CIRRUS LOGIC®

CDB150x-00

CS1500 90W, High-efficiency PFC Demonstration Board

Features

- ❑ Variable On Time, Variable Frequency, DCM PFC Controller
- ❑ Line Voltage Range: 90 to 265 VAC RMS
- ❑ Output voltage: 400 V
- ❑ Rated Pout: 90 W
- ❑ Efficiency: 97% @ 90 W, 230 VAC
- ❑ No-load Power Dissipation: <0.3 W
- ❑ Low Component Count
- ❑ Supports Cirrus Logic Product CS1500

General Description

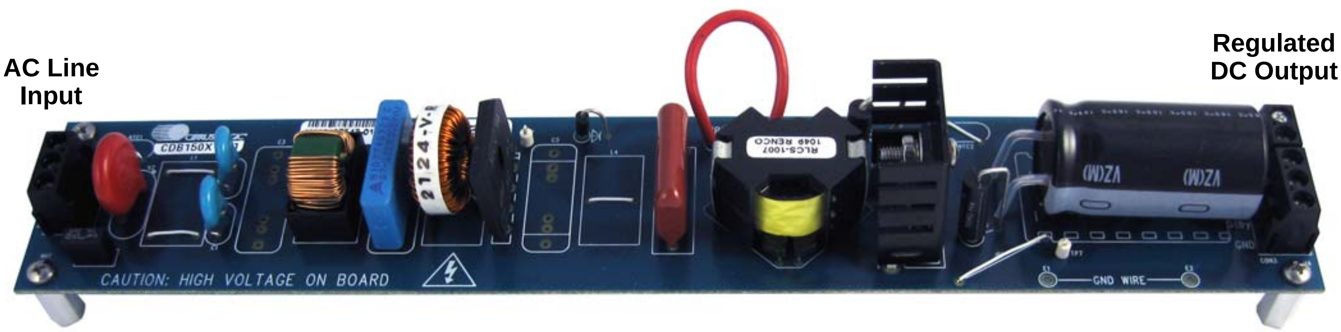
The CDB150x-00 board demonstrates the performance of the CS1500 digital PFC controller with a 90 watt output at a link voltage of 400 volts.

ORDERING INFORMATION

CDB150x-00 PFC Demonstration Board - Supports CS1500

AC Line Input

Regulated DC Output



Actual Size:
254mm x 44mm

IMPORTANT SAFETY INSTRUCTIONS

Read and follow all safety instructions prior to using this demonstration board.

This Engineering Evaluation Unit or Demonstration Board must only be used for assessing IC performance in a laboratory setting. This product is not intended for any other use or incorporation into products for sale.

This product must only be used by qualified technicians or professionals who are trained in the safety procedures associated with the use of demonstration boards.

DANGER Risk of Electric Shock

- The direct connection to the AC power line and the open and unprotected boards present a serious risk of electric shock and can cause serious injury or death. Extreme caution needs to be exercised while handling this board.
- Avoid contact with the exposed conductor or terminals of components on the board. High voltage is present on exposed conductor and it may be present on terminals of any components directly or indirectly connected to the AC line.
- Dangerous voltages and/or currents may be internally generated and accessible at various points across the board.
- Charged capacitors store high voltage, even after the circuit has been disconnected from the AC line.
- Make sure that the power source is off before wiring any connection. Make sure that all connectors are well connected before the power source is on.
- Follow all laboratory safety procedures established by your employer and relevant safety regulations and guidelines, such as the ones listed under, OSHA General Industry Regulations - Subpart S and NFPA 70E.

WARNING Suitable eye protection must be worn when working with or around demonstration boards. Always comply with your employer's policies regarding the use of personal protective equipment.

WARNING All components, heat sinks or metallic parts may be extremely hot to touch when electrically active.

WARNING Heatsinking is required for Q1. The end product should use tar pitch or an equivalent compound for this purpose. For lab evaluation purposes, a fan is recommended to provide adequate cooling.

Contacting Cirrus Logic Support

For all product questions and inquiries contact a Cirrus Logic Sales Representative. To find the one nearest to you go to www.cirrus.com

1. INTRODUCTION

The CS1500 is a high-performance Variable Frequency Discontinuous Conduction Mode (VF-DCM), active Power Factor Correction (PFC) controller, optimized to deliver the lowest system cost in switched mode power supply (SMPS) applications. The CS1500 uses a digital control algorithm that is optimized for high efficiency and near-unity power factor over a wide input voltage range (90-265 VAC).

Using an adaptive digital control algorithm, both the ON time and the switching frequency are varied on a cycle-by-cycle basis over the entire AC line to achieve close-to-unity power factor. The feedback loop is closed through an integrated digital control system within the IC.

The variation in switching frequency also provides a spread-frequency spectrum, thus minimizing the conducted EMI filtering requirements. Burst mode control minimizes the light-load/standby losses. Protection features such as overvoltage, overpower, open circuit, overtemperature, and brownout help protect the device during abnormal transient conditions.

For startup in to a constant power load (CPL), the inductor value is multiplied by the following formula:

$$L_{cpl} = 2.04 \times \frac{V_{acmin}}{V_{link}}$$

where V_{acmin} is the peak of the minimum AC input voltage, and V_{link} is the DC output voltage of the PFC.

This equation does not affect operation in constant power, if load is applied once V_{link} has risen to its nominal value.

The CDB150x-00 board demonstrates the performance of the CS1500 with input voltage range of 90-265 VAC, typically seen in universal input applications. This board has been designed for 400V V_{link}, 90 Watts, full load.

Extreme caution needs to be exercised while handling this board. This board is to be used by trained professionals only. Prior to applying AC power to the CDB150x-00 board, the CS1500 needs to be biased using an external 13 VDC power supply.

This document provides the schematic for the board. It includes oscilloscope screen shots that indicate operating waveforms. Graphs are also provided that document the performance of the board in terms of Efficiency vs. Load, Total Harmonic Distortion vs. Load, and Power Factor vs. Load for the CS1500 PFC controller IC.

