CRD1600-120W

CS1600 120W, High-efficiency PFC + Fluorescent Lamp Driver Reference Design

Features

- Line Voltage Range: 108 to 305 VACrms
- Output Voltage (V_{link}): 460V
- Rated Maximum P_{in}: 120W
- Spread Spectrum Switching Frequency
- Integrated Digital Feedback Control
- Low Component Count

General Description

The CRD1600-120W board demonstrates the performance of the CS1600 digital PFC controller in an electronic ballast application. The CRD1600 uses a resonant second stage driver to power up to two T5 fluorescent lamps. The CRD1600 has been designed to fit into a slimline T5 fluorescent electronic ballast form-factor.

ORDERING INFORMATION

CRD1600-120W PFC Customer Reference Design

Actual Size:
349 mm x 25 mm
13.75 in x 1 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 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 CS1600 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 CS1600 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 CS1600 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 CS1600 data sheet.

The CRD1600-120W board demonstrates the performance of the CS1600 over a wide input voltage range. This board has been designed to generate 460V from the PFC stage, which is then processed by the resonant driver, to power up to two T5 lamps connected in series, for a total output of 108W.

Extreme caution needs to be exercised while handling this board. This board should be energized by trained professionals only.

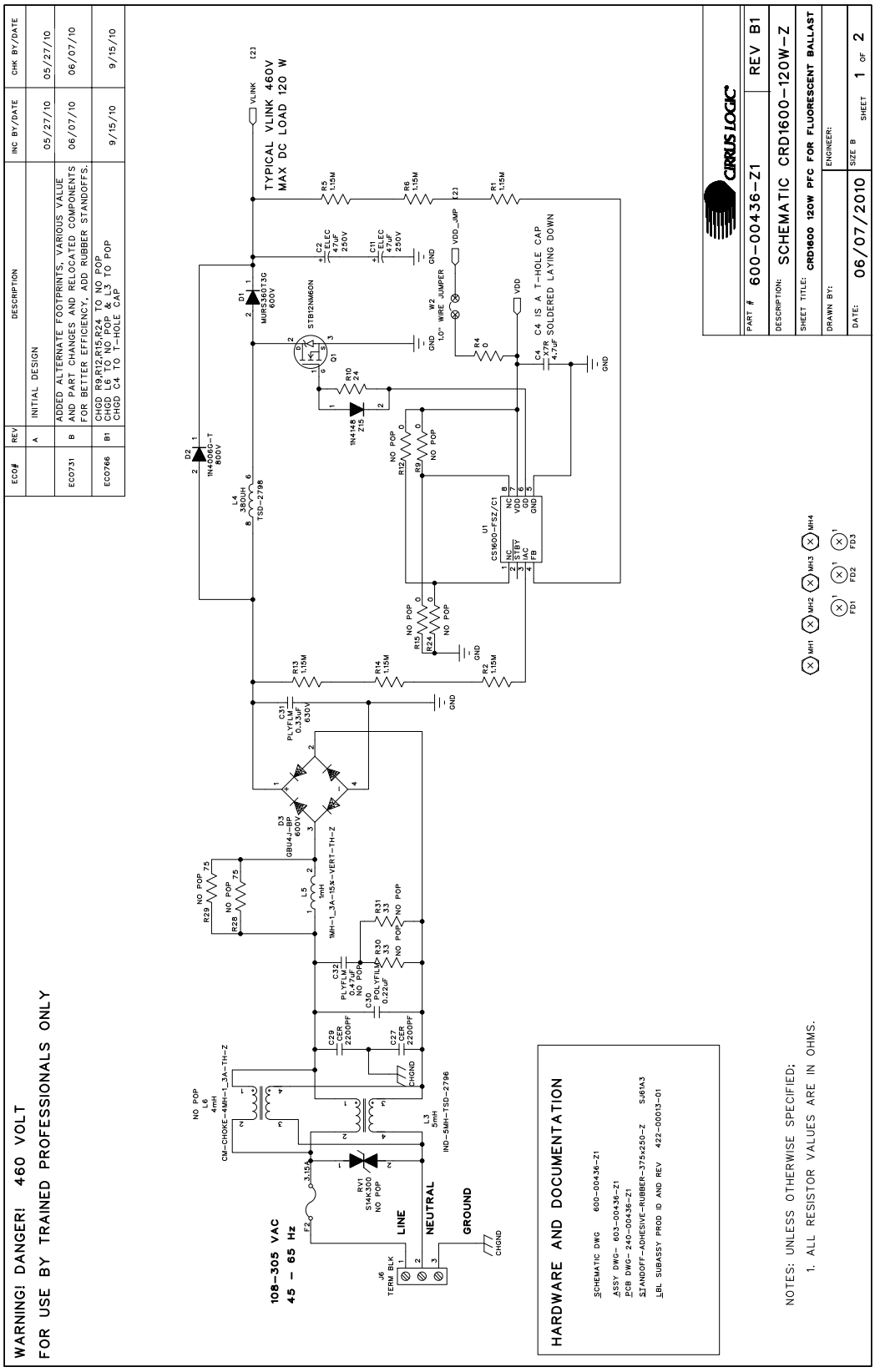
Terminal block J1 is used to connect the AC line. The lamp is connected to terminal J2 as shown in the schematic.

