設計範例報告

標題	*使用 **LinkSwitch™-PH LNK420EG150 W**、雙通道功率因數修正 **SSL LED** 驅動器，效率高達 **91%**以上*
規格	184 VAC ～ 277 VAC 輸入；30 V ～ 36 V，4.2 A_{TOTAL} (每通道 2.1 A) 輸出
應用	街燈 LED 驅動器
作者	應用工程部門
文件編號	DER-291
日期	2012 年 10 月 19 日
修訂	2.0

摘要與功能

- 150 W 雙通道 LED 驅動器，每通道 75 W
- 大幅簡化了已執行功率因數修正之離線式 LED 驅動器的設計
  - Single-stage 功率因數修正的隔離式 LED 驅動器
  - 體積小巧，所需元件極少
  - 線電壓和負載範圍內的功率因數 (PF) 高 (大於 0.95)
  - 線電壓和負載範圍內超過 91% 的高效率
  - 低 THD，線電壓和負載範圍內低於 22%
  - 符合 IEC61000-3-2 CLASS C 標準，並具有充分的餘裕
  - 符合 IEC 61000-4-5 標準，振盪波超過 2.5 kV，差模突波耐受性超過 2 kV
  - 免除所有控制迴路補償
  - 不需要輸出電流感測
  - 頻率抖動功能可大幅降低 EMI 濾波器成本
  - 整合式保護與可靠性功能
    - 鎖定輸出開路負載 (OVP) 電路
    - 藉由自動恢復功能提供輸出短路保護

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- 透過高磁滯溫度提供自動恢復過溫保護功能，同時保護元件與印刷電路板
- 在電壓關閉和電壓啓動情況下，不會發生任何損壞

目錄

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重要附註：
雖然此電路板的設計滿足安全隔離需求，但其工程原型未經相關機構核准。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

本文件說明效率高於 92%、雙通道、150 W (2 x 75 W)、隔離式、功率因數修正、低 THD、低諧波電流含量、高效率 LED 驅動器，其設計爲在 2.1 A 條件下，驅動 30 V ～ 36 V LED 燈串，輸入電壓爲 184 VAC 至 277 VAC。

LinkSwitch-PH 能以符合成本效益的方式設計高效率 Single-stage 功率因數修正 LED 驅動器和一次側定電流控制。LinkSwitch-PH 控制器經過最佳化，最適合 LED 驅動器應用，且所需的外部零件極少。這個裝置不需借助光耦合器，可直接透過 LED 負載控制輸出電流。

LinkSwitch-PH 將 725 V 功率 MOSFET 和控制器整合到單一晶片上。這個控制器功能包含振盪器、PWM、6 V 調整器、旁路 (BP) 接腳程式化功能、過溫保護、頻率抖動、週期性電流限制、前緣雜訊消除，以及充電控制器，用於輸出 CC (定電流) 控制和功率因數修正。

LinkSwitch-PH 另外還提供精密的多種保護功能，其中包括控制迴路開路/短路故障和輸出短路狀況時的自動重新啓動。精確的磁滯回復過溫保護功能可確保 PCB 在所有情況下皆可保持在安全的溫度。

本文件包含 LED 驅動器規格、電路圖、PCB 圖、物料清單、傳導性 EMI 測量、散熱測量、變壓器文件以及典型的效能特性。

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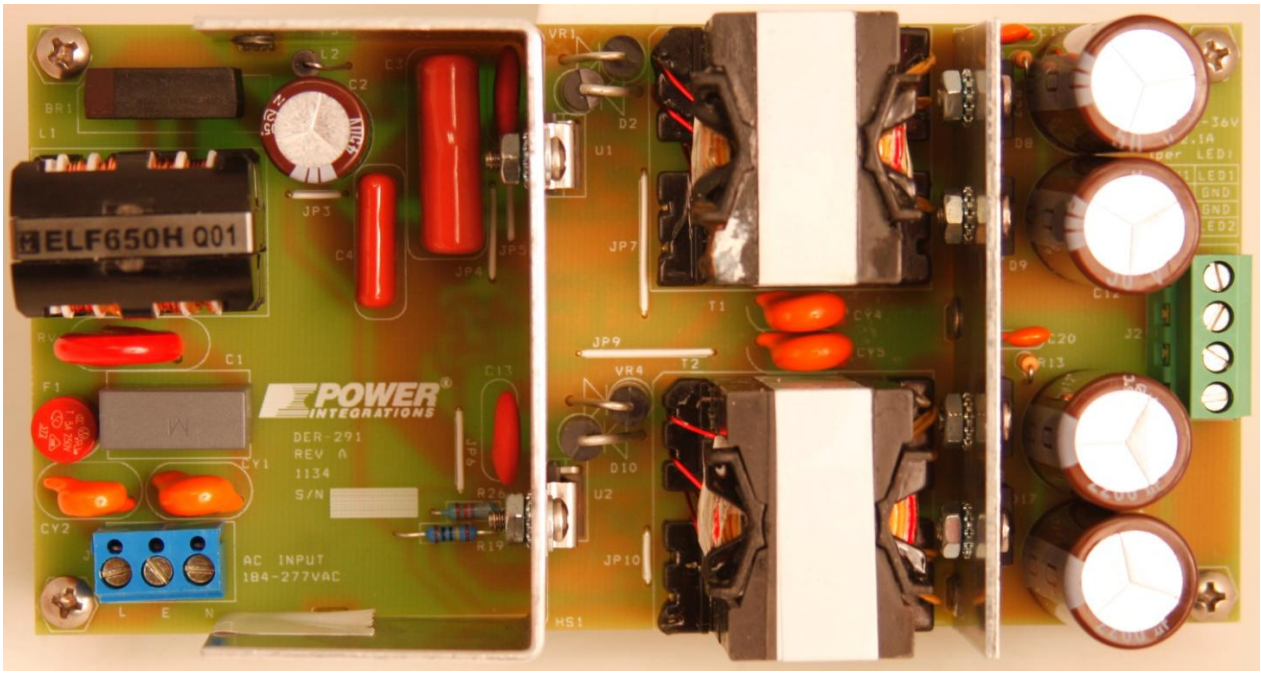

Figure 1 – Populated Circuit Board Photograph, Top (3” x 6”).

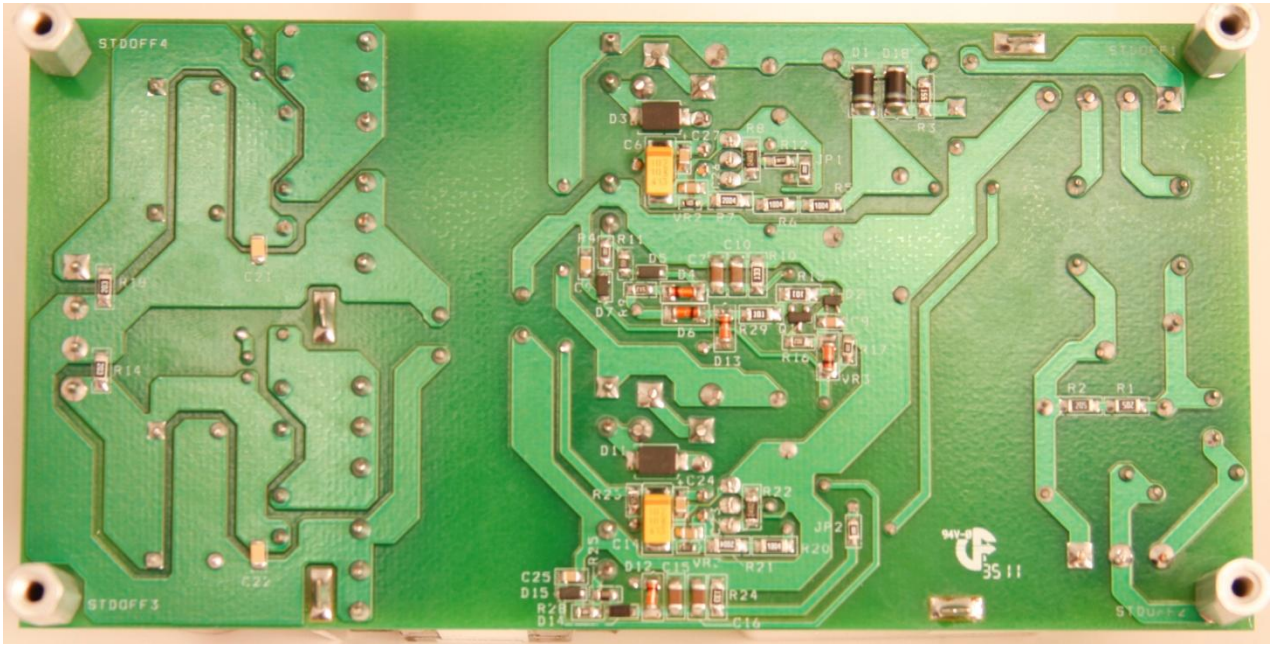

Figure 2 – Populated Circuit Board Photograph, Bottom.

2 設計重點

- 高效率
  - 使用較大的 PQ3230 以降低銅損失，並搭配高品質鐵氧體材質 (例如 PC44 或 4F4) 以降低鐵芯損失。
  - 採用偏壓電源來驅動 LinkSwitch-PH，此裝置會從偏壓電壓消耗的功率比透過內部調節器的匯流排供電要少。
  - 使用 2 個並聯蕭特基二極體於輸出整流器
  - 使用蕭特基二極體進行汲極阻隔
- 2 kV 突波耐受性
  - 爲 V 接腳峰值偵測器電容器 C3 使用較小值，以加快過壓偵測
  - 使用被動 10 µF 電解電容器 C2 吸收突波能量，藉此限制整流後匯流排電壓的峰值電壓。
- 符合 EN61000-3-2 C 級限值
  - 使用返馳式架構 KP <0.65。
  - 輸入電容降至最低 (如 X 電容器)

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3 電源供應器規格

下表列出可接受此設計的最低效能。實際效能列在結果部分。

說明	符號	最小值	類型	最大值	單位	註解
輸入						
電壓	V_{IN}	184		277	VAC	3 線 – 輸出浮接
頻率	f_{LINE}		50/60		Hz	
輸出						
LED 電壓	V_{OUT}	30	33	36	V	
LED1 電流		1.950	2.10	2.250	mA	
LED2 電流		1.950	2.10	2.250	mA	
總輸出功率						
連續輸出功率	P_{OUT}		150		W	兩個通道總計
環境						
傳導性 EMI		符合 EN55015B 標準				
安全		隔離式				
效率		91	92			
諧波電流		C 級				IEC 61000-3-2
功率因數		0.95				
環境溫度	T_{AMB}		65		°C	
保護						
開路負載鎖定				50	V	AC 重設時間不到 1 秒

4 電路圖

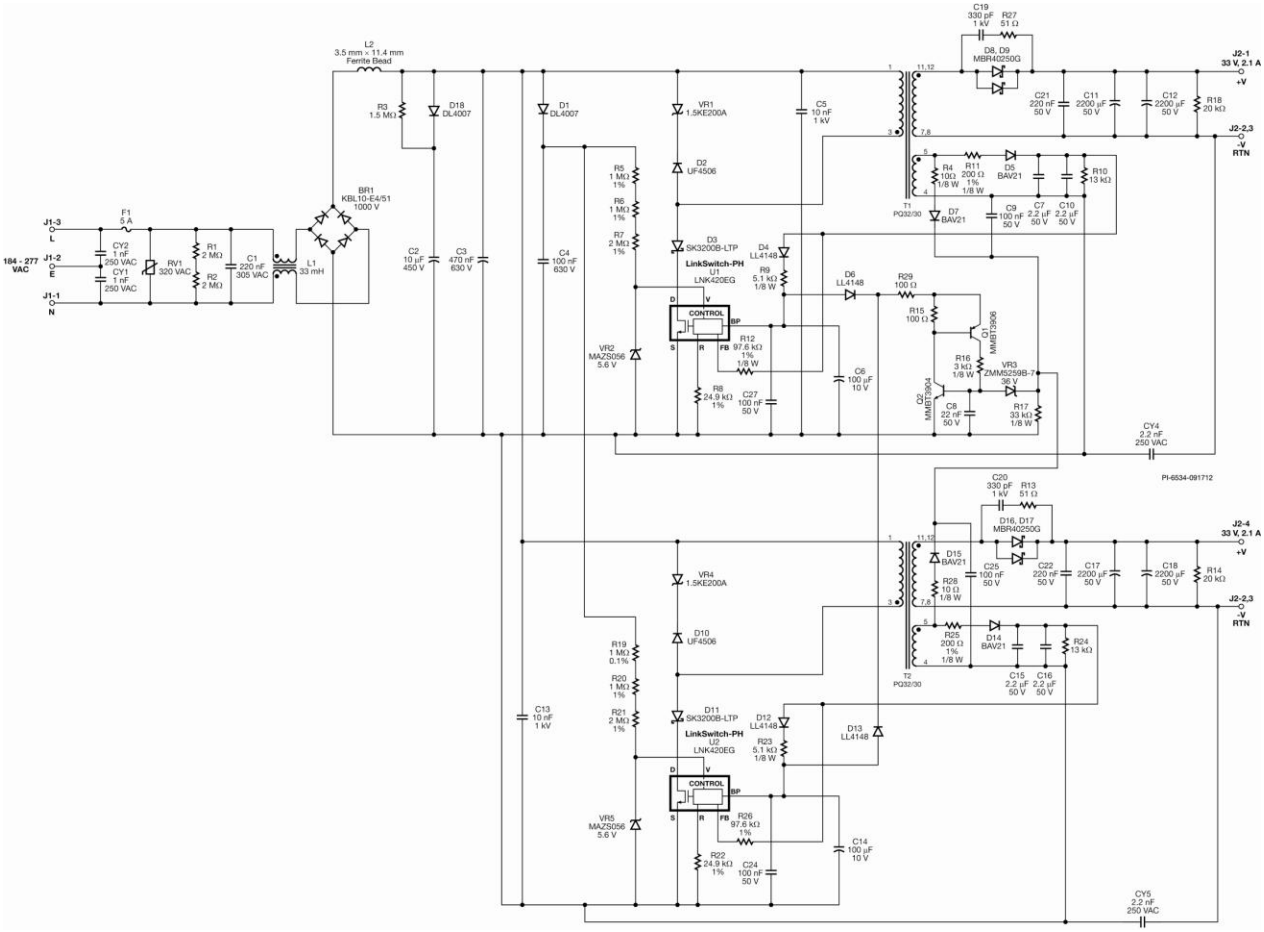

Figure 3 – Schematic.

