

설계 예제 보고서

제목	8W 디머블, 비절연 벽-부스트 LED 드라이버 (LYTSwitch™-4, LYT4322E 사용)
사양	195VAC - 265VAC 입력, 72V, 115mA 출력
애플리케이션	A19 LED 드라이버
작성자	애플리케이션 엔지니어링 부서
문서 번호	DER-404
날짜	2013 년 12 월 5 일
개정	1.0

요약 및 기능

- 일체형(single-stage) 역률 보정(230V에서 0.9 초과) 및 정확한 CC(정전류) 출력
- 디밍 기능과 높은 호환성
- 낮은 비용, 적은 부품 수 및 소형 PCB 풋프린트 솔루션
- 높은 에너지 효율, 240VAC 입력에서 84% 초과
- 고역률과 낮은 THD
- 최상의 성능 및 최종 사용자 환경
 - 빠른 스타트업 시간(150ms 미만) - 인지되는 지연 시간 없음
- 내장된 보호 및 안정성 기능
 - 단일 샷 무부하 보호 기능, 오토 리커버리 기능으로 출력 회로 단락 방지
 - 큰 히스테리시스(Hysteresis)가 있는 오토 리커버리 써멀 섯다운 기능으로 부품과 PCB 모두 보호
 - 브라운아웃 상태에서 손상 없음
- IEC 링 웨이브, 디퍼렌셜 라인 서지 및 EN55015 전도성 EMI 충족

특허 정보

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중요 사항:

이 기판은 안전 절연거리 요구 사항에 맞도록 설계되었지만 엔지니어링 프로토타입은 아직 기관 승인을 받지 않은 상태입니다. 따라서 **AC** 입력을 프로토타입 보드에 제공하도록 절연 트랜스포머를 사용하여 모든 테스트를 수행해야 합니다.



1 소개

이 문서에서는 단면 PCB 에 초소형 벅-부스트 토폴로지의 LYTSwitch-4 제품군 (LYT4322E)을 사용하는 경제적인 LED 디머블 파워 서플라이 드라이버에 대해 설명합니다.

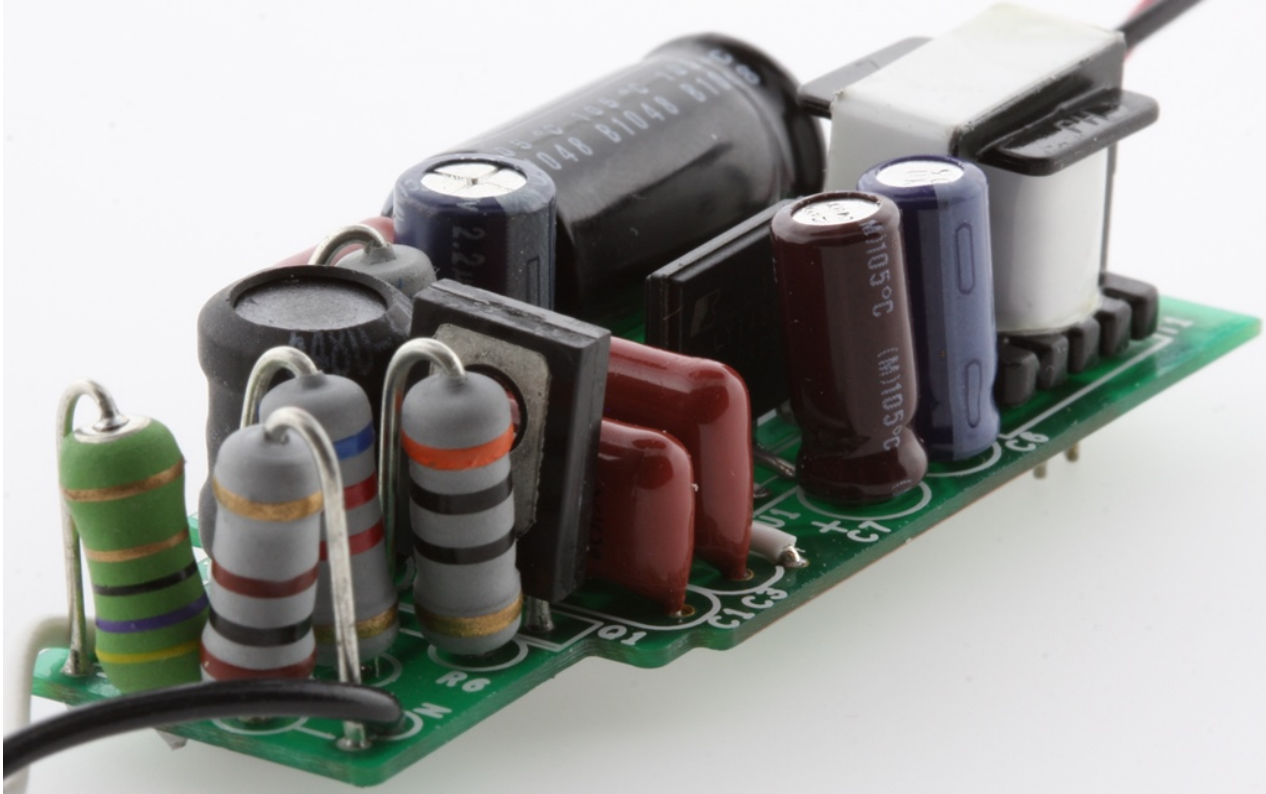


Figure 1 – Sample Unit.

이 파워 서플라이는 195VAC~265VAC의 입력 전압 범위에서 작동하며, 일체형(single stage) 액티브 PFC 및 낮은 고조파 왜곡을 갖추고 있어 산업용 및 상업용 애플리케이션에 적합합니다. 이 LED 드라이버는 리딩 및 트레일링 엣지 디머를 위한 디머 기능을 지원하며 대부분의 독일, 이탈리아, 오스트레일리아 및 중국 디머와 호환됩니다.

오픈 루프 및 출력 단락 회로 상태에 대비한 오토-리스타트와 라인 고장 및 라인 서지 내성을 강화하는 입력 과전압 보호 기능과 같은 기타 기능이 디바이스에 통합되어 있습니다. 또한 모든 조건에서 평균 PCB 온도를 안전하게 유지하는 정확한 히스테리시스(Hysteresis) 쉼 설정 기능도 포함되어 있습니다. 이러한 집적 기술을 통해 필요한 개별 부품의 수를 최소화합니다.

이 문서에는 LED 드라이버 사양, 회로도, PCB 정보, BOM, 트랜스포머 규격 및 일반 성능 특성이 설명되어 있습니다.



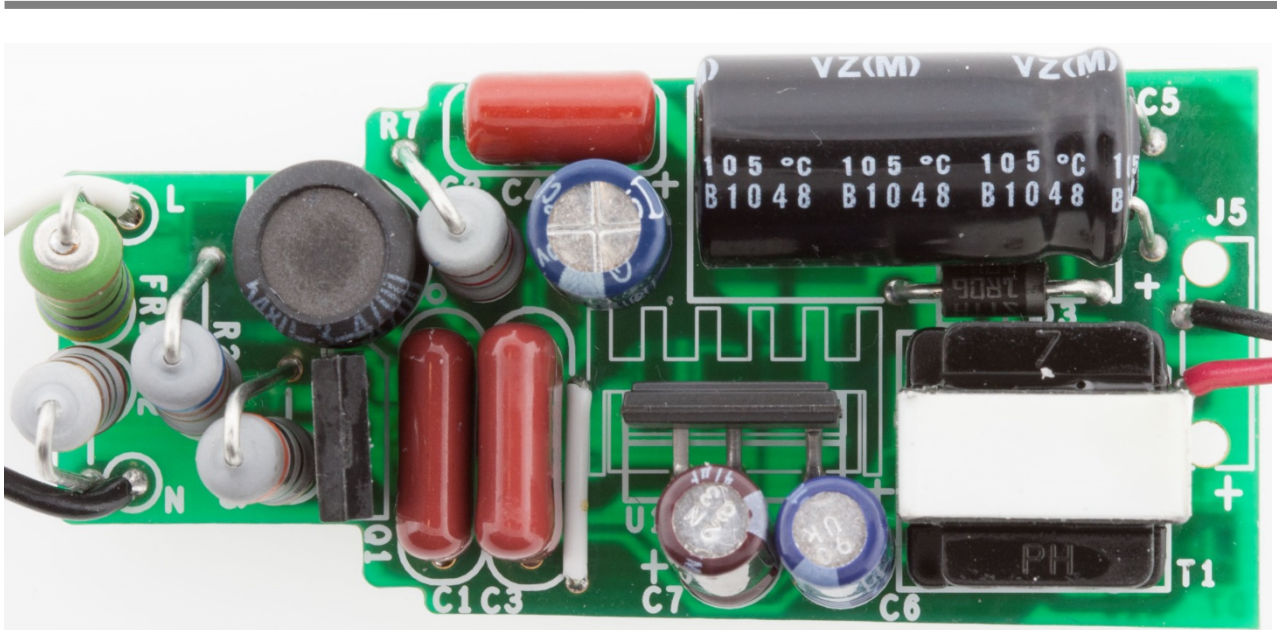


Figure 2 – Populated Circuit Board Photograph, Top.

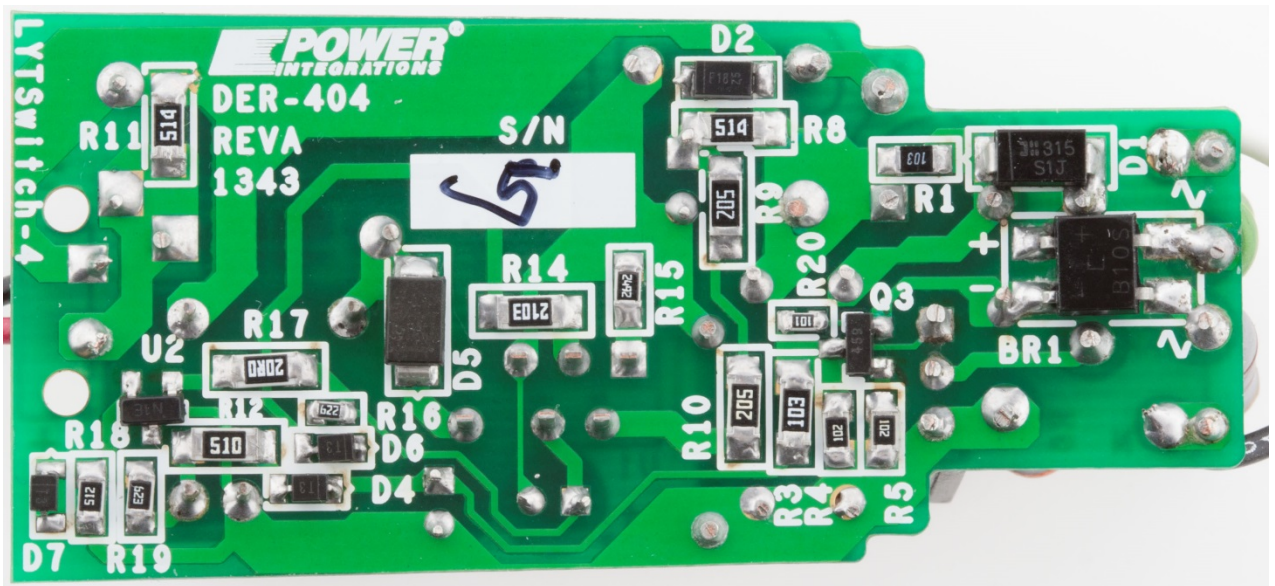


Figure 3 – Populated Circuit Board Photograph, Bottom.



2 파워 서플라이 사양

아래 표에는 설계의 최소 허용 성능이 나와 있습니다. 실제 성능은 결과 섹션에 나열되어 있습니다.

설명	기호	최소	일반	최대	단위	설명
입력 전압 작동	V_{IN}	195		265	VAC	2 선식 - P.E. 없음 작동 주파수는 제한되지 않습니다. 400Hz 라인에 사용할 경우 센싱 저항을 조절합니다.
주파수	f_{LINE}	47	50/60		Hz	
출력 출력 전압 출력 전류 총 출력 전력 연속 출력 전력	V_{OUT} I_{OUT} P_{OUT}	68	72 115 8	76	V mA W	±4%, 100VAC-240VAC
효율 240VAC, 72V LED	η	84			%	P_{OUT} 25°C 에서 측정
역률 240VAC, 54V LED	PF	0.9				P_{OUT} 25°C 에서 측정
환경 전도성 EMI 라인 서지 디퍼렌셜 모드(L1-L2) 링 웨이브(100kHz) 디퍼렌셜 모드(L1-L2)		CISPR22B/EN55015B 충족				1.2/50 μ 서지, IEC 1000-4-5, 직렬 임피던스: 디퍼렌셜 모드: 2 Ω 500A 단락 회로 직렬 임피던스: 디퍼렌셜 모드: 12 Ω
주변 온도	T_{AMB}	-20	25		°C	자유대류, 임해고도



3 회로도

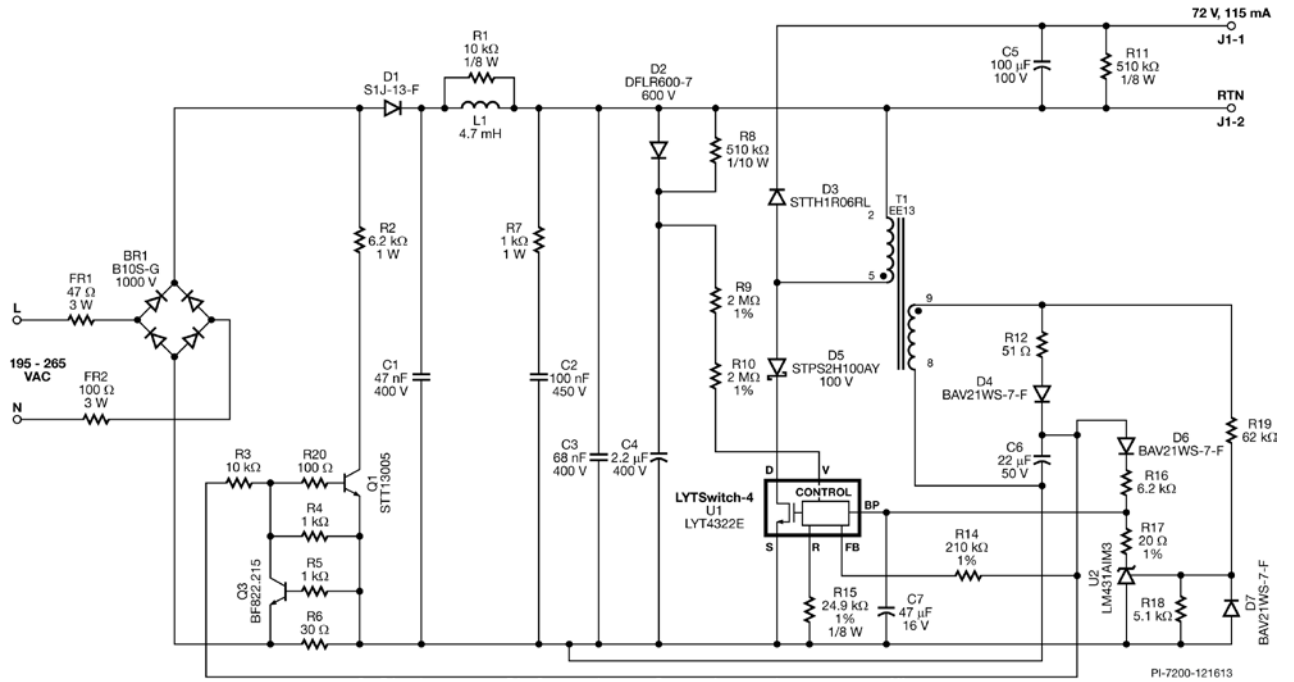


Figure 4 – Schematic.

4 회로 설명

LYT4322E(U1)를 사용하는 백-부스트 구성의 저렴한 디머블 LED 드라이버 파워 서플라이는 72VDC 정격 출력 전압에서 115mA 정전류를 공급합니다. 이 파워 서플라이는 항상 CC(정전류)로 구동되어야 하는 비절연 LED용으로 설계되었습니다. 비절연 드라이버를 사용하려면 드라이버와 레트로핏 램프의 금속 하우징이 안전 규정을 충족하도록 적절한 절연이 필요합니다.

4.1 입력 EMI 필터링

퓨즈 RF1이 회로 단락 보호 기능을 제공합니다. 브리지 BR1이 우수한 역률과 낮은 고조파 성분을 위해 전파 정류를 제공합니다. 커패시터 C1, C3과 커먼 모드 초크 L1이 전도성 EMI 규격을 준수하기 위해 π 필터를 구성합니다. 또한 커패시터 C1과 C3을 에너지 저장용으로 사용하여 라인 노이즈를 줄이고 라인 서지에 대비합니다. 퓨저블 저항 FR2는 디밍 중에 입력 전류의 링잉을 줄이는 댐핑용 저항이며, 라인 서지 중에는 제한 임피던스로 작동합니다.

4.2 디밍 호환성 - 액티브 블리더, 패시브 RC 블리더 및 댐퍼

디머블 LED 드라이버와 시판되는 대부분의 하이라인 디머 간의 호환성은 약 20mA 미만의 순간 전류를 보상하는 액티브 블리더를 추가하여 구현할 수 있습니다. 액티브 블리더는 리딩 엣지 디머에 필요한 유지 전류를 형성하고 디밍 중에 트레일링 엣지 디머의 바이어스를 공급합니다. 이러한 처리는 9개 부품으로 제어됩니다.

D1 - 직렬 블로킹 다이오드로, 벌크 커패시터(C1 및 C2) 간에 원치않는 에너지 방전을 방지합니다.

R2 - 제한 블리더 저항으로, 입력 전류를 보상할 때 Q1과 전력 손실을 공유합니다.

Q1 - 선형적으로 바이어스되어 센싱 댐퍼 저항 R6 및 Q3에 의해 설정된 대로 기준값 미만의 전류를 보상합니다.

R20 - Q1의 베이스 전류 제한 저항으로, 디퍼렌셜 라인 서지 중에 애벌란치를 방지합니다.

R3 - LYTSwitch-4 컨버터 보조 회로로부터의 바이어스 저항입니다.

R4 - 빠른 응답과 안정화를 위한 Q1의 베이스 저항입니다.

Q3 - 센싱 댐퍼 저항 R6의 기준값 트랜지스터입니다.

R5 - Q3의 베이스 전류 제한 저항으로, 디퍼렌셜 라인 서지 중에 애벌란치를 방지합니다.

R6 - 센싱 저항과 추가 댐퍼의 역할을 동시에 수행합니다.

리딩 엣지 디머와 함께 사용하는 경우 원치않는 링잉 및 입력 전류 발진이 발생합니다. 이러한 발진을 댐핑하기 위해 패시브 RC 블리더(R7 및 C2)가 사용되었습니다. 고주파 발진을 최소화하려면 이러한 부품을 L1 다음에 배치하는 것이 더 효율적입니다.

패시브 댐퍼 FR1, FR2 및 R6의 총 저항(177 Ω)은 리딩 엣지 디머의 턴 온 중에 피크 전류를 최소화합니다. 패시브 댐퍼를 액티브 댐퍼로 교체하면 최소한의 비용으로 2%의 효율 향상 효과를 얻을 수 있습니다.



4.3 LYTSwitch-4

LYTSwitch-4 는 전체 온도 범위에서 우수한 라인 레귤레이션으로 간편하고 경제적인 디머블 LED 드라이버를 구현할 수 있도록 최적화되었습니다. LYTSwitch-4 제품군에는 전구의 동작 온도가 과도하게 높아진 경우 파워 서플라이를 보호하기 위한 써멀 제한 기능이 내장되어 있습니다.

벅-부스트 컨버터단은 파워 MOSFET 스위치를 포함한 LYTSwitch-4(U1), 프리휠링 다이오드 D3(스위칭 손실을 최소화하기 위해 패스트 프리휠링 다이오드가 선택됨), 파워 인덕터/트랜스포머 T1 및 출력 커패시터(C5)로 구성됩니다. 컨버터는 도통 시간 중의 RMS 손실을 최소화하기 위해 대부분 CCM(연속 도통 모드)으로 작동합니다.

LYTSwitch-4 피크 감지기 회로 C4, D2 및 R8 은 입력 전압에 대한 아날로그 정보를 제공하며, 라인 교란이 발생하는 동안 라인 서지 전압을 억제하여 IEC 1000-4-5 를 충족합니다.

입력 과전압 섯다운 기능을 통해 정류된 입력 전압 내성(서지 및 입력 증가 시)을 하이 라인 디바이스 제품군의 내부 파워 MOSFET의 725V_{DSS} 정격으로 확장합니다.

4.4 출력 정류

효율성을 높이고 써멀 관리를 용이하게 하기 위해 패스트 출력 다이오드(D3)가 사용되었습니다. 일반적으로 LED 애플리케이션의 경우 주변 온도가 70°C 이상입니다. 이 경우 t_{RR} 이 낮은(35nS 미만) 디바이스를 사용하는 것이 좋습니다. D3에서 정류된 에너지는 커패시터 C5에서 필터링됩니다. 더 높은 리플을 사용해도 되며 비용을 낮춰야 하는 설계의 경우 출력 커패시턴스 값을 줄일 수 있습니다.

4.5 출력 피드백

센싱 저항을 통해 출력 전류를 레귤레이션하는 대신, LYTSwitch-4에는 출력 전류를 제어하여 효율성을 높이는 고유한 방법이 있습니다. 즉, T1의 바이어스 권선을 통해 등가 출력 전압을 측정하는 것입니다. 바이어스 권선 전압은 출력 전압을 간접적으로 센싱하는데 사용되기 때문에 2차측 피드백 부품을 사용할 필요가 없습니다. 바이어스 권선 전압은 출력 전압에 비례합니다(바이어스와 2차측 권선 간의 권선비에 의해 설정됨). 저항 R14는 바이어스 전압을 U1의 FB 핀에 공급되는 전류로 변환합니다. U1의 내장 엔진에서는 FB 핀 전류, V 핀 전류, 내장 드레인 전류 정보를 결합하여 높은 입력 역률을 유지하면서 일정한 출력 전류를 제공합니다.

4.6 단락 보호 기능

FB 전류가 76ms 이상 $I_{FB(AR)}$ 기준값 이하로 떨어지면 부품이 오토-리스타트 상태가 됩니다.



4.7 무부하 보호

무부하 동작이 발생하는 경우 출력 전압이 100V 로 제한됩니다. 출력 전압은 바이어스 권선에서 메인 권선과 바이어스 권선의 권선비에 따라 감지됩니다. IC U2 가 오토-리스타트 상태에서 BP 핀을 작동시켜 출력 전압을 레귤레이션합니다. 분배 저항 R19 및 R18 이 OVP(과전압 보호) 기준값을 설정합니다. 다이오드 D7 은 U2 의 역전류를 방지하며 R17 은 U2 의 바이어스 저항 및 제한 저항으로 사용됩니다.



5 PCB 레이아웃

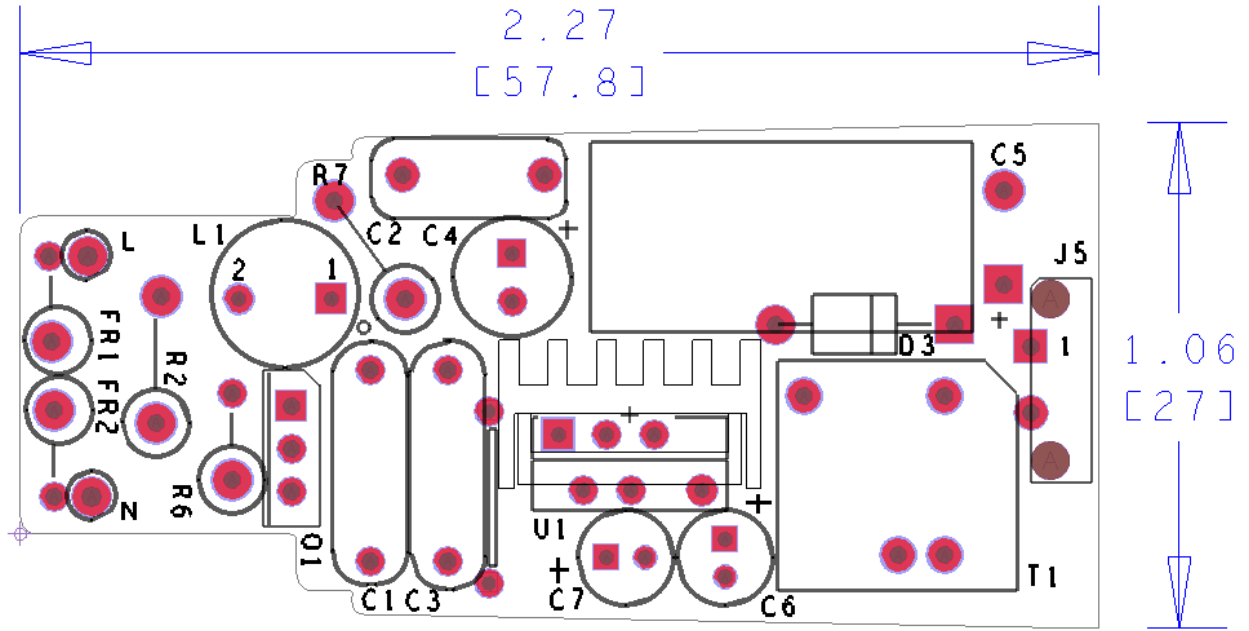


Figure 5 – Printed Circuit Layout. Top View.

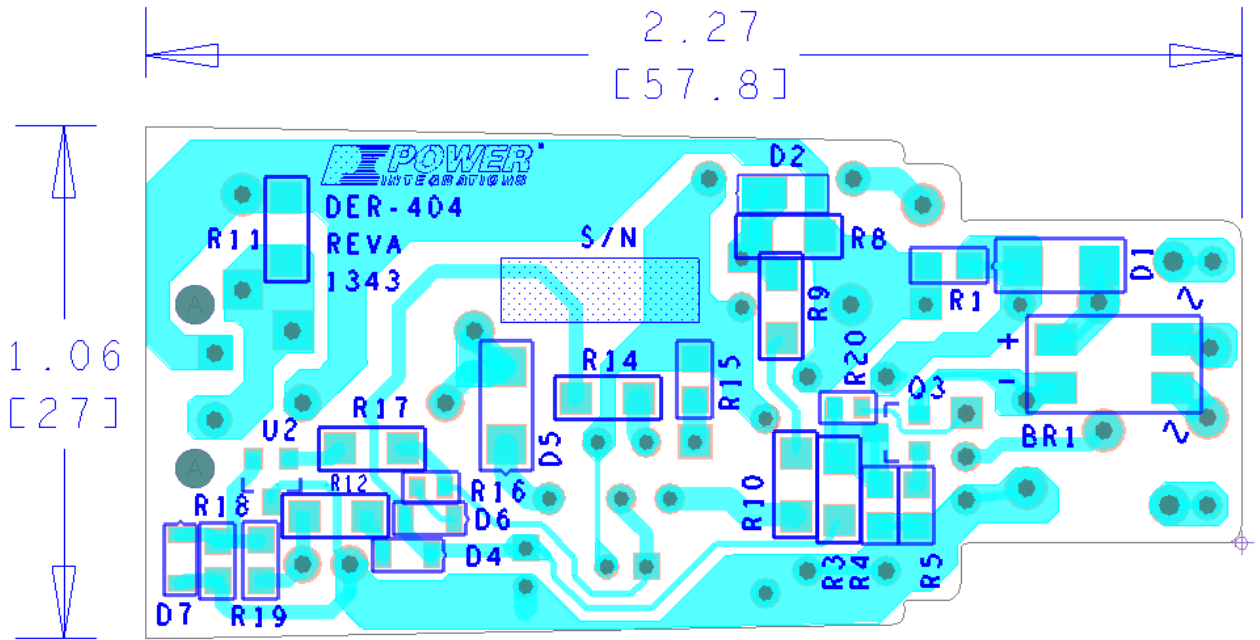
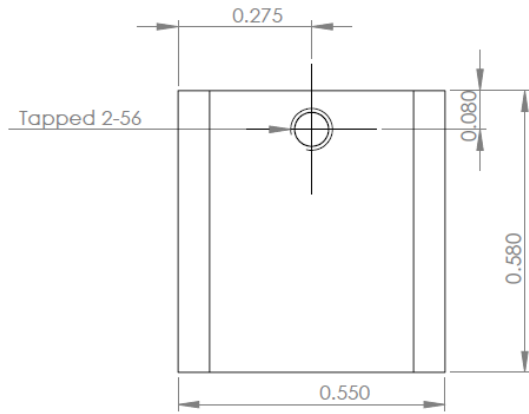


Figure 6 – Printed Circuit Layout. Bottom View.

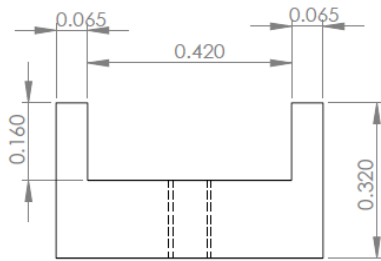


6 히트 싱크 설계

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



TOP VIEW



FRONT VIEW

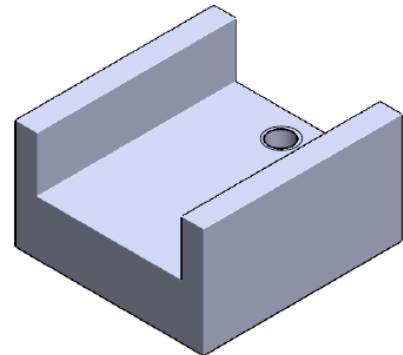


Figure 7 – U1 Heat Sink 1.



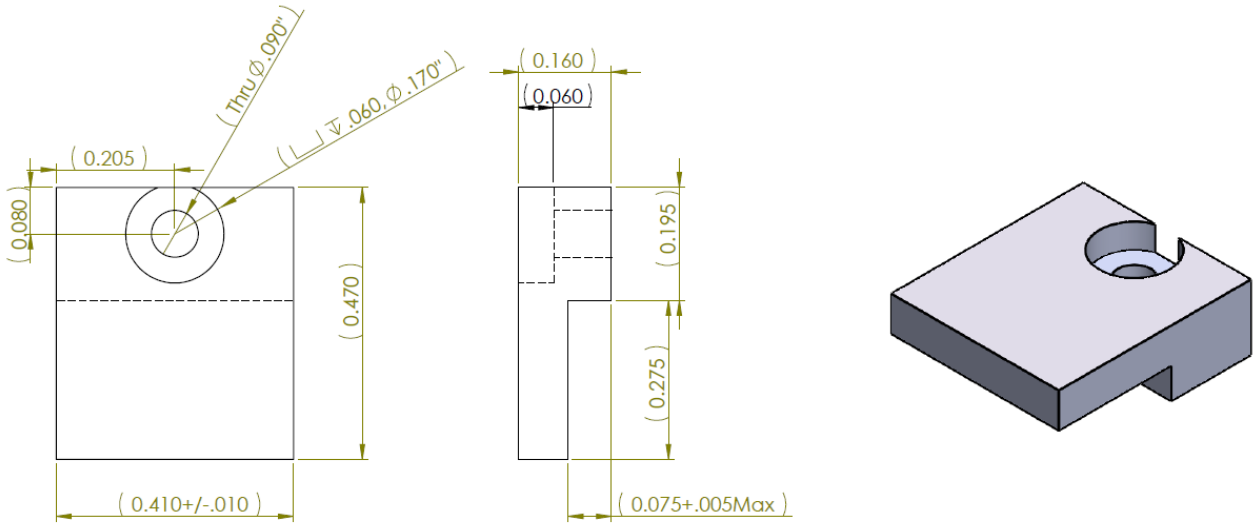


Figure 8 – U1 Heat Sink 2 for Clamping.

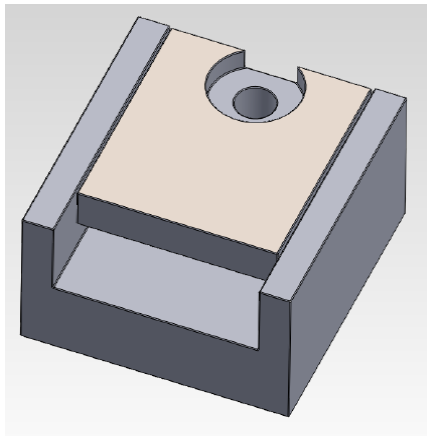


Figure 9 – U1 Heat Sink 2 Combination.



7 BOM

Below are the parts used in the build of the sample design. The design does not limit 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 voltage rating is 100 V minimum.



8 인덕터 설계 스프레드시트

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 PF 0.9, 0.4 < KP < 0.9)/>
LP			815	uH	Primary Inductance
VOR	72.00		72	V	Reflected Output Voltage.
Expected IO (average)			0.12	A	Expected Average Output Current
KP_VNOM			0.96		Expected ripple current ratio at VACNOM
TON_MIN			1.22	us	Minimum on time at maximum AC input voltage
PCLAMP			0.07	W	Estimated dissipation in primary clamp
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	EF20		EF20		Select Core Size
Custom Core					Enter Custom core part number (if applicable)
AE	0.17		0.17	cm^2	Core Effective Cross Sectional Area
LE	3.02		3.02	cm	Core Effective Path Length



AL	1130.00		1130	nH/T ²	Ungapped Core Effective Inductance
BW	7.40		7.4	mm	Bobbin Physical Winding Width
M	0.00		0	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	4.00		4		Number of Primary Layers
NS			106		Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			276	V	Peak input voltage at VACMIN
VMAX			375	V	Peak input voltage at VACMAX
CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.21		Minimum duty cycle at peak of VACMIN
IAVG			0.05	A	Average Primary Current
IP			0.57	A	Peak Primary Current (calculated at minimum input voltage VACMIN)
IRMS			0.13	A	Primary RMS Current (calculated at minimum input voltage VACMIN)
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			815	uH	Primary Inductance
LP_TOL			10		Tolerance of primary inductance
NP			105		Primary Winding Number of Turns
NB			38		Bias Winding Number of Turns
ALG			74	nH/T ²	Gapped Core Effective Inductance
BM			2582	Gaus s	Maximum Flux Density at PO, VMIN (BM<3100)
BP			3459	Gaus s	Peak Flux Density (BP<3700)
BAC			1291	Gaus s	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1597		Relative Permeability of Ungapped Core
LG			0.27	mm	Gap Length (Lg 0.1 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 인덕터 설계

9.1 전기적 구성도

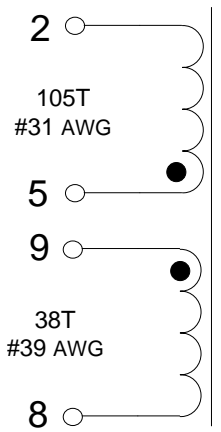


Figure 10 – Transformer Electrical Diagram.

9.2 전기적 사양

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 재료

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 인덕터 제작 구성도

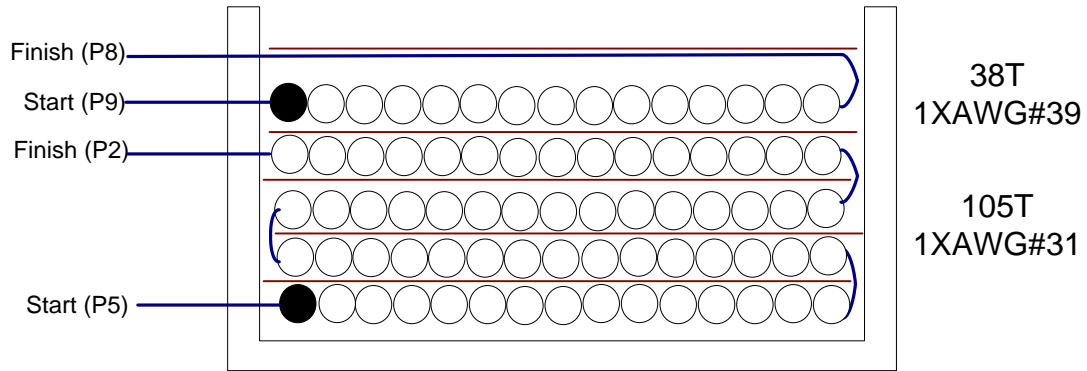


Figure 11 – Transformer Build Diagram.