2. SCHEMATIC

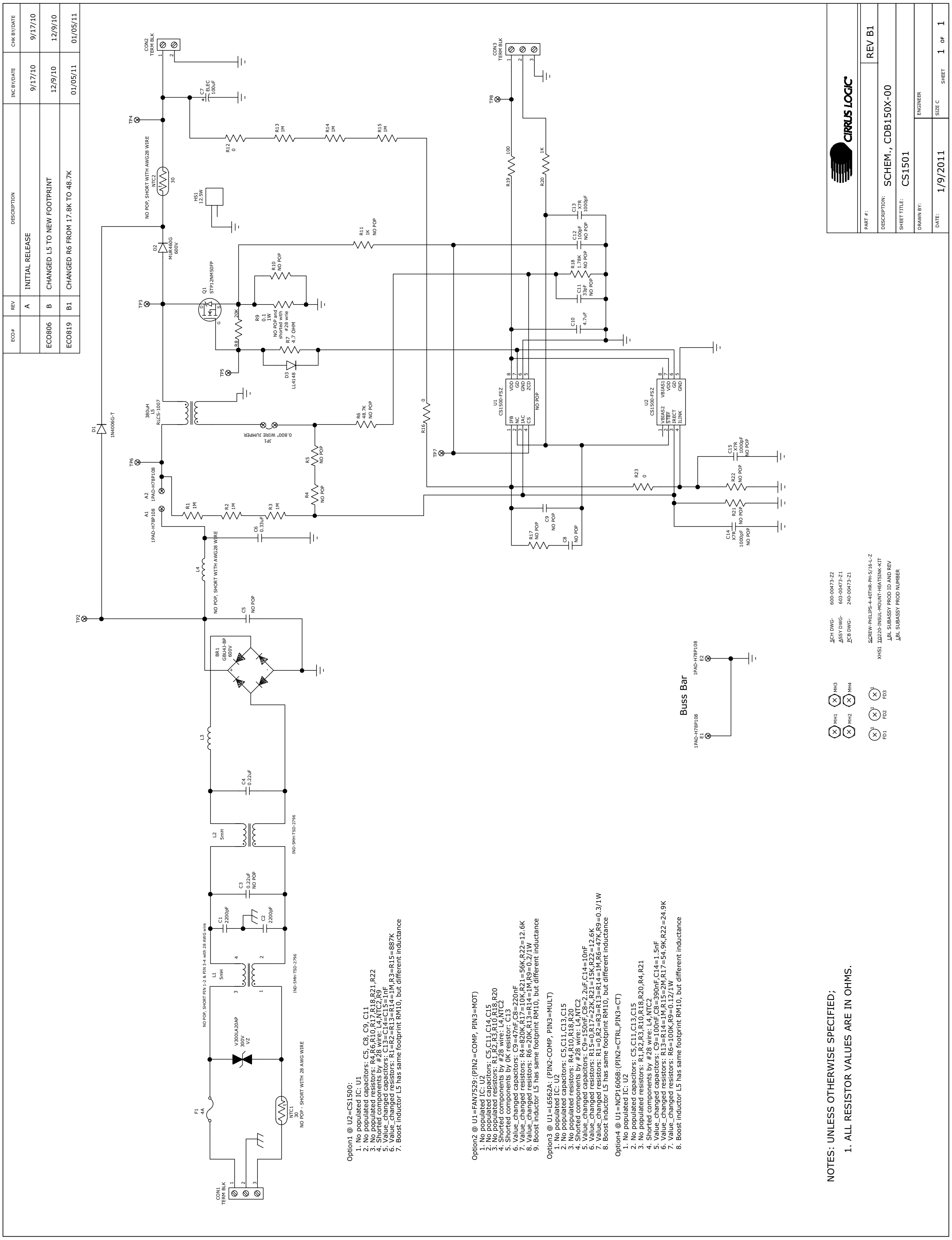


Figure 1. Schematic

3. BILL OF MATERIALS

CDB150X-00_Rev_B1 — BILL OF MATERIAL

Item	Cirrus P/N	Rev	Description	Qty	Reference Designator	MFG	MFG P/N	Notes
1	070-00157-Z1	A	DIODE RECT BRIDGE 600V 4A NPb GBU	1	BR1	MICRO COMMERCIAL CO	GBU4J-BP	
2	011-00042-Z1	A	CAP 2200pF ±10% 2000V CER NPb RAD	2	C1 C2	MURATA	DEBB33D222KA2B	
3	011-00055-Z1	A	CAP 0.22uF ±20% 305V PLY FLM NPb TH	0	C3	EPCOS	B32923C3224M	DO NOT POPULATE
4	011-00055-Z1	A	CAP 0.22uF ±20% 305V PLY FLM NPb TH	1	C4	EPCOS	B32923C3224M	
5	011-00040-Z1	A	CAP 0.47uF ±20% 305V PLY FLM NPb TH	0	C5	EPCOS	B32922C3474M	DO NOT POPULATE
6	013-00034-Z1	A	CAP 0.33uF ±10% 630V POLY NPb RAD	1	C6	PANASONIC	ECQE6334KF	
7	012-00191-Z1	A	CAP 100UF ±20% 450V ELEC NPb RAD	1	C7	NICHICON	UVZ2W101MRD	
8	000-00009-Z1	A	NO POP CAP NPb 1206	0	C8 C9 C11 C12	NO POP	NP-CAP-1206	DO NOT POPULATE
9	001-10233-Z1	A	CAP 4.7uF ±20% 25V X7R NPb 1206	1	C10	TDK	C3216X7R1E475M	
10	001-06035-Z1	A	CAP 1000pF ±5% 50V X7R NPb 1206	1	C13	KEMET	C1206C102J5RAC	
11	001-06035-Z1	A	CAP 1000pF ±5% 50V X7R NPb 1206	0	C14 C15	KEMET	C1206C102J5RAC	DO NOT POPULATE
12	110-00301-Z1	A	CON 3POS TERM BLK 5.08mm SPR NPb RA	2	CON1 CON3	WEIDMULLER	1716030000	
13	110-00302-Z1	A	CON 2POS TERM BLK 5.08mm SPR NPb RA	1	CON2	WEIDMULLER	1716020000	
14	070-00132-Z1	A	DIODE RECT 800V 1A 200mA NPb DO-41	1	D1	DIODES INC	1N4006G-T	
15	070-00154-Z1	A	DIODE RECT 600V 4A NPb DO-201AD TH	1	D2	ON SEMICONDUCTOR	MUR460G	
16	070-00001-Z1	A	DIODE SS 75V 500mW NPb SOD80	1	D3	DIODES INC	LL4148	
17	180-00025-Z1	A	FUSE 4A SLO BLO 250V NPb RAD	1	F1	BELFUSE	RST 4	
18	311-00019-Z1	A	HTSNK W LOCK TAB .5" TO220 NPb	1	HS1	AAVID THERMALLOY	6021BG	REQUIRES 1 SCREW 1 WASHER, 1 NUT
19	080-00013-Z1	A	WIRE 24 AWG SOLID PVC INS BLK NPb	1	JP1	ALPHA WIRE COMPANY	3050/1 BK005	SEE ASSY DWG FOR LENGTH
20	050-00039-Z1	A	XFMR 5mH 1:1 1500Vrms 4PIN NPb TH	0	L1	PREMIER MAGNETICS	TSD-2796	DO NOT POPULATE, SHORT PIN 1-2 & PIN 3-4 with 28 AWG wire
21	050-00039-Z1	A	XFMR 5mH 1:1 1500Vrms 4PIN NPb TH	1	L2	PREMIER MAGNETICS	TSD-2796	
22	040-00127-Z1	A	IND 1mH 1.3A ±15% TOR VERT NPb TH	1	L3	BOURNS	2124-V-RC	
23	040-00127-Z1	A	IND 1mH 1.3A ±15% TOR VERT NPb TH	0	L4	BOURNS	2124-V-RC	DO NOT POPULATE, Shorted with #28 AWG wire
24	050-00051-Z1	A	XFMR 380uH 10:1 PFC BOOST NPb TH	1	L5	RENCO	RLCS-1007	ECO805
