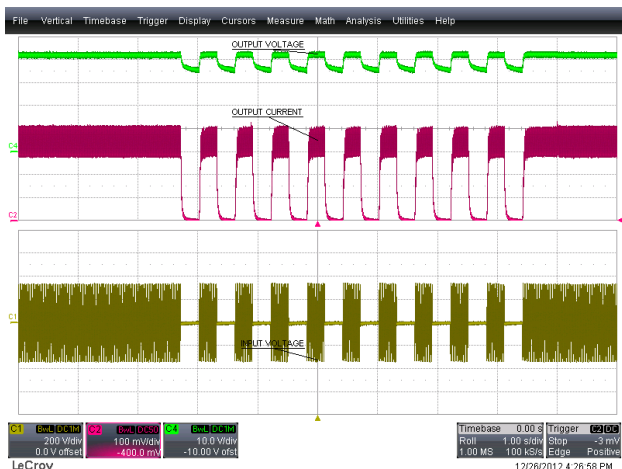


Figure 54 – 230 VAC, 50 Hz.
 300 ms ON, 300 ms OFF.
 CH4: V_{OUT} , 10 V / div.
 CH2: I_{OUT} , 100 mA / div.
 CH1: V_{IN} , 200 V / div.

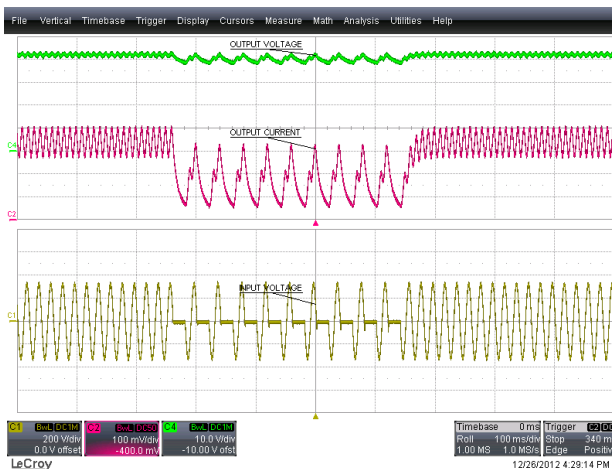


Figure 55 – 230 VAC, 50 Hz.
 20 ms ON, 20 ms OFF.
 CH4: V_{OUT} , 10 V / div.
 CH2: I_{OUT} , 100 mA / div.
 CH1: V_{IN} , 200 V / div.

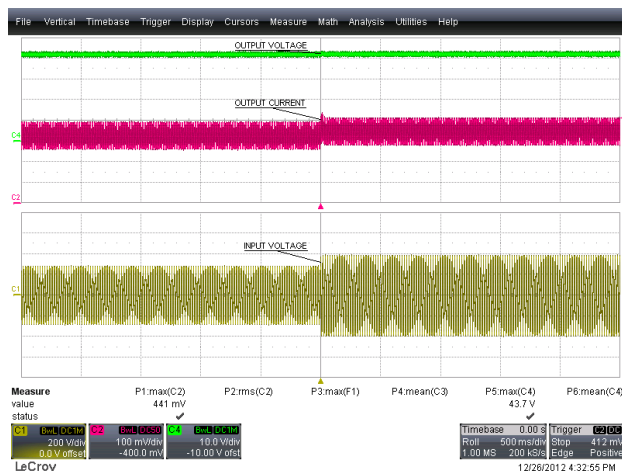


Figure 56 – 190 V to 265 V Step.
 CH4: V_{OUT} , 10 V / div.
 CH2: I_{OUT} , 100 mA / div.
 CH1: V_{IN} , 200 V / div.



