CDB1601-120W

CS1601 120W, High-efficiency PFC Demonstration Board

Features

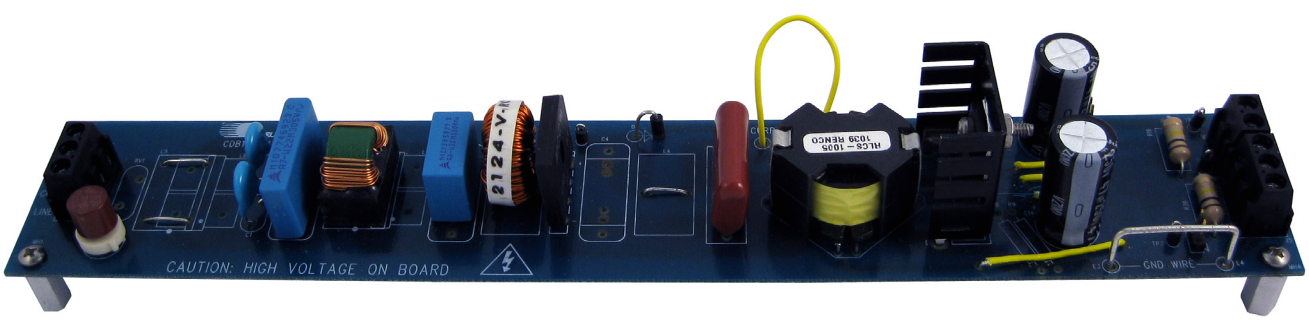
- Line Voltage Range: 108 to 305 VACrms
- Output Voltage (V_{LINK}): 460V
- Rated P_{out} : 115W
- Efficiency: 95% @ 115W
- Spread Spectrum Switching Frequency
- Integrated Digital Feedback Control
- Low Component Count

General Description

The CDB1601-120W board demonstrates the performance of the CS1601 digital PFC controller as a stand-alone unit. This board is 95% efficient at full load, and has been tailored for use with a resonant second stage to power up to two T5 fluorescent lamps for a maximum output power of 108W. A resonant second stage driver efficiency of 94% is assumed for this application.

ORDERING INFORMATION

CDB1601-120W-Z Customer Demonstration Board



Actual Size:
258 mm x 43 mm
8.16 in x 1.7 in

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 Q4. 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 CS1601 is a high-performance Variable Frequency Discontinuous Conduction Mode (VF-DCM), active Power Factor Correction (PFC) controller, optimized to deliver the lowest PFC system cost for electronic ballast applications. The CS1601 uses a digital control algorithm that is optimized for high efficiency and near unity power factor over a wide input voltage range (108-305 VAC).

The CS1601 uses 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 variation in switching frequency also provides a spread frequency spectrum, thus minimizing the conducted EMI filtering requirements.

The feedback loop is closed through an integrated digital control system within the IC. Protection features such as overvoltage, overcurrent, overpower, open circuit, overtemperature, and brownout help protect the device during abnormal transient conditions. Details of these features are provided in the CS1601 data sheet.

The CDB1601-120W board demonstrates the performance of the CS1601 over a wide input voltage range of 108 to 305 VAC, typically seen in universal input ballast applications. This board has been designed for a 460 V, 115 W full load output application.

Extreme caution needs to be exercised while handling this board. This board is to be powered up by trained professionals only.

Prior to applying AC power to the CDB1601-120W board, the CS1601 needs to be biased using an external 13 VDC power supply, applied across pins 1 and 3 of terminal block J5. Terminal block J6 is used to connect the AC line. The load is connected to J7. As a safety measure, jumper J1 is provided as a means to apply a small resistive load (200 kΩ minium) to rapidly discharge the output capacitors. Other jumpers and test points are provided to evaluate the behavior of the IC and the various sections of the design.

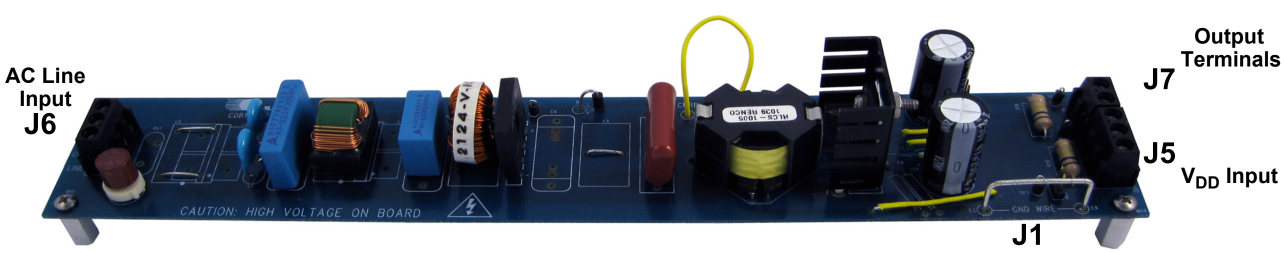


Figure 1. Board Connections

DANGER
High Voltage Hazard
ONLY QUALIFIED PERSONNEL SHOULD HANDLE THE CDB1601-120W.

WARNING:
Heatsinking is required for Q4.
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.

2. SCHEMATIC

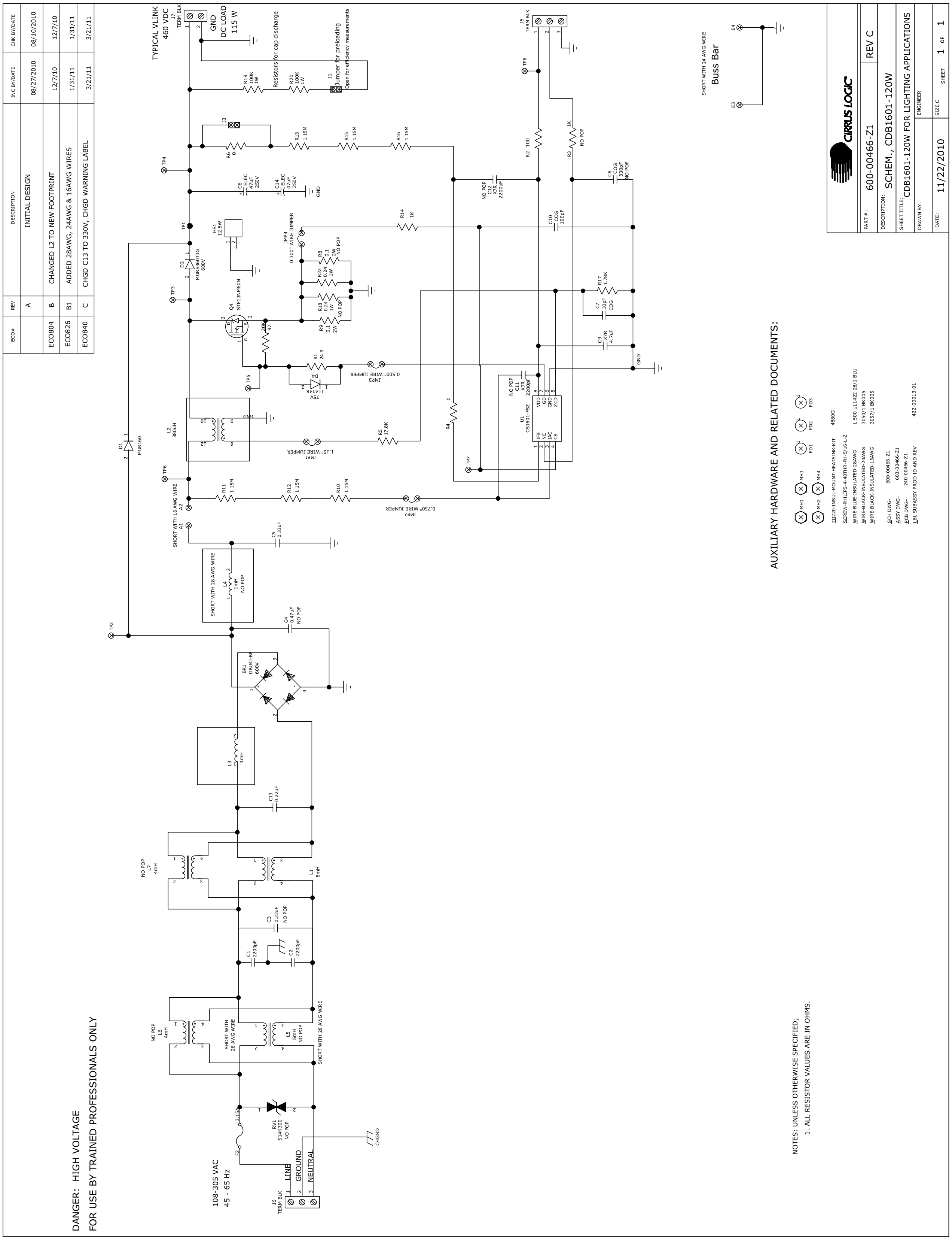


Figure 2. Schematic

3. BILL OF MATERIALS

CIRRUS LOGIC
CDB1601-120W_Rev_C

BILL OF MATERIAL (Page 1 of 1)