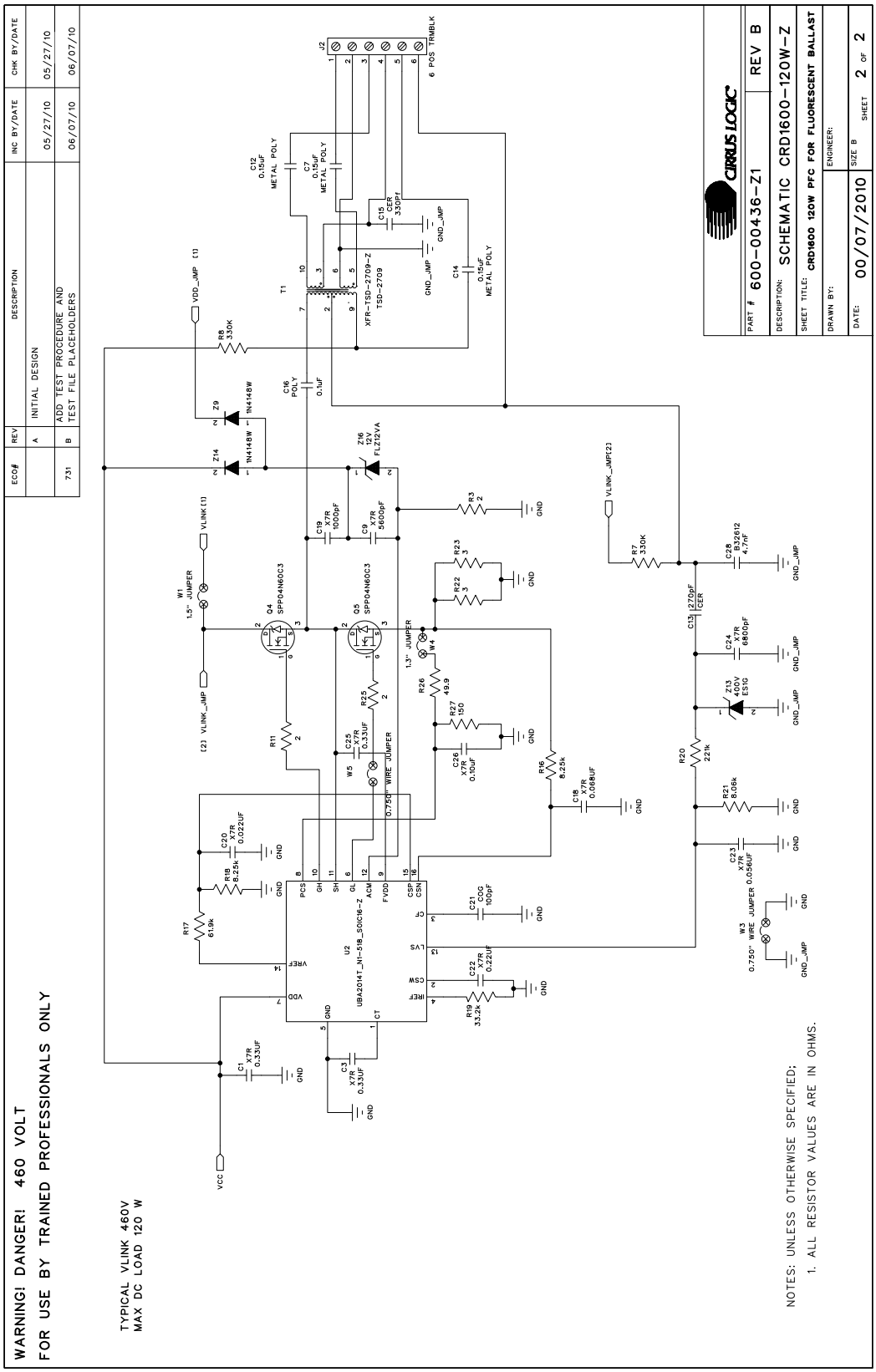
Figure 1. Board Connections

WARNING
High Voltage Hazard
ONLY QUALIFIED PERSONNEL SHOULD HANDLE THE CRD1600-120W.