25	304-00004-Z1	A	SPCR STANDOFF 4-40 THR .500"L NPb	4	MH1 MH2 MH3 MH4	KEYSTONE	2203	REQUIRES SCREW 4-40X5X16" PH STEEL
26	036-00008-Z1	A	THERM 30 OHM 1.5A 5% NPb RAD	0	NTC1	GE SENSING	CL-210	DO NOT POPULATE, Shorted with #28 AWG wire
27	036-00008-Z1	A	THERM 30 OHM 1.5A 5% NPb RAD	0	NTC2	GE SENSING	CL-210	DO NOT POPULATE, Shorted with #28 wire
28	071-00083-Z1	A	TRAN MOSFET nCH 12A 500V NPb TO220	1	Q1	ST MICROELECTRONICS	STP12NM50FP	
29	020-06374-Z1	A	RES 1M OHM 1/4W ±1% NPb 1206	6	R1 R2 R3 R13 R14 R15	DALE	CRCW12061M00FKEA	
30	000-00004-Z1	A	NO POP RES NPb 1206	0	R4 R5 R6 R11 R17 R18 R21 R22	NO POP	NP-RES-1206	DO NOT POPULATE
31	020-06389-Z1	A	RES 4.7 OHM 1/4W ±1% NPb 1206	1	R7	DALE	CRCW12064R70FKEA	
32	020-06310-Z1	A	RES 20K OHM 1/4W ±1% NPb 1206 FILM	1	R8	DALE	CRCW120620K0FKEA	
33	030-00092-Z1	A	RES 0.1 OHM 3W ±1% WW ISEN NPb AXL	0	R9	OHMITE	13FR100E	DO NOT POPULATE, Shorted with #28 wire
34	021-01186-Z1	A	RES 1 OHM 1W ±5% NPb 2512 FILM	0	R10	DALE	CRCW25121R00JNEG	DO NOT POPULATE
35	020-02273-Z1	A	RES 0 OHM 1/4W NPb 1206 FILM	3	R12 R16 R23	DALE	CRCW12060000Z0EA	
36	020-02502-Z1	A	RES 100 OHM 1/4W ±1% NPb 1206 FILM	1	R19	DALE	CRCW1206100RFKEA	
37	020-02616-Z1	A	RES 1k OHM 1/4W ±1% NPb 1206 FILM	1	R20	DALE	CRCW12061K00FKEA	
38	110-00025-Z1	A	CON TEST PT .1" TIN PLATE WHT NPb	7	TP2 TP3 TP4 TP5 TP6 TP7 TP8	KEYSTONE	5002	
39	065-00328-Z2	A1	IC CRUS LPWR FACTOR CORR NPb SOIC8	0	U1	CIRRUS LOGIC	CS1501-FSZ/A1	DO NOT POPULATE
40	065-00276-Z5	C1	IC CRUS LPWR FACTOR CORR NPb SOIC8	1	U2	CIRRUS LOGIC	CS1500-FSZ/C1	
41	036-00006-Z1	A	VARISTOR 300V 400pF 14mm NPb RAD	1	VZ	LITTELFUSE	V300LA20AP	
42	311-00025-Z1	A	HTSNK TO220 MOUNTING KIT NPb	1	XHS1	AAVID THERMALLOY	4880G	INCLUDES ALL MOUNTING HARDWARE
43	300-00025-Z1	A	SCREW 4-40X5/16" PH MACH SS NPb	4	XMH1 XMH2 XMH3 XMH4	BUILDING FASTENERS	PMSSS 440 0031 PH	SCREWS FOR STANDOFFS
44	422-00013-01	C	LBL SUBASSY PRODUCT ID AND REV	1		CIRRUS LOGIC	422-00013-01	
45	603-00473-Z1	B1	ASSY DWG CDB150X-0X-Z-NPb	REF		CIRRUS LOGIC	603-00473-Z1	ECO805/ECO824
46	240-00473-Z1	B	PCB CDB150X-0X-Z-NPb	1		CIRRUS LOGIC	240-00473-Z1	ECO805
47	600-00473-Z1	B	SCHEM CDB150X-00-Z-NPb	REF		CIRRUS LOGIC	600-00473-Z1	ECO805
48	080-00036-Z1	A	WIRE 22AWG 19/34 STR BLK 105C NP	1		ALPHA WIRE COMPANY	5855 BK005	ECO824, SEE ASSY DWG
49	080-00002-01	A	WIRE 28/1 AWG, KYNAR MOD, 500FT	1		SQUIRES	L 500 UL1422 28/1 BLU	ECO824, SEE ASSY DWG