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	NO POP
4	011-00040-Z1	A	CAP 0.47uF ±20% 305V PLY FLM NPb TH	0	C4	EPCOS	B32922C3474M	NO POP
5	013-00034-Z1	A	CAP 0.33uF ±10% 630V POLY NPb RAD	1	C5	PANASONIC	ECQE6334KF	
6	012-00186-Z1	A	CAP 47UF ±20% 250V ELEC NPb RAD	2	C6 C14	NICHICON	UVZ2E470MHD	
7	001-05280-Z1	A	CAP 33pF ±5% 50V C0G NPb 1206	1	C7	KEMET	C1206C330J5GAC	
8	001-05783-Z1	A	CAP 330pF ±10% 50V C0G NPb 1206	0	C8	KEMET	C1206C331K5GAC	NO POP
9	001-10233-Z1	A	CAP 4.7uF ±20% 25V X7R NPb 1206	1	C9	TDK	C3216X7R1E475M	
10	001-05542-Z1	A	CAP 100pF ±5% 50V C0G NPb 1206	1	C10	KEMET	C1206C101J5GAC	
11	001-06276-Z1	A	CAP 2200pF ±10% 50V X7R NPb 1206	0	C11 C12	KEMET	C1206C222K5RAC	NO POP
12	011-00064-Z1	A	CAP 0.22uF ±20% 330V PLY FLM NPb TH	1	C13	EPCOS	B32912B3224M	ECO840
13	070-00132-Z1	A	DIODE RECT 800V 1A 200mA NPb DO-41	1	D1	DIODES INC	1N4006G-T	
14	070-00166-Z1	A	DIODE RECT 600V 4A ULT FST NPb SMC	1	D2	ON SEMICONDUCTOR	MURS360T3G	
15	070-00001-Z1	A	DIODE SS 75V 500mW NPb SOD80	1	D4	DIODES INC	LL4148	
16	180-00022-Z1	A	FUSE 3.15A TLAG IEC NPb SHORT TR5	1	F2	LITTLE FUSE	37213150411	
17	311-00019-Z1	A	HTSNK W LOCK TAB .5" TO220 NPb	1	HS1	AAVID THERMALLOY	6021PBG	REQUIRES 1 SCREW, 300-00025-Z1, 1 WASHER, 301-00013-Z1, 1 NUT, 302-00007-Z1 OR MOUNTING KIT 4880G AAVID
18	115-00014-Z1	A	HDR 2x1 ML .1" 062BD ST GLD NPb TH	2	J1 J3	SAMTEC	TSW-102-07-G-S	
19	110-00301-Z1	A	CON 3POS TERM BLK 5.08mm SPR NPb RA	2	J5 J6	WEIDMULLER	1716030000	
20	110-00302-Z1	A	CON 2POS TERM BLK 5.08mm SPR NPb RA	1	J7	WEIDMULLER	1716020000	
21	080-00013-Z1	A	WIRE 24 AWG SOLID PVC INS BLK NPb	6.000	JMP1 JMP2 JMP3 JMP4 W2	ALPHA WIRE COMPANY	3050/1 BK005	SEE ASSY DWG FOR LENGTH
22	050-00039-Z1	A	XFMR 5mH 1:1 1500Vrms 4PIN NPb TH	1	L1	PREMIER MAGNETICS	TSD-2796	
23	050-00050-Z1	A	XFMR 380uH 10% .265O NPb TH	1	L2	RENCO	RLCS-1005	
24	040-00127-Z1	A	IND 1mH 1.3A ±15% TOR VERT NPb TH	1	L3	BOURNS	2124-V-RC	
25	040-00127-Z1	A	IND 1mH 1.3A ±15% TOR VERT NPb TH	0	L4	BOURNS	2124-V-RC	NO POP
26	050-00039-Z1	A	XFMR 5mH 1:1 1500Vrms 4PIN NPb TH	0	L5	PREMIER MAGNETICS	TSD-2796	NO POP
27	050-00047-Z1	A	XFMR COMMON MODE CHOKE 1.3 A TH NPb	0	L6 L7	RENCO	RL-4400-2-4.00	NO POP
28	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 300-00025-Z1
29	071-00107-Z1	A	TRAN MOSFT nCH 11A 600V NPb TO220FP	1	Q4	ST MICROELECTRONICS	STF13NM60N	
30	020-06337-Z1	A	RES 24.9 OHM 1/4W ±1% NPb 1206 FILM	1	R1	DALE	CRCW120624R9FKEA	
31	020-02502-Z1	A	RES 100 OHM 1/4W ±1% NPb 1206 FILM	1	R2	DALE	CRCW1206100RFKEA	
32	020-02616-Z1	A	RES 1k OHM 1/4W ±1% NPb 1206 FILM	0	R3	DALE	CRCW12061K00FKEA	NO POP
33	020-02273-Z1	A	RES 0 OHM 1/4W NPb 1206 FILM	2	R4 R6	DALE	CRCW12060000Z0EA	
34	020-06390-Z1	A	RES 17.8K OHM 1/4W ±1% NPb 1206	1	R5	DALE	CRCW120617K8FKEA	
35	020-06310-Z1	A	RES 20K OHM 1/4W ±1% NPb 1206 FILM	1	R7	DALE	CRCW120620K0FKEA	
36	030-00091-Z1	A	RES 0.1 OHM 2W ±1% WW NPb AXL	0	R8	VISHAY	G003R1000FE7080	NO POP
37	030-00091-Z1	A	RES 0.1 OHM 2W ±1% WW NPb AXL	1	R9	VISHAY	G003R1000FE7080	
38	020-06356-Z1	A	RES 1.15M OHM 1/4W ±1% NPb 1206	6	R10 R11 R12 R13 R15 R16	DALE	CRCW12061M15FKEA	
39	020-02616-Z1	A	RES 1k OHM 1/4W ±1% NPb 1206 FILM	1	R14	DALE	CRCW12061K00FKEA	
40	020-06391-Z1	A	RES 1.78K OHM 1/4W ±1% NPb 1206	1	R17	DALE	CRCW12061K78FKEA	
41	020-06372-Z1	A	RES 0.24 OHM 1W ±1% NPb 2512	0	R18 R22	PANASONIC	ERJ1TRQFR24U	NO POP
42	030-00080-Z1	A	RES 100K 1W ±5% MTL FLM NPb AXL	2	R19 R20	XICON	294-100K-RC	
43	036-00015-Z1	A	VARISTOR 470V RMS 14MM NPb RAD	0	RV1	EPCOS	S14K300	NO POP
44	110-00045-Z1	A	CON TEST PT .1"CTR TIN PLAT NPb BLK	7	TP2 TP3 TP4 TP5 TP6 TP7 TP8	KEYSTONE	5001	
45	065-00331-Z3	A2	IC CRUS LPWR FACTOR CORR NPb SOIC8	1	U1	CIRRUS LOGIC	CS1601-FSZ/A2	ECO840
46	080-00002-01	A	WIRE 28/1 AWG, KYNAR MOD, 500FT	2.000	W1	SQUIRES	L 500 UL1422 28/1 BLU	ADD LENGTH TO BOM QUANTITY IN INCHES
47	080-00040-Z1	A	WIRE 16AWG SOLID PVC INS BLK NPb	4.000	W3	ALPHA WIRE COMPANY	3057/1 BK005	ADD LENGTH TO BOM QUANTITY IN INCHES
48	311-00025-Z1	A	HTSNK TO220 MOUNTING KIT NPb	1	XHS1	AAVID THERMALLOY	4880G	INCLUDES ALL MOUNTING HARDWARE
49	300-00025-Z1	A	SCREW 4-40X5/16" PH MACH SS NPb	4	XMH1MXMH2 XMH3 XMH4	BUILDING FASTENERS	PMSSS 440 0031 PH	SCREWS FOR STANDOFFS
50	240-00466-Z1	C	PCB CDB1601-120W-Z-NPb	1		CIRRUS LOGIC	240-00466-Z1	ECO805/826/840
51	603-00466-Z1	C	ASSY DWG CDB1601-120W-Z-NPb	REF		CIRRUS LOGIC	603-00466-Z1	ECO805/826/840
52	600-00466-Z1	C	SCHEM CDB1601-120W-Z-NPb	REF		CIRRUS LOGIC	600-00466-Z1	ECO805/826/840
53	422-00013-01	C	LBL SUBASSY PRODUCT ID AND REV	1		CIRRUS LOGIC	422-00013-01	

4. BOARD LAYOUT

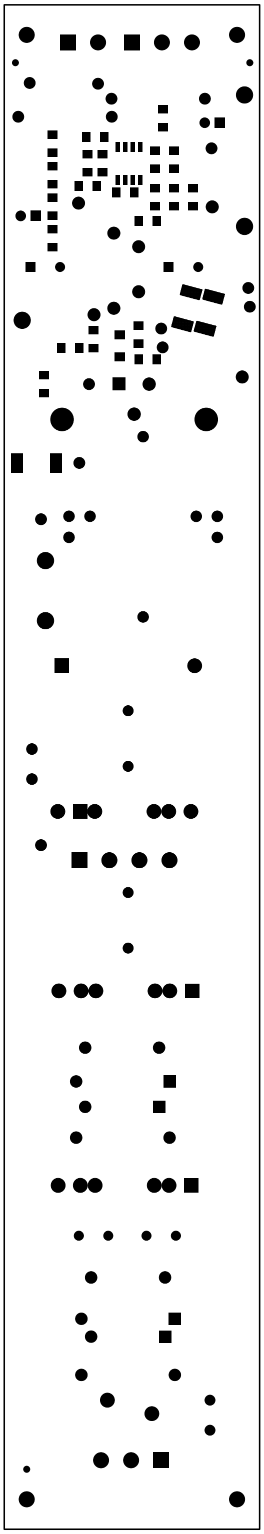


Figure 3. Solder Mask (Bottom)

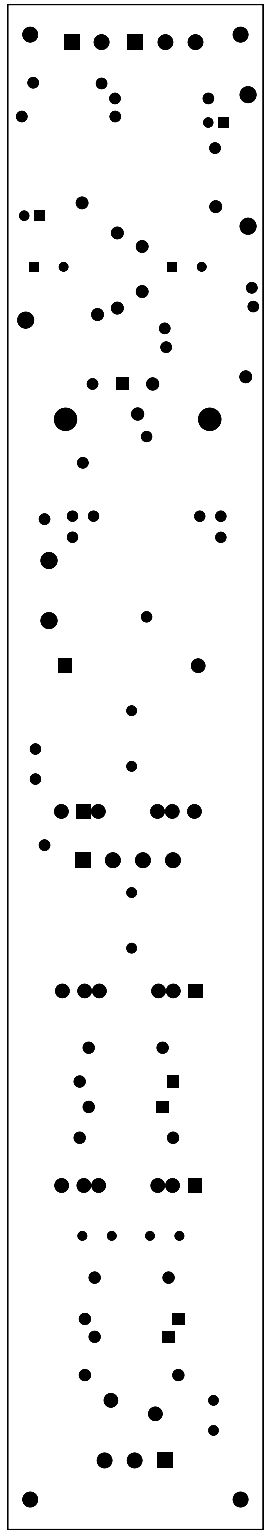


Figure 4. Solder Mask (Top)

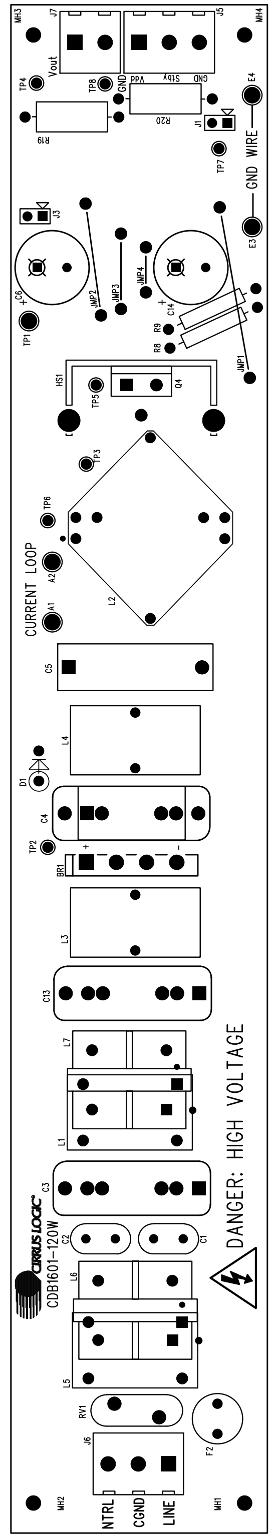


Figure 5. Silkscreen (Top)

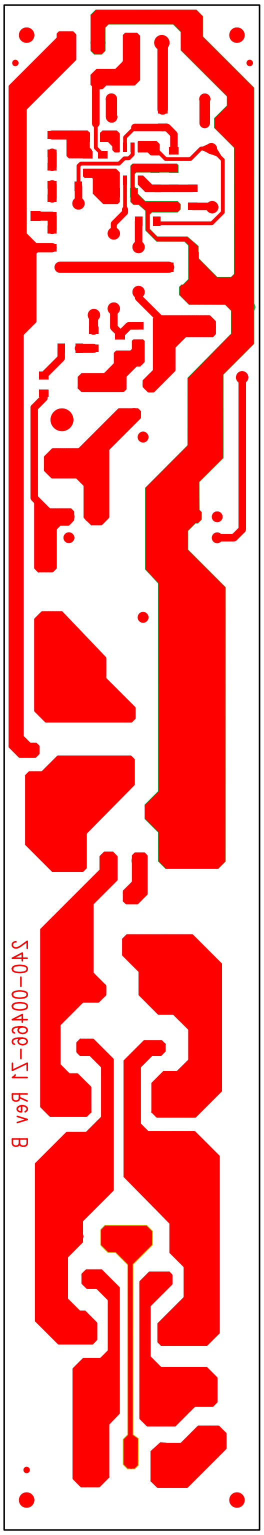


Figure 6. Circuit Routing (Bottom)

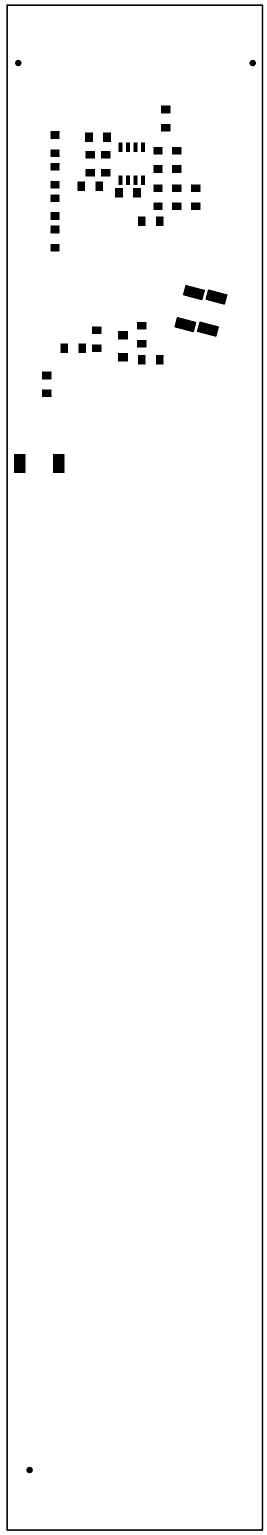


Figure 7. Solder Paste Mask (Bottom)

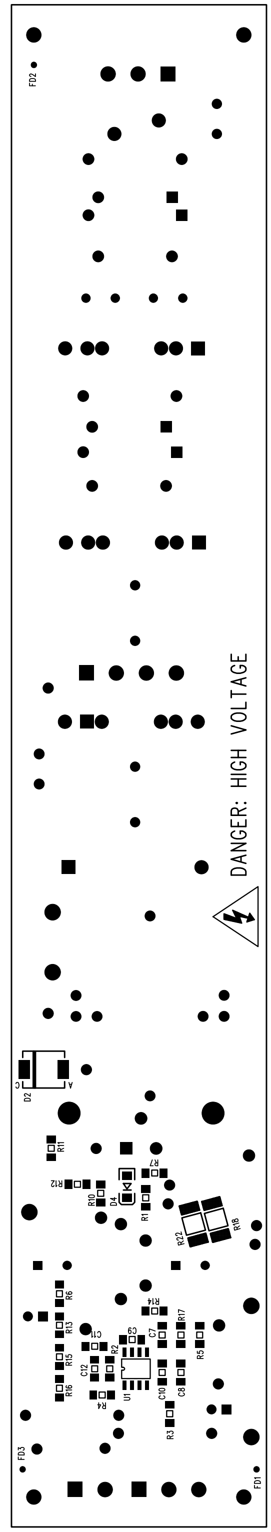


Figure 8. Silkscreen (Bottom)