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5 說明

LinkSwitch-PH 裝置由控制器和整合式 725 V MOSFET所組成，主要應用於 LED 驅動器。LinkSwitch-PH 設定用於 Single-stage 連續導通模式及返馳式架構，可提供調節好的一次側定電流輸出，同時保持 AC 輸入端的高功率因數和諧波含量。

5.1 輸入濾波功能

保險絲 F1 可保護輸入，而 BR1 會對 AC 線電壓進行整流。電感器 L1、L2 和 C1 會形成 EMI 濾波器，加上 CY1、CY2、CY4 和 CY5 (Y1 安全性) 電容器，可使設計符合 EN55015B 傳導 EMI 限值。電容器 C3 會將低阻抗路徑提供給一次側切換電流，爲了使功率因數保持大於 0.9，需要少量的電容。高壓旁路電容器 C13 和 C5 會縮小每個轉換器的輸出端迴路面積，藉此減少產生 EMI。

5.2 LinkSwitch-PH 一次側

二極體 D1 和高電壓電容器 C4 會偵測峰值 AC 線電壓。電容器 C4 採用小的值 (100 nF)，以加快偵測線上電壓，尤其在差模突波事件期間。此電壓會轉換爲電流，然後經由串聯電阻器 (連接至 U1 和 U2 的 V 接腳) 進入電壓監測器 (V) 接腳。偵測的電流也會使用此電流，來設定輸入過壓/欠壓保護臨界值。會在內部使用 V 接腳電流和回授 (FB) 接腳電流，以控制平均輸出 LED 電流。非調光設計在參考 (R) 接腳 (R8、R22) 上需要 24.9 kΩ 電阻器，在 V 接腳上則需要 4 MΩ 電阻器。積納二極體(Zener diode) VR2 和 VR5 可在啓動期間保護 V 插腳。

二極體 D2、D10、VR1 和 VR4 會將汲極電壓箝制在 U1 和 U2 中內部功率 MOSFET 的 BV_{DSS} 額定值 (725 V) 以下。需要二極體 D3 和 D11 來防止反向電流流經 LinkSwitch-PH 裝置 (這是因爲最低輸入電容所致結果)。

爲了能承受 2 kV 差動線電壓突波，使用可變電阻器 RV1 和 C10 (10 μF) 吸收突波期間的大部分能量，藉此限制最大的匯流排電壓。二極體 D18 會在正常操作期間，使 C2 與 AC 輸出隔離，而 R3 是突波事件之後的充電路徑 C2。

5.3 偏壓電源供應器和輸出過壓感測

二極體 D5、D14、C7、C10、C15 和 C16 會形成一次側偏壓電源供應器。這會在正常運作期間，透過 D4、D12 和 R9、R23 提供 IC 工作電流至旁路 (BP) 接腳。電阻器 R11、R25 提供濾波功能，可在 R10、R24 用作最低負載時改善輸出調節。

電容器 C6 和 C14 爲 LinkSwitch-PH 提供供電器去耦合。在啓動期間，會從裝置汲極 (D) 接腳連接的內部高電壓電流源將這些電容器充電至約 6 V。一旦充電，儲存在這些電容器的能量會供應給裝置，直到調節時輸出和偏壓繞組電壓上升。電容器 C24 和 C27 提供本機高頻率去耦合。這些必需置於 U1 和 U2 的裝置接腳處。

開路負載/過壓關機功能由兩個電晶體 Q1 和 Q2 提供。當透過 VR3 偵測到過電壓時，Q2 會透過 D6、D13 將 U1 和 U2 的 BP 接腳同時往下拉至其 BP-UVLO 臨界值等級，並且會保持關閉，直到 AC 輸入再利用爲止。獨立偏壓供電會使用 (R4、D7 和 C9) 來允許較低值的濾波電容器 (C9)，藉此縮短回應輸出 OV 條件的時間。

5.4 輸出回授

與一次側偏壓繞組之輸出電壓成比例的電流會透過 R12 和 R26 饋送至 FB 接腳。此資訊加上輸入電壓及汲極電流，會用於維持定輸出電流。

5.5 輸出整流和濾波

二極體 D8、D9、D16 和 D17 可整流二次側繞組，而電容器 C11、C12、C17 和 C18 則過濾輸出。爲達成高效率，在每個輸出端使用兩個 20 A、250 V 蕭特基二極體。電阻器 R18 和 R14 提供了最低負載，以確保拔除 AC 電源時，將輸出電容器內剩餘的電量放電。

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6 PCB 佈局

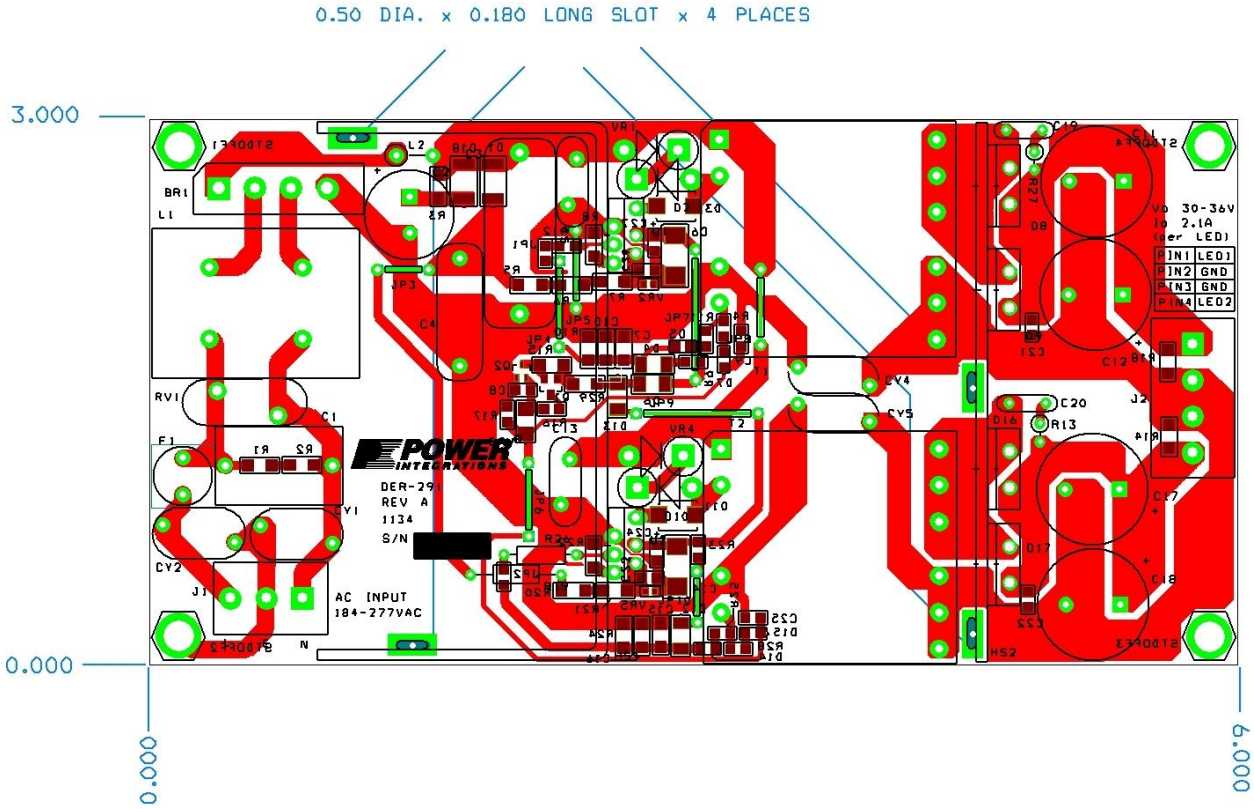

Figure 4 – Printed Circuit Layout, Top and Bottom (3” x 6”).

7 物料清單

7.1 電氣物料清單

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR1	1000 V, 4 A, Bridge Rectifier	KBL10-E4/51	Vishay
2	1	C1	220 nF, 305 VAC, Film, X2	R463I322000M2M	Kemet
3	1	C2	10 μF, 450 V, Electrolytic, (12.5 x 20)	EKMG451ELL100MK20S	United Chemi-Com
4	1	C3	470 nF, 630 V, Film	ECQ-E6474KF	Panasonic
5	1	C4	100 nF, 630 V, Film	ECQ-E6104KF	Panasonic
6	2	C5 C13	10 nF, 1 kV, Disc Ceramic	562R5HKMS10	Vishay
7	2	C6 C14	100 μF, 10 V, Tant Electrolytic, C Case, SMD	T491C107K010AS	Kemet
8	4	C7 C10 C15 C16	2.2 μF, 50 V, Ceramic, Y5V, 1206	GRM31MF51H225ZA01L	Murata
9	1	C8	22 nF, 50 V, Ceramic, X7R, 0805	ECJ-2VB1H223K	Panasonic
10	4	C9 C24 C25 C27	100 nF, 50 V, Ceramic, X7R, 0805	CC0805KRX7R9BB104	Yageo
11	4	C11 C12 C17 C18	2200 μF, 50 V, Electrolytic, Gen. Purpose, (16 x 35.5)	EKMG500ELL222MLP1S	Nippon Chemi-Con
12	2	C19 C20	330 pF, 1 kV, Disc Ceramic	562R5GAT33	Vishay
13	1	C21	220 nF, 50 V, Ceramic, X7R, 1206	ECJ-3YB1H224K	Panasonic
14	1	C22	220 nF, 50 V, Ceramic, X7R, 1206	12065C224KAT2A	AVX
15	2	CY1 CY2	1 nF, Ceramic, Y1	440LD10-R	Vishay
16	2	CY4 CY5	2.2 nF, Ceramic, Y1	440LD22-R	Vishay
17	2	D1 D18	1000 V, 1 A, Rectifier, Glass Passivated, DO-213AA (MELF)	DL4007-13-F	Diodes, Inc.
18	2	D2 D10	600 V, 3 A, Ultrafast Recovery, 75 ns, DO-201AD	UF5406-E3/54	Vishay
19	2	D3 D11	200 V, 3 A, Diode Schottky 1 A 200 V, SMB	SK3200B-LTP	Micro Commercial
20	4	D4 D6 D12 D13	75 V, 0.15 A, Fast Switching, 4 ns, MELF	LL4148-13	Diodes, Inc.
21	4	D5 D7 D14 D15	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
22	4	D8 D9 D16 D17	250 V, 40 A, Schottky, TO-220AC	MBR40250G	On Semi
23	1	F1	5 A, 250 V, Slow, TR5	37215000411	Wickman
24	1	L1	33 mH, 0.8 A, Common Mode Choke	ELF-18D650H	Panasonic
25	1	L2	3.5 mm x 11.4 mm, 144 Ohms at 100 MHz, #22 AWG hole, Ferrite Bead	2761008112	Fair-Rite
26	1	Q1	PNP, Small Signal BJT, 40 V, 0.2 A, SOT-23	MMBT3906LT1G	On Semi
27	1	Q2	NPN, Small Signal BJT, 40 V, 0.2 A, SOT-323	MMST3904-7-F	Diodes, Inc.
28	2	R1 R2	2 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ205V	Panasonic
29	1	R3	1.5 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ155V	Panasonic
30	2	R4 R28	10 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ100V	Panasonic
31	3	R5 R6 R20	1.00 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF1004V	Panasonic
32	2	R7 R21	2.00 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF2004V	Panasonic
33	2	R8 R22	24.9 kΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF2492V	Panasonic
34	2	R9 R23	5.1 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ512V	Panasonic
35	2	R10 R24	13 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ133V	Panasonic
36	2	R11 R25	200 Ω, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2000V	Panasonic
37	1	R12	97.6 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF9762V	Panasonic
38	2	R13 R27	51 Ω, 5%, 1/4 W, Carbon Film	CFR-25JB-51R	Yageo
39	2	R14 R18	20 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ203V	Panasonic

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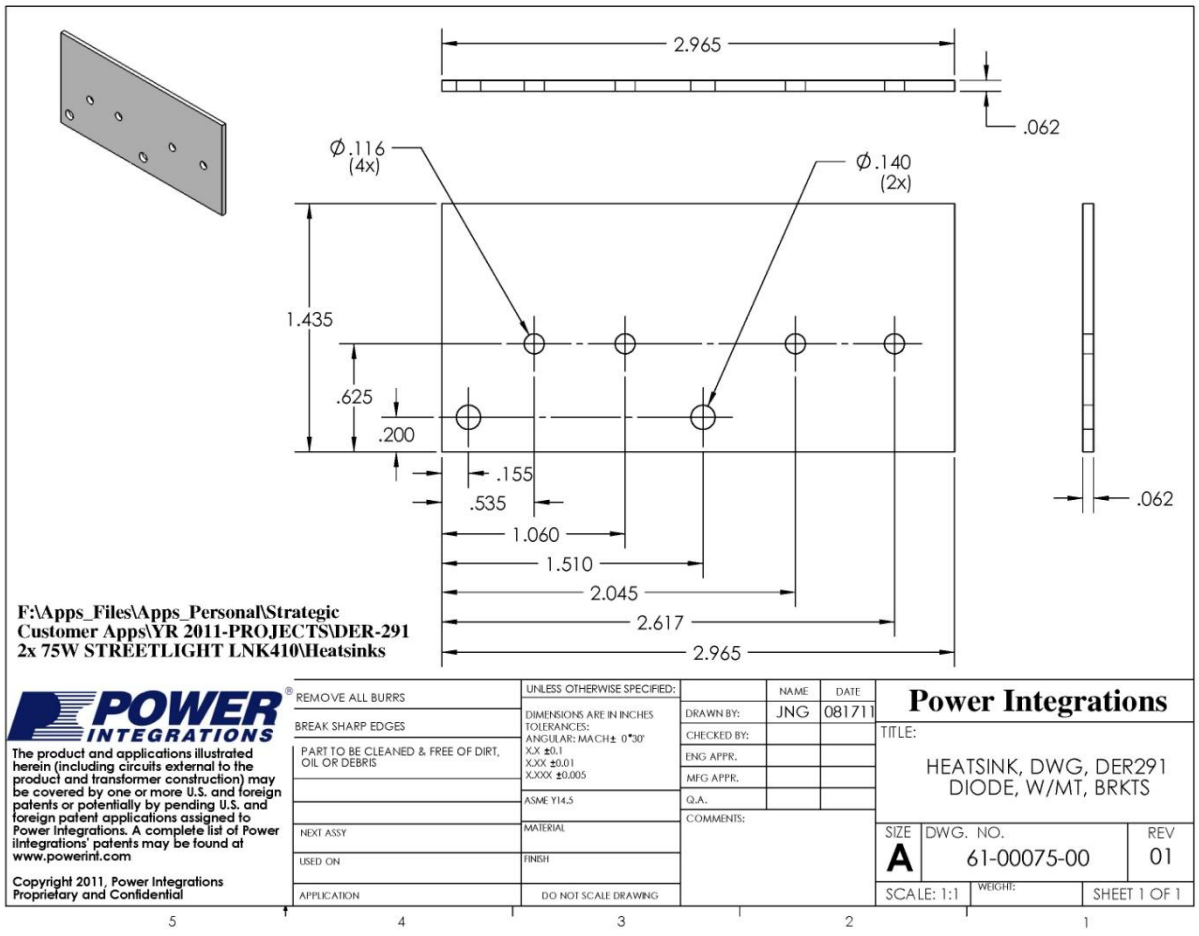
40	2	R15 R29	100 Ω, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ101V	Panasonic
41	1	R16	3 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ302V	Panasonic
42	1	R17	33 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ333V	Panasonic
43	1	R19	1 MΩ, 0.1%, 1/4 W, Metal Film	RC55Y-1M0BI	Welwyn Comp
44	1	R26	97.6 kΩ, 1%, 1/4 W, Metal Film	MFR-25FBF-97K6	Yageo
45	1	RV1	320 V, 80 J, 14 mm, RADIAL	V320LA20AP	Littlefuse
46	2	U1 U2	LinkSwitch-PH, eSIP	LNK420EG	Power Integrations
47	2	VR1 VR4	200 V, 1500 W, TVS, GP-20	1.5KE200A-E3/54	Vishay
48	2	VR2 VR5	5.6 V, 5%, 150 mW, SOD-323	MAZS0560ML	Panasonic
49	1	VR3	39 V, 5%, 500 mW, DO-213AA (MELF)	ZMM5259B-7	Diodes, Inc.

