

デザイン例レポート

役職	LYTSwitch™-4 LYT4322E を使用した 8 W 調光機能付き、非絶縁極性反転型 LED ドライバ
仕様	195 ~ 265 VAC 入力、72 V、115 mA 出力
アプリケーション	A19 LED ドライバ
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ドキュメント番号	DER-404
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改訂	1.0

概要と機能

- ワンコンバータ型力率改善 (230 V 時で 0.9 以上) 対応定電流 (CC) 出力
- 調光機能付きで、互換性が高い
- 低コスト、少ない部品点数、基板上の実装面積が小さいソリューション
- 高効率、240 VAC 入力時で 84 % 以上
- 高力率、低 THD
- 優れたパフォーマンスと使用感
 - 素早い点灯 (150 ms 未満) – 知覚可能な遅延無し
- 内蔵保護機能と高い信頼性
 - クランプ型無負荷保護、出力短絡の自動復帰タイプ保護
 - ヒステリシスを十分確保した自動復帰タイプ過熱保護機能により部品と基板を保護
 - 停止条件時でも損傷を受けない
- IEC リング ウェーブ、ディファレンシャル モード入力サージ、及び伝導 EMI EN55015 に適合

特許情報

ここで提示した製品及びアプリケーション (製品の外付け周辺回路及びトランス構造も含む) は、米国及び他国の特許の対象である場合があります。また、Power Integrations に譲渡された米国及び他国の出願中特許の対象である場合があります。Power Integrations の持つ特許の全リストは、www.powerint.com に掲載されています。Power Integrations は、<http://www.powerint.com/ip.htm> に定めるところに従って、特定の特許権に基づくライセンスを顧客に許諾します。

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重要なお知らせ:

この電源は絶縁に関する安全要件を満たすよう設計されていますが、評価プロトタイプは認証機関の承認を得られていません。従って、すべての試験は、プロトタイプ電源に絶縁トランスを使用して、AC 入力を供給する必要があります。



1 はじめに

本書では、片面基板レイアウトによる非常に小型で極性反転型設計の LYTSwitch™-4 ファミリー (LYT4322E) を使用した、対費用効果の高い LED 調光機能付き電源ドライバについて説明します。

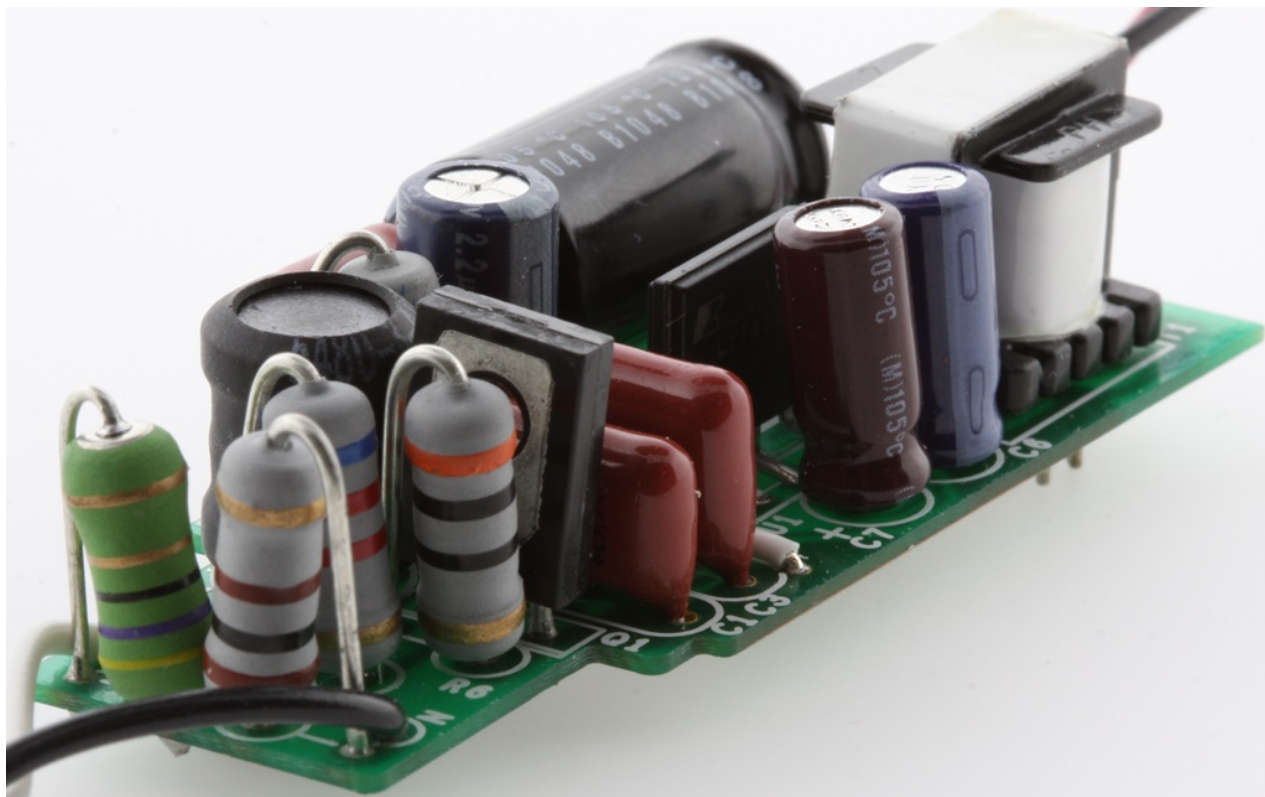


Figure 1 – Sample Unit.

この電源は 195 VAC ~ 265 VAC の入力電圧で動作します。ワンコンバータ、アクティブな力率修正、低い調波歪みは商用及び産業用として最適です。この LED ドライバは調光機能付きであり、リーディング エッジ型及びトレイリング エッジ型の調光器に対応します。ドイツ、イタリア、オーストラリア、中国の調光器の大半と互換性があります。

オープンループ状態や出力短絡状態のオートリスタートや入力の異常及びサージの耐量を拡大する入力過電圧保護など、その他の機能がこのデバイスに組み込まれています。いかなる条件でも PCB 平均温度を安全に維持する高精度な自動復帰タイプ過熱保護機能も含まれています。この統合により、必要な別個の構成部品数が最小限に抑えられます。

本書には、LED ドライバの仕様、回路図、PCB 情報、部品表、トランスに関する説明、標準パフォーマンス特性が記載されています。



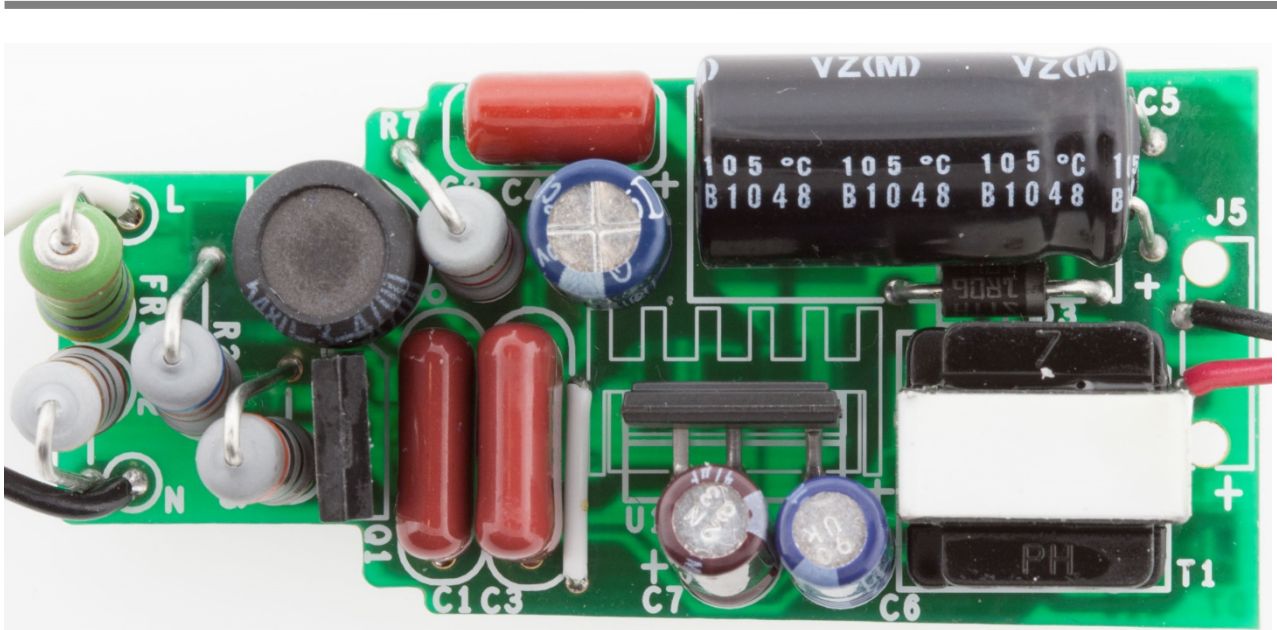


Figure 2 – Populated Circuit Board Photograph, Top.

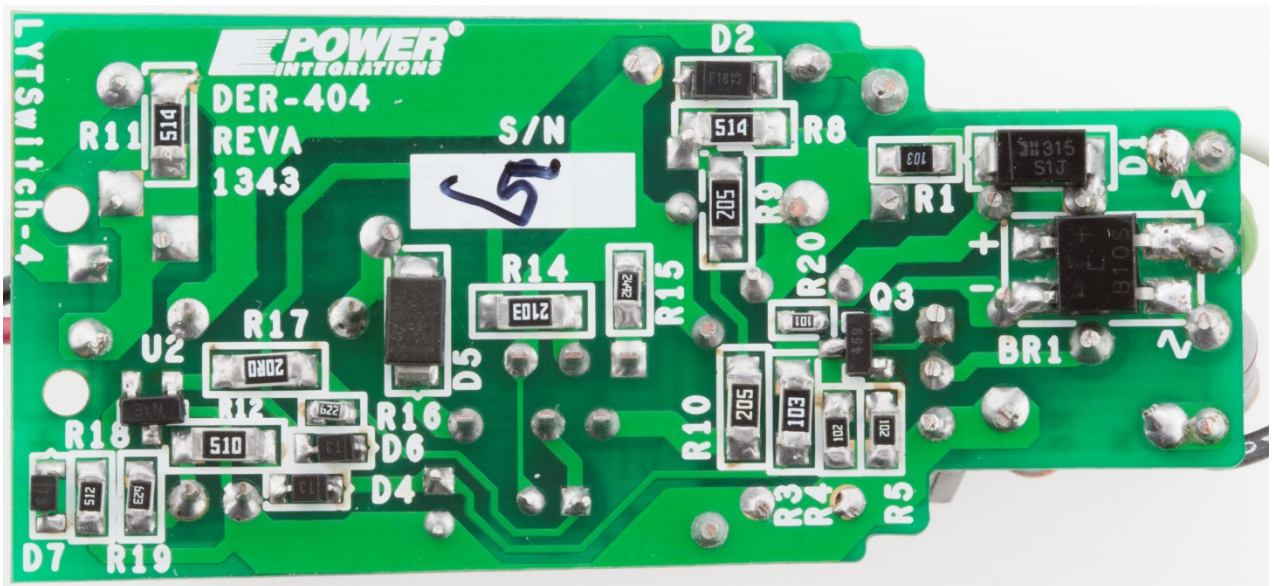


Figure 3 – Populated Circuit Board Photograph, Bottom.



2 電源仕様

次のテーブルは、設計上の許容特性の概要です。実際の性能は、「性能データ」のセクションを参照してください。

概要	記号	最小	標準	最大	単位	コメント
入力 入力電圧	V_{IN}	195		265	VAC	2ワイヤ-P.E. 無し 入力周波数は制限されません。アプリケーションが 400 Hz の入力周波数の場合、センス抵抗を調整します。
周波数	f_{LINE}	47	50/60		Hz	
出力 出力電圧	V_{OUT}	68	72	76	V	±4%、100 VAC ~ 240 VAC 時
出力電流	I_{OUT}		115		mA	
出力電力の合計 連続出力電力	P_{OUT}		8		W	
効率 240 VAC、72 V LED	η	84			%	P_{OUT} 25 °C で測定
力率 240 VAC、54 V LED	PF	0.9				P_{OUT} 25 °C で測定
環境 伝導 EMI		CISPR22B/EN55015B に適合				1.2/50 μ s サージ、IEC 1000-4-5、直列インピーダンス: ディファレンシャル モード: 2 Ω 500 A 短絡 直列インピーダンス: ディファレンシャル モード: 12 Ω
入力サージ ディファレンシャル モード (L1-L2)		0.5			kV	
リング ウェーブ (100 kHz) ディファレンシャル モード (L1-L2)		2.5			kV	
周囲温度	T_{AMB}	-20	25		°C	自由対流、海水面



3 回路图

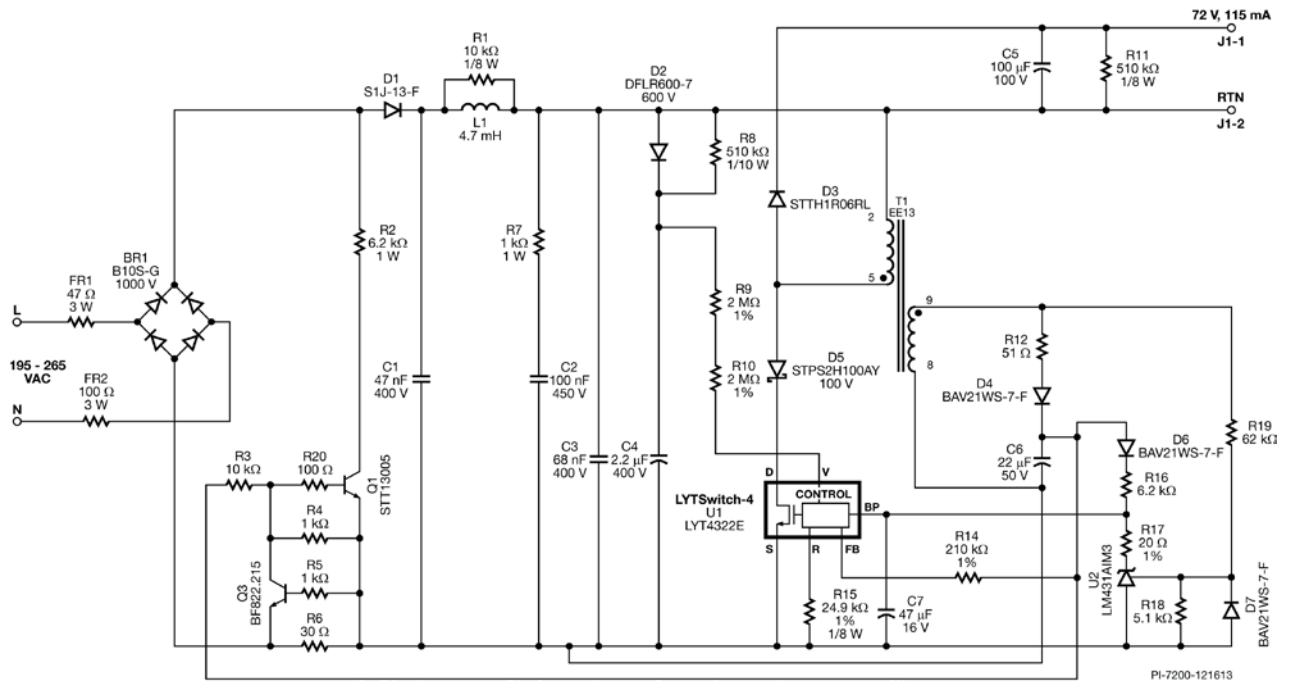


Figure 4 – Schematic.



4 回路の説明

低価格の調光機能付き LED ドライバ電源では、極性反転型回路に LYT4322E (U1) を使用し、72 VDC の公称出力電圧で 115 mA の定電流出力です。電源は、常に定電流 (CC) で駆動が必要な非絶縁駆動 LED 用に設計されています。非絶縁ドライバを安全に利用するには、ドライバの適切な絶縁とレトロフィット ランプの金属筐体が必要です。

4.1 入力部の EMI フィルタ

ヒューズ RF1 は短絡に対する保護用です。ブリッジ BR1 は、良好な力率と低い高調波成分に対応するための全波整流器になります。コンデンサ C1、C3 及びコモンモード チョーク L1 は、伝導 EMI 規格を満たすために π フィルタを形成します。さらにコンデンサ C1、C3 は、ラインノイズを削減しサージに対する保護を行い、入力コンデンサとしても使用されます。ヒューズ抵抗 FR2 は減衰抵抗であり、調光中、入力電流のリングングを減らします。入力サージの間、制限インピーダンスとして機能します。

4.2 調光機能の互換性 - アクティブ ブリーダー、パッシブ PC ブリーダー、ダンパー

調光機能付き LED ドライバと市販されている大半の高電圧調光器の互換性は、アクティブ ブリーダーを追加し、20 mA を下回る過渡電流を補うことで達成されます。これは、リーディング エッジ型の調光器に必要な保持電流を維持し、調光中にトレーリング エッジ型の調光器の供給にバイアスをかけるのに役立ちます。これは 9 個の構成部品により制御されます。

D1 – 整流コンデンサ全体 (C1 と C2) で電気の不必要な放電を回避するための直列ブロッキング ダイオード。

R2 – 制限ブリーダー抵抗は、入力電流補正時、Q1 と電力損失を分け合います。

Q1 – センスダンパー抵抗 R6 及び Q3 により設定されたスレッシュホールド以下の電流を補うためにリニアにバイアスがかけられています。

R20 – ディファレンシャル モード入力サージ中のアバランシェを防ぐための Q1 のベース電流制限抵抗。

R3 – LYTSwitch-4 コンバータの補助電源からのバイアス抵抗。

R4 – 迅速な応答と安定化に必要な Q1 へのベース抵抗。

Q3 – センスダンパー抵抗 R6 からのスレッシュホールドトランジスタ。

R5 – ディファレンシャル モード入力サージ中のアバランシェを避けるための Q3 のベース電流制限抵抗。

R6 – センス抵抗と追加ダンパー。

不要なリングングと入力電流発振は、リーディング エッジ型の調光器の使用時に発生します。この発振を減衰させるために、パッシブの RC ブリーダー (R7 と C2) が使用されました。高周波発振を最小限に抑えるには、L1 の後にこれらの構成部品を配置するとさらに効果的です。



パッシブダンパー FR1、FR2、R6 の合成抵抗 (177 Ω) により、リーディングエッジ型の調光器の電源を入れたときのピーク電流が最小限に抑えられます。パッシブダンパーをアクティブダンパーに換えると、最小限のコストで効率が 2% 向上します。

4.3 LYTSwitch-4

LYTSwitch-4 は、全温度範囲の入力レギュレーションに優れた、シンプルで費用対効果の高い調光機能付き LED ドライバのために最適化されています。LYTSwitch-4 ファミリーには内蔵サーマルリミットがあり、電球の動作温度が過剰に上昇する場合に電源を保護します。

極性反転型コンバータは、LYTSwitch-4 (U1) 内の一体型電源 MOSFET スイッチ、フリーホイーリングダイオード D3 (スイッチング損失を最小限に抑えるために高速のフリーホイーリングダイオードが選ばれました)、電源インダクタトランス T1、出力コンデンサ (C5) から構成されます。コンバータは連続動作モード (CCM) で作動し、導通時間の実効 rms 損失を最小限に抑えます。

LYTSwitch-4 ピーク検出回路 C4、D2、R8 により入力電圧のアナログ情報が提供され、ラインノイズによる入力サージ電圧が抑えられ、IEC 1000-4-5 に対応します。

過入力電圧シャットダウン機能は、高入力電圧ファミリーに対応し、整流入力電圧耐量 (サージ及び入力上昇時) を内部パワー MOSFET の 725 BV_{DSS} 定格にまで拡大します。

4.4 出力整流

高効率で温度上昇を抑えるため、高速出力ダイオード (D3) が採用されています。通常、LED の用途では、周囲温度は 70 °C 以上です。 t_{RR} が低い (35 nS 未満) のデバイスが推奨されます。コンデンサ D3 で整流された電流がコンデンサ C5 でフィルタリングされます。これよりも高いリップルが許容され、コストの削減が要求される設計では、出力容量の値を減らすことができます。

4.5 出力フィードバック

センス抵抗経由で出力電流を調整する代わりに、LYTSwitch-4 では独自の手法で出力電流を制御し、効率を向上させます。すなわち、T1 のバイアス巻線を通して出力に相当する電圧を測定します。バイアス巻線電圧は、二次側フィードバック部品無しで出力電圧を間接的に検出するために使用されます。バイアス巻線の電圧は、出力電圧 (バイアス巻線と二次巻線の巻線比率によって設定されます) に比例します。抵抗 R14 は、バイアス電圧を電流に変換し、この電流が U1 の FB ピンにフィードされます。U1 内の内部エンジンは、FB ピン電流、V ピン電流、及び内部ドレイン電流の情報を組み合わせて、高い入力力率を維持しながら一定の出力電流を供給します。



4.6 ショート負荷の保護

フィードバック電流が $I_{FB(AR)}$ のスレッシュホールドを 76 ms 以上下回ると、オートリスタートに切り替わります。

4.7 無負荷時の保護

無負荷の操作時は、出力電圧が 100 V に制限されます。出力電圧は、メイン巻線とバイアス巻線の巻線比率により、バイアス巻線で検出されます。IC U2 により BP ピンにオートリスタートに入り、出力電圧を制限します。分圧器 R19 及び R18 により、過電圧保護 (OVP) スレッシュホールドが設定されます。ダイオード D7 は U2 の逆電流保護であり、R17 は U2 のバイアス制限抵抗です。



5 PCB レイアウト

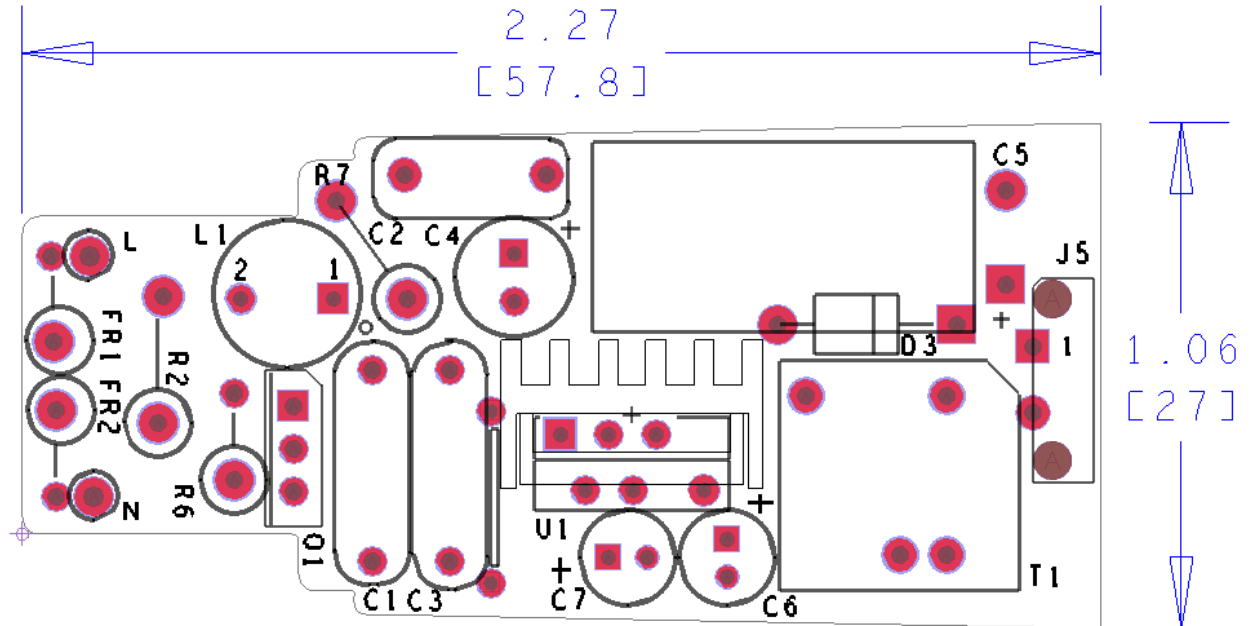


Figure 5 – Printed Circuit Layout. Top View.

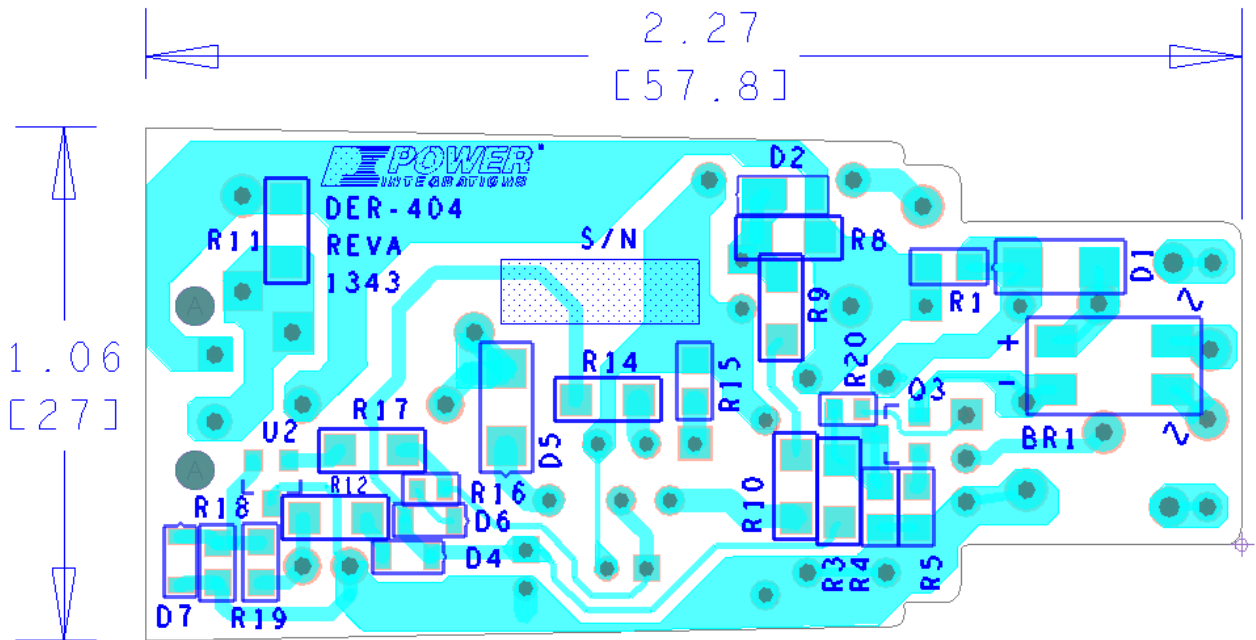
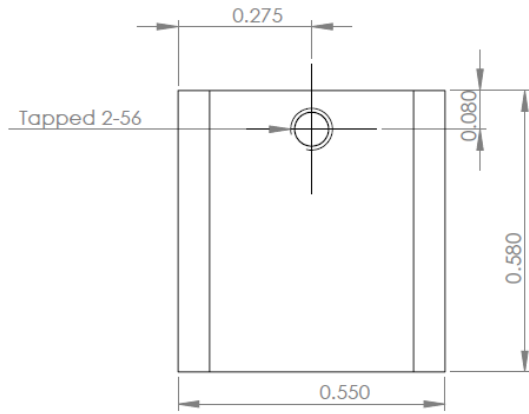


Figure 6 – Printed Circuit Layout. Bottom View.

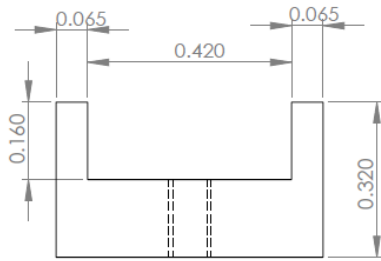


6 ヒートシンク設計

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



TOP VIEW



FRONT VIEW

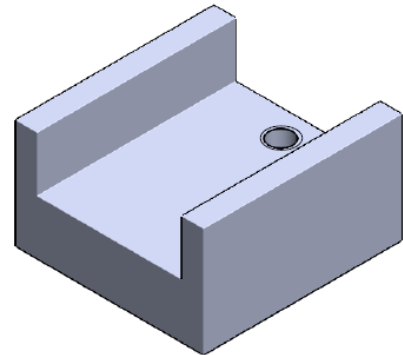


Figure 7 – U1 Heat Sink 1.



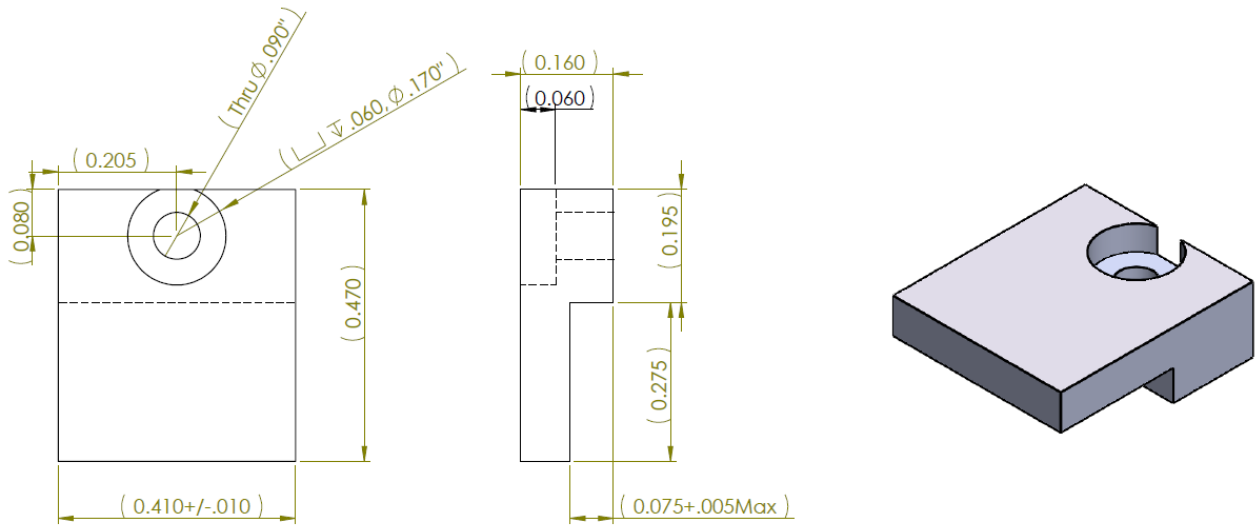


Figure 8 – U1 Heat Sink 2 for Clamping.

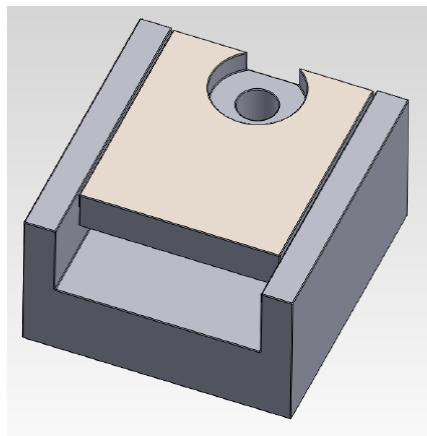


Figure 9 – U1 Heat Sink 2 Combination.



7 部品表

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 vltage rating is 100 V minimum.



8 インダクタの設計計算シート

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
I AVG			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 インダクタ設計

9.1 回路図

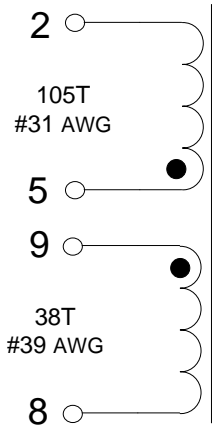


Figure 10 – Transformer Electrical Diagram.

9.2 電氣的仕様

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 インダクタの構造図

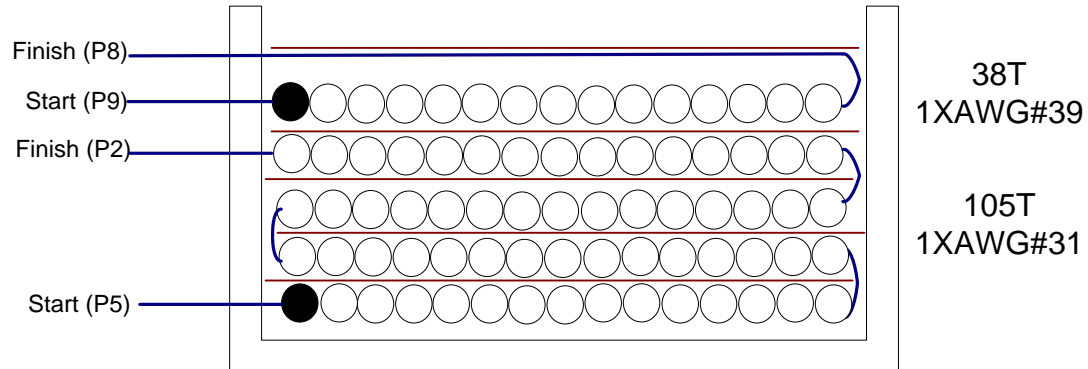


Figure 11 – Transformer Build Diagram.

9.5 インダクタ製造仕様

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 性能データ

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 效率

Measured at 25 °C ambient, open frame.

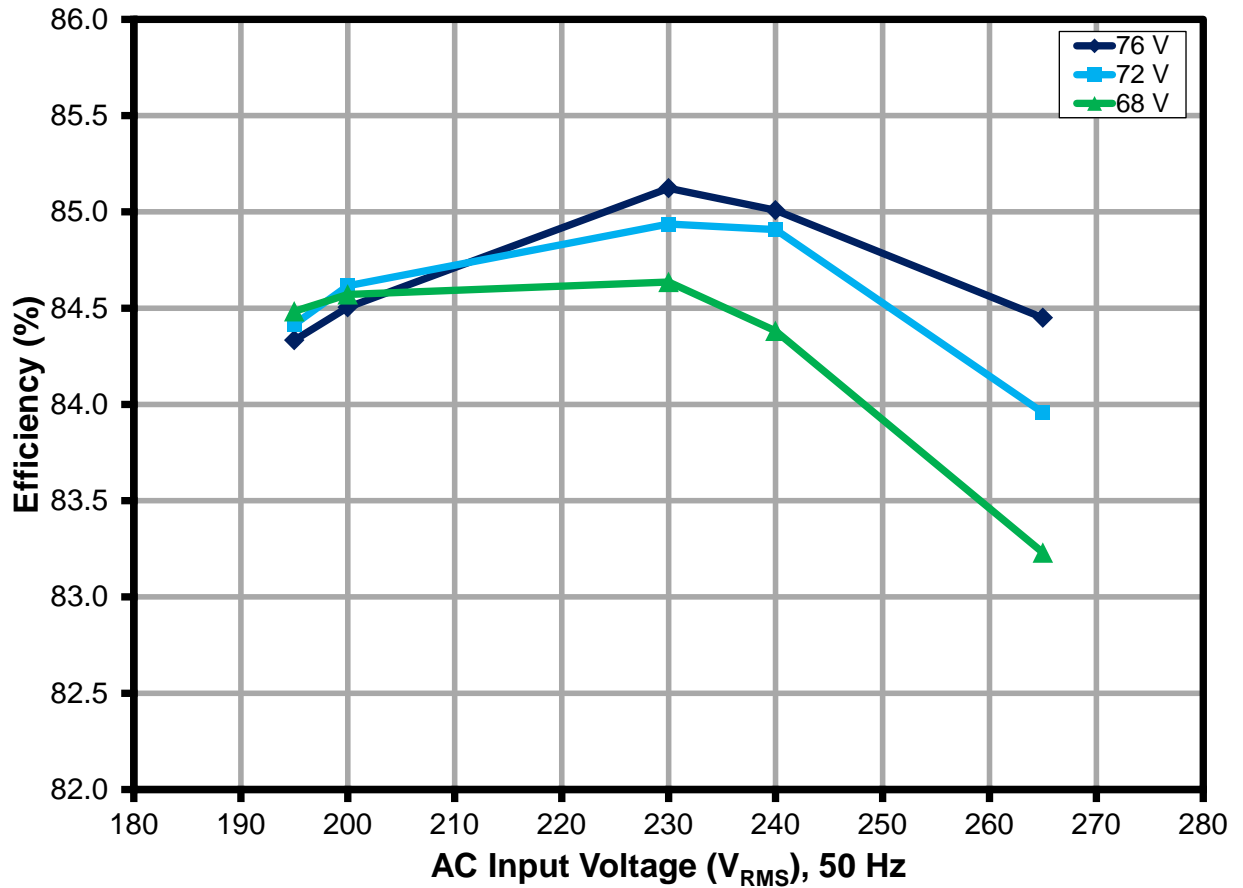


Figure 12 – Efficiency with Respect to AC Input Voltage. 195-265 VAC (60 Hz) Input.



