設計範例報告

標題	***採用 TinySwitch™-4 TNY286PG 的 12 W 功率因數修正 (Valley Fill)、非調光、隔離返馳式、定電壓 (24 V) LED 驅動器***
規格	輸入：190 VAC – 265 VAC (47 – 63 Hz)； 輸出：24 V，500 mA_{CONT}
應用	鎮流器 LED 驅動器
作者	應用工程部門
文件編號	DER-423
日期	2014 年 11 月 7 日
修訂	1.0

摘要與功能

- EcoSmart™ – 符合所有現行與提案中的調和節能標準
    - CECP (中國)、CEC、EPA、AGO、歐盟執行委員會
- 230 VAC 條件下，無負載功耗低於 100 mW
- 工作模式效率超過 80%
- 嚴格公差的 I^2f 參數 (-10%、+12%) 可降低系統成本
    - 增加 MOSFET 和變壓器功率傳輸
    - 減少過載功率，降低輸出二極體和電容器成本
- 整合式 TinySwitch-4 安全/可靠性功能
    - 精確的 (±5%) 自動恢復磁滯回復過溫保護功能可確保 PCB 在所有情況下皆保持在安全的溫度
    - 自動重新啟動功能可防止發生輸出短路及開迴路的故障狀況
    - 封裝上的安規距離大於 3.2 mm，可在高濕度和高污染環境中進行可靠的運作

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- 符合 EN550022、EN55015 和 CISPR-22 B 級傳導性 EMI

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

1 簡介

本工程報告文件說明採用 TinySwitch-4 產品系列之 TNY286PG 的 12 W 電源供應器。此電源供應器專為滿足 LED 鎮流器應用而設計，但亦可用作為一般評估平台。

本文件內容涵蓋電源供應器的規格、電路圖、物料表、變壓器文件、印刷電路板佈局和效能資料。

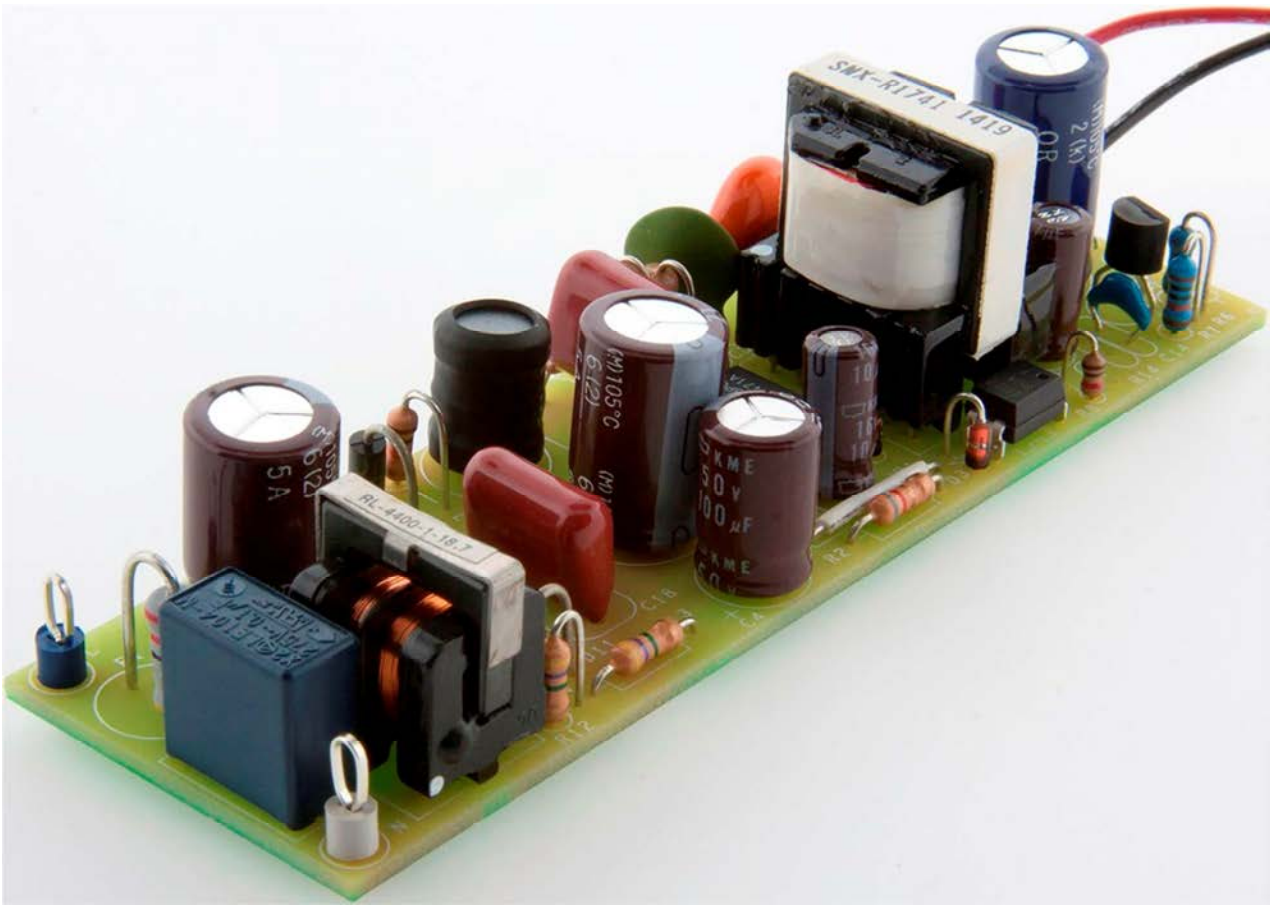

Figure 1 – Populated Circuit Board Photograph.

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2 電源供應器規格

下表列出此設計可接受的最低效能。實際效能列在結果部分。

說明	符號	最小值	典型值	最大值	單位	註解
輸入						
電壓	V_{IN}	190		265	VAC	雙線 – 無 P.E.
頻率	f_{LINE}	47	50/60	63	Hz	
無負載輸入功率 (230 VAC)				0.1	W	
浪湧電流 (冷啟動)	I_{RUSH}					269 V；50 Hz – PSU 不會發生損壞，保險絲亦不會成為開路狀態
輸出						
輸出電壓	V_{OUT}	22	24	26	V	± 5%
輸出漣波電壓	V_{RIPPLE}			1	V	以 180 µF、0.1 µF 和 1 µF 陶瓷電容器測得的峰至峰 20 MHz 頻寬
總輸出功率						
連續輸出功率	P_{OUT}			12	W	
效率						
25、50、75 和 100 % 的 P_{OUT} 條件下所需的平均效率	η_{AVE}	80			%	根據能源之星測試方法
環境						
傳導性 EMI		符合 CISPR22B/EN55022B/FCC 第 15 條				接地或未接地外殼均有 6 dBuV 餘裕
安全		設計符合 IEC950 / UL1950 第 II 級				
漏電流	I_{LEAK}	0.25 mA				於 265 V_{RMS}，50/60 Hz 條件下測得
線電壓突波						
差模 (L1-L2)				1	kV	IEC 61000-4-5/EN5504，
共模 (L1/L2-PE)				2.5	kV	
振盪波 (100 kHz)						500 A 短路
差模 (L1-L2)				2.5	kV	串聯阻抗：差模：2 Ω
共模 (L1/L2-PE)					kV	共模： 12 Ω
環境溫度	T_{AMB}	0		40	^{o}C	自然對流，海平面

3 電路圖

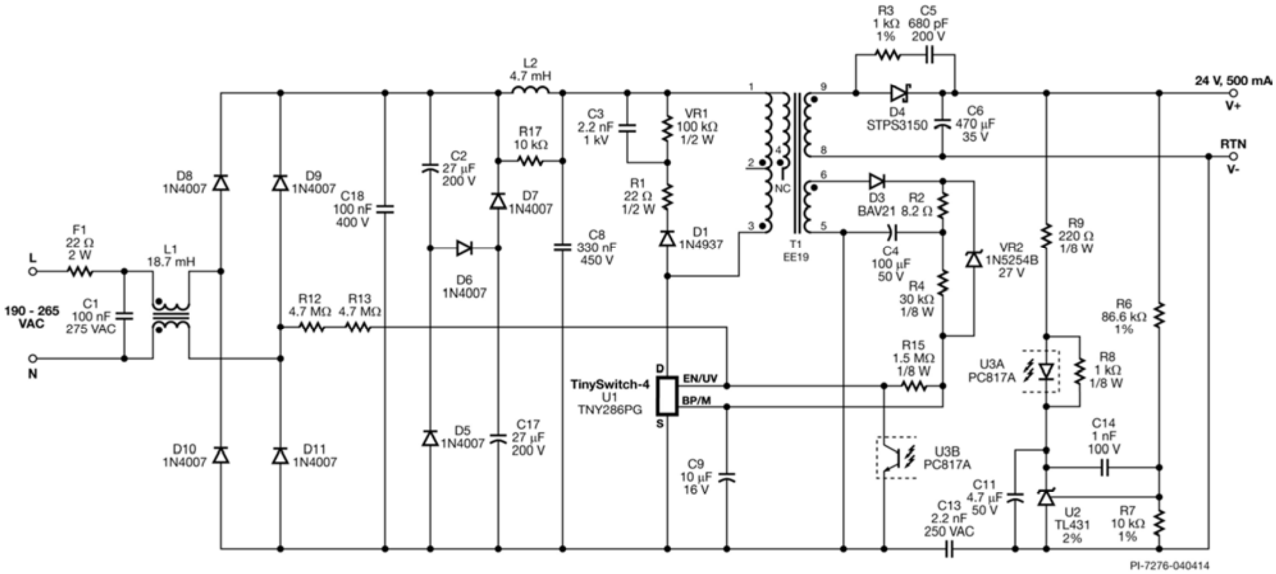

Figure 2 – Schematic.

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4 電路說明

此電路設計適用於配置為當輸入電壓範圍為 190 VAC 至 265 VAC 時，於 24 V 條件下提供 500 mA 的隔離返馳式 LED 鎮流器驅動器應用。

4.1 輸入階段

可熔電阻器 F1 可在元件發生故障時提供保護，以避免一次側電路短路或過載。此可熔電阻器亦可在調光時協助抑制輸入電流振盪。其電阻有助於抑制差模線間突波。

二極體 D8 至 D11 配置為全橋整流器。

共模電感器 L1、電容器 C1、C18、C8 和差模電感器 L2 共同構成 EMI 濾波器。TinySwitch-4 的頻率抖動功能確保符合 B 級輻射量限值。電阻器 R17 可抑制 L2 的諧振，有助於降低 EMI 高頻雜訊。電感器 L2 放置於橋式後方，以平衡火線和地線之間的 EMI 波形。這也讓我們得以在輸入濾波器中使用高電壓的小陶瓷電容器。

Valley Fill 電路是由 C2、C17 和 D6、D7 及 D5 構成，提供大於 0.7 的功率因數 (PF)。同一個電路會吸收來自線間突波擾動的電能。

4.2 TinySwitch-4 一次側

TNY286PG 裝置 (U1) 是一個積體電路，其中包含功率 MOSFET、振盪器、控制、啟動和保護等功能。

箝位電路 (D1、VR1、R1 和 C3) 會在每次功率 MOSFET 關閉時限制 U1 的汲極上的電壓。此箝位設計可在輕載狀況下發揮最大效率。

偏壓/輔助供電繞組的輸出由二極體 D3 進行整流，並由電容器 C4 進行濾波。偏壓繞組用於在進行穩態操作期間向 TNY286PG BYPASS/多功能 (BP/M) 接腳供應電流。選用電阻器 R4 的值來讓 IC 供應電流給 BP/M 接腳，藉此禁用通常為 BP/M 接腳電容器 (C9) 充電的內部高電壓電流源。這會減少 IC 散熱，進而降低所有負載條件下的輸入功耗，同時也會降低無負載功耗。C9 有三個不同的電容器值可用，它會選擇三種內部限電流 (如 RED、STD、INC) 之一。此設計採用 10 µF 電容器，它會為 TNY286PG 選擇增加限電流 (INC) 設定值。

光耦合器 U3 的電晶體會從 U1 的啟用/欠壓 (EN/UV) 接腳帶出電流。只要從 EN/UV 接腳汲取的電流低於 90 µA，IC 就會持續切換。一旦從 EN/UV 接腳汲取的電流超過該臨界值 (即 90 µA 到 150 µA 之間，典型值為 ≈115 µA)，IC 就會停止切換。藉由啟用和停用切換脈衝，回授迴路即能調節輸出電壓。

內部狀態機器會根據主輸出負載電流，將功率 MOSFET 限電流設定為 4 種等級之一。如此可確保有效切換頻率維持在可聞頻率範圍之上。最低限電流 (用於無負載) 可大幅降低變壓器磁通密度，使其不產生可感雜訊，特別是浸凡立水變壓器。

4.3 輸出整流

蕭特基二極體 D4 提供輸出整流，而電容器 C6 是主輸出濾波器電容器。二次側 RC (R3、C5) 吸收器是在 D4 上用於降低 EMI。

4.4 輸出回授

電阻器 R6 和 R7 組成電壓分壓網路，可將輸出電壓的成比例電壓訊號提供給 TL431 (U2) 的輸入端。TL431 會變換其陰極電壓，以使其輸入電壓保持恆定 (等於 2.5 V，±2%)。當陰極電壓變化時，流經 LED 和 U3 內電晶體的電流也會隨之改變。每當 EN/UV 接腳電流超過臨界值時，下一個切換週期就會停用，而當 EN/UV 接腳電流降低至臨界值以下時，下一個切換週期就會啟用。當負載減少時，啟用的切換週期的數目會藉由跳離一個週期而減少，以降低有效切換頻率和切換損失。這可在極輕負載下提供恆定效率，符合節能要求。電容器 C14 可利用頻率使 U2 的增益下降，以確保工作穩定。電容器 C11 提供軟啟動，可避免輸出電壓過衝。

4.5 線路感測

電阻器 R12 和 R13 會直接感測橋式整流器輸入端的輸入電壓。如此可降低無負載功耗。電阻器 R15 確保有足夠電流流入 EN/UV 接腳，即使沒有電流流經電阻器 R12 和 R13，其約為每個線間週期的 50%。這可確保永遠啟用 UV 偵測功能，藉此避免在緩慢電壓啟動或線間電壓下降期間發生任何暫時性延誤。

4.6 過壓保護 (OVP)

此 IC 透過 BP/M 接腳提供內部 OVP 鎖定保護。當因為開路回授情況而使電流超過 OV 關機臨界值 (≈5.5 mA)，以及當偏壓電壓上升至超過 VR2 臨界值時，就會觸發此保護功能。一旦 AC 線間再利用，就會透過 R12 和 R13 重設鎖定狀態。

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4.7 PCB 佈局

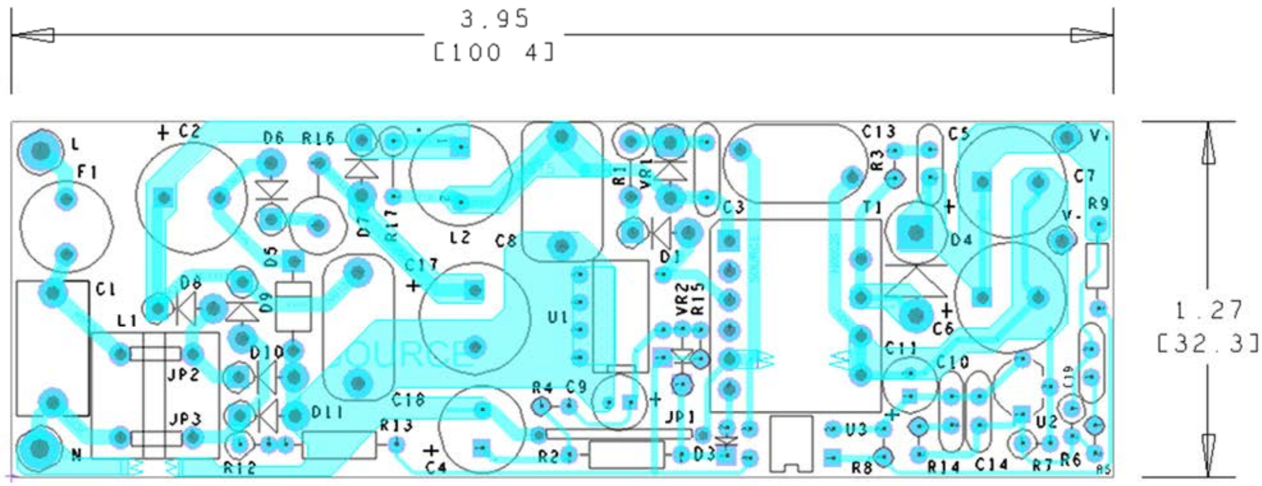

Figure 3 – Printed Circuit Layout.

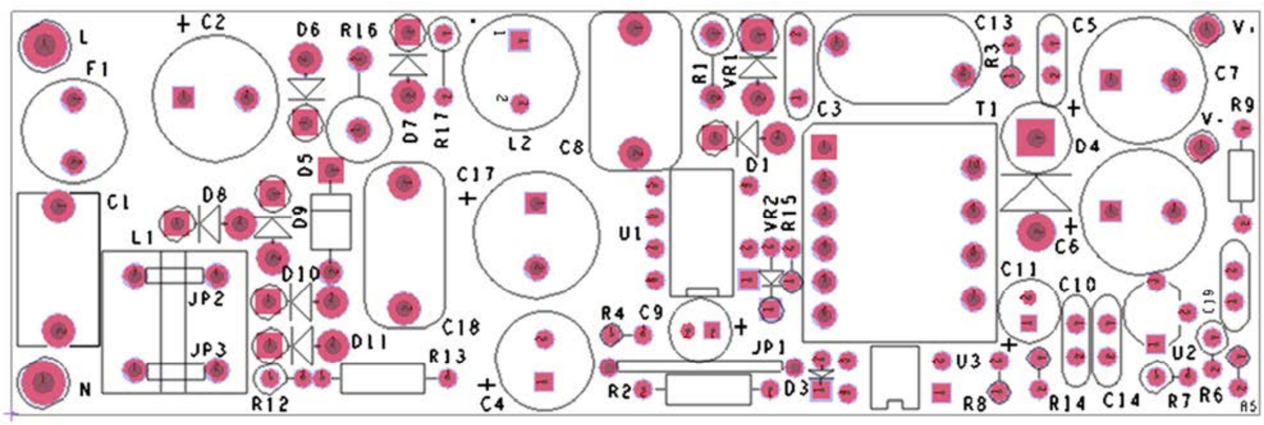

Figure 4 – Component legend.