13 調光波形

13.1 輸入電壓和輸入電流波形

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

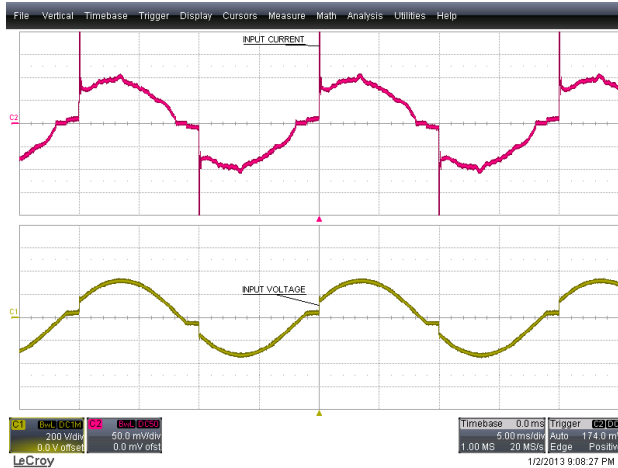


Figure 57 – 160° Conduction Angle.
 Upper: I_{IN} , 50 mA / div.
 Lower: V_{IN} , 200 V, 5 ms / div.



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



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



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

13.2 輸出電流波形

Input: 230 VAC, 50 Hz

Output: 41 V LED Load

Dimmer: MERTEN 572499 400 W

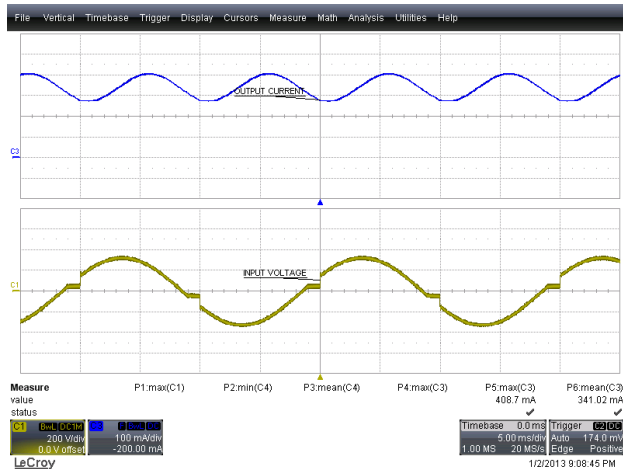


Figure 61 – 160° Conduction Angle.
Upper: I_{OUT} , 100 mA / div.
Lower: V_{IN} , 200 V, 5 ms / div.

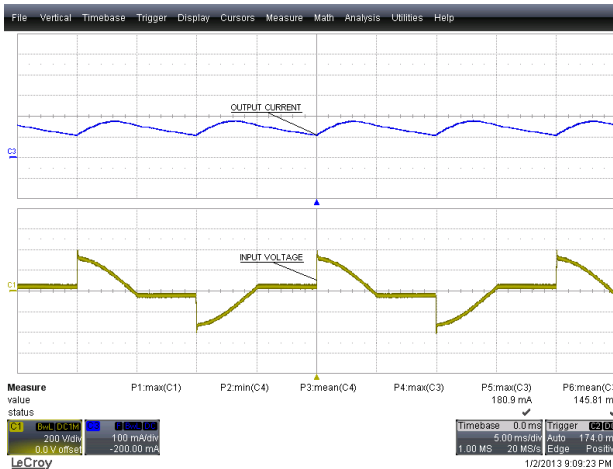


Figure 62 – 90° Conduction Angle.
Upper: I_{OUT} , 100 mA / div.
Lower: V_{IN} , 200 V, 5 ms / div.

