

設計範例報告

標題	採用 LYTSwitch™-4 、 LYT4322E 的 8 W 可調光、非隔離升降壓式 LED 驅動器
規格	195 VAC – 265 VAC 輸入；72 V、115 mA 輸出
應用	A19 LED 驅動器
作者	應用工程部門
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修訂	1.0

摘要與功能

- Single-stage 功率因數修正 (PFC) (在 230 V 條件下大於 0.9) 與精準的定電流 (CC) 輸出
- 可調光，具有高相容性
- 所需元件極少且 PCB 佔位面積小的低成本解決方案
- 高度節能，在 240 VAC 輸入條件下效率大於 84 %
- 高功率因數；低 THD
- 優異的效能和使用者體驗
 - 快速啟動 (小於 150 ms) – 無可感延遲
- 整合式保護與信賴度特性
 - 藉由自動恢復功能提供單擊 (Single shot) 無負載保護、輸出短路保護
 - 具有高磁滯時間的自動恢復回復過溫保護，同時保護元件和 PCB
 - 在電壓關閉情況下，不會發生任何損壞
- 符合 IEC 振盪波、線差動電壓突波和 EN55015 傳導性 EMI 規定

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目錄

1	簡介	4
2	電源供應器規格	6
3	電路圖.....	7
4	電路說明	8
4.1	輸入 EMI 濾波.....	8
4.2	調光相容性 – 主動洩放器、被動 RC 洩放器和阻尼器	8
4.3	LYTSwitch-4	8
4.4	輸出整流	9
4.5	輸出回授.....	9
4.6	負載短路保護.....	9
4.7	無負載保護	9
5	PCB 佈局	10
6	散熱片設計.....	11
7	物料清單	13
8	電感器設計試算表.....	14
9	電感器設計.....	17
9.1	電氣圖.....	17
9.2	電氣規格	17
9.3	材料	17
9.4	電感構建圖	18
9.5	電感器結構	18
10	效能資料.....	19
10.1	模式效率	20
10.2	輸出電流調節	21
10.2.1	輸入線間與負載電壓至輸出電流調節.....	21
10.3	功率因數 (PF)	22
10.4	總諧波失真.....	23
10.5	諧波含量	24
11	散熱效能.....	26
11.1	使用設備	26
11.2	散熱成效	27
11.3	感熱掃描	29
12	波形.....	31
12.1	正常運作下的汲極電壓和電流	31
12.2	輸出短路時的汲極電壓和電流	33
12.3	汲極電壓和電流啓動輪廓	35
12.4	輸出電流啓動分析.....	36
12.5	輸入-輸出分析.....	37



12.6	線電壓弛波和突波	39
12.7	無負載保護	40
12.8	電壓關閉/電壓啓動	42
13	調光	43
13.1	調光相容性	43
13.2	調光波形	44
14	線電壓突波	86
15	傳導性 EMI	89
16	修訂記錄	92

重要事項：

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



1 簡介

本文件說明採用 LYTSwitch-4 系列 (LYT4322E) 且具有使用單面 PCB 之極輕薄小巧型升降壓式架構的成本效益型可調光 LED 電源供應器驅動器。

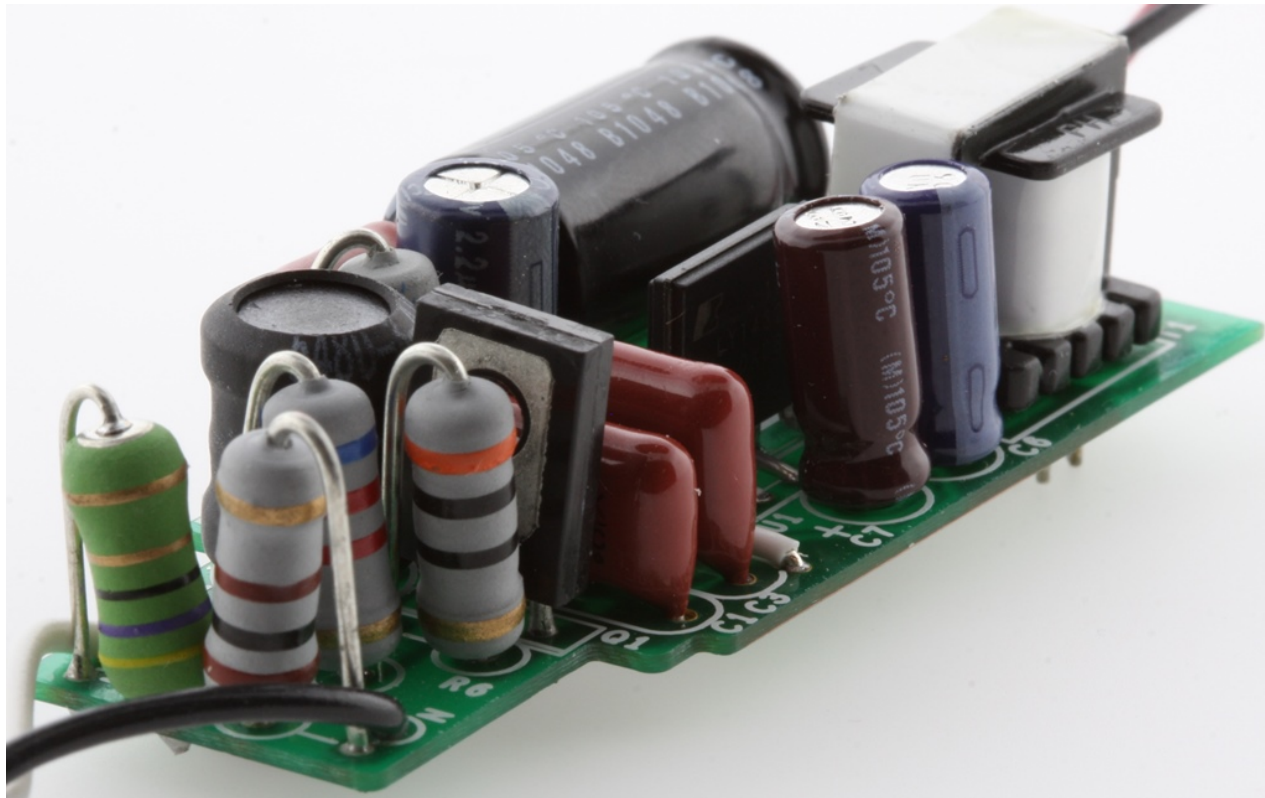


Figure 1 – Sample Unit.

此電源供應器可在 190 VAC 至 265 VAC 的輸入電壓範圍內運作，具有 Single-stage 主動功率因數修正和低諧波失真，適用於商業和工業應用。此 LED 驅動器可用於前緣和後緣調光器調光，並且與德國、義大利、澳大利亞和中國的大多數調光器相容。

裝置中整合了一些其他功能，例如開路迴路與輸出短路狀況時的自動重新啓動和線路過壓保護，可提高對線路故障與線間突波的耐受度。還加入了精確的磁滯回復過溫保護功能，可確保 PCB 在所有情況下皆可保持在安全的溫度。此整合將所需的分離式元件數目降低最低。

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



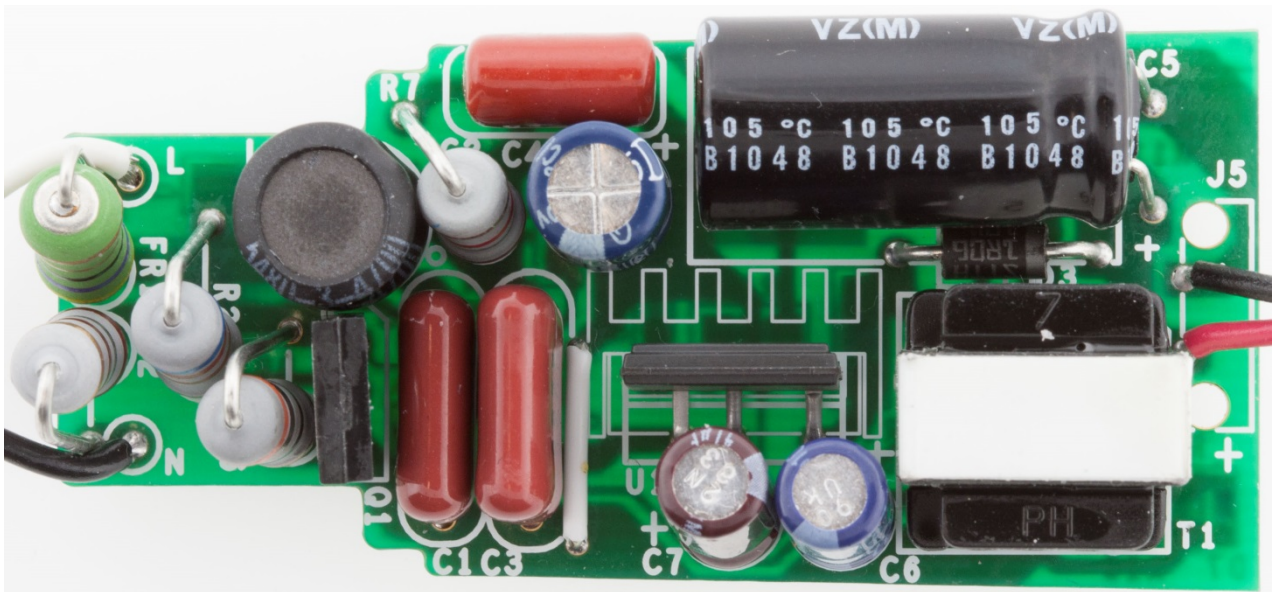


Figure 2 – Populated Circuit Board Photograph, Top.

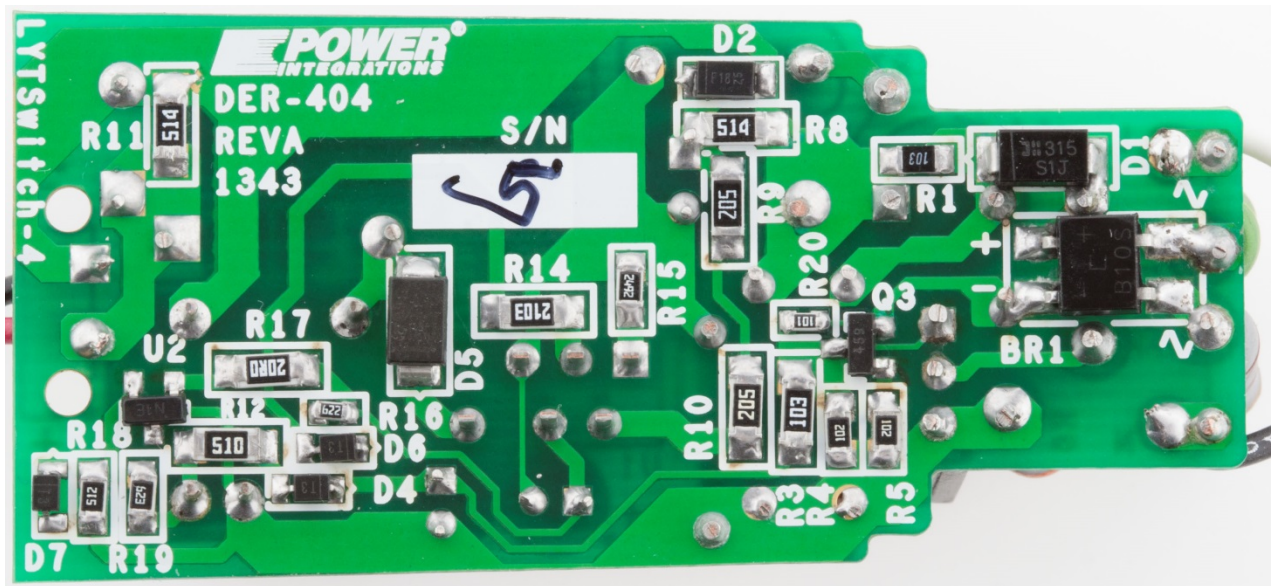


Figure 3 – Populated Circuit Board Photograph, Bottom.



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	典型值	最大值	單位	註解
輸入 電壓操作	V_{IN}	195		265	VAC	雙線 – 無 P.E. 工作頻率不受限制。如果是針對 400 Hz 的線電壓頻率，請調整感測 電阻器。
頻率	f_{LINE}	47	50/60		Hz	
輸出 輸出電壓	V_{OUT}	68	72	76	V	在 100 VAC - 240 VAC 條件下 $\pm 4\%$
輸出電流	I_{OUT}		115		mA	
總輸出功率 連續輸出功率	P_{OUT}		8		W	
效率 240 VAC ; 72 V LED	η	84			%	在 P_{OUT} 25 °C 時測量
功率因數 (PF) 240 VAC ; 54 V LED	功率因數 (PF)	0.9				在 P_{OUT} 25 °C 時測量
環境 傳導性 EMI		符合 CISPR22B / EN55015B 標準				1.2/50 μ s 突波，IEC 1000-4-5，串 聯阻抗： 差模：2 Ω 500 A 短路 串聯阻抗： 差模：12 Ω
線電壓突波 差模 (L1-L2)			0.5		kV	
振盪波 (100 kHz) 差模 (L1-L2)			2.5		kV	
環境溫度	T_{AMB}	-20	25		°C	自然對流，海平面



3 電路圖

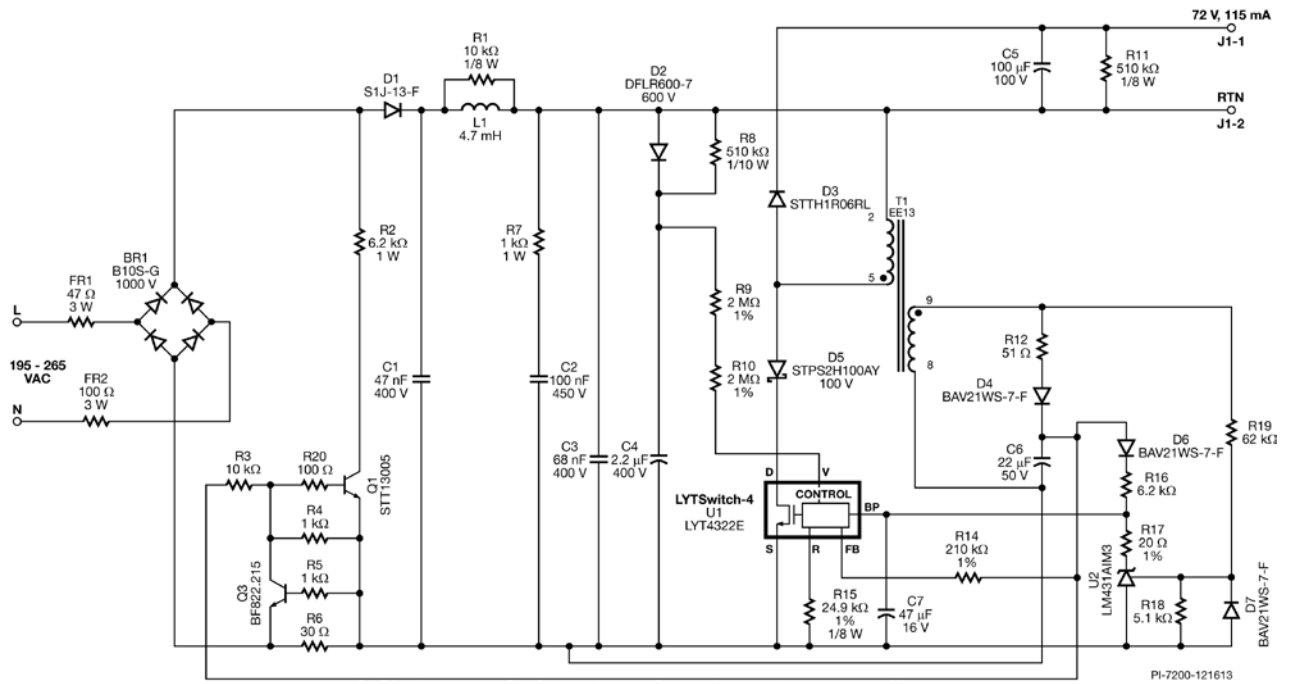


Figure 4 – Schematic.



4 電路說明

可調光的低成本 LED 驅動器電源供應器採用升降壓式配置的 LYT4322E (U1)，可在 72 VDC 的標準輸出電壓下提供 115 mA 定電流。該電源供應器專用於非隔離式驅動 LED，而 LED 應始終透過定電流 (CC) 驅動。使用非隔離式驅動器時，驅動器需要適當的絕緣體，且改良式燈具必須採用金屬外殼，以符合安全要求。

4.1 輸入 EMI 濾波

保險絲 RF1 提供短路保護。橋式整流器 BR1 提供全波整流，以實現良好的功率因數 (PF) 和低諧波含量。電容器 C1 和 C3 及共模電感器 L1 構成 π 濾波器，以符合傳導性 EMI 標準。電容器 C1 和 C3 還用於能量儲存，以減少線間噪音並防止線電壓突波。可熔電阻器 FR2 是一個阻尼電阻器，可在調光時減少輸入電流的振盪，這可用作為線路突波時的限制阻抗。

4.2 調光相容性 – 主動洩放器、被動 RC 洩放器和阻尼器

透過加入主動洩放器來補償低於 ~20 mA 以下的瞬間電流，讓此款可調光 LED 驅動器可與市場上大多數高線間調光器相容。這有助於在調光期間維持前緣調光器所需的保持電流 (holding current)，以及為後緣調光器提供偏壓共電。這由以下 9 個元件控制：

- D1 – 串聯阻隔二極體，可避免大電容器 (C1 和 C2) 進行不必要的放電。
- R2 – 在補償輸入電流時，限制洩放電阻器與 Q1 分擔功率損失。
- Q1 – 線性施加偏壓以在低於感測阻尼器 R6 和 Q3 設定之臨界值以下時補償電流。
- R20 – Q1 的基極限電流電阻器，可防止差模線間突波時發生崩潰。
- R3 – LYTSwitch-4 轉換器的輔助偏壓電阻器。
- R4 – Q1 的基極電阻器，可更快回應並且穩定。
- Q3 – 感測阻尼器電阻器 R6 的臨界電晶體。
- R5 – Q3 的基極限電流電阻器，可避免差模線間突波時發生崩潰。
- R6 – 同時感測電阻器和其他的阻尼器。

當使用前緣調光器操作時，會發生不必要的振盪和輸入電流振盪。為了減弱此振盪，將使用被動 RC 洩放器 (R7 和 C2)。將這些元件放置在 L1 之後，可更有效地將高頻振盪降至最低。

在開啓前緣調光器期間，被動阻尼器 FR1、FR2 和 R6 (177 Ω) 的總電阻會將峰值電流降至最低。可以用主動阻尼器來取代被動阻尼器，成本更低但效率可提升 2%。

4.3 LYTSwitch-4

LYTSwitch-4 已經過最佳化，使得可調光 LED 驅動器簡單易用、具有成本效益，且提供良好的線電壓與溫度調節。LYTSwitch-4 系列具有內建過熱限制，可在燈泡承受過高工作溫度時保護電源供應器。



升降壓式轉換器階段由 LYTSwitch-4 (U1) 內的整合式功率 MOSFET 切換開關、飛輪二極體 D3 (選用了快速飛輪二極體以將切換損失降至最低)、功率電感器/變壓器 T1 和輸出電容器 (C5) 組成。此轉換器通常在連續導通模式 (CCM) 下運作，以將導通時間期間的同步整流器損失降至最低。

LYTSwitch-4 峰值偵測器電路 C4、D2 和 R8 可提供輸入電壓的模擬資訊，並且會在線路擾動期間抑制線間突波電壓以符合 IEC 1000-4-5 規範。

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) 提高至高線間系列之內部功率 MOSFET 的 725 V_{DSS} 額定值。

4.4 輸出整流

快速輸出二極體 (D3) 用於實現良好效率和散熱管理，通常適用於環境溫度高於 70 °C 的 LED 應用。建議使用具有低 t_{RR} (小於 35 nS) 的裝置。由 D3 進行能量整流，由 C5 進行濾波。對於需要可接受更高漣波且成本更低的設計，可以減少輸出電容值。

4.5 輸出回授

LYTSwitch-4 捨棄透過感測電阻器來調節輸出電流，而是利用專有的方法控制輸出電流，以達到良好的效率。此方法是透過測量流經 T1 的偏壓繞組的相等輸出電壓。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 R14 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 (PF)。

4.6 負載短路保護

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。

4.7 無負載保護

在無負載操作的情況下，輸出電壓將限制為 100 V。偏壓繞組上的輸出電壓是透過主繞組和偏壓繞組的圈數比來偵測的。IC U2 會在自動重新啓動時強制 BP 接腳調節輸出電壓。分壓器 R19 和 R18 會設定過壓保護 (OVP) 臨界值。二極體 D7 是 U2 的反向電流保護，而 R17 是 U2 的偏壓電阻器和限制電阻器。



5 PCB 佈局

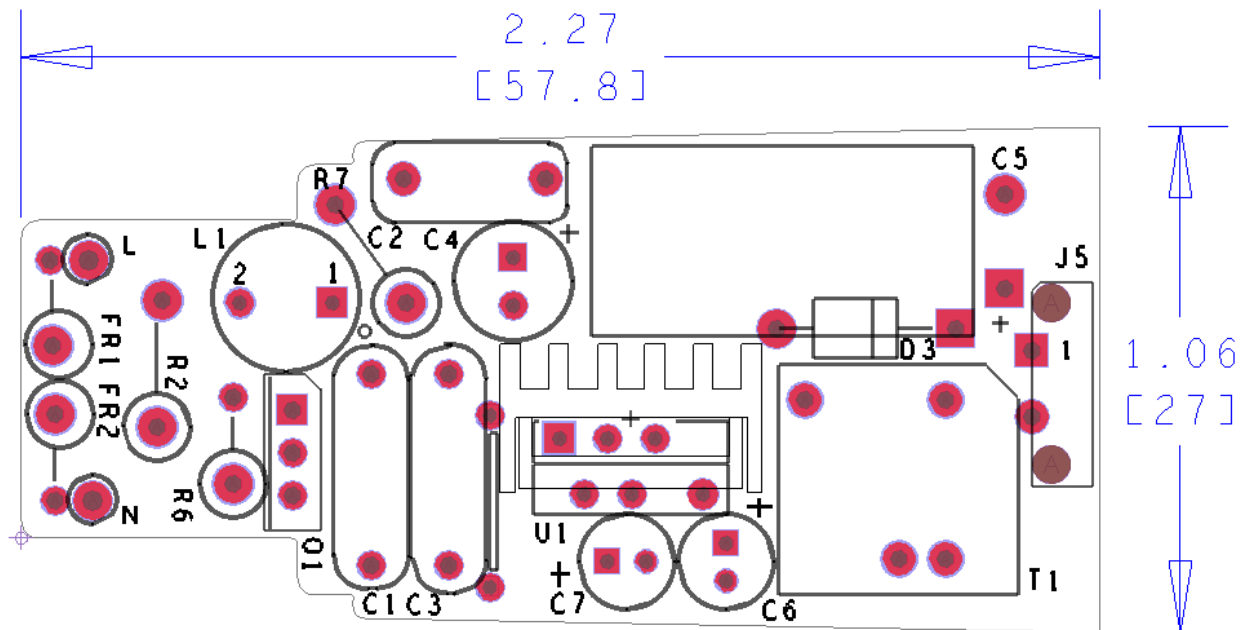


Figure 5 – Printed Circuit Layout. Top View.

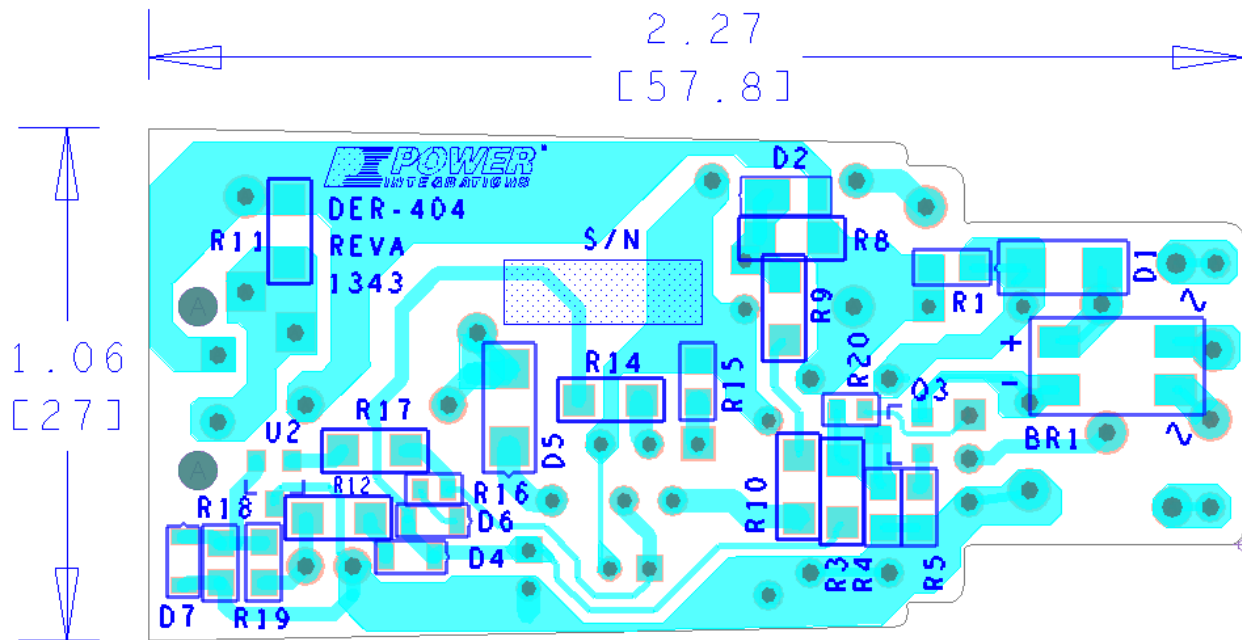
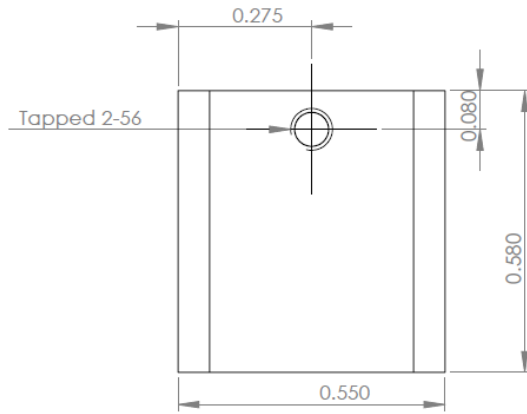


Figure 6 – Printed Circuit Layout. Bottom View.

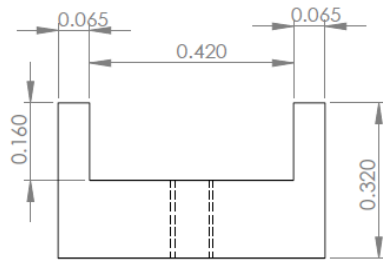


6 散熱片設計

Heat sink is not required if the system design is potted.



TOP VIEW



FRONT VIEW

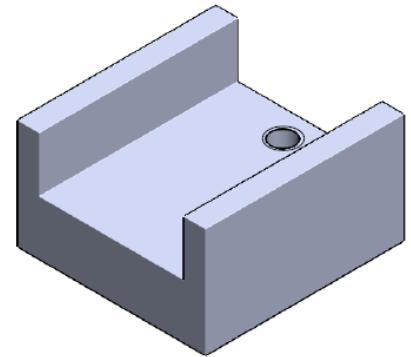


Figure 7 – U1 Heat Sink 1.



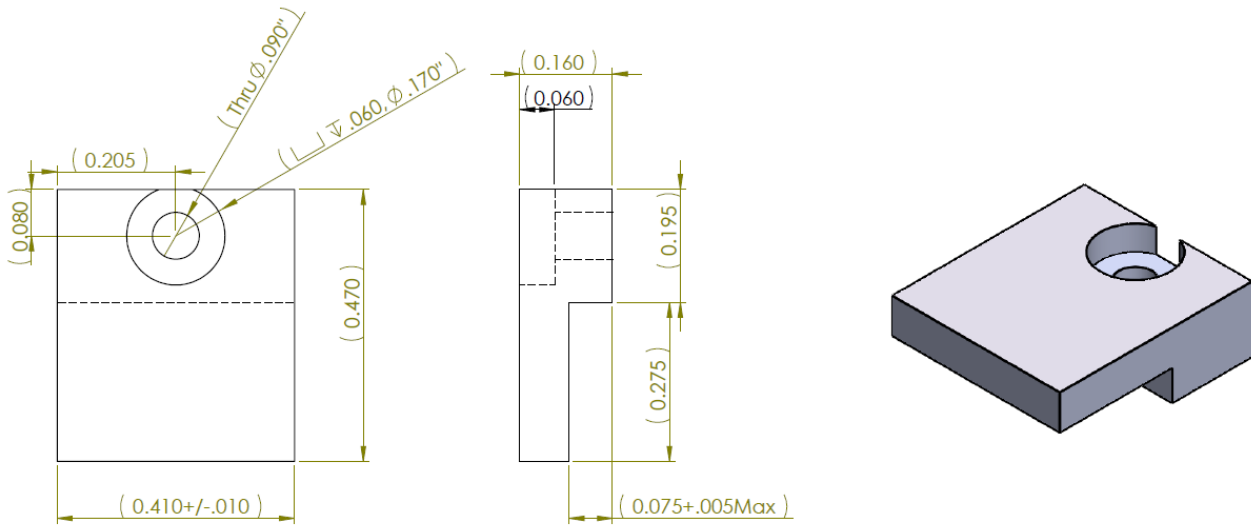


Figure 8 – U1 Heat Sink 2 for Clamping.

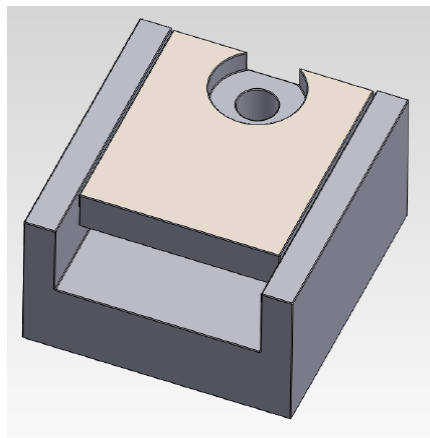


Figure 9 – U1 Heat Sink 2 Combination.



7 物料清單

Below are the parts used in the build of the sample design. The design does not limits the selection of part, any alternative parts can be used for optimum cost in a given region.

Item	Qty	Ref Des	Description	Manufacturer P/N	Manufacturer
Electrical					
1	1	BR1	1000 V, 0.8 A, Bridge Rectifier, SMD, MBS-1, 4-SOIC	B10S-G	Comchip
2	1	C1	47 nF, 400 V, Film	ECQ-E4473KF	Panasonic
3	1	C2	100 nF, 450 V, Film	MEXXD31004JJ1	Duratech
4	1	C3	68 nF, 400 V, Film	ECQ-E4683KF	Panasonic
5	1	C4	2.2 μ F, 400 V, Electrolytic, (6.3 x 11)	TAB2GM2R2E110	Ltec
6	1	C5	100 μ F, 100 V, Electrolytic, Gen. Purpose, (10 x 20)	UVZ2A101MPD	Nichicon
7	1	C6	22 μ F, 50 V, Electrolytic, (5 x 11)	UPW1H220MDD	Nichicon
8	1	C7	47 μ F, 16 V, Electrolytic, Gen. Purpose, (5 x 11)	USV1C470MFD	Nichicon
9	1	D1	600 V, 1 A, Standard Recovery, SMA	S1J-13-F	Diodes, Inc.
10	1	D2	600 V, 1 A, Rectifier, Glass Passivated, POWERDI123	DFLR1600-7	Diodes, Inc.
11	1	D3	600 V, 1 A, Ultrafast Recovery, DO-41	STTH1R06RL	ST Micro
12	3	D4 D6 D7	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diode, Inc.
13	1	D5	100 V, 2 A, Schottky, SMA	STPS2H100AY	ST Micro
14	2	FR1 FR2	75 R, 5%, 1 W, Metal Oxide	RSF100JB-75R	Yageo
15	1	L1	4.7 mH, 0.150 A, 20%	RL-5480-3-4700	Renco Elect, Inc
16	1	Q1	NPN, NPN FAST SW BIPO SOT-32, TO-126-3	STT13005	ST Micro
17	1	Q3	TRANS NPN 250V 50MA SOT23	BF822.215	NXP
18	1	R1	10 k Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ103V	Panasonic
19	1	R2	6.2 k Ω , 5%, 1 W, Metal Oxide	RSF100JB-6K2	Yageo
20	1	R3	10 k Ω , 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ103V	Panasonic
21	2	R4 R5	1 k Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ102V	Panasonic
22	1	R6	30 Ω , 5%, 1 W, Metal Oxide	RSF100JB-30R	Yageo
23	1	R7	1 k Ω , 5%, 1 W, Metal Oxide	RSF100JB-1K0	Yageo
24	2	R8 R11	510 k Ω , 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ514V	Panasonic
25	2	R9 R10	2 M Ω , 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ205V	Panasonic
26	1	R12	51 Ω , 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ510V	Panasonic
27	1	R14	221 k Ω , 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF2213V	Panasonic
28	1	R15	24.9 k Ω , 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF2492V	Panasonic
29	1	R16	6.2 k Ω , 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ622V	Panasonic
30	1	R17	20 Ω , 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF20R0V	Panasonic
31	1	R18	5.1 k Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ512V	Panasonic
32	1	R19	62 k Ω , 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ623V	Panasonic
33	1	R20	100 Ω , 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ101V	Panasonic
34	1	T1	Custom, EE13, Vertical, 10 pins	Custom	Custom
35	1	U1	LYTSwitch, eSIP-7C	LYT4322E	Power Integrations
36	1	U2	IC, REG ZENER SHUNT ADJ SOT-23	LM431AIM3/NOPB	National Semi
Mechanical					
16	1	WIRE(V-)	Wire, UL1007, #24 AWG, Blk, PVC, 4"	1007-24/7-0	Anixter
17	1	WIRE (L)	Wire, UL1007, #24 AWG, Blu, PVC, 4"	1007-24/7-6	Anixter
18	1	WIRE(V+)	Wire, UL1007, #24 AWG, Red, PVC, 4"	1007-24/7-2	Anixter
19	1	WIRE(N)	Wire, UL1007, #24 AWG, Wht, PVC, 4"	1007-24/7-9	Anixter
20	1	PCB	FR4, 0.31, 1Oz Cu (0.51" X 2.1")		

Note: Reverse voltage <100 on the DRAIN pin. Diode D5 vottage rating is 100 V minimum.