4. BOARD LAYOUT

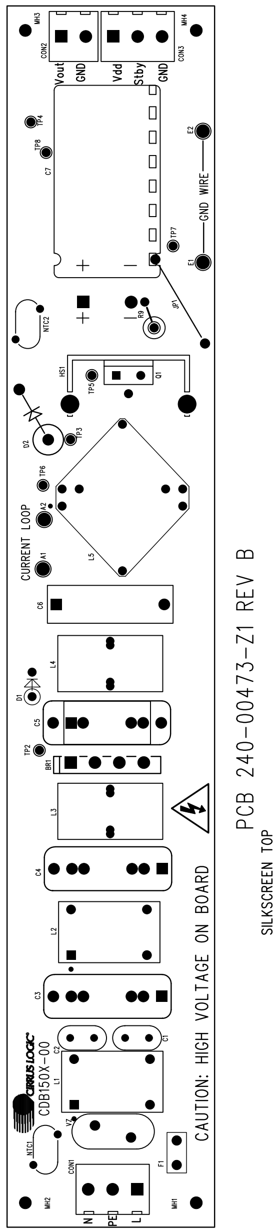


Figure 2. Top Silkscreen

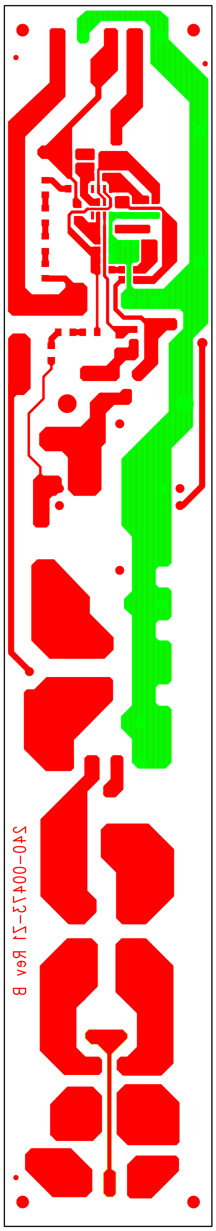


Figure 3. Bottom Routing

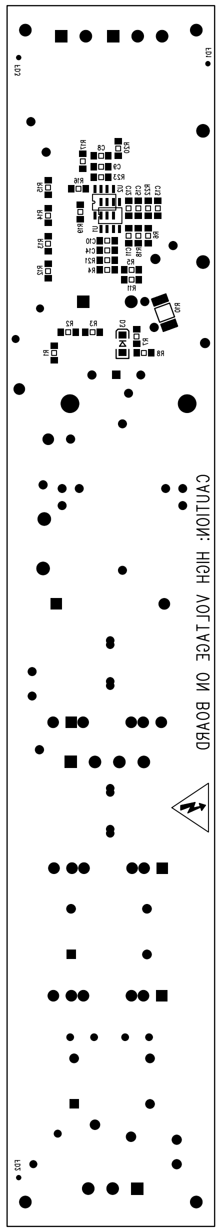


Figure 4. Bottom Silkscreen

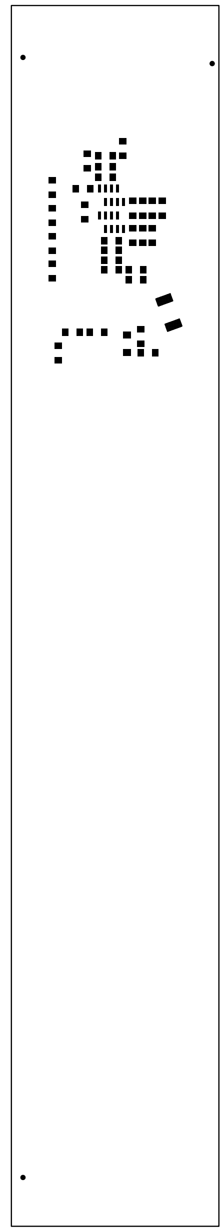


Figure 5. Bottom Solder Paste Mask

5. PERFORMANCE PLOTS

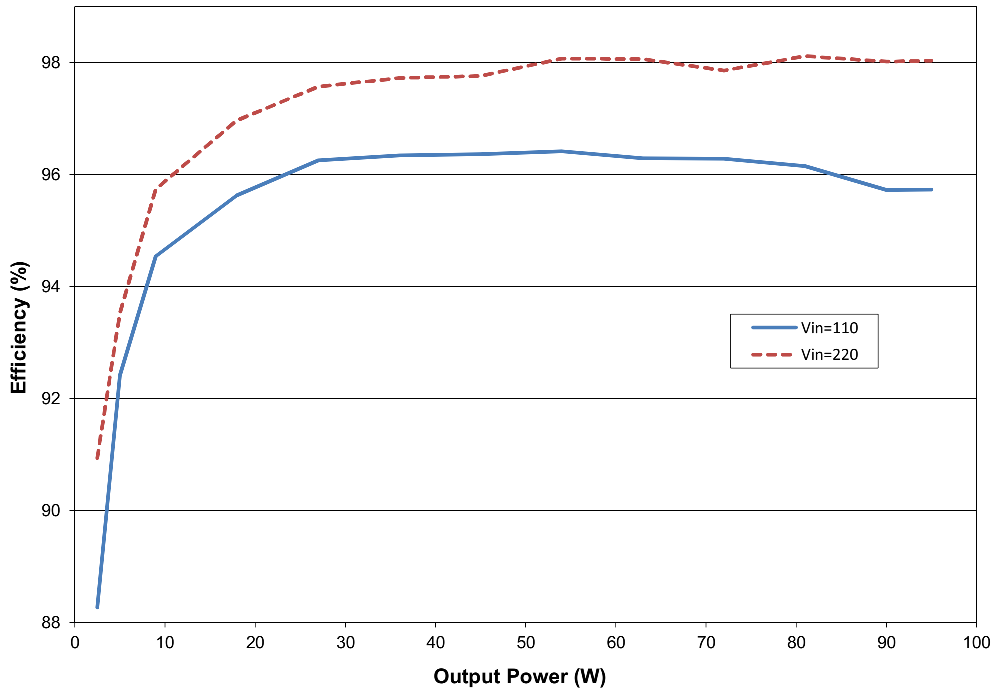


