Reference Design

AL9910EV8
Non-Dimmable 120V$_{AC}$
Evaluation Board

Case #1:
(Input=120V$_{AC}$; Output=48V/90mA)

Case #2:
(Input=120V$_{AC}$; Output=96V/45mA)

Applications: ***B10*** *Light Bulbs*

-Customer: Cree-

Date: October 27, 2011

Table of Contents

1. PURPOSE

Introduction

We are using our AL9910 Non-Dimmable board to evaluate two test condition requirements using high-power LEDs from Cree for functional performance.

1) Test condition requirement #1: VIN=120VAC; OUT=48V/90mA.
2) Test condition requirement #2: VIN=120VAC; OUT=96V/45mA.

Customer: **Cree**

Features

- Non-Dimmable
- Selectable 5W-8W output power
- Active PFC with power factor >0.9
- No electrolytic capacitor
- High temperature operation
- Long operating life
- Typical Applications: Retrofit B10/E27 LED Light Bulbs

Specifications

Parameter	Units	Value
AC Input Voltage	V, AC	90 - 140
DC Output Voltage	V, DC	40 – 98
Output Current	mA	45 - 90
Output Power	W	3 – 6
Power Factor	NA	>0.9
Efficiency	%	87%-90%
Operating Ambient temperature	C	-40 to +85
Operating Junction Temperature	C	-40 to +125
ROHS Compliance	NA	Yes

Test conditions:
Input Voltage: 120VAC, 60Hz
Output Voltage: 40VDC - 98VDC
Operating Ambient Temperature: -40°C to 85°C

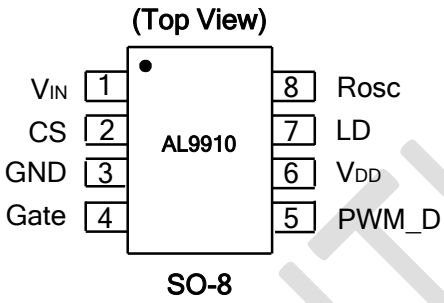
Connection Instructions:
AC+ Input: Red – Hot
AC- Input: Black - Neutral
DC LED+ Output: LED+ (Red)
DC LED- Output: LED- (Black)

Board Dimension (components included)**:**
WxLxH (in mm) = 18mm x 25mm x 13mm

2. EVALUATION BOARD INFORMATION

2.1 AL9910 Pin Assignment and Description

AL9910 Pin Assignment



AL9910 Pin Description

Pin Name	Pin Number	Description
V_{IN}	1	Input voltage
CS	2	Senses LED string current
GND	3	Device ground
Gate	4	Drives the gate of the external MOSFET
PWM_D	5	Low Frequency PWM Dimming pin, also Enable input. Internal 100kΩ pull-down to GND
V_{DD}	6	Internally regulated supply voltage. 7.5V nominal for AL9910. Can supply up to 1 mA for external circuitry. A sufficient storage capacitor is used to provide storage when the rectified AC input is near the zero crossings
LD	7	Linear Dimming by changing the current limit threshold at current sense comparator
R_{OSC}	8	Oscillator control. A resistor connected between this pin and ground sets the PWM frequency.