10.2 出力電流レギュレーション

10.2.1 入力ライン及び負荷電圧に対する出力電流レギュレーション

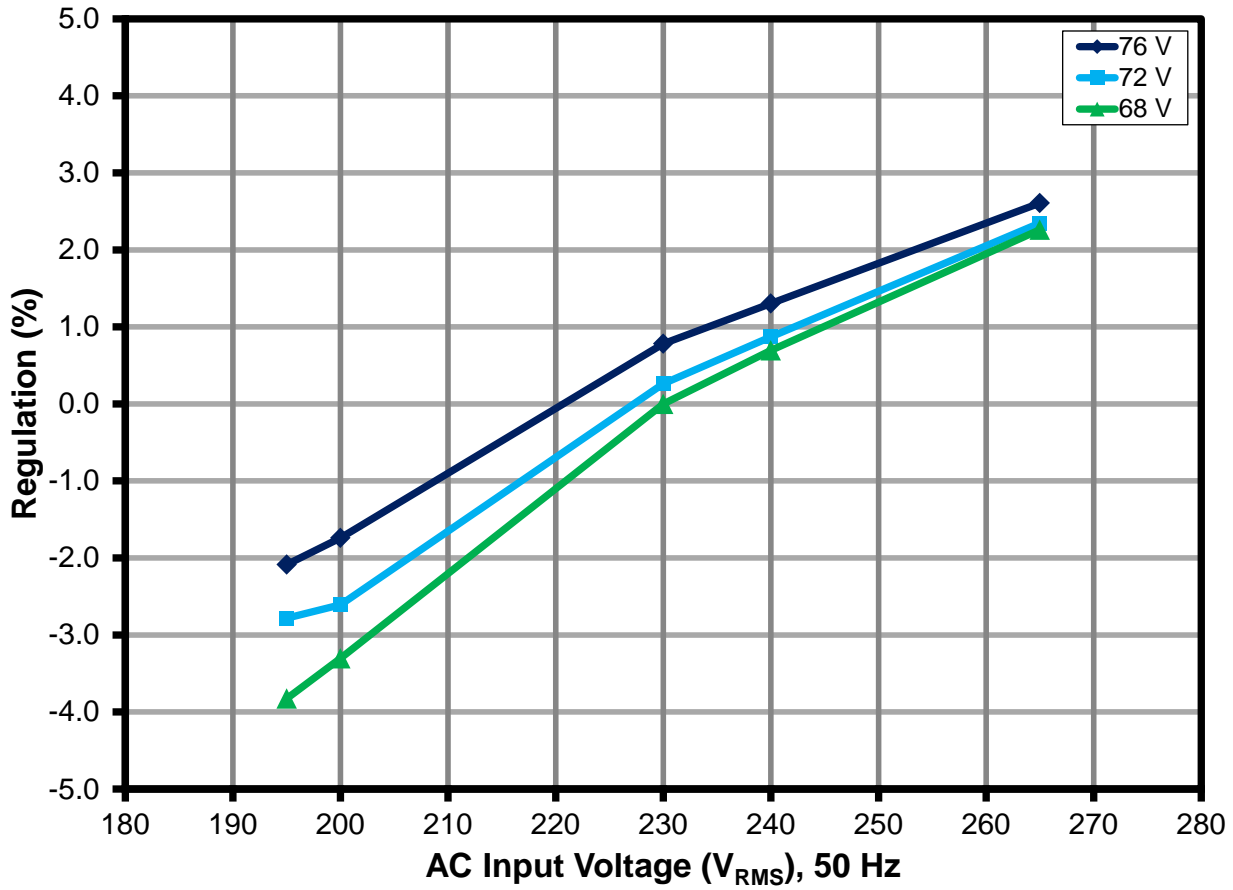


Figure 13 – Load Regulation, Room Temperature.



10.3 力率

Measured at 25 °C ambient, open frame.

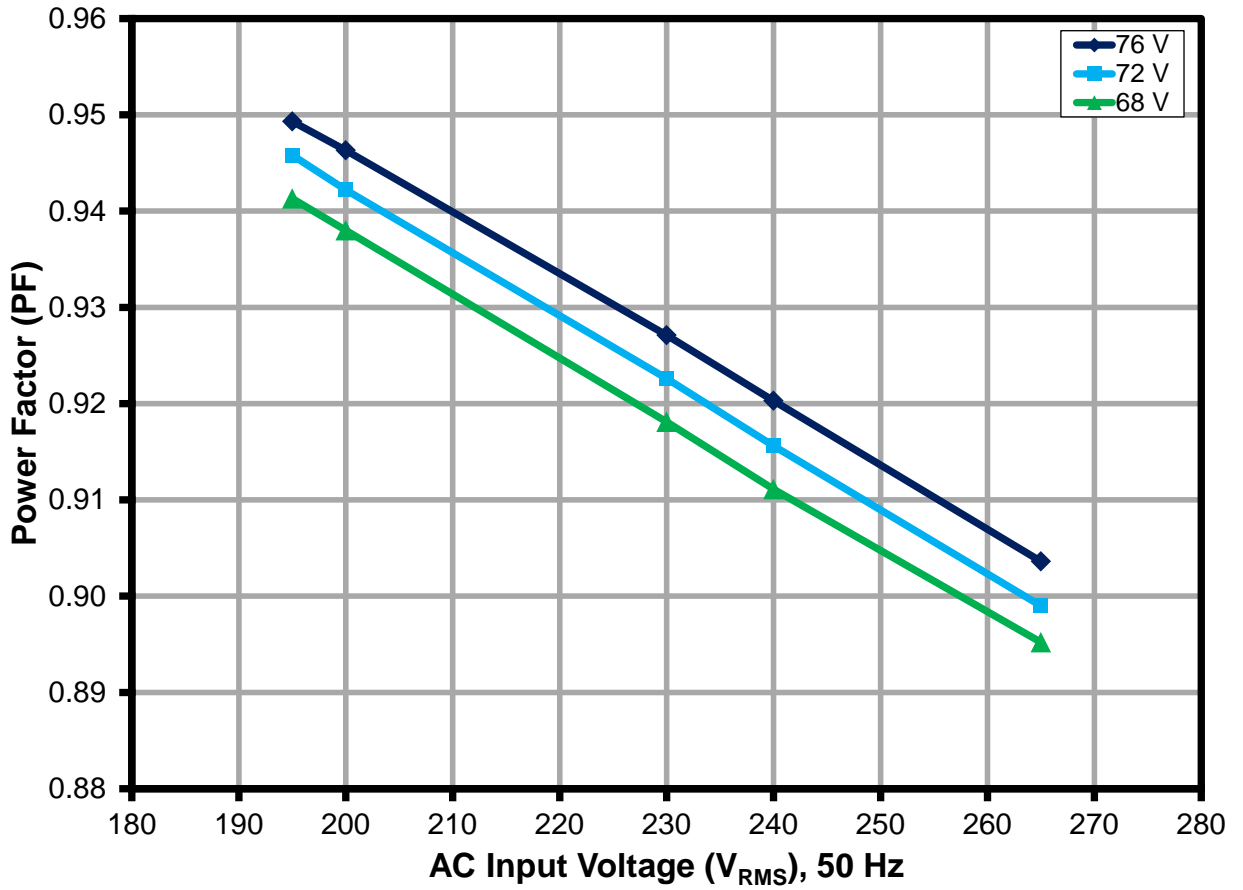


Figure 14 – Power Factor, Room Temperature.



10.4 全高調波歪み

Measured at 25 °C ambient, open frame.

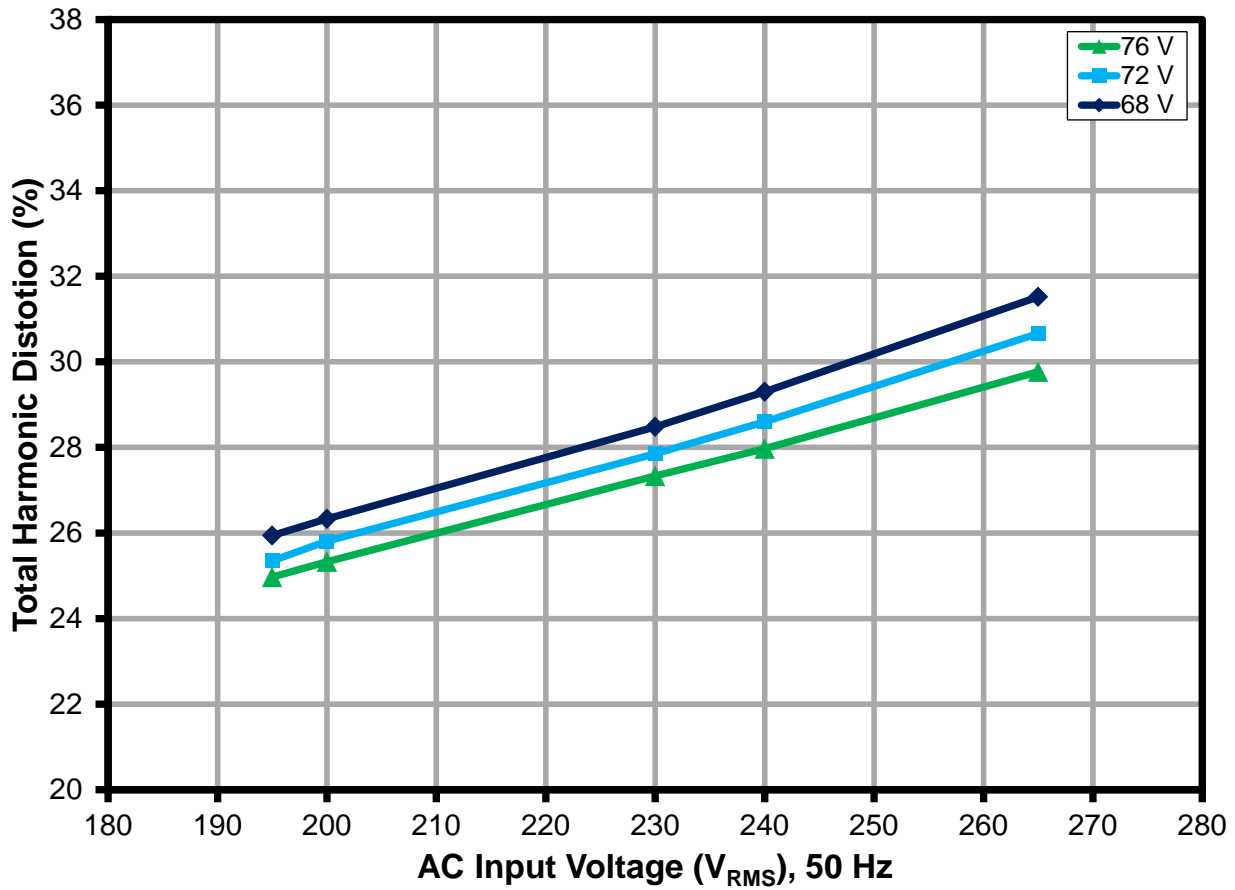


Figure 15 – %THD, Room Temperature.



10.5 高調波成分

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.



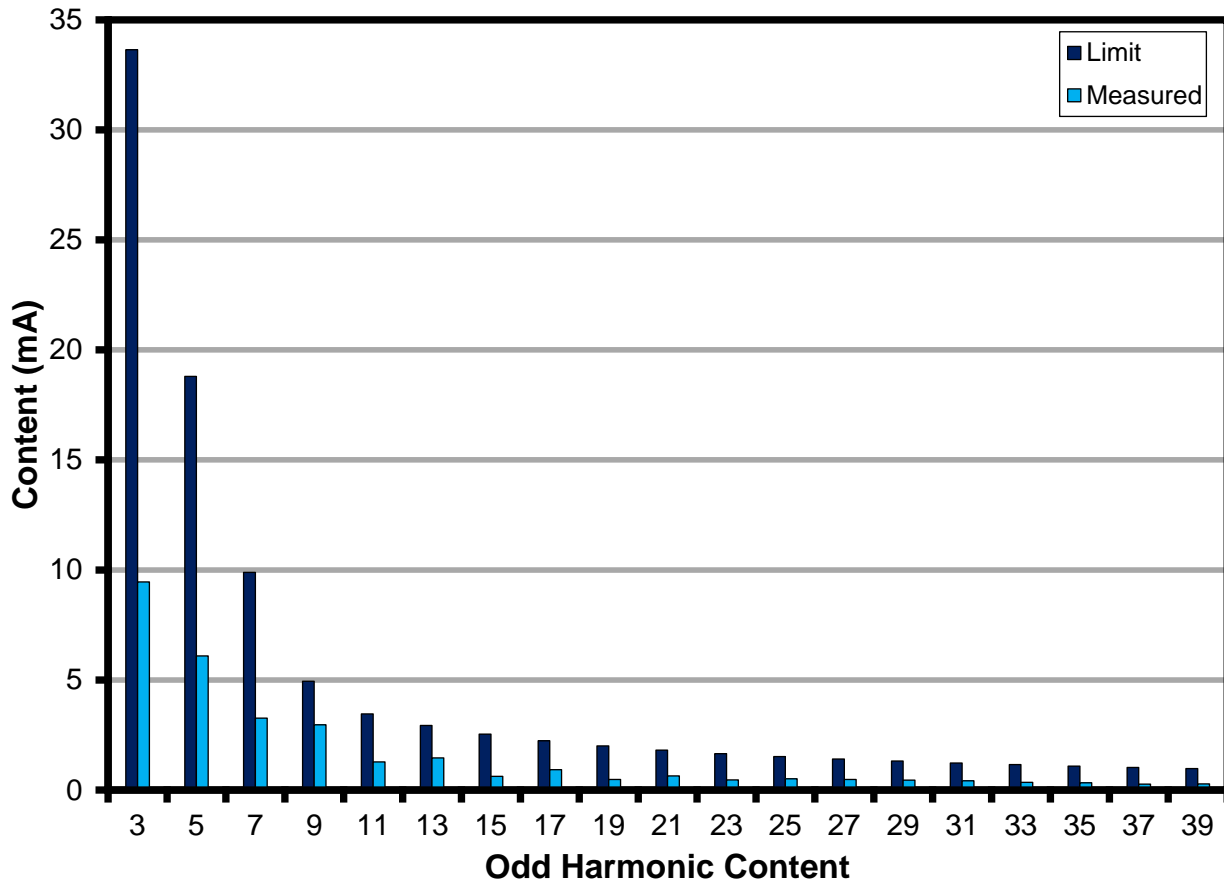


Figure 16 – Harmonic Content, Room Temperature.



11 熱特性

11.1 使用した装置

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 熱特性測定結果

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.

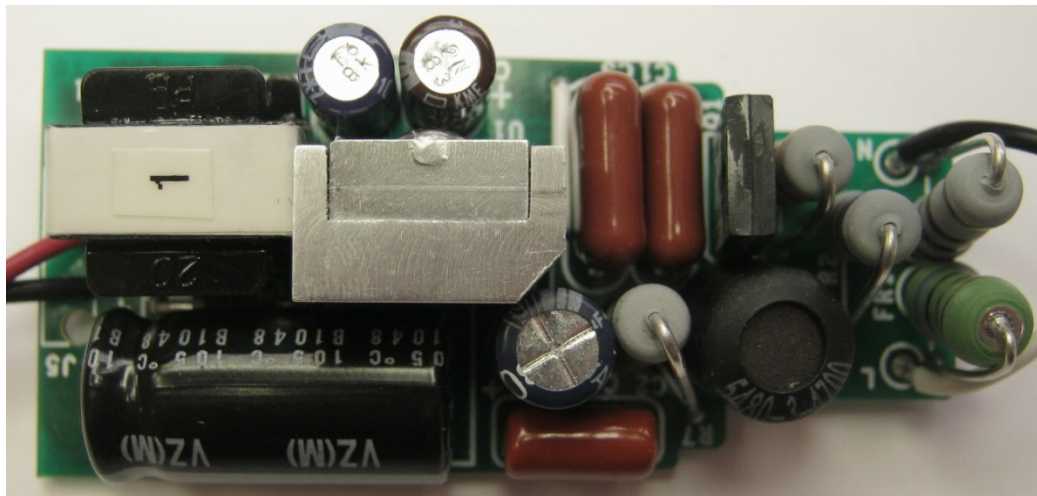


Figure 19 – Sample Design with Heat Sink.

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.



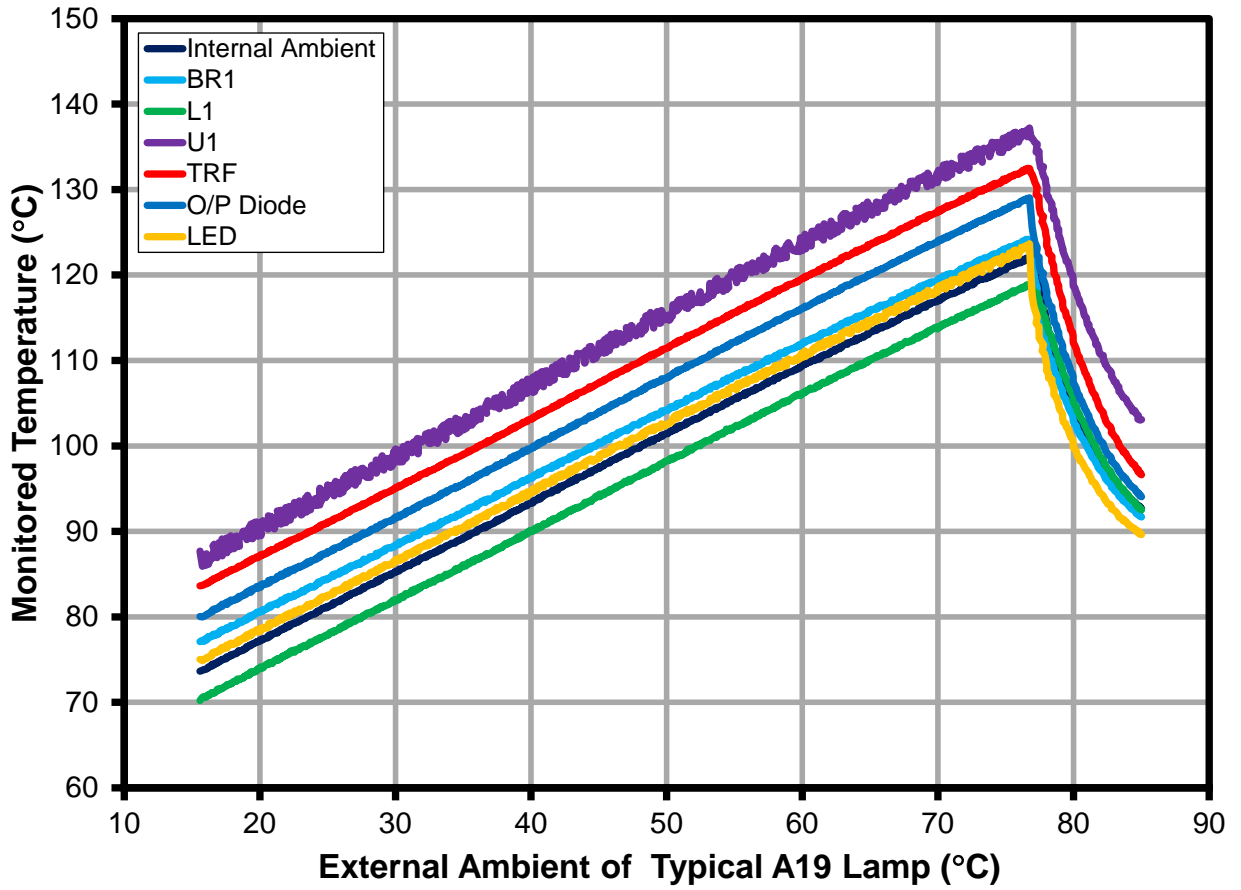


Figure 20 – Thermal Curve at 195 VAC / 50 Hz Input in Typical A19 Housing. LYT4322EG with heatsink.



11.3 熱スキャン

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

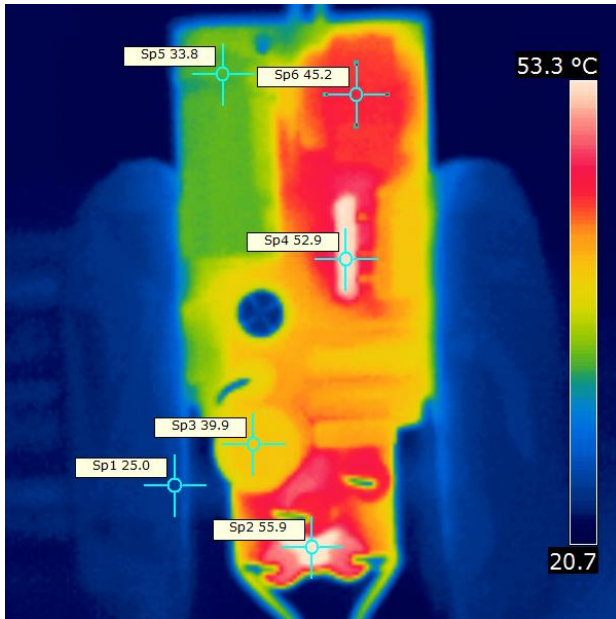


Figure 21 – Temperature (°C) at Top Side of PCB During Non-dimming Operation at 195 VAC.
 SP1 – Ambient.
 SP2 – L1, EMI Choke.
 SP3 – PCB, Temperature at BR1.
 SP4 – U1, LYT4322E Without Heat Sink.
 SP5 – C6, Output Capacitor.
 SP6 – T1, Power Inductor.

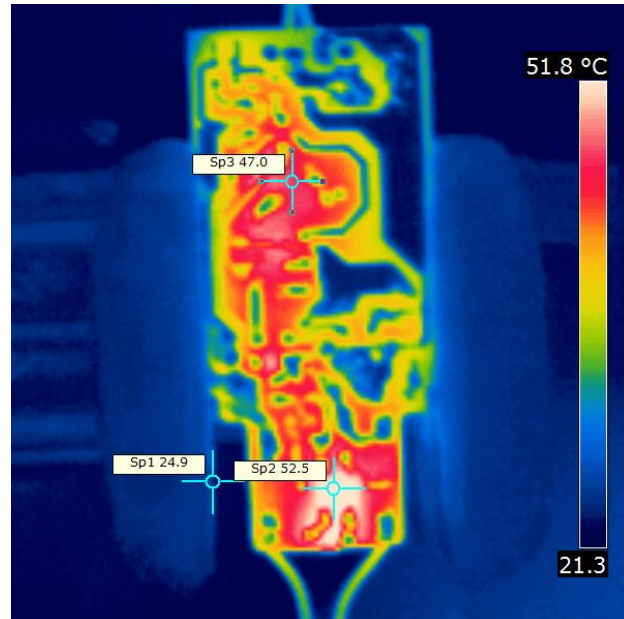


Figure 22 – Temperature (°C) at Bottom Side of PCB During Non-dimming Operation at 195 VAC.
 SP1 – Ambient.
 SP2 – BR1, Bridge Rectifier.
 SP3 – D5, Blocking Diode.



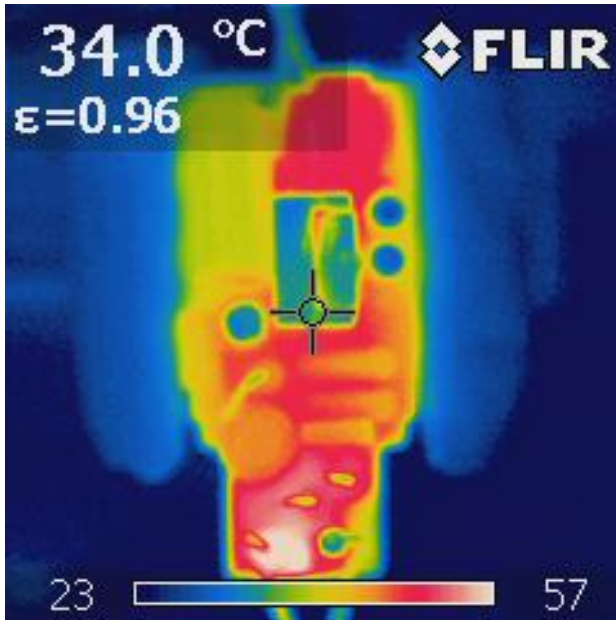


Figure 23 – Temperature (°C) at Top Side of PCB During Normal Operation at 195 VAC. SP1 – U1, LYT4322E with Heat Sink.

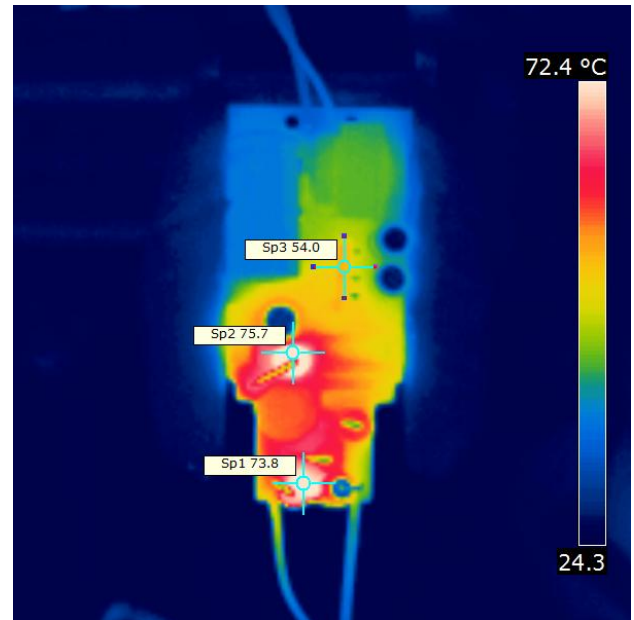


Figure 24 – Temperature (°C) at Top Side of PCB During Dimming Operation at 240 VAC at 90° Conduction Angle. SP1 – FR2, Damper Resistor. SP2 – R7, Bleeder Resistor. SP3 – U1, LYT4322E Without Heat Sink.



12 波形

12.1 通常動作時のドレイン電圧とドレイン電流

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.

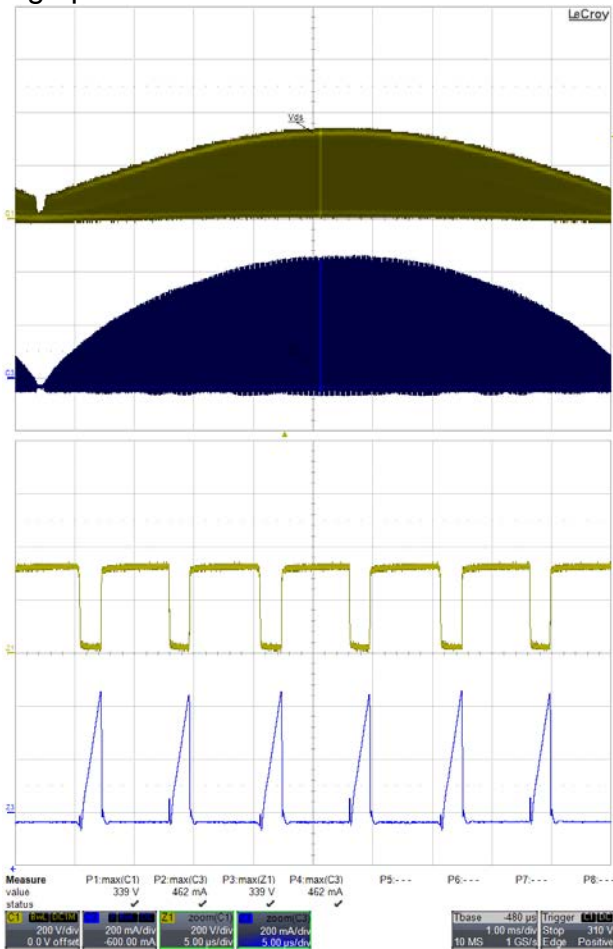


Figure 25 – 195 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

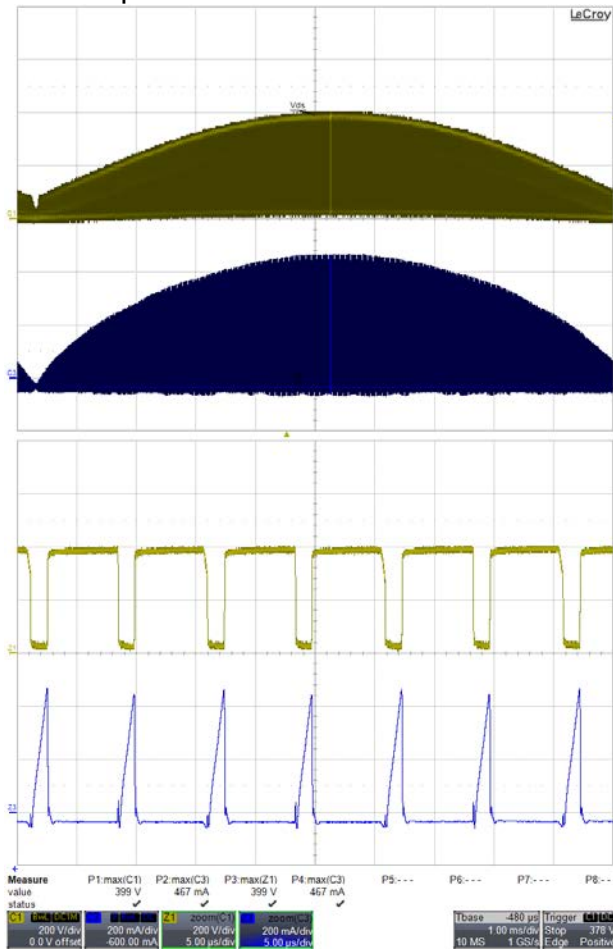


Figure 26 – 230 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.



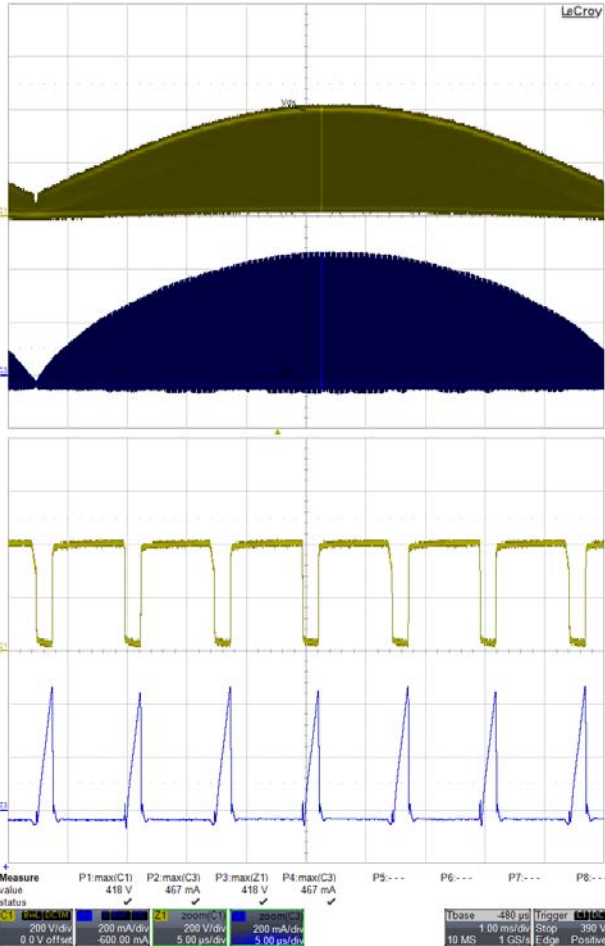


Figure 27 – 240 VAC, 50Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

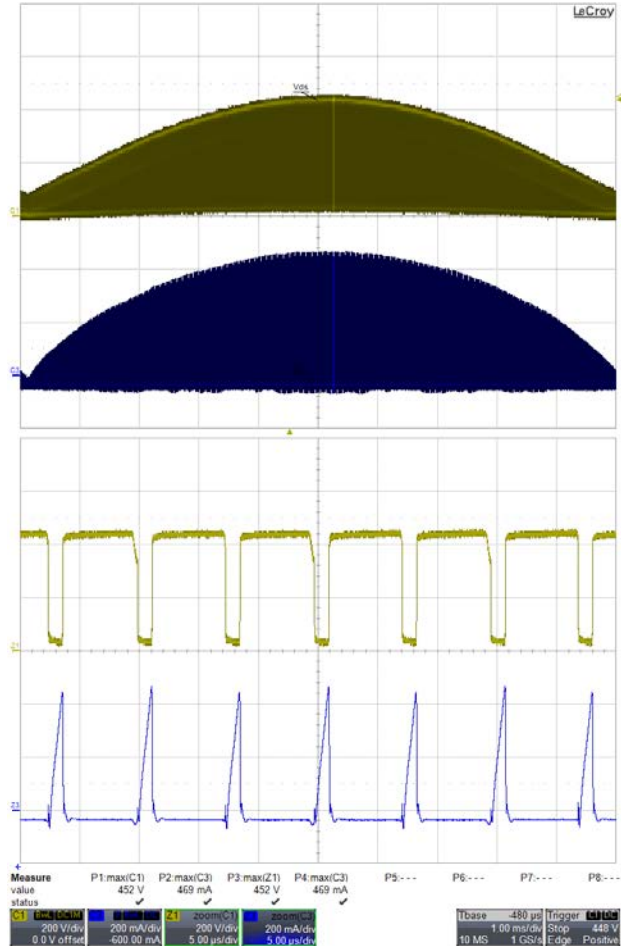


Figure 28 – 265 VAC, 50Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

12.2 出力短絡時のドレイン電圧及び電流

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

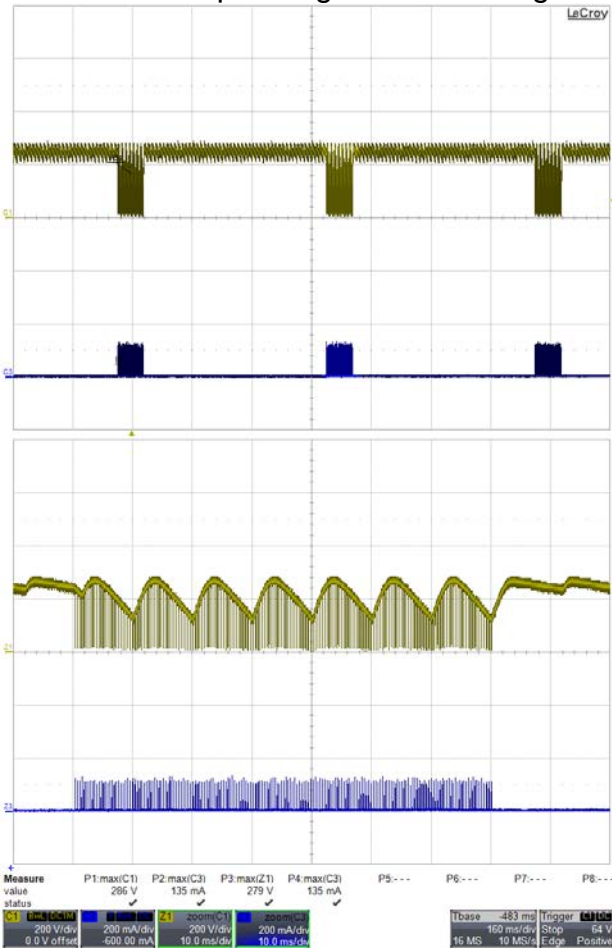


Figure 29 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 160 ms / div.
 Zoom Time Scale: 10 ms / div.