9.5 인덕터 구성

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 성능 데이터

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 모드 효율성

Measured at 25 °C ambient, open frame.

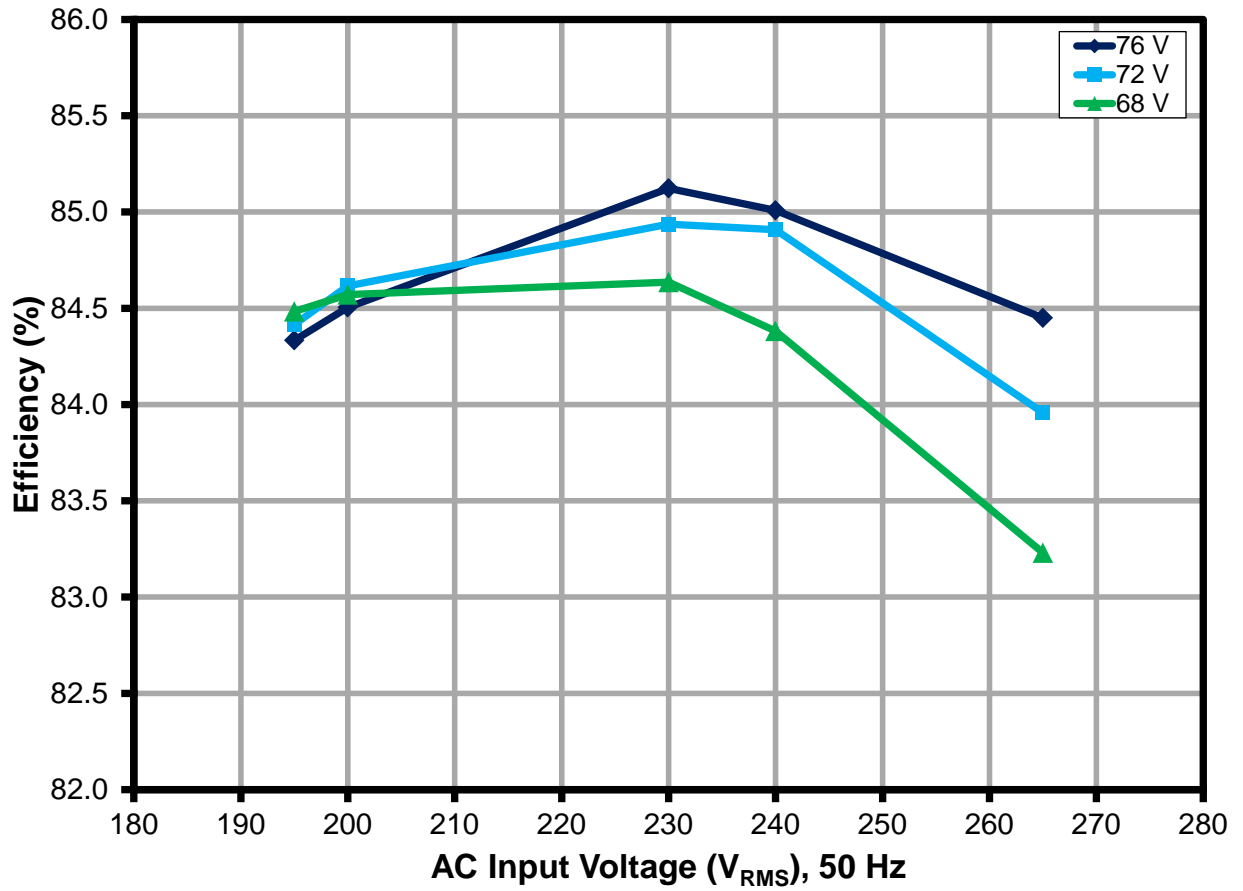


Figure 12 – Efficiency with Respect to AC Input Voltage. 195-265 VAC (60 Hz) Input.



10.2 출력 전류 레귤레이션

10.2.1 출력 전류 레귤레이션에 대한 입력 라인 및 부하 전압

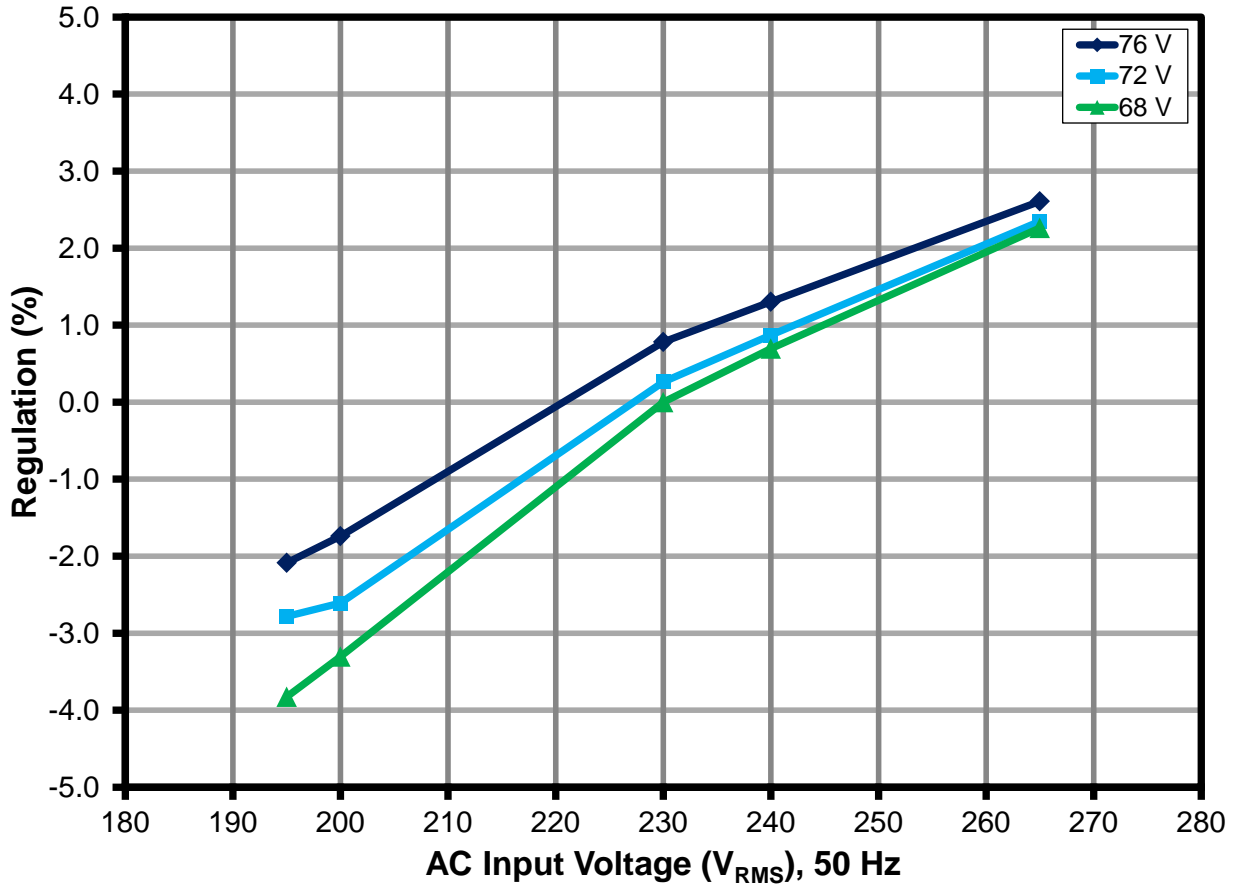


Figure 13 – Load Regulation, Room Temperature.



10.3 역률

Measured at 25 °C ambient, open frame.

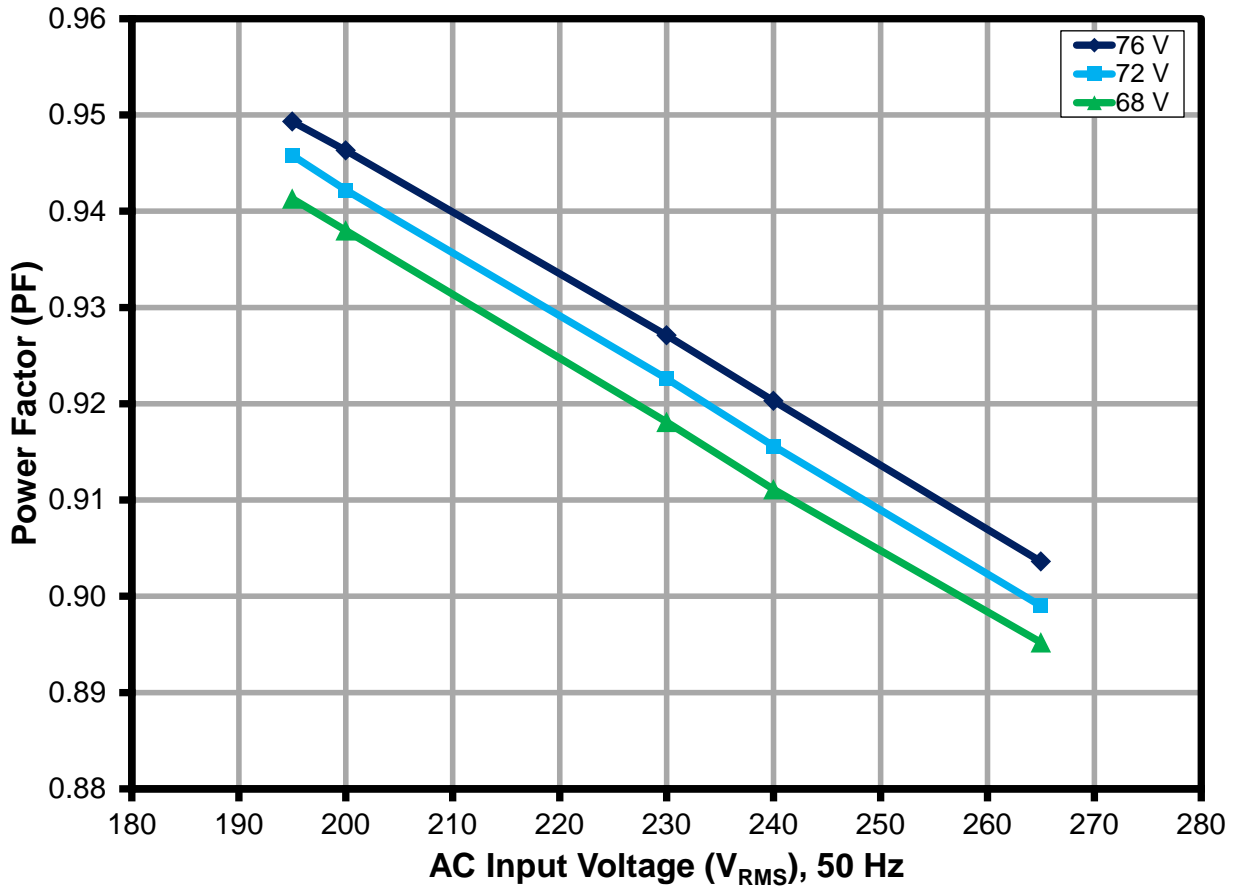


Figure 14 – Power Factor, Room Temperature.



10.4 THD

Measured at 25 °C ambient, open frame.

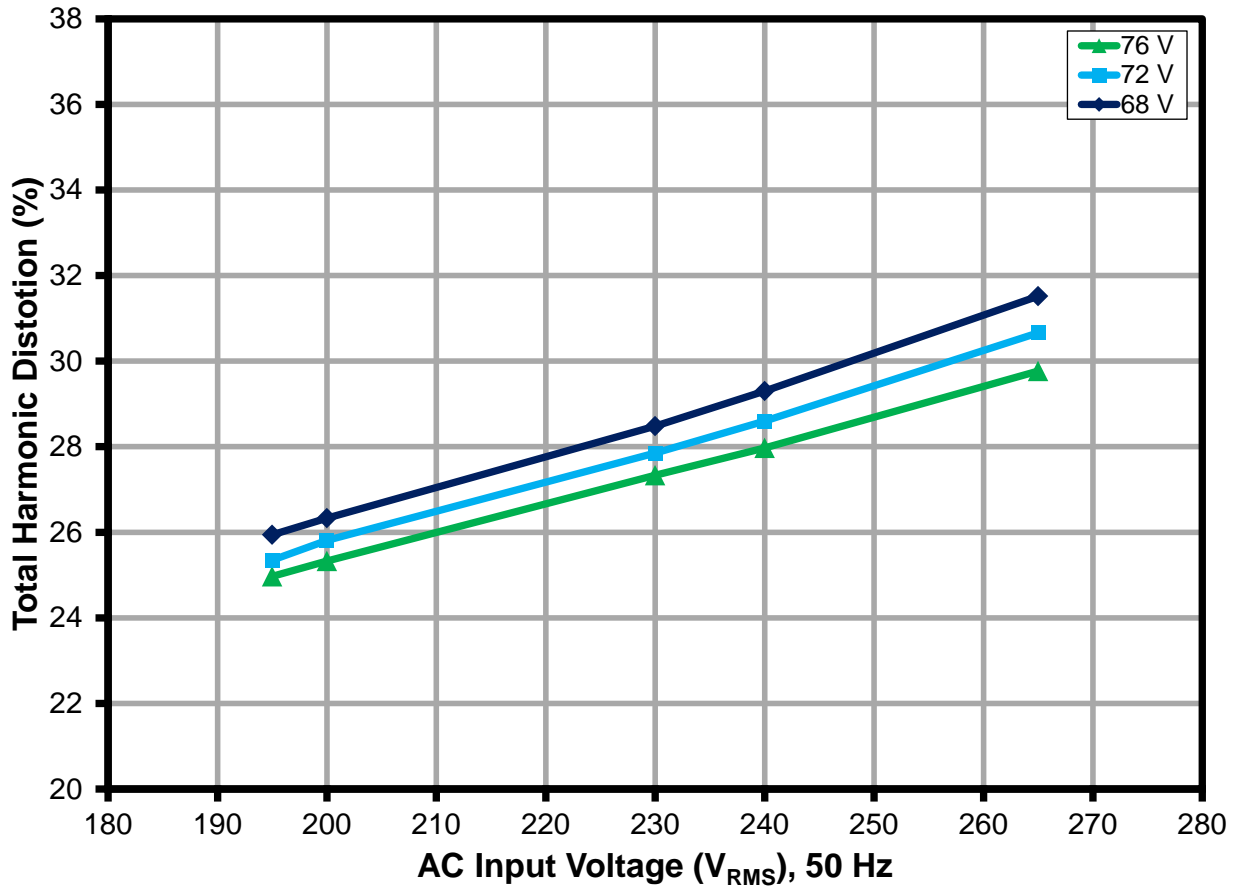


Figure 15 – %THD, Room Temperature.



10.5 고조파 성분

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.



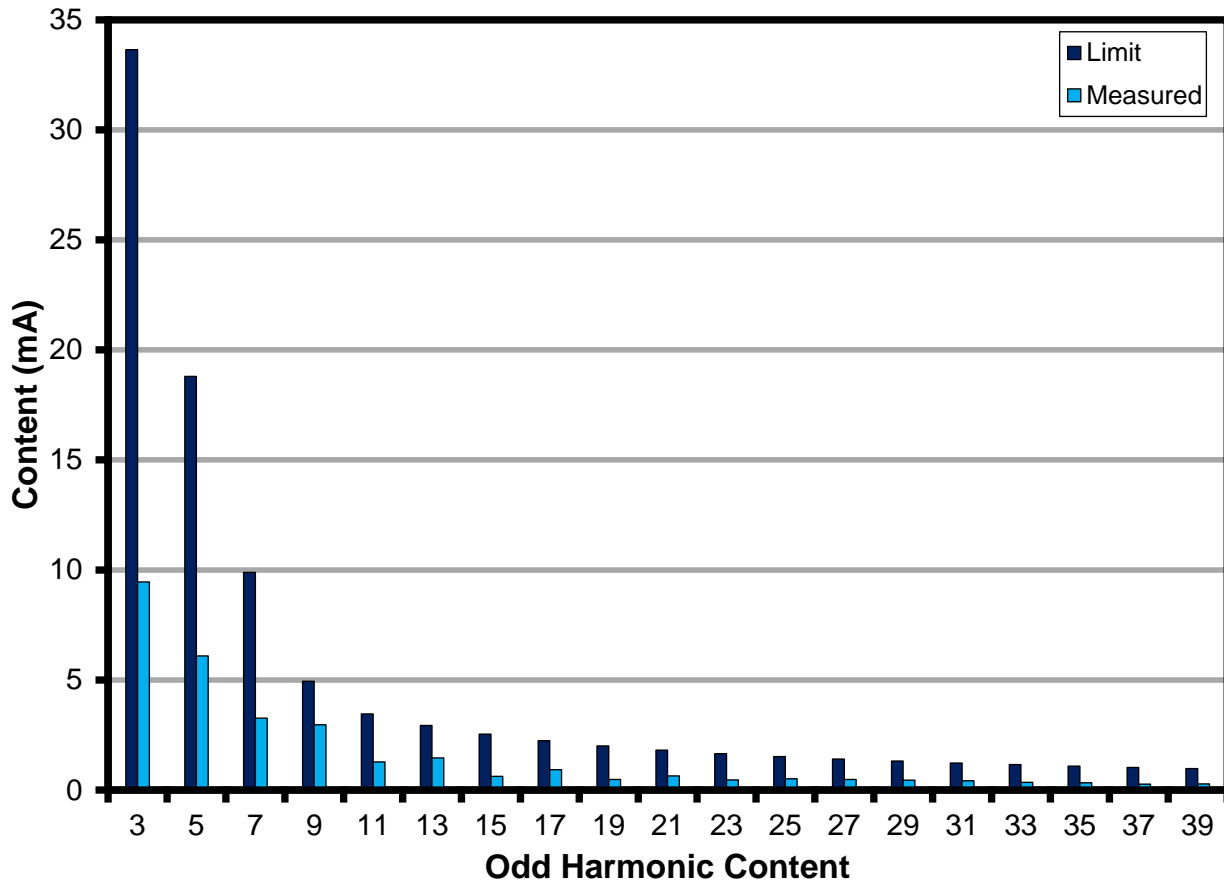


Figure 16 – Harmonic Content, Room Temperature.



11 씨말 성능

11.1 사용 장비

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

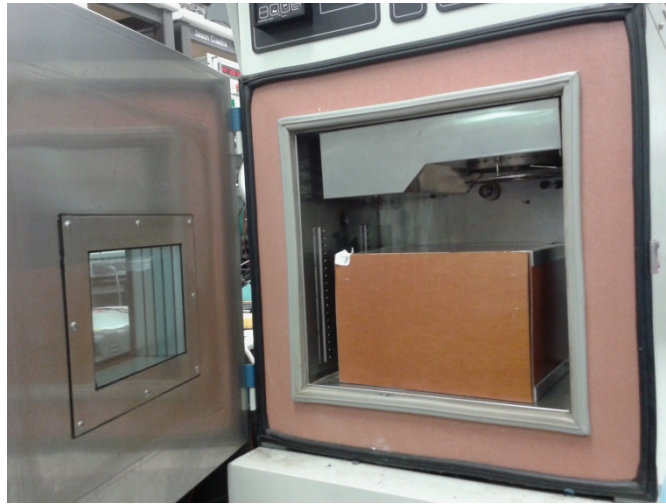


Figure 17 – Thermal Chamber Set-up Showing Box Used to Prevent Airflow Over UUT. Open Frame Set-up Measurement.



Figure 18 – Thermal Unit Thermocouple Measurement Set-up.

Note: Typical A19 enclosure is used in the verification.

11.2 씨얼 결과

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.

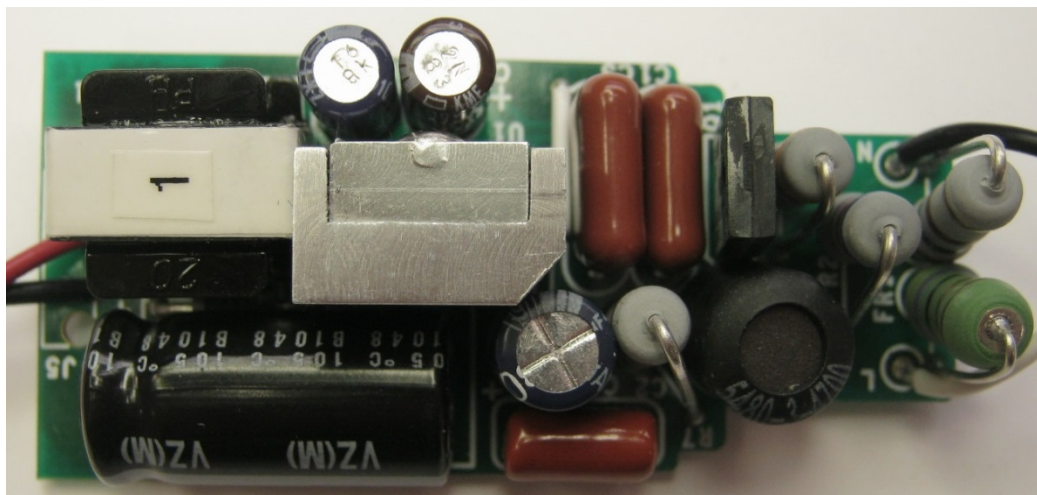


Figure 19 – Sample Design with Heat Sink.

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.



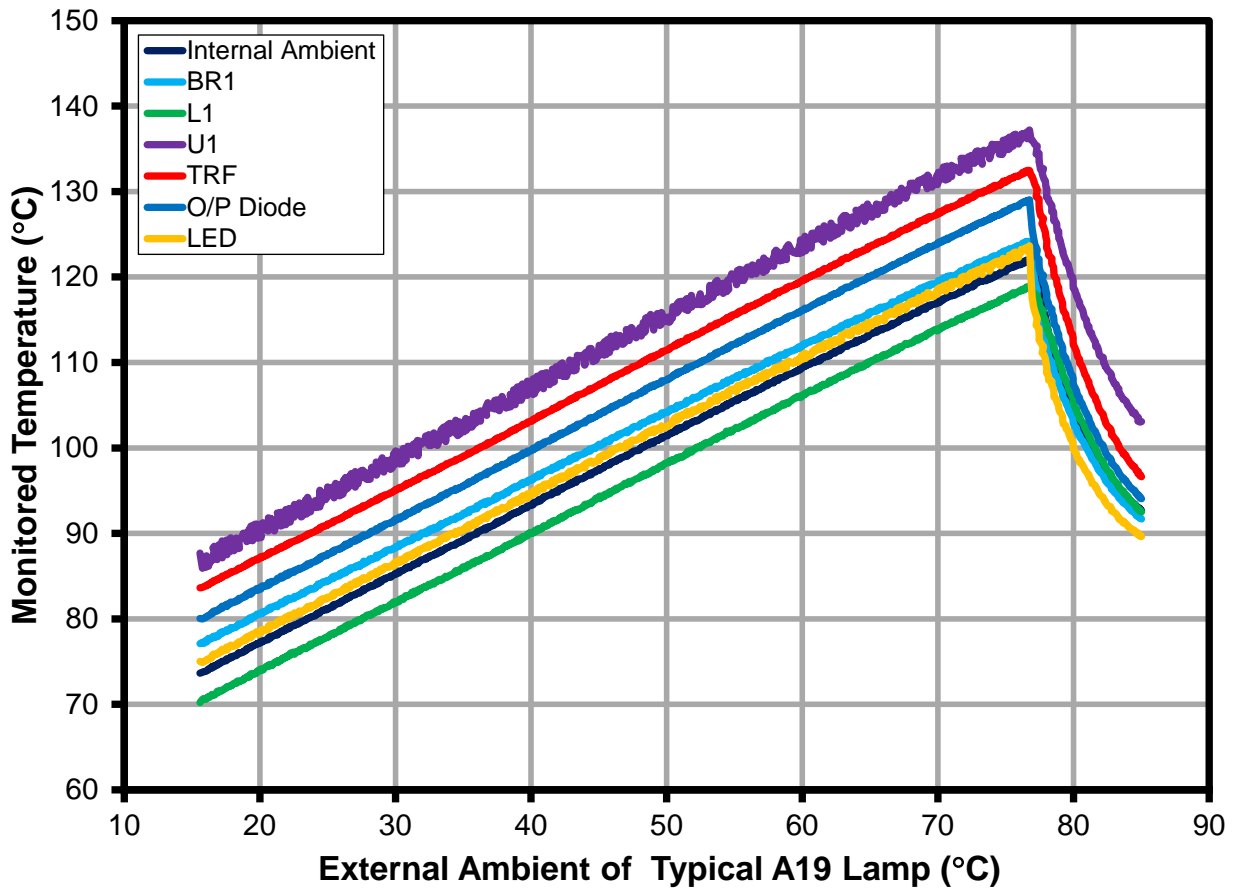


Figure 20 – Thermal Curve at 195 VAC / 50 Hz Input in Typical A19 Housing. LYT4322EG with heatsink.



11.3 써멀 스캔

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

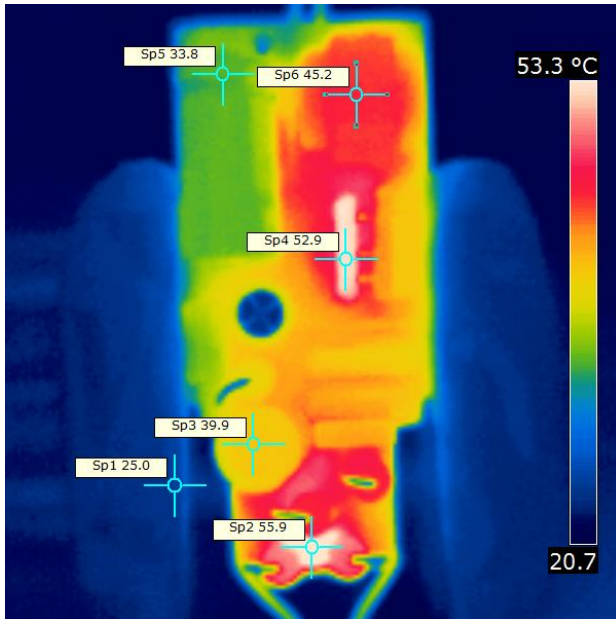


Figure 21 – Temperature (°C) at Top Side of PCB During Non-dimming Operation at 195 VAC.
 SP1 – Ambient.
 SP2 – L1, EMI Choke.
 SP3 – PCB, Temperature at BR1.
 SP4 – U1, LYT4322E Without Heat Sink.
 SP5 – C6, Output Capacitor.
 SP6 – T1, Power Inductor.

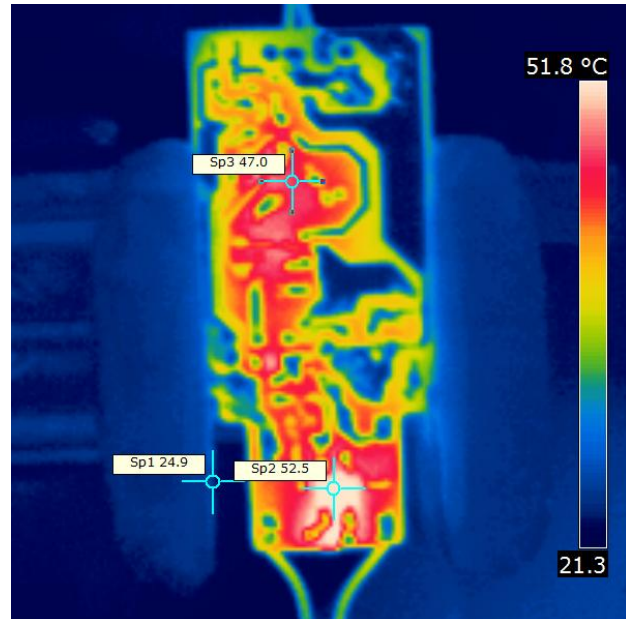


Figure 22 – Temperature (°C) at Bottom Side of PCB During Non-dimming Operation at 195 VAC.
 SP1 – Ambient.
 SP2 – BR1, Bridge Rectifier.
 SP3 – D5, Blocking Diode.



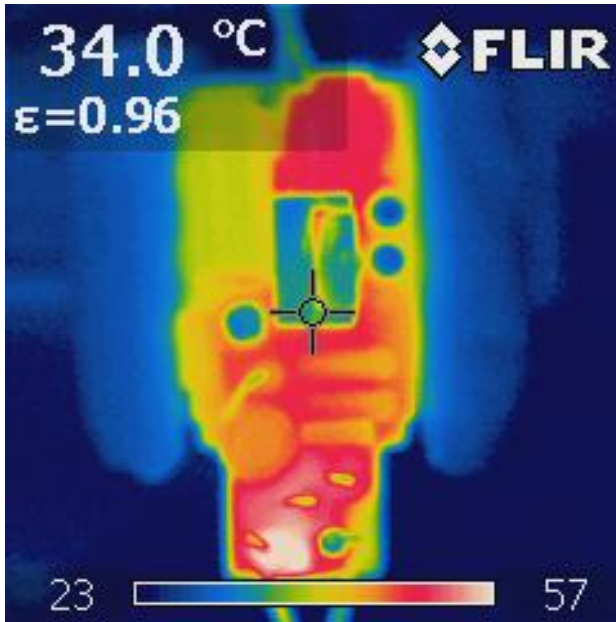


Figure 23 – Temperature (°C) at Top Side of PCB During Normal Operation at 195 VAC. SP1 – U1, LYT4322E with Heat Sink.

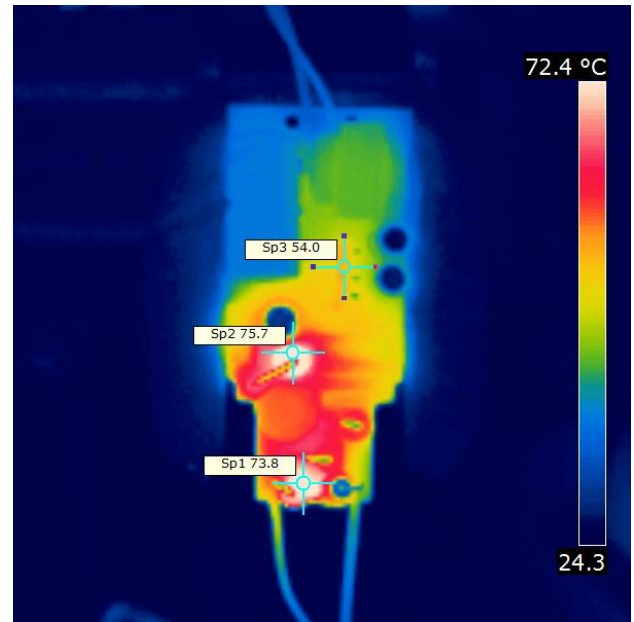


Figure 24 – Temperature (°C) at Top Side of PCB During Dimming Operation at 240 VAC at 90° Conduction Angle. SP1 – FR2, Damper Resistor. SP2 – R7, Bleeder Resistor. SP3 – U1, LYT4322E Without Heat Sink.



12 파형

12.1 정상 작동 시 드레인 전압 및 전류

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.

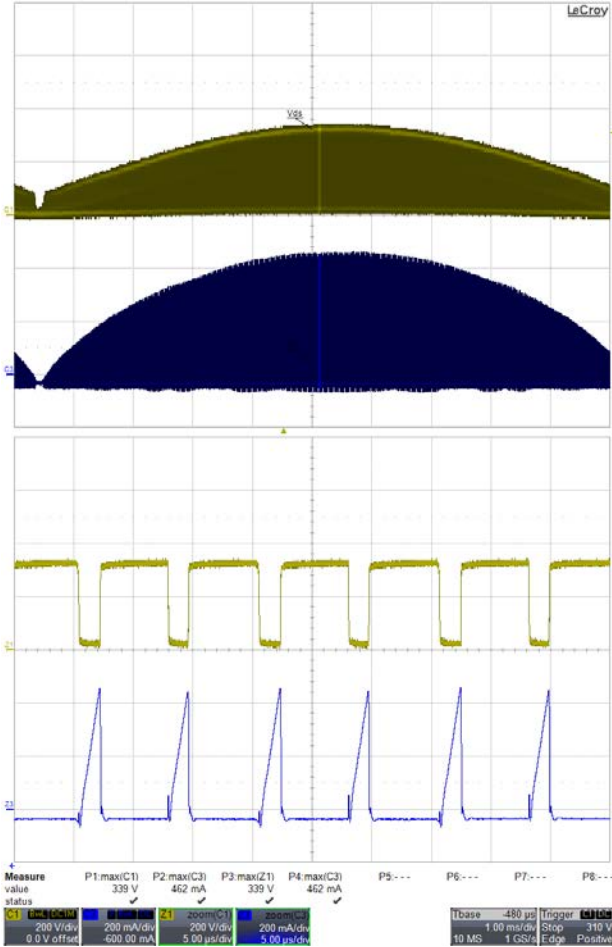


Figure 25 – 195 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

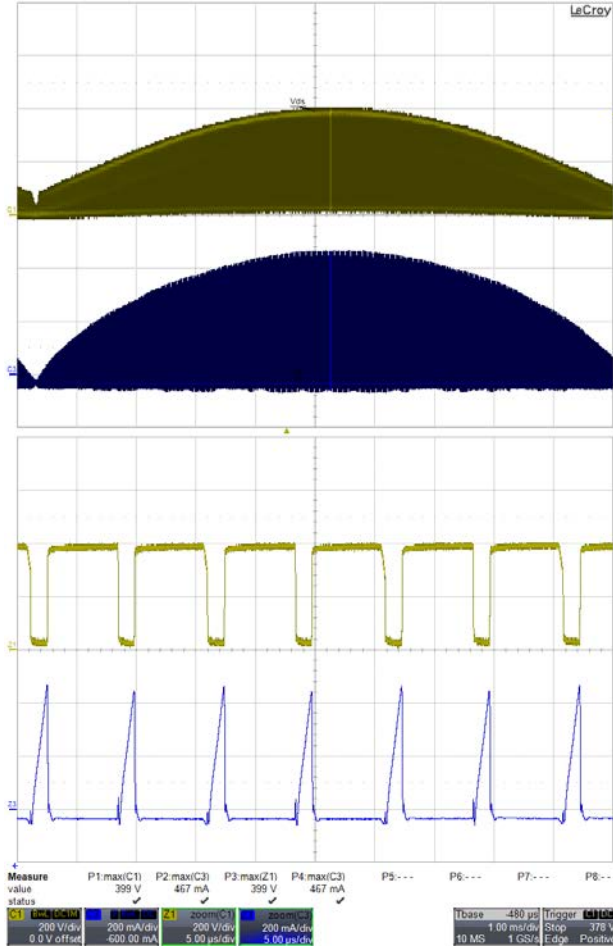


Figure 26 – 230 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.



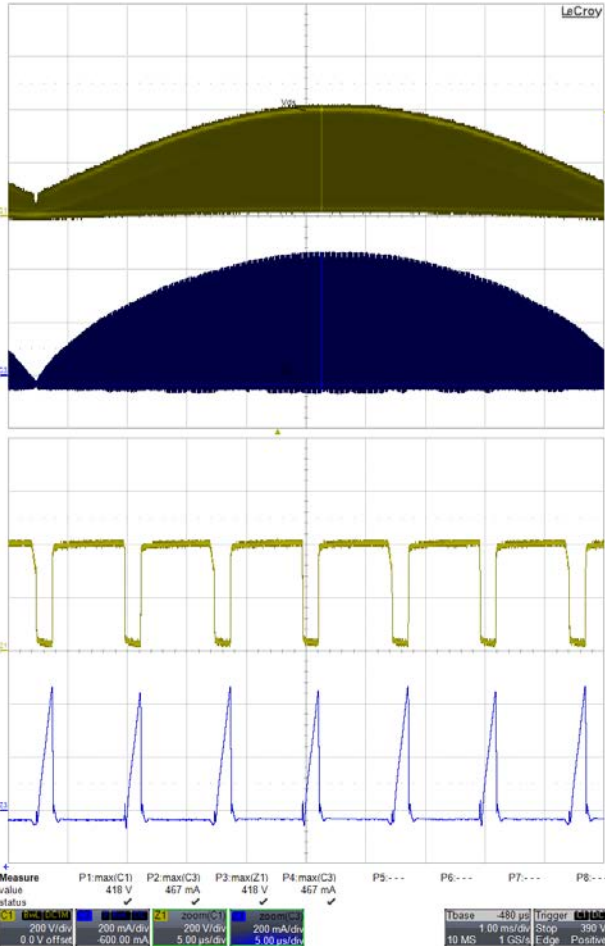


Figure 27 – 240 VAC, 50Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.

