

## 設計範例報告

|      |  |
|------|--|
| 標題   | 使用 <b>LYTSwitch™ LYT4314E</b> 的 <b>9.5 W 隔離返馳式、可調光雙向閘流器 (TRIAC)、功率因數修正 (大於 0.96) LED 驅動器</b> |
| 規格   | 90 VAC – 132 VAC 輸入；18 V、530 mA 輸出   |
| 應用   | 軌道燈 LED 驅動器  |
| 作者   | 應用工程部門   |
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### 摘要與功能

- 於 120 VAC 時可達 81% 或以上的高效率
- 功率因數 (PF) 大於 0.96，輕鬆符合 EN 61000-3-2 D (C) 類標準
- 總諧波失真 (THD) 小於 15%
- 提供兩種 TRIAC 可調光設定
  - 使用主動預載 - 最大的調光器機型相容性與大調光範圍
  - 不採用主動預載情況下，成本最低 - 大範圍的 600 W 調光器相容性
- 低系統成本
  - Single-stage 轉換器
  - 單面 PCB
  - 元件數量少
- 強化使用者體驗
  - 無閃爍、快速單向啓動 (小於 200 ms) – 無可感延遲
  - 調光時光源穩定或低導通角
  - 廣泛的調光器相容性
- 整合式保護與可靠性功能
  - 使用自動恢復功能以保護輸出開路/輸出短路

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- 快速線電壓輸入過壓保護，增強了線路故障時的耐壓程度
  - 輕鬆符合  $\pm 2500\text{ V}$  振盪波及  $\pm 500\text{ V}$  差動突波

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**重要事項：**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

本文件說明隔離式高功率因數 (PF) 且雙向閘流器 (TRIAC) 調光的 LED 驅動器，其設計為輸入電壓範圍為 90 VAC 至 132 VAC 時，用於驅動 21 V (530 mA) 的標準 LED 串電壓。此 LED 驅動器採用 LYTSwitch IC 系列中的 LYT4314E。

所使用的架構是 Single-stage 功率因數修正返馳式轉換器，用於實現高效能、高功率因數、隔離、低 THD，以及低元件數，並且能提供優異的 TRIAC 調光效能。

高功率因數和低 THD 是透過採用 LYTSwitch IC 來達成，此裝置也提供眾多而精密的保護功能，包括開路控制迴路與輸出短路狀況的自動重新啟動。線電壓過壓保護可提高線路故障與突波承受度，而精確的磁滯回復過溫保護功能可確保 PCB 在各種狀況下皆可保持在安全的平均溫度。

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

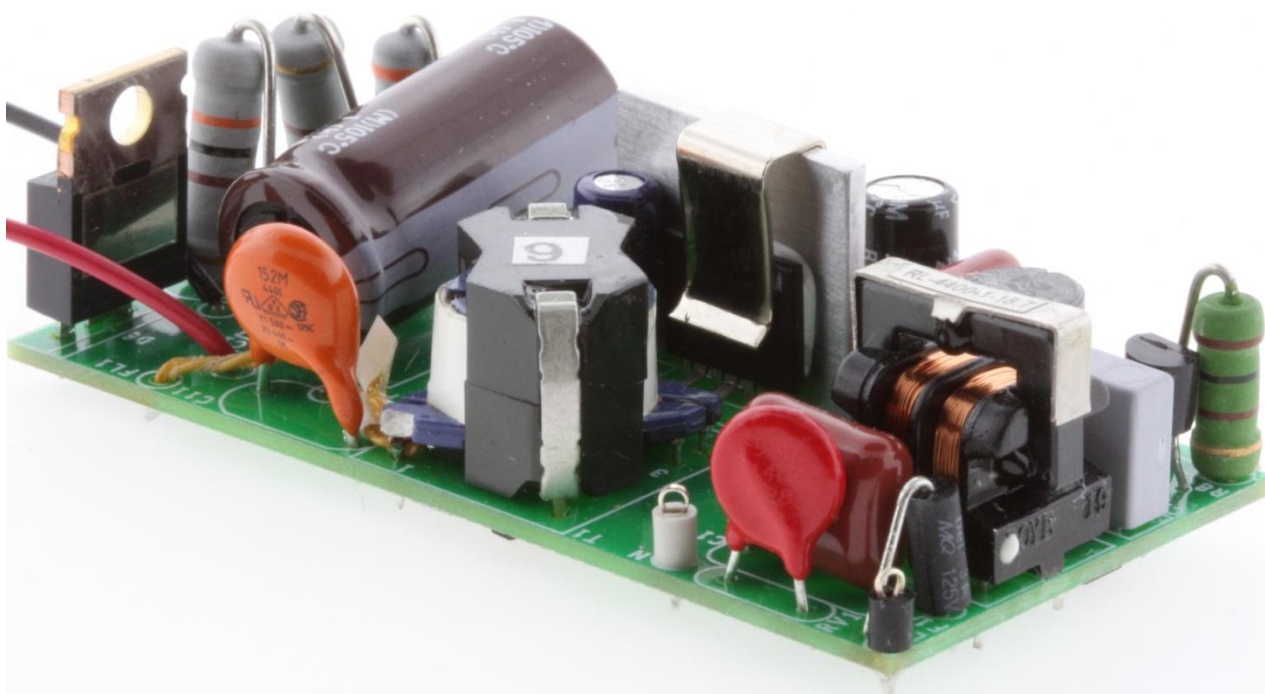


Figure 1 – Populated Circuit Board Photograph





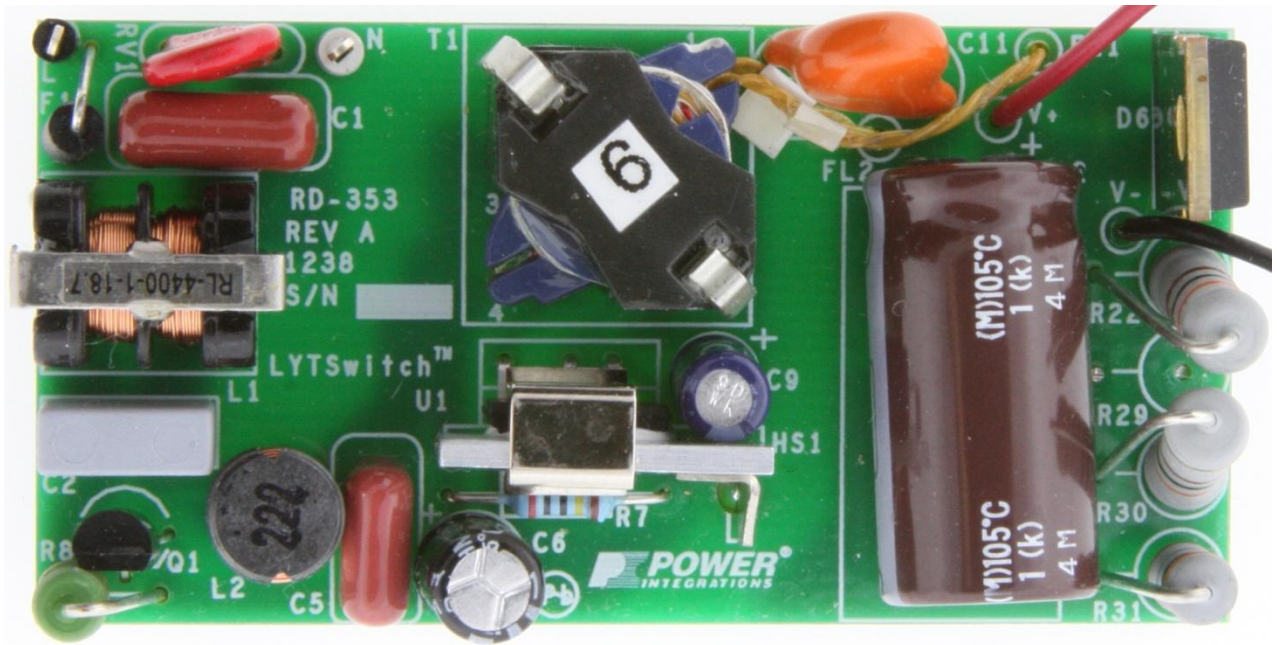


Figure 2 – Populated Circuit Board Photograph (Top View).

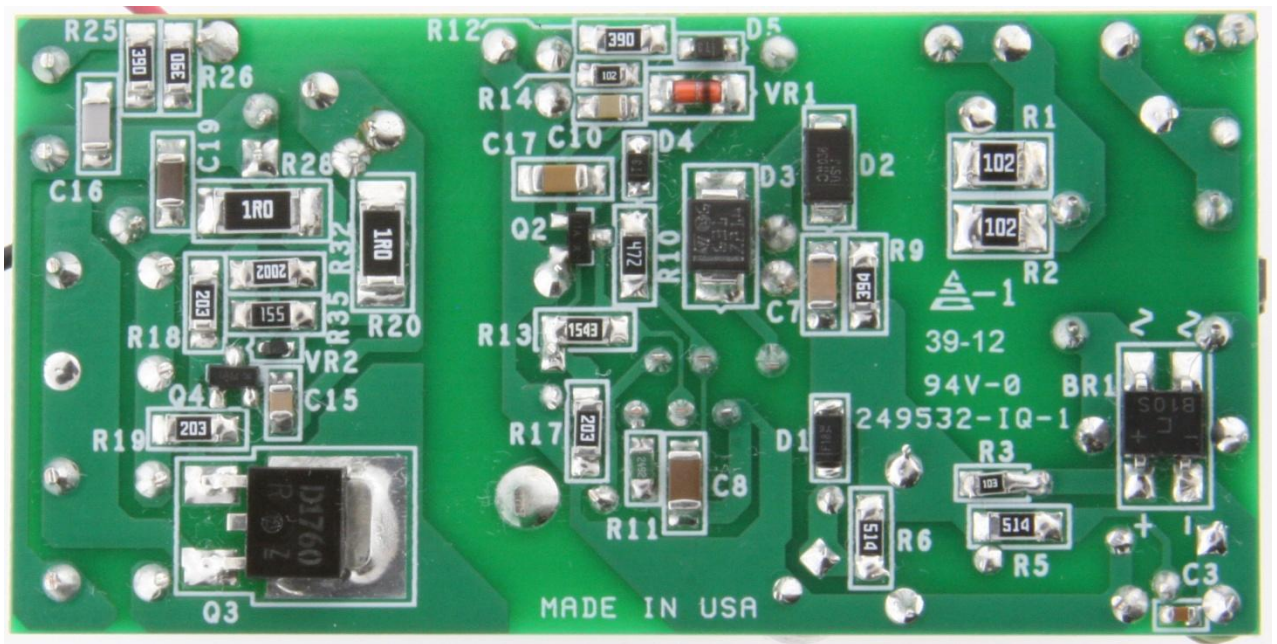


Figure 3 – Populated Circuit Board Photograph (Bottom View).



## 2 電源供應器規格

下表展示設計的最低可接受效能。實際效能列在結果部分。

| 說明                      | 符號         | 最小值 | 類型                   | 最大值 | 單位  | 註解   |
|-------------------------|------------|-----|----------------------|-----|-----|--|
| 輸入<br>電壓                | $V_{IN}$   | 90  | 120                  | 132 | VAC |  |
| 頻率                      | $f_{LINE}$ |     | 60                   |     | Hz  |  |
| 輸出<br>輸出電壓              | $V_{OUT}$  | 15  | 18                   | 21  | V   | $V_{OUT} = 21$ , $V_{IN} = 120$ VAC, 25°C                  |
| 輸出電流                    | $I_{OUT}$  |     | 530                  |     | mA  |  |
| 總輸出功率                   |            |     | 9.5                  |     | W   |  |
| 連續輸出功率                  | $P_{OUT}$  |     |                      |     |     |  |
| 效率<br>滿載                | $\eta$     |     | 82                   |     | %   | 在 $P_{OUT}$ 25°C 時測量                                       |
| 環境<br>傳導性 EMI           |            |     | CISPR 15B / EN55015B |     |     |  |
| 安全<br>振盪波 (100 kHz)     |            |     | 隔離式                  |     |     |  |
| 差模 (L1-L2)              |            |     | 2.5                  |     | kV  |  |
| 共模 (L1/L2-PE)           |            |     |                      |     |     |  |
| 差動突波 (1.2 / 50 $\mu$ s) |            |     | 500                  |     | V   |  |
| 功率因數                    |            |     | 0.96                 |     |     | 於 $V_{OUT(TYP)}$ 、 $I_{OUT(TYP)}$<br>及 120 VAC、60 Hz 條件下測量 |
| 諧波電流                    |            |     | EN 61000-3-2 D 級 (C) |     |     | C 級規範 P <sub>N</sub> 小於 25 W 時的 D 級<br>限值                  |
| 環境溫度                    | $T_{AMB}$  |     | 50                   |     | °C  | 自然對流，海平面   |





### 3 電路圖

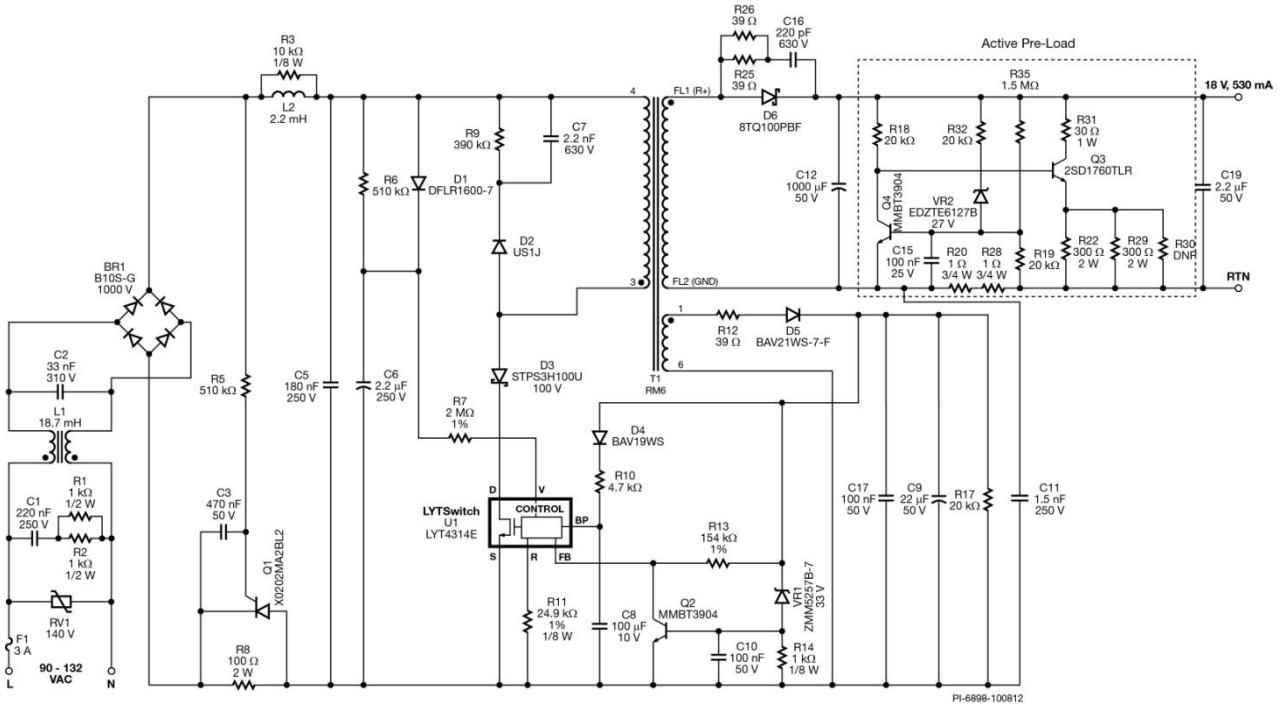


Figure 4 – Schematic with Optional Active Pre-load.

附註：

1. R30 並未安裝，因為它並不是調整調光曲線必須使用的電阻器。
2. 對具有成本考量的應用，且可接受 ~0.2% 的效率降低時，可將阻隔二極體 D3 換成快速整流器，如 ES2D。
3. 線電壓差動電壓突波量小於或等於 500 V 時，不需要 RV1。



## 4 電路說明

LYTSwitch 裝置是一種控制器，採用整合式 650 V 功率 MOSFET，用於 LED 驅動器應用。LYTSwitch 設定用於 Single-stage 返馳式結構，具備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。

### 4.1 輸入濾波功能

保險絲 F1 可防止元件發生故障。為防止線電壓高壓 (1.2  $\mu$ s / 50  $\mu$ s) 突波，已選用極高的電流額定值。LYTSwitch 的快斷型線電壓過壓偵測加上搭配使用 D1 和 C6 峰值偵測器電容器，可提供箝位以限制整合式功率 MOSFET 上的最大電壓應力。如果需要大於 500 V 線電壓高壓突波，可使用選用 MOV (金屬氧化物可變電阻) RV1。電阻 RV1 會提供箝位以限制線電壓高壓突波期間的最大電壓。建議使用 140 VAC 額定部分，其稍微高於指定的最大工作電壓 132 VAC。橋式整流器 BR1 可利用電容器 C5 對 AC 線電壓進行整流，來為一次側切換電流提供低阻抗路徑 (去耦合)。

EMI 濾波由電感器 L1和 L2，以及電容器 C2 和 C5 提供。L2 上的電阻器 R3 會抑制因濾波元件和 AC 線間阻抗而產生的 LC 任何 LC 諧振，否則會導致傳導性 EMI 測量增加。

### 4.2 LYTSwitch 一次側

變壓器 (T1) 的一端會連接到 DC 匯流排，而另一端會透過阻隔二極體 D3 連接到 LYTSwitch 裝置的汲極 (D) 接腳。電流會在功率 MOSFET 開啓期間逐漸增加一次側儲存能量，然後在功率 MOSFET 關閉期間傳輸至輸出。為符合設計的功率處理要求，所以選擇了 RM6S/I 鐵芯尺寸。

為了提供峰值線間電壓資訊給 U1，輸入整流 AC 峰值電壓會透過 D1 為 C6 充電。然後該電壓將以透過 R7 的電流形式饋送至 U1 的電壓監測器 (V) 接腳。電阻器 R6 為 C6 提供放電路徑，時間常數遠大於整流 AC 的時間常數，防止以線電壓頻率調變 V 接腳電流 (其會使功率因數降低)。

線電壓過壓關機功能可讓整流線電壓的承受度 (在突波和線間陡昇期間) 提高至內部功率 MOSFET 的 650 BV<sub>DSS</sub> 額定值。當 V 接腳電流超過 112  $\mu$ A 或約為 158 VAC 時，就會觸發線電壓過壓關機。

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。為改善線電壓負載調節，在參考接腳 (R11) 上使用了 24.9 k $\Omega$  電阻器，同時在 V 接腳上使用 2 M $\Omega$  (R7) 電阻，以便使輸入電壓和輸出電流之間形成線性關係。

在功率 MOSFET 關閉期間，由於漏電感的影響，D2、R9 及 C7 會將汲極電壓箝制在安全等級。需要使用二極體 D3，才能在 C5 上的電壓 (整流 AC 輸入) 低於輸出反射電壓 (設計試算表中的參數 V<sub>OR</sub>) 時防止反向電流流經 U1。為降低成本，可能選擇超快類型 (ES2D)，但效率會稍微 (0.3%) 降低。



二極體 D5、C9、R12 及 R17 會從變壓器上的輔助繞組產生一次側偏壓供電。電阻器 R12 提供濾波功能，以讓偏壓電壓可密切追蹤輸出電壓，以便 LED 電壓變更時維持恆定的輸出電流。電阻器 R17 會在輸出短路情況下防止 C9 峰值充電，以確保驅動器安全進入自動重新啓動。

電容器 C8 會為 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，會從汲極 (D) 接腳連接的內部高電壓電流源將 C8 充電至約 ~6 V。完成充電之後，U1 就可以在透過 R10 從偏壓供電元件提供操作供應電流時啓動切換。

建議使用外部偏壓供電 (透過 D4 和 R10) 以提供最低的裝置消耗功率，並在深度調光情況下，充裕供電給 U1。

電容器 C8 也可選取輸出功率模式，選取 100  $\mu$ F (降低的功率模式) 可讓裝置的消耗功率與散熱需求降至最低。

#### 4.3 回授

使用偏壓繞組電壓可間接感測輸出電壓，而不再需要二次側回授元件。偏壓繞組電壓與輸出電壓成正比 (由偏壓繞組和二次側繞組之間的圈數比設定)。電阻器 R13 會將偏壓電壓轉換成電流，再將該電流饋送至 U1 的 FB 接腳。U1 的內部引擎會結合 FB 接腳電流、V 接腳電流及內部汲極電流資訊，以便提供恆定的輸出電流，同時維持高輸入功率因數。

#### 4.4 輸出整流

變壓器二次側繞組由 D6 進行整流，由電容器 C12 和 C19 進行濾波。如果不需要主動預載，則應該將電容器 C19 換成 20 k $\Omega$  1206 smd 電阻器。

對於可接受更高漣波的設計，可以減少輸出電容值。

#### 4.5 斷開和短路保護

只要 FB 電流降至低於  $I_{FB(AR)}$  臨界值超過 ~76 ms，零件即進入自動重新啓動。

在開路 (斷開) 故障情況下，積納二極體 VR1 將會在電晶體 Q2 上執行啓動。電晶體 Q2 接著會降低 FB 接腳，以強制 IC 進入重新啓動模式。

輸出短路期間，輸出電壓會衰退，進而偏壓電壓也會衰退。這會使進入 FB 接腳的電流降至低於  $I_{FB(AR)}$ 。

一旦進入自動重新啓動，功率消耗將限制在額定輸出功率的 ~25%，以確保安全。當故障一移除，驅動器就會在目前自動重新啓動關閉期間 (~225 ms) 完成時恢復正常運作。

#### 4.6 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 的上升邊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，因此燈具所汲取的電流會低於調光器內 TRIAC 的吸持電流。這會引起不良狀況，例如燈具在調光器控制範圍結束之前關閉及/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浪湧電流而導致大幅振盪。這同樣會引起不良狀況，因為振盪可能導致 TRIAC 電流降至零。

爲了克服這些問題，加入了被動洩放器電路。這些電路的缺點是會增大功耗，進而降低電源供應器的效率。對於非調光應用，省略這些元件即可。

主動阻尼器由元件 R5、Q1、C3 及 R8 構成。此電路透過串聯 R8，可在 TRIAC 開啓時，於導通期間的第 1 ms 內限制對 C5 充電的浪湧電流。約 1 ms 後，Q1 會開啓，從而使 R8 短路。這樣可保持 R8 功耗較低，並允許使用較大的值，以實現更有效的電流限制效能。電阻器 R5 和 C3 會在 TRIAC 導通後提供 1 ms 延遲時間。選取以供 Q1 使用的 SCR 是 TO-92 封裝中的低電流、低成本裝置。可選用放置電阻器 R36 (典型值 10 – 22  $\Omega$ ) 與 R8 串聯，以進一步箝制 TRIAC，額定在 1000 W。

被動洩放器電路包含 C1 以及 R1 和 R2 的並聯組合。此電路可在每個 AC 半週期內驅動器的輸入電流增大時，保持輸入電流高於 TRIAC 的吸持電流，防止 TRIAC 切換在每個導通角期間開始 (和結束) 時震盪。

#### 4.6.1 主動預載電路

增加主動預載電路以延伸調光範圍能力，並在 TRIAC 調光期間提供額外的負載，這可以增加相容調光器機型的數量。

電阻器 R20 和 R28 會感測輸出電流。如果輸出電流谷值降至低於 ~200 mA，電晶體 Q4 會關閉，電晶體 Q3 則開啓，以降低流入 LED 的輸出電流。這樣的配置可在 30 V<sub>RMS</sub> 輸入 (輸入電壓銳減) 下，提供 ~1% (滿載) 的輸出電流給 LED 驅動器。在最低輸出電流 (漣波谷值) 200 mA 下，主動預載電路會解除耦合，以防止效率降低。電阻器 R22、R29 和 R31 會設定流入預載電路的最大電流，藉此可用於調整所需的調光曲線。積納二極體 VR2 和 R32 也會用在開路情況下停用主動預載。電阻器 R22、R29 和 R31 的溫升可能很明顯，在最終產品時應該加以驗證。這些元件也可以安裝到 LED 散熱片，因為功率消耗只會在小於滿載 LED 電流的 50% 時發生。



### 5 PCB 佈局

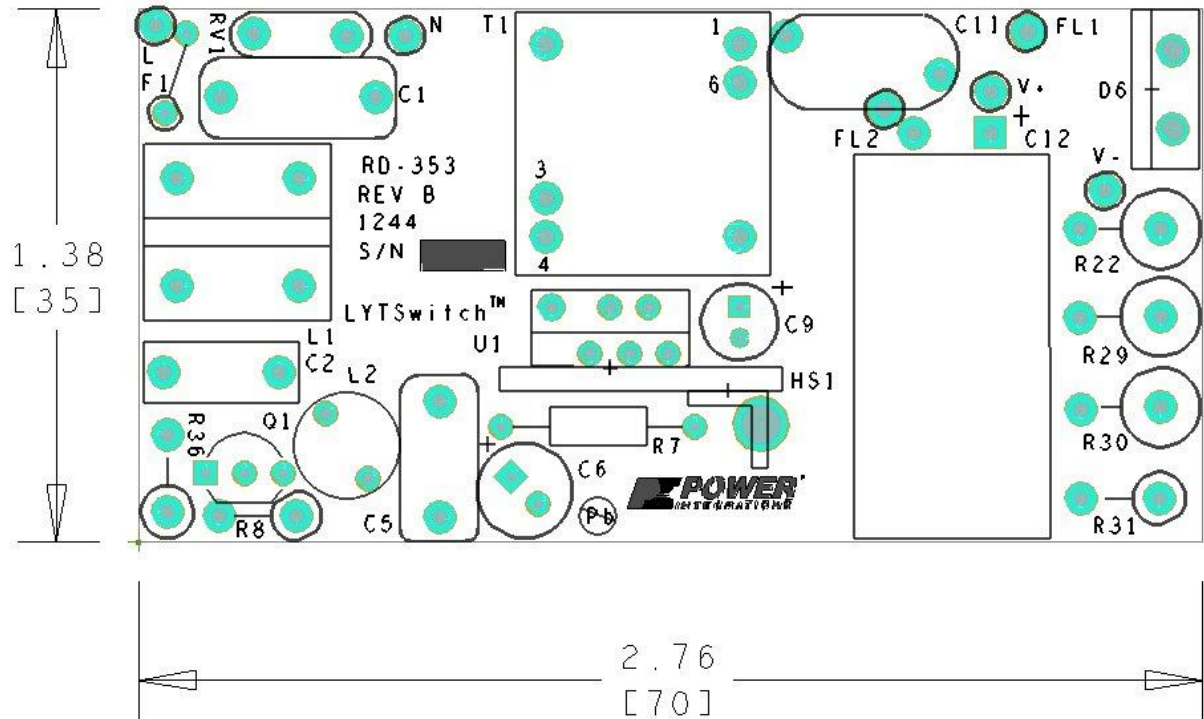


Figure 5 – Top Side.

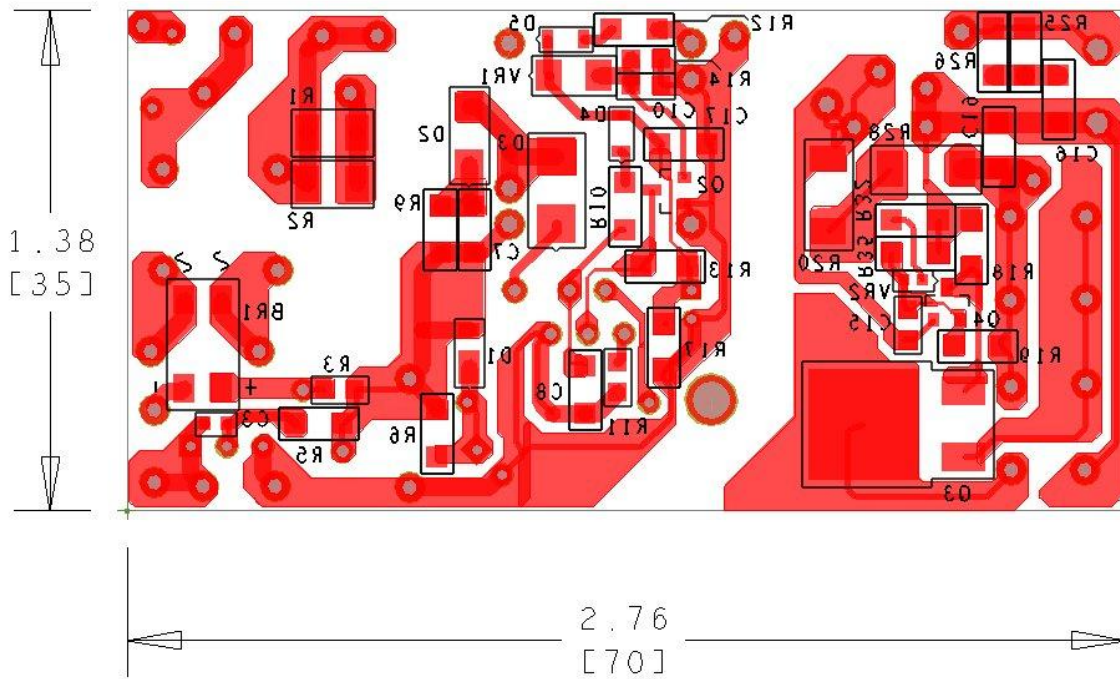


Figure 6 – Bottom Side.