CAUTION:
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.

2. SCHEMATIC


WARNING! DANGER! 460 VOLT
FOR USE BY TRAINED PROFESSIONALS ONLY
ECO# | REV | DESCRIPTION | INC BY/DATE | CHK BY/DATE
A | INITIAL DESIGN | 05/27/10 | 05/27/10
ECO731 | B | ADDED ALTERNATE FOOTPRINTS, VARIOUS VALUE AND PART CHANGES AND RELOCATED COMPONENTS FOR BETTER EFFICIENCY, ADD RUBBER STANDOFFS. | 06/07/10 | 06/07/10
ECO766 | B1 | CHGD R9,R12,R15,R24 TO NO POP PER ECO#731, CHGD R3 TO POP CHGD C4 TO T-HOLE CAP | 9/15/10 | 9/15/10
TYPICAL VLINK 460V MAX DC LOAD 120 W
108-305 VAC
45 - 65 Hz
LINE
NEUTRAL
GROUND
HARDWARE AND DOCUMENTATION
SCHEMATIC DWG 600-00436-Z1
ASSY DWG- 603-00436-Z1
PCB DWG- 240-00436-Z1
STANDOFF-ADHESIVE-RUBBER-375x250-Z SJ61A3
LBL SUBASSY PROD ID AND REV 422-00013-01
NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTOR VALUES ARE IN OHMS.
CIRRUS LOGIC
PART # 600-00436-Z1 REV B1
DESCRIPTION: SCHEMATIC CRD1600-120W-Z
SHEET TITLE: CRD1600 120W PFC FOR FLUORESCENT BALLAST
DRAWN BY:
ENGINEER:
DATE: 06/07/2010
SIZE B
SHEET 1 OF 2


WARNING! DANGER! 460 VOLT
FOR USE BY TRAINED PROFESSIONALS ONLY
TYPICAL VLINK 460V
MAX DC LOAD 120 W
NOTES: UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTOR VALUES ARE IN OHMS.
ECO# REV DESCRIPTION INC BY/DATE CHK BY/DATE
A INITIAL DESIGN 05/27/10 05/27/10
731 B ADD TEST PROCEDURE AND TEST FILE PLACEHOLDERS 06/07/10 06/07/10
CIRRUS LOGIC
PART # 600-00436-Z1 REV B
DESCRIPTION: SCHEMATIC CRD1600-120W-Z
SHEET TITLE: CRD1600 120W PFC FOR FLUORESCENT BALLAST
DRAWN BY: ENGINEER:
DATE: 00/07/2010 SIZE B SHEET 2 OF 2
U2 UBA2014T_JN-518_SOIC16-Z
T1 XFR-TSD-2709-Z TSD-2709
J2 6 POS TERMBLK
Q4 SPP04N60C3
Q5 SPP04N60C3
Z9 1N4148W
Z14 1N4148W
Z16 12V FLZ12VA
Z13 400V ES1G
W1 1.5" JUMPER
W2 1.3" JUMPER
W3 0.750" WIRE JUMPER
W5 0.750" WIRE JUMPER
VDD_JMP (1)
VLINK (1)
(2) VLINK_JMP
VLINK_JMP(2)
GND_JMP
VCC
GND

3. BILL OF MATERIALS

CIRRUS LOGIC
CRD1600-120W-Z_REV_B1

BILL OF MATERIAL (Page 1 of 2)