2.2 Evaluation Board Schematic

2.1.1 **Case #1** => Test conditions: VIN=120VAC; OUT=48V/90mA

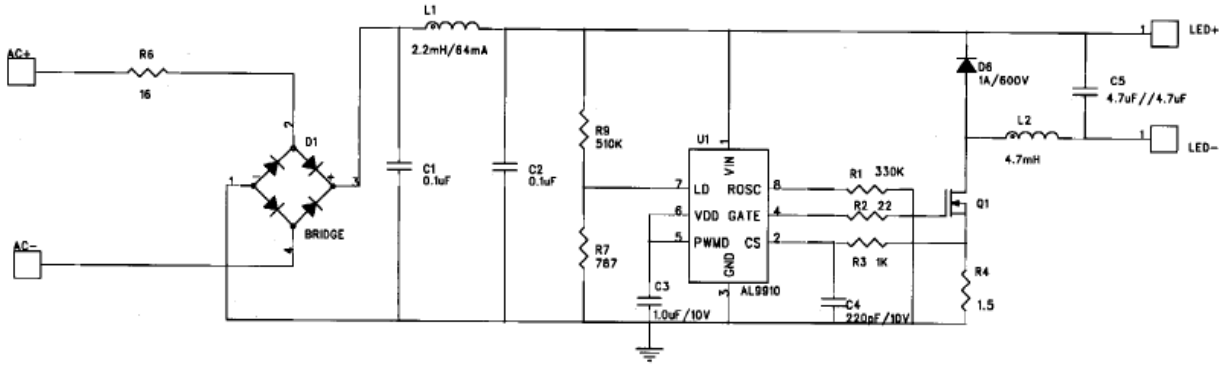


Figure 1: Evaluation Board Schematic (Case#1)

2.1.2 **Case #2** => Test conditions: VIN=120VAC; OUT=96V/45mA

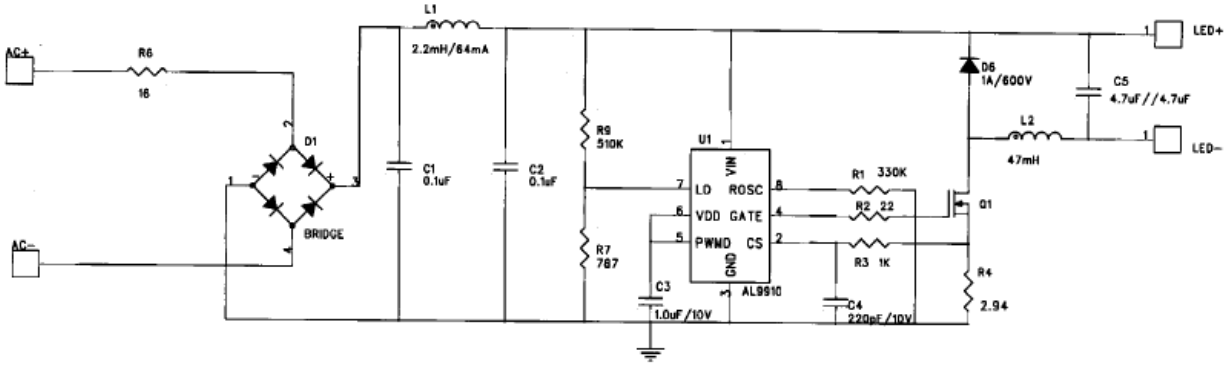


Figure 2: Evaluation Board Schematic (Case#2)

2.3 Evaluation Board BOM List

Case #1 = > Test conditions: VIN=120VAC; OUT=48V/90mA					
#	Name	Quantity	Part number	Manufacturer	Description
1	U1	1	AL9910S-13	Diodes	Universal High Voltage LED Driver
2	D1,2,3, 4	1	HD02-T	Diodes	RECT BRIDGE GP 200V 0.8A MINIDIP
3	D6	1	MUR160-T	Diodes	DIODE ULTRA FAST 1A 600V DO-41
4	Q1	1	STD7NK40ZT4	ST	MOSFET N-CH 400V 5.4A DPAK
5	C4	1	C0402X7R1A221K	Vishay	CAP CER 220PF 10V X7R 01005
6	C3	1	C1608X7R1A105K	TDK	CAP CER 1.0UF 10V X7R 0603
7	R1	1	CRCW0402330KFKTD	Vishay	RES 330K OHM 1/16W 1% 0402 SMD
8	R3	1	CRCW04021K00FKED	Vishay	RES 1.0K OHM 1/16W 1% 0402 SMD
9	R2	1	CRCW040222R0FKED	Vishay	RES 22.0 OHM 1/16W 1% 0402 SMD
10	R4	1	CRCW08051R50FKEA	Vishay	RES 1.5 OHM 1/8W 1% 0805 SMD
11	R6	1	CRCW120616R0FKEA	Vishay	RES 16.0 OHM 1/4W 1% 1206 SMD
12	R9	1	CRCW1206510KJNEA	Vishay	RES 510K OHM 1/4W 5% 1206 SMD
13	R7	1	CRCW0402787RFKED	Vishay	RES 787 OHM 1/16W 1% 0402 SMD
14	C1, C2	2	VJ1812Y104KXETW1BC	Vishay	CAP Multilayer Cer (MLCC) – SMD / SMT 1812 0.1uF 500volts X7R 10%
16	C5	2	UMK325C7106MM-T	Taiyo	CAP CER 4.7uF//4.7uF 100V X7R 1210
16	L1	1	LPS5015-225ML	Coilcraft	Inductor 2.2mH 64mA
17	L2	1	13R475C	Murata	Inductor Radial 4.7mH 0.16A