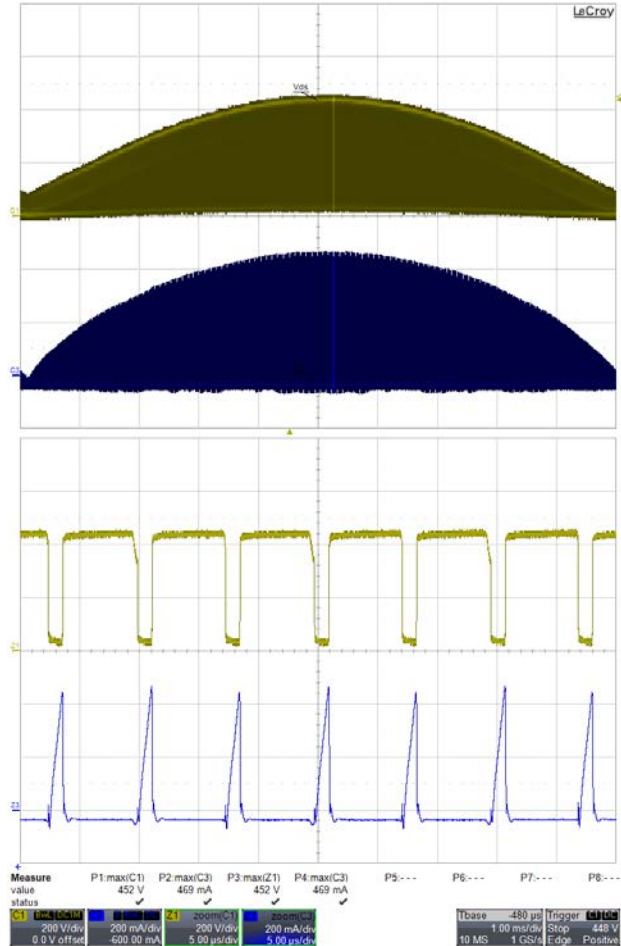


Figure 28 – 265 VAC, 50Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 μ s / div.



12.2 출력 단락 상태 시 드레인 전압 및 전류

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

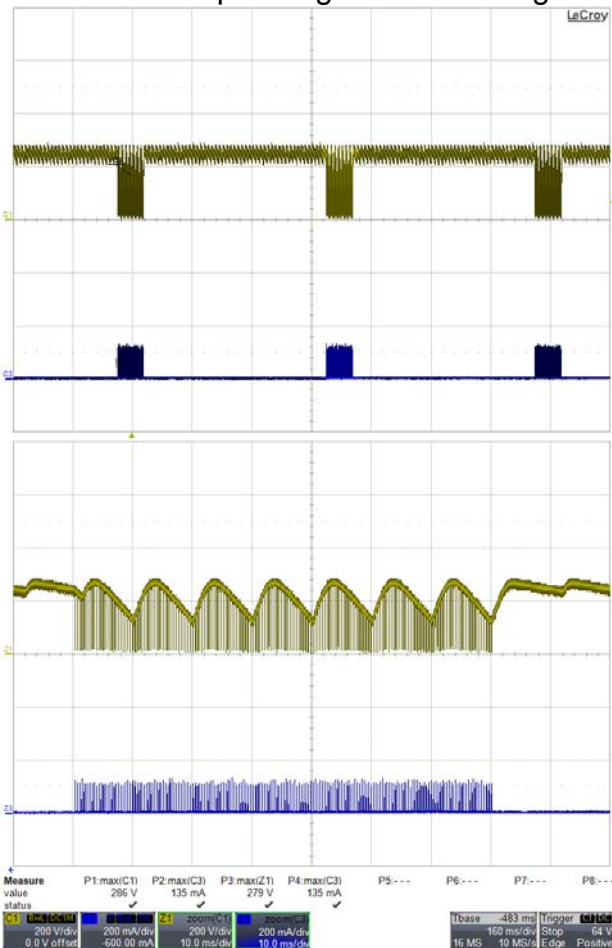


Figure 29 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 160 ms / div.
 Zoom Time Scale: 10 ms / div.

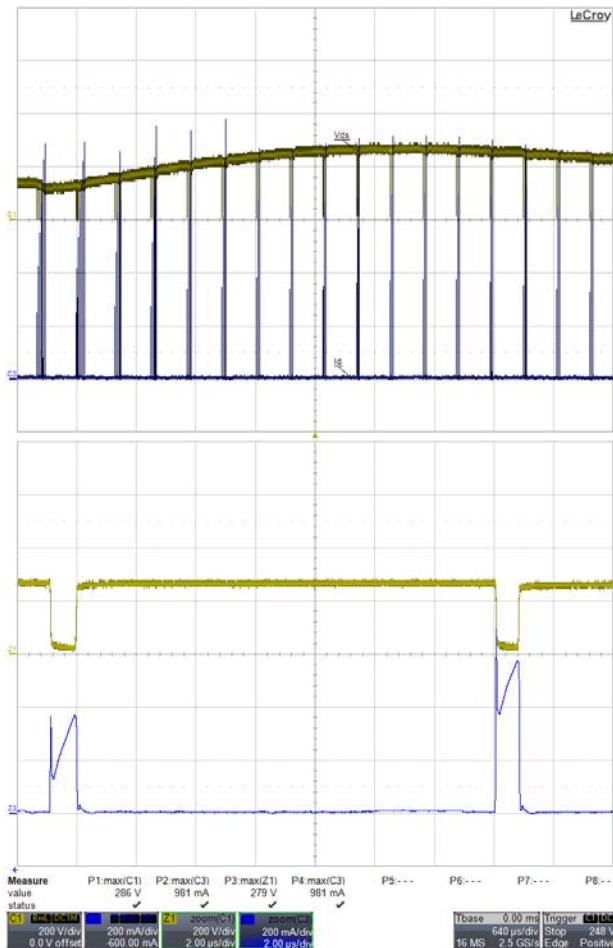


Figure 30 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 640 μ s / div.
 Zoom Time Scale: 2 μ s / div.



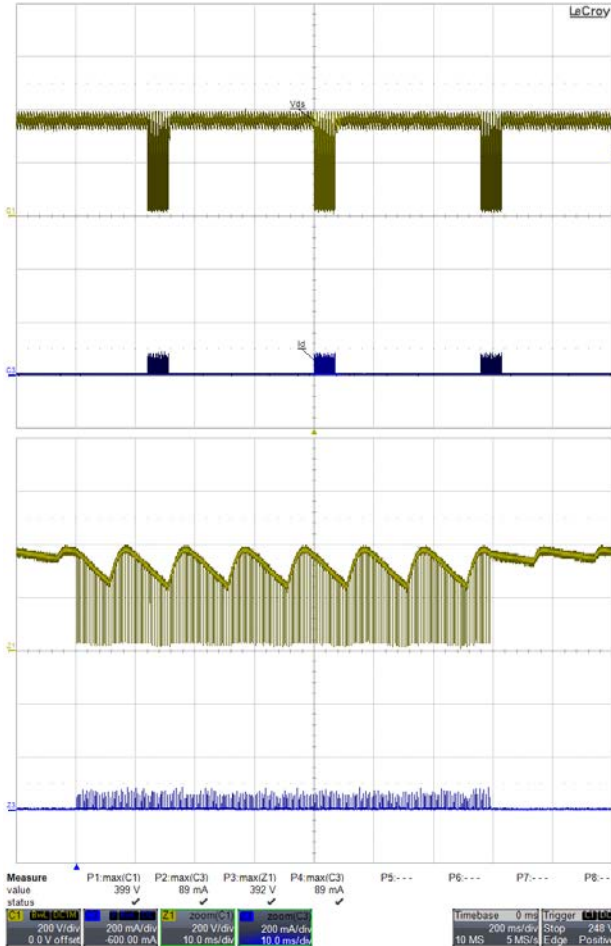


Figure 31 – LYT4322E Output Short. 265 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 200 ms / div.
 Zoom Time Scale: 10 ms / div

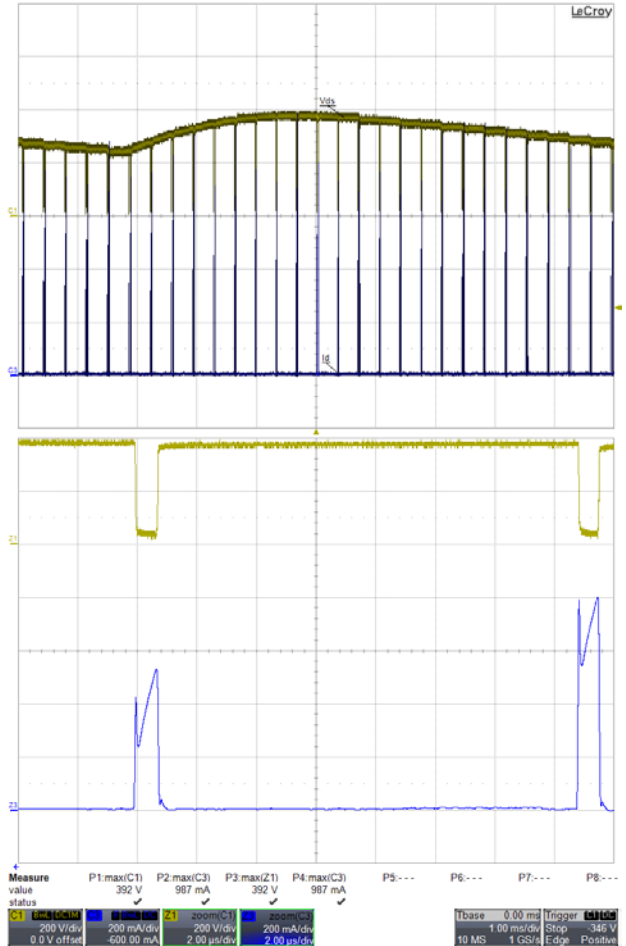


Figure 32 – LYT4322E Output Short. 195 VAC / 50 Hz.
 Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1ms / div. Zoom
 Time Scale: 2 μ s / div



12.3 드레인 전압 및 전류 스타트업 프로파일

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

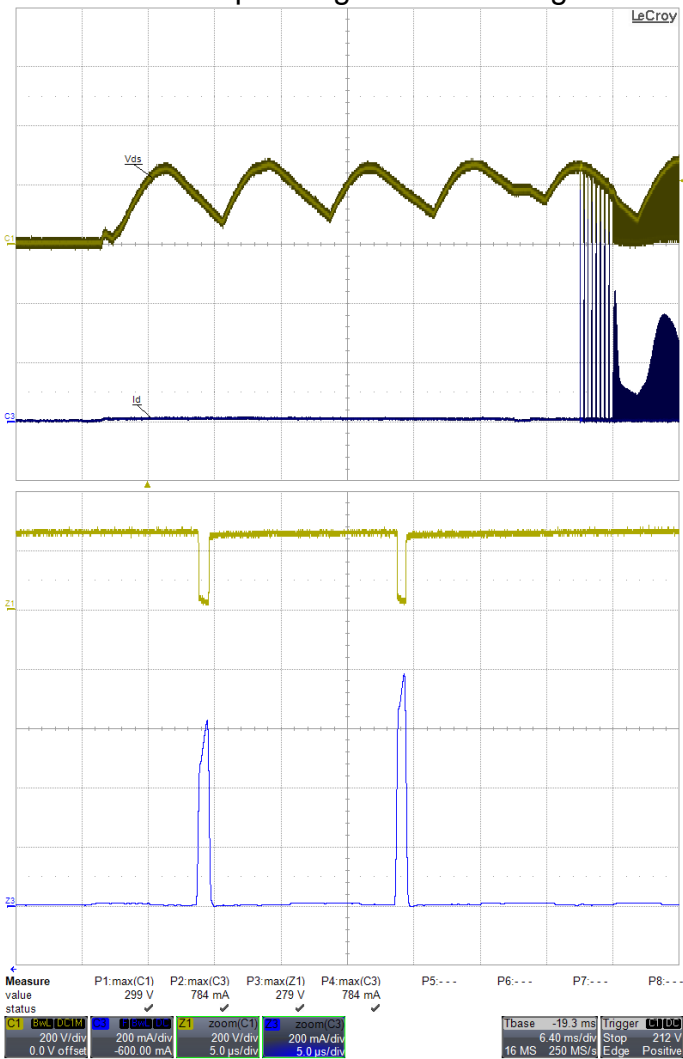


Figure 33 – 195 VAC / 50 Hz Start-up.

Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 µs / div.

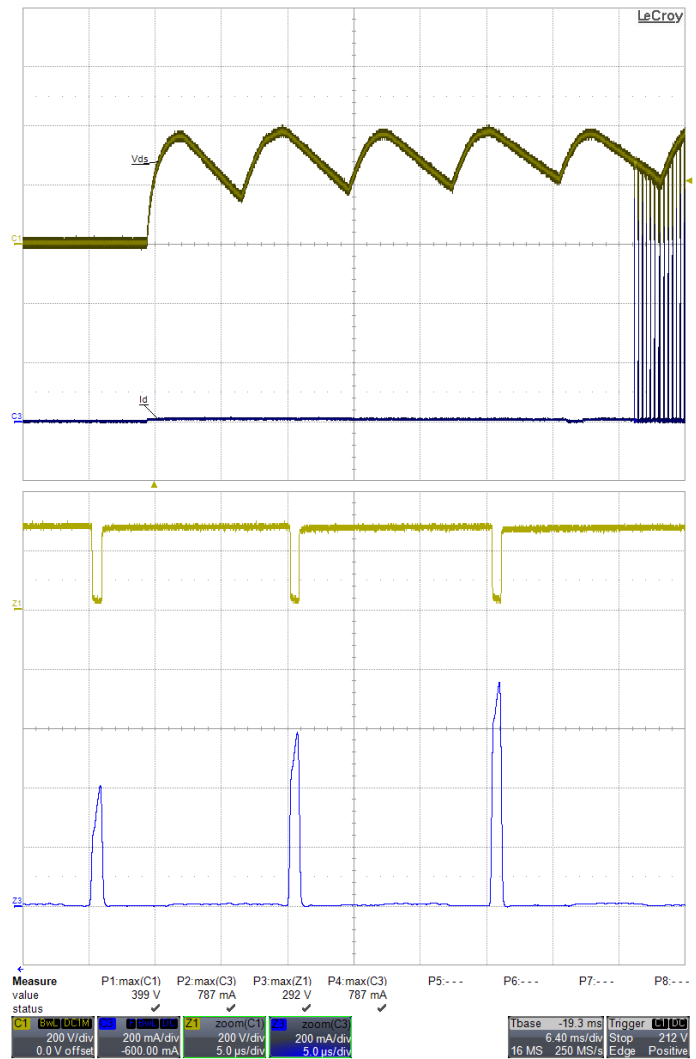


Figure 34 – 265 VAC / 50 Hz Start-up.

Ch1 (Yellow): $V_{DRAIN-SOURCE}$, 200 V / div.
 Ch3 (Blue): I_{DRAIN} , 200 mA / div.
 Time Scale: 1 ms / div.
 Zoom Time Scale: 5 µs / div.



12.4 출력 전류 스타트업 프로파일

Output current is available in <150 ms.

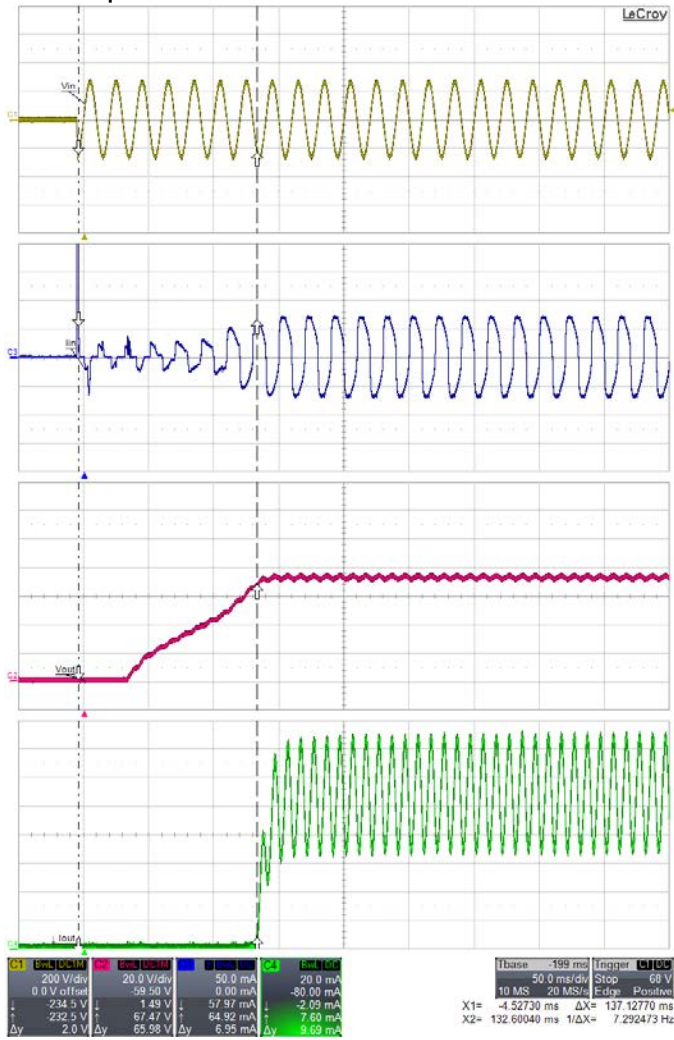


Figure 35 – 195 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 20 ms / div.

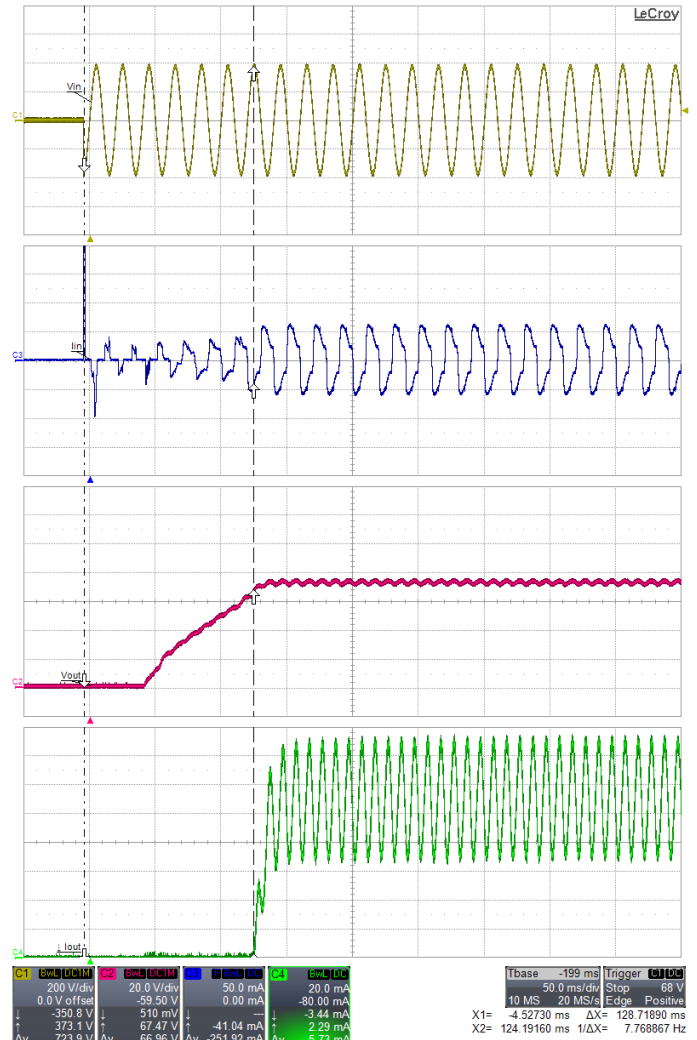


Figure 36 – 265 VAC, 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 20 ms / div.



12.5 입력-출력 프로파일

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.

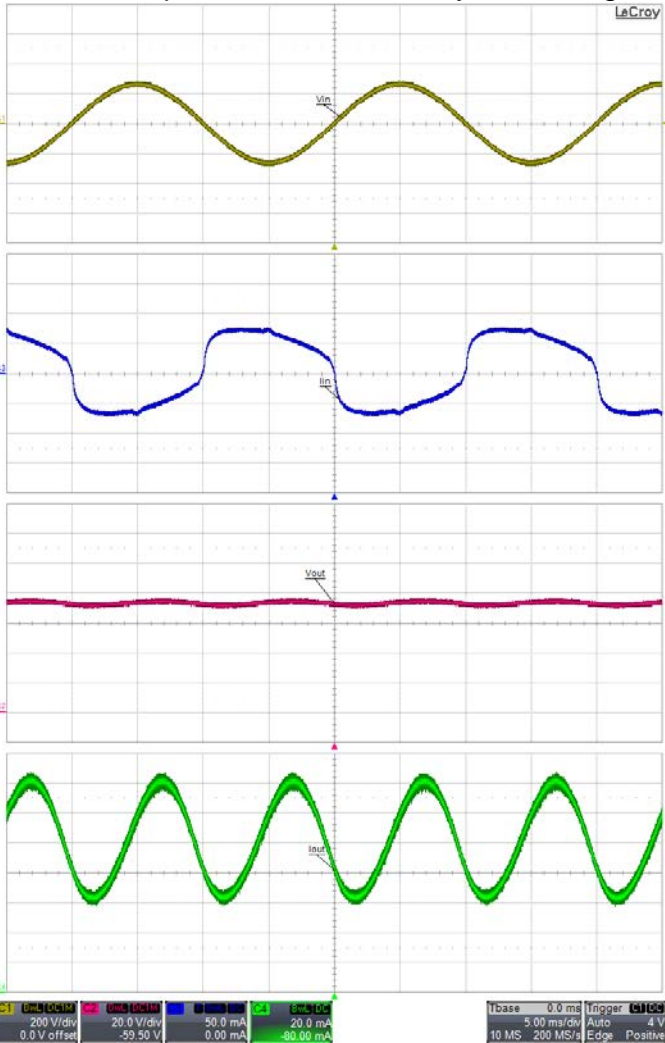


Figure 37 – 195 VAC / 50 Hz, Nominal V_{LED} Load.

- 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.

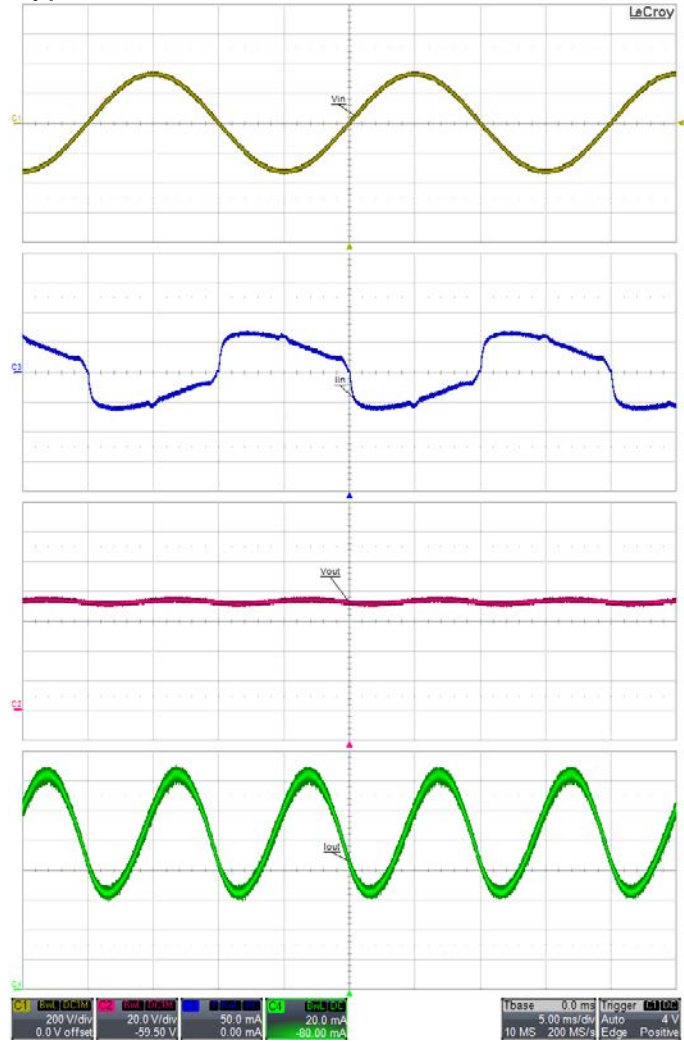


Figure 38 – 230 VAC / 50 Hz, Nominal V_{LED} Load.

- 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.



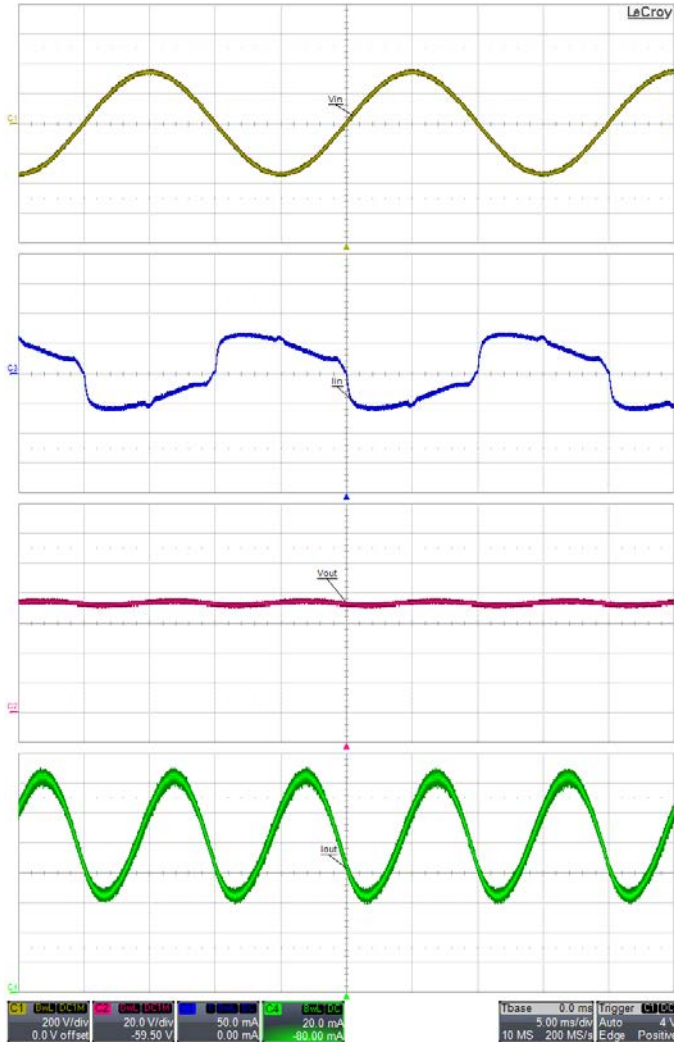


Figure 39 – 240 VAC / 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 5 ms / div.

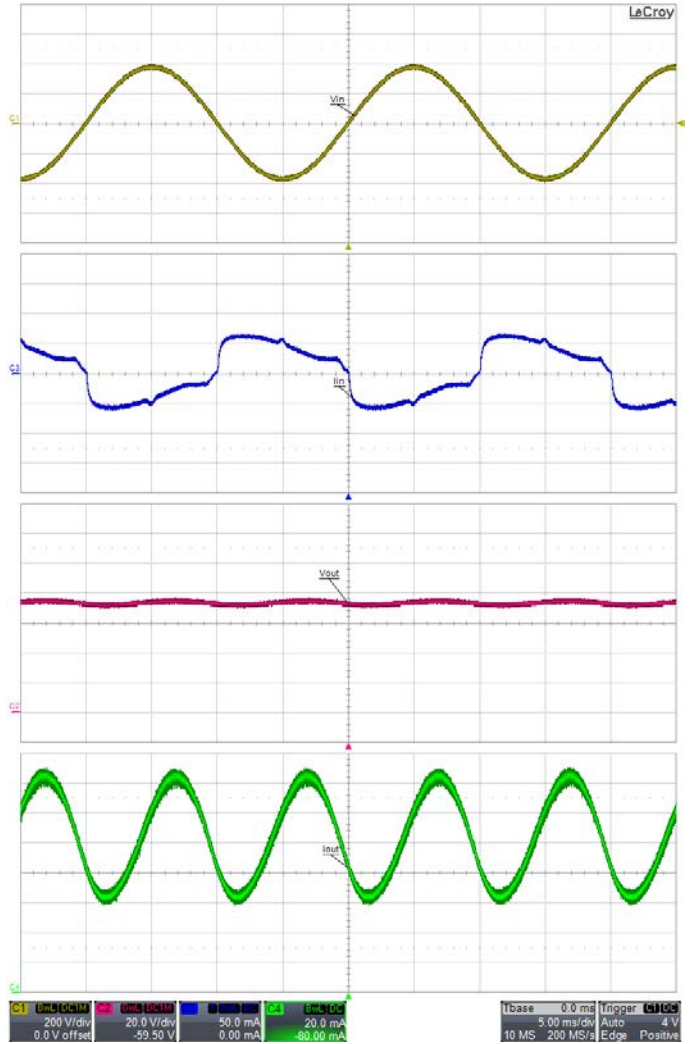


Figure 40 – 265 VAC / 50 Hz, Nominal V_{LED} Load.
 Ch1 (Yellow): V_{IN} , 200 V / div.
 Ch2 (Red): V_{OUT} , 20 V.
 Ch3 (Blue): I_{IN} , 50 mA / div.
 Ch4 (Green): I_{OUT} , 20 mA / div.
 Time Scale: 5 ms / div.

12.6 라인 새그 및 서지

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.

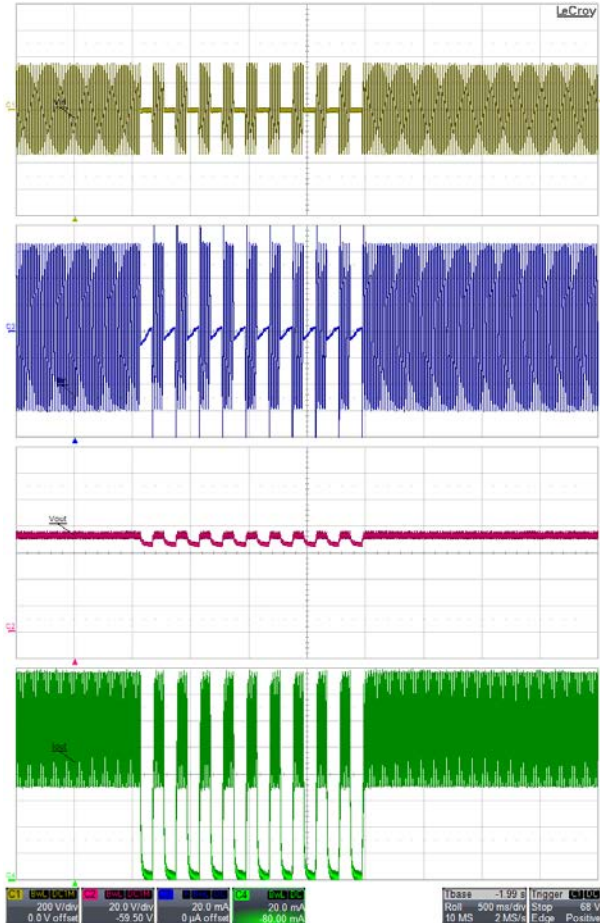


Figure 41 – Line Sag Test at 230 - 0 V at 0.1 sec Interval.
 Ch1: V_{IN} ; 200 V / div.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{IN} ; 20 mA / div
 Ch4: I_{OUT} ; 20 mA / div.
 Time Scale: 500 ms / div.

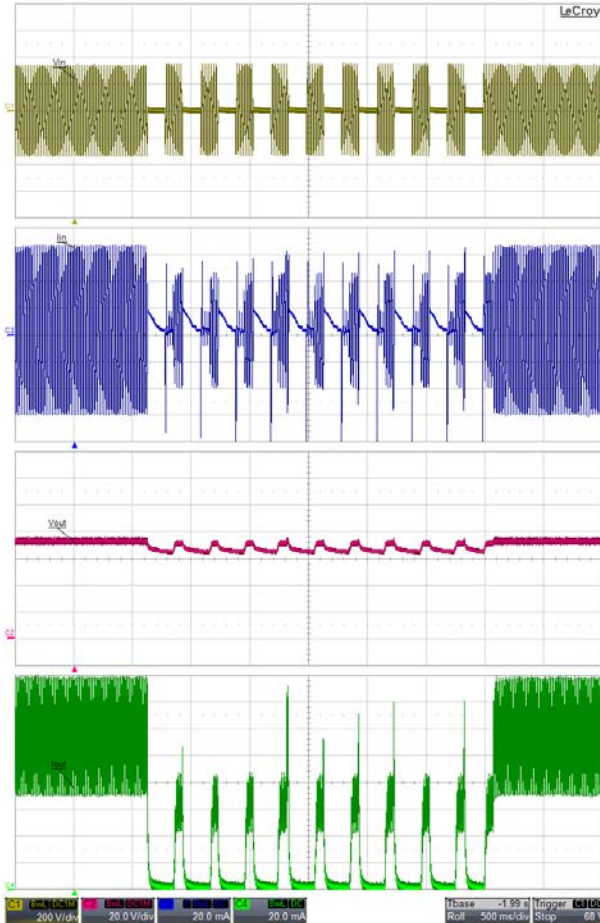


Figure 42 – Line Surge Test at 230 - 0 at 0.15 sec Interval.
 Ch1: V_{IN} ; 200 V / div.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{IN} ; 20 mA / div
 Ch4: I_{OUT} ; 20 mA / div.
 Time Scale: 500 ms / div.



12.7 무부하 보호

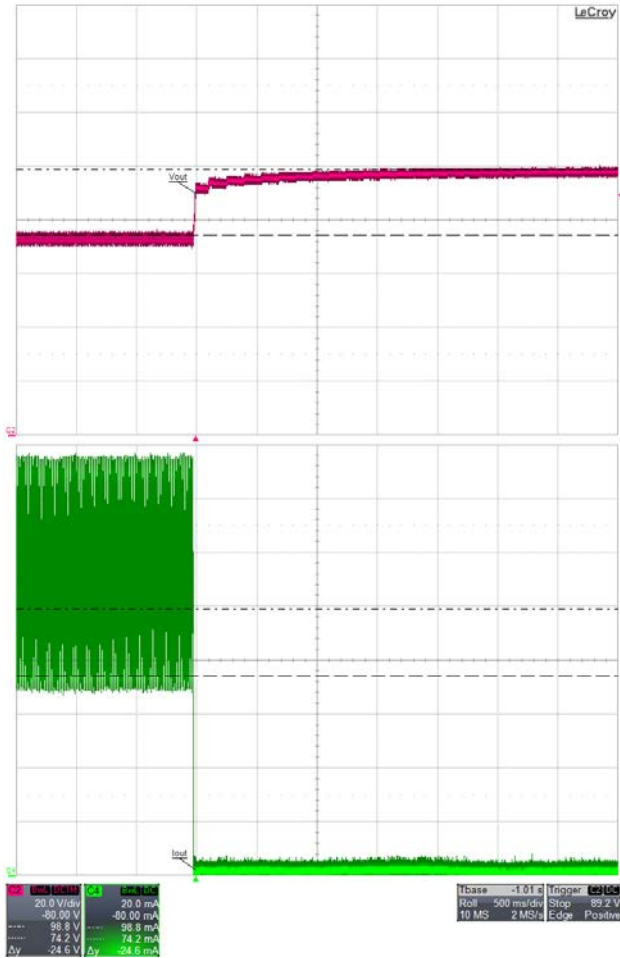


Figure 43 – No-load Protection when Load is Disconnected. 195 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.