8 散熱片組裝

8.1 輸出二極體散熱片

8.1.1 輸出二極體散熱片圖示



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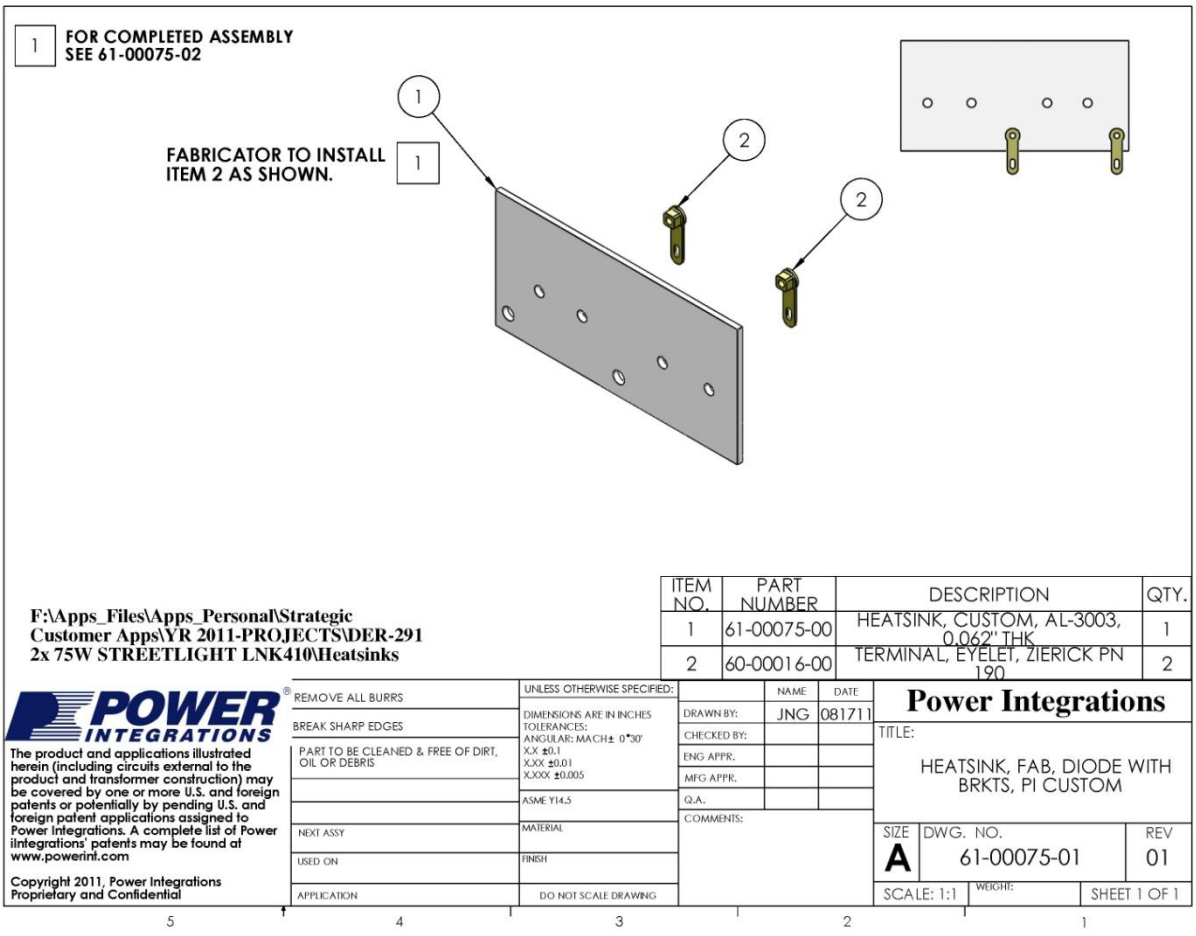
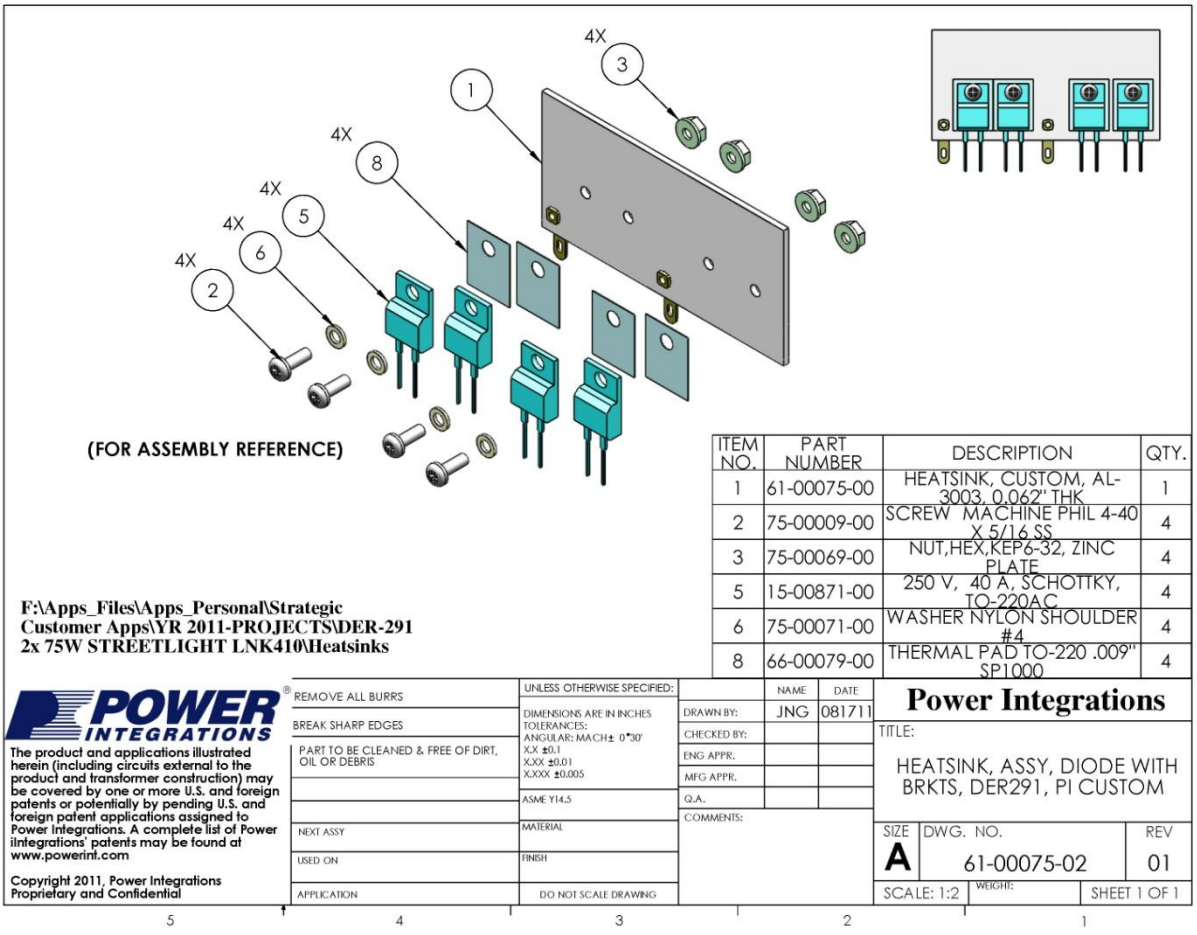
8.1.2 輸出二極體散熱片製造圖



8.1.3 輸出二極體和散熱片組裝圖



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00075-00	HEATSINK, CUSTOM, AL-3003, 0.062" THK	1
2	75-00009-00	SCREW MACHINE PHIL 4-40 X 5/16 SS	4
3	75-00069-00	NUT,HEX,KEP6-32, ZINC PLATE	4
5	15-00871-00	250 V, 40 A, SCHOTTKY, TO-220AC	4
6	75-00071-00	WASHER NYLON SHOULDER #4	4
8	66-00079-00	THERMAL PAD TO-220 .009" SP1000	4

F:\Apps_Files\Apps_Personal\Strategic Customer Apps\YR 2011-PROJECTS\DER-291 2x 75W STREETLIGHT LNK410\Heatsinks

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

REMOVE ALL BURRS
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NEXT ASSY
USED ON
APPLICATION

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

	NAME	DATE
DRAWN BY:	JNG	081711
CHECKED BY:		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

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TITLE: HEATSINK, ASSY, DIODE WITH BRKTS, DER291, PI CUSTOM

SIZE	DWG. NO.	REV
A	61-00075-02	01
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

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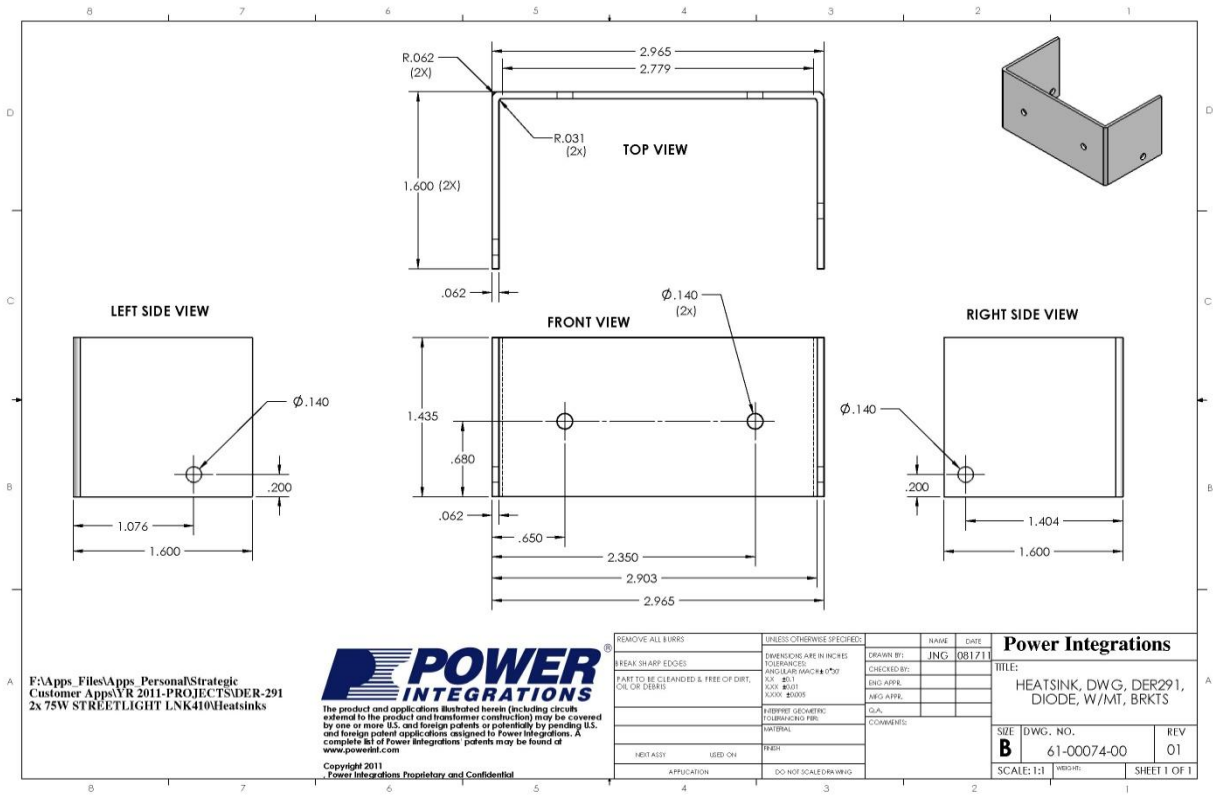
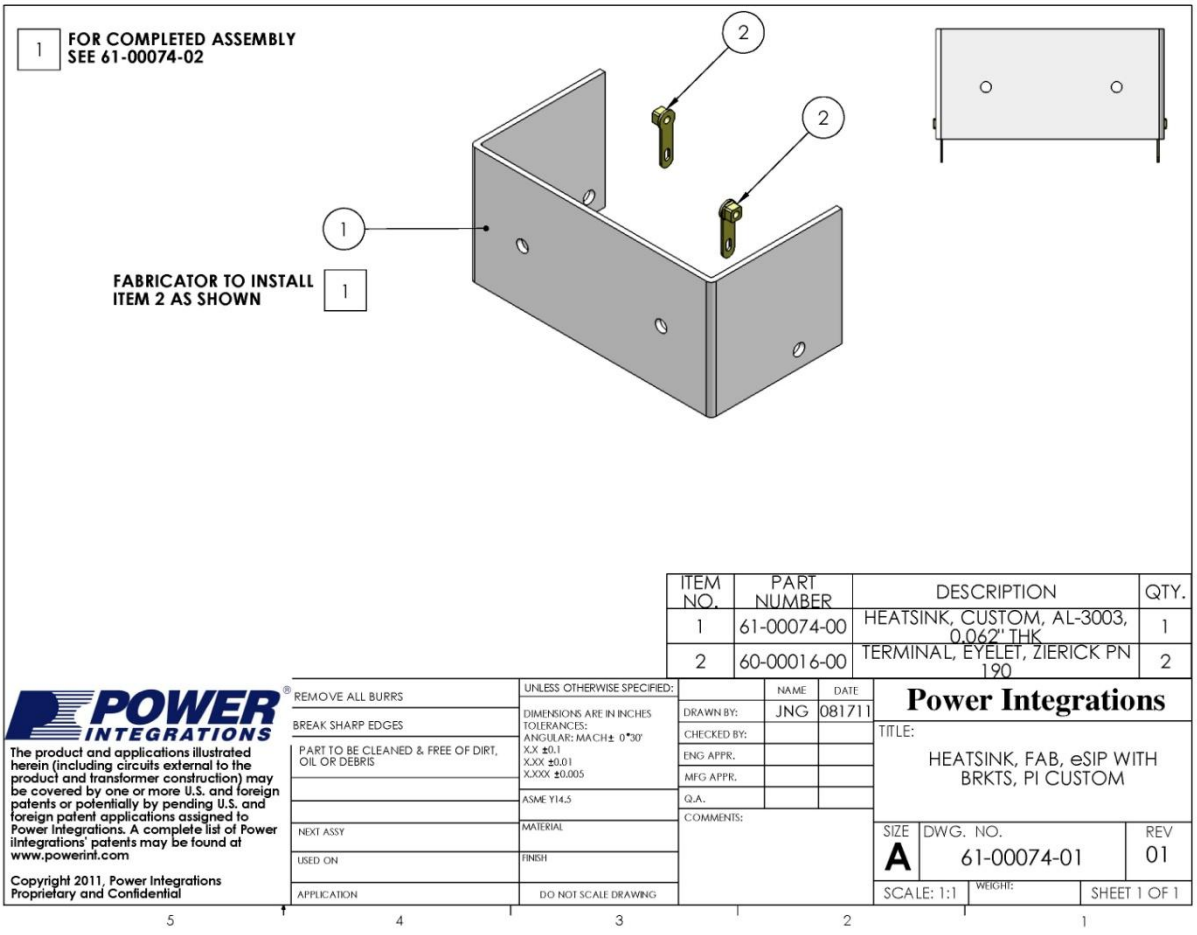
8.2 eSIP 散熱片

8.2.1 eSIP 散熱片圖示



8.2.2 eSIP 散熱片製造圖



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00074-00	HEATSINK, CUSTOM, AL-3003, 0.062" THK	1
2	60-00016-00	TERMINAL, EYELET, ZIERICK PN 190	2