Case #2 => Test conditions: VIN=120VAC; OUT=96V/45mA					
#	**Name**	**Quantity**	**Part number**	**Manufacturer**	**Description**
1	U1	1	AL9910S-13	Diodes	Universal High Voltage LED Driver
2	D1,2,3, 4	1	HD02-T	Diodes	RECT BRIDGE GP 200V 0.8A MINIDIP
3	D6	1	MUR160-T	Diodes	DIODE ULTRA FAST 1A 600V DO-41
4	Q1	1	STD7NK40ZT4	ST	MOSFET N-CH 400V 5.4A DPAK
5	C4	1	C0402X7R1A221K	Vishay	CAP CER 220PF 10V X7R 01005
6	C3	1	C1608X7R1A105K	TDK	CAP CER 1.0UF 10V X7R 0603
7	R1	1	CRCW0402330KFKTD	Vishay	RES 330K OHM 1/16W 1% 0402 SMD
8	R3	1	CRCW04021K00FKED	Vishay	RES 1.0K OHM 1/16W 1% 0402 SMD
9	R2	1	CRCW040222R0FKED	Vishay	RES 22.0 OHM 1/16W 1% 0402 SMD
10	R4	1	CRCW08052R94FKEA	Vishay	RES 2.94 OHM 1/8W 1% 0805 SMD
11	R6	1	CRCW120616R0FKEA	Vishay	RES 16.0 OHM 1/4W 1% 1206 SMD
12	R9	1	CRCW1206510KJNEA	Vishay	RES 510K OHM 1/4W 5% 1206 SMD
13	R7	1	CRCW0402787RFKED	Vishay	RES 787 OHM 1/16W 1% 0402 SMD
14	C1, C2	2	VJ1812Y104KXETW1BC	Vishay	CAP Multilayer Cer (MLCC) – SMD / SMT 1812 0.1uF 500volts X7R 10%
16	C5	2	C3225X7S2A475K	TDK	CAP CER 4.7uF//4.7uF 100V 1210
16	L1	1	LPS5015-225ML	Coilcraft	Inductor 2.2mH 64mA
17	L2	1	13R476C	Murata	Inductor Radial 47mH 0.045A