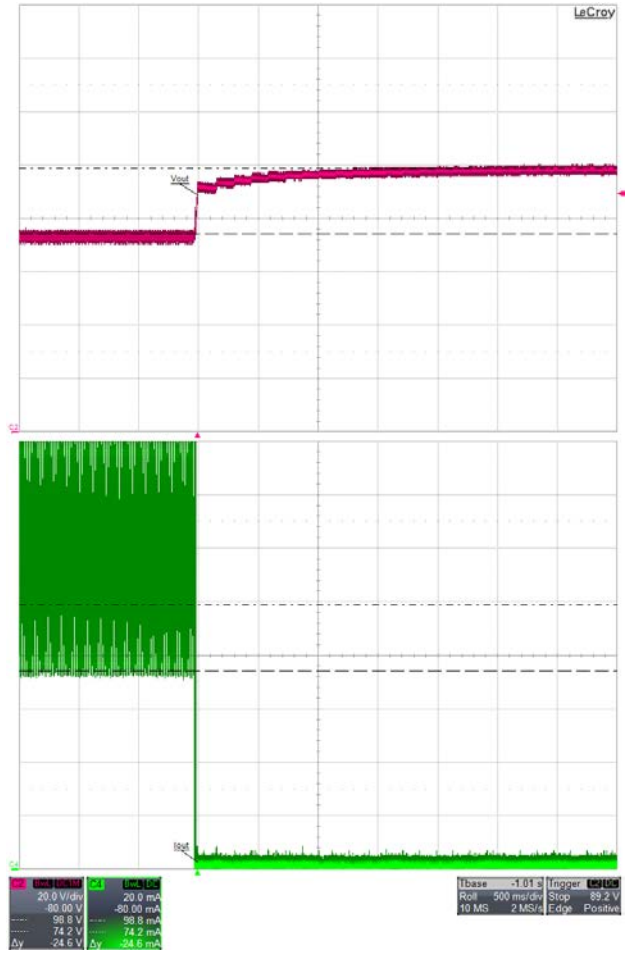


Figure 44 – No-load Protection when Load is Disconnected. 265 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.



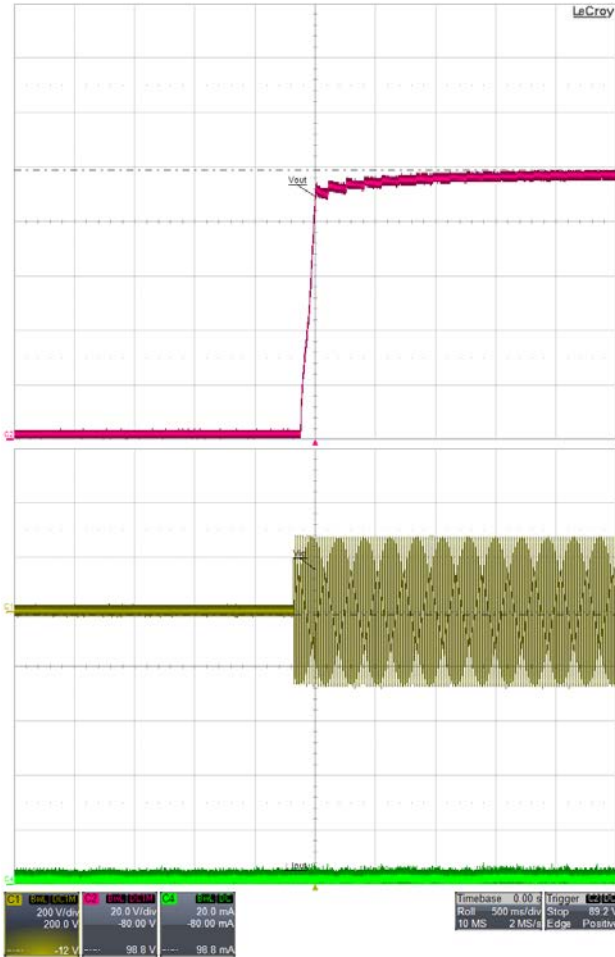


Figure 45 – No-load Start-up. 195 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.

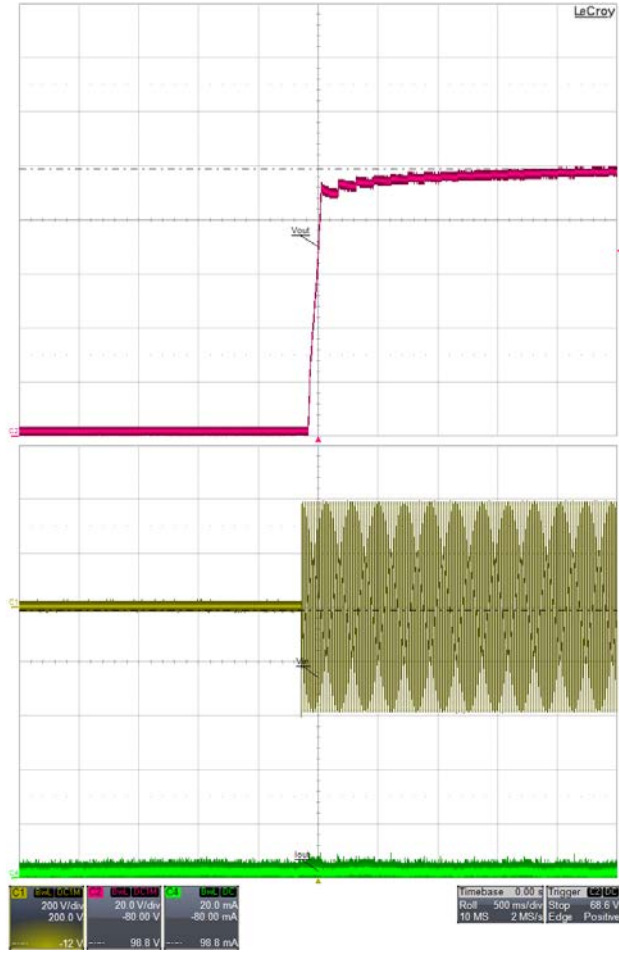


Figure 46 – No-load Start-up. 265 V / 50 Hz.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 50 mA / div.
 Time Scale: 500 ms / div.



12.8 브라운아웃/브라운인

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

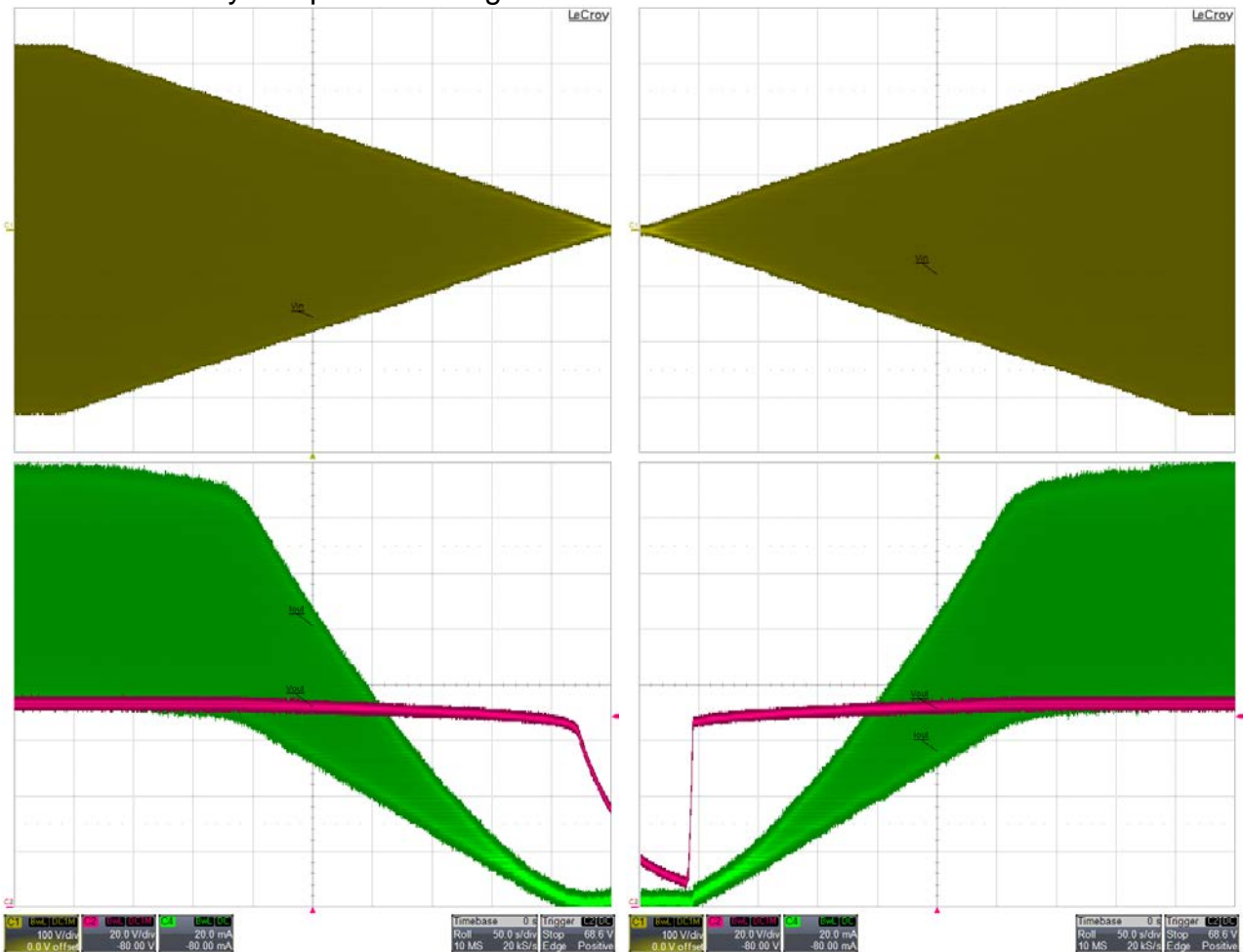


Figure 47 – Brown-out Test at 0.5 V / s. The Unit is Able to Operate Normally Without Any Failure and Without Flicker.
 230 V-0-230 V
 Ch1: V_{IN} ; 100 V / div.
 Ch2: V_{OUT} ; 20 V / div.
 Ch3: I_{OUT} ; 20 mA / div.
 Time Scale: 50 s / div.

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 디밍

13.1 디밍 호환성

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 디밍 파형

Dimmer: Berker 2830 10

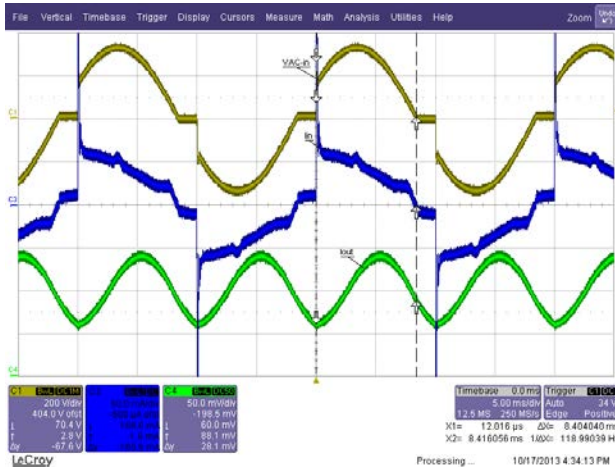


Figure 49 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

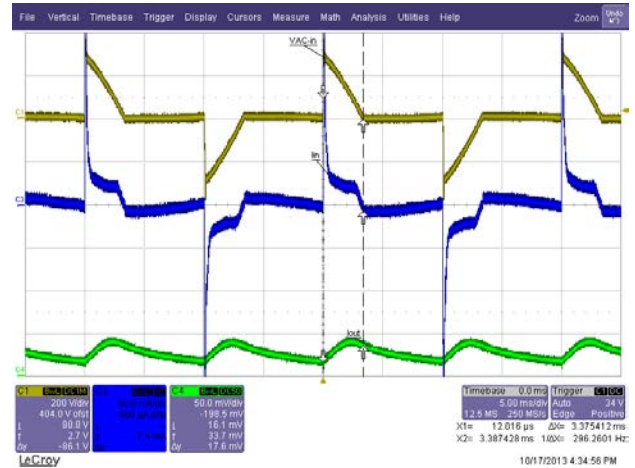


Figure 50 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

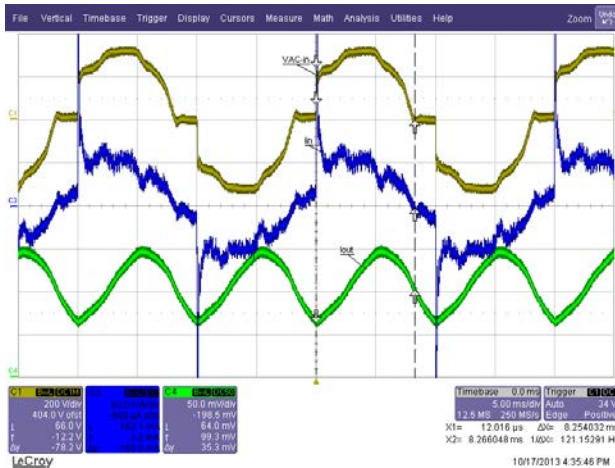


Figure 51 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

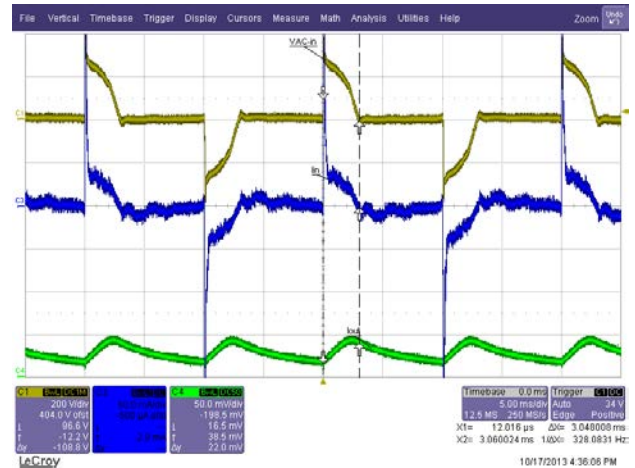


Figure 52 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Jung 225 NV DE

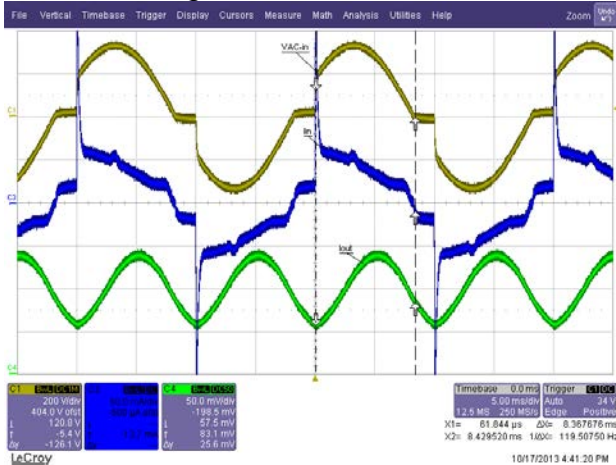


Figure 53 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

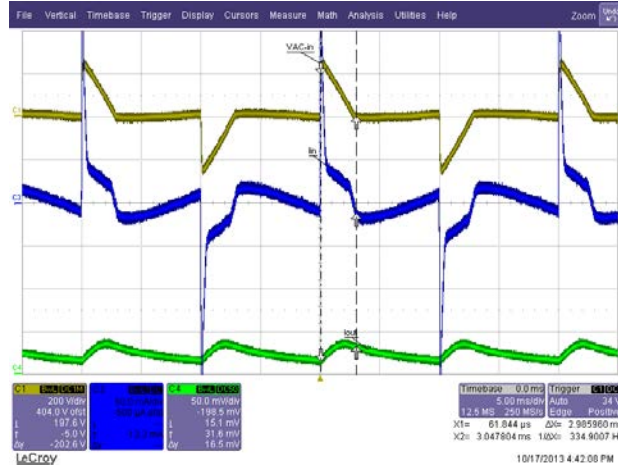


Figure 54 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

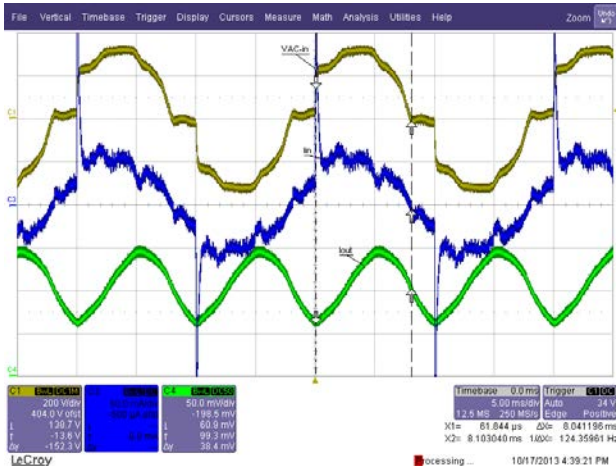


Figure 55 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

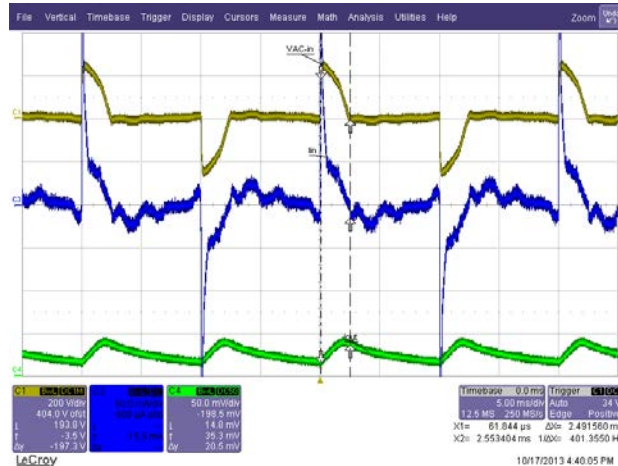


Figure 56 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Jung 254 UDIE 1

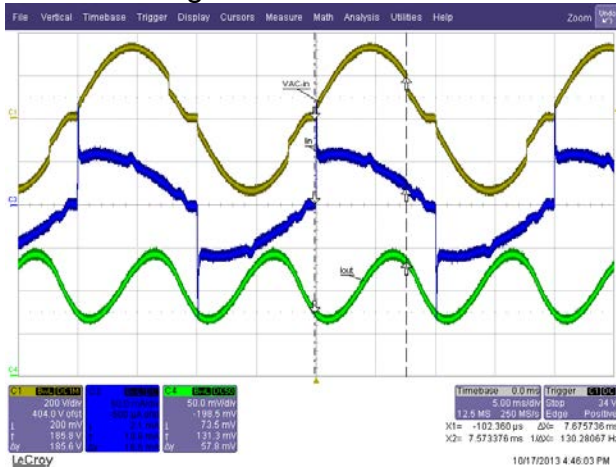


Figure 57 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

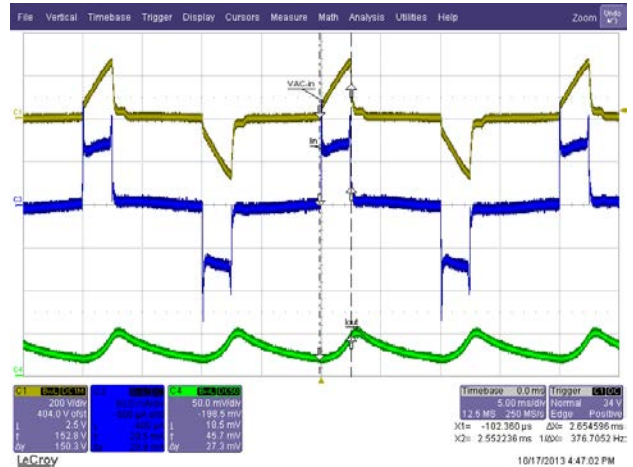


Figure 58 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

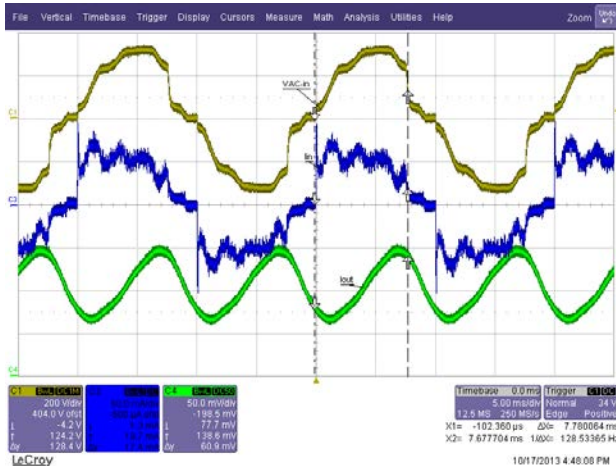


Figure 59 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

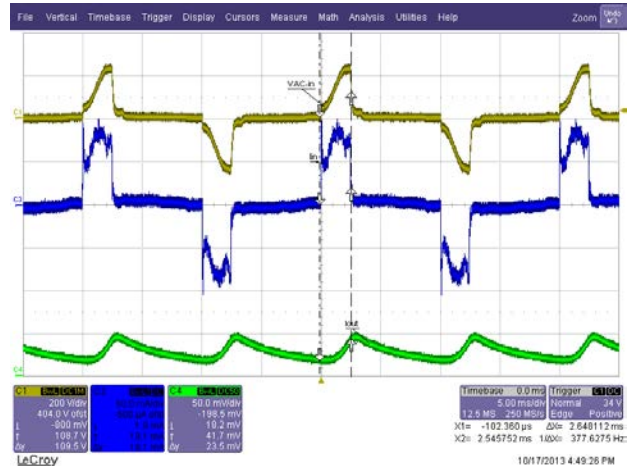


Figure 60 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Jung 266 G DE

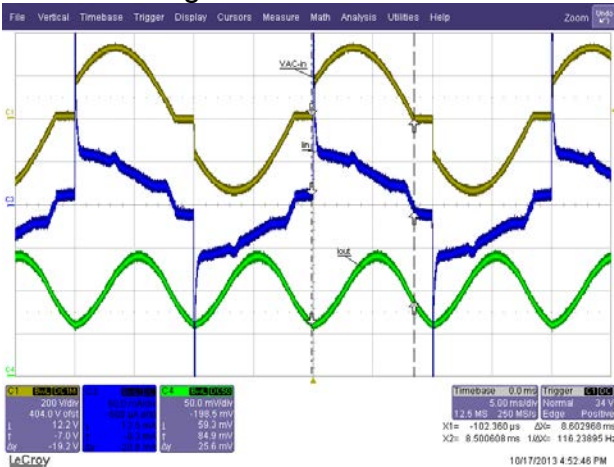


Figure 61 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

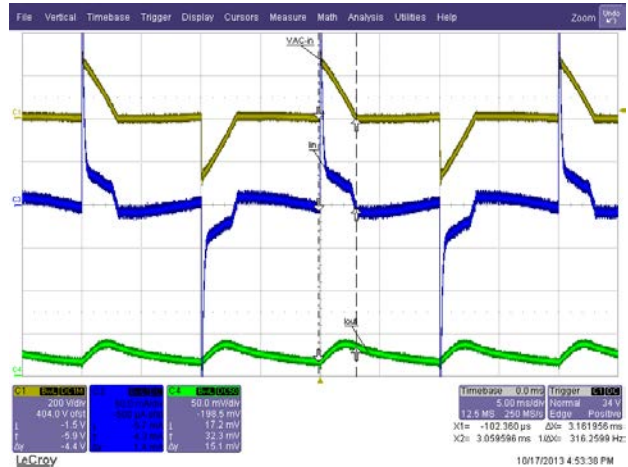


Figure 62 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

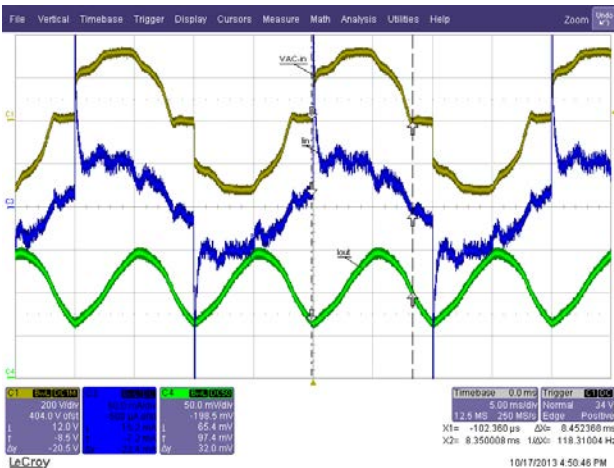


Figure 63 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

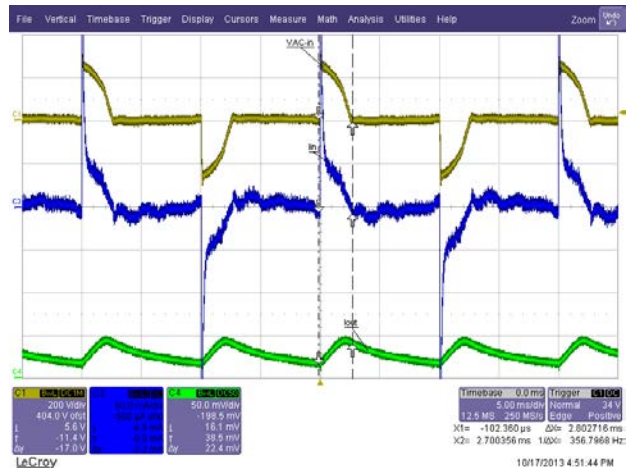


Figure 64 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2200 UJ-212

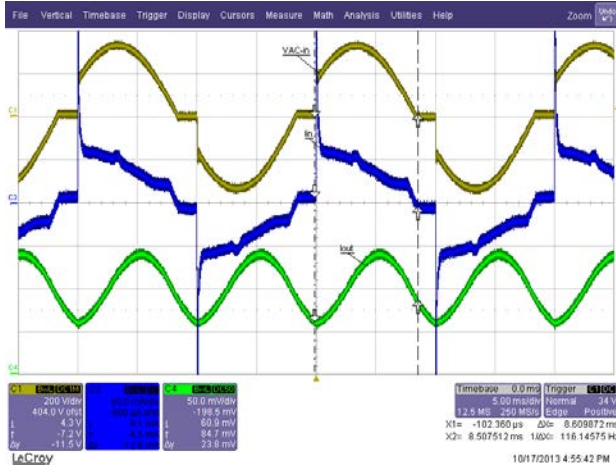


Figure 65 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

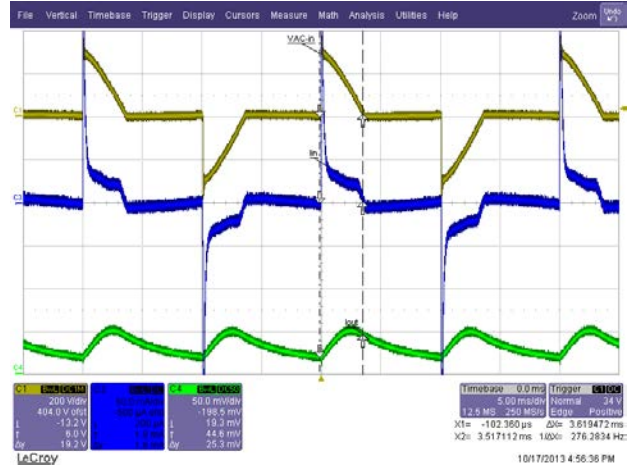


Figure 66 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

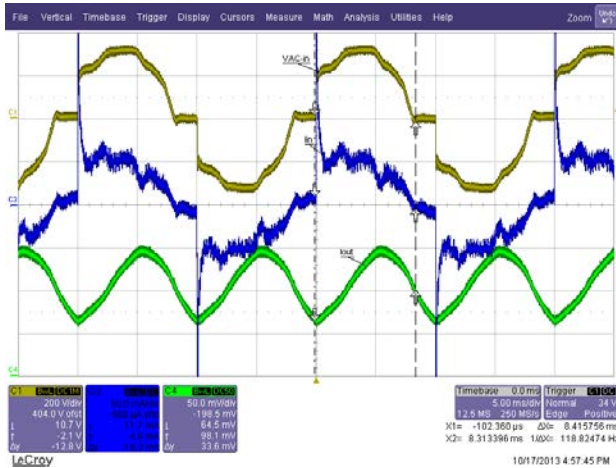


Figure 67 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

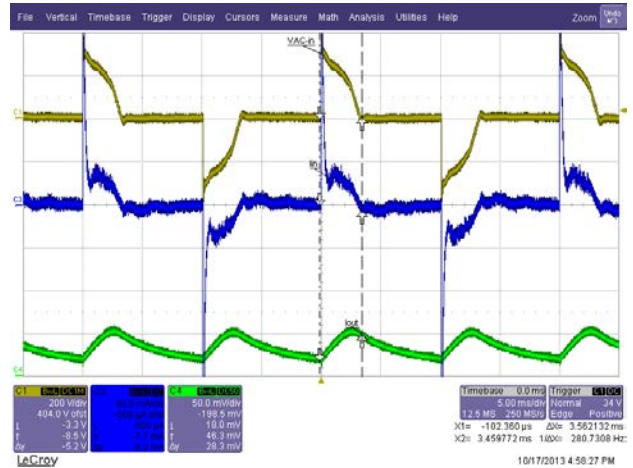


Figure 68 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250 U

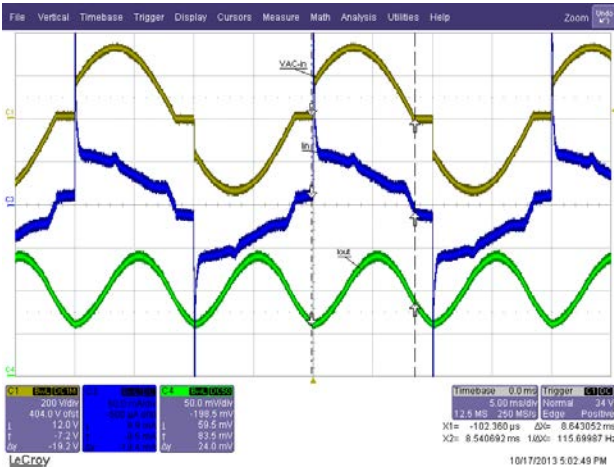


Figure 69 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

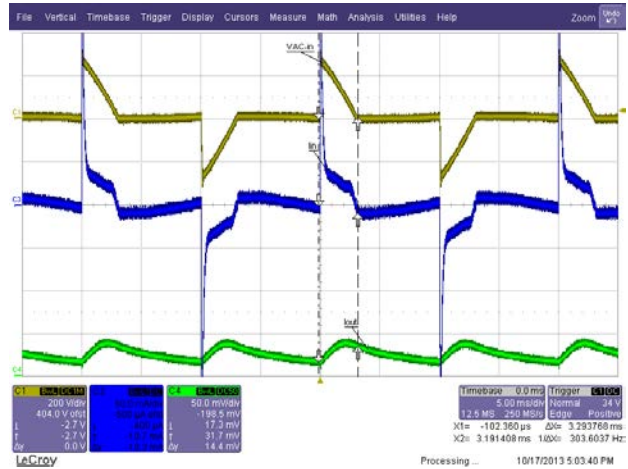


Figure 70 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

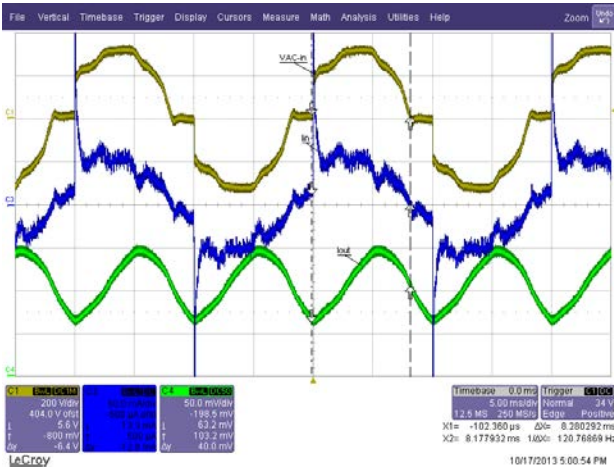


Figure 71 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

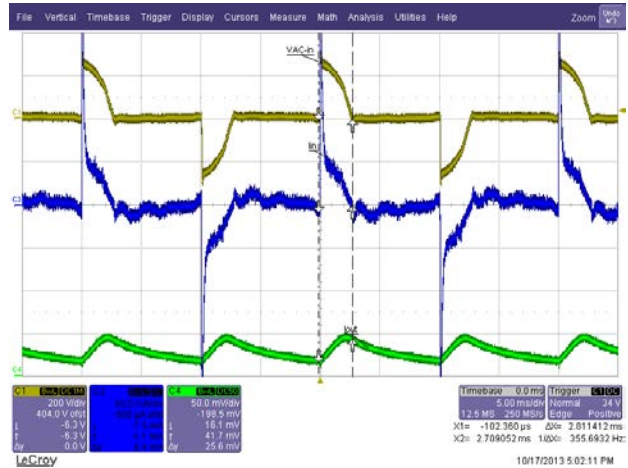


Figure 72 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

Dimmer: Busch 2247 U

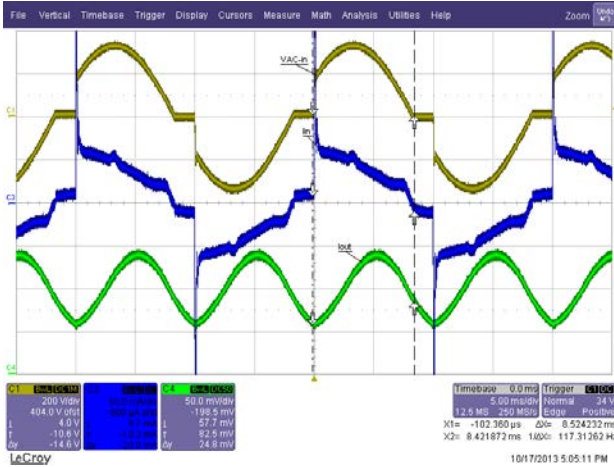


Figure 73 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

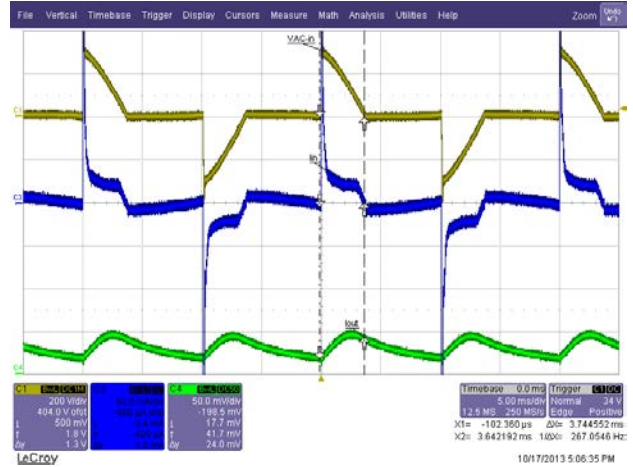


Figure 74 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

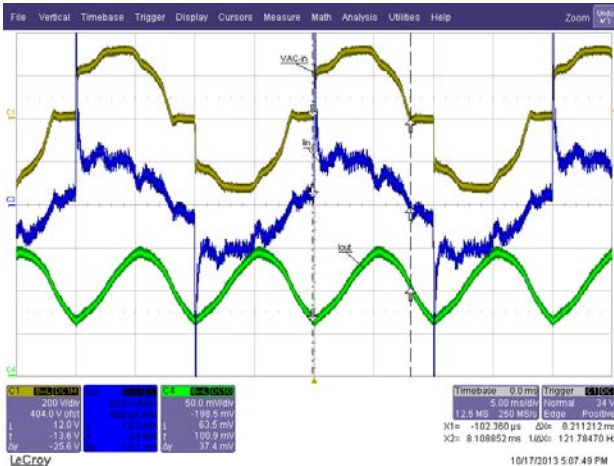


Figure 75 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

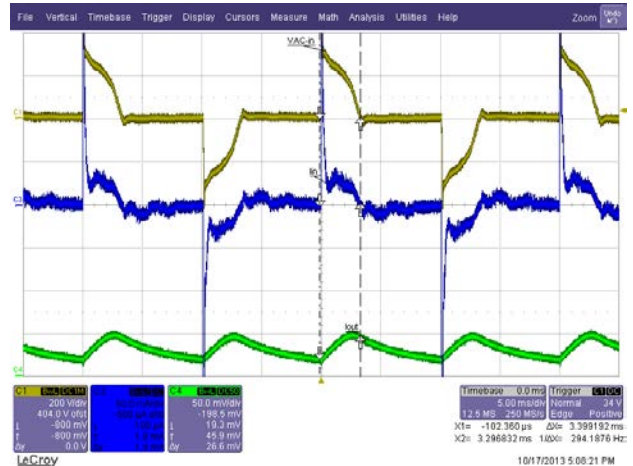


Figure 76 – Minimum Conduction from Distorted AC Line
 AC Line 230V/50Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Gira 2262 00 I01