POWER INTEGRATIONS

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

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

	NAME	DATE
DRAWN BY:	JNG	081711
CHECKED BY:		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

Power Integrations

TITLE: HEATSINK, FAB, eSIP WITH BRKTS, PI CUSTOM

SIZE A | DWG. NO. 61-00074-01 | REV 01

SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1

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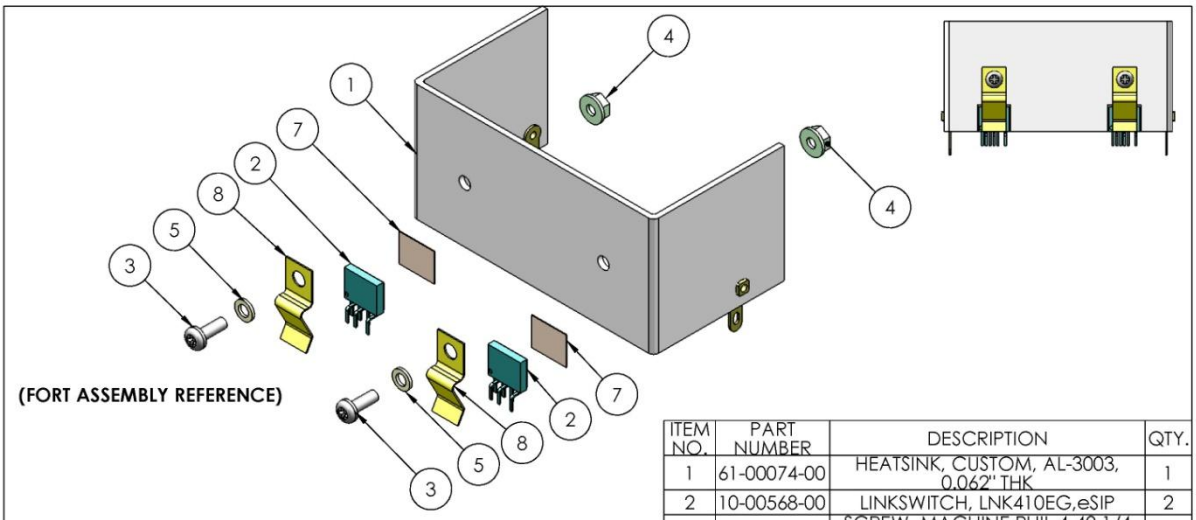
8.2.3 eSIP 和散熱片組裝圖



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00074-00	HEATSINK, CUSTOM, AL-3003, 0.062" THK	1
2	10-00568-00	LINKSWITCH, LNK410EG,eSIP	2
3	75-00001-00	SCREW MACHINE PHIL 4-40 1/4 SS	2
4	75-00069-00	NUT,HEX,KEP6-32, ZINC PLATE	2
5	75-00165-00	WASHER FLAT, # 6, SS ,	2
7	66-00024-00	THERMAL TAPE DOUBLE SIDED .008"	2
8	60-00042-00	EDGE CLIP, 20.76mm L x 8 mm WX 0.015mm THK	2

F:\Apps_Files\Apps_Personal\Strategic Customer Apps\YR 2011-PROJECTS\DER-291 2x 75W STREETLIGHT LNK410\Heatsinks

POWER INTEGRATIONS

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

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

	NAME	DATE
DRAWN BY:	JNG	081611
CHECKED BY:		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

Power Integrations

TITLE: HEATSINK, ASSY,eSIP WITH BRKTS DER291, PI CUSTOM

SIZE	DWG. NO.	REV
A	61-00074-02	01

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

9 變壓器規格

9.1 電氣圖

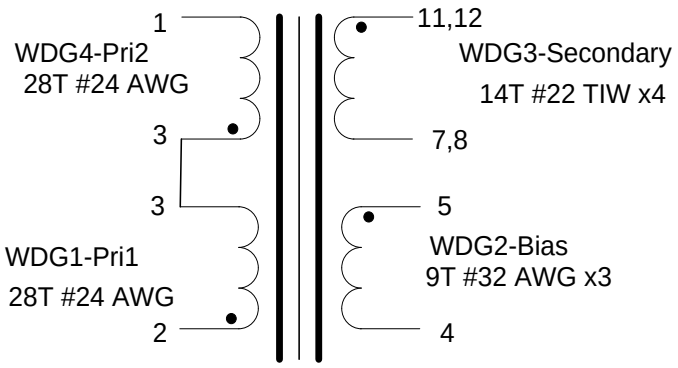


Figure 5 – Transformer Electrical Diagram.

9.2 電氣規格

Electrical Strength	1 second, 60 Hz, from pins 1-6 to pins 7-12	3000 VAC
Primary Inductance	Pins 1-2, all other windings open, measured at 100 kHz, 0.4 V_{RMS}	1186 μH, +/-10%
Resonant Frequency	Pins 1-2, all other windings open	1700 kHz (Min.)
Primary Leakage Inductance	Pins 1-2, with pins 7-12 shorted, measured at 100 kHz, 0.4 V_{RMS}	7 μH (Max.)

9.3 物料

Item	Description
[1]	Core:PC444; PQ3230.
[2]	Bobbin:RPQ3230 Vertical, 6+6 Pins.
[3]	Magnet Wire:#24 AWG.
[4]	Magnet Wire:#33 AWG.
[5]	Magnet Wire:#22 AWG Triple-insulated Wire.
[6]	Tape:3M 1298 Polyester Film, 17.7 mm Width.
[7]	Tape:3M 1298 Polyester Film, 36 mm Width.
[7]	Tape:3M 1298 Polyester Film, 10 mm Width.
[8]	Varnish.

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9.4 變壓器建構圖

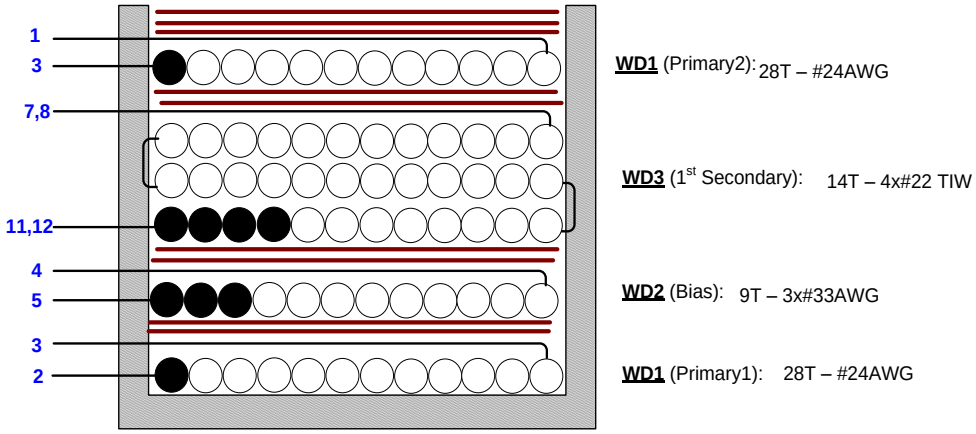
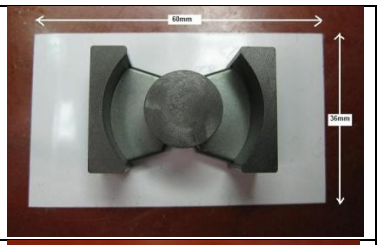
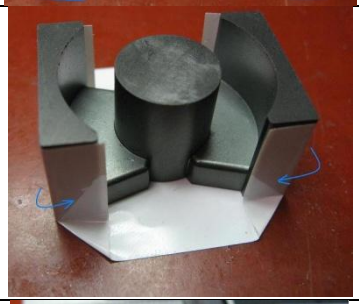
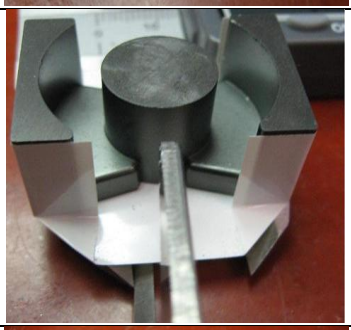
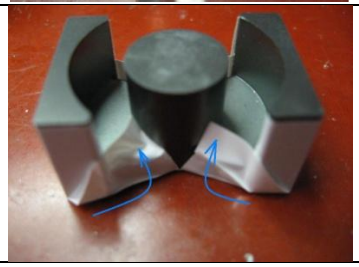


Figure 6 – Transformer Build Diagram.

9.5 變壓器結構

Bobbin Preparation	Position the bobbin such that the pins are on the left side of the bobbin chuck.Machine rotates in forward direction.
WDG1 Primary 1	Start at pin 2; wind with firm tension 28 turns of item [3] from left to right.Finish at pin 3.
Insulation	2 layers of tape [6] for insulation.
WDG2 Bias	Start at pin 5; wind with firm tension 9 trifilar turns of item [4] from left to right.Finish at pin 4.
Insulation	2 layers of tape [6] for insulation.
WDG3 Secondary	Start at pin 11 and 12; wind with firm tension 14 quadfilar turns of item [5] in continuously in three layers.Finish at pin 7 and 8. Termination is 2 wires per pin.
Insulation	2 layers of tape [6] for insulation.
WDG4 Primary 2	Start at pin 3; wind with firm tension 28 turns of item [3] from left to right.Finish at pin 1.
Insulation	3 layers of tape [6] for insulation.
Taping	Add 1 layer of tape [7] on the bottom side of the transformer to isolate the core to secondary and primary pins.Refer to the figures below.
Assemble core	Assemble and secure the cores with 3 layers of tape [7].
Finish	Varnish transformer assembly.

9.6 變壓器鐵芯纏繞程序

Step 1. Position the core at the center of 60 mm X 36 mm polyester film tape [7]	
Step 2. Fold both ends of the tape into the sides of the core as shown in the illustration.Make sure that no excess tape higher than the core.	
Step 3. Fold the tape in the 4 corners of the core.Extend the folding down to the bottom of the tape until it locks.	
Step 4. Cut the center of the bottom tape on its 2 sides.	
Step 5. Fold the tape into the legs of the core as shown in the illustration.Same procedure is applied to the other side of the core.	

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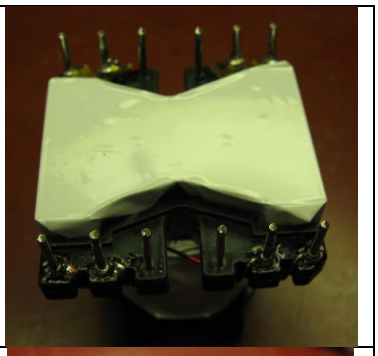
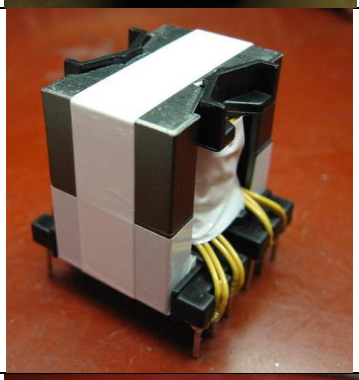
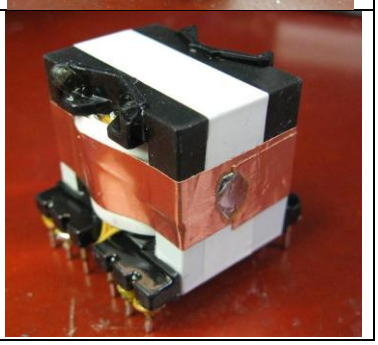
Step 6. Insert the wrapped core into the bottom side of the bobbin.Make sure that the tape is inserted between the core and the bobbin as shown in the figure.	
Step 7. Grind the top portion of the core to set the inductance as required.Assemble and fix the cores as shown in the illustration.Varnish.	
Step 8. Add 1 turn of copper shield as shown in the illustration.Solder the end of the copper shield.Varnish.	

Figure 7 – Core Wrapping Illustration.

10 變壓器設計試算表

ACDC_LinkSwitch-PH_040312; Rev.1.8; Copyright Power Integrations 2012	INPUT	INFO	OUTPUT	UNIT	LinkSwitch-PH_040312:Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES					
Dimming required	**NO**		**NO**		Select 'YES' option if dimming is required.Otherwise select 'NO'.
VACMIN	184		184	V	Minimum AC Input Voltage
VACMAX	277		277	V	Maximum AC input voltage
fL			50	Hz	AC Mains Frequency
VO	33.00		33	V	Typical output voltage of LED string at full load
VO_MAX			36.30	V	Maximum expected LED string Voltage.
VO_MIN			29.70	V	Minimum expected LED string Voltage.
V_OVP			38.50	V	Over-voltage protection setpoint
IO	2.10		2.10	A	Typical full load LED current
PO			69.3	W	Output Power
n			0.8		Estimated efficiency of operation
VB			20	V	Bias Voltage
ENTER LinkSwitch-PH VARIABLES					
LinkSwitch-PH	**LNK420**			Universal	115 Doubled/230V
Chosen Device		LNK420	Power Out	79W	74W
Current Limit Mode	**FULL**		FULL		Select "RED" for reduced Current Limit mode or "FULL" for Full current limit mode
ILIMITMIN			4.90	A	Minimum current limit
ILIMITMAX			5.70	A	Maximum current limit
fS			66000	Hz	Switching Frequency
fSmin			62000	Hz	Minimum Switching Frequency
fSmax			70000	Hz	Maximum Switching Frequency
IV			78.4	uA	V pin current
RV	4.00		4	M-ohms	Upper V pin resistor
RV2			1.402	M-ohms	Lower V pin resistor
IFB	180.00		180.0	uA	FB pin current (85 uA < IFB < 210 uA)
RFB1			94.4	k-ohms	FB pin resistor
VDS			10	V	LinkSwitch-PH 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	0.53		0.53		Ripple to Peak Current Ratio (For PF > 0.9, 0.4 < KP < 0.9)
LP			1186	uH	Primary Inductance
VOR	133.00		133	V	Reflected Output Voltage.
Expected IO (average)		Info	1.90	A	Expected Average Output current is outside 5% tolerance band.Change IFB to 206 for better current regulation set-point
KP_VACMAX			0.65		Expected ripple current ratio at VACMAX
TON_MIN			3.84	us	Minimum on time at maximum AC input voltage
PCLAMP			0.78	W	Estimated dissipation in primary clamp
11 ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	**PQ3230**		**PQ3230**		
Bobbin		*PQ3230/ 12pins*			
AE	1.6700		1.67	cm^2	Core Effective Cross Sectional Area
LE	7.5000		7.5	cm	Core Effective Path Length
AL	4500.0		4500	nH/T^2	Ungapped Core Effective Inductance
BW	17.0		17	mm	Bobbin Physical Winding Width