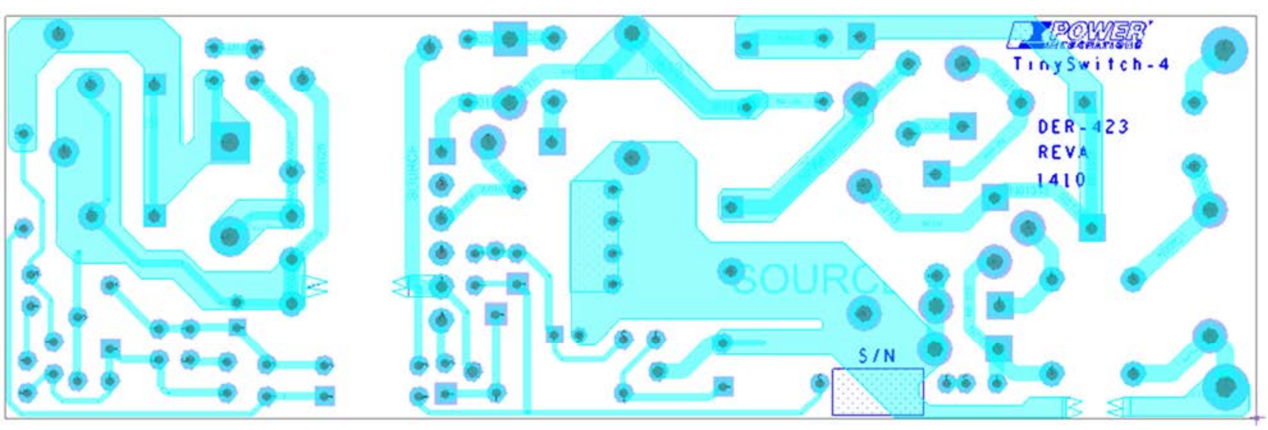

Figure 5 – Bottom Layout.

5 PCB 組裝

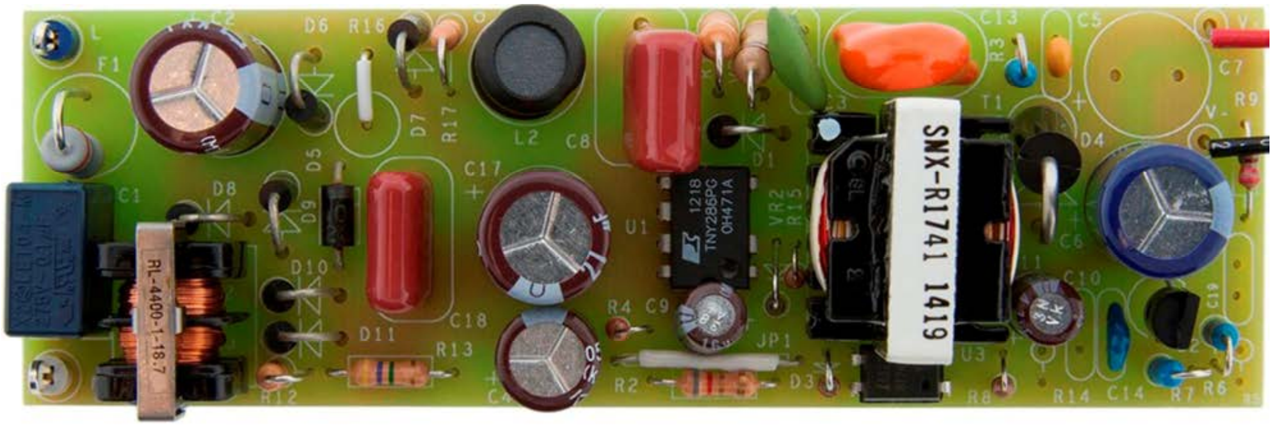

Figure 6 – Top Assembly, No Components on the Bottom Side. Some Parts can be Converted to SMD for More Compact Applications.

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6 物料清單

Item	Qty	Ref Des	Description	Mfg P/N	Manufacturer
1	1	C1	100 nF, 275VAC, Film, X2	LE104-M	OKAYA
2	2	C2 C17	27 μF, 200 V, Electrolytic, (10 x 16),	EKXJ201ELL270MJ16S	Nippon Chemi-Con
3	1	C3	2.2 nF, 1 kV, Disc Ceramic	NCD222K1KVY5FF	NIC
4	1	C4	100 μF, 50 V, Electrolytic, Gen. Purpose, (8 x 11.5)	KME50VB101M6X11LL	Nippon Chemi-Con
5	1	C5	680 pF, 200 V, Ceramic, X7R	C315C681K2R5TA	Kemet
6	1	C6	470 μF, 35 V, Electrolytic, Low ESR, 52 mΩ, (10 x 20)	ELXZ350ELL471MJ20S	Nippon Chemi-Con
7	1	C8	330 nF, 450 V, METALPOLYPRO	ECW-F2W334JAQ	Panasonic
8	1	C9	10 μF, 16 V, Electrolytic, Gen. Purpose, (5 x 11)	EKMG160ELL100ME11D	United Chemi-Con
9	1	C11	4.7 μF, 50 V, Electrolytic, Gen. Purpose, (5 x 11)	EKMG500ELL4R7ME11D	Nippon Chemi-Con
10	1	C13	2.2 nF, Ceramic, Y1	440LD22-R	Vishay
11	1	C14	1 nF, 100 V, Ceramic, X7R	FK18X7R2A102K	TDK
12	1	C18	100 nF, 400 V, Film	ECQ-E4104KF	Panasonic
13	1	D1	600 V, 1 A, Fast Recovery Diode, 200 ns, DO-41	1N4937RLG	On Semi
14	1	D3	250 V, 250 mA, Fast Switching, DO-35	BAV21	Vishay
15	1	D4	150 V, 3 A, Schottky, DO-201AD	STPS3150RL	ST
16	7	D5 D6 D7 D8 D9 D10 D11	1000 V, 1 A, Rectifier, DO-41	1N4007-E3/54	Vishay
17	1	F1	22 Ω, 10%, 2 W, 10 % Axial Flame Proof, Fusible, Pulse Withstanding	EMC2-22RKI	TT Electronics
18	1	L1	18.7 mH, 0.22 A, Common Mode Choke	RL-4400-1-18.7	Renco
19	1	L2	4.7 mH, 0.150 A, 20%	RL-5480-3-4700	Renco
20	1	R1	22 Ω, 5%, 1/2 W, Carbon Film	CFR-50JB-22R	Yageo
21	1	R2	8.2 Ω, 5%, 1/4 W, Carbon Film	CFR-25JB-8R2	Yageo
22	1	R3	1 kΩ, 1%, 1/4 W, Metal Film	MFR-25FBF-1K00	Yageo
23	1	R4	30 kΩ, 5%, 1/8 W, Carbon Film	CF18JT30K0	Stackpole
24	1	R6	86.6 kΩ, 1%, 1/4 W, Metal Film	MFR-25FBF-86K6	Yageo
25	1	R7	10 kΩ, 1%, 1/4 W, Metal Film	MFR-25FBF-10K0	Yageo
26	1	R8	1 kΩ, 5%, 1/8 W, Carbon Film	CF18JT1K00	Stackpole
27	1	R9	220 Ω, 5%, 1/8 W, Carbon Film	CF18JT220R	Stackpole
28	2	R12 R13	4.7 MΩ, 5%, 1/4 W, Carbon Film	CFR-25JB-4M7	Yageo
29	1	R15	1.5 MΩ, 5%, 1/8 W, Carbon Film	CF18JT1M50	Stackpole
30	1	R17	10 kΩ, 5%, 1/4 W, Carbon Film	CFR-25JB-10K	Yageo
31	1	T1	Bobbin, EE19, Vertical, 10 pins, 6pri, 4sec Transformer Transformer	TF-1939 SNX-R1741-X1 PNU-28624	Taiwan Shulin Santronics Premier Magnetics
32	1	U1	TinySwitch-4, DIP-8C	TNY286PG	Power Integrations
33	1	U2	2.495 V Shunt Regulator IC, 2%, 0 to 70C, TO-92	TL431CLPG	On Semi
34	1	U3	Optocoupler, 35 V, CTR 80-160%, 4-DIP	LTV817A	Liteon
35	2	V+ V-	PCB Terminal Hole, #22 AWG	N/A	N/A
36	1	VR1	100 kΩ, 5%, 1/2 W, Carbon Film	CFR-50JB-100K	Yageo
37	1	VR2	27 V, 5%, 500 mW, DO-35	1N5254B	Microsemi
Mechanical BOM					
1	1	JP1	Wire Jumper, Insulated, #24 AWG, 0.6 in	C2003A-12-02	Gen Cable
2	1	N	Test Point, WHT, THRU-HOLE MOUNT	5012	Keystone
3	1	L	Test Point, BLU, THRU-HOLE MOUNT	5127	Keystone
4	1	R16	Wire Jumper, Insulated, TFE, #22 AWG, 0.2 in	C2004-12-02	Alpha

5	1	WIRE #24 AWG INS (V+)	Wire, UL1007, #24 AWG, Red, PVC, 4 "	1007-24/7-2	Anixter
6	1	WIRE #24 AWG INS (V-)	Wire, UL1007, #24 AWG, Blk, PVC, 4"	1007-24/7-0	Anixter
7	1	PCB	PCB, 0.062 X 1.25 X 4 in; 2 oz Cu	-	-

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7 變壓器規格

7.1 *電氣圖*

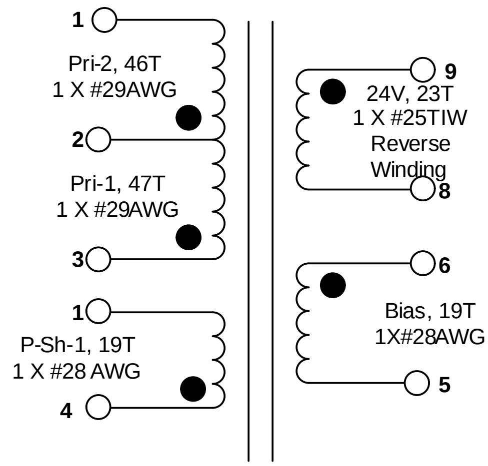

Figure 7 – Transformer Electrical Diagram.

7.2 *電氣規格*

Electrical Strength	1 second, 60 Hz, from pins 1-3 to pins 8-9.	3000 VAC
Primary Inductance	Pins 1-3, all other windings open, measured at 100 kHz, 0.4 V_{RMS}.	1200 µH ±10%
Resonant Frequency	Pins 1-3 all other windings open.	700 kHz (Min.)
Primary Leakage Inductance	Pins 1-3, with pins 5-9 shorted, measured at 100 kHz, 0.4 V_{RMS}.	25 µH (Max.)

7.3 *材料*

Item	Description
[1]	Core: EE19, P4 (Acme) or Equivalent, gapped for A_{LG} of 136 nH/T².
[2]	Bobbin: EE19 (6-4 pins) Vertical, High Creepage.
[3]	Tape Polyester film [2 mil (25 µm) base thickness], 9.00 mm wide.
[4]	Varnish; BC346 or BC359 (Dolphs).
[5]	Magnet Wire: AWG #29.
[6]	Triple Insulated Wire: AWG #25.
[7]	Magnet Wire: AWG #28.
[8]	Tape Polyester film [2 mil (25 µm) base thickness], 5.00 mm wide.

7.4 變壓器建構圖

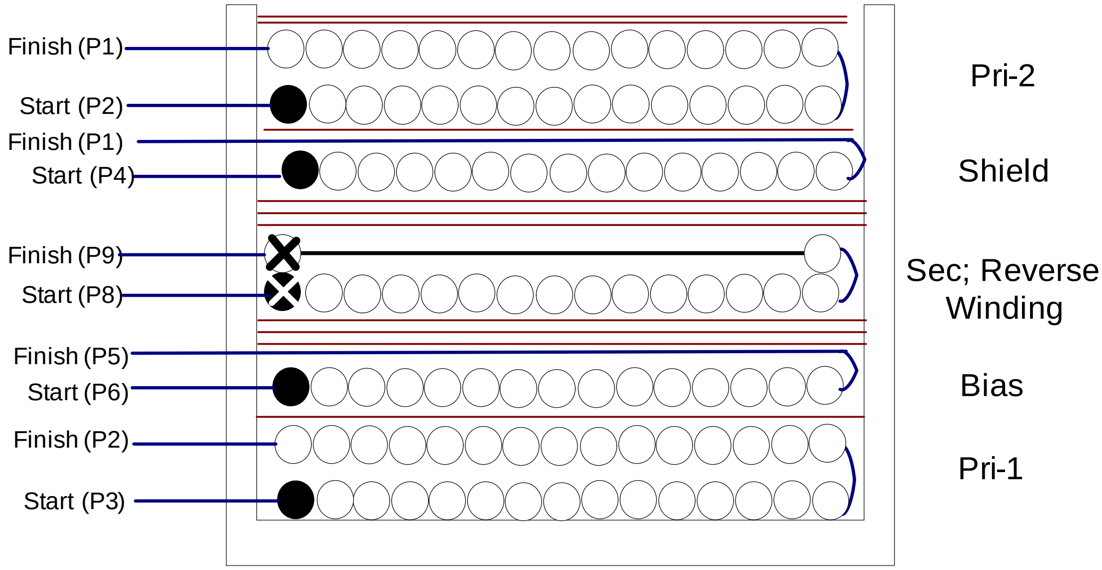

Figure 8 – Transformer Build Diagram.

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7.5 變壓器結構

Bobbin Preparation	For the purpose of these instructions, bobbin is oriented on winder such that pin 1 side is on the left. Winding direction is counter-clockwise. Follow the pin number assignment in the specification.
WDG1; Pri-1	Start on pin(s) 3 and wind 47 turns (x 1 filar) of item [5]. in 2 layer(s) from left to right. At the end of 1st layer, continue to wind the next layer from right to left. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 2. Wind 12 bifilar turns of #27 AWG. Finish on pin 10.
Insulation	Add 1 layer of tape, item [3], for insulation.
WDG2; Bias	Start on pin(s) 6 and wind 19 turns (x 1 filar) of item [7]. Wind in same rotational direction as primary winding. Spread the winding evenly across entire bobbin. Finish this winding on pin(s) 5.
Insulation	Add 3 layers of tape, item [3], for insulation.
WDG3; Sec Reverse Winding	Start on pin(s) 8 and reverse wind 23 turns (x 1 filar) of item [6]. Spread the winding evenly across entire bobbin. Wind in opposite rotational direction as primary winding. Finish this winding on pin(s) 9.
Insulation	Add 3 layers of tape, item [3], for insulation.
WDG4; Pri-Shield	Start at pin 4 on the secondary side and wind 19 turns (x 1 filar) of item [7]. Wind in same rotational direction as primary winding. Spread the winding evenly across entire bobbin. Finish this winding on pin(s) 1. Cut out wire connected to temp pin on secondary side. Leave this end of primary shield winding not connected. Bend the end 90 degree and cut the wire in the middle of the bobbin.
Insulation	Add 1 layer of tape, item [3], for insulation.
WDG5; Pri-2	Start on pin(s) 2 and wind 46 turns (x 1 filar) of item [5] in 2 layer(s) from left to right. At the end of 1st layer, continue to wind the next layer from right to left. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 1.
Core Preparation	Grind E core to get the desired inductance. Wrap bottom of one E core with 2 layers of tape to secure the core
Varnish	Dip the transformer to the varnish [4] then dry.

8 變壓器設計試算表

ACDC_TinySwitch-4_121812; Rev.1.1; Copyright Power Integrations 2012	INPUT	INFO	OUTPUT	UNIT	ACDC_TinySwitch-4_121812_Rev1-1.xls; TinySwitch-4 Continuous/Discontinuous Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES					
VACMIN	150		150	Volts	Minimum AC Input Voltage
VACMAX	265		265	Volts	Maximum AC Input Voltage
fL			50	Hertz	AC Mains Frequency
VO	24.00		24.00	Volts	Output Voltage (at continuous power)
IO	0.50		0.50	Amps	Power Supply Output Current (corresponding to peak power)
Power			12	Watts	Continuous Output Power
n	0.85		0.85		Efficiency Estimate at output terminals. Under 0.7 if no better data available
Z			0.50		Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available
tC			3.00	mSeconds	Bridge Rectifier Conduction Time Estimate
CIN	30.00		30	uFarads	Input Capacitance
ENTER TinySwitch-4 VARIABLES					
TinySwitch-4	**TNY286P**		**TNY286P**		User-defined TinySwitch-4
Chose Configuration	**INC**		Increased Current Limit		Enter "RED" for reduced current limit (sealed adapters), "STD" for standard current limit or "INC" for increased current limit (peak or higher power applications)
ILIMITMIN			0.419	Amps	Minimum Current Limit
ILIMITTYP			0.450	Amps	Typical Current Limit
ILIMITMAX			0.499	Amps	Maximum Current Limit
fSmin			124000	Hertz	Minimum Device Switching Frequency
I^2fmin			24.057	A^2kHz	I^2f (product of current limit squared and frequency is trimmed for tighter tolerance)
VOR	100.00		100	Volts	Reflected Output Voltage (VOR < 135 V Recommended)
VDS			10	Volts	TinySwitch-4 on-state Drain to Source Voltage
VD			0.7	Volts	Output Winding Diode Forward Voltage Drop
KP			0.97		Ripple to Peak Current Ratio (KP < 6)
KP_TRANSIENT			0.73		Transient Ripple to Peak Current Ratio. Ensure KP_TRANSIENT > 0.25
ENTER BIAS WINDING VARIABLES					
VB	20.00		20.00	Volts	Bias Winding Voltage
VDB			0.70	Volts	Bias Winding Diode Forward Voltage Drop
NB			18.62		Bias Winding Number of Turns
VZOV			26.00	Volts	Over Voltage Protection zener diode voltage.
UVLO VARIABLES					
V_UV_TARGET			215.59	Volts	Target DC under-voltage threshold, above which the power supply with start
V_UV_ACTUAL			207.20	Volts	Typical DC start-up voltage based on standard value of RUV_ACTUAL
RUV_IDEAL			8.54	Mohms	Calculated value for UV Lockout resistor
RUV_ACTUAL			8.20	Mohms	Closest standard value of resistor to RUV_IDEAL
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	**EE19**		**EE19**		Enter Transformer Core
Core		EE19		P/N:	PC40EE19-Z
Custom core				P/N:	EE19_BOBBIN
AE			0.23	cm^2	Core Effective Cross Sectional Area
LE			3.94	cm	Core Effective Path Length