## 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            |
| 2    | 1   | C1                 | 220 nF, 250 V, Film  | ECQ-E2224KF        | Panasonic          |
| 3    | 1   | C2                 | 33 nF, 310 VAC, Polyester Film, X2                                   | BFC233920333       | Vishay             |
| 4    | 1   | C3                 | 470 nF, 50 V, Ceramic, Y5G, 0603                                     | C1608Y5V1H474Z     | TDK                |
| 5    | 1   | C5                 | 180 nF, 250 V, Film  | ECQ-E2184KB        | Panasonic          |
| 6    | 1   | C6                 | 2.2 $\mu$ F, 250 V, Electrolytic, (6.3 x 11)                         | 225CKH250M         | Illinois Capacitor |
| 7    | 1   | C7                 | 2.2 nF, 630 V, Ceramic, X7R, 1206                                    | ECJ-3FBJ222K       | Panasonic          |
| 8    | 1   | C8                 | 100 $\mu$ F, 10 V, X5R, 1206   | C3216X5R1A107M     | TDK                |
| 9    | 1   | C9                 | 22 $\mu$ F, 50 V, Electrolytic, Low ESR, 900 m $\Omega$ , (5 x 11.5) | ELXZ500ELL220MEB5D | Nippon Chemi-Con   |
| 10   | 1   | C10                | 100 nF, 50 V, Ceramic, X7R, 0805                                     | CC0805KRX7R9BB104  | Yageo              |
| 11   | 1   | C11                | 1.5 nF, Ceramic, Y1  | 440LD15-R          | Vishay             |
| 12   | 1   | C12                | 1000 $\mu$ F, 50 V, Electrolytic, Gen. Purpose, (12.5 x 25)          | EKMG500ELL102MK25S | Nippon Chemi-Con   |
| 13   | 1   | C15                | 100 nF, 25 V, Ceramic, X7R, 0805                                     | 08053C104KAT2A     | AVX                |
| 14   | 1   | C16                | 220 pF, 630 V, Ceramic, NPO, 1206                                    | C3216C0G2J221J     | TDK                |
| 15   | 1   | C17                | 100 nF, 50 V, Ceramic, X7R, 1206                                     | GRM319R71H104KA01D | Murata             |
| 16   | 1   | C19                | 2.2 $\mu$ F, 50 V, Ceramic, Y5V, 1206                                | GRM31MF51H225ZA01L | Murata             |
| 17   | 1   | D1                 | 600 V, 1 A, Rectifier, Glass Passivated, POWERDI123                  | DFLR1600-7         | Diodes, Inc.       |
| 18   | 1   | D2                 | Diode Ultrafast, SW 600 V, 1 A, SMA                                  | US1J-13-F          | Diodes, Inc.       |
| 19   | 1   | D3                 | 100 V, 3 A, Schottky, DO-214AA                                       | STPS3H100U         | ST Micro           |
| 20   | 1   | D4                 | 100 V, 0.2 A, Fast Switching, 50 ns, SOD-323                         | BAV19WS-7-F        | Diodes, Inc.       |
| 21   | 1   | D5                 | 250 V, 0.2 A, Fast Switching, 50 ns, SOD-323                         | BAV21WS-7-F        | Diodes, Inc.       |
| 22   | 1   | D6                 | 100 V, 8 A, Schottky, TO-220AC                                       | 8TQ100PBF          | Vishay             |
| 23   | 1   | F1                 | 3 A, 125 V, Fast, Microfuse, Axial                                   | MQ3                | BelFuse            |
| 24   | 1   | L1                 | 18.7 mH, 0.22 A, Common Mode Choke                                   | RL-4400-1-18.7     | Renco              |
| 25   | 1   | L2                 | 2.2 mH, 0.19 A, Ferrite Core   | CTCH895F-222K      | CT Parts           |
| 26   | 1   | Q1                 | SCR, 600 V, 1.25 A, TO-92  | X0202MA 2BL2       | ST Micro           |
| 27   | 2   | Q2 Q4              | NPN, Small Signal BJT, 40 V, 0.2 A, SOT-23                           | MMBT3904LT1G       | On Semir           |
| 28   | 1   | Q3                 | NPN, Power BJT, 400 V, 2 A, SOT-428                                  | 2SD1760TLR         | Rohm Semi          |
| 29   | 2   | R1 R2              | 1 k $\Omega$ , 5%, 1/2 W, Thick Film, 1210                           | ERJ-14YJ102U       | Panasonic          |
| 30   | 1   | R3                 | 10 k $\Omega$ , 5%, 1/8 W, Thick Film, 0805                          | ERJ-6GEYJ103V      | Panasonic          |
| 31   | 2   | R5 R6              | 510 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ514V      | Panasonic          |
| 32   | 1   | R7                 | 2.00 M $\Omega$ , 1%, 1/4 W, Metal Film                              | RNF14FTD2M00       | Stackpole          |
| 33   | 1   | R8                 | 100 $\Omega$ , 5%, 2 W, Metal Oxide                                  | RSMF2JT100R        | Stackpole          |
| 34   | 1   | R9                 | 390 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ394V      | Panasonic          |
| 35   | 1   | R10                | 4.7 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ472V      | Panasonic          |
| 36   | 1   | R11                | 24.9 k $\Omega$ , 1%, 1/8 W, Thick Film, 0805                        | ERJ-6ENF2492V      | Panasonic          |
| 37   | 3   | R12 R25<br>R26     | 39 $\Omega$ , 5%, 1/4 W, Thick Film, 1206                            | ERJ-8GEYJ390V      | Panasonic          |
| 38   | 1   | R13                | 154 k $\Omega$ , 1%, 1/4 W, Thick Film, 1206                         | ERJ-8ENF1543V      | Panasonic          |
| 39   | 1   | R14                | 1 k $\Omega$ , 5%, 1/8 W, Thick Film, 0805                           | ERJ-6GEYJ102V      | Panasonic          |
| 40   | 4   | R17 R18<br>R19 R32 | 20 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                          | ERJ-8GEYJ203V      | Panasonic          |
| 41   | 2   | R20 R28            | 1 $\Omega$ , 5%, 3/4 W, Thick Film, 2010                             | ERJ-12ZYJ1R0U      | Panasonic          |
| 42   | 2   | R22 R29            | 300 $\Omega$ , 5%, 2 W, Metal Oxide                                  | RSF200JB-300R      | Yageo              |
| 43   | 1   | R31                | 30 $\Omega$ , 5%, 1 W, Metal Oxide                                   | RSF100JB-30R       | Yageo              |
| 44   | 1   | R35                | 1.5 M $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ155V      | Panasonic          |
| 45   | 1   | R36                | 0 $\Omega$ , 1/4 W, Metal Oxide                                      | Z0R-25-R-52-0R     | Yageo              |



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|    |   |     |  |                              |                         |
|----|---|-----|--|------------------------------|-------------------------|
| 46 | 1 | RV1 | 140 V, 12 J, 7 mm, RADIAL                    | V140LA2P                     | Littlefuse              |
| 47 | 1 | T1  | Bobbin, RM6, Vertical, 6 pins<br>Transformer | B65808-N1006-D1<br>SNX-R1662 | Epcos<br>Santronics USA |
| 48 | 1 | U1  | LYTSwitch, eSIP-7C                           | LYT4314E                     | Power Integrations      |
| 49 | 1 | VR1 | 33 V, 5%, 500 mW, DO-213AA (MiniMELF)        | ZMM5257BDICT-ND              | Diodes, Inc.            |
| 50 | 1 | VR2 | 27 V, 5%, 150 mW, SOD 523                    | EDZTE6127B                   | Rohm Semi               |





## 7 變壓器規格

### 7.1 電氣圖

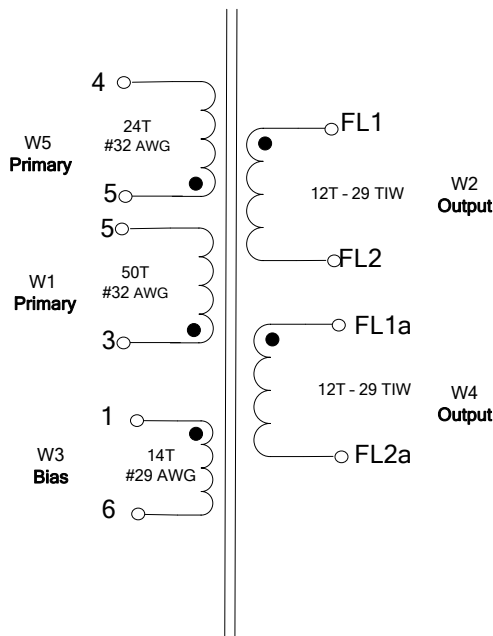


Figure 7 – Transformer Electrical Diagram.

### 7.2 電氣規格

|                                   |  |                 |
|-----------------------------------|--|-----------------|
| <b>Electrical Strength</b>        | 1 second, 60 Hz, from pins 1, 3, 4, 6 to FL1, FL2.                             | 3000 VAC        |
| <b>Primary Inductance</b>         | Pins 3-4, all other windings open, measured at 100 kHz, 0.4 V <sub>RMS</sub> . | 1.4 mH ±5%      |
| <b>Resonant Frequency</b>         | Pins 3-4, all other windings open.   | 1000 kHz (Min.) |
| <b>Primary Leakage Inductance</b> | Pins 3-4, with FL1-FL2 shorted, measured at 100 kHz, 0.4 V <sub>RMS</sub> .    | 15 nH max       |

### 7.3 材料

| Item | Description   |
|------|---|
| [1]  | Core: RM6S/I 3F3.   |
| [2]  | B-RM6-V 6 pins (3/3) or equivalent.<br>With mounting clip, CLI/P-RM6. |
| [3]  | Tape, Polyester film, 3M 1350F-1 or equivalent, 6.4 mm wide.          |
| [4]  | Wire: Magnet, #32 AWG, solderable double coated.                      |
| [5]  | Wire: Magnet, #29 AWG, solderable double coated.                      |
| [6]  | Wire, Triple Insulated, Furukawa TEX-E or Equivalent, #29 TIW.        |
| [7]  | Transformer Varnish, Dolph BC-359 or equivalent.                      |



7.4 變壓器構圖

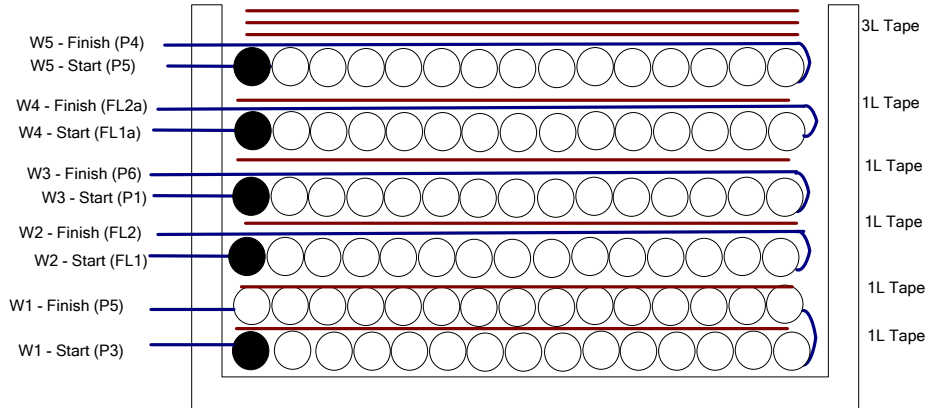


Figure 8 – Transformer Build Diagram.

7.5 變壓器結構

|                           |   |
|---------------------------|---|
| <b>Bobbin Preparation</b> | Place the bobbin item [2] on the mandrel such that pin side on the left side. Winding direction is the clockwise direction.   |
| <b>WDG 1 (Primary)</b>    | Starting at pin 3, wind 50 turns of wire item [4] in two layers. Apply one layer of tape item [3] between 1 <sup>st</sup> and 2 <sup>nd</sup> layer. Finish at pin 5.   |
| <b>Insulation</b>         | Apply one layer of tape item [3].   |
| <b>WDG 2 (Secondary)</b>  | Starting at pin 1 side of the bobbin, leave about 1" of wire item [6], use small tape to mark as FL1, wind 12 turns in one layer. At the last turn exit the same slot, leave about 0.75", and mark as FL2.  |
| <b>Insulation</b>         | Apply one layer of tape item [3].   |
| <b>WDG 3 (Bias)</b>       | Starting at pin 1, wind 14 turns of wire item [5], spreading the wire, and finish at pin 6.   |
| <b>Insulation</b>         | Apply one layer of tape item [3].   |
| <b>WDG 2 (Secondary)</b>  | Starting at pin 1 side of the bobbin, leave about 1" of wire item [6], use small tape to mark as FL1a, wind 12 turns in one layer. At the last turn exit the same slot, leave about 0.75", and mark as FL2a. Twist FL1a with FL1 and FL2a with FL2. |
| <b>WDG 3 (Primary)</b>    | Starting at pin 5, wind 24 turns of wire item [4] in one layer. Finish at pin 4.  |
| <b>Finish Wrap</b>        | Apply three layers of tape item [3] for finish wrap.  |
| <b>Final Assembly</b>     | Cut pin 2 and pin 5. Grind core to get 1.4 mH inductance. Assemble and secure core halves. Dip impregnate using varnish item [7].   |

## 8 U1 散熱片

### 8.1 U1 散熱片製造圖

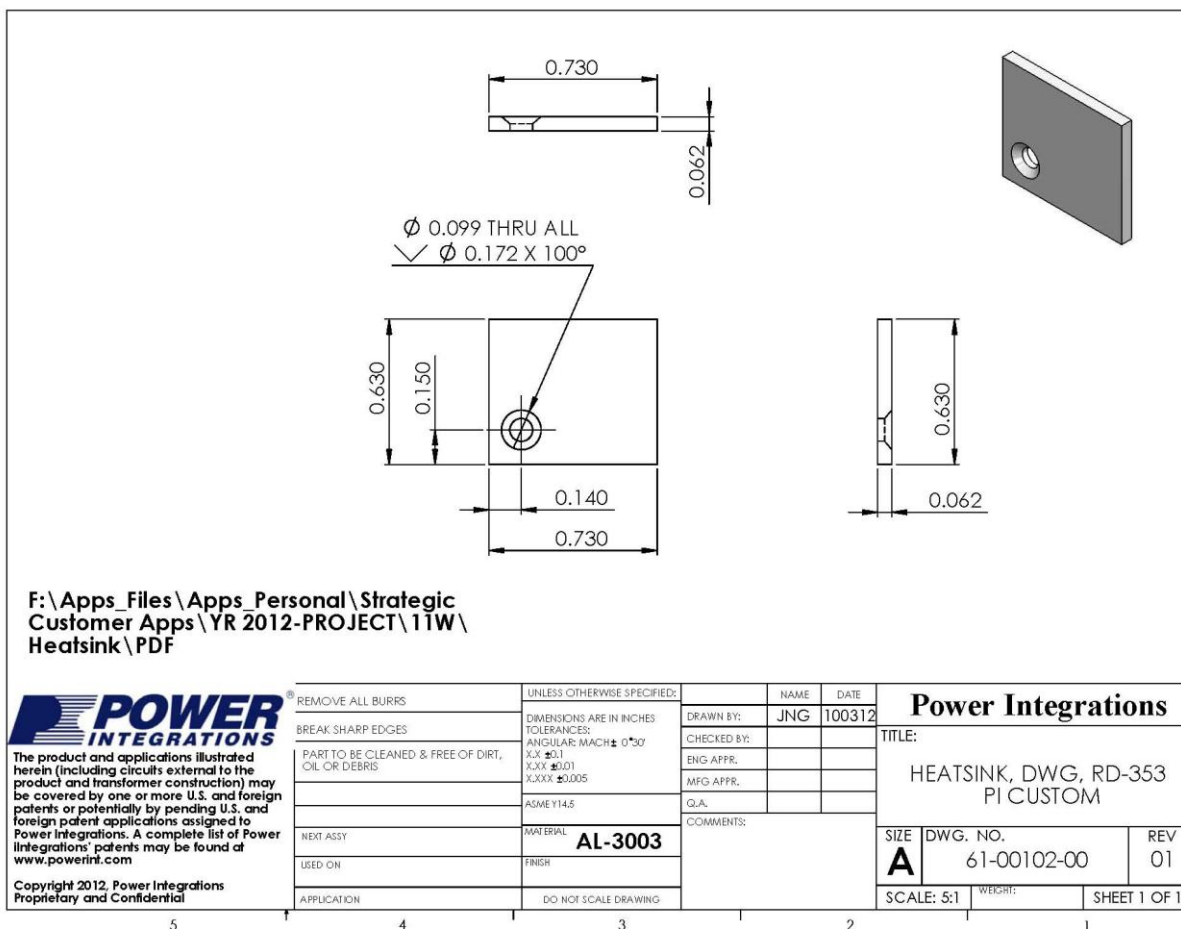


Figure 9 – Heat Sink Dimensions.



8.2 U1 散熱片組裝圖

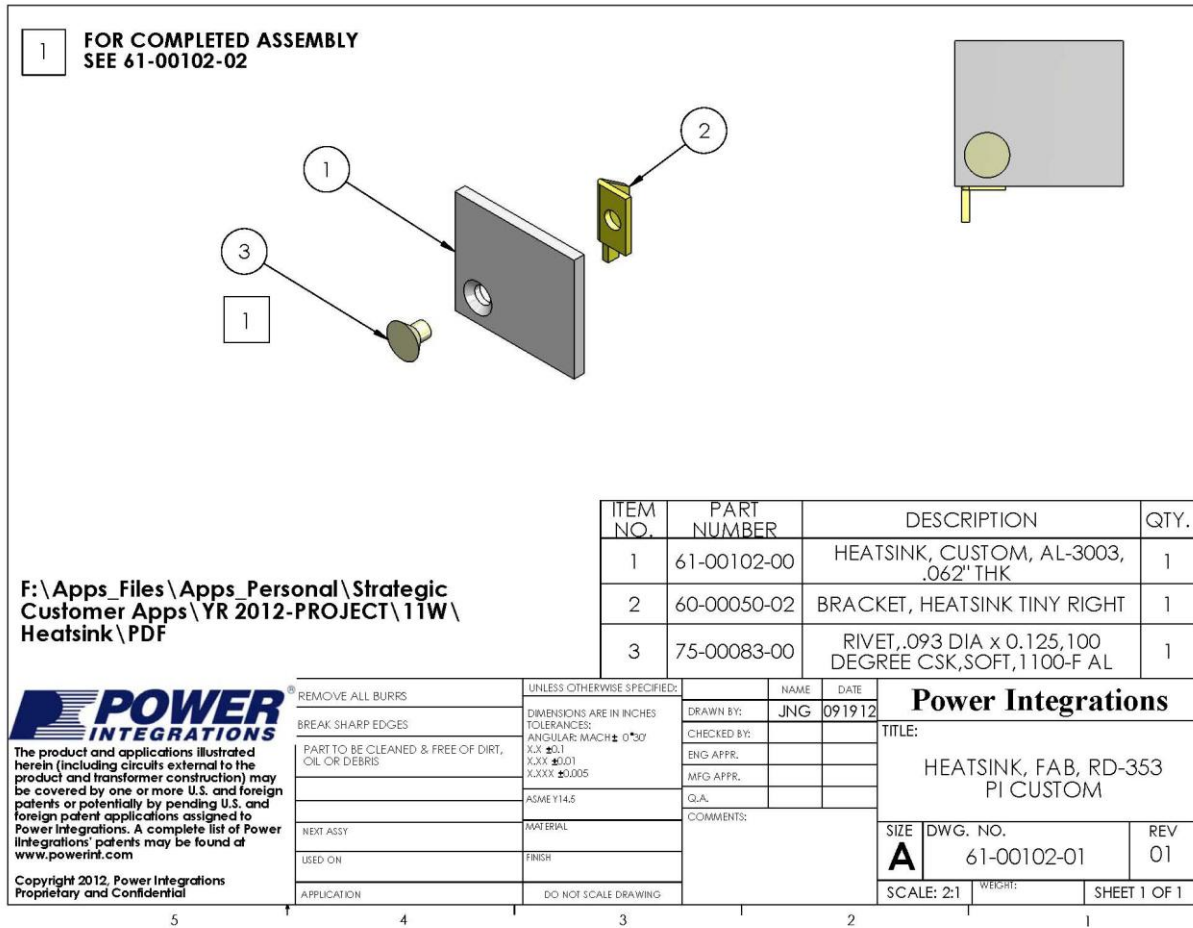


Figure 9a – U1 Heat Sink Assembly Drawing.

8.3 U1 和散熱片組裝圖

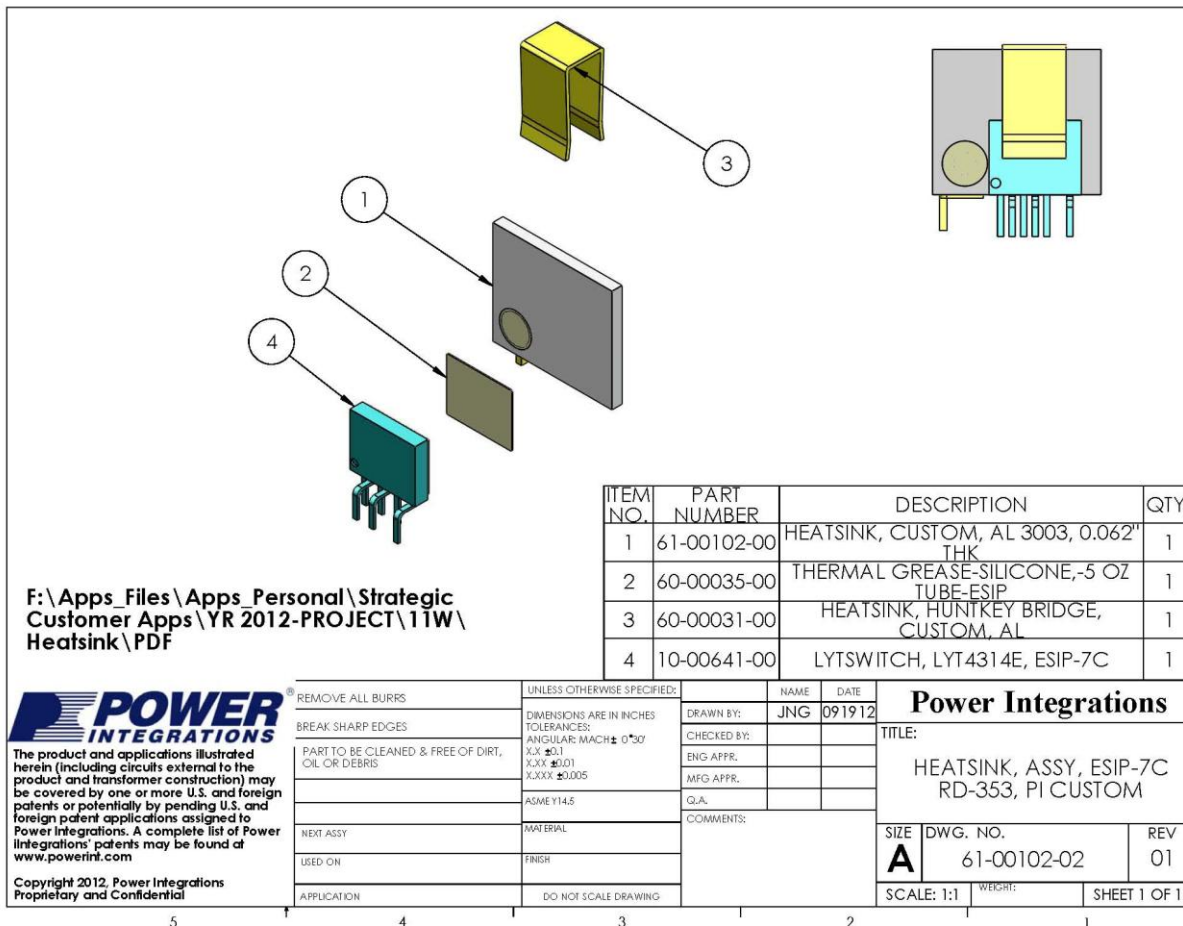


Figure 10 – U1 and Heat Sink Assembly Drawing.



## 9 效能資料

All measurements performed at room temperature using an LED load. The following data were measured using 3 sets of loads to represent a voltage of 15 V ~ 21 V. The table in Section 9.6 shows complete test data values.

### 9.1 效率

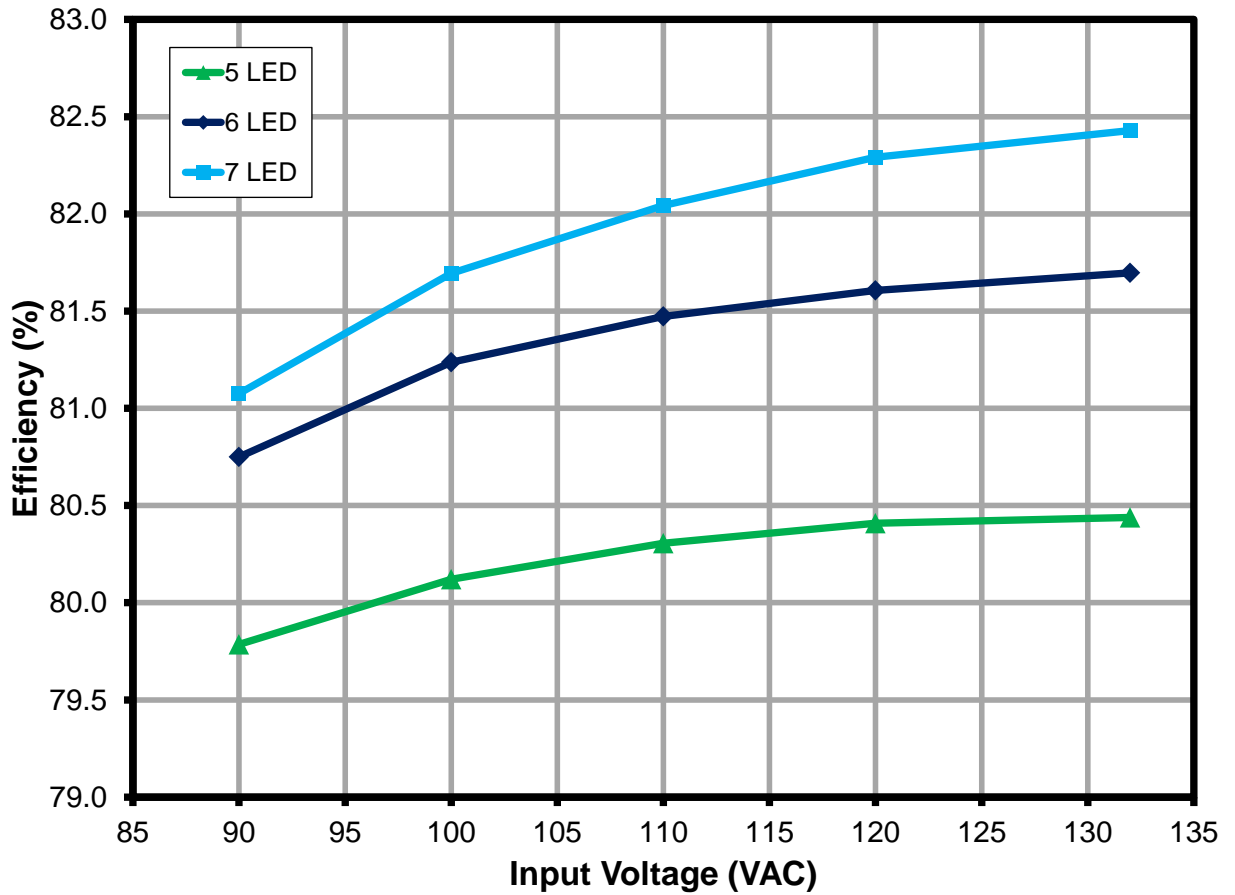


Figure 11 – Efficiency vs. Line and Load.



9.2 線電壓與負載穩定度關係圖

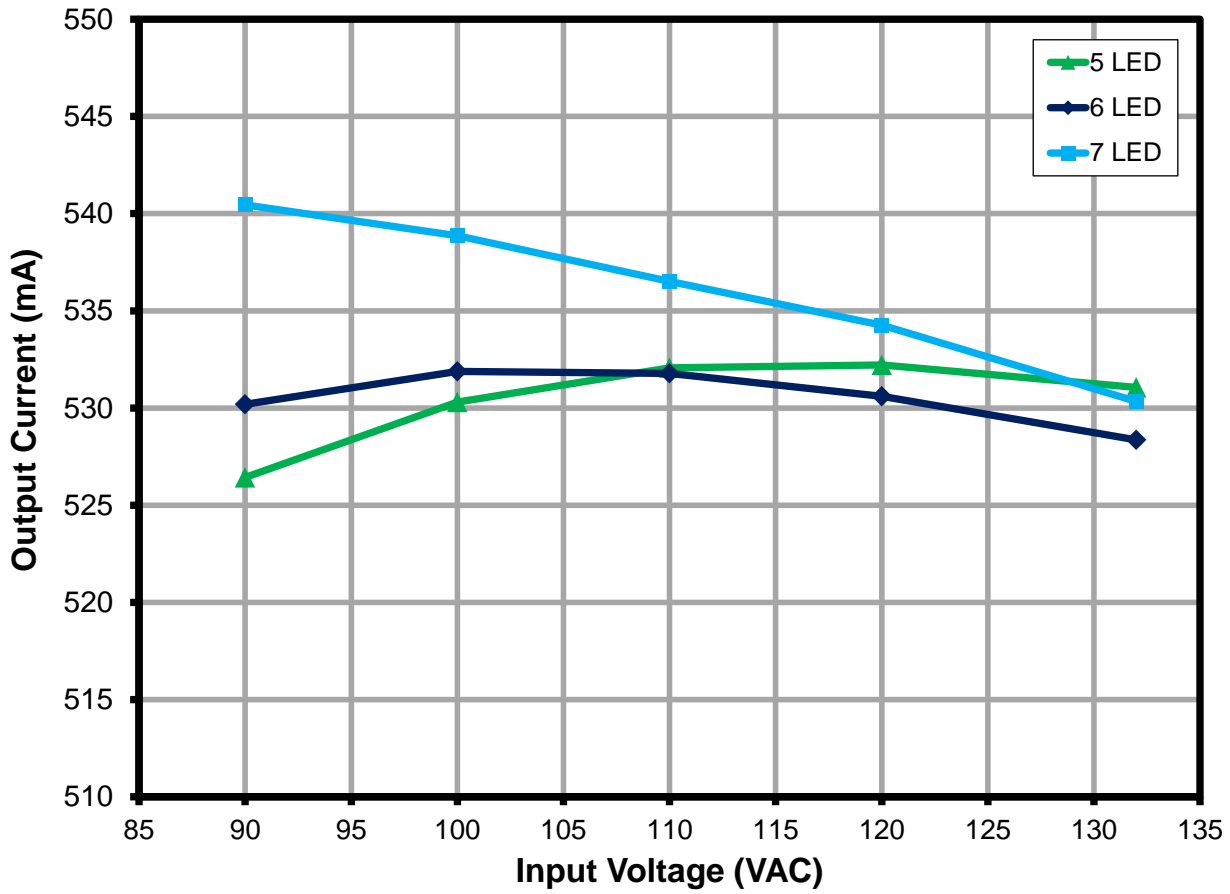


Figure 12 – Regulation vs. Line and Load.