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M			0	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	2.00		2		Number of Primary Layers
NS	14		14		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			260	V	Peak input voltage at VACMIN
VMAX			392	V	Peak input voltage at VACMAX
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.35		Minimum duty cycle at peak of VACMIN
IAVG			0.48	A	Average Primary Current
IP			2.42	A	Peak Primary Current (calculated at minimum input voltage VACMIN)
IRMS			0.83	A	Primary RMS Current (calculated at minimum input voltage VACMIN)
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			1186	uH	Primary Inductance
NP			56		Primary Winding Number of Turns
NB			9		Bias Winding Number of Turns
ALG			384	nH/T^2	Gapped Core Effective Inductance
BM			3089	Gauss	Maximum Flux Density at PO, VMIN (BM<3100)
BP			3603	Gauss	Peak Flux Density (BP<3700)
BAC			818	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
Ur			1608		Relative Permeability of Ungapped Core
LG			0.50	mm	Gap Length (Lg > 0.1 mm)
BWE			34	mm	Effective Bobbin Width
OD			0.61	mm	Maximum Primary Wire Diameter including insulation
INS			0.07	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.54	mm	Bare conductor diameter
AWG			24	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			406	Cmils	Bare conductor effective area in circular mils
CMA			490	Cmils/Amp	!!! DECREASE CMA (200 < CMA < 600) Decrease L(primary layers),increase NS,smaller Core
LP_TOL	10		10		Tolerance of primary inductance
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT)					
Lumped parameters					
ISP			9.60	A	Peak Secondary Current
ISRMS			4.16	A	Secondary RMS Current
IRIPPLE			3.60	A	Output Capacitor RMS Ripple Current
CMS			833	Cmils	Secondary Bare Conductor minimum circular mils
AWGS			20	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS			0.81	mm	Secondary Minimum Bare Conductor Diameter
ODS			1.21	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
VOLTAGE STRESS PARAMETERS					
VDRAIN			660	V	Estimated Maximum Drain Voltage assuming maximum LED string voltage (Includes Effect of Leakage Inductance)
PIVS			137	V	Output Rectifier Maximum Peak Inverse Voltage (calculated at VOVP, excludes leakage inductance spike)
PIVB			84	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			4.00	M-ohms	Upper V Pin Resistor Value

RV2			1.40	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			2.10	A	Measured Output Current at VAC1
IO_VAC2			2.10	A	Measured Output Current at VAC2
RV1 (new)			4.00	M-ohms	New RV1
RV2 (new)			1.40	M-ohms	New RV2
V_OV			325.6	V	Typical AC input voltage at which OV shutdown will be triggered
V_UV			72.4	V	Typical AC input voltage beyond which power supply can startup
FB pin resistor Fine Tuning					
RFB1	97.6		98	k-ohms	Upper FB Pin Resistor Value
RFB2			1E+012	k-ohms	Lower FB Pin Resistor Value
VB1			18.0	V	Test Bias Voltage Condition1
VB2			22.0	V	Test Bias Voltage Condition2
IO1	2.1		2.10	A	Measured Output Current at Vb1
IO2			2.10	A	Measured Output Current at Vb2
RFB1 (new)			97.6	k-ohms	New RFB1
RFB2(new)			1.00E+12	k-ohms	New RFB2

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11 效能資料

The following data was measured using 3 sets of loads (30 V, 33 V, and 36 V).Refer to the table on Section 12.6 for the complete set of data values.All measurements were performed open frame at room temperature.

11.1 效率

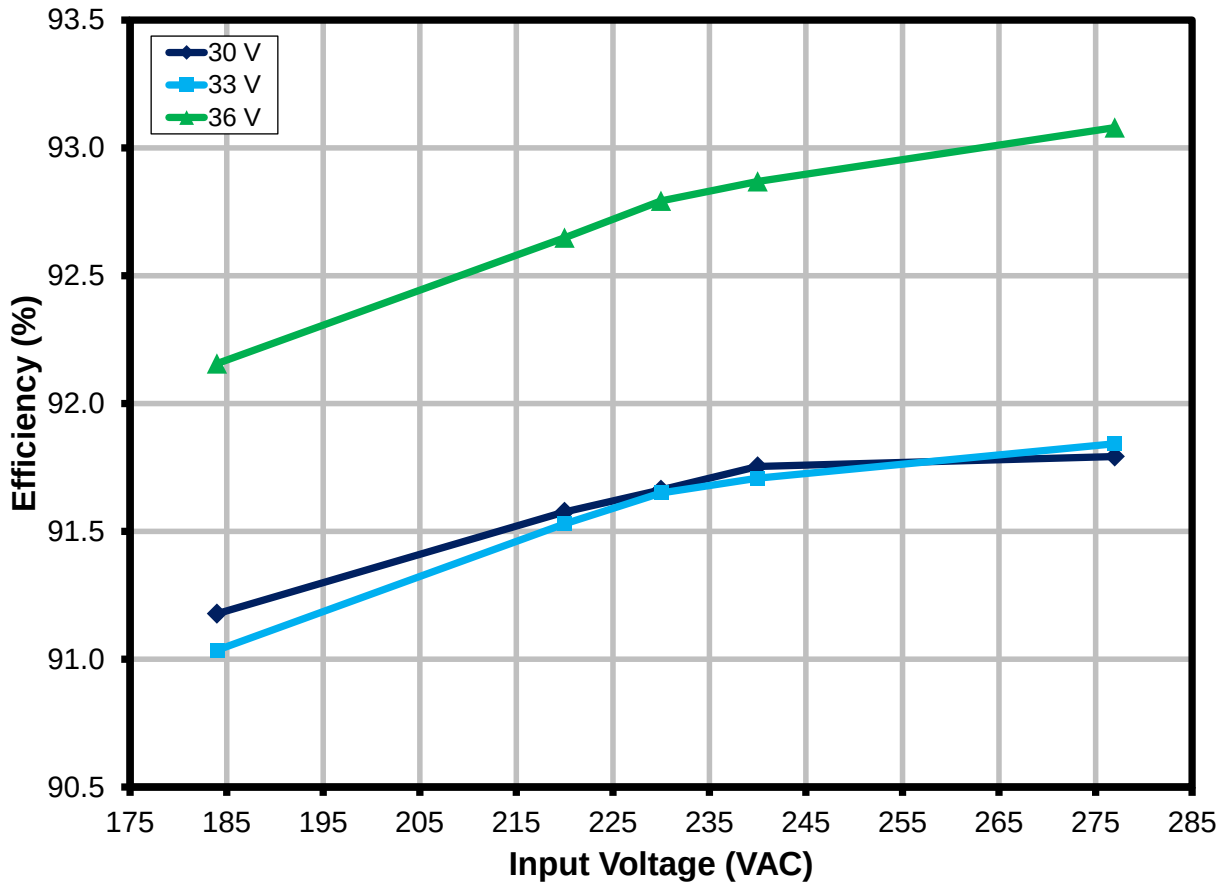

Figure 8 – Efficiency vs. Line and Load.

11.2 線電壓與負載穩定度關係圖

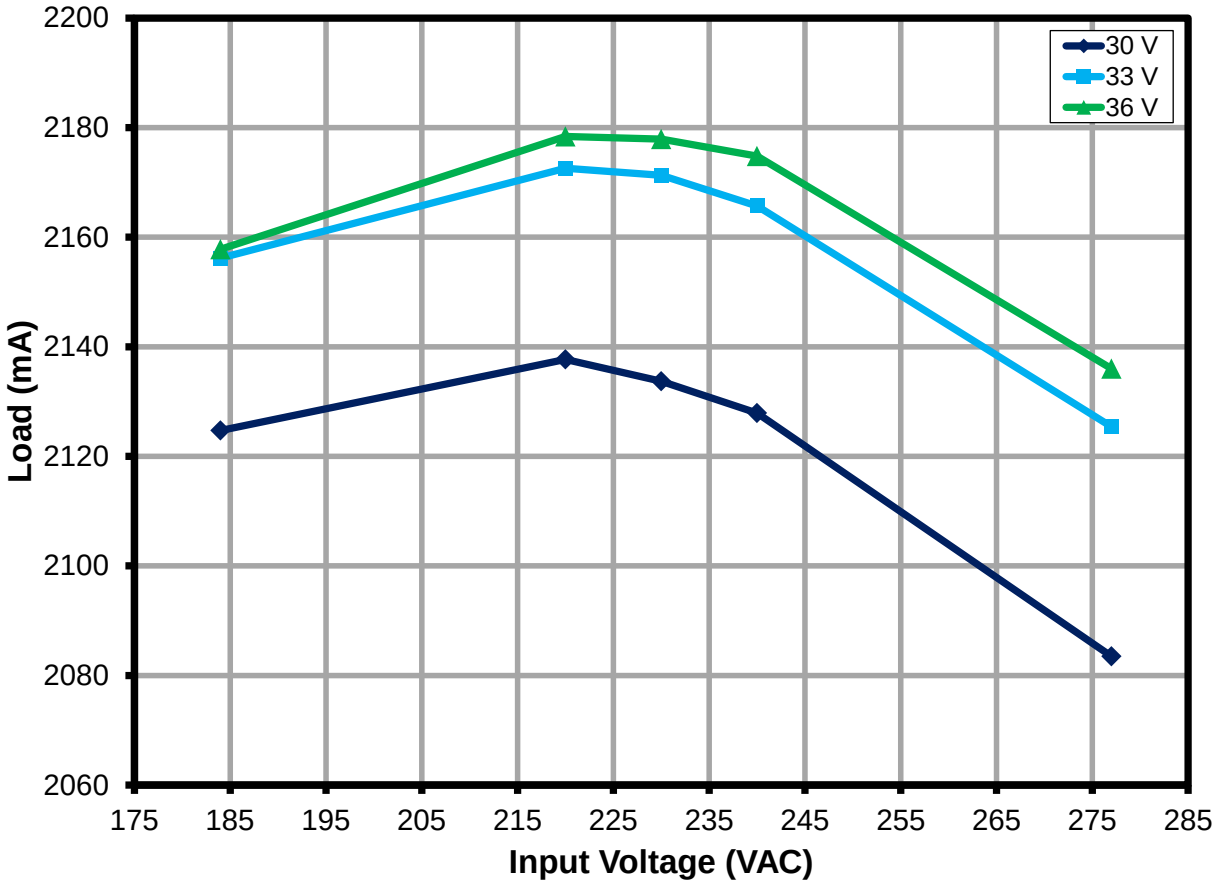

Figure 9 – Regulation vs. Line and Load.

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11.3 功率因數

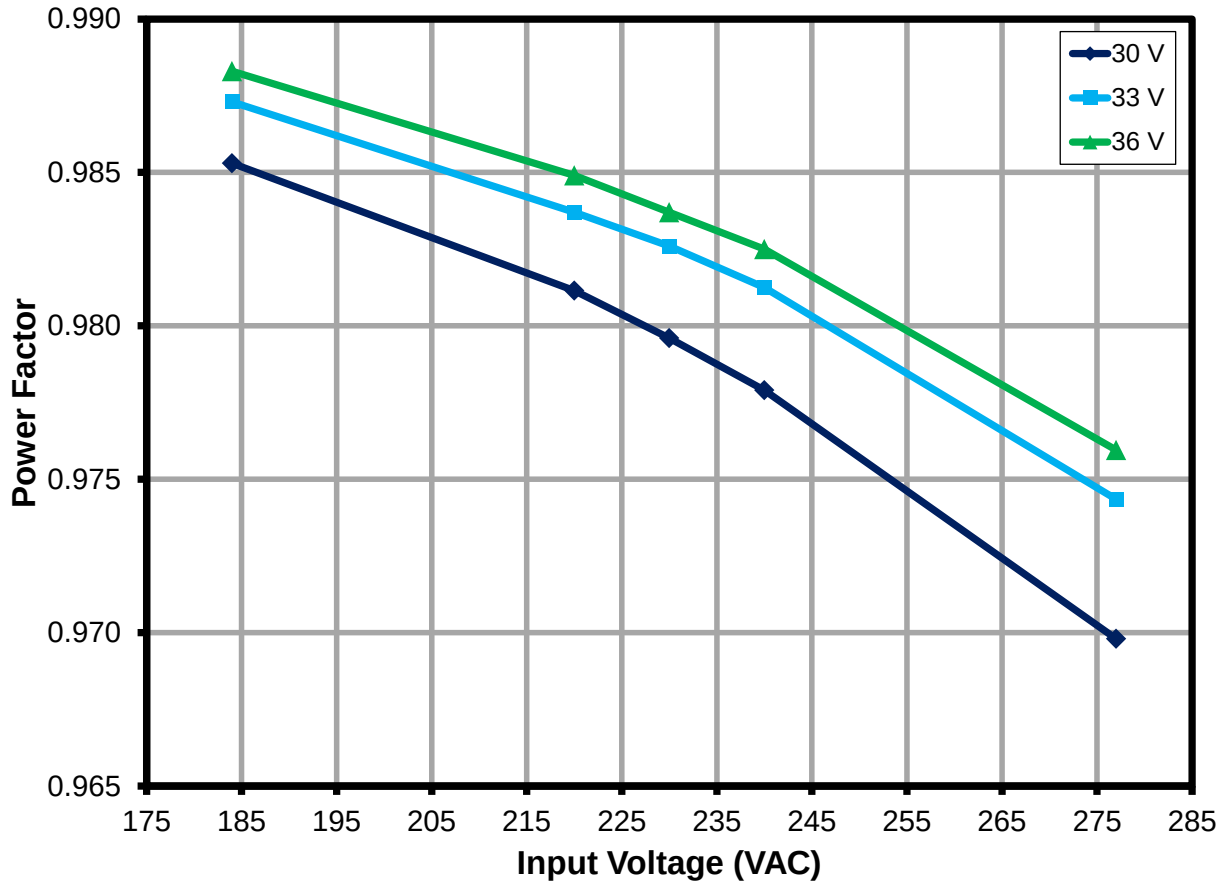

Figure 10 – Power Factor vs. Line and Load.

11.4 A-THD

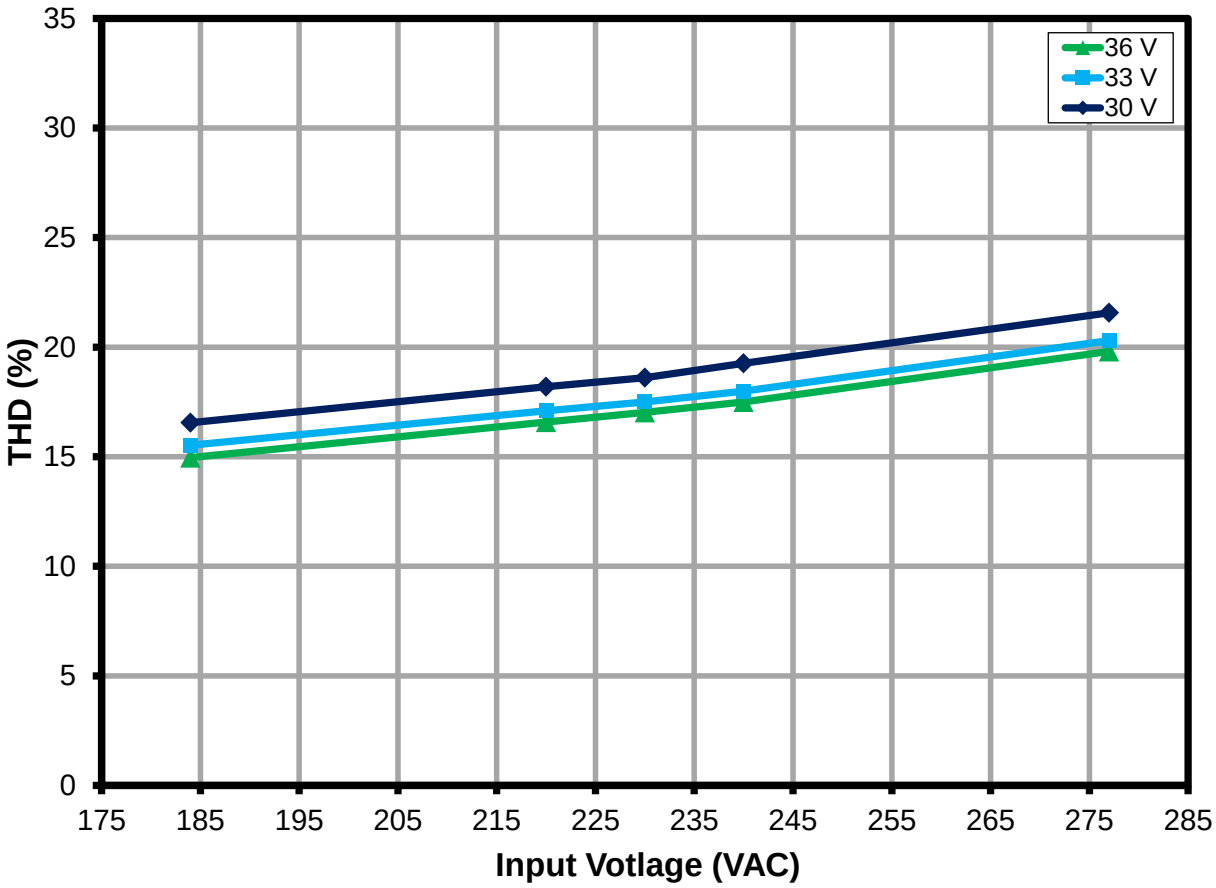

Figure 11 – A-THD vs. Line and Load.