8 電感器設計試算表

ACDC_LYTSwitch-4_HL_062013; Rev.1.0; Copyright Power Integrations 2013	INPUT	INFO	OUTPUT	UNIT	LYTSwitch-4_HL_062013: Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES					
Dimming required	YES		YES		Select 'YES' option if dimming is required. Otherwise select 'NO'.
VACMIN			195	V	Minimum AC Input Voltage
VACMAX			265	V	Maximum AC input voltage
fL			50	Hz	AC Mains Frequency
VO	72.00		72	V	Typical output voltage of LED string at full load
VO_MAX			79.20	V	Maximum expected LED string Voltage.
VO_MIN			64.80	V	Minimum expected LED string Voltage.
V_OVP			87.12	V	Over-voltage protection setpoint
IO	0.12		0.12	A	Typical full load LED current
PO			8.6	W	Output Power
n			0.8		Estimated efficiency of operation
VB			25	V	Bias Voltage
ENTER LYTSwitch VARIABLES					
LYTSwitch	LYT4322		LYT4322		Selected LYTSwitch
Current Limit Mode	RED		RED		Select "RED" for reduced Current Limit mode or "FULL" for Full current limit mode
ILIMITMIN			0.65	A	Minimum current limit
ILIMITMAX			0.76	A	Maximum current limit
fS			132000	Hz	Switching Frequency
fSmin			124000	Hz	Minimum Switching Frequency
fSmax			140000	Hz	Maximum Switching Frequency
IV			80.6	uA	V pin current
RV			4	M-ohms	Upper V pin resistor
RV2			100000000000	M-ohms	Lower V pin resistor
IFB			114.7	uA	FB pin current (85 uA < IFB < 210 uA)
RFB1			191.9	k-ohms	FB pin resistor
VDS			10	V	LYTSwitch on-state Drain to Source Voltage
VD			0.50	V	Output Winding Diode Forward Voltage Drop (0.5 V for Schottky and 0.8 V for PN diode)
VDB			0.70	V	Bias Winding Diode Forward Voltage Drop
Key Design Parameters					
KP	1.00		1.00		Ripple to Peak Current Ratio (For PF0.9 · 0.4 < KP < 0.9)/>
LP			815	uH	Primary Inductance
VOR	72.00		72	V	Reflected Output Voltage.
Expected IO (average)			0.12	A	Expected Average Output Current
KP_VNOM			0.96		Expected ripple current ratio at VACNOM
TON_MIN			1.22	us	Minimum on time at maximum AC input voltage
PCLAMP			0.07	W	Estimated dissipation in primary clamp
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	EF20		EF20		Select Core Size
Custom Core					Enter Custom core part number (if applicable)
AE	0.17		0.17	cm^2	Core Effective Cross Sectional Area
LE	3.02		3.02	cm	Core Effective Path Length



AL	1130.00		1130	nH/T ²	Ungapped Core Effective Inductance
BW	7.40		7.4	mm	Bobbin Physical Winding Width
M	0.00		0	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	4.00		4		Number of Primary Layers
NS			106		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			276	V	Peak input voltage at VACMIN
VMAX			375	V	Peak input voltage at VACMAX
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.21		Minimum duty cycle at peak of VACMIN
IAVG			0.05	A	Average Primary Current
IP			0.57	A	Peak Primary Current (calculated at minimum input voltage VACMIN)
IRMS			0.13	A	Primary RMS Current (calculated at minimum input voltage VACMIN)
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			815	uH	Primary Inductance
LP_TOL			10		Tolerance of primary inductance
NP			105		Primary Winding Number of Turns
NB			38		Bias Winding Number of Turns
ALG			74	nH/T ²	Gapped Core Effective Inductance
BM			2582	Gaus s	Maximum Flux Density at PO, VMIN (BM<3100)
BP			3459	Gaus s	Peak Flux Density (BP<3700)
BAC			1291	Gaus s	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1597		Relative Permeability of Ungapped Core
LG			0.27	mm	Gap Length (Lg0.1 mm)/>
BWE			29.6	mm	Effective Bobbin Width
OD			0.28	mm	Maximum Primary Wire Diameter including insulation
INS			0.05	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.23	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		Info	635	Cmils /Amp	!!! Info. Decrease CMA (200 < CMA < 600) Decrease L(primary layers),increase NS,smaller Core
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT)					
Lumped parameters					
ISP			0.56	A	Peak Secondary Current
ISRMS			0.22	A	Secondary RMS Current
IRIPPLE			0.19	A	Output Capacitor RMS Ripple Current
CMS			44	Cmils	Secondary Bare Conductor minimum circular mils
AWGS			33	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS			0.18	mm	Secondary Minimum Bare Conductor Diameter
ODS			0.07	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
VOLTAGE STRESS PARAMETERS					
VDRAIN			529	V	Estimated Maximum Drain Voltage assuming maximum LED string voltage (Includes Effect of Leakage Inductance)
PIVS			464	V	Output Rectifier Maximum Peak Inverse Voltage (calculated at VOVP, excludes leakage inductance spike)
PIVB			164	V	Bias Rectifier Maximum Peak Inverse Voltage (calculated at VOVP, excludes leakage inductance spike)



FINE TUNING (Enter measured values from prototype)					
V pin Resistor Fine Tuning					
RV1	4.00		4.00	M-ohms	Upper V Pin Resistor Value
RV2			100000000 0000	M-ohms	Lower V Pin Resistor Value
VAC1	195.00		195.0	V	Test Input Voltage Condition1
VAC2	265.00		265.0	V	Test Input Voltage Condition2
IO_VAC1	0.11		0.11	A	Measured Output Current at VAC1
IO_VAC2	0.12		0.12	A	Measured Output Current at VAC2
RV1 (new)			3.32	M-ohms	New RV1
RV2 (new)			0.16	M-ohms	New RV2
V_OV			310.3	V	Typical AC input voltage at which OV shutdown will be triggered
V_UV			100.3	V	Typical AC input voltage beyond which power supply can startup
FB pin resistor Fine Tuning					
RFB1	210.00		210	k-ohms	Upper FB Pin Resistor Value
RFB2			100000000 0000	k-ohms	Lower FB Pin Resistor Value
VB1			22.4	V	Test Bias Voltage Condition1
VB2			27.6	V	Test Bias Voltage Condition2
IO1			0.12	A	Measured Output Current at Vb1
IO2			0.12	A	Measured Output Current at Vb2
RFB1 (new)			210.0	k-ohms	New RFB1
RFB2(new)			100000000 0000.0000	k-ohms	New RFB2
Input Current Harmonic Analysis					
Harmonic			Max Current (mA)	Limit (mA)	
1st Harmonic					
3rd Harmonic			12.43	317.26	PASS. 3rd Harmonic current content is lower than the limit
5th Harmonic			6.6	177.29	PASS. 5th Harmonic current content is lower than the limit
7th Harmonic			4.1	93.31	PASS. 7th Harmonic current content is lower than the limit
9th Harmonic			2.95	46.66	PASS. 9th Harmonic current content is lower than the limit
11th Harmonic			2.20	32.66	PASS. 11th Harmonic current content is lower than the limit
13th Harmonic			1.70	27.63	PASS. 13th Harmonic current content is lower than the limit
15th Harmonic			1.38	23.94	PASS. 15th Harmonic current content is lower than the limit
THD			31.7	%	Estimated total Harmonic Distortion (THD)



9 電感器設計

9.1 電氣圖

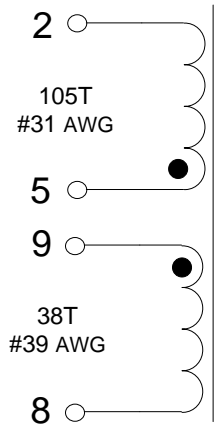


Figure 10 – Transformer Electrical Diagram.

9.2 電氣規格

Primary Inductance	Pins 2-5, all other windings open, measured at 100 kHz, 0.4 V _{RMS}	815 μH ±7%
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9.3 材料

Item	Description
[1]	Core: EE13; NC2H or equivalent.
[2]	Bobbin: EE13;5/5 pin Vertical;Pin Shine, P-1302-2 or equivalent.
[3]	Magnet Wire: #31 AWG.
[4]	Magnet Wire: #39 AWG.
[5]	Transformer tape: 6.5 mm.

9.4 電感構建圖

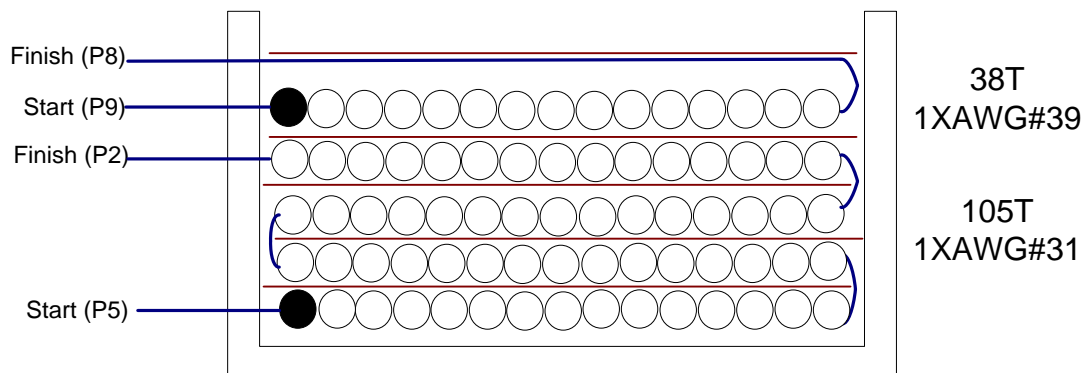


Figure 11 – Transformer Build Diagram.

9.5 電感器結構

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.
WDG 1	Start at pin 5. Wind 105 turns of item [3] and terminate at pin 1. Note that there is one turn of transformer tape item[5] per layer
Insulation	Add 1 layer of tape of item [5].
WDG 2	Start at pin 9. Wind 38 turns of item [4] and terminate at pin 8.
Taping	Add 1 layer of tape to secure the winding.
Final Assembly	Grind the core to get the specified inductance. Secure the core with tape.



10 效能資料

All measurements performed at room temperature (~25 °C) otherwise specified.

Input		Input Measurement					LED Load Measurement			Efficiency (%)	Reg (%)
VAC (V _{RMS})	Frequency (Hz)	V _{IN} (V _{RMS})	I _{IN} (mA _{RMS})	P _{IN} (W)	PF	% THD	V _{OUT} (V _{DC})	I _{OUT} (mA _{DC})	P _{OUT} (W)		
Vo min											
195	50	194.96	48.57	8.913	0.941	25.94	68.0	110.6	7.53	84.48	84.48
200	50	199.93	47.73	8.951	0.938	26.33	68.0	111.2	7.57	84.57	84.57
230	50	229.94	43.94	9.275	0.918	28.48	68.2	115.0	7.85	84.64	84.64
240	50	239.97	42.87	9.374	0.911	29.3	68.2	115.8	7.91	84.38	84.38
265	50	265.02	40.77	9.672	0.895	31.52	68.3	117.6	8.05	83.23	83.23
Vo nom											
195	50	194.96	51.78	9.548	0.946	25.35	72.0	111.8	8.06	84.42	84.42
200	50	199.94	50.69	9.549	0.942	25.81	72.0	112.0	8.08	84.62	84.62
230	50	229.94	46.28	9.819	0.923	27.85	72.2	115.3	8.34	84.94	84.94
240	50	239.97	45.03	9.893	0.916	28.6	72.2	116.0	8.40	84.91	84.91
265	50	265.03	42.59	10.148	0.899	30.66	72.3	117.7	8.52	83.96	83.96
Vo max											
195	50	194.96	54.91	10.162	0.949	24.97	76.0	112.6	8.57	84.33	84.33
200	50	199.93	53.79	10.177	0.946	25.33	75.9	113.0	8.60	84.50	84.50
230	50	229.94	48.72	10.385	0.927	27.33	76.1	115.9	8.84	85.12	85.12
240	50	239.97	47.30	10.446	0.920	27.97	76.1	116.5	8.88	85.01	85.01
265	50	265.02	44.55	10.669	0.904	29.77	76.2	118.0	9.01	84.45	84.45

Table 1 – Raw Data.



10.1 模式效率

Measured at 25 °C ambient, open frame.

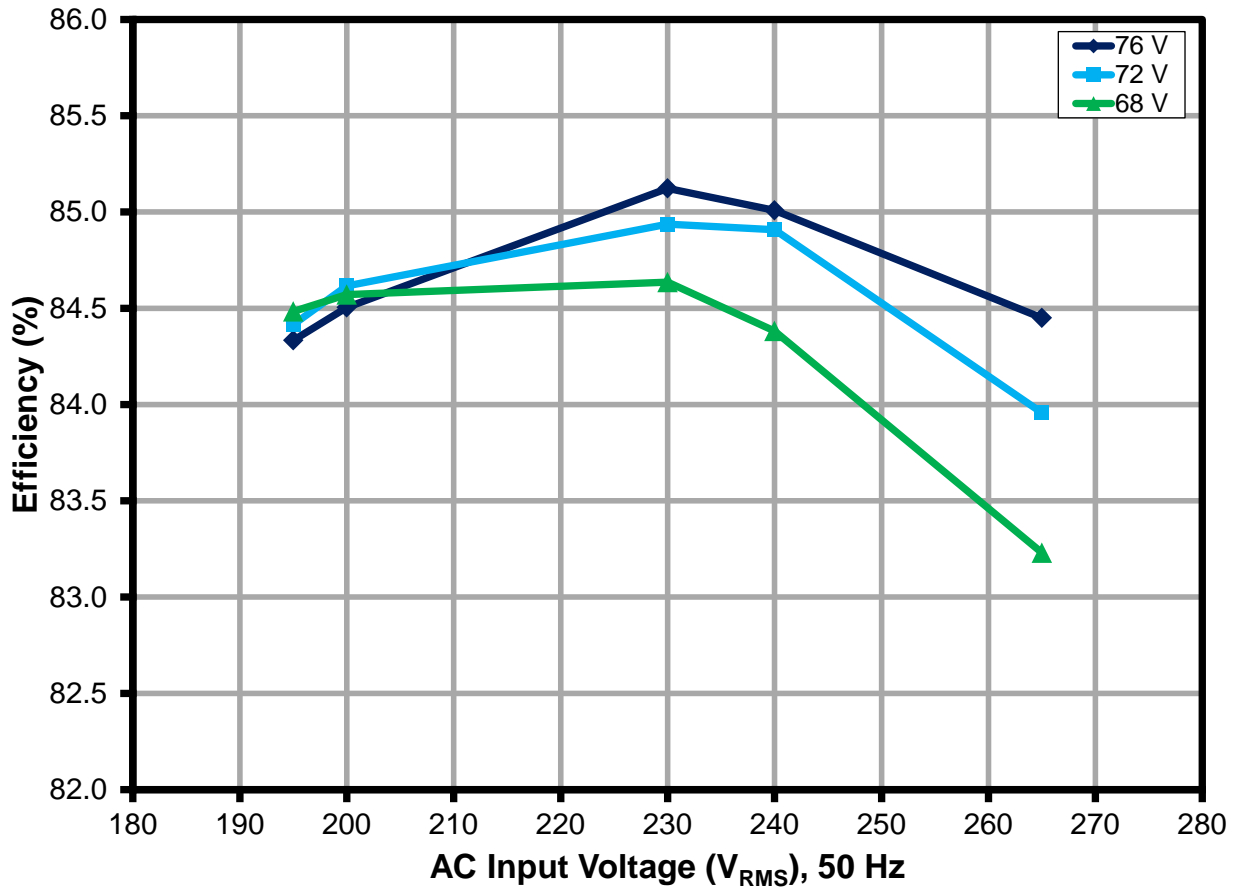


Figure 12 – Efficiency with Respect to AC Input Voltage. 195-265 VAC (60 Hz) Input.



10.2 輸出電流調節

10.2.1 輸入線電壓與負載電壓至輸出電流調節

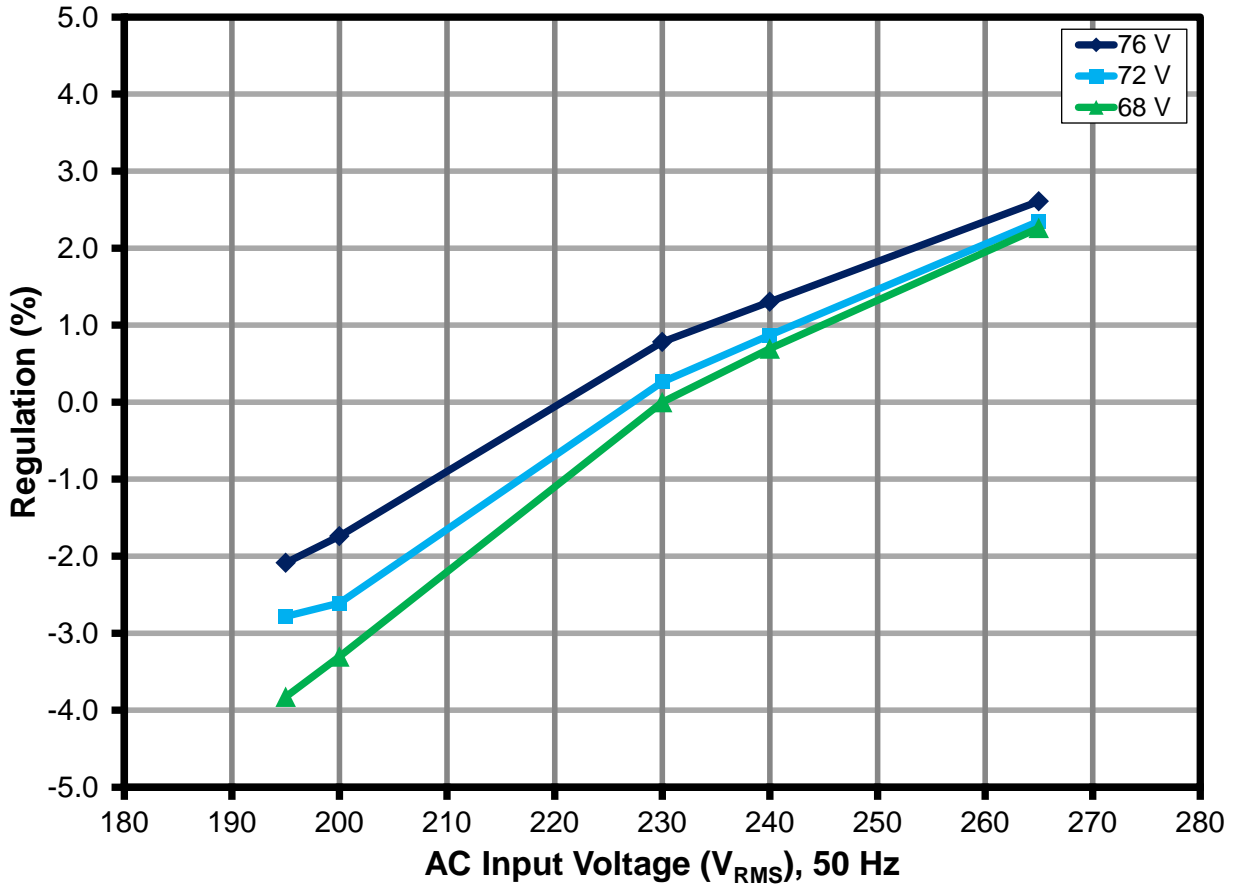


Figure 13 – Load Regulation, Room Temperature.



10.3 功率因數 (PF)

Measured at 25 °C ambient, open frame.

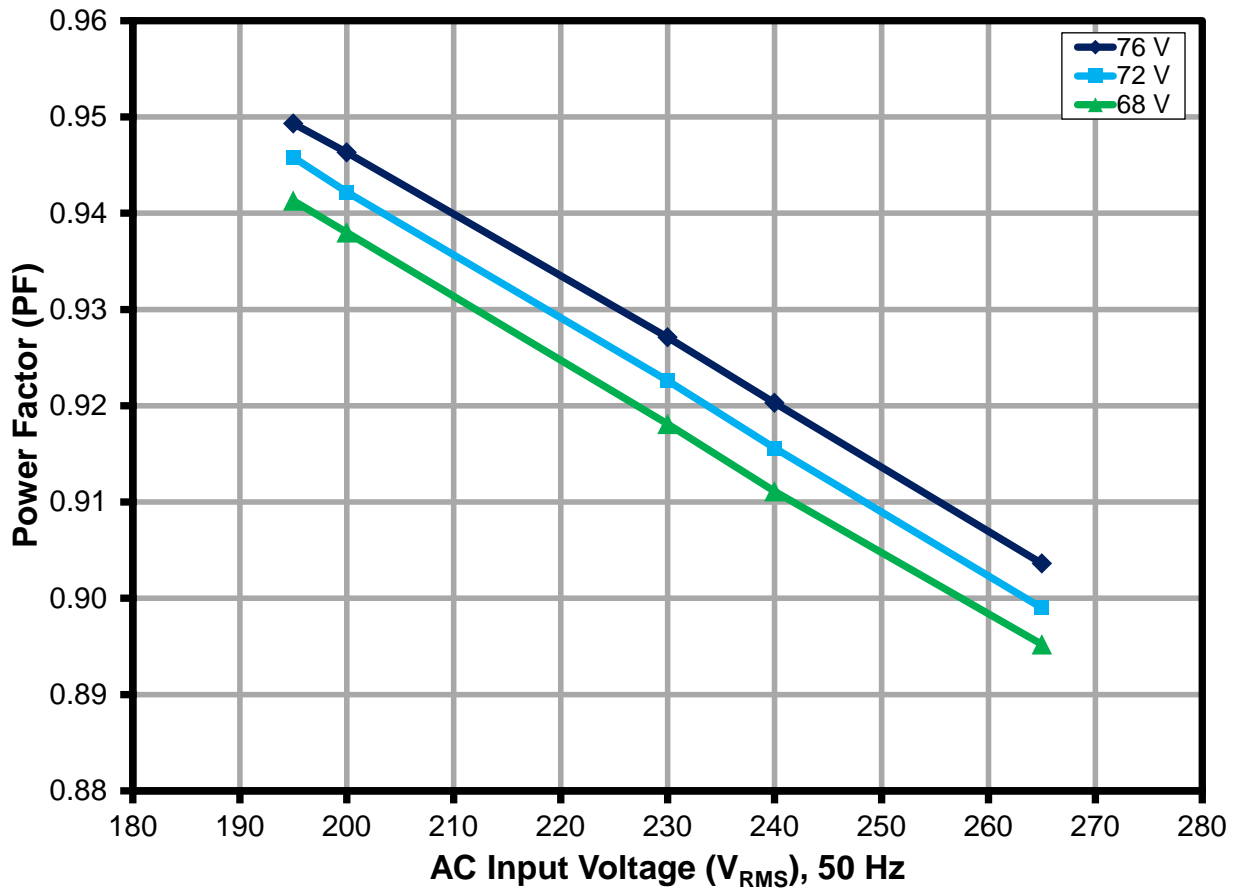


Figure 14 – Power Factor, Room Temperature.



10.4 總諧波失真

Measured at 25 °C ambient, open frame.

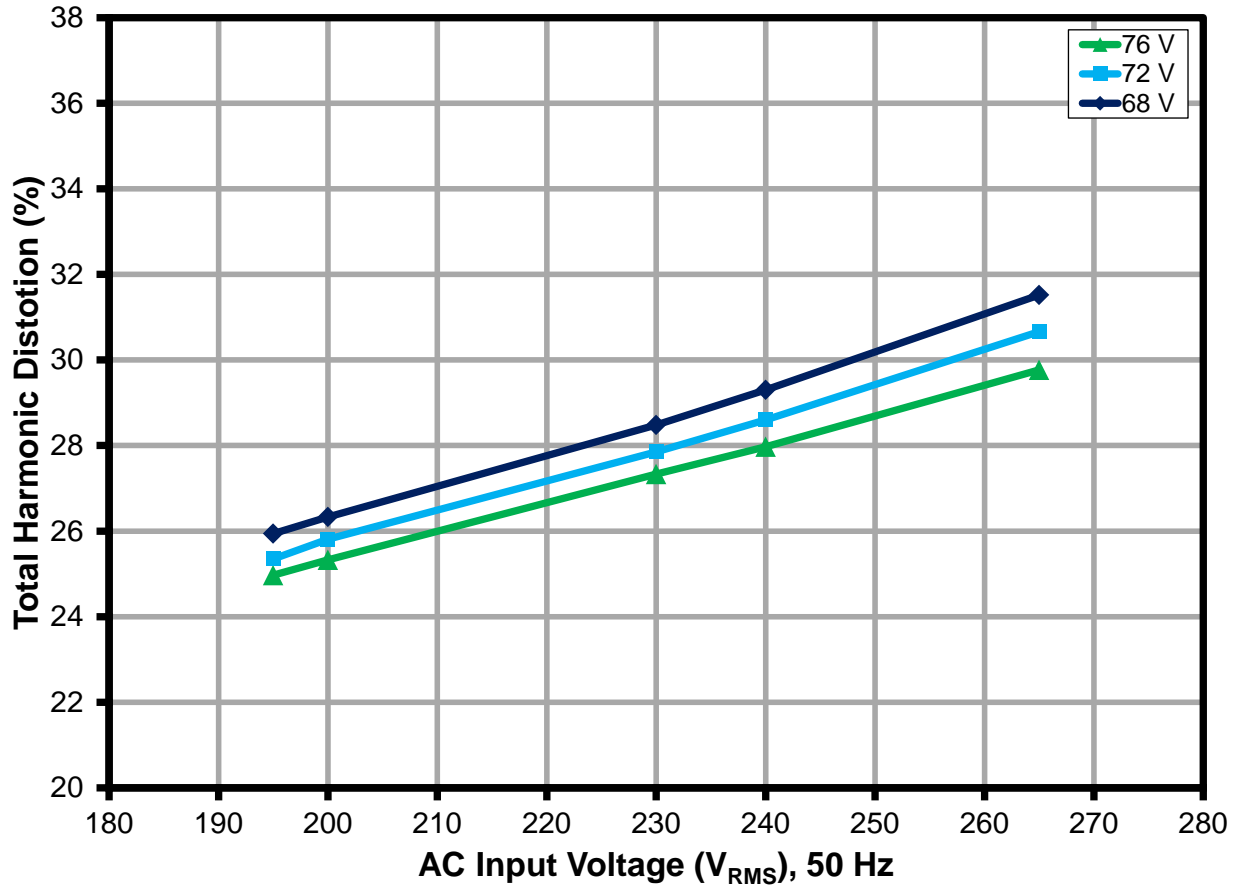


Figure 15 – %THD, Room Temperature.



10.5 諧波含量

Measured at 25 °C ambient, open frame. Load: 72 V LED

V	Freq	I (mA)	P	PF	%THD
240	50.00	45.03	9.8930	0.9156	28.6
nth Order	mA Content	% Content	Limit <25 W	Remarks	
1	43.29				
2	0.02	0.04			
3	9.45	21.84	33.64	Pass	
5	6.09	14.07	18.80	Pass	
7	3.27	7.55	9.89	Pass	
9	2.96	6.84	4.95	Pass	
11	1.28	2.95	3.46	Pass	
13	1.46	3.38	2.93	Pass	
15	0.62	1.43	2.54	Pass	
17	0.93	2.14	2.24	Pass	
19	0.48	1.10	2.00	Pass	
21	0.64	1.47	1.81	Pass	
23	0.46	1.05	1.66	Pass	
25	0.51	1.18	1.52	Pass	
27	0.48	1.10	1.41	Pass	
29	0.45	1.03	1.31	Pass	
31	0.42	0.97	1.23	Pass	
33	0.35	0.81	1.15	Pass	
35	0.33	0.75	1.09	Pass	
37	0.27	0.62	1.03	Pass	
39	0.28	0.64	0.98	Pass	
41	0.23	0.54			
43	0.23	0.53			
45	0.19	0.45			
47	0.18	0.42			
49	0.20	0.46			

Table 2 – Harmonic Content at 240 V, 72 V LED Load.

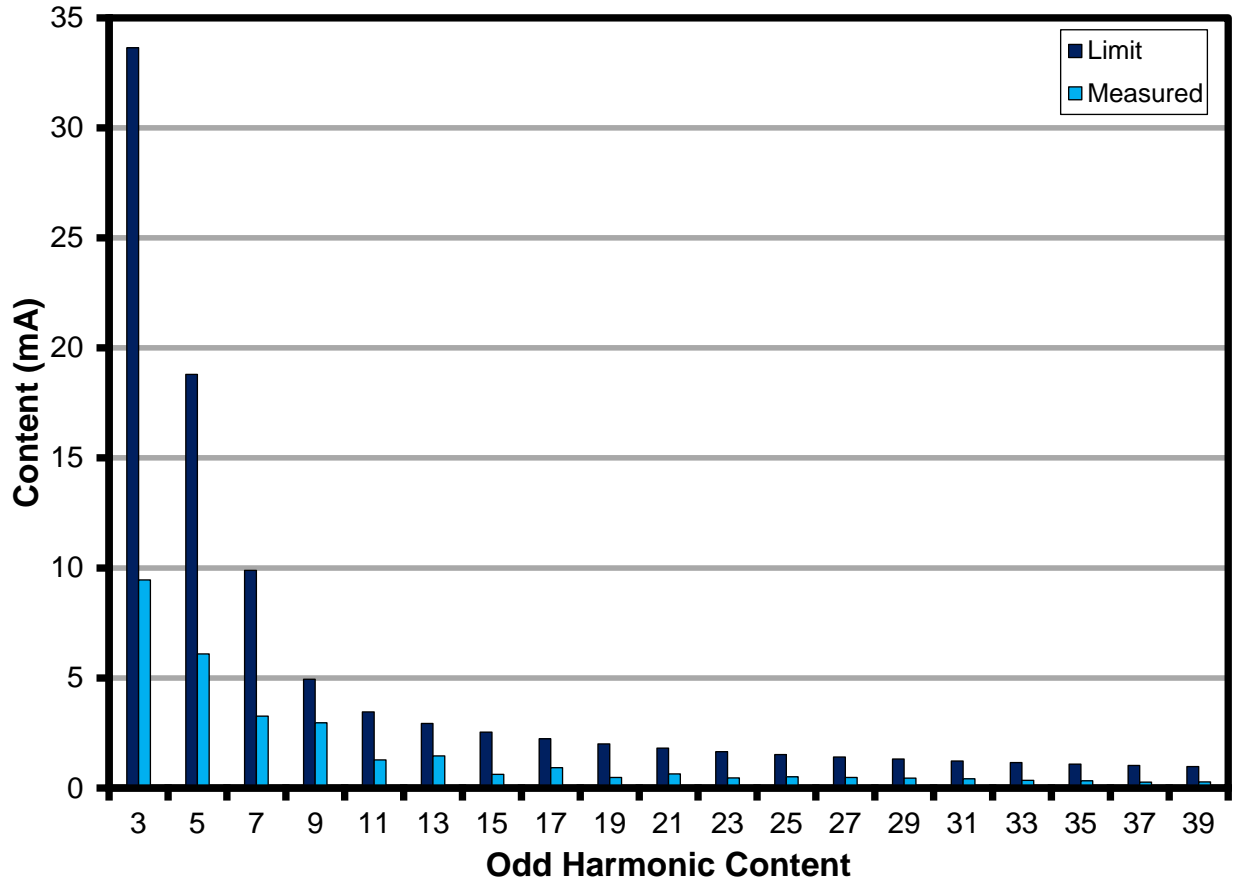


Figure 16 – Harmonic Content, Room Temperature.



11 散熱效能

11.1 使用設備

Chamber:	Tenney Environmental Chamber Model No: TJR-17 942	Wattmeter:	Yokogawa Power Meter Model No: WT2000
AC Source:	Chroma Programmable AC Source Model No: 6415	Data Logger:	Agilent



Figure 17 – Thermal Chamber Set-up Showing Box Used to Prevent Airflow Over UUT. Open Frame Set-up Measurement.



Figure 18 – Thermal Unit Thermocouple Measurement Set-up.

Note: Typical A19 enclosure is used in the verification.



11.2 散熱成效

Load: 72 V / 115 m A LED load in a standard A19.

Remarks	External Ambient °C	Internal Ambient °C	LYT4322E °C	L1;EMI Inductor °C	TRF °C	BR °C	Output Diode °C
Normal Operation Open Frame in the Thermal Chamber 195 V / 50 Hz	20	77.201	89.775	74.156	87.107	80.621	83.485
	30	85.214	98.664	81.992	95.039	88.324	91.526
	40	93.288	107.379	89.969	103.12	96.217	99.751
	50	101.436	115.298	98.268	111.483	104.187	108.028
	60	109.391	122.862	106.171	119.597	111.99	116.073
	70	117.048	132.062	113.899	127.464	119.386	124.062
Normal Operation Open Frame in the Thermal Chamber 195 V / 50 Hz	20	82.468	97.413	78.321	94.615	81.872	89.841
	30	90.235	105.86	86.31	102.329	89.556	97.674
	40	98.159	113.916	94.325	110.368	97.492	105.659
	50	106.465	121.373	102.681	118.875	105.811	113.94
	60	114.527	130.029	110.884	127.147	113.944	122.109
	65	118.451	133.979	114.843	131.103	118.042	126.044
OTP; 195 V / 50 Hz	76	122	137	118	132	124	129
OTP; 265 V / 50 Hz	66	120	137	116	133	119	127

Table 3 – Thermal Measurement, U1 with Heat Sink.

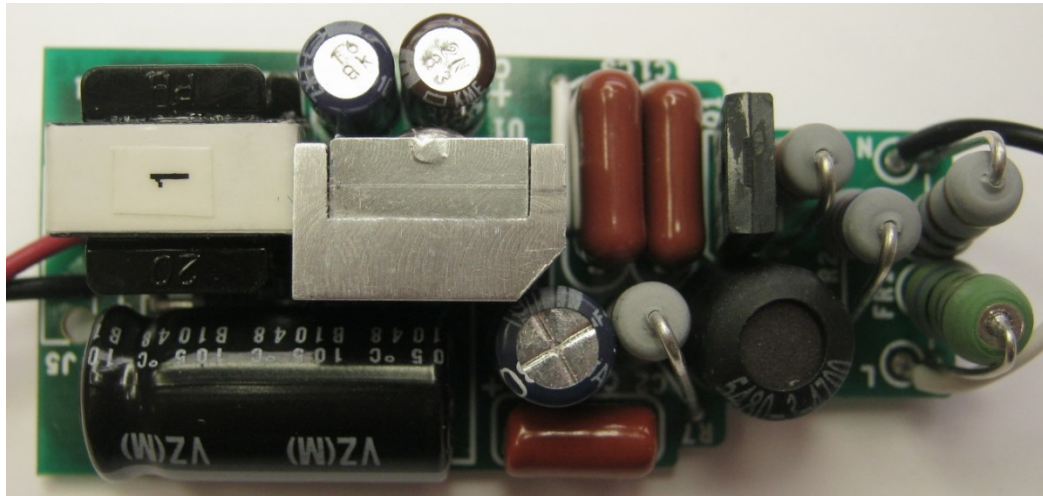


Figure 19 – Sample Design with Heat Sink.

Note: The heat sink is optional and depends on the end system design. In some applications the heat sink is not required or potting may be used.



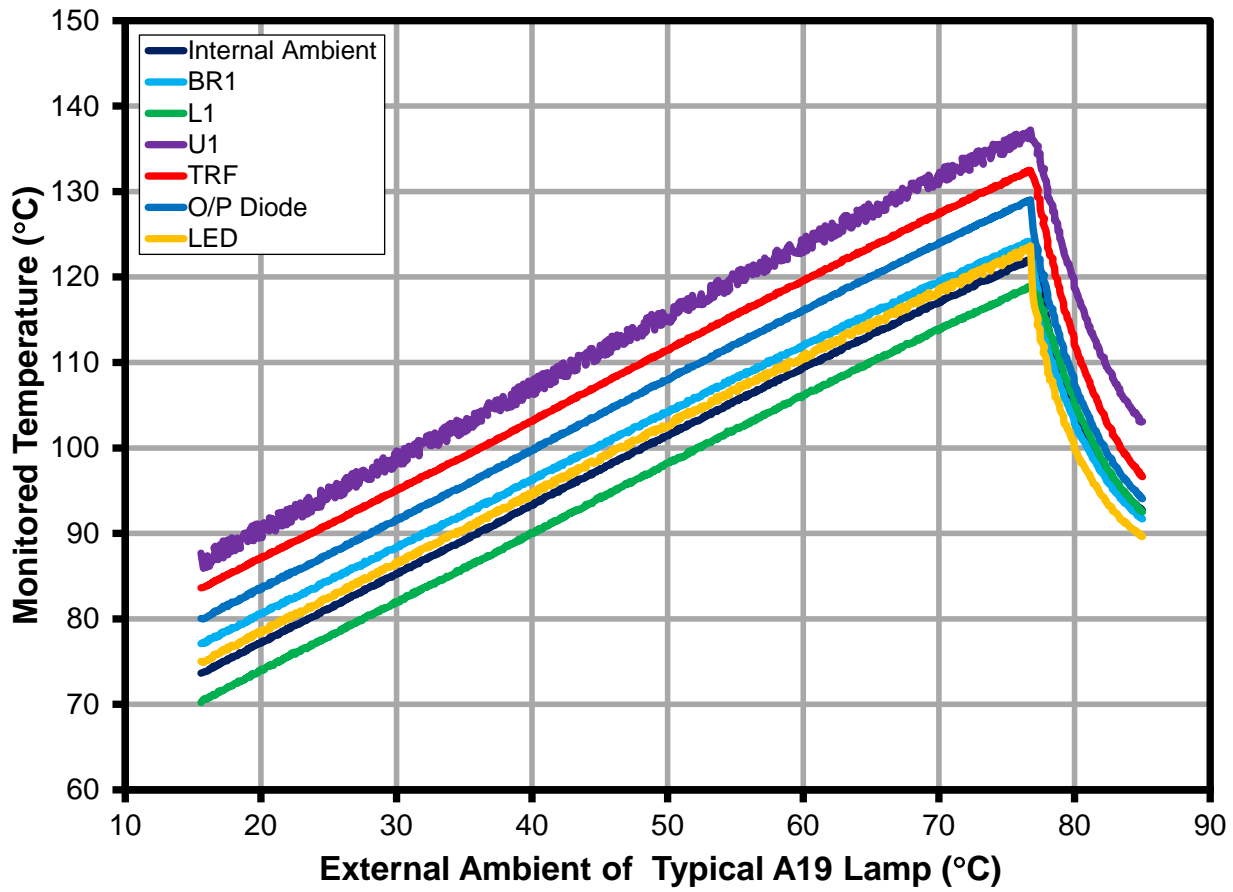


Figure 20 – Thermal Curve at 195 VAC / 50 Hz Input in Typical A19 Housing. LYT4322EG with heatsink.



11.3 感熱掃描

Open-frame thermal measurement at 25 °C ambient. UUT was soaked for 1 hour to achieve steady-state before the measurement.

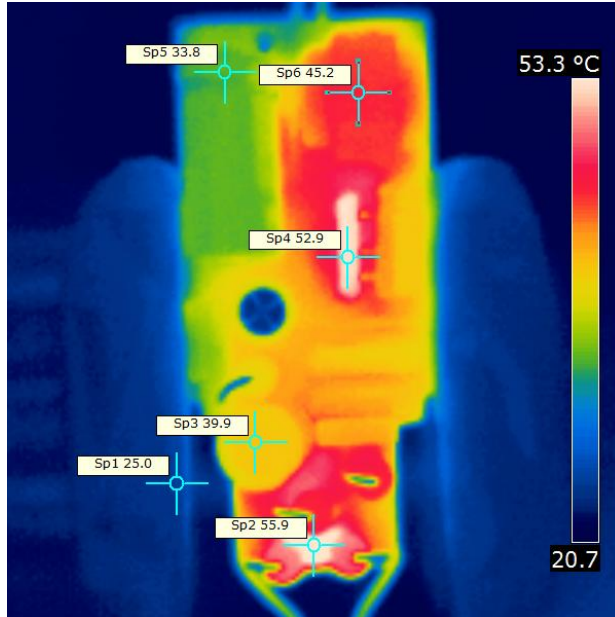


Figure 21 – Temperature (°C) at Top Side of PCB During Non-dimming Operation at 195 VAC.
 SP1 – Ambient.
 SP2 – L1, EMI Choke.
 SP3 – PCB, Temperature at BR1.
 SP4 – U1, LYT4322E Without Heat Sink.
 SP5 – C6, Output Capacitor.
 SP6 – T1, Power Inductor.

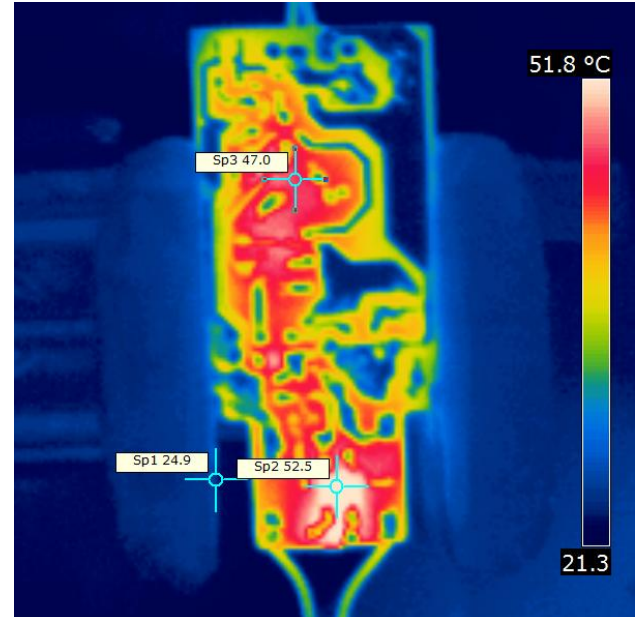


Figure 22 – Temperature (°C) at Bottom Side of PCB During Non-dimming Operation at 195 VAC.
 SP1 – Ambient.
 SP2 – BR1, Bridge Rectifier.
 SP3 – D5, Blocking Diode.