9.3 功率因數

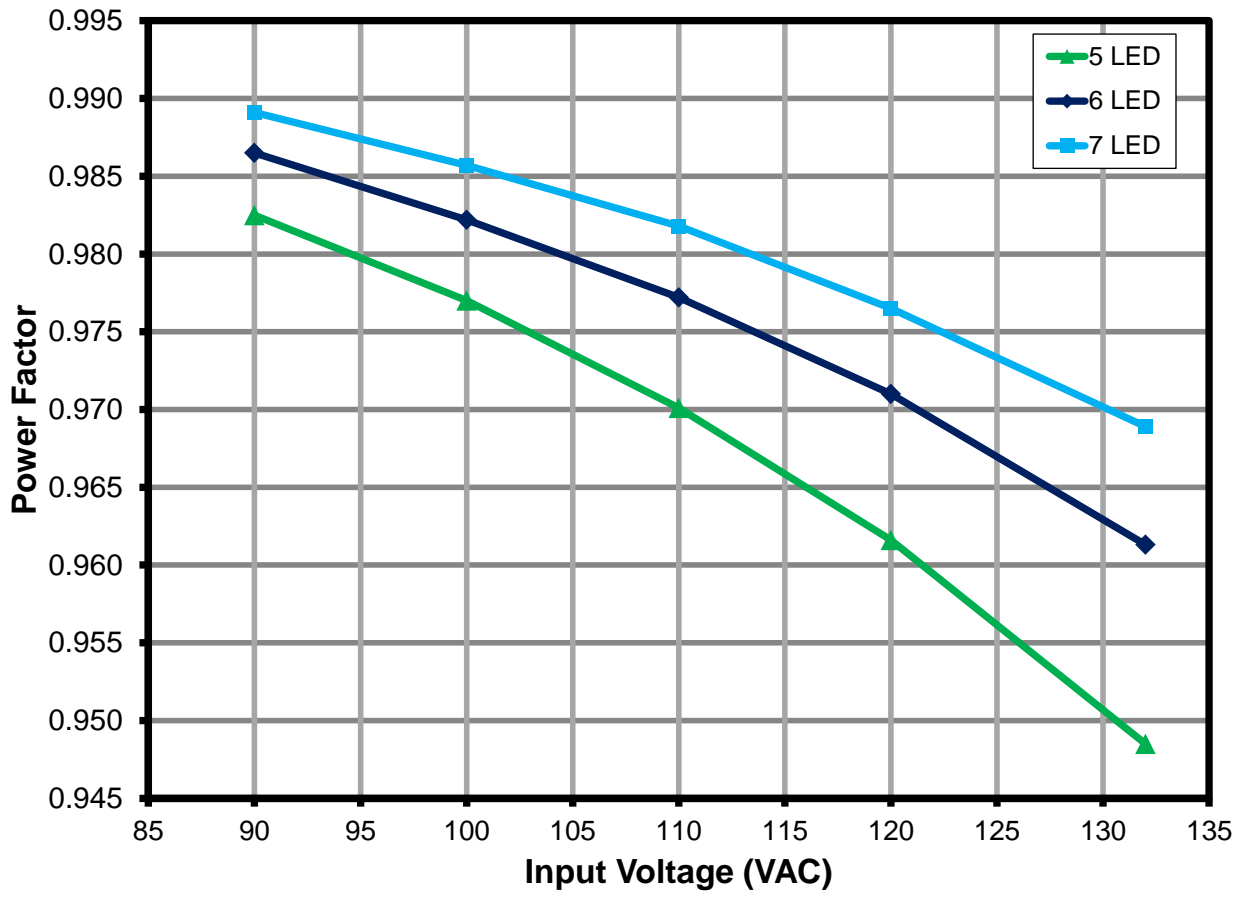


Figure 13 – Power Factor vs. Line and Load.

9.4 A-THD

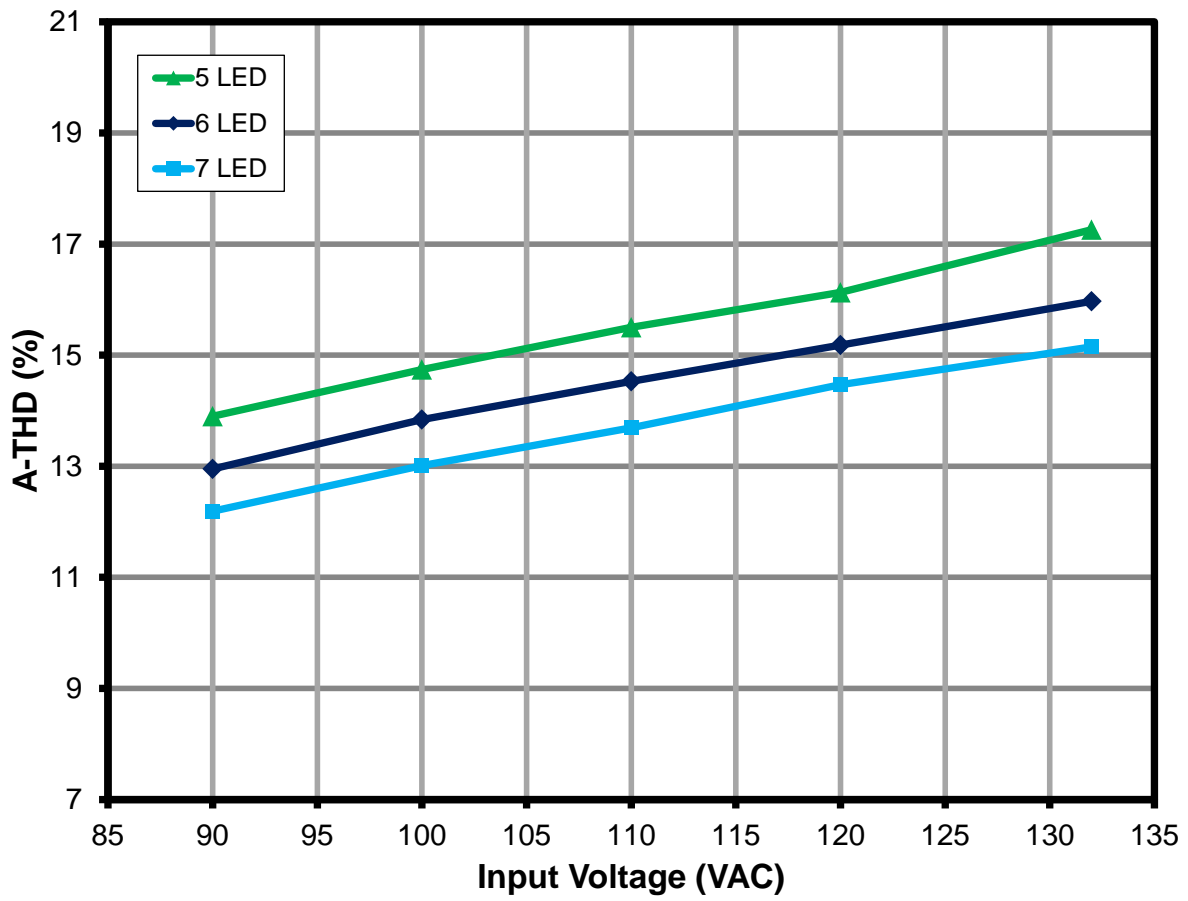


Figure 14 – A-THD vs. Line and Load.



### 9.5 諧波電流

The design met the IEC61000-3-2 Limits for Class C equipment (section 7.3-b) for an Active input power of  $\leq 25$  W, which states that the harmonic currents shall not exceed the power –related limits of Table 3, column 2 for the Limits for Class D equipment.

#### 9.5.1 15 V LED 負載

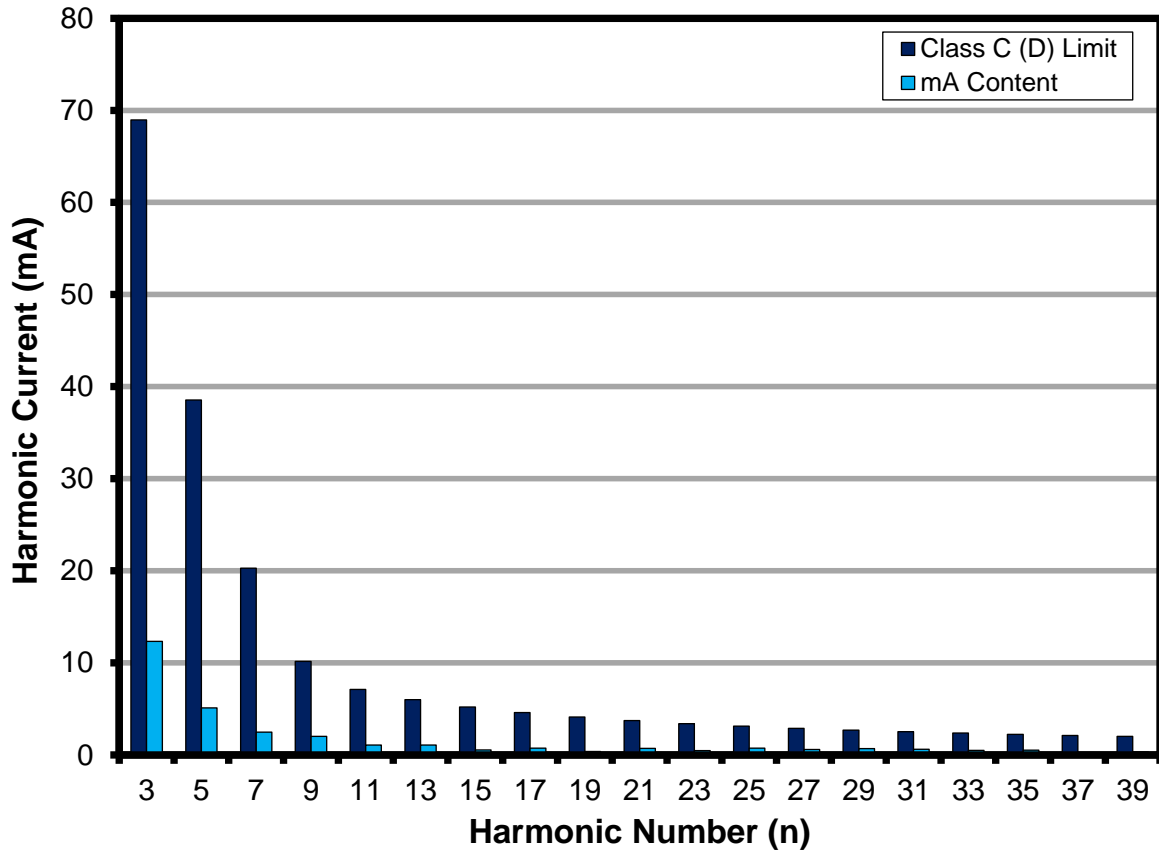


Figure 15 – 15 V LED Load Input Current Harmonics case (IEC61000-3-2) at 120 VAC, 60 Hz.

9.5.3 18 V LED 負載

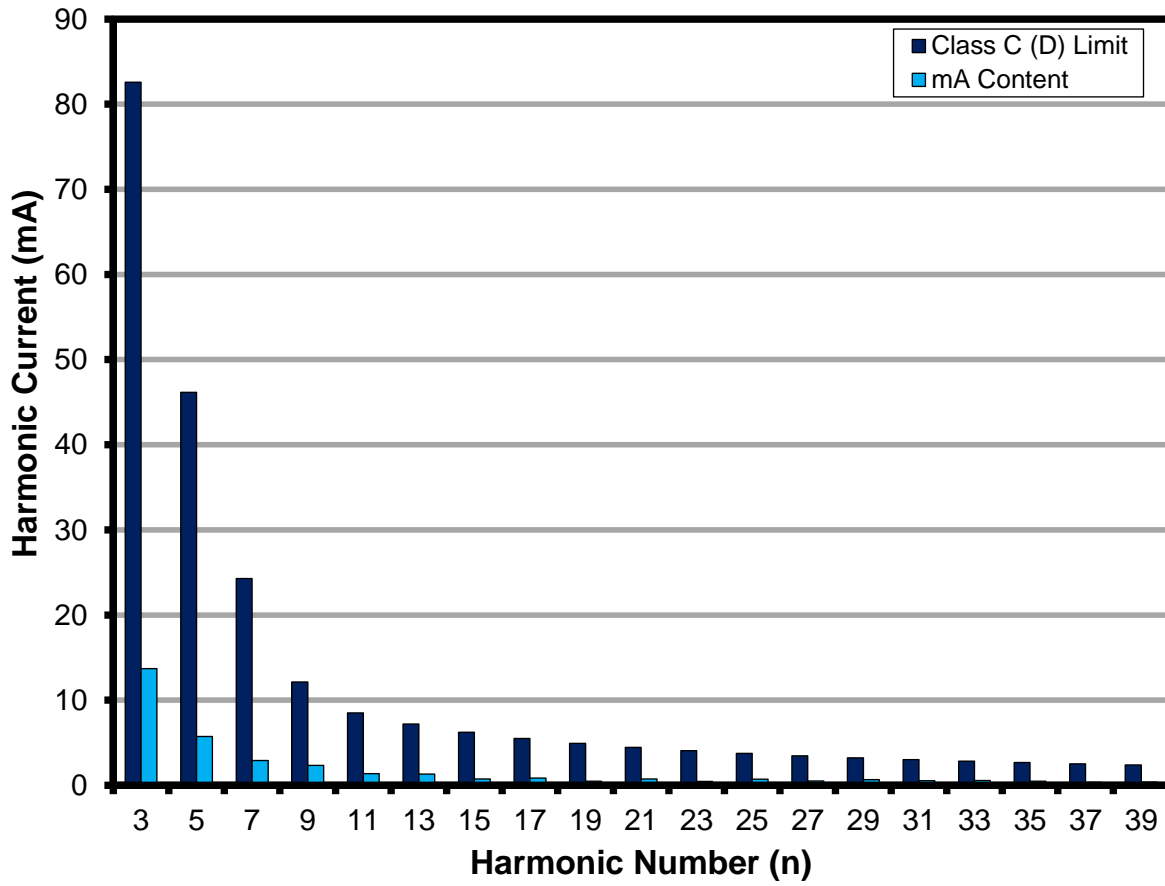


Figure 16 – 18 V LED Load Input Current Harmonics (IEC61000-3-2) at 120 VAC, 60 Hz.



9.5.4 21 V LED 負載

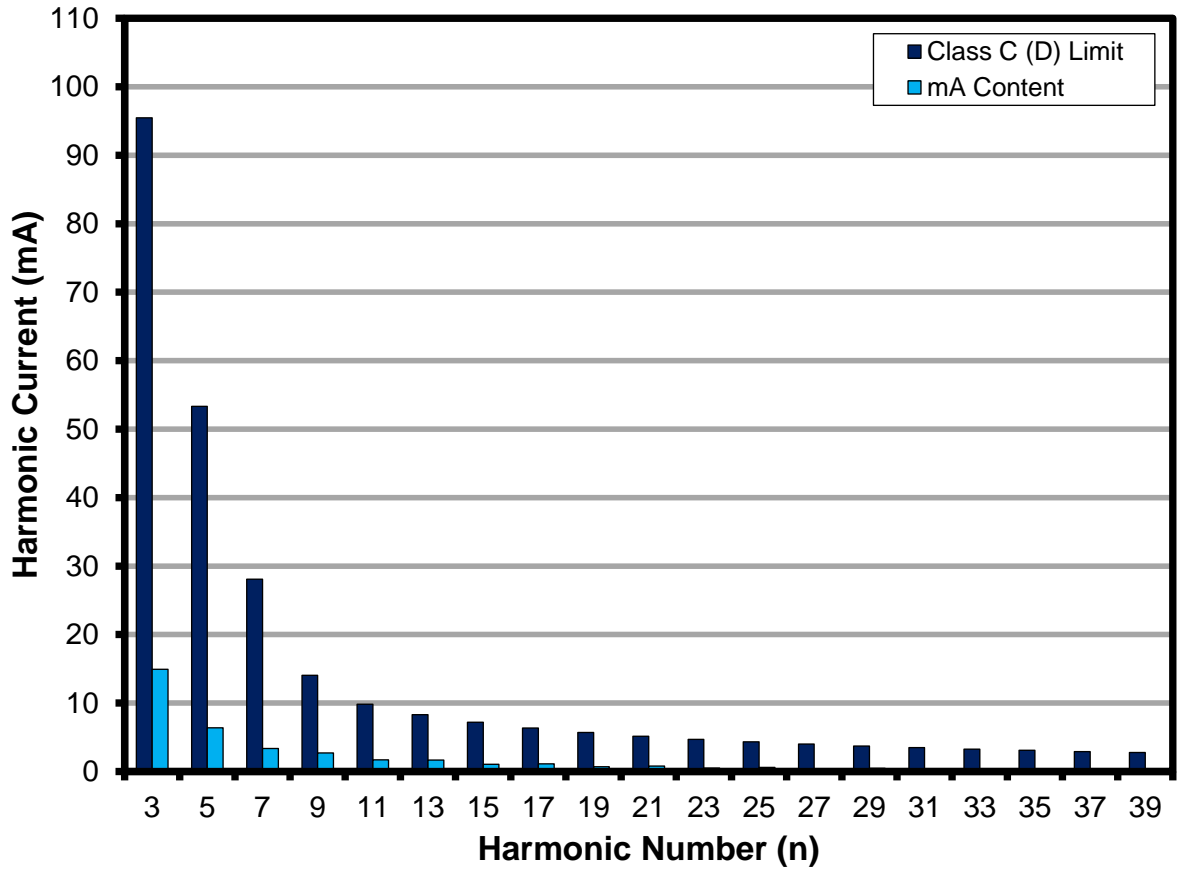


Figure 17 – 21 V LED Load Input Current Harmonics (IEC61000-3-2) at 120 VAC, 60 Hz.



## 9.6 測試資料

All measurements were taken with the board at open frame, 25 °C ambient, and 60 Hz line frequency.

### 9.6.1 測試資料，15 V LED 負載

| Input Measurement                      |   |                        |       |       | Load Measurement                       |   |                         | Calculation             |                   |             |
|--|---|------------------------|-------|-------|--|---|-------------------------|-------------------------|-------------------|-------------|
| V <sub>IN</sub><br>(V <sub>RMS</sub> ) | I <sub>IN</sub><br>(mA <sub>RMS</sub> ) | P <sub>IN</sub><br>(W) | PF    | %ATHD | V <sub>OUT</sub><br>(V <sub>DC</sub> ) | I <sub>OUT</sub><br>(mA <sub>DC</sub> ) | P <sub>OUT</sub><br>(W) | P <sub>CAL</sub><br>(W) | Efficiency<br>(%) | Loss<br>(W) |
| 90.05                                  | 114.25                                  | 10.109                 | 0.983 | 13.90 | 15.27                                  | 526.43                                  | 8.07                    | 8.04                    | 79.79             | 2.04        |
| 100.02                                 | 103.80                                  | 10.144                 | 0.977 | 14.74 | 15.28                                  | 530.30                                  | 8.13                    | 8.10                    | 80.12             | 2.02        |
| 110.08                                 | 95.09                                   | 10.155                 | 0.970 | 15.5  | 15.28                                  | 532.07                                  | 8.16                    | 8.13                    | 80.31             | 2.00        |
| 120.05                                 | 87.86                                   | 10.143                 | 0.962 | 16.13 | 15.28                                  | 532.21                                  | 8.16                    | 8.13                    | 80.41             | 1.99        |
| 132.08                                 | 80.73                                   | 10.114                 | 0.949 | 17.26 | 15.28                                  | 531.06                                  | 8.14                    | 8.11                    | 80.44             | 1.98        |

### 9.6.2 測試資料，18 V LED 負載

| Input Measurement                      |   |                        |       |       | Load Measurement                       |   |                         | Calculation             |                   |             |
|--|---|------------------------|-------|-------|--|---|-------------------------|-------------------------|-------------------|-------------|
| V <sub>IN</sub><br>(V <sub>RMS</sub> ) | I <sub>IN</sub><br>(mA <sub>RMS</sub> ) | P <sub>IN</sub><br>(W) | PF    | %ATHD | V <sub>OUT</sub><br>(V <sub>DC</sub> ) | I <sub>OUT</sub><br>(mA <sub>DC</sub> ) | P <sub>OUT</sub><br>(W) | P <sub>CAL</sub><br>(W) | Efficiency<br>(%) | Loss<br>(W) |
| 90.05                                  | 138.29                                  | 12.285                 | 0.987 | 12.95 | 18.66                                  | 530.19                                  | 9.92                    | 9.90                    | 80.75             | 2.36        |
| 100.02                                 | 124.65                                  | 12.245                 | 0.982 | 13.84 | 18.66                                  | 531.88                                  | 9.95                    | 9.92                    | 81.24             | 2.30        |
| 110.07                                 | 113.40                                  | 12.199                 | 0.977 | 14.53 | 18.65                                  | 531.78                                  | 9.94                    | 9.92                    | 81.47             | 2.26        |
| 120.05                                 | 104.18                                  | 12.144                 | 0.971 | 15.18 | 18.63                                  | 530.60                                  | 9.91                    | 9.89                    | 81.61             | 2.23        |
| 132.08                                 | 95.06                                   | 12.070                 | 0.961 | 15.97 | 18.62                                  | 528.36                                  | 9.86                    | 9.84                    | 81.70             | 2.21        |

### 9.6.3 測試資料，21 V LED 負載

| Input Measurement                      |   |                        |       |       | Load Measurement                       |   |                         | Calculation             |                   |             |
|--|---|------------------------|-------|-------|--|---|-------------------------|-------------------------|-------------------|-------------|
| V <sub>IN</sub><br>(V <sub>RMS</sub> ) | I <sub>IN</sub><br>(mA <sub>RMS</sub> ) | P <sub>IN</sub><br>(W) | PF    | %ATHD | V <sub>OUT</sub><br>(V <sub>DC</sub> ) | I <sub>OUT</sub><br>(mA <sub>DC</sub> ) | P <sub>OUT</sub><br>(W) | P <sub>CAL</sub><br>(W) | Efficiency<br>(%) | Loss<br>(W) |
| 90.04                                  | 162.22                                  | 14.447                 | 0.989 | 12.19 | 21.63                                  | 540.45                                  | 11.71                   | 11.69                   | 81.08             | 2.73        |
| 100.01                                 | 144.90                                  | 14.285                 | 0.986 | 13.01 | 21.61                                  | 538.86                                  | 11.67                   | 11.65                   | 81.69             | 2.62        |
| 110.07                                 | 130.95                                  | 14.151                 | 0.982 | 13.69 | 21.60                                  | 536.52                                  | 11.61                   | 11.59                   | 82.04             | 2.54        |
| 120.04                                 | 119.76                                  | 14.038                 | 0.977 | 14.47 | 21.58                                  | 534.26                                  | 11.55                   | 11.53                   | 82.29             | 2.49        |
| 132.07                                 | 108.61                                  | 13.898                 | 0.969 | 15.15 | 21.56                                  | 530.34                                  | 11.46                   | 11.43                   | 82.43             | 2.44        |



## 9.6.4 120 VAC 60 Hz , 15 V LED 負載諧波資料

## Current Harmonics Limits for IEC61000-3-2

| V         | Freq       | I (mA)    | P           | PF          | %THD    |
|-----------|------------|-----------|-------------|-------------|---------|
| 120       | 60.00      | 87.86     | 10.1430     | 0.9616      | 16.13   |
|           |            |           |             |             |         |
| nth Order | mA Content | % Content | Limit <25 W | Limit >25 W | Remarks |
| 1         | 86.63      |           |             |             |         |
| 2         | 0.02       | 0.02%     |             | 2.00%       |         |
| 3         | 12.32      | 14.22%    | 68.9724     | 28.85%      | Pass    |
| 5         | 5.11       | 5.90%     | 38.5434     | 10.00%      | Pass    |
| 7         | 2.46       | 2.84%     | 20.2860     | 7.00%       | Pass    |
| 9         | 2.00       | 2.31%     | 10.1430     | 5.00%       | Pass    |
| 11        | 1.08       | 1.25%     | 7.1001      | 3.00%       | Pass    |
| 13        | 1.08       | 1.25%     | 6.0078      | 3.00%       | Pass    |
| 15        | 0.54       | 0.62%     | 5.2067      | 3.00%       | Pass    |
| 17        | 0.73       | 0.84%     | 4.5942      | 3.00%       | Pass    |
| 19        | 0.38       | 0.44%     | 4.1106      | 3.00%       | Pass    |
| 21        | 0.71       | 0.82%     | 3.7191      | 3.00%       | Pass    |
| 23        | 0.47       | 0.54%     | 3.3957      | 3.00%       | Pass    |
| 25        | 0.74       | 0.85%     | 3.1240      | 3.00%       | Pass    |
| 27        | 0.58       | 0.67%     | 2.8926      | 3.00%       | Pass    |
| 29        | 0.68       | 0.78%     | 2.6931      | 3.00%       | Pass    |
| 31        | 0.61       | 0.70%     | 2.5194      | 3.00%       | Pass    |
| 33        | 0.49       | 0.57%     | 2.3667      | 3.00%       | Pass    |
| 35        | 0.51       | 0.59%     | 2.2315      | 3.00%       | Pass    |
| 37        | 0.25       | 0.29%     | 2.1108      | 3.00%       | Pass    |
| 39        | 0.31       | 0.36%     | 2.0026      | 3.00%       | Pass    |
| 41        | 0.09       | 0.10%     |             |             |         |
| 43        | 0.13       | 0.15%     |             |             |         |
| 45        | 0.16       | 0.18%     |             |             |         |
| 47        | 0.20       | 0.23%     |             |             |         |
| 49        | 0.26       | 0.30%     |             |             |         |





## 9.6.5 120 VAC 60 Hz , 18 V LED 負載諧波資料

## Current Harmonics Limits for IEC61000-3-2

| V         | Freq       | I (mA)    | P           | PF          | %THD    |
|-----------|------------|-----------|-------------|-------------|---------|
| 120       | 60.00      | 104.18    | 12.1440     | 0.9710      | 15.18   |
|           |            |           |             |             |         |
| nth Order | mA Content | % Content | Limit <25 W | Limit >25 W | Remarks |
| 1         | 102.92     |           |             |             |         |
| 2         | 0.04       | 0.04%     |             | 2.00%       |         |
| 3         | 13.71      | 13.32%    | 82.5792     | 29.13%      | Pass    |
| 5         | 5.73       | 5.57%     | 46.1472     | 10.00%      | Pass    |
| 7         | 2.90       | 2.82%     | 24.2880     | 7.00%       | Pass    |
| 9         | 2.34       | 2.27%     | 12.1440     | 5.00%       | Pass    |
| 11        | 1.37       | 1.33%     | 8.5008      | 3.00%       | Pass    |
| 13        | 1.32       | 1.28%     | 7.1930      | 3.00%       | Pass    |
| 15        | 0.73       | 0.71%     | 6.2339      | 3.00%       | Pass    |
| 17        | 0.86       | 0.84%     | 5.5005      | 3.00%       | Pass    |
| 19        | 0.47       | 0.46%     | 4.9215      | 3.00%       | Pass    |
| 21        | 0.73       | 0.71%     | 4.4528      | 3.00%       | Pass    |
| 23        | 0.45       | 0.44%     | 4.0656      | 3.00%       | Pass    |
| 25        | 0.72       | 0.70%     | 3.7404      | 3.00%       | Pass    |
| 27        | 0.51       | 0.50%     | 3.4633      | 3.00%       | Pass    |
| 29        | 0.67       | 0.65%     | 3.2244      | 3.00%       | Pass    |
| 31        | 0.54       | 0.52%     | 3.0164      | 3.00%       | Pass    |
| 33        | 0.55       | 0.53%     | 2.8336      | 3.00%       | Pass    |
| 35        | 0.49       | 0.48%     | 2.6717      | 3.00%       | Pass    |
| 37        | 0.34       | 0.33%     | 2.5273      | 3.00%       | Pass    |
| 39        | 0.38       | 0.37%     | 2.3977      | 3.00%       | Pass    |
| 41        | 0.18       | 0.17%     |             |             |         |
| 43        | 0.24       | 0.23%     |             |             |         |
| 45        | 0.11       | 0.11%     |             |             |         |
| 47        | 0.13       | 0.13%     |             |             |         |
| 49        | 0.13       | 0.13%     |             |             |         |



## 9.6.6 120 VAC 60 Hz , 21 V LED 負載諧波資料

## Current Harmonics Limits for IEC61000-3-2

| V         | Freq       | I (mA)    | P           | PF          | %THD    |
|-----------|------------|-----------|-------------|-------------|---------|
| 120       | 60.00      | 119.76    | 14.0380     | 0.9765      | 14.47   |
|           |            |           |             |             |         |
| nth Order | mA Content | % Content | Limit <25 W | Limit >25 W | Remarks |
| 1         | 118.44     |           |             |             |         |
| 2         | 0.04       | 0.03%     |             | 2.00%       |         |
| 3         | 14.93      | 12.61%    | 95.4584     | 29.30%      | Pass    |
| 5         | 6.39       | 5.40%     | 53.3444     | 10.00%      | Pass    |
| 7         | 3.38       | 2.85%     | 28.0760     | 7.00%       | Pass    |
| 9         | 2.72       | 2.30%     | 14.0380     | 5.00%       | Pass    |
| 11        | 1.71       | 1.44%     | 9.8266      | 3.00%       | Pass    |
| 13        | 1.67       | 1.41%     | 8.3148      | 3.00%       | Pass    |
| 15        | 1.05       | 0.89%     | 7.2062      | 3.00%       | Pass    |
| 17        | 1.12       | 0.95%     | 6.3584      | 3.00%       | Pass    |
| 19        | 0.70       | 0.59%     | 5.6891      | 3.00%       | Pass    |
| 21        | 0.79       | 0.67%     | 5.1473      | 3.00%       | Pass    |
| 23        | 0.49       | 0.41%     | 4.6997      | 3.00%       | Pass    |
| 25        | 0.59       | 0.50%     | 4.3237      | 3.00%       | Pass    |
| 27        | 0.37       | 0.31%     | 4.0034      | 3.00%       | Pass    |
| 29        | 0.48       | 0.41%     | 3.7273      | 3.00%       | Pass    |
| 31        | 0.30       | 0.25%     | 3.4869      | 3.00%       | Pass    |
| 33        | 0.40       | 0.34%     | 3.2755      | 3.00%       | Pass    |
| 35        | 0.34       | 0.29%     | 3.0884      | 3.00%       | Pass    |
| 37        | 0.39       | 0.33%     | 2.9214      | 3.00%       | Pass    |
| 39        | 0.26       | 0.22%     | 2.7716      | 3.00%       | Pass    |
| 41        | 0.32       | 0.27%     |             |             |         |
| 43        | 0.23       | 0.19%     |             |             |         |
| 45        | 0.26       | 0.22%     |             |             |         |
| 47        | 0.23       | 0.19%     |             |             |         |
| 49        | 0.20       | 0.17%     |             |             |         |



## 10 調光效能資料

TRIAC dimming results were taken at an input voltage of 120 VAC, 60 Hz line frequency, room temperature, and 21 V LED load.