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11.5 諧波電流

11.5.1 30 V LED 負載

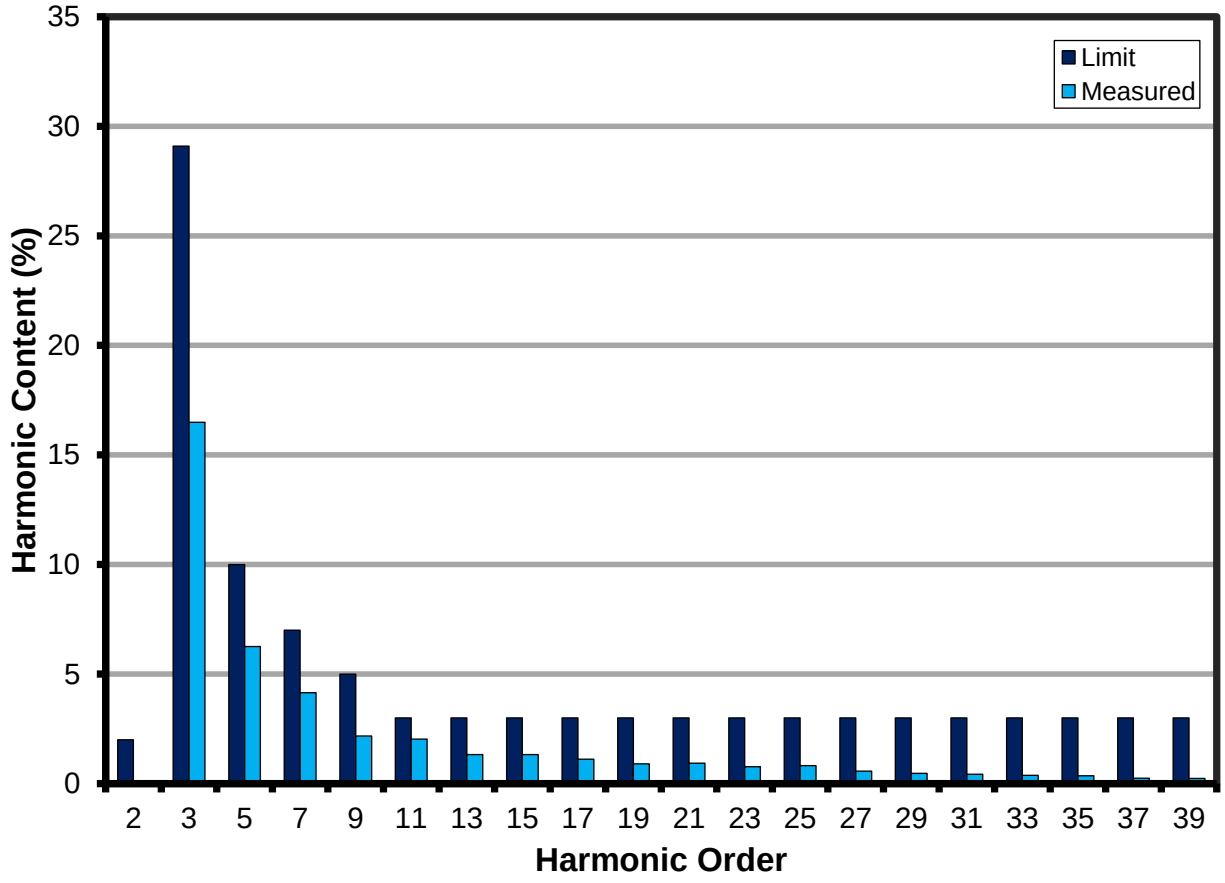

Figure 12 – Input Current Harmonics.Class C EN61000-3-2.

11.5.2 33 V LED 負載

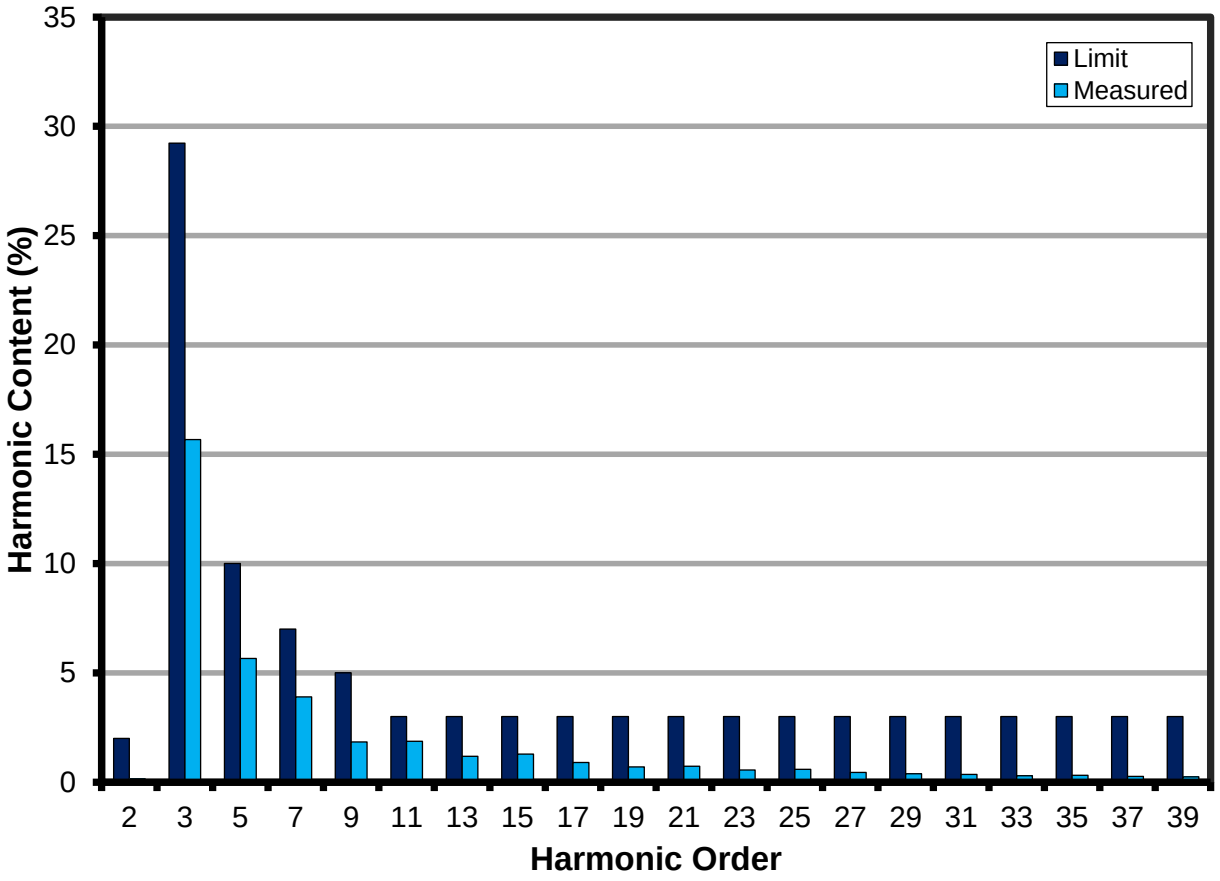

Figure 13 – Input Current Harmonics.Class C EN61000-3-2.

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11.5.3 36 V LED 負載

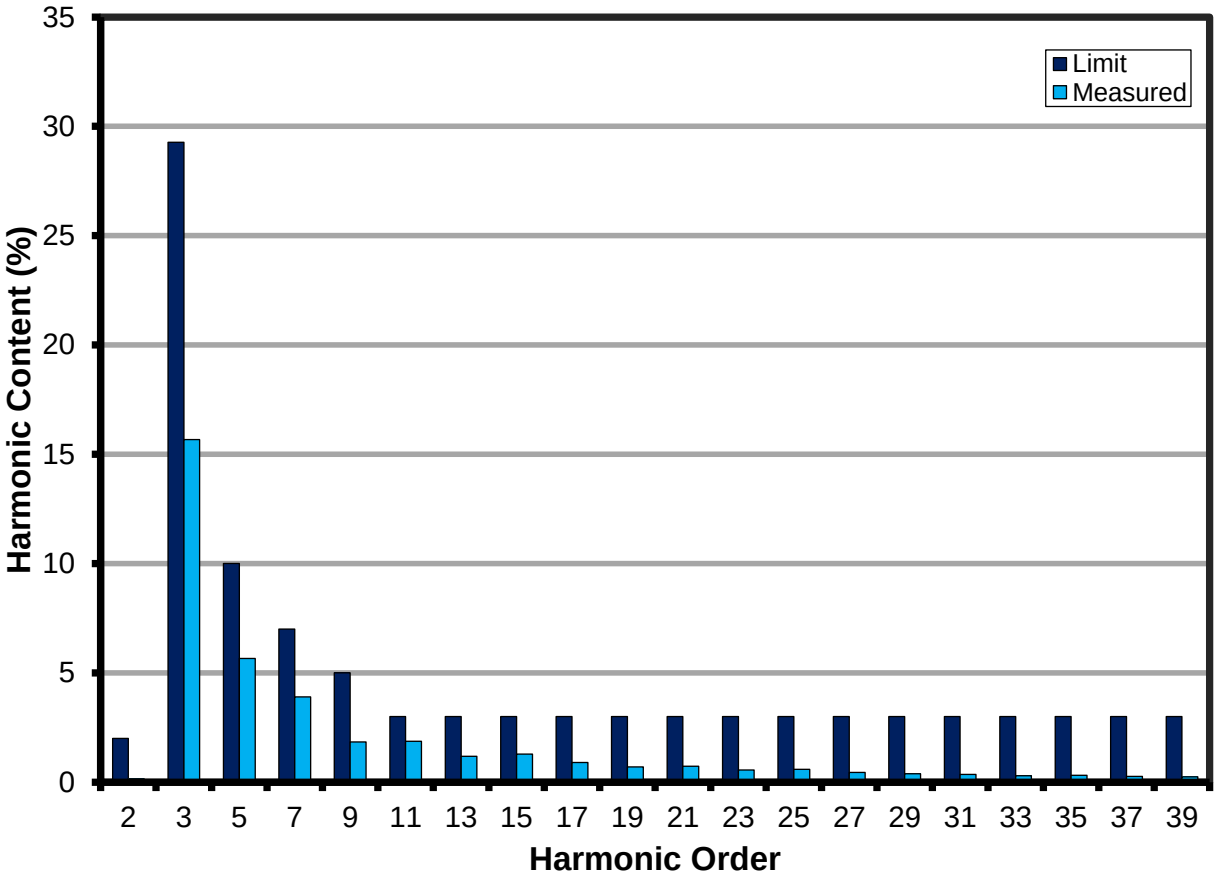

Figure 14 – Input Current Harmonics.Class C EN61000-3-2.

11.6 測試資料

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

11.6.1 測試資料，30 V LED 負載

Input		Input Measurement					Load Measurement CH1			Load Measurement CH2			Calculation	
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)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	$P_{TOTAL(CAL)}$ (W)	Efficiency (%)
184	50	184.66	742.70	135.13	0.985	16.56	29.56	2124.70	62.95	28.91	2087.90	60.51	123.46	91.18
220	50	220.83	623.30	135.05	0.981	18.20	29.47	2137.70	63.14	28.86	2099.60	60.75	123.88	91.58
230	50	230.93	594.45	134.47	0.980	18.61	29.39	2133.70	62.84	28.82	2097.10	60.58	123.42	91.66
240	50	240.97	567.80	133.80	0.978	19.26	29.33	2127.90	62.54	28.78	2092.40	60.36	122.90	91.75
277	50	278.19	484.35	130.68	0.970	21.57	29.24	2083.50	61.04	28.71	2051.40	59.03	120.07	91.79

11.6.2 測試資料，33 V LED 負載

Input		Input Measurement					Load Measurement CH1			Load Measurement CH2			Calculation	
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)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	$P_{TOTAL(CAL)}$ (W)	Efficiency (%)
184	50	184.63	861.55	157.05	0.987	15.52	33.32	2156.20	71.97	33.36	2120.60	70.86	142.84	91.04
220	50	220.91	723.05	157.13	0.984	17.10	33.31	2172.60	72.48	33.32	2135.20	71.26	143.75	91.53
230	50	230.90	690.20	156.59	0.983	17.50	33.28	2171.30	72.38	33.27	2133.50	71.10	143.48	91.65
240	50	240.99	659.25	155.90	0.981	17.99	33.25	2165.70	72.13	33.23	2128.10	70.83	142.96	91.71
277	50	278.27	562.10	152.42	0.974	20.30	33.18	2125.40	70.62	33.15	2089.20	69.37	139.99	91.84

11.6.3 測試資料，36 V LED 負載

Input		Input Measurement					Load Measurement CH1			Load Measurement CH2			Calculation	
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)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	$P_{TOTAL(CAL)}$ (W)	Efficiency (%)
184	50	184.70	915.95	167.19	0.988	14.96	36.02	2157.80	77.84	35.87	2125.50	76.35	154.187	92.16
220	50	220.92	767.10	166.90	0.985	16.59	35.82	2178.40	78.14	35.70	2143.60	76.65	154.787	92.65
230	50	230.97	730.15	165.90	0.984	17.03	35.65	2177.90	77.75	35.55	2143.20	76.30	154.054	92.79
240	50	241.06	696.30	164.91	0.983	17.50	35.51	2174.80	77.35	35.44	2138.20	75.88	153.233	92.87
277	50	278.34	592.65	160.99	0.976	19.81	35.36	2136.00	75.64	35.30	2101.30	74.27	149.914	93.08

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11.6.4 277 VAC 50 Hz，30 V LED 負載諧波資料