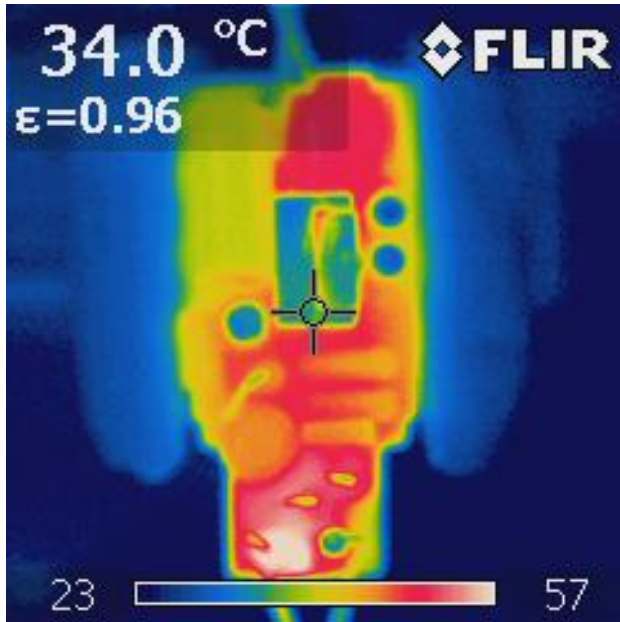


Figure 23 – Temperature (°C) at Top Side of PCB During Normal Operation at 195 VAC. SP1 – U1, LYT4322E with Heat Sink.

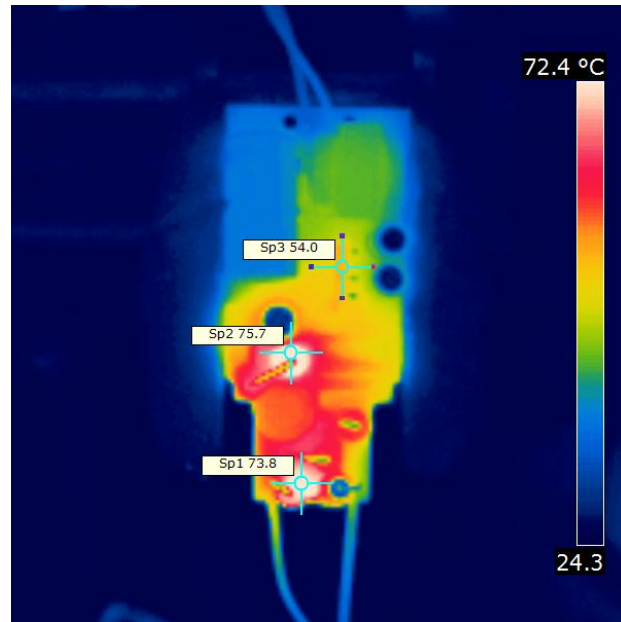


Figure 24 – Temperature (°C) at Top Side of PCB During Dimming Operation at 240 VAC at 90° Conduction Angle. SP1 – FR2, Damper Resistor. SP2 – R7, Bleeder Resistor. SP3 – U1, LYT4322E Without Heat Sink.



12 波形

12.1 正常運作下的汲極電壓和電流

The LYTSwitch-4 optimized in continuous mode operation of inductor current that yields a high power factor and low harmonic distortion in the input current.

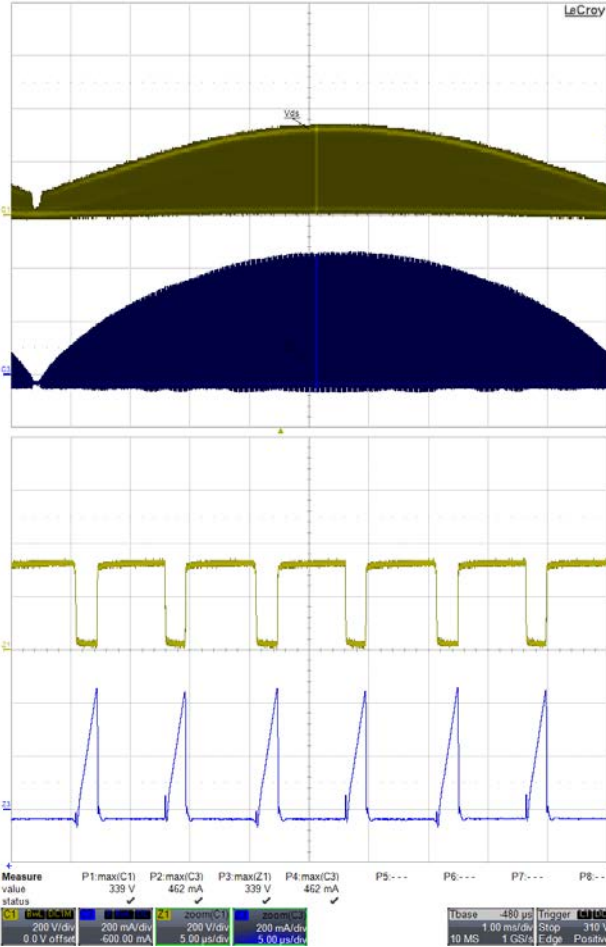


Figure 25 – 195 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

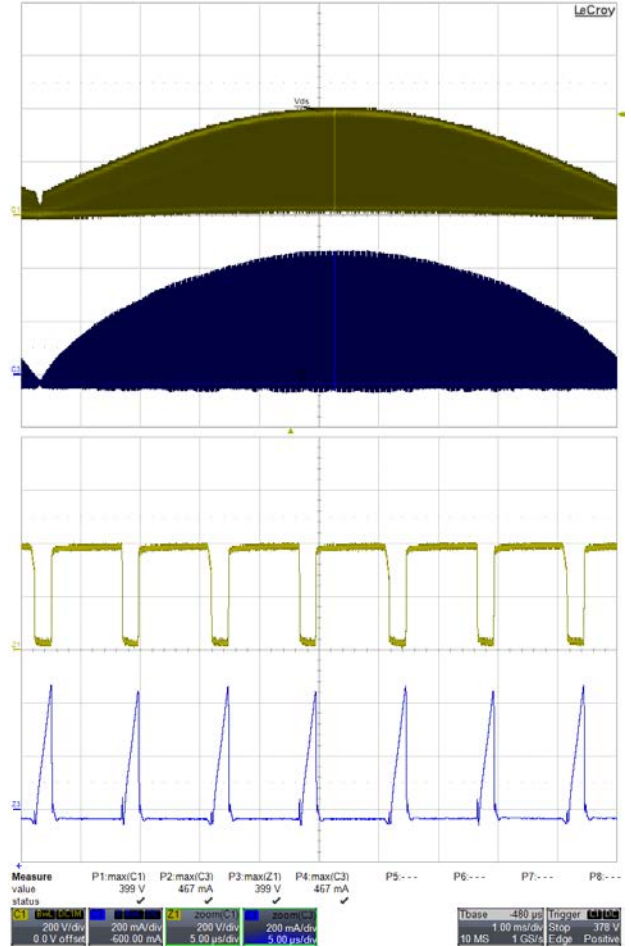


Figure 26 – 230 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.



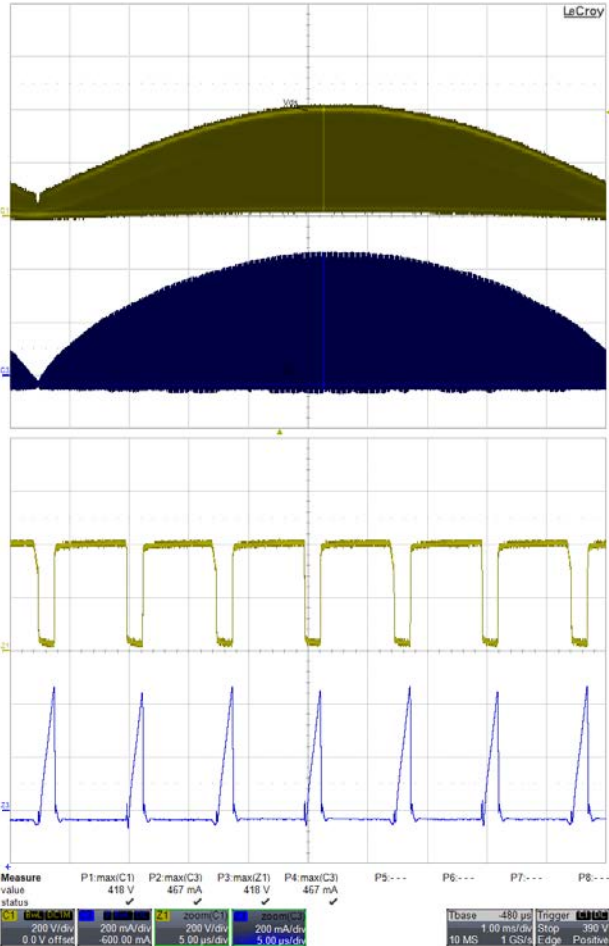


Figure 27 – 240 VAC, 50Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

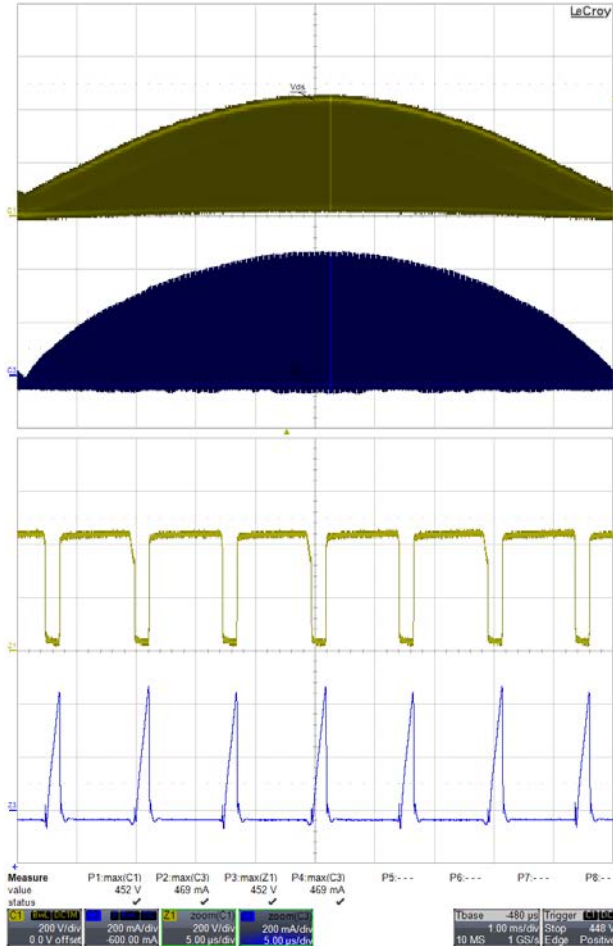


Figure 28 – 265 VAC, 50Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.



12.2 輸出短路時的汲極電壓和電流

Device is operating within the range and no inductor saturation was observed.

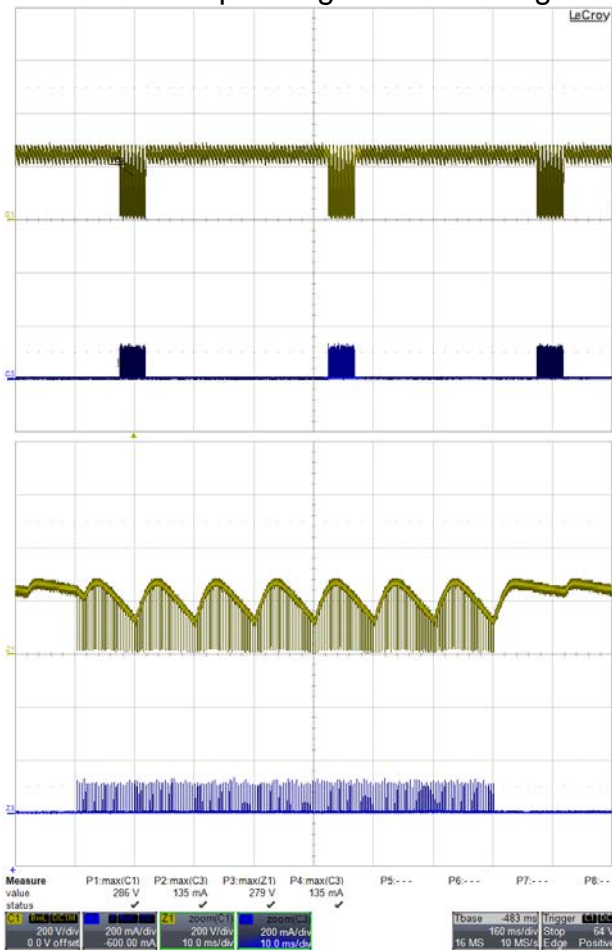


Figure 29 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 160 ms / div.
 Zoom Time Scale: 10 ms / div.

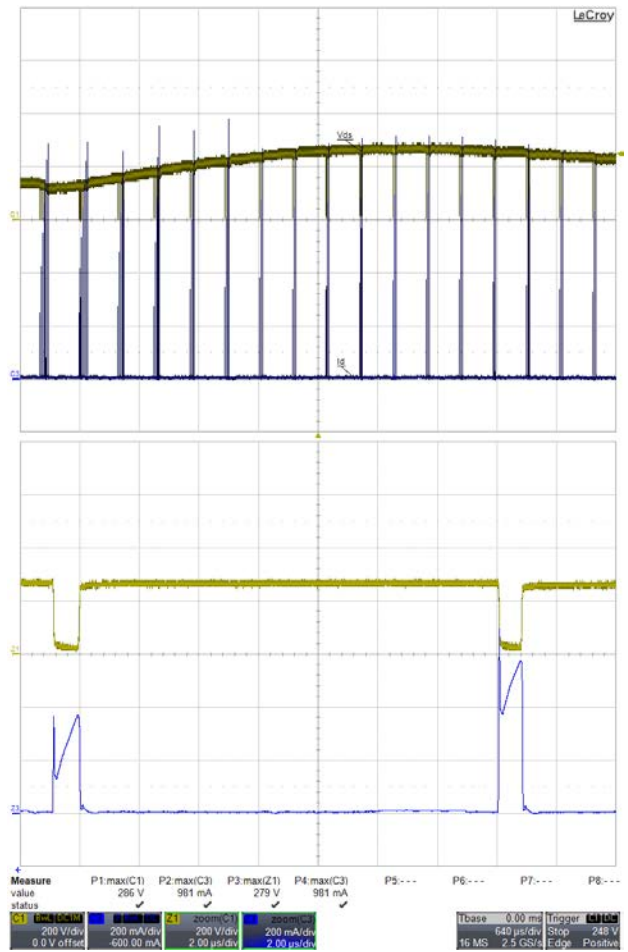


Figure 30 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 640 μ s / div.
 Zoom Time Scale: 2 μ s / div.



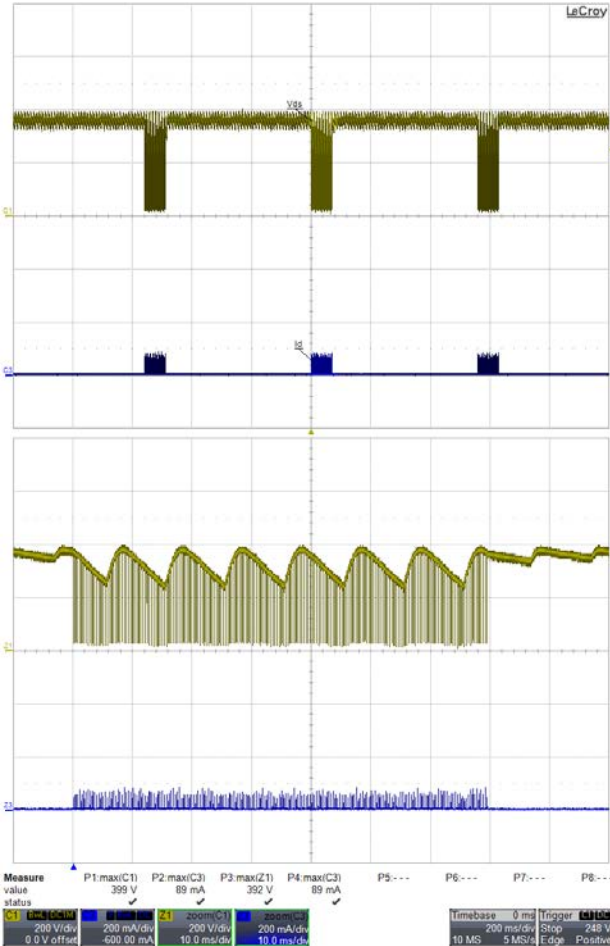


Figure 31 – LYT4322E Output Short. 265 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 200 ms / div.
 Zoom Time Scale: 10 ms / div

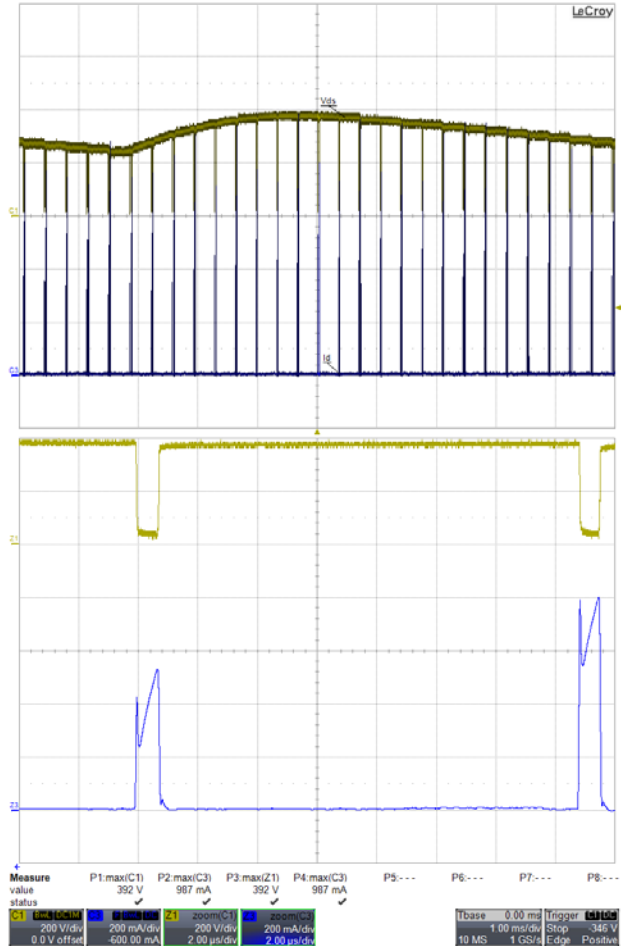


Figure 32 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1ms / div.
 Zoom Time Scale: 2 μ s / div

Zoom



12.3 汲極電壓和電流啓動輪廓

Device is operating within the range and no inductor saturation was observed.

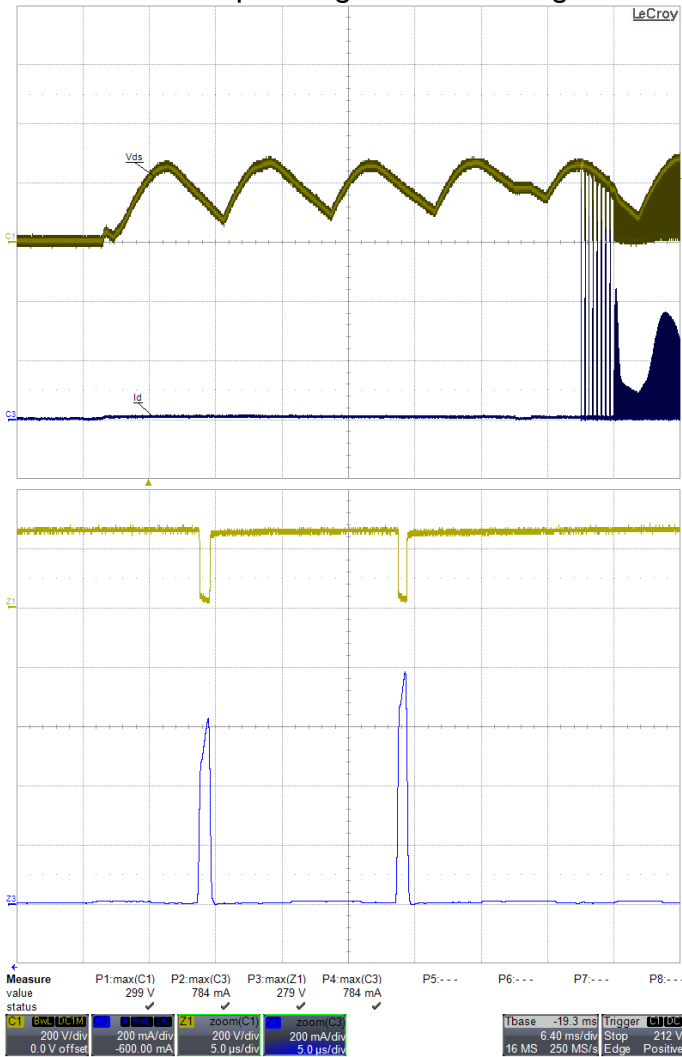


Figure 33 – 195 VAC / 50 Hz Start-up.

Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.

Ch3 (Blue): I_{DRAIN} , 200 mA / div.

Time Scale: 1 ms / div.

Zoom Time Scale: 5 µs / div.

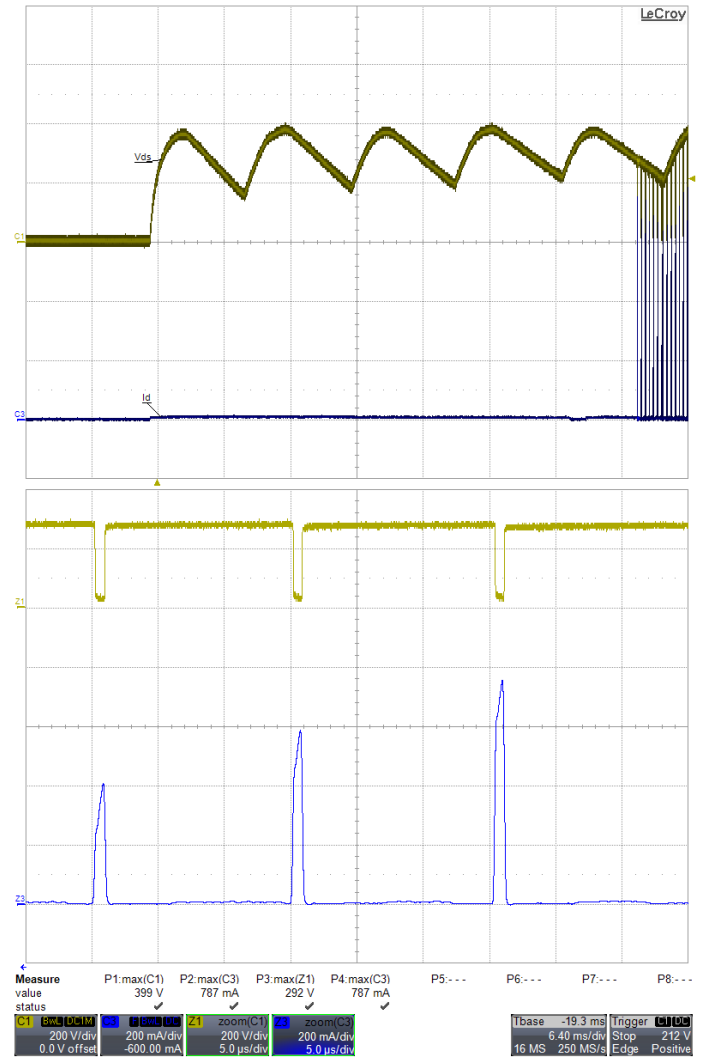


Figure 34 – 265 VAC / 50 Hz Start-up.

Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.

Ch3 (Blue): I_{DRAIN} , 200 mA / div.

Time Scale: 1 ms / div.

Zoom Time Scale: 5 µs / div.



12.4 輸出電流啟動分析

Output current is available in <150 ms.

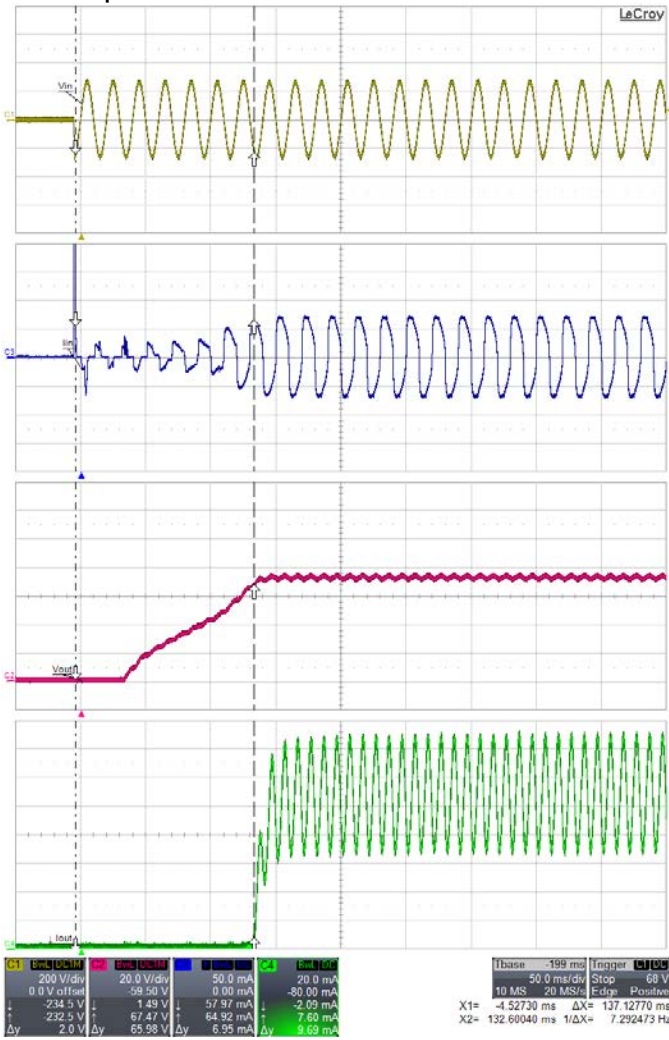


Figure 35 – 195 VAC, 50 Hz, Nominal V_{LED} Load.

- Ch1 (Yellow): V_{IN} , 200 V / div.
- Ch2 (Red): V_{OUT} , 20 V.
- Ch3 (Blue): I_{IN} , 50 mA / div.
- Ch4 (Green): I_{OUT} , 20 mA / div.
- Time Scale: 20 ms / div.

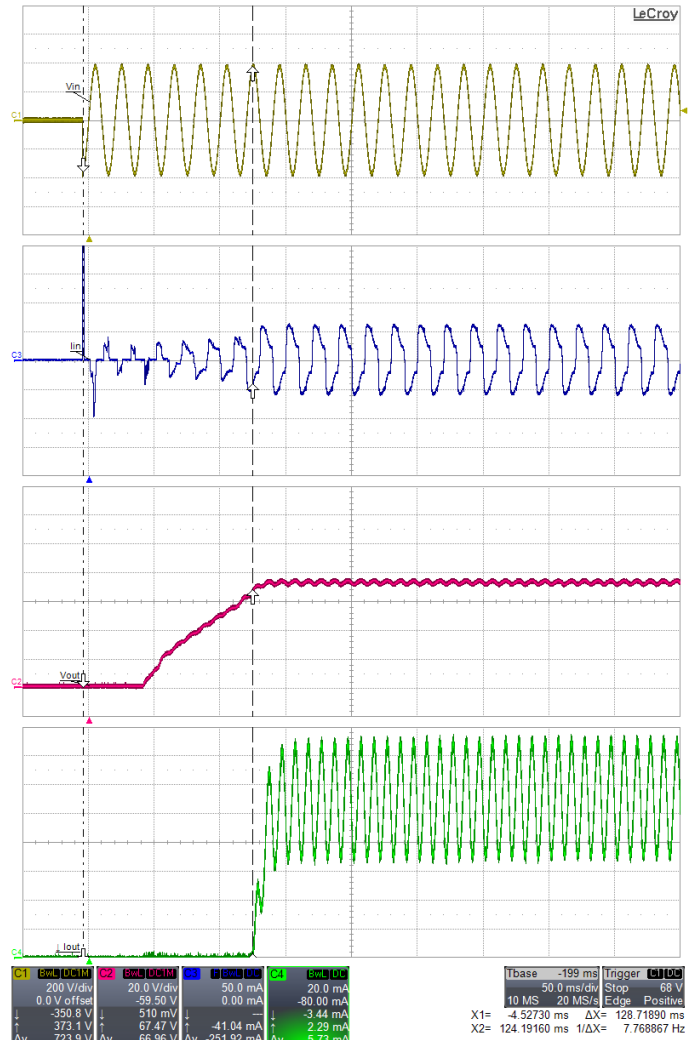


Figure 36 – 265 VAC, 50 Hz, Nominal V_{LED} Load.

- Ch1 (Yellow): V_{IN} , 200 V / div.
- Ch2 (Red): V_{OUT} , 20 V.
- Ch3 (Blue): I_{IN} , 50 mA / div.
- Ch4 (Green): I_{OUT} , 20 mA / div.
- Time Scale: 20 ms / div.



12.5 輸入-輸出分析

There is no limitation to the amount of output capacitance that can be added. If the application requires less output current ripple then increasing the output capacitance is straight forward. Note that the output current waveform below will vary depending on LED load impedance and will vary according to LED type.

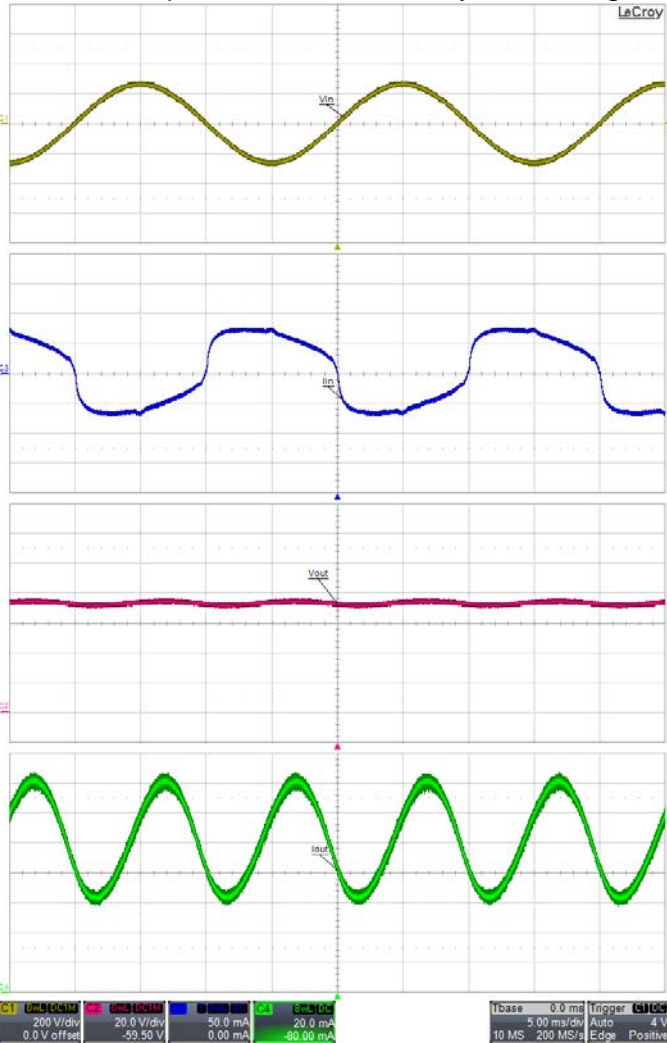


Figure 37 – 195 VAC / 50 Hz, Nominal V_{LED} Load.

Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div,
 Time Scale: 5 ms / div.

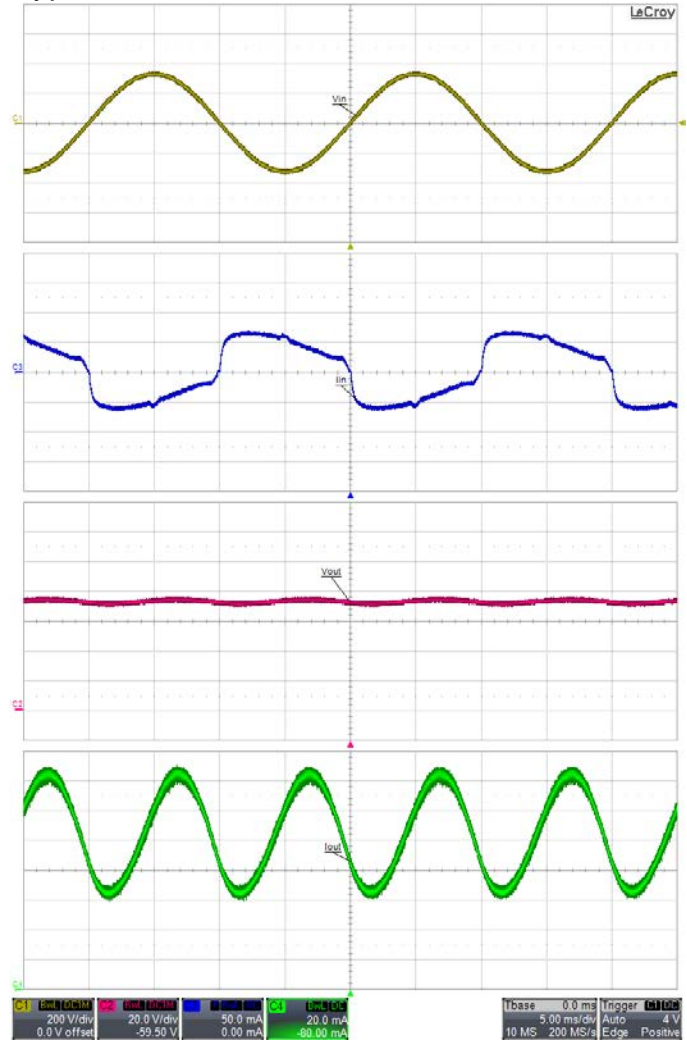


Figure 38 – 230 VAC / 50 Hz, Nominal V_{LED} Load.

Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div,
 Time Scale: 5 ms / div.



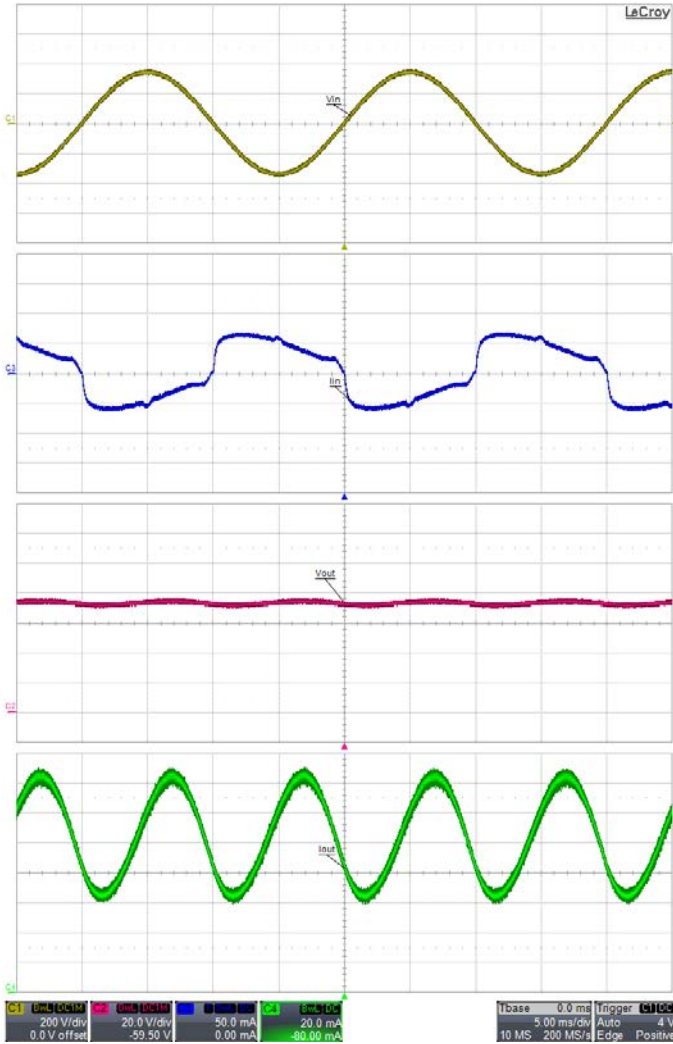


Figure 39 – 240 VAC / 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 5 ms / div.



Figure 40 – 265 VAC / 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 5 ms / div.



12.6 線電壓弛波和突波

The inherent advantage of the buck converter implemented with LYTSwitch-4 is the imperceptible start-up delay, the driver will turn-on within 100 ms as shown in the figures below. No failure of any component occurred during Line fluctuation tests.

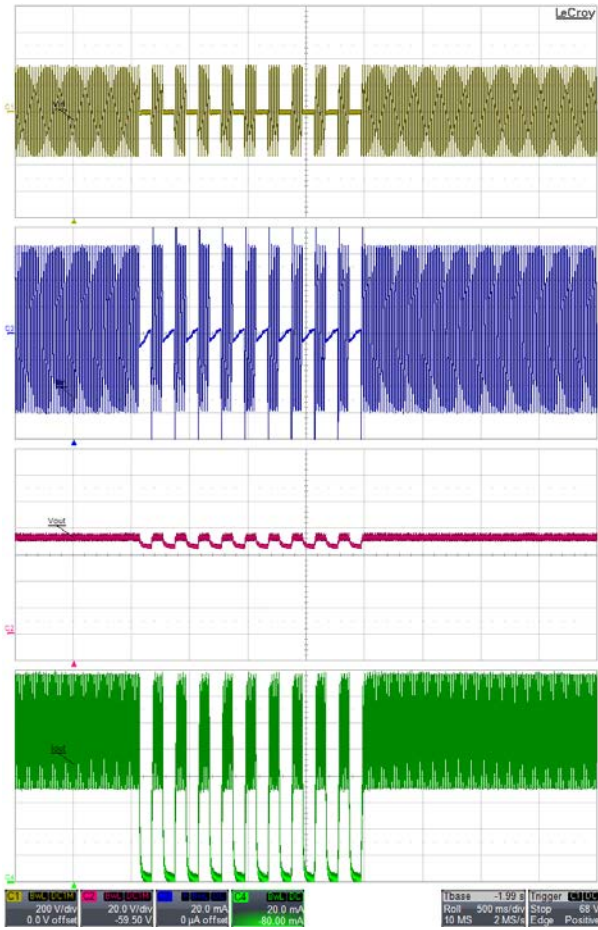


Figure 41 – Line Sag Test at 230 - 0 V at 0.1 sec Interval.