Figure 6. Efficiency vs. Load at 110 VAC, 220 VAC

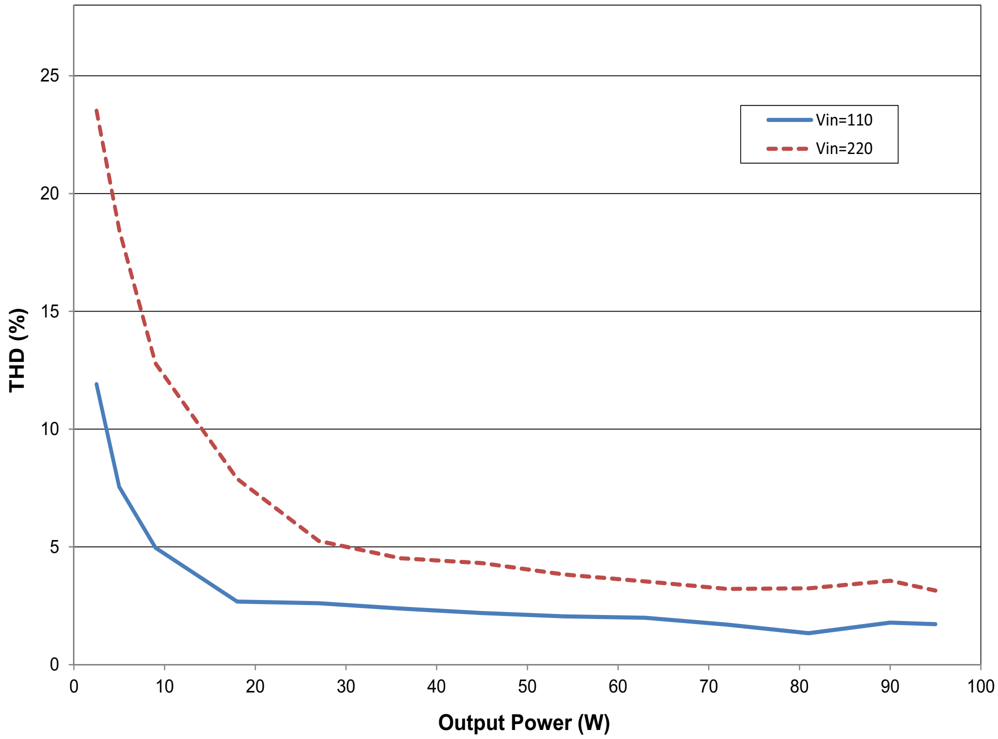


Figure 7. Distortion vs. Load at 110 VAC, 220 VAC

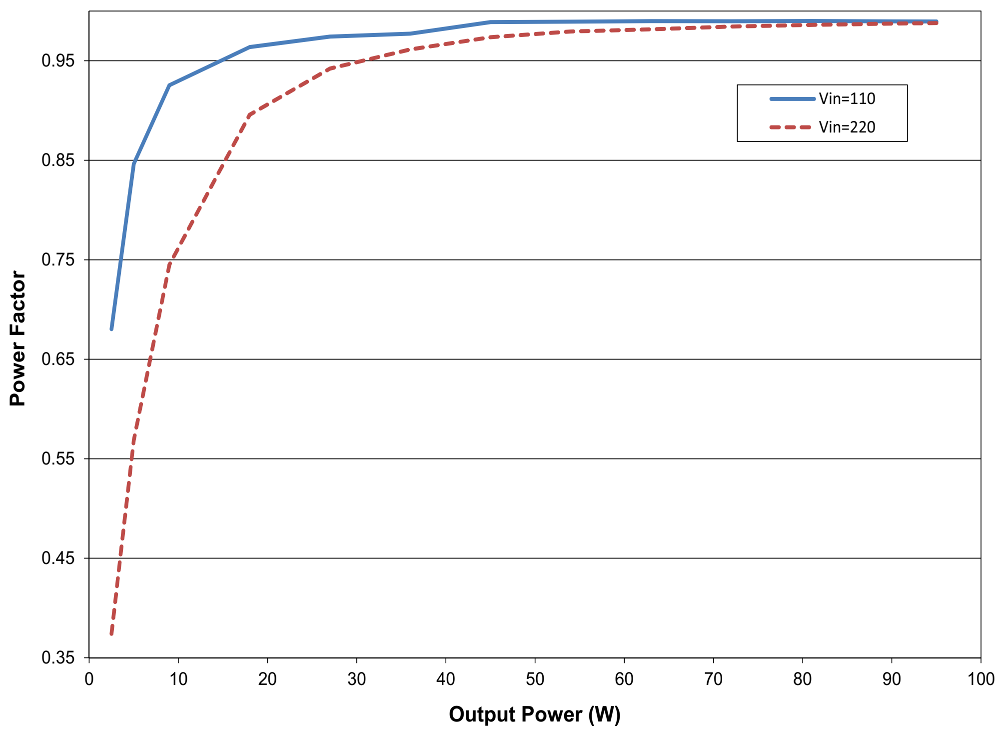


Figure 8. Power Factor vs. Load at 110 VAC, 220 VAC

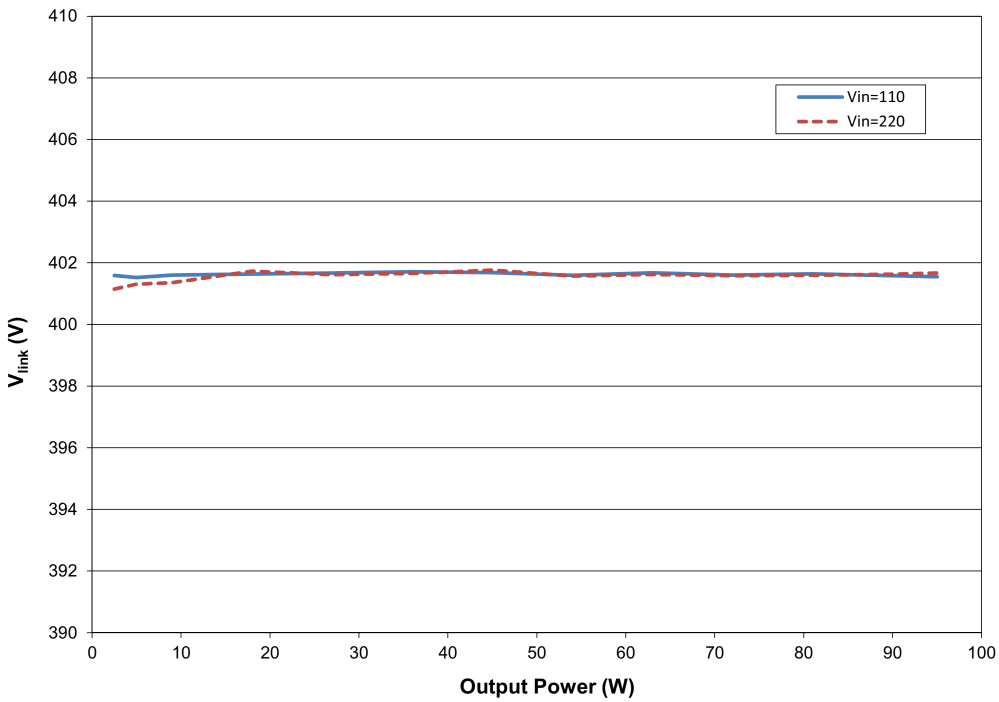


Figure 9. V_{link} vs. Output Power at 110 VAC, 220 VAC

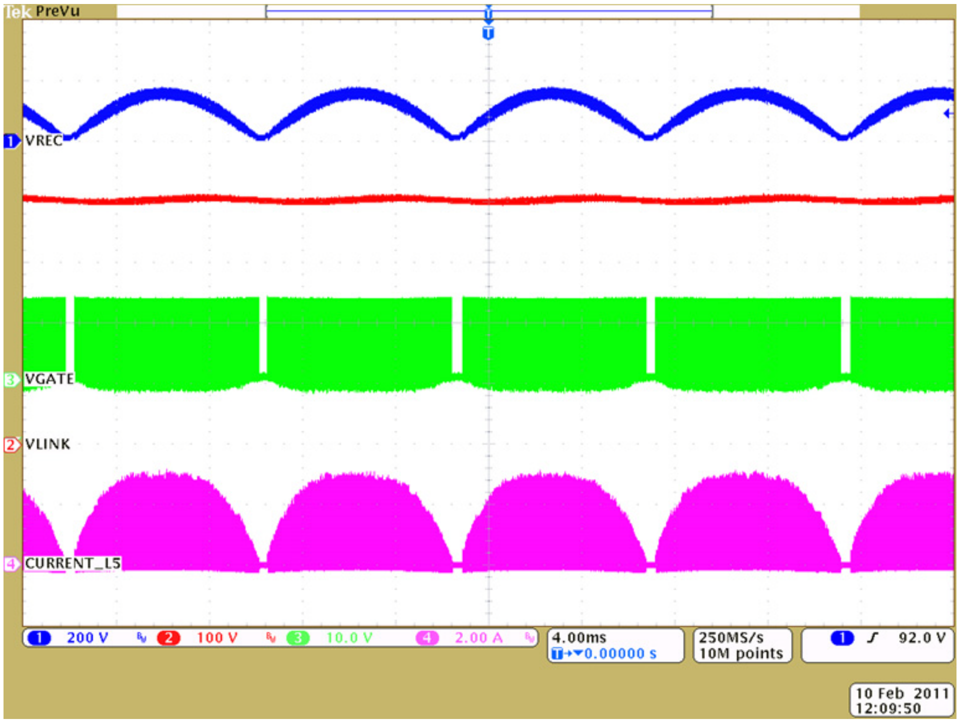