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AL			1250	nH/T^2	Ungapped Core Effective Inductance
BW			9	mm	Bobbin Physical Winding Width
M			0	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L			3		Number of Primary Layers
NS	23		23		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			196	Volts	Minimum DC Input Voltage
VMAX			375	Volts	Maximum DC Input Voltage
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.34		Duty Ratio at full load, minimum primary inductance and minimum input voltage
IAVG			0.08	Amps	Average Primary Current
IP			0.42	Amps	Minimum Peak Primary Current
IR			0.42	Amps	Primary Ripple Current
IRMS			0.17	Amps	Primary RMS Current
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			1184	uHenries	Typical Primary Inductance. +/- 10% to ensure a minimum primary inductance of 1065 uH
LP_TOLERANCE			10	%	Primary inductance tolerance
NP			93		Primary Winding Number of Turns
ALG			136	nH/T^2	Gapped Core Effective Inductance
BM			2758	Gauss	Maximum Operating Flux Density, BM<3100 is recommended
BAC			1379	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1704		Relative Permeability of Ungapped Core
LG			0.19	mm	Gap Length (Lg > 0.1 mm)
BWE			27	mm	Effective Bobbin Width
OD			0.29	mm	Maximum Primary Wire Diameter including insulation
INS			0.05	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.24	mm	Bare conductor diameter
AWG			31	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			81	Cmils	Bare conductor effective area in circular mils
CMA			477	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)
TRANSFORMER SECONDARY DESIGN PARAMETERS					
Lumped parameters					
ISP			1.70	Amps	Peak Secondary Current
ISRMS			0.96	Amps	Secondary RMS Current
IRIPPLE			0.82	Amps	Output Capacitor RMS Ripple Current
CMS			191	Cmils	Secondary Bare Conductor minimum circular mils
AWGS			27	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
VOLTAGE STRESS PARAMETERS					
VDRAIN			605	Volts	Maximum Drain Voltage Estimate (Assumes 20% zener clamp tolerance and an additional 10% temperature tolerance)
PIVS			117	Volts	Output Rectifier Maximum Peak Inverse Voltage
TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)					
1st output					
VO1			24	Volts	Main Output Voltage (if unused, defaults to single output design)
IO1			0.500	Amps	Output DC Current
PO1			12.00	Watts	Output Power
VD1			0.7	Volts	Output Diode Forward Voltage Drop

NS1			23.00		Output Winding Number of Turns
ISRMS1			0.957	Amps	Output Winding RMS Current
IRIPPLE1			0.82	Amps	Output Capacitor RMS Ripple Current
PIVS1			117	Volts	Output Rectifier Maximum Peak Inverse Voltage
Recommended Diodes			1N5817, SB120		Recommended Diodes for this output
CMS1			191	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS1			27	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS1			0.36	mm	Minimum Bare Conductor Diameter
ODS1			0.39	mm	Maximum Outside Diameter for Triple Insulated Wire
2nd output					
VO2				Volts	Output Voltage
IO2				Amps	Output DC Current
PO2			0.00	Watts	Output Power
VD2			0.7	Volts	Output Diode Forward Voltage Drop
NS2			0.65		Output Winding Number of Turns
ISRMS2			0.000	Amps	Output Winding RMS Current
IRIPPLE2			0.00	Amps	Output Capacitor RMS Ripple Current
PIVS2			3	Volts	Output Rectifier Maximum Peak Inverse Voltage
Recommended Diode					Recommended Diodes for this output
CMS2			0	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS2			N/A	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS2			N/A	mm	Minimum Bare Conductor Diameter
ODS2			N/A	mm	Maximum Outside Diameter for Triple Insulated Wire
3rd output					
VO3				Volts	Output Voltage
IO3				Amps	Output DC Current
PO3			0.00	Watts	Output Power
VD3			0.7	Volts	Output Diode Forward Voltage Drop
NS3			0.65		Output Winding Number of Turns
ISRMS3			0.000	Amps	Output Winding RMS Current
IRIPPLE3			0.00	Amps	Output Capacitor RMS Ripple Current
PIVS3			3	Volts	Output Rectifier Maximum Peak Inverse Voltage
Recommended Diode					Recommended Diodes for this output
CMS3			0	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS3			N/A	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS3			N/A	mm	Minimum Bare Conductor Diameter
ODS3			N/A	mm	Maximum Outside Diameter for Triple Insulated Wire
Total power			12	Watts	Total Output Power
Negative Output	N/A		N/A		If negative output exists enter Output number; eg: If VO2 is negative output, enter 2

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9 效能資料

All measurements performed at room temperature unless specified.

9.1 效率

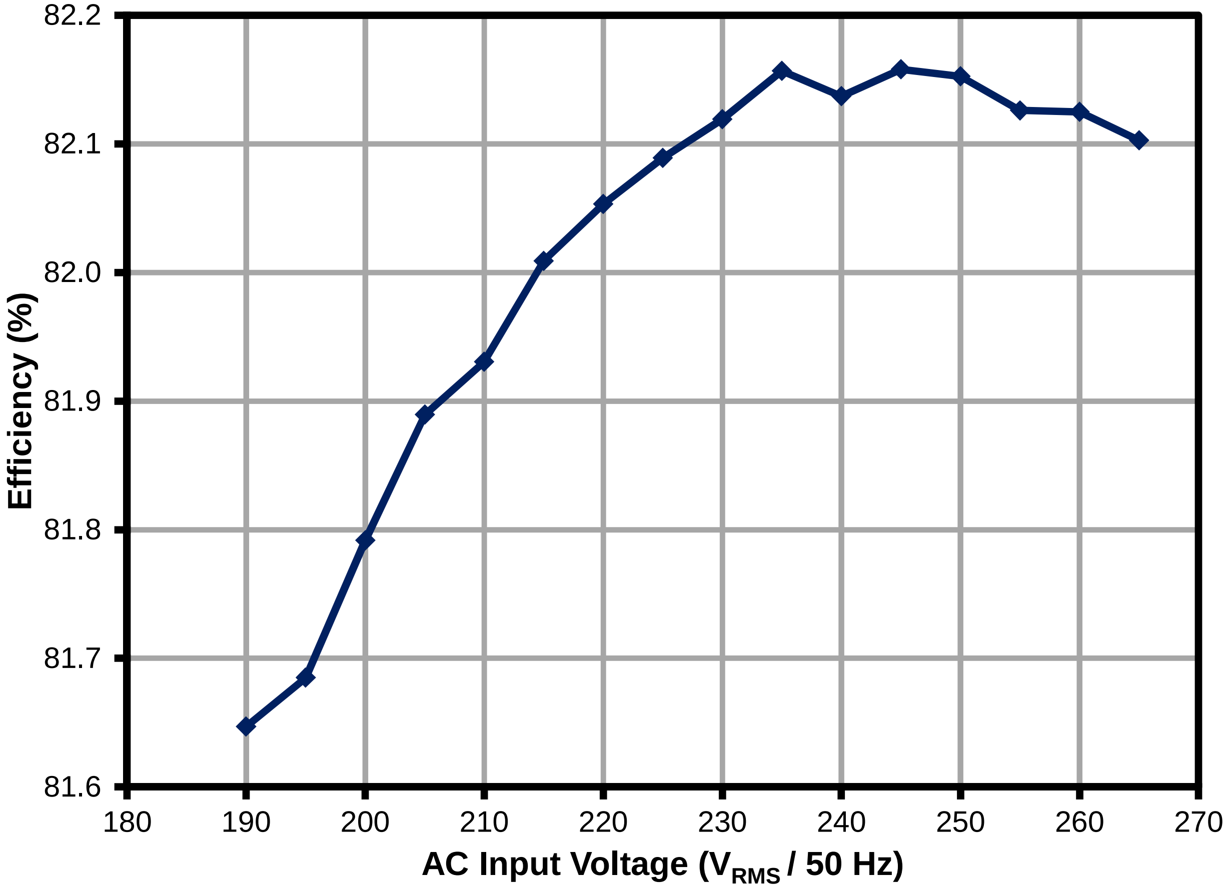

Figure 9 – Efficiency vs. Input Voltage, Room Temperature, 60 Hz.

Input		Input Measurement				Load Measurement			
VAC (V_{RMS})	Freq (Hz)	V_{IN} (V_{RMS})	I_{IN} (A_{RMS})	P_{IN} (W)	PF	V_{OUT} (V_{DC})	I_{OUT} (A_{DC})	P_{OUT} (W)	Efficiency (%)
180	50	179.94	0.10	14.98	0.83	24.48	0.50	12.21	81.52
185	50	184.91	0.10	14.97	0.83	24.48	0.50	12.21	81.57
190	50	189.97	0.10	14.95	0.82	24.48	0.50	12.21	81.65
195	50	194.95	0.09	14.94	0.82	24.47	0.50	12.2	81.68
200	50	199.91	0.09	14.93	0.81	24.48	0.50	12.21	81.79
205	50	204.97	0.09	14.91	0.81	24.48	0.50	12.21	81.89
210	50	209.94	0.09	14.90	0.80	24.47	0.50	12.21	81.93
215	50	214.92	0.09	14.89	0.80	24.48	0.50	12.21	82.01
220	50	219.97	0.09	14.88	0.79	24.48	0.50	12.21	82.05
225	50	224.94	0.08	14.87	0.79	24.47	0.50	12.21	82.09
230	50	229.92	0.08	14.87	0.78	24.48	0.50	12.21	82.12
235	50	234.97	0.08	14.86	0.78	24.48	0.50	12.21	82.16
240	50	239.95	0.08	14.86	0.77	24.48	0.50	12.21	82.14
245	50	244.92	0.08	14.86	0.77	24.48	0.50	12.21	82.16
250	50	249.98	0.08	14.86	0.76	24.48	0.50	12.21	82.15
255	50	254.95	0.08	14.86	0.76	24.48	0.50	12.21	82.13
260	50	259.93	0.08	14.87	0.75	24.48	0.50	12.21	82.12
265	50	265.00	0.08	14.87	0.75	24.48	0.50	12.21	82.10
270	50	269.97	0.07	14.88	0.74	24.48	0.50	12.21	82.07
275	50	274.94	0.07	14.88	0.74	24.47	0.50	12.21	82.02

Table 1 – Data for Figure 9.

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9.2 工作模式效率

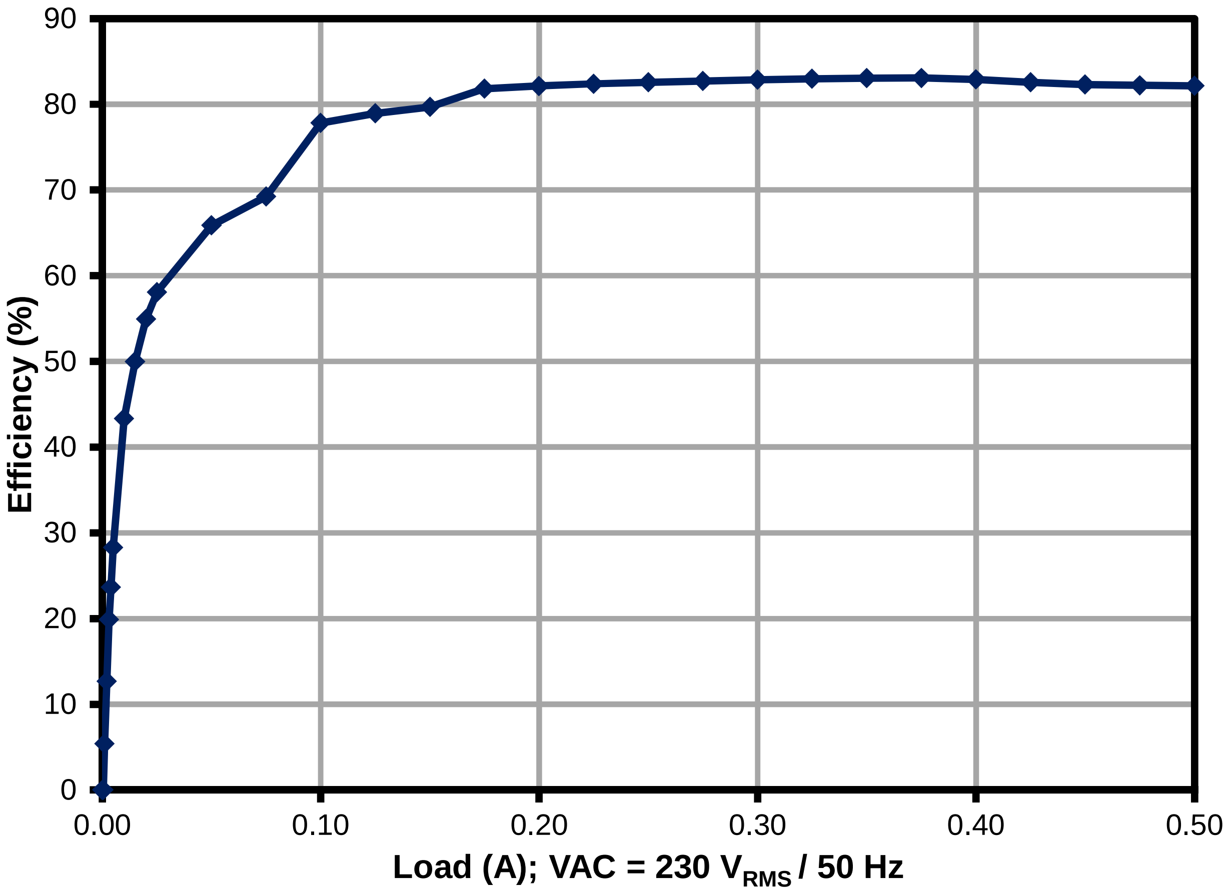

Figure 10 – Load efficiency at 230 V_{RMS} / 60 Hz line, Room Temperature, 60 Hz.

Load Setting		Input Measurement				Load Measurement			
Load (%)	Load (A)	V_{IN} (V_{RMS})	I_{IN} (A_{RMS})	P_{IN} (W)	PF	V_{OUT} (V_{DC})	I_{OUT} (A_{DC})	P_{OUT} (W)	Efficiency (%)
100	0.50	229.93	0.08	14.87	0.78	24.48	0.50	12.21	82.14
95	0.48	229.93	0.08	14.11	0.78	24.48	0.47	11.60	82.21
90	0.45	229.93	0.08	13.35	0.77	24.48	0.45	10.99	82.31
85	0.43	229.93	0.07	12.57	0.76	24.48	0.42	10.37	82.55
80	0.40	229.94	0.07	11.77	0.75	24.48	0.40	9.76	82.91
75	0.38	229.94	0.06	11.02	0.74	24.48	0.37	9.15	83.06
70	0.35	229.94	0.06	10.29	0.73	24.48	0.35	8.54	83.02
65	0.33	229.94	0.06	9.56	0.72	24.48	0.32	7.93	82.95
60	0.30	229.94	0.05	8.83	0.71	24.48	0.30	7.32	82.86
55	0.28	229.94	0.05	8.10	0.69	24.48	0.27	6.70	82.70
50	0.25	229.94	0.05	7.38	0.67	24.48	0.25	6.09	82.54
45	0.23	229.94	0.04	6.65	0.65	24.48	0.22	5.48	82.37
40	0.20	229.94	0.04	5.93	0.64	24.48	0.20	4.87	82.12
35	0.18	229.94	0.04	5.20	0.62	24.48	0.17	4.25	81.81
30	0.15	229.94	0.03	4.57	0.61	24.48	0.15	3.64	79.70
25	0.13	229.94	0.03	3.84	0.58	24.48	0.12	3.03	78.94
20	0.10	229.94	0.03	3.11	0.53	24.48	0.10	2.42	77.81
15	0.08	229.95	0.02	2.61	0.48	24.48	0.07	1.80	69.21
10	0.05	229.95	0.02	1.81	0.44	24.48	0.05	1.19	65.86
5	0.03	229.95	0.01	1.00	0.34	24.48	0.02	0.58	58.09
4	0.02	229.95	0.01	0.83	0.31	24.48	0.02	0.46	54.93
3	0.02	229.95	0.01	0.66	0.26	24.48	0.01	0.33	49.99
2	0.01	229.95	0.01	0.49	0.21	24.48	0.01	0.211	43.32
1	0.01	229.95	0.01	0.30	0.14	24.48	0.00	0.09	28.28
0.80	0.004	229.95	0.01	0.26	0.13	24.48	0.00	0.06	23.66
0.60	0.003	229.95	0.01	0.23	0.11	24.48	0.00	0.05	19.88
0.40	0.002	229.95	0.01	0.20	0.10	24.48	0.00	0.03	12.67
0.20	0.001	229.95	0.01	0.17	0.08	24.48	0.00	0.01	5.41
0.10	0.0005	229.95	0.01	0.15	0.08	24.48	0.00	0.00	0.00
0.00	0	229.95	0.01	0.08	0.04	24.48	0.00	0.00	0.00
							Average Efficiency		81.67

Table 2 – Data for Figure 10.

The external power supply requirements below all require meeting active mode efficiency and no-load input power limits. Minimum active mode efficiency is defined as the average efficiency of 25, 50, 75 and 100% of output current (based on the nameplate output current rating).

For adapters that are single input voltage only then the measurement is made at the rated single nominal input voltage (115 VAC or 230 VAC), for universal input adapters the measurement is made at both nominal input voltages (115 VAC and 230 VAC).

To meet the standard the measured average efficiency (or efficiencies for universal input supplies) must be greater than or equal to the efficiency specified by the standard.

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The test method can be found here:
http://www.energystar.gov/ia/partners/prod_development/downloads/power_supplies/EPSupplyEffic_TestMethod_0804.pdf

For the latest up to date information please visit the PI Green Room:
http://www.powerint.com/greenroom/regulations.htm

9.2.1 美國 2007 能源獨立和安全法案

This legislation mandates all single output single output adapters, including those provided with products, manufactured on or after July 1st, 2008 must meet minimum active mode efficiency and no load input power limits.

Active Mode Efficiency Standard Models

Nameplate Output (P_O)	Minimum Efficiency in Active Mode of Operation
< 1 W	$0.5 \times P_O$
≥ 1 W to ≤ 51 W	$0.09 \times \ln(P_O) + 0.5$
> 51 W	0.85

ln = natural logarithm

No-load Energy Consumption

Nameplate Output (P_O)	Maximum Power for No-load AC-DC EPS
All	≤ 0.5 W

This requirement supersedes the legislation from individual US States (for example CEC in California).