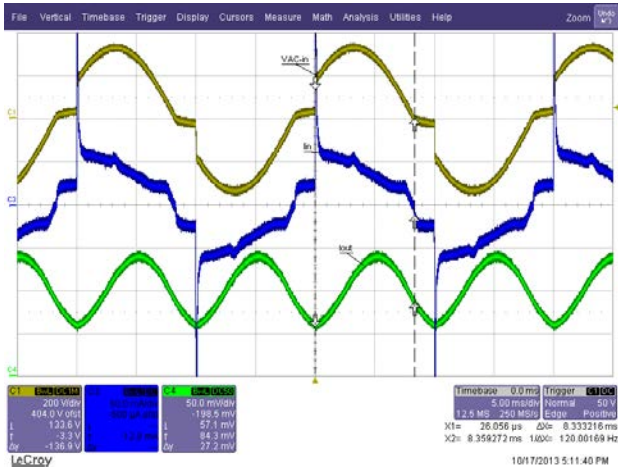


Figure 77 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

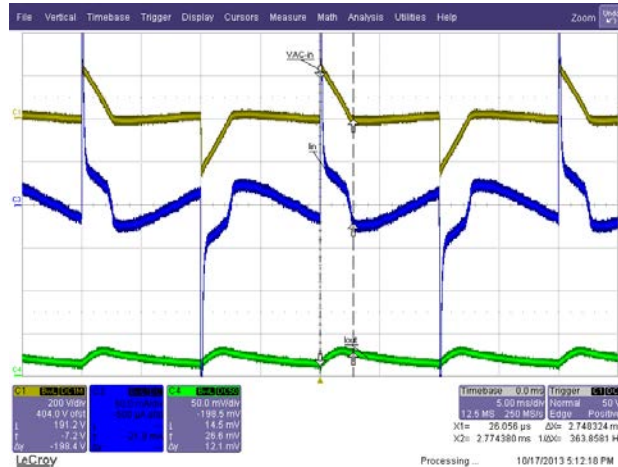


Figure 78 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

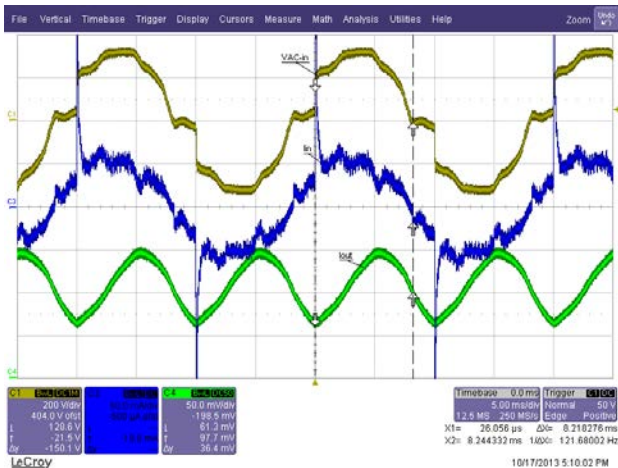


Figure 79 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

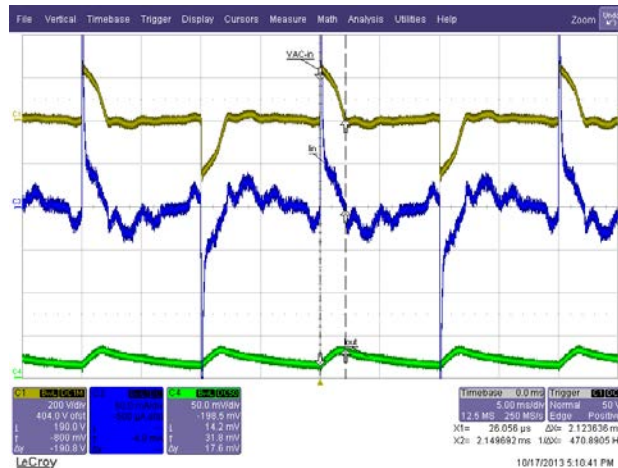


Figure 80 – Minimum Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Gira 0300 00 I01

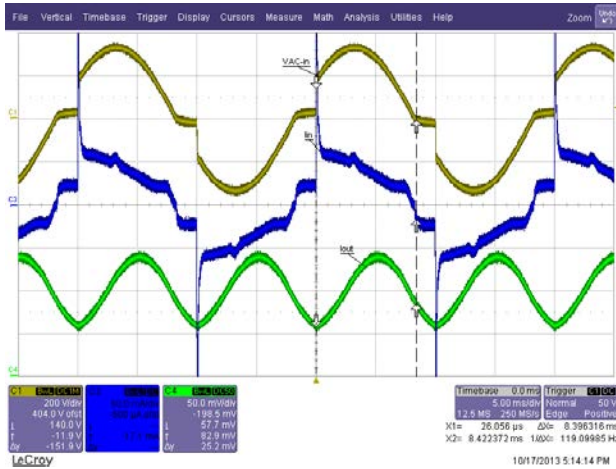


Figure 81 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

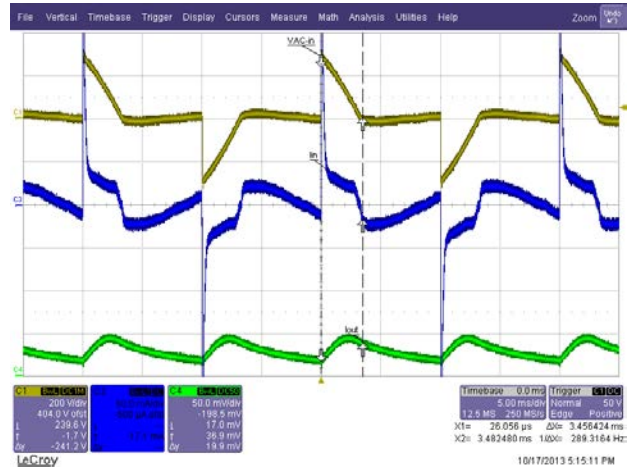


Figure 82 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

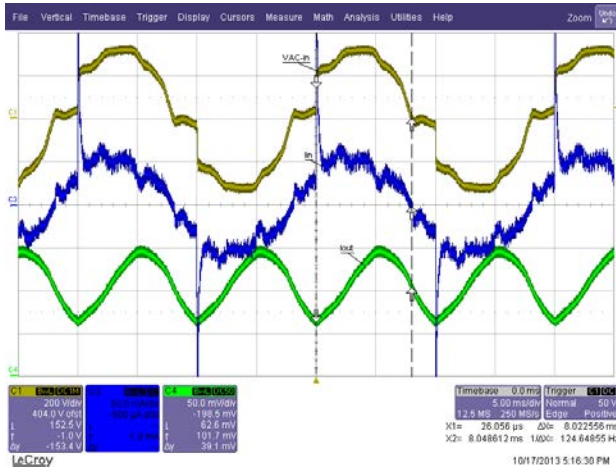


Figure 83 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

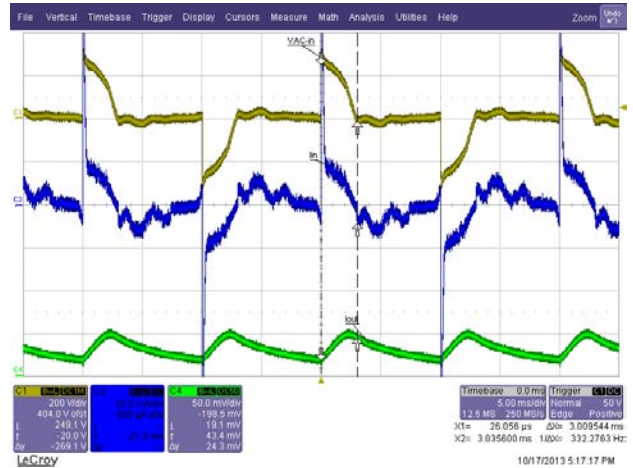


Figure 84 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250 U

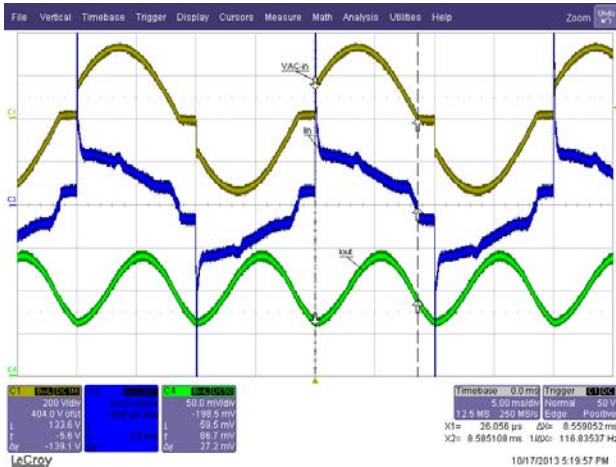


Figure 85 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

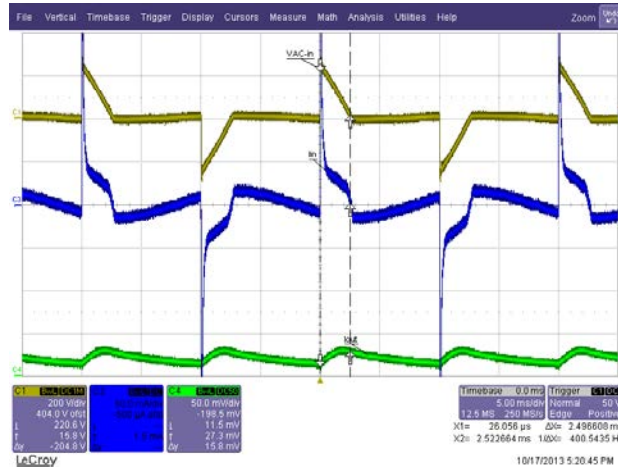


Figure 86 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

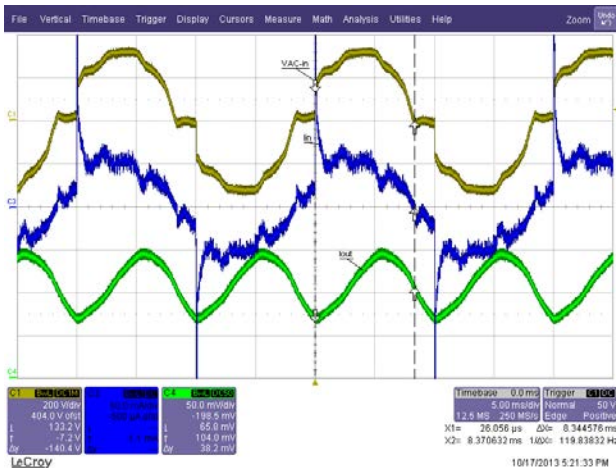


Figure 87 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

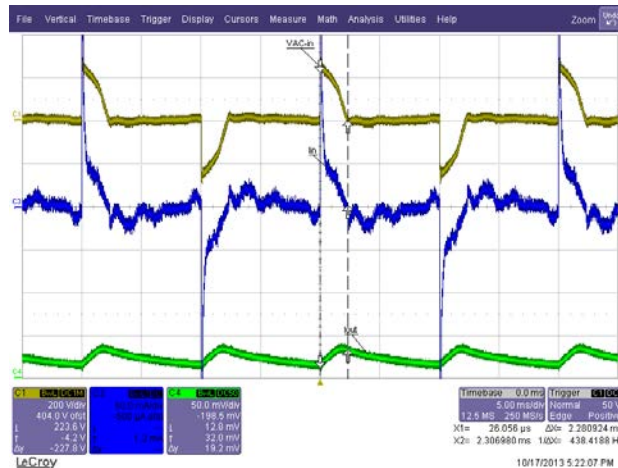


Figure 88 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: TCL

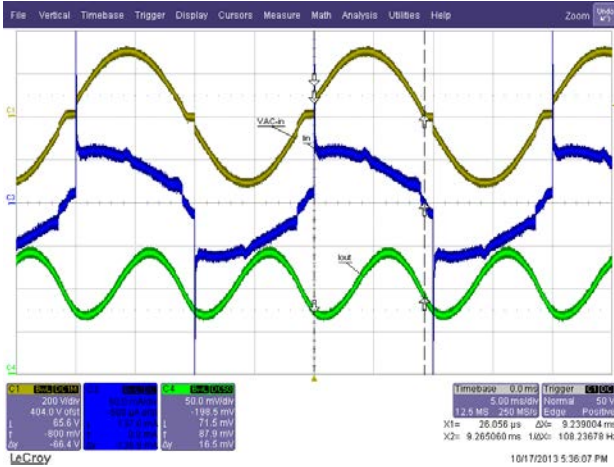


Figure 89 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

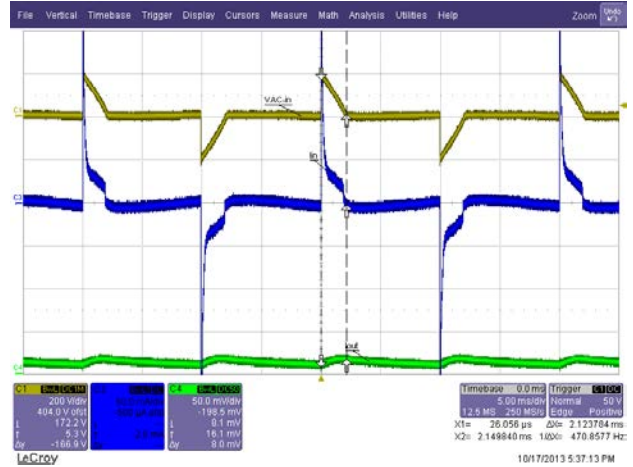


Figure 90 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

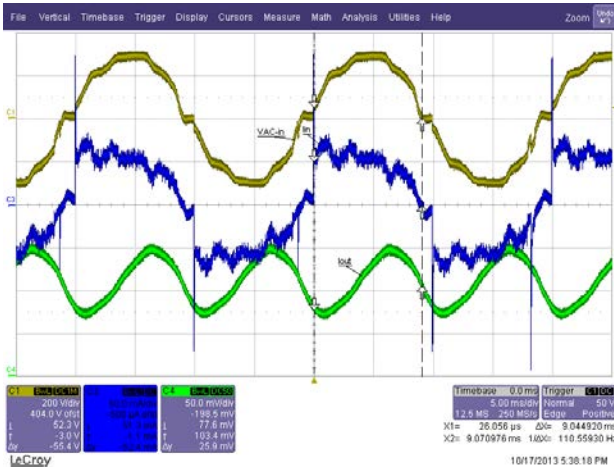


Figure 91 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

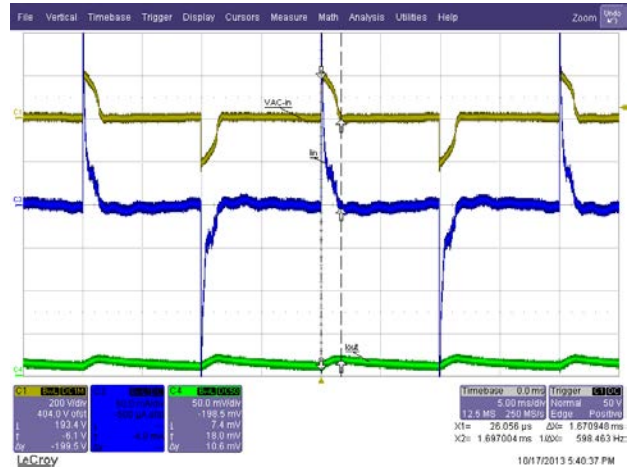


Figure 92 – Minimum Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: SEN BO LANG

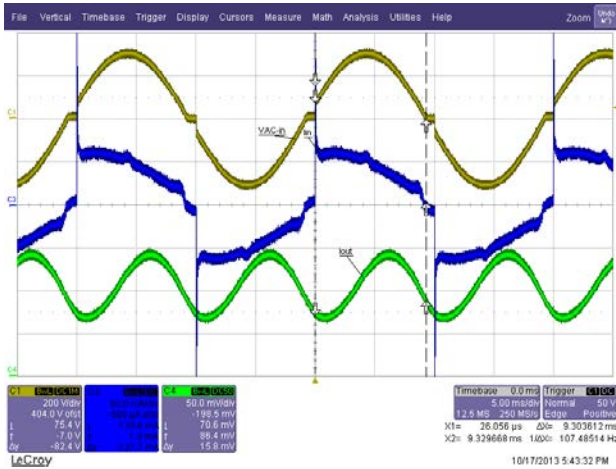


Figure 93 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

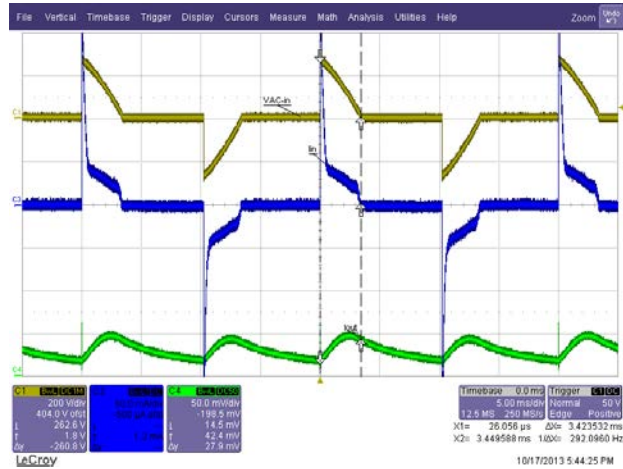


Figure 94 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

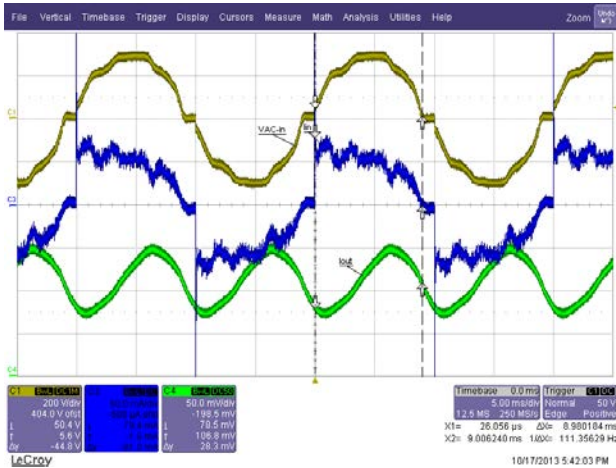


Figure 95 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

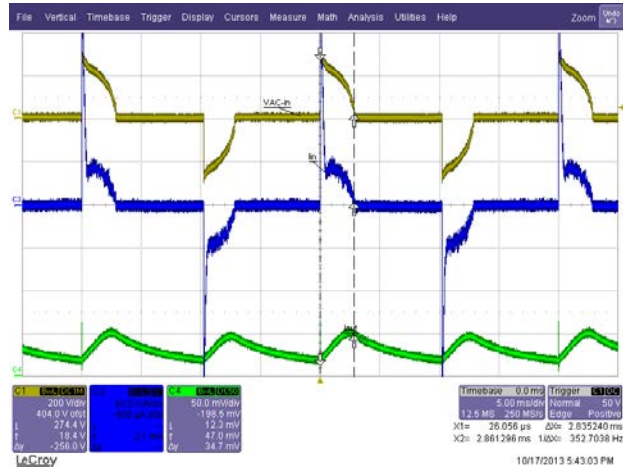


Figure 96 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: EBA HUANG

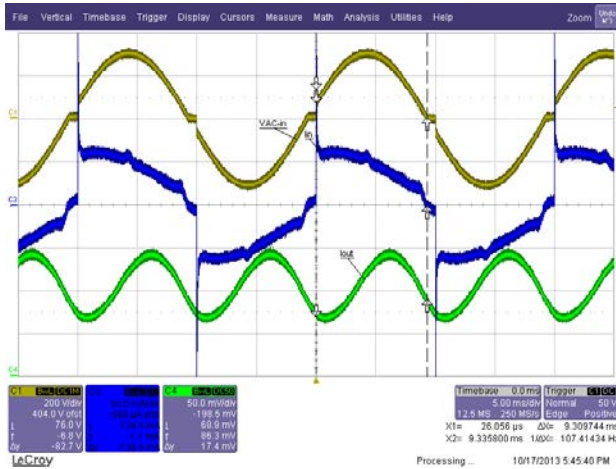


Figure 97 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

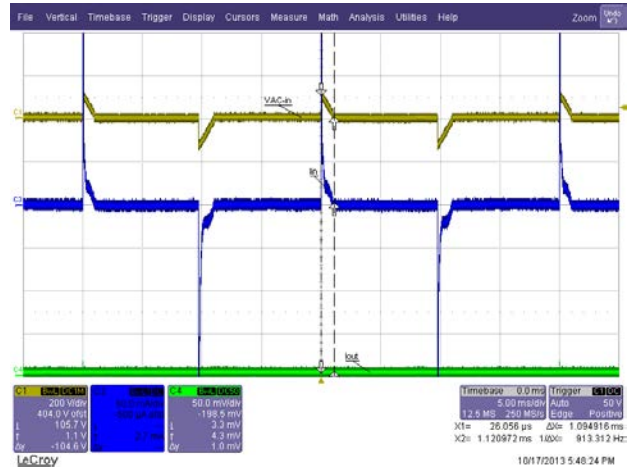


Figure 98 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

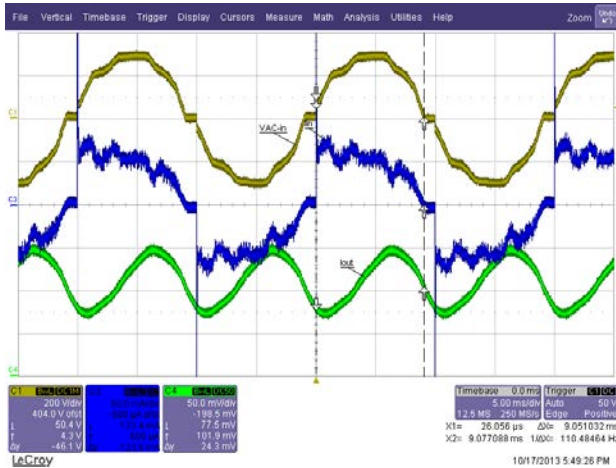


Figure 99 – Full Conduction from Distorted AC Line
 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

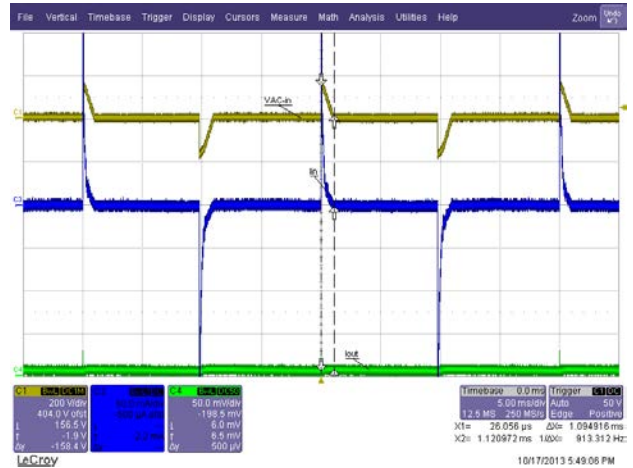


Figure 100 – Minimum Conduction from Distorted AC Line
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: SB ELECT