Figure 10. Steady State Waveforms — 110 VAC

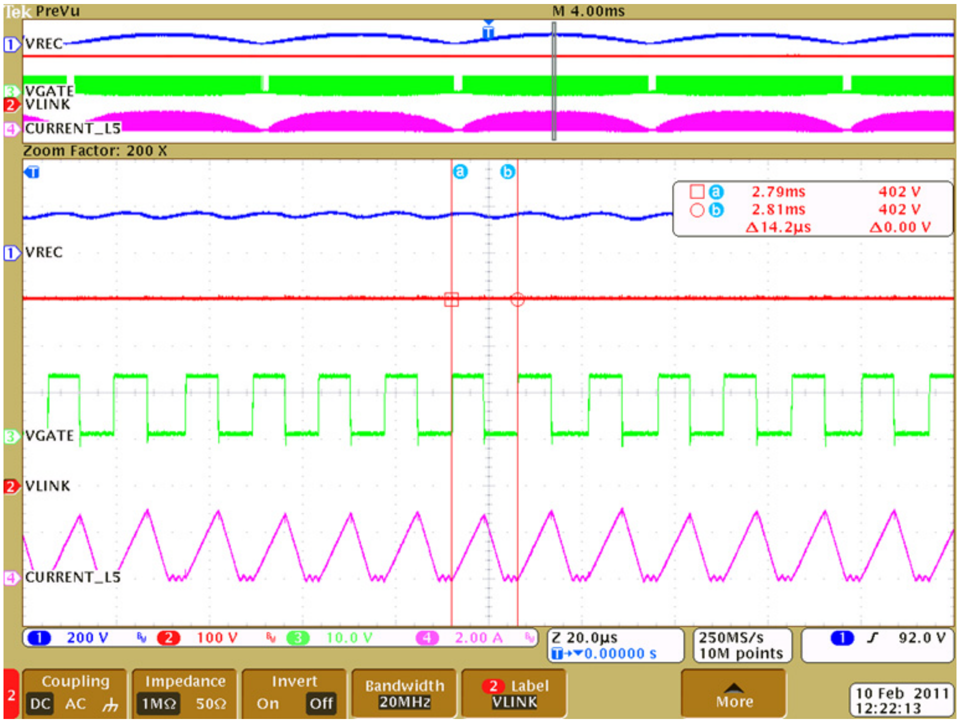


Figure 11. Switching Frequency Profile at Peak of AC Line Voltage — 110 VAC

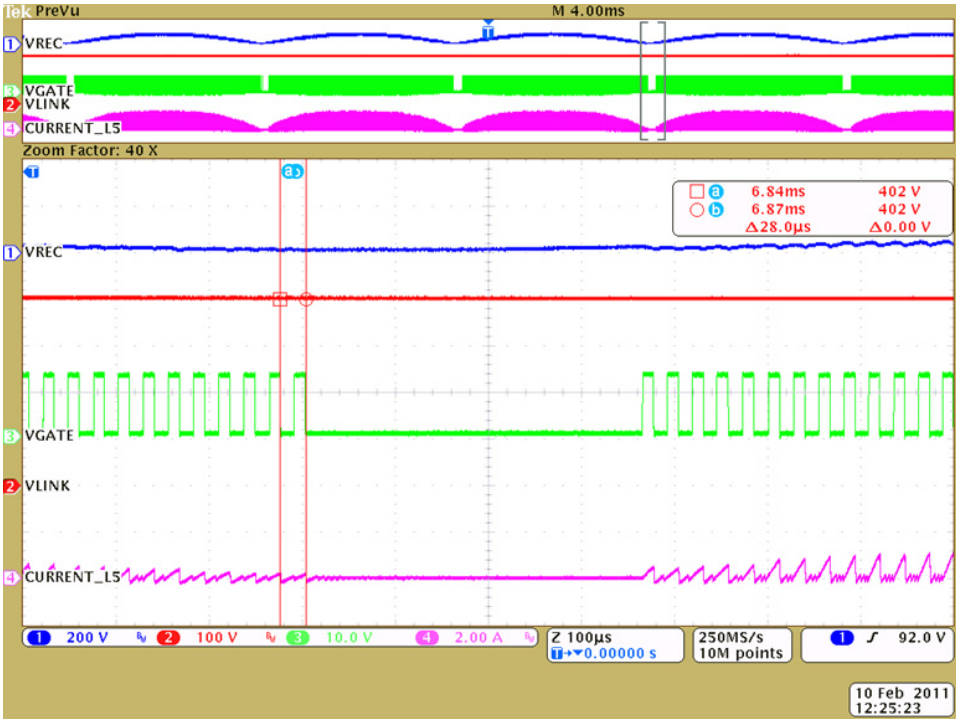


Figure 12. Switching Frequency Profile at Trough of AC Line Voltage — 110 VAC

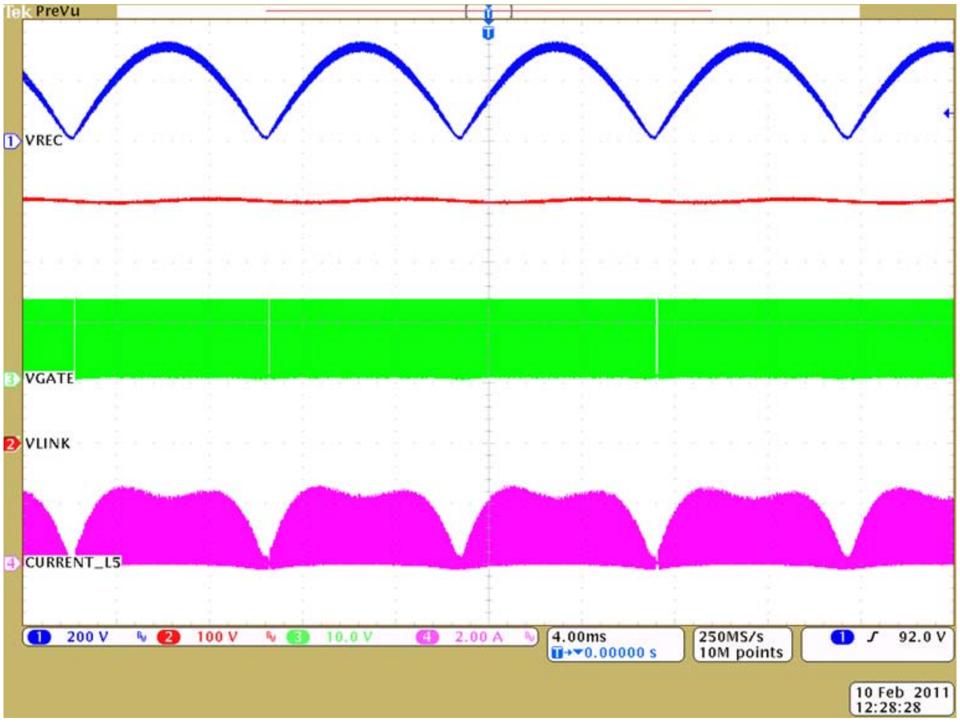


Figure 13. Steady State Waveforms — 220 VAC