5. TYPICAL PERFORMANCE PLOTS

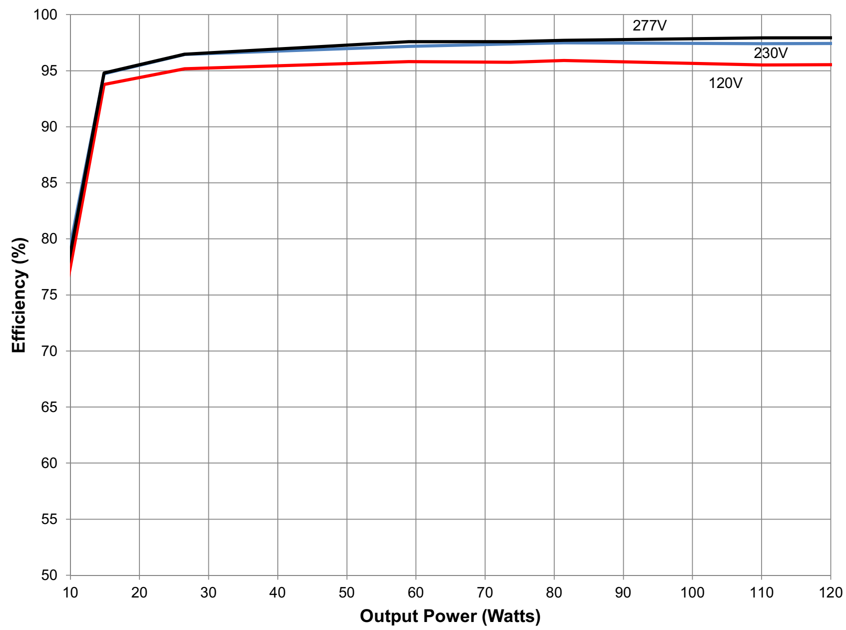


Figure 9. Efficiency vs. Output Power

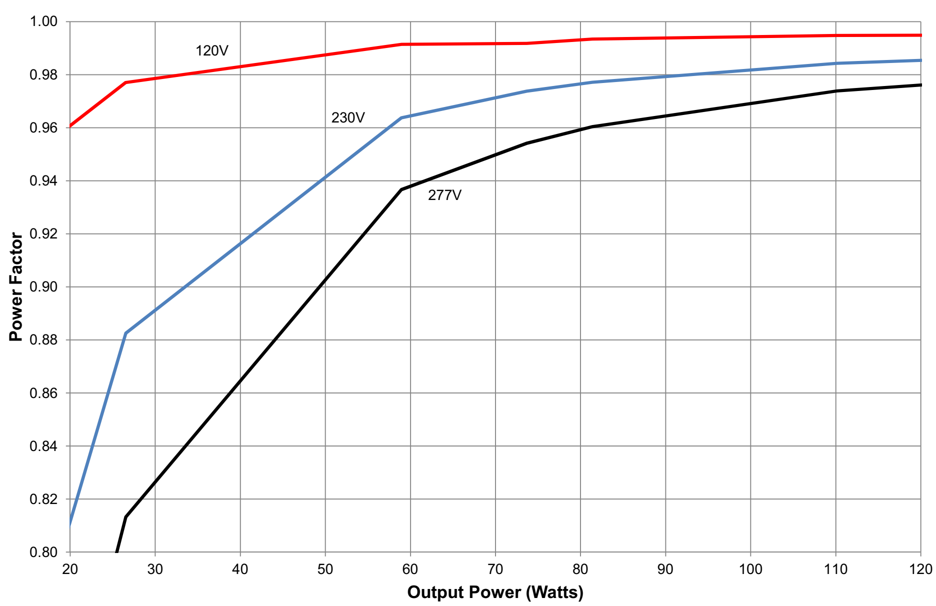


Figure 10. Power Factor vs. Output Power

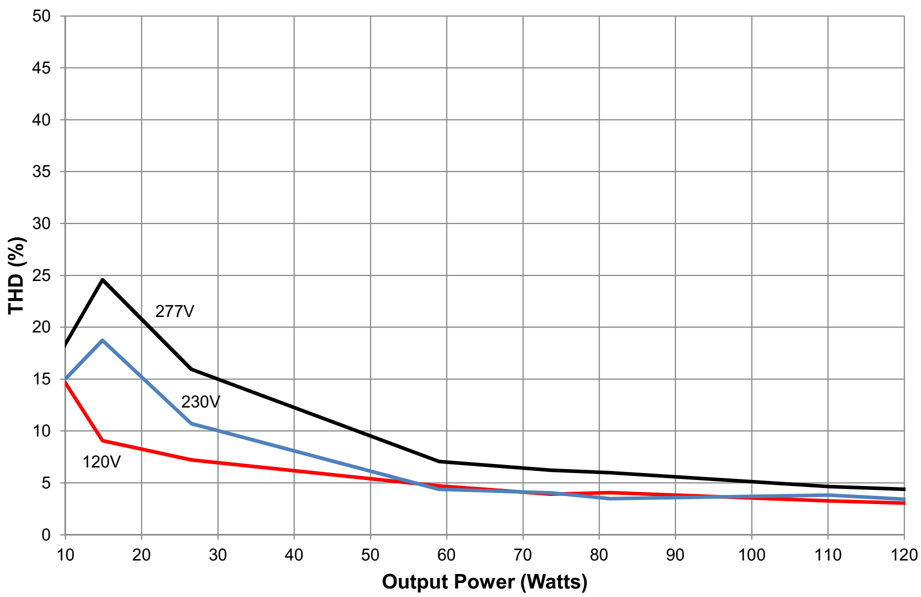


Figure 11. THD vs. Output Power

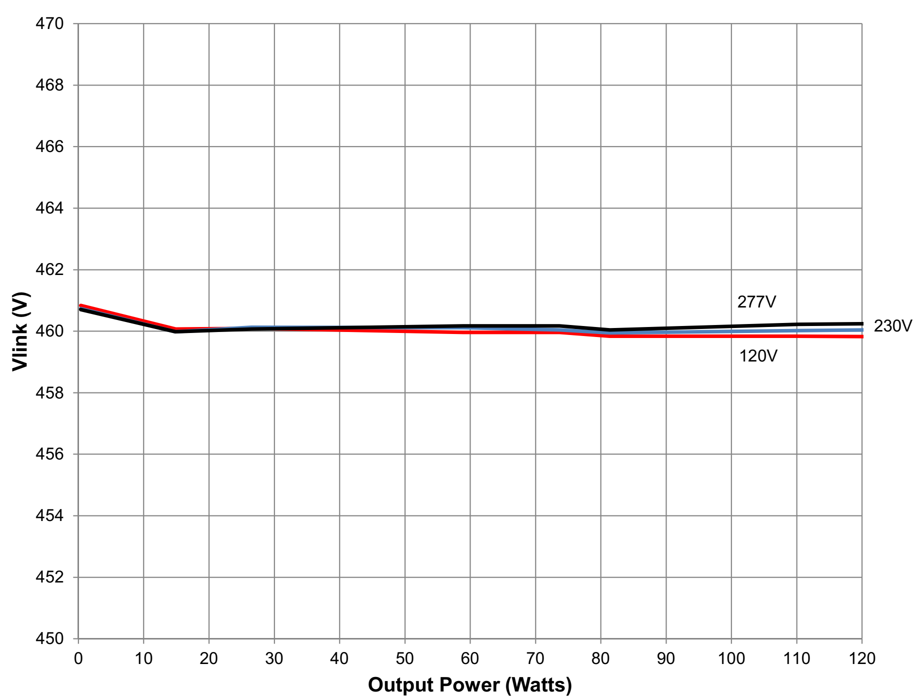


Figure 12. V_{Link} Voltage vs. Output Power

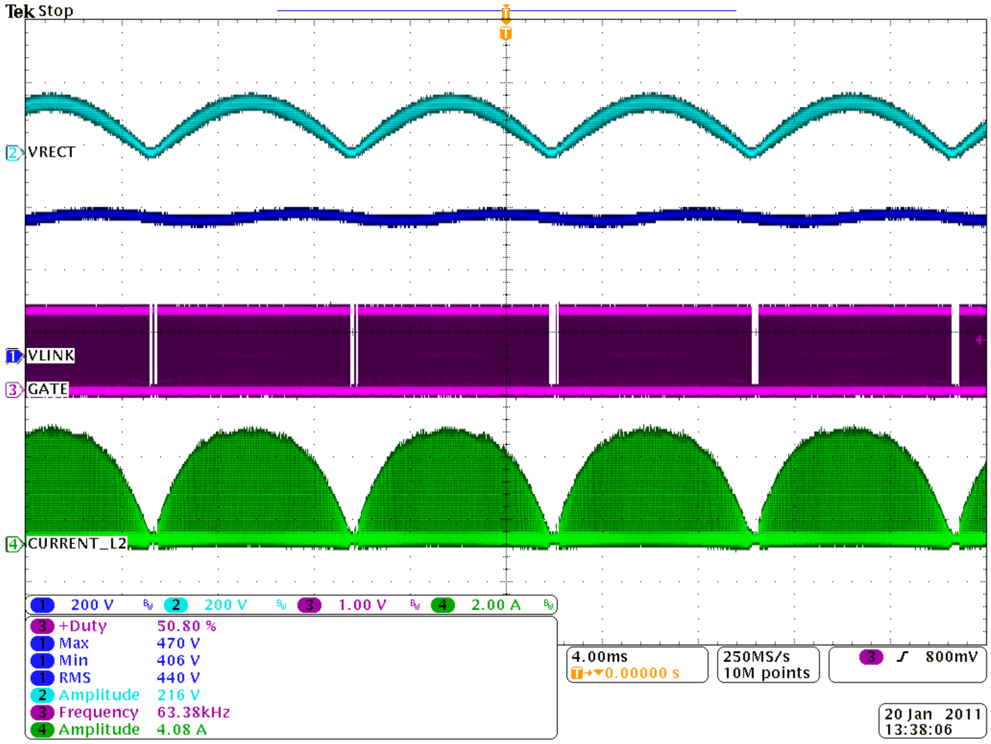


Figure 13. Steady State Waveforms — 120 VAC

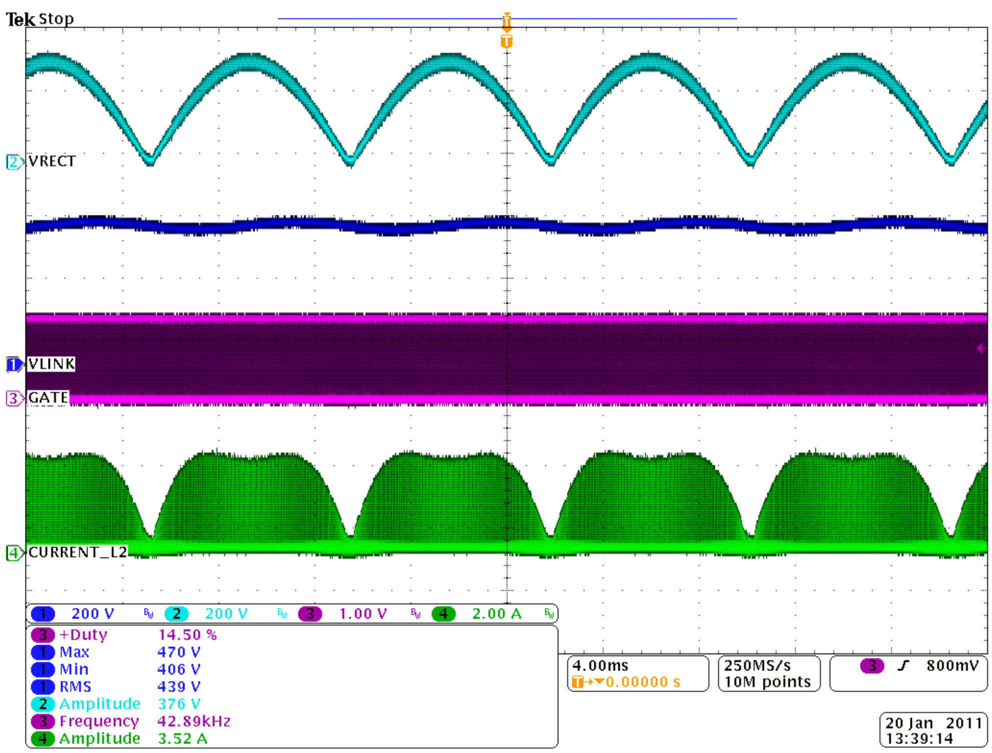


Figure 14. Steady State Waveforms — 230 VAC

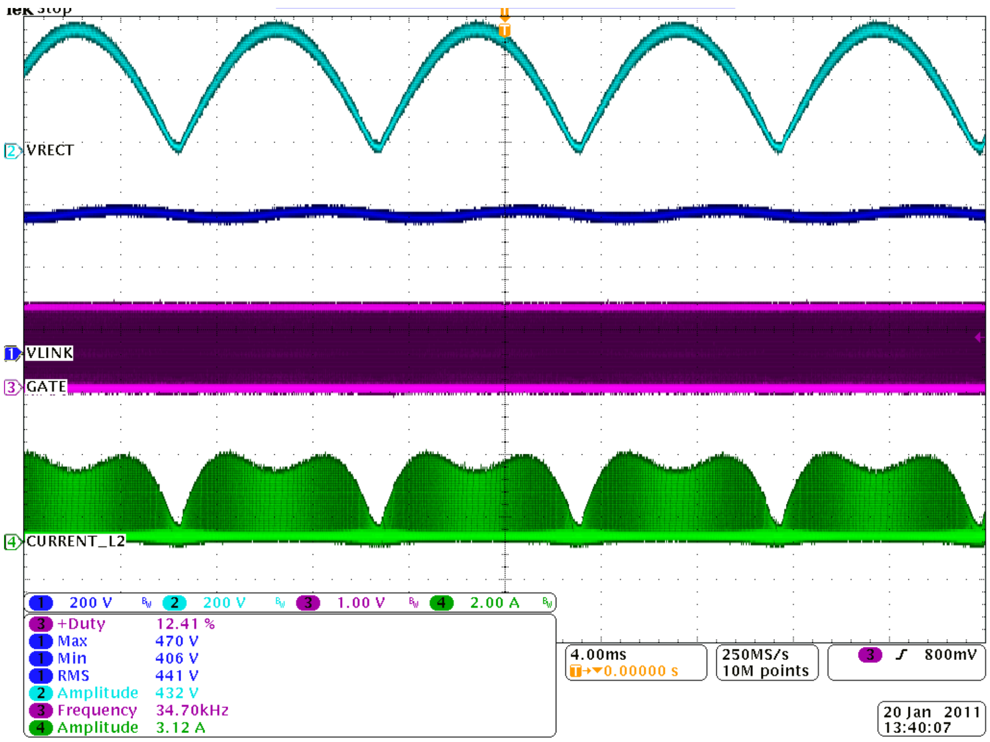


