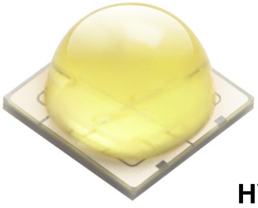
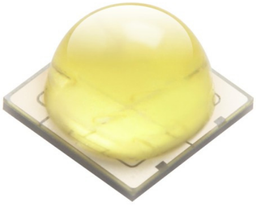
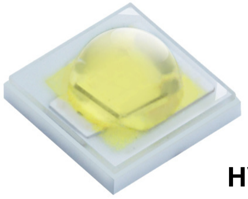
Everlight HV series
Driving Solutions Note



HV 4W series



HV 2W series



HV 1W series

Introduction

Everlight HV high brightness LEDs deliver a high voltage and low driving current concept, which make the driver design more flexible and easier for lighting applications. Without a voltage transformer, Everlight HV LEDs can not only be driven by power supply ICs, like general DC LEDs, but can also be directly operated on an AC line with a bridge rectifier and minimized number of components. The HV LED is ideal as a low cost, space saving, and efficient lighting solution. In this technical document, we introduce a few drive solution concepts for the Everlight HV series LEDs and discuss their performance and properties. Please read this note carefully before applying the suggested solutions.

Content

1. Driver design guideline

Basic design concept

During LED driver design, the following factors are considered: efficiency, efficacy, power factor, size, cost, lifetime, flicker, dimming ability, voltage floating range, thermal management, safety, and EMI. In many situations, these factors conflict and require a clear direction for the fixture design. We suggest to design in accordance with specific user and market requirements to find the most suitable solution.

LED properties and power source

Since LEDs are sensitive to current, the light output varies with the input current. A driver which can provide a constant current to LEDs can maintain more stable light output. This is the preferred way to use the LEDs. On the other hand, forward voltage (Vf) of LEDs decrease with increasing temperature. When using a constant voltage source to drive LEDs, any Vf drop will cause an increase in current to the LEDs. This also results in a flux change. In addition, after long term aging, the Vf may increase and limit the current, causing the performance to drop. Designing the driver with current control is suggested to get better efficiency and lumen maintenance.

2. Driver design concept introduction

A. Constant current driver

-A cascode topology driver design by Grenergy CO., provides a constant current (CC) and stable flux output solution.

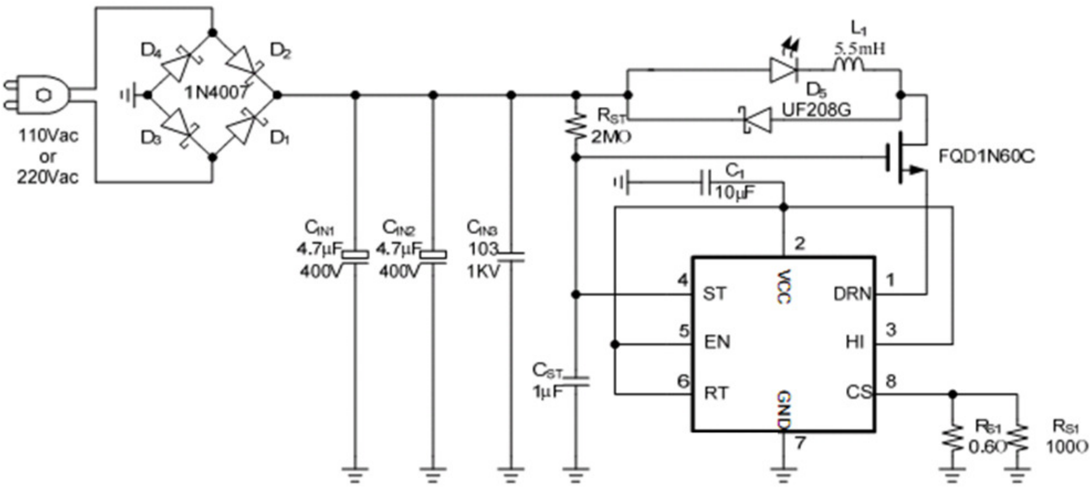
Main Component:

Sense Resistor, IC, and Bridge diode

Functional Description:

The GR8210 is a high brightness LED driver with a cascode topology that is patented by Grenergy. The source terminal and the drain terminal of an external MOSFET device are connected to the DRN pin of the GR8210 and protect the input voltage rail from large voltage potentials. The current peak value is decided by the sensing resistor in the CS pin. The internal MOSFET is turned off by the current peak detection, and the delay of 'off' time is fixed by the resistor in the RT pin of GR8210. In addition, there is PWM functionality and linear dimming in the GR8210 to adjust LED brightness.