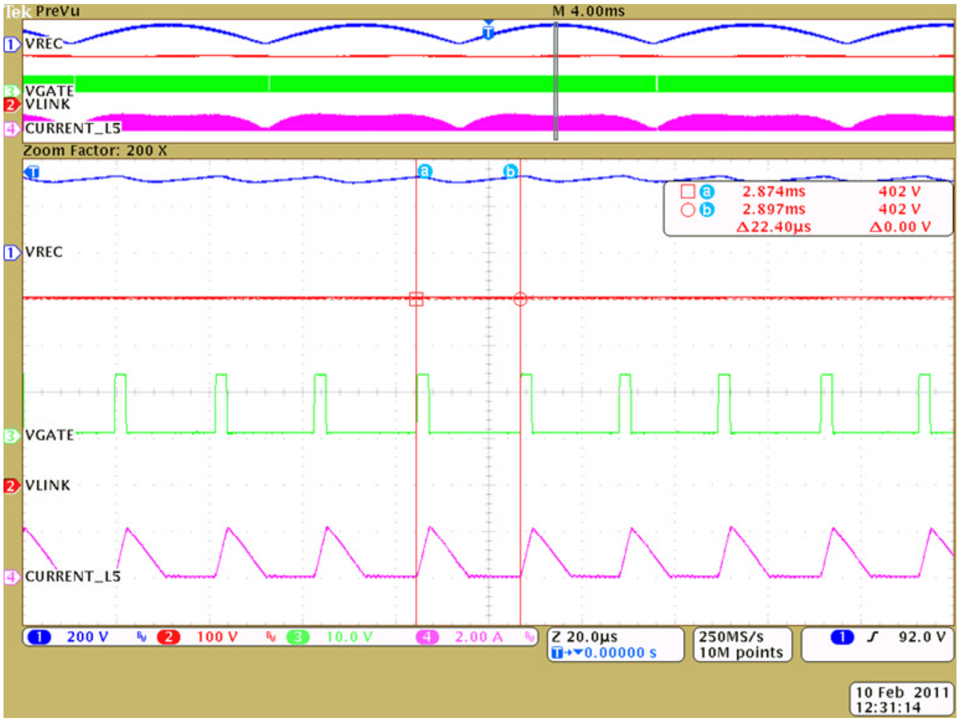


Figure 14. Switching Frequency Profile at Peak of AC Line Voltage — 220 VAC

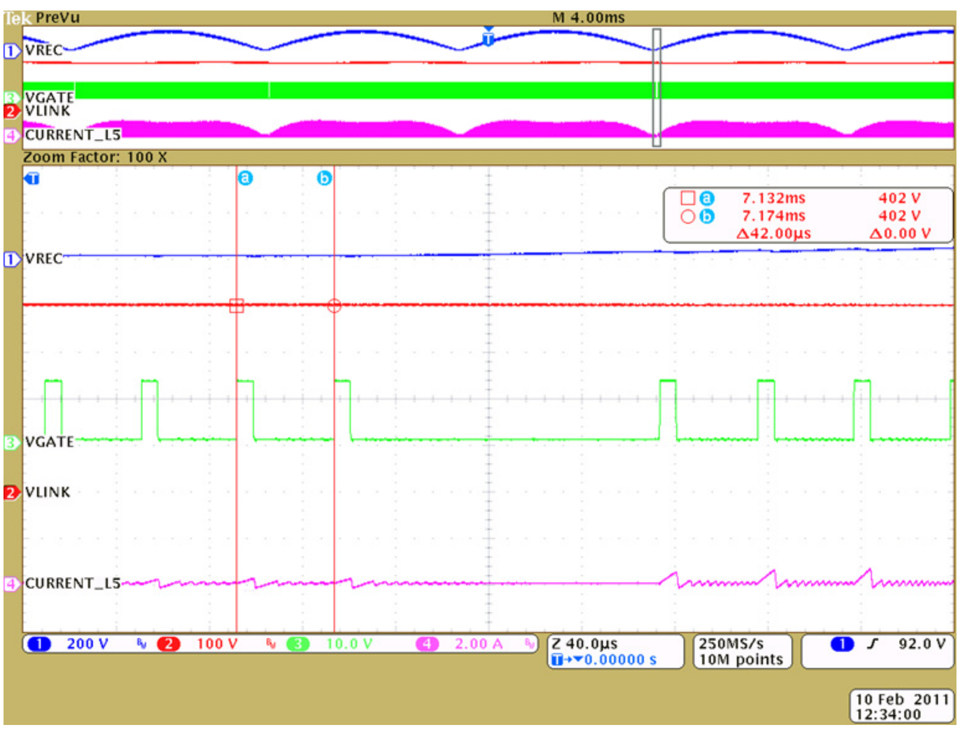


Figure 15. Switching Frequency Profile at Trough of AC Line Voltage — 220 VAC

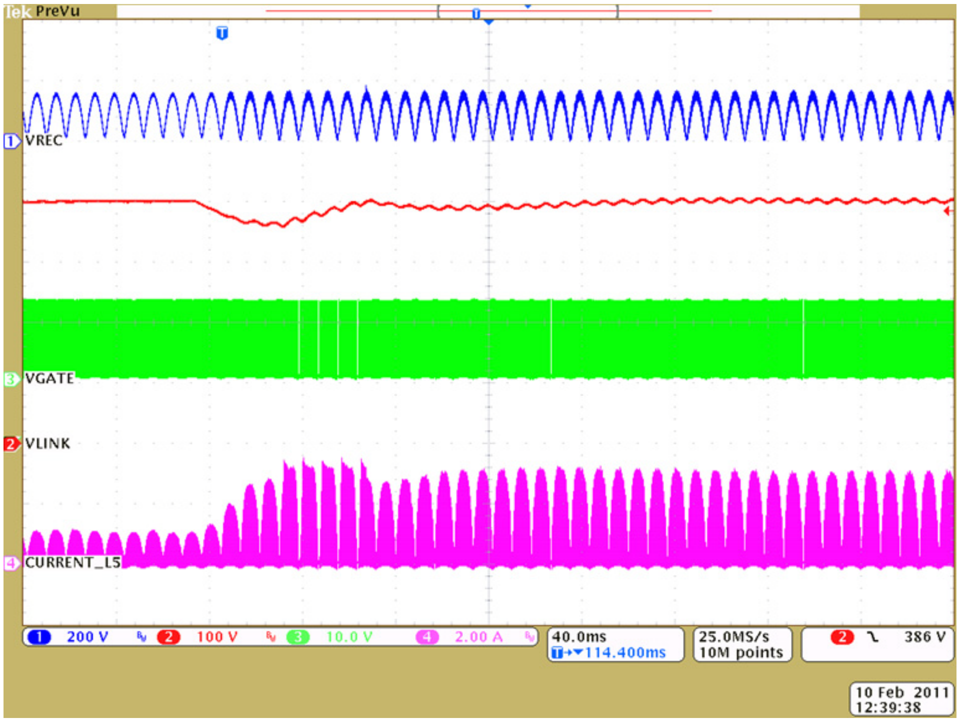


Figure 16. Load Transient — 9 W to 90 W, 1 W/uS, 110 VAC

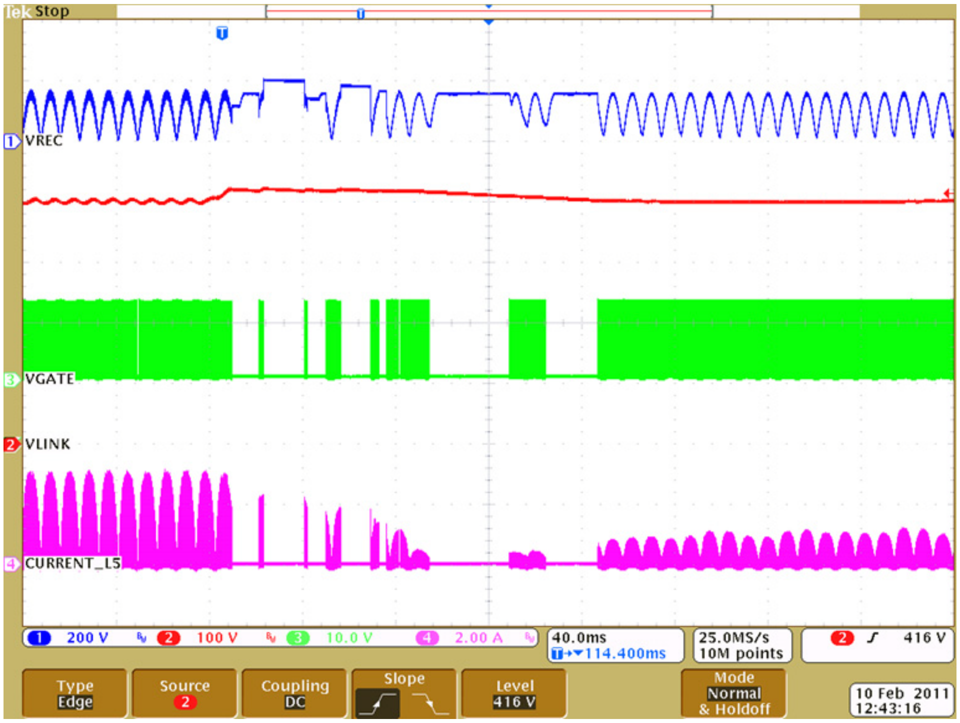