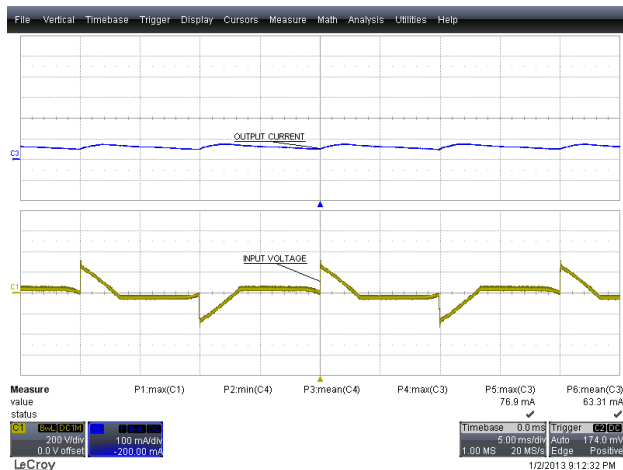


Figure 63 – 60° Conduction Angle.
Upper: I_{OUT} , 100 mA / div.
Lower: V_{IN} , 200 V, 5 ms / div.

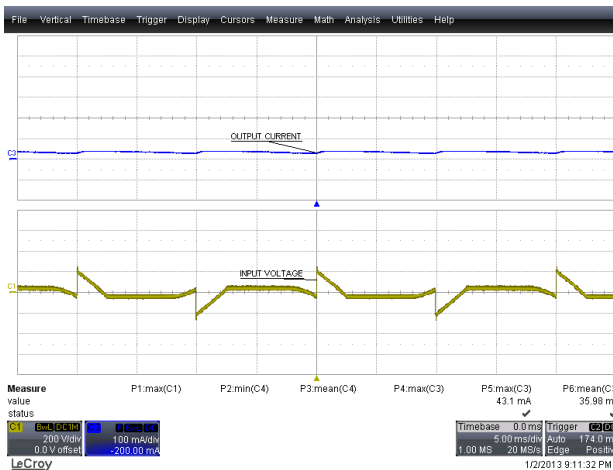


Figure 64 – 45° Conduction Angle.
Upper: I_{OUT} , 100 mA / div.
Lower: V_{IN} , 200 V, 5 ms / div.