Ch1: V_{IN} ; 200 V / div.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{IN} ; 20 mA / div
 Ch4: I_{OUT} ; 20 mA / div.
 Time Scale: 500 ms / div.

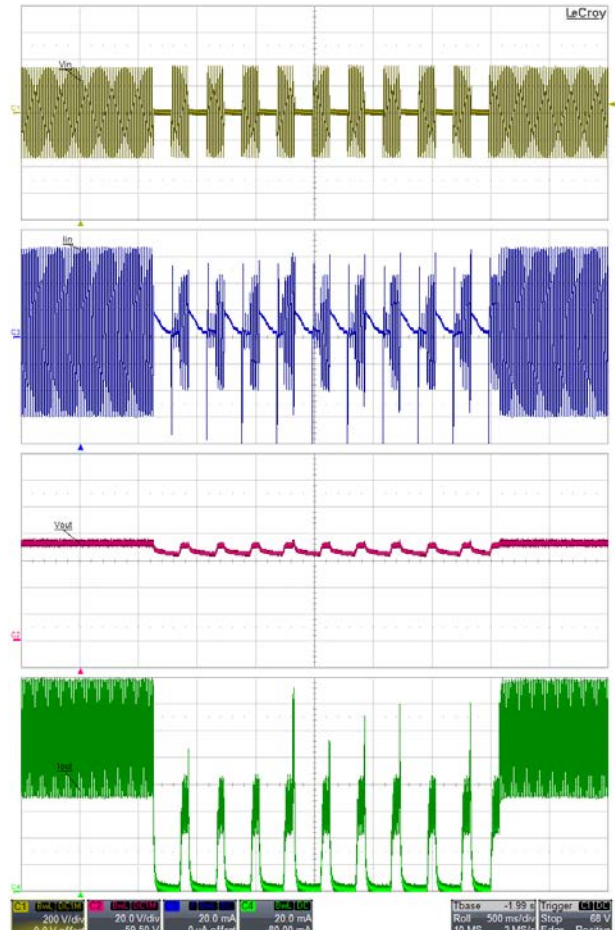


Figure 42 – Line Surge Test at 230 - 0 at 0.15 sec Interval.

Ch1: V_{IN} ; 200 V / div.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{IN} ; 20 mA / div
 Ch4: I_{OUT} ; 20 mA / div.
 Time Scale: 500 ms / div.



12.7 無負載保護

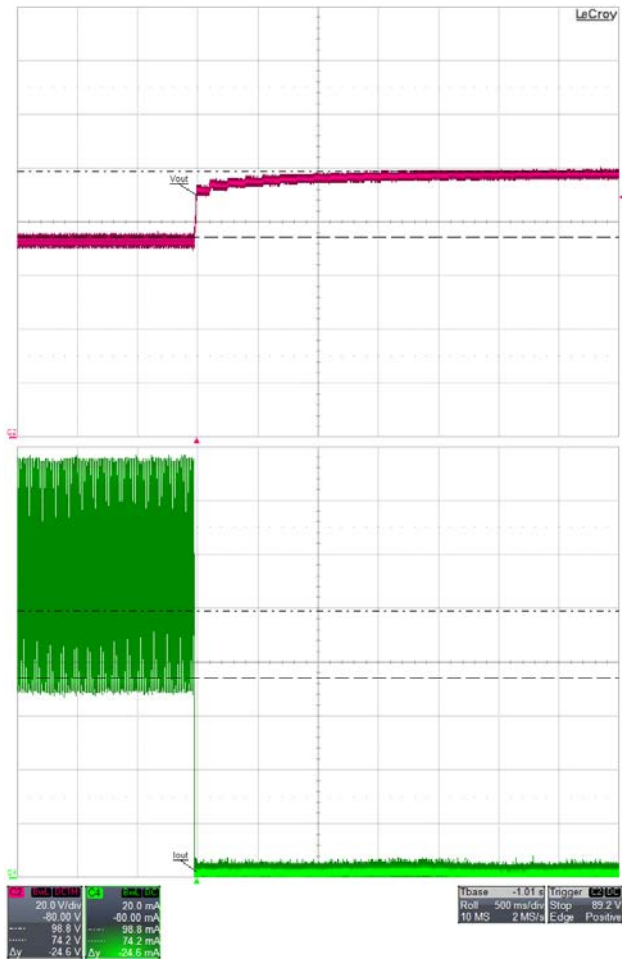


Figure 43 – No-load Protection when Load is Disconnected. 195 V / 50 Hz.
 Ch2: V_{OUT}; 20 V / div.
 Ch3: I_{OUT}; 50 mA / div.
 Time Scale: 500 ms / div.

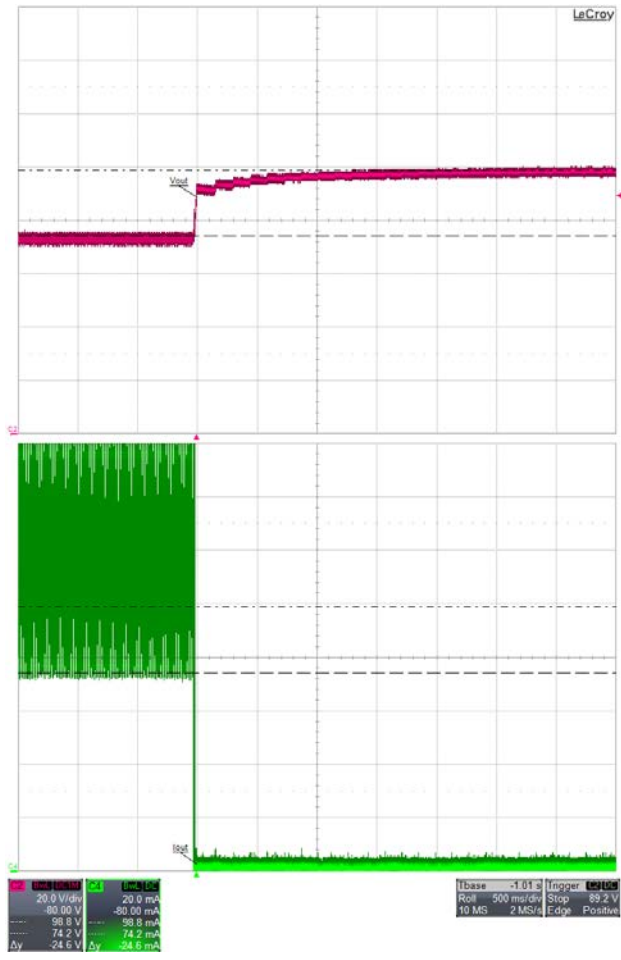


Figure 44 – No-load Protection when Load is Disconnected. 265 V / 50 Hz.
 Ch2: V_{OUT}; 20 V / div.
 Ch3: I_{OUT}; 50 mA / div.
 Time Scale: 500 ms / div.



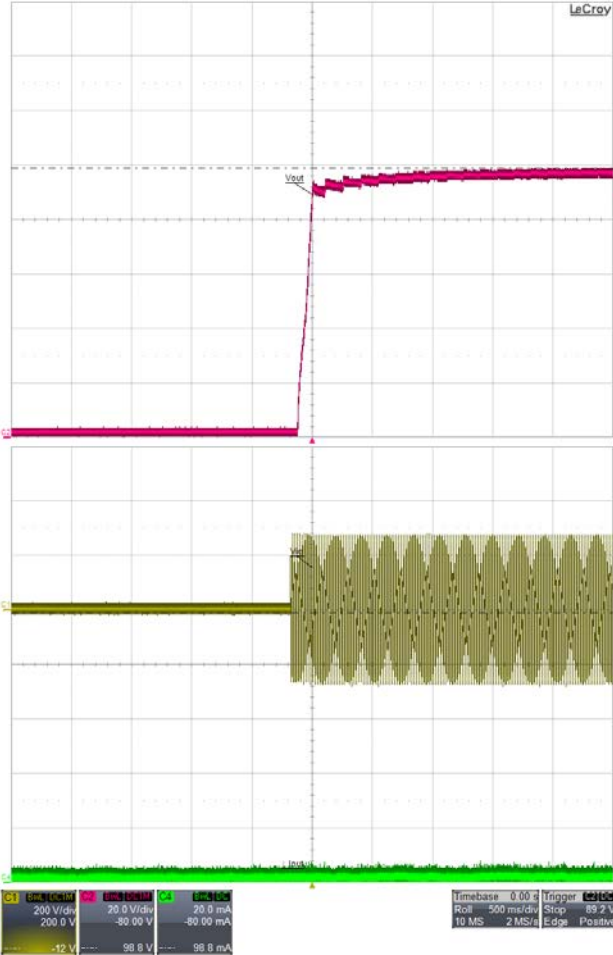


Figure 45 – No-load Start-up. 195 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.

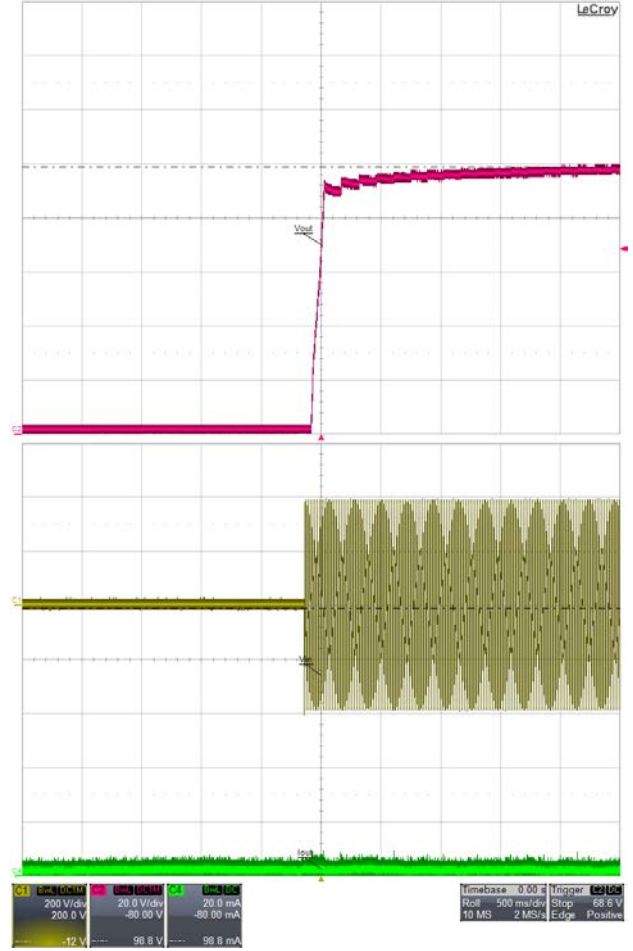


Figure 46 – No-load Start-up. 265 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.



12.8 電壓關閉/電壓啓動

No failure of any component during brownout test of 0.5V / sec.

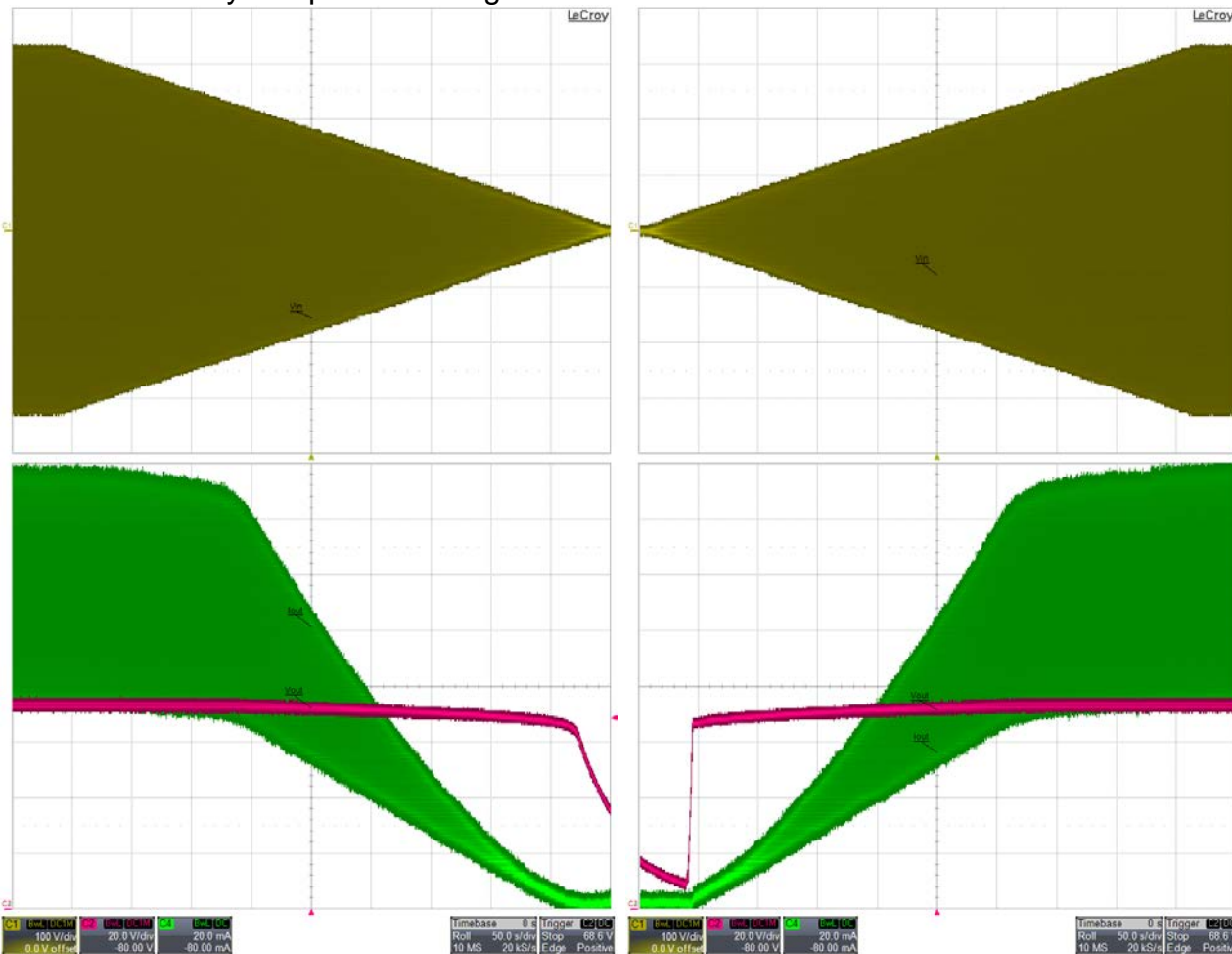


Figure 47 – Brown-out Test at 0.5 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.
 230 V-0-230 V
 Ch1: V_{IN} ; 100 V / div.
 Ch1: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 20 mA / div.
 Time Scale: 50 s / div.

Figure 48 – Brown-out Test at 0.5 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.
 230 V-0-230 V
 Ch1: V_{IN} ; 100 V / div.
 Ch1: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 20 mA / div.
 Time Scale: 50 s / div.



13 調光

13.1 調光相容性

List of Dimmers	Type	Max Iout	Min Iout	Ratio	Conduction Time (mS)				Compatibility
					Regulated AC Line		Distorted AC Line		
					Min	Max	Min	Max	
Berker KOPP 8033	L	102	16.37	6.23	7.64	2.54	7.51	1.95	Pass
Busch 6591-101	T	107.9	22.66	4.76	6.87	2.08	7.58	2.54	Pass
Busch 6513 U-102	T	110.9	24.74	4.48	7.64	2.02	7.97	2.28	Pass
PEHA 433HAB 0A	T	106.1	34.9	3.04	7.58	3.25	7.39	3.25	Pass
PEHA 433HAB 0A	T	99.2	19.56	5.07	6.93	2.6	7.06	2.6	Pass
Busch 2250	L	110.7	12.2	9.07	8.6	2.46	8.34	2.22	Pass
PEHA 400W	L	102.7	0.087	1180.46	7.91	0.73	7.58	0.606	Pass
Merten 572499	L	113.5	8.08	14.05	9.01	1.9	8.69	1.71	Pass
Busch 6513	T	110.8	25.07	4.42	7.91	1.9	7.91	2.35	Pass
Berker 2875	L	109.4	17.23	6.35	8.29	2.53	8.02	2.14	Pass
Berker 2830 10	L	104.7	26.19	4.00	8.4	3.37	8.25	3.04	Pass
Jung 225 NV DE	L	104.4	22.94	4.55	8.37	2.98	8.04	2.49	Pass
Jung 254 UDIE 1	T	104.8	31.1	3.37	7.67	2.65	7.78	2.65	Pass
Jung 266 G DE	L	105.9	24.27	4.36	8.6	3.16	8.45	2.8	Pass
Busch 2200 UJ-212	L	105.4	32.8	3.21	8.61	3.62	8.42	3.56	Pass
Busch 2250 U	L	106.3	24.95	4.26	8.64	3.29	8.28	2.81	Pass
Busch 2247 U	L	105.3	30.13	3.49	8.524	3.74	8.21	3.4	Pass
Gira 2262 00 I01	L	105.5	19.33	5.46	8.33	2.75	8.21	2.12	Pass
Busch 2247 U	L	105.2	28.87	3.64	8.39	3.45	8.02	3	Pass
Busch 2250 U	L	107.4	19.74	5.44	8.55	2.45	8.34	2.28	Pass
GIRA 1176 00 I03	T	103.4	30.2	3.42	7.06	2.27	7.56	2.51	Pass
Niko 310-013	L	108.9	27.61	3.94	8.79	3.29	8.35	2.85	Pass
Niko 310-017	T	99.8	33.8	2.95	7.21	3	7.44	3.24	Pass
Niko 310-014	L	108.7	33	3.29	8.76	3.78	8.49	3.45	Pass
Niko 310-016	L	107.6	29.91	3.60	8.3	3.44	8.3	2.93	Slight Shimmer for Distorted Line
Relco RM34DMA	L	113.6	24	4.73	8.87	2.79	8.81	2.59	Pass
Relco RTM34LED DAXS	L	95.1	9.37	10.15	7.18	2.08	7.12	2.08	Pass
Relco RM34DMA	L	115	22.22	5.18	9.13	3.11	9.18	2.46	Pass
Relco RTS34.43 RLI	L	114.6	3.77	30.40	9.26	1.5	9.06	1.75	Pass
Relco RT34DSL	L	115	20.48	5.62	9.26	2.85	9.13	2.53	Pass
TCL	L	109.5	11.85	9.24	9.23	2.12	9.04	1.67	Pass
SEN BO LANG	L	109.5	29.56	3.70	9.3	3.42	8.98	2.83	Pass
EBA HUANG	L	109.5	1.58	69.30	9.3	1.09	9.05	1.09	Pass
SB ELECT	L	107.1	1.78	60.17	8.47	0.906	8.08	0.38	Pass
MYONGBO	L	109.6	28.41	3.86	9.32	3.11	9.121	2.84	Pass
KBE	L	109	0.7	155.71	8.99	1.14	8.86	0.68	Pass
CLIPMEI	L	109.1	10.9	10.01	9.09	2.17	9.035	1.69	Pass
MANK	L	109.5	31.8	3.44	9.26	3.5	9.13	3.11	Pass
Clipsal 32E450LM	L	104.4	12.77	8.18	7.96	2.2	7.42	2.01	Pass
Clipsal 32E450TM	T	108.2	16.83	6.43	7.9	2.47	8.03	2.47	Pass
Clipsal 32E2CFLDM	T	106.6	16.14	6.60	7.53	2.28	7.94	2.44	Pass
Clipsal 32E450UDM	T	112	21.19	5.29	8.04	2.61	8.3	2.87	Pass