The output current high limit  $I_{OUT}$  (HL) and low limit  $I_{OUT}$  (LL) were incorporated based on the NEMA SSL6-2010 (section 4, page 9). The limits incorporated on the succeeding graphs assumes that 100% relative light output falls on the maximum operating output current of 530 mA and 0 mA is 0% light output, and input line of 120 VAC, 60 Hz.

### 10.1 使用模擬 TRIAC 的調光曲線

Agilent 6812B AC Source programmed as perfect leading edge dimmer

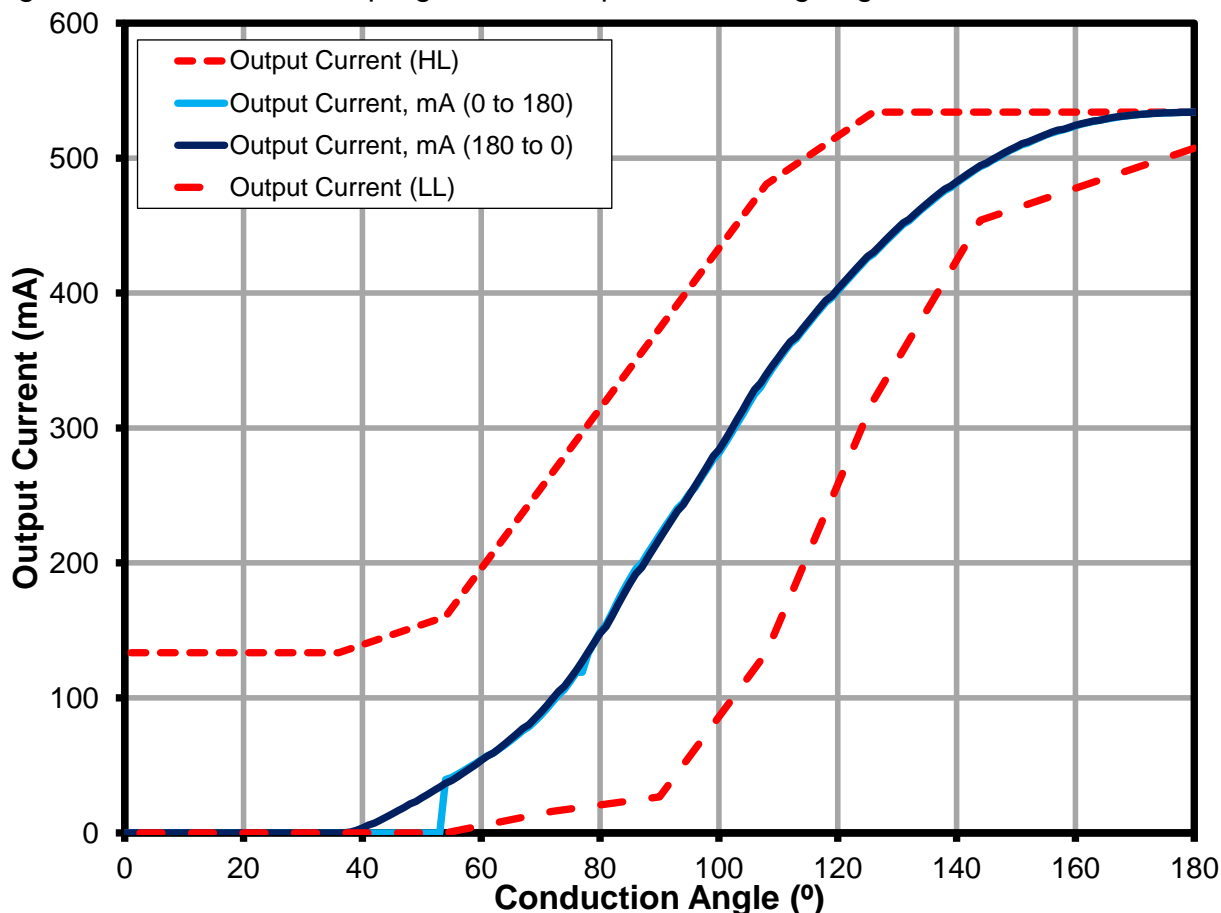


Figure 18 – Dimming Curve at 120 VAC, 60 Hz Input, 21 V LED Load.



### 10.2 實際調光器的效能

The following data were taken by measuring the RMS input voltage to the driver as a result of TRIAC chopping the AC input. A leading and trailing edge TRIAC dimmer was used on the data below using 21 V LED load and 120 V, 60 Hz AC input.

#### 10.2.1 調光曲線

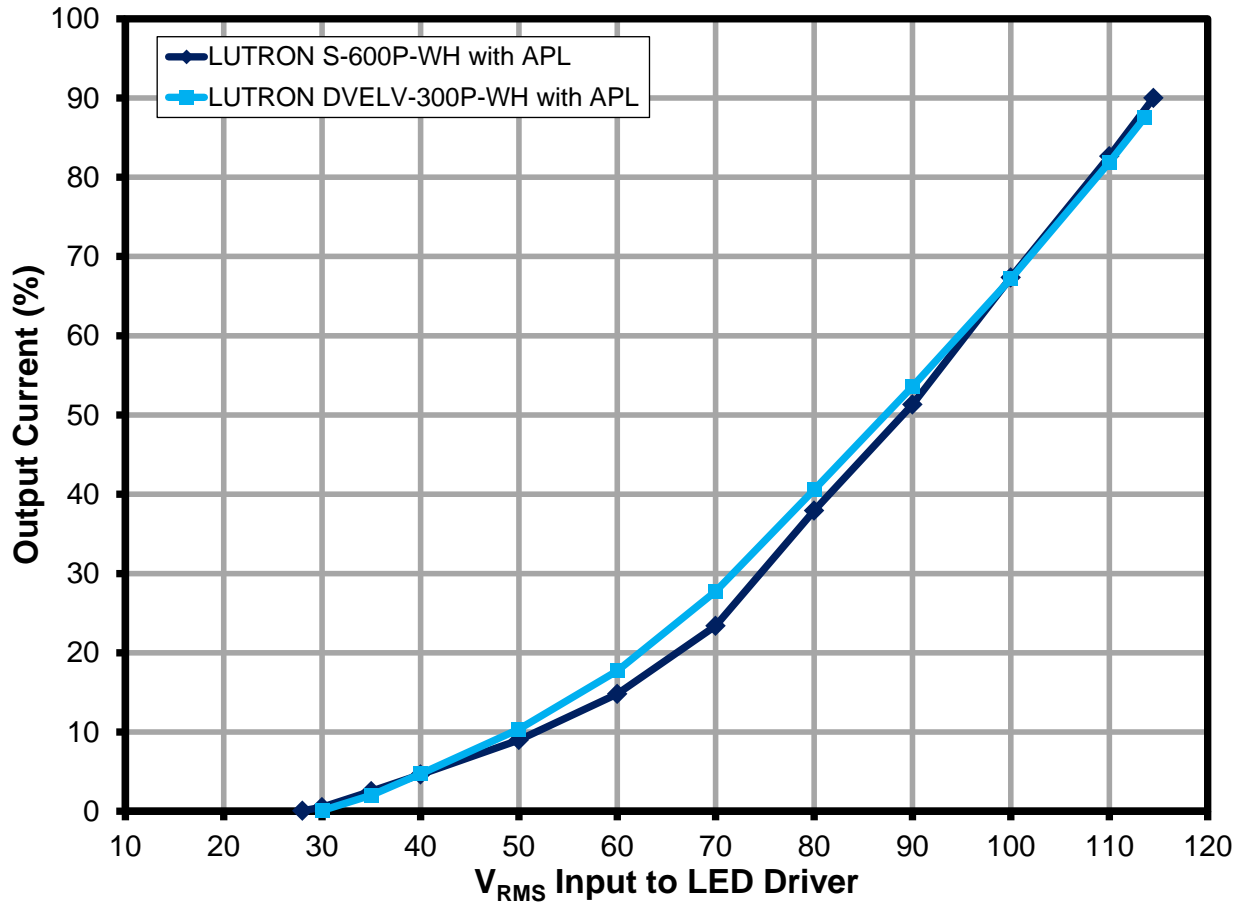


Figure 19 – Dimming Curve as a function of Input Voltage to the Driver.



## 10.2.2 典型前緣調光器效能資料

Dimmer: LUTRON S-600P-WH

Input: 120 VAC, 60 Hz

| $V_{IN(RMS)}$<br>(V) | $I_{OUT}$<br>(mA) | $I_{OUT}$<br>(%) | $V_{OUT}$<br>(V) | $P_{OUT}$<br>(W) | $P_{IN}$<br>(W) | Efficiency<br>(%) | $P_{LOSS}$<br>(W) | Start-upTime<br>(ms) |
|----------------------|-------------------|------------------|------------------|------------------|-----------------|-------------------|-------------------|----------------------|
| 114.5                | 477               | 90.00            | 21.4             | 10.25            | 14              | 73.2              | 3.75              | 137                  |
| 110                  | 438               | 82.64            | 21.22            | 9.33             | 13.1            | 71.2              | 3.77              | 149                  |
| 100                  | 357               | 67.36            | 20.92            | 7.5              | 11.12           | 67.4              | 3.62              | 167                  |
| 90                   | 272               | 51.32            | 20.58            | 5.63             | 9.2             | 61.2              | 3.57              | 197                  |
| 80                   | 201               | 37.92            | 20.23            | 4.11             | 7.8             | 52.7              | 3.69              | 228                  |
| 70                   | 124               | 23.40            | 19.81            | 2.49             | 6.67            | 37.3              | 4.18              | 274                  |
| 60                   | 78.5              | 14.81            | 19.4             | 1.53             | 5.79            | 26.4              | 4.26              | 335                  |
| 50                   | 47.6              | 8.98             | 19.05            | 0.91             | 4.95            | 18.4              | 4.04              | 506                  |
| 40                   | 24.6              | 4.64             | 18.66            | 0.46             | 4.26            | 10.8              | 3.8               | 1250                 |
| 35                   | 13.5              | 2.55             | 18.37            | 0.25             | 3.9             | 6.4               | 3.65              |                      |
| 30                   | 2.8               | 0.53             | 17.83            | 0.05             | 3.51            | 1.4               | 3.46              |                      |
| 28                   | 0.43              | 0.08             | 17.3             | 0.007            | 3.34            | 0.2               | 3.333             |                      |



## 10.2.3 典型後緣調光器效能資料

Dimmer: LUTRON DVELV-300P-WH

Input: 120 VAC, 60 Hz

| V <sub>IN(RMS)</sub><br>(V) | I <sub>OUT</sub><br>(mA) | I <sub>OUT</sub><br>(%) | V <sub>OUT</sub><br>(V) | P <sub>OUT</sub><br>(W) | P <sub>IN</sub><br>(W) | Efficiency<br>(%) | P <sub>LOSS</sub><br>(W) | Start-upTime<br>(ms) |
|-----------------------------|--------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------------------|--------------------------|----------------------|
| 113.6                       | 464                      | 87.55                   | 21.42                   | 9.97                    | 13.37                  | 74.6              | 3.4                      | 133                  |
| 110                         | 434                      | 81.89                   | 21.24                   | 9.25                    | 12.48                  | 74.1              | 3.23                     | 133                  |
| 100                         | 356                      | 67.17                   | 20.95                   | 7.5                     | 10.38                  | 72.3              | 2.88                     | 140                  |
| 90                          | 284                      | 53.58                   | 20.64                   | 5.88                    | 8.58                   | 68.5              | 2.7                      | 151                  |
| 80                          | 215                      | 40.57                   | 20.3                    | 4.39                    | 7.19                   | 61.1              | 2.8                      | 176                  |
| 70                          | 147                      | 27.74                   | 19.97                   | 2.97                    | 6.13                   | 48.5              | 3.16                     | 189                  |
| 60                          | 94                       | 17.74                   | 19.55                   | 1.86                    | 5.26                   | 35.4              | 3.4                      | 226                  |
| 50                          | 55                       | 10.38                   | 19.1                    | 1.05                    | 4.45                   | 23.6              | 3.4                      | 296                  |
| 40                          | 25                       | 4.72                    | 18.63                   | 0.466                   | 3.7                    | 12.6              | 3.234                    | 468                  |
| 35                          | 10.85                    | 2.05                    | 18.26                   | 0.198                   | 3.3                    | 6.0               | 3.102                    | 727                  |
| 30                          | 0.47                     | 0.09                    | 17.28                   | 0.008                   | 2.9                    | 0.3               | 2.892                    | 1520                 |

## 10.2.4 調光器相容性清單

| Item | List of Dimmers      | Part Number      | V <sub>RMS(MIN)</sub> | I <sub>MIN</sub> (mA) | V <sub>RMS(MAX)</sub> | I <sub>MAX</sub> (mA) | Dim Ratio |
|------|----------------------|------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| 1    | LUTRON LG600PH-LA    | LG-600PH-WH      | 26                    | 0.16                  | 114.4                 | 475                   | 2969      |
| 2    | LUTRON S603P         | S-603P-WH        | 27.27                 | 0.24                  | 115.0                 | 478                   | 1992      |
| 3    | LUTRON SLV600P       | SLV600P-WH       | 28.3                  | 0.96                  | 115.4                 | 485                   | 505       |
| 4    | LUTRON S600          | S-600-WH         | 27                    | 0.17                  | 117.5                 | 508                   | 2988      |
| 5    | LUTRON S-600PH-WH    | S-600PH-WH       | 27                    | 0.24                  | 114.8                 | 479                   | 1996      |
| 6    | LUTRON DVCL153P      | DVWCL-153-PLH-WH | 27                    | 0.27                  | 113.3                 | 464                   | 1719      |
| 7    | LUTRON DV603P        | DV-603P-WH       | 27                    | 0.25                  | 114.4                 | 477                   | 1908      |
| 8    | LUTRON DV600P        | DV-600P-WH       | 26.9                  | 0.18                  | 114.6                 | 477                   | 2650      |
| 9    | LUTRON TG600PH-IV    | TG-600PH-WH      | 35                    | 12.00                 | 115.6                 | 488                   | 41        |
| 10   | LUTRON AY600P        | AY-600P-WH       | 36                    | 14.30                 | 115.1                 | 483                   | 34        |
| 11   | LUTRON GL600P-WH     | GL-600P-WH       | 27.6                  | 0.48                  | 114.7                 | 479                   | 998       |
| 12   | LEVITON 6633PLI      | R62-06633-1LW    | 27                    | 0.70                  | 118.4                 | 521                   | 744       |
| 13   | LEVITON 6631-LI      | R62-06631-1LW    | 28                    | 0.22                  | 116.4                 | 495                   | 2250      |
| 14   | LEVITON IPI06        | R60-IPI06-1LM    | 38                    | 22.00                 | 118.1                 | 516                   | 23        |
| 15   | LEVITON 6161-I       | R52-06161-00W    | 33                    | 0.65                  | 115.0                 | 482                   | 742       |
| 16   | LEVITON RP106        | R52-RPI06-1LW    | 36                    | 0.68                  | 119.0                 | 526                   | 774       |
| 17   | LEVITON 6681         | R60-06681-0IW    | 27.4                  | 0.20                  | 112.0                 | 450                   | 2250      |
| 18   | LEVITON TGM10-1LW    | TGM10-1LW        | 30                    | 2.60                  | 113.2                 | 463                   | 178       |
| 19   | LEVITON 6684         | R60-06684-1IW    | 28.7                  | 0.12                  | 118.9                 | 527                   | 4392      |
| 20   | LEVITON 6683         | 6683             | 30                    | 0.22                  | 119.0                 | 527                   | 2395      |
| 21   | LEVITON 6613         | R02-06613-PLW    | 27                    | 0.30                  | 118.6                 | 522                   | 1740      |
| 22   | COOPER SLC03         | SLC03P-W-K-L     | 27.4                  | 0.36                  | 116.0                 | 492                   | 1367      |
| 23   | LUTRON GL600-WH      | GL-600-WH        | 27                    | 0.37                  | 117.1                 | 505                   | 1365      |
| 24   | LUTRON DVPDC-203P-WH | DVPDC-203P-WH    | 60                    | 80.00                 | 117.0                 | 500                   | 6         |
| 25   | LUTRON LX600PL       | LX-600PL-wh      | 27                    | 0.21                  | 116.6                 | 497                   | 2367      |
| 26   | LUTRON D600P         | D-600P-WH        | 28                    | 0.50                  | 113.1                 | 462                   | 924       |
| 27   | LUTRON CTCL-153PDH   |                  | 28                    | 0.10                  | 113.6                 | 467                   | 4670      |
| 28   | LUTRON S-600P        | S-600P           | 27                    | 0.30                  | 114.8                 | 479                   | 1597      |



|    |                     |               |       |       |       |     |      |
|----|---------------------|---------------|-------|-------|-------|-----|------|
| 29 | LUTRON TGLV-600P    | TGLV-600P     | 32    | 9.30  | 116.0 | 491 | 53   |
| 30 | LUTRON TGLV-600PR   | TGLV-600PR    | 34    | 11.00 | 115.3 | 485 | 44   |
| 31 | LUTRON TT-300NLH-WH | TT-300NLH-WH  | 27    | 0.35  | 117.8 | 513 | 1466 |
| 32 | LUTRON TT-300H-WH   | TT-300H-WH    | 28    | 0.60  | 117.8 | 513 | 855  |
| 33 | LUTRON NLV-1000-WH  | NLV-1000-WH   | 26    | 0.10  | 116.1 | 493 | 4930 |
| 34 | Lutron              | MAELV -600    | 33.8  | 9.40  | 115.1 | 478 | 51   |
| 35 | Lutron              | S-600P        | 26.2  | 0.12  | 114.4 | 475 | 3958 |
| 36 | Lutron              | MAW-600       | 27    | 0.37  | 117.3 | 506 | 1368 |
| 37 | Cooper              | MIR-600       | 30.1  | 5.10  | 117.1 | 503 | 99   |
| 38 | Lutron              | S-600P        | 29.8  | 4.10  | 115.0 | 480 | 117  |
| 39 | Lutron              | S106P         | 27.8  | 0.20  | 114.0 | 469 | 2345 |
| 40 | Lutron              | S-600PNLH-WH  | 26.7  | 0.19  | 115.4 | 485 | 2553 |
| 41 | Lutron              | S-603PNL-WH   | 27.8  | 0.49  | 115.3 | 484 | 988  |
| 42 | Lutron              | SLV-603P-WH   | 33.44 | 10.40 | 115.1 | 482 | 46   |
| 43 | Lutron              | S-603PGH-WH   | 27.2  | 0.33  | 105.6 | 397 | 1203 |
| 44 | Lutron              | AYLV-600P-WH  | 32.2  | 8.80  | 115.2 | 485 | 55   |
| 45 | Lutron              | AYLV-603P-WH  | 34    | 12.00 | 114.4 | 477 | 40   |
| 46 | Lutron              | AY-103PNL-WH  | 29.5  | 1.50  | 116.4 | 496 | 331  |
| 47 | Lutron              | AY-10PNL-WH   | 28.8  | 0.90  | 118.5 | 520 | 578  |
| 48 | Lutron              | AY-10P-WH     | 26    | 0.10  | 116.8 | 501 | 5010 |
| 49 | Lutron              | AY-603PNL-WH  | 30.4  | 3.20  | 112.6 | 459 | 143  |
| 50 | Lutron              | AY-603PG-WH   | 32.3  | 6.70  | 102.4 | 372 | 56   |
| 51 | Lutron              | AY-603P-WH    | 36.5  | 14.30 | 112.7 | 460 | 32   |
| 52 | Lutron              | AY-600PNL-WH  | 31.2  | 3.70  | 115.1 | 483 | 131  |
| 53 | Lutron              | DVELV-300P-WH | 29.87 | 0.41  | 113.8 | 467 | 1139 |
| 54 | Lutron              | DVLV-10P-WH   | 33.37 | 10.65 | 114.3 | 474 | 45   |
| 55 | Lutron              | DVLV-103P-WH  | 31.74 | 7.00  | 114.6 | 477 | 68   |
| 56 | Lutron              | DVLV-603P-WH  | 30.67 | 4.70  | 114.8 | 479 | 102  |
| 57 | Lutron              | S-1000-WH     | 28.3  | 0.75  | 117.4 | 507 | 676  |
| 58 | Lutron              | SELV-300P-WH  | 28.3  | 0.06  | 112.4 | 455 | 7583 |
| 59 | Lutron              | S-600P-WH     | 27    | 0.18  | 114.6 | 476 | 2644 |
| 60 | Lutron              | S-103PNL-WH   | 31    | 0.59  | 114.3 | 474 | 803  |
| 61 | Lutron              | GLV-600-WH    | 27.5  | 0.58  | 117.3 | 507 | 874  |

Figure 20 – Dimmer Compatibility List.



## 11 散熱效能

Images captured after running for >30 minutes at room temperature (25 °C), open frame for the conditions specified.

### 11.1 非調光 $V_{IN} = 90 \text{ VAC}$ , 60 Hz , 21 V LED 負載

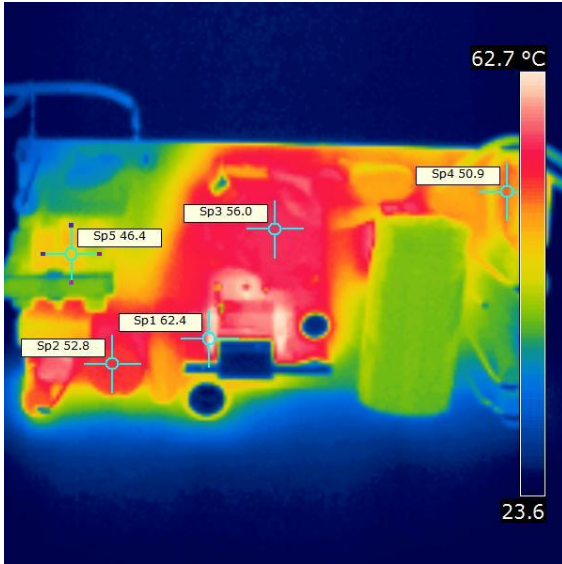


Figure 21 – Top Side. U1 = 62.4 °C.

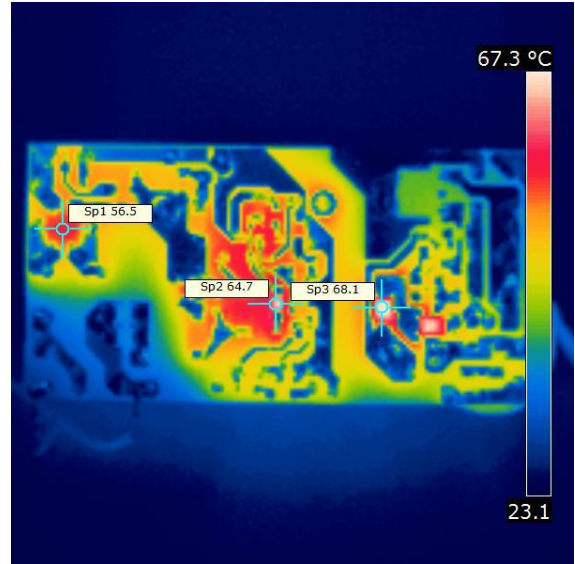


Figure 22 – Bottom Side. R20 = 68.1 °C.

### 11.2 非調光 $V_{IN} = 132 \text{ VAC}$ , 60 Hz , 21 V LED 負載

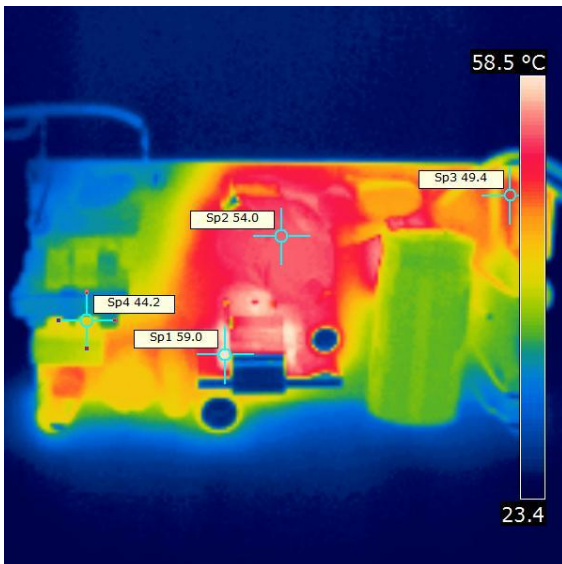


Figure 23 – Top Side. U1 = 59 °C.

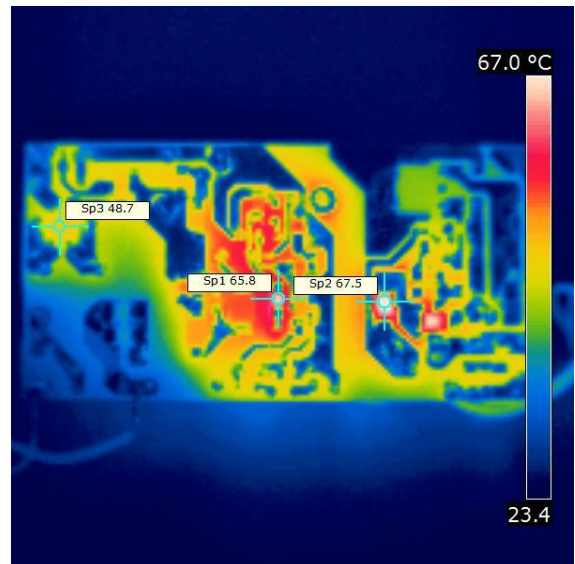


Figure 24 – Bottom Side. R20 = 67.3 °C.





11.3 調光  $V_{IN} = 120 \text{ VAC}$  ,  $60 \text{ Hz}$  ,  $90^\circ$  導通角 ,  $21 \text{ V LED}$  負載

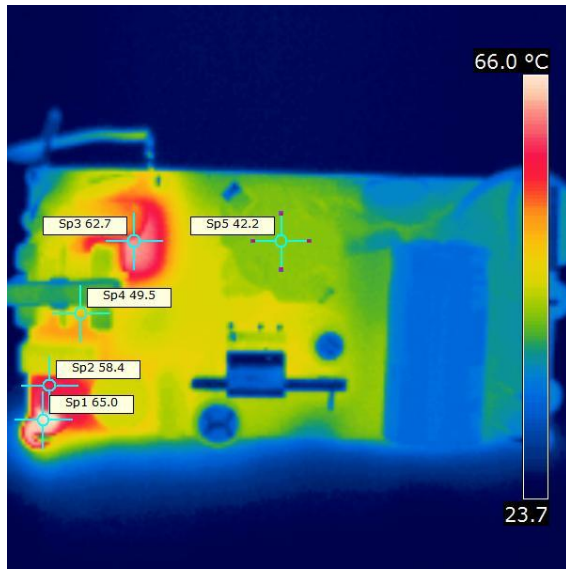


Figure 25 – Top Side.  $R_8 = 65 \text{ }^\circ\text{C}$ .

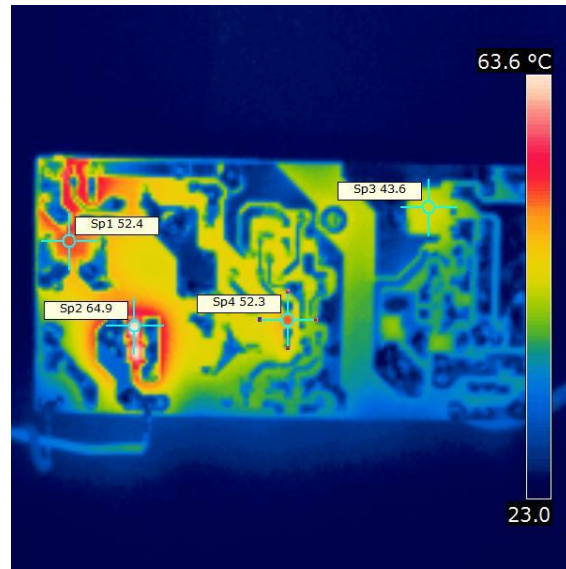
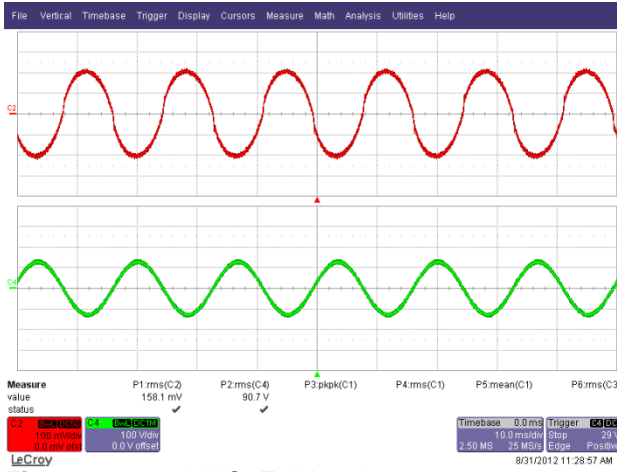


Figure 26 – Bottom Side.  $R_2=64.9 \text{ }^\circ\text{C}$ .