14 傳導性 EMI

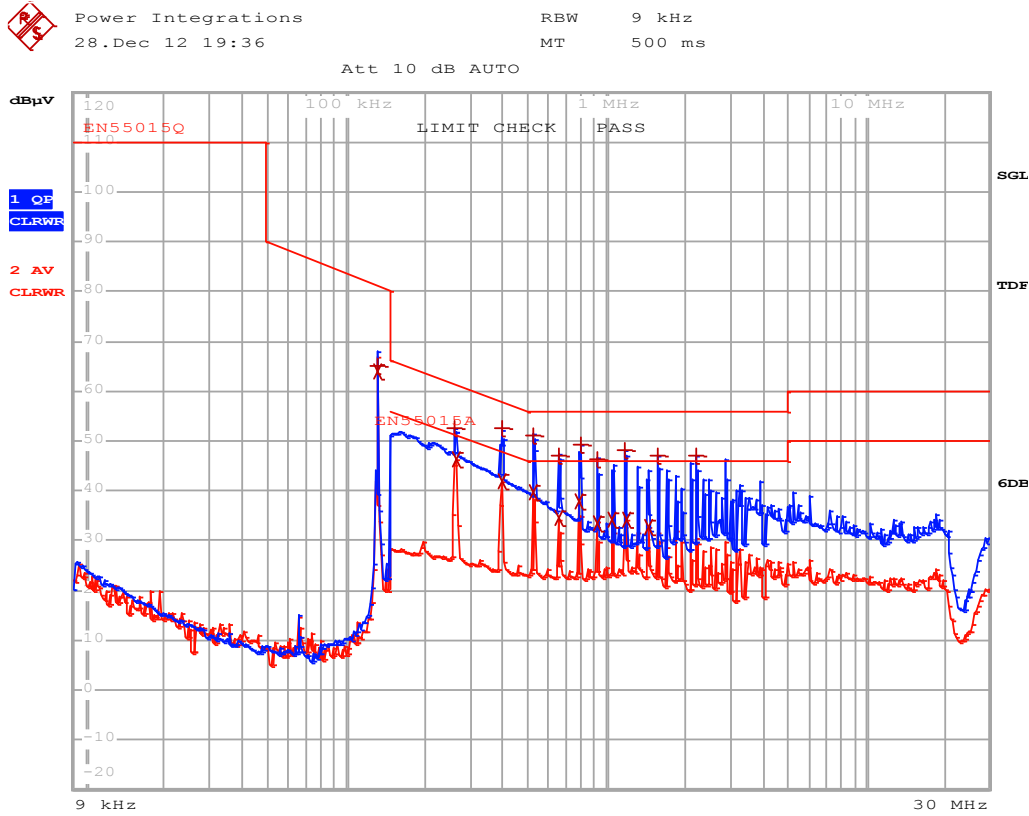
14.1 測試裝置

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



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

14.2 測試結果



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

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

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



15 線電壓突波測試

The unit was subjected to ± 2500 V, 100 kHz ring wave and ± 500 V differential surge at 230 VAC using 10 strikes at each condition. A test failure was defined as a non-recoverable interruption of output requiring supply repair or recycling of input voltage.

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

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

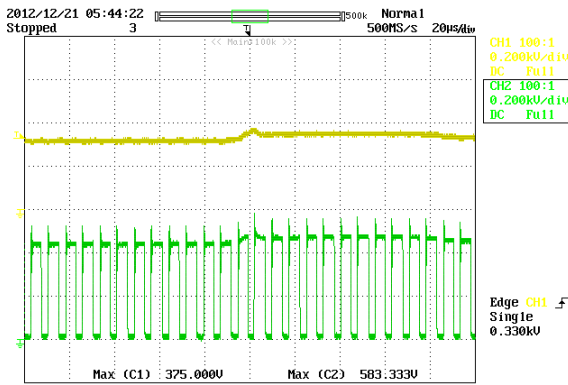


Figure 67 – (+)500 V Differential Surge, 90°. Upper: V_{BULK} , 200 V / div. Lower: V_{DRAIN} , 200 V, 20 μ s / div.

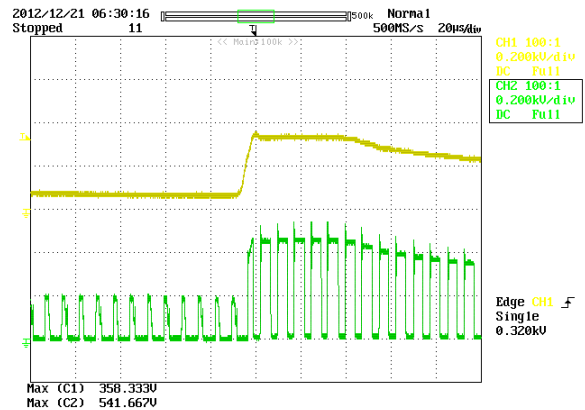


Figure 68 – (+)500 V Differential Surge, 0°. Upper: V_{BULK} , 200 V / div. Lower: V_{DRAIN} , 200 V, 20 μ s / div.



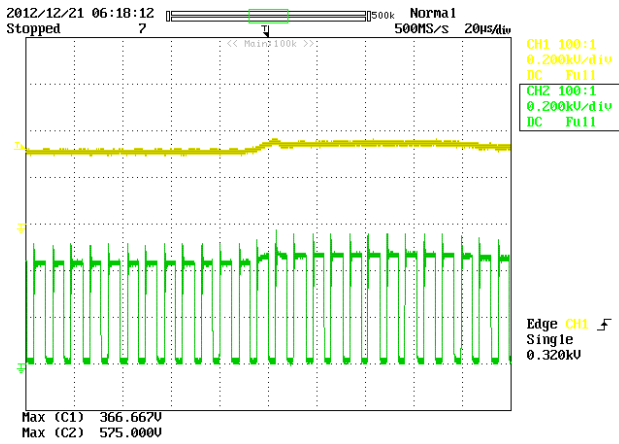


Figure 69 – (-)500 V Differential Surge, 90°. Upper: V_{BULK} , 200 V / div. Lower: V_{DRAIN} , 200 V, 20 μ s / div.