9.2.2 能源之星 EPS 2.0 版

This specification takes effect on November 1st, 2008.

Active Mode Efficiency Standard Models

Nameplate Output (P_O)	Minimum Efficiency in Active Mode of Operation
≤ 1 W	$0.48 \times P_O + 0.14$
> 1 W to ≤ 49 W	$0.0626 \times \ln(P_O) + 0.622$
> 49 W	0.87

ln = natural logarithm

Active Mode Efficiency Low Voltage Models (V_O<6 V and $I_O \geq$ 550 mA)

Nameplate Output (P_O)	Minimum Efficiency in Active Mode of Operation
≤ 1 W	$0.497 \times P_O + 0.067$
> 1 W to ≤ 49 W	$0.075 \times \ln(P_O) + 0.561$
> 49 W	0.86

ln = natural logarithm

No-load Energy Consumption (both models)

Nameplate Output (P_O)	Maximum Power for No-load AC-DC EPS
0 to < 50 W	≤ 0.3 W
≥ 50 W to ≤ 250 W	≤ 0.5 W

9.3 無負載輸入功率

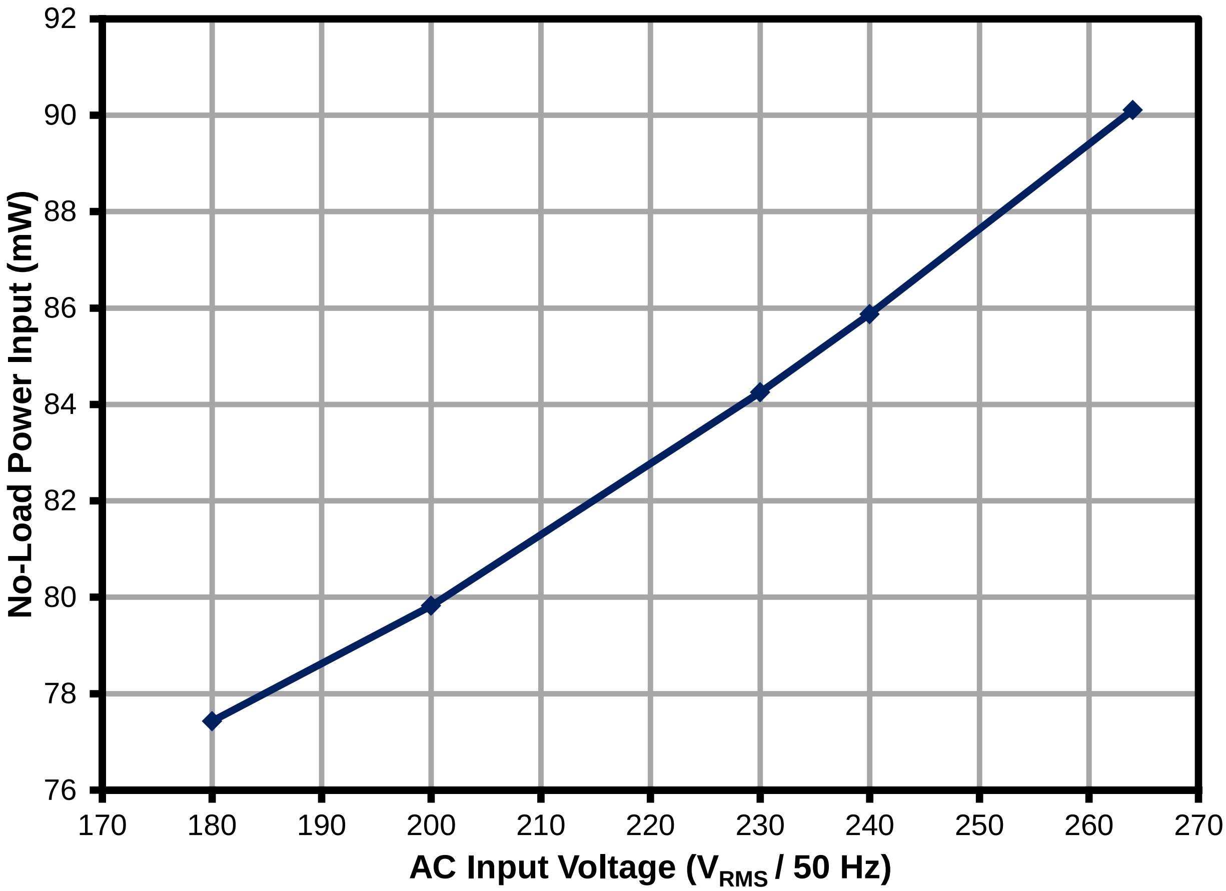

Figure 11- Zero Load Input Power vs. Input Line Voltage, Room Temperature, 50 Hz.

Input		Input Measurement (Integration)				
VAC (V_{RMS})	Freq (Hz)	P_{IN} (mW)	I_{IN} (mA_{RMS})	V_{OUT} (V_{DC})	Limit (mW)	Remarks
180	50	77.43	7.44	24.48	100	Pass
200	50	79.82	7.85	24.48	100	Pass
230	50	84.25	8.53	24.48	100	Pass
240	50	85.87	8.77	24.48	100	Pass
265	50	90.11	9.35	24.48	100	Pass

Table 3 – Data for Figure 10.

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9.4 可用的待機輸出功率

The chart below shows the available output power vs line voltage for an input power of 1 W, 2 W and 3 W.

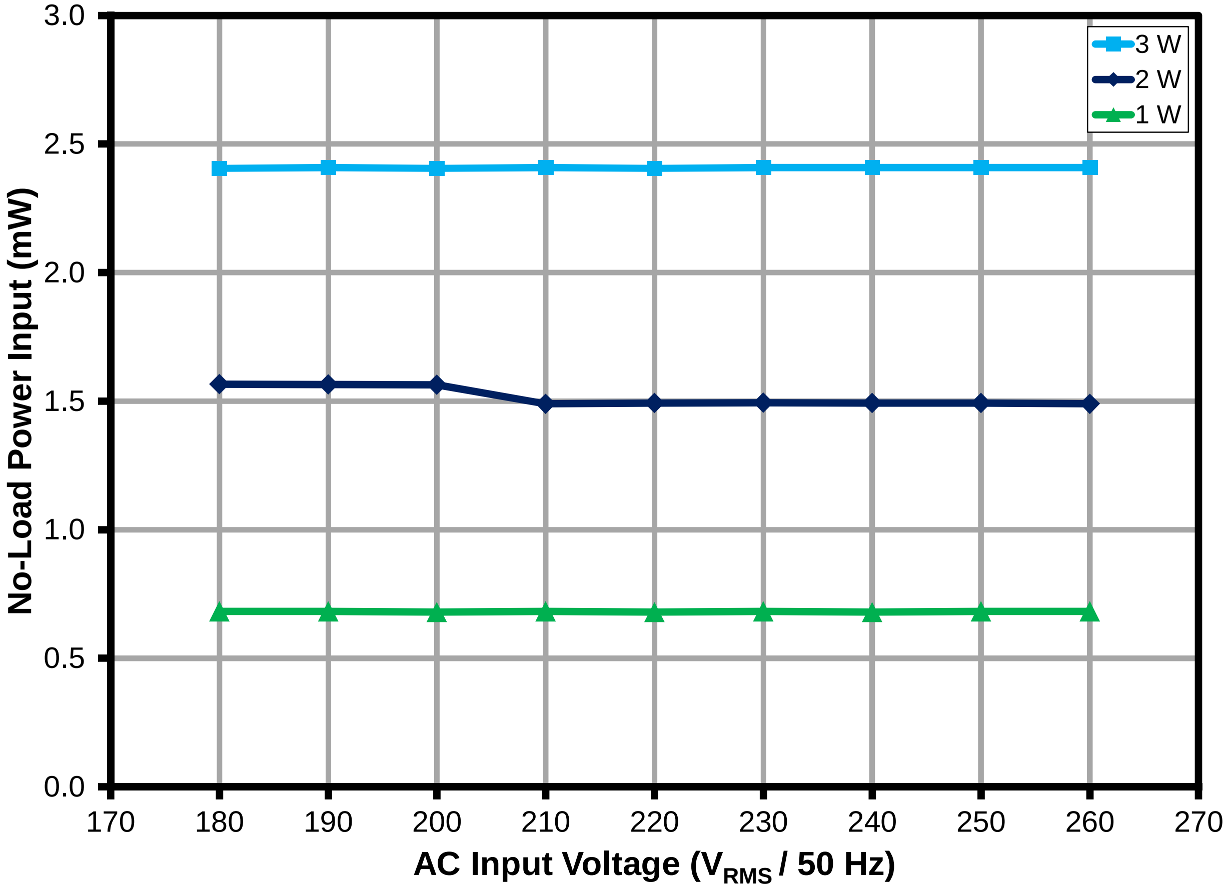

Figure 12 – Available Standby Power vs. Line.

9.5 調節

9.5.1 負載

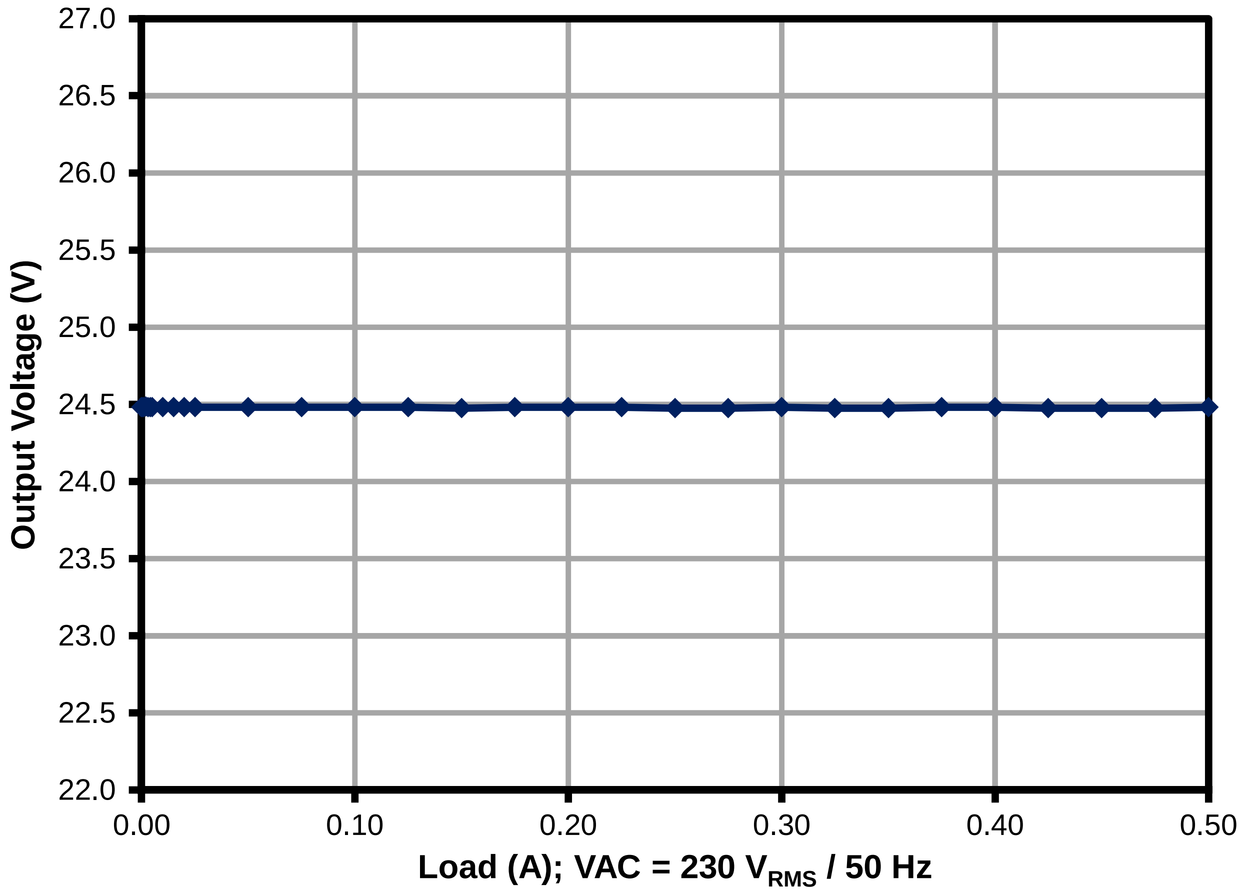

Figure 13 – Load Regulation, Room Temperature.

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9.5.2 線電壓

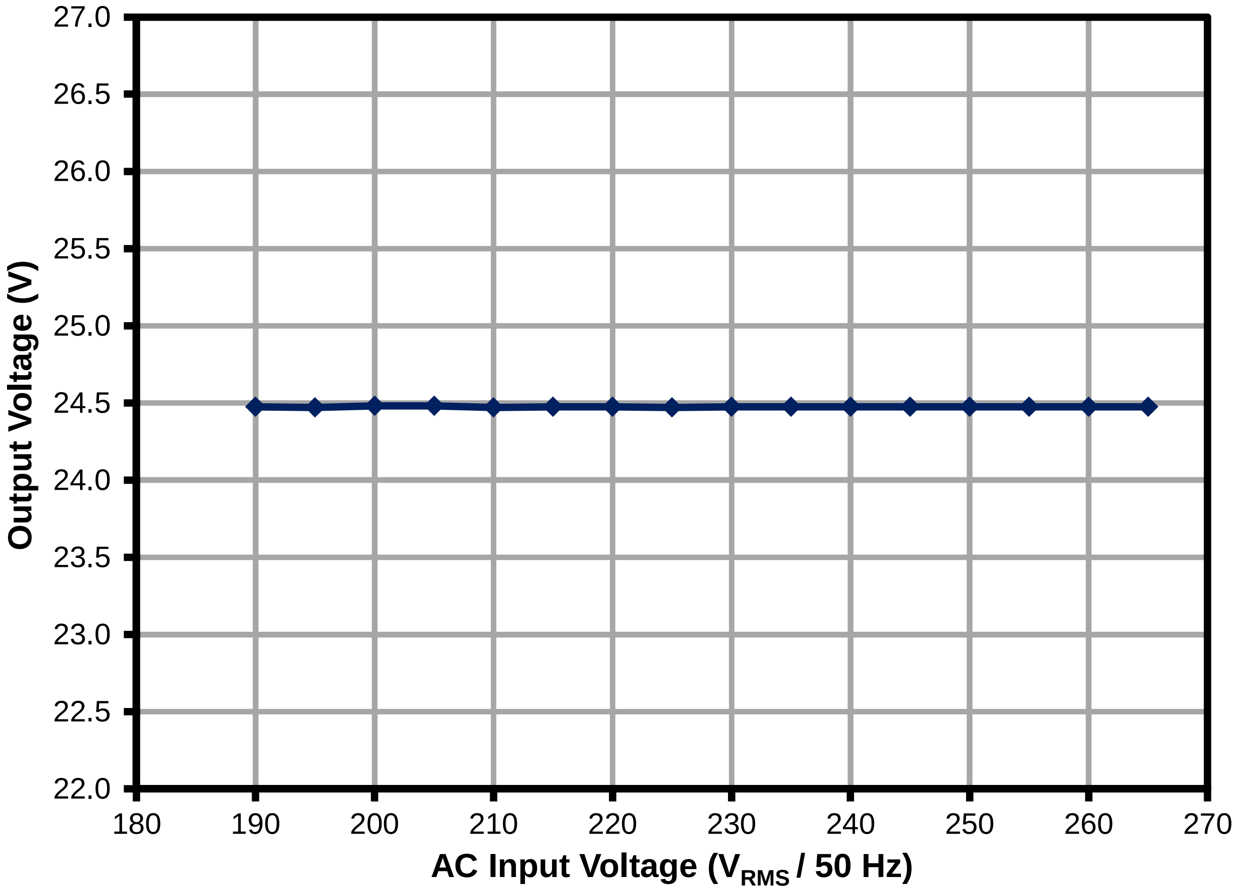

Figure 14 – Line Regulation, Room Temperature, Full Load.

9.5.3 功率因數 (PF)

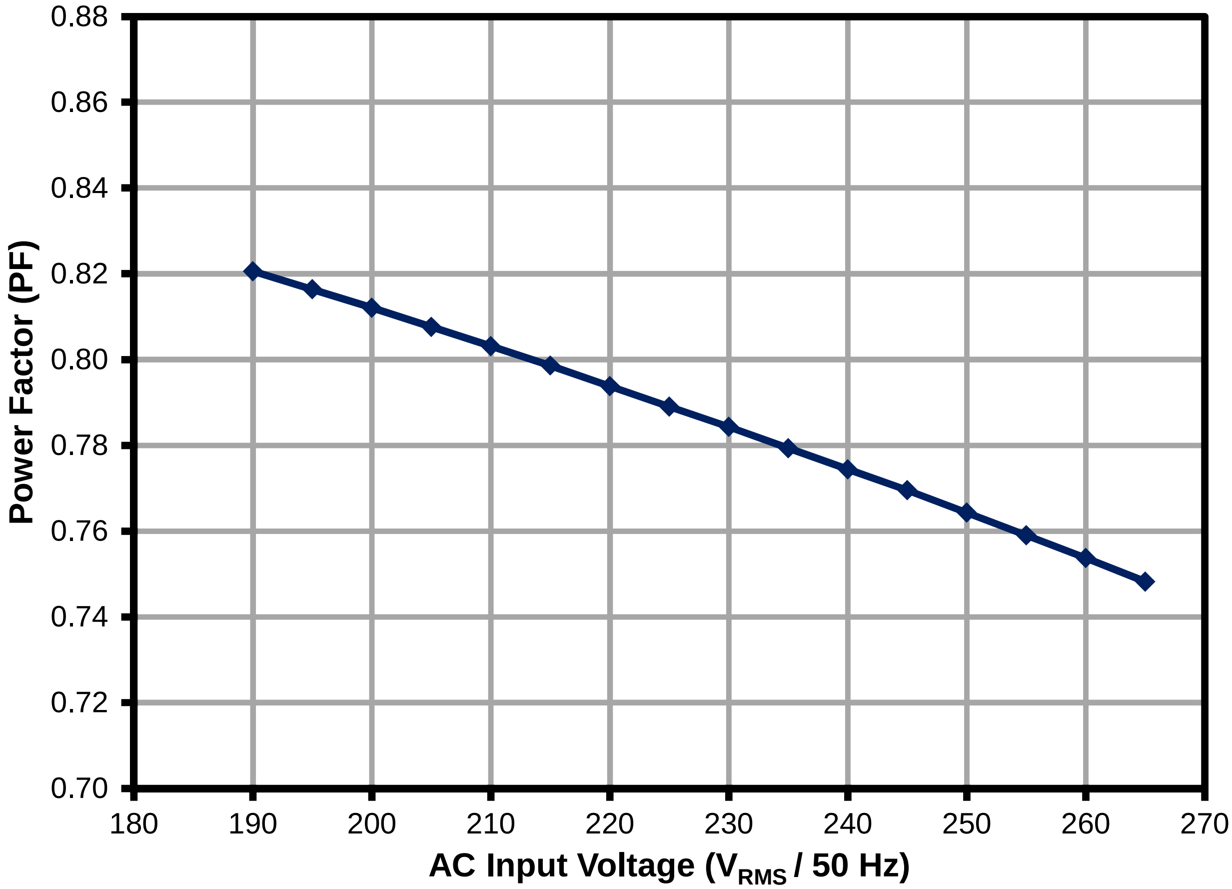

Figure 15 – Power Factor vs. AC Input at full load.