Item	Cirrus P/N	Rev	Description	Qty	Reference Designator	MFG	MFG P/N	Notes	Status
1	001-10235-Z1	A	CAP 0.33uF ±10% 50V X7R NPb 1206	3	C1 C3 C25	KEMET	C1206C334K5RAC		A
2	012-00186-Z1	A	CAP 47UF ±20% 250V ELEC NPb RAD	2	C2 C11	NICHICON	UVZ2E470MHD		A
3	011-00056-Z1	A	CAP 4.7uF ±10% 25V X7R RAD NPb	1	C4	TDK	FK20X7R1E475K	SEE ASSEMBLY DRAWING FOR ASSEMBLY, ECO766	A
4	013-00028-Z1	A	CAP 0.15uF ±10% 250V POLY NPb RAD	3	C7 C12 C14	EPCOS	B32559C3154K000		A
5	001-06516-Z1	A	CAP 5600pF ±10% 50V X7R NPb 1206	1	C9	KEMET	C1206C562K5RAC		A
6	011-00047-Z1	A	CAP 270pF ±10% 1kV CER RAD	1	C13	PANASONIC	ECC-A3A271JGE		A
7	011-00046-Z1	A	CAP 330pF ±10% 2kV CER RAD	1	C15	TDK	CK45-R3DD331K-NR		A
8	013-00027-Z1	A	CAP 0.1uF ±10% 630V POLY NPb RAD	1	C16	PANASONIC	ECQE6104KF		A
9	001-06838-Z1	A	CAP 0.068uF ±10% 50V X7R NPb 1206	1	C18	KEMET	C1206C683K5RAC		A
10	011-00045-Z1	A	CAP 1000PF ±10% 500V X7R NPb RAD	1	C19	VISHAY/SPRAGUE	562R5TSD10		A
11	001-06709-Z1	A	CAP 0.022uF ±5% 50V X7R NPb 1206	1	C20	KEMET	C1206C223J5RAC		A
12	001-05542-Z1	A	CAP 100pF ±5% 50V C0G NPb 1206	1	C21	KEMET	C1206C101J5GAC		A
13	001-06948-Z1	A	CAP 0.22uF ±10% 50V X7R NPb 1206	1	C22	KEMET	C1206C224K5RAC		A
14	001-06821-Z1	A	CAP 0.056uF ±10% 50V X7R NPb 1206	1	C23	KEMET	C1206C563K5RAC		A
15	001-06548-Z1	A	CAP 6800pF ±10% 50V X7R NPb 1206	1	C24	KEMET	C1206C682K5RAC		A
16	001-10225-Z1	A	CAP 0.10uF 10% 25V X7RLESR NPb 0603	1	C26	MURATA	GRM188R71E104KA01D		A
17	011-00049-Z1	A	CAP 2200pF ±20% DISC 500V RAD NPb	2	C27 C29	VISHAY	VY1222M47Y5UQ63V0		A
18	013-00026-Z1	A	CAP 4.7nF ±5% 1600V POLY NPb RAD	1	C28	EPCOS	B32612A1472J008		A
19	011-00055-Z1	A	CAP 0.22uF ±20% 305V PLY FLM NPb TH	1	C30	EPCOS	B32923C3224M		P
20	013-00034-Z1	A	CAP 0.33uF ±10% 630V POLY NPb RAD	1	C31	PANASONIC	ECQE6334KF		A
21	013-00031-Z1	A	CAP 0.47uF ±10% 400V POLY NPb RAD	0	C32	WIMA	MKP10-.47/400/10P27	NO POP	A
22	070-00166-Z1	A	DIODE RECT 600V 4A ULT FST NPb SMC	1	D1	ON SEMICONDUCTOR	MURS360T3G		A
23	070-00132-Z1	A	DIODE RECT 800V 1A 200mA NPb DO-41	1	D2	DIODES INC	1N4006G-T		A
24	070-00157-Z1	A	DIODE RECT BRIDGE 600V 4A NPb GBU	1	D3	MICRO COMMERCIAL CO	GBU4J-BP		A
25	180-00022-Z1	A	FUSE 3.15A TLAG IEC NPb SHORT TR5	1	F2	LITTLE FUSE	37213150411		A
27	110-00321-Z1	A	CON TERM BLK 6X1 FML RA GRN NPb TH	1	J2	PHOENIX CONTACT	1727052		A