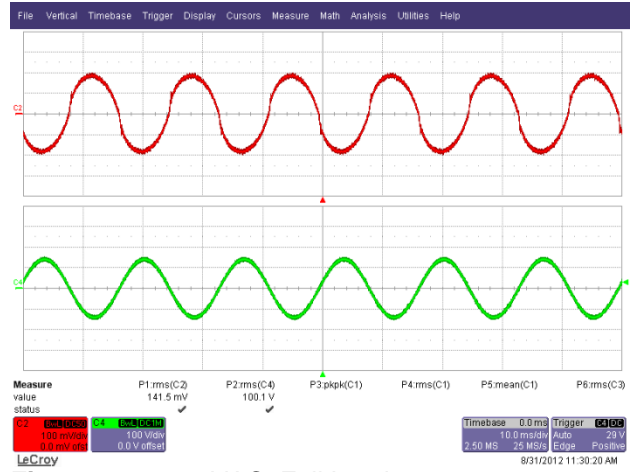


## 12 非調光波形

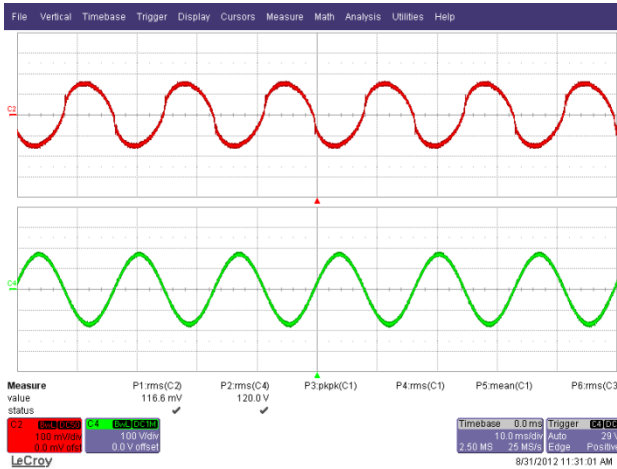
### 12.1 輸入電壓和輸入電流波形



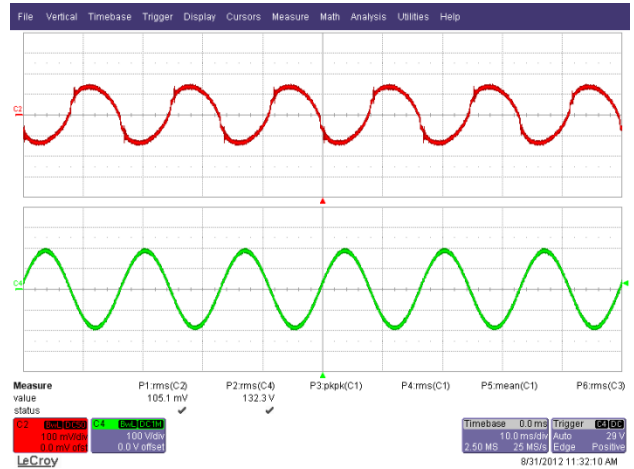
**Figure 27 – 90 VAC, Full Load.**  
 Upper:  $I_{IN}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 10 ms / div.



**Figure 28 – 100 VAC, Full Load.**  
 Upper:  $I_{IN}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 10 ms / div.



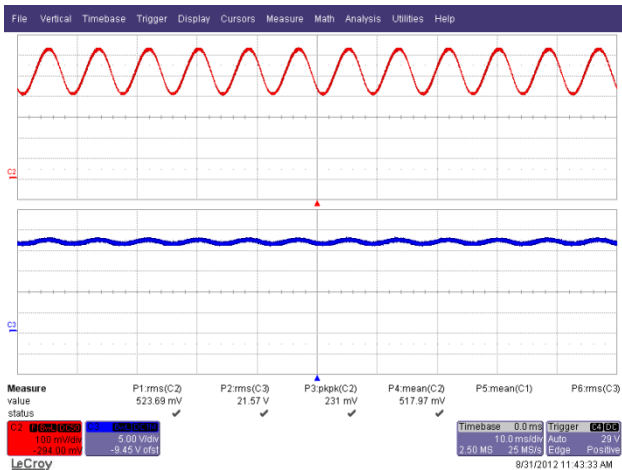
**Figure 29 – 120 VAC, Full Load.**  
 Upper:  $I_{IN}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 10 ms / div.



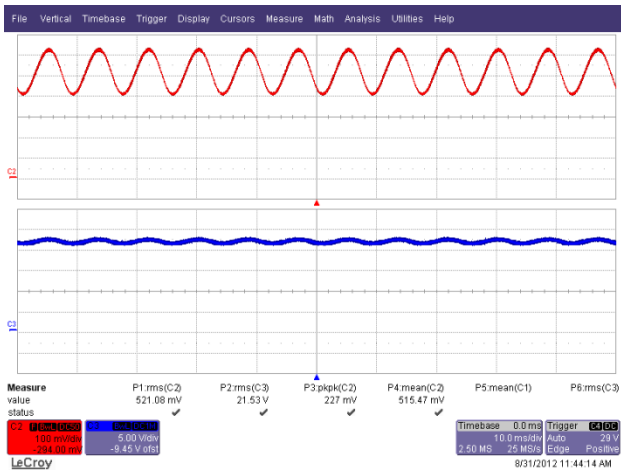
**Figure 30 – 132 VAC, Full Load.**  
 Upper:  $I_{IN}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 10 ms / div.



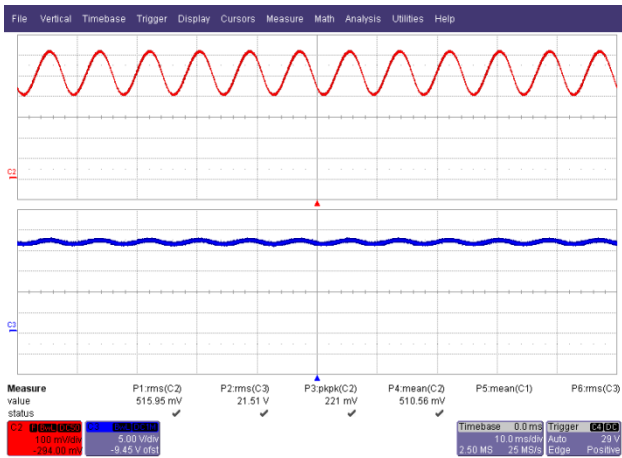
### 12.2 正常運作下的輸出電流和輸出電壓



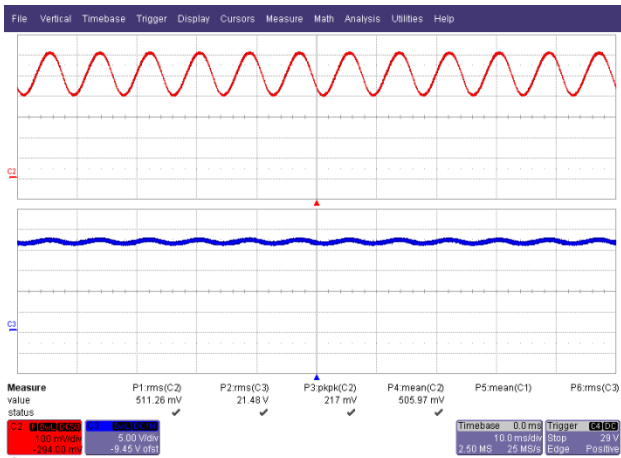
**Figure 31 – 90 VAC, 60 Hz Full Load.**  
Upper:  $I_{OUT}$ , 100 mA / div.  
Lower:  $V_{OUT}$ , 5 V, 10 ms / div.



**Figure 32 – 100 VAC, 60 Hz Full Load.**  
Upper:  $I_{OUT}$ , 100 mA / div.  
Lower:  $V_{OUT}$ , 5 V, 10 ms / div.



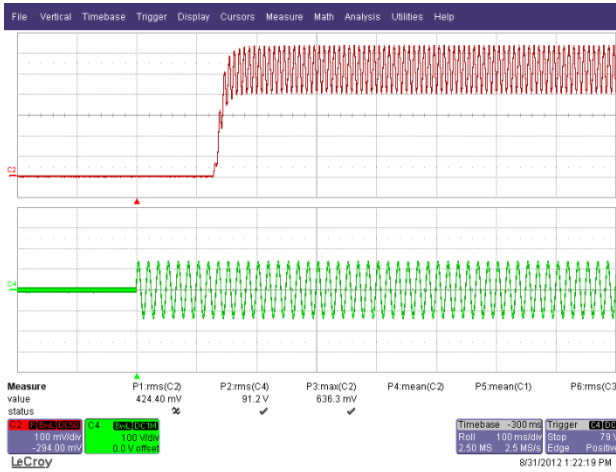
**Figure 33 – 120 VAC, 60 Hz Full Load.**  
Upper:  $I_{OUT}$ , 100 mA / div.  
Lower:  $V_{OUT}$ , 5 V, 10 ms / div.



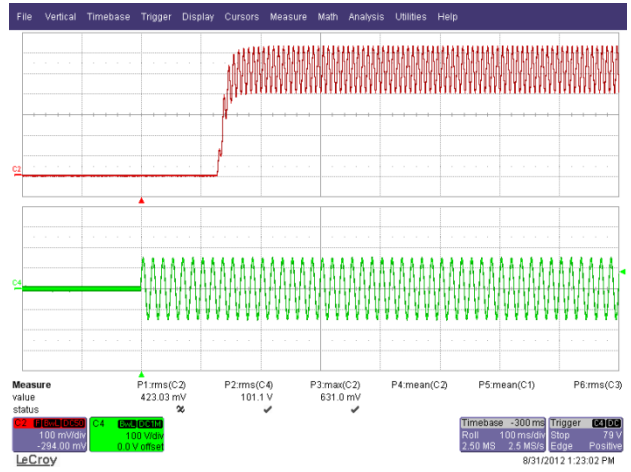
**Figure 34 – 132 VAC, 60 Hz Full Load.**  
Upper:  $I_{OUT}$ , 100 mA / div.  
Lower:  $V_{OUT}$ , 5 V, 10 ms / div.



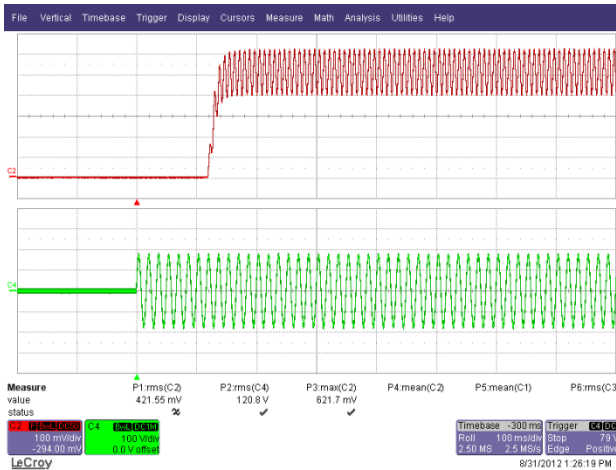
### 12.3 啟動時的輸入電壓和輸出電流波形



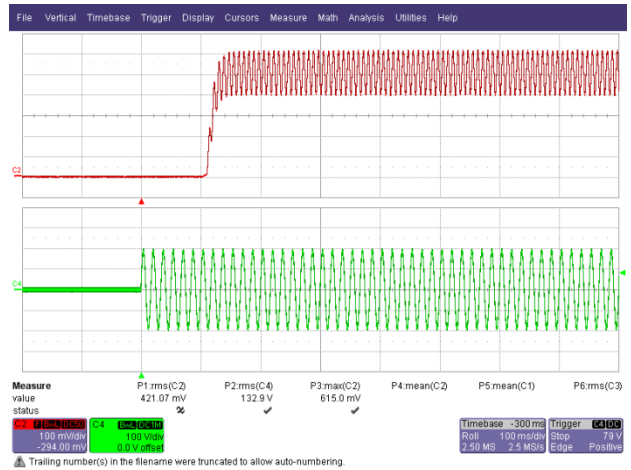
**Figure 35 – 90 VAC, 60 Hz.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 100 ms / div.



**Figure 36 – 100 VAC, 60 Hz.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 100 ms / div.



**Figure 37 – 120 VAC, 60 Hz.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 100 ms / div.



**Figure 38 – 132 VAC, 60 Hz.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 100 ms / div.

12.4 正常運作下的汲極電壓和電流

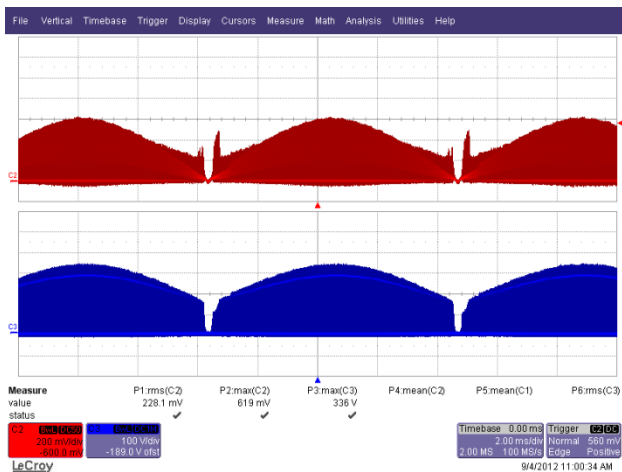


Figure 39 – 90 VAC, 60 Hz.  
 Upper:  $I_{DRAIN}$ , 0.2 A / div.  
 Lower:  $V_{DRAIN}$ , 100 V, 2 ms / div.

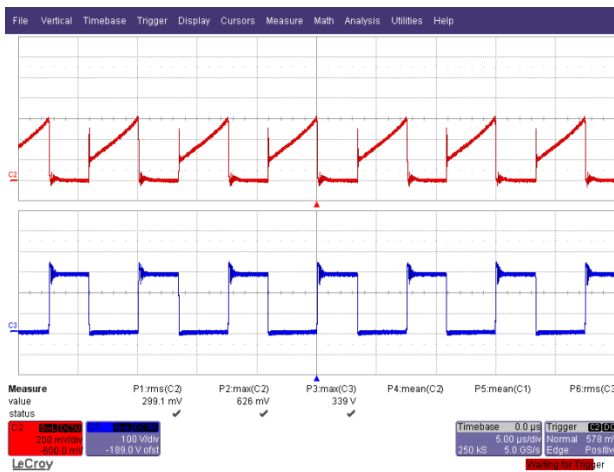


Figure 40 – 90 VAC, 60 Hz.  
 Upper:  $I_{DRAIN}$ , 0.2 A / div.  
 Lower:  $V_{DRAIN}$ , 100 V / div., 5  $\mu$ s / div.

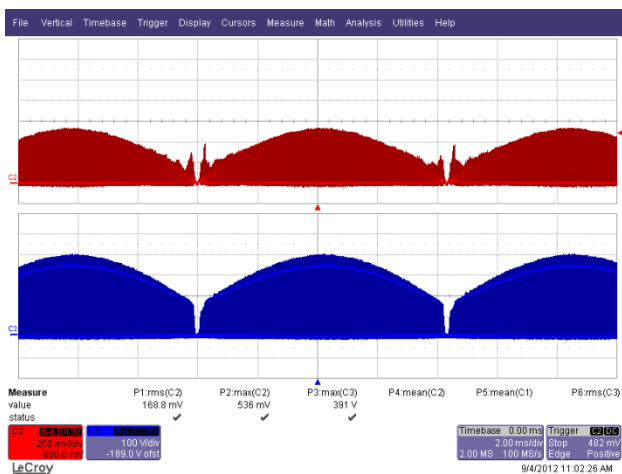


Figure 41 – 132 VAC, 60 Hz.  
 Upper:  $I_{DRAIN}$ , 0.2 A / div.  
 Lower:  $V_{DRAIN}$ , 100 V, 2 ms / div.

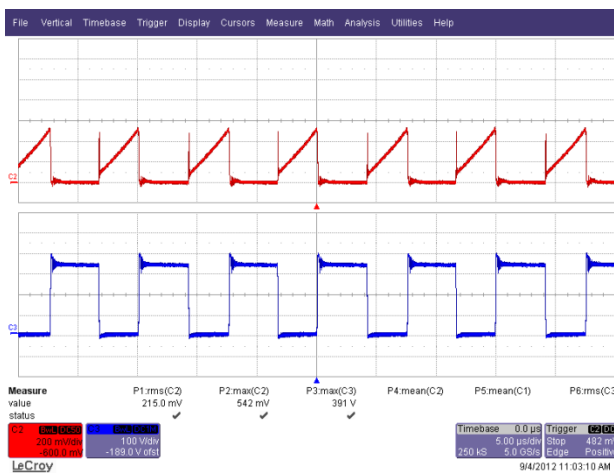
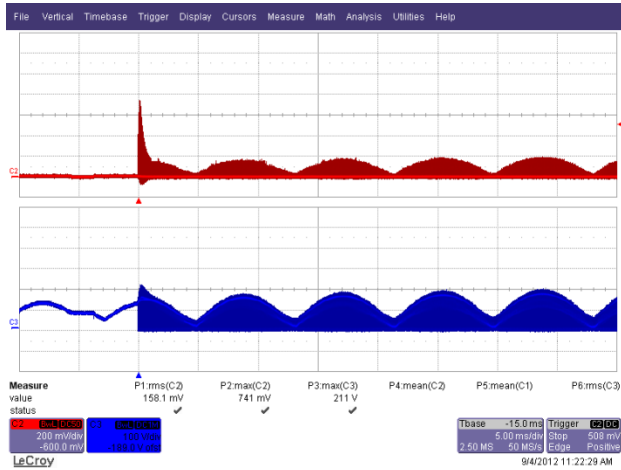


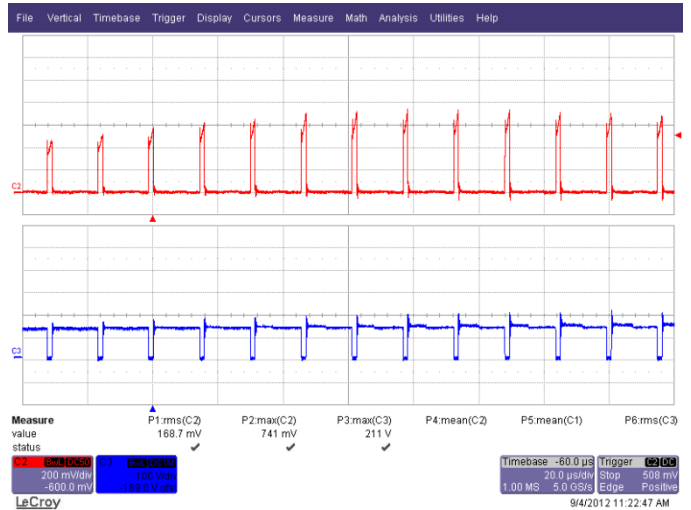
Figure 42 – 132 VAC, 60 Hz.  
 Upper:  $I_{DRAIN}$ , 0.2 A / div.  
 Lower:  $V_{DRAIN}$ , 100 V / div., 5  $\mu$ s / div.



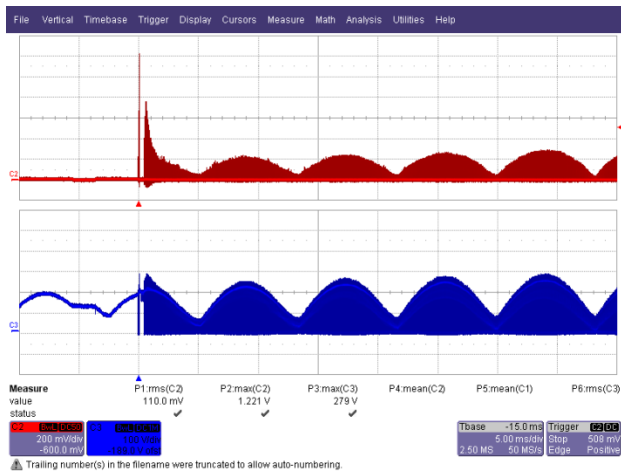
### 12.5 啟動時的汲極電壓和電流



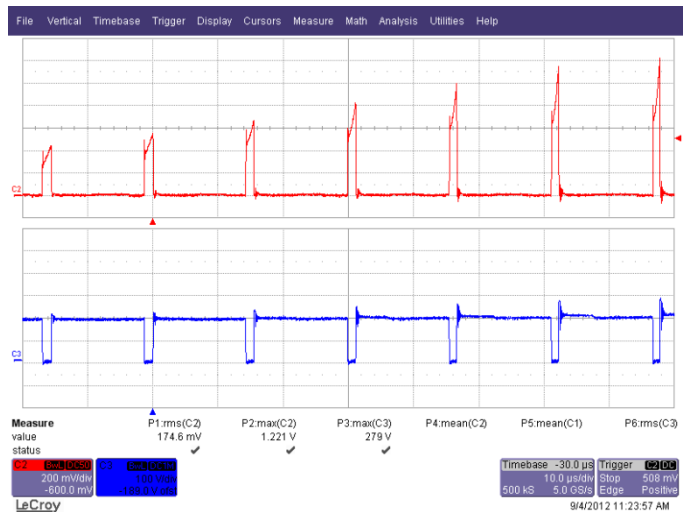
**Figure 43** – 90 VAC, 60 Hz Start-up.  
Upper:  $I_{DRAIN}$ , 200 mA / div.  
Lower:  $V_{DRAIN}$ , 100 V, 5 ms / div.



**Figure 44** – 90 VAC, 60 Hz Start-up.  
Upper:  $I_{DRAIN}$ , 200 mA / div.  
Lower:  $V_{DRAIN}$ , 100 V, 20 μs / div.



**Figure 45** – 132 VAC, 60 Hz Start-up.  
Upper:  $I_{DRAIN}$ , 200 mA / div.  
Lower:  $V_{DRAIN}$ , 100 V, 5 ms / div.

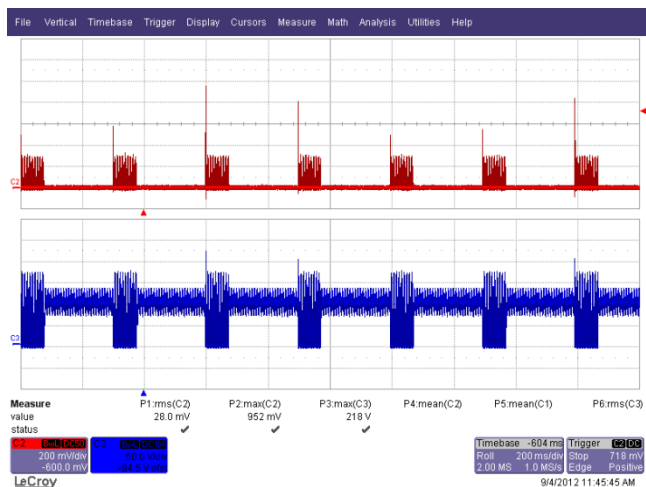


**Figure 46** – 132 VAC, 60 Hz Start-up.  
Upper:  $I_{DRAIN}$ , 200 mA / div.  
Lower:  $V_{DRAIN}$ , 100 V, 10 μs / div.

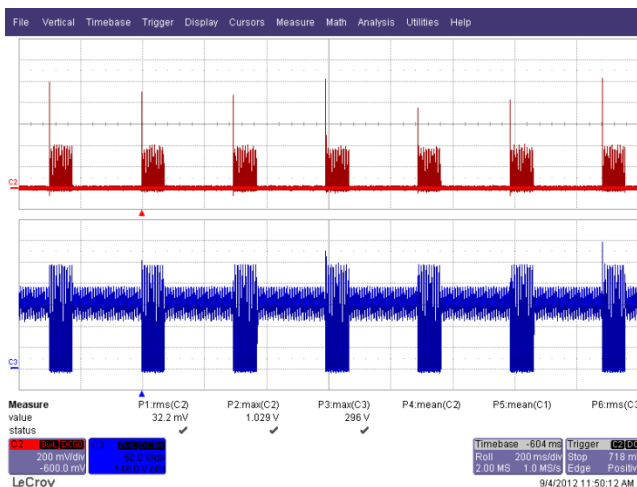


### 12.6 輸出短路情況下的汲極電壓和電流輸出

During output short condition, the  $I_{FB}$  current falls below the  $I_{FB(AR)}$  threshold and enters the auto-restart condition. During this condition, to minimize power dissipation on the power components, the auto-restart circuit turns the power supply on and off at an auto-restart duty cycle of typically  $DC_{AR}$  for as long as the fault condition persists.



**Figure 47 – 90 VAC, 60 Hz Output Short Condition.**  
 Upper:  $I_{DRAIN}$ , 200 mA / div.  
 Lower:  $V_{DRAIN}$ , 50 V, 200 ms / div.



**Figure 48 – 132 VAC, 60 Hz Output Short Condition.**  
 Upper:  $I_{DRAIN}$ , 200 mA / div.  
 Lower:  $V_{DRAIN}$ , 50 V, 200 ms / div.





12.7 正常運作下的輸出二極體電壓和電流

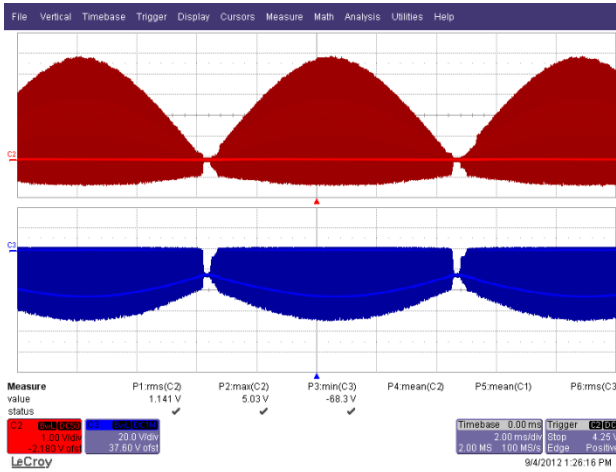


Figure 49 – 90 VAC, 60 Hz.  
Upper:  $I_{D6}$ , 1 A / div.  
Lower:  $V_{D6}$ , 20 V, 2 ms / div.

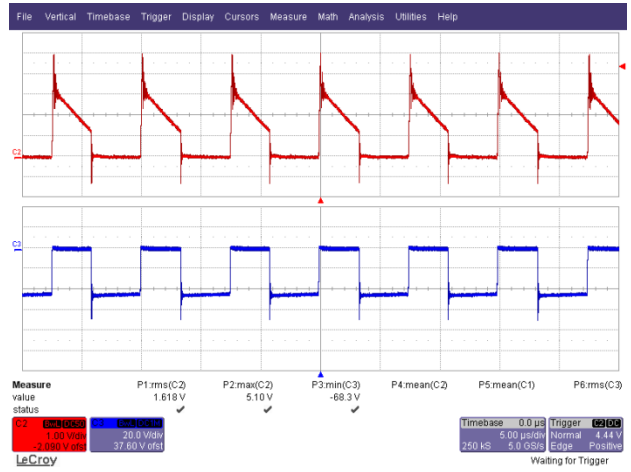


Figure 50 – 90 VAC, 60 Hz.  
Upper:  $I_{D6}$ , 1 A / div.  
Lower:  $V_{D6}$ , 20 V / div., 5 μs / div.

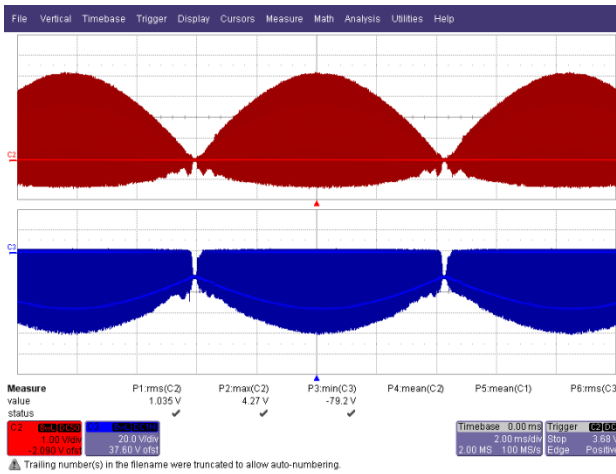


Figure 51 – 132 VAC, 60 Hz.  
Upper:  $I_{D6}$ , 1 A / div.  
Lower:  $V_{D6}$ , 20 V, 2 ms / div.

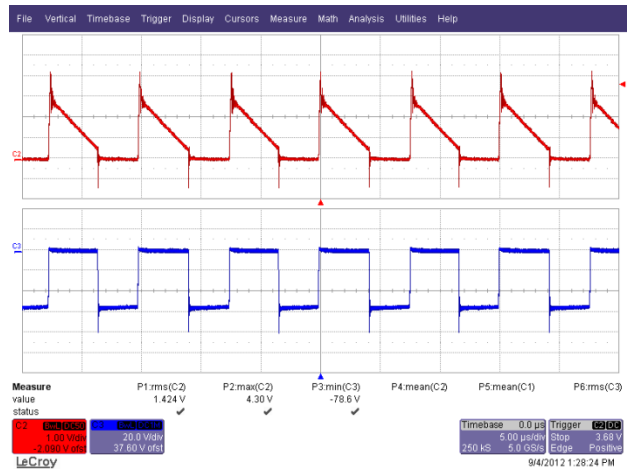
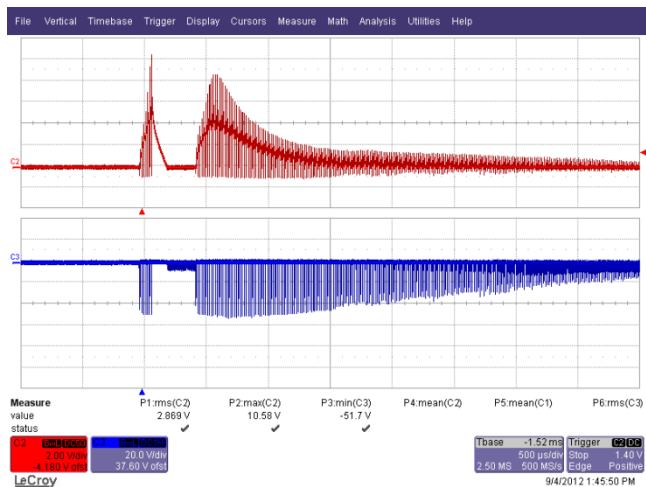


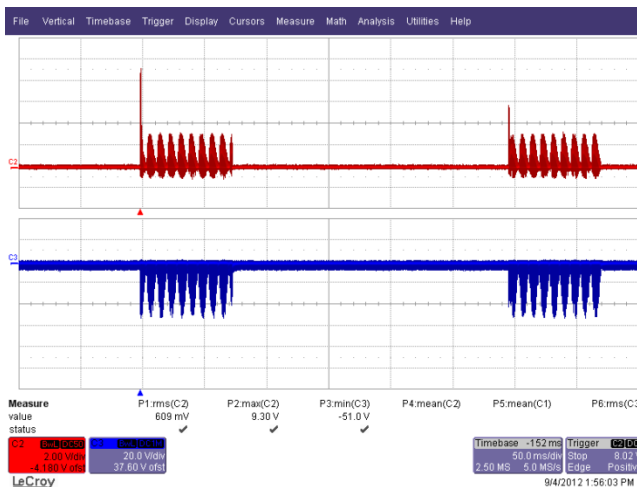
Figure 52 – 132 VAC, 60 Hz.  
Upper:  $I_{D6}$ , 1 A / div.  
Lower:  $V_{D6}$ , 20 V / div., 5 μs / div.