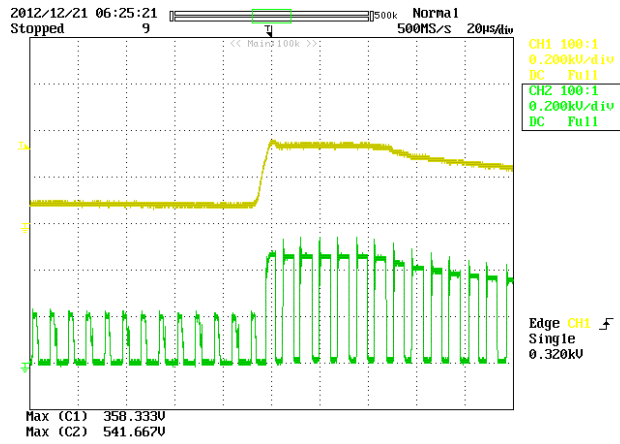


Figure 70 – (-)500 V Differential Surge, 0°. Upper: V_{BULK} , 200 V / div. Lower: V_{DRAIN} , 200 V, 20 μ s / div.

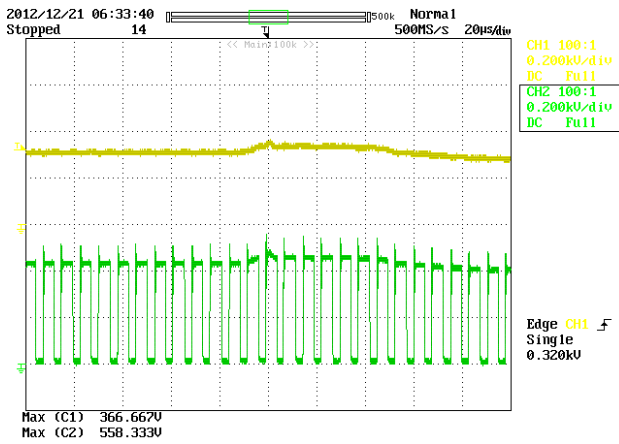


Figure 71 – (+)2.5 kV Ring Wave, 90°. Upper: V_{BULK} , 200 V / div. Lower: V_{DRAIN} , 200 V, 20 μ s / div.

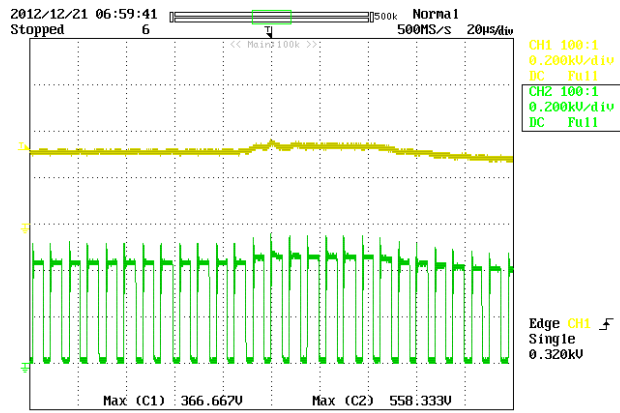


Figure 72 – (-)2.5 kV Ring Wave, 90°. Upper: V_{BULK} , 200 V / div. Lower: V_{DRAIN} , 200 V, 20 μ s / div.