28	110-00301-Z1	A	CON 3POS TERM BLK 5.08mm SPR NPb RA	1	J6	WEIDMULLER	1716030000		A
29	050-00039-Z1	A	XFMR 5mH 1:1 1500Vrms 4PIN NPb TH	1	L3	PREMIER MAGNETICS	TSD-2796	ECO766	C
30	050-00041-Z1	A	XFMR 280uH .03O 500Vrms 8PIN NPb TH	1	L4	PREMIER MAGNETICS	TSD-2798		C
31	040-00127-Z1	A	IND 1mH 1.3A ±15% TOR VERT NPb TH	1	L5	BOURNS	2124-V-RC		A
32	050-00047-Z1	A	XFMR COMMON MODE CHOKE 1.3 A TH NPb	0	L6	RENCO	RL-4400-2-4.00	NO POP, ECO766	A
33	304-00001-Z1	A	SPCR STANDOFF 4-40 THR .875L AL NPb	0	MH1 MH2 MH3 MH4	KEYSTONE	1809	NO POP	A
34	071-00096-Z1	A	TRAN MOSFET nCH 10A 600V NPb D2PAK	1	Q1	ST MICROELECTRONICS	STB12NM60N		A
35	071-00082-Z1	A	TRAN MOSFET nCH 69W NPb TO220-3	2	Q4 Q5	INFINEON	SPP04N60C3		A
36	020-06356-Z1	A	RES 1.15M OHM 1/4W ±1% NPb 1206	6	R1 R2 R5 R6 R13 R14	DALE	CRCW12061M15FKEA		A
37	020-06347-Z1	A	RES 2.00 OHM 1/4W ±1% NPb 1206	3	R3 R11 R25	DALE	CRCW12062R00FKEA		A
38	020-02273-Z1	A	RES 0 OHM 1/4W NPb 1206 FILM	1	R4	DALE	CRCW12060000Z0EA	ECO766	A
39	031-00052-Z1	A	RES 330K OHM 1/4W ±5% CARFL NPb AXL	2	R7 R8	PANASONIC	ERD-S2TJ334V		A
40	031-00048-Z1	A	RES 24 OHM 1/4W ±5% CAR FLM NPb AXL	1	R10	PANASONIC	ERD-S2TJ240V		A
41	020-06343-Z1	A	RES 8.25K OHM 1/4W ±1% NPb 1206	2	R16 R18	DALE	CRCW12068K25FKEA		A
42	020-06345-Z1	A	RES 61.9K OHM 1/4W ±1% NPb 1206	1	R17	DALE	CRCW120661K9FKEA		A
43	020-06346-Z1	A	RES 33.2K OHM 1/4W ±1% NPb 1206	1	R19	DALE	CRCW120633K2FKEA		A
44	020-06342-Z1	A	RES 221K OHM 1/4W ±1% NPb 1206 FILM	1	R20	DALE	CRCW1206221KFKEA		A
45	020-06344-Z1	A	RES 8.06K OHM 1/4W ±1% NPb 1206	1	R21	DALE	CRCW12068K06FKEA		A
46	021-06319-Z1	A	RES 3 OHM 1/2W ±5% NPb 1210 FILM	2	R22 R23	PANASONIC	ERJ14YJ3R0U		A
47	020-02467-Z1	A	RES 49.9 OHM 1/4W ±1% NPb 1206 FILM	1	R26	DALE	CRCW120649R9FKEA		A
48	020-02520-Z1	A	RES 150 OHM 1/4W ±1% NPb 1206 FILM	1	R27	DALE	CRCW1206150RFKEA		A
49	020-02488-Z1	A	RES 75 OHM 1/4W ±1% NPb 1206 FILM	0	R28 R29	DALE	CRCW120675R0FKEA	NO POP	A
50	021-00544-Z1	A	RES 33 OHM 1/4W ±5% NPb 1206 FILM	0	R30 R31	DALE	CRCW120633R0JNEA	NO POP	A
51	036-00015-Z1	A	VARISTOR 470V RMS 14MM NPb RAD	0	RV1	EPCOS	S14K300	NO POP	A
52	050-00042-Z1	A	XFMR 1.3mH 2000Vac 10PIN NPb TH	1	T1	PREMEIR	TSD-2709		A
53	065-00319-Z2	C1	IC CRUS PFC CNTR BALLAST NPb SOIC8	1	U1	CIRRUS LOGIC	CS1600-FSZ/C1		A
54	060-00477-Z1	A	IC CNTL BALLAST 600V NPB SOIC16	1	U2	NXP	UBA2014T/N1,518		A