V	Freq	I (mA)	P	PF	%THD
277	50.00	483.90	130.5400	0.9698	21.59

nth Order	mA Content	% Content	Limit >25 W	Remarks
1	556.00			
2	0.50	0.09%	2.00%	Pass
3	91.70	16.49%	29.09%	Pass
5	34.80	6.26%	10.00%	Pass
7	23.10	4.15%	7.00%	Pass
9	12.10	2.18%	5.00%	Pass
11	11.30	2.03%	3.00%	Pass
13	7.40	1.33%	3.00%	Pass
15	7.40	1.33%	3.00%	Pass
17	6.20	1.12%	3.00%	Pass
19	5.00	0.90%	3.00%	Pass
21	5.20	0.94%	3.00%	Pass
23	4.30	0.77%	3.00%	Pass
25	4.60	0.83%	3.00%	Pass
27	3.20	0.58%	3.00%	Pass
29	2.60	0.47%	3.00%	Pass
31	2.40	0.43%	3.00%	Pass
33	2.10	0.38%	3.00%	Pass
35	2.00	0.36%	3.00%	Pass
37	1.40	0.25%	3.00%	Pass
39	1.30	0.23%	3.00%	Pass
41	1.60	0.29%		
43	1.20	0.22%		
45	2.80	0.50%		
47	17.00	3.06%		
49	16.50	2.97%		

11.6.5 230 VAC 50 Hz，33 V LED 負載諧波資料

V	Freq	I (mA)	P	PF	%THD
277	50.00	562.10	152.4200	0.9744	20.32

nth Order	mA Content	% Content	Limit >25 W	Remarks
1	648.50			
2	1.00	0.15%	2.00%	Pass
3	101.60	15.67%	29.23%	Pass
5	36.70	5.66%	10.00%	Pass
7	25.30	3.90%	7.00%	Pass
9	11.90	1.84%	5.00%	Pass
11	12.10	1.87%	3.00%	Pass
13	7.70	1.19%	3.00%	Pass
15	8.30	1.28%	3.00%	Pass
17	5.80	0.89%	3.00%	Pass
19	4.50	0.69%	3.00%	Pass
21	4.70	0.72%	3.00%	Pass
23	3.60	0.56%	3.00%	Pass
25	3.80	0.59%	3.00%	Pass
27	2.90	0.45%	3.00%	Pass
29	2.50	0.39%	3.00%	Pass
31	2.30	0.35%	3.00%	Pass
33	1.90	0.29%	3.00%	Pass
35	2.00	0.31%	3.00%	Pass
37	1.70	0.26%	3.00%	Pass
39	1.60	0.25%	3.00%	Pass
41	1.50	0.23%		
43	1.70	0.26%		
45	3.70	0.57%		
47	17.70	2.73%		
49	16.00	2.47%		

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11.6.6 230 VAC 50 Hz，36 V LED 負載諧波資料

V	Freq	I (mA)	P	PF	%THD
277	50.00	592.90	161.0600	0.9759	19.83

nth Order	mA Content	% Content	Limit >25 W	Remarks
1	684.70			
2	0.80	0.12%	2.00%	Pass
3	104.80	15.31%	29.28%	Pass
5	37.30	5.45%	10.00%	Pass
7	26.00	3.80%	7.00%	Pass
9	12.20	1.78%	5.00%	Pass
11	12.20	1.78%	3.00%	Pass
13	11.50	1.68%	3.00%	Pass
15	6.00	0.88%	3.00%	Pass
17	6.00	0.88%	3.00%	Pass
19	4.20	0.61%	3.00%	Pass
21	4.70	0.69%	3.00%	Pass
23	3.80	0.55%	3.00%	Pass
25	3.80	0.55%	3.00%	Pass
27	3.00	0.44%	3.00%	Pass
29	2.70	0.39%	3.00%	Pass
31	2.40	0.35%	3.00%	Pass
33	2.20	0.32%	3.00%	Pass
35	2.00	0.29%	3.00%	Pass
37	1.90	0.28%	3.00%	Pass
39	1.70	0.25%	3.00%	Pass
41	1.80	0.26%		
43	1.50	0.22%		
45	3.80	0.55%		
47	16.90	2.47%		
49	17.40	2.54%		

12 波形

12.1 輸入線電流

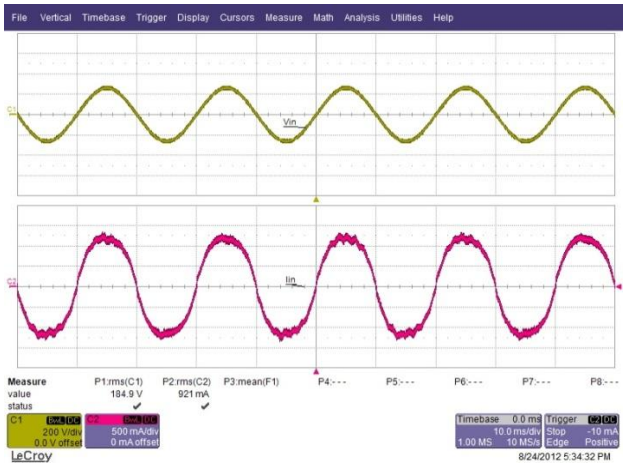

Figure 15 – 184 VAC 50 Hz, Full Load.
Upper:V_{IN}, 200 V
Lower:I_{IN}, 0.5 A / div.,10 ms / div.

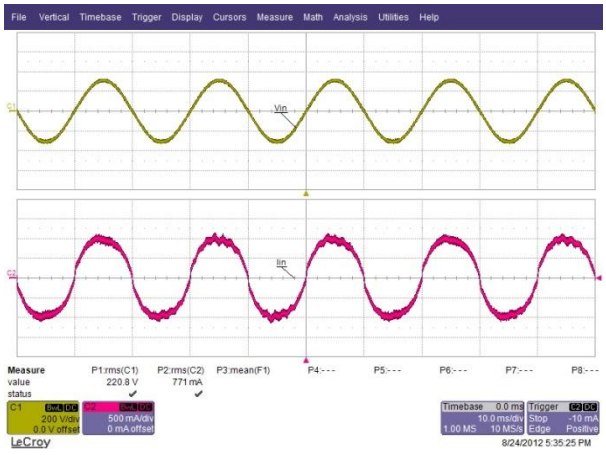

Figure 16 – 220 VAC 50 Hz, Full Load.
Upper:V_{IN}, 200 V
Lower:I_{IN}, 0.5 A / div.,10 ms / div.

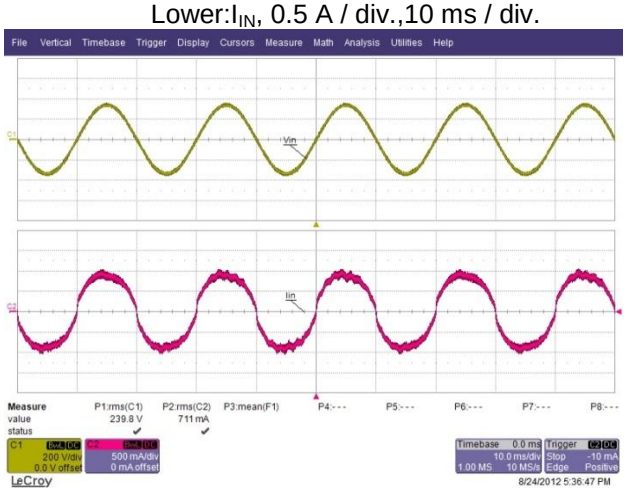

Figure 17 – 240 VAC 50 Hz, Full Load.
Upper:V_{IN}, 200 V
Lower:I_{IN}, 0.5 A / div.,10 ms / div.

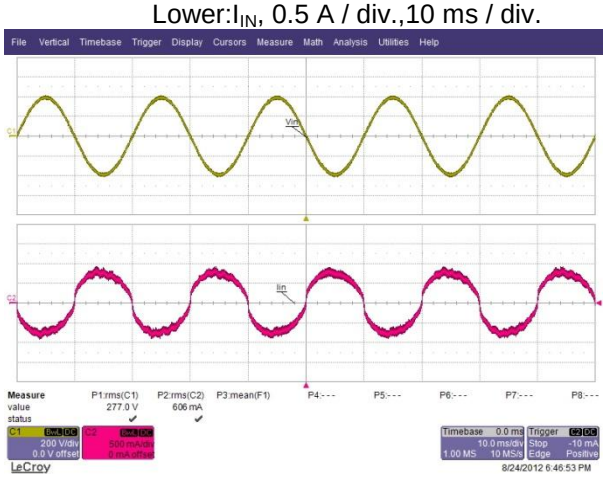

Figure 18 – 277 VAC 50 Hz, Full Load.
Upper:V_{IN}, 200 V
Lower:I_{IN}, 0.5 A / div.,10 ms / div.

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12.2 汲極電壓和電流與正常操作

Figure 19 – 184 VAC 50 Hz, Full Load.
Upper:I_{DRAIN}, 1 A / div.
Lower:V_{DRAIN}, 200 V, 2 ms / div.

Figure 20 – 277 VAC 50 Hz, Full Load.
Upper:I_{DRAIN}, 1 A / div.
Lower:V_{DRAIN}, 200 V, 2 ms / div.

12.3 汲極電壓和電流啓動操作

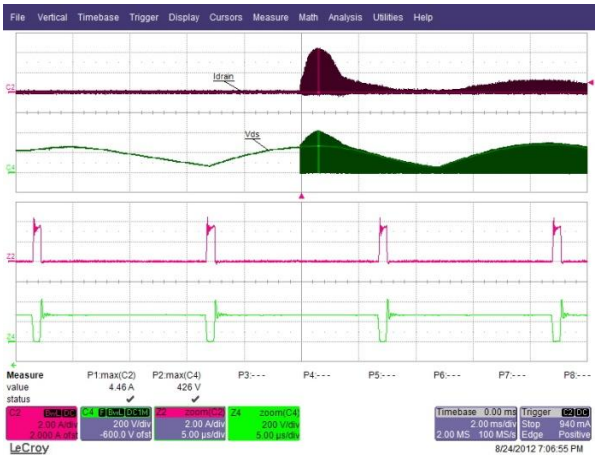

Figure 21 – 184 VAC 50 Hz., Full Load Start-up.
Upper:I_{DRAIN}, 2 A / div.
Lower:V_{DRAIN}, 200 V, 2 ms / div.

Figure 22 – 277 VAC 50 Hz., Full Load Start-up.
Upper:I_{DRAIN}, 2 A / div.
Lower:V_{DRAIN}, 200 V, 2 ms / div.

12.4 輸出電流與輸出電壓

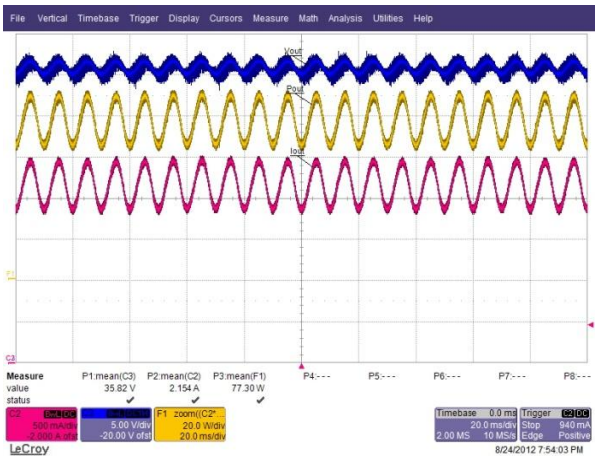

Figure 23 – 184 VAC 50 Hz., Max Load.
Upper:V_{OUT}, 5V / div.
Middle:P_{OUT}, 20W / div.
Lower:I_{OUT}, 500 mA / div.

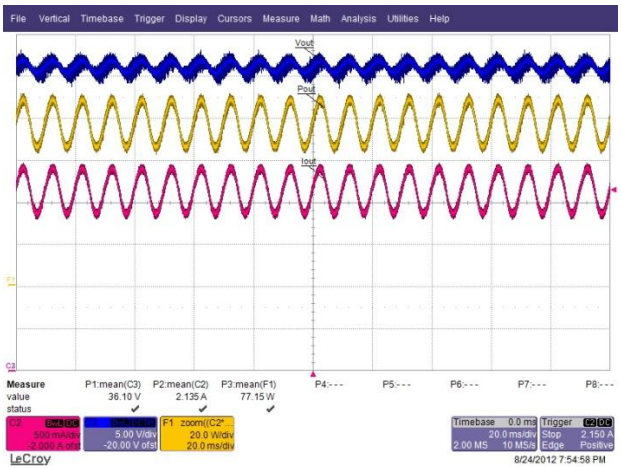

Figure 24 – 277 VAC 50 Hz., Max Load.
Upper:V_{OUT}, 5V / div.
Middle:P_{OUT}, 20W / div.
Lower:I_{OUT}, 500 mA / div.

12.5 啓動輸出電流和電壓

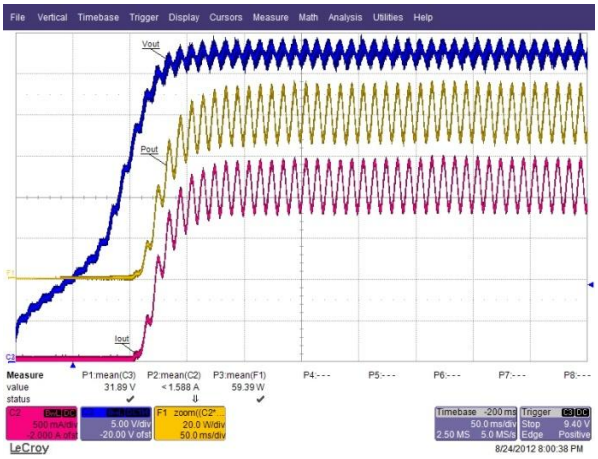

Figure 25 – 184 VAC 50 Hz, Output Rise.
Upper:V_{OUT}, 5V / div.
Middle:P_{OUT}, 20W / div.
Lower:I_{OUT}, 500 mA / div.

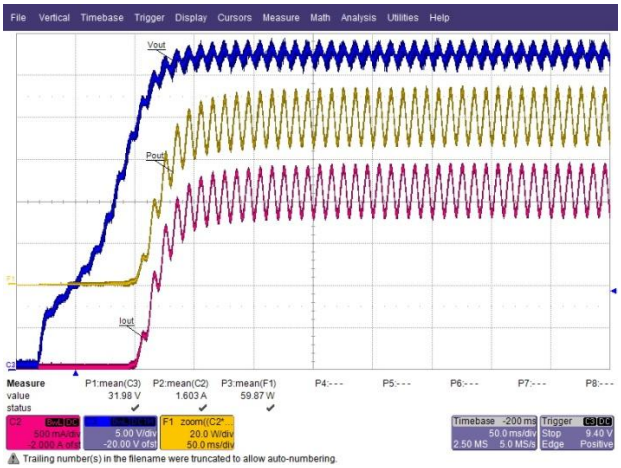

Figure 26 – 277 VAC 50 Hz, Output Rise.
Upper:V_{OUT}, 5V / div.
Middle:P_{OUT}, 20W / div.
Lower:I_{OUT}, 500 mA / div.

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12.6 開機、關機時的輸出追蹤

Figure 27 – 184 VAC 50 Hz, Power-up.
Upper:$V_{OUT-LED1}$, 5 V / div.
Lower:$V_{OUT-LED2}$, 5 V / div., 50ms / div.

Figure 28 – 277 VAC 50 Hz, Power-down.
Upper:$V_{OUT-LED1}$, 5 V / div.
Lower:$V_{OUT-LED2}$, 5 V / div., 50ms / div.