Figure 15. Steady State Waveforms — 277 VAC

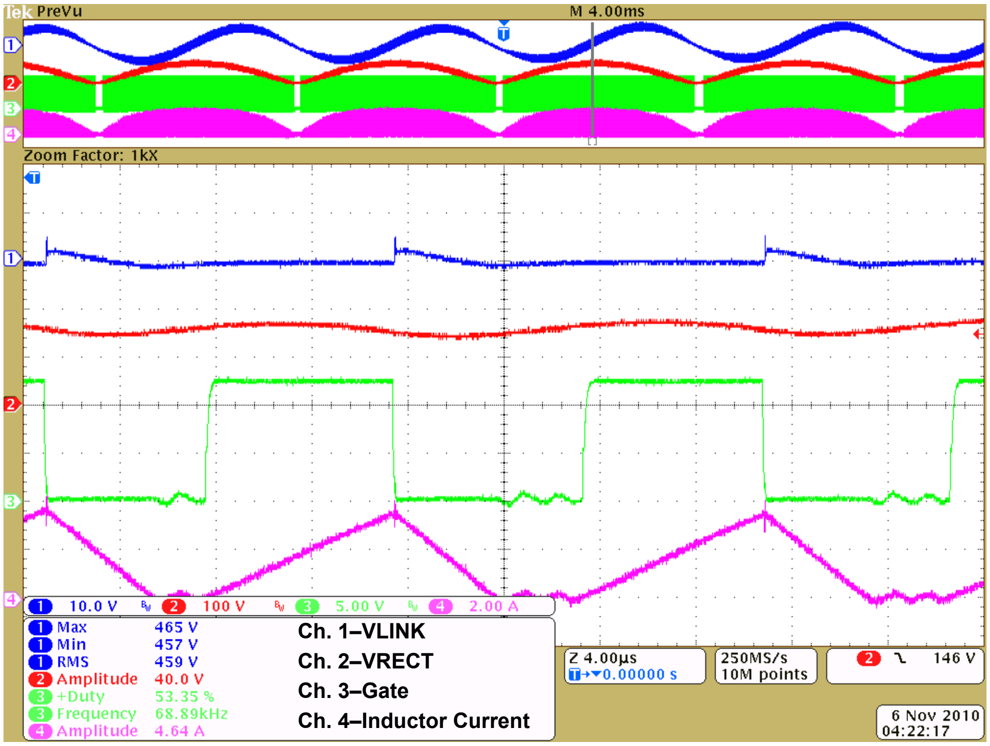


Figure 16. Switching Frequency Profile at Peak of AC Line Voltage — 120 VAC

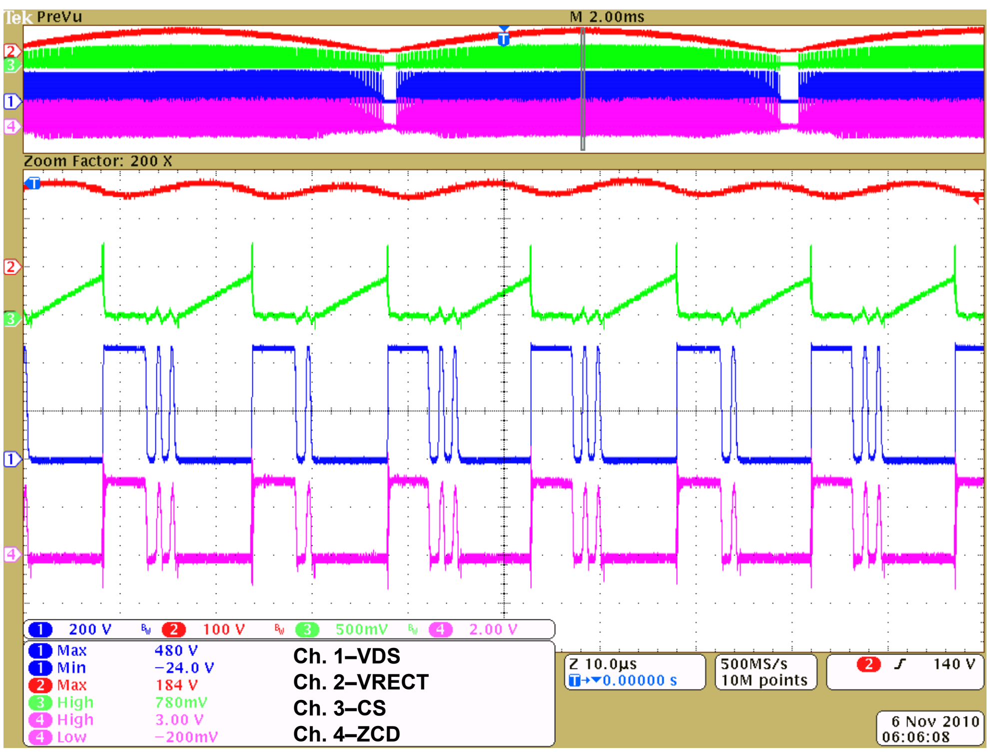


Figure 17. Switching Frequency Profile at Peak of AC Line Voltage — 120 VAC (cont.)

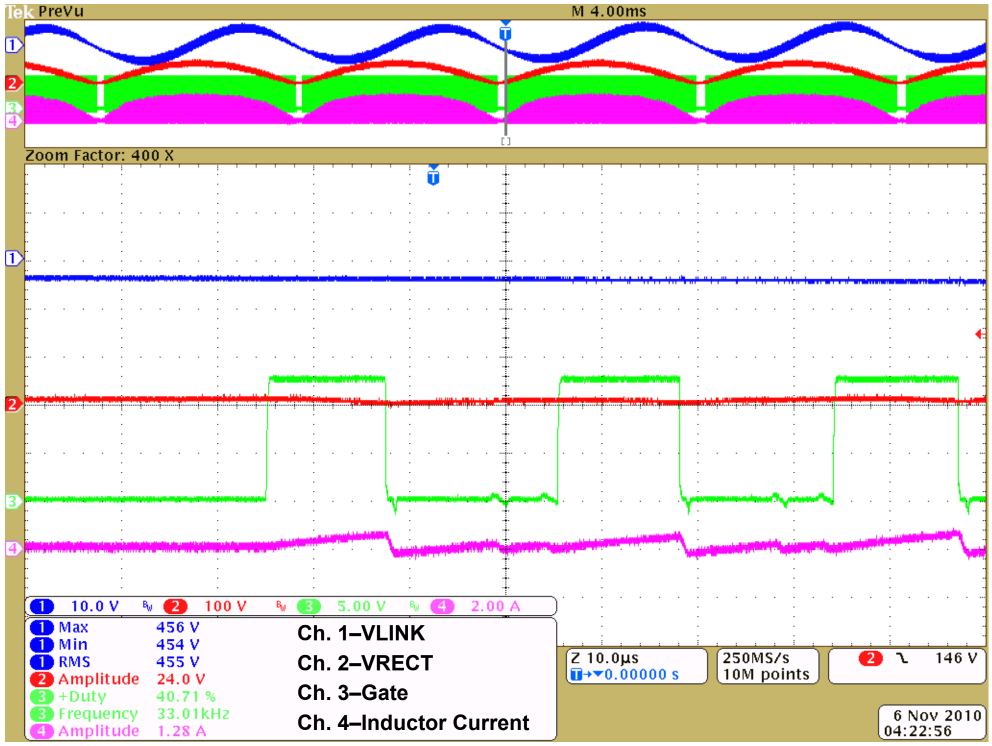


Figure 18. Switching Frequency Profile at Trough of AC Line Voltage —120 VAC

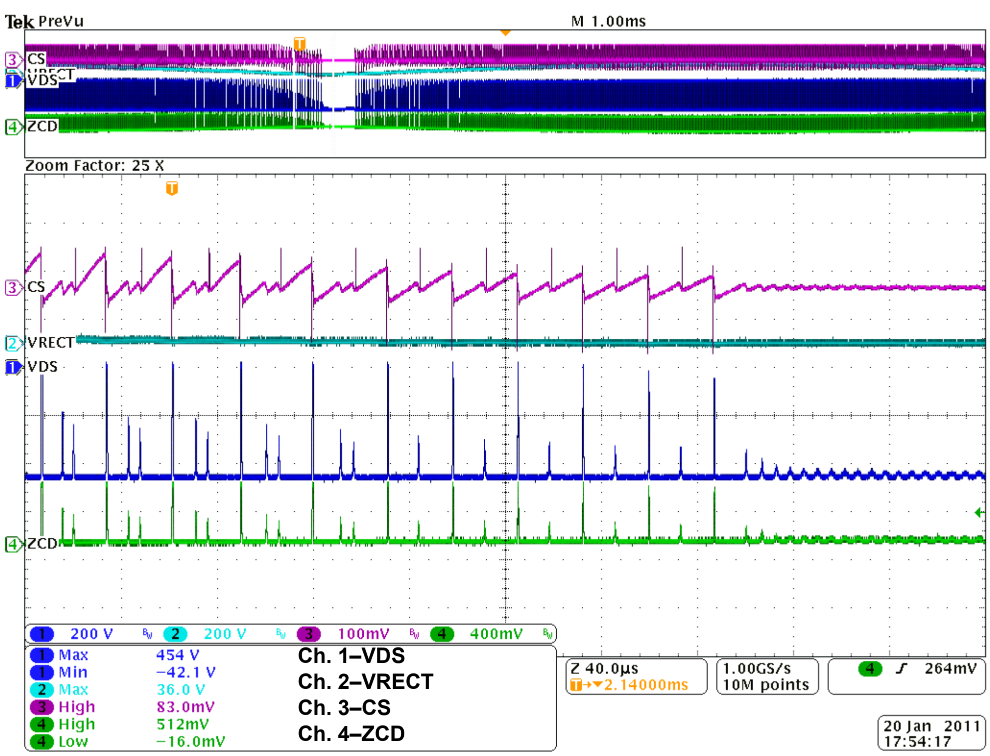


Figure 19. Switching Frequency Profile at Trough of AC Line Voltage — 120 VAC (cont.)