Circuit configuration (Provided by Grerengy):



Design Note:

1. Constant current output.
2. Universal drive in 110V/220V
3. High efficient (Eff.>85%, PF>0.8)
4. External EMC component required.

B. Direct AC Drive

-An efficient driver with minimal external components

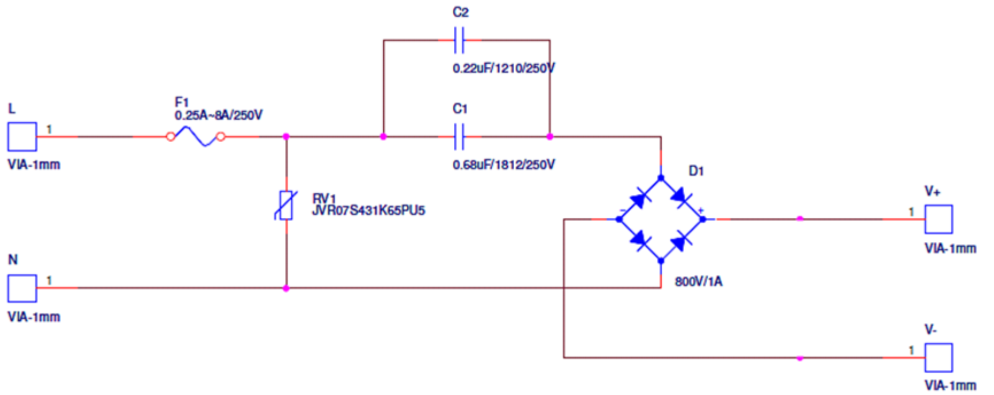
Main Component:

Fuse, Varistor, Capacitors and Bridge diode.

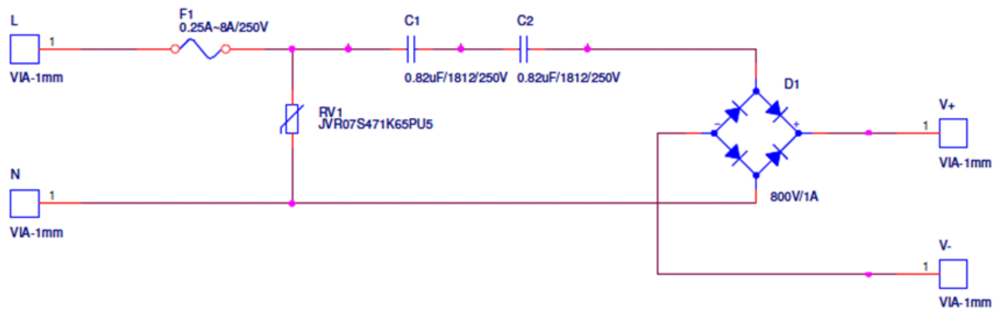
Functional Description:

This solution, which incorporates direct power by the AC voltage line, is the simplest way to drive Everlight HV LEDs. It is ideal for space limited and budgeted applications. Compact design provides more space for heat sink to increase thermal dissipation. The capacitors (C1and C2) provide the specific current output to Everlight HV LEDs (as a current regulator). Capacitors help reduce the undesirable flicker by voltage variation. In addition, resistors are also workable for limiting current but may cause reduced power and light efficiency. With this circuit configuration, driving at around 2 Watts gets the best cost and efficacy.