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10 散熱效能

10.1 散熱影像

Unit was measured open frame (no enclosure). Temperatures were allowed to stabilize prior to making measurements (>30 mins)

10.1.1 元件溫度 (190 VAC，50 Hz，25 °C)

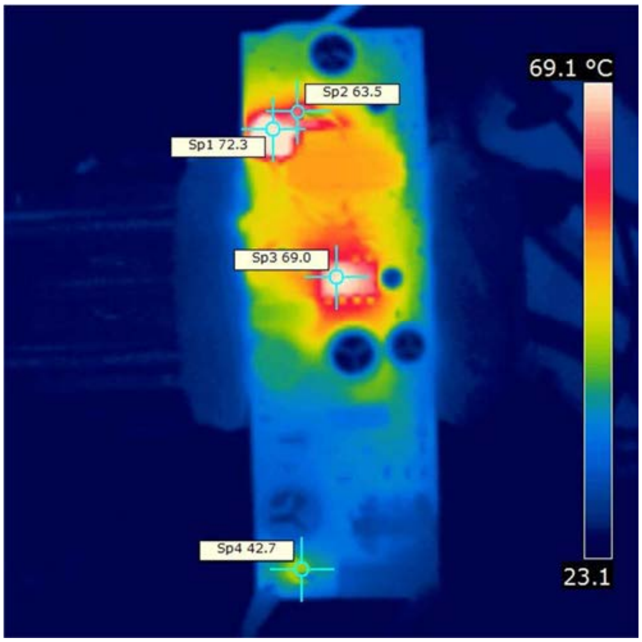

Figure 16 – SP1 – Snubber Output Resistor (R3).
SP2 – Output Diode (D4).
SP3 – TNY286PG (U1).
SP4 – Fusible Resistor (F1).

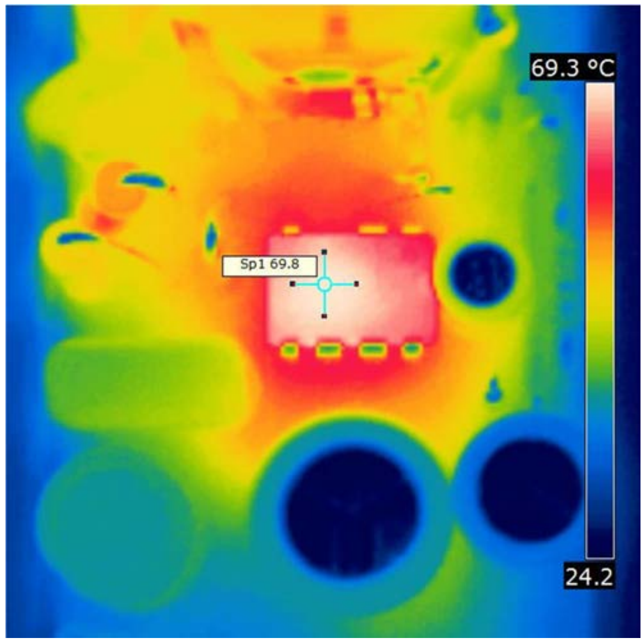

Figure 17 – SP1 – TNY286PG (U1).

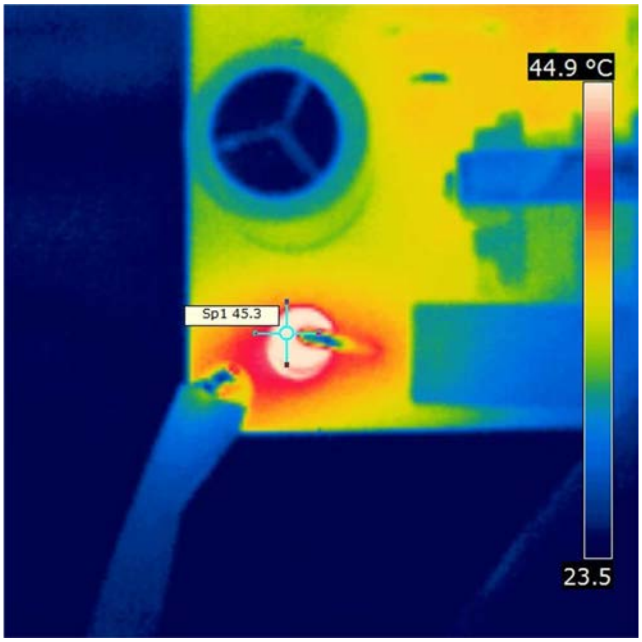

Figure 18 – SP1 – Fusible Resistor (F1).

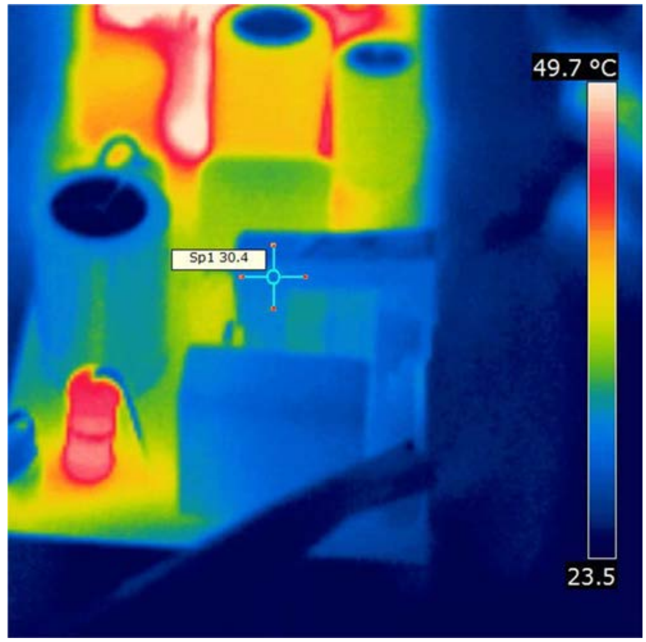

Figure 19 – SP1 – Common Mode Choke (L1).

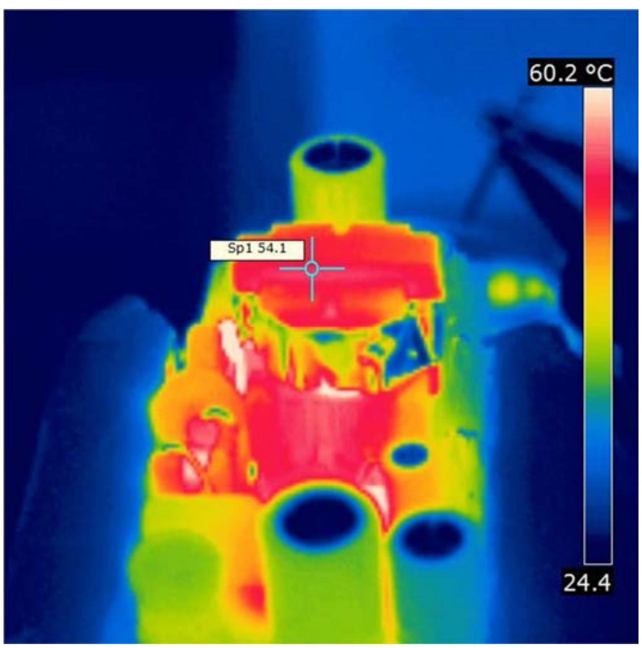

Figure 20 – SP1 – Transformer (T1).

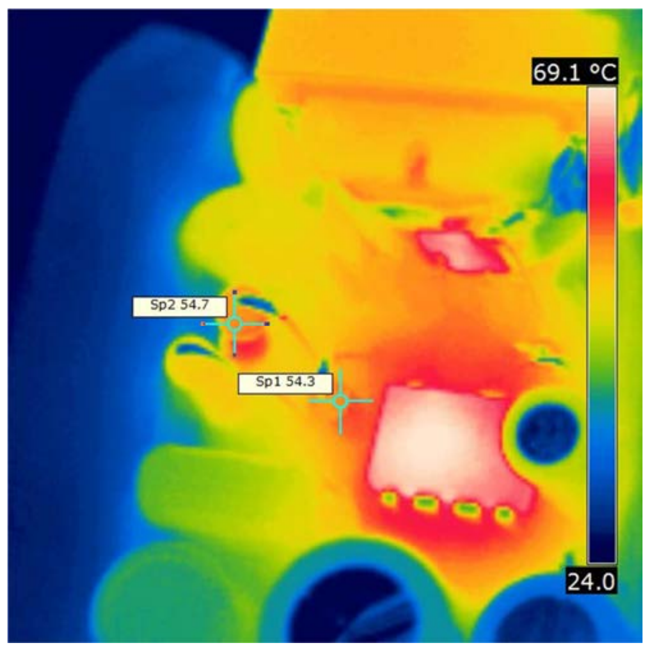

Figure 21 – SP1 – Snubber Diode (D1).
SP2 – Snubber Resistor (VR1).

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10.1.2 元件溫度 (265 VAC，50 Hz，25°C)

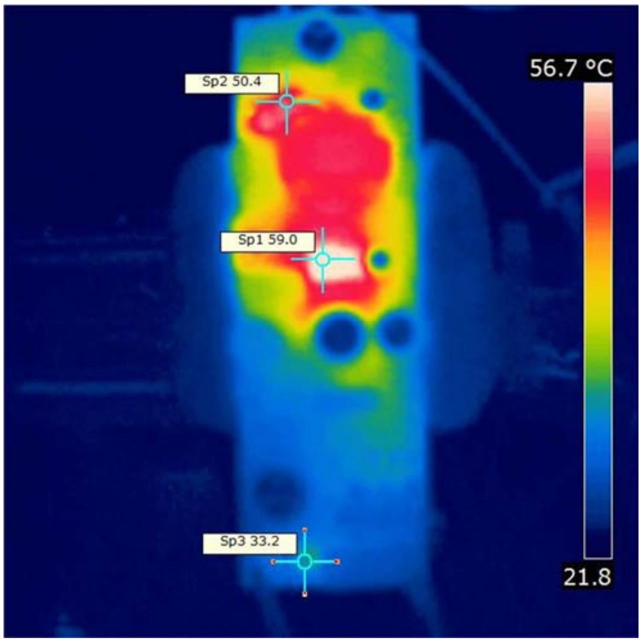

Figure 22 – SP1 – TNY286PG (U1).
SP2 – Output Diode (D4).
SP3 – Fusible Resistor (FR1).

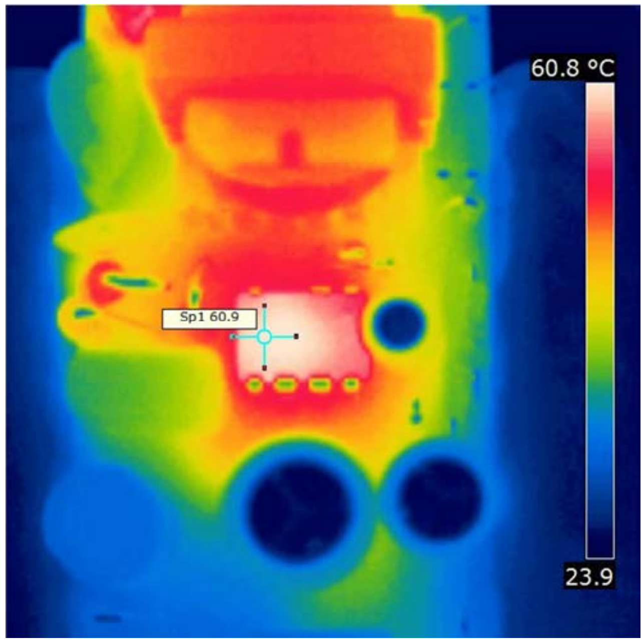

Figure 23 – SP1 – TNY286PG (U1).

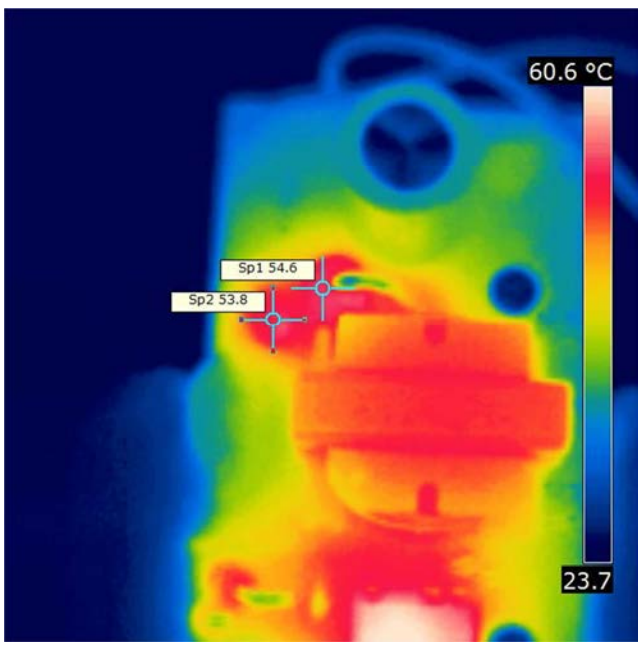

Figure 24 – SP1 – Output Diode (D4).
SP2 – Output Snubber Resistor (R4).

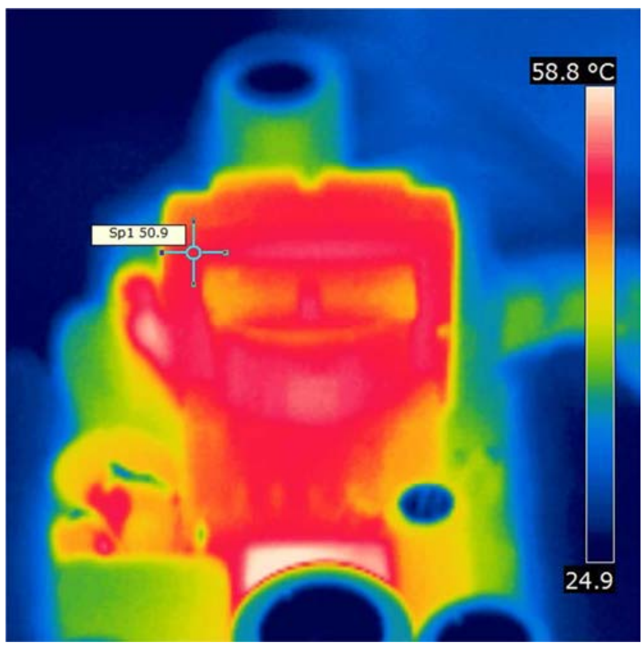

Figure 25 – SP1 – Transformer (T1).

11 波形

11.1 正常運作下的輸入電壓和電流

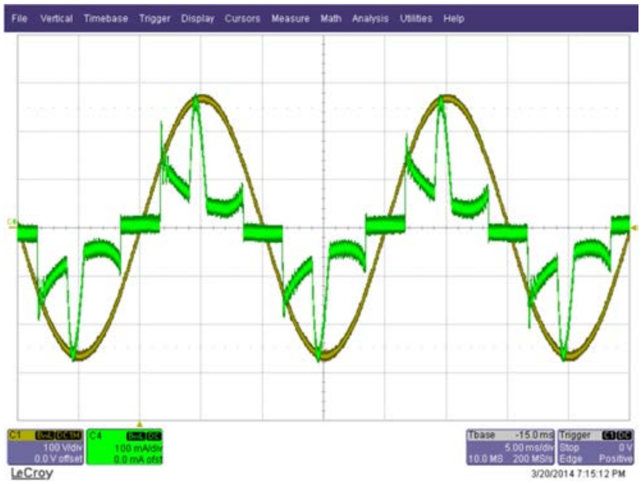

Figure 26 – 190 VAC, Full Load.
Green: I_{IN}, 0.1 A / div.
Yellow: V_{DIN}, 100 V, 5 ms / div.

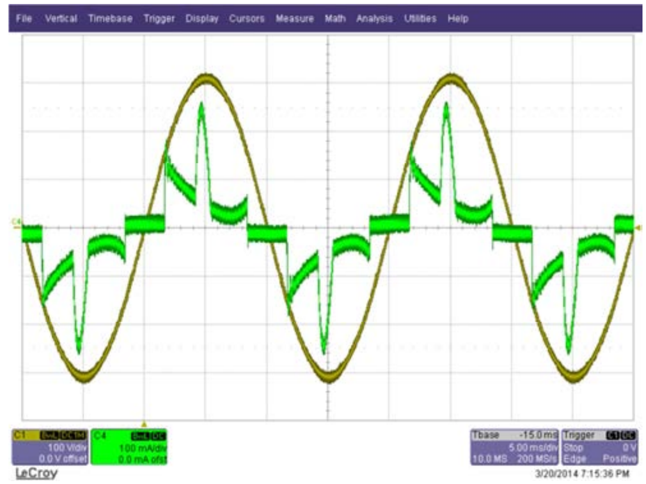

Figure 27 – 220 VAC, Full Load.
Green: I_{IN}, 0.1 A / div.
Yellow: V_{DIN}, 100 V, 5 ms / div.