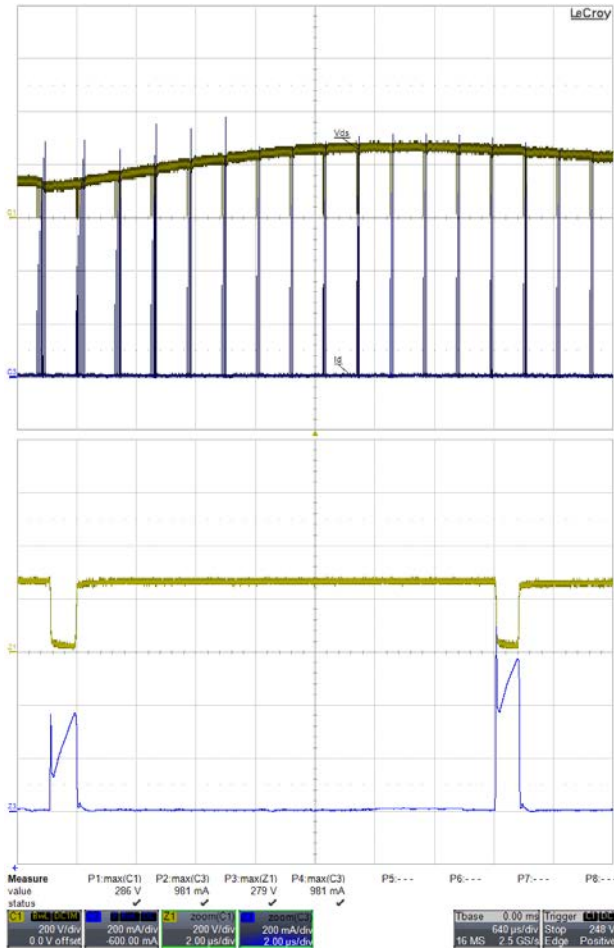


Figure 30 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 640 μ s / div.
 Zoom Time Scale: 2 μ s / div.



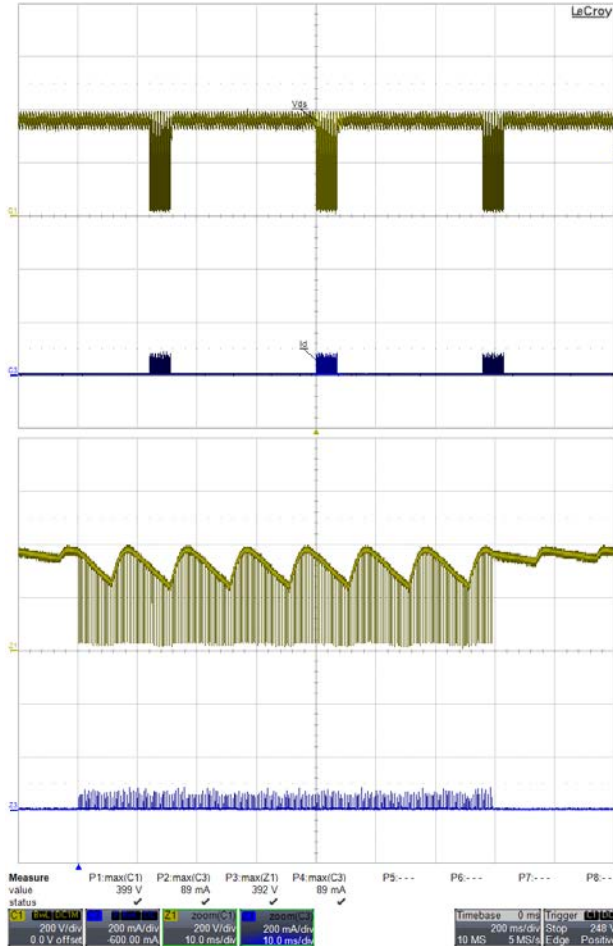


Figure 31 – LYT4322E Output Short. 265 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 200 ms / div.
 Zoom Time Scale: 10 ms / div

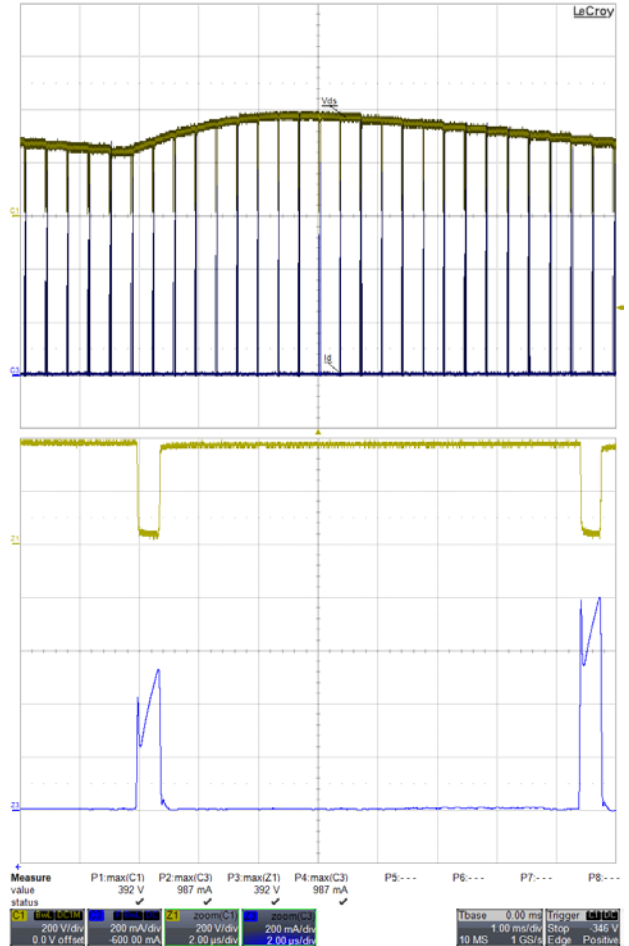


Figure 32 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 2 μ s / div



12.3 ドレイン電圧及び電流起動プロファイル

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

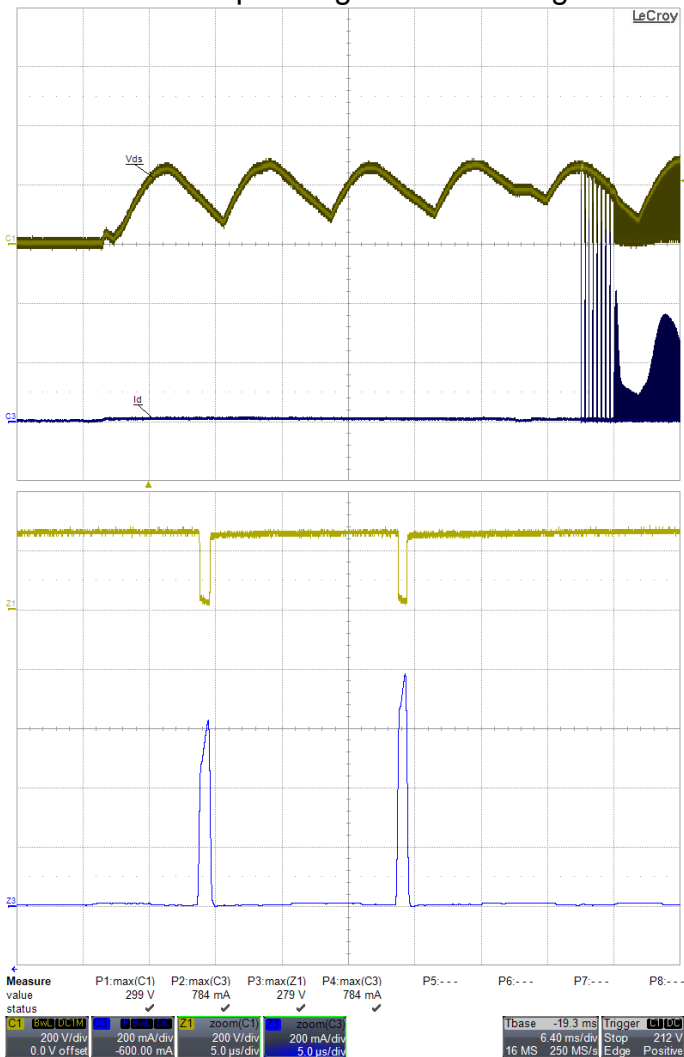


Figure 33 – 195 VAC / 50 Hz Start-up.

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

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

Time Scale: 1 ms / div.

Zoom Time Scale: 5 μ s / div.

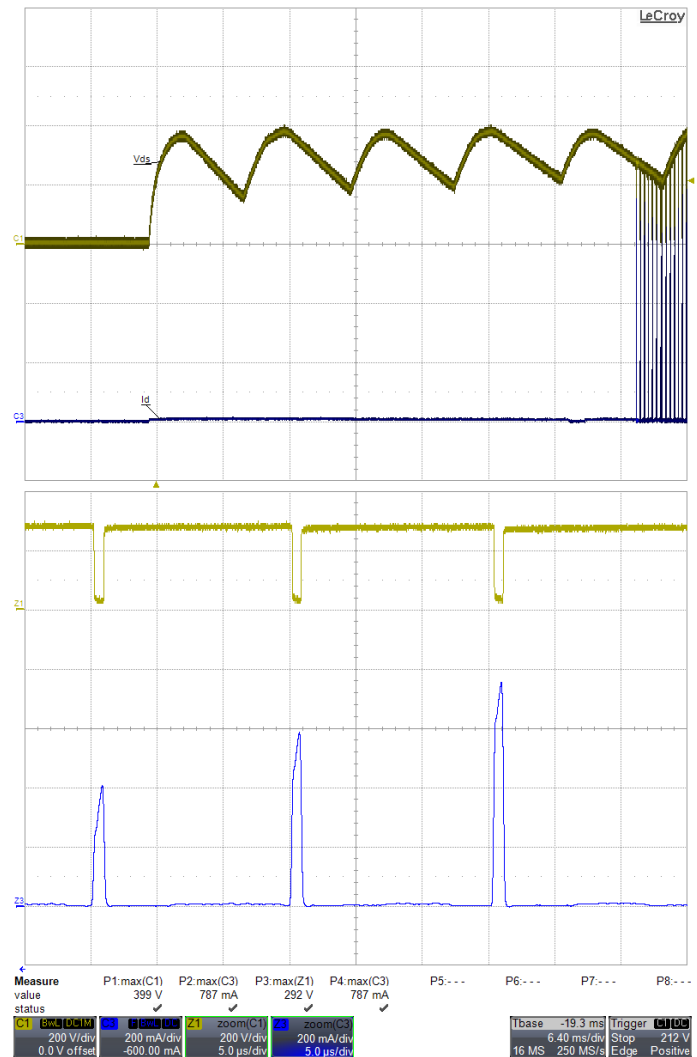


Figure 34 – 265 VAC / 50 Hz Start-up.

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

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

Time Scale: 1 ms / div.

Zoom Time Scale: 5 μ s / div.



12.4 出力電流起動プロファイル

Output current is available in <150 ms.

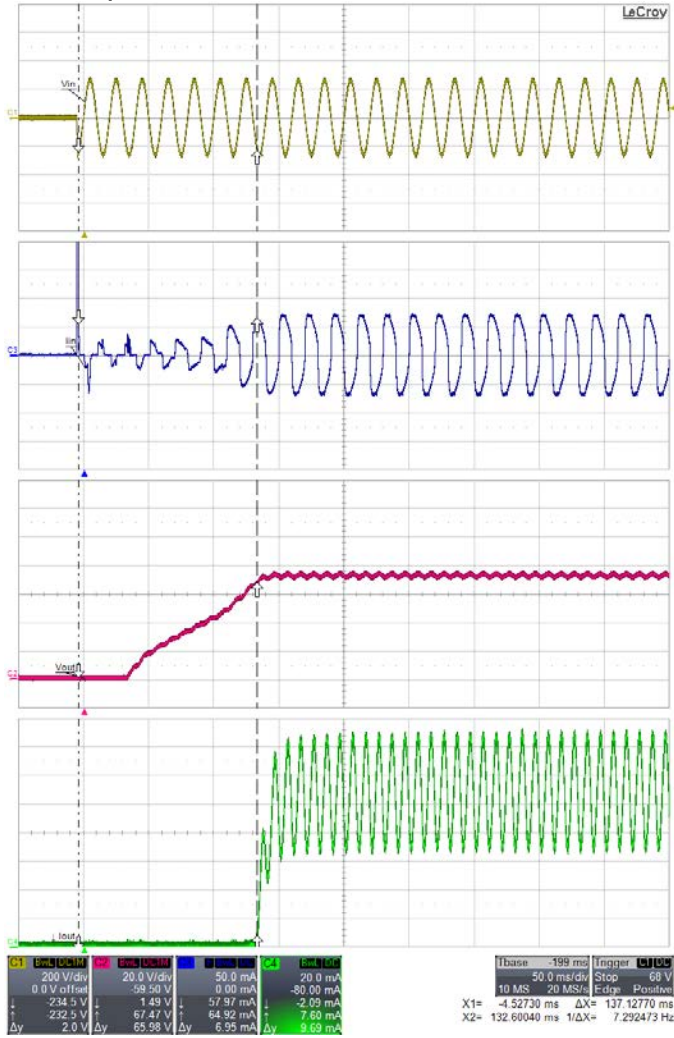


Figure 35 – 195 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 20 ms / div.

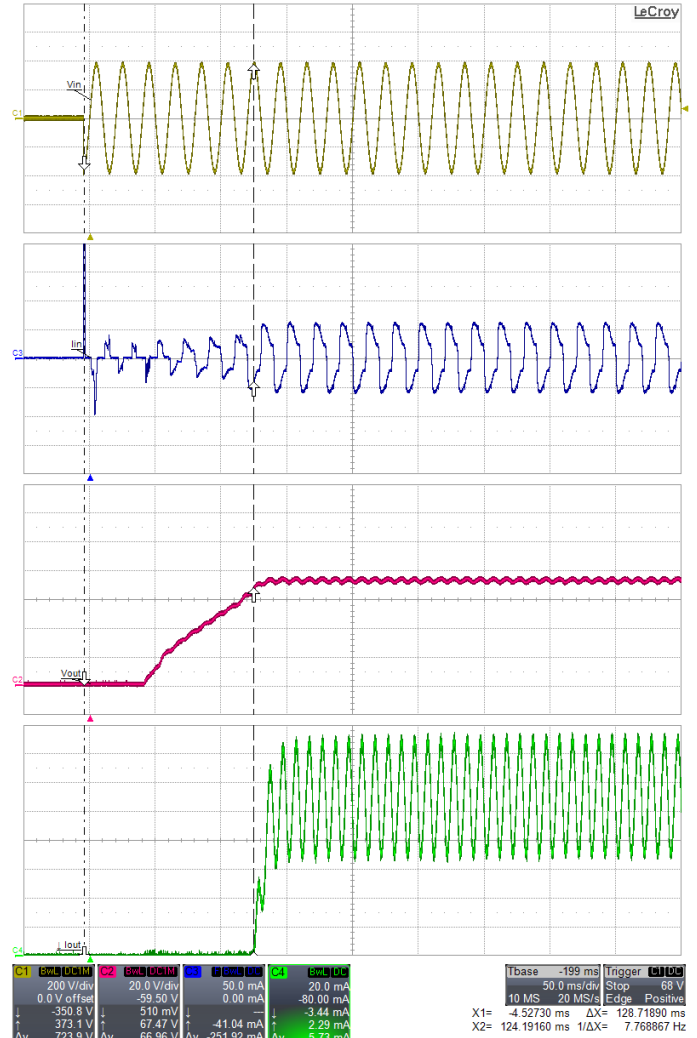


Figure 36 – 265 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 20 ms / div.



12.5 入出カプロファイル

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.

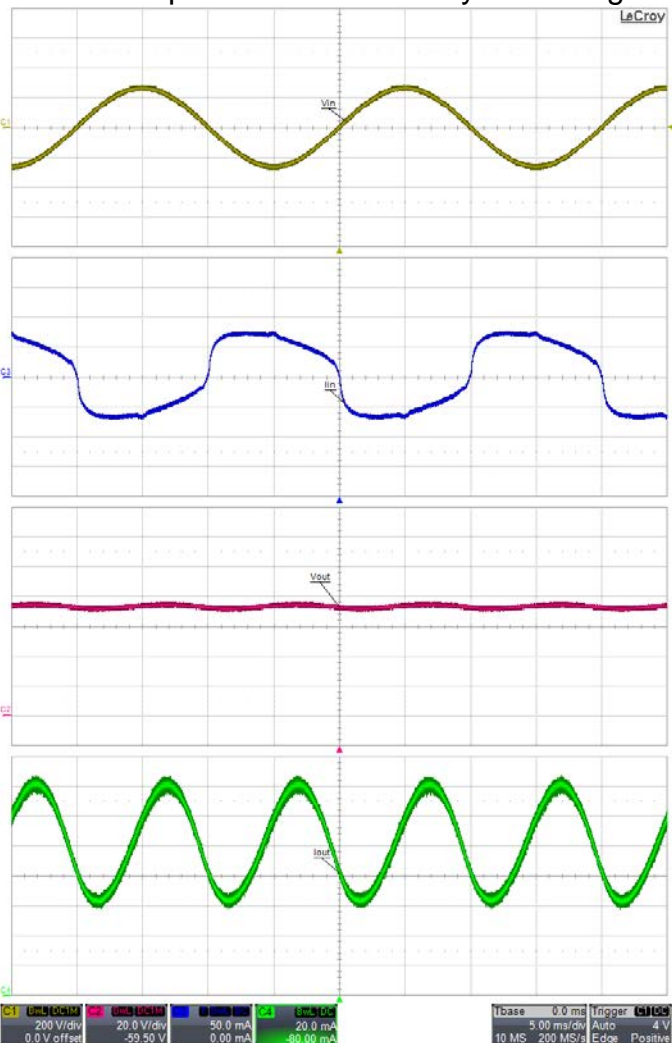


Figure 37 – 195 VAC / 50 Hz, Nominal V_{LED} Load.

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.

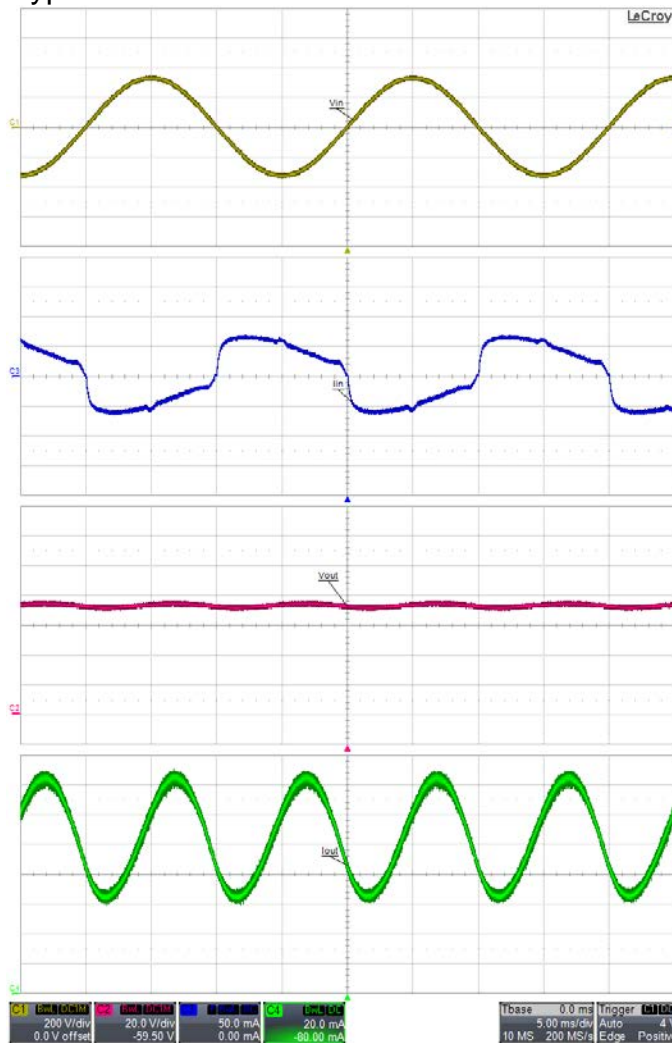


Figure 38 – 230 VAC / 50 Hz, Nominal V_{LED} Load.

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.



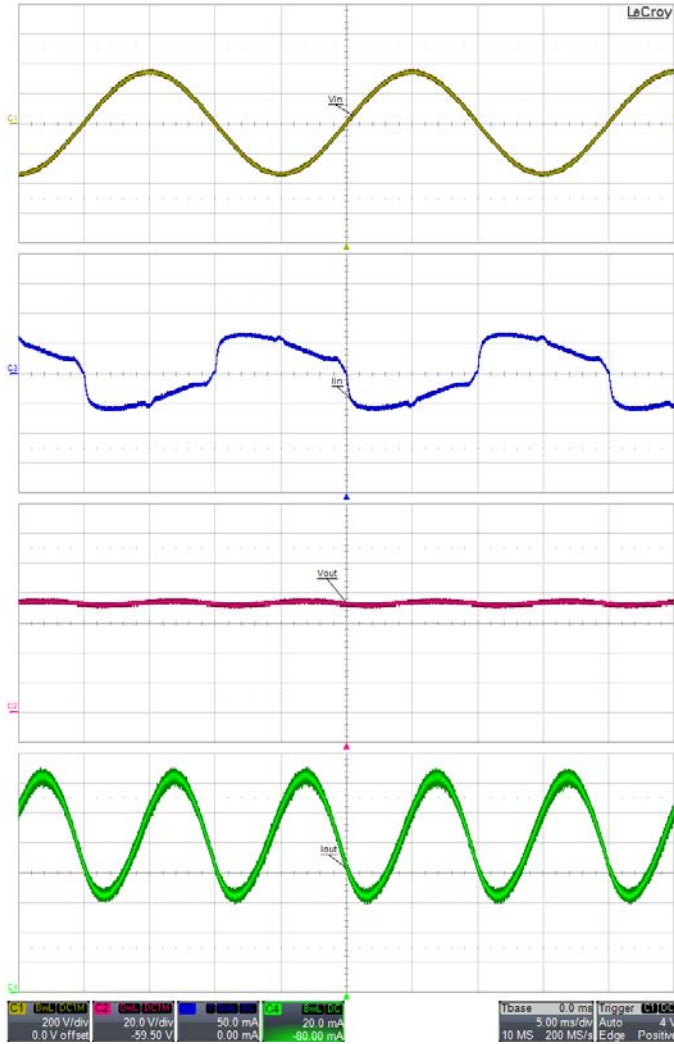


Figure 39 – 240 VAC / 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 5 ms / div.

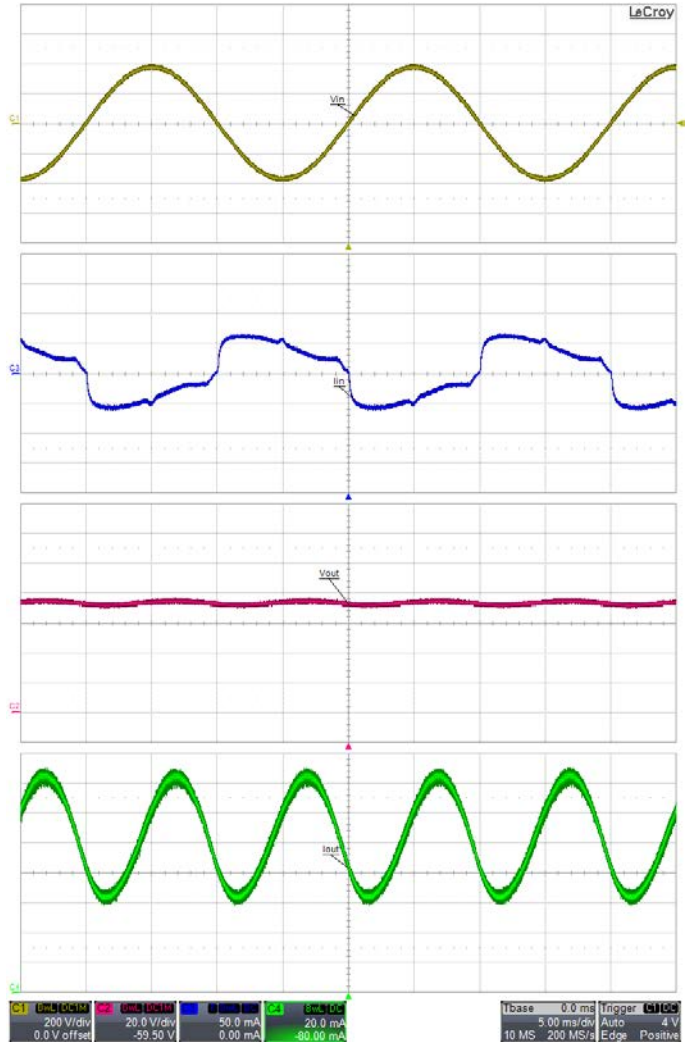


Figure 40 – 265 VAC / 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 5 ms / div.



12.6 入カサグ及びびサージ

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.

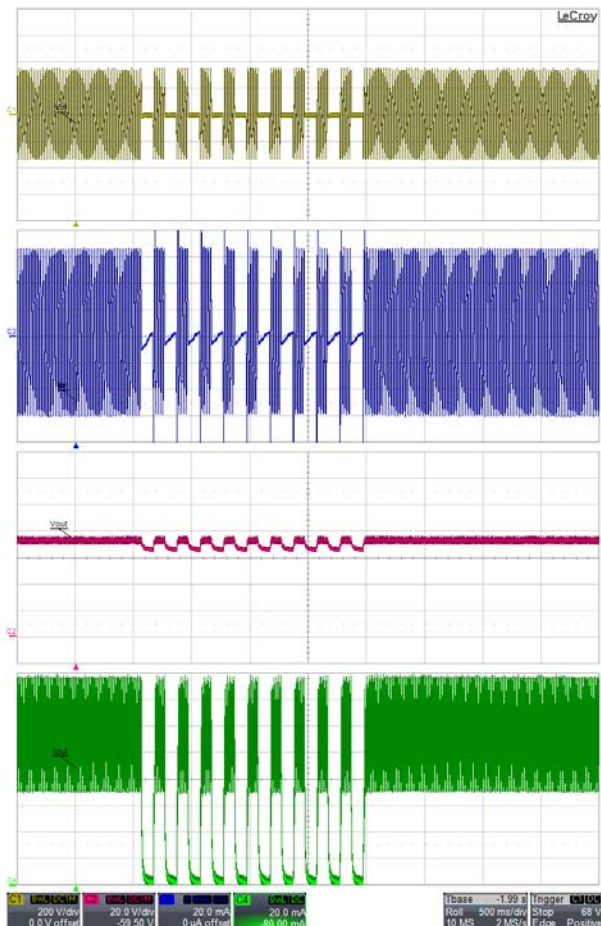


Figure 41 – Line Sag Test at 230 - 0 V at 0.1 sec Interval.

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.

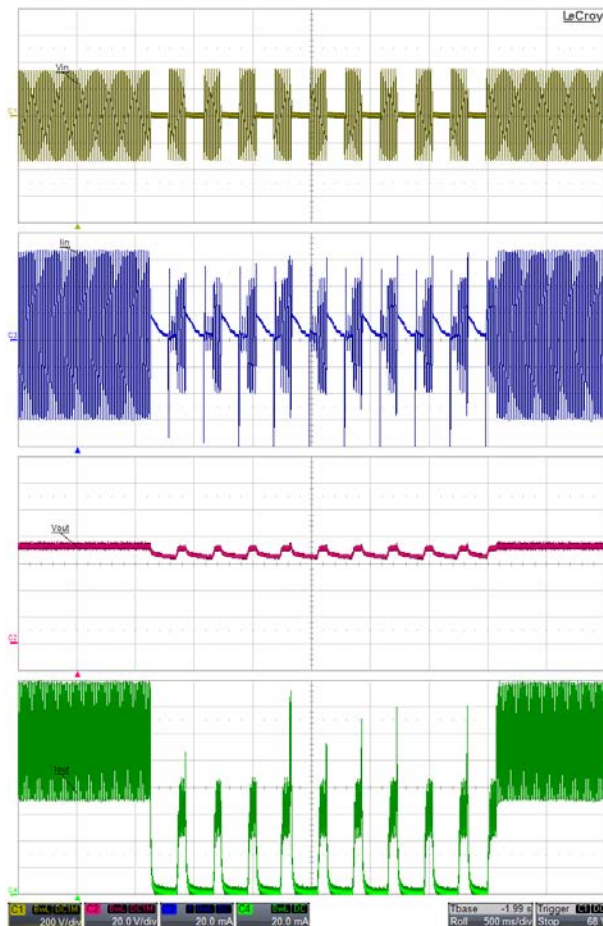


Figure 42 – Line Surge Test at 230 - 0 at 0.15 sec Interval.

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 無負荷時の保護

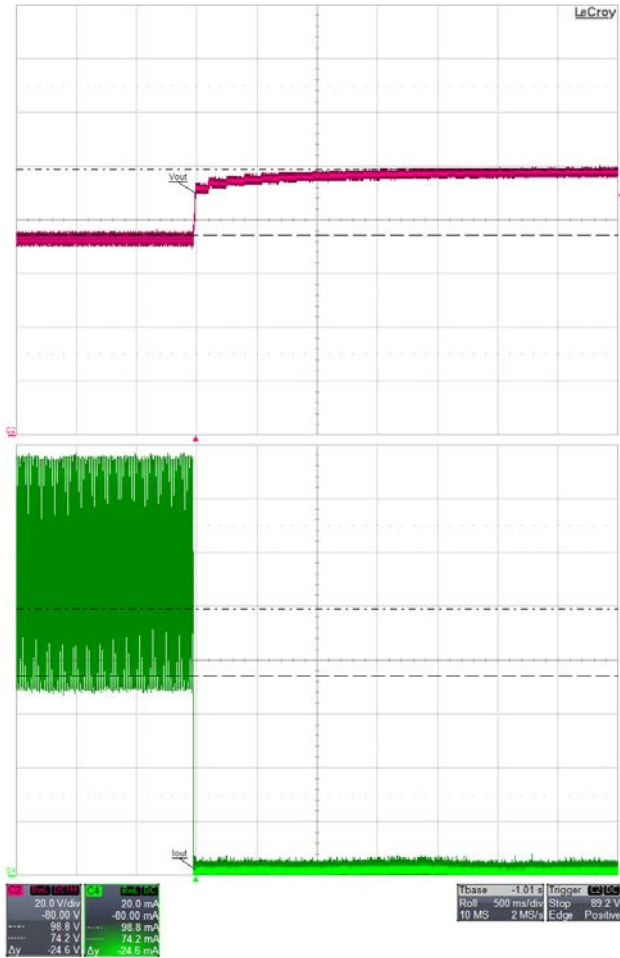


Figure 43 – No-load Protection when Load is Disconnected. 195 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.

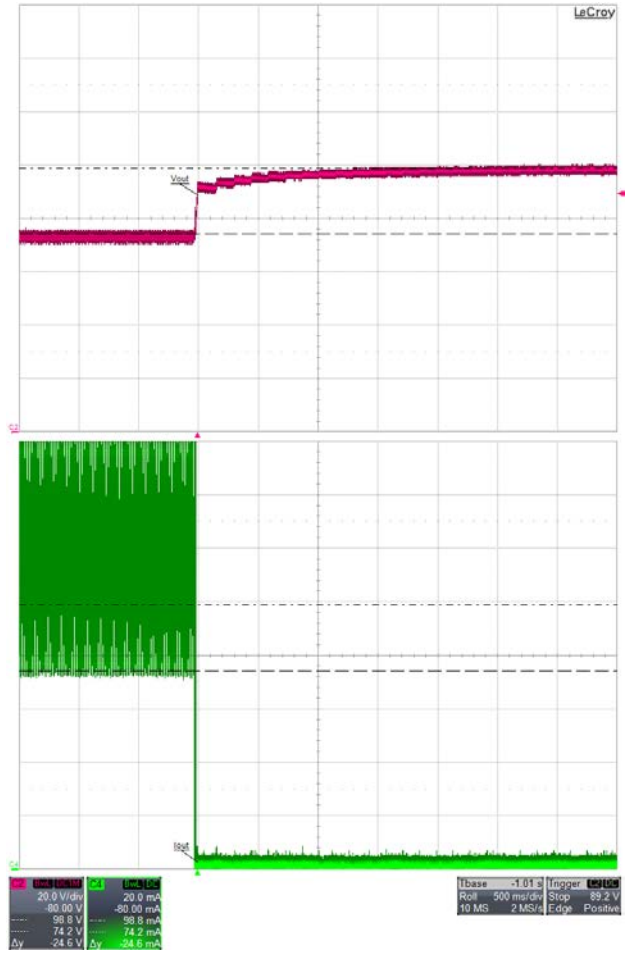


Figure 44 – No-load Protection when Load is Disconnected. 265 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.