Circuit configuration (Example for 2W LEDs in 220V and 110V AC line):



2W /110V circuit configuration

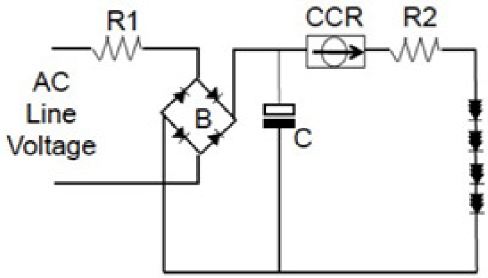


2W /220V circuit configuration

Design Note:

1. Direct AC Input without convertor.
2. Fuse (F1) and varistor (RV1), which provide protection from surge conditions (Ex: ESD, lightning), is optional but strongly recommended.
3. The current through LEDs is decided by input capacitors (C1 and C2). The trade -offs between high and low capacitance value is power factor, efficiency and sensitivity to voltage variation. The recommended range of capacitance value is from 0.1 to 1uf.
4. Performance: Eff. >0.90, PF>0.75, slight voltage sensitivity.

   If high light output quality and stability is required, put a CCR (constant current regulator) in series on LEDs string to control voltage variation. Note that this will sacrifice a part of the efficiency. The CCR is selected according to different operating conditions and output current should be rated below the Maximum Current rating noted in the HV LEDs series datasheet. The circuit configuration shown below is an RC:



5. 1-3W of LED power is recommended.
6. No EMI component required.

C: Time domain current controller

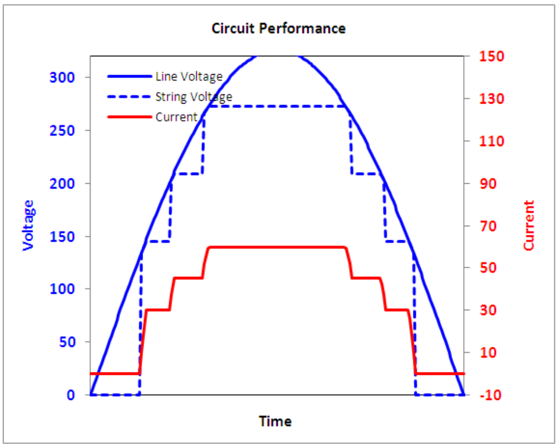
-A Multi-channel linear driver- small and efficient.

Main Component:

Sense Resistor, Time domain current controller IC, Fuse and Bridge diode

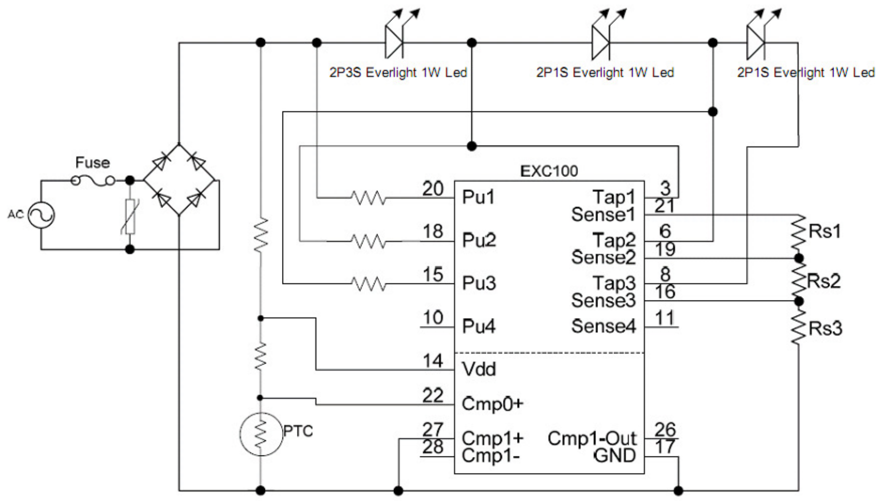
Functional Description:

Another solution is to use a time domain current controller, which can create higher efficiency and stability. This system will control the LED’s current in phase with AC line voltage via 3 various current levels. LED current control is managed by three external sense resistors (Rs1~ Rs3). When the system voltage and current is at a low level, the internal FETs will activate and current will be directed through the 1st LED segment. When the system voltage and current reach to middle and high levels, the current will be directed across the 2nd LED segment and then the 3rd LED segment, respectively.