### 12.8 啟動及輸出短路情況下的輸出二極體電壓和電流

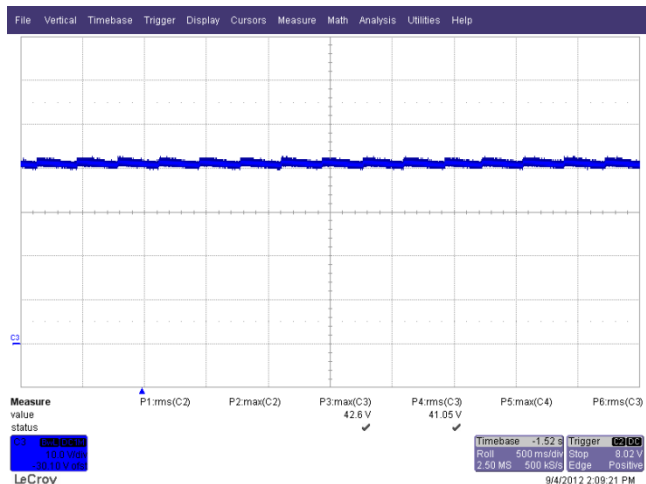


**Figure 53** – 132 VAC, 60 Hz Start-up Condition.  
 Upper:  $I_{D6}$ , 2 A / div.  
 Lower:  $V_{D6}$ , 20 V, 0.5 ms / div.

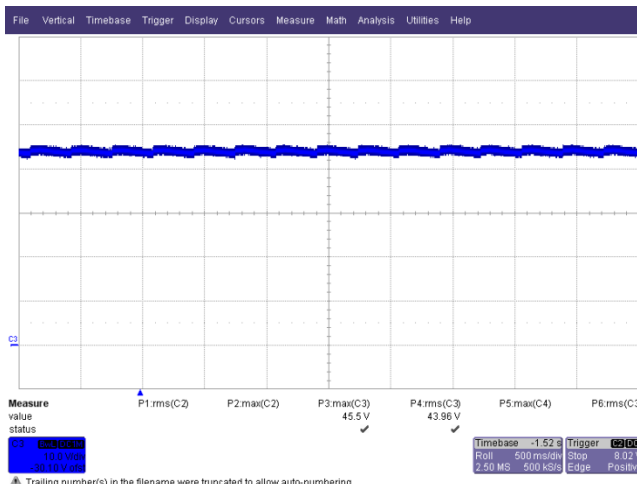


**Figure 54** – 132 VAC, 60 Hz Output Short Condition.  
 Upper:  $I_{D6}$ , 2 A / div.  
 Lower:  $V_{D6}$ , 20 V, 50 ms / div.

### 12.9 開路情況下的輸出電壓



**Figure 55** – 90 VAC, 60 Hz Open Load Condition.  
 $V_{OUT}$ , 10 V / div.



**Figure 56** – 132 VAC, 60 Hz Open Load Condition.  
 $V_{OUT}$ , 10 V / div.



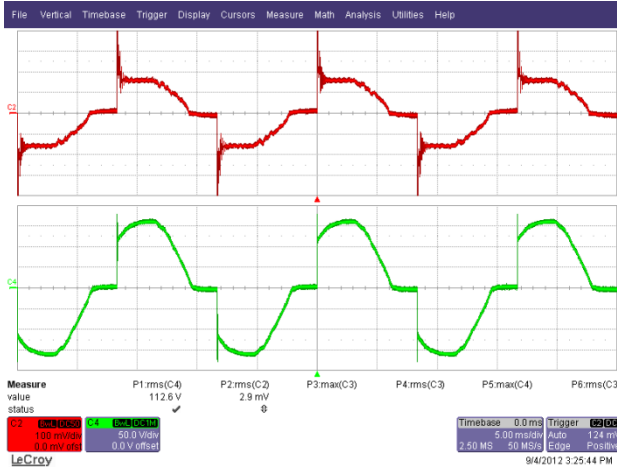
### 13 調光波形

#### 13.1 輸入電壓和輸入電流波形

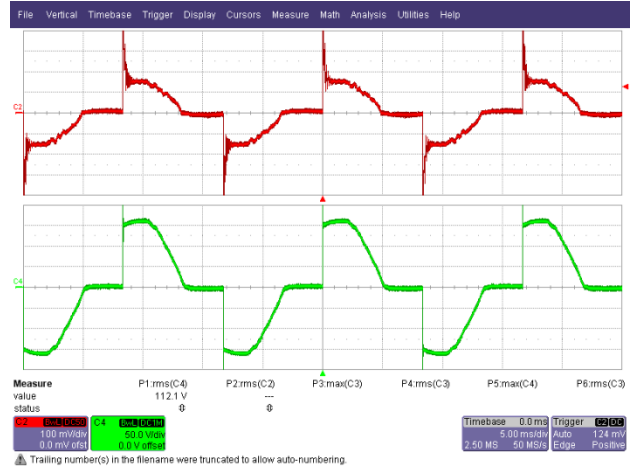
Input: 120 VAC, 60 Hz Utility Line

Output: 22.5 V LED Load

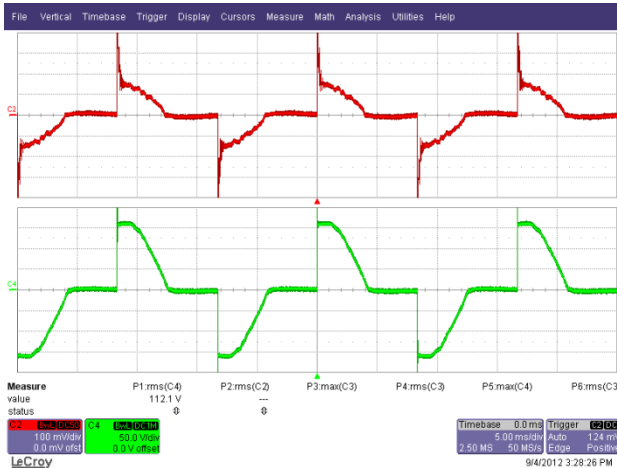
Dimmer: LUTRON S-600P-WH



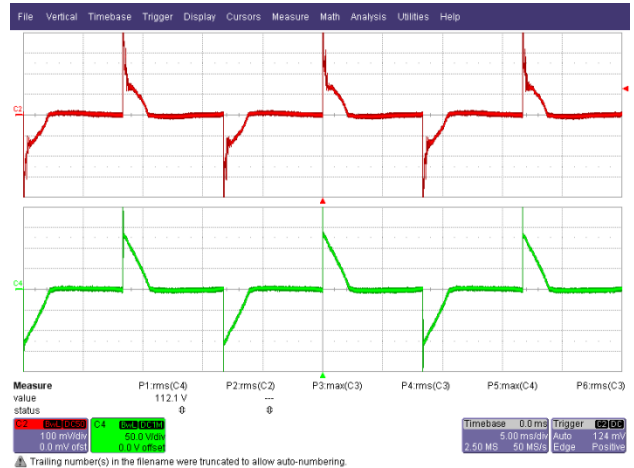
**Figure 57** – 132° Conduction Angle.  
Upper:  $I_{IN}$ , 100 mA / div.  
Lower:  $V_{IN}$ , 50 V, 5 ms / div.



**Figure 58** – 108° Conduction Angle.  
Upper:  $I_{IN}$ , 100 mA / div.  
Lower:  $V_{IN}$ , 50 V, 5 ms / div.



**Figure 59** – 86° Conduction Angle.  
Upper:  $I_{IN}$ , 100 mA / div.  
Lower:  $V_{IN}$ , 50 V, 5 ms / div.

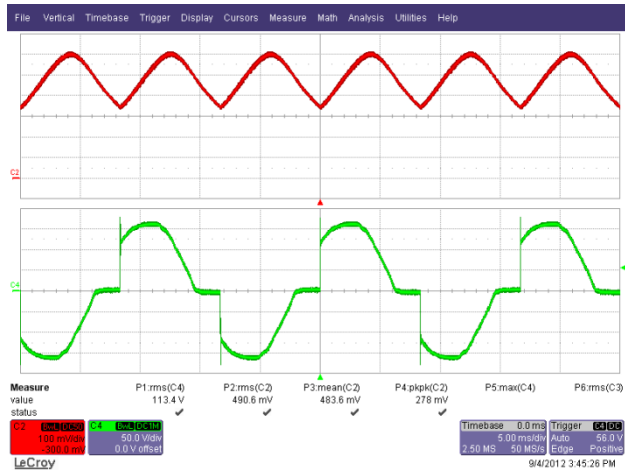


**Figure 60** – 45° Conduction Angle.  
Upper:  $I_{IN}$ , 100 mA / div.  
Lower:  $V_{IN}$ , 50 V, 5 ms / div.

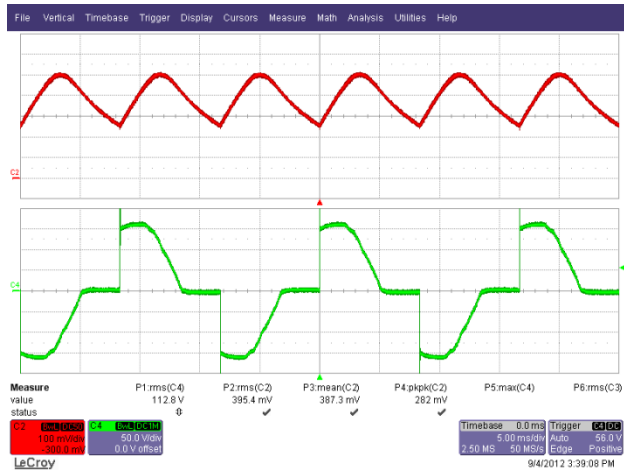


### 13.2 輸出電流波形

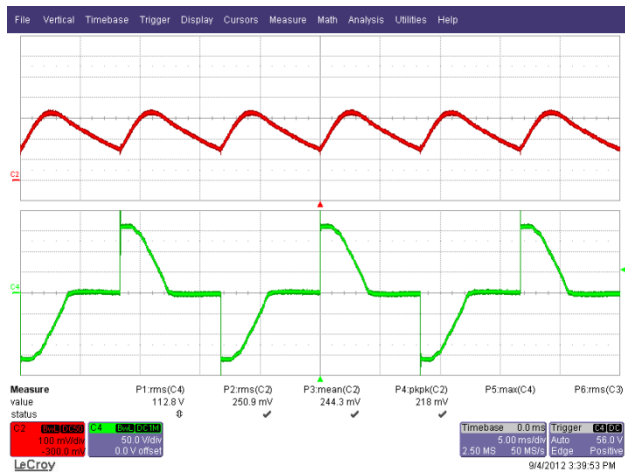
Input: 120 VAC, 60 Hz Utility Line  
 Output: 22.5 V LED Load  
 Dimmer: LUTRON S-600P-WH



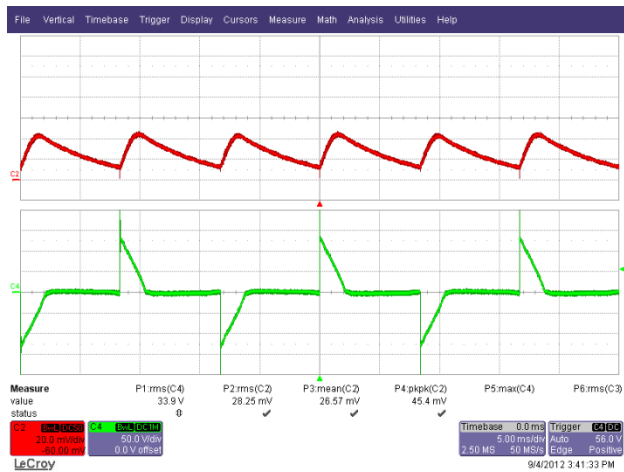
**Figure 61 – 132° Conduction Angle.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 50 V, 5 ms / div.



**Figure 62 – 108° Conduction Angle.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 5 ms / div.



**Figure 63 – 86° Conduction Angle.**  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 50 V, 5 ms / div.



**Figure 64 – 45° Conduction Angle.**  
 Upper:  $I_{OUT}$ , 20 mA / div.  
 Lower:  $V_{IN}$ , 50 V, 5 ms / div.

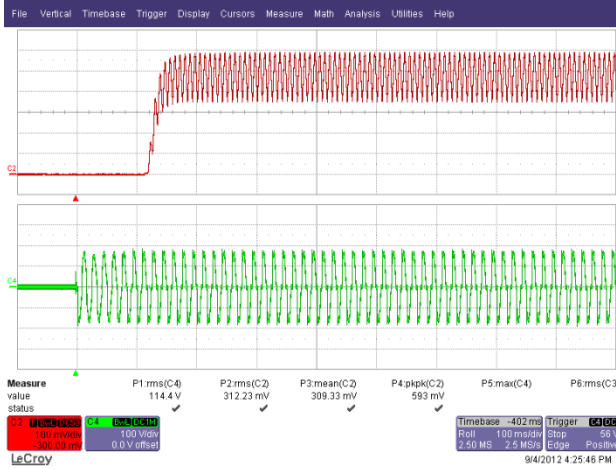


### 13.3 啟動時的輸入電壓和輸出電流波形

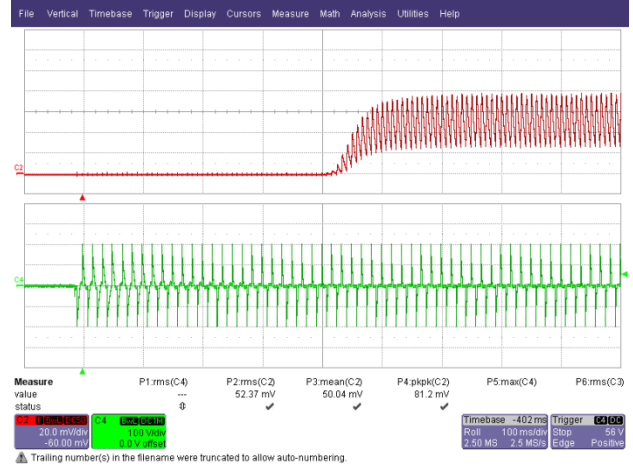
Input: 120 VAC, 60 Hz Utility Line

Output: 22.5 V LED Load

Dimmer: LUTRON S-600P-WH



**Figure 65** – 120 VAC, 60 Hz, 132 °Conduction Angle Start-up.  
 Upper:  $I_{OUT}$ , 100 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 100 ms / div.



**Figure 66** – 120 VAC, 60 Hz 10%  $I_{OUT}$  Start-up.  
 Upper:  $I_{OUT}$ , 20 mA / div.  
 Lower:  $V_{IN}$ , 100 V, 100 ms / div.

## 14 傳導性 EMI

### 14.1 測試裝置

The unit was tested using LED load (21 V  $V_{OUT}$ ) with input voltage of 120 VAC, 60 Hz at room temperature and with the unit place inside a grounded cone.

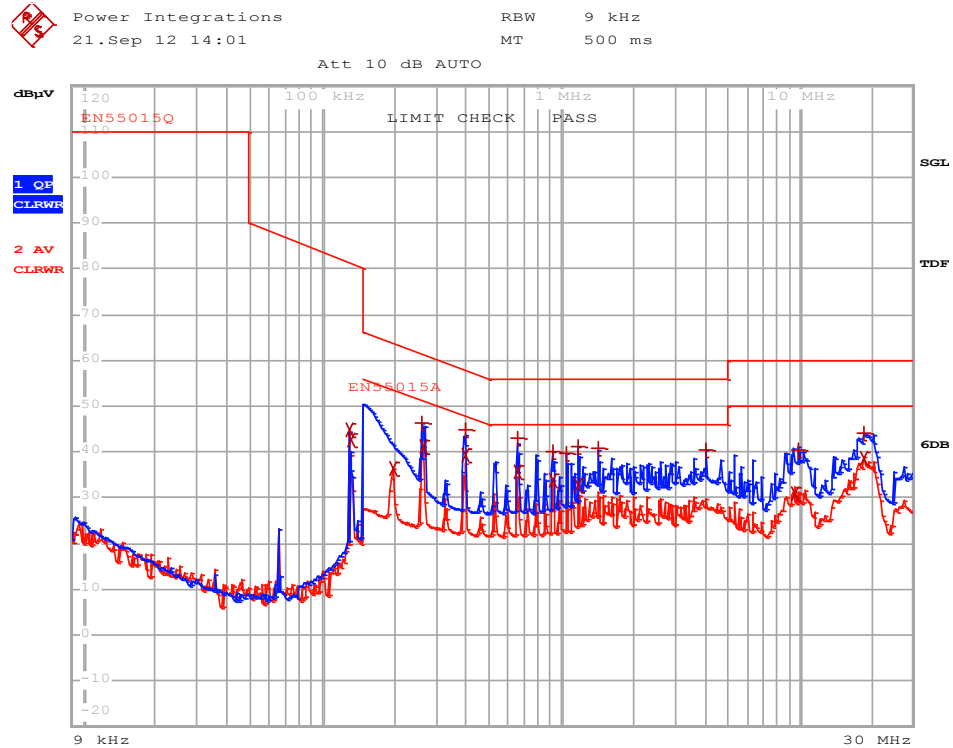


Figure 67 – EMI Test Set-up.





14.2 測試結果



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q  
Trace2: EN55015A  
Trace3: ---

| TRACE        | FREQUENCY         | LEVEL dBµV   | DELTA LIMIT dB |
|--------------|-------------------|--------------|----------------|
| 2 Average    | 129.530094744 kHz | 44.77 N gnd  |                |
| 2 Average    | 132.133649648 kHz | 42.78 N gnd  |                |
| 2 Average    | 198.193645035 kHz | 36.40 L1 gnd | -17.27         |
| 1 Quasi Peak | 261.871472881 kHz | 46.17 L1 gnd | -15.19         |
| 2 Average    | 264.49018761 kHz  | 41.30 L1 gnd | -9.98          |
| 2 Average    | 393.789848222 kHz | 39.17 N gnd  | -8.80          |
| 1 Quasi Peak | 397.727746704 kHz | 44.74 N gnd  | -13.15         |
| 1 Quasi Peak | 654.11570866 kHz  | 42.94 N gnd  | -13.06         |
| 2 Average    | 654.11570866 kHz  | 35.60 N gnd  | -10.39         |
| 1 Quasi Peak | 917.447639259 kHz | 40.02 L1 gnd | -15.97         |
| 2 Average    | 917.447639259 kHz | 33.82 L1 gnd | -12.17         |
| 1 Quasi Peak | 1.04414099339 MHz | 39.67 L1 gnd | -16.33         |
| 1 Quasi Peak | 1.17656420634 MHz | 41.21 L1 gnd | -14.78         |
| 2 Average    | 1.17656420634 MHz | 32.71 L1 gnd | -13.28         |
| 1 Quasi Peak | 1.43563192593 MHz | 40.67 L1 gnd | -15.32         |
| 1 Quasi Peak | 4.04078721227 MHz | 40.45 L1 gnd | -15.54         |
| 2 Average    | 9.60341065306 MHz | 30.94 L1 gnd | -19.05         |
| 1 Quasi Peak | 9.89440359926 MHz | 40.43 L1 gnd | -19.56         |
| 1 Quasi Peak | 18.7049927256 MHz | 44.12 L1 gnd | -15.87         |
| 2 Average    | 18.7049927256 MHz | 38.65 N gnd  | -11.34         |

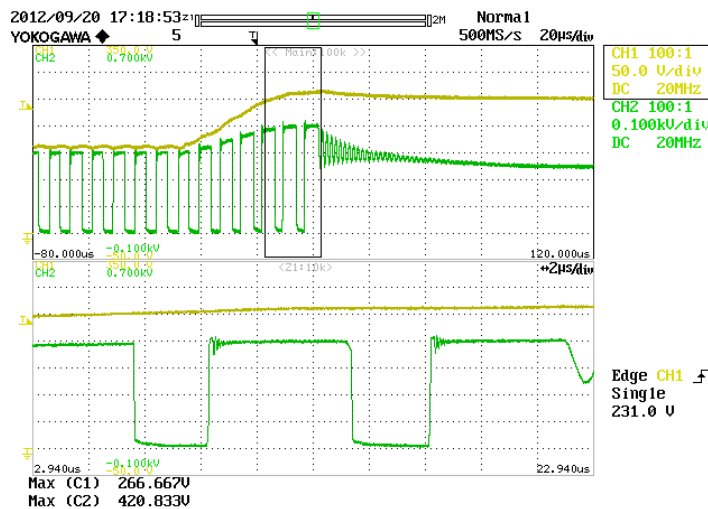
Figure 68 – Conducted EMI, 21 V LED Load, 120 VAC, 60 Hz, and EN55015 B Limits.

### 15 線電壓突波

The unit was subjected to  $\pm 2500$  V 100 kHz ring wave and  $\pm 500$  V differential surge at 120 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     | 120                 | L1, L2             | 0                   | 100 kHz Ring Wave (500 A) | Pass                    |
| -2500     | 120                 | L1, L2             | 0                   | 100 kHz Ring Wave (500 A) | Pass                    |
| +2500     | 120                 | L1, L2             | 90                  | 100 kHz Ring Wave (500 A) | Pass                    |
| -2500     | 120                 | L1, L2             | 90                  | 100 kHz Ring Wave (500 A) | Pass                    |

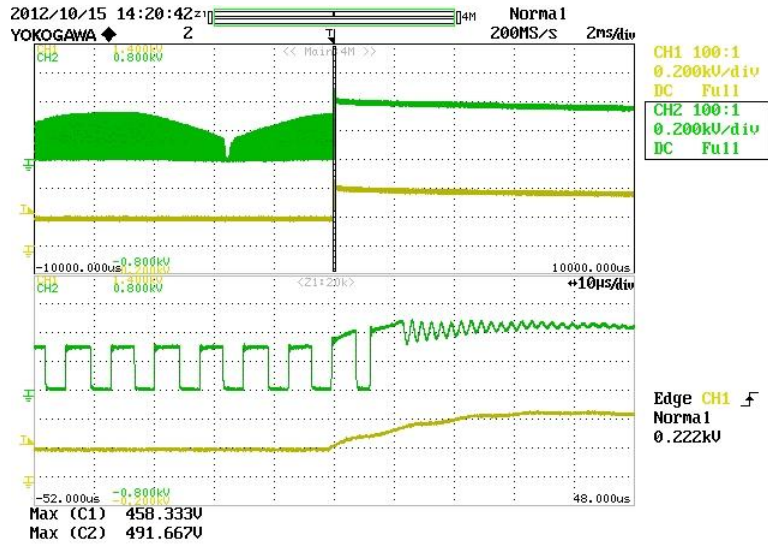
| Level (V) | Input Voltage (VAC) | Injection Location | Injection Phase (°) | Type        | Test Result (Pass/Fail) |
|-----------|---------------------|--------------------|---------------------|-------------|-------------------------|
| +500      | 120                 | L1, L2             | 0                   | Surge (2 □) | Pass                    |
| -500      | 120                 | L1, L2             | 0                   | Surge (2 □) | Pass                    |
| +500      | 120                 | L1, L2             | 90                  | Surge (2 □) | Pass                    |
| -500      | 120                 | L1, L2             | 90                  | Surge (2 □) | Pass                    |



**Figure 69** – 500 V Differential Line Surge at 90° Injection Phase.  
CH1: Input Rectified Voltage; CH3:  $VDS_{U1}$ .



The unit was also tested with RV1 removed and C6 replaced by a 400 V rated 2.2  $\mu$ F, electrolytic capacitor. U1 drain voltage measured was 458 V when a 500 V differential surge was applied.



**Figure 70** 500 V Differential Line Surge at 90° Injection Phase with RV1 removed.  
 CH1: Voltage across C6 (peak detector capacitor); CH2:  $V_{DS_{U1}}$ .



## 16 無主動預載選項

The active pre-load can be removed for improve efficiency performance. The trade-off is limited dim ratio for TRIAC dimmers with a higher minimum conduction angle.

### 16.1 電路圖

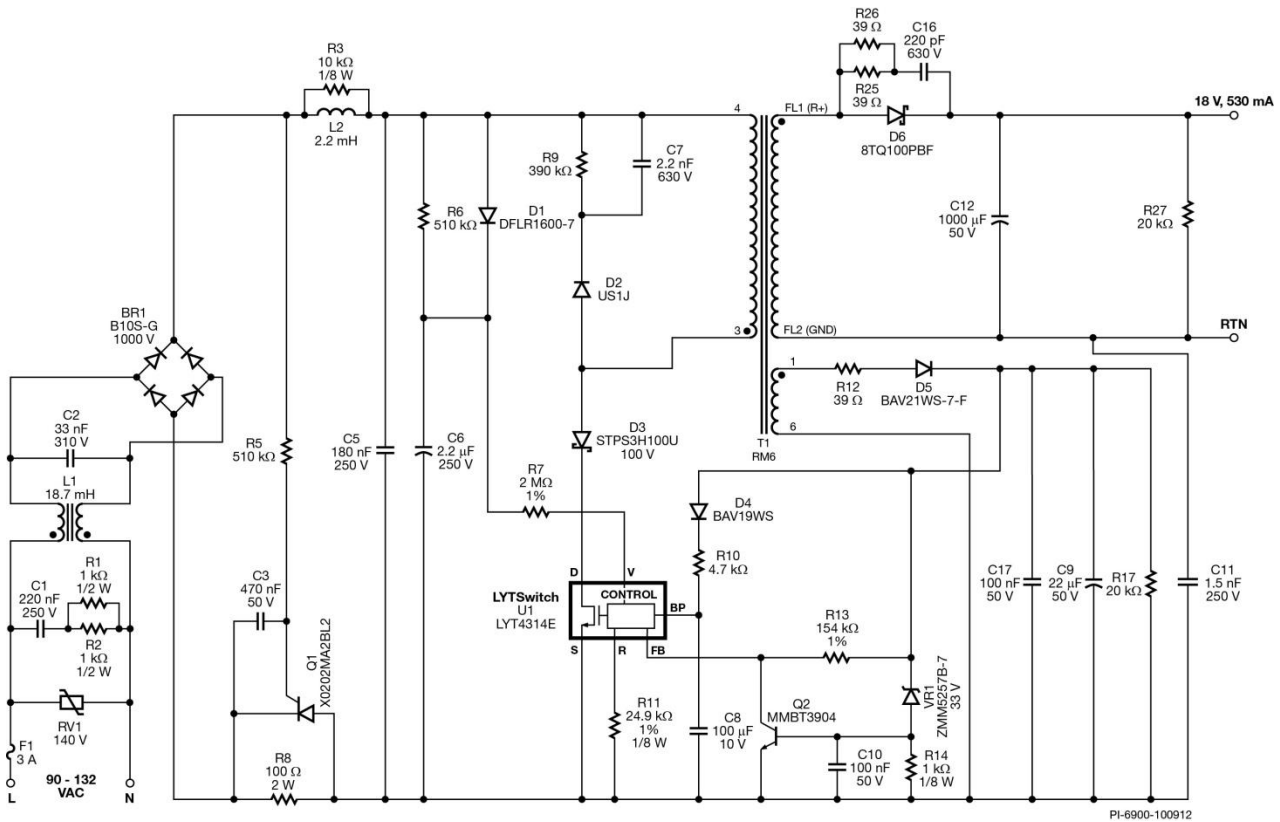


Figure 71 – No Active Pre-Load Schematic.