CIRRUS LOGIC
CRD1600-120W-Z_REV_B1

BILL OF MATERIAL (Page 2 of 2)

Item	Cirrus P/N	Rev	Description	Qty	Reference Designator	MFG	MFG P/N	Notes	Status
55	080-00013-Z1	A	WIRE 24 AWG SOLID PVC INS BLK NPb	5	W1 W2 W3 W4 W5	ALPHA WIRE COMPANY	3050/1 BK005	SEE ASSY DWG FOR LENGTH	A
56	305-00005-Z1	A	FEET PROT ADH BACK .375x.25 BLK NPb	6		3M	SJ61A3	SEE ASSY DWG PAGE 2 FOR PLACEMENT	A
57	070-00007-Z1	A	DIODE FAST SW 75V 350mW NPb SOD123	2	Z9 Z14	DIODES INC	1N4148W-7-F		A
58	070-00144-Z1	A	DIODE RECT 400V 1A SMA NPb DO-214AC	1	Z13	TAIWAN SEMICONDUCTOR	ES1G		A
59	070-00013-Z1	A	DIODE HS SW 100V 200mA 4nS NPb DO35	1	Z15	VISHAY	1N4148		A
60	070-00167-Z1	A	DIODE ZEN 12V 10mA NPb SOD80	1	Z16	FAIRCHILD	FLZ12VA		A
61	603-00436-Z1	B1	ASSY DWG CRD1600-120W	REF		CIRRUS LOGIC	603-00436-Z1	ECO# 731, ECO766	A
62	422-00013-01	B	LBL SUBASSY PRODUCT ID AND REV	1		CIRRUS LOGIC	422-00013-01		A
63	240-00436-Z1	B	PCB CRD1600-120W-Z-NPb	1		CIRRUS LOGIC	240-00436-Z1	ECO# 731	A
64	600-00436-Z1	B1	SCHEM CRD1600-120W	REF		CIRRUS LOGIC	600-00436-Z1	ECO# 731, ECO766	A
38	020-02273-Z1	A	RES 0 OHM 1/4W NPb 1206 FILM	0	R9 R12 R15 R24	DALE	CRCW12060000Z0EA	NO POP, ECO766	A

4. BOARD LAYOUT

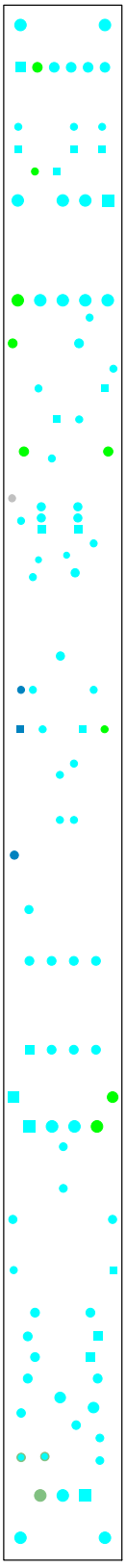


Figure 2. Solder Mask (Top)

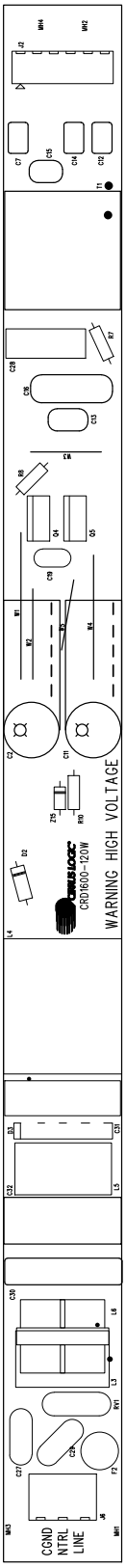


Figure 3. Silkscreen (Top)

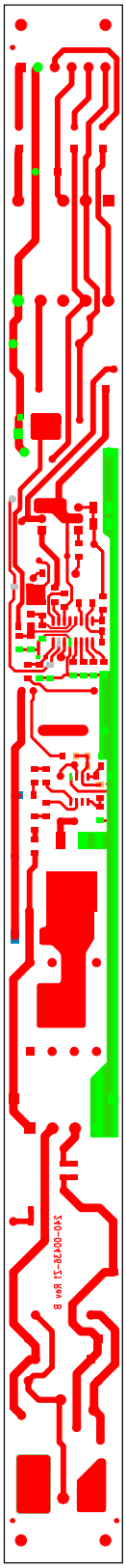


Figure 4. Circuit Routing (Bottom)

