Universal High Brightness LED Driver

HV9910

FEATURES

- > 90% Efficiency
- Universal rectified 85 – 265V_{AC} input range
- Constant-current LED driver
- Applications from a few mA to more than 1A Output
- LED string from one to hundreds of diodes
- PWM Low-Frequency Dimming via Enable pin
- Input Voltage Surge ratings up to 500V
- Internal thermal overload protection

DESCRIPTION

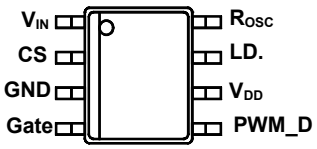
The HV9910 is a PWM high-efficiency LED driver control IC. It allows efficient operation of High Brightness (HB) LEDs from voltage sources ranging from 85V_{AC} up to 265V_{AC}. The HV9910 controls an external MOSFET at fixed switching frequency up to 300kHz. The frequency can be programmed using a single external resistor. The LED string is driven at constant current rather than constant voltage, thus providing constant light output and enhanced reliability. The output current can be programmed between a few milliamps and up to more than 1.0A.

HV9910 uses a rugged high voltage junction isolated process that can withstand an input voltage surge of up to 500V. Output current to an LED string can be programmed to any value between zero and its maximum value by applying an external control voltage at the linear dimming control input of the HV9910. The HV9910 provides a low-frequency PWM dimming input that can accept an external control signal with a duty ratio of 0-100% and a frequency of up to a few kilohertz.

APPLICATIONS

- AC/DC LED Driver applications
- RGB Backlighting LED Driver
- Back Lighting of Flat Panel Displays
- General purpose constant current source
- Signage and Decorative LED Lighting
- Chargers

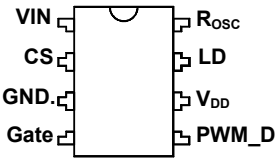
PACKAGE/ORDER INFORMATION



8-Pin Plastic S.O.I.C.
(Top View)

Order Part Number

HV9910



8-Pin Plastic DIP
(Top View)

HV9910

PIN FUNCTIONS

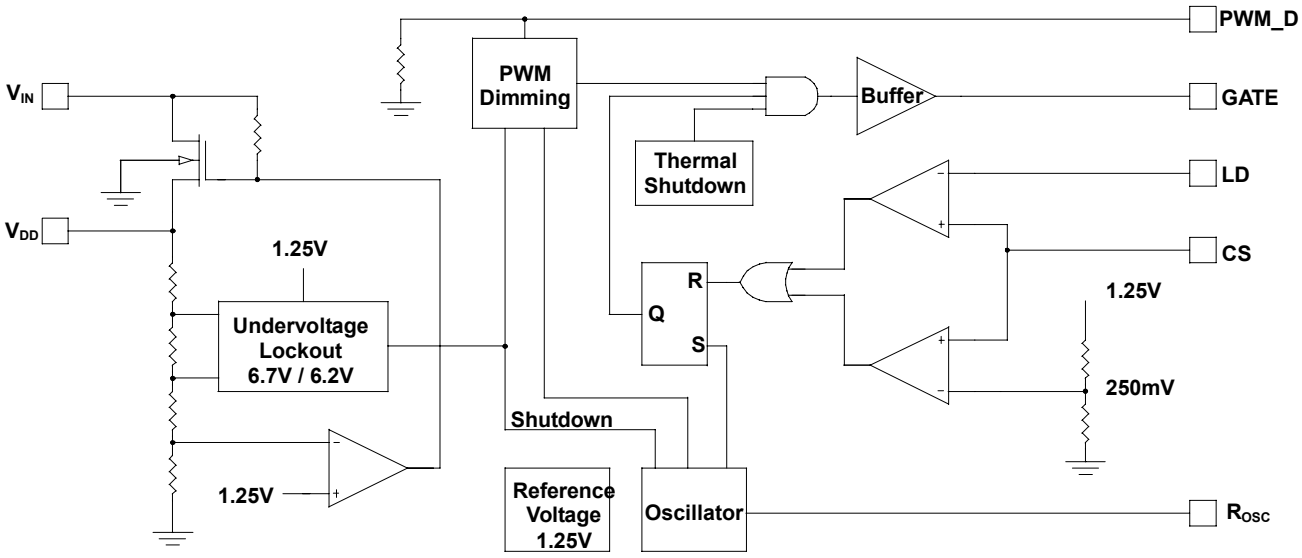
Pin No.	Pin Name	Function
1	V_{IN}	Input voltage
2	CS	Senses LED string current
3	GND	Device ground
4	GATE	Drives the gate of the external MOSFET
5	PWM_D	Low Frequency PWM Dimming pin, also Enable input. Internal 100k pull-down to GND
6	V_{DD}	Internally regulated supply voltage. 7.5V nominal. Can supply 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.
7	LD	Linear Dimming by changing the current limit threshold at current sense comparator
8	R_{OSC}	Oscillator control. A resistor connected between this pin and ground sets the PWM frequency.