## 16.2 無 APL 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            |
| 2    | 1   | C1                | 220 nF, 250 V, Film  | ECQ-E2224KF        | Panasonic          |
| 3    | 1   | C2                | 33 nF, 310 VAC, Polyester Film, X2                                   | BFC233920333       | Vishay             |
| 4    | 1   | C3                | 470 nF, 50 V, Ceramic, Y5G, 0603                                     | C1608Y5V1H474Z     | TDK                |
| 5    | 1   | C5                | 180 nF, 250 V, Film  | ECQ-E2184KB        | Panasonic          |
| 6    | 1   | C6                | 2.2 $\mu$ F, 250 V, Electrolytic, (6.3 x 11)                         | 225CKH250M         | Illinois Capacitor |
| 7    | 1   | C7                | 2.2 nF, 630 V, Ceramic, X7R, 1206                                    | ECJ-3FBJ222K       | Panasonic          |
| 8    | 1   | C8                | 100 $\mu$ F, 10 V, X5R, 1206   | C3216X5R1A107M     | TDK                |
| 9    | 1   | C9                | 22 $\mu$ F, 50 V, Electrolytic, Low ESR, 900 m $\Omega$ , (5 x 11.5) | ELXZ500ELL220MEB5D | Nippon Chemi-Con   |
| 10   | 1   | C10               | 100 nF, 50 V, Ceramic, X7R, 0805                                     | CC0805KRX7R9BB104  | Yageo              |
| 11   | 1   | C11               | 1.5 nF, Ceramic, Y1  | 440LD15-R          | Vishay             |
| 12   | 1   | C12               | 1000 $\mu$ F, 50 V, Electrolytic, Gen. Purpose, (12.5 x 25)          | EKM500ELL102MK25S  | Nippon Chemi-Con   |
| 13   | 1   | C16               | 220 pF, 630 V, Ceramic, NPO, 1206                                    | C3216C0G2J221J     | TDK                |
| 14   | 1   | C17               | 100 nF, 50 V, Ceramic, X7R, 1206                                     | GRM319R71H104KA01D | Murata             |
| 15   | 1   | D1                | 600 V, 1 A, Rectifier, Glass Passivated, POWERDI123                  | DFLR1600-7         | Diodes, Inc.       |
| 16   | 1   | D2                | Diode Ultrafast, SW 600 V, 1 A, SMA                                  | US1J-13-F          | Diodes, Inc.       |
| 17   | 1   | D3                | 100 V, 3 A, Schottky, DO-214AA                                       | STPS3H100U         | ST Micro           |
| 18   | 1   | D4                | 100 V, 0.2 A, Fast Switching, 50 ns, SOD-323                         | BAV19WS-7-F        | Diodes, Inc.       |
| 19   | 1   | D5                | 250 V, 0.2 A, Fast Switching, 50 ns, SOD-323                         | BAV21WS-7-F        | Diodes, Inc.       |
| 20   | 1   | D6                | 100 V, 8 A, Schottky, TO-220AC                                       | 8TQ100PBF          | Vishay             |
| 21   | 1   | F1                | 3 A, 125V, Fast, Microfuse, Axial                                    | MQ3                | BelFUSE            |
| 22   | 1   | L1                | 18.7 mH, 0.22 A, Common Mode Choke                                   | RL-4400-1-18.7     | Renco              |
| 23   | 1   | L2                | 2.2 mH, 0.19 A, Ferrite Core   | CTCH895F-222K      | CT Parts           |
| 24   | 1   | Q1                | SCR, 600 V, 1.25 A, TO-92  | X0202MA 2BL2       | ST Micro           |
| 25   | 1   | Q2                | NPN, Small Signal BJT, 40 V, 0.2 A, SOT-23                           | MMBT3904LT1G       | On Semi            |
| 26   | 2   | R1 R2             | 1 k $\Omega$ , 5%, 1/2 W, Thick Film, 1210                           | ERJ-14YJ102U       | Panasonic          |
| 27   | 1   | R3                | 10 k $\Omega$ , 5%, 1/8 W, Thick Film, 0805                          | ERJ-6GEYJ103V      | Panasonic          |
| 28   | 2   | R5 R6             | 510 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ514V      | Panasonic          |
| 29   | 1   | R7                | 2.00 M $\Omega$ , 1%, 1/4 W, Metal Film                              | RNF14FTD2M00       | Stackpole          |
| 30   | 1   | R8                | 100 $\Omega$ , 5%, 2 W, Metal Oxide                                  | RSMF2JT100R        | Stackpole          |
| 31   | 1   | R9                | 390 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ394V      | Panasonic          |
| 32   | 1   | R10               | 4.7 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                         | ERJ-8GEYJ472V      | Panasonic          |
| 33   | 1   | R11               | 24.9 k $\Omega$ , 1%, 1/8 W, Thick Film, 0805                        | ERJ-6ENF2492V      | Panasonic          |
| 34   | 3   | R12<br>R25<br>R26 | 39 $\Omega$ , 5%, 1/4 W, Thick Film, 1206                            | ERJ-8GEYJ390V      | Panasonic          |
| 35   | 1   | R13               | 154 k $\Omega$ , 1%, 1/4 W, Thick Film, 1206                         | ERJ-8ENF1543V      | Panasonic          |
| 36   | 1   | R14               | 1 k $\Omega$ , 5%, 1/8 W, Thick Film, 0805                           | ERJ-6GEYJ102V      | Panasonic          |
| 37   | 2   | R17<br>R27        | 20 k $\Omega$ , 5%, 1/4 W, Thick Film, 1206                          | ERJ-8GEYJ203V      | Panasonic          |
| 38   | 1   | RV1               | 140 V, 12 J, 7 mm, RADIAL  | V140LA2P           | Littlefuse         |
| 39   | 1   | T1                | Bobbin, RM6, Vertical, 6 pins  | B65808-N1006-D1    | Epcos              |
| 40   | 1   | U1                | LYTSwitch, eSIP-7C   | LYT4314E           | Power Integrations |
| 41   | 1   | VR1               | 33 V, 5%, 500 mW, DO-213AA (MiniMELF)                                | ZMM5257BDICT-ND    | Diodes, Inc.       |



16.3 無 APL 效率

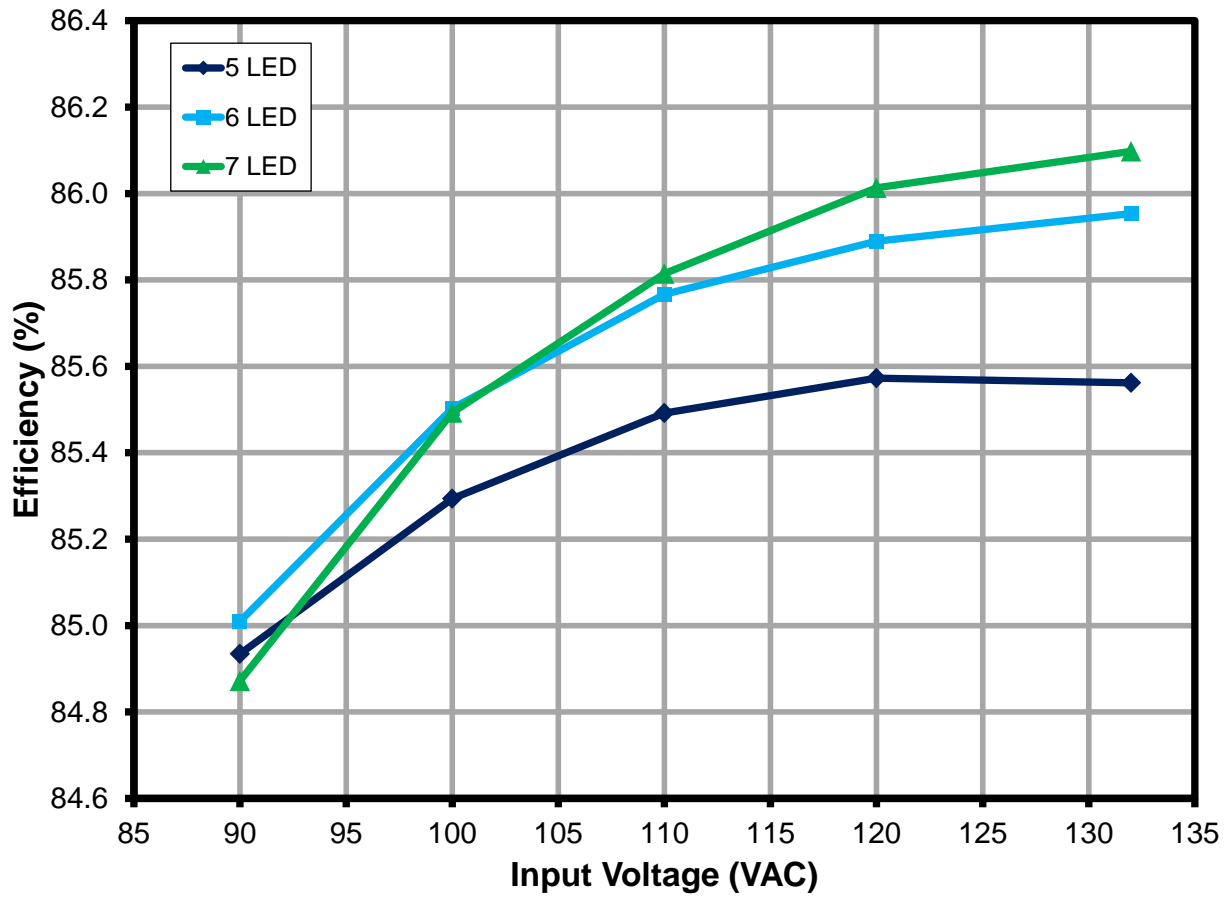


Figure 72 – Efficiency vs. Line and Load.



16.4 無 APL 線電壓和負載穩定度關係圖

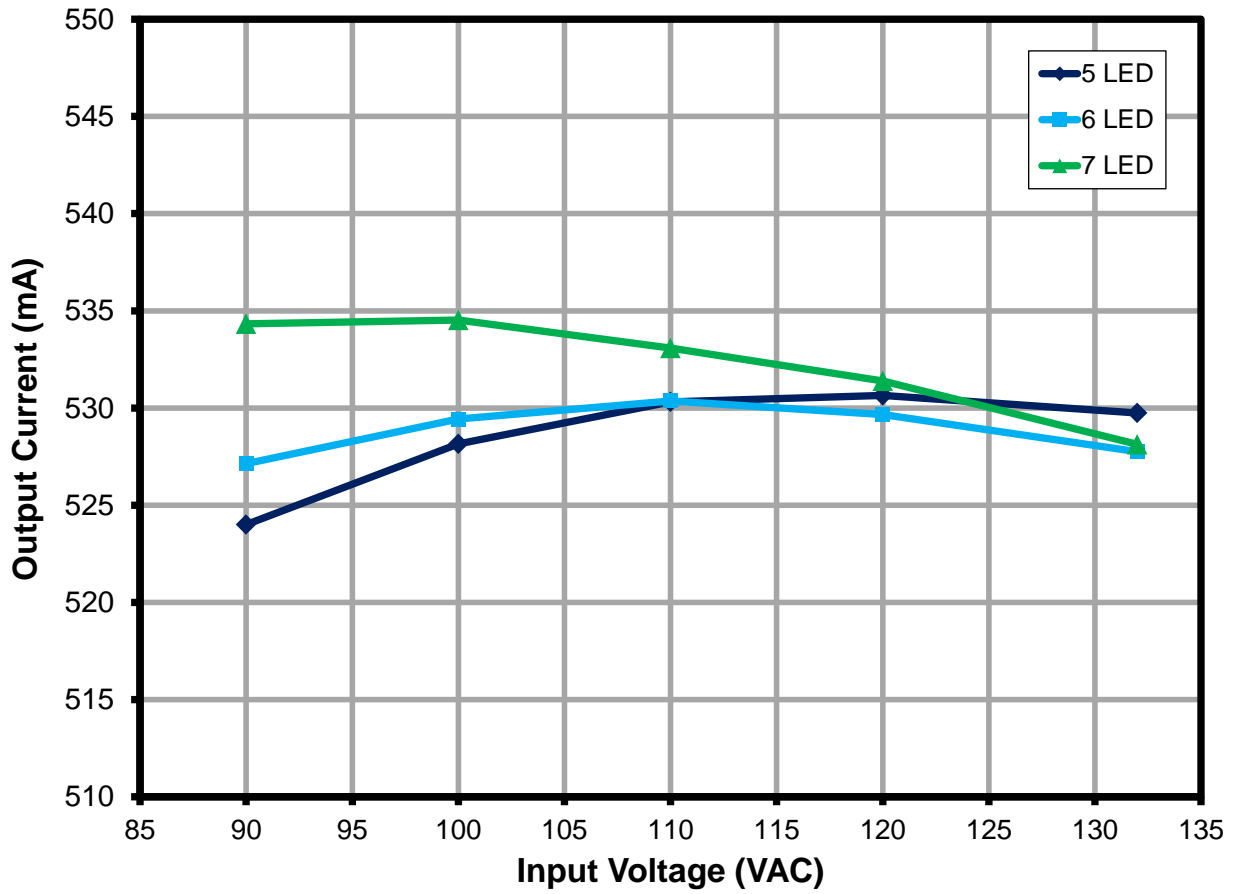


Figure 73 – Regulation vs. Line and Load.

16.5 無 APL 功率因數

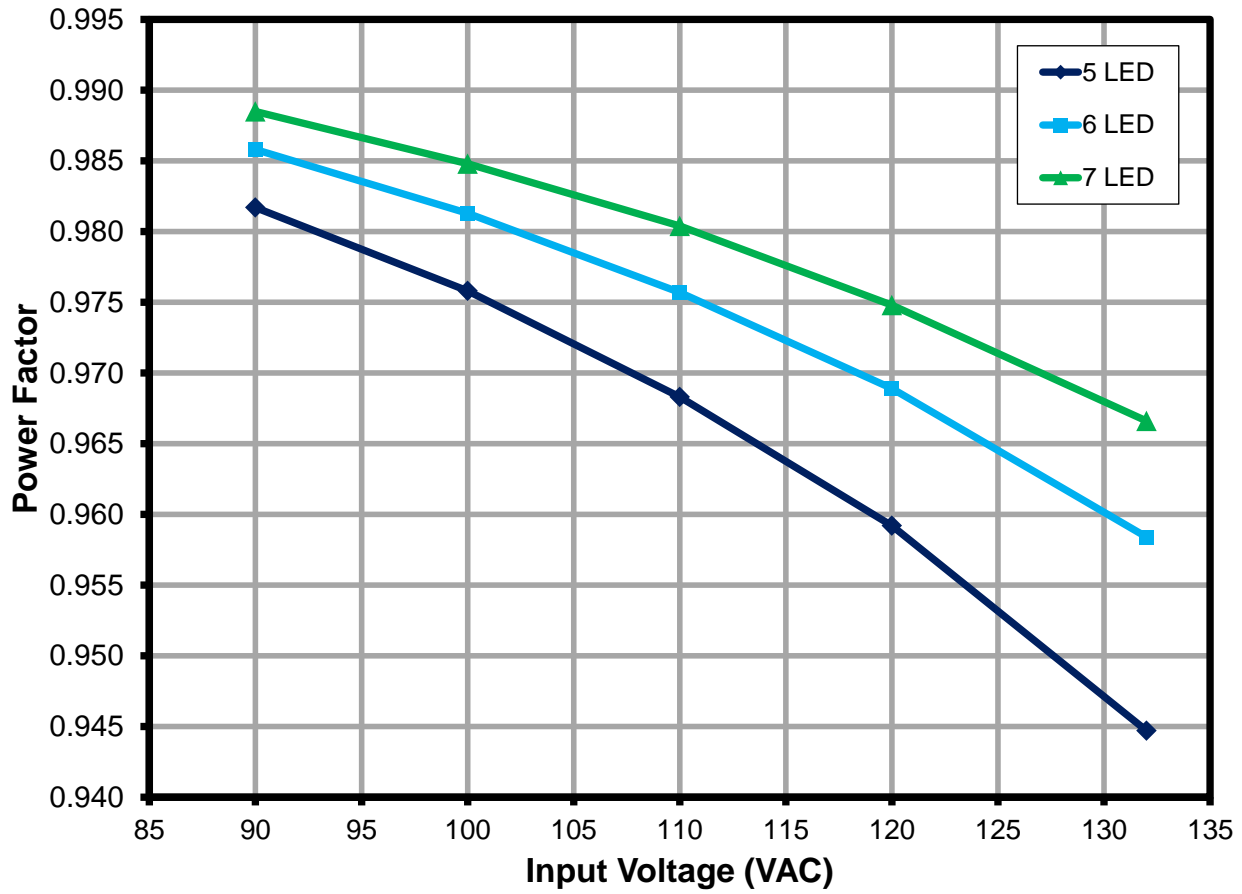


Figure 74 – Power Factor vs. Line and Load.



16.6 ~~無~~ APL A-THD

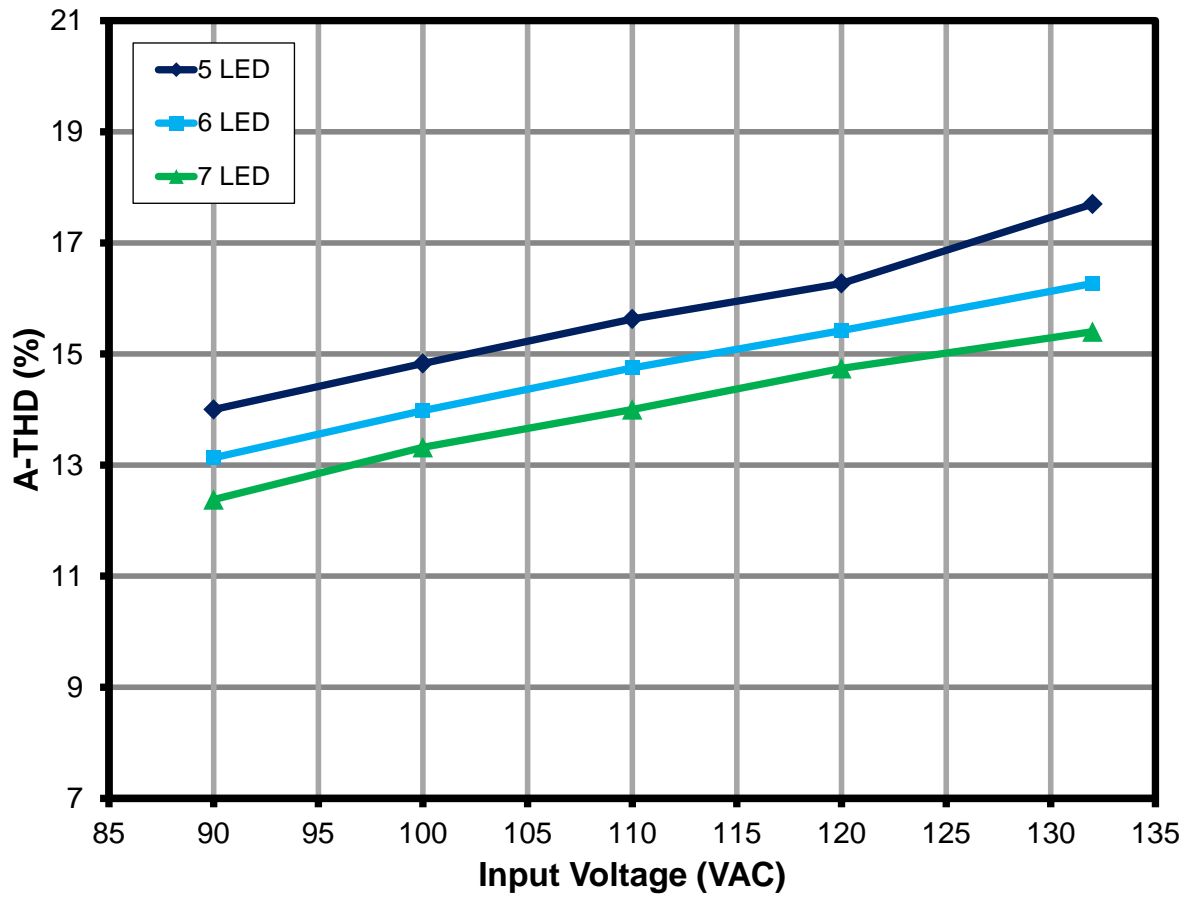


Figure 75 – A-THD vs. Line and Load.



### 16.7 無 APL 諧波電流

The design met the limits for Class C equipment for an active input power of <25 W. In this case IEC61000-3-2 specifies that harmonic currents shall not exceed the limits of Class D equipment<sup>1</sup>. Therefore the limits shown in the charts below are Class D limits which must not be exceeded to meet Class C compliance.

#### 16.7.1 15 V LED 負載

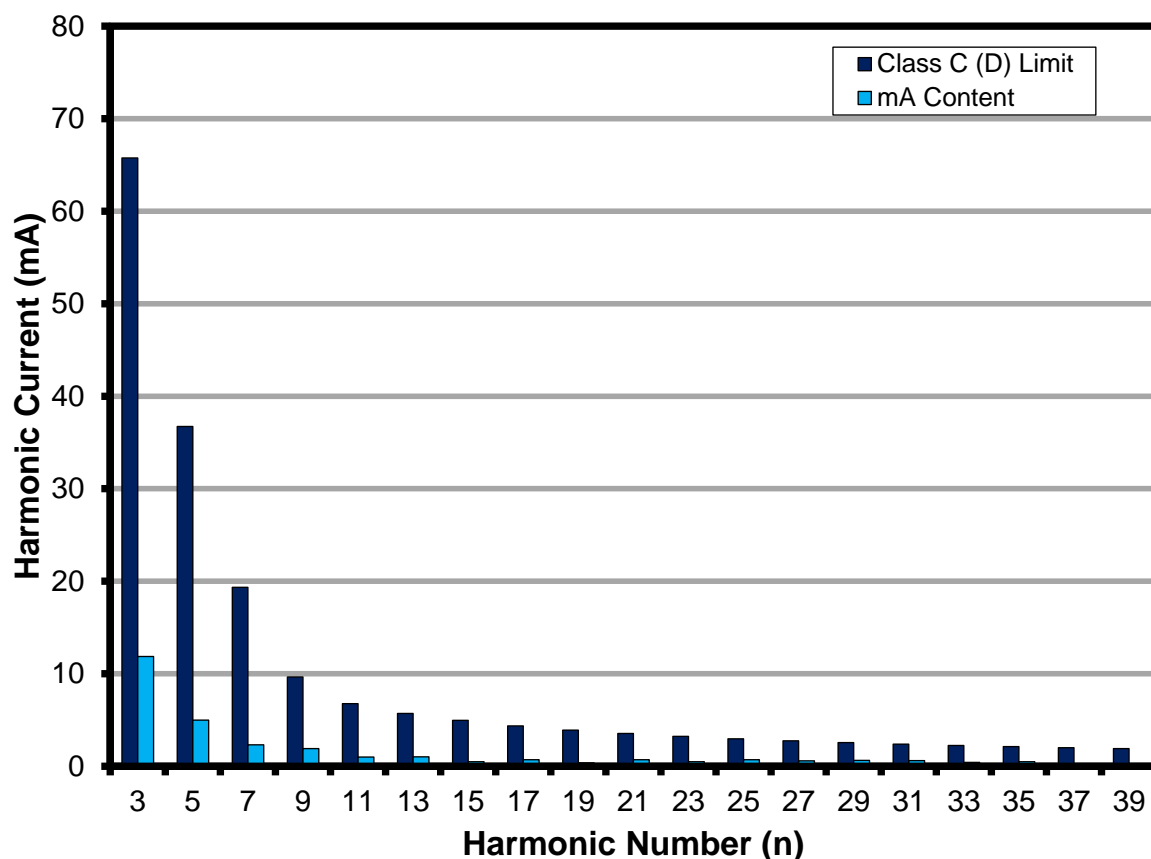


Figure 76 – 15 V LED Load Input Current Harmonics case (IEC61000-3-2) at 120 VAC, 60 Hz.

<sup>1</sup> IEC6000-3-2 Section 7.3, table 2, column 2.



16.7.3 18 V LED 負載

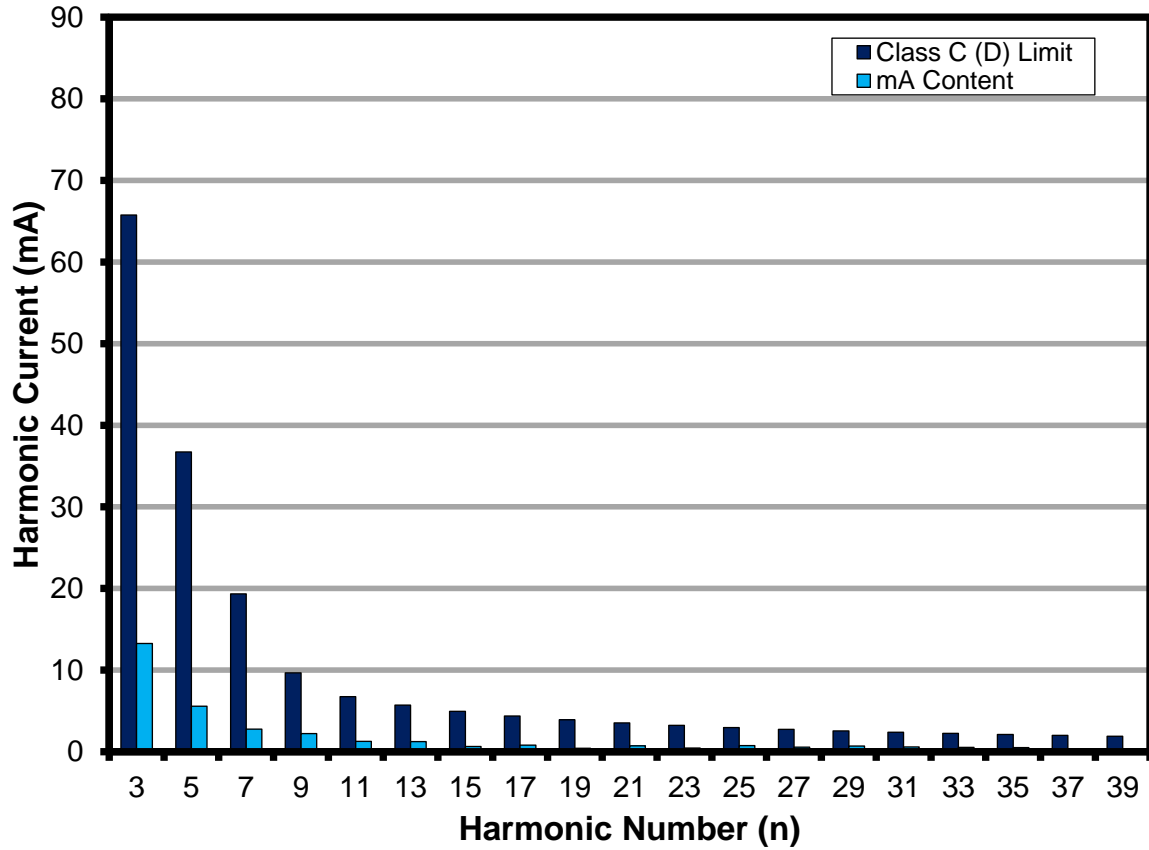


Figure 77 – 18 V LED Load Input Current Harmonics (IEC61000-3-2) at 120 VAC, 60 Hz.





16.7.4 21 V LED 負載

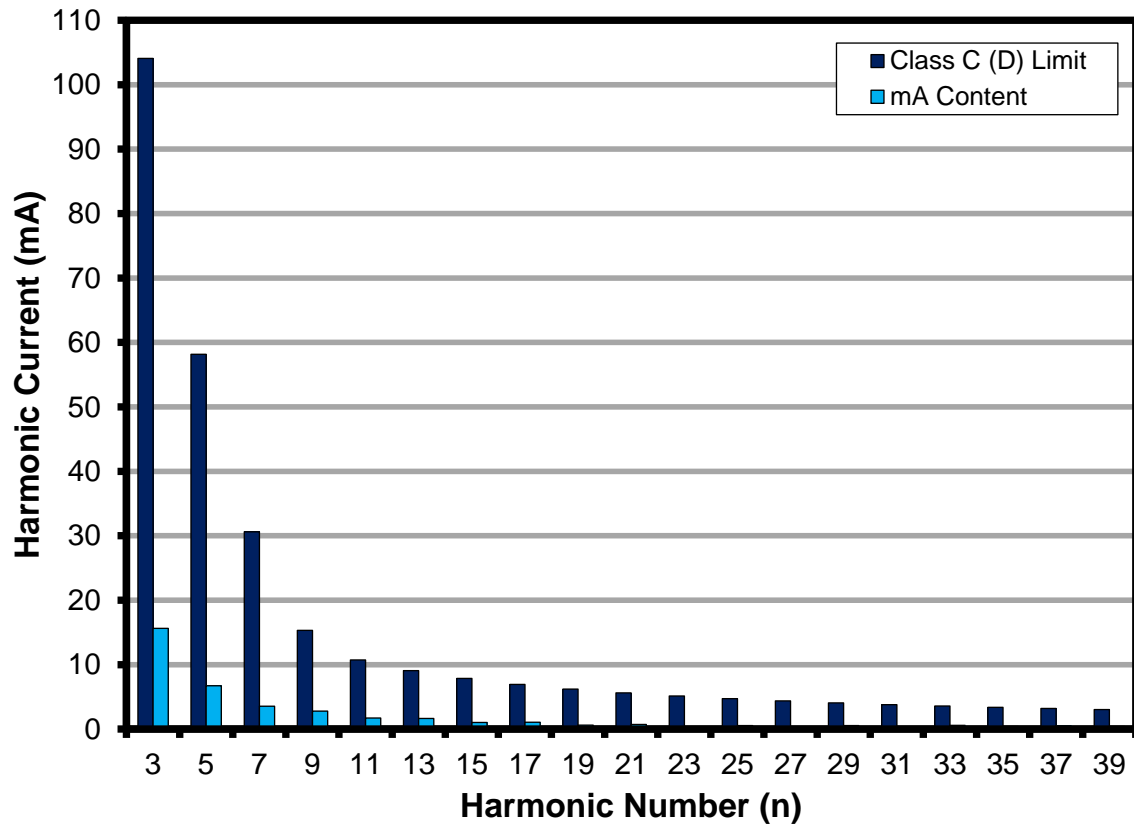


Figure 78 – 21 V LED Load Input Current Harmonics (IEC61000-3-2) at 120 VAC, 60 Hz.



**16.8 無 APL 測試資料**

All measurements were taken with the board at open frame, 25 °C ambient, and 60 Hz line frequency.