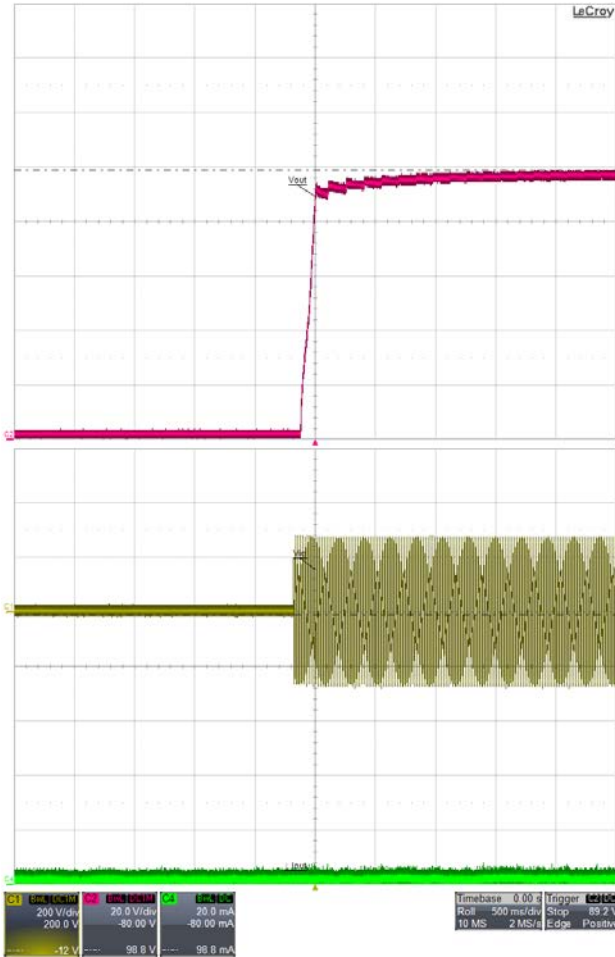


Figure 45 – No-load Start-up. 195 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.

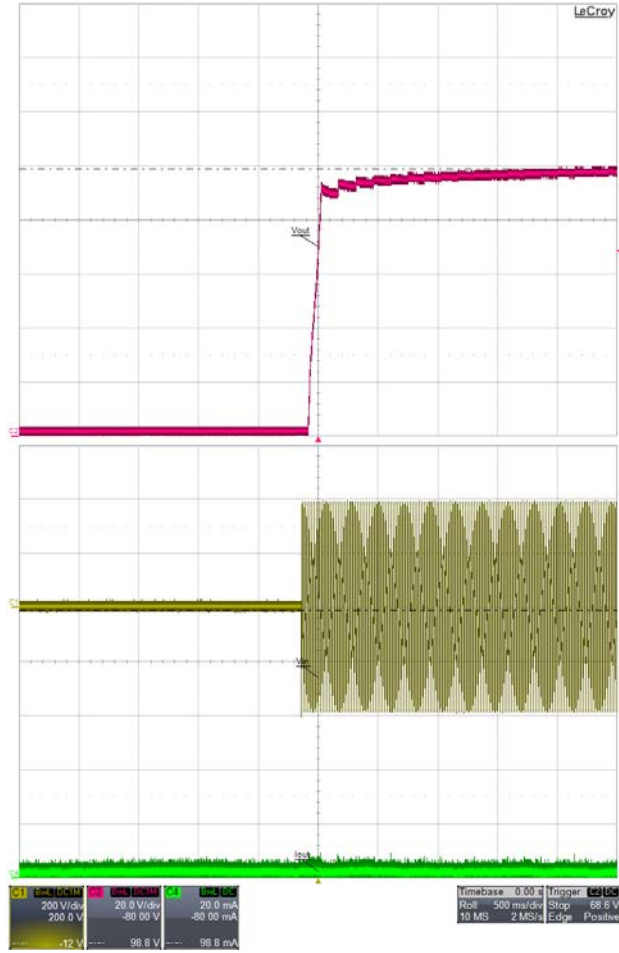


Figure 46 – No-load Start-up. 265 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.



12.8 入力停止/入力起動

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

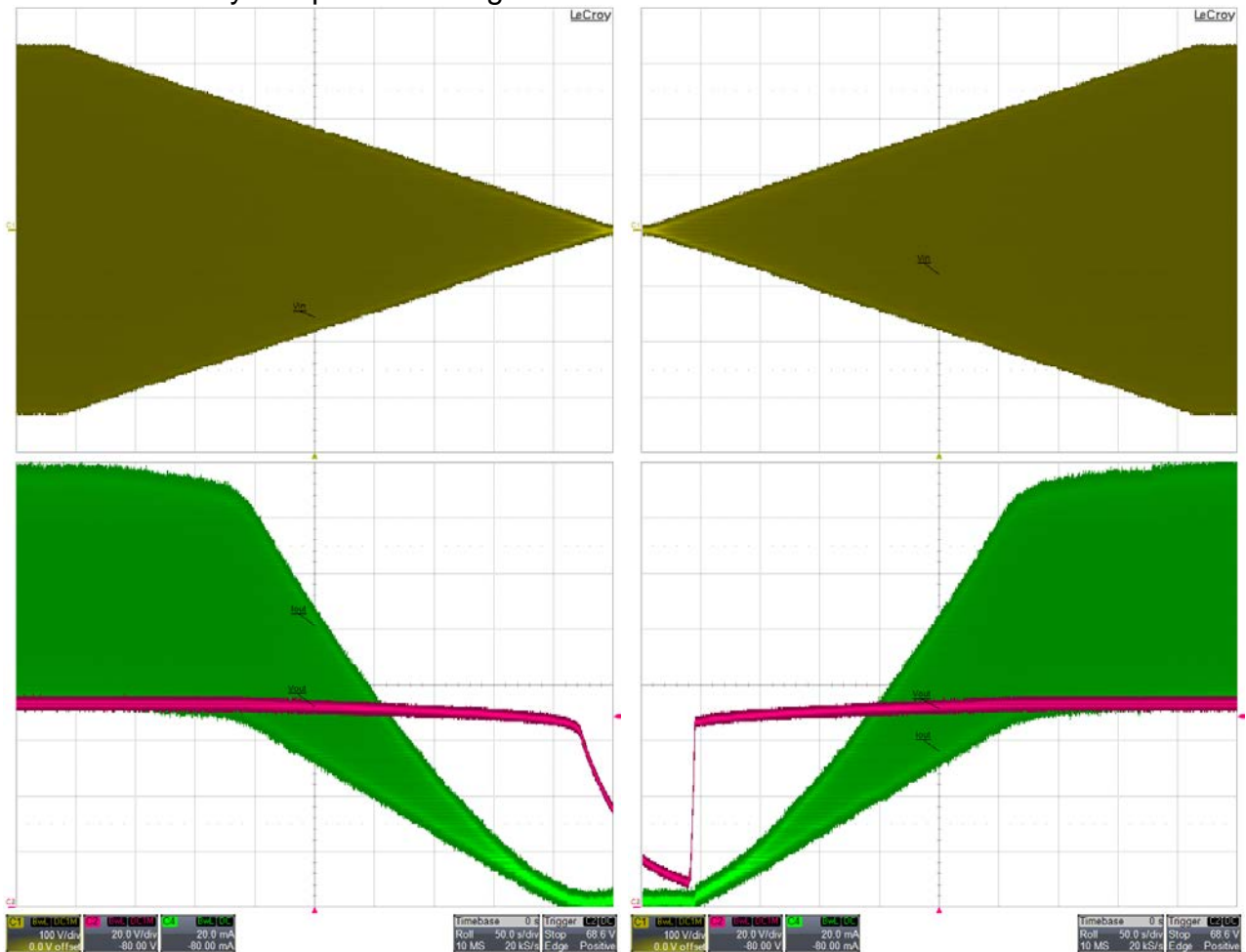


Figure 47 – Brown-out Test at 0.5 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.
 230 V-0-230 V
 Ch1: V_{IN} ; 100 V / div.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 20 mA / div.
 Time Scale: 50 s / div.

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.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 20 mA / div.
 Time Scale: 50 s / div.



13 調光機能

13.1 調光器互換性

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 調光時の波形

Dimmer: Berker 2830 10

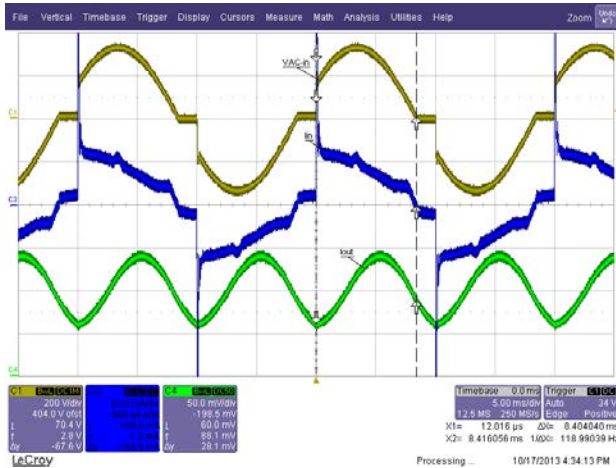


Figure 49 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

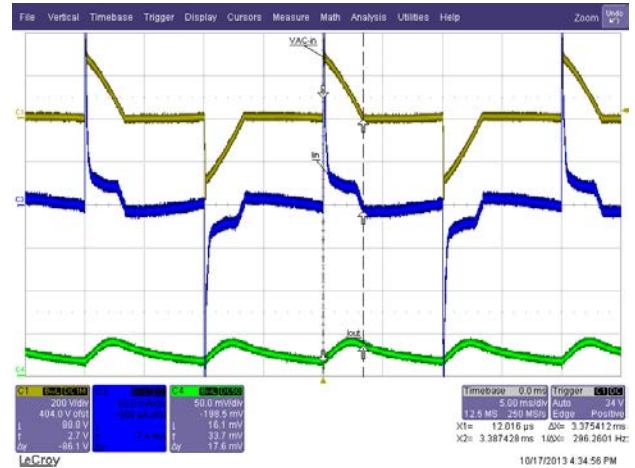


Figure 50 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

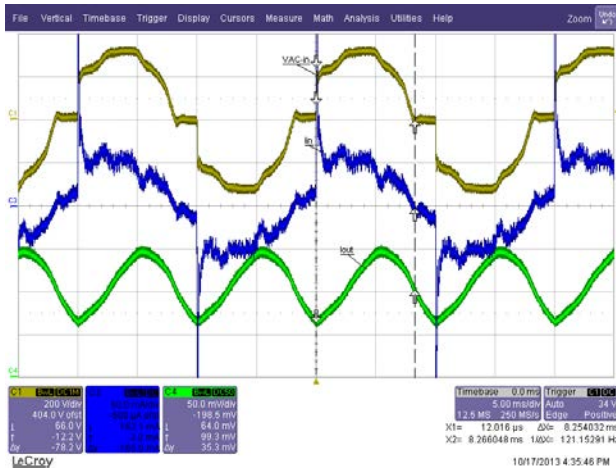


Figure 51 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

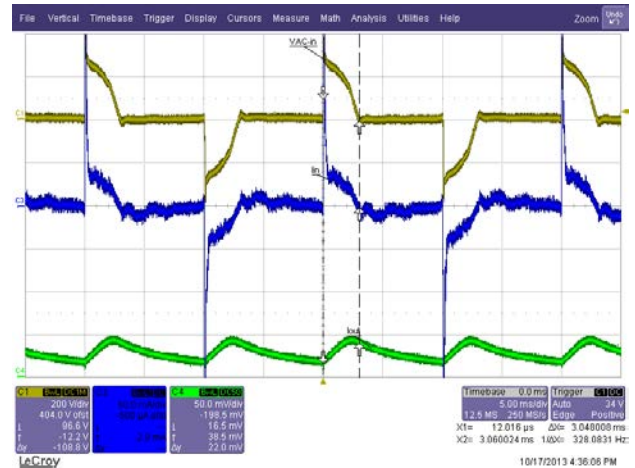


Figure 52 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Jung 225 NV DE

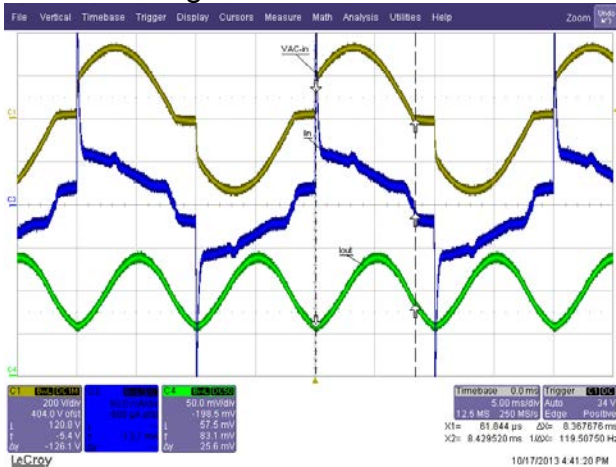


Figure 53 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

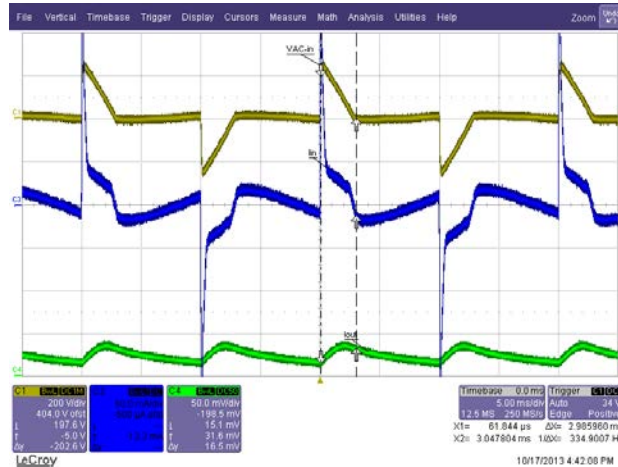


Figure 54 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

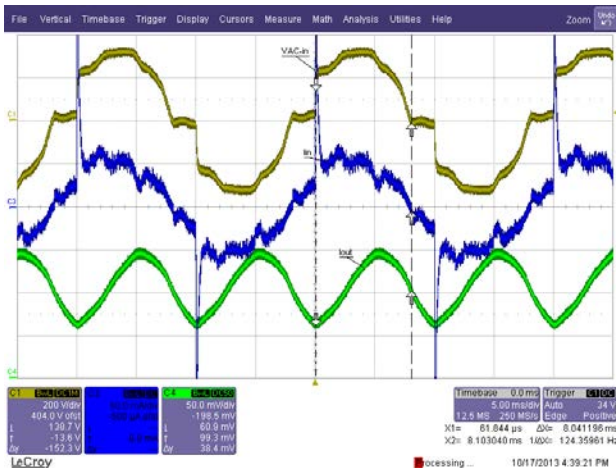


Figure 55 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

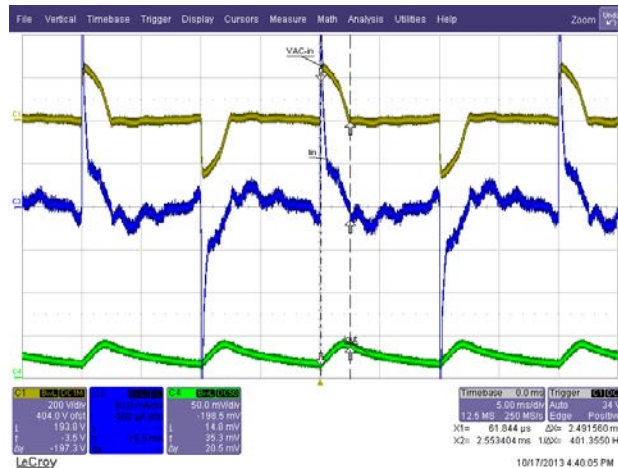


Figure 56 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Jung 254 UDIE 1

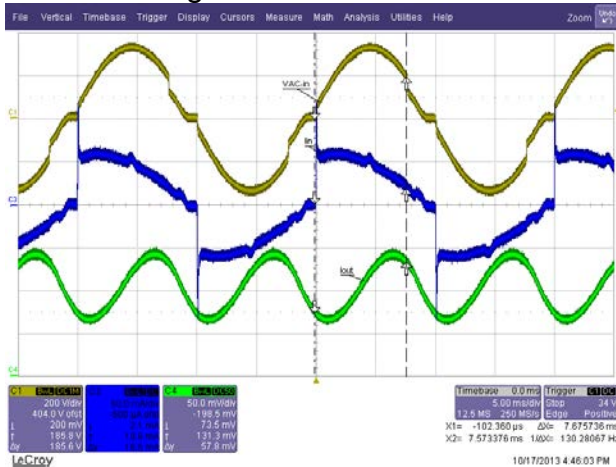


Figure 57 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

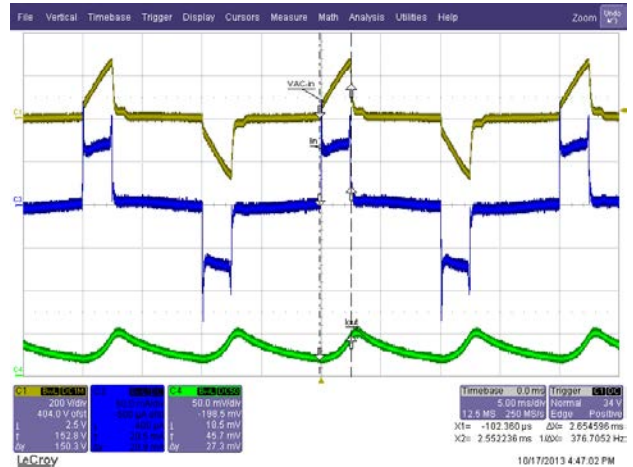


Figure 58 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

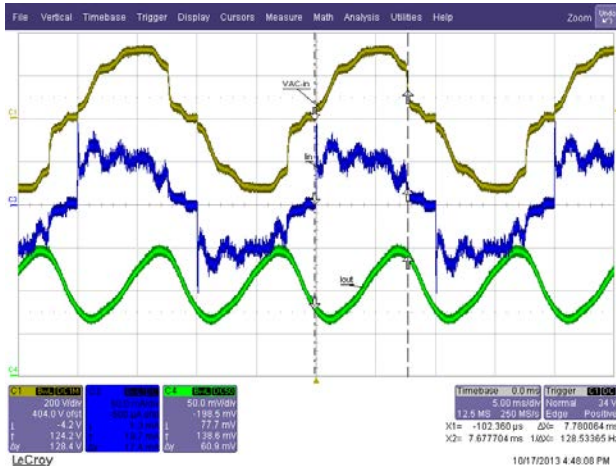


Figure 59 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

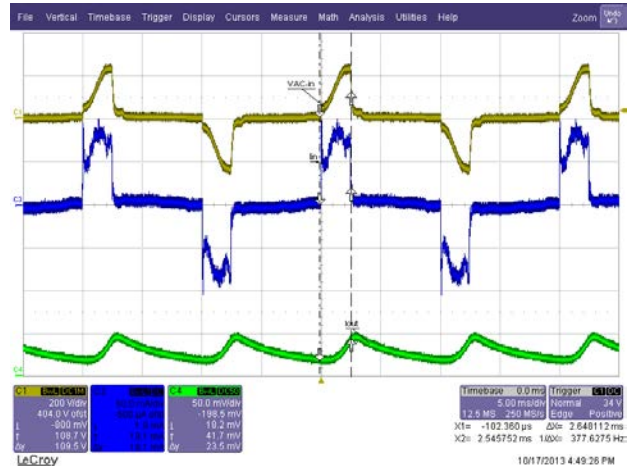


Figure 60 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Jung 266 G DE

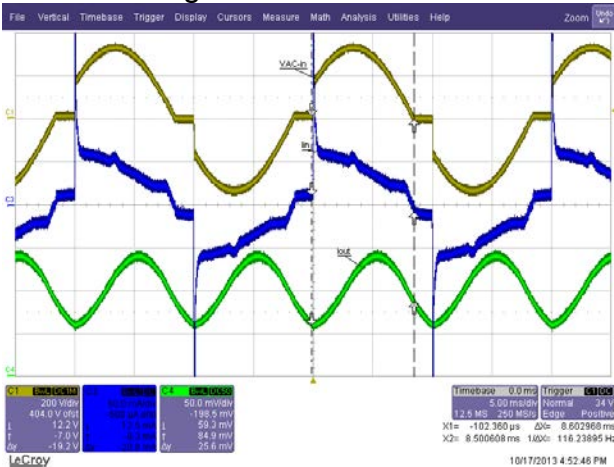


Figure 61 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

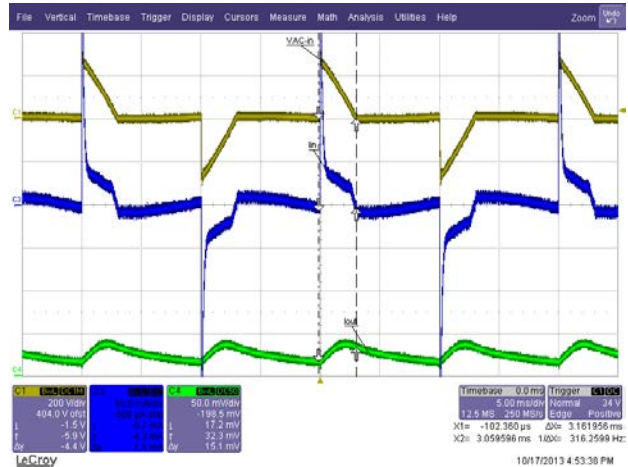


Figure 62 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

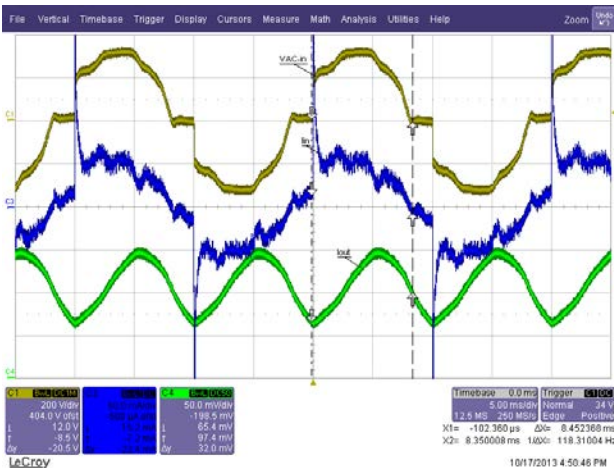


Figure 63 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

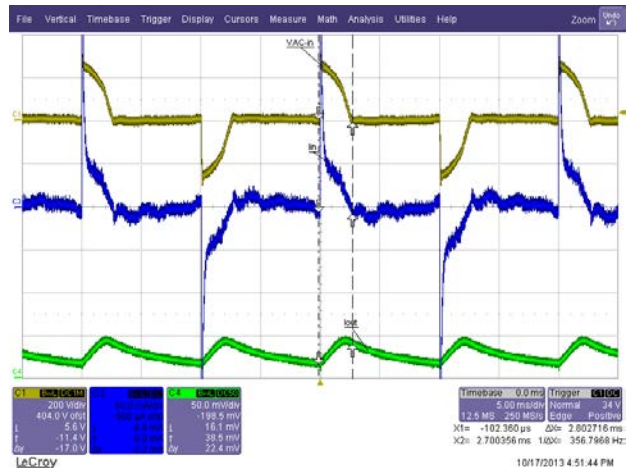


Figure 64 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2200 UJ-212

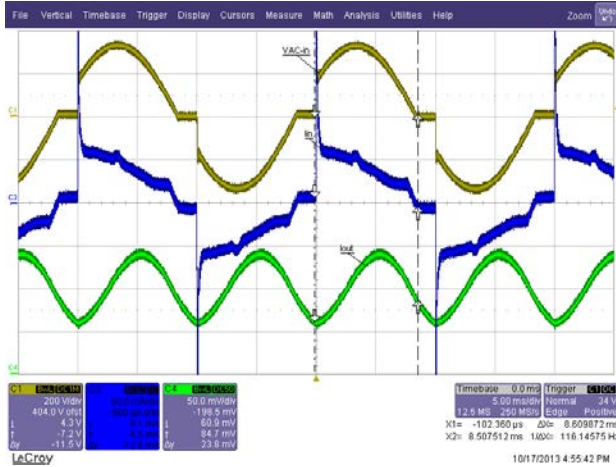


Figure 65 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

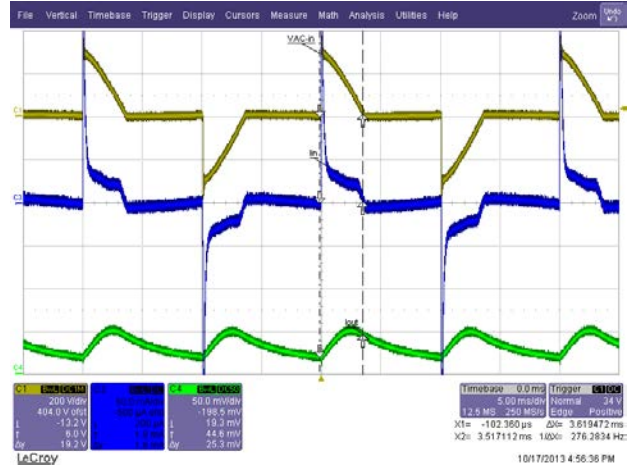


Figure 66 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

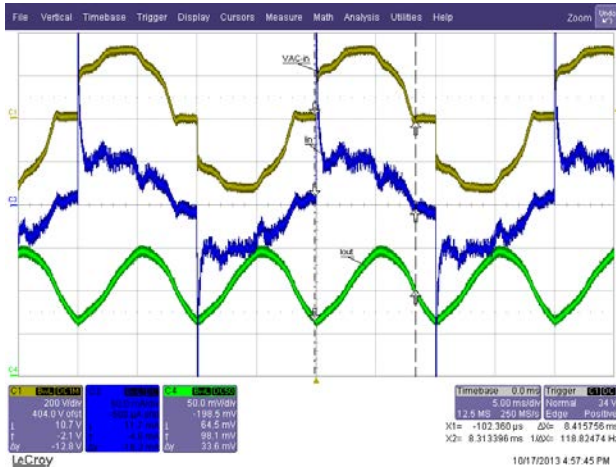


Figure 67 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

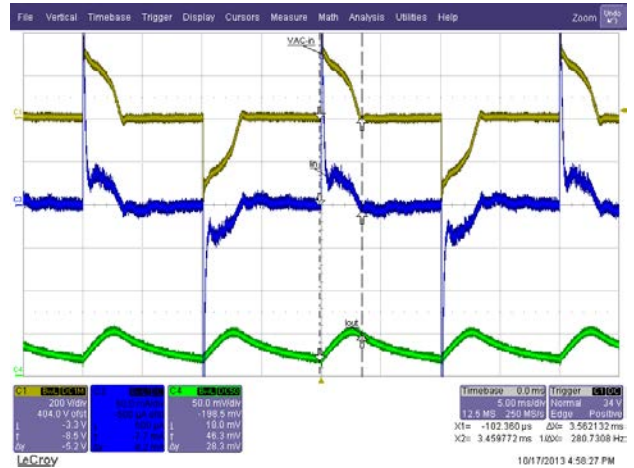


Figure 68 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250 U

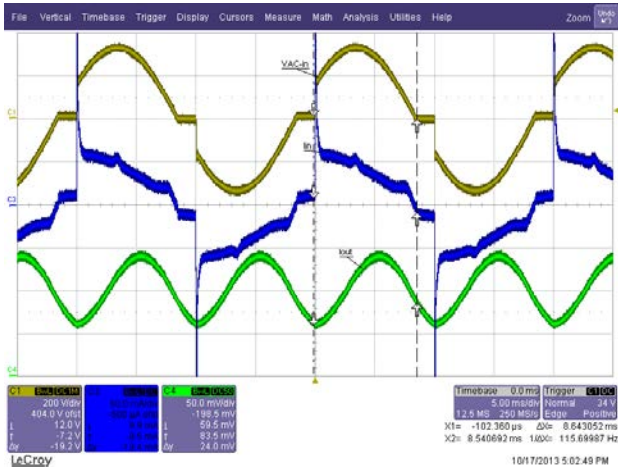


Figure 69 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

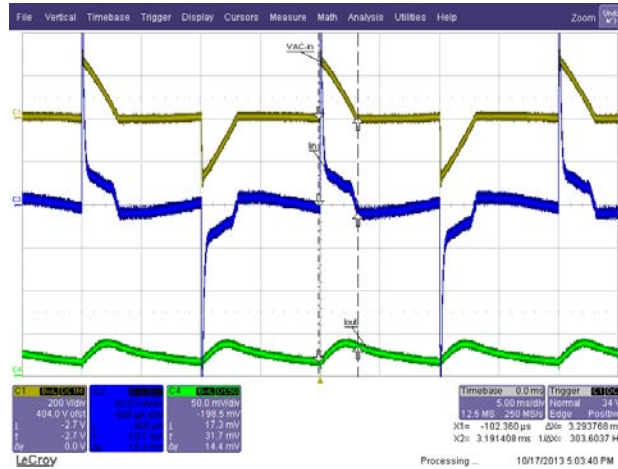


Figure 70 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

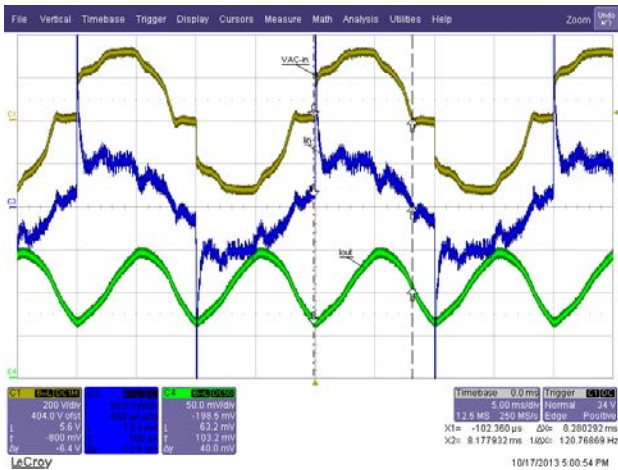


Figure 71 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

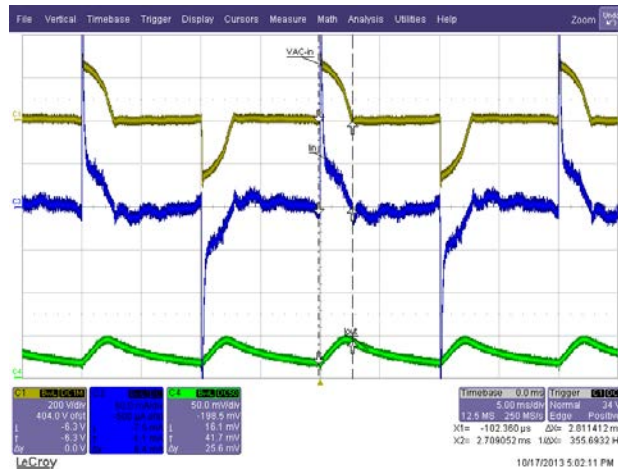


Figure 72 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2247 U

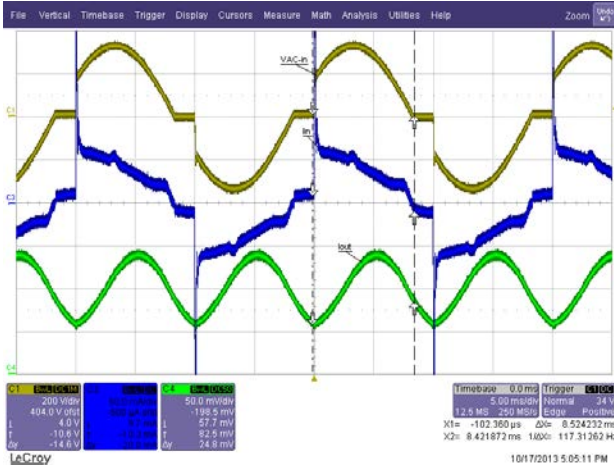


Figure 73 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

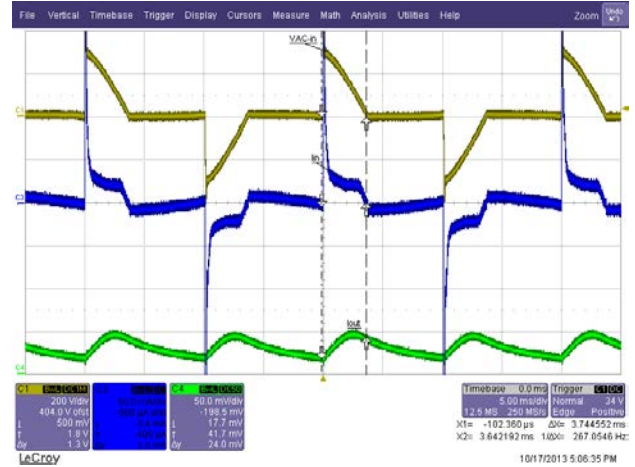


Figure 74 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

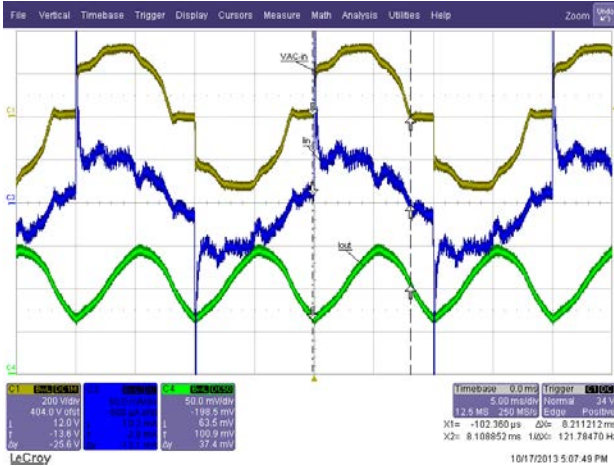


Figure 75 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

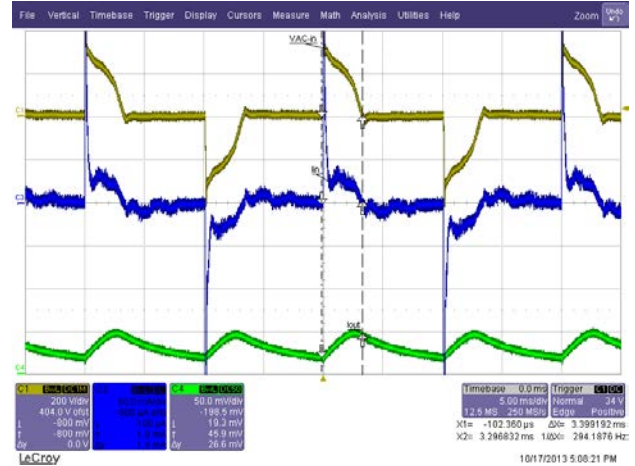


Figure 76 – Minimum Conduction from Distorted AC Line
 AC Line 230V/50Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Gira 2262 00 I01