12.7 開路負載測試

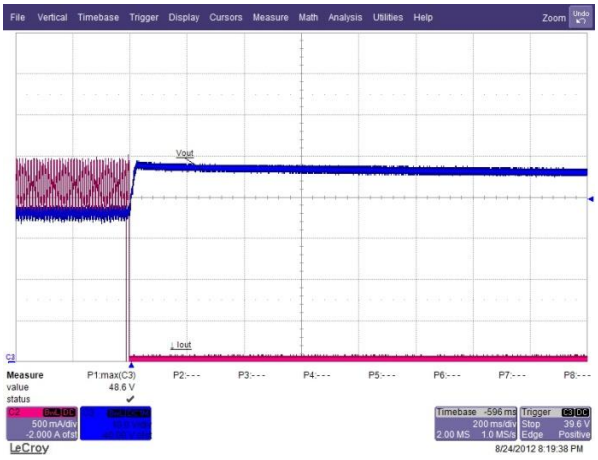

Figure 29 – 277 VAC 50 Hz, Output 1 Open.
Upper:$V_{OUT-LED1}$, 10 V / div.
Lower:$I_{OUT-LED1}$, 500 mA, 200 ms / div.

Figure 30 – 277 VAC 50 Hz, Output 2 Open.
Upper:$V_{OUT-LED1}$, 10 V / div.
Lower:$I_{OUT-LED1}$, 500 mA, 200 ms / div.

12.8 輸出整流器反向峰值電壓

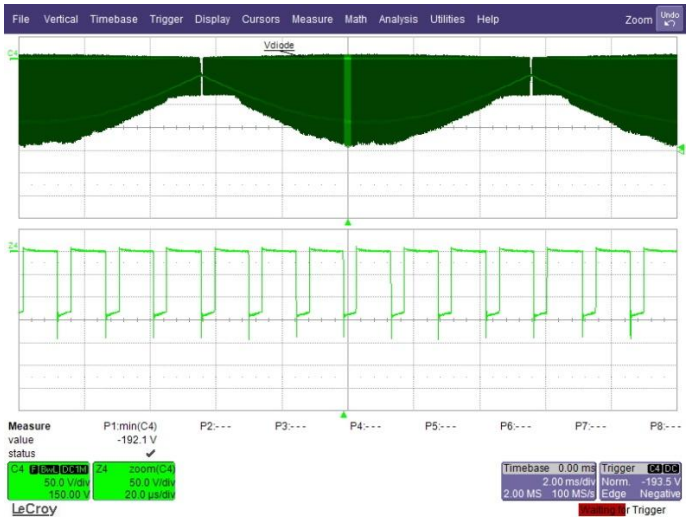

Figure 31 – 277 VAC 50 Hz, Output Short.
Lower:V_{PIV}, 50 V, 5 ms / div.

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13 電源線路動態測試

The unit was subjected to ±2500 V, 100 kHz ring wave and ±2000 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)
+2000	230	L1, L2	0	Surge (2Ω)	Pass
-2000	230	L1, L2	90	Surge (2Ω)	Pass
+2000	230	L1, L2	0	Surge (2Ω)	Pass
-2000	230	L1, L2	90	Surge (2Ω)	Pass

14 散熱測量

Thermal performance was measured inside an enclosure with two 36 V LED loads with no airflow.The thermocouple was attached to the body of the components.Temperature stabilized after 2 hour.

DESCRIPTION	184 VAC / 50 Hz. (ºC)	230 VAC / 50 Hz. (ºC)	277 VAC / 50 Hz. (ºC)
Ambient Temperature	65	65	65
Input Bridge (BR1)	110.5	103.5	95.5
Transformer (T1)	78.6	81.3	82.6
Transformer (T2)	77.3	79.6	81.9
LNK-PH (U1)	119.7	116.3	114.2
LNK-PH (U2)	120.5	117.9	115.5
Output Diode (D17)	99.9	98.5	98
Output Diode (D9)	99.6	99.9	99.5
Output Diode (D16)	97.3	97.8	97.3
Output Diode (D8)	99.1	99	98.3
TVS (VR1)	110.9	105.2	102.7
TVS (VR4)	112.3	107.6	104
Block Diode (D3)	114.6	108.9	105.5
Block Diode (D11)	116.6	111.3	106.6

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15 傳導性 EMI 測量

15.1 傳導性 EMI 測試設定

The UUT is placed on a ground plane as shown below together with the LED load.

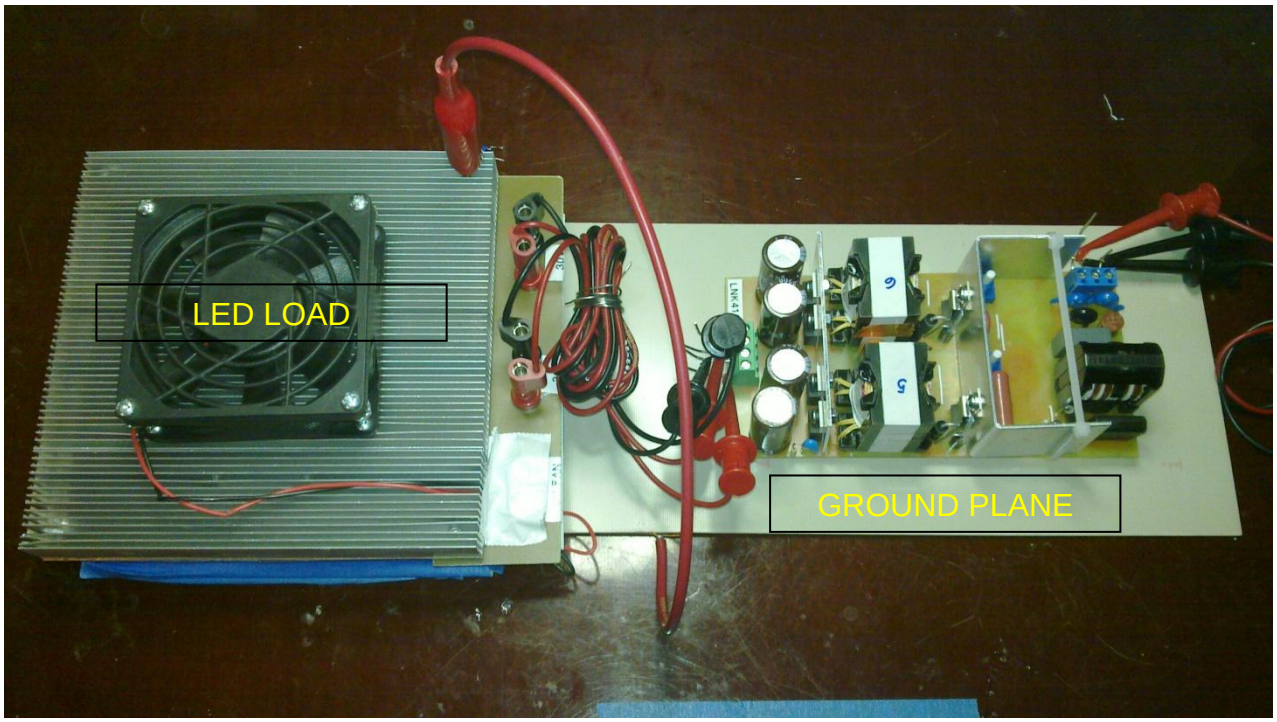

Figure 32 – EMI Measurement Set-up.

15.2 傳導性 EMI 測試結果

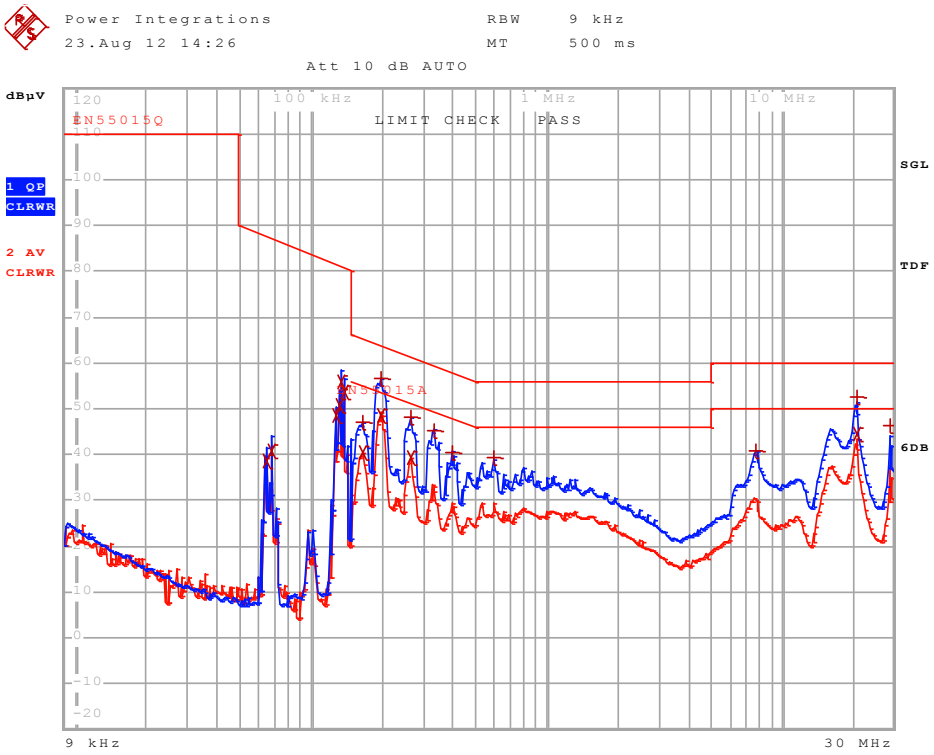

Figure 33 – 30 V LED Load, 230 VAC, 60 Hz, and EN55015 Limits.

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
2	Average	64.5467705779 kHz	38.64	N gnd	
2	Average	67.8393045788 kHz	40.85	N gnd	
2	Average	126.977840157 kHz	48.68	L1 gnd	
2	Average	130.825395691 kHz	50.77	L1 gnd	
2	Average	133.454986145 kHz	55.87	N gnd	
2	Average	137.49880568 kHz	53.71	N gnd	
1	Quasi Peak	164.052790903 kHz	47.12	N gnd	-18.12
2	Average	165.693318812 kHz	40.45	L1 gnd	-14.71
2	Average	196.231331718 kHz	48.41	L1 gnd	-5.35
1	Quasi Peak	198.193645035 kHz	56.59	L1 gnd	-7.09
1	Quasi Peak	264.49018761 kHz	48.32	L1 gnd	-12.96
2	Average	264.49018761 kHz	39.23	L1 gnd	-12.05
1	Quasi Peak	332.507282579 kHz	45.25	L1 gnd	-14.13
1	Quasi Peak	397.727746704 kHz	40.49	L1 gnd	-17.40
1	Quasi Peak	598.084042089 kHz	39.43	L1 gnd	-16.56
1	Quasi Peak	7.71534368894 MHz	40.79	L1 gnd	-19.21
1	Quasi Peak	20.6619488204 MHz	52.62	N gnd	-7.37
2	Average	20.6619488204 MHz	44.60	N gnd	-5.39
1	Quasi Peak	28.9799739049 MHz	46.37	N gnd	-13.62

Figure 34 – Scan Summary at 30 V LED Load, 230 VAC, 60 Hz, and EN55015 Limits.

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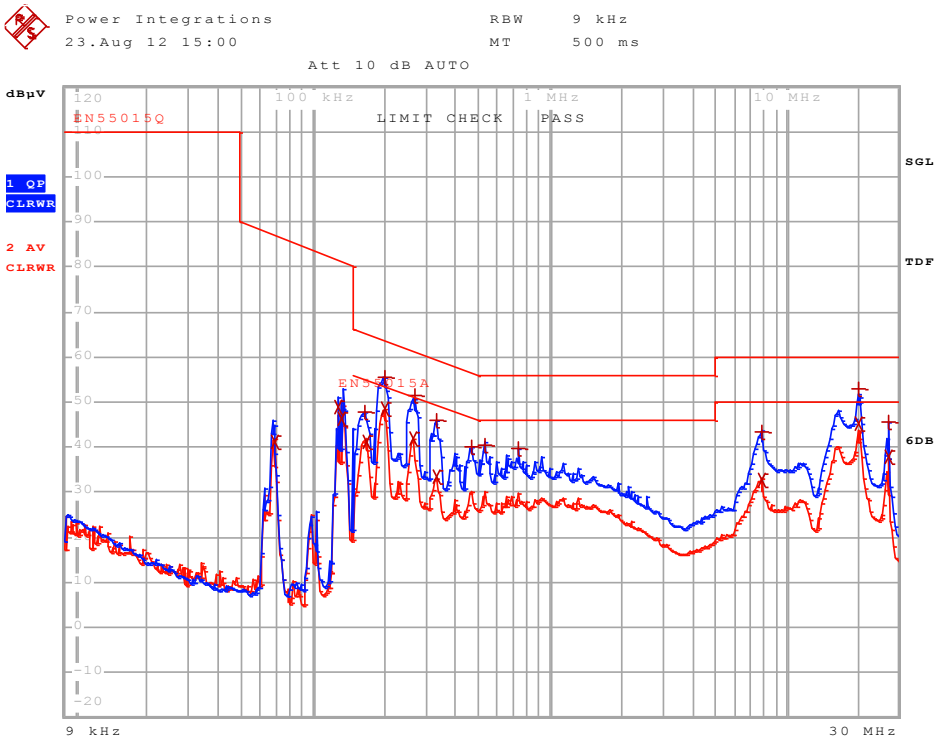

Figure 35 – Line Conducted EMI, 36 V LED Load, 230 VAC, 60 Hz, and EN55015 Limits

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV			DELTA LIMIT dB
2	Average	68.5176976246 kHz	41.29	L1	gnd	
2	Average	126.977840157 kHz	48.93	N	gnd	
2	Average	132.133649648 kHz	46.48	N	gnd	
1	Quasi Peak	164.052790903 kHz	47.91	L1	gnd	-17.34
2	Average	167.350252 kHz	41.25	L1	gnd	-13.83
1	Quasi Peak	200.175581485 kHz	55.59	N	gnd	-8.00
2	Average	200.175581485 kHz	48.52	L1	gnd	-5.07
2	Average	264.49018761 kHz	41.74	L1	gnd	-9.54
1	Quasi Peak	267.135089486 kHz	51.30	L1	gnd	-9.90
1	Quasi Peak	332.507282579 kHz	46.06	L1	gnd	-13.32
2	Average	332.507282579 kHz	33.55	L1	gnd	-15.83
1	Quasi Peak	466.367062279 kHz	40.20	L1	gnd	-16.37
1	Quasi Peak	530.769219795 kHz	40.56	L1	gnd	-15.43
1	Quasi Peak	729.776191209 kHz	39.79	L1	gnd	-16.20
1	Quasi Peak	7.79249712583 MHz	43.47	L1	gnd	-16.52
2	Average	7.79249712583 MHz	32.54	L1	gnd	-17.45
1	Quasi Peak	20.2548268017 MHz	52.99	N	gnd	-7.00
2	Average	20.2548268017 MHz	45.25	N	gnd	-4.74
1	Quasi Peak	26.7625196891 MHz	45.70	N	gnd	-14.29
2	Average	26.7625196891 MHz	37.87	N	gnd	-12.12

Figure 36 – Scan Summary at 36 V LED Load, 230 VAC, 60 Hz, and EN55015 Limits.

16 修訂記錄

Date	Author	Revision	Description and Changes	Reviewed
11-Nov-11	ME	1.0	Initial Release	Apps & Mktg
19-Oct-12	JDC	2.0	Updated Test Results for LNK420EG	Apps & Mktg

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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,
Zhongtou 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：
eurosales@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：
eurosales@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：
eurosales@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