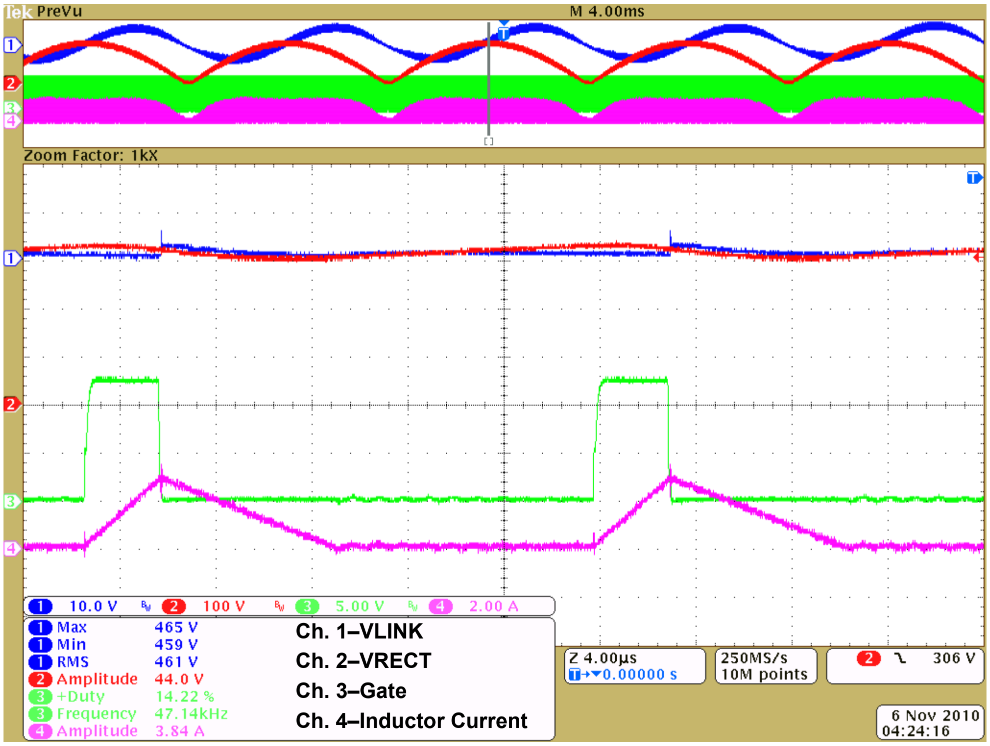


Figure 20. Switching Frequency Profile at Peak of AC Line Voltage — 230 VAC

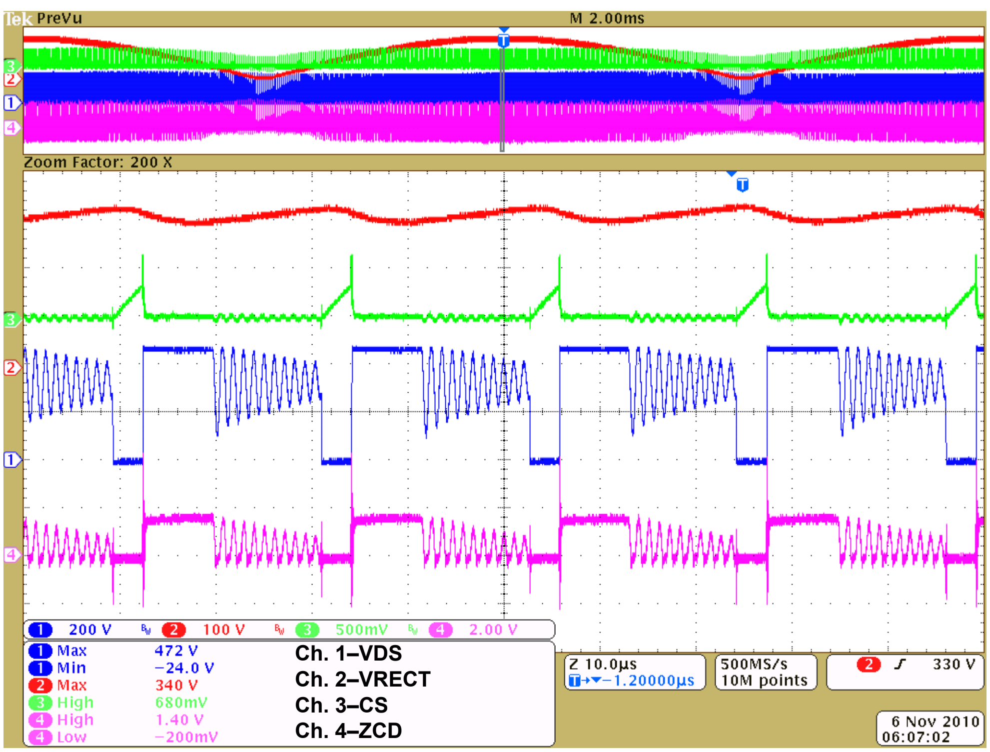


Figure 21. Switching Frequency Profile at Peak of AC Line Voltage — 230 VAC (cont.)

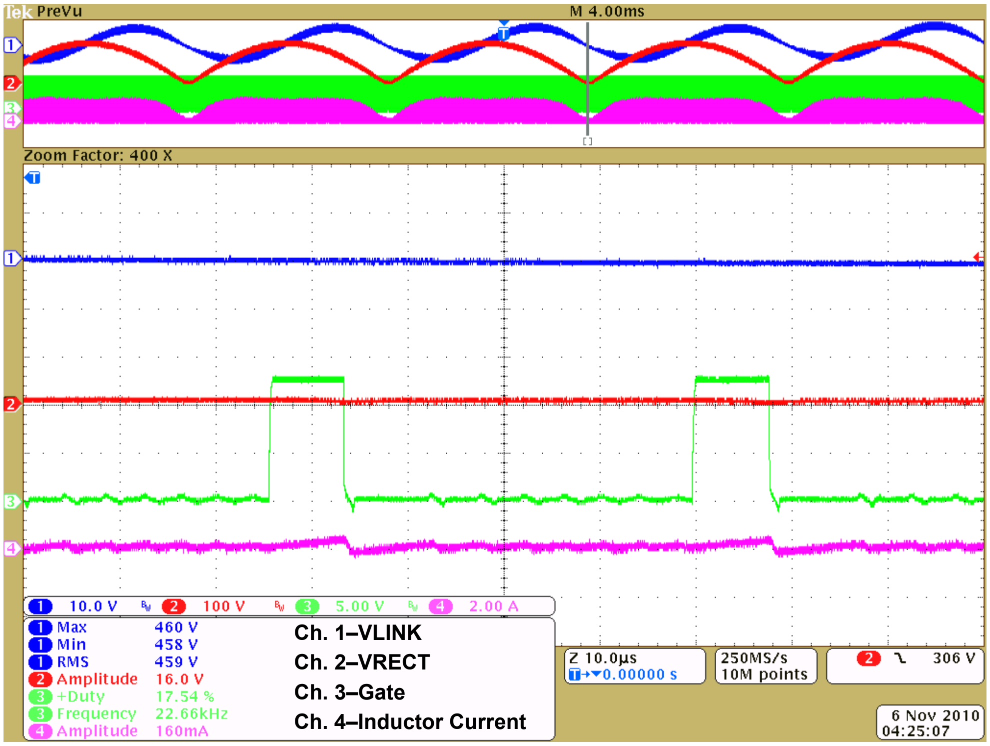


Figure 22. Switching Frequency Profile at Trough of AC Line Voltage — 230 VAC

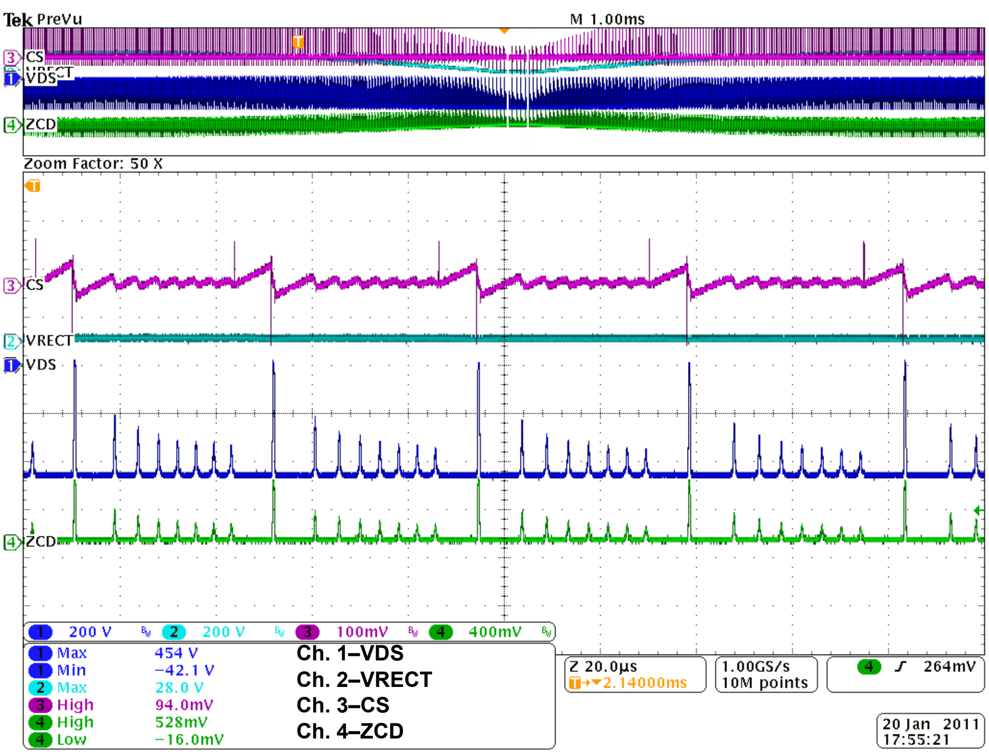


Figure 23. Switching Frequency Profile at Trough of AC Line Voltage — 230 VAC (cont.)