13.2 調光波形

Dimmer: Berker 2830 10

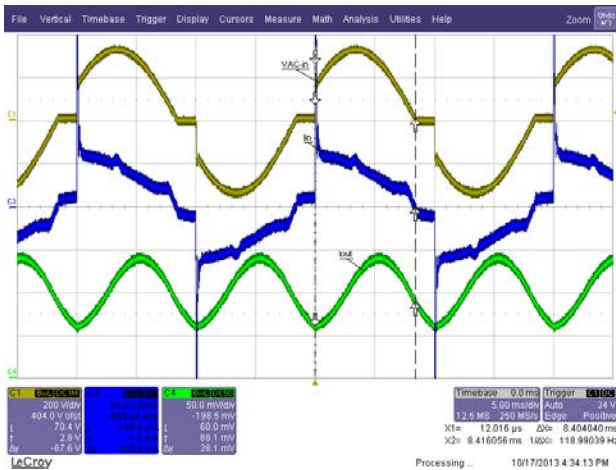


Figure 49 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

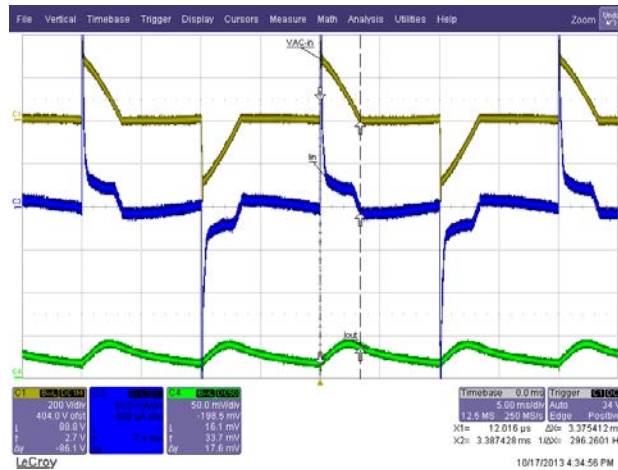


Figure 50 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

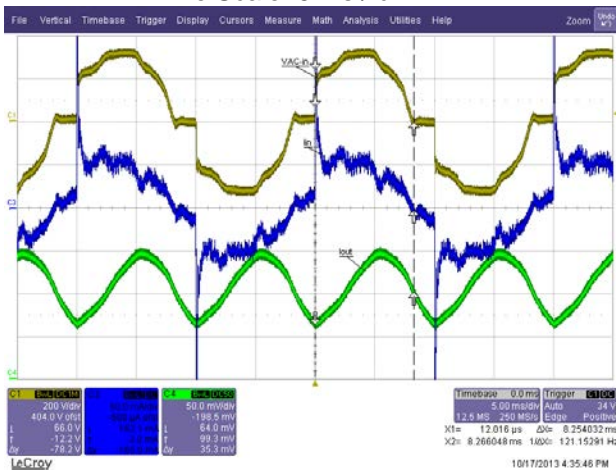


Figure 51 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

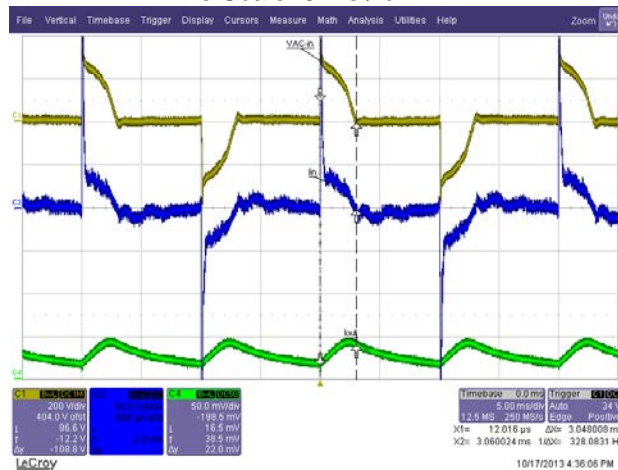


Figure 52 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Jung 225 NV DE

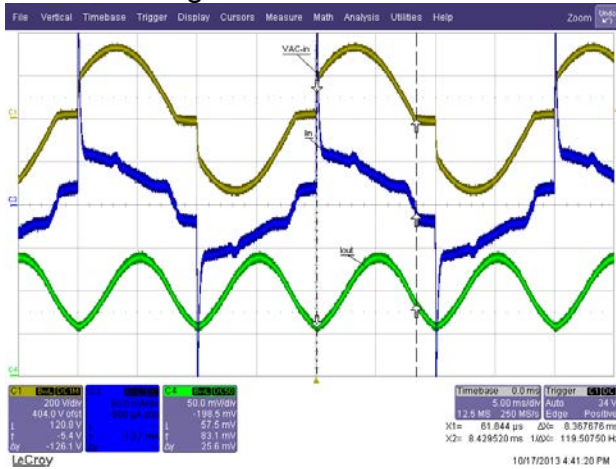


Figure 53 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

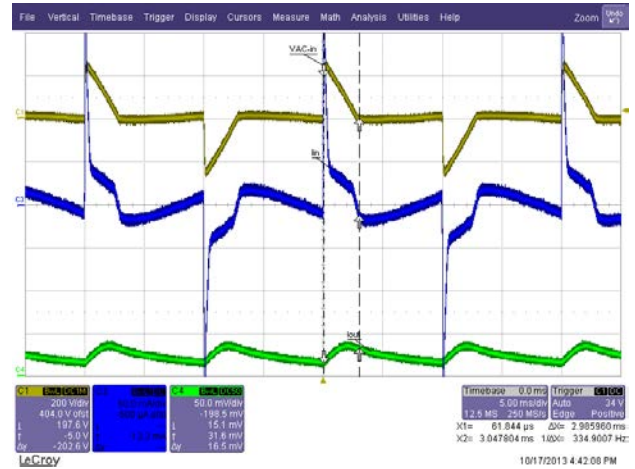


Figure 54 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

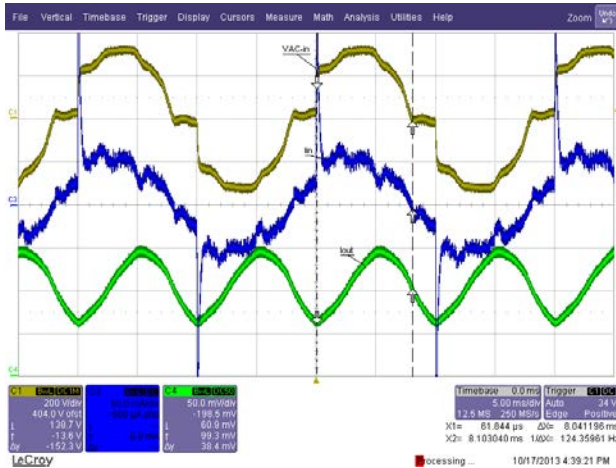


Figure 55 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

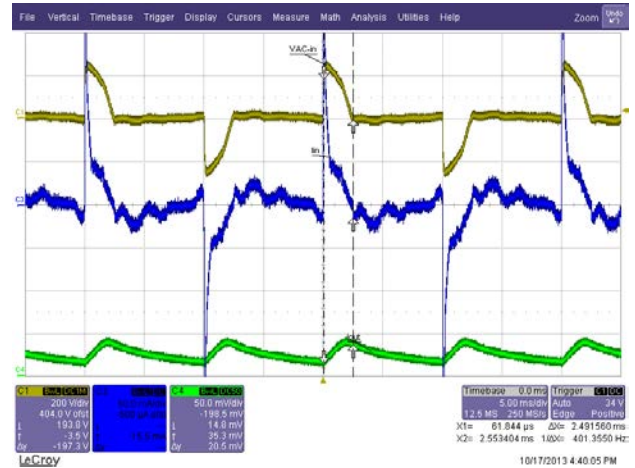


Figure 56 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Jung 254 UDIE 1

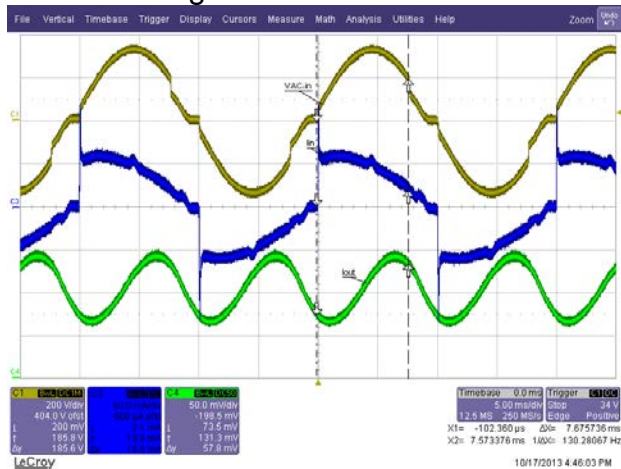


Figure 57 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

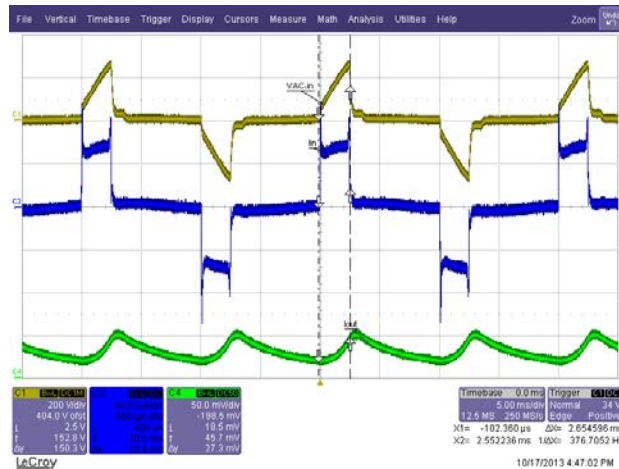


Figure 58 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

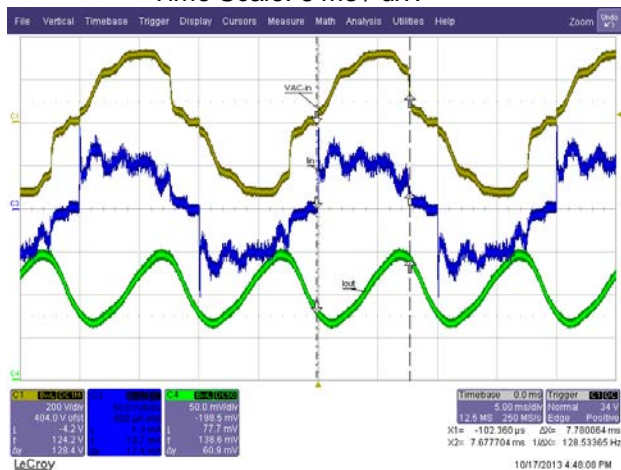


Figure 59 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

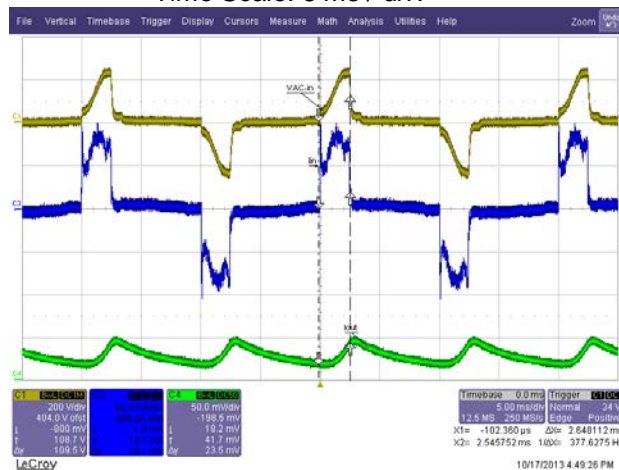


Figure 60 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Jung 266 G DE

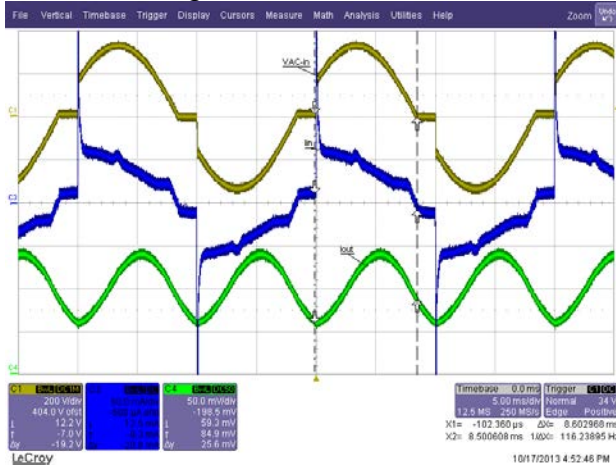


Figure 61 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

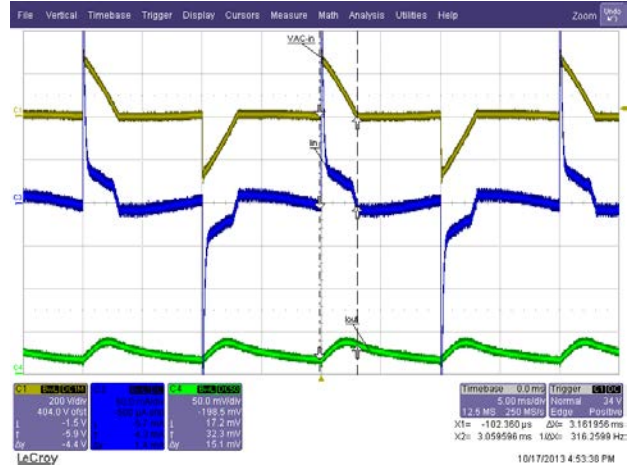


Figure 62 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

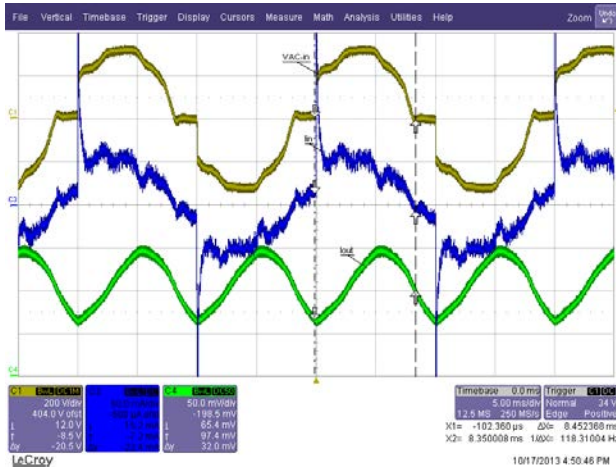


Figure 63 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

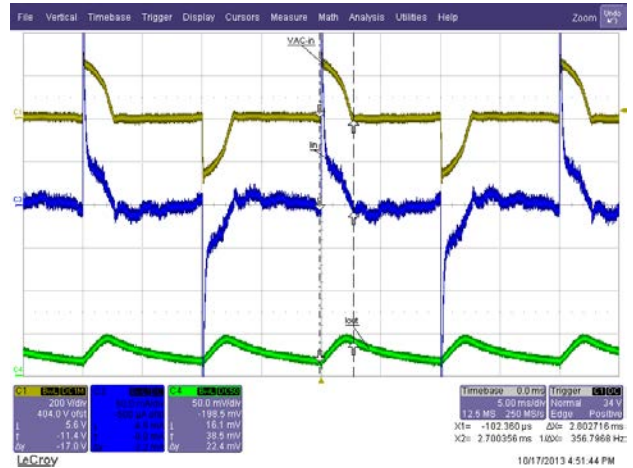


Figure 64 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2200 UJ-212

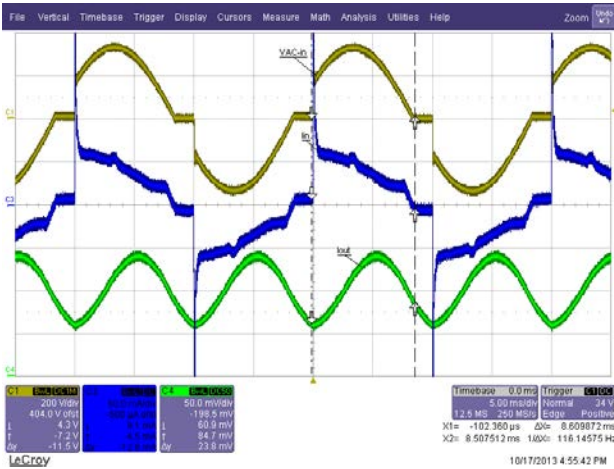


Figure 65 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

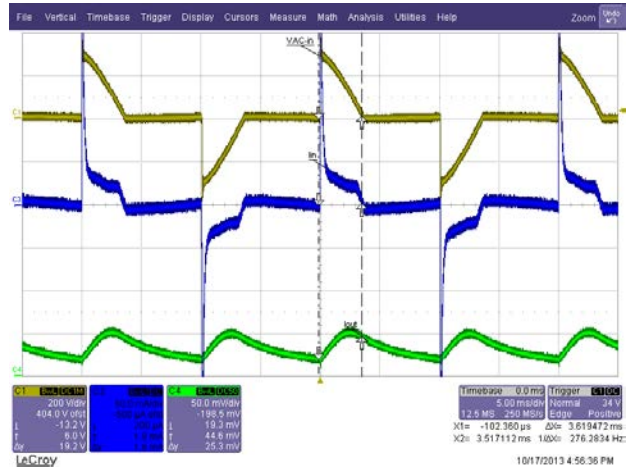


Figure 66 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

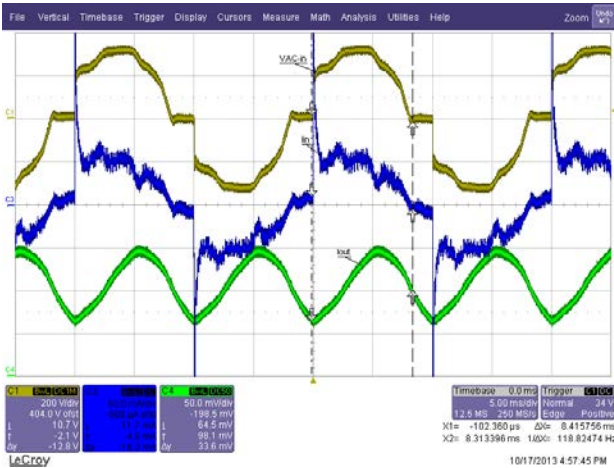


Figure 67 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

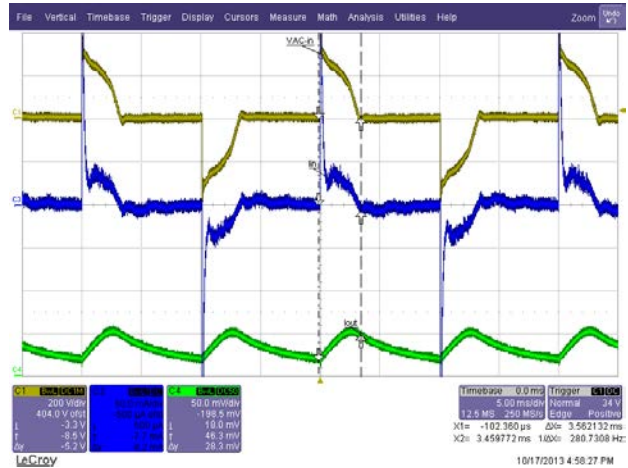


Figure 68 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

Dimmer: Busch 2250 U

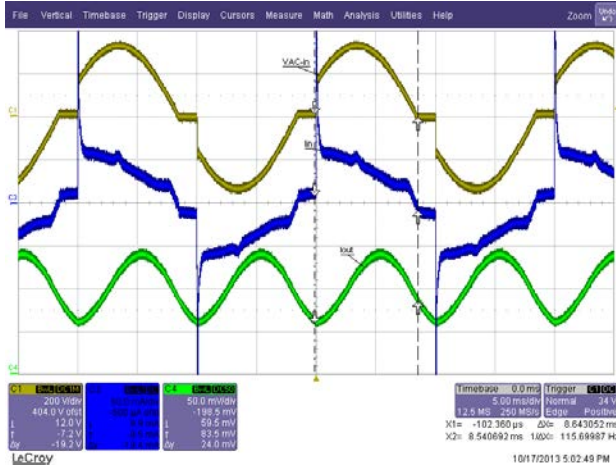


Figure 69 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

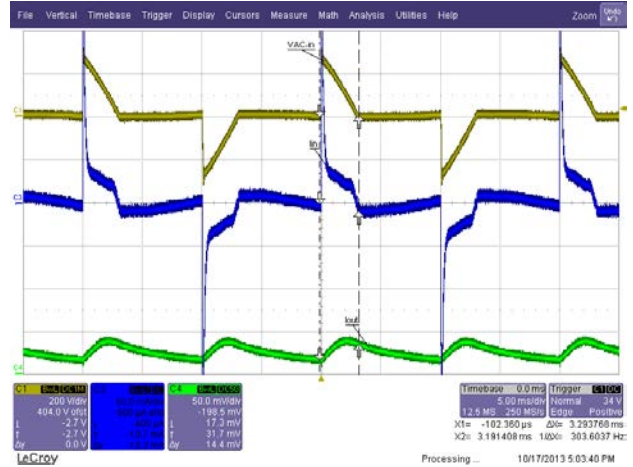


Figure 70 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

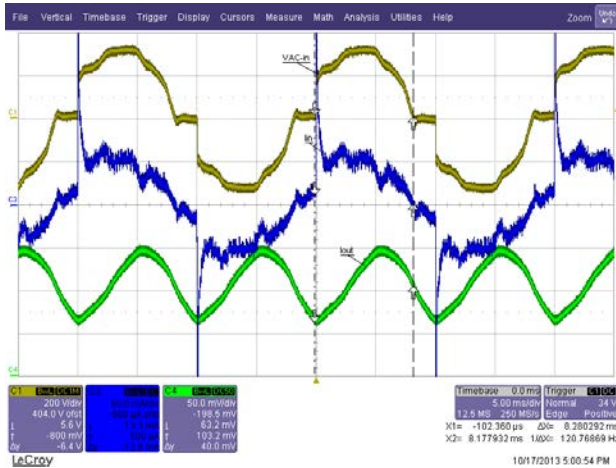


Figure 71 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

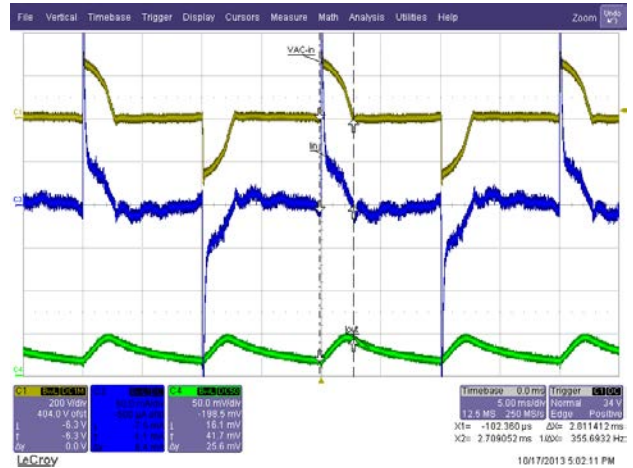


Figure 72 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2247 U

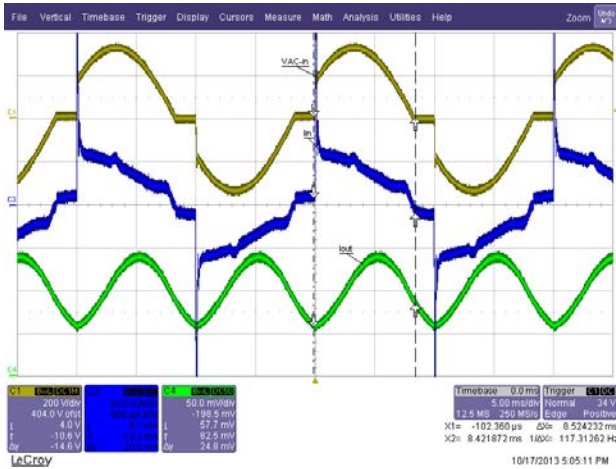


Figure 73 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

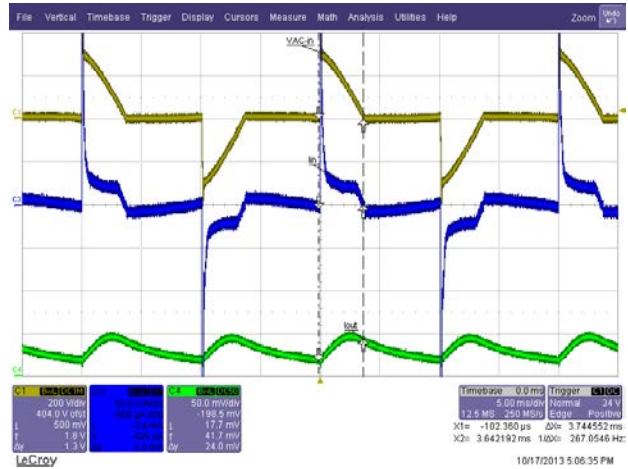


Figure 74 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

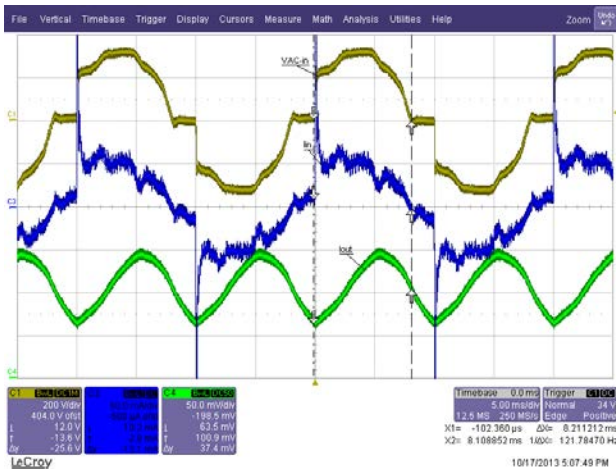


Figure 75 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

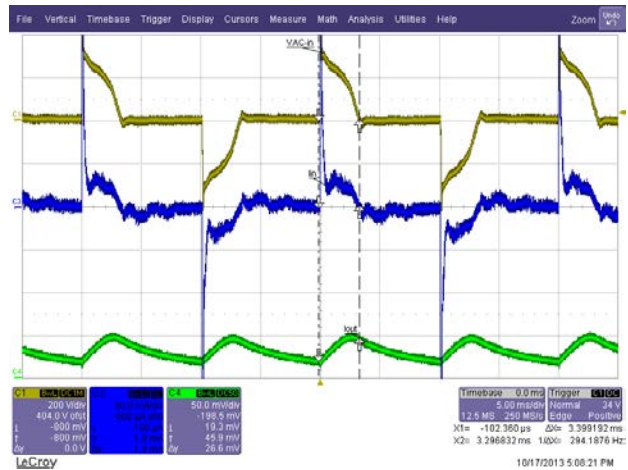


Figure 76 – Minimum Conduction from Distorted AC Line 230V/50Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Gira 2262 00 I01

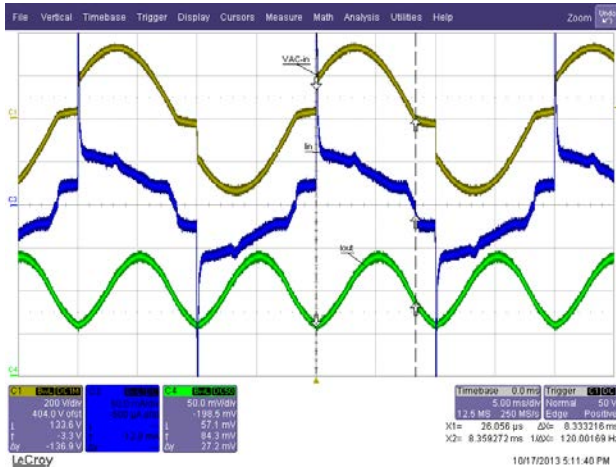


Figure 77 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

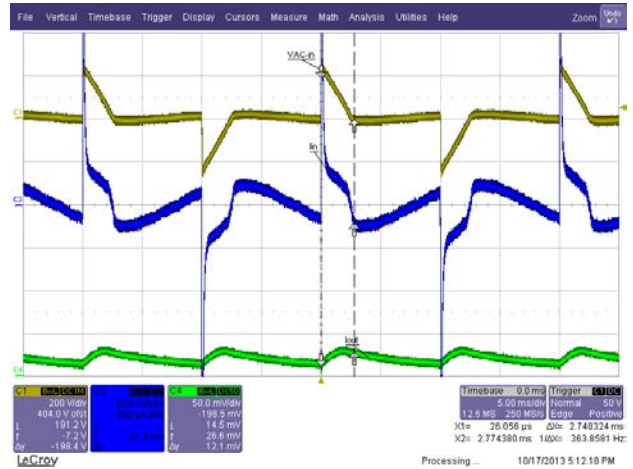


Figure 78 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

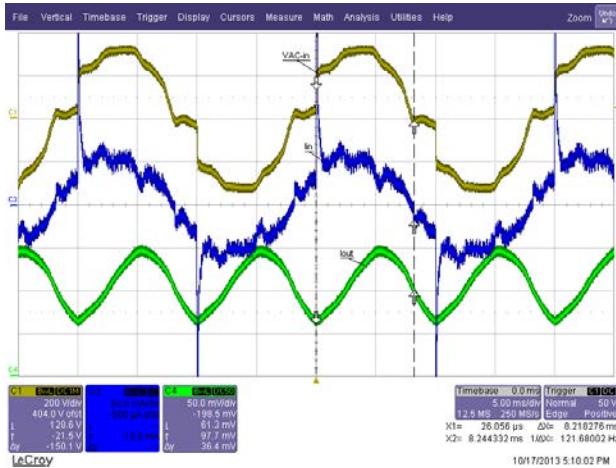


Figure 79 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

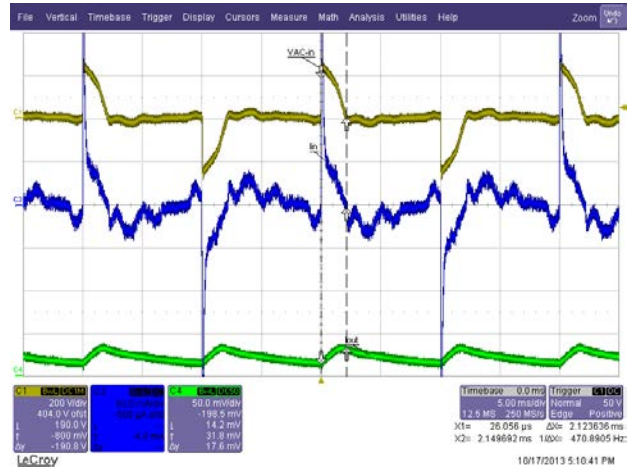


Figure 80 – Minimum Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Gira 0300 00 I01

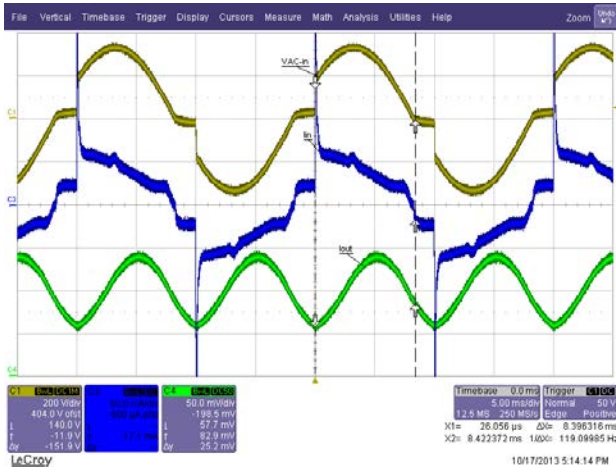


Figure 81 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

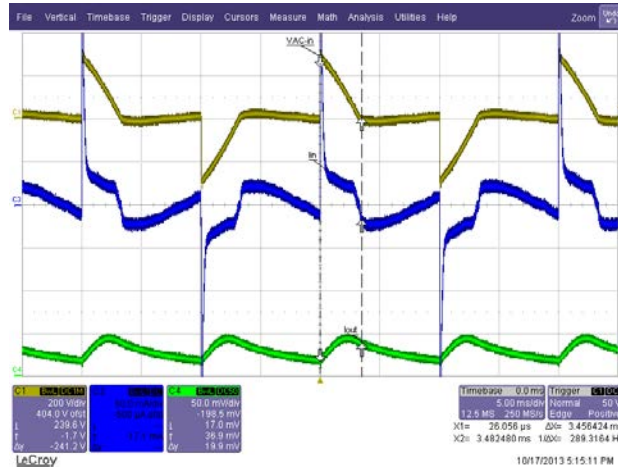


Figure 82 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

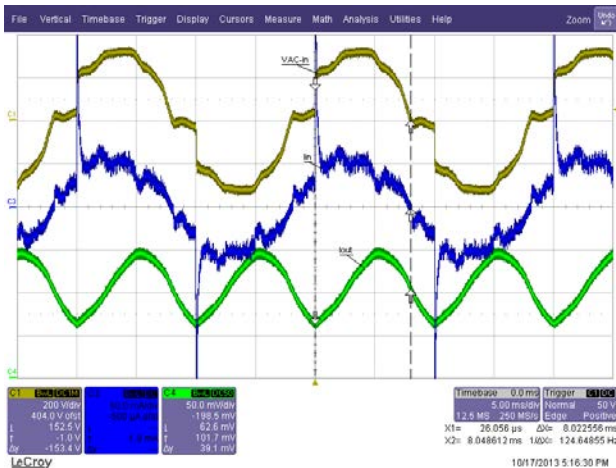


Figure 83 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

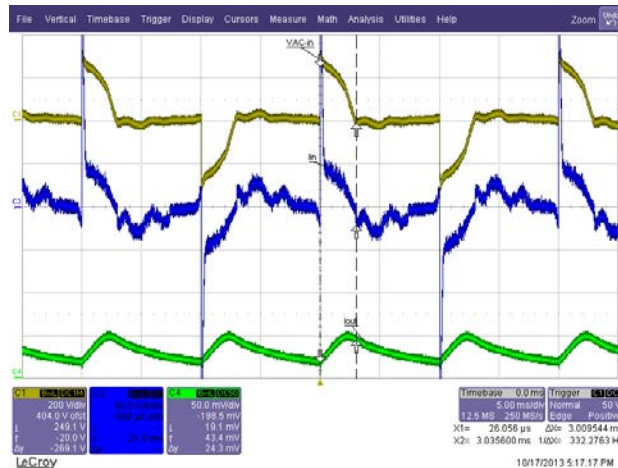


Figure 84 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250 U

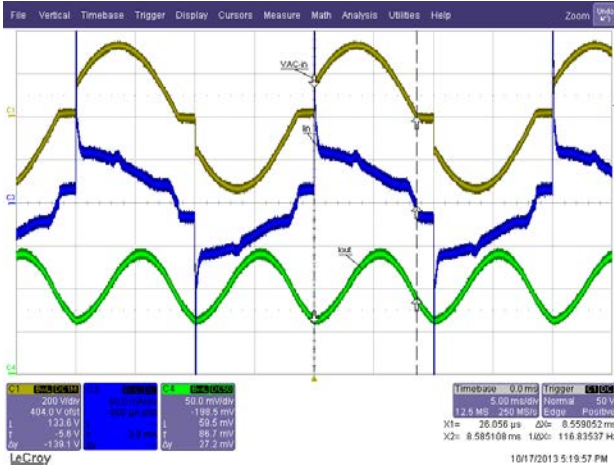


Figure 85 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

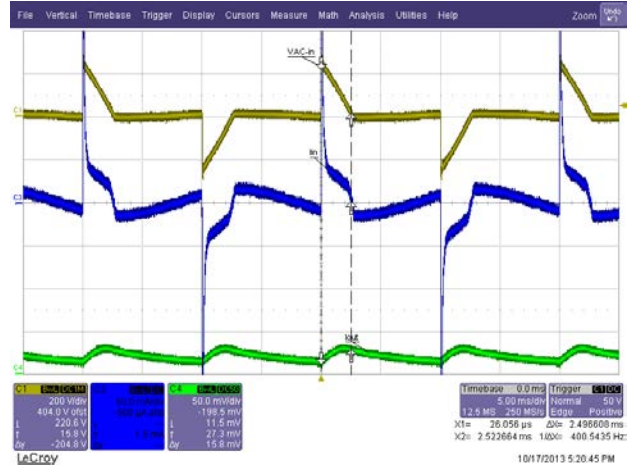


Figure 86 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

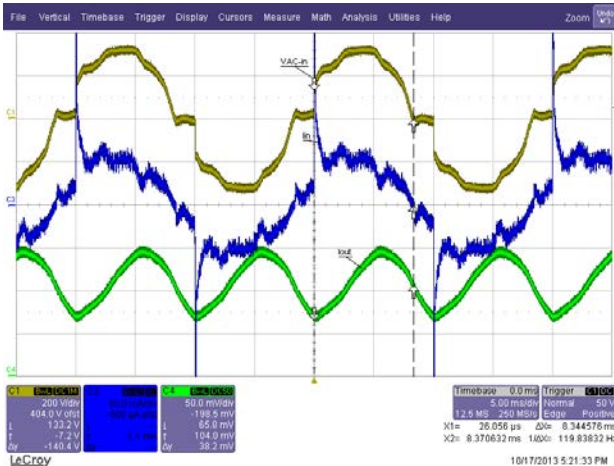


Figure 87 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

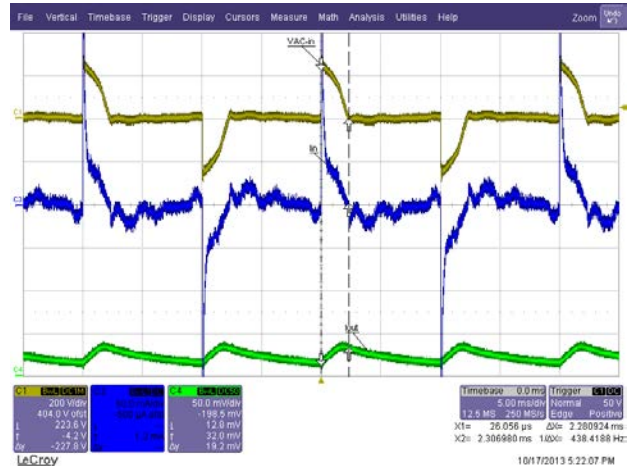


Figure 88 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: TCL

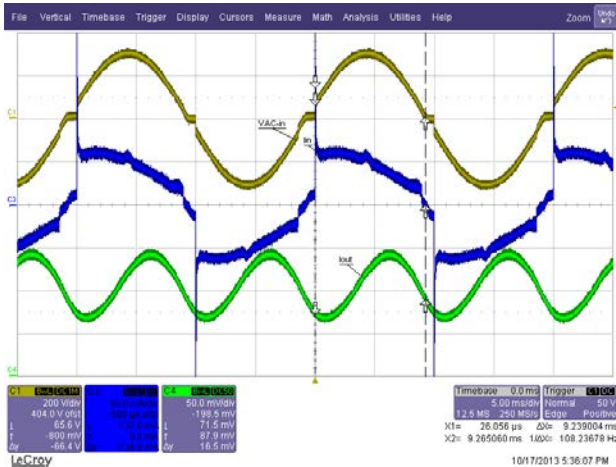


Figure 89 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

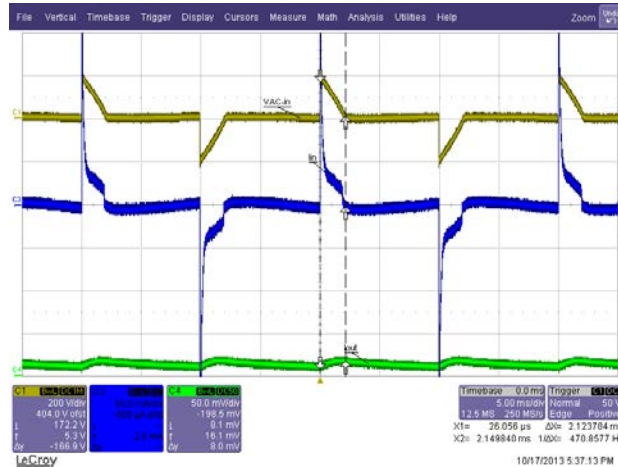


Figure 90 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

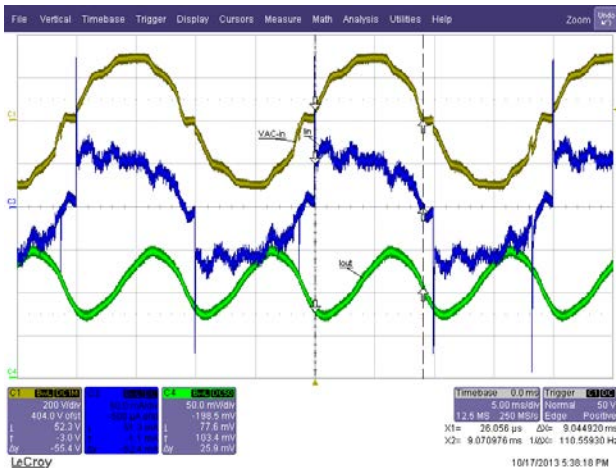


Figure 91 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

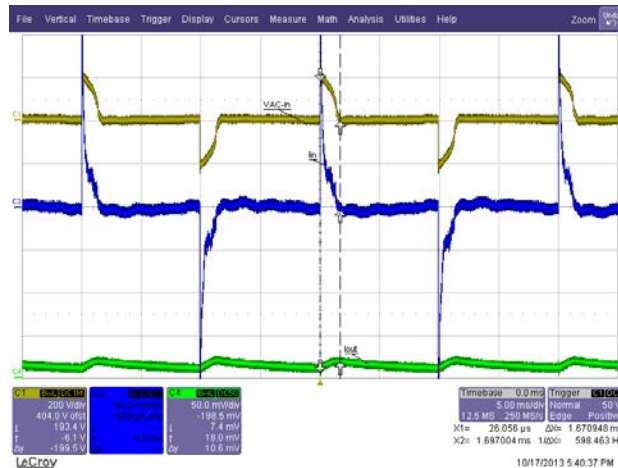


Figure 92 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: SEN BO LANG

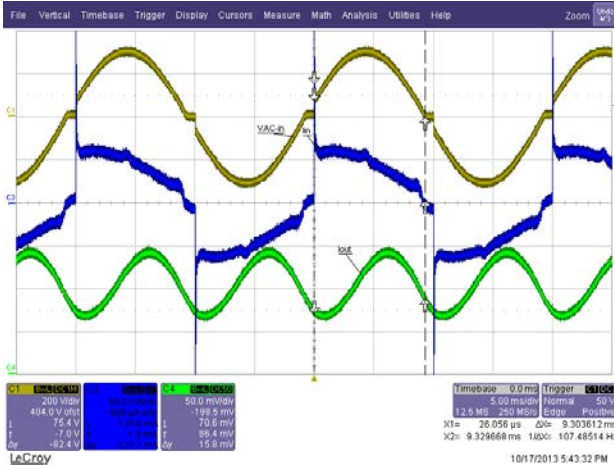


Figure 93 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

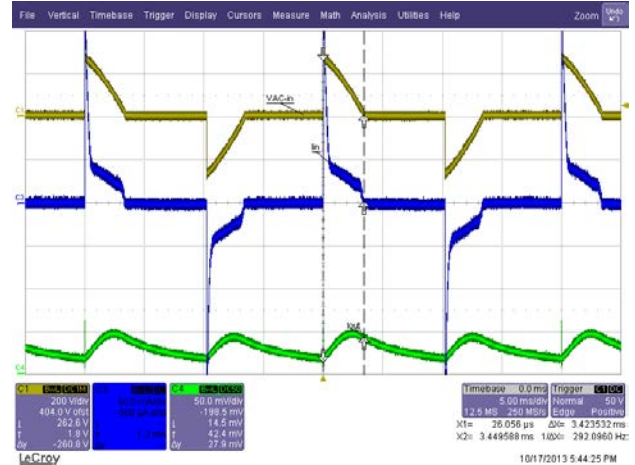


Figure 94 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

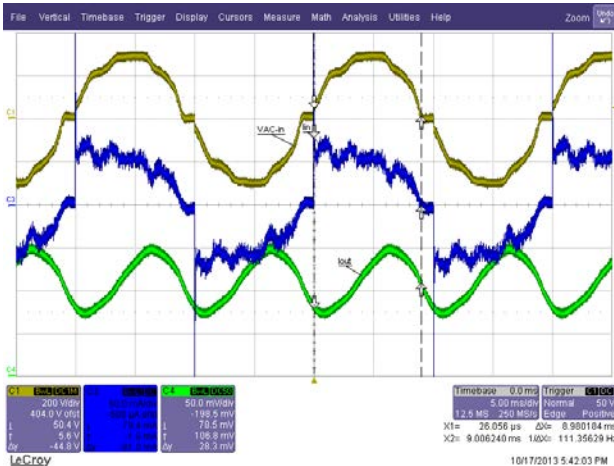


Figure 95 – Full Conduction from Distorted AC Line
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

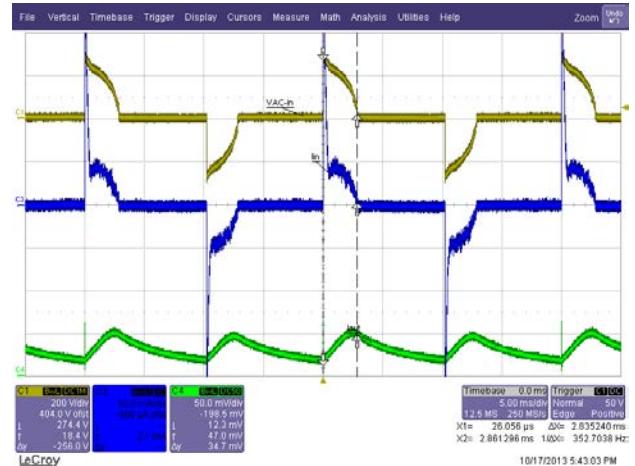


Figure 96 – Minimum Conduction from Distorted AC Line
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: EBA HUANG