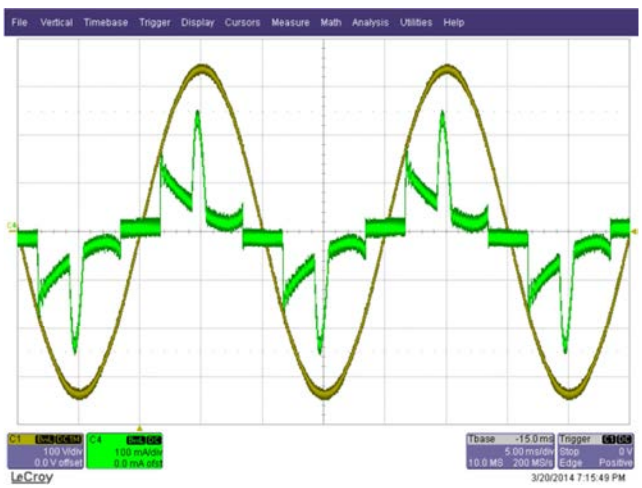

Figure 28 – 240 VAC, Full Load.
Green: I_{IN}, 0.1 A / div.
Yellow: V_{DIN}, 100 V, 5 ms / div.

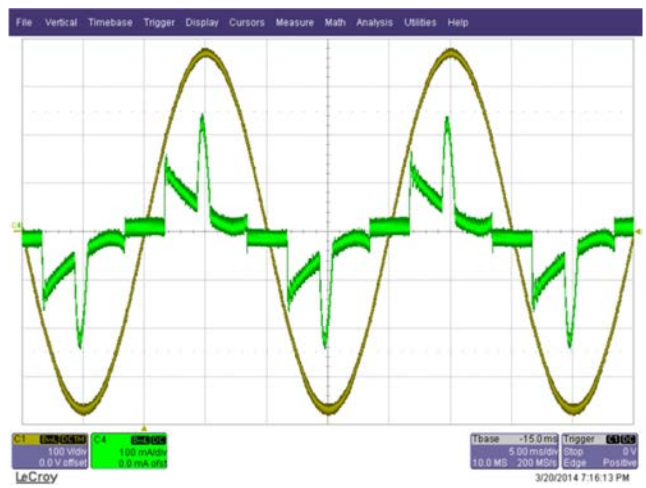

Figure 29 – 265 VAC, Full Load.
Green: I_{IN}, 0.1 A / div.
Yellow: V_{DIN}, 100 V, 5 ms / div.

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11.2 正常運作下的汲極電壓和電流

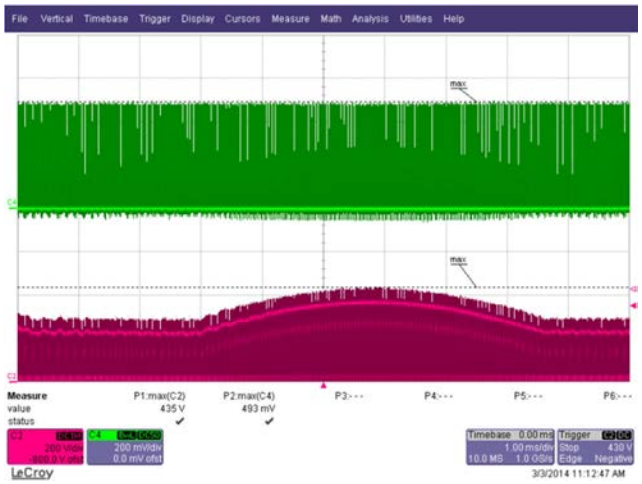

Figure 30 – 190 VAC, Full Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V, 1 ms / div.

Figure 31 – 190 VAC, Full Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.
Zoom Time Scale: 100 μs / div.

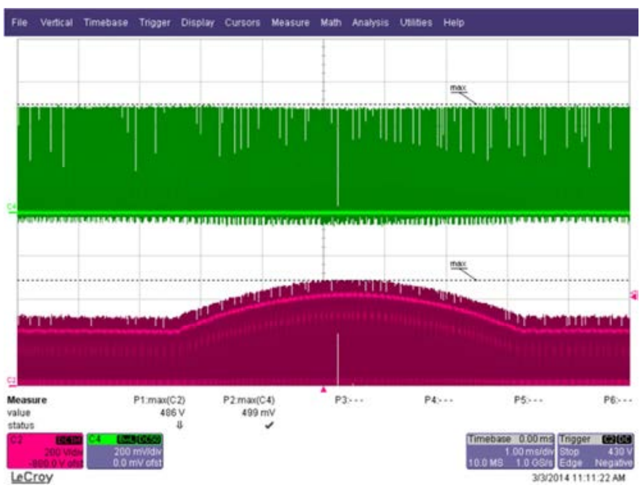

Figure 32 – 230 VAC, Full Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V, 1ms / div.

Figure 33 – 230 VAC, Full Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V /div.
Time Scale: 1 ms / div.
Zoom Time Scale: 10 μs / div.

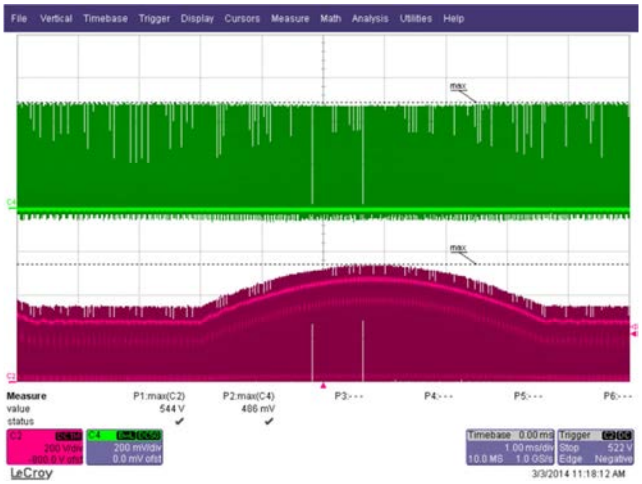

Figure 34 – 265 VAC, Full Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V.
Time Scale:1 ms / div.

Figure 35 – 265 VAC, Full Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.
Zoom Time Scale: 10 μs / div.

11.3 汲極電壓和電流啟動分析

No saturation or any possible cause of failure.

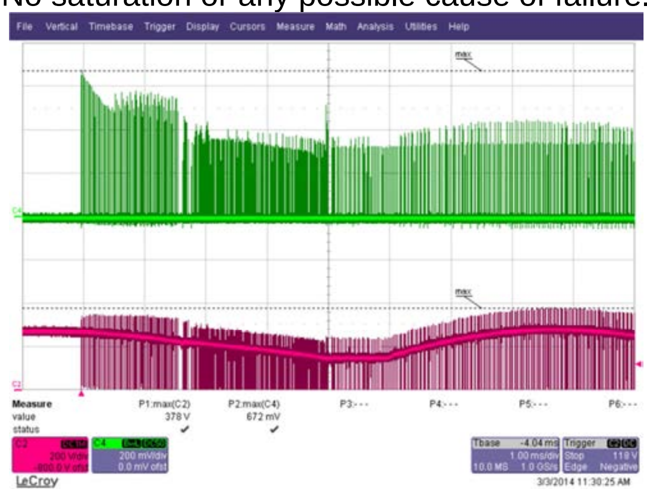

Figure 36 – 190 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.

Figure 37 – 190 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.
Zoom Time Scale: 2 μs / div.

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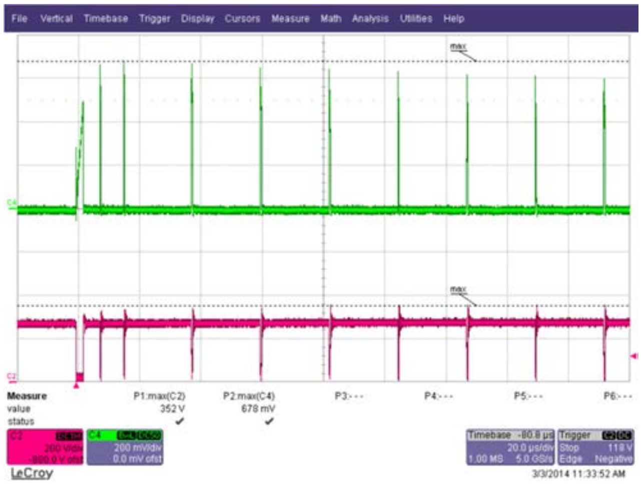

Figure 38 – 190 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 µs / div.

Figure 39 – 190 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 20 µs / div.
Zoom Time Scale: 1 µs / div.

Figure 40 – 265 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.

Figure 41 – 265 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.
Zoom Time Scale: 5 µs / div.

11.4 *汲極電壓和電流啟動短路波形*

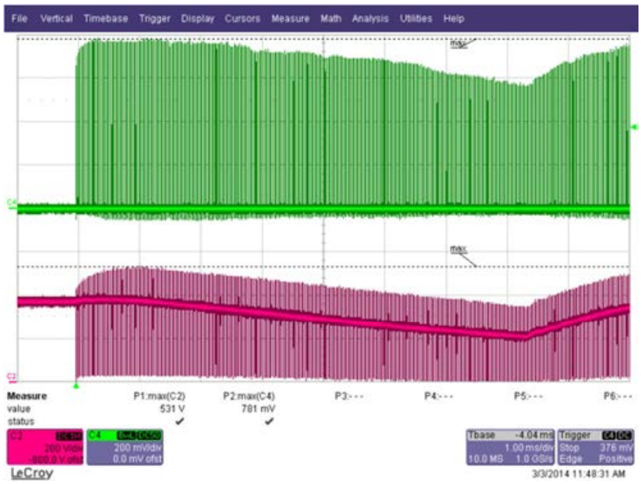

Figure 42 – 265 VAC Input and Shorted Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.

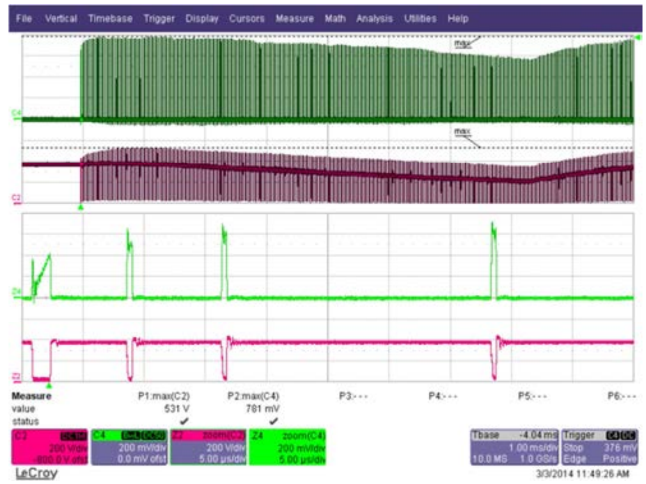

Figure 43 – 265 VAC Input and Shorted Load.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 1 ms / div.
Zoom Time Scale: 5 µs / div.

11.5 *汲極電壓和電流正常運行短路波形*

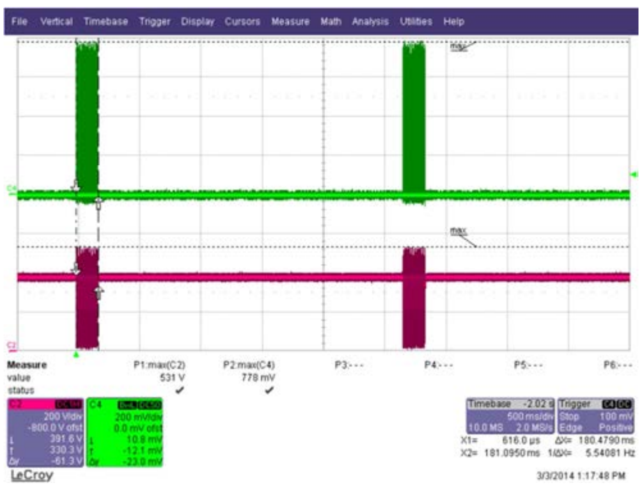

Figure 44 – 265 VAC Input, Full Load then Short.
180 ms Continuous Switching.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 500 ms / div.

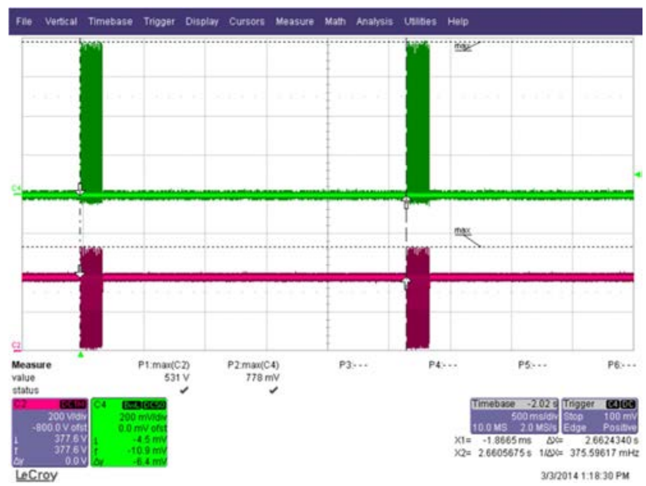

Figure 45 – 265 VAC Input, Full Load then Short.
2.5 s Off Time before Auto-restart.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 500 ms / div.

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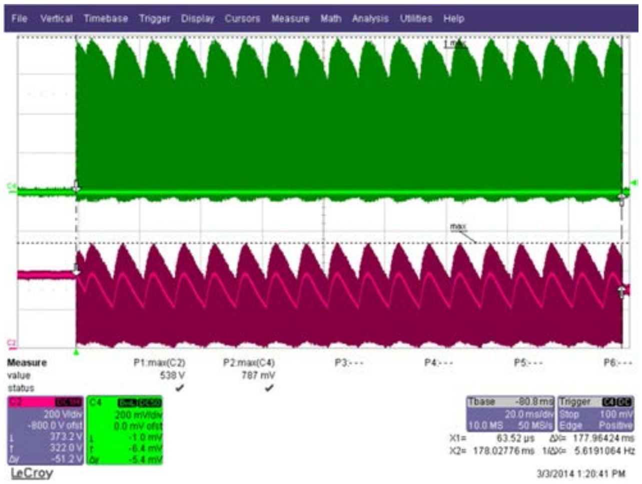

Figure 46 – 265 VAC Input and Full Load then Short.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 20 ms / div.

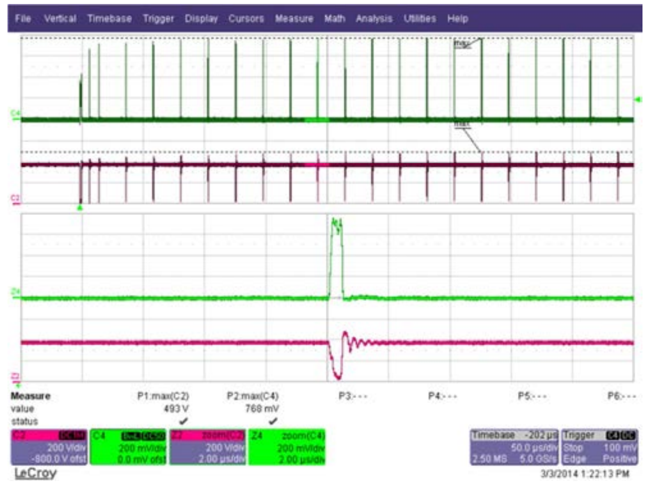

Figure 47 – 265 VAC Input and Full Load then Short.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 50 μs / div.
Zoom Time Scale: 2 μs / div.

11.6 正常運作下的輸出二極體波形

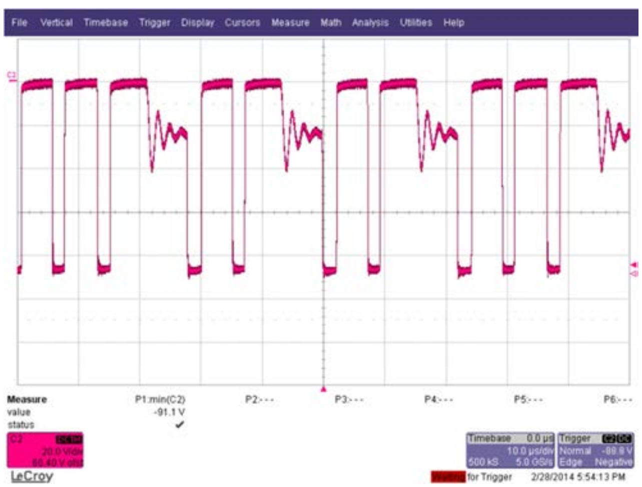

Figure 48 – 190 VAC Input and Full Load then Short.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{OUT}, 20 V / div.
Time Scale: 100 μs / div.

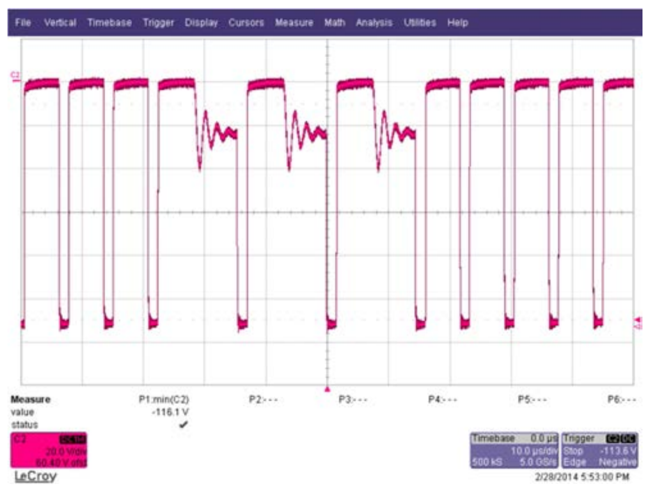

Figure 49 – 265 VAC Input and Full Load then Short.
Upper: I_{DRAIN}, 0.2 A / div.
Lower: V_{DRAIN}, 200 V / div.
Time Scale: 50 μs / div.
Zoom Time Scale: 2 μs / div.