Figure 17. Load Transient — 90 W to 9 W, 1 W/uS, 110 VAC

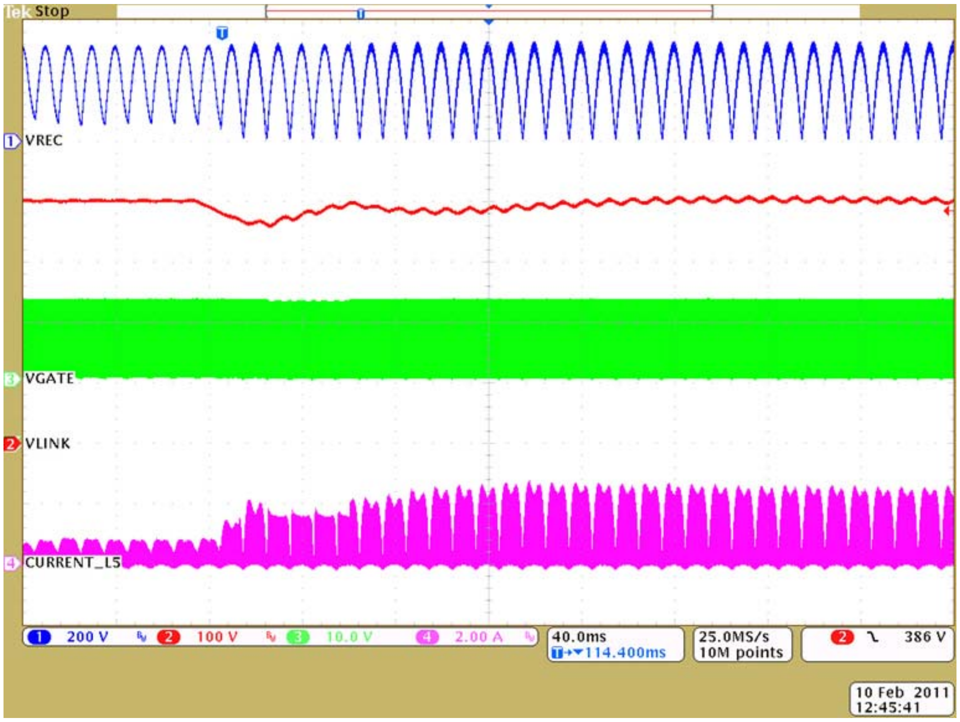


Figure 18. Load Transient — 9 W to 90 W, 1 W/uS, 220 VAC

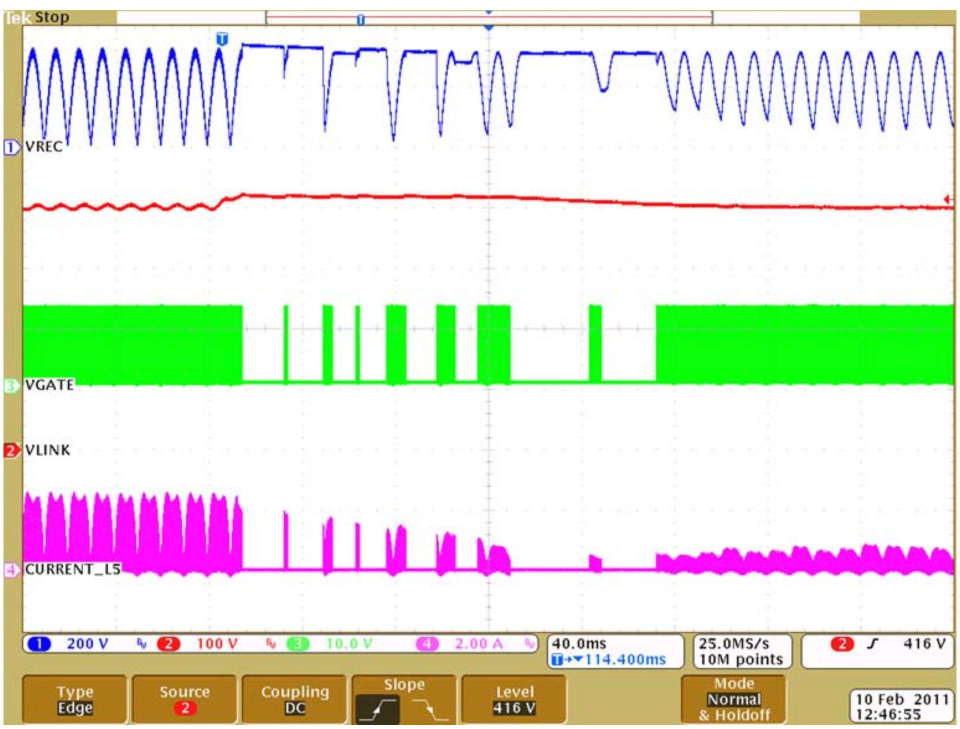


Figure 19. Load Transient — 90 W to 9 W, 1 W/uS, 220 VAC

6. REVISION HISTORY

Revision	Date	Changes
DB1	FEB 2011	Initial Release.

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