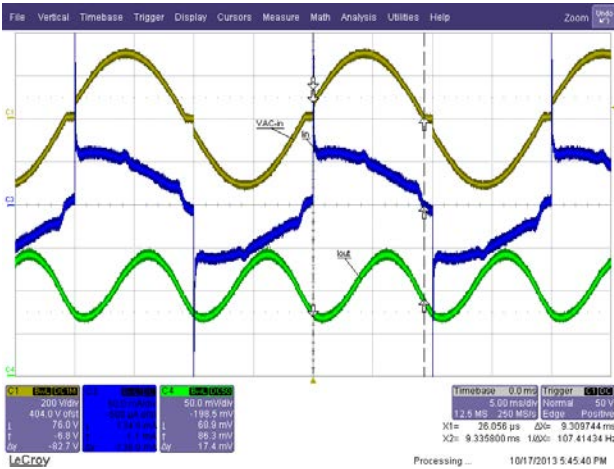


Figure 97 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

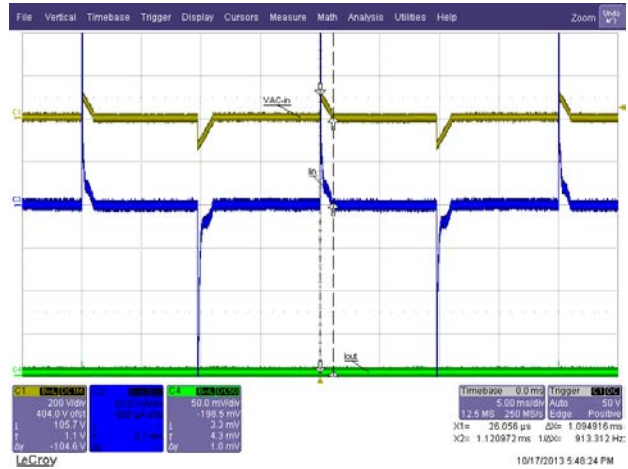


Figure 98 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

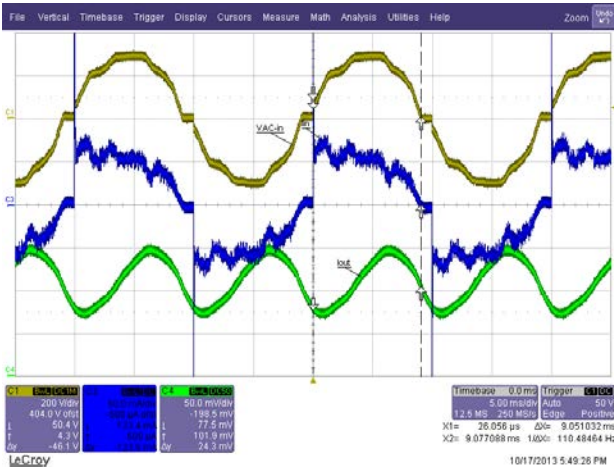


Figure 99 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

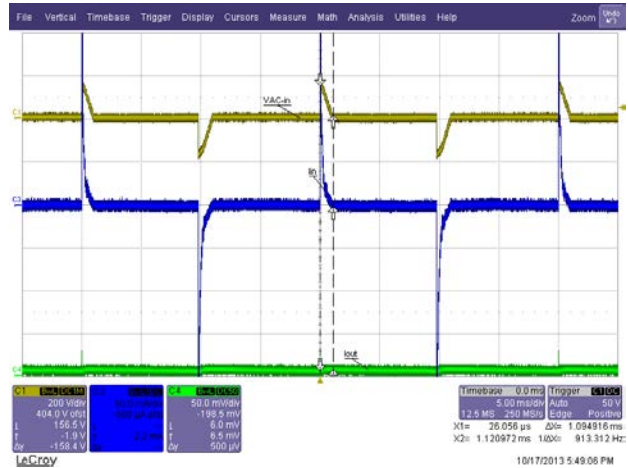


Figure 100 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: SB ELECT

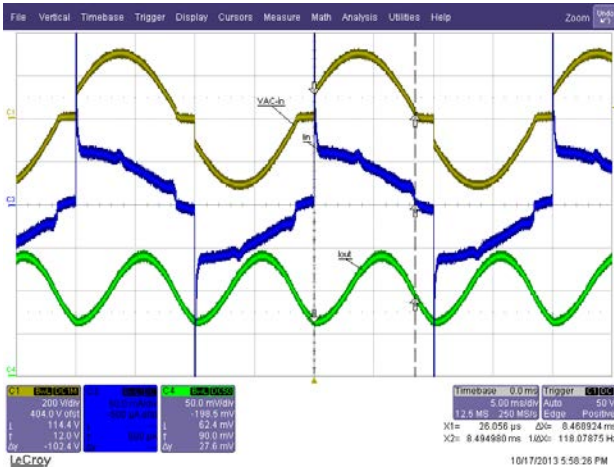


Figure 101 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

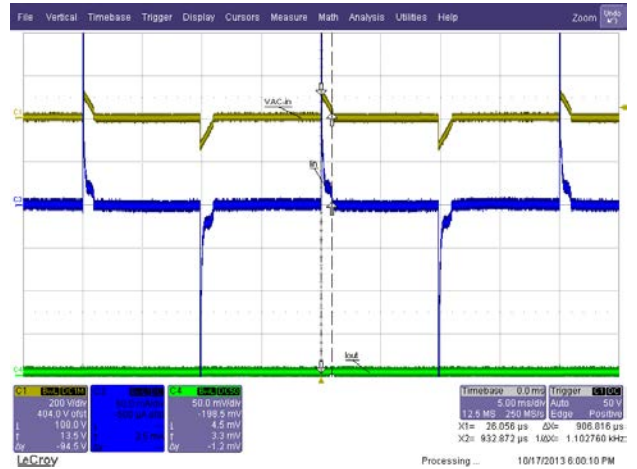


Figure 102 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

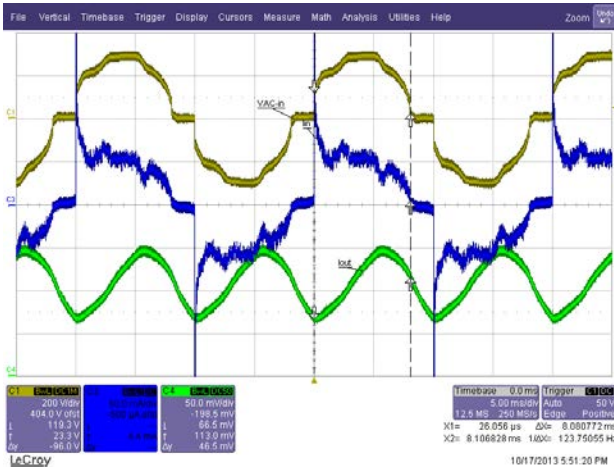


Figure 103 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

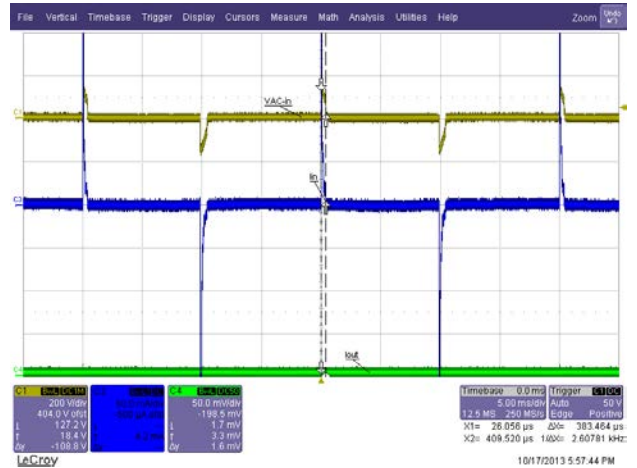


Figure 104 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: MYONGBO

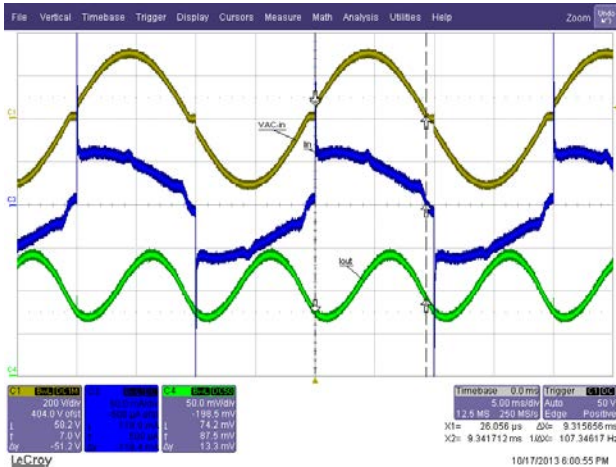


Figure 105 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

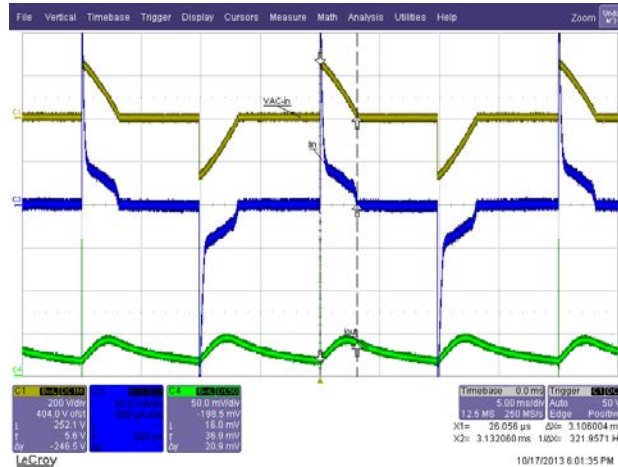


Figure 106 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

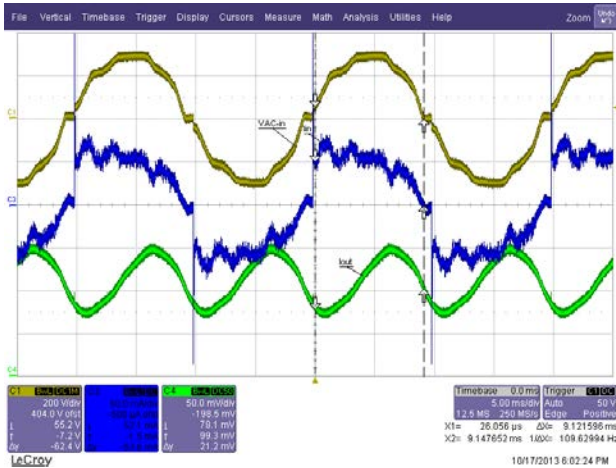


Figure 107 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

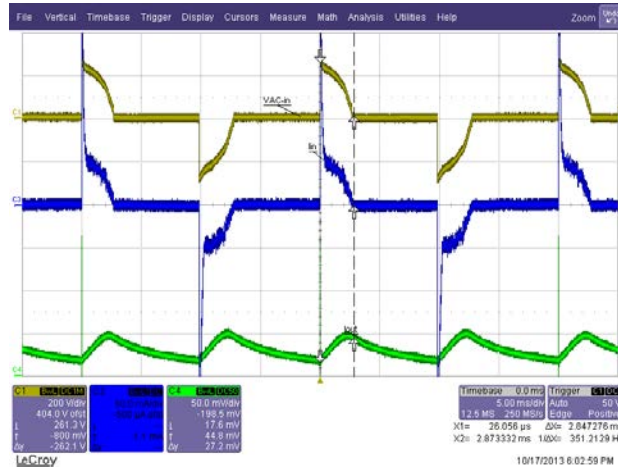


Figure 108 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: KBE

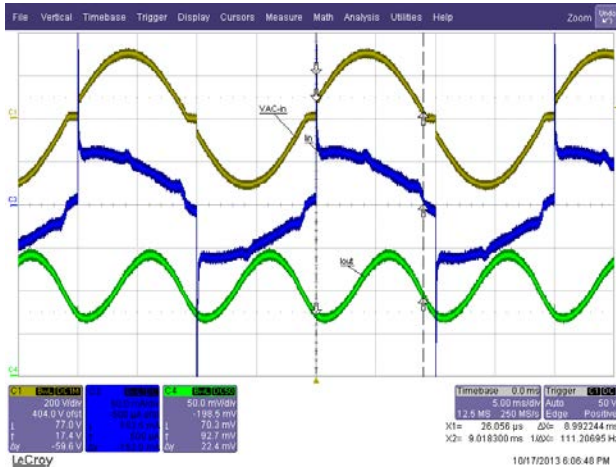


Figure 109 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

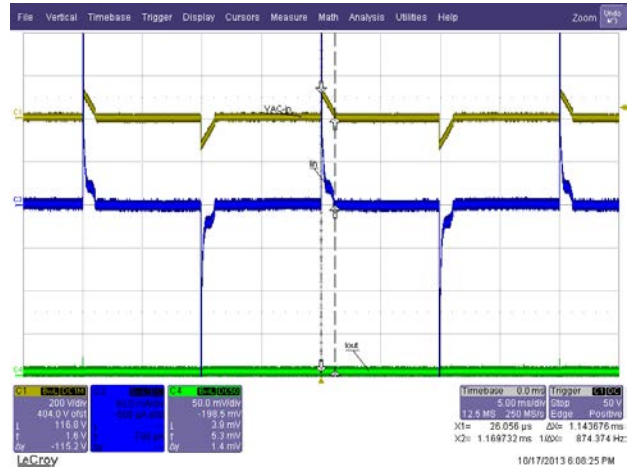


Figure 110 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

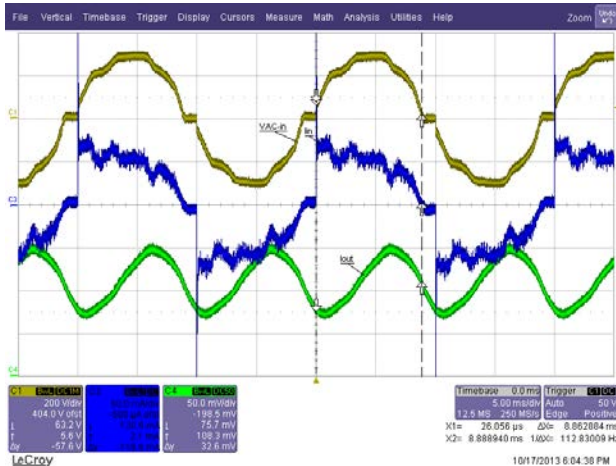


Figure 111 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

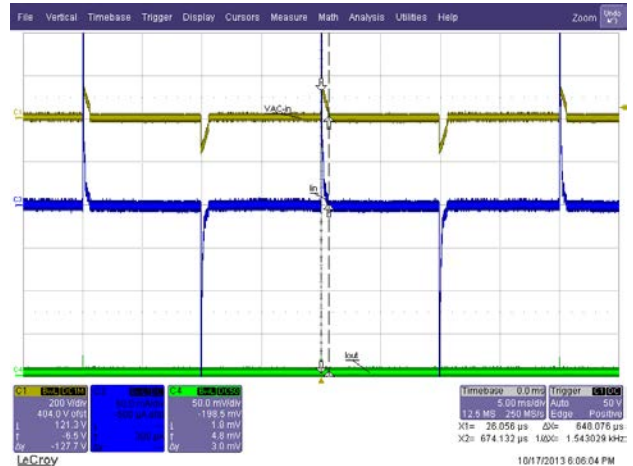


Figure 112 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: CLIPMEI

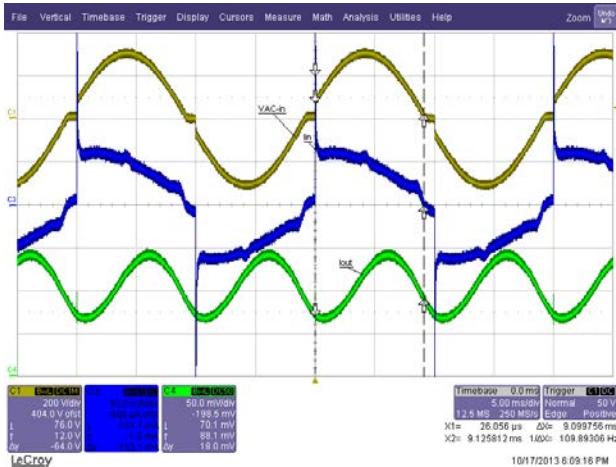


Figure 113 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

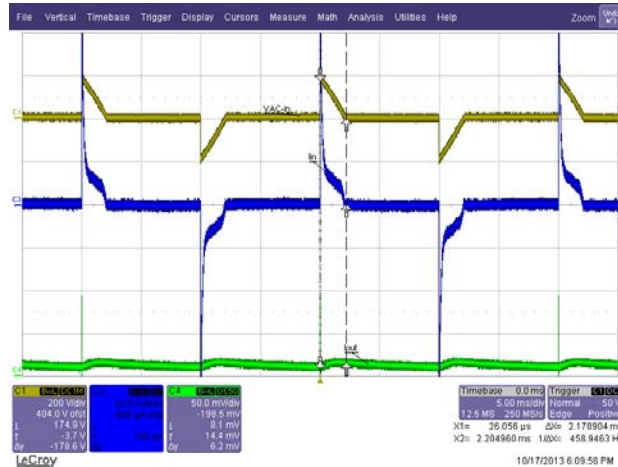


Figure 114 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

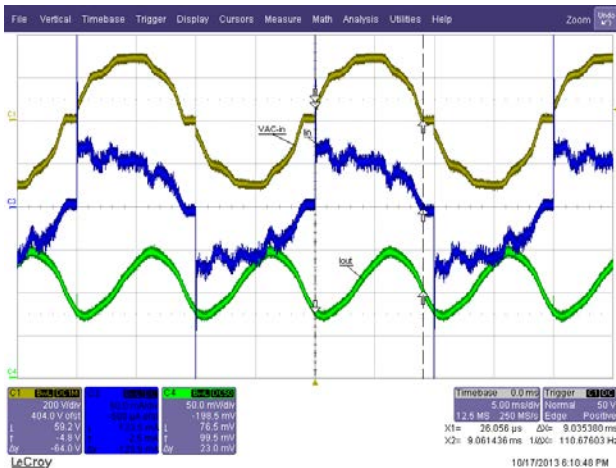


Figure 115 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

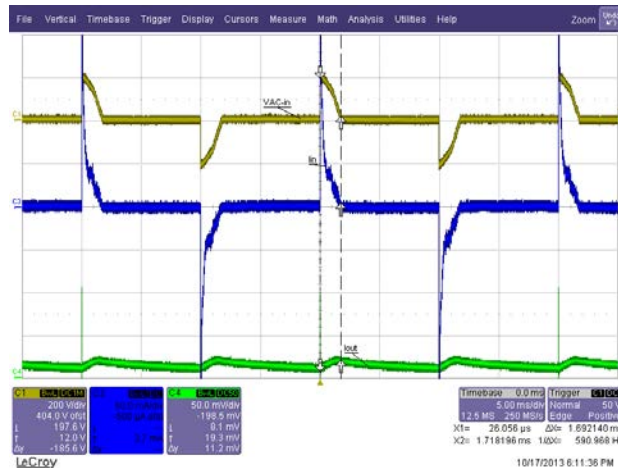


Figure 116 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: MANK

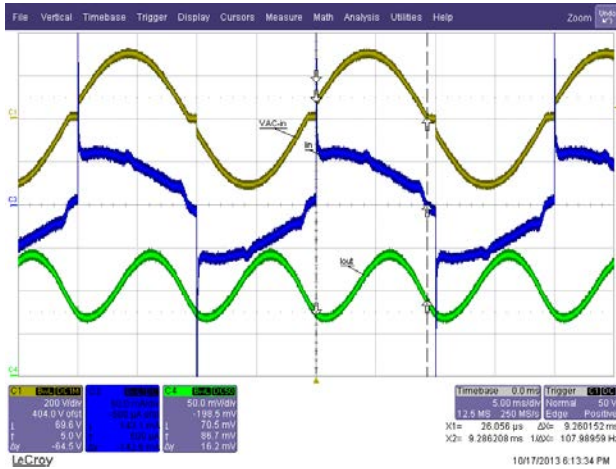


Figure 117 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

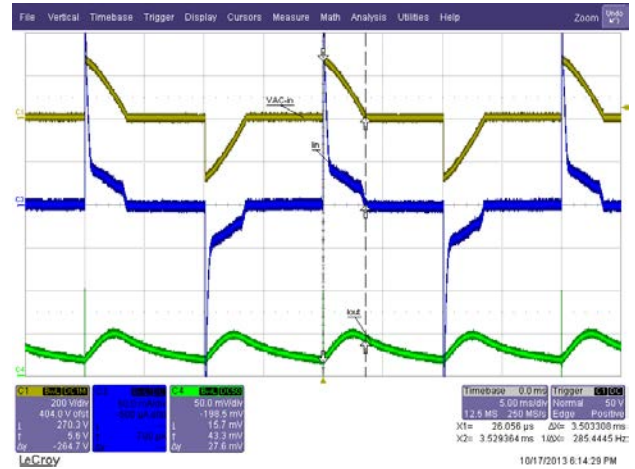


Figure 118 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

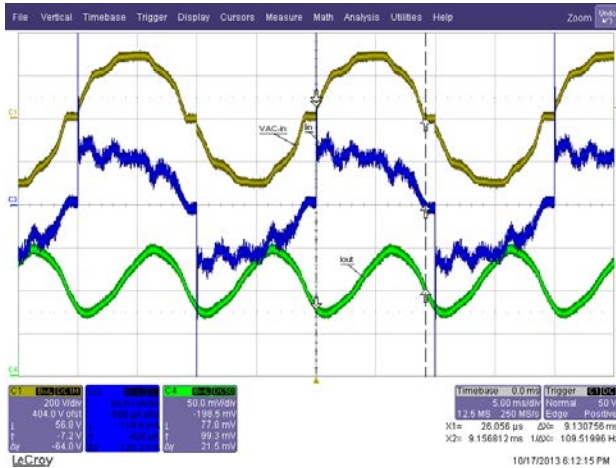


Figure 119 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

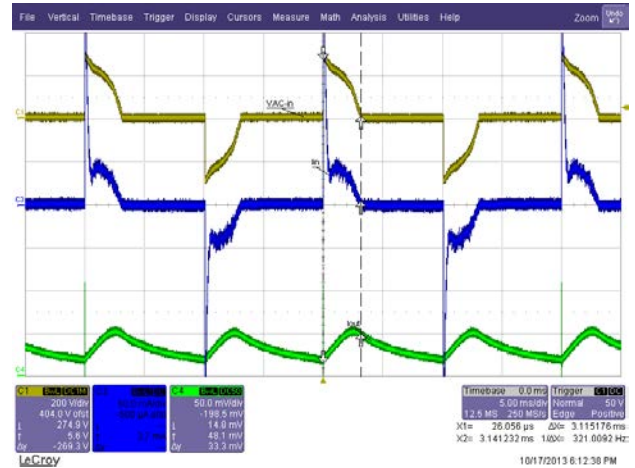


Figure 120 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: GIRA 1176 00 I03

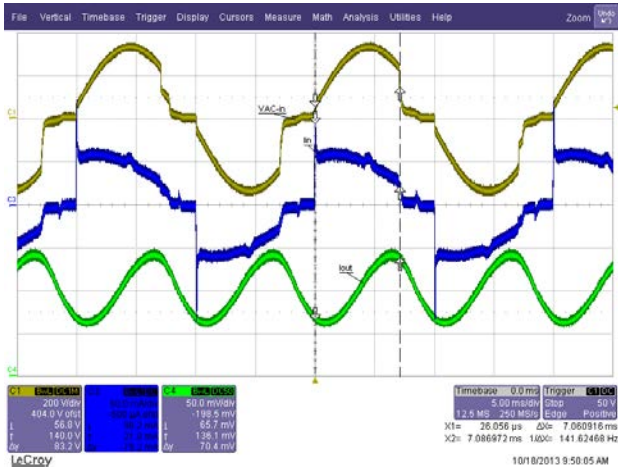


Figure 121 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

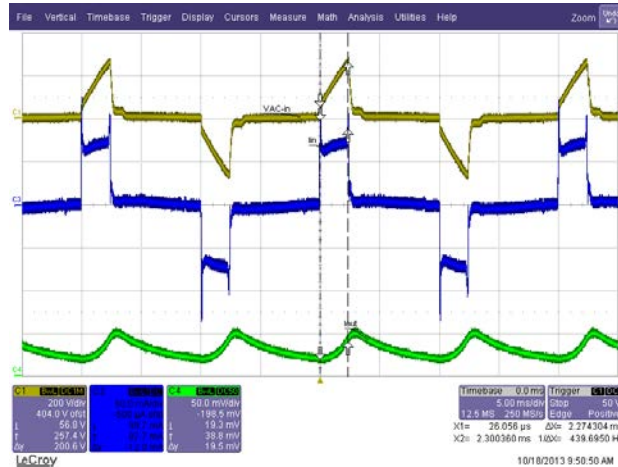


Figure 122 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

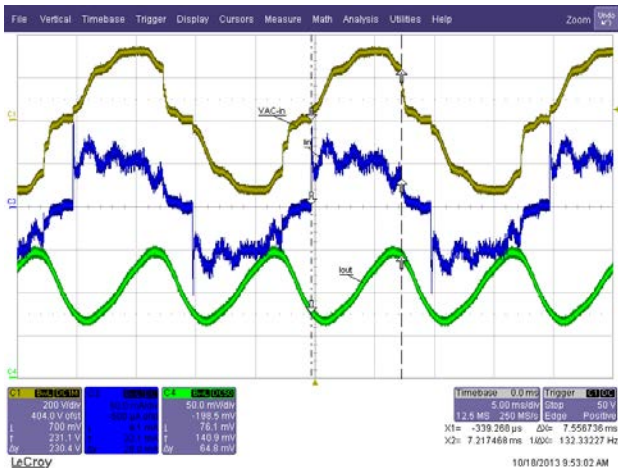


Figure 123 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

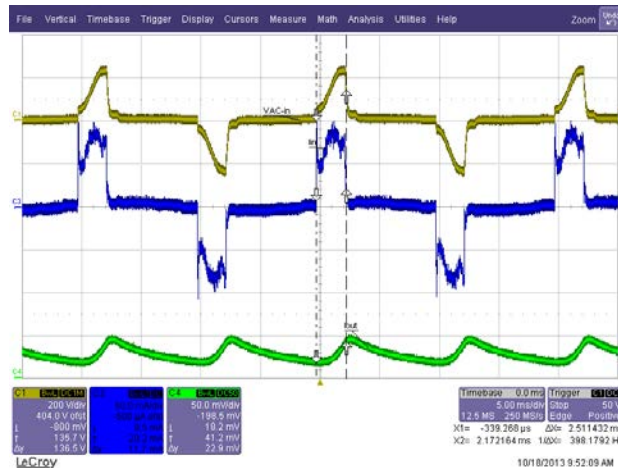


Figure 124 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-013

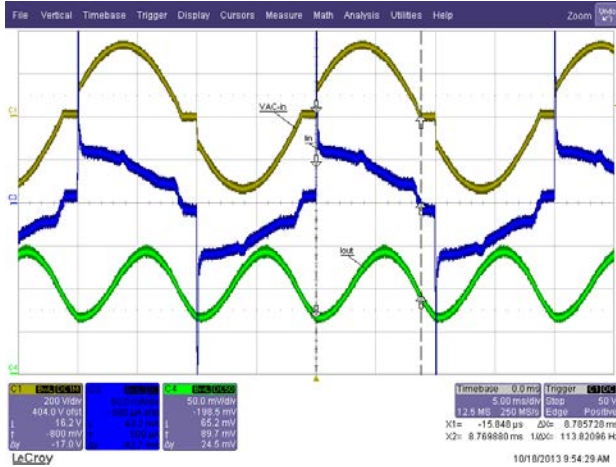


Figure 125 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

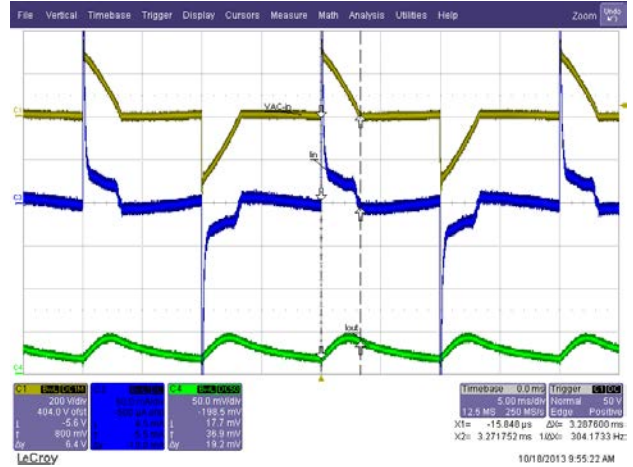


Figure 126 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

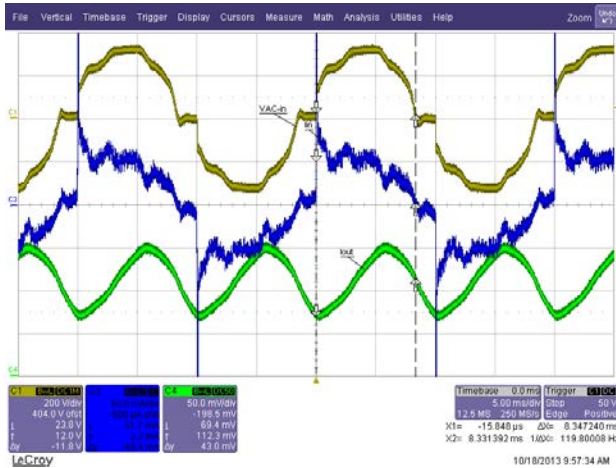


Figure 127 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

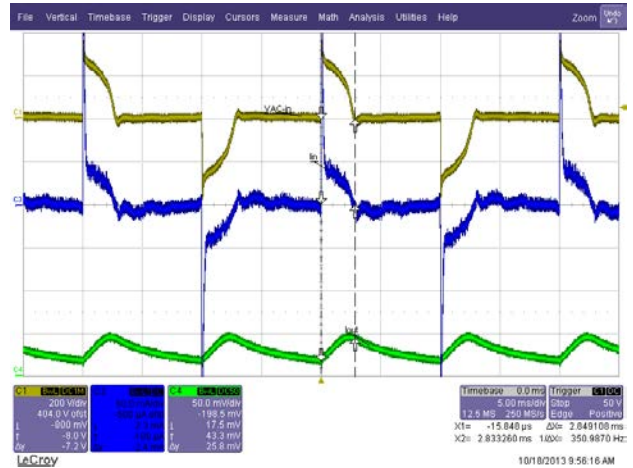


Figure 128 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-017

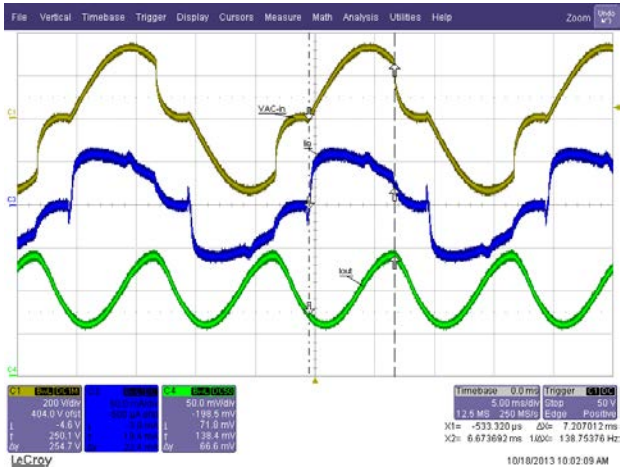


Figure 129 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

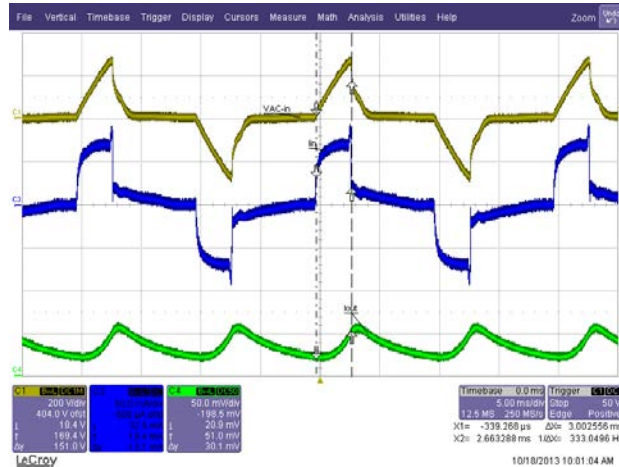


Figure 130 – Minimum Conduction from Regulated AC Input 230 V / 50Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

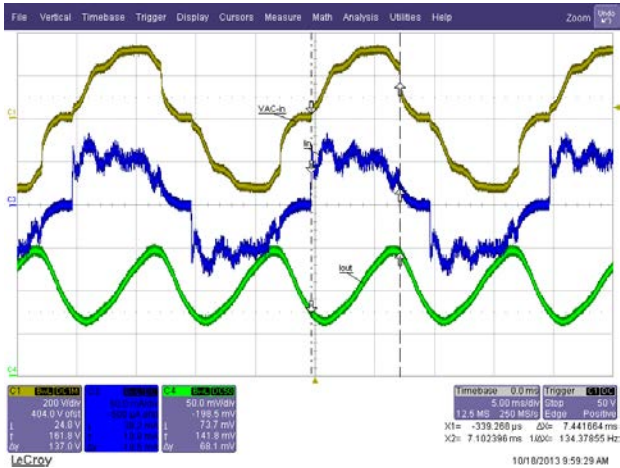


Figure 131 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

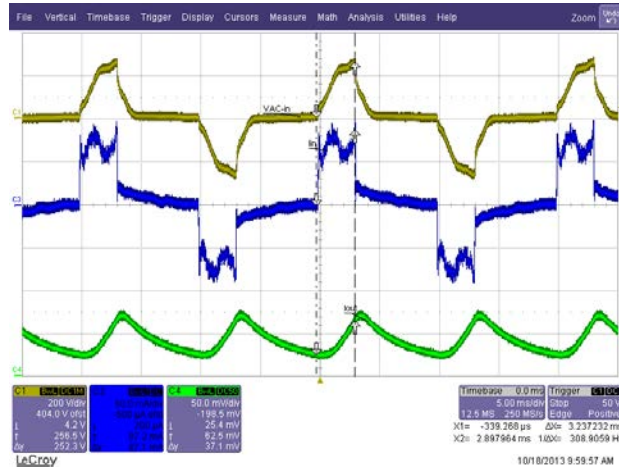


Figure 132 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-014

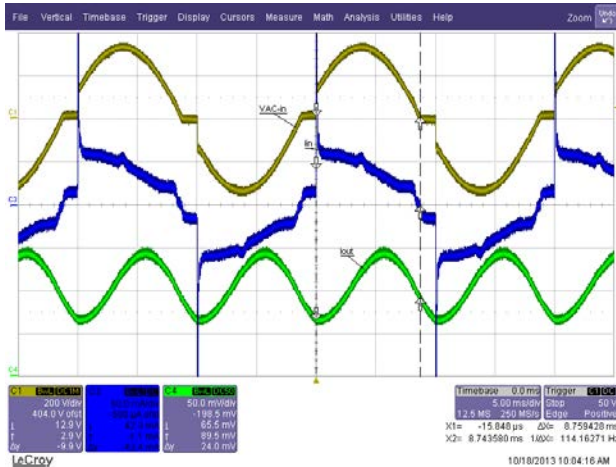


Figure 133 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

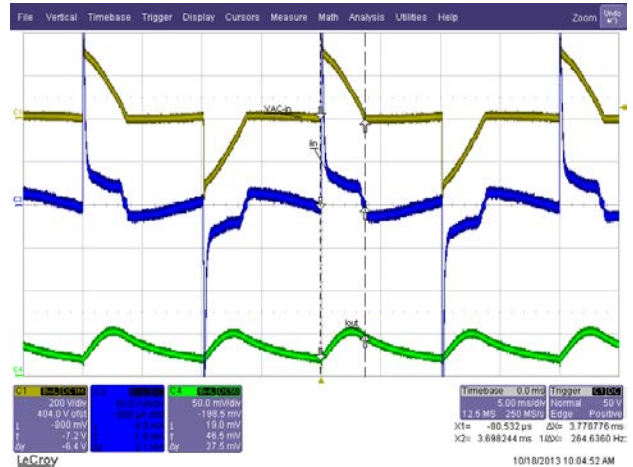


Figure 134 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

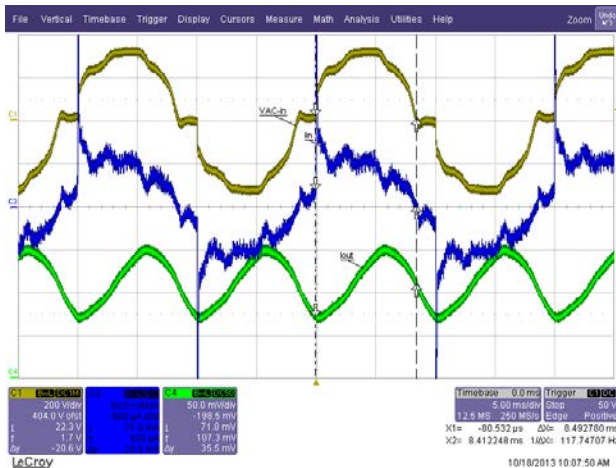


Figure 135 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

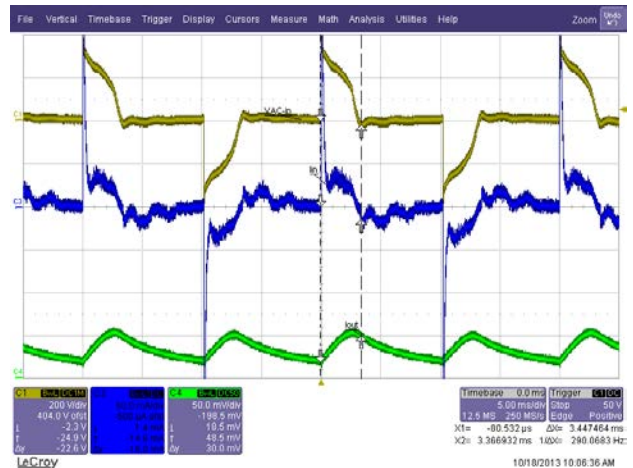


Figure 136 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-016

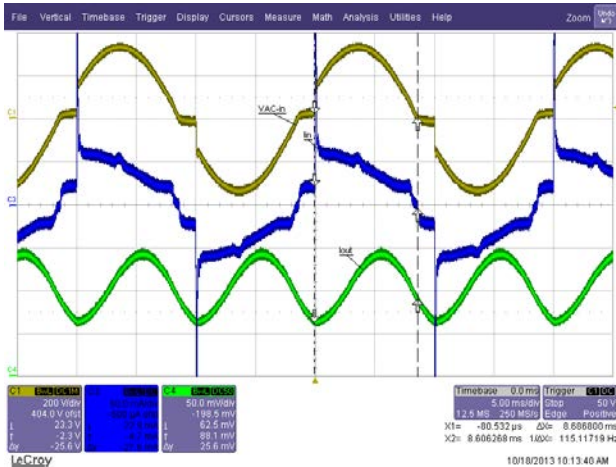


Figure 137 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

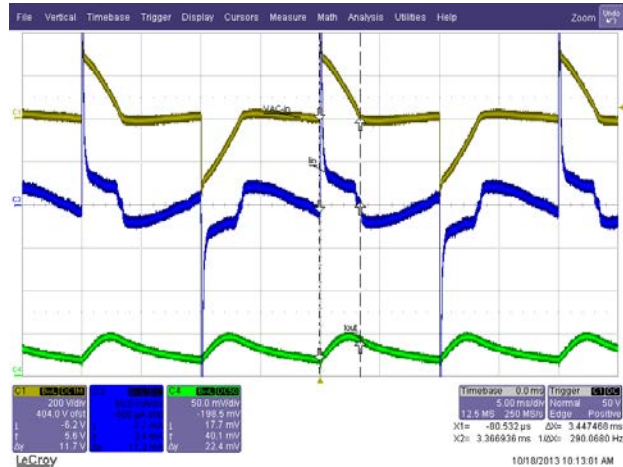


Figure 138 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

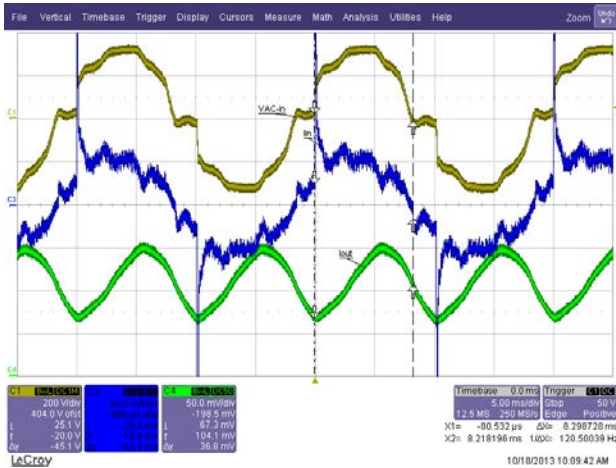


Figure 139 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

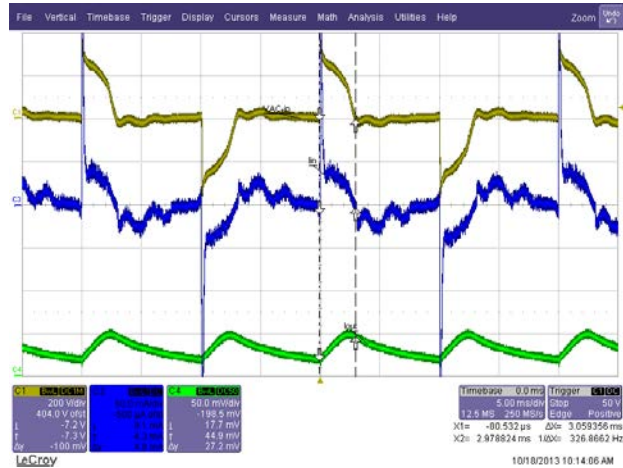


Figure 140 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250

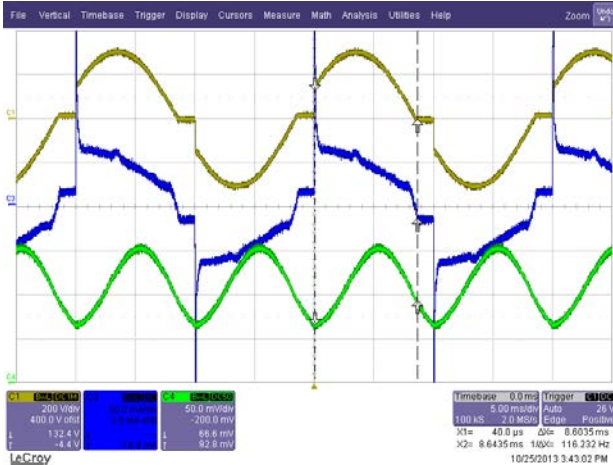


Figure 141 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

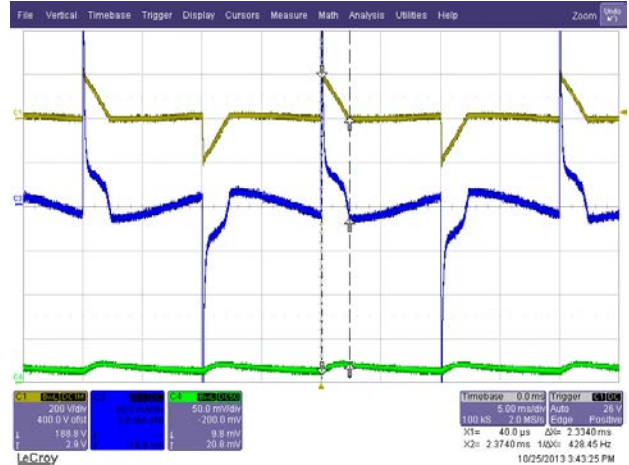


Figure 142 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

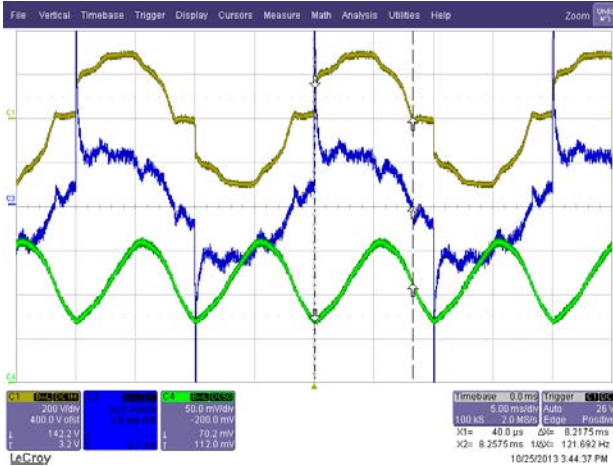


Figure 143 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

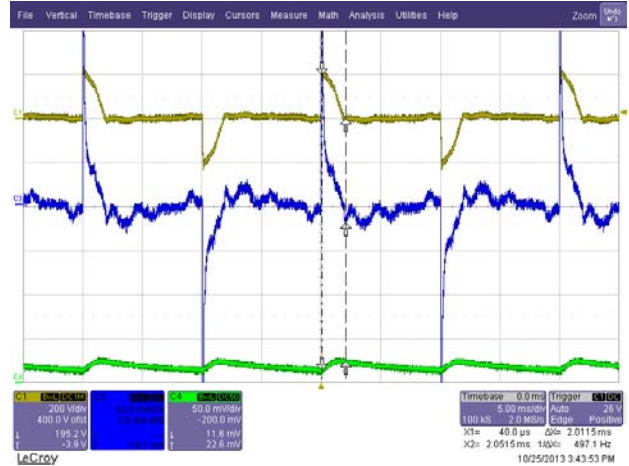


Figure 144 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 400 W

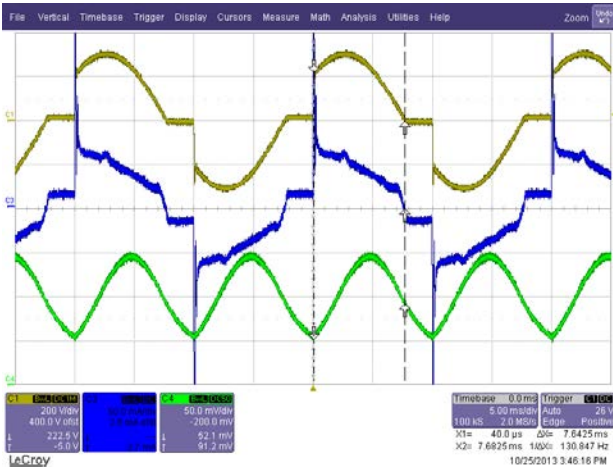


Figure 145 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50mA / div.
 Time Scale: 5 ms / div.