11.7 輸出電壓啟動分析

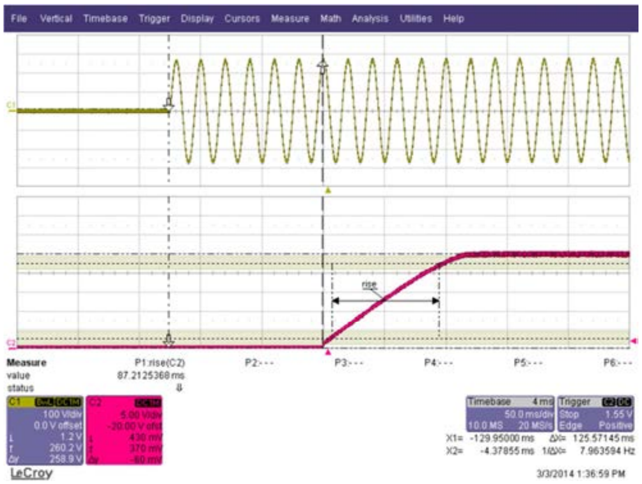

Figure 50 – Start-up Profile, 190 VAC
Upper: V_{IN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.
Time Scale: 50 ms / div.

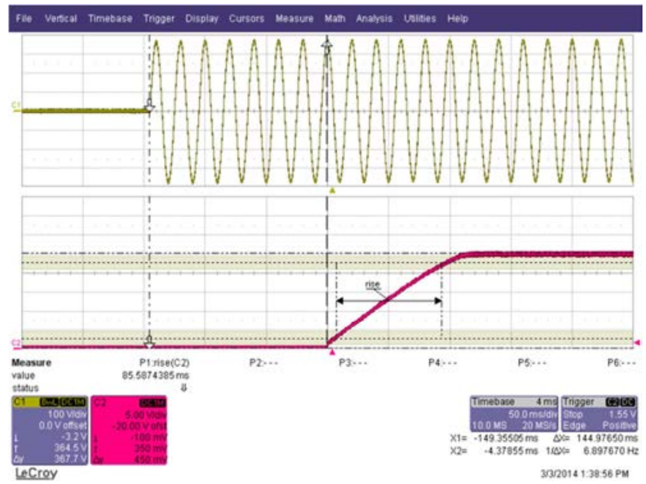

Figure 51 – Start-up Profile, 265 VAC.
Upper: V_{IN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.
Time Scale: 50 ms / div.

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11.8 負載暫態反應 (0% 至 100% 負載步階)

In the figures shown below, signal averaging was used to better enable viewing the load transient response. The oscilloscope was triggered using the load current step as a trigger source. Since the output switching and line frequency occur essentially at random with respect to the load transient, contributions to the output ripple from these sources will average out, leaving the contribution only from the load step response.

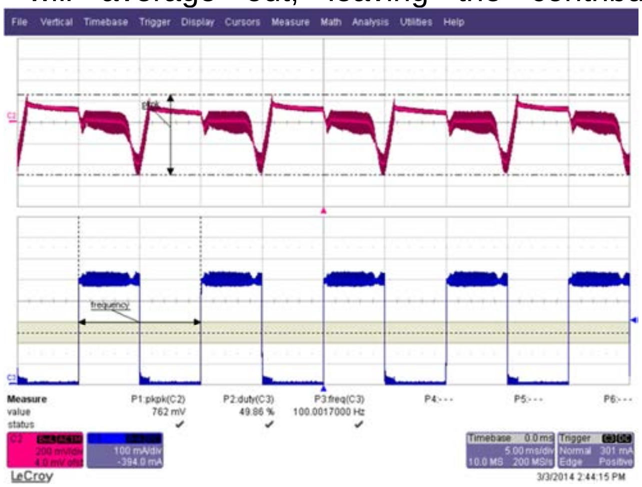

Figure 52 – Transient Response, 230 VAC, 0-100-0% Load Step for Worst Case Condition at 100 Hz.
Upper: V_{OUT}, 200 mV / div.
Lower: I_{OUT}, 100 mA / div.
Time Scale: 5 ms / div.

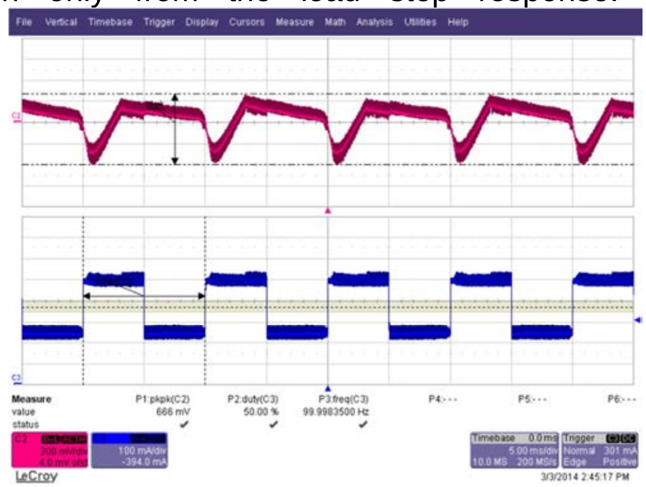

Figure 53 – Transient Response, 230 VAC, 50-100-50% Load Step for Worst Case Condition at 100 Hz.
Upper: V_{OUT}, 200 mV / div.
Lower: I_{OUT}, 100 mA / div.
Time Scale: 5 ms / div.

Figure 54 – Transient Response, 230 VAC, 0-100-0% Load Step for Worst Case Condition at 1 kHz.
Upper: V_{OUT}, 200 mV / div.
Lower: I_{OUT}, 100 mA / div.
Time Scale: 5 ms / div.

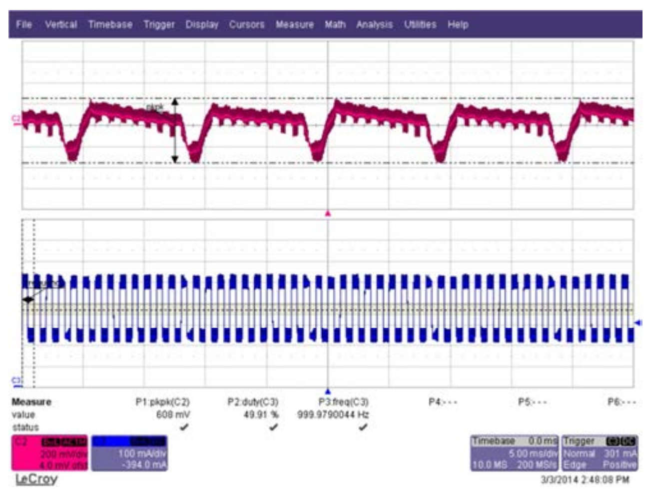

Figure 55 – Transient Response, 230 VAC, 50-100-50% Load Step for Worst Case Condition at 1 kHz.
Upper: V_{OUT}, 200 mV / div.
Lower: I_{OUT}, 100 mA / div.
Time Scale: 5 ms / div.

11.9 電壓關閉測試

No component failure was observed.

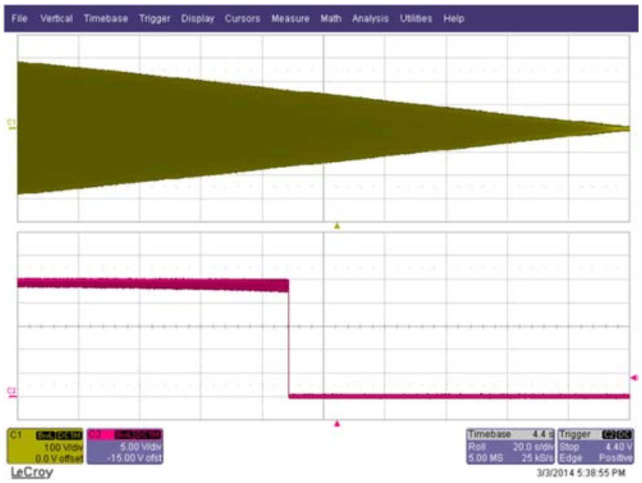

Figure 56 – Brown-out at 0.5 V / div.
Upper: V_{IN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.
Time Scale: 20 s / div.

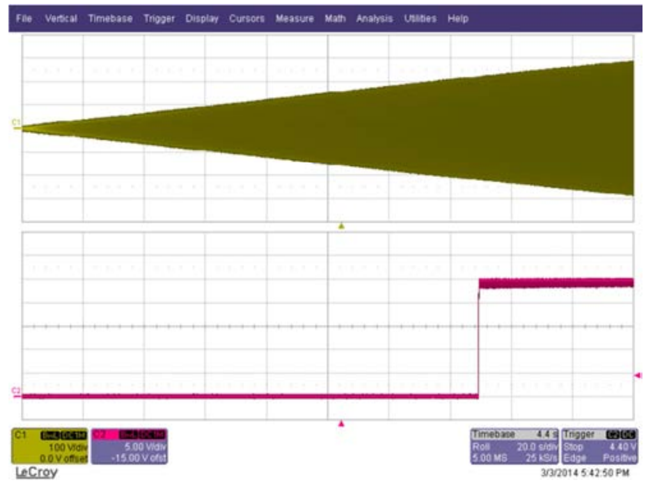

Figure 57 – Brown-in at 0.5 V / div.
Upper: V_{IN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.
Time Scale: 20 s / div.

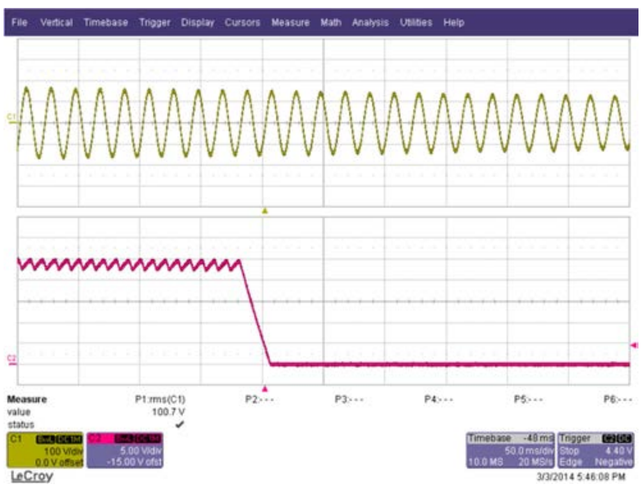

Figure 58 – Brown-out at 0.5 V / div.
Upper: V_{IN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.
Time Scale: 50 ms / div.

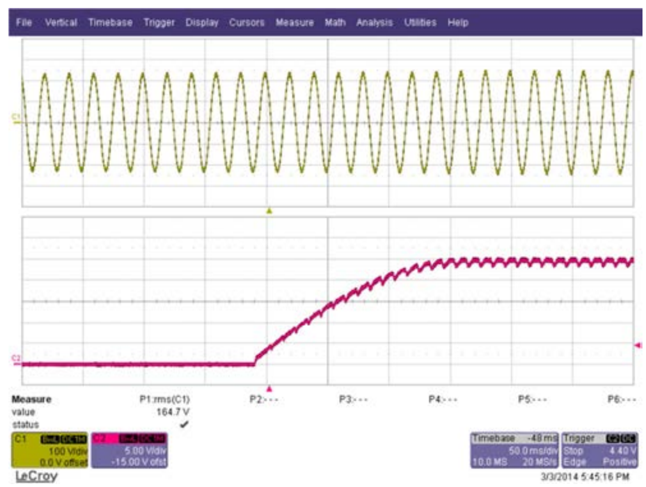

Figure 59 – Brown-in at 0.5 V / div.
Upper: V_{IN}, 100 V / div.
Lower: V_{OUT}, 5 V / div.
Time Scale: 50 ms / div.

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11.10 開迴路測試

Figure 60 – 190 VAC Open Loop at No-Load.
V_{OUT}, 5 V / div.
Time Scale: 500 ms / div.

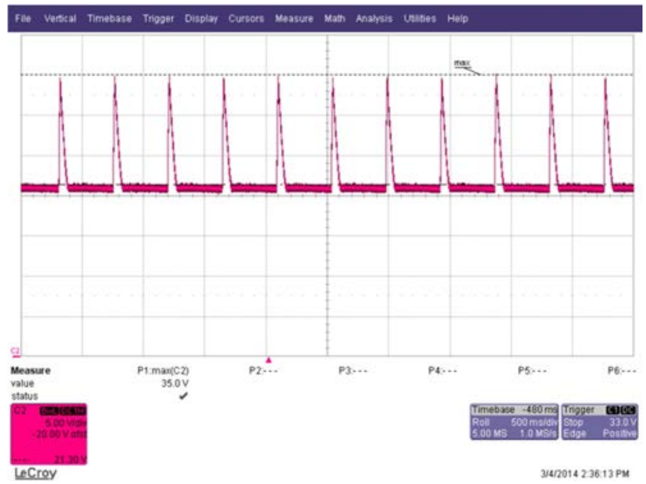

Figure 61 – 265 VAC Open Loop at No-Load.
V_{OUT}, 5 V / div.
Time Scale: 500 ms / div.

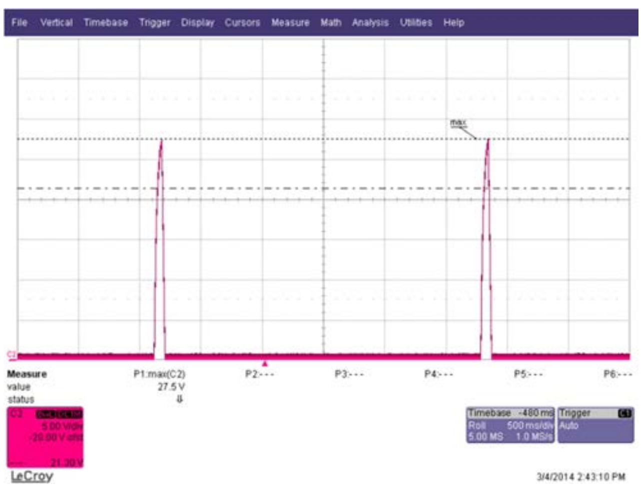

Figure 62 – 190 VAC Open Loop at Full-Load.
V_{OUT}, 5 V / div.
Time Scale: 500 ms / div.

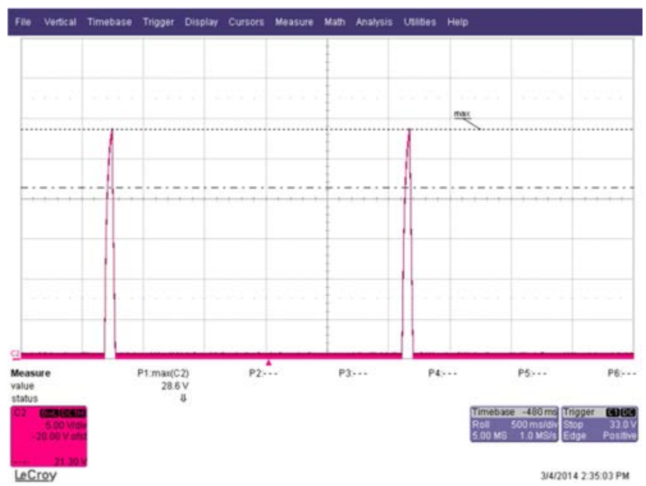

Figure 63 – 265 VAC Open Loop at Full-Load.
V_{OUT}, 5 V / div.
Time Scale: 500 ms / div.

11.11 輸出漣波測量

11.11.1 漣波測量技術

For DC output ripple measurements, a modified oscilloscope test probe must be utilized in order to reduce spurious signals due to pick-up. Details of the probe modification are provided in the Figures below.

The 4987BA probe adapter is affixed with two capacitors tied in parallel across the probe tip. The capacitors include one (1) 0.1 μF/50 V ceramic type and one (1) 1.0 μF/50 V aluminum electrolytic. The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).

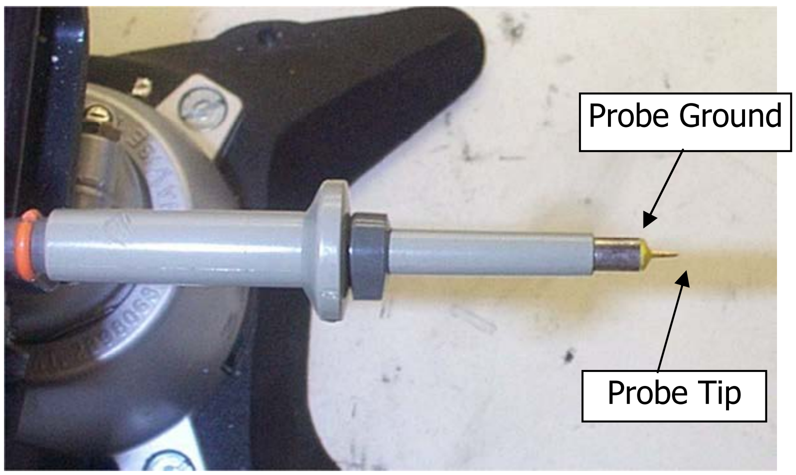

Figure 64 – Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed)

Figure 65 – Oscilloscope Probe with Probe Master (**www.probemaster.com**) 4987A BNC Adapter. (Modified with wires for ripple measurement, and two parallel decoupling capacitors added)

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11.11.2 測量結果

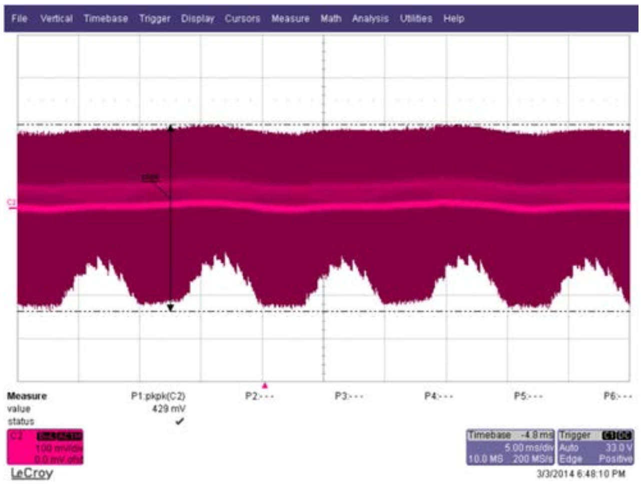

Figure 66 – Ripple, 190 VAC, Full Load.
5 ms, 100 mV / div.

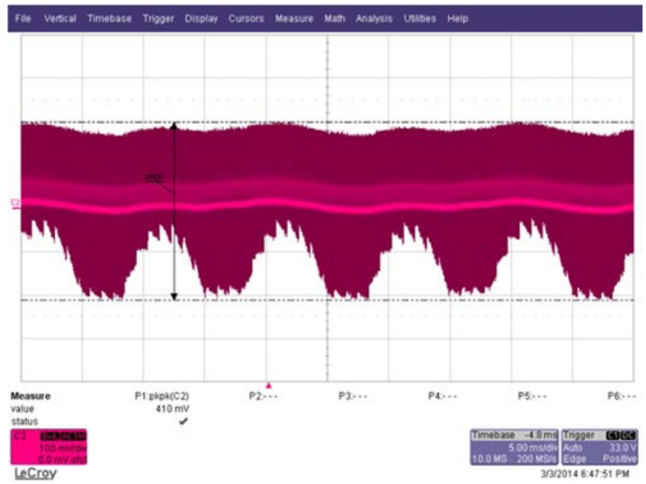

Figure 67 – Ripple, 265 VAC, Full Load.
5 ms, 100 mV / div.