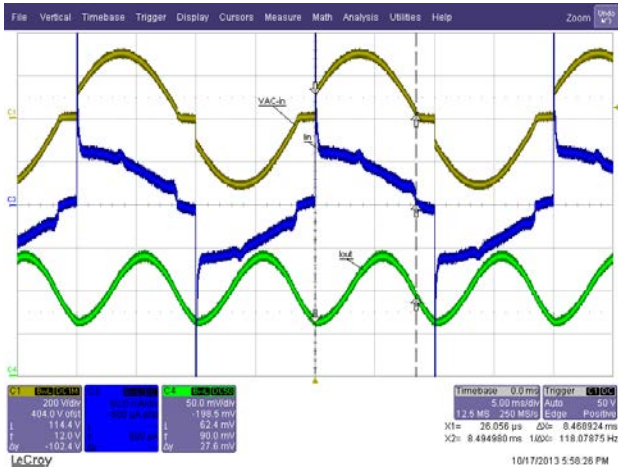


Figure 101 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

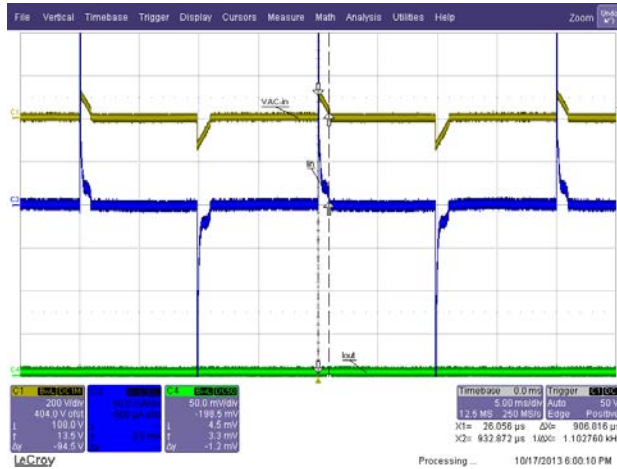


Figure 102 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

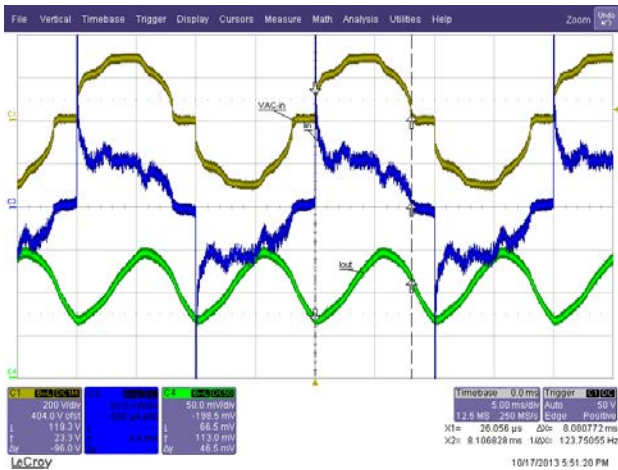


Figure 103 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



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

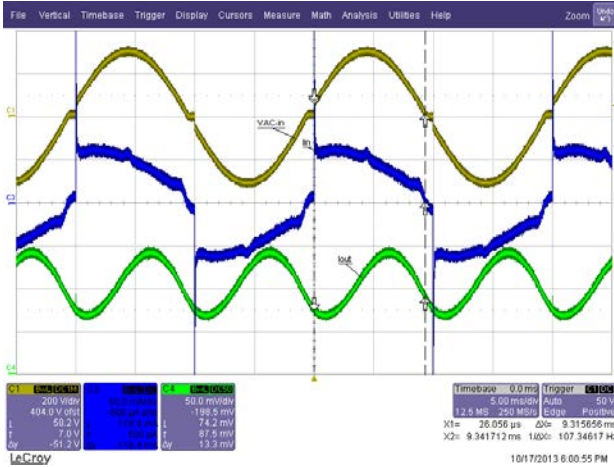


Figure 105 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

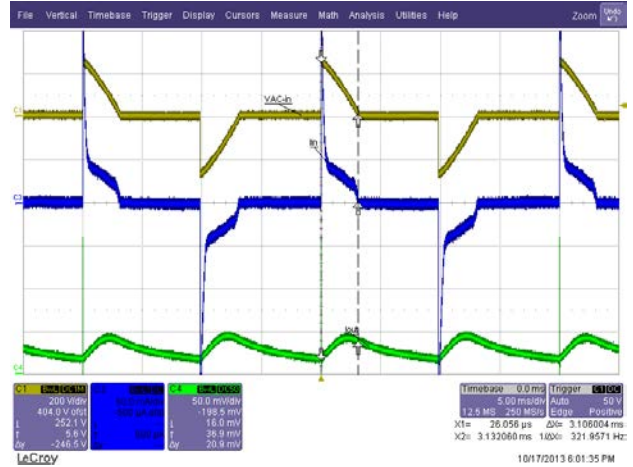


Figure 106 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

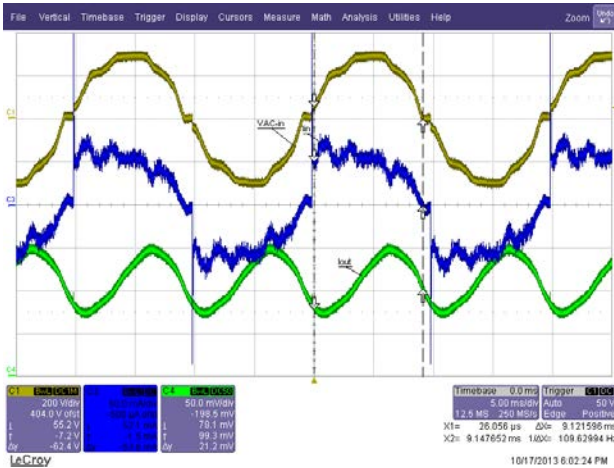


Figure 107 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

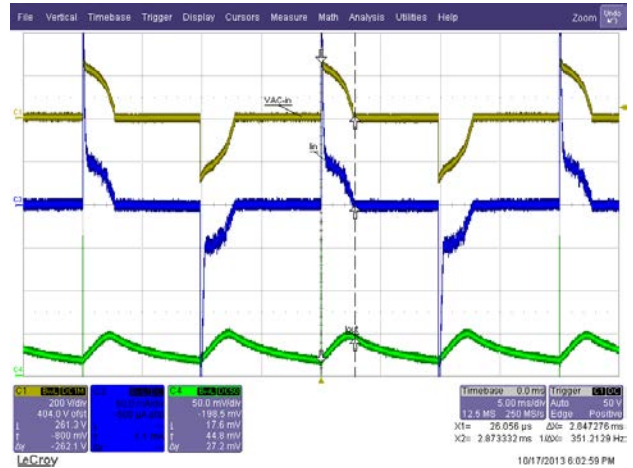


Figure 108 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: KBE

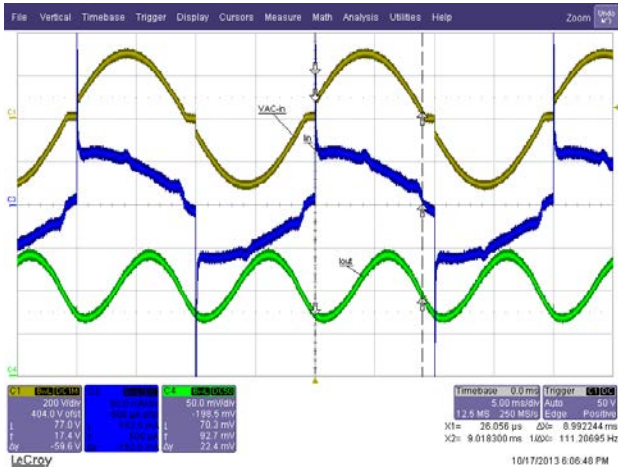


Figure 109 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

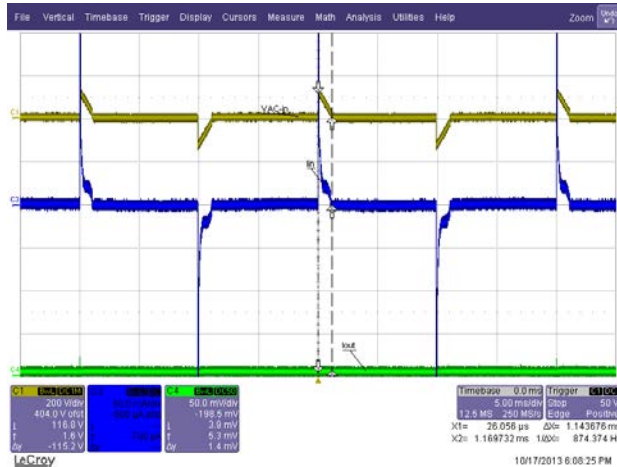


Figure 110 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

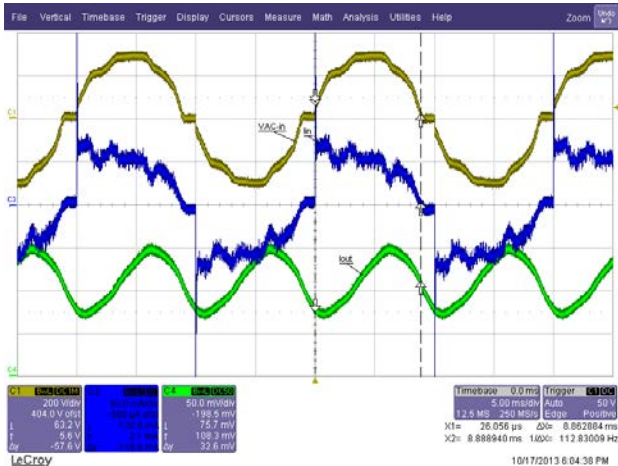


Figure 111 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

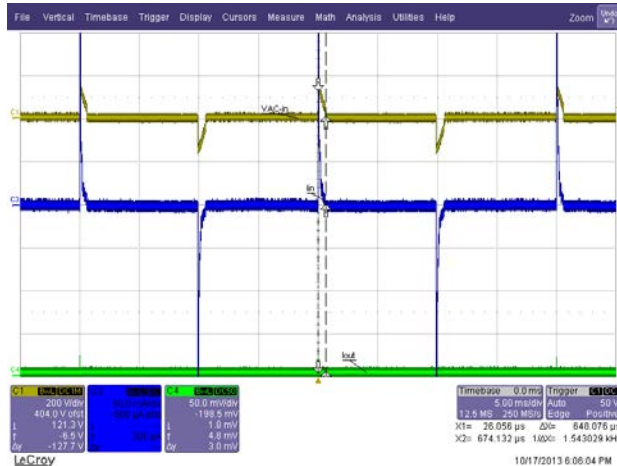


Figure 112 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: CLIPMEI

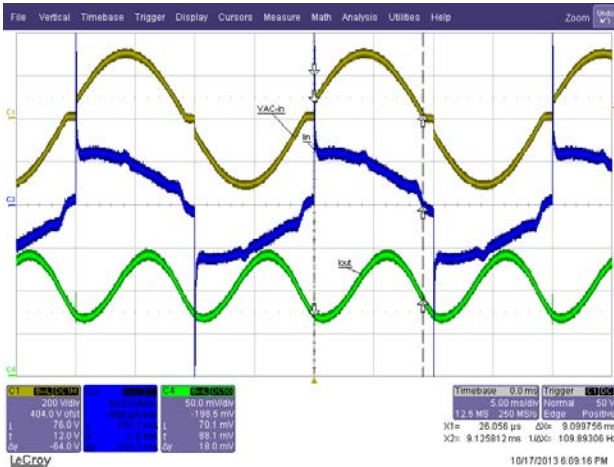


Figure 113 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

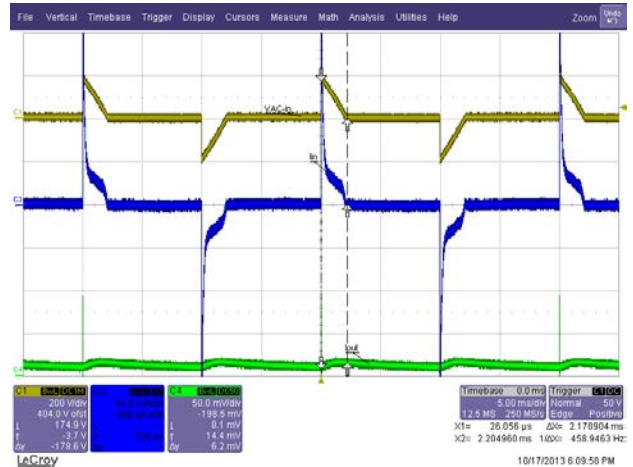


Figure 114 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

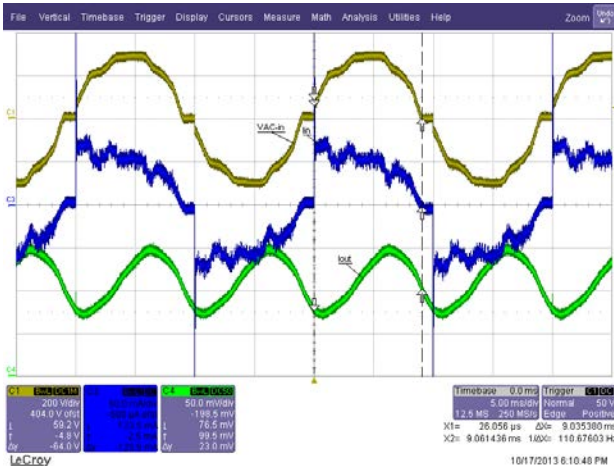


Figure 115 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

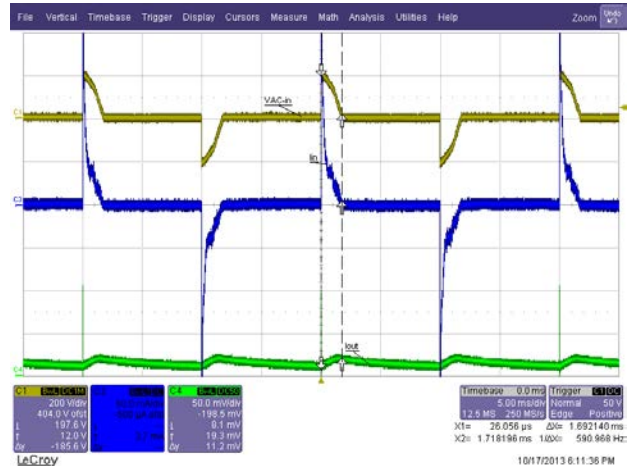


Figure 116 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: MANK

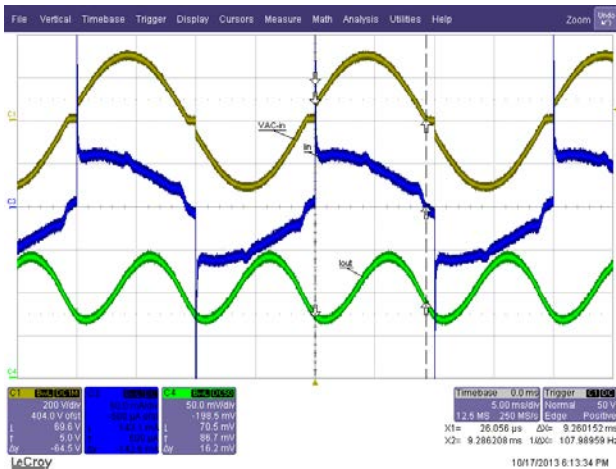


Figure 117 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

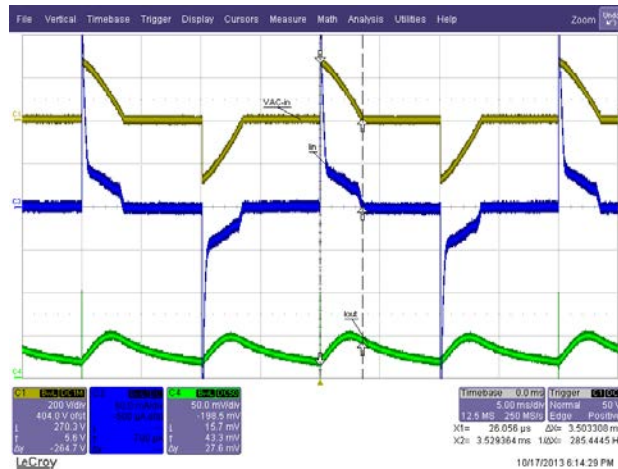


Figure 118 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

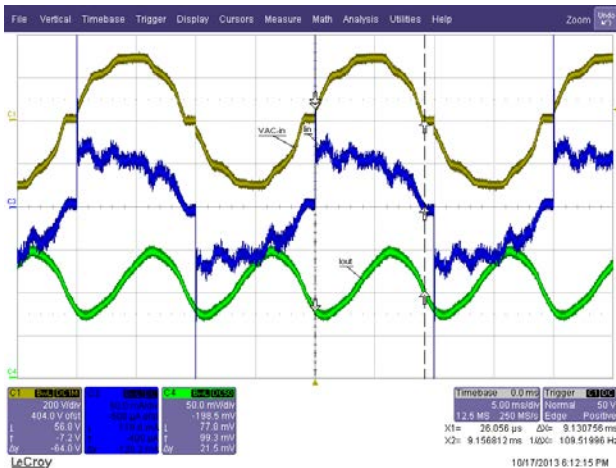


Figure 119 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

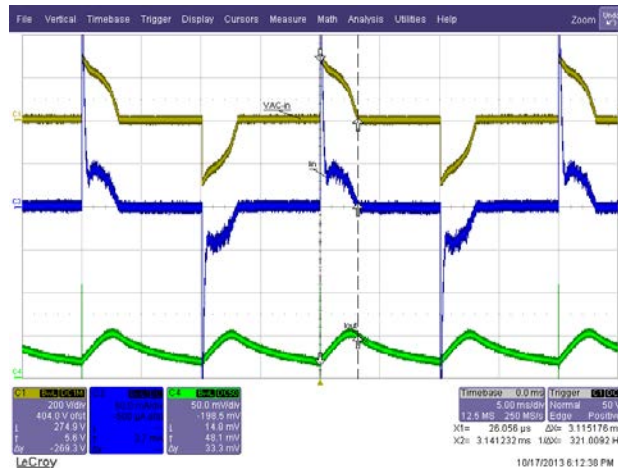


Figure 120 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: GIRA 1176 00 I03

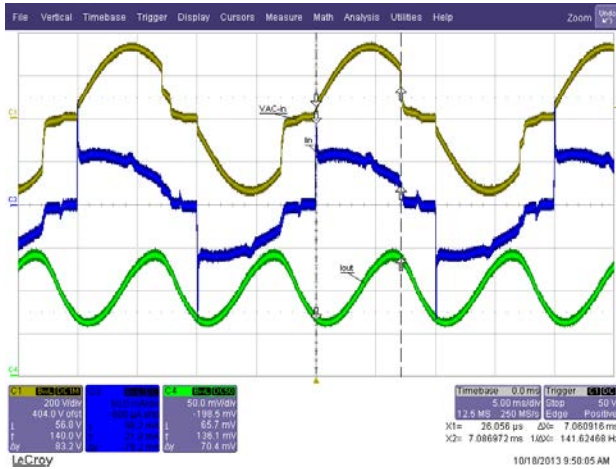


Figure 121 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

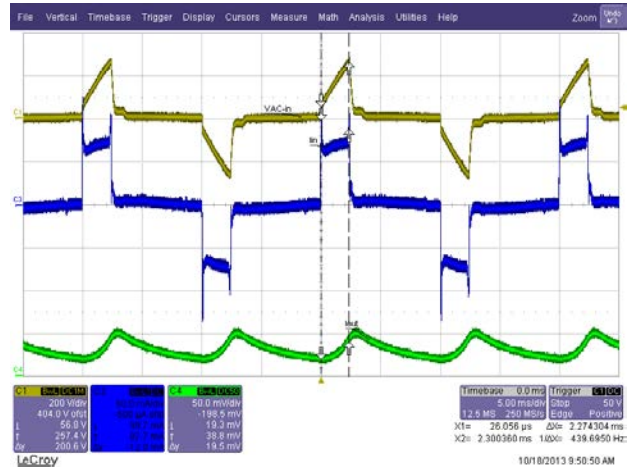


Figure 122 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

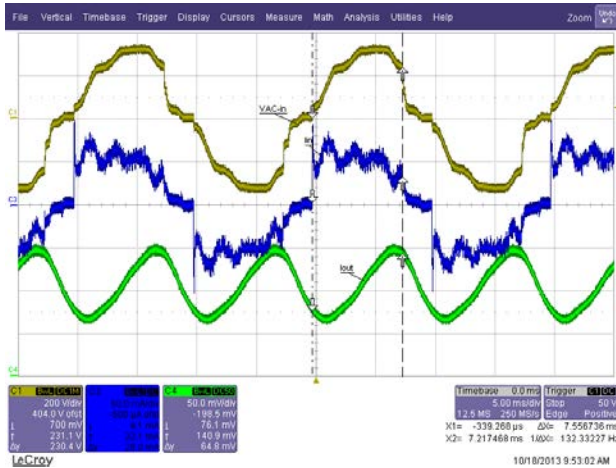


Figure 123 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.

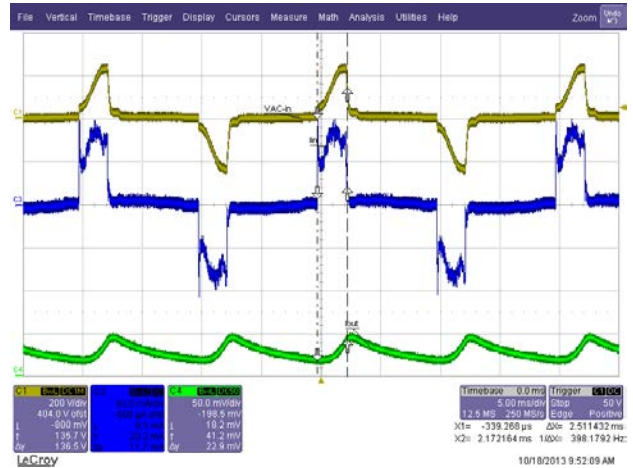


Figure 124 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN}; 200 V / div.
 Ch3: I_{IN}; 50 mA / div.
 Ch4: I_{OUT}; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-013

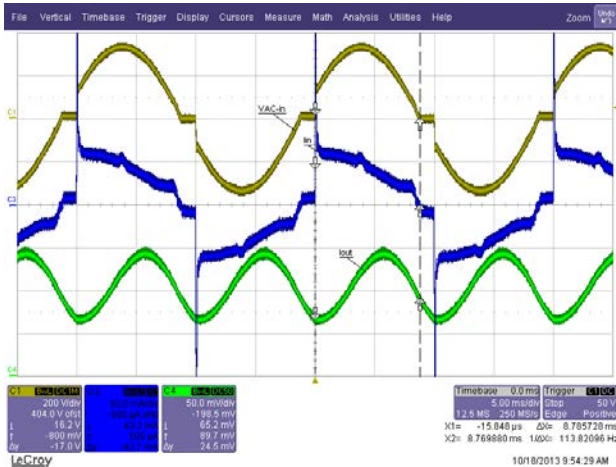


Figure 125 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

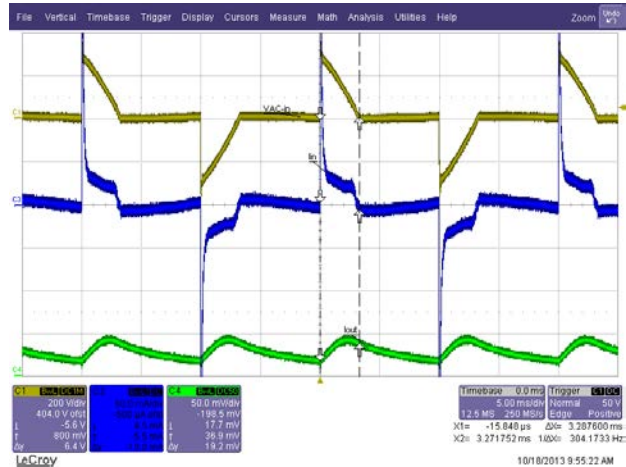


Figure 126 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

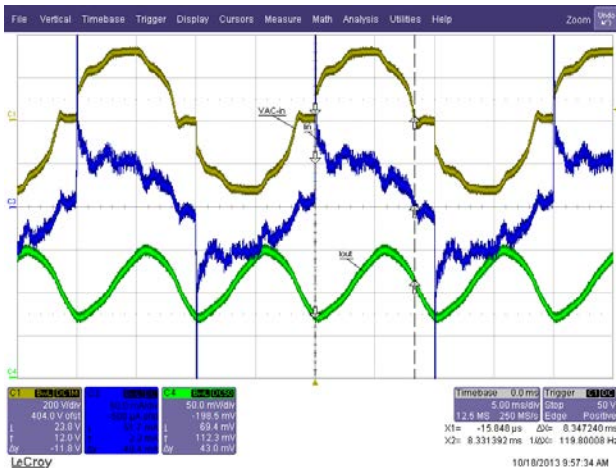


Figure 127 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

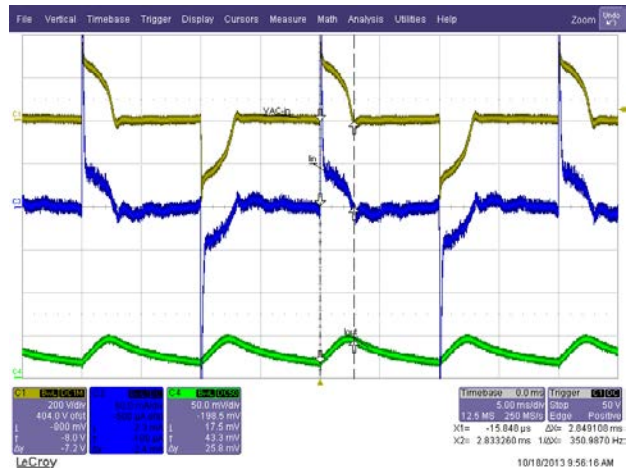


Figure 128 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-017

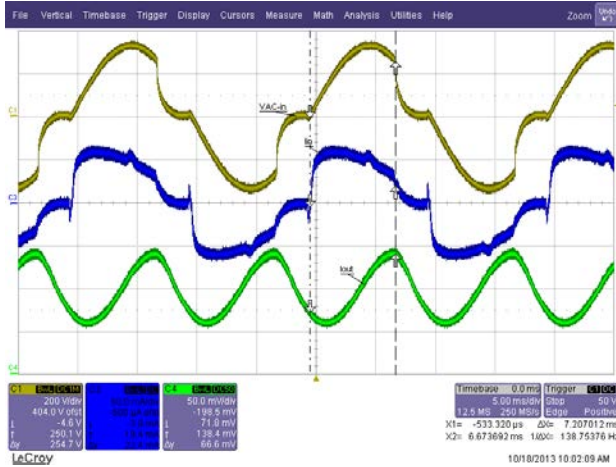


Figure 129 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

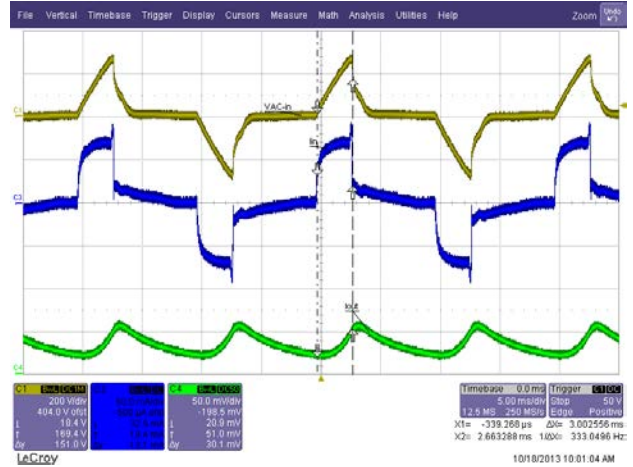


Figure 130 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

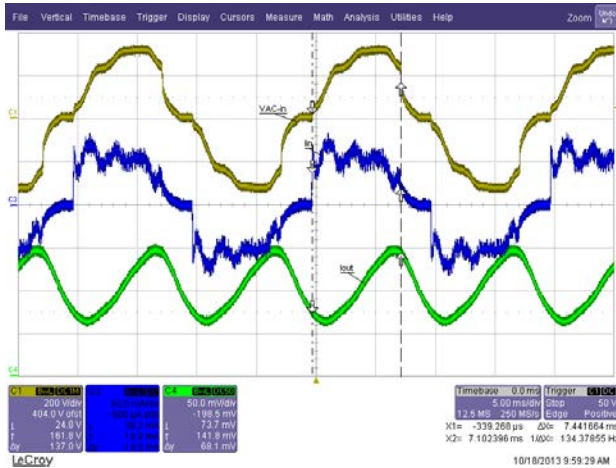


Figure 131 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

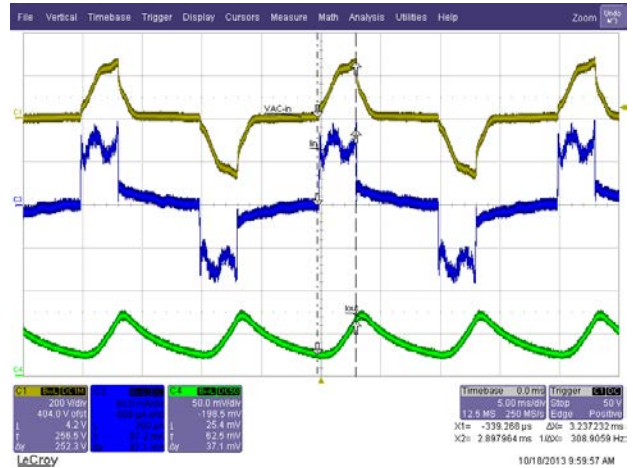


Figure 132 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-014

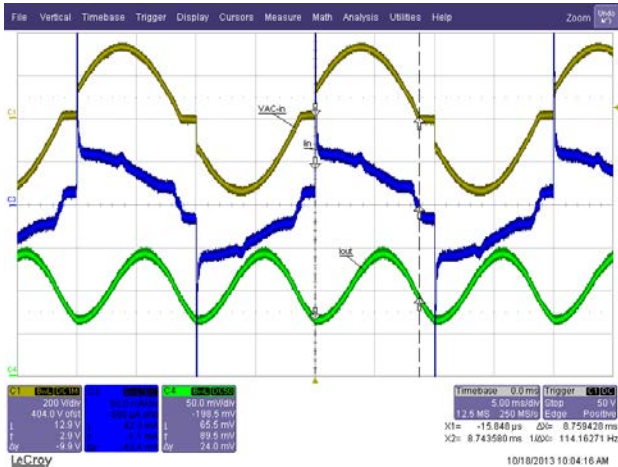


Figure 133 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

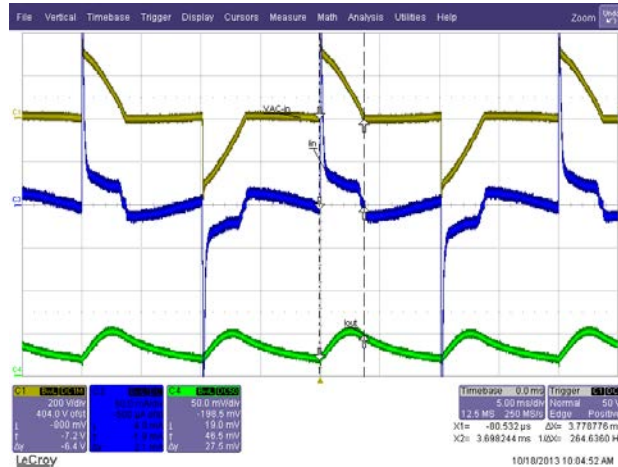


Figure 134 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

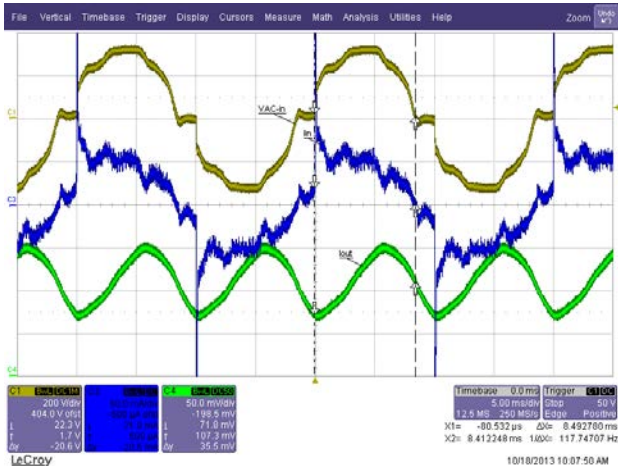


Figure 135 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

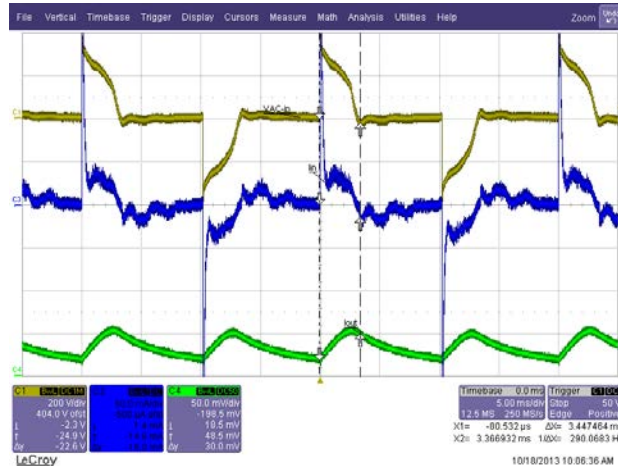


Figure 136 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Niko 310-016

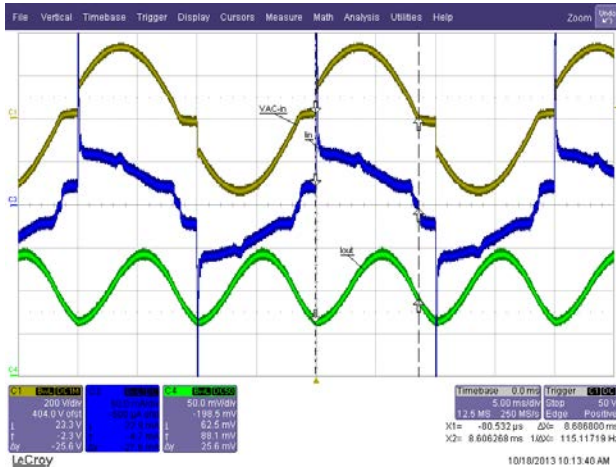


Figure 137 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

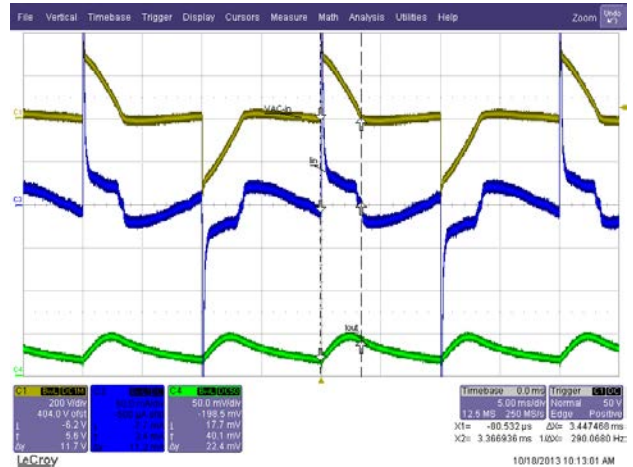


Figure 138 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

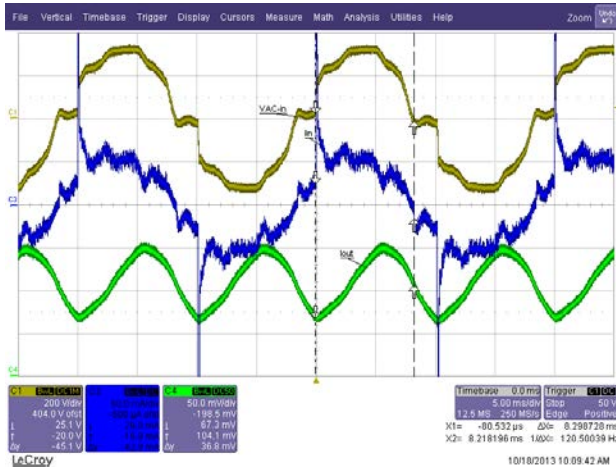


Figure 139 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

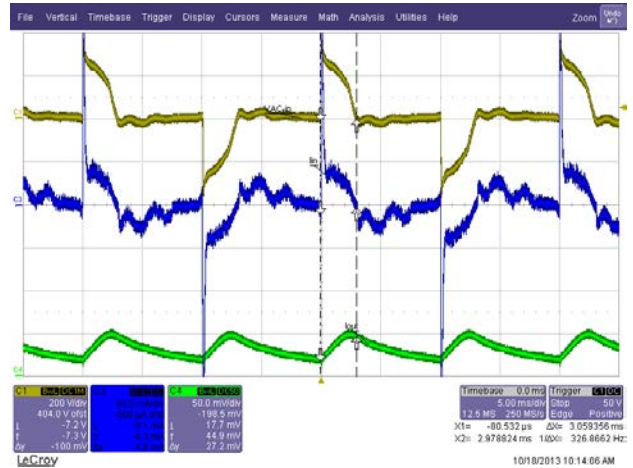


Figure 140 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 2250

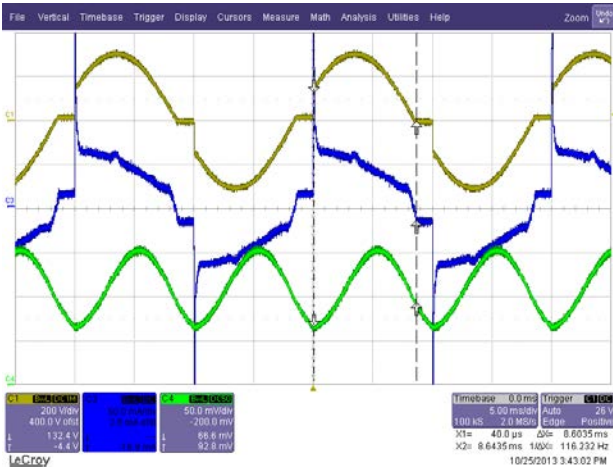


Figure 141 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

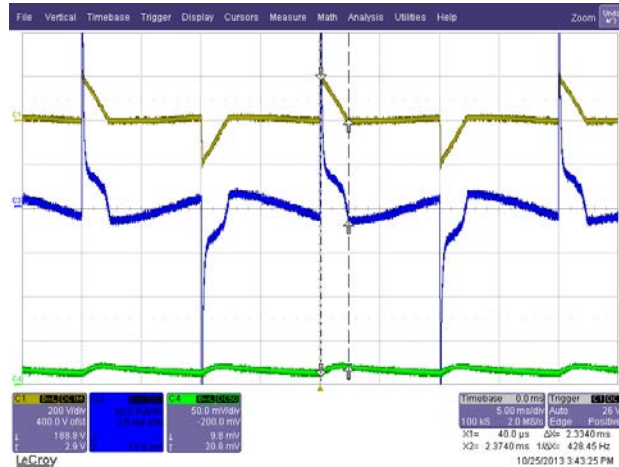


Figure 142 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

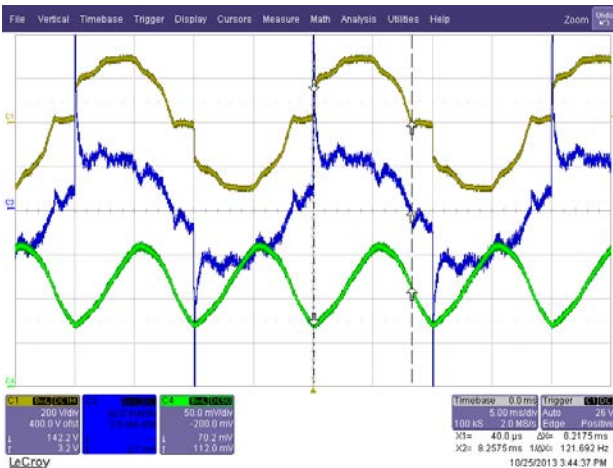


Figure 143 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

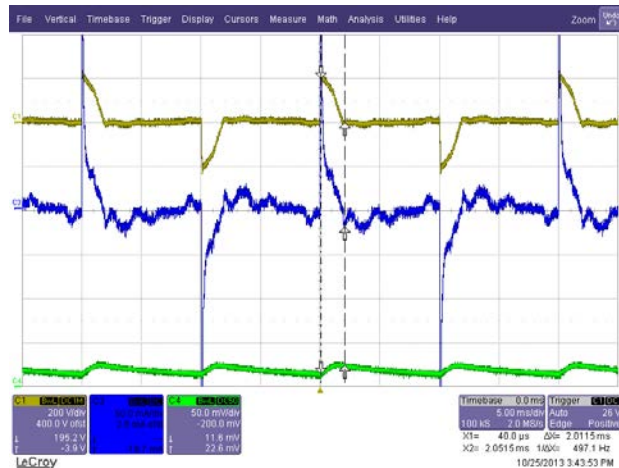


Figure 144 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

Dimmer: PEHA 400 W

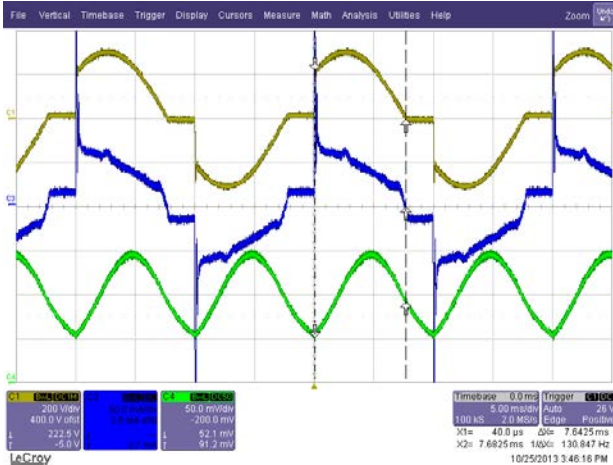


Figure 145 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50mA / div.
 Time Scale: 5 ms / div.