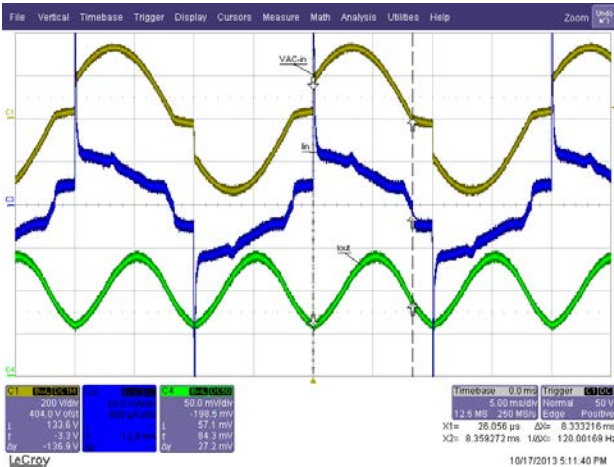


Figure 77 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

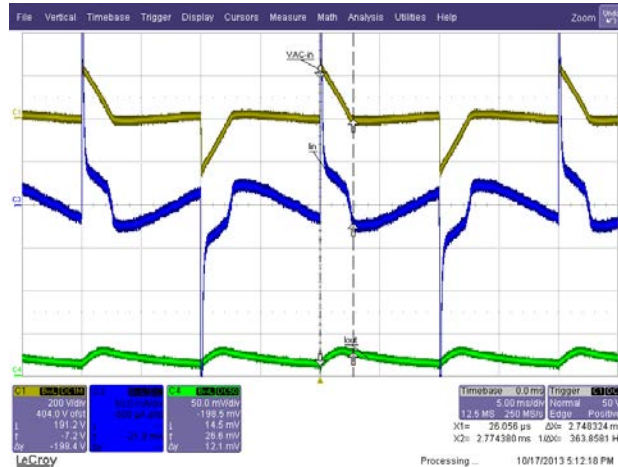


Figure 78 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

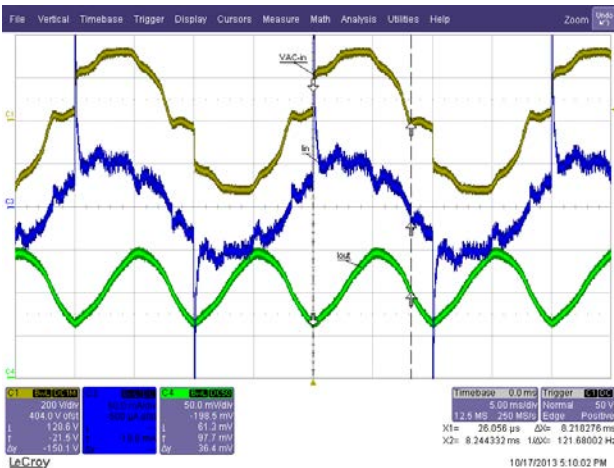


Figure 79 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

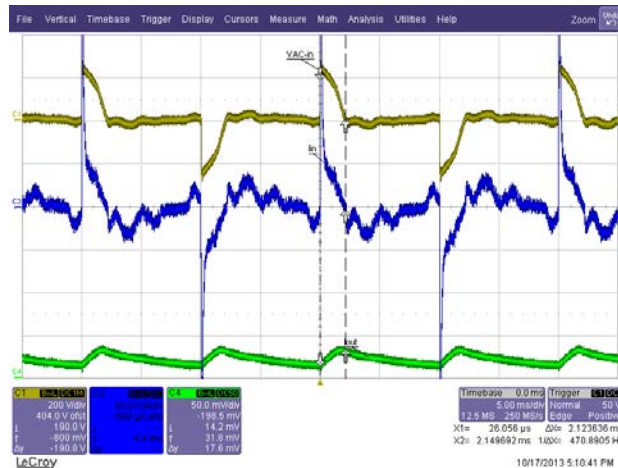


Figure 80 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Gira 0300 00 I01

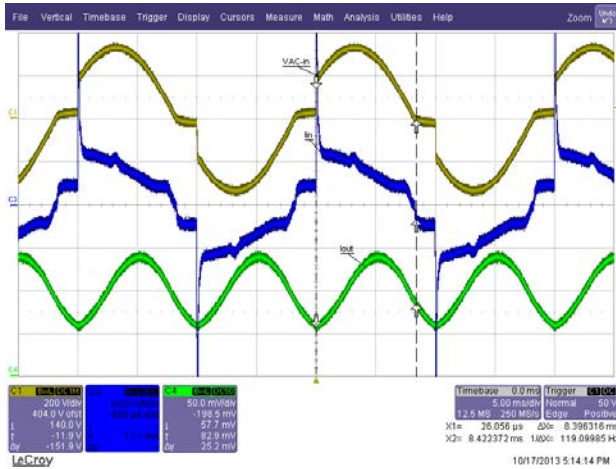


Figure 81 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

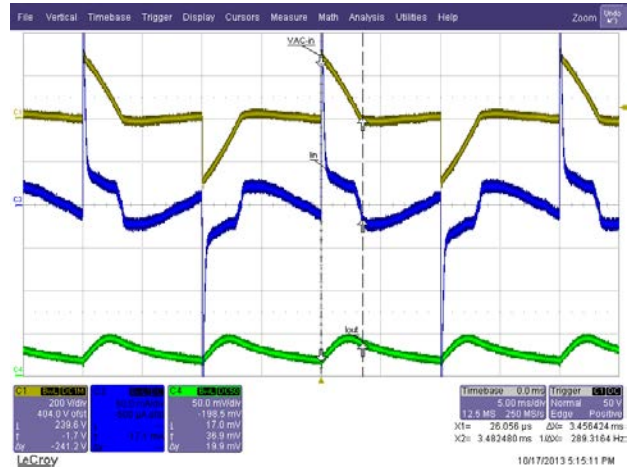


Figure 82 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

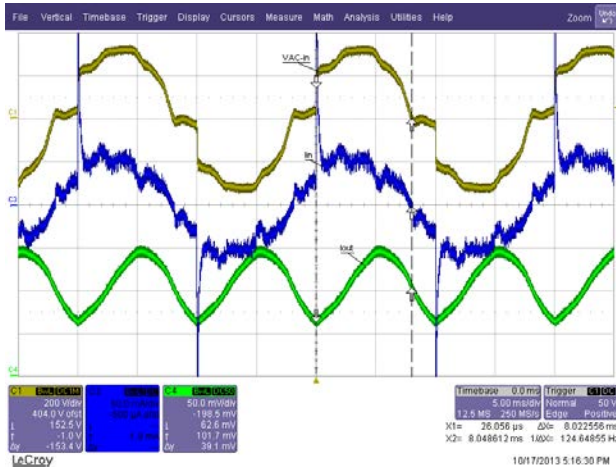


Figure 83 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

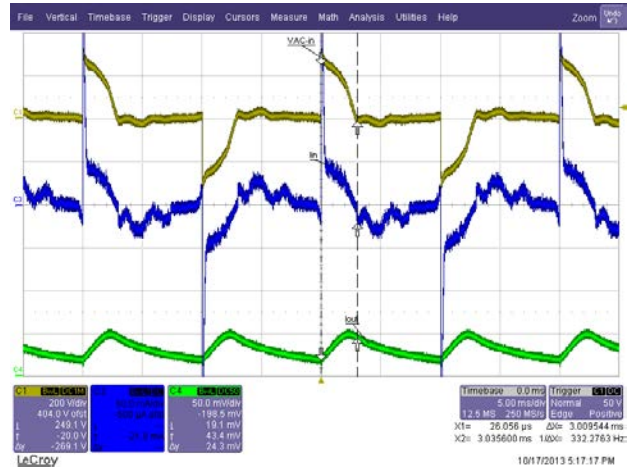


Figure 84 – Minimum Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250 U

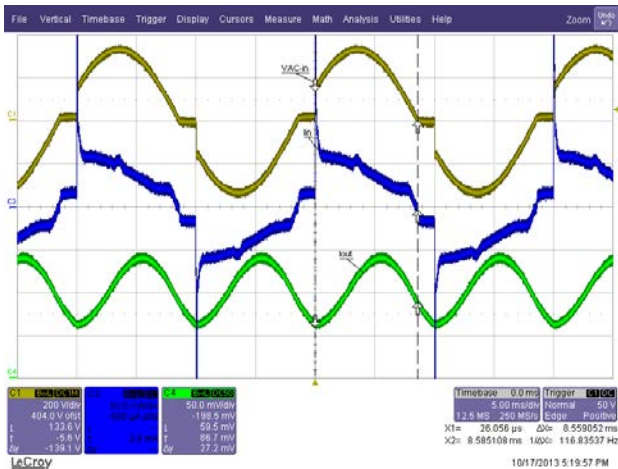


Figure 85 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

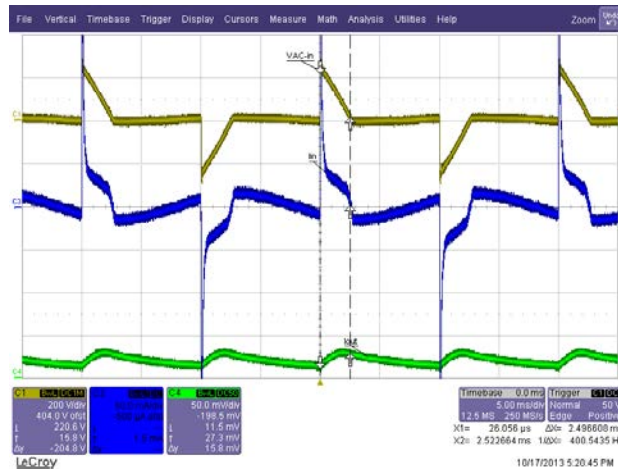


Figure 86 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

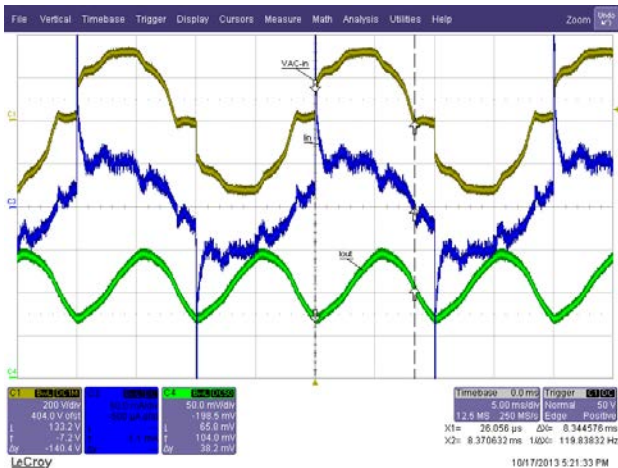


Figure 87 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

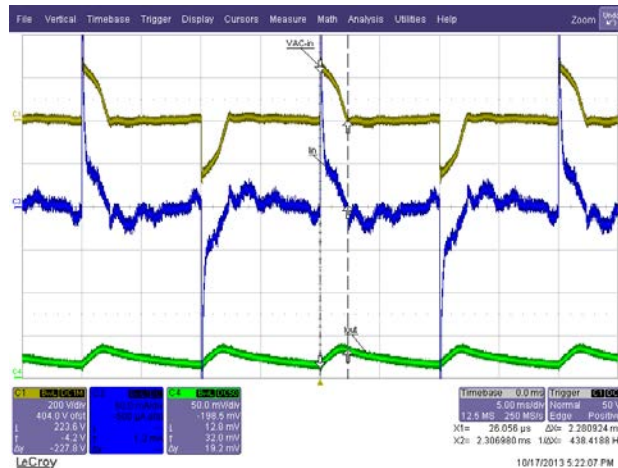


Figure 88 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: TCL

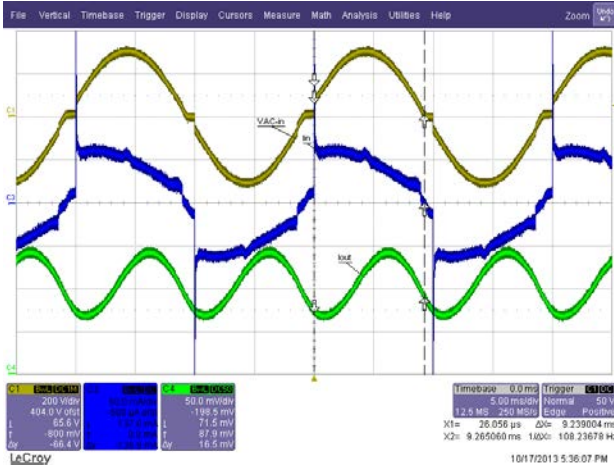


Figure 89 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

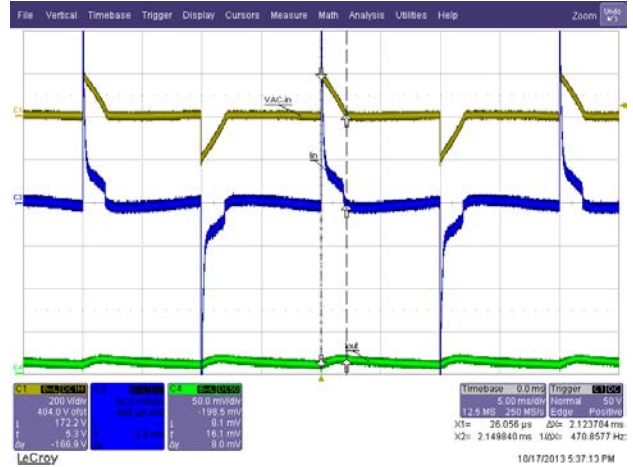


Figure 90 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

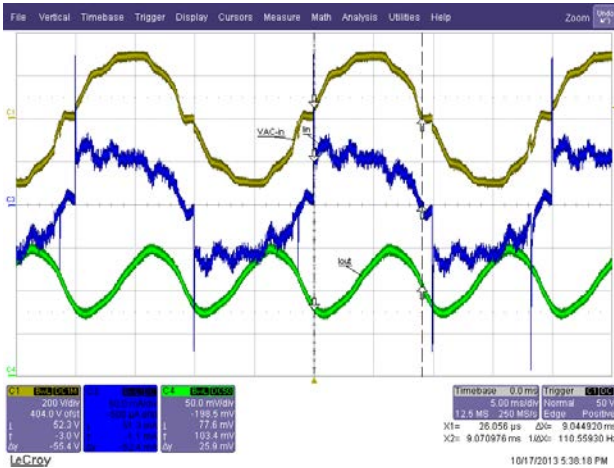


Figure 91 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

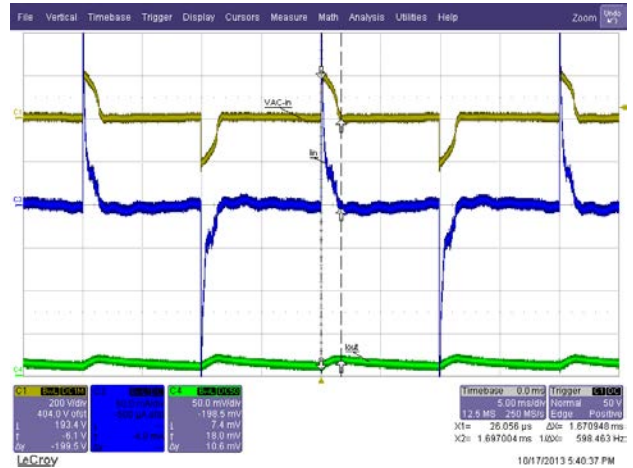


Figure 92 – Minimum Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: SEN BO LANG