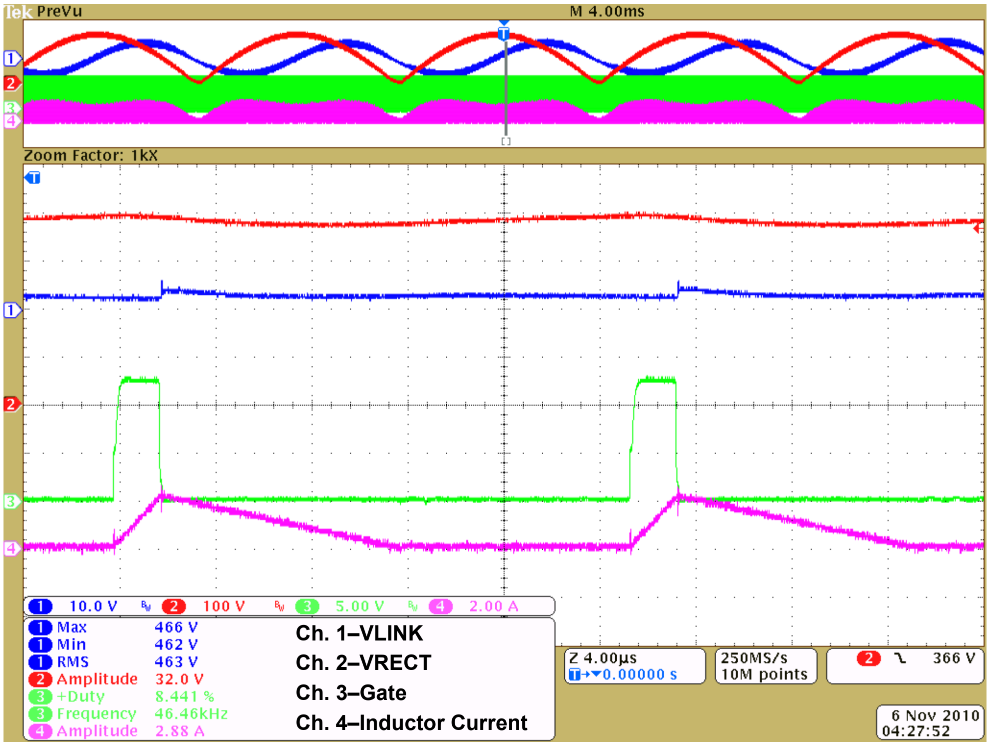


Figure 24. Switching Frequency Profile at Peak of AC Line Voltage — 277 VAC

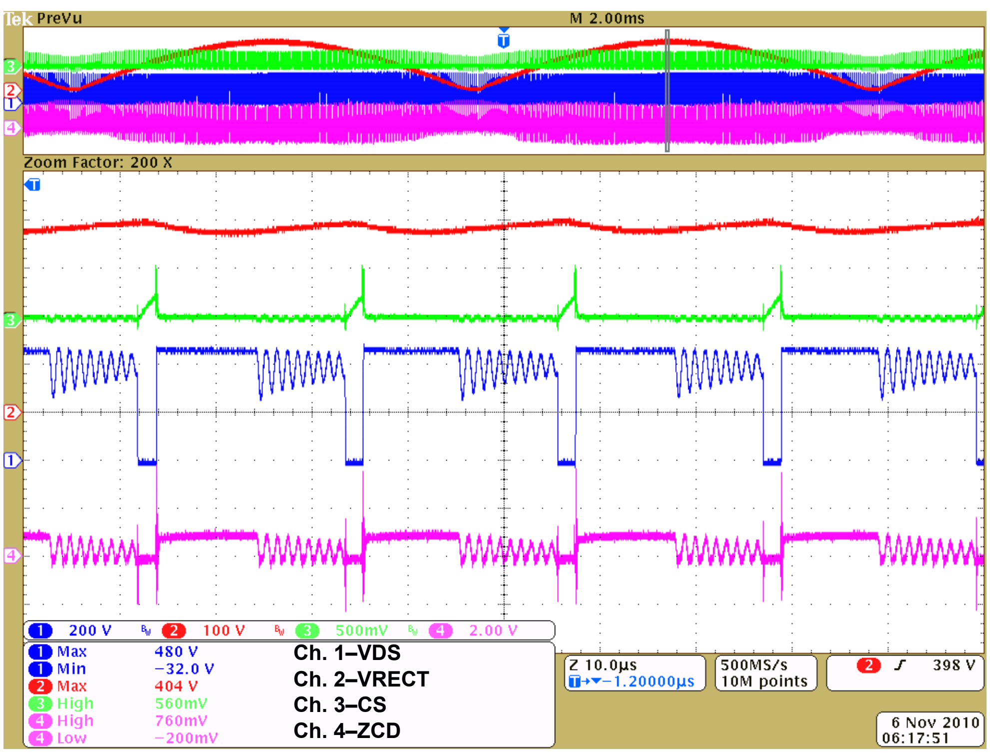


Figure 25. Switching Frequency Profile at Peak of AC Line Voltage — 277 VAC (cont.)

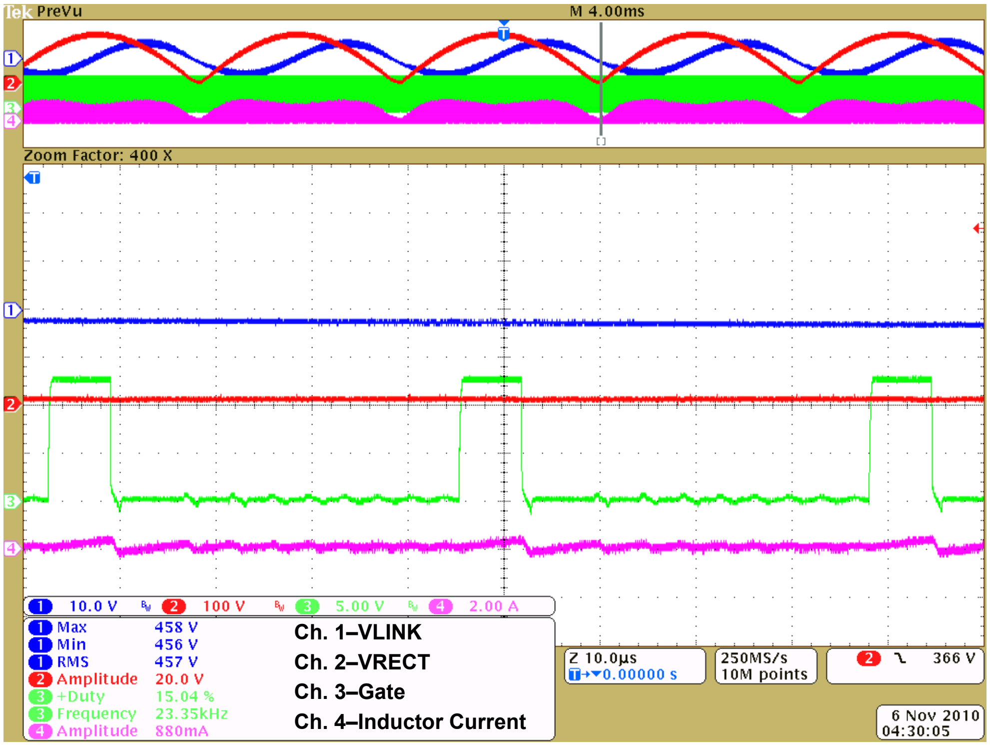


Figure 26. Switching Frequency Profile at Trough of AC Line Voltage — 277 VAC

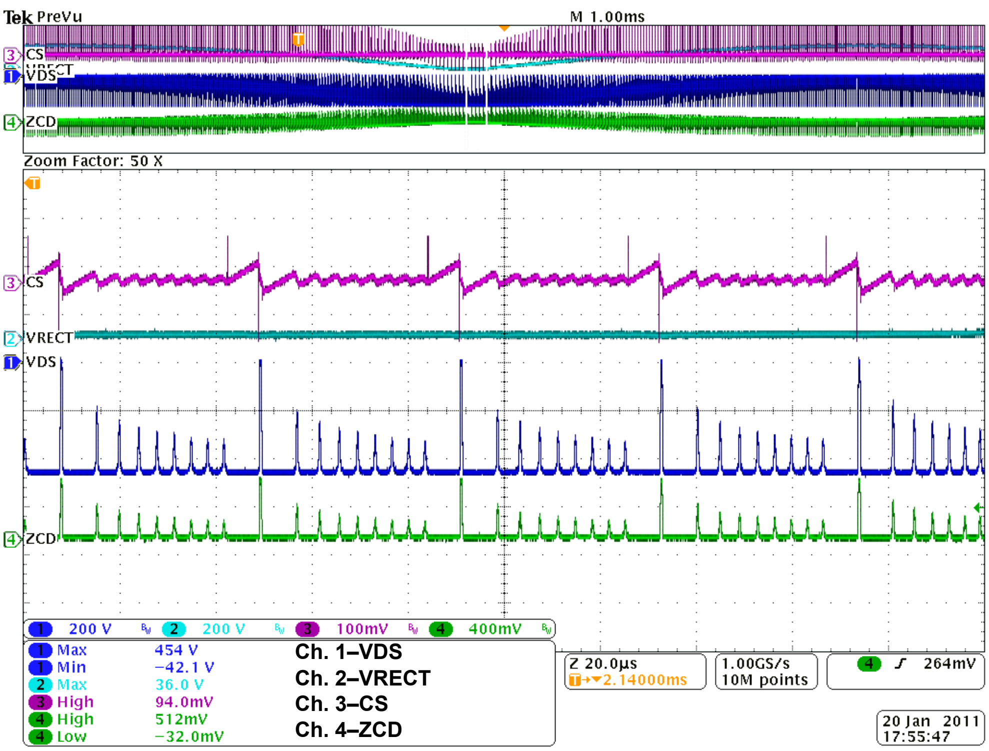


Figure 27. Switching Frequency Profile at Trough of AC Line Voltage — 277 VAC (cont.)

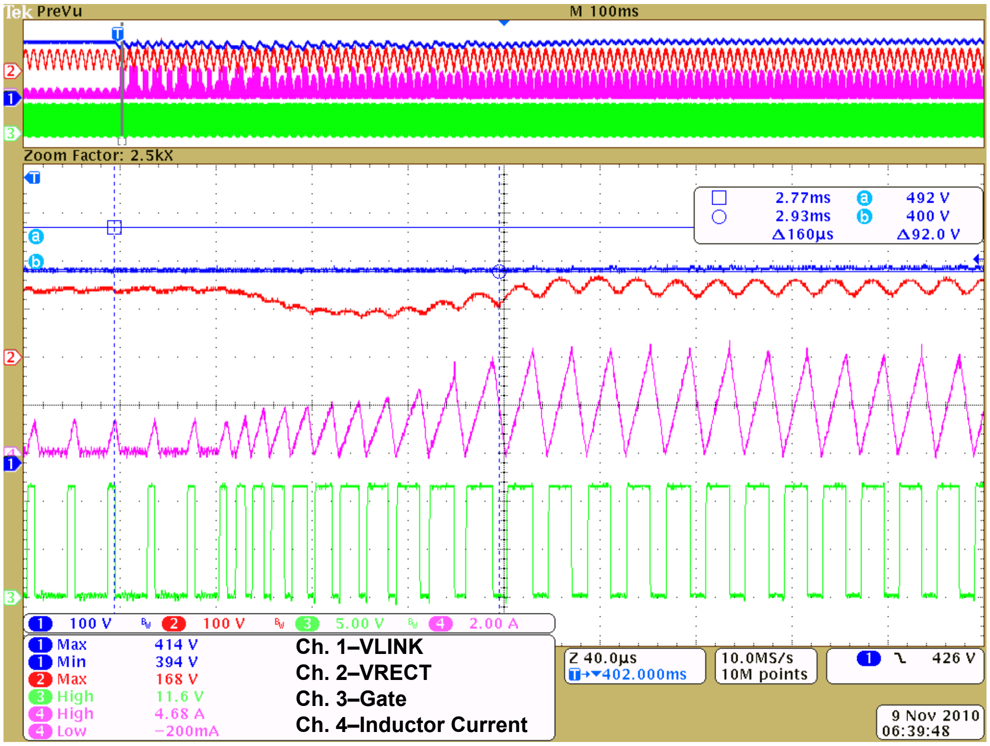


Figure 28. Transient — 15W to 115W Load at 10W/µs, Vin = 120VAC

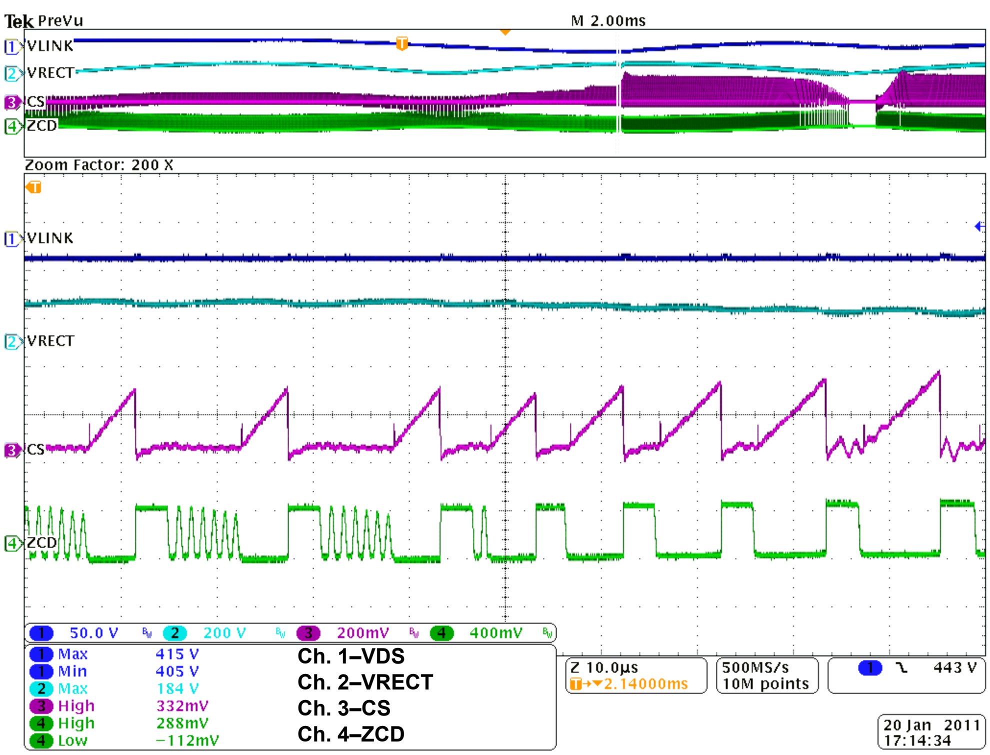


Figure 29. Transient — 15W to 115W Load at 10W/µs, Vin = 120VAC (cont.)