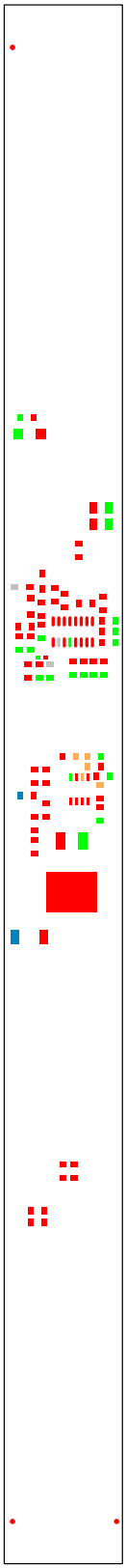


Figure 5. Solder Paste Mask (Bottom)

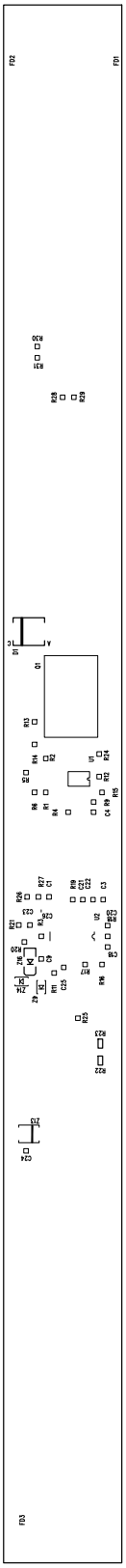


Figure 5. SSilkscreen (Bottom)

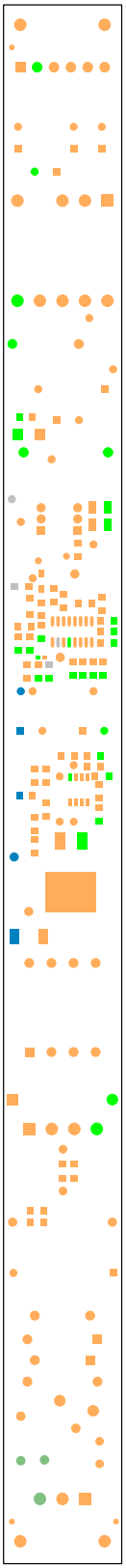


Figure 6. Solder Mask (Bottom)