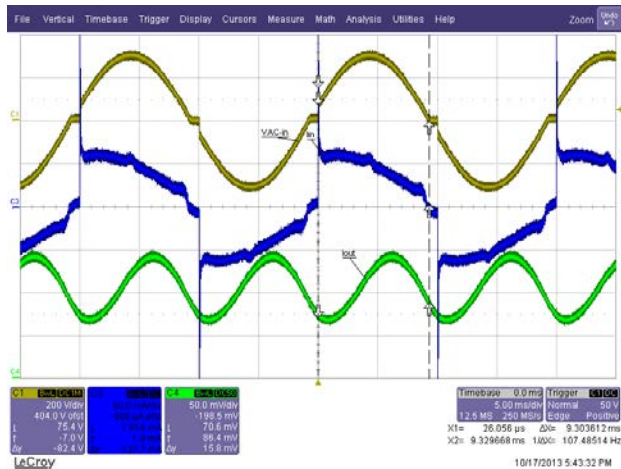


Figure 93 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

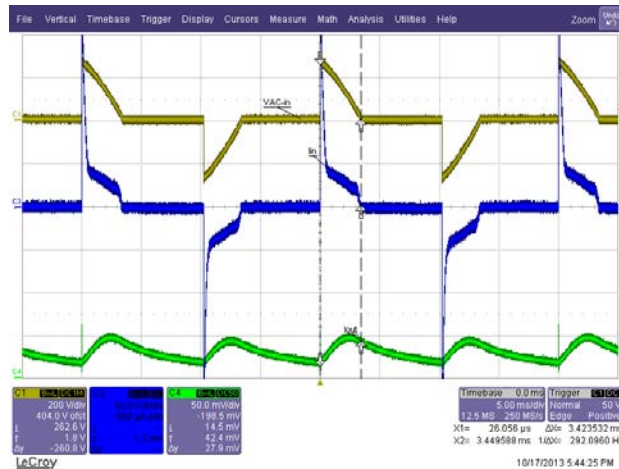


Figure 94 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

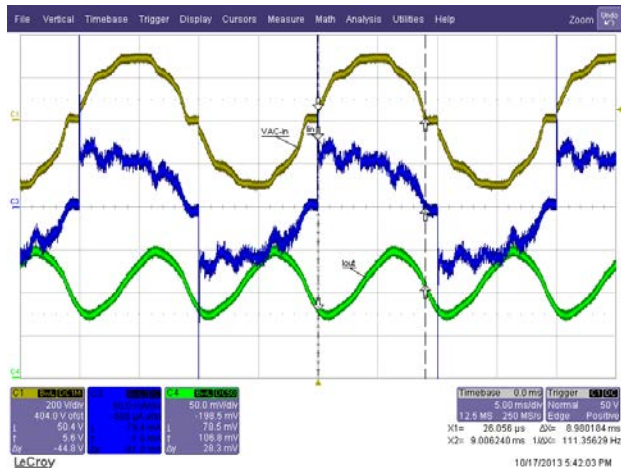


Figure 95 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

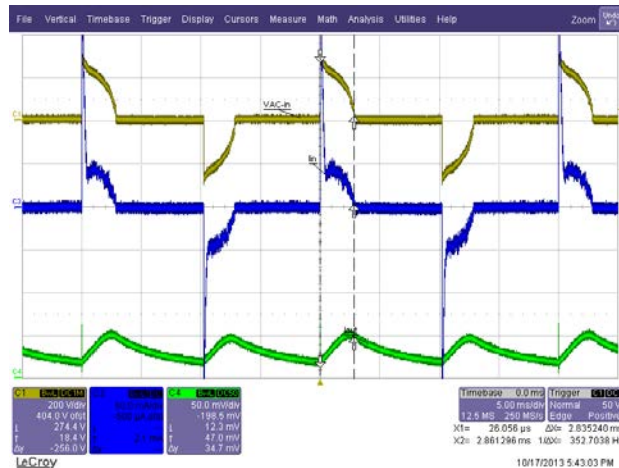


Figure 96 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: EBA HUANG

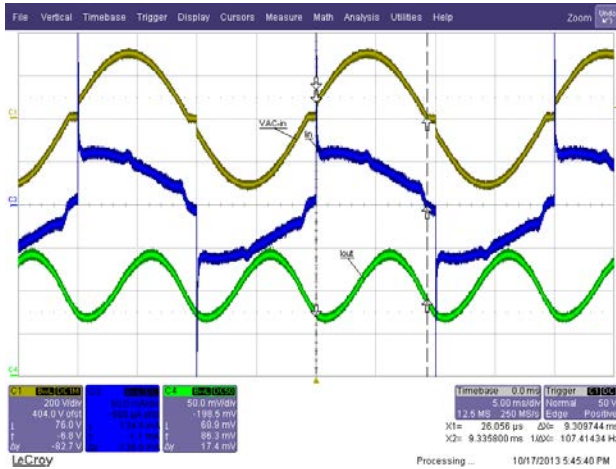


Figure 97 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

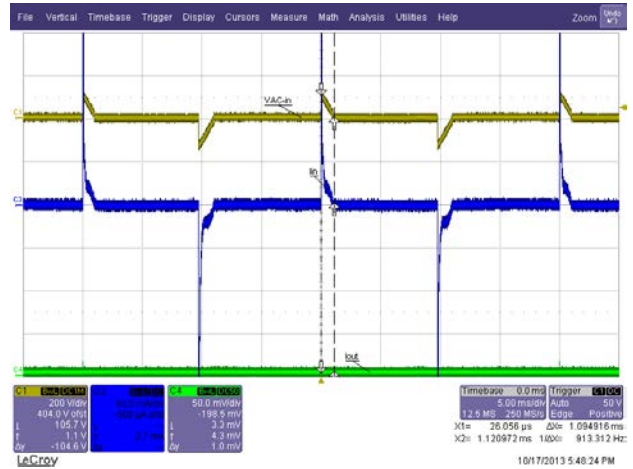


Figure 98 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

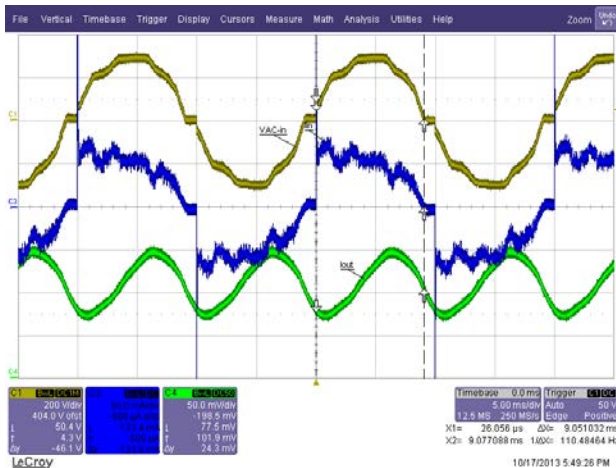


Figure 99 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

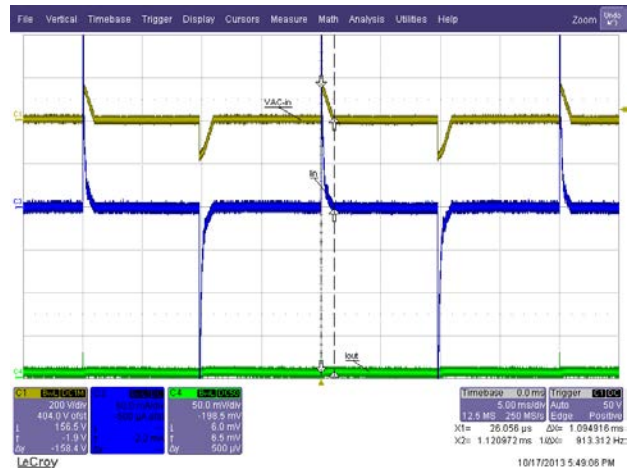


Figure 100 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: SB ELECT

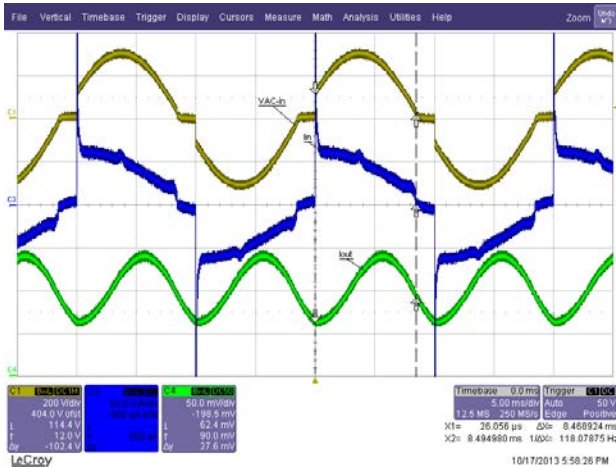


Figure 101 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

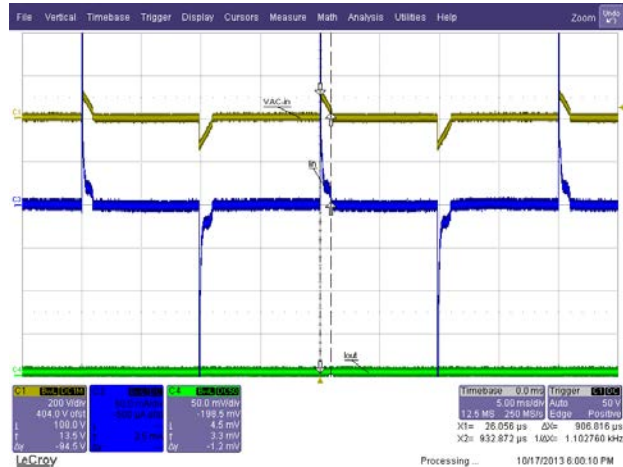


Figure 102 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

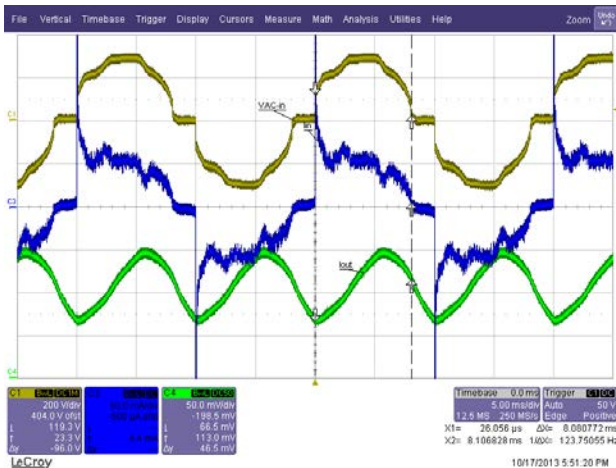


Figure 103 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

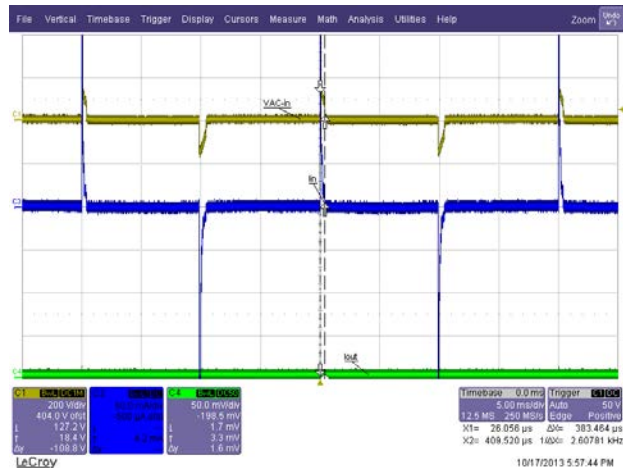


Figure 104 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: MYONGBO

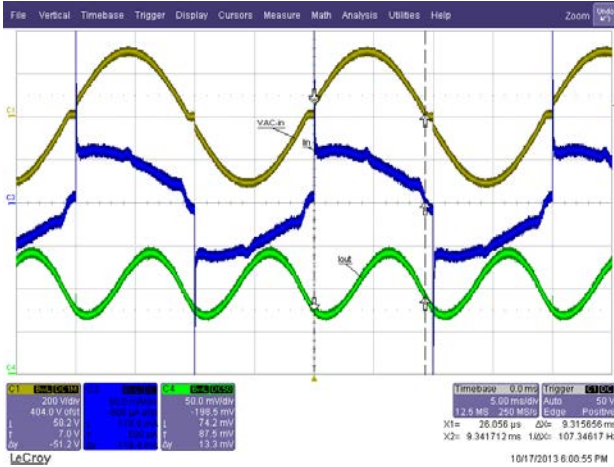


Figure 105 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

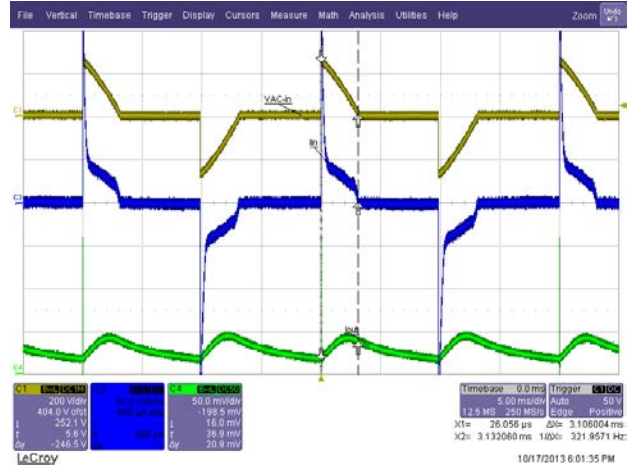


Figure 106 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

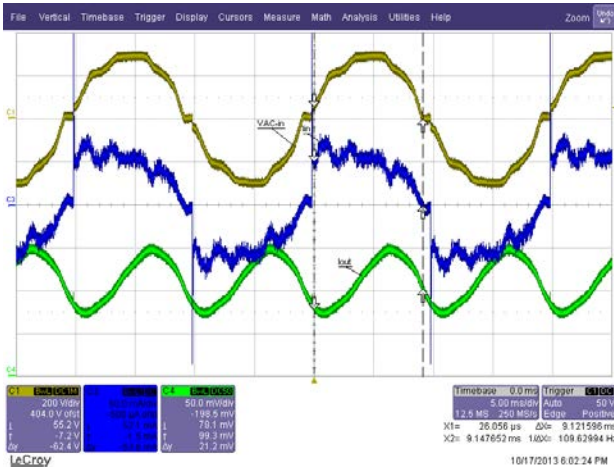


Figure 107 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

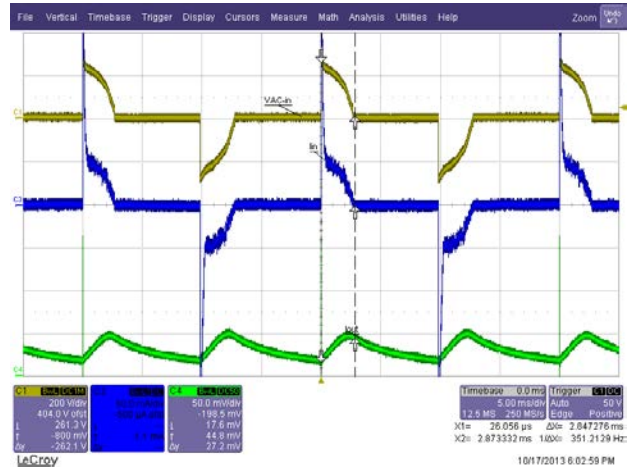


Figure 108 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: KBE

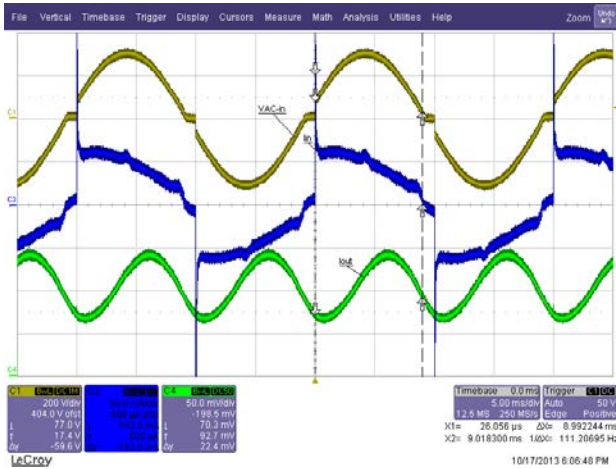


Figure 109 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

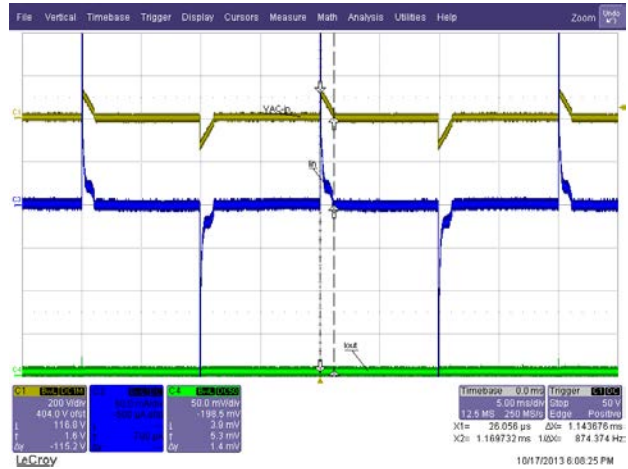


Figure 110 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

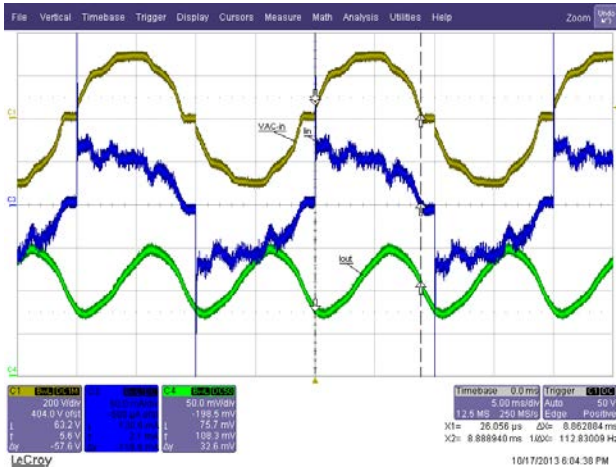


Figure 111 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

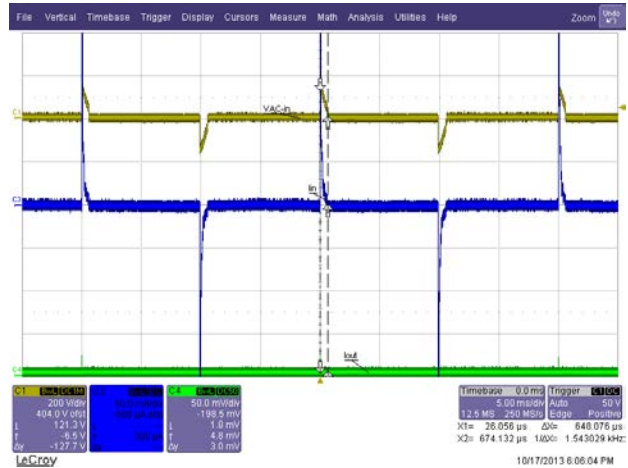


Figure 112 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: CLIPMEI

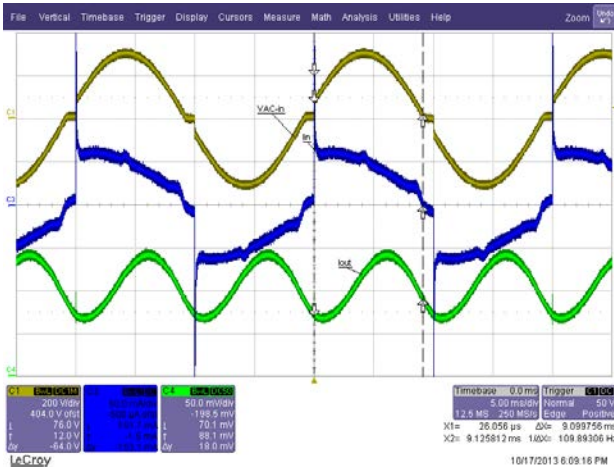


Figure 113 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

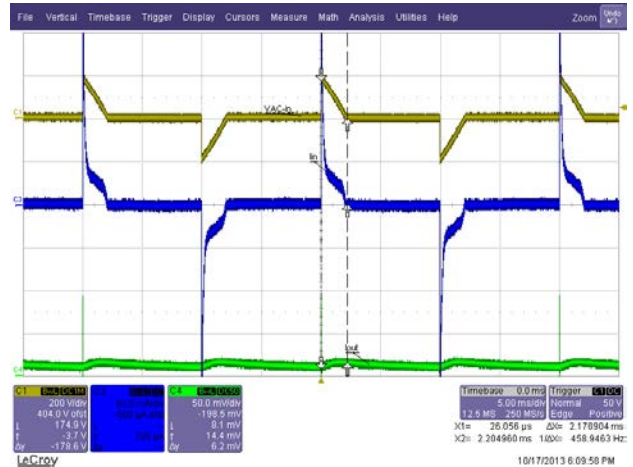


Figure 114 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

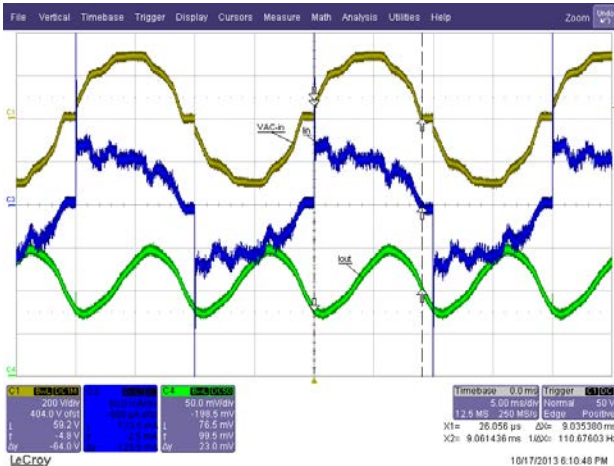


Figure 115 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

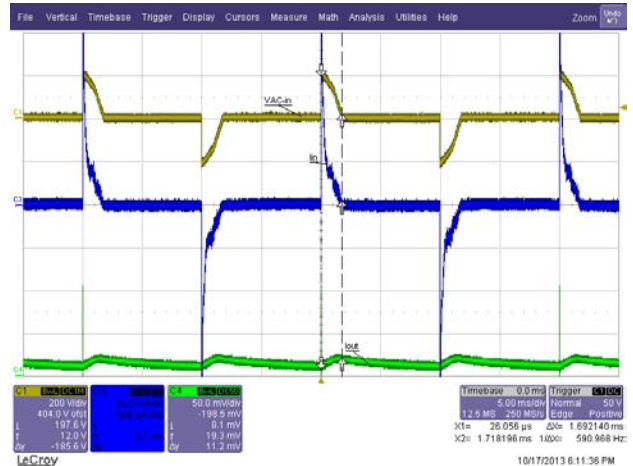


Figure 116 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: MANK

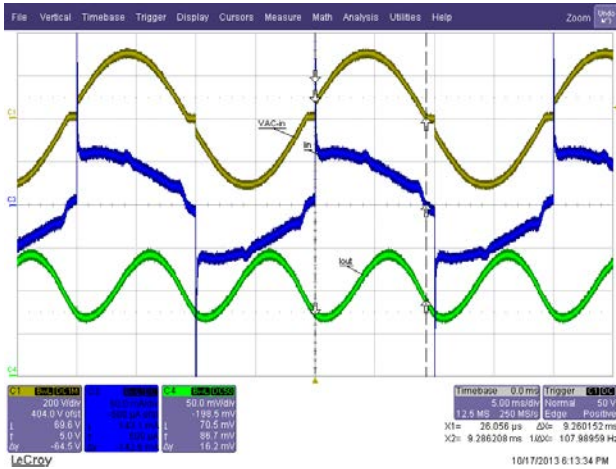


Figure 117 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

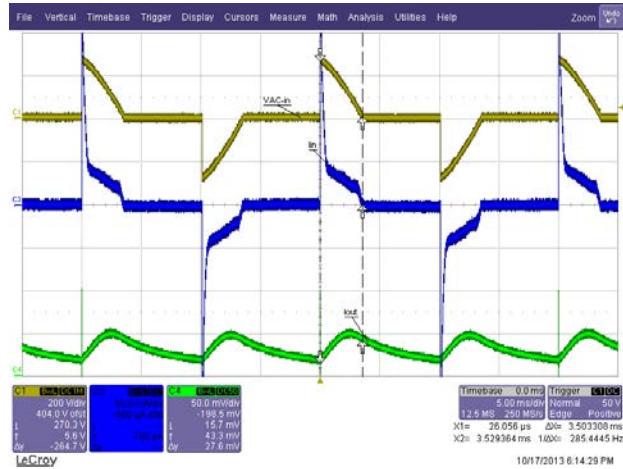


Figure 118 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

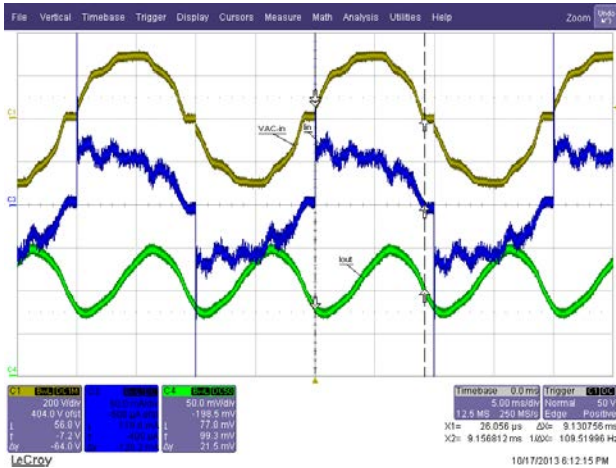


Figure 119 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

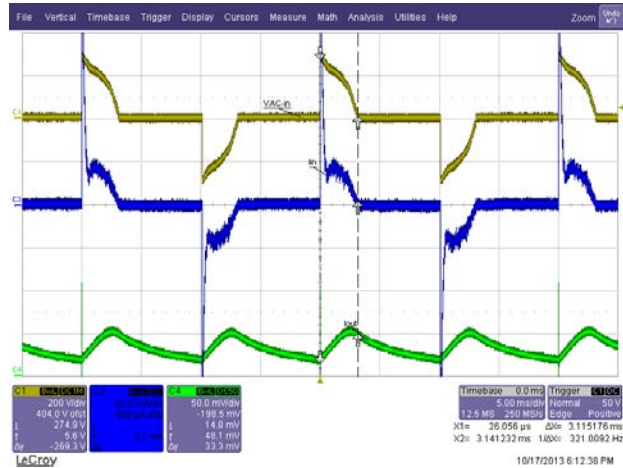


Figure 120 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: GIRA 1176 00 I03

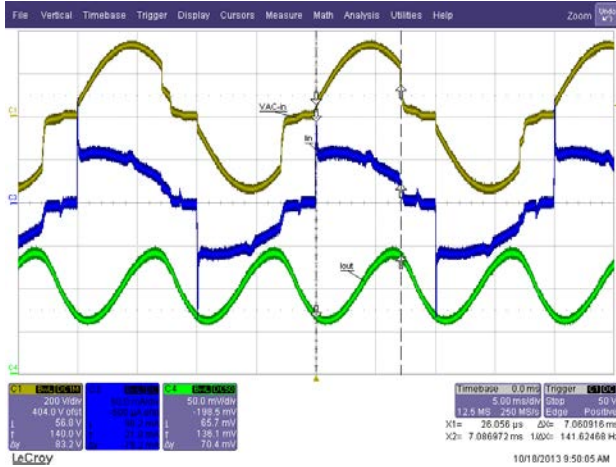


Figure 121 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

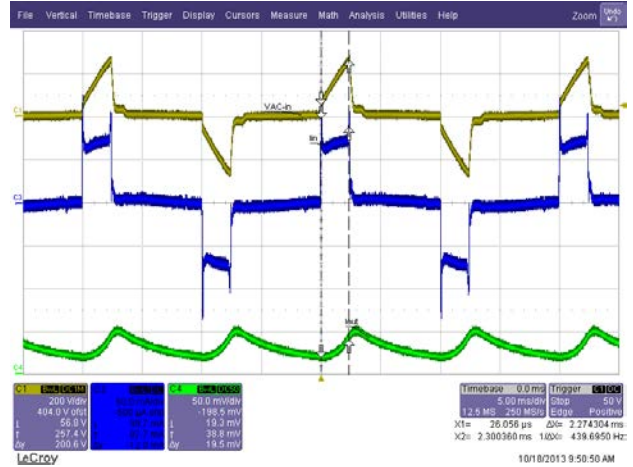


Figure 122 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

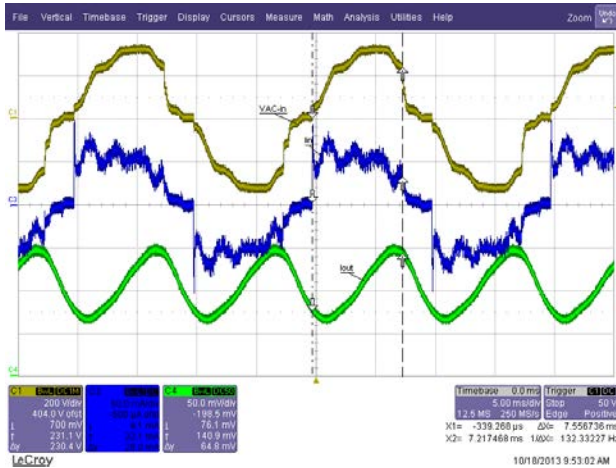


Figure 123 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

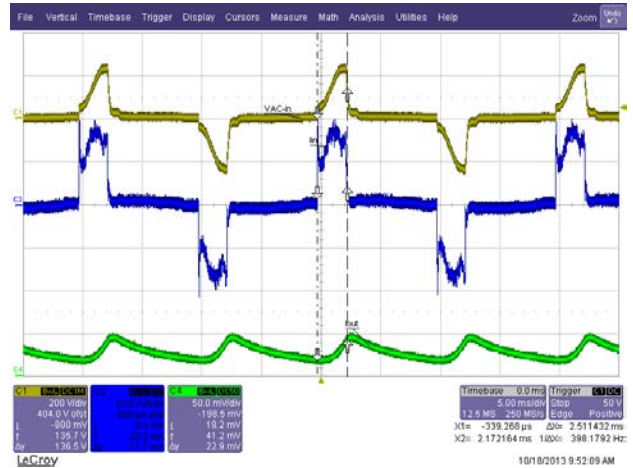


Figure 124 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-013

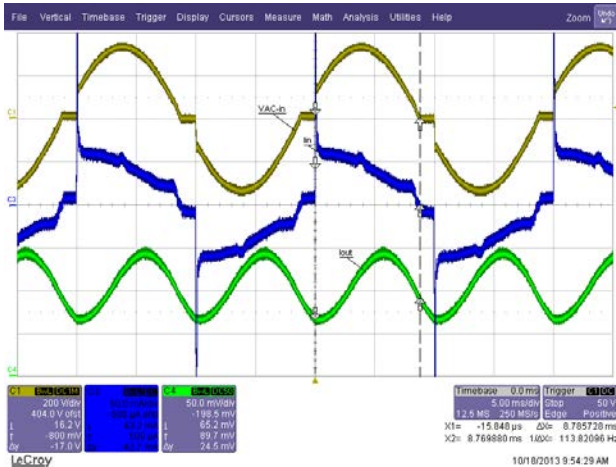


Figure 125 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

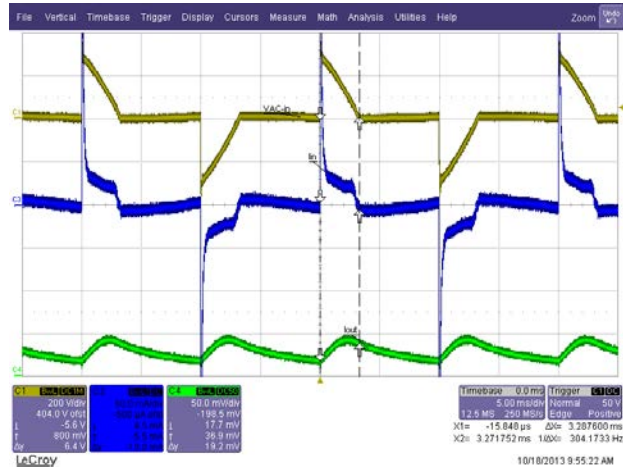


Figure 126 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

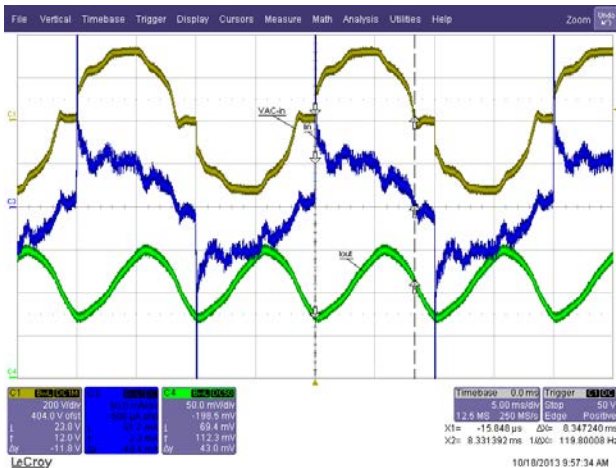


Figure 127 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

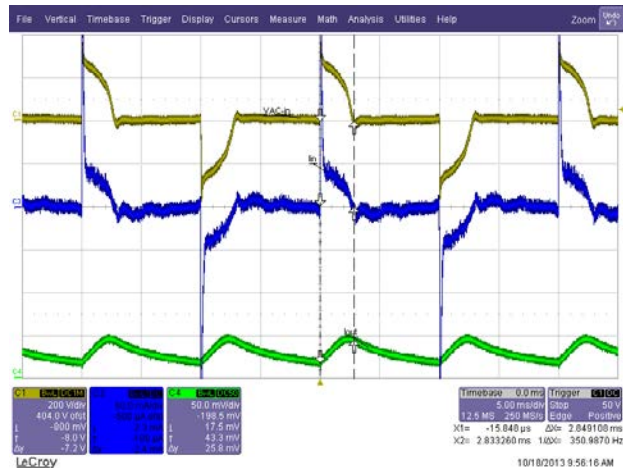


Figure 128 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-017

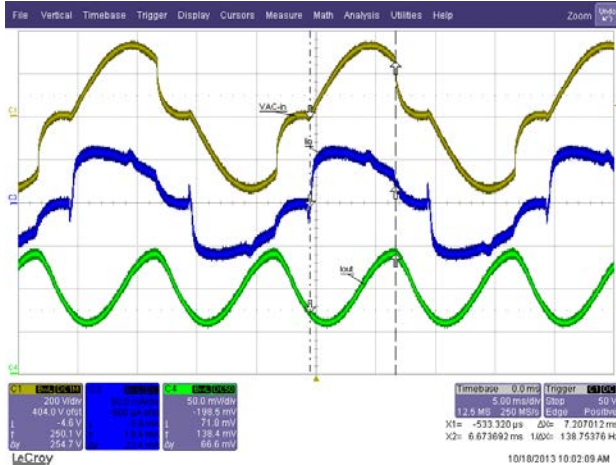


Figure 129 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

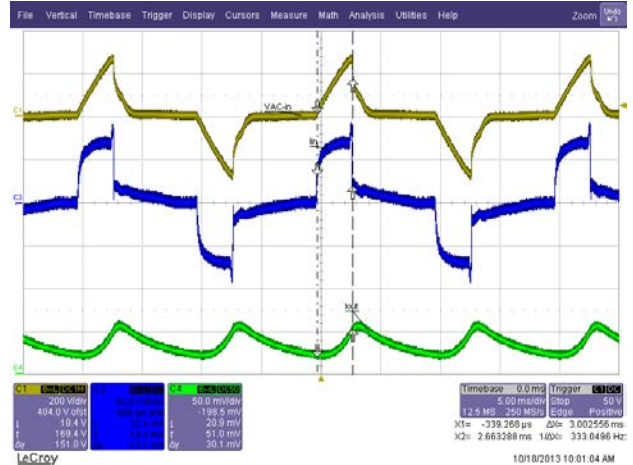


Figure 130 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

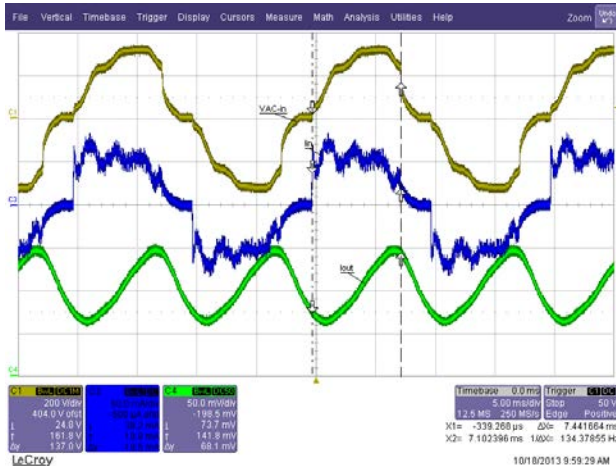


Figure 131 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

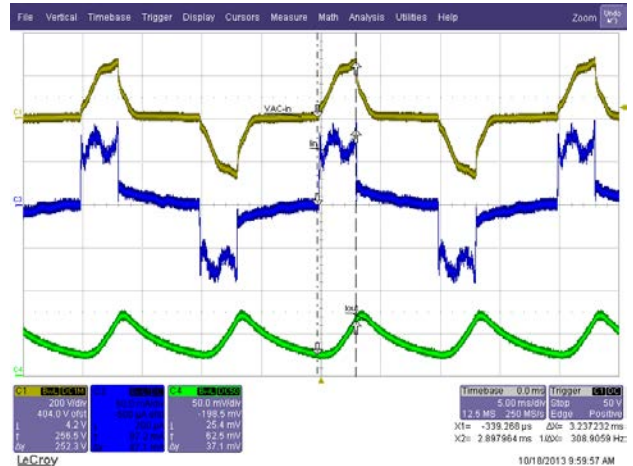


Figure 132 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-014

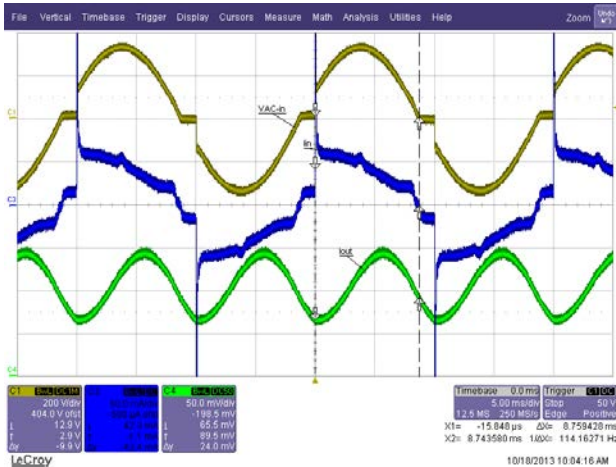


Figure 133 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

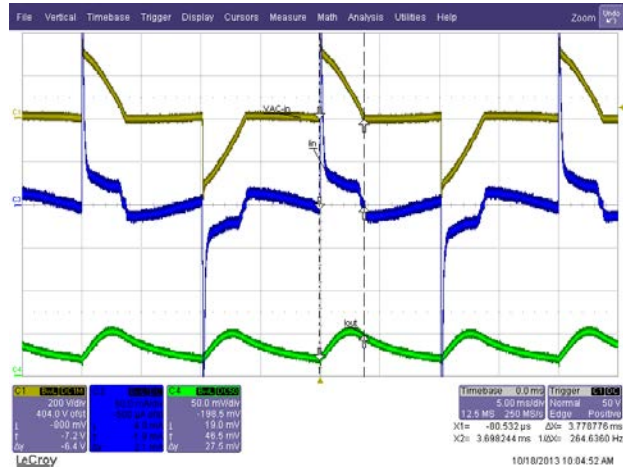


Figure 134 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

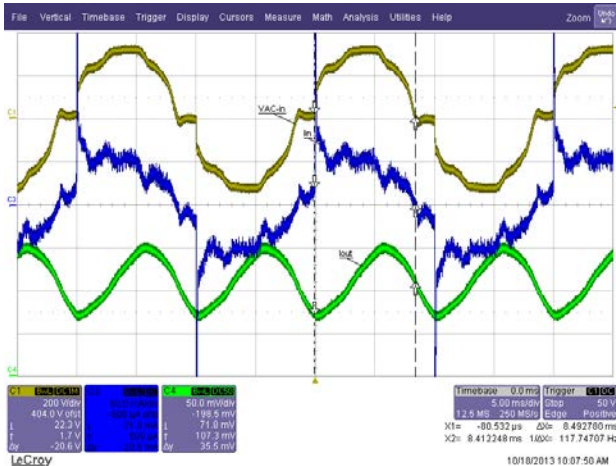


Figure 135 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

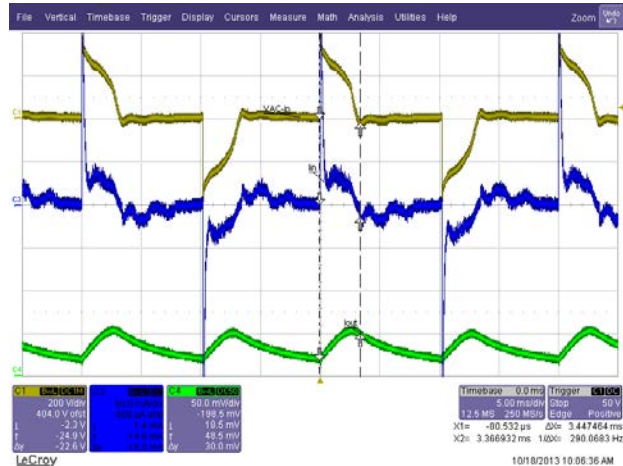


Figure 136 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-016

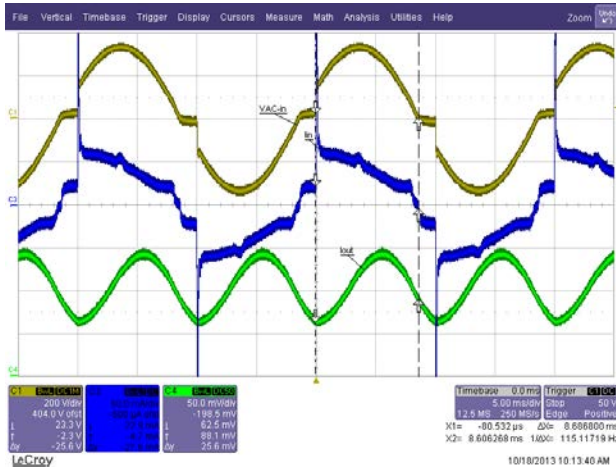


Figure 137 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

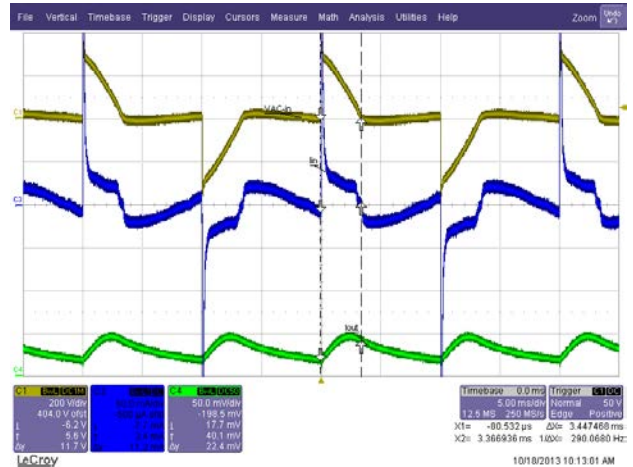


Figure 138 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

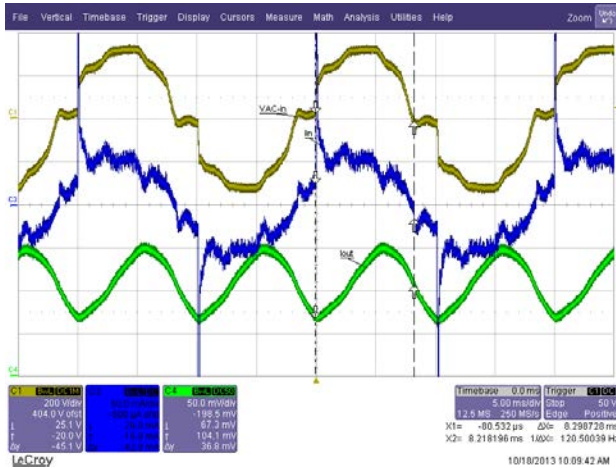


Figure 139 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

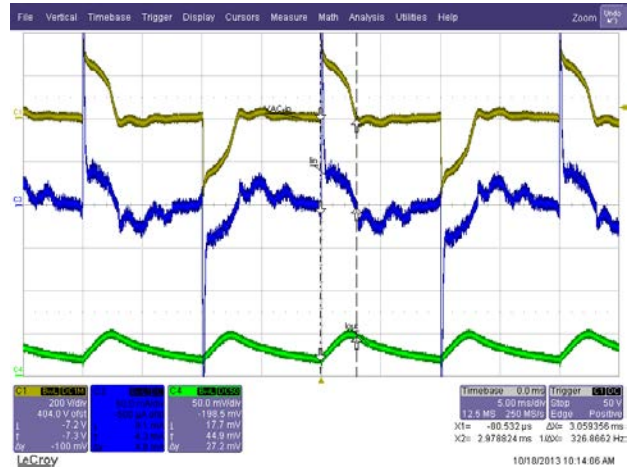


Figure 140 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250

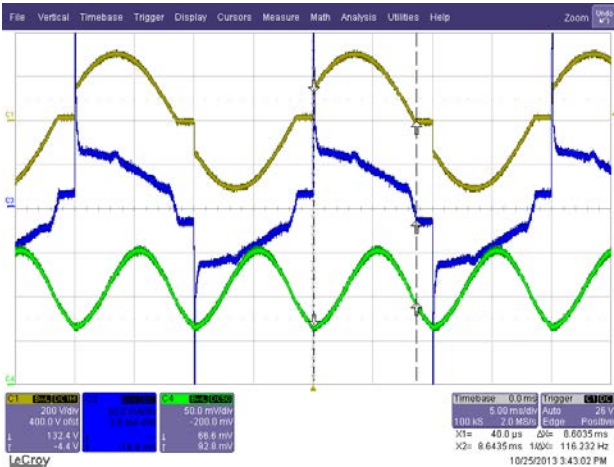


Figure 141 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

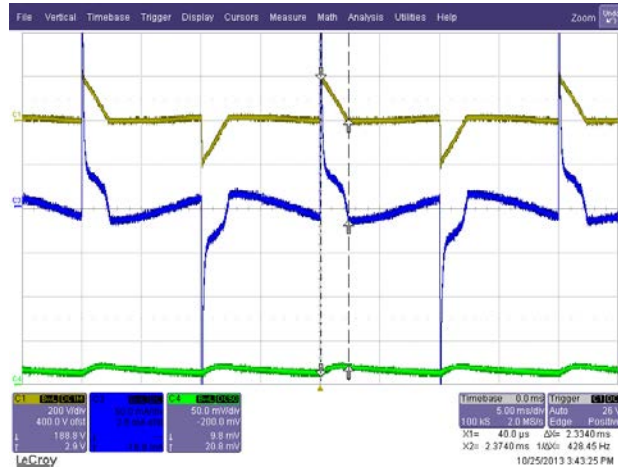


Figure 142 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

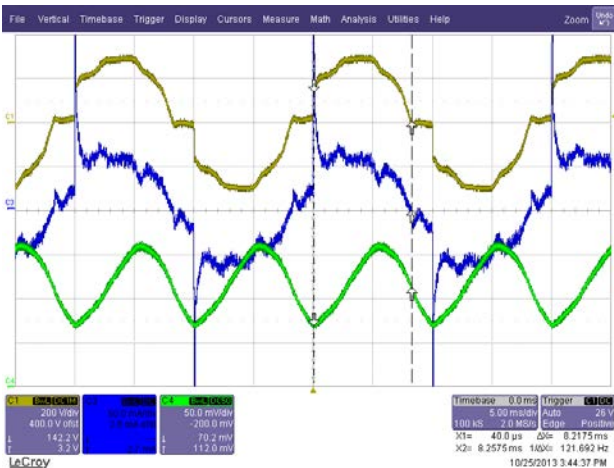


Figure 143 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

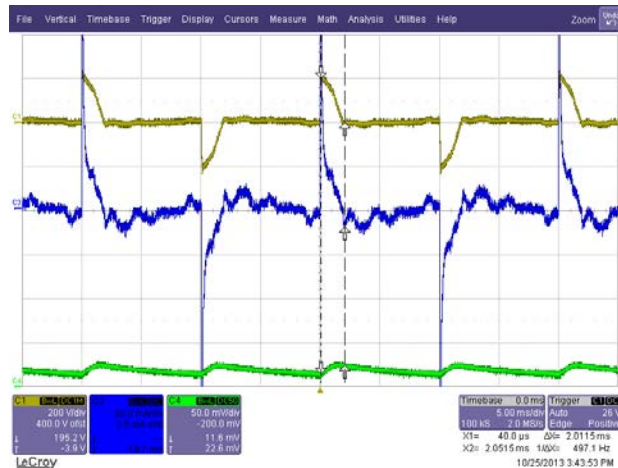


Figure 144 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 400 W

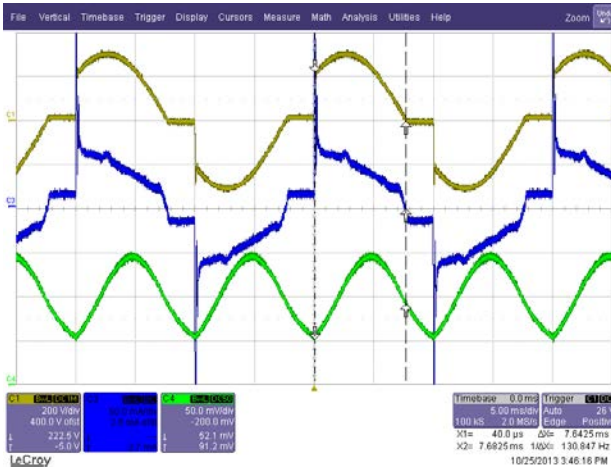


Figure 145 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50mA / div.
 Time Scale: 5 ms / div.