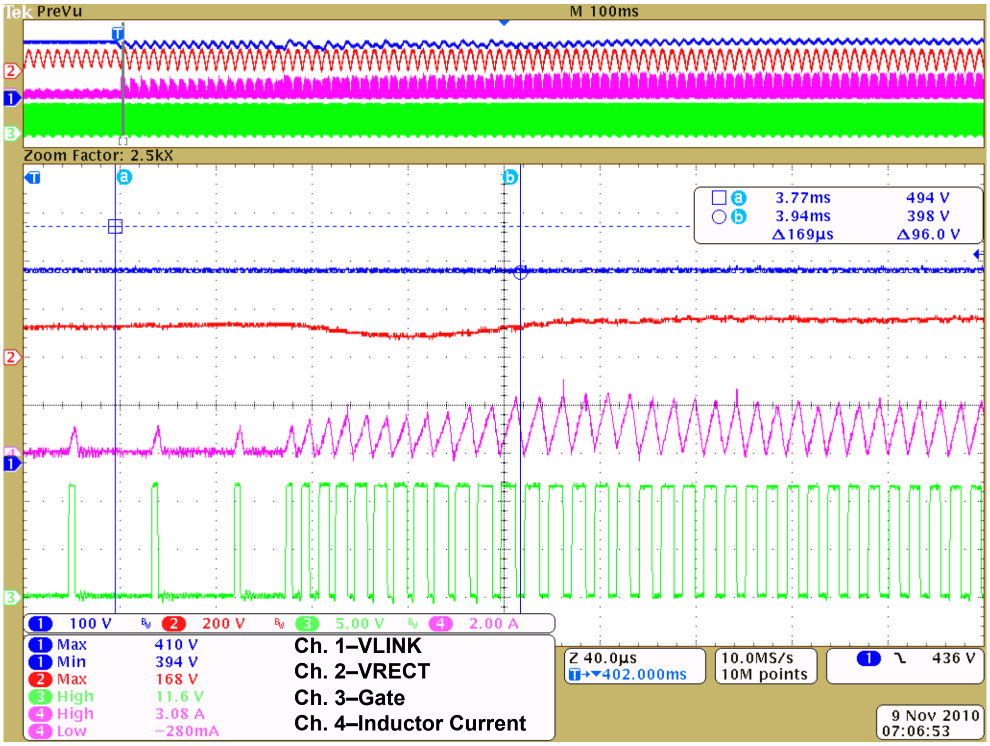


Figure 30. Transient — 15W to 115W Load at 10W/µs, Vin = 230VAC

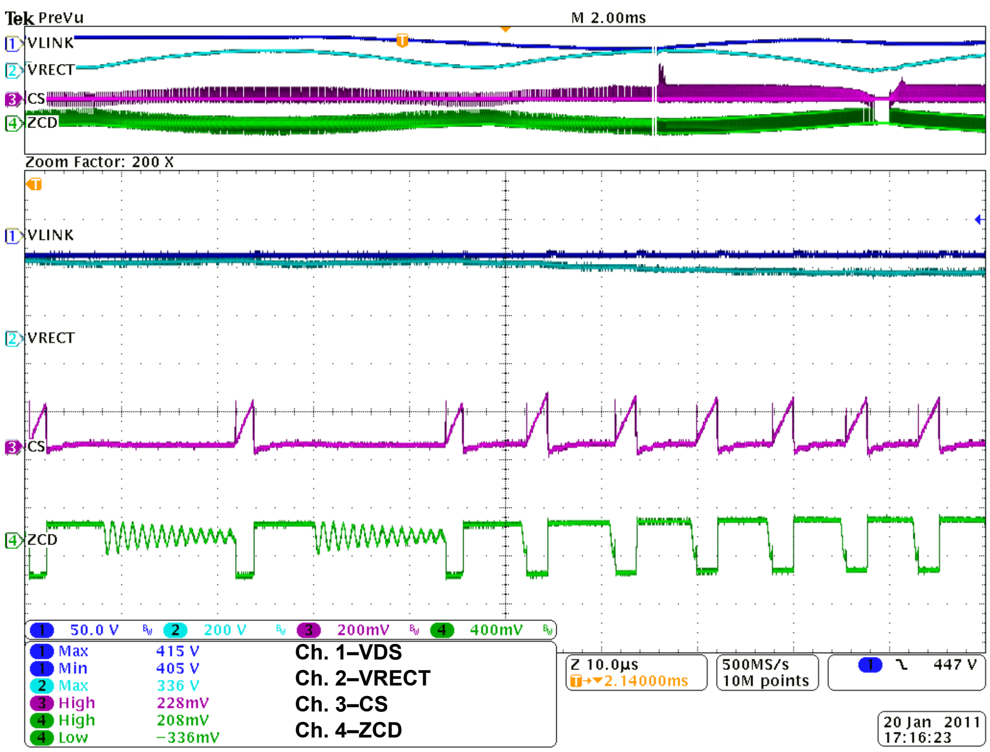


Figure 31. Transient — 15W to 115W Load at 10W/µs, Vin = 230VAC (cont.)

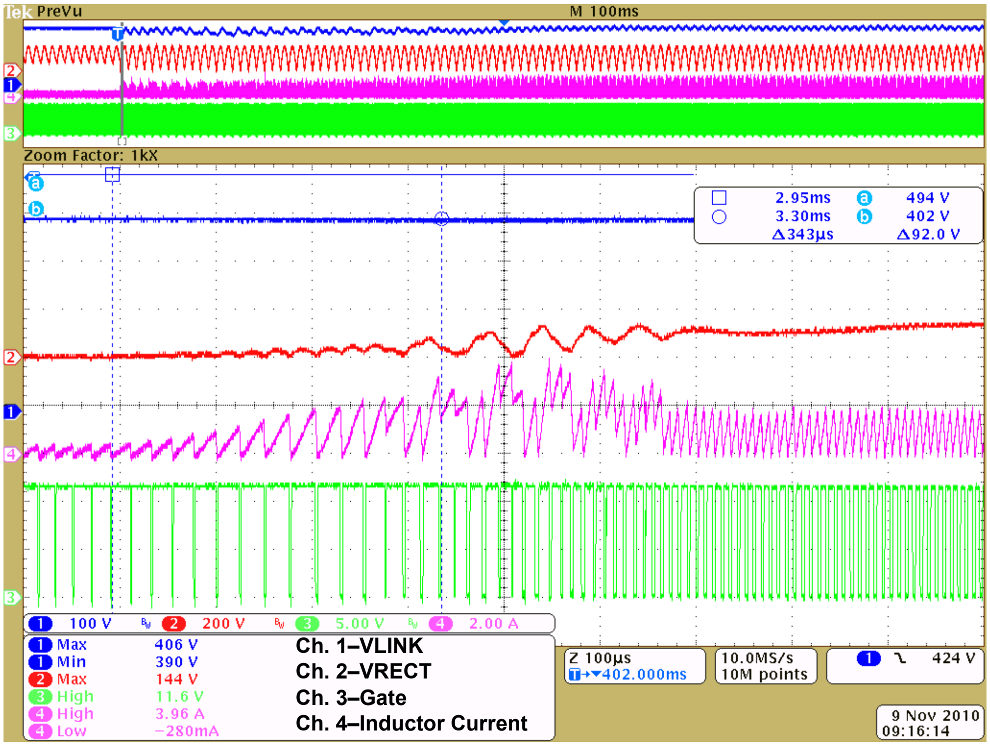


Figure 32. Transient — 15W to 115W Load at 10W/µs, Vin = 277VAC

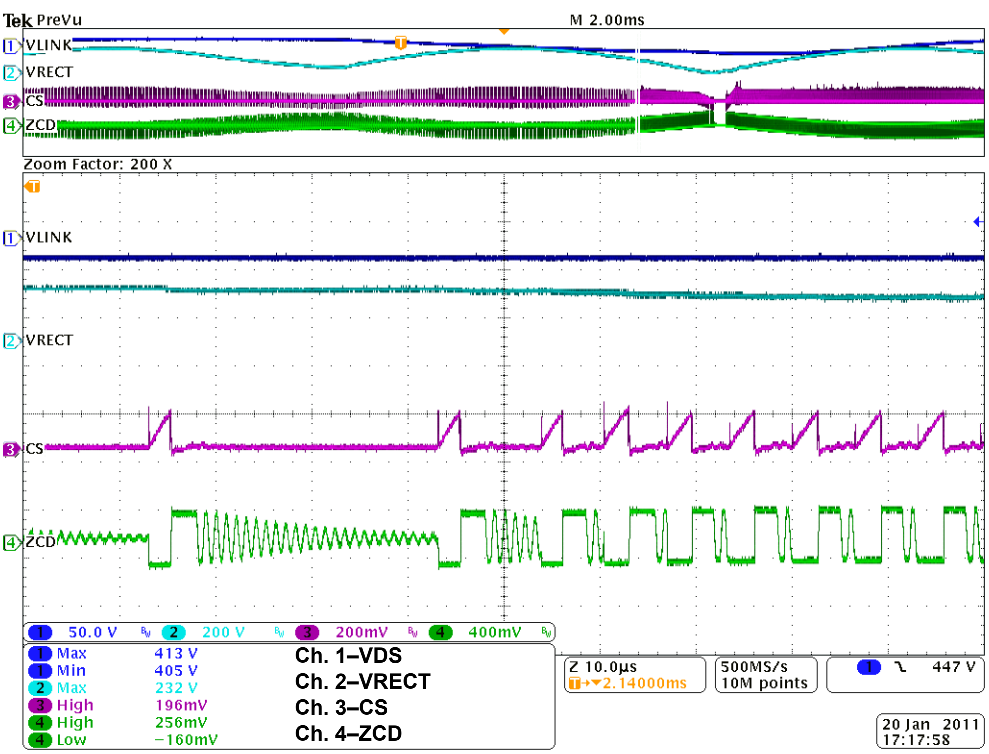


Figure 33. Transient — 15W to 115W Load at 10W/µs, Vin = 277VAC (cont.)