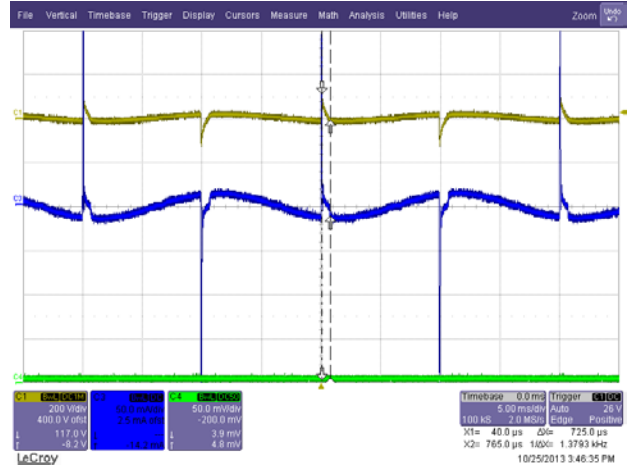


Figure 146 – Minimum Conduction from Regulated AC
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

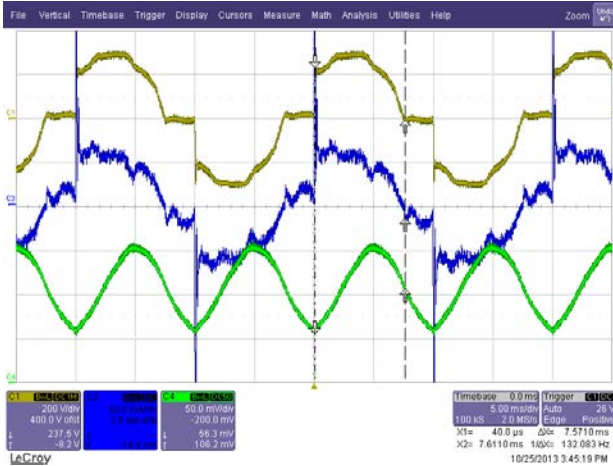


Figure 147 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

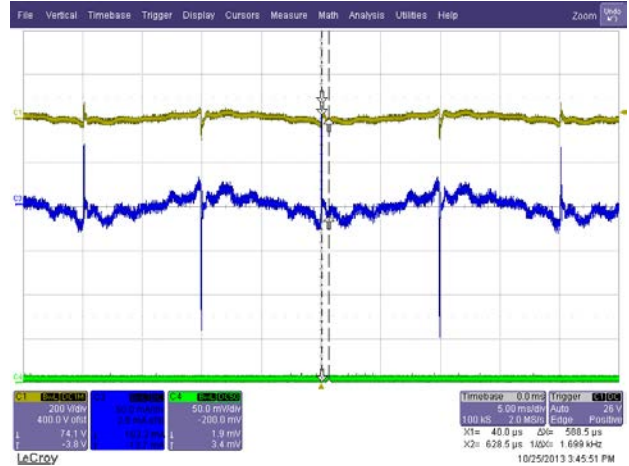


Figure 148 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Merten 572499

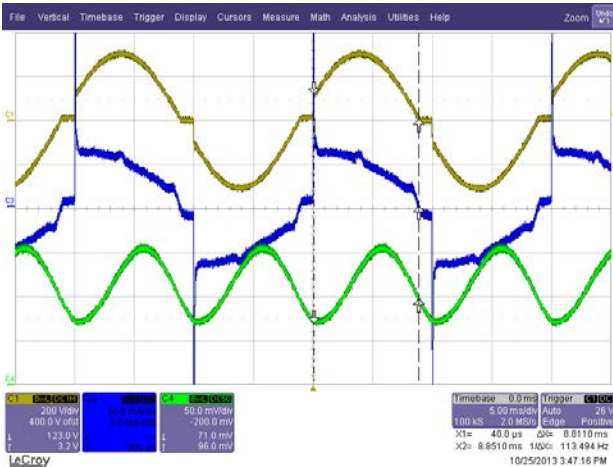


Figure 149 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

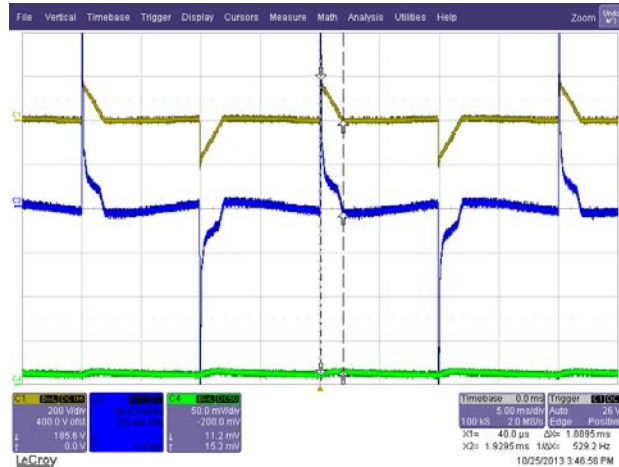


Figure 150 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

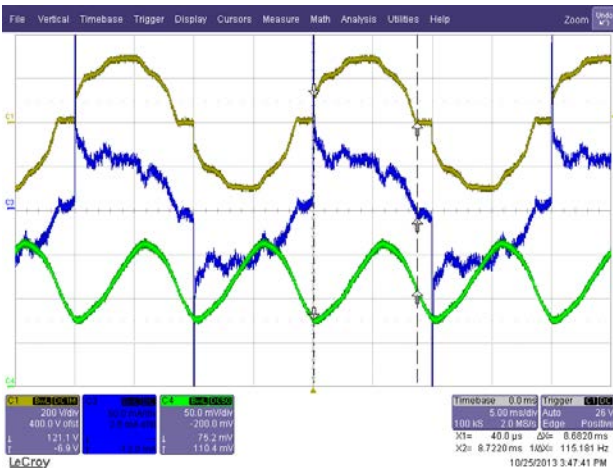


Figure 151 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

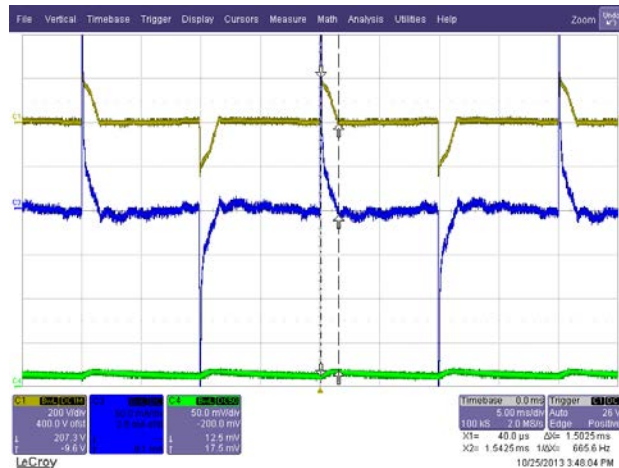


Figure 152 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6513

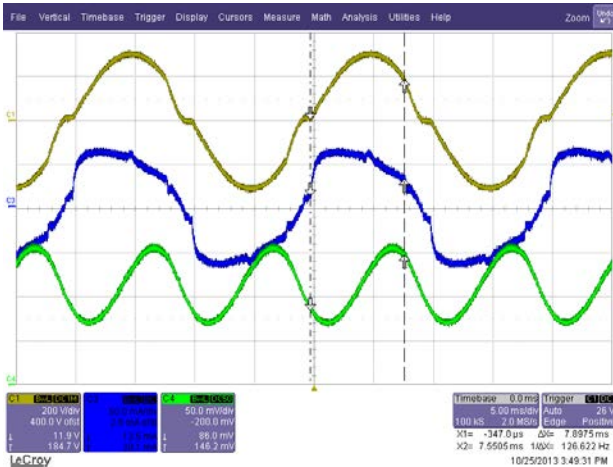


Figure 153 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

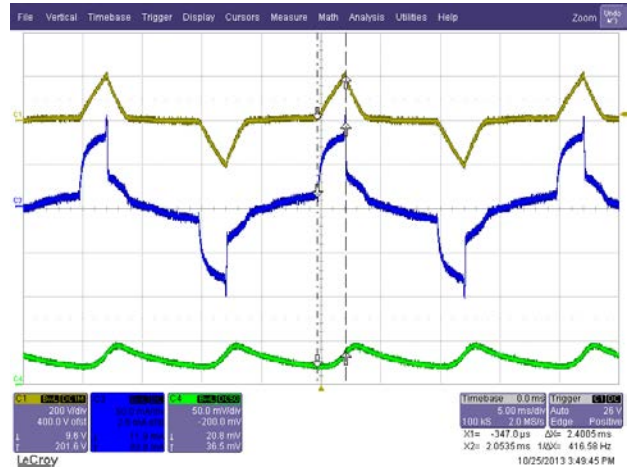


Figure 154 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

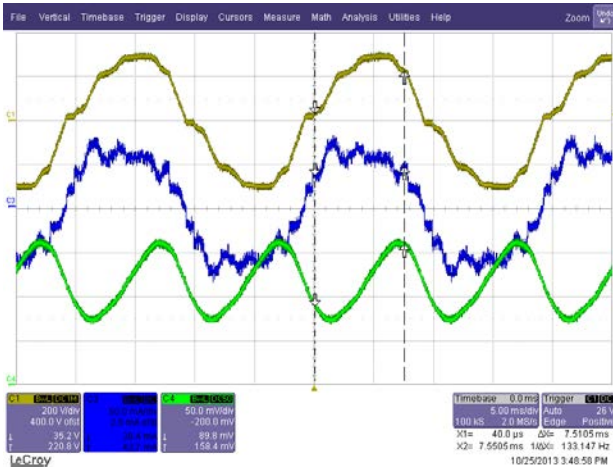


Figure 155 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

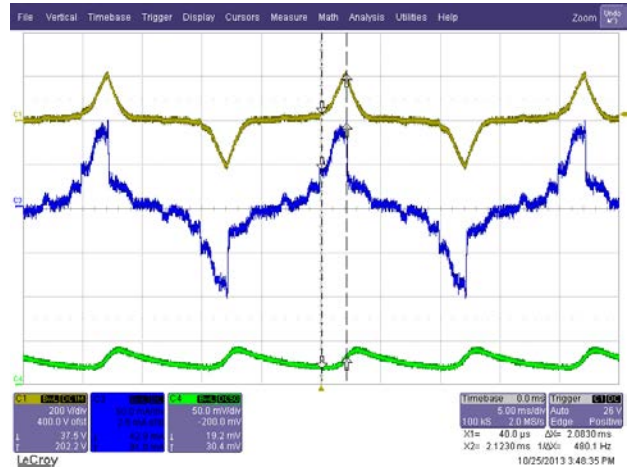


Figure 156 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Berker 2875

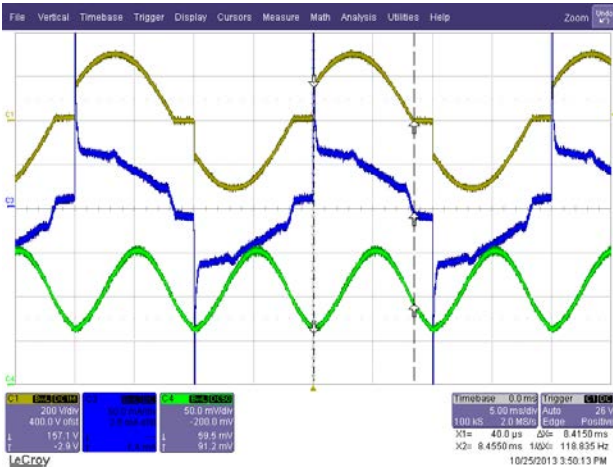


Figure 157 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

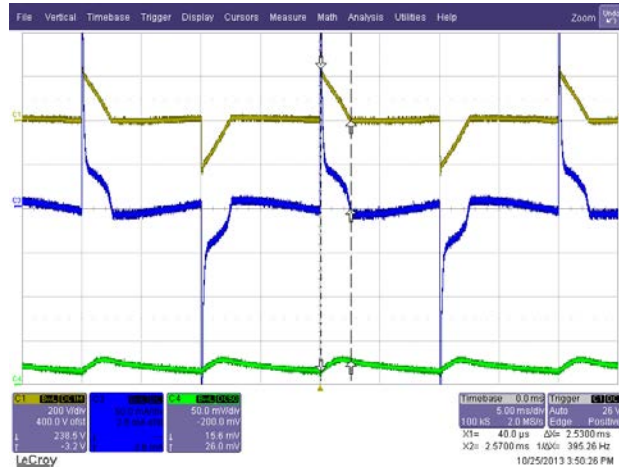


Figure 158 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

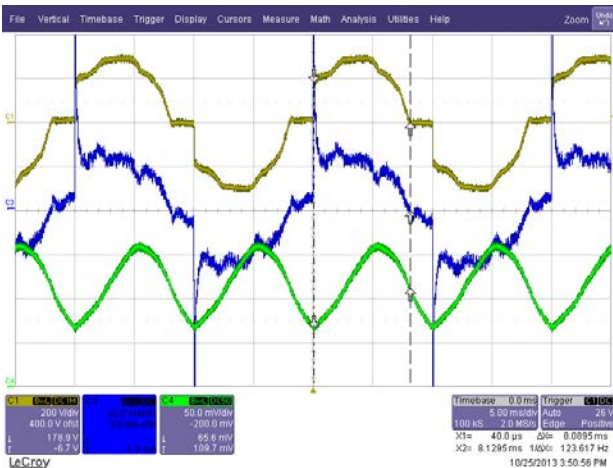


Figure 159 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

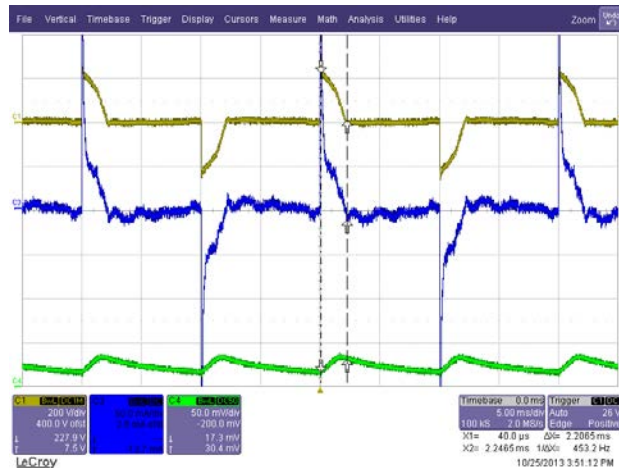


Figure 160 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Berker 2830-10

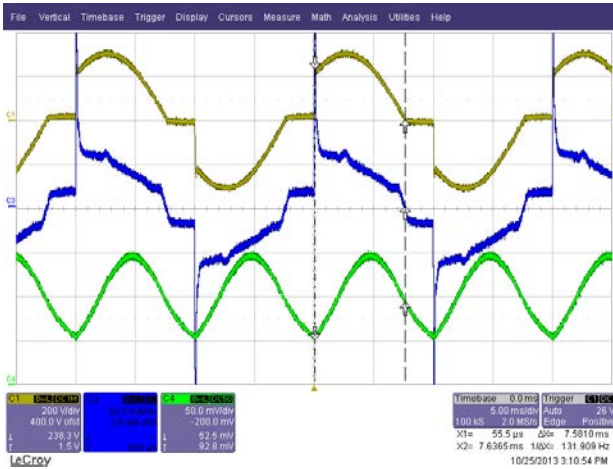


Figure 161 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

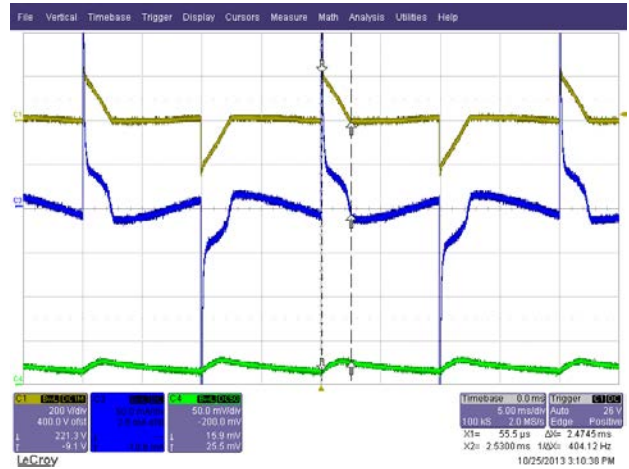


Figure 162 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

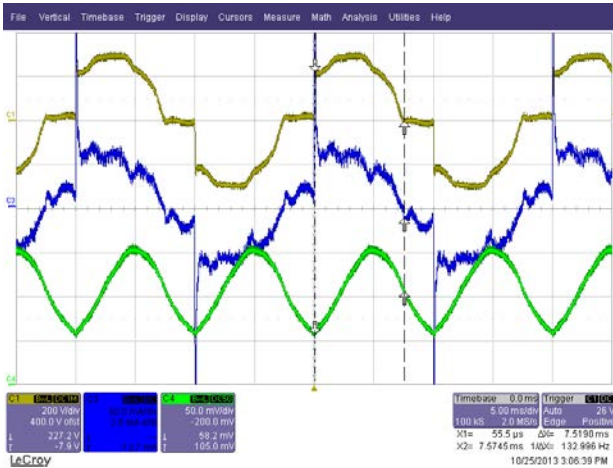


Figure 163 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

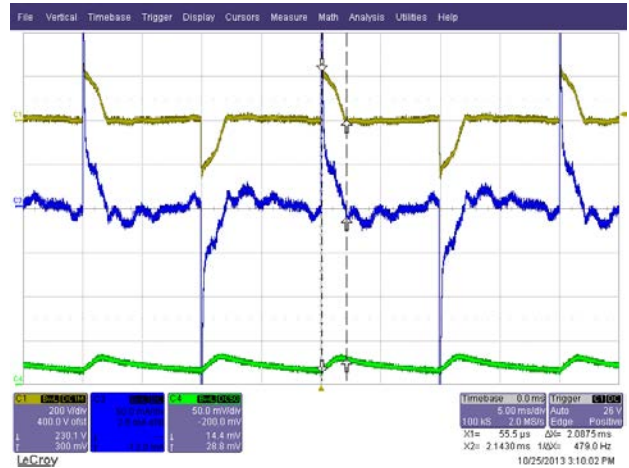


Figure 164 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Busch 6591-101

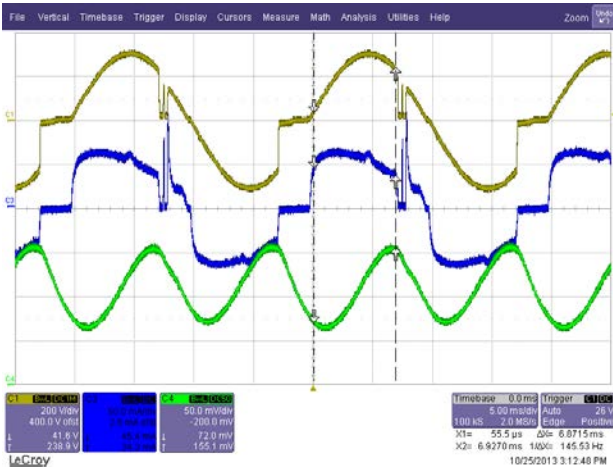


Figure 165 – Full Conduction from Regulated AC Input 230 V / 50 Hz. Natural characteristic of the dimmer is asymmetric.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

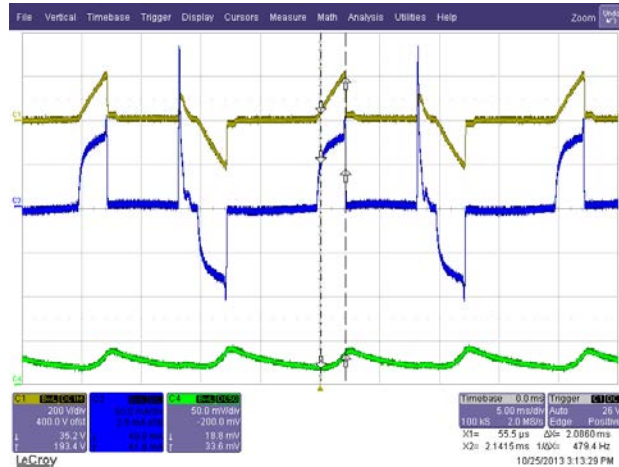


Figure 166 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

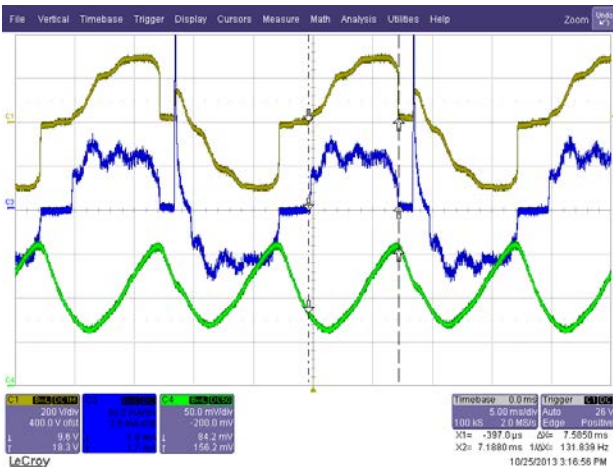


Figure 167 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

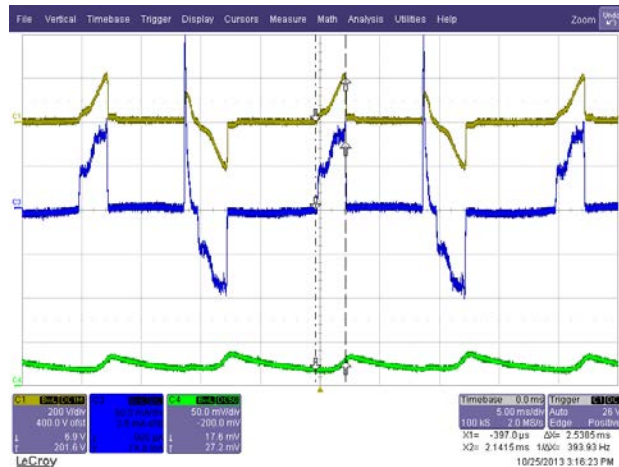


Figure 168 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

Dimmer: Busch 6513 U-102

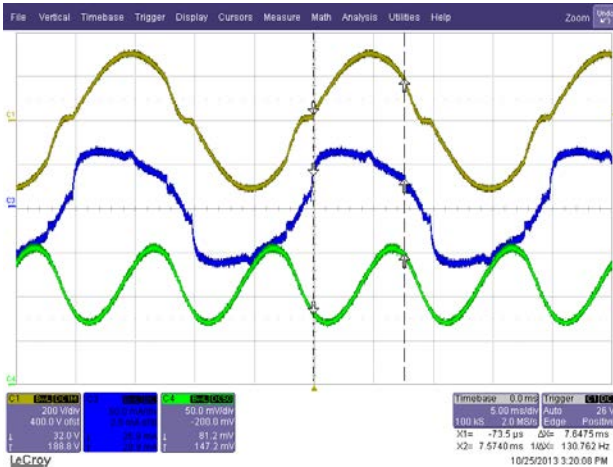


Figure 169 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

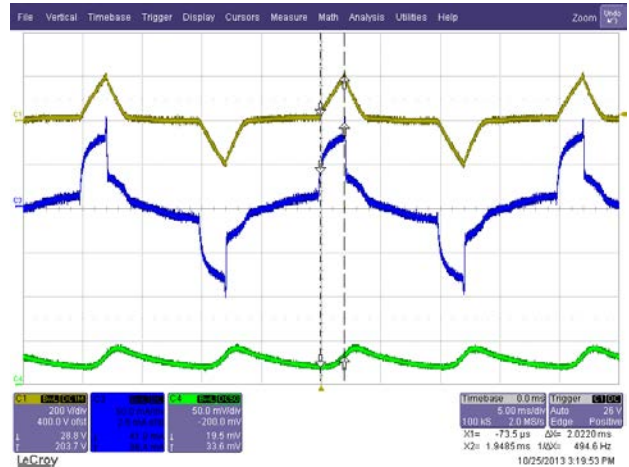


Figure 170 – Minimum Conduction from Regulated
 AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

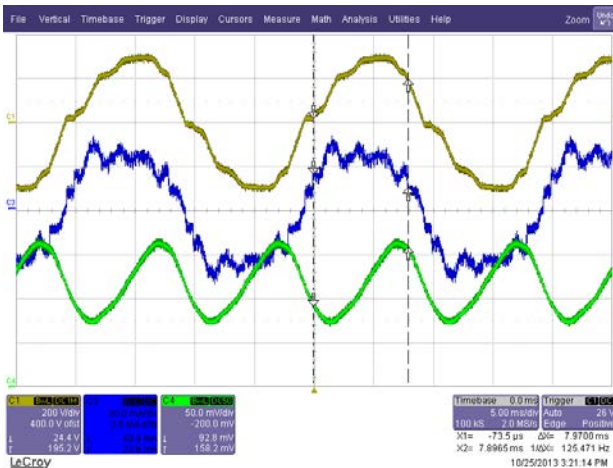


Figure 171 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

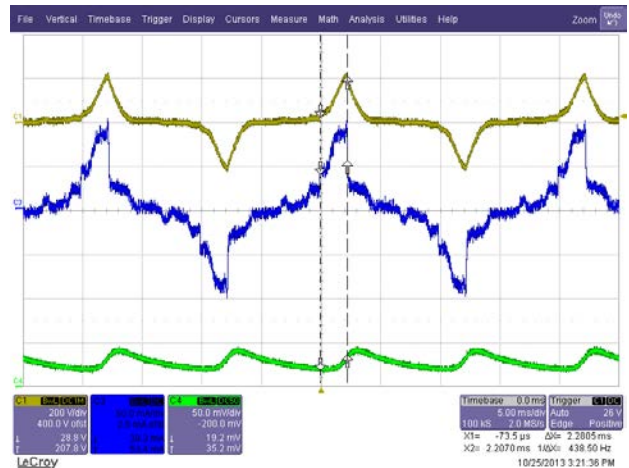


Figure 172 – Minimum Conduction from Distorted
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 433HAB 0A

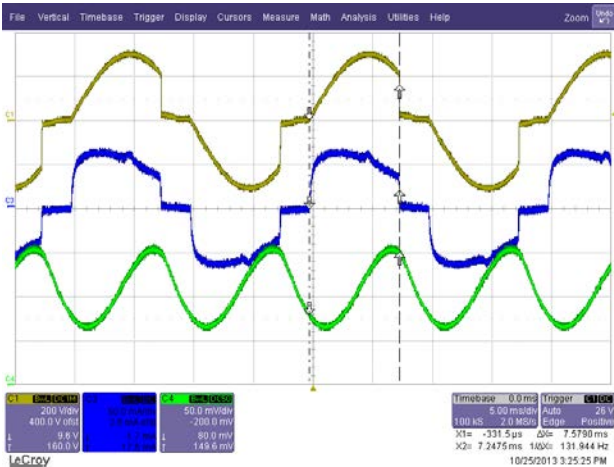


Figure 173 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

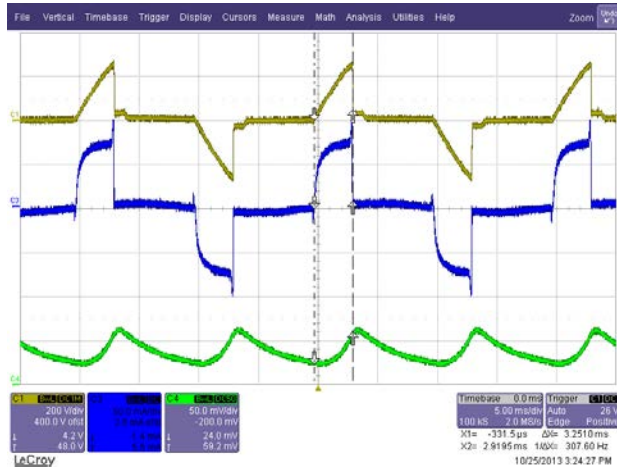


Figure 174 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

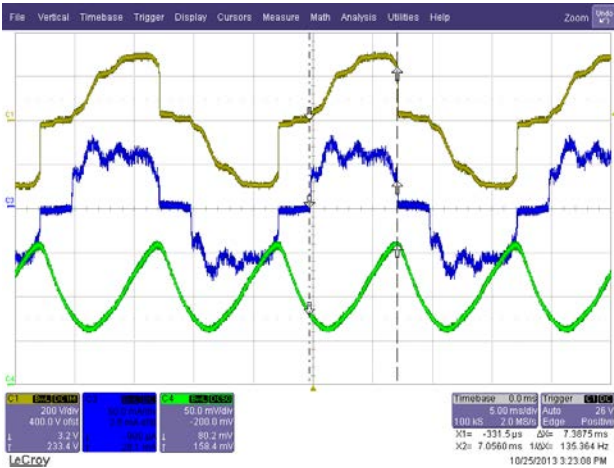


Figure 175 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

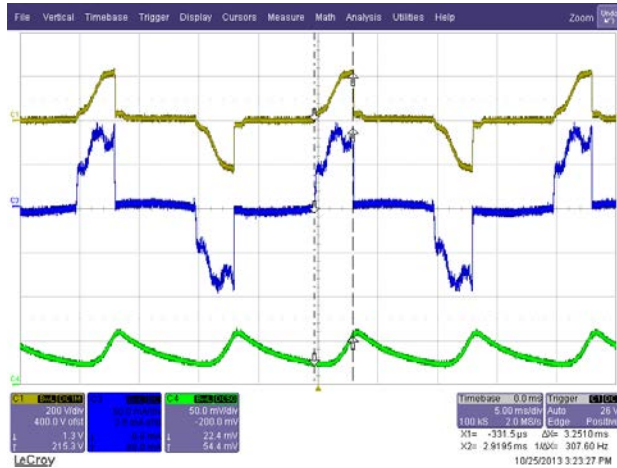


Figure 176 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: PEHA 433HAB 0A

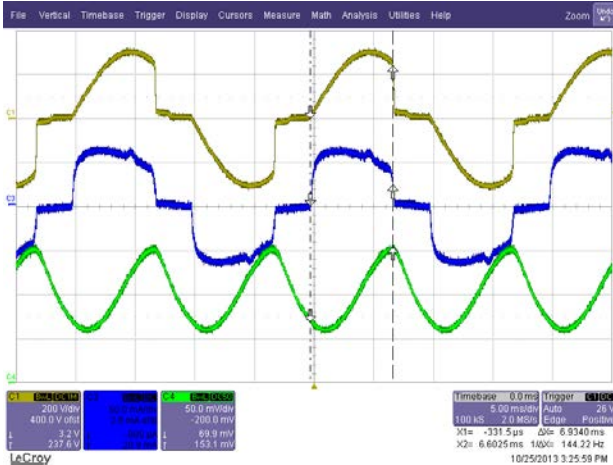


Figure 177 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

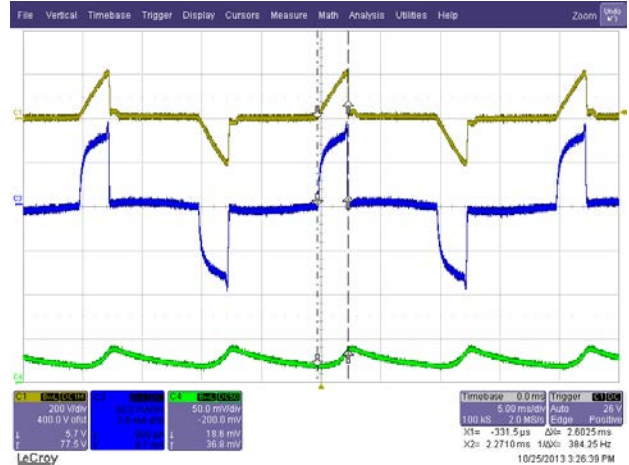


Figure 178 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

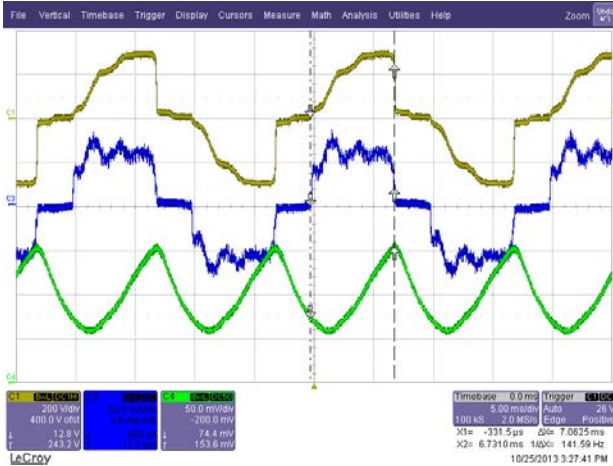


Figure 179 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

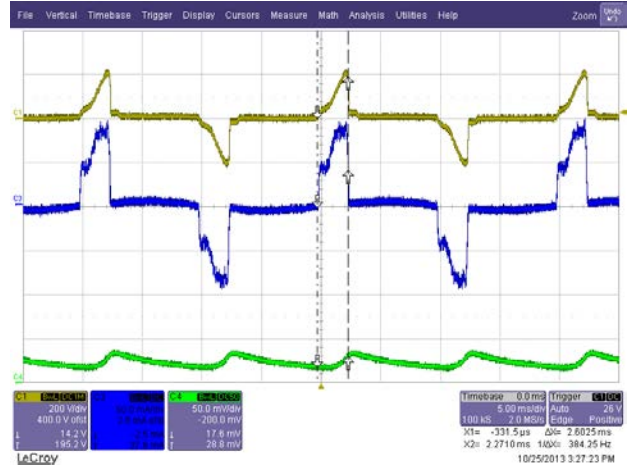


Figure 180 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms /



Dimmer: Relco RM34DMA

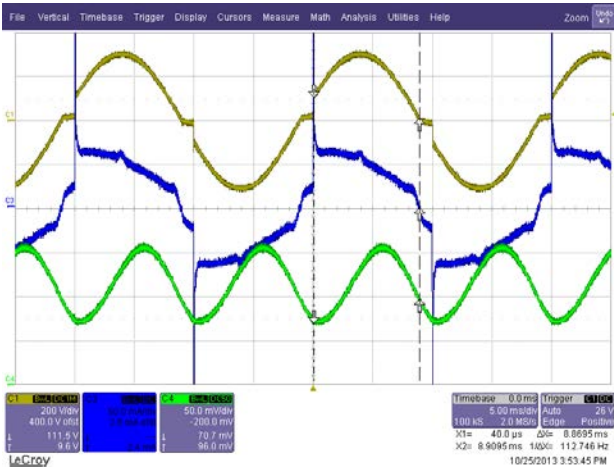


Figure 181 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

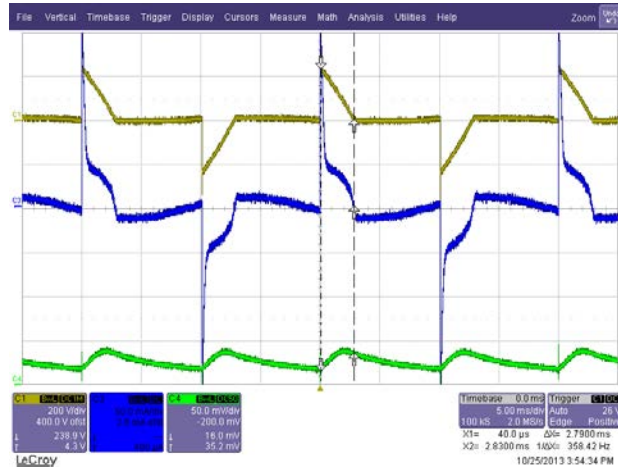


Figure 182 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

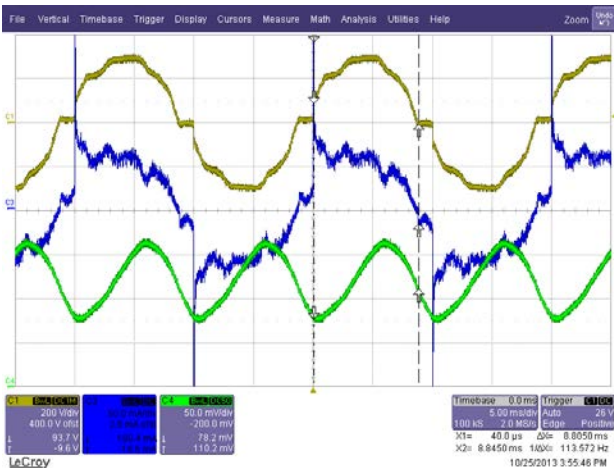


Figure 183 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

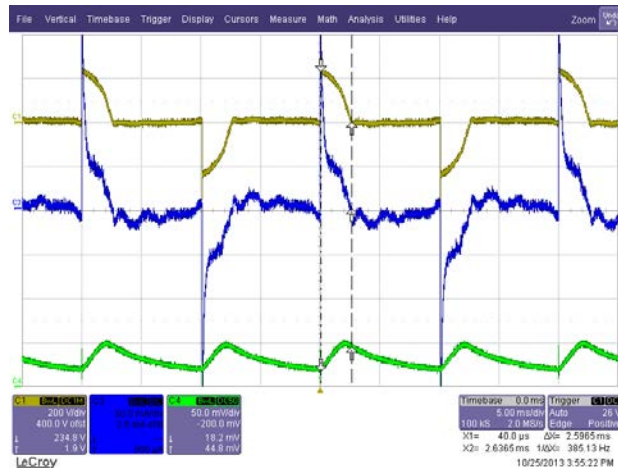


Figure 184 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5ms / div.