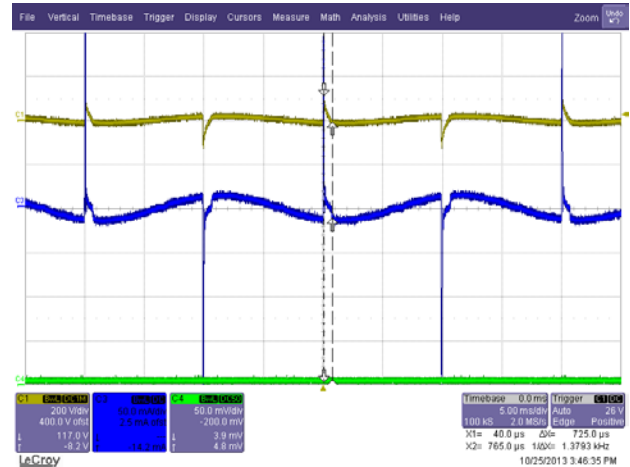


Figure 146 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

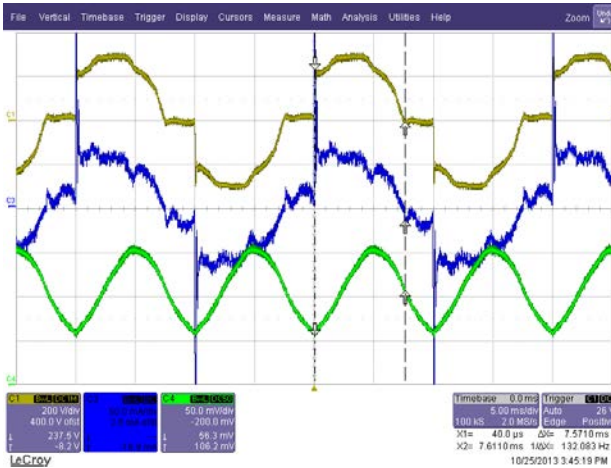


Figure 147 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

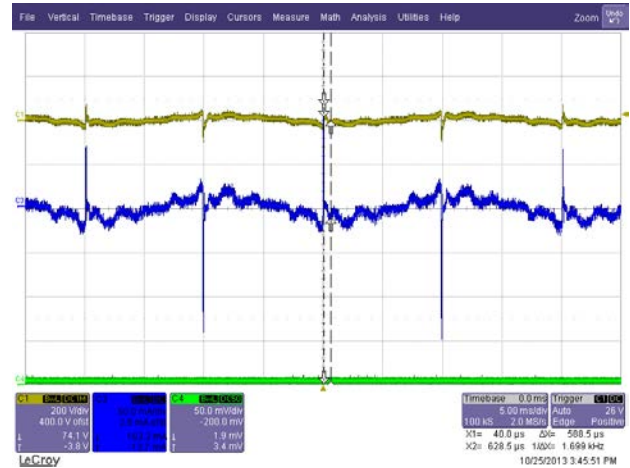


Figure 148 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Merten 572499

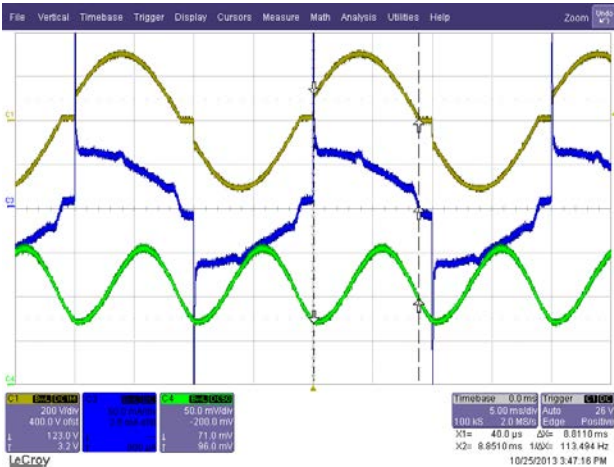


Figure 149 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

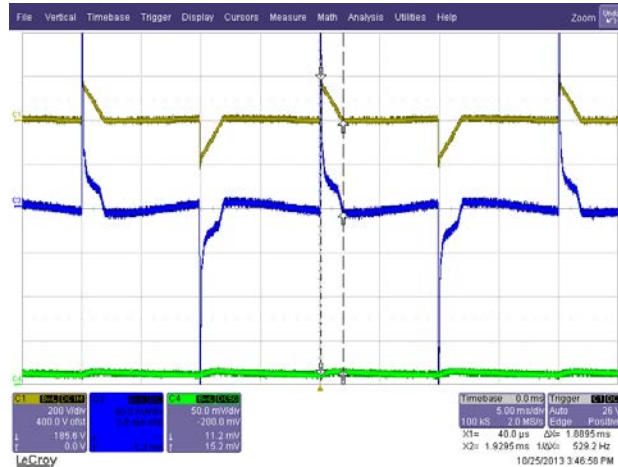


Figure 150 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

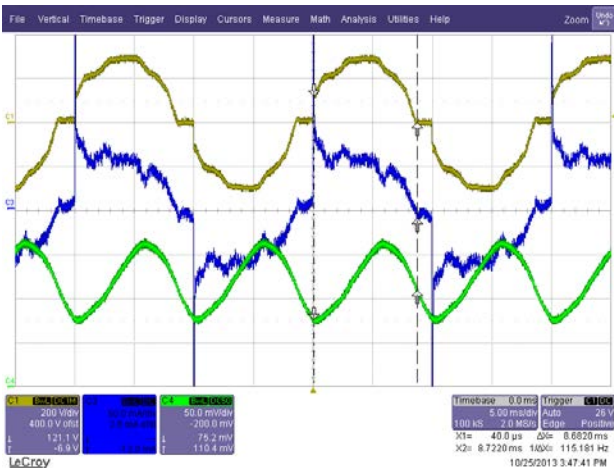


Figure 151 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

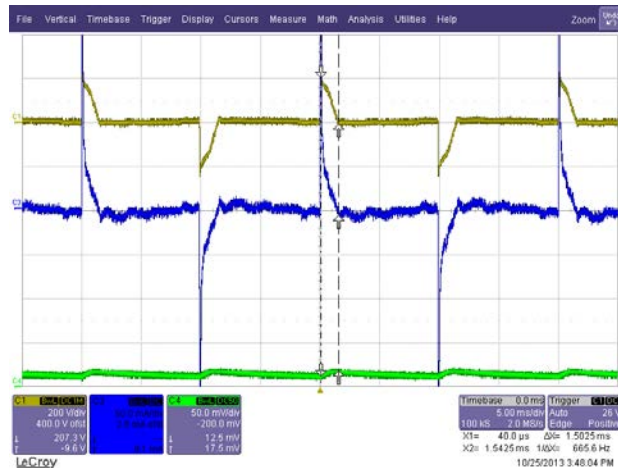


Figure 152 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6513

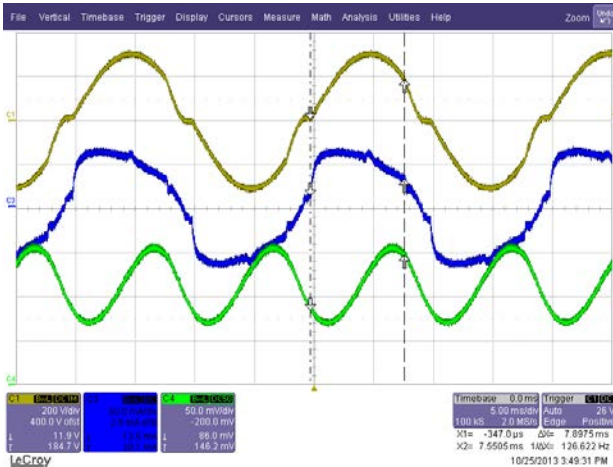


Figure 153 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

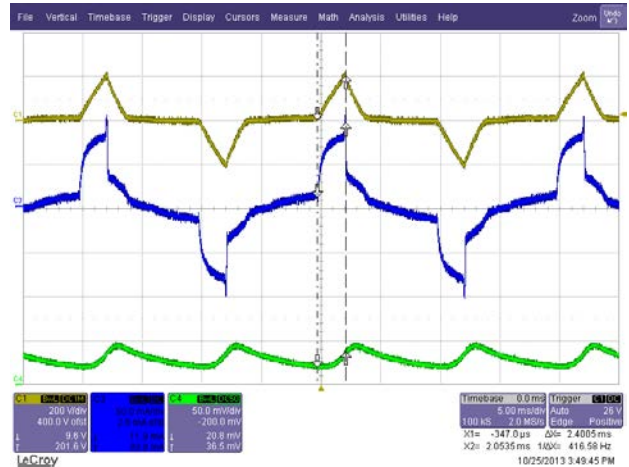


Figure 154 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

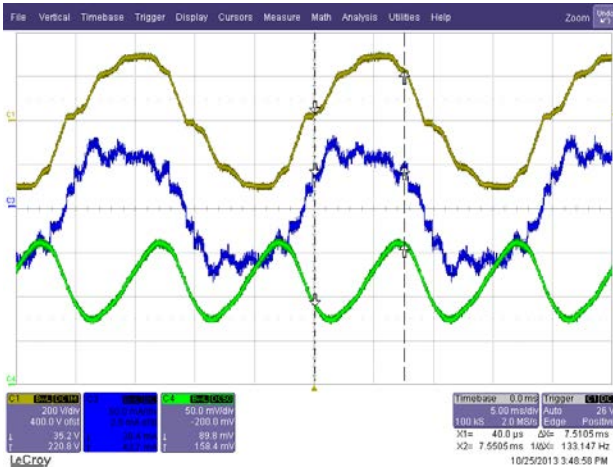


Figure 155 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

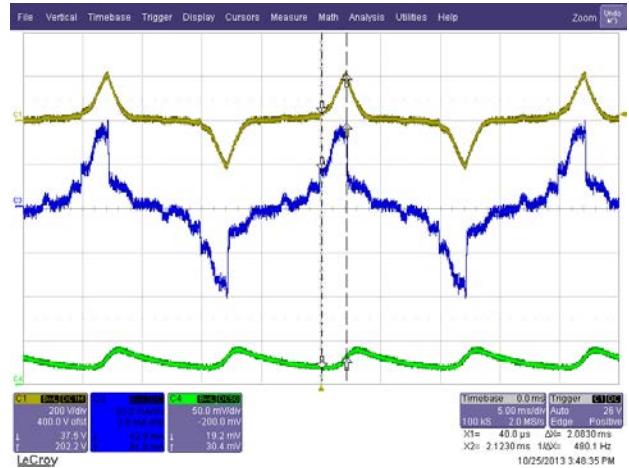


Figure 156 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Berker 2875

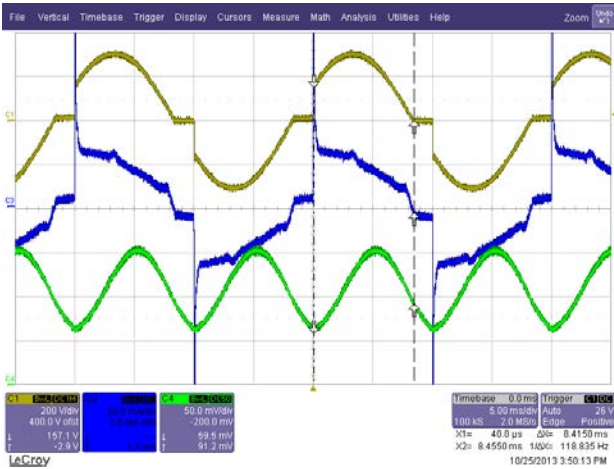


Figure 157 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

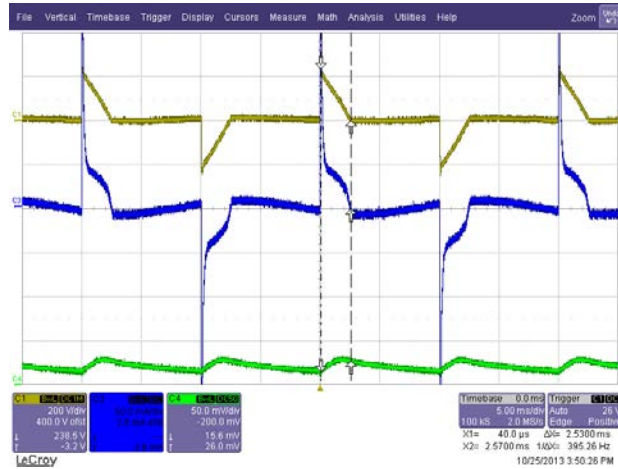


Figure 158 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

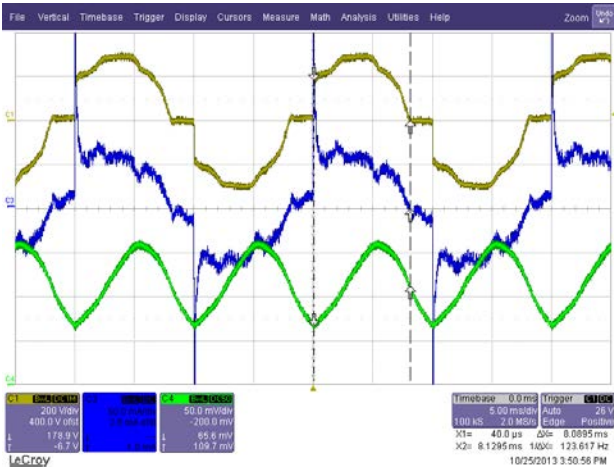


Figure 159 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

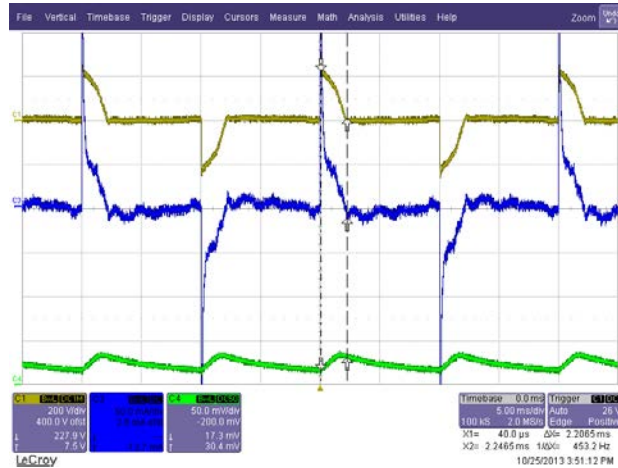


Figure 160 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Berker 2830-10

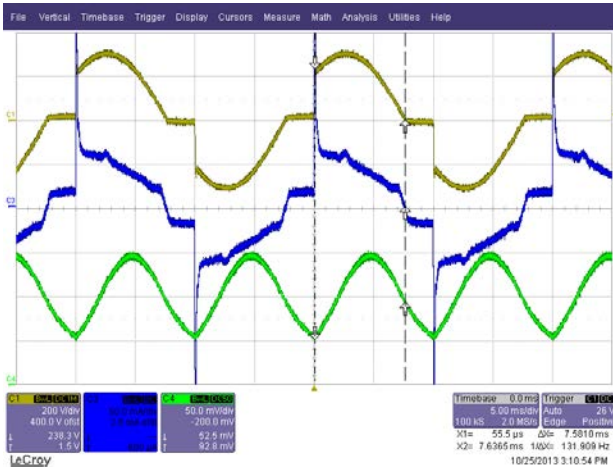


Figure 161 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

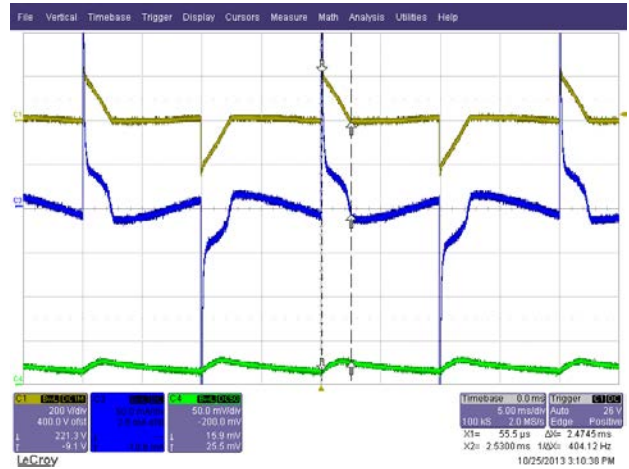


Figure 162 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

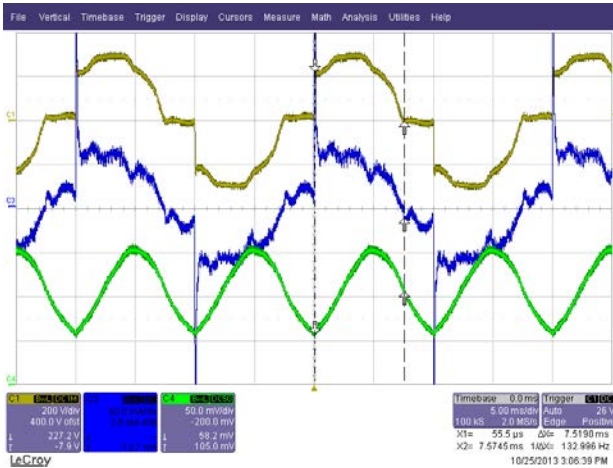


Figure 163 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

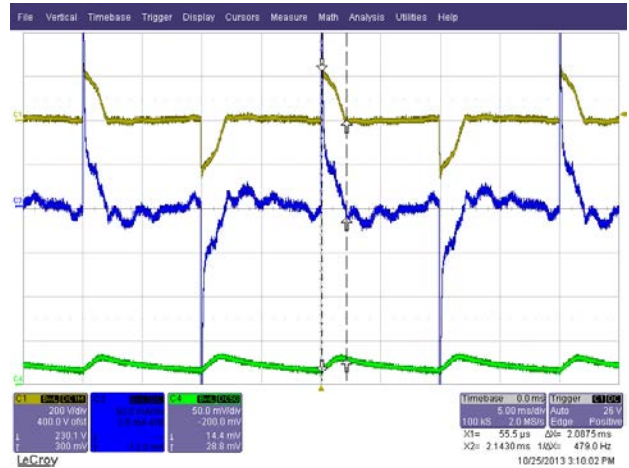


Figure 164 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6591-101

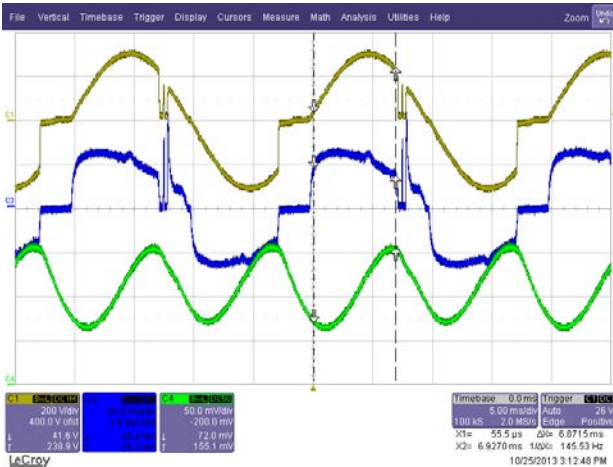


Figure 165 – Full Conduction from Regulated AC Input 230 V / 50 Hz. Natural characteristic of the dimmer is asymmetric.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

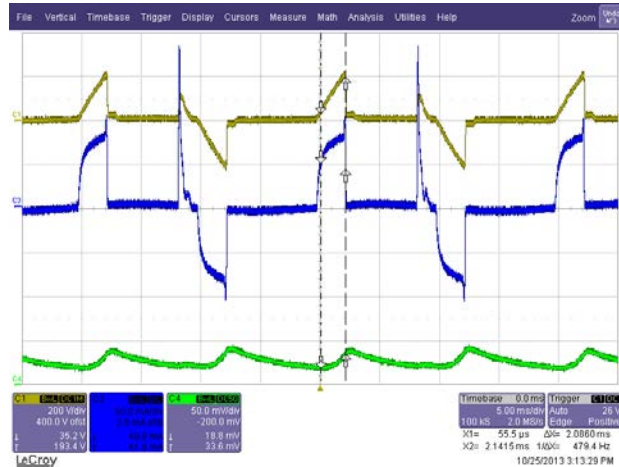


Figure 166 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

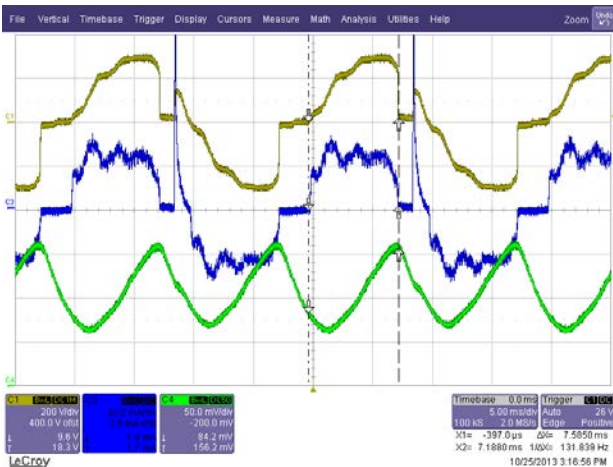


Figure 167 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

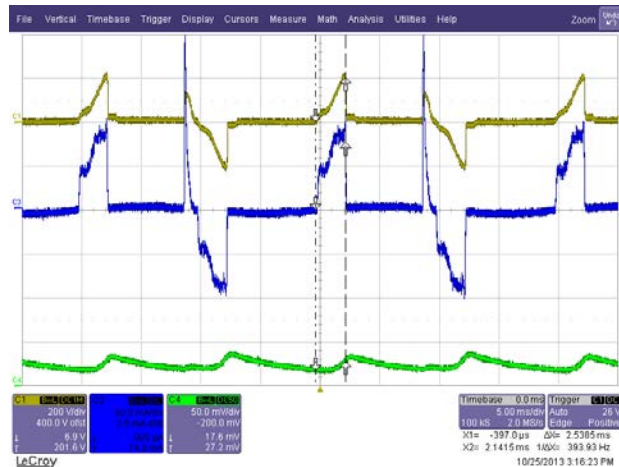


Figure 168 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6513 U-102

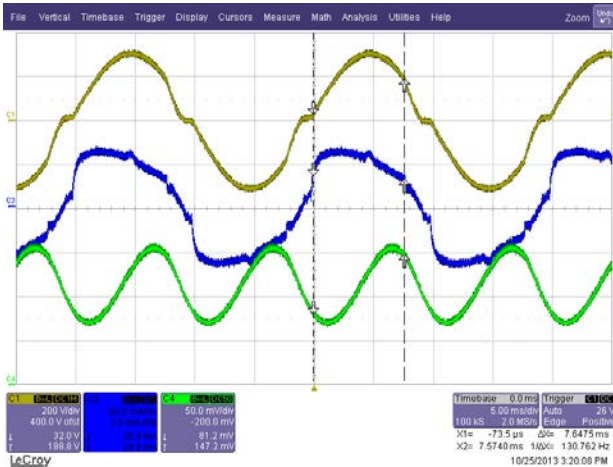


Figure 169 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

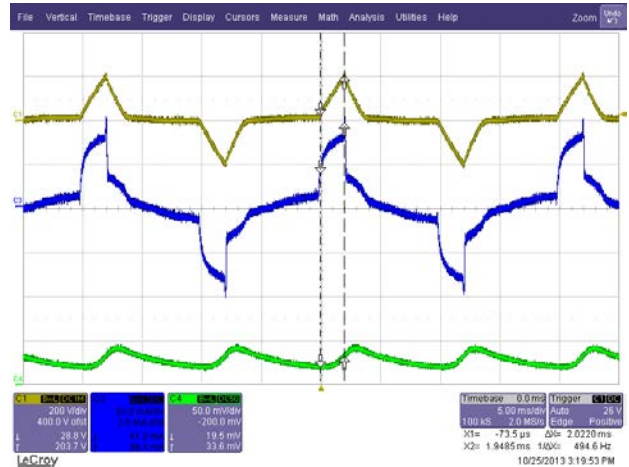


Figure 170 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

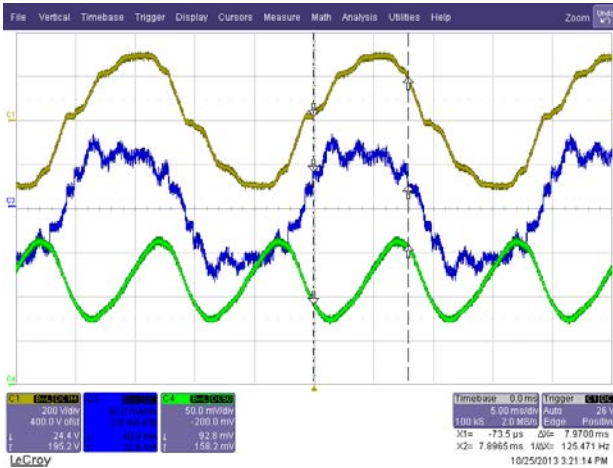


Figure 171 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

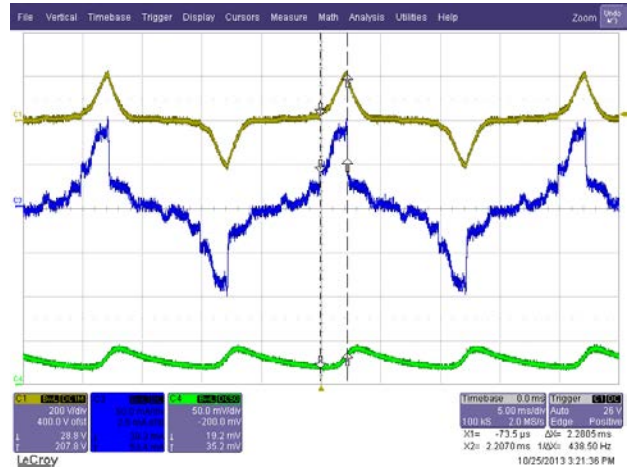


Figure 172 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 433HAB 0A

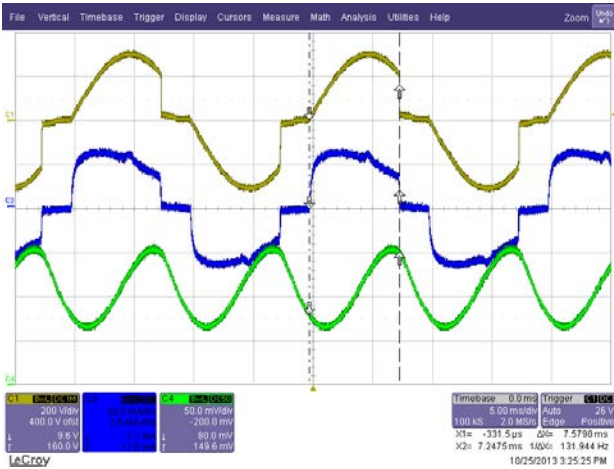


Figure 173 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

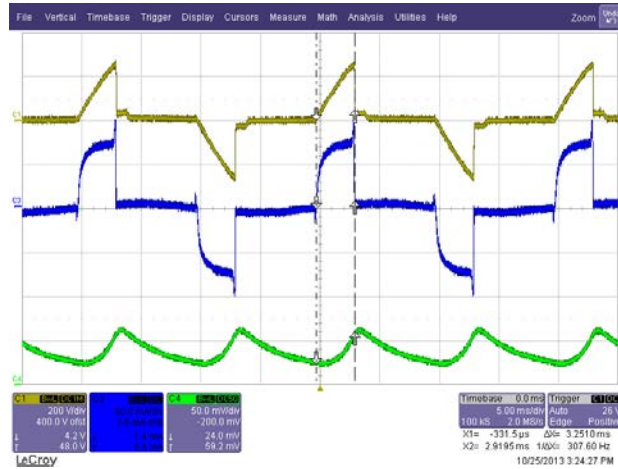


Figure 174 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

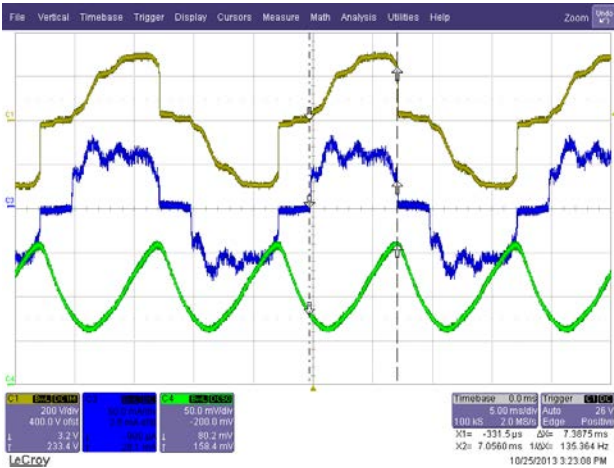


Figure 175 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

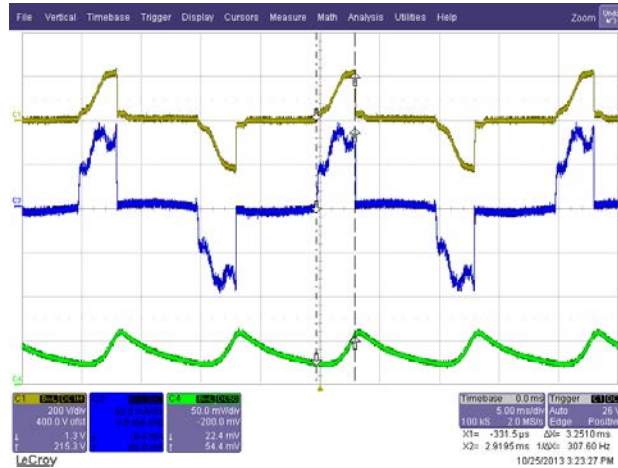


Figure 176 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 433HAB 0A

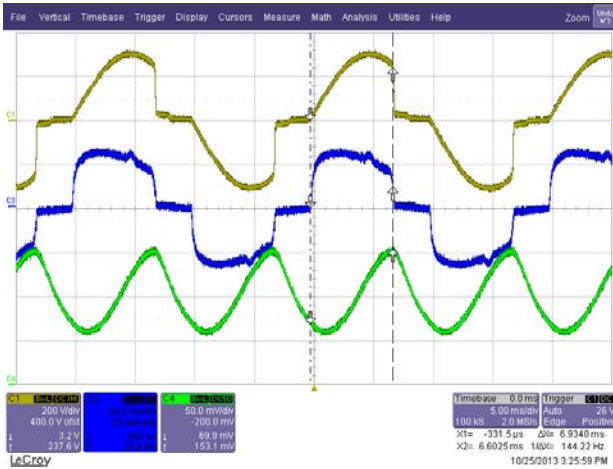


Figure 177 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

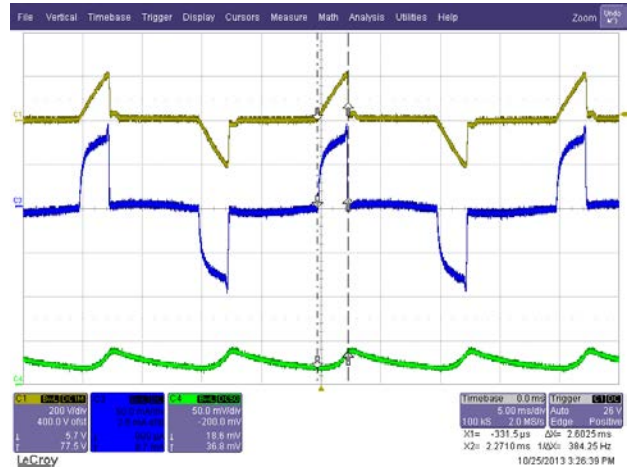


Figure 178 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

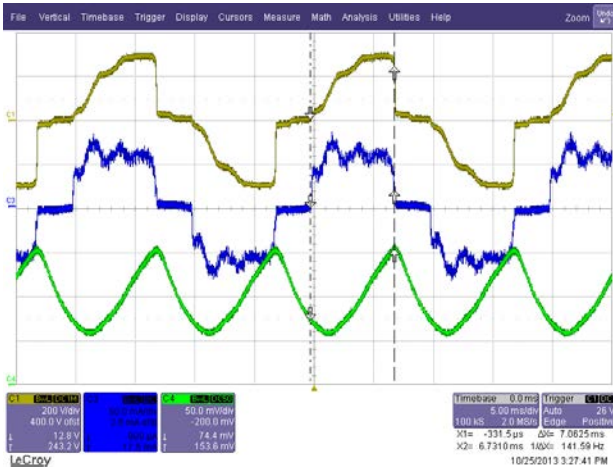


Figure 179 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

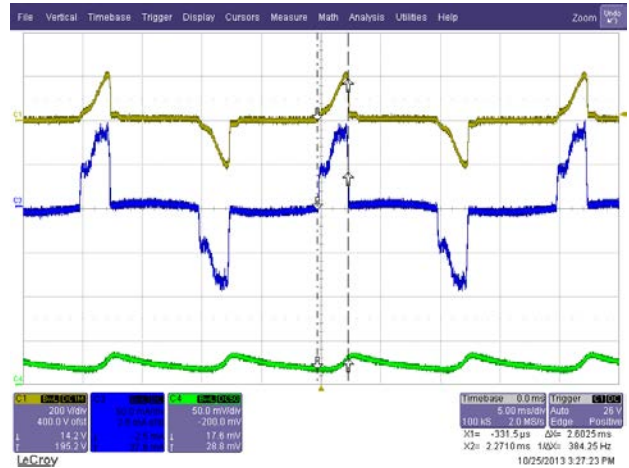


Figure 180 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Relco RM34DMA

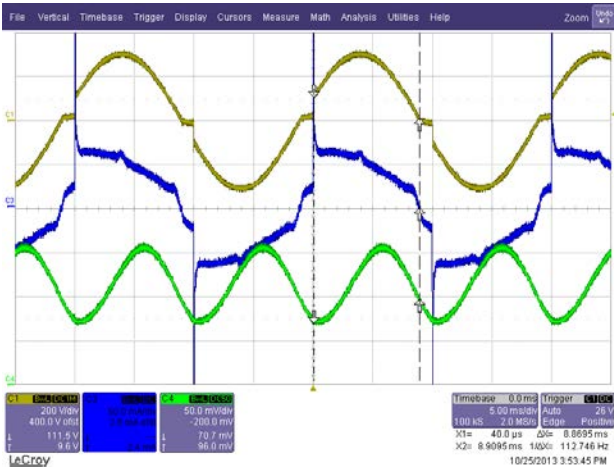


Figure 181 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

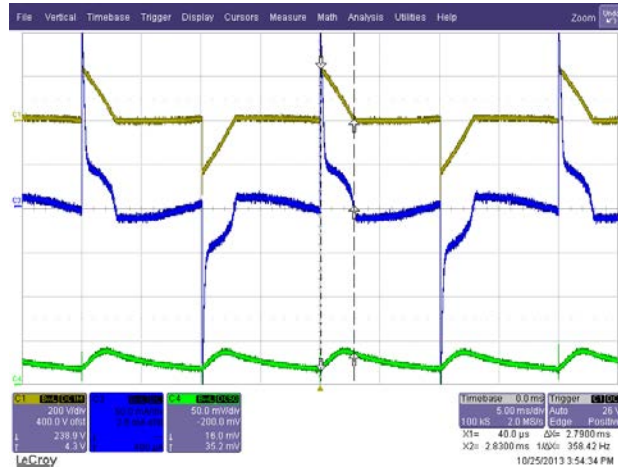


Figure 182 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

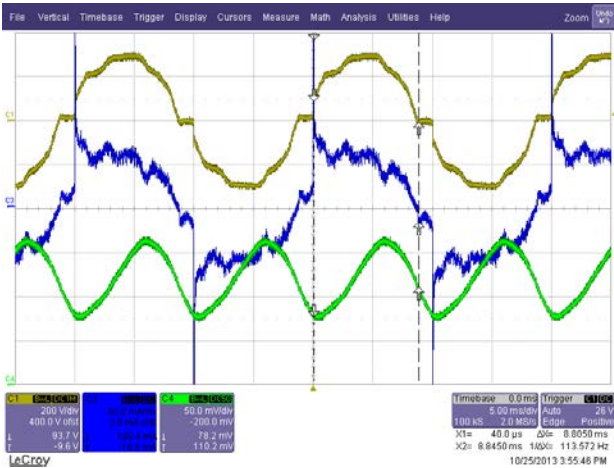


Figure 183 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

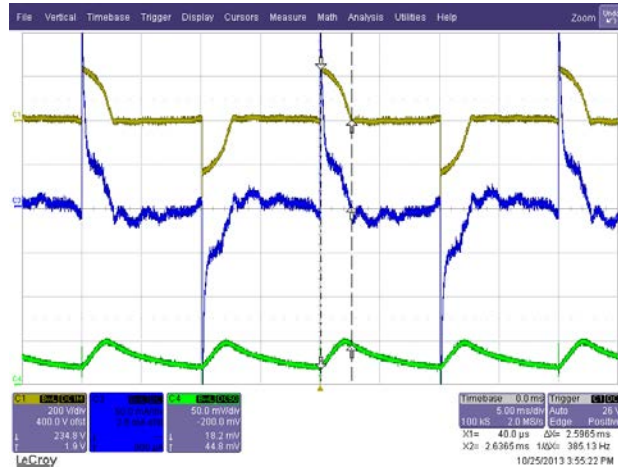


Figure 184 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5ms / div.