2.4 Evaluation Board Layouts

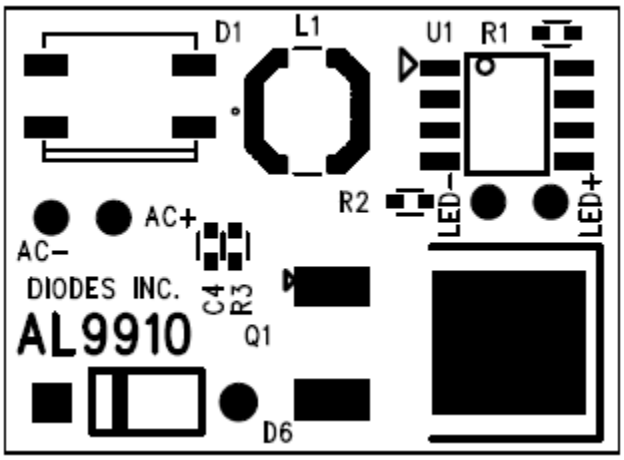


Figure 3: Top-View PCB Layout

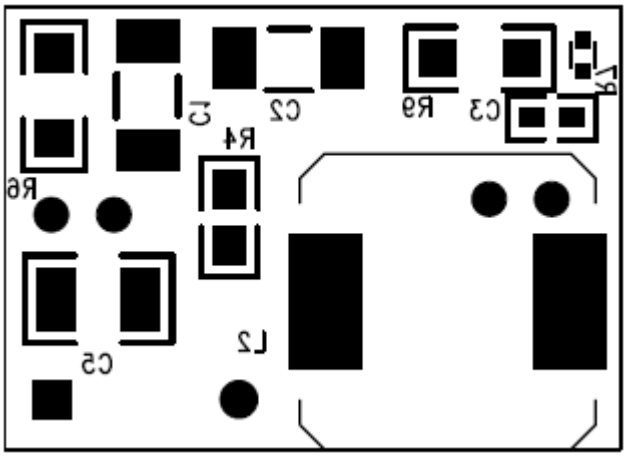


Figure 4: Bottom-View PCB Layout

2.5 Evaluation Board Snapshots

Figure 5: Top-View PCB Board

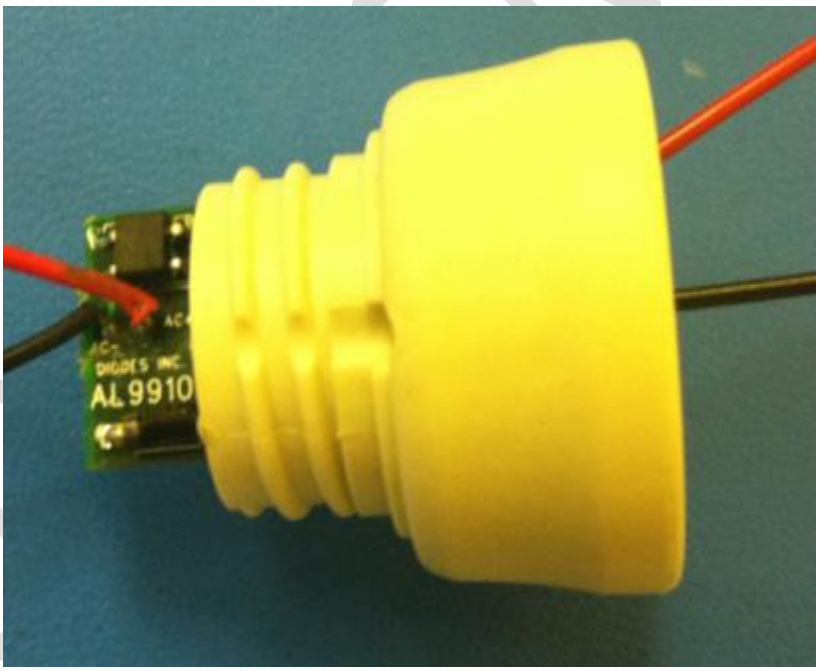
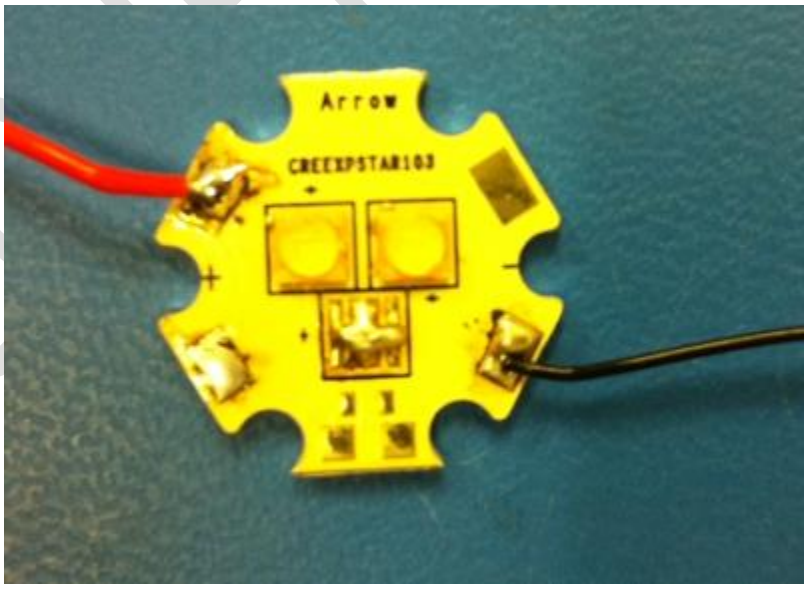