5. PERFORMANCE PLOTS

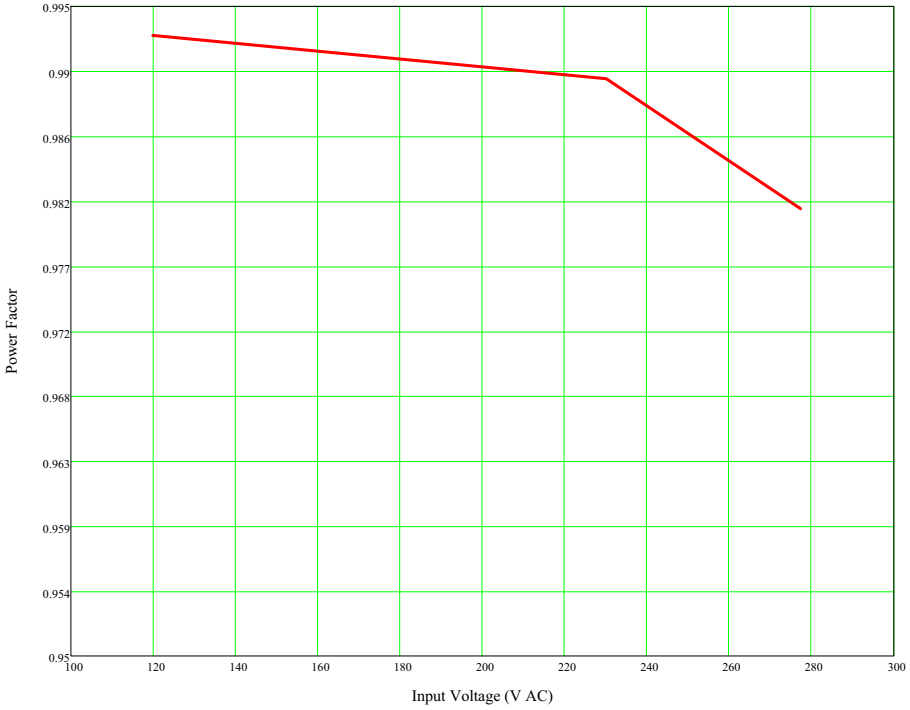


Figure 7. Power Factor vs. AC Input Voltage

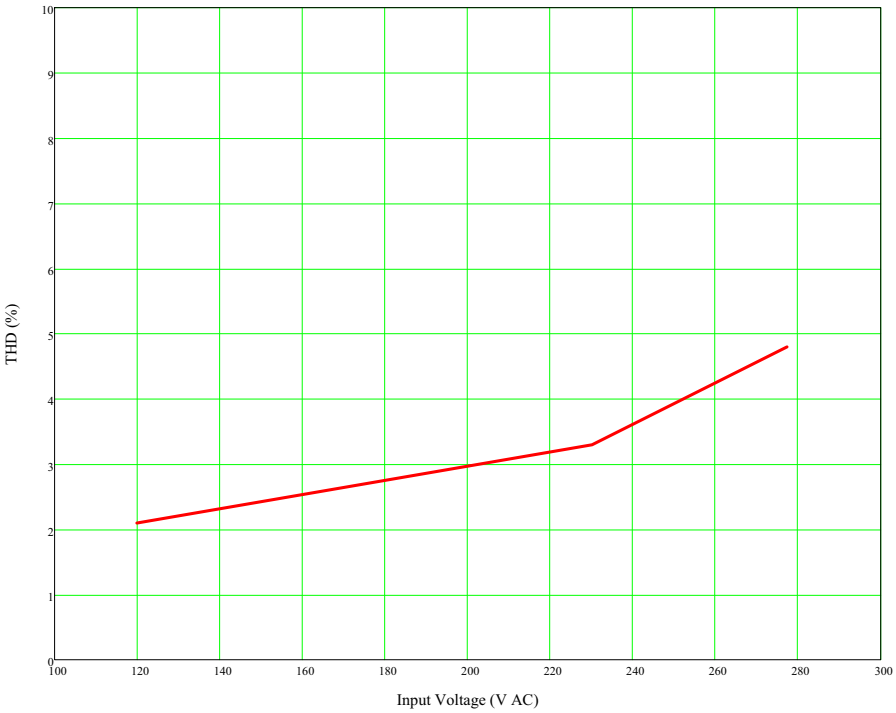


Figure 8. THD vs. AC Input Voltage

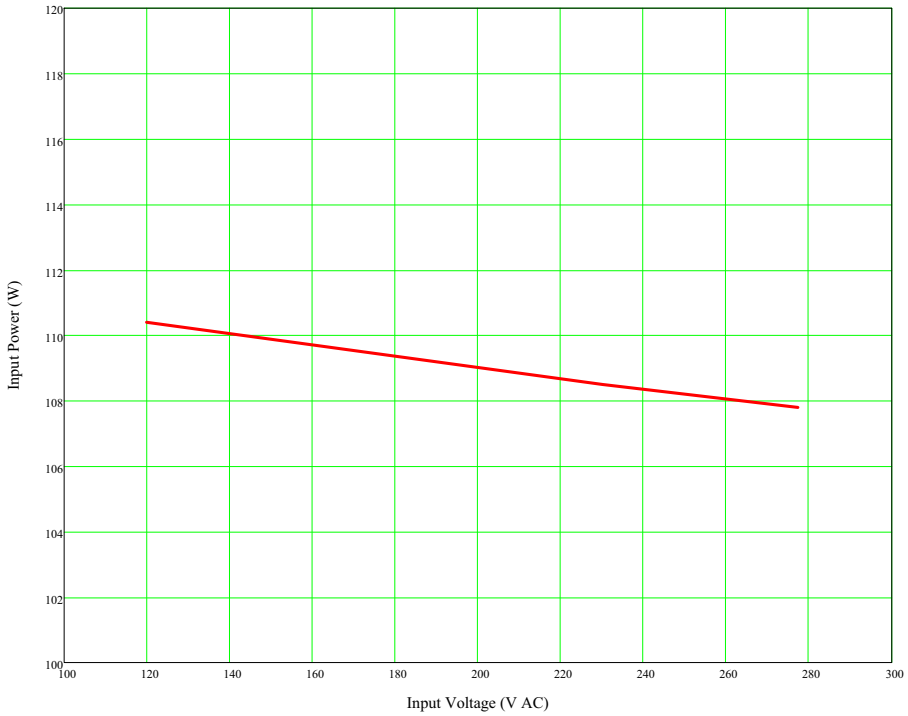


Figure 9. Input Power vs. AC Input Voltage

6. REVISION HISTORY

Revision	Date	Changes
RD4	NOV 2010	Updated schematic, BOM, and layer plots to layout rev B1.