**16.8.1 測試資料，15 V LED 負載**

| Input Measurement                      |   |                        |       |       | Load Measurement                       |   |                         | Calculation             |                   |             |
|--|---|------------------------|-------|-------|--|---|-------------------------|-------------------------|-------------------|-------------|
| V <sub>IN</sub><br>(V <sub>RMS</sub> ) | I <sub>IN</sub><br>(mA <sub>RMS</sub> ) | P <sub>IN</sub><br>(W) | PF    | %ATHD | V <sub>OUT</sub><br>(V <sub>DC</sub> ) | I <sub>OUT</sub><br>(mA <sub>DC</sub> ) | P <sub>OUT</sub><br>(W) | P <sub>CAL</sub><br>(W) | Efficiency<br>(%) | Loss<br>(W) |
| 90.01                                  | 108.92                                  | 9.624                  | 0.982 | 14.00 | 15.50                                  | 524.00                                  | 8.17                    | 8.12                    | 84.93             | 1.45        |
| 99.97                                  | 99.04                                   | 9.661                  | 0.976 | 14.83 | 15.50                                  | 528.16                                  | 8.24                    | 8.19                    | 85.29             | 1.42        |
| 110.02                                 | 90.82                                   | 9.676                  | 0.968 | 15.63 | 15.50                                  | 530.32                                  | 8.27                    | 8.22                    | 85.49             | 1.40        |
| 119.99                                 | 84.00                                   | 9.669                  | 0.959 | 16.27 | 15.49                                  | 530.65                                  | 8.27                    | 8.22                    | 85.57             | 1.40        |
| 132.01                                 | 77.36                                   | 9.648                  | 0.945 | 17.7  | 15.49                                  | 529.75                                  | 8.26                    | 8.20                    | 85.56             | 1.39        |

**16.8.2 測試資料，18 V LED 負載**

| Input Measurement                      |   |                        |       |       | Load Measurement                       |   |                         | Calculation             |                   |             |
|--|---|------------------------|-------|-------|--|---|-------------------------|-------------------------|-------------------|-------------|
| V <sub>IN</sub><br>(V <sub>RMS</sub> ) | I <sub>IN</sub><br>(mA <sub>RMS</sub> ) | P <sub>IN</sub><br>(W) | PF    | %ATHD | V <sub>OUT</sub><br>(V <sub>DC</sub> ) | I <sub>OUT</sub><br>(mA <sub>DC</sub> ) | P <sub>OUT</sub><br>(W) | P <sub>CAL</sub><br>(W) | Efficiency<br>(%) | Loss<br>(W) |
| 90.00                                  | 130.67                                  | 11.594                 | 0.986 | 13.13 | 18.60                                  | 527.14                                  | 9.86                    | 9.81                    | 85.01             | 1.74        |
| 99.97                                  | 118.18                                  | 11.593                 | 0.981 | 13.98 | 18.63                                  | 529.44                                  | 9.91                    | 9.86                    | 85.50             | 1.68        |
| 110.03                                 | 107.77                                  | 11.570                 | 0.976 | 14.75 | 18.62                                  | 530.36                                  | 9.92                    | 9.87                    | 85.77             | 1.65        |
| 119.99                                 | 99.19                                   | 11.532                 | 0.969 | 15.42 | 18.61                                  | 529.66                                  | 9.90                    | 9.86                    | 85.89             | 1.63        |
| 132.02                                 | 90.72                                   | 11.479                 | 0.958 | 16.27 | 18.61                                  | 527.76                                  | 9.87                    | 9.82                    | 85.95             | 1.61        |

**16.8.3 測試資料，21 V LED 負載**

| Input Measurement                      |   |                        |       |       | Load Measurement                       |   |                         | Calculation             |                   |             |
|--|---|------------------------|-------|-------|--|---|-------------------------|-------------------------|-------------------|-------------|
| V <sub>IN</sub><br>(V <sub>RMS</sub> ) | I <sub>IN</sub><br>(mA <sub>RMS</sub> ) | P <sub>IN</sub><br>(W) | PF    | %ATHD | V <sub>OUT</sub><br>(V <sub>DC</sub> ) | I <sub>OUT</sub><br>(mA <sub>DC</sub> ) | P <sub>OUT</sub><br>(W) | P <sub>CAL</sub><br>(W) | Efficiency<br>(%) | Loss<br>(W) |
| 90.00                                  | 152.60                                  | 13.577                 | 0.989 | 12.38 | 21.47                                  | 534.33                                  | 11.52                   | 11.47                   | 84.87             | 2.05        |
| 99.97                                  | 136.89                                  | 13.476                 | 0.985 | 13.32 | 21.46                                  | 534.52                                  | 11.52                   | 11.47                   | 85.49             | 1.96        |
| 110.03                                 | 124.04                                  | 13.380                 | 0.980 | 14    | 21.45                                  | 533.09                                  | 11.48                   | 11.43                   | 85.81             | 1.90        |
| 120.00                                 | 113.68                                  | 13.298                 | 0.975 | 14.74 | 21.44                                  | 531.39                                  | 11.44                   | 11.39                   | 86.01             | 1.86        |
| 132.02                                 | 103.37                                  | 13.192                 | 0.967 | 15.4  | 21.42                                  | 528.13                                  | 11.36                   | 11.31                   | 86.10             | 1.83        |



## 16.8.4 120 VAC 60 Hz, 15 V LED 負載諧波資料

## Current Harmonics Limits for IEC61000-3-2

| V         | Freq       | I (mA)    | P           | PF          | %THD    |
|-----------|------------|-----------|-------------|-------------|---------|
| 120       | 60.00      | 84.00     | 9.6690      | 0.9592      | 16.27   |
|           |            |           |             |             |         |
| nth Order | mA Content | % Content | Limit <25 W | Limit >25 W | Remarks |
| 1         | 82.79      |           |             |             |         |
| 2         | 0.02       | 0.02%     |             | 2.00%       |         |
| 3         | 11.88      | 14.35%    | 65.7492     | 28.78%      | Pass    |
| 5         | 4.99       | 6.03%     | 36.7422     | 10.00%      | Pass    |
| 7         | 2.34       | 2.83%     | 19.3380     | 7.00%       | Pass    |
| 9         | 1.92       | 2.32%     | 9.6690      | 5.00%       | Pass    |
| 11        | 1.01       | 1.22%     | 6.7683      | 3.00%       | Pass    |
| 13        | 1.03       | 1.24%     | 5.7270      | 3.00%       | Pass    |
| 15        | 0.51       | 0.62%     | 4.9634      | 3.00%       | Pass    |
| 17        | 0.71       | 0.86%     | 4.3795      | 3.00%       | Pass    |
| 19        | 0.39       | 0.47%     | 3.9185      | 3.00%       | Pass    |
| 21        | 0.72       | 0.87%     | 3.5453      | 3.00%       | Pass    |
| 23        | 0.49       | 0.59%     | 3.2370      | 3.00%       | Pass    |
| 25        | 0.73       | 0.88%     | 2.9781      | 3.00%       | Pass    |
| 27        | 0.60       | 0.72%     | 2.7575      | 3.00%       | Pass    |
| 29        | 0.64       | 0.77%     | 2.5673      | 3.00%       | Pass    |
| 31        | 0.61       | 0.74%     | 2.4017      | 3.00%       | Pass    |
| 33        | 0.44       | 0.53%     | 2.2561      | 3.00%       | Pass    |
| 35        | 0.49       | 0.59%     | 2.1272      | 3.00%       | Pass    |
| 37        | 0.24       | 0.29%     | 2.0122      | 3.00%       | Pass    |
| 39        | 0.28       | 0.34%     | 1.9090      | 3.00%       | Pass    |
| 41        | 0.09       | 0.11%     |             |             |         |
| 43        | 0.13       | 0.16%     |             |             |         |
| 45        | 0.20       | 0.24%     |             |             |         |
| 47        | 0.27       | 0.33%     |             |             |         |
| 49        | 0.28       | 0.34%     |             |             |         |



## 16.8.5 120 VAC 60 Hz, 18 V LED 負載諧波資料

## Current Harmonics Limits for IEC61000-3-2

| V         | Freq       | I (mA)    | P           | PF          | %THD    |
|-----------|------------|-----------|-------------|-------------|---------|
| 120       | 60.00      | 99.19     | 11.5320     | 0.9689      | 15.42   |
|           |            |           |             |             |         |
| nth Order | mA Content | % Content | Limit <25 W | Limit >25 W | Remarks |
| 1         | 97.97      |           |             |             |         |
| 2         | 0.03       | 0.03%     |             | 2.00%       |         |
| 3         | 13.27      | 13.54%    | 78.4176     | 29.07%      | Pass    |
| 5         | 5.57       | 5.69%     | 43.8216     | 10.00%      | Pass    |
| 7         | 2.77       | 2.83%     | 23.0640     | 7.00%       | Pass    |
| 9         | 2.23       | 2.28%     | 11.5320     | 5.00%       | Pass    |
| 11        | 1.27       | 1.30%     | 8.0724      | 3.00%       | Pass    |
| 13        | 1.24       | 1.27%     | 6.8305      | 3.00%       | Pass    |
| 15        | 0.65       | 0.66%     | 5.9198      | 3.00%       | Pass    |
| 17        | 0.81       | 0.83%     | 5.2233      | 3.00%       | Pass    |
| 19        | 0.43       | 0.44%     | 4.6735      | 3.00%       | Pass    |
| 21        | 0.74       | 0.76%     | 4.2284      | 3.00%       | Pass    |
| 23        | 0.47       | 0.48%     | 3.8607      | 3.00%       | Pass    |
| 25        | 0.77       | 0.79%     | 3.5519      | 3.00%       | Pass    |
| 27        | 0.57       | 0.58%     | 3.2888      | 3.00%       | Pass    |
| 29        | 0.71       | 0.72%     | 3.0619      | 3.00%       | Pass    |
| 31        | 0.59       | 0.60%     | 2.8644      | 3.00%       | Pass    |
| 33        | 0.54       | 0.55%     | 2.6908      | 3.00%       | Pass    |
| 35        | 0.51       | 0.52%     | 2.5370      | 3.00%       | Pass    |
| 37        | 0.34       | 0.35%     | 2.3999      | 3.00%       | Pass    |
| 39        | 0.38       | 0.39%     | 2.2768      | 3.00%       | Pass    |
| 41        | 0.13       | 0.13%     |             |             |         |
| 43        | 0.18       | 0.18%     |             |             |         |
| 45        | 0.11       | 0.11%     |             |             |         |
| 47        | 0.12       | 0.12%     |             |             |         |
| 49        | 0.17       | 0.17%     |             |             |         |



## 16.8.7 120 VAC 60 Hz, 21 V LED 負載諧波資料

## Current Harmonics Limits for IEC61000-3-2

| V         | Freq       | I (mA)    | P           | PF          | %THD    |
|-----------|------------|-----------|-------------|-------------|---------|
| 120       | 60.00      | 113.68    | 13.2980     | 0.9748      | 14.74   |
|           |            |           |             |             |         |
| nth Order | mA Content | % Content | Limit <25 W | Limit >25 W | Remarks |
| 1         | 112.41     |           |             |             |         |
| 2         | 0.07       | 0.06%     |             | 2.00%       |         |
| 3         | 14.43      | 12.84%    | 90.4264     | 29.24%      | Pass    |
| 5         | 6.18       | 5.50%     | 50.5324     | 10.00%      | Pass    |
| 7         | 3.20       | 2.85%     | 26.5960     | 7.00%       | Pass    |
| 9         | 2.62       | 2.33%     | 13.2980     | 5.00%       | Pass    |
| 11        | 1.62       | 1.44%     | 9.3086      | 3.00%       | Pass    |
| 13        | 1.58       | 1.41%     | 7.8765      | 3.00%       | Pass    |
| 15        | 0.96       | 0.85%     | 6.8263      | 3.00%       | Pass    |
| 17        | 1.04       | 0.93%     | 6.0232      | 3.00%       | Pass    |
| 19        | 0.64       | 0.57%     | 5.3892      | 3.00%       | Pass    |
| 21        | 0.76       | 0.68%     | 4.8759      | 3.00%       | Pass    |
| 23        | 0.48       | 0.43%     | 4.4519      | 3.00%       | Pass    |
| 25        | 0.63       | 0.56%     | 4.0958      | 3.00%       | Pass    |
| 27        | 0.43       | 0.38%     | 3.7924      | 3.00%       | Pass    |
| 29        | 0.55       | 0.49%     | 3.5308      | 3.00%       | Pass    |
| 31        | 0.40       | 0.36%     | 3.3031      | 3.00%       | Pass    |
| 33        | 0.44       | 0.39%     | 3.1029      | 3.00%       | Pass    |
| 35        | 0.36       | 0.32%     | 2.9256      | 3.00%       | Pass    |
| 37        | 0.39       | 0.35%     | 2.7674      | 3.00%       | Pass    |
| 39        | 0.32       | 0.28%     | 2.6255      | 3.00%       | Pass    |
| 41        | 0.25       | 0.22%     |             |             |         |
| 43        | 0.25       | 0.22%     |             |             |         |
| 45        | 0.15       | 0.13%     |             |             |         |
| 47        | 0.17       | 0.15%     |             |             |         |
| 49        | 0.13       | 0.12%     |             |             |         |



### 16.9 使用模擬 TRIAC 的無 APL 調光曲線

Using Agilent 6812B AC Source programmed as perfect leading edge dimmer

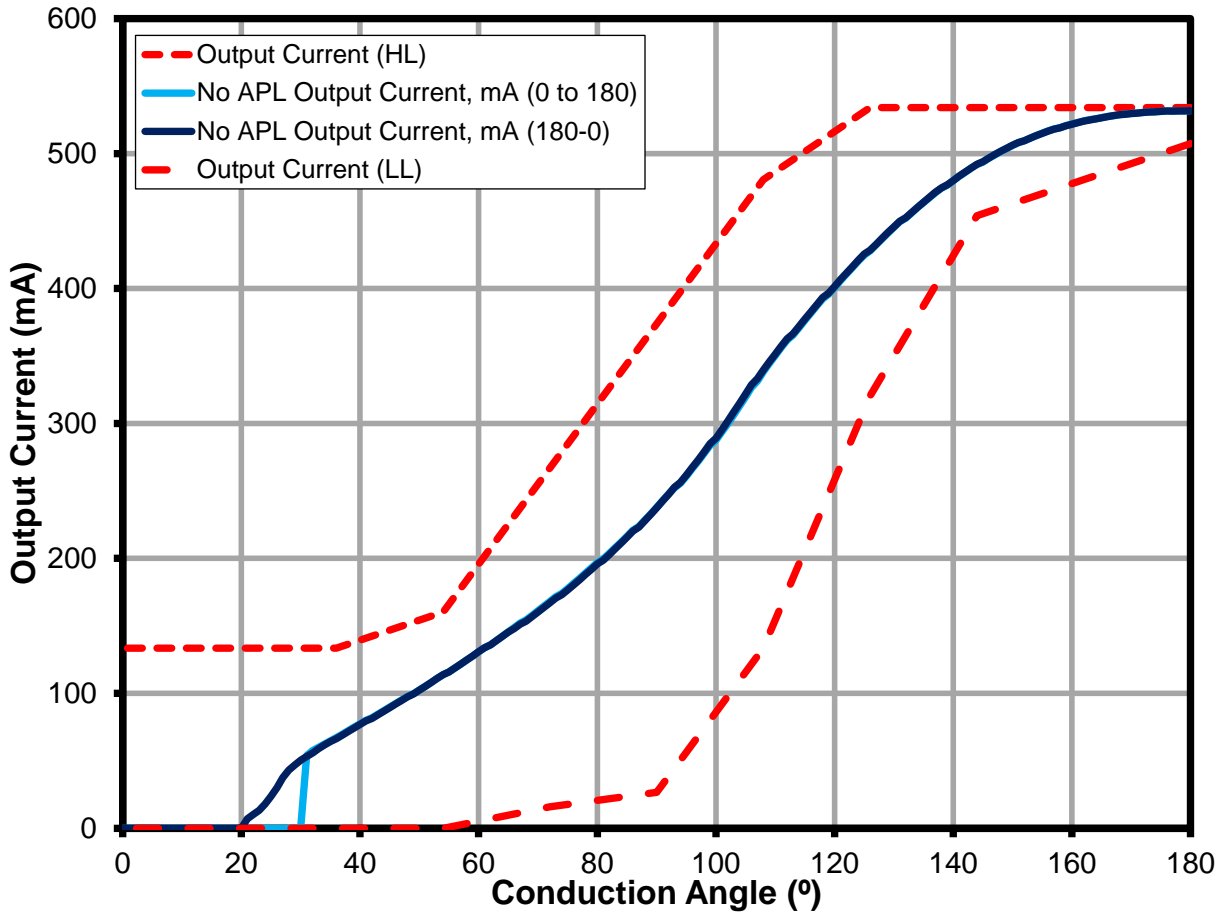


Figure 79 – Dimming Curve at 120 VAC, 60 Hz Input.

**16.10 使用真實調光器的無 APL 效能**

The following data were taken by measuring the RMS input voltage to the driver as a result of TRIAC chopping the AC input. A leading and trailing edge TRIAC dimmer was used on the data below using 21 V LED load and 120 V, 60 Hz AC input.

16.10.1 調光曲線

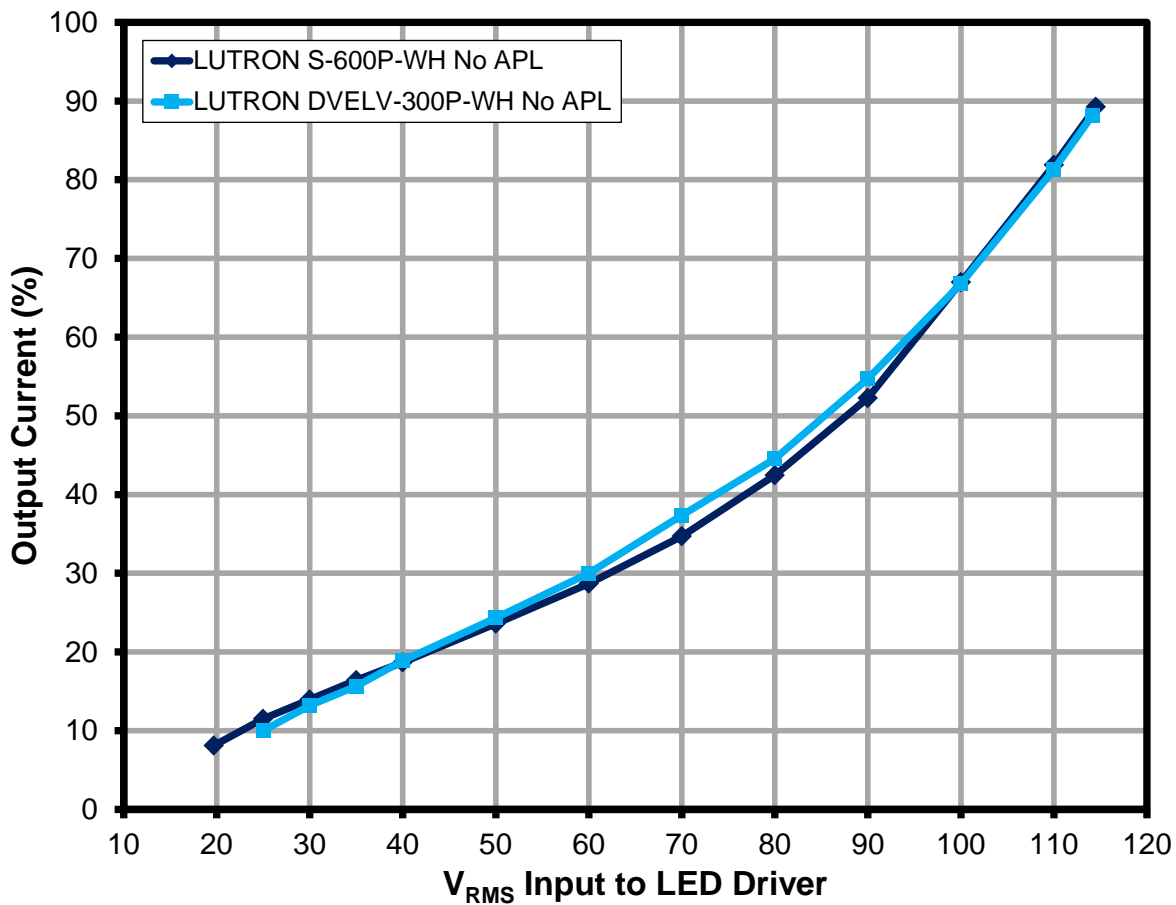


Figure 80 – Dimming Curve as a Function of Input Voltage to the Driver.



## 16.10.2 典型前緣調光器效能資料

Dimmer: LUTRON S-600P-WH

Input: 120 VAC, 60 Hz

| V <sub>IN(RMS)</sub><br>(V) | I <sub>OUT</sub><br>(mA) | I <sub>OUT</sub><br>(%) | V <sub>OUT</sub><br>(V) | P <sub>OUT</sub><br>(W) | P <sub>IN</sub><br>(W) | Efficiency<br>(%) | P <sub>LOSS</sub><br>(W) | Start-upTime<br>(ms) |
|-----------------------------|--------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------------------|--------------------------|----------------------|
| 114.5                       | 473                      | 89.25                   | 21.25                   | 10.11                   | 13.47                  | 75.1              | 3.36                     | 128                  |
| 110                         | 434                      | 81.89                   | 21.14                   | 9.21                    | 12.65                  | 72.8              | 3.44                     | 128                  |
| 100                         | 355                      | 66.98                   | 20.82                   | 7.43                    | 10.9                   | 68.2              | 3.47                     | 153                  |
| 90                          | 277                      | 52.26                   | 20.51                   | 5.7                     | 9.1                    | 62.6              | 3.4                      | 164                  |
| 80                          | 225                      | 42.45                   | 20.3                    | 4.58                    | 7.84                   | 58.4              | 3.26                     | 186                  |
| 70                          | 184                      | 34.72                   | 20.2                    | 3.73                    | 6.82                   | 54.7              | 3.09                     | 204                  |
| 60                          | 152                      | 28.68                   | 20                      | 3.05                    | 5.98                   | 51.0              | 2.93                     | 251                  |
| 50                          | 125                      | 23.58                   | 19.81                   | 2.48                    | 5.19                   | 47.8              | 2.71                     | 318                  |
| 40                          | 99                       | 18.68                   | 19.6                    | 1.95                    | 4.5                    | 43.3              | 2.55                     | 412                  |
| 35                          | 87                       | 16.42                   | 19.5                    | 1.7                     | 4.1                    | 41.5              | 2.4                      | 550                  |
| 30                          | 74                       | 13.96                   | 19.37                   | 1.44                    | 3.78                   | 38.1              | 2.34                     | 1800                 |
| 25                          | 61                       | 11.51                   | 19.22                   | 1.16                    | 3.5                    | 33.1              | 2.34                     |                      |
| 19.7                        | 43                       | 8.11                    | 19                      | 0.82                    | 3.1                    | 26.5              | 2.28                     |                      |

## 16.10.3 典型後緣調光器效能資料

Dimmer: LUTRON DVELV-300P-WH

Input: 120 VAC, 60 Hz

| V <sub>IN(RMS)</sub><br>(V) | I <sub>OUT</sub><br>(mA) | I <sub>OUT</sub><br>(%) | V <sub>OUT</sub><br>(V) | P <sub>OUT</sub><br>(W) | P <sub>IN</sub><br>(W) | Efficiency<br>(%) | P <sub>LOSS</sub><br>(W) | Start-upTime<br>(ms) |
|-----------------------------|--------------------------|-------------------------|-------------------------|-------------------------|------------------------|-------------------|--------------------------|----------------------|
| 114.1                       | 467                      | 88.11                   | 21.14                   | 9.96                    | 12.97                  | 76.8              | 3.01                     | 110                  |
| 110                         | 431                      | 81.32                   | 21                      | 9.12                    | 12.05                  | 75.7              | 2.93                     | 118                  |
| 100                         | 354                      | 66.79                   | 20.75                   | 7.4                     | 10.1                   | 73.3              | 2.7                      | 122                  |
| 90                          | 290                      | 54.72                   | 20.5                    | 6                       | 8.53                   | 70.3              | 2.53                     | 123                  |
| 80                          | 236                      | 44.53                   | 20.3                    | 4.83                    | 7.2                    | 67.1              | 2.37                     | 128                  |
| 70                          | 198                      | 37.36                   | 20.2                    | 4.03                    | 6.28                   | 64.2              | 2.25                     | 147                  |
| 60                          | 159                      | 30.00                   | 20                      | 3.2                     | 5.35                   | 59.8              | 2.15                     | 187                  |
| 50                          | 129                      | 24.34                   | 19.81                   | 2.6                     | 4.62                   | 56.3              | 2.02                     | 212                  |
| 40                          | 100                      | 18.87                   | 19.58                   | 1.96                    | 3.93                   | 49.9              | 1.97                     | 254                  |
| 35                          | 83                       | 15.66                   | 19.5                    | 1.62                    | 3.54                   | 45.8              | 1.92                     | 307                  |
| 30                          | 70                       | 13.21                   | 19.3                    | 1.36                    | 3.24                   | 42.0              | 1.88                     | 355                  |
| 25                          | 53                       | 10.00                   | 19.12                   | 1                       | 2.86                   | 35.0              | 1.86                     | 520                  |

## 16.10.4 調光器相容性清單

| Item | List of Dimmers   | Part Number      | V <sub>RMS(MIN)</sub> | I <sub>MIN</sub> (mA) | V <sub>RMS(MAX)</sub> | I <sub>MAX</sub> (mA) | Dim Ratio |
|------|-------------------|------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| 1    | LUTRON LG600PH-LA | LG-600PH-WH      | 21                    | 53                    | 114.6                 | 474                   | 9         |
| 2    | LUTRON S603P      | S-603P-WH        | 21                    | 48                    | 115.0                 | 476                   | 10        |
| 3    | LUTRON SLV600P    | SLV600P-WH       | 28                    | 70                    | 115.5                 | 482                   | 7         |
| 4    | LUTRON S600       | S-600-WH         | 24                    | 58                    | 117.6                 | 505                   | 9         |
| 5    | LUTRON S-600PH-WH | S-600PH-WH       | 19                    | 41                    | 115.0                 | 477                   | 12        |
| 6    | LUTRON DVCL153P   | DVWCL-153-PLH-WH | 15.3                  | 22                    | 113.3                 | 462                   | 21        |





|    |                      |               |       |     |       |     |     |
|----|----------------------|---------------|-------|-----|-------|-----|-----|
| 7  | LUTRON DV603P        | DV-603P-WH    | 23    | 56  | 114.6 | 473 | 8   |
| 8  | LUTRON DV600P        | DV-600P-WH    | 21.7  | 53  | 114.7 | 474 | 9   |
| 9  | LUTRON TG600PH-IV    | TG-600PH-WH   | 35    | 85  | 115.6 | 484 | 6   |
| 10 | LUTRON AY600P        | AY-600P-WH    | 36    | 87  | 115.2 | 480 | 6   |
| 11 | LUTRON GL600P-WH     | GL-600P-WH    | 25    | 62  | 114.8 | 476 | 8   |
| 12 | LEVITON 6633PLI      | R62-06633-1LW | 20    | 51  | 118.7 | 518 | 10  |
| 13 | LEVITON 6631-LI      | R62-06631-1LW | 12    | 5   | 116.5 | 493 | 105 |
| 14 | LEVITON IPI06        | R60-IPI06-1LM | 34    | 87  | 118.3 | 513 | 6   |
| 15 | LEVITON 6161-I       | R52-06161-00W | 33    | 68  | 115.2 | 480 | 7   |
| 16 | LEVITON RP106        | R52-RPI06-1LW | 32    | 56  | 119.0 | 523 | 9   |
| 17 | LEVITON 6681         | R60-06681-0IW | 12    | 6   | 115.5 | 484 | 82  |
| 18 | LEVITON TGM10-1LW    | TGM10-1LW     | 16.5  | 34  | 113.2 | 459 | 14  |
| 19 | LEVITON 6684         | R60-06684-1IW | 14    | 17  | 119.0 | 524 | 31  |
| 20 | LEVITON 6683         | 6683          | 17    | 25  | 119.0 | 524 | 21  |
| 21 | LEVITON 6613         | R02-06613-PLW | 19    | 42  | 118.7 | 519 | 12  |
| 22 | COOPER SLC03         | SLC03P-W-K-L  | 16    | 25  | 116.0 | 490 | 20  |
| 23 | LUTRON GL600-WH      | GL-600-WH     | 26.67 | 68  | 117.4 | 502 | 7   |
| 24 | LUTRON DVPDC-203P-WH | DVPDC-203P-WH | 60    | 152 | 117.0 | 497 | 3   |
| 25 | LUTRON LX600PL       | LX-600PL-wh   | 27    | 65  | 116.7 | 495 | 8   |
| 26 | LUTRON D600P         | D-600P-WH     | 15    | 27  | 113.2 | 460 | 17  |
| 27 | LUTRON CTCL-153PDH   |               | 15.5  | 26  | 113.7 | 465 | 18  |
| 28 | LUTRON S-600P        | S-600P        | 18    | 41  | 115.0 | 477 | 12  |
| 29 | LUTRON TGLV-600P     | TGLV-600P     | 32.7  | 81  | 116.0 | 489 | 6   |
| 30 | LUTRON TGLV-600PR    | TGLV-600PR    | 34    | 83  | 115.0 | 482 | 6   |
| 31 | LUTRON TT-300NLH-WH  | TT-300NLH-WH  | 24    | 59  | 118.0 | 510 | 9   |
| 32 | LUTRON TT-300H-WH    | TT-300H-WH    | 12    | 7   | 118.0 | 510 | 73  |
| 33 | LUTRON NLV-1000-WH   | NLV-1000-WH   | 24    | 61  | 116.2 | 490 | 8   |
| 34 | Lutron               | MAELV -600    | 31    | 72  | 115.3 | 477 | 7   |
| 35 | Lutron               | S-600P        | 23    | 57  | 114.5 | 473 | 8   |
| 36 | Lutron               | S-600P        | 18.7  | 41  | 117.5 | 503 | 12  |
| 37 | Cooper               | S106P         | 29.9  | 76  | 117.0 | 500 | 7   |
| 38 | Lutron               | S-103P-WH     | 29.9  | 75  | 115.0 | 477 | 6   |
| 39 | Lutron               | S-10P-WH      | 25.6  | 59  | 114.0 | 467 | 8   |
| 40 | Lutron               | S-600PNLH-WH  | 25.4  | 63  | 115.5 | 483 | 8   |
| 41 | Lutron               | S-603PNL-WH   | 28    | 68  | 115.4 | 482 | 7   |
| 42 | Lutron               | SLV-603P-WH   | 33.33 | 83  | 115.2 | 480 | 6   |
| 43 | Lutron               | S-603PGH-WH   | 21    | 50  | 106.0 | 395 | 8   |
| 44 | Lutron               | AYLV-600P-WH  | 32.2  | 81  | 114.8 | 475 | 6   |
| 45 | Lutron               | AYLV-603P-WH  | 33.8  | 85  | 114.8 | 475 | 6   |
| 46 | Lutron               | AY-103PNL-WH  | 29.4  | 71  | 116.5 | 493 | 7   |
| 47 | Lutron               | AY-103P-WH    | 29.2  | 65  | 116.9 | 497 | 8   |
| 48 | Lutron               | AY-10PNL-WH   | 26    | 65  | 118.6 | 518 | 8   |
| 49 | Lutron               | AY-10P-WH     | 23    | 57  | 117.0 | 497 | 9   |
| 50 | Lutron               | AY-603PNL-WH  | 30    | 73  | 112.7 | 455 | 6   |
| 51 | Lutron               | AY-603PG-WH   | 32.6  | 78  | 103.6 | 380 | 5   |
| 52 | Lutron               | AY-603P-WH    | 36    | 87  | 114.3 | 470 | 5   |
| 53 | Lutron               | AY-600PNL-WH  | 31    | 74  | 115.4 | 482 | 7   |
| 54 | Lutron               | DVELV-300P-WH | 24.8  | 50  | 114.0 | 462 | 9   |
| 55 | Lutron               | DVLV-10P-WH   | 33.3  | 84  | 114.4 | 470 | 6   |



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|    |        |              |      |    |       |     |    |
|----|--------|--------------|------|----|-------|-----|----|
| 56 | Lutron | DVLV-103P-WH | 31.6 | 79 | 114.7 | 474 | 6  |
| 57 | Lutron | DVLV-603P-WH | 30.6 | 76 | 114.9 | 476 | 6  |
| 58 | Lutron | S-1000-WH    | 28   | 69 | 117.5 | 503 | 7  |
| 59 | Lutron | SELV-300P-WH | 24.5 | 50 | 112.6 | 452 | 9  |
| 60 | Lutron | S-600P-WH    | 19.5 | 42 | 114.6 | 474 | 11 |
| 61 | Lutron | S-103PNL-WH  | 30.8 | 69 | 114.4 | 472 | 7  |
| 62 | Lutron | GLV-600-WH   | 22.8 | 58 | 117.5 | 503 | 9  |

**Figure 81** – Dimmer Compatibility List.



**17 修訂記錄**

| <b>Date</b> | <b>Author</b> | <b>Revision</b> | <b>Description and Changes</b> | <b>Reviewed</b> |
|-------------|---------------|-----------------|--------------------------------|-----------------|
| 13-Nov-12   | CA            | 1.0             | Initial Release                | Apps & Mktg     |
|             |               |                 |                                |                 |
|             |               |                 |                                |                 |



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