Figure 6: Top-View PCB Board in Bulb Module

3. LED OUTPUT

3.1 LED P/N: Cree XM-L T6
LED Output: ~+48V (ideal)

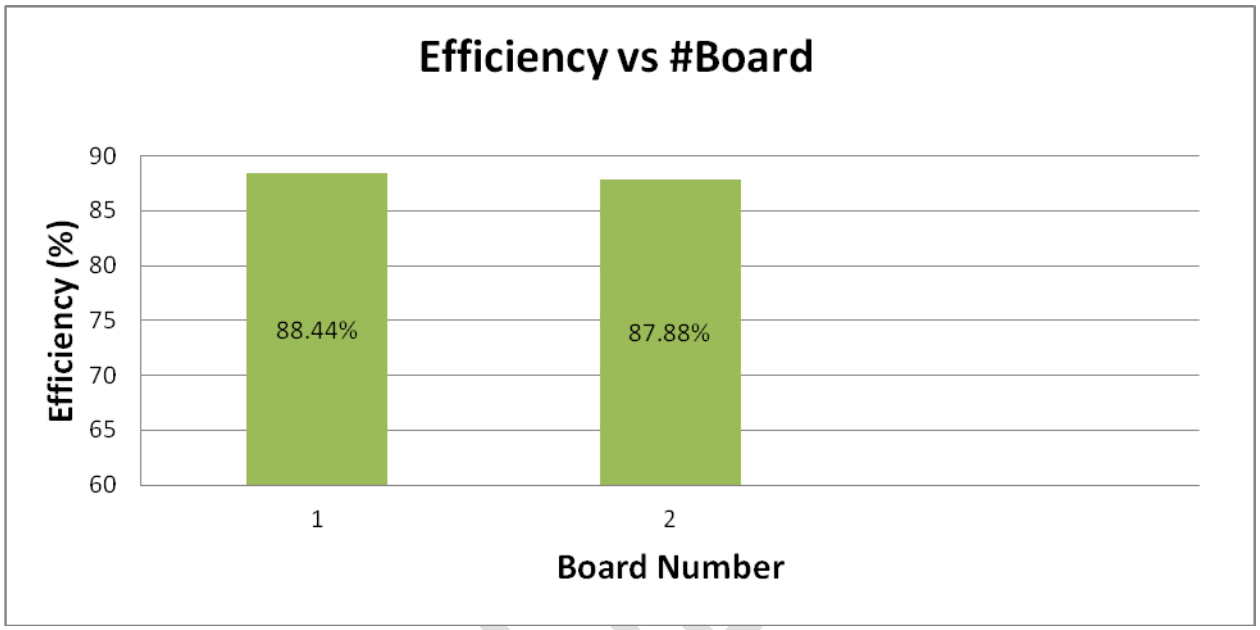
3.2 LED P/N: Cree XPSTAR103
LED Output: ~+96V (ideal)



4. EVALUATION BOARD TESTING SUMMARY

4.1 Testing Results (case #1):

(Case #1 = > Test conditions: VIN=120VAC; OUT=48V/90mA):