Dimmer: Relco RTM34LED DAXS

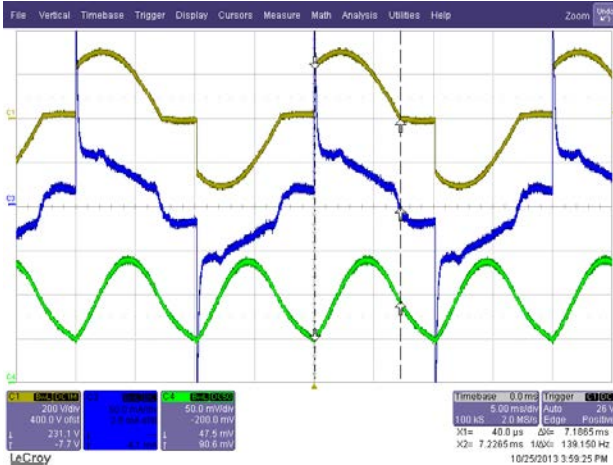


Figure 185 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

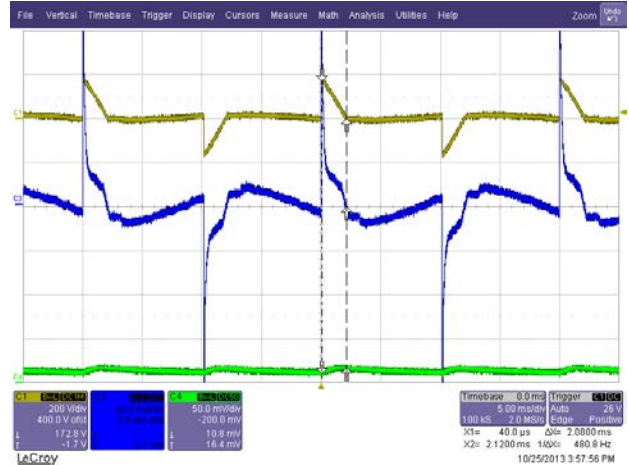


Figure 186 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

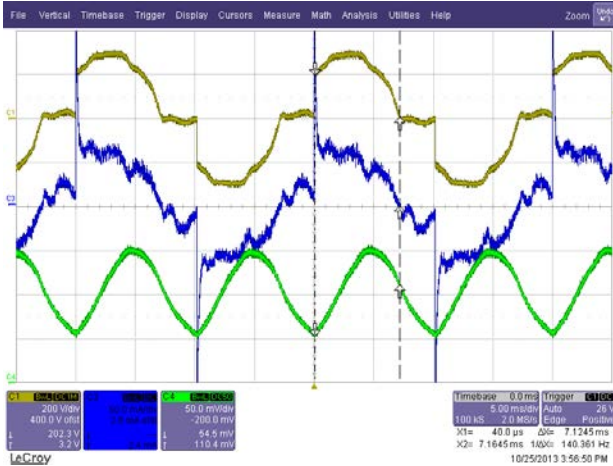


Figure 187 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

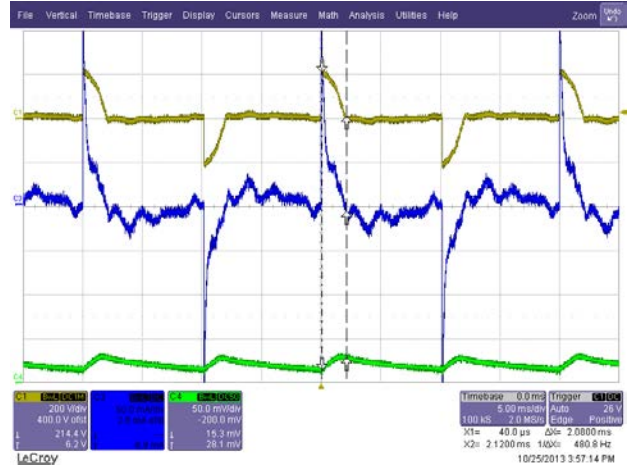


Figure 188 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RM34DMA

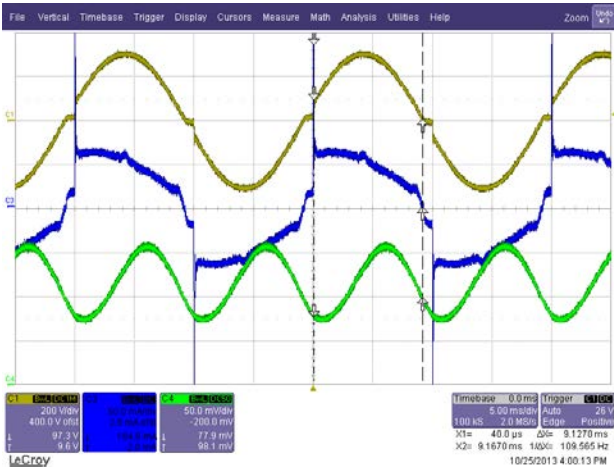


Figure 189 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

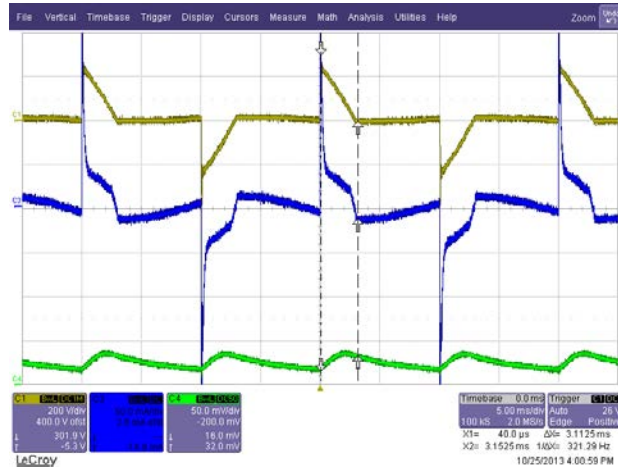


Figure 190 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

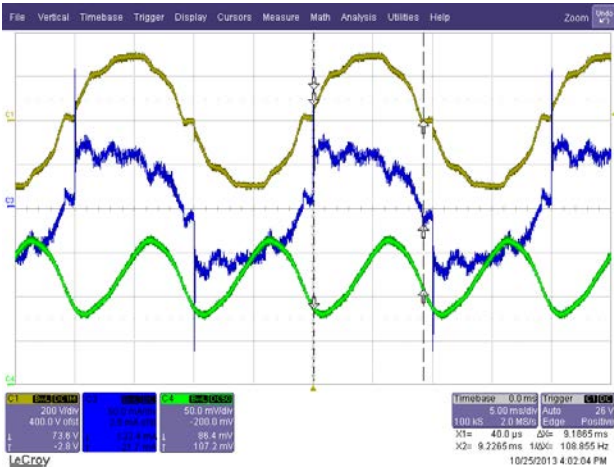


Figure 191 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

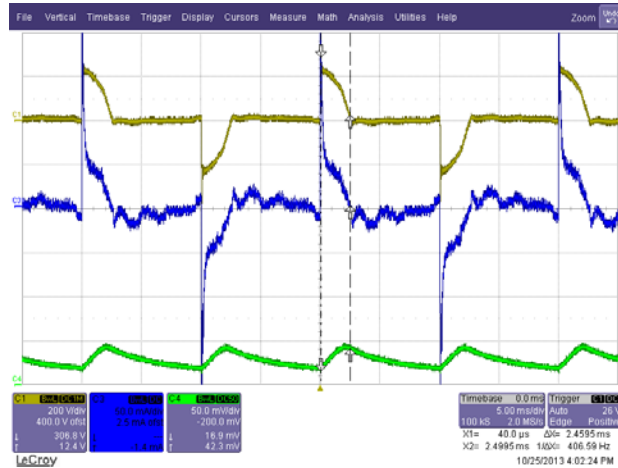


Figure 192 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RTS34.43 RLI

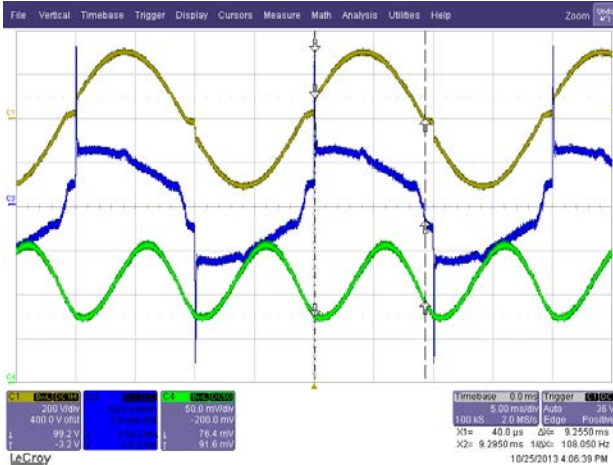


Figure 193 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

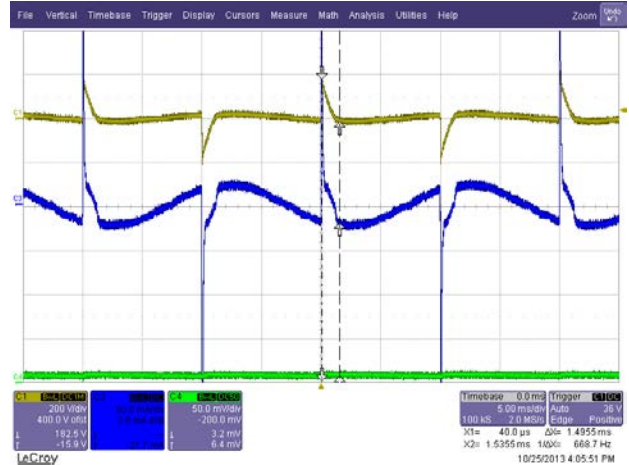


Figure 194 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

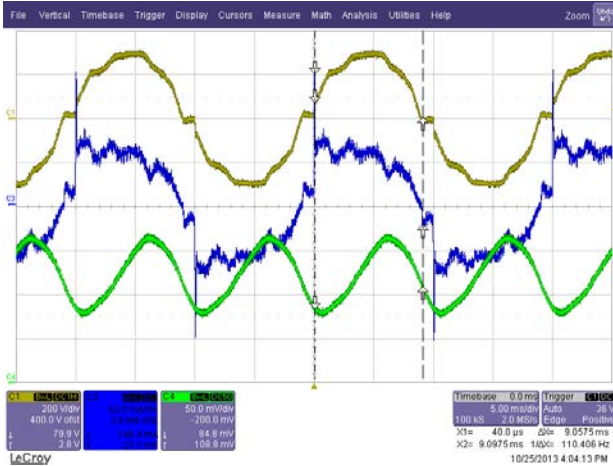


Figure 195 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

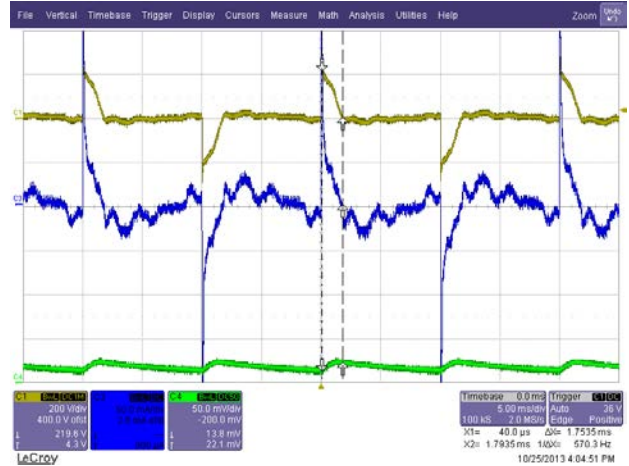


Figure 196 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Relco RT34DSL

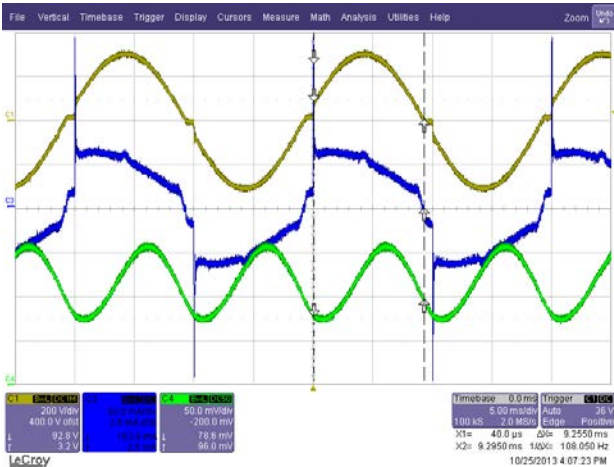


Figure 197 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

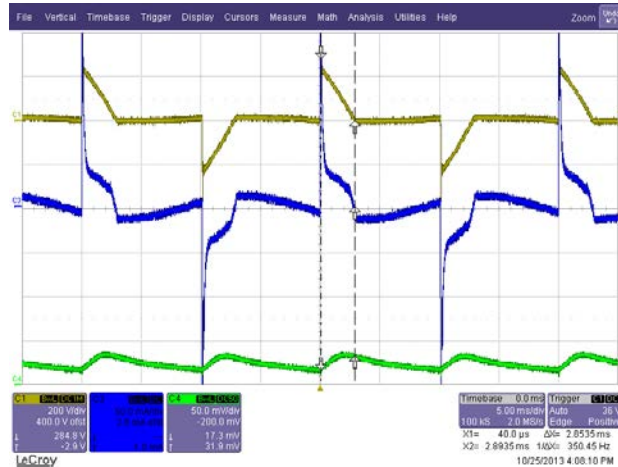


Figure 198 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

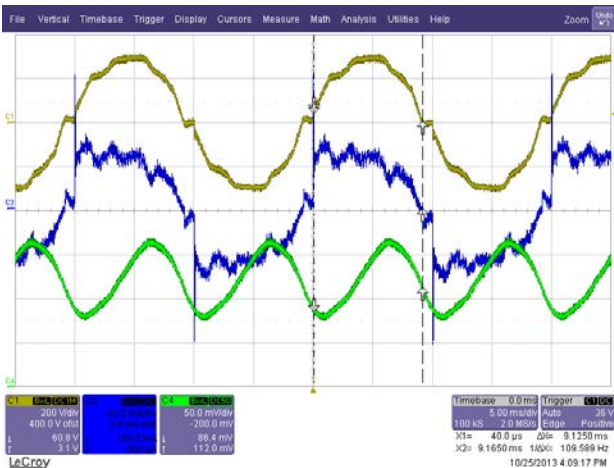


Figure 199 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

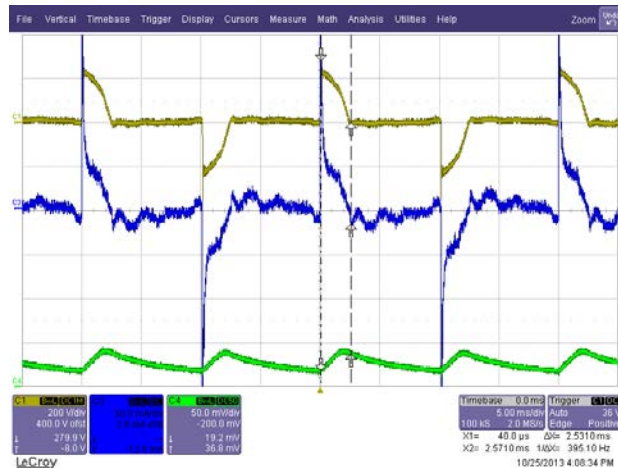


Figure 200 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450LM

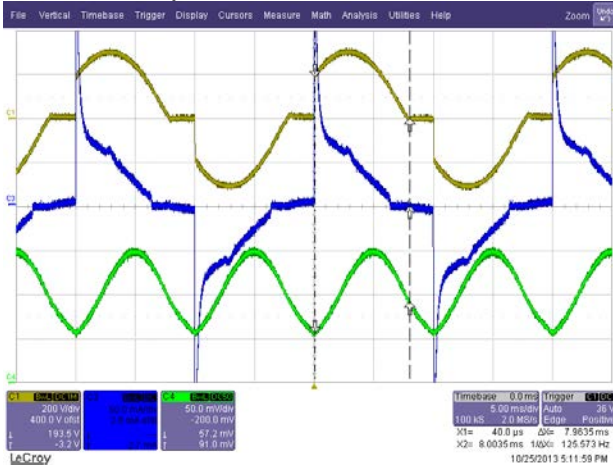


Figure 201 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

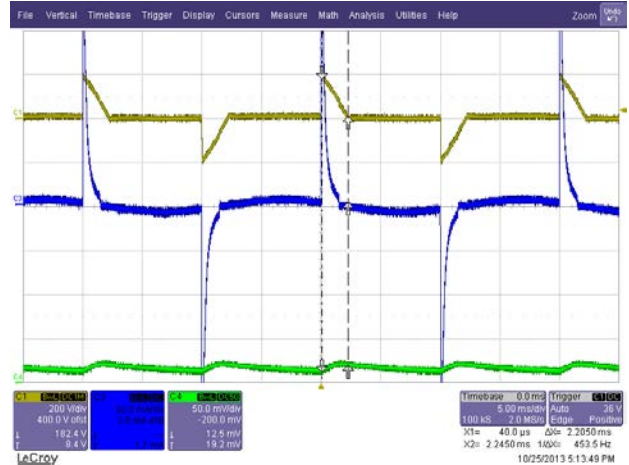


Figure 202 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

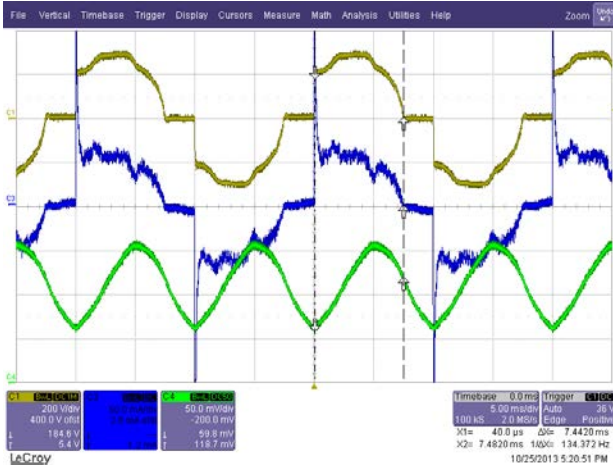


Figure 203 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

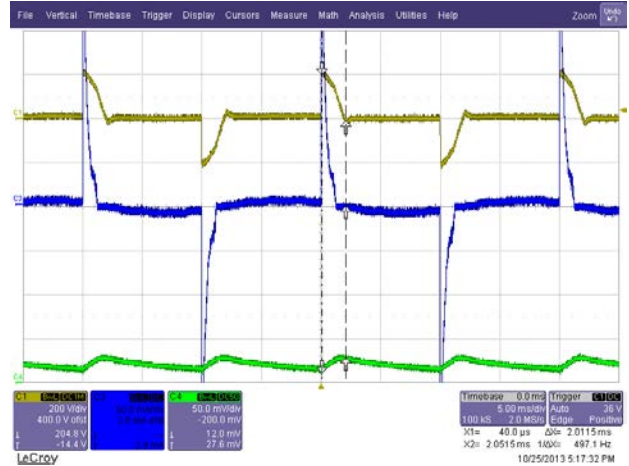


Figure 204 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450TM

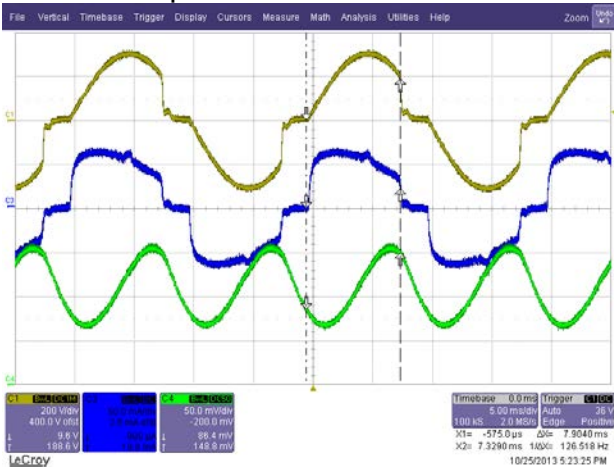


Figure 205 – Full Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

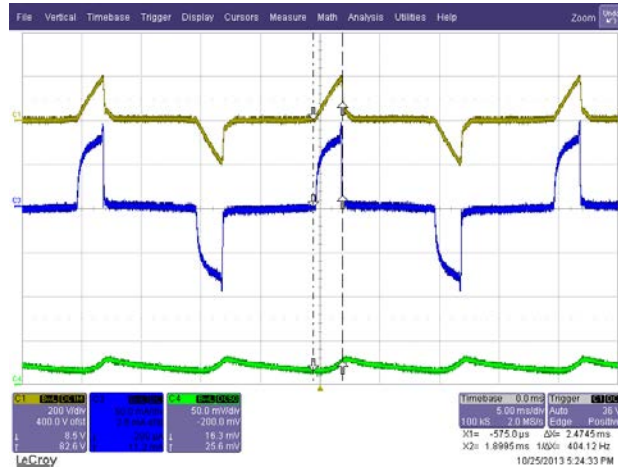


Figure 206 – Minimum Conduction from Regulated AC Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

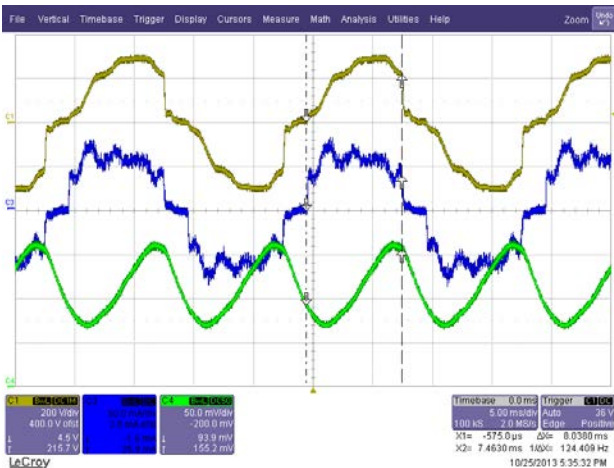


Figure 207 – Full Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

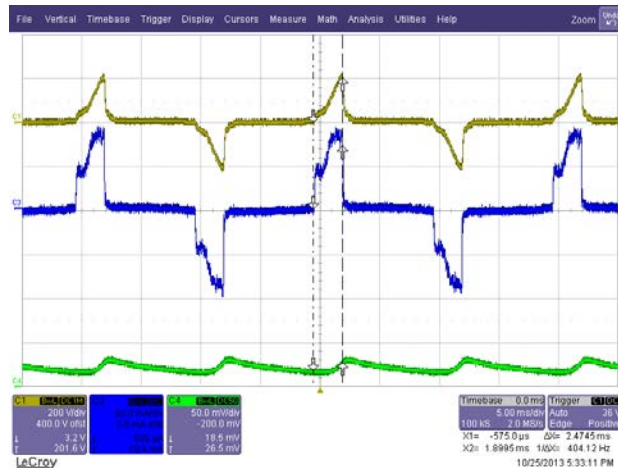


Figure 208 – Minimum Conduction from Distorted AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E2CFLDM

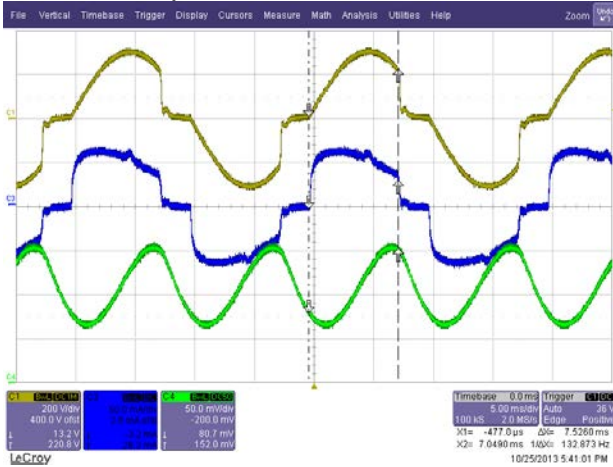


Figure 209 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

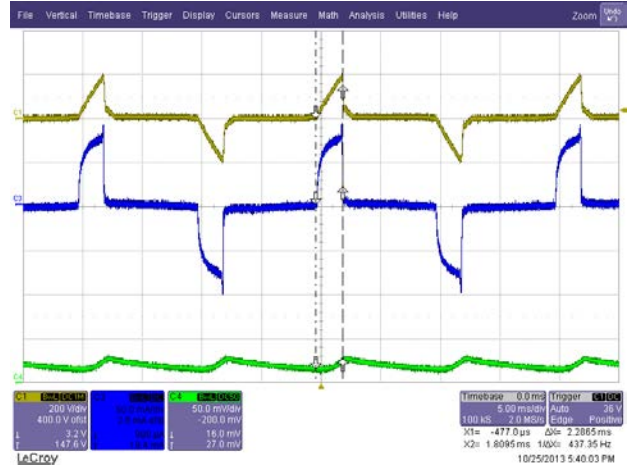


Figure 210 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

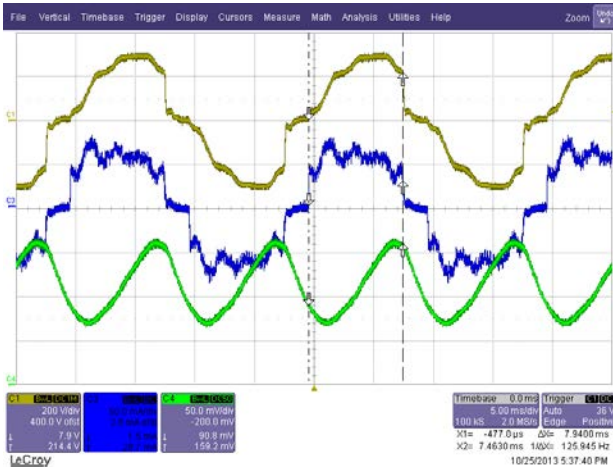


Figure 211 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

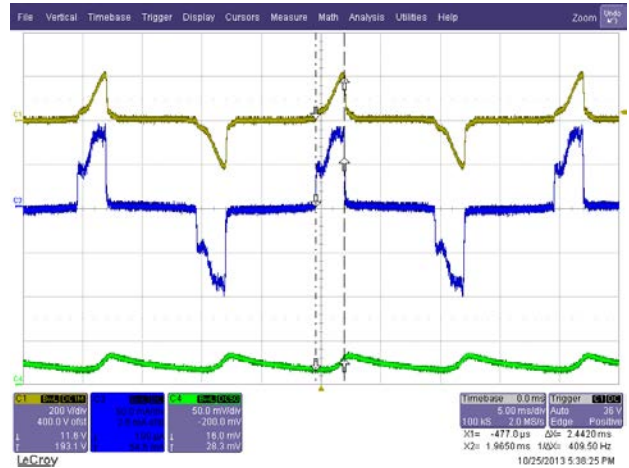


Figure 212 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



Dimmer: Clipsal 32E450UDM

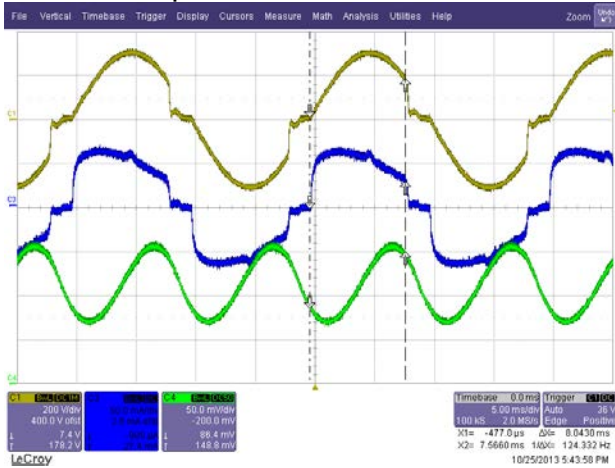


Figure 213 – Full Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

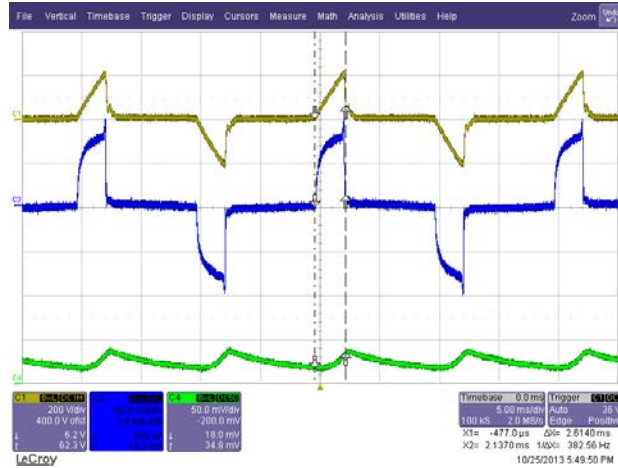


Figure 214 – Minimum Conduction from Regulated AC
 Input 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

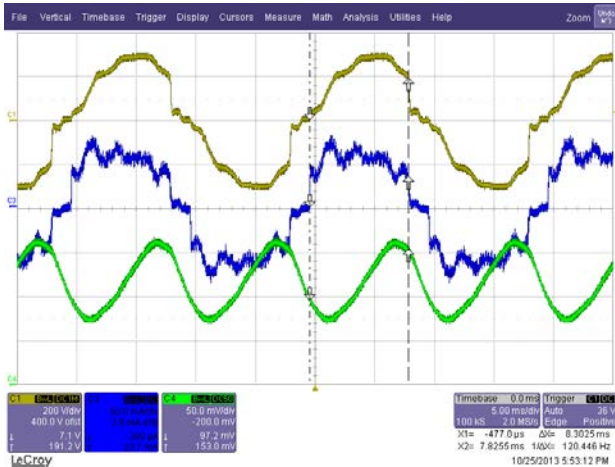


Figure 215 – Full Conduction from Distorted AC
 Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.

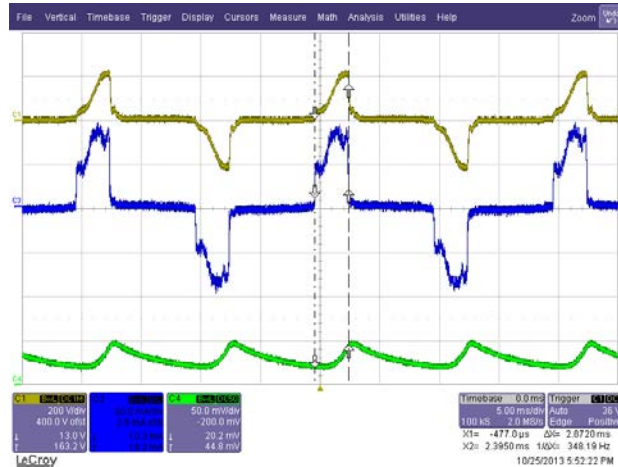


Figure 216 – Minimum Conduction from Distorted AC
 AC Line 230 V / 50 Hz.
 Ch1: V_{IN} ; 200 V / div.
 Ch3: I_{IN} ; 50 mA / div.
 Ch4: I_{OUT} ; 50 mA / div.
 Time Scale: 5 ms / div.



14 라인 서지

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.

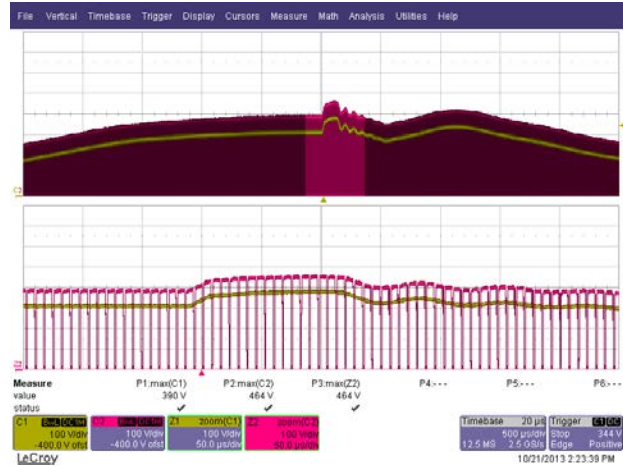


Figure 218 – Differential Line Surge at 500 V / 90°. Peak Drain Voltage Recorded is 464 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 200 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 50 μ s / div.

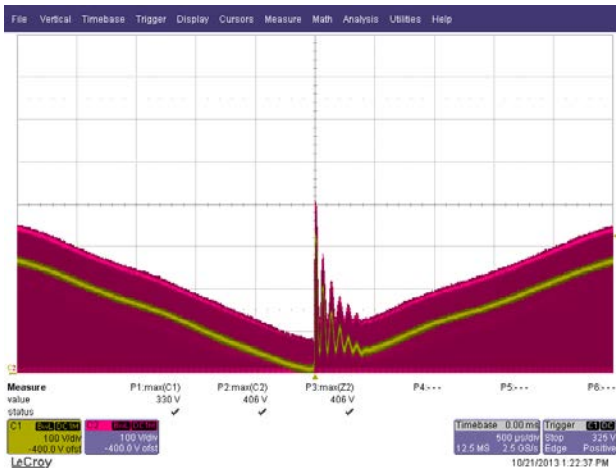


Figure 219 – Differential Ring Surge at 2500 V / 0°. Peak Drain Voltage Recorded is 406 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.

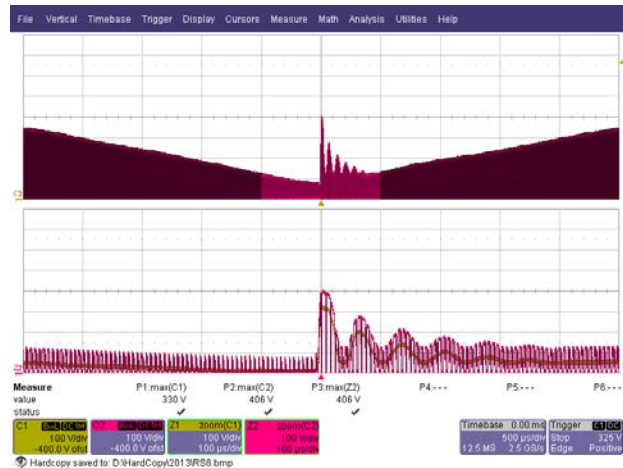


Figure 220 – Differential Ring Surge at 2500 V / 0°. Peak Drain Voltage Recorded is 406 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 100 μ s / div.





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.

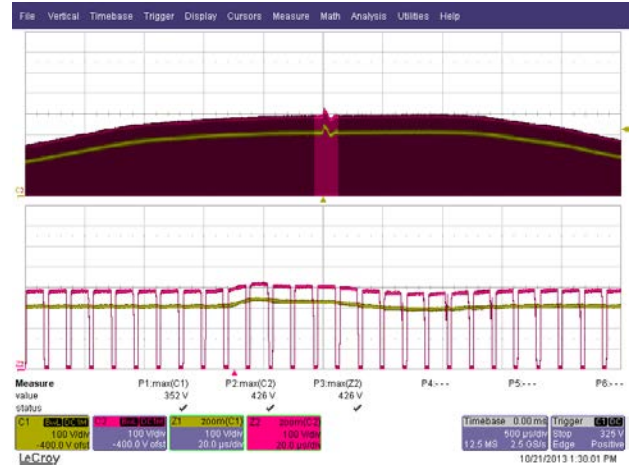


Figure 222 – Differential Ring Surge at 2500 V / 90°. Peak Drain Voltage Recorded is 426 V.
 Ch1: V_{BULK} ; 100 V / div.
 F1: V_{DRAIN} ; 100 V / div.
 Time Scale: 500 μ s / div.
 Zoom time Scale: 20 μ s / div.



15 전도성 EMI



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



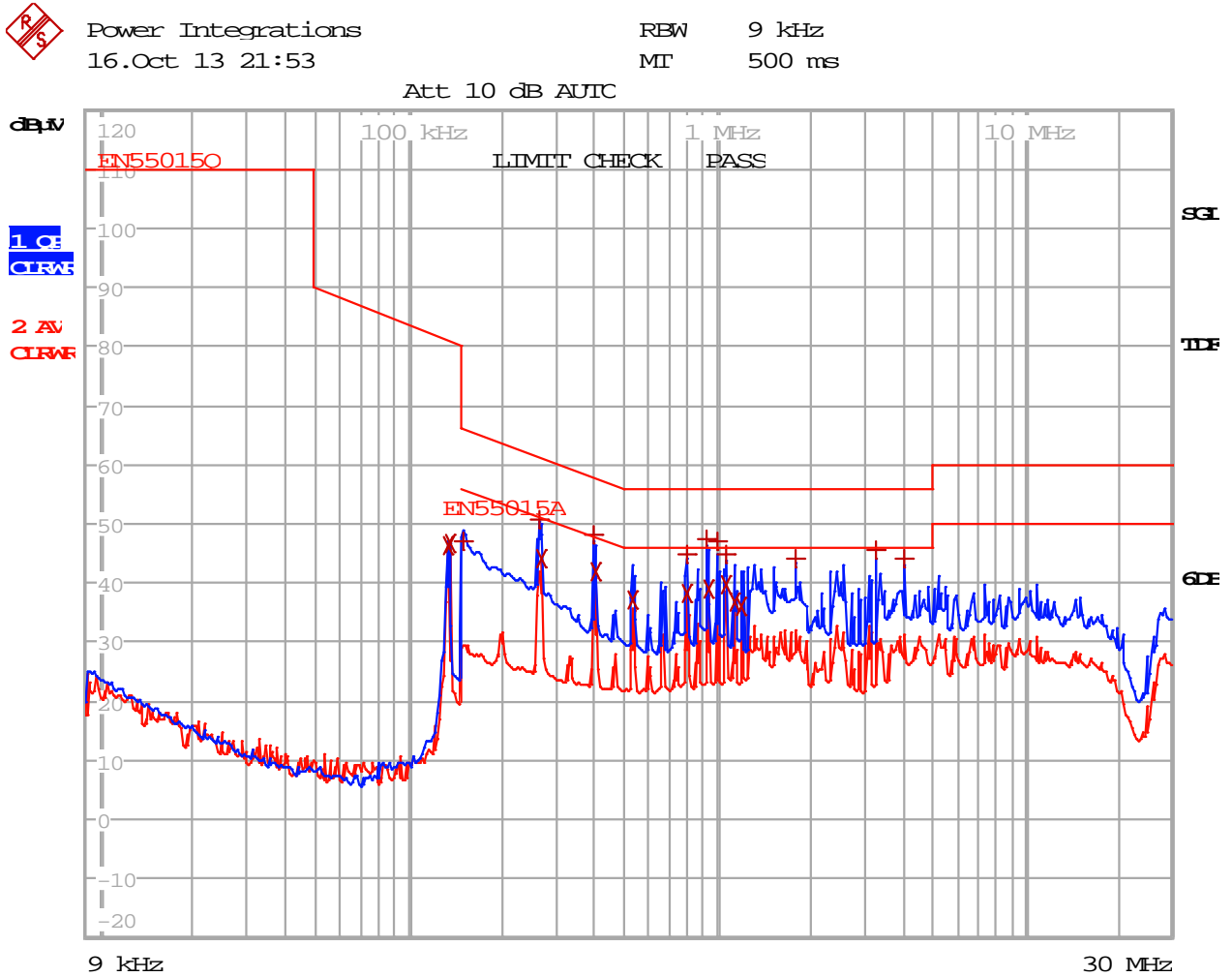


Figure 224 – Conducted EMI, Maximum Steady-State Load, 230 VAC, 60 Hz, and EN55015 B Limits. Enclosed Unit in A19 Bulb Replacement.



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55015Q
 Trace2: EN55015A
 Trace3: ---

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

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



16 개정 내역

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



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