Current / Voltage curve

Circuit configuration (Provided by Exclara Co.):



Design Note:

1. Direct AC Input without convertor.
2. Fuse and varistor, which can provide protection from surge condition (Ex: ESD, lightning), is optional but strongly recommend. For 110V application, voltage rating 250V is suggested.
3. The current peak value is decided by the sensing resistor in the sense pin (Rs1~Rs3). The ratio of LEDs number for each of 3 segments is around 3:1:1. To co-operate with development IC engineers and fine-tune the circuit can reduce the power variation by voltage floating as well as creating higher efficiency.
4. Without an external MOS, 4-10W of LED power is recommended.
5. 4th current level is available with external MOS.
6. Performance: Eff. >0.85, PF>0.95, slight voltage sensitivity and step dimming.
7. Small packing size and no EMC component required.

3. Driver solution comparison

The comparison of different driver solutions is shown below. Solution B encompasses the lowest cost and smallest form factor in driving HV LEDs but is limited in power. If higher flux is required, solution C can operate without extra EMI components to save space and reduce cost. If light quality is important, solution A provide a constant current without a heavy convertor but more space is needed. However, it is still smaller and more cost effective than DC LED drivers.

	Solution A	Solution B	Solution C
Driver Type	Constant Current Driver Solution	Direct AC Solution	Time Domain Current Controller Solution
Driver Size	Smaller than DC LEDs Driver	Extremely small	Much smaller than DC LEDs Driver
Components	IC，Few Components	Less than 5 Components	Less than 10 Components
PF	>0.8	>0.7	>0.95
Power Range	1-10W	1-3W	4-10W
Efficiency	> 85%	> 90%	>85%
Flicker	No Flicker	Not Noticeable[1]	Not Noticeable[1]
Cost[2]	<2.5USD (w/o EMI component)	<0.5USD	<2 USD
Dimmable	TRIAC or PWM	No	TRIAC
Application Field	Retrofit Bulb Indoor Lighting	Candle Light/GU10 Bulb Retrofit	Retrofit Bulb Indoor Lighting
EMI Component	Need External EMI Component	Not Required	Not Required

Note1. “Not Noticeable” means there is not a constant light output but operates over 100Hz. Human eyes cannot see flicker in that frequency.
Note2. The cost is estimated and only for reference. It may be different with brand and materials in used.

4. Examples for lamp retrofit

This is an example which provides the method of replacing a conventional incandescent lamp and candle light. We set down a reference specification for using HV LEDs. Based on this specification we can easily find a proper and efficient driver solution.

Retrofit Solution Example [1]		15W Candle Light Replacement	40W Incandescent Bulb Replacement	60W Incandescent Bulb Replacement
Reference Spec for HV LED Solution		110V 3000K 100lm / CRI>80	110V/220V 3000K 450lm / CRI>80	110V/220V 3000K 800lm / CRI>80
LED Solution	LED Type	1W 50V Everlight HV LED	1W 50V Everlight HV LED	1W 50V Everlight HV LED
	LED Qty.	2pc	8pc	14pc
	Connecting Circuit	1Parallel 2Series	8Parallel 1Series	14Parallel 1Series
	LED power consumption	2W	8W	14W
	CRI	82	82	82
	Total LED Flux	140lm	560lm	980lm
	LED Efficacy	70lm/W	70lm/W	70lm/W
Driver Solution	Driver Type	Direct AC	Constant Current	Constant Current
	Minimum Driver Size	1x2cm	4X3mm	4X3mm
	Efficiency	90%	85%	85%
	Ability to Dim	No	Yes	Yes
	Extra EMI Component	No	Yes	Yes
Performance	Total Flux Output [2]	112lm	466lm	815lm
	Total Power Consumption	2.2W	9.4W	16.4W
	Total Efficacy	50.4lm/W	50lm/W	50lm/W

Note1. Test information has not been independently verified.
Note2. Including 20% optical loss in candle light, and 17% optical loss in bulb.

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