ABSOLUTE MAXIMUM RATINGS (Note 1)

V_{IN} to GND	-0.5V to +520V
CS	-0.3V to (Vdd + 0.3V)
LD, PWM_D to GND	-0.3V to (Vdd – 0.3V)
GATE to GND	-0.3V to (Vdd + 0.3V)
V_{DDMAX}	13.5V
Continuous Power Dissipation (TA = 25°C) (Note 1)	
8 Pin DIP (derate 9mW/°C above +25°C	900mW
8 Pin SO (derate 6.3mW/°C above +25°C	630mW
Operating Temperature Range	-40°C to +85°C
Junction Termperature	+125°C
Storage Temperature Range	-65°C to +150°C

Note 1: Exceeding these ratings could cause permanent damage to the device. All voltages are with respect to ground. Currents are positive into, negative out of the specified terminal.

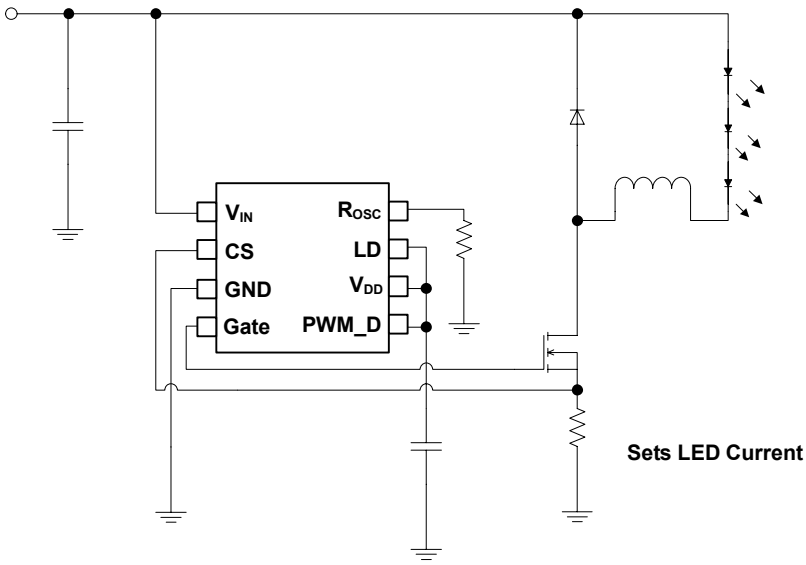
BLOCK DIAGRAM



TYPICAL APPLICATIONS

Universal Input

15V – 500 V_{DC}
85 – 265 V_{AC}
rectified

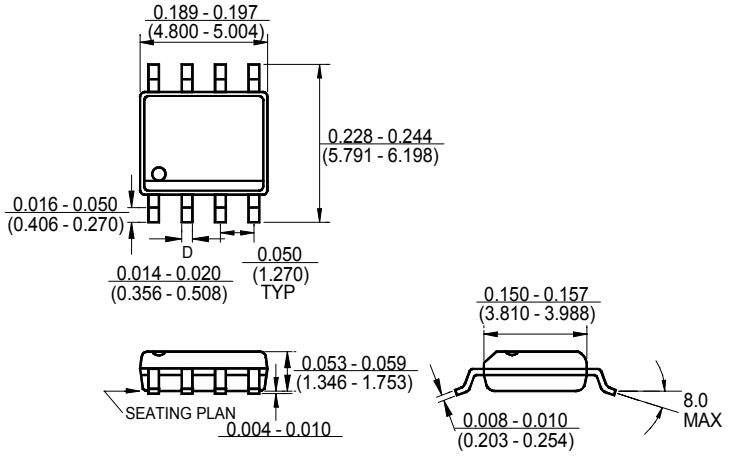


ELECTRICAL CHARACTERISTICS Unless otherwise specified, T_A = 25°C.