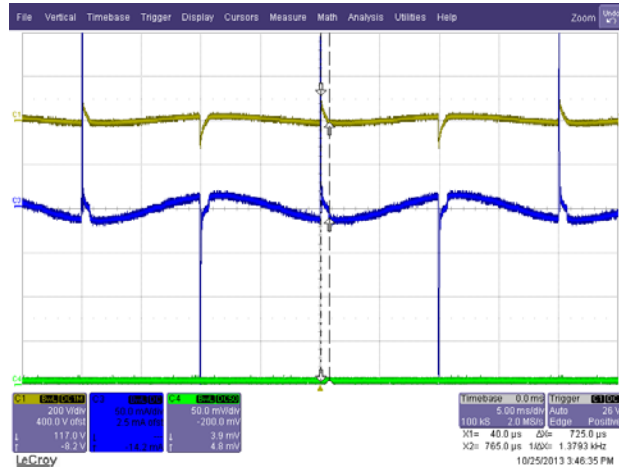


Figure 146 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

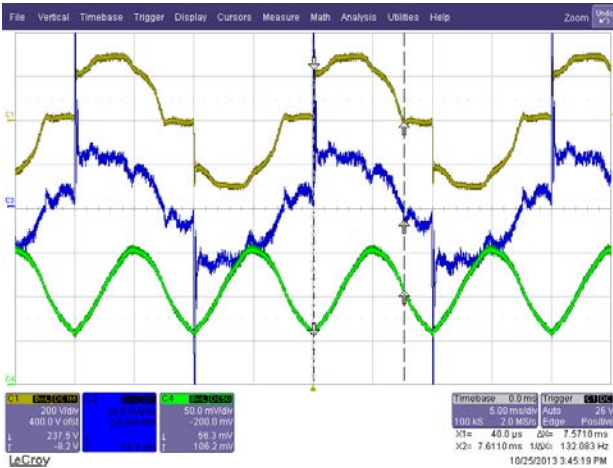


Figure 147 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

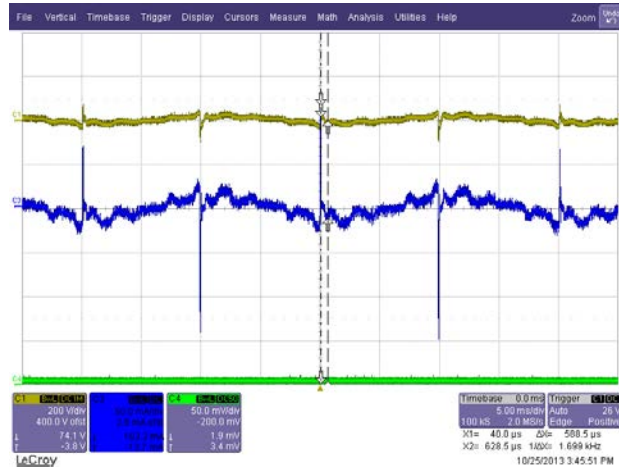


Figure 148 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Merten 572499

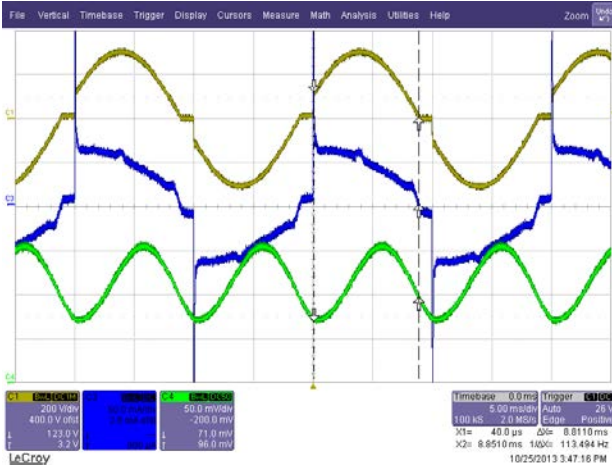


Figure 149 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

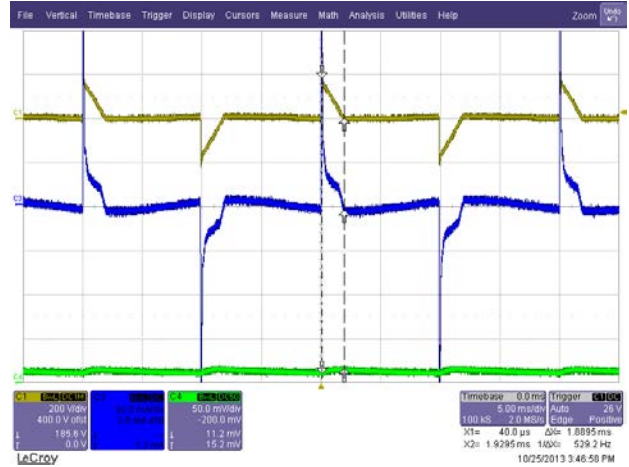


Figure 150 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

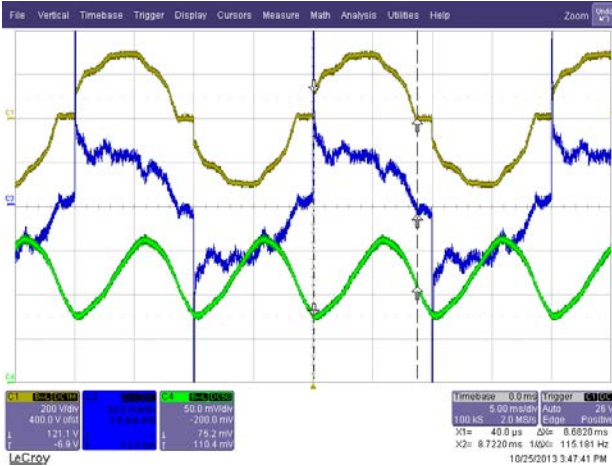


Figure 151 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

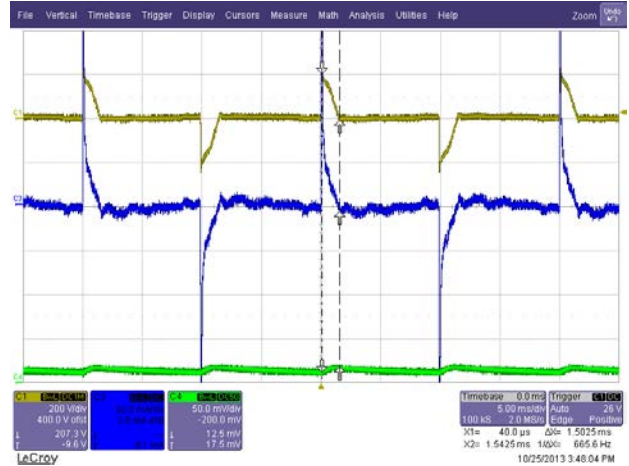


Figure 152 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6513

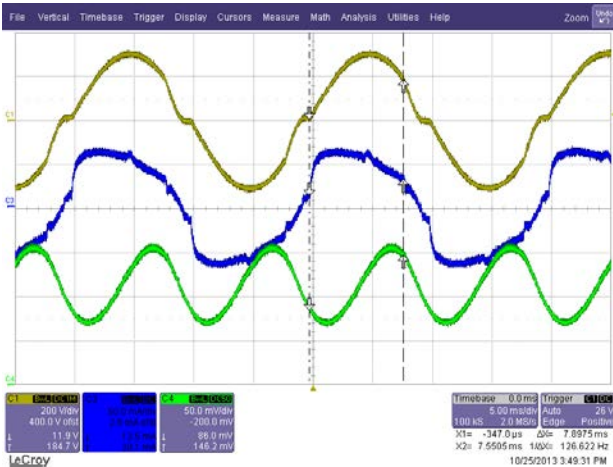


Figure 153 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

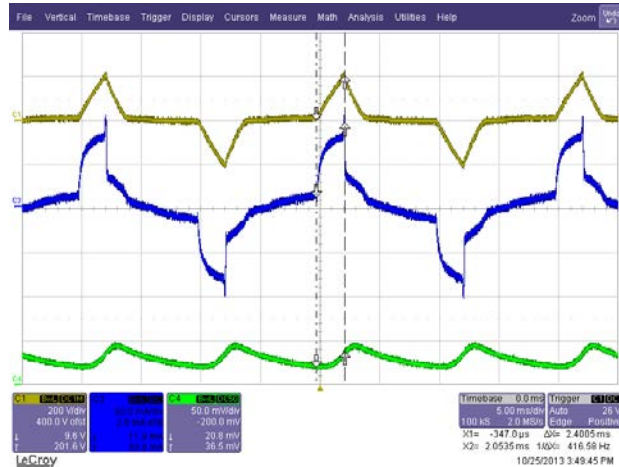


Figure 154 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

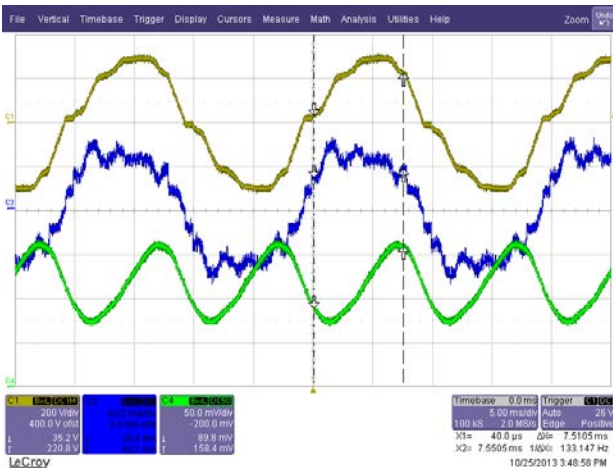


Figure 155 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

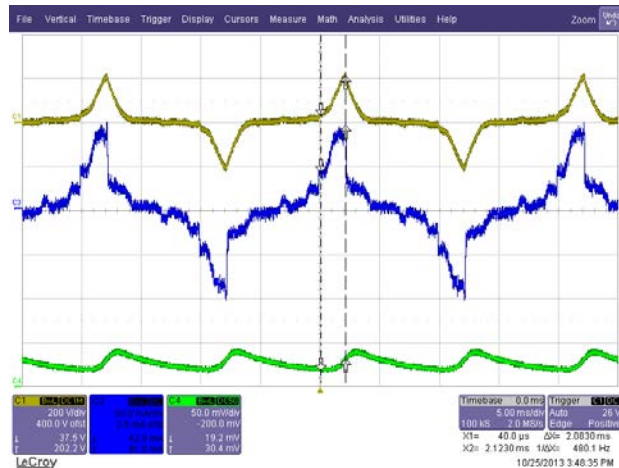


Figure 156 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Berker 2875

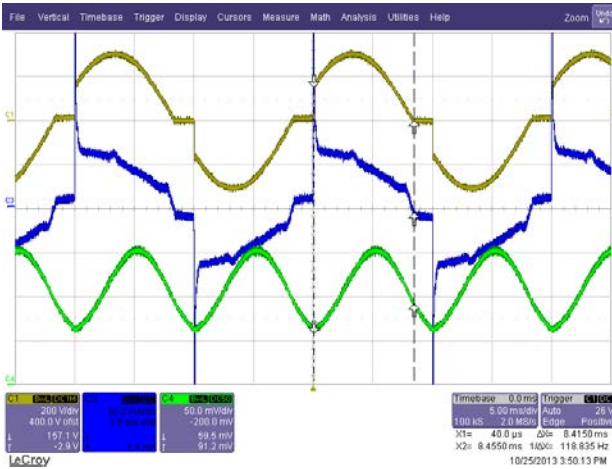


Figure 157 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

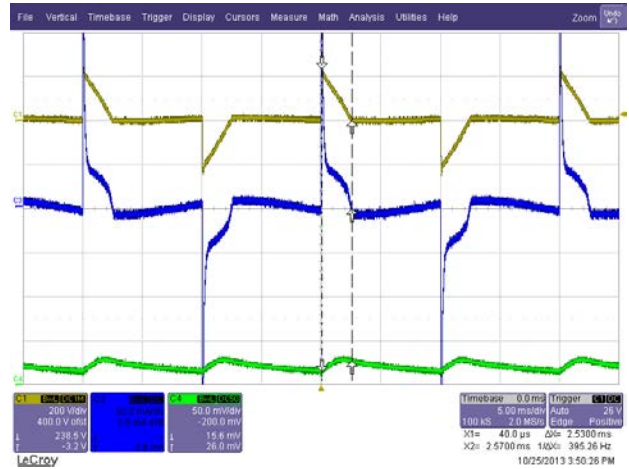


Figure 158 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

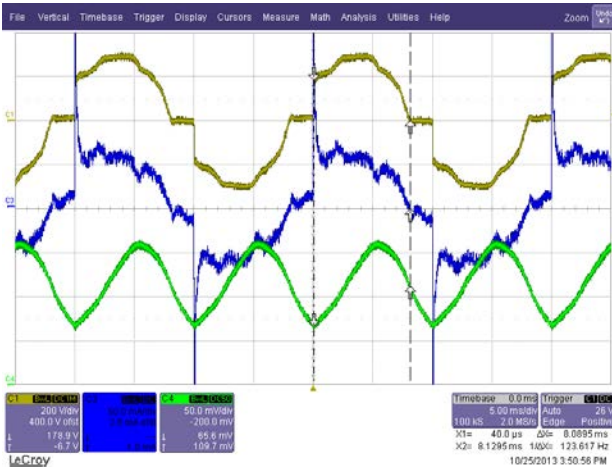


Figure 159 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

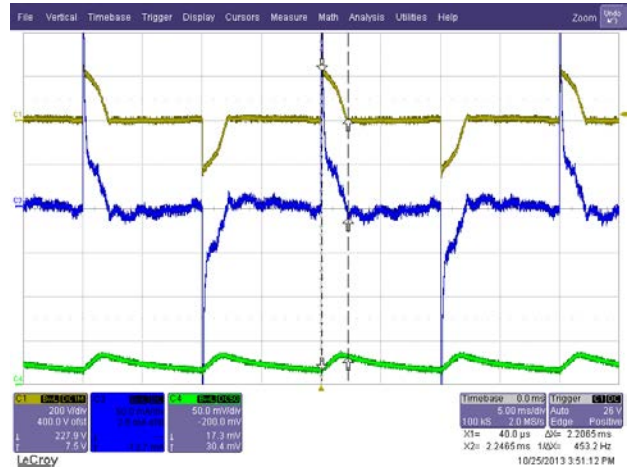


Figure 160 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Berker 2830-10

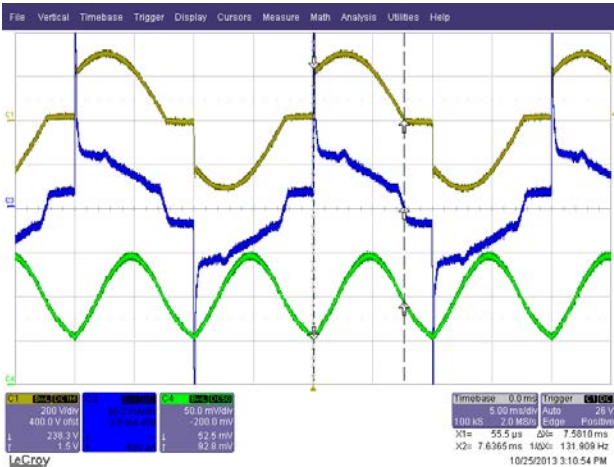


Figure 161 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

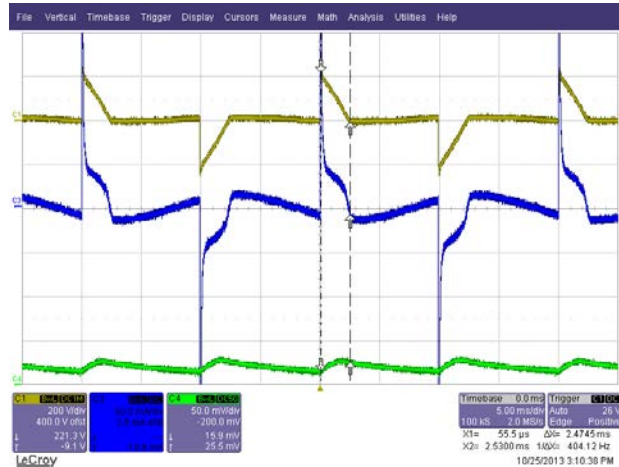


Figure 162 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

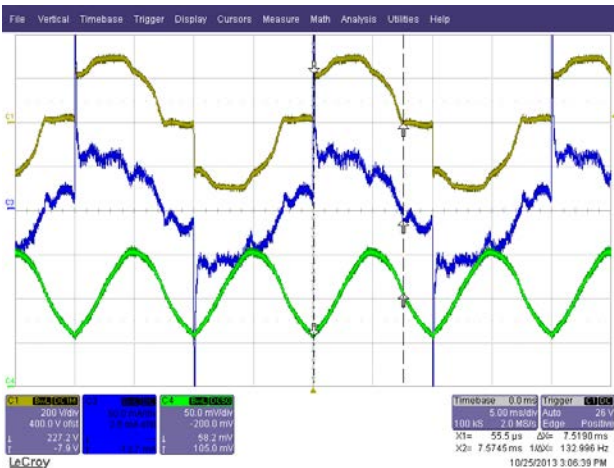


Figure 163 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

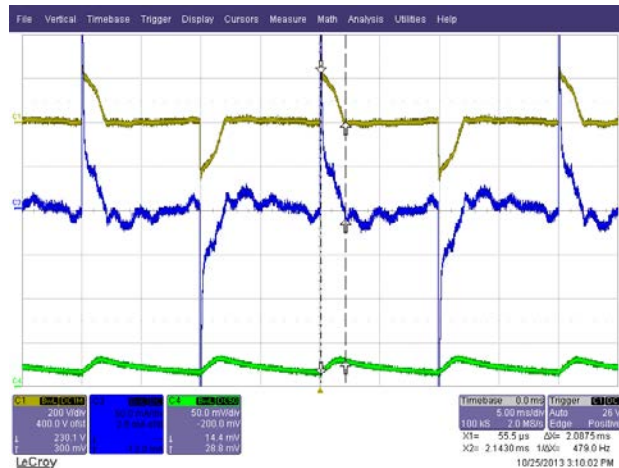


Figure 164 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6591-101

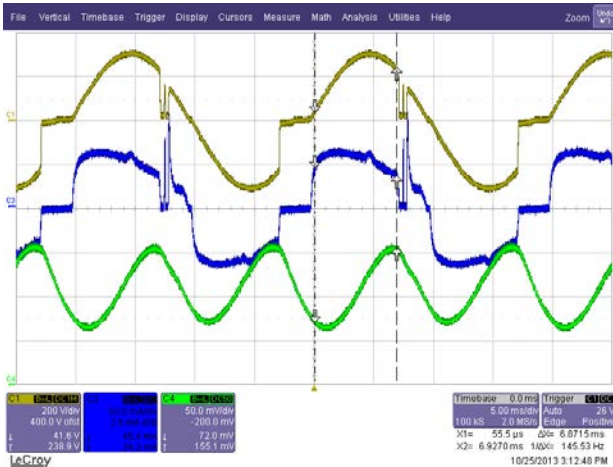


Figure 165 – Full Conduction from Regulated AC Input 230 V / 50 Hz. Natural characteristic of the dimmer is asymmetric.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

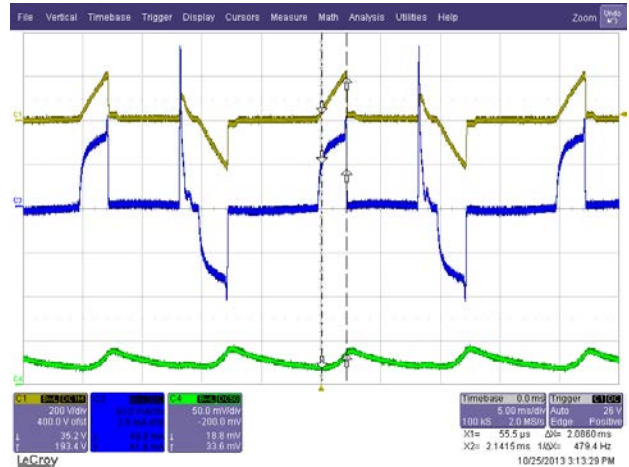


Figure 166 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

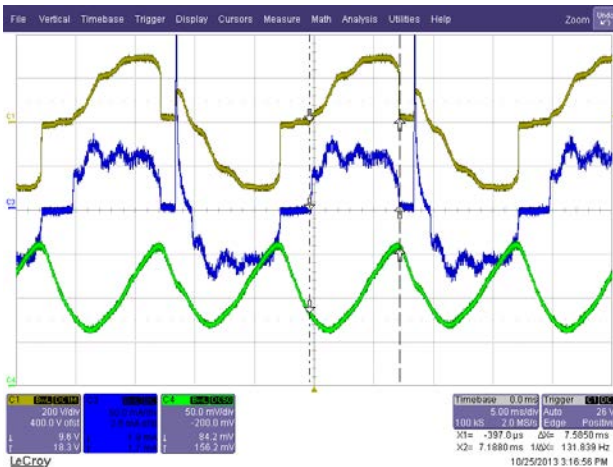


Figure 167 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

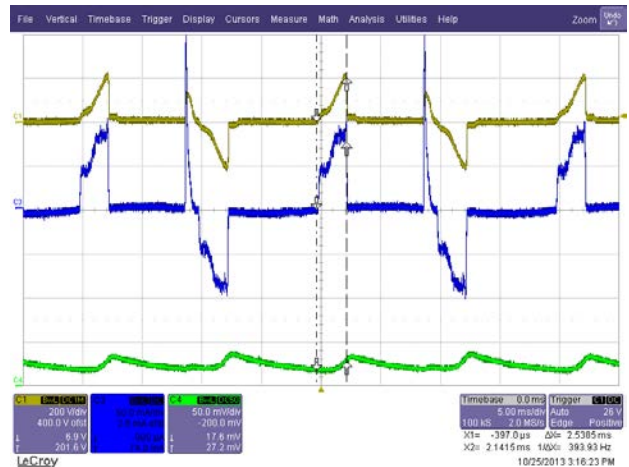


Figure 168 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6513 U-102

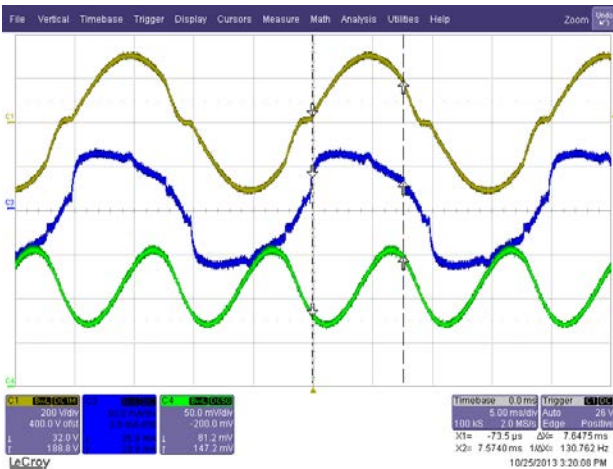


Figure 169 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

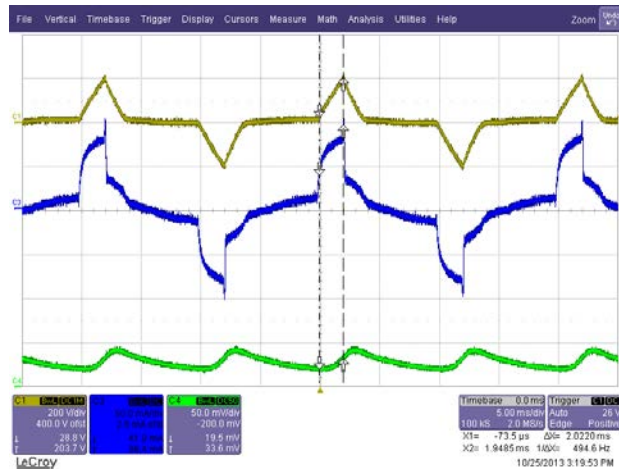


Figure 170 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

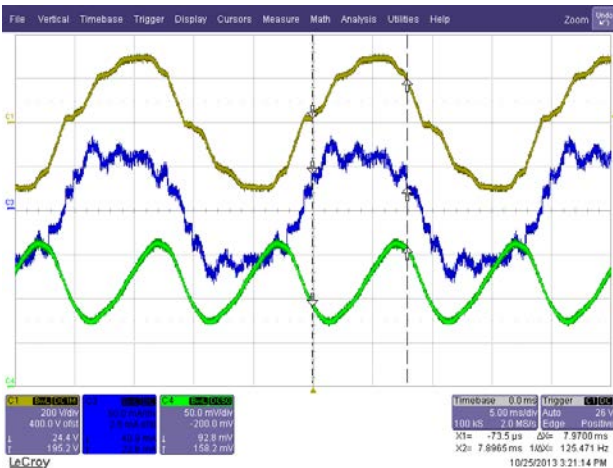


Figure 171 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

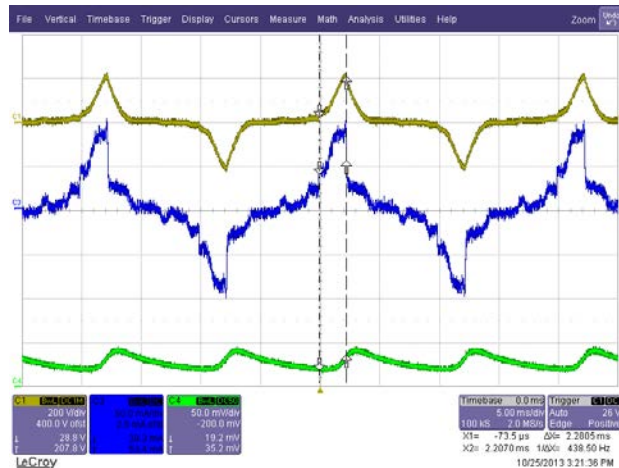


Figure 172 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 433HAB 0A

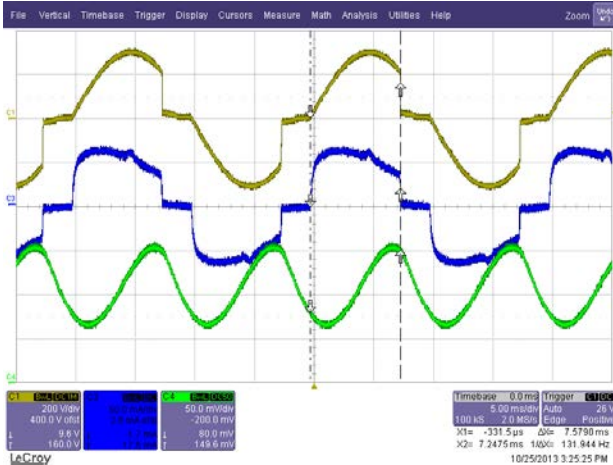


Figure 173 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

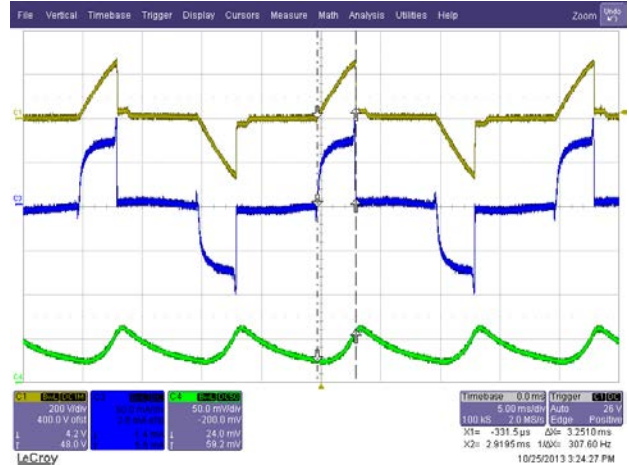


Figure 174 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

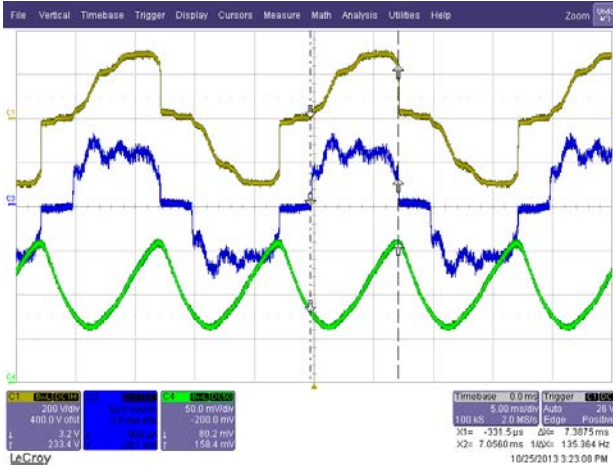


Figure 175 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

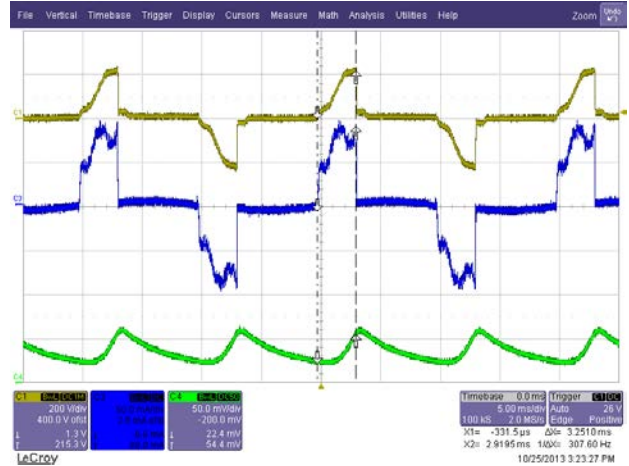


Figure 176 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 433HAB 0A

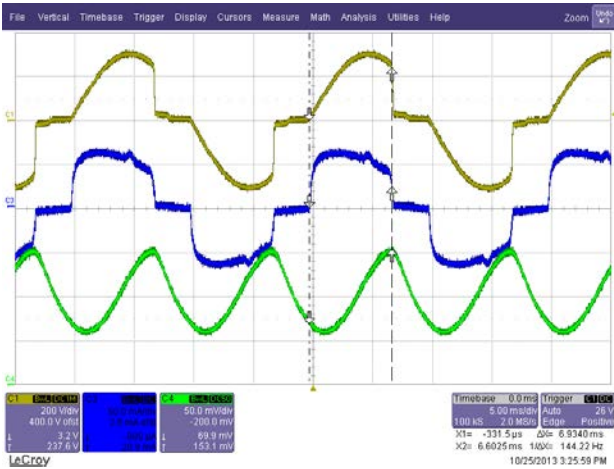


Figure 177 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

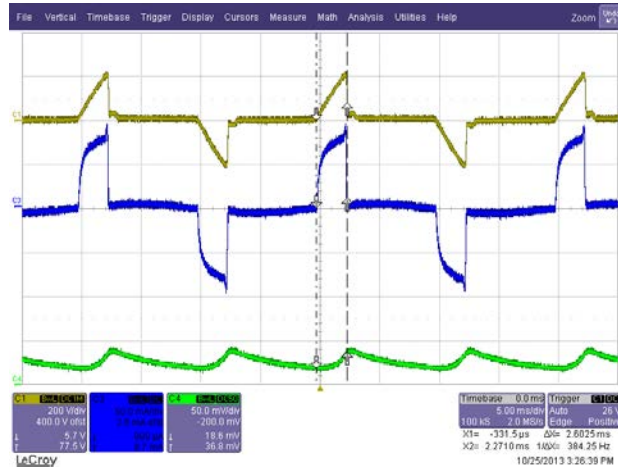


Figure 178 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

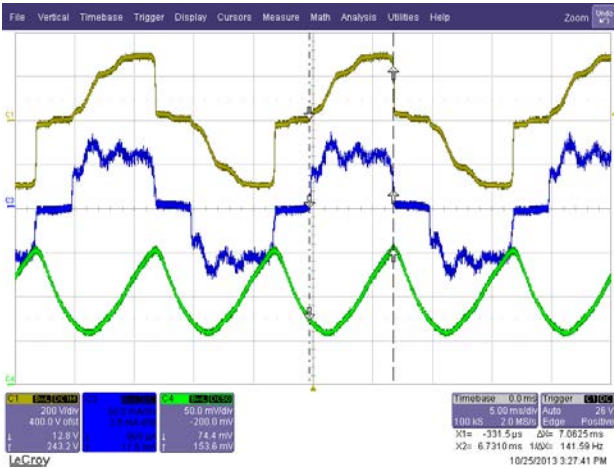


Figure 179 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

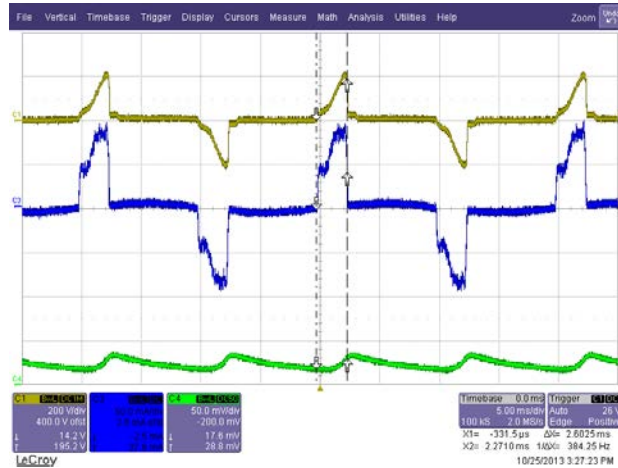


Figure 180 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Relco RM34DMA

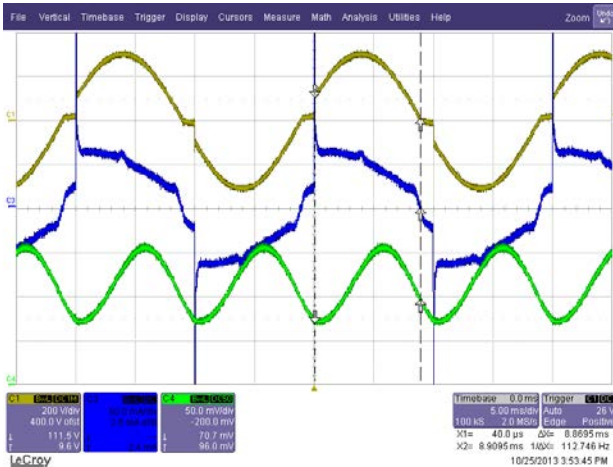


Figure 181 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

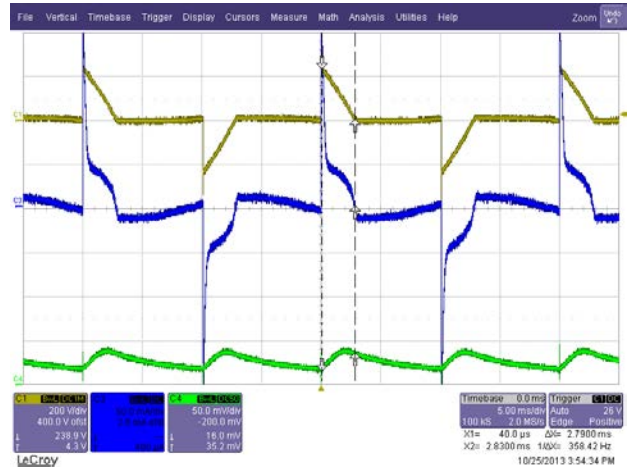


Figure 182 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

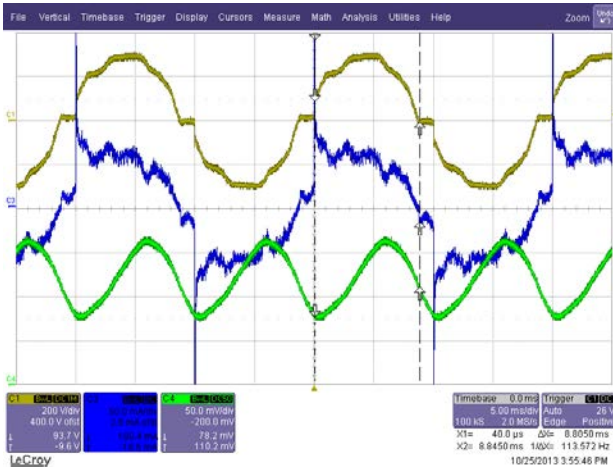


Figure 183 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

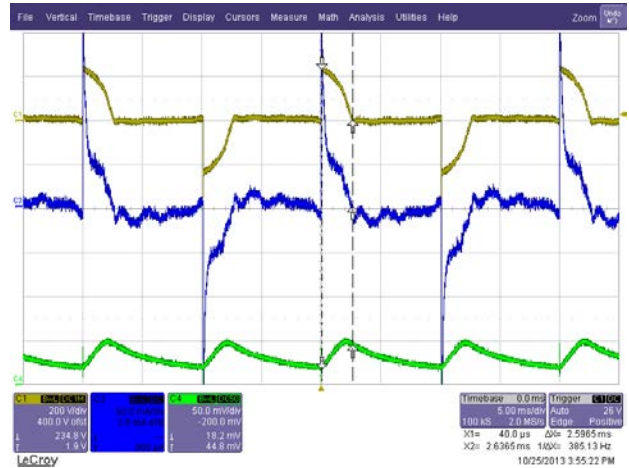


Figure 184 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5ms / div.