Dimmer: Relco RTM34LED DAXS

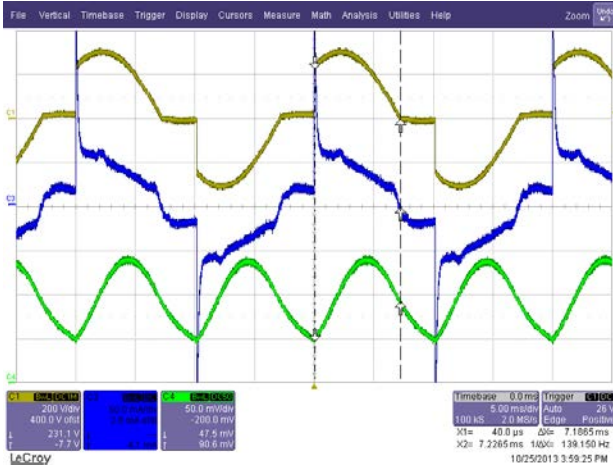


Figure 185 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

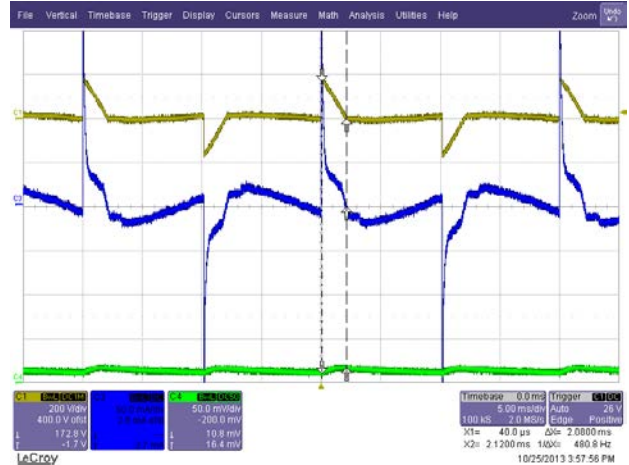


Figure 186 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

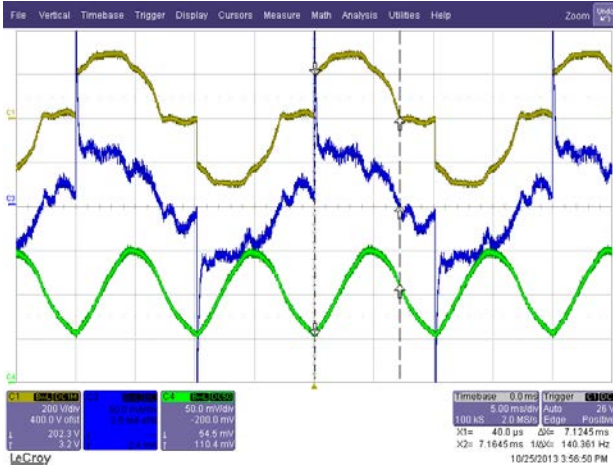


Figure 187 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

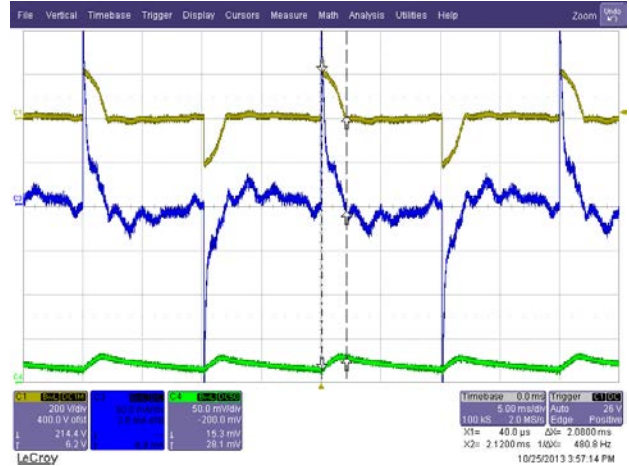


Figure 188 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RM34DMA

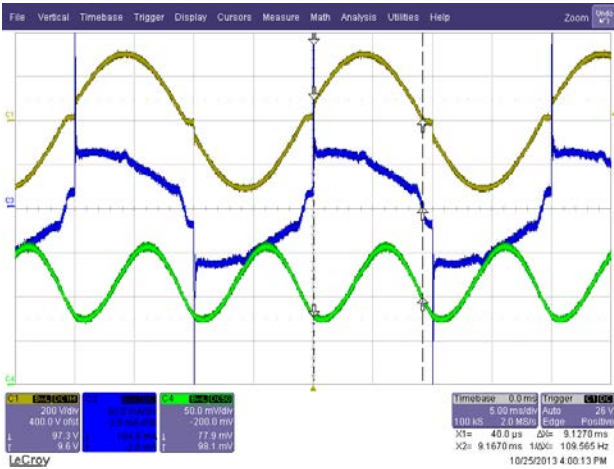


Figure 189 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

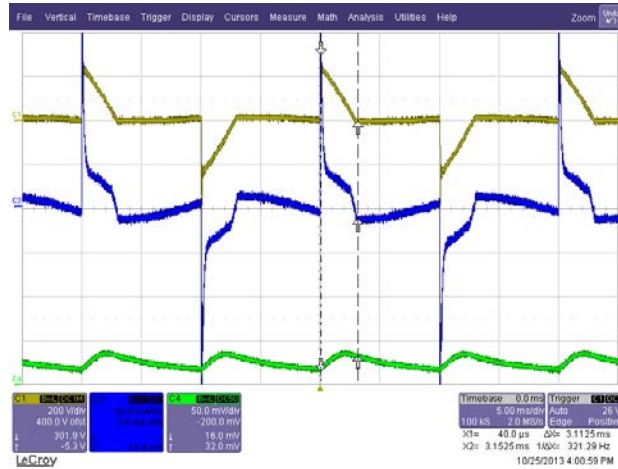


Figure 190 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

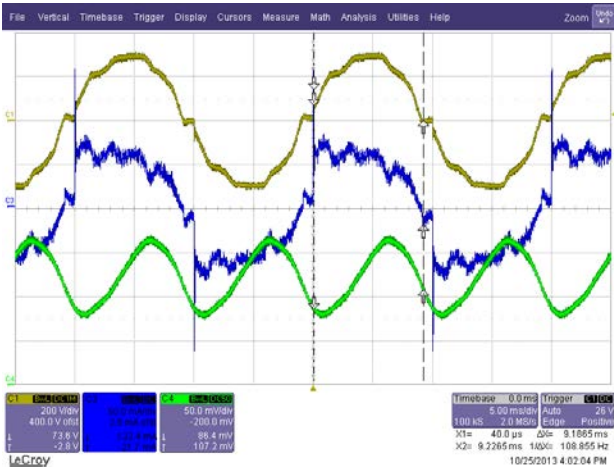


Figure 191 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

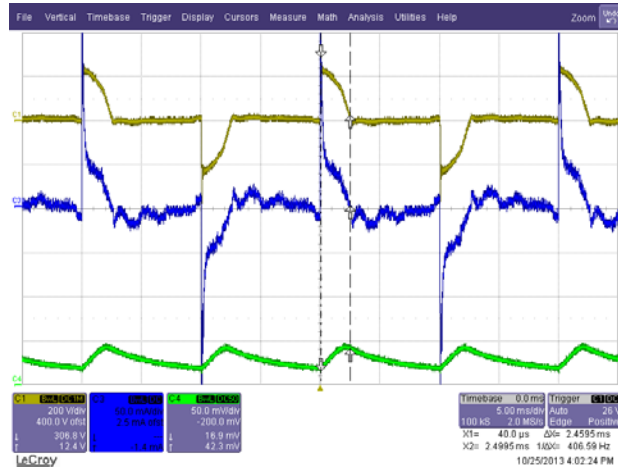


Figure 192 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RTS34.43 RLI

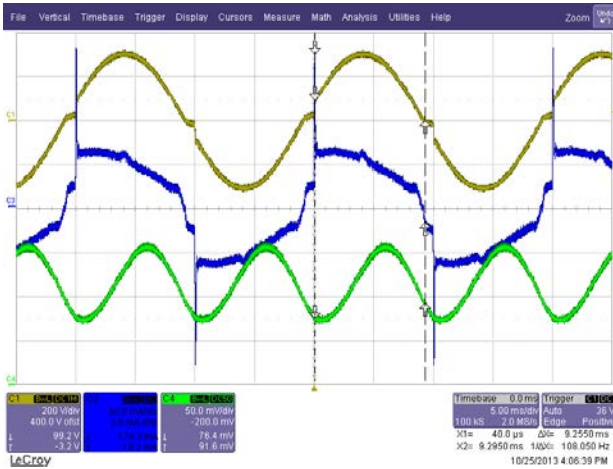


Figure 193 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

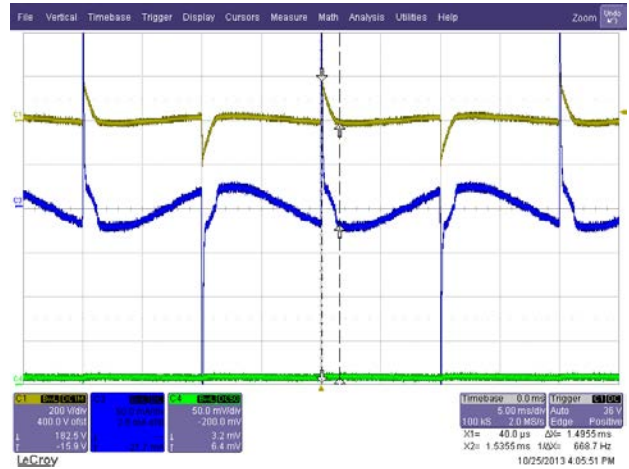


Figure 194 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

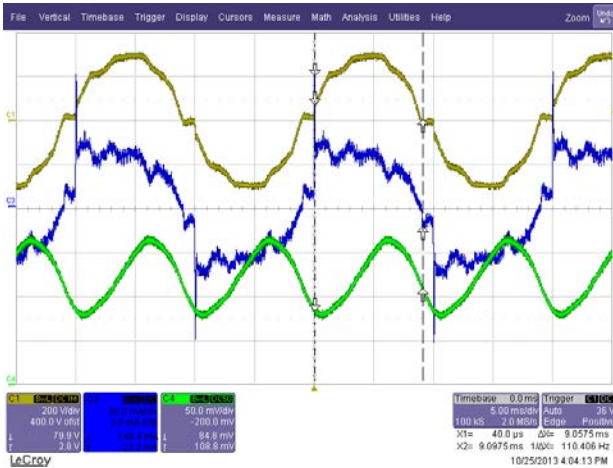


Figure 195 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

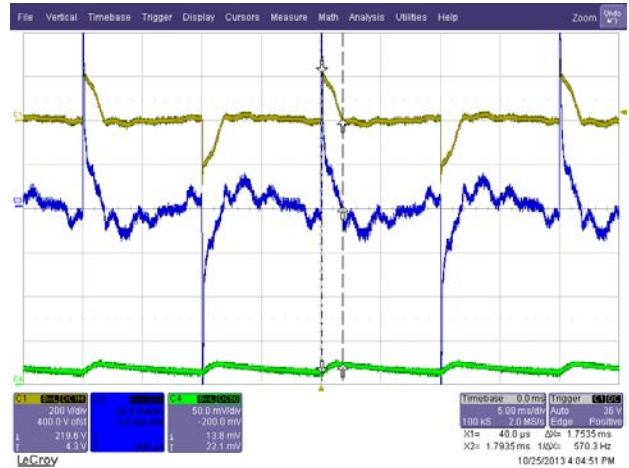


Figure 196 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RT34DSL

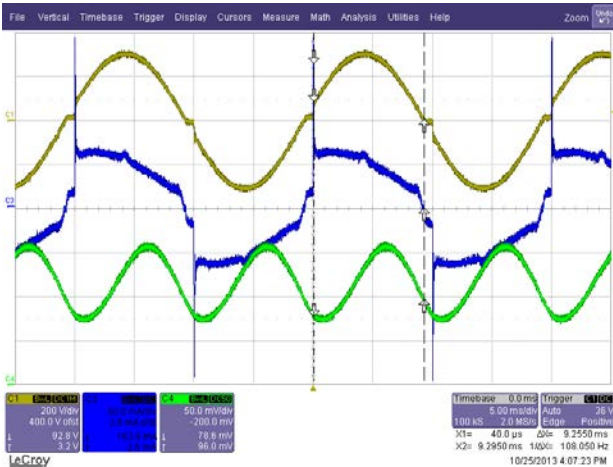


Figure 197 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

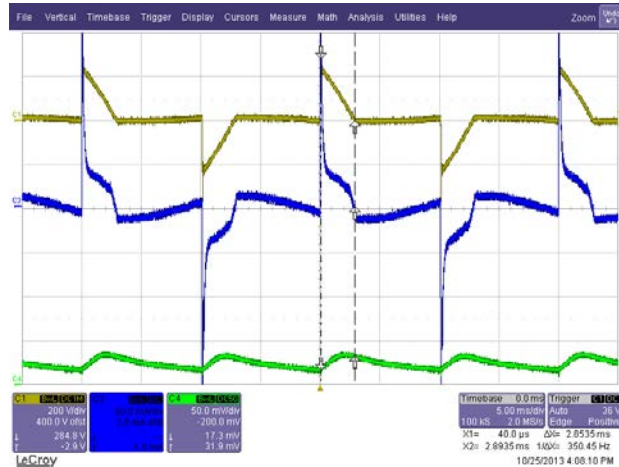


Figure 198 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

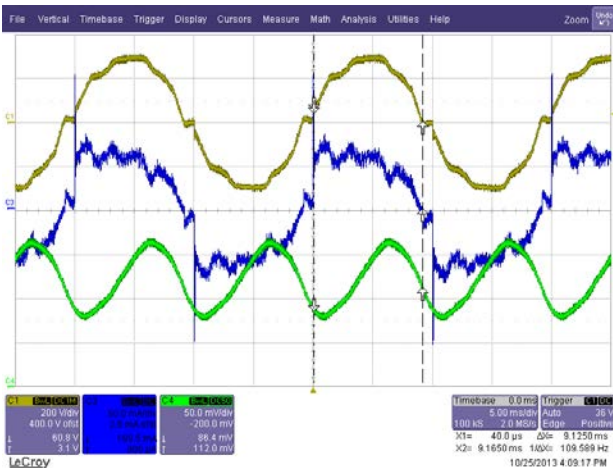


Figure 199 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

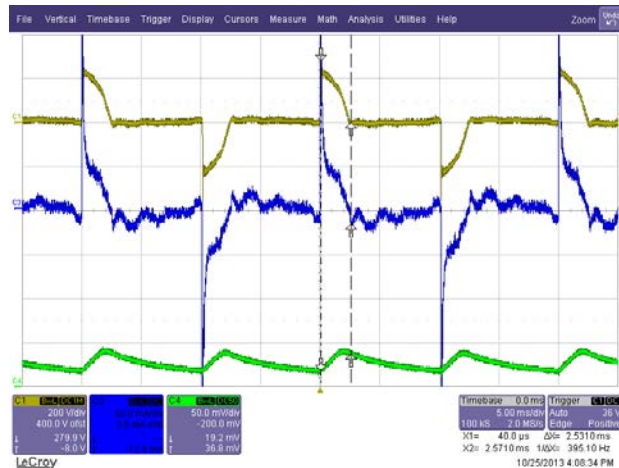


Figure 200 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450LM

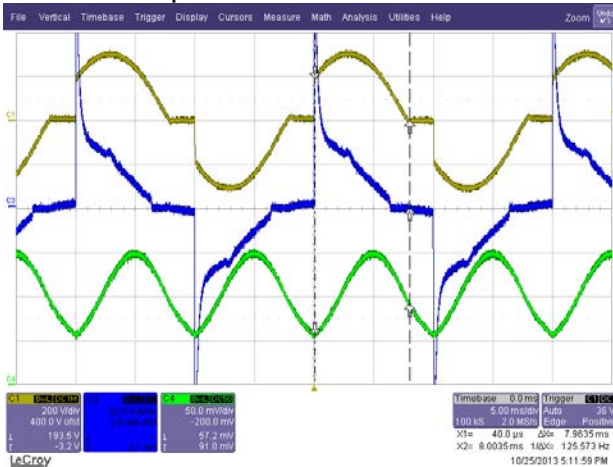


Figure 201 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

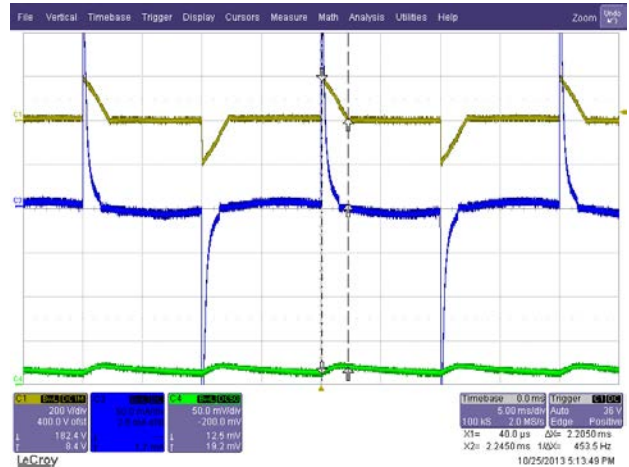


Figure 202 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

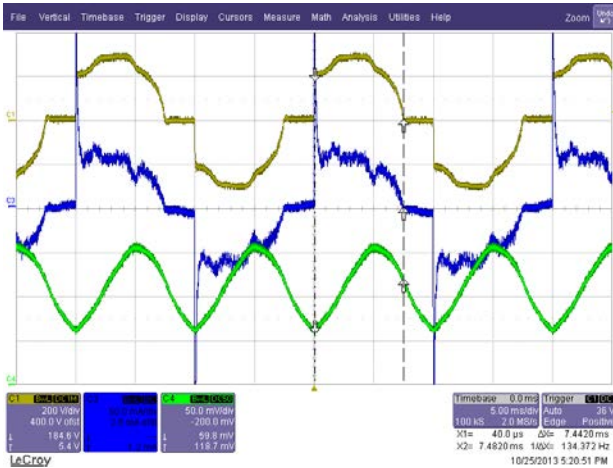


Figure 203 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

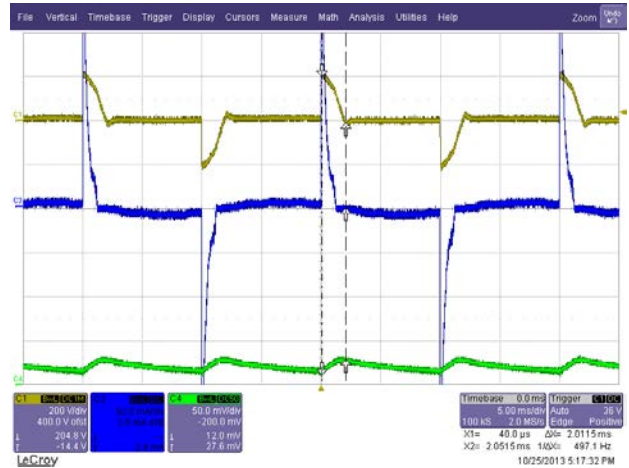


Figure 204 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450TM

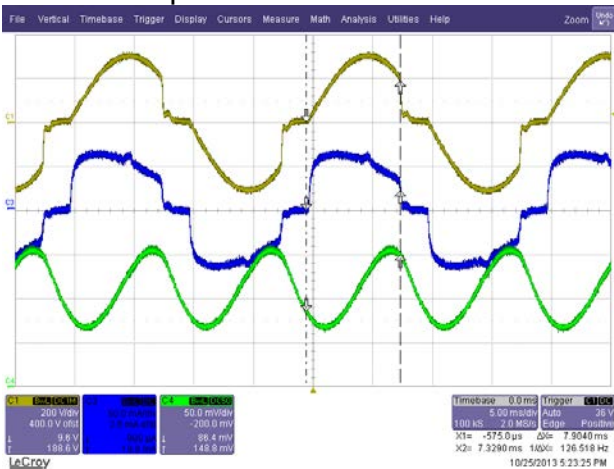


Figure 205 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

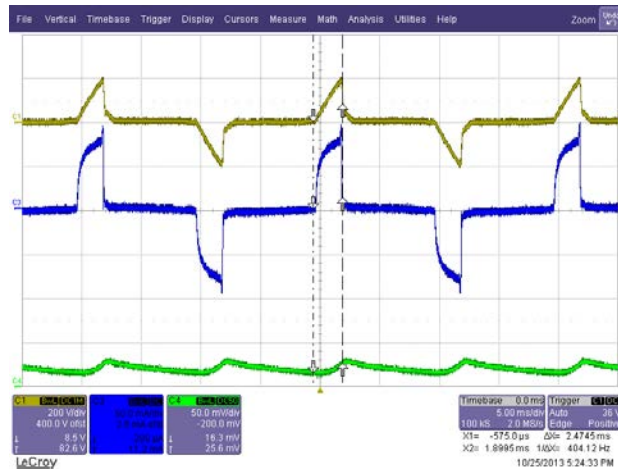


Figure 206 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

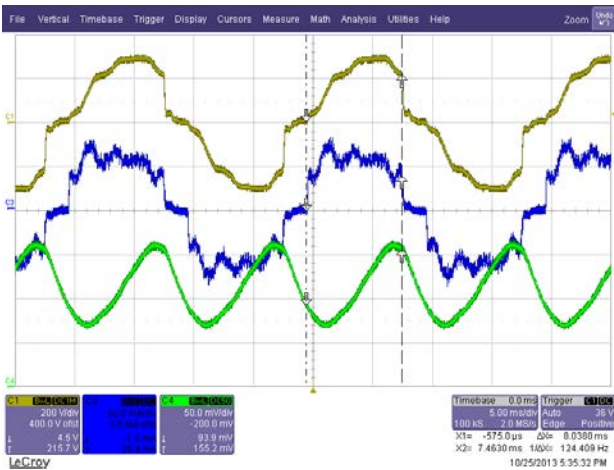


Figure 207 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

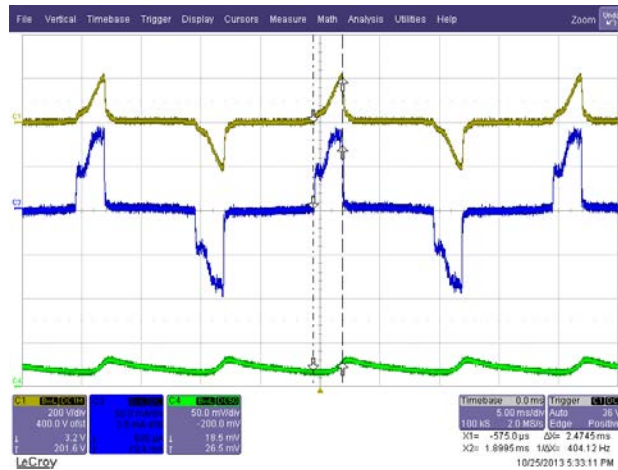


Figure 208 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

Dimmer: Clipsal 32E2CFLDM

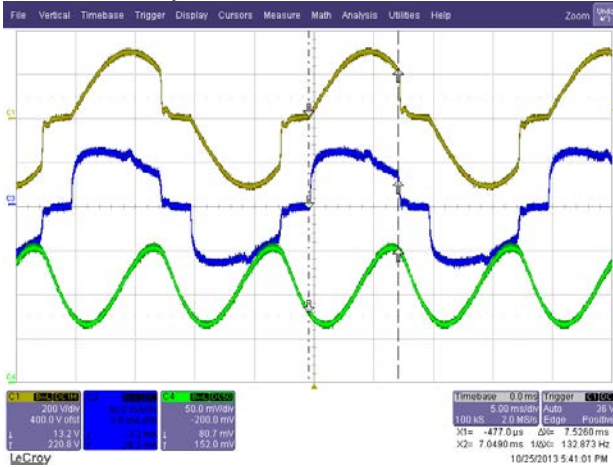


Figure 209 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

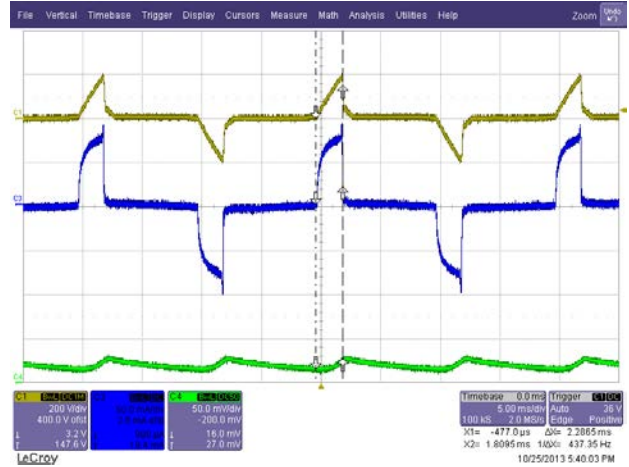


Figure 210 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

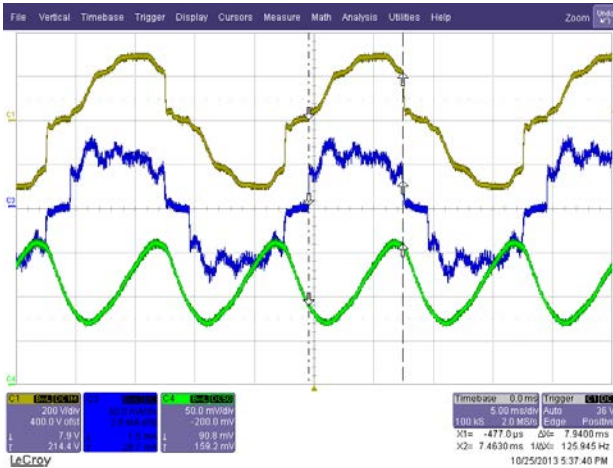


Figure 211 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

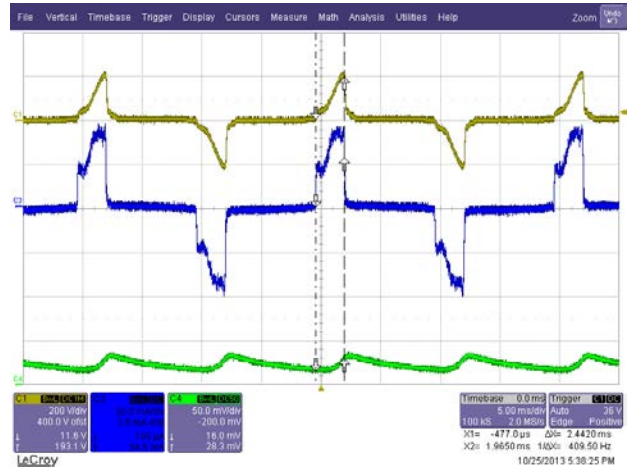


Figure 212 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450UDM

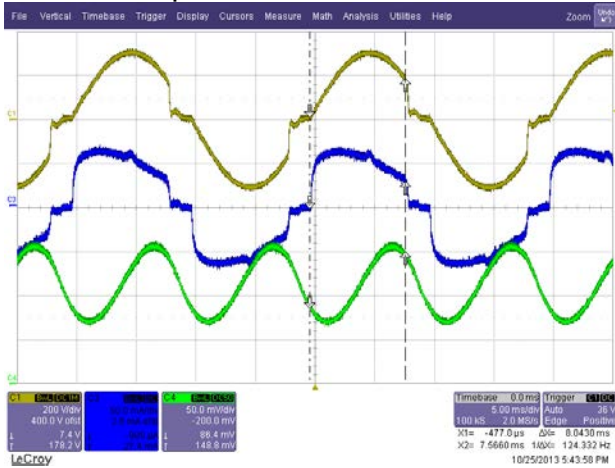


Figure 213 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

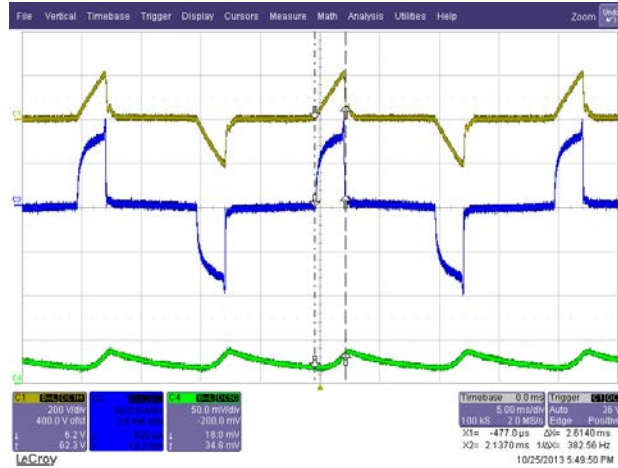


Figure 214 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

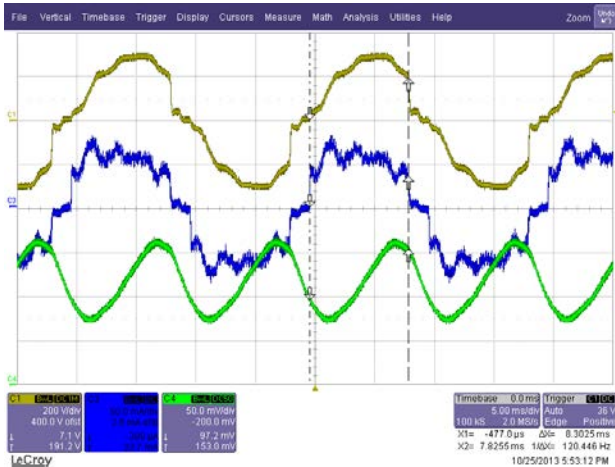


Figure 215 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

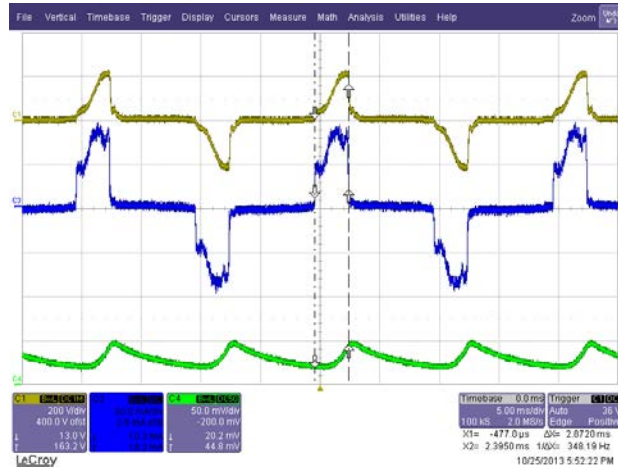


Figure 216 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



14 入力サージ

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.

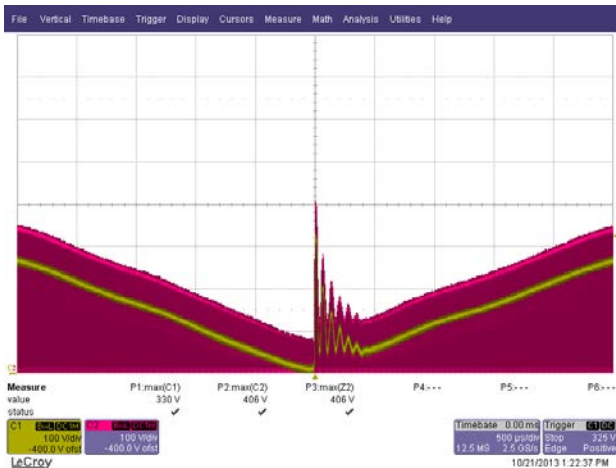


Figure 219 – Differential Ring Surge at 2500 V / 0°. Peak Drain Voltage Recorded is 406 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.

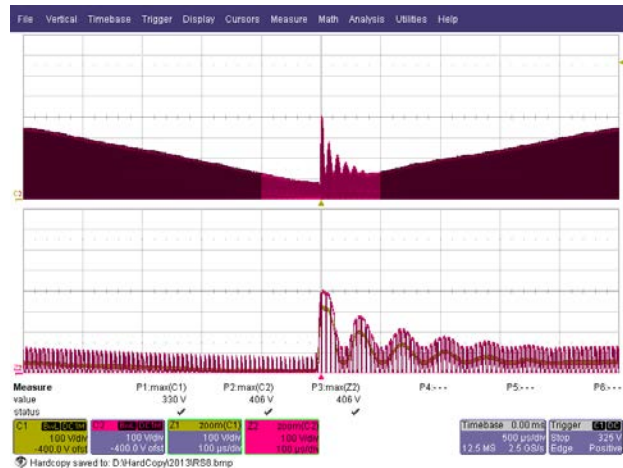


Figure 220 – Differential Ring Surge at 2500 V / 0°. Peak Drain Voltage Recorded is 406 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 100 μ s / div.





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.

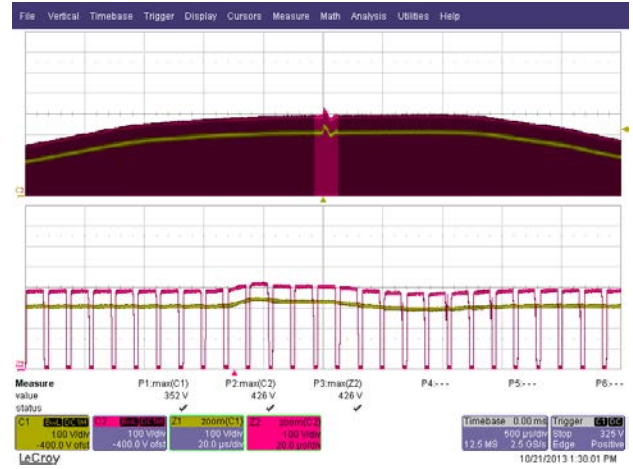


Figure 222 – Differential Ring Surge at 2500 V / 90°. Peak Drain Voltage Recorded is 426 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 20 μ s / div.



15 伝導 EMI



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



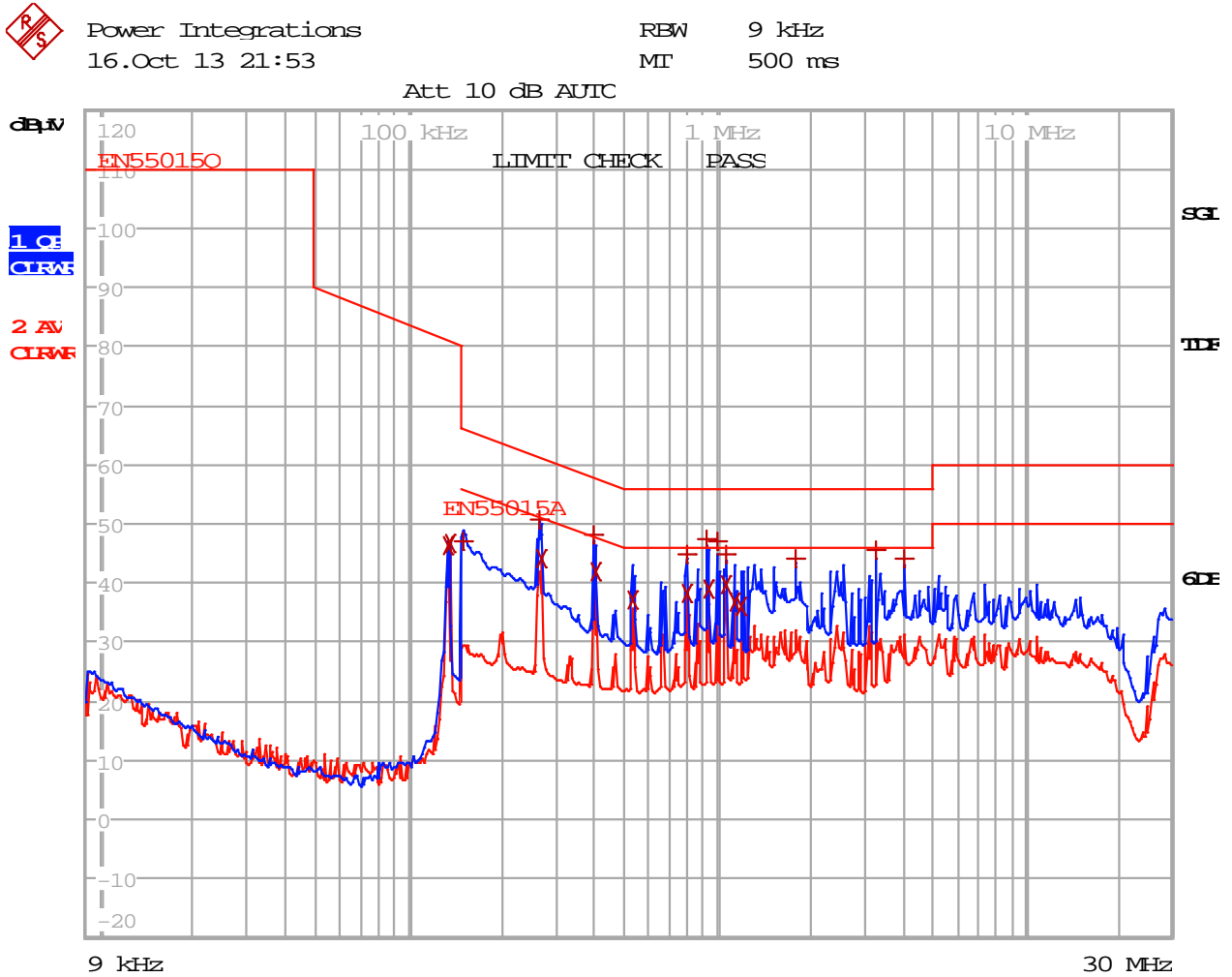


Figure 224 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Enclosed Unit in A19 Bulb Replacement.



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
 Trace2: EN55015A
 Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV		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 改訂履歷

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



最新の情報については、弊社ウェブサイト www.powerint.com

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