16 修訂記錄

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



如需最新更新，請造訪我們的網站：www.powerint.com

Power Integrations 保留隨時更改產品以提高可靠性或可製造性的權利。Power Integrations 對因使用此處所說明的任何裝置或電路所造成的損失概不負責。POWER INTEGRATIONS 在此不作任何保證，並明確否認所有保證，包括但不限於適售性、針對特定用途的適用性以及不侵犯第三方權利等默示保證。

專利資訊

本處所述的產品和應用 (包括 PI 裝置 IC 之外的變壓器結構和電路) 可能包含 Power Integrations 的一項或多項美國及國外專利，或是正在申請的美國及國外專利。www.powerint.com 上提供了 Power Integrations 專利的完整清單。Power Integrations 授予其客戶某些特定專利權的授權，詳情請參閱 <http://www.powerint.com/ip.htm>。

PI 標誌、TOPSwitch、TinySwitch、LinkSwitch、LYTSwitch、DPA-Switch、PeakSwitch、CAPZero、SENZero、LinkZero、HiperPFS、HiperTFS、HiperLCS、Qspeed、EcoSmart、Clampless、E-Shield、Filterfuse、StackFET、PI Expert 和 PI FACTS 均為 Power Integrations, Inc. 的商標。其他商標為其個別公司之財產。©Copyright 2013 Power Integrations, Inc.

Power Integrations 全球銷售支援地點

全球總部

5245 Hellyer Avenue
San Jose, CA 95138, USA.
總機：+1-408-414-9200
客戶服務：
電話：+1-408-414-9665
傳真：+1-408-414-9765
電子郵件：
usasales@powerint.com

中國 (上海)

Rm 1601/1610, Tower 1,
Kerry Everbright City
No. 218 Tianmu Road West,
Shanghai, P.R.C. 200070
電話：+86-21-6354-6323
傳真：+86-21-6354-6325
電子郵件：
chinasales@powerint.com

中國 (深圳)

3rd Floor, Block A,
Zhongtuo International Business
Center, No. 1061, Xiang Mei Rd,
FuTian District, ShenZhen,
China, 518040
電話：+86-755-8379-3243
傳真：+86-755-8379-5828
電子郵件：
chinasales@powerint.com

德國

Lindwurmstrasse 114
80337, Munich
Germany
電話：+49-895-527-39110
傳真：+49-895-527-39200
電子郵件：
eurossales@powerint.com

印度

#1, 14th Main Road
Vasanthanagar
Bangalore-560052
India
電話：+91-80-4113-8020
傳真：+91-80-4113-8023
電子郵件：
indiasales@powerint.com

義大利

Via Milanese 20, 3rd Fl.
20099 Sesto San Giovanni
(MI) Italy
電話：+39-024-550-8701
傳真：+39-028-928-6009
電子郵件：
eurossales@powerint.com

日本

Kosei Dai-3 Building
2-12-11, Shin-Yokohama,
Kohoku-ku, Yokohama-shi,
Kanagawa 222-0033
Japan
電話：+81-45-471-1021
傳真：+81-45-471-3717
電子郵件：
japansales@powerint.com

韓國

RM 602, 6FL
Korea City Air Terminal B/D,
159-6
Samsung-Dong, Kangnam-Gu,
Seoul, 135-728 Korea
電話：+82-2-2016-6610
傳真：+82-2-2016-6630
電子郵件：
koreasales@powerint.com

新加坡

51 Newton Road,
#19-01/05 Goldhill Plaza
Singapore, 308900
電話：+65-6358-2160
傳真：+65-6358-2015
電子郵件：
singaporesales@powerint.com

台灣

5F, No. 318, Nei Hu Rd.,
Sec. 1
Nei Hu District
Taipei 11493, Taiwan R.O.C.
電話：+886-2-2659-4570
傳真：+886-2-2659-4550
電子郵件：
taiwansales@powerint.com

歐洲總部

1st Floor, St. James's House
East Street, Farnham
Surrey GU9 7TJ
United Kingdom
電話：+44 (0) 1252-730-141
傳真：+44 (0) 1252-727-689
電子郵件：
eurossales@powerint.com

應用服務專線

全球 +1-408-414-9660

應用服務傳真

全球 +1-408-414-9760



Power Integrations, Inc.

Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.powerint.com