Dimmer: Relco RTM34LED DAXS

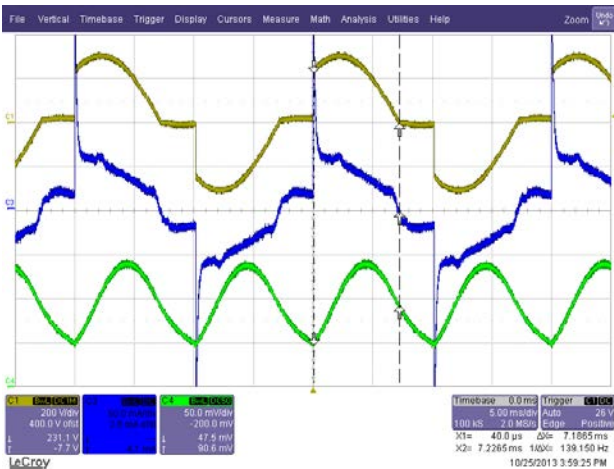


Figure 185 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

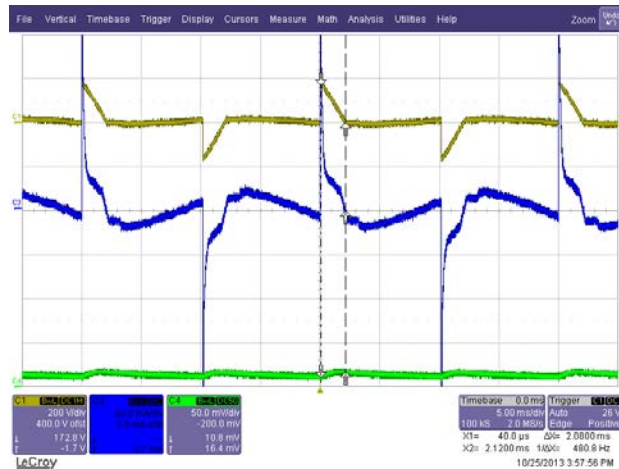


Figure 186 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

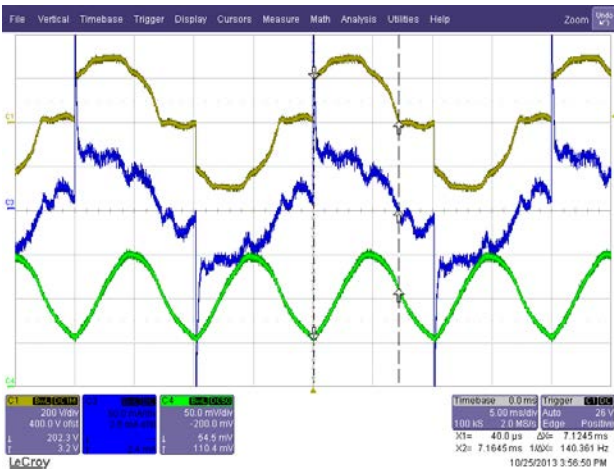


Figure 187 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

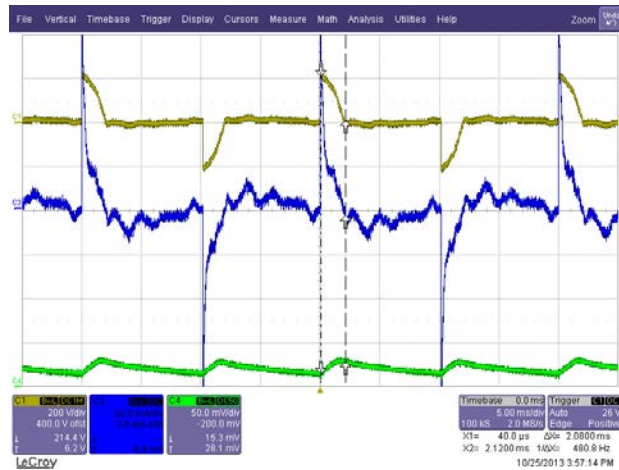


Figure 188 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RM34DMA

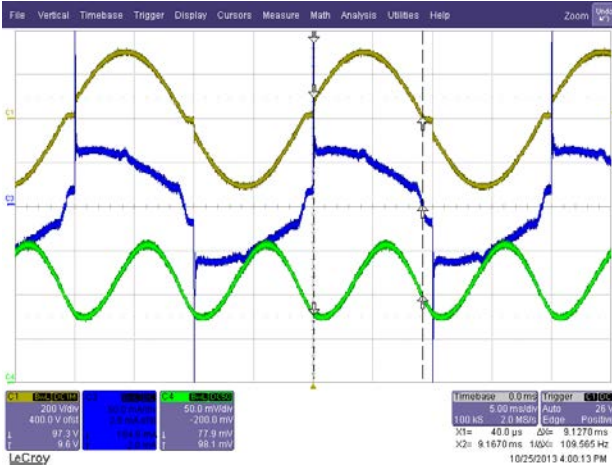


Figure 189 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

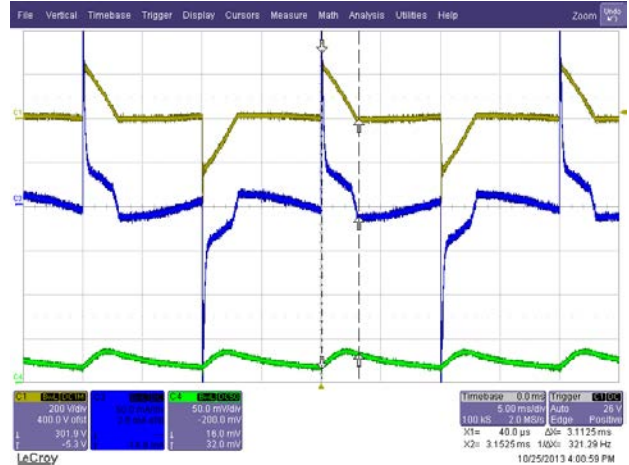


Figure 190 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

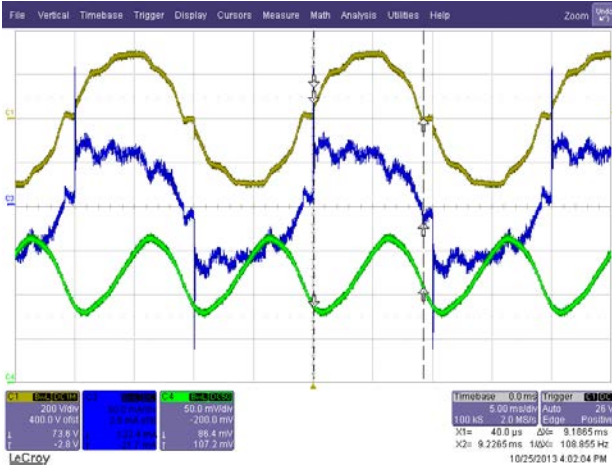


Figure 191 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

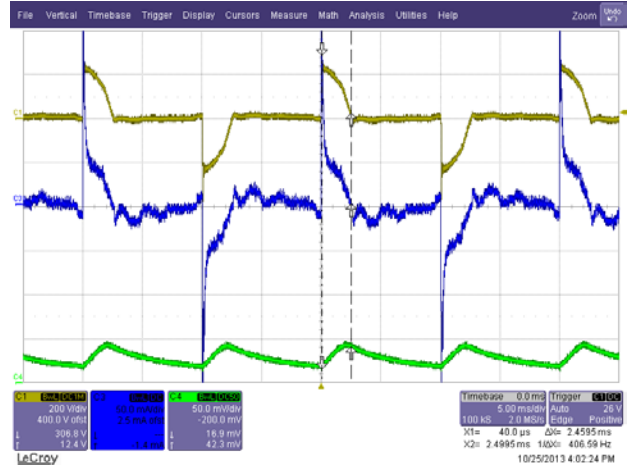


Figure 192 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RTS34.43 RLI

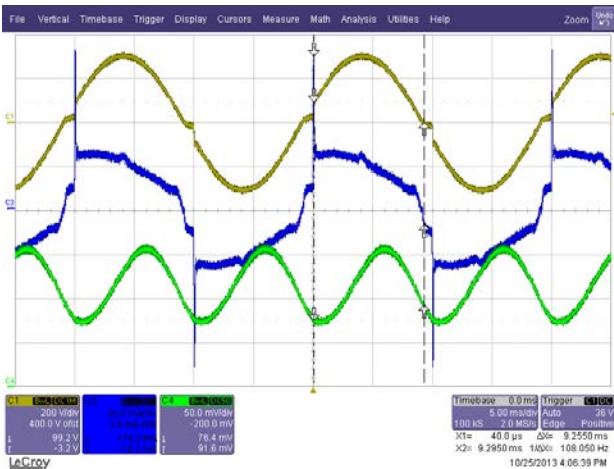


Figure 193 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

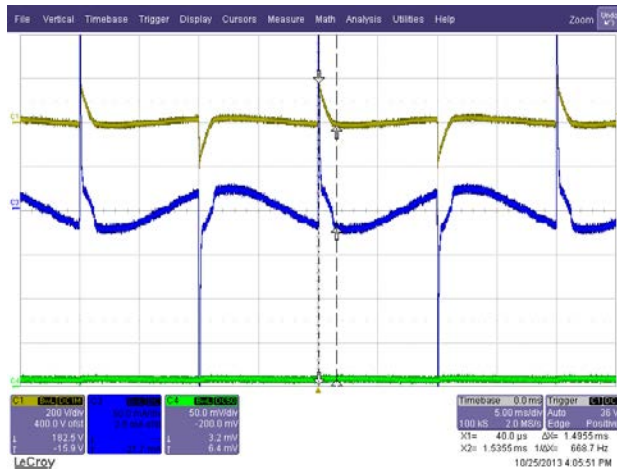


Figure 194 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

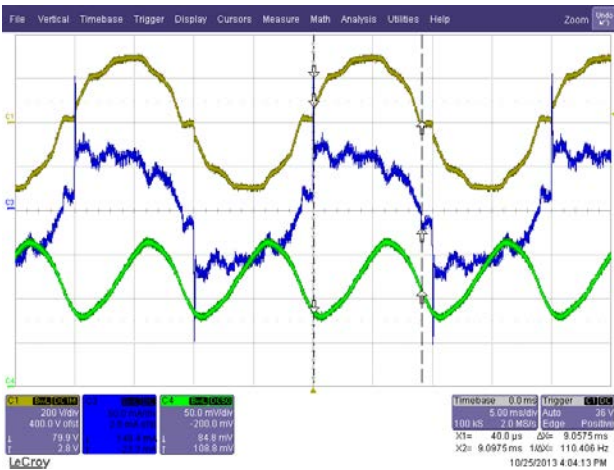


Figure 195 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

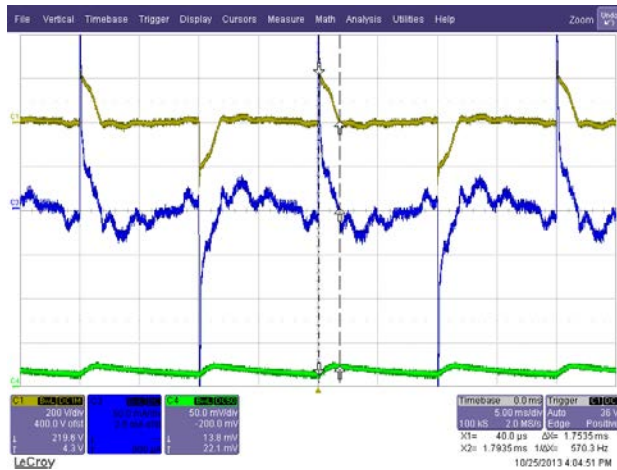


Figure 196 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RT34DSL

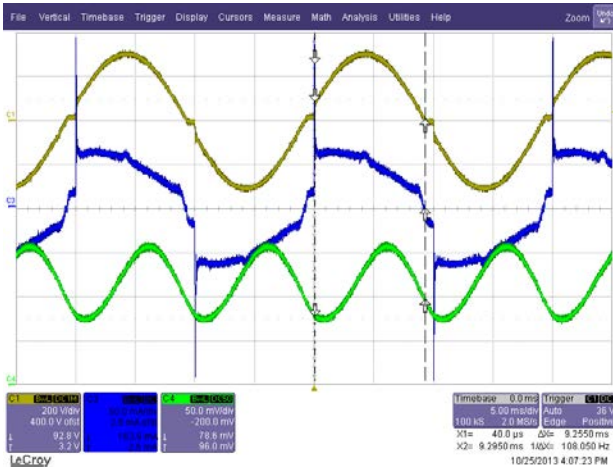


Figure 197 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

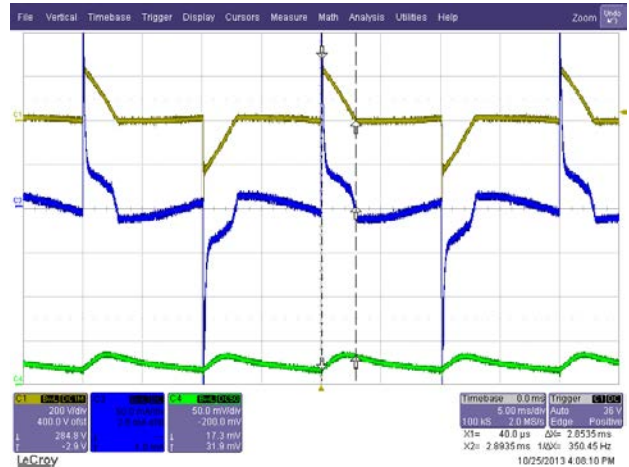


Figure 198 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

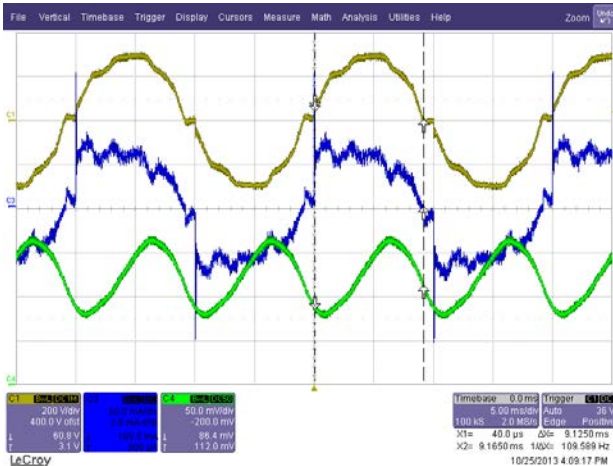


Figure 199 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

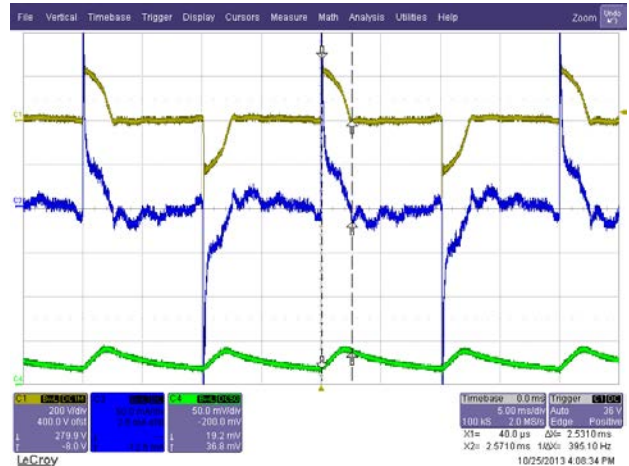


Figure 200 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450LM

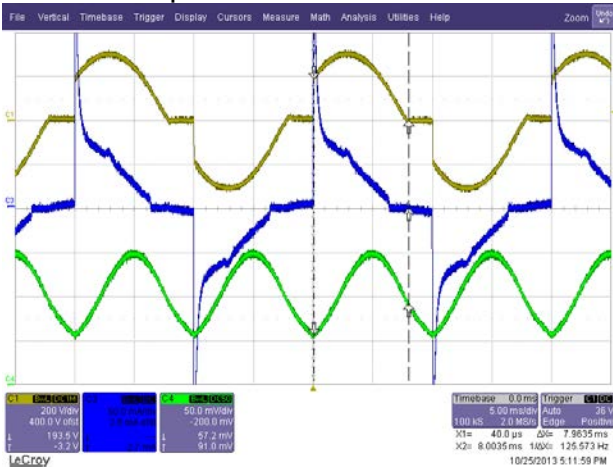


Figure 201 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

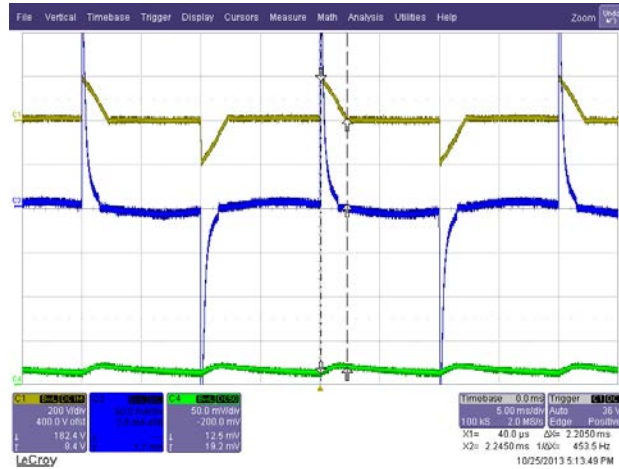


Figure 202 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

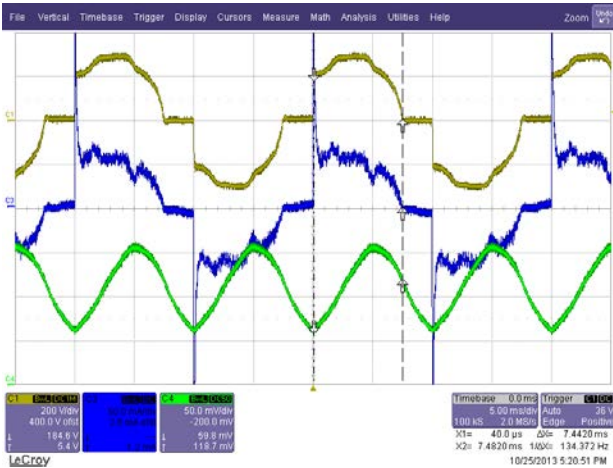


Figure 203 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

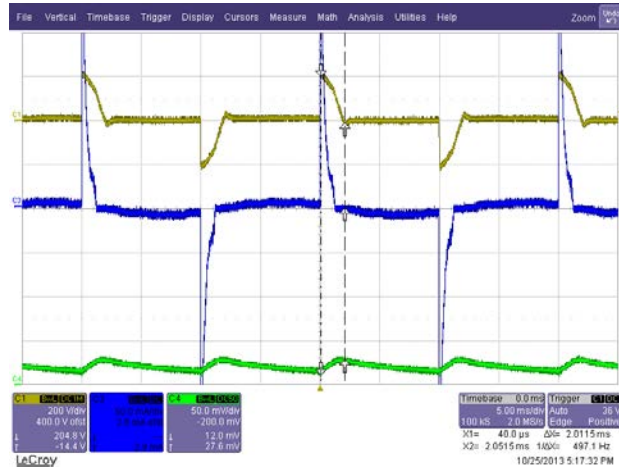


Figure 204 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450TM

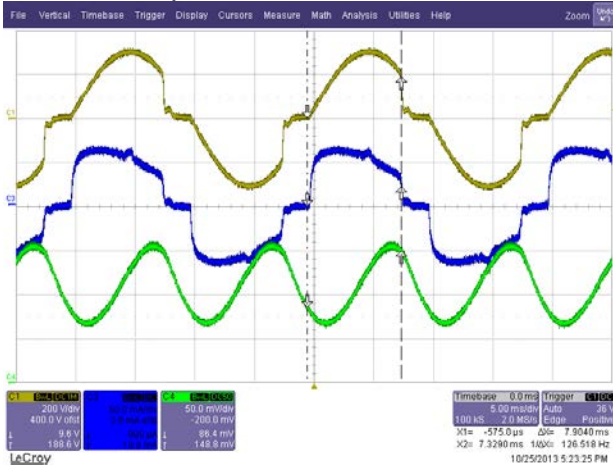


Figure 205 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

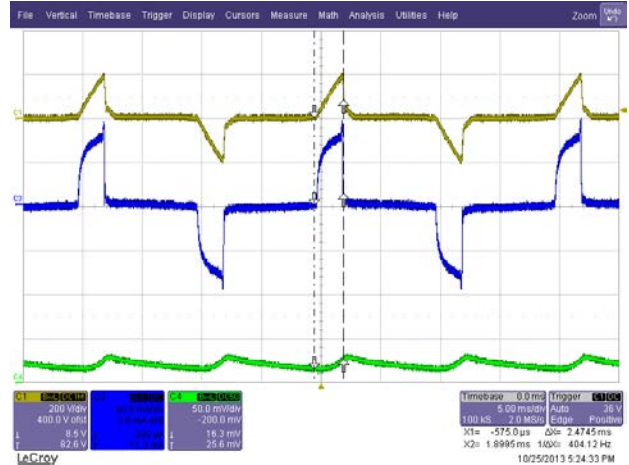


Figure 206 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

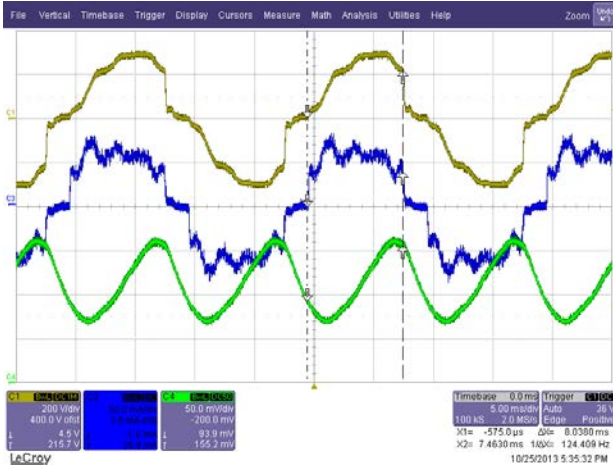


Figure 207 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

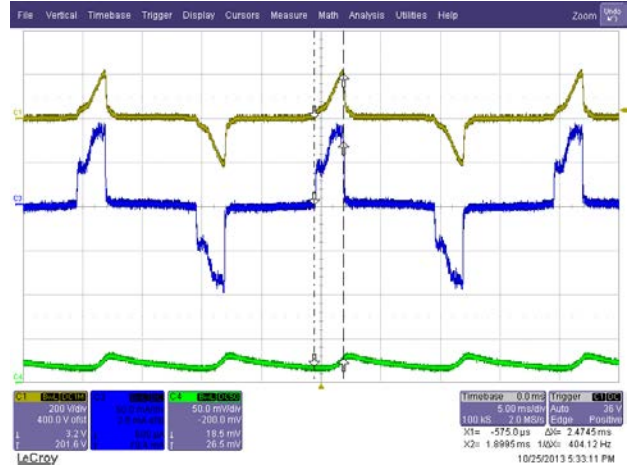


Figure 208 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E2CFLDM

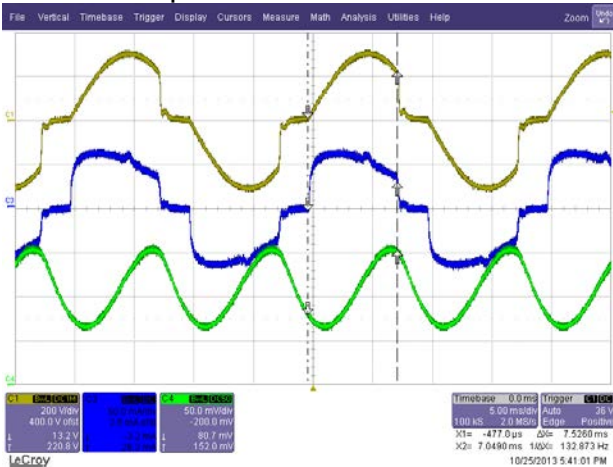


Figure 209 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

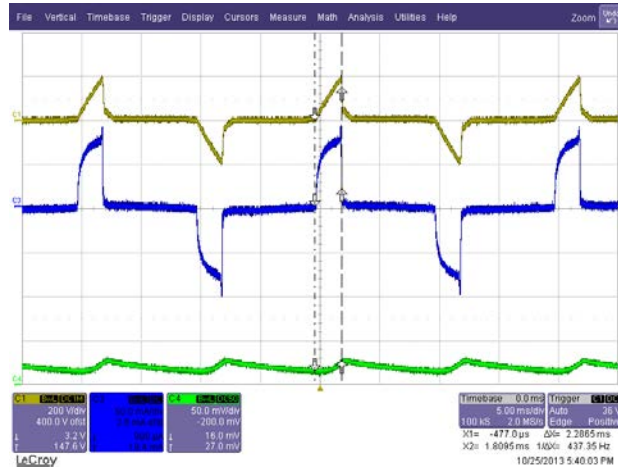


Figure 210 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

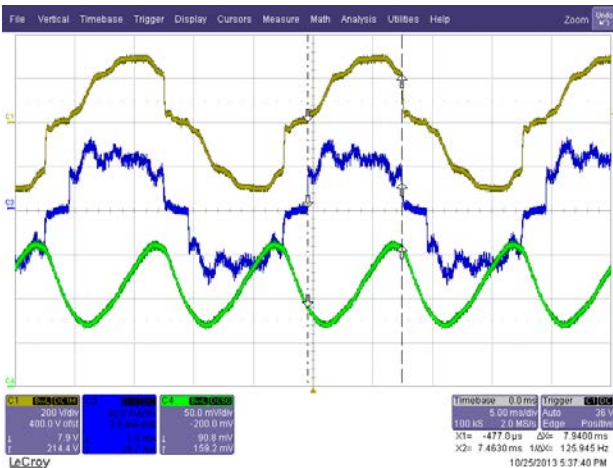


Figure 211 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

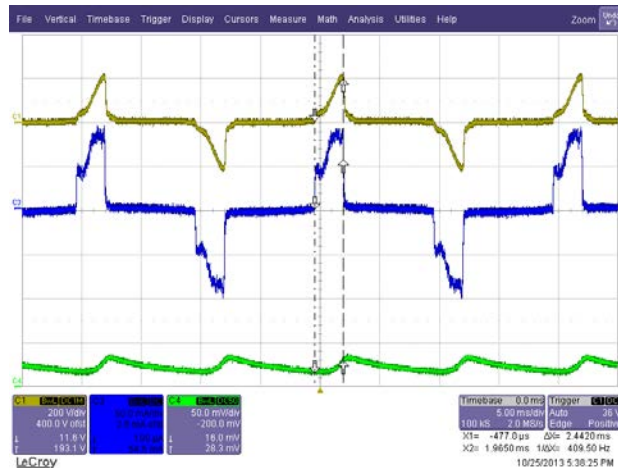


Figure 212 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

Dimmer: Clipsal 32E450UDM

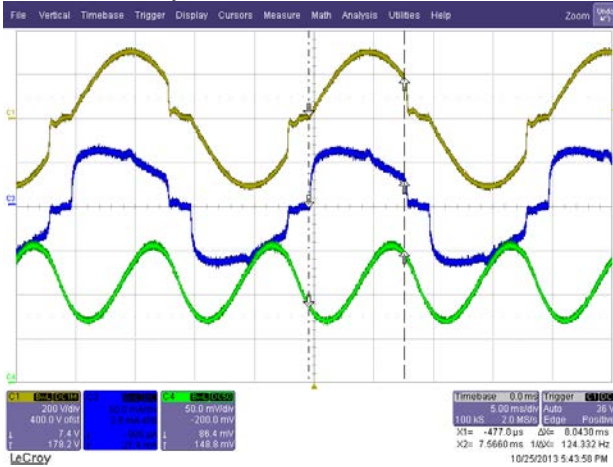


Figure 213 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

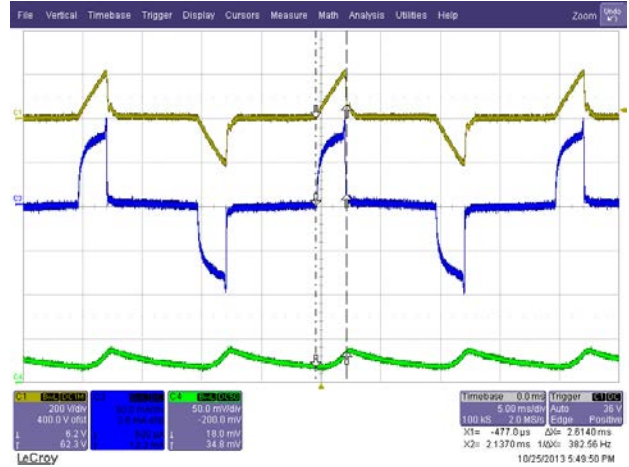


Figure 214 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

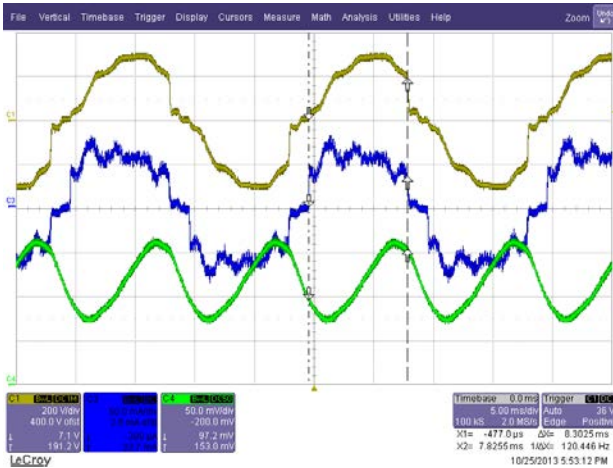


Figure 215 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

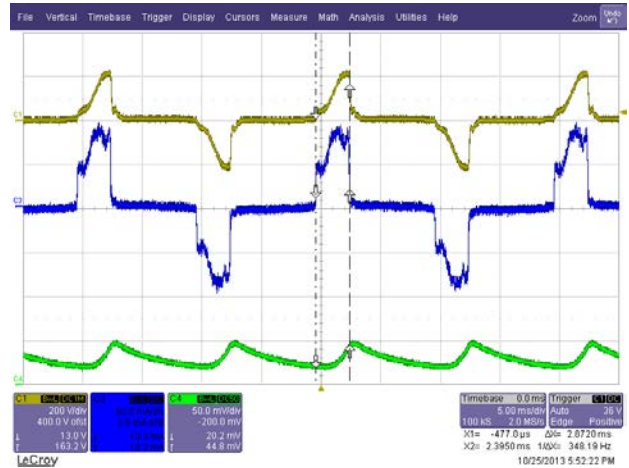


Figure 216 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



14 線電壓突波

Differential input Line 1.2/50 μ s 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)
+500	230	L to N	90	Pass
-500	230	L to N	90	Pass
+500	230	L to N	270	Pass
-500	230	L to N	270	Pass
+500	230	L to N	0	Pass
-500	230	L to N	0	Pass

Unit passed 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
-2500	230	L to N	90	Pass
+2500	230	L to N	270	Pass
-2500	230	L to N	270	Pass
+2500	230	L to N	0	Pass
-2500	230	L to N	0	Pass

Unit passed under all test conditions.





Figure 217 – Differential Line Surge at 500 V / 90°. Peak Drain Voltage Recorded is 464 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 200 V / div.
 Time Scale: 500 μ s / div.



Figure 218 – Differential Line Surge at 500 V / 90°. Peak Drain Voltage Recorded is 464 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 200 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 50 μ s / div.

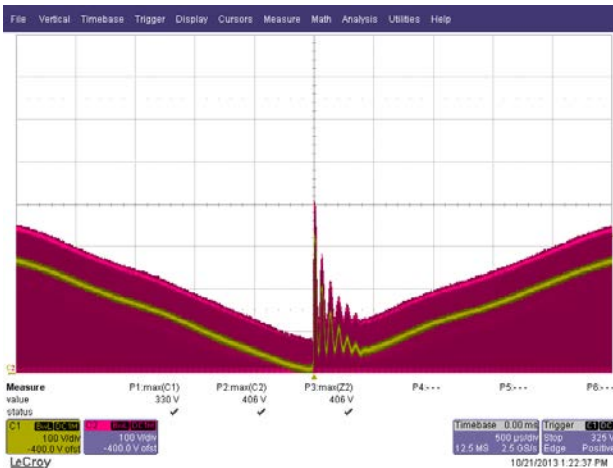


Figure 219 – Differential Ring Surge at 2500 V / 0°. Peak Drain Voltage Recorded is 406 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.

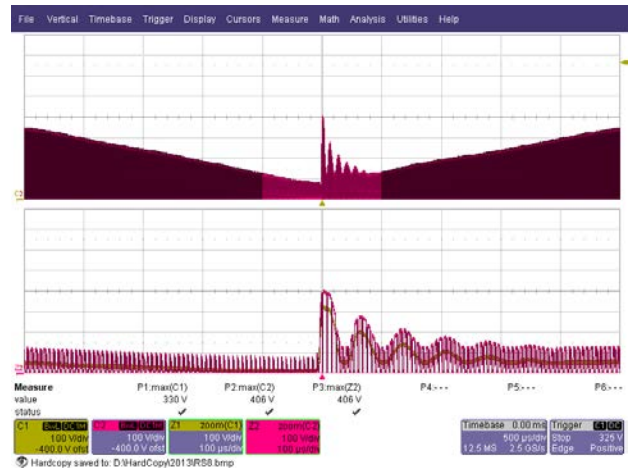


Figure 220 – Differential Ring Surge at 2500 V / 0°. Peak Drain Voltage Recorded is 406 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 100 μ s / div.



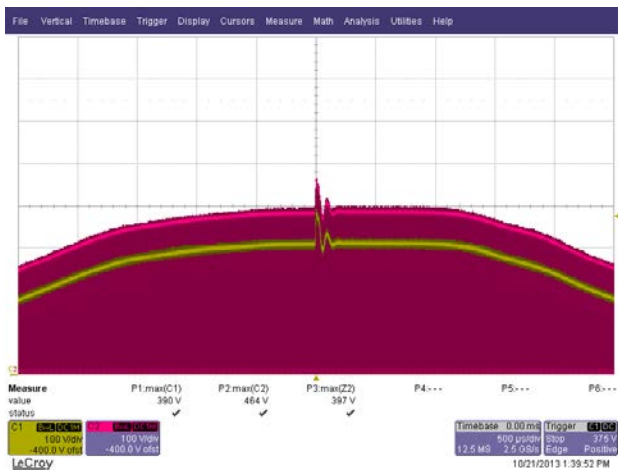


Figure 221 – Differential Ring Surge at 2500 V / 90°. Peak Drain Voltage Recorded is 464 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.

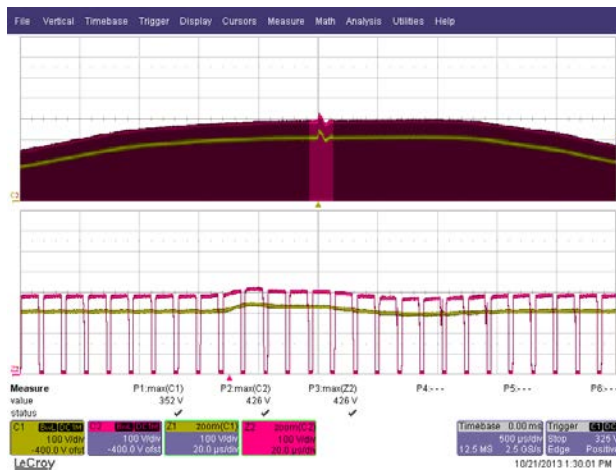


Figure 222 – Differential Ring Surge at 2500 V / 90°. Peak Drain Voltage Recorded is 426 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 20 μ s / div.



15 傳導性 EMI



Figure 223 – The Retrofit Lamp was Verified in a Conical Cone as per EN55015.





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16.Oct 13 21:53

REW 9 kHz
MT 500 ms

Att 10 dB AUTC

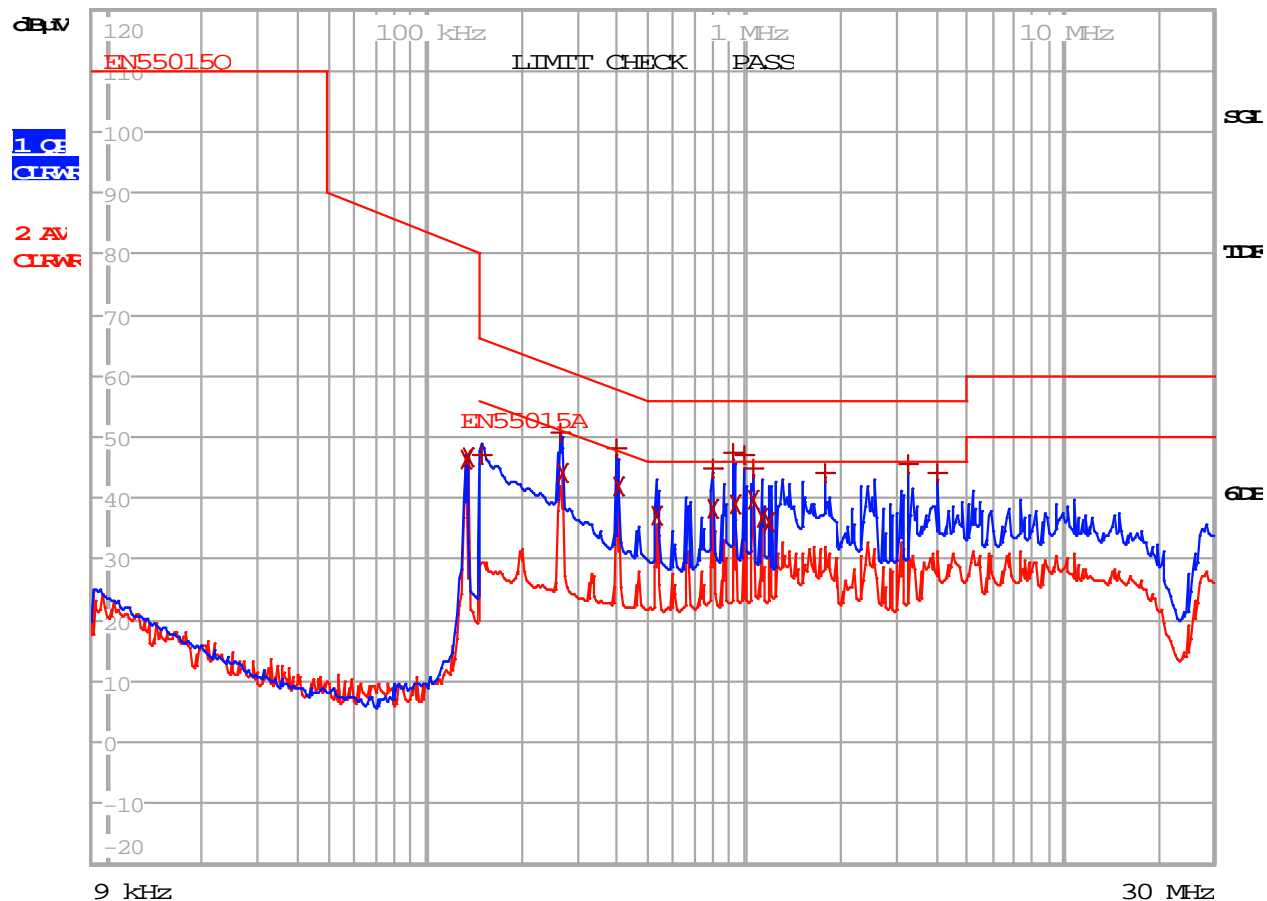


Figure 224 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Enclosed Unit in A19 Bulb Replacement.



EDIT PEAK LIST (Final Measurement Results)						
Trace1:	EN55015Q					
Trace2:	EN55015A					
Trace3:	---					
TRACE	FREQUENCY	LEVEL dB μ V	DELTA LIMIT dB			
2 Average	133.454986145 kHz	46.49	L1	gnd		
2 Average	136.137431366 kHz	46.55	L1	gnd		
1 Quasi Peak	151.5 kHz	47.03	L1	gnd	-18.88	
1 Quasi Peak	264.49018761 kHz	50.70	N	gnd	-10.58	
2 Average	267.135089486 kHz	44.11	N	gnd	-7.09	
1 Quasi Peak	397.727746704 kHz	48.11	N	gnd	-9.78	
2 Average	401.705024172 kHz	41.76	N	gnd	-6.05	
2 Average	530.769219795 kHz	37.13	N	gnd	-8.86	
1 Quasi Peak	798.145472681 kHz	44.73	N	gnd	-11.26	
2 Average	798.145472681 kHz	38.25	N	gnd	-7.74	
1 Quasi Peak	926.622115652 kHz	47.49	N	gnd	-8.50	
2 Average	935.888336808 kHz	39.00	N	gnd	-6.99	
1 Quasi Peak	993.464328234 kHz	47.04	N	gnd	-8.95	
1 Quasi Peak	1.06512822736 MHz	44.92	N	gnd	-11.07	
2 Average	1.06512822736 MHz	39.75	N	gnd	-6.24	
2 Average	1.13065507631 MHz	36.81	N	gnd	-9.18	
2 Average	1.20021314689 MHz	36.19	N	gnd	-9.80	
1 Quasi Peak	1.78695382697 MHz	44.28	N	gnd	-11.71	
1 Quasi Peak	3.24635311795 MHz	45.49	N	gnd	-10.50	
1 Quasi Peak	4.04078721227 MHz	44.26	N	gnd	-11.73	

Table 4 – Conducted EMI, Maximum Steady-State Load, 2390VAC, 60 Hz, and EN55015 B Limits. Enclosed Unit in A19 Bulb Replacement.



16 修訂記錄

Date	Author	Revision	Description & changes	Reviewed
05-Dec-13	JDC	1.0	Initial Release	Apps & Mktg



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