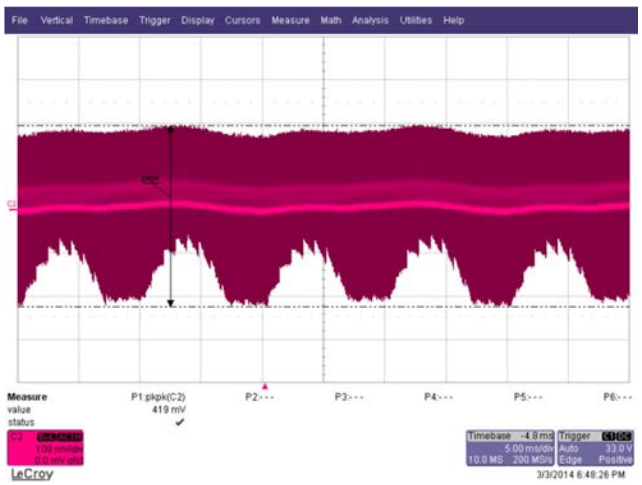

Figure 68 – Ripple, 230 VAC, Full Load.
5 ms, 100 mV / div.

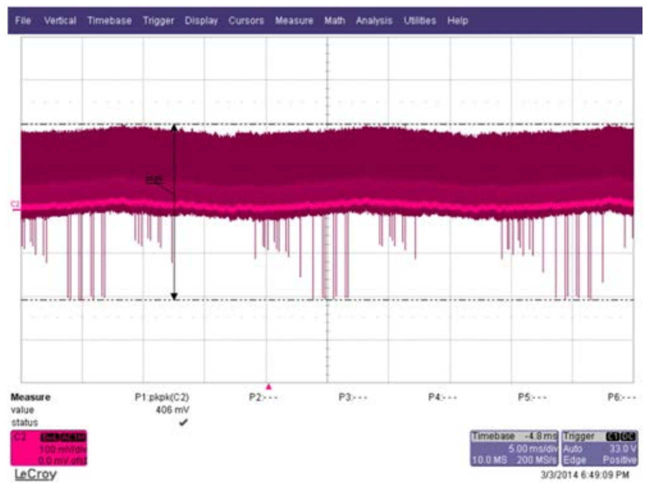

Figure 69 – Ripple, 230 VAC, ¾ Full Load.
5 ms, 100 mV / div.

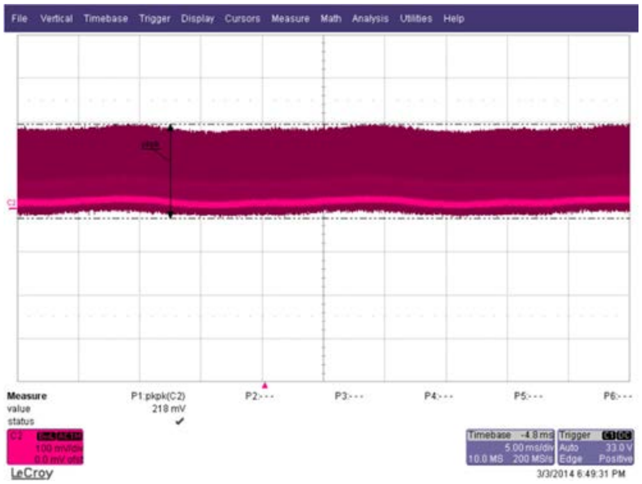

Figure 70 – Ripple, 230 VAC, ½ Full Load.
5 ms, 100 mV / div.

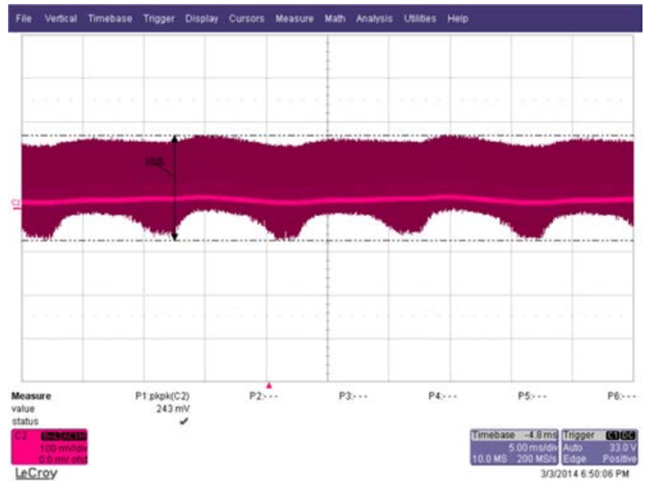

Figure 71 – Ripple, 230 VAC, ¼ Full Load.
5 ms, 100 mV / div.

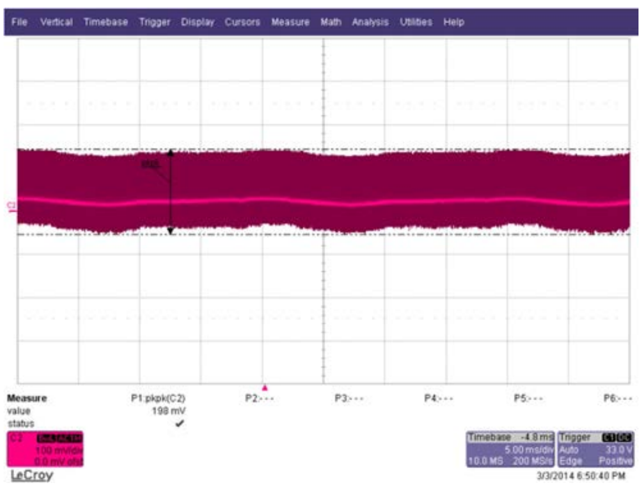

Figure 72 – Ripple, 230 VAC, 1/8 Full Load.
5 ms, 100 mV / div.

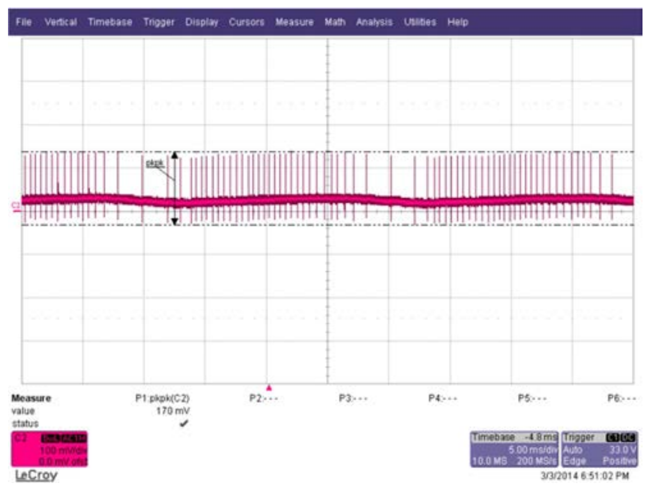

Figure 73 – Ripple, 230 VAC, No-Load.
5 ms, 100 mV / div.

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13 線電壓突波

Differential input line 1.2/50 µs surge testing was completed on a single test unit to IEC61000-4-5. Input voltage was set at 230 VAC / 60 Hz. Output was loaded at full load and operation was verified following each surge event.

Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
+250	230	L to N	90	Pass
-250	230	L to N	90	Pass
+500	230	L to N	90	Pass
-500	230	L to N	90	Pass
+750	230	L to N	90	Pass
-750	230	L to N	90	Pass
+1000	230	L to N	90	Pass
-1000	230	L to N	90	Pass

Unit passes under all test conditions.

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

Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
+2500	230	L to N	90	Pass
-25000	230	L to N	90	Pass
+2500	230	L to N	0	Pass
-25000	230	L to N	0	Pass

Unit passes under all test conditions.

14 傳導性 EMI

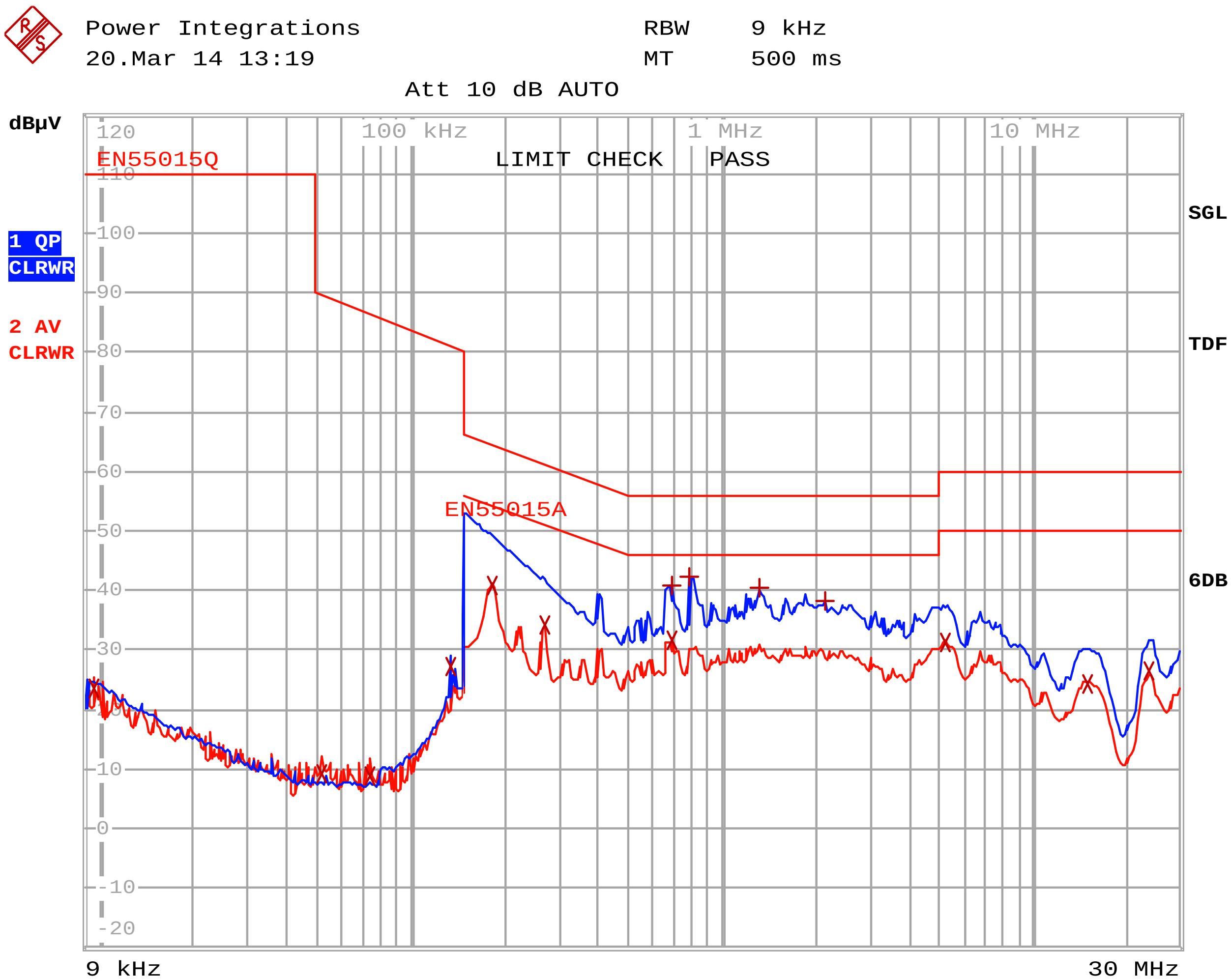

Figure 74 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Unit on Top of Copper Plane.

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EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
2	Average	9.4590904509 kHz	23.72	L1 gnd	
2	Average	51.3431986431 kHz	9.32	L1 gnd	
2	Average	73.4602458683 kHz	8.87	L1 gnd	
2	Average	134.789536006 kHz	27.12	N gnd	
2	Average	183.028505992 kHz	40.98	N gnd	-13.36
2	Average	269.806440381 kHz	34.16	N gnd	-16.96
1	Quasi Peak	687.48218373 kHz	40.89	N gnd	-15.10
2	Average	687.48218373 kHz	31.76	N gnd	-14.23
1	Quasi Peak	790.243042258 kHz	42.18	N gnd	-13.81
1	Quasi Peak	1.32578199726 MHz	40.35	N gnd	-15.64
1	Quasi Peak	2.1374603093 MHz	38.12	N gnd	-17.87
2	Average	5.23385515413 MHz	31.40	N gnd	-18.59
2	Average	15.0275202 MHz	24.45	N gnd	-25.55
2	Average	23.7503773643 MHz	26.52	L1 gnd	-23.47

Table 4 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Unit on Top of Copper Plane.

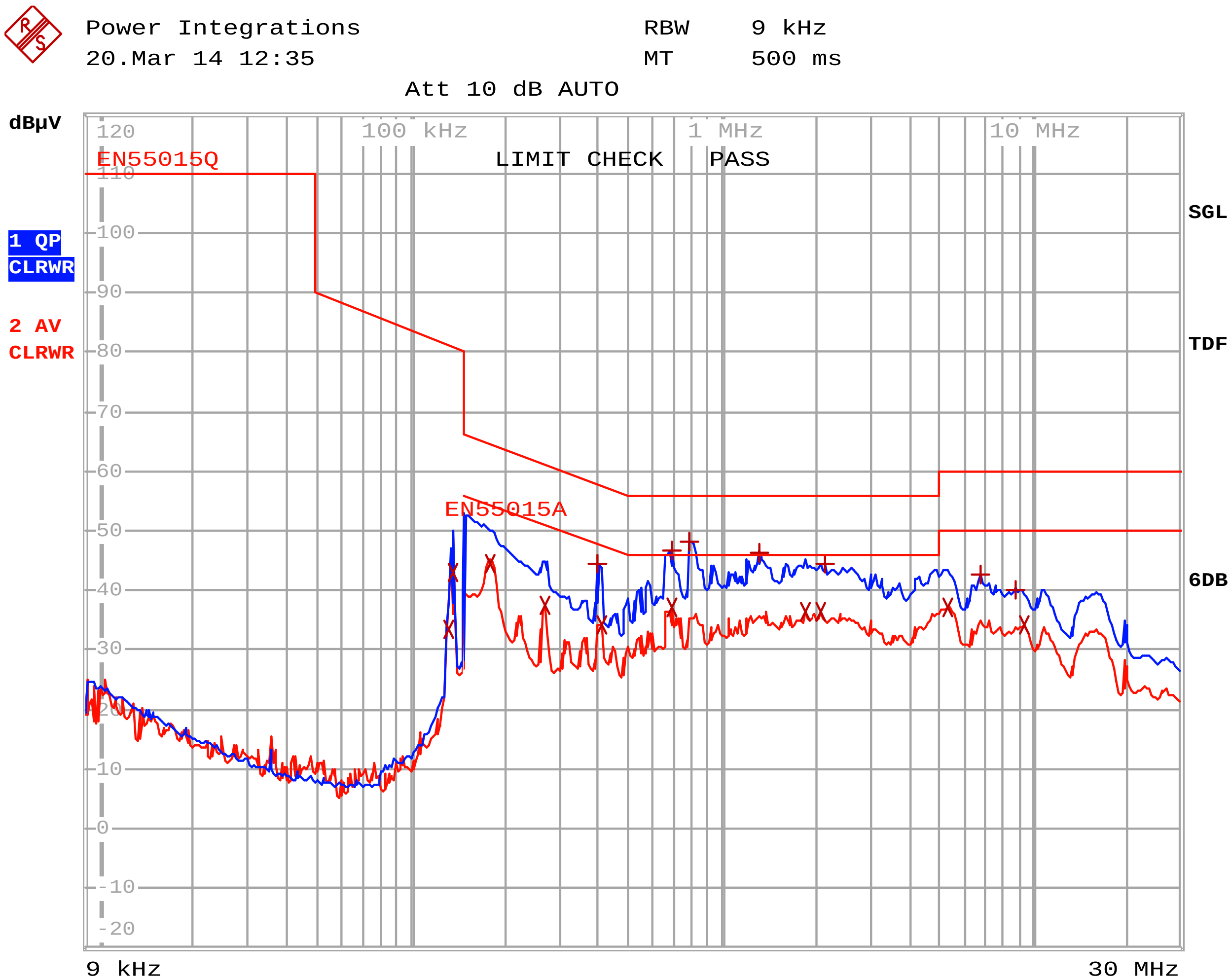

Figure 75 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Unit on Top of Copper Plane that is Connected to Earth.

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EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
Trace2: EN55015A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
2	Average	130.825395691 kHz	33.39	N gnd	
2	Average	136.137431366 kHz	43.13	N gnd	
2	Average	179.422121353 kHz	44.63	N gnd	-9.88
2	Average	269.806440381 kHz	37.40	N gnd	-13.72
1	Quasi Peak	397.727746704 kHz	44.42	N gnd	-13.47
2	Average	409.779295157 kHz	34.21	N gnd	-13.43
1	Quasi Peak	687.48218373 kHz	46.75	N gnd	-9.24
2	Average	687.48218373 kHz	37.01	N gnd	-8.98
1	Quasi Peak	790.243042258 kHz	48.05	N gnd	-7.94
1	Quasi Peak	1.32578199726 MHz	46.42	N gnd	-9.57
2	Average	1.84110031489 MHz	36.42	N gnd	-9.57
2	Average	2.0745979178 MHz	36.39	N gnd	-9.60
1	Quasi Peak	2.1588349124 MHz	44.56	N gnd	-11.43
2	Average	5.28619370567 MHz	36.97	N gnd	-13.02
1	Quasi Peak	6.77918394001 MHz	42.52	N gnd	-17.47
1	Quasi Peak	8.86858861671 MHz	40.08	N gnd	-19.91
2	Average	9.32097576636 MHz	34.03	N gnd	-15.96

Table 5 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Unit on Top of Copper Plane that is Connected to Earth.

15 修訂記錄

日期	作者	修訂	說明與變更	已審核
2014 年 11 月 7 日	JdC	1.0	初始版本	Apps & Mktg

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