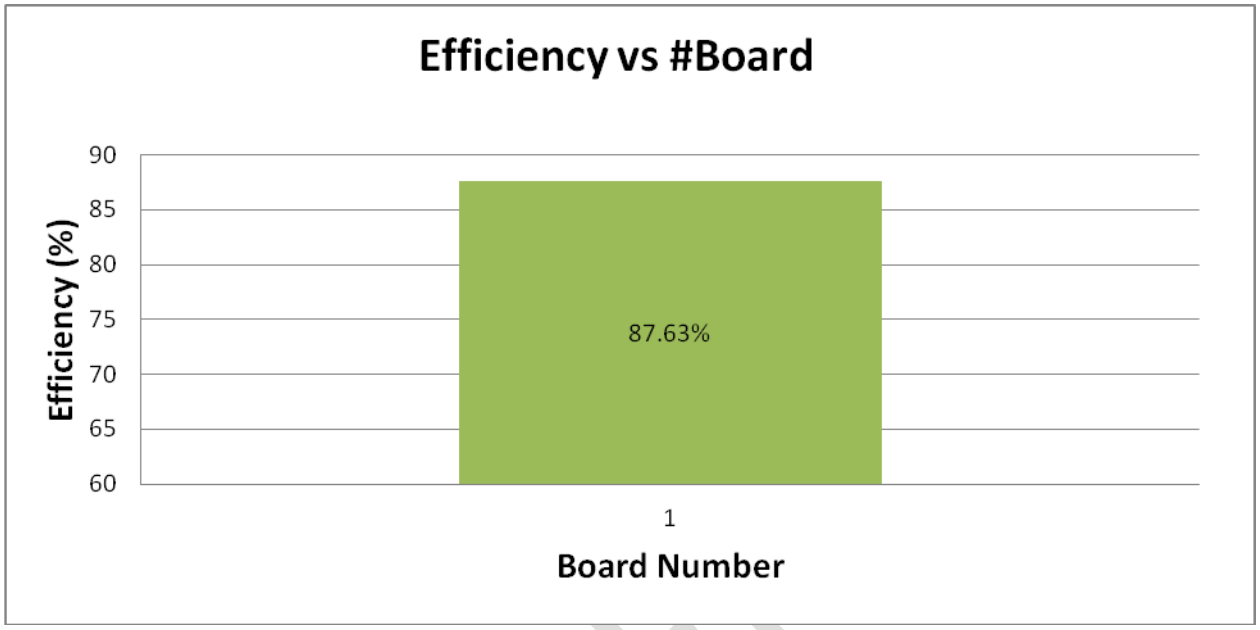


(Case #1 = > Test conditions: VIN=120VAC; OUT=48V/90mA):

Board #	Cree LED	VRMS (V)	IRMS (mA)	PIN (W)	PFC	VLED (V)	ILED (mA)	POUT (W)	Efficiency (%)
1	48V	120.52	34.45	4.032	0.969	41.35	91.14	3.566	88.44
2	48V	120.62	35.32	4.125	0.966	41.4	91.95	3.625	87.88

4.2 Testing Results (case #2):

(Case #2 = > Test conditions: VIN=120VAC; OUT=96V/45mA):



(Case #2 = > Test conditions: VIN=120VAC; OUT=96V/45mA):

Board #	Cree LED	VRMS (V)	IRMS (mA)	PIN (W)	PFC	VLED (V)	ILED (mA)	POUT (W)	Efficiency (%)
1	96	120.02	37.03	4.227	0.962	94.43	46.17	3.704	87.63

5. CONCLUSION

It is concluded that the new circuit implementation of replacing the inductor (L2) and changing the RSENSE (R4) fully function as expected. As configured in a high-power 48V LED module, the efficiency is about ~88% and PFC is ~0.969. As configured in a high-power 96V LED module, the efficiency is about ~87.6% and PFC is ~0.962.

Main benefits are achieved in the high-power LED evaluation:

1) High Efficiency
2) High PFC (>0.9)
3) No electrolytic capacitor
4) Correct average LED output current
5) Suitable for E27 LED Light Bulbs

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