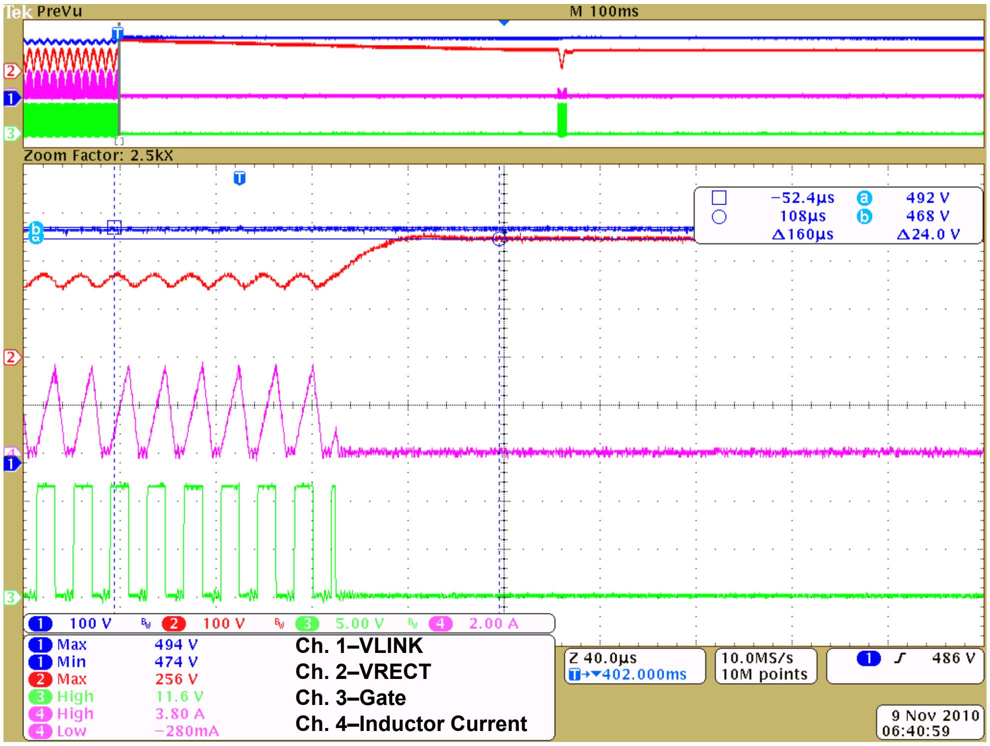


Figure 34. Transient — 115W to Zero Load at 10W/µs, Vin = 120VAC

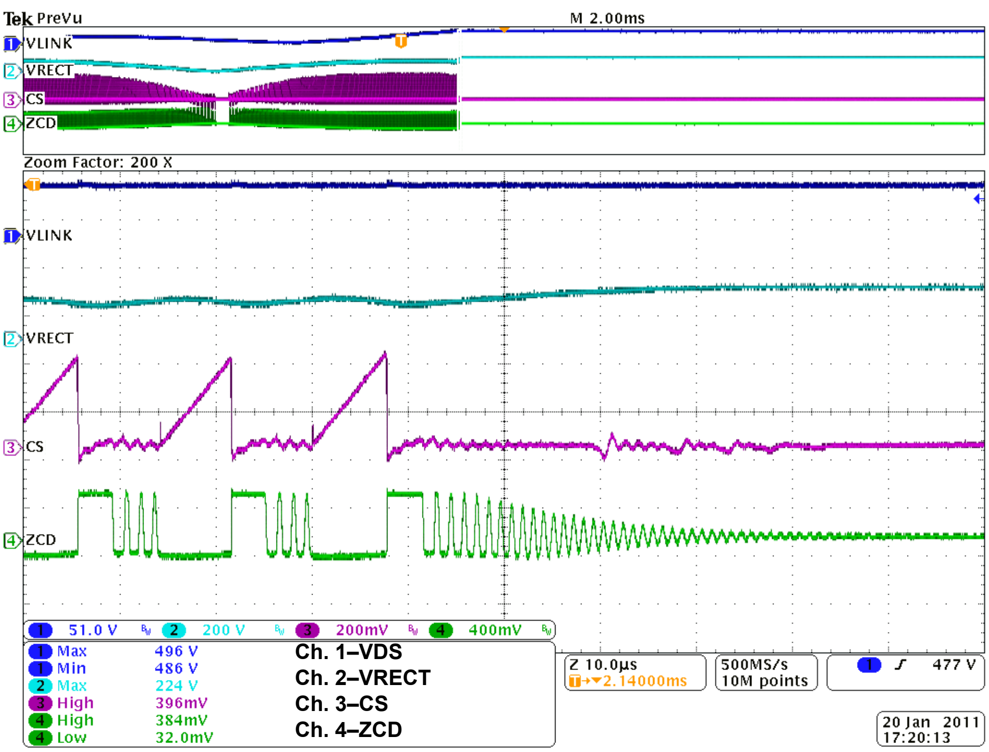


Figure 35. Transient — 115W to Zero Load at 10W/µs, Vin = 120VAC (cont.)

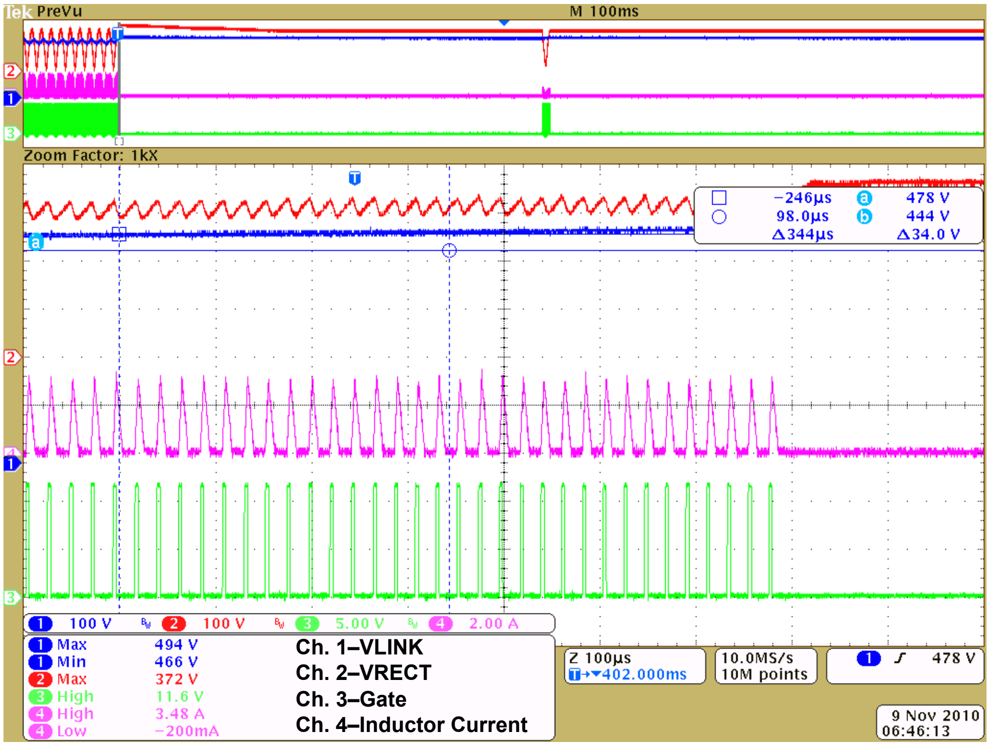


Figure 36. Transient — 115W to Zero Load at 10W/µs, Vin = 230VAC

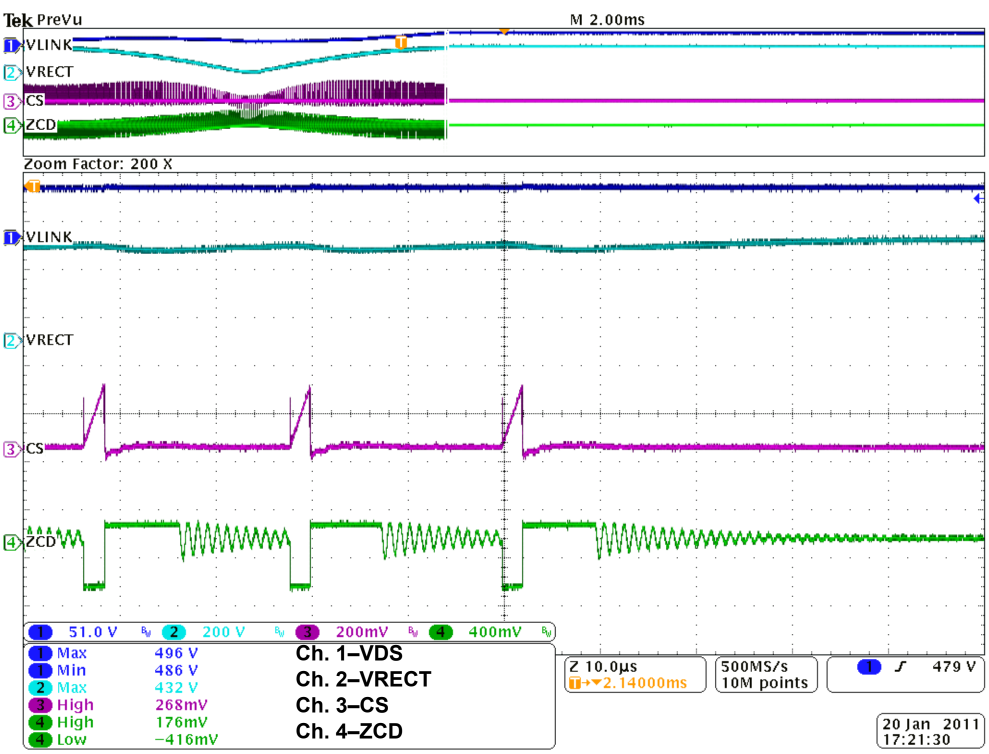


Figure 37. Transient — 115W to Zero Load at 10W/µs, Vin = 230VAC (cont.)

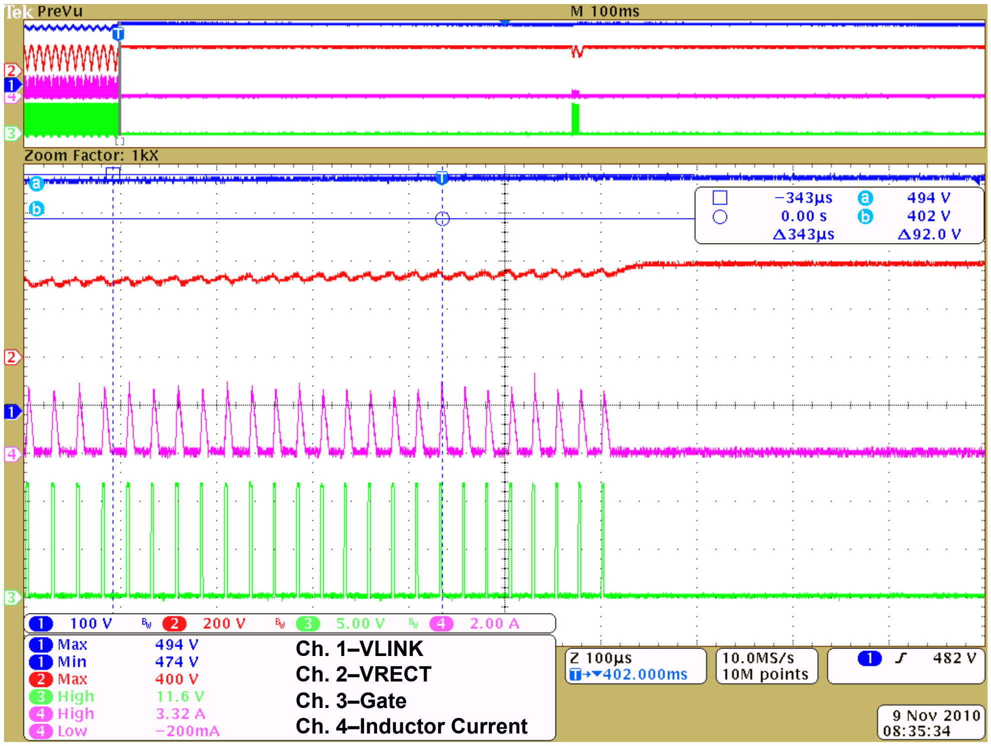


Figure 38. Transient — 115W to Zero Load at 10W/µs, Vin = 277VAC

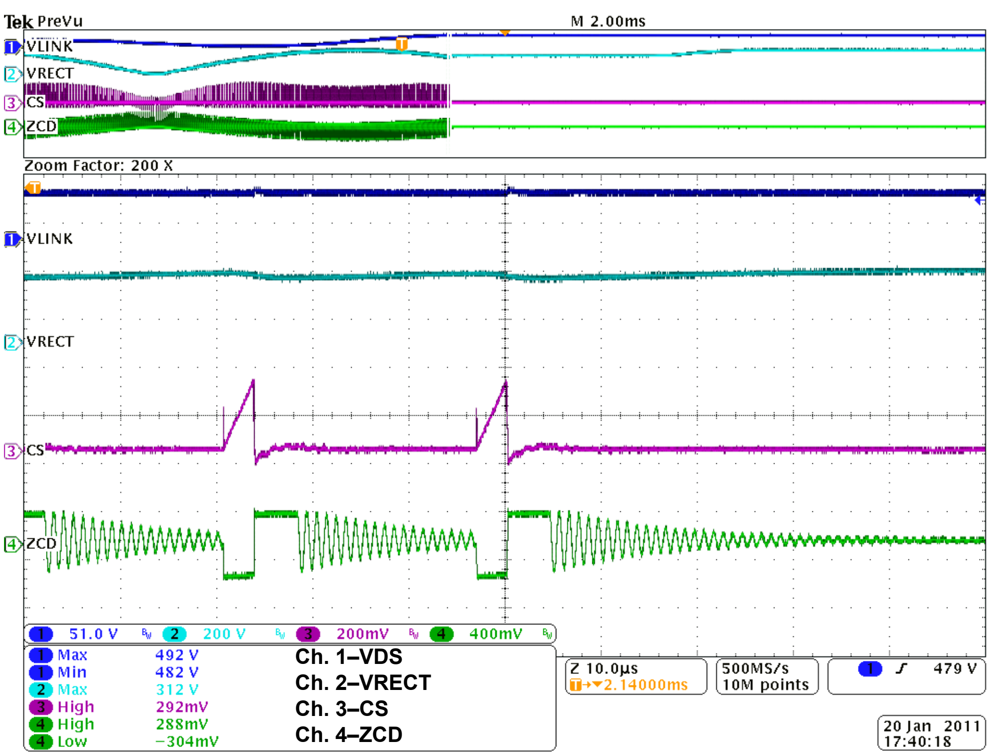


Figure 39. Transient — 115W to Zero Load at 10W/µs, Vin = 277VAC (cont.)

6. REVISION HISTORY

Revision	Date	Changes
DB1	FEB 2011	Initial Release.
DB2	FEB 2011	Minor BOM change.
DB3	MAR 2011	Updated BOM & Layers to rev C.
DB4	OCT 2011	Revised part number to reflect lead free.