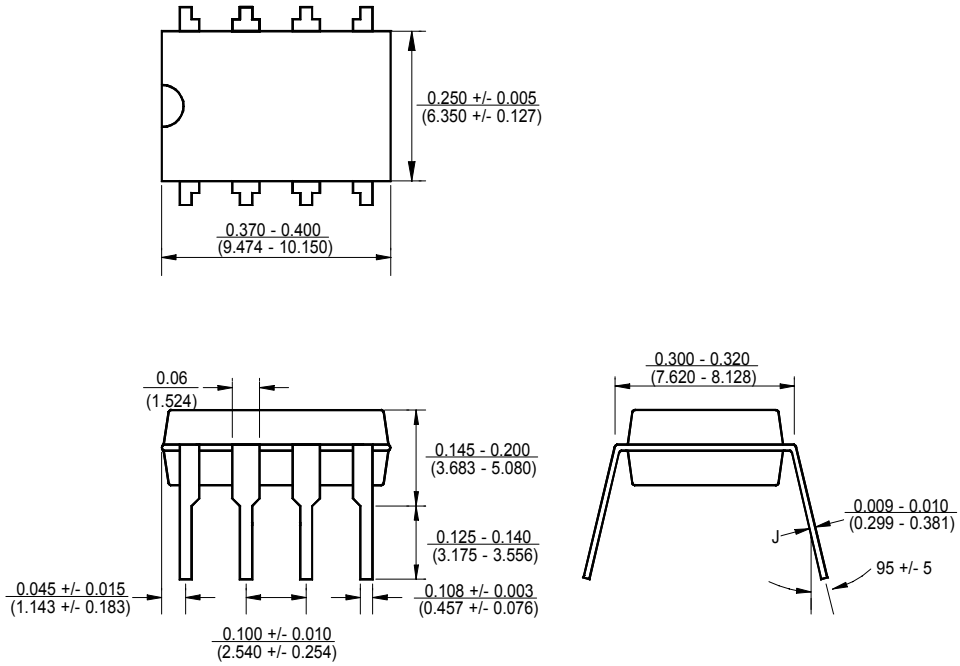
Parameter	Test Conditions	Symbol	Min	Typ	Max	Units
Input DC supply voltage range	DC input voltage	V_{INDC}	15.0		500	V
Shut-Down mode supply current	Pin PWM_D to GND, V_{IN} = 15V	I_{INsd}		0.4	1	mA
Internally regulated voltage	V_{IN} = 15-500V, $I_{DD(ext)}$=0, pin Gate open	V_{DD}	7.0	7.5	8.0	V
Maximal pin Vdd voltage	When an external voltage applied to pin Vdd	V_{DDmax}			13.5	V
V_{DD} current available for external circuitry [1]	V_{IN} = 15-100V	$I_{DD(ext)}$			1.0	mA
VDD under voltage lockout threshold	Vin rising	UVLO	6.45	6.7	6.95	V
VDD under voltage lockout hysteresis	Vin falling	ΔUVLO		520		mV
Pin PWM_D input low voltage	V_{IN} = 15-500V	$V_{EN(lo)}$			1.0	V
Pin PWM_D input high voltage	V_{IN} = 15-500V	$V_{EN(hi)}$	2.4			V
Pin PWM_D pull-down resistance	V_{EN} = 5V	R_{EN}	50	100	150	k
Current sense pull-in threshold voltage	@TA = -40°C to +85°C	$V_{CS(hi)}$	225	250	275	mV
GATE high output voltage	I_{OUT} = 10mA	$V_{GATE(hi)}$	V_{DD} -0.3		V_{DD}	V
GATE low output voltage	I_{OUT} = -10mA	$V_{GATE(lo)}$	0		0.3	V
Oscillator frequency	R_{OSC} = 1.00M	f_{OSC}	20	24	30	kHz
	R_{OSC} = 226k		80	96	120	
Maximum Oscillator PWM Duty Cycle	F_{PWMhf} = 25kHz, at GATE, CS to GND.	D_{MAXhf}			100	%
Linear Dimming pin voltage range	@TA = <85°C, Vin = 20V	V_{LD}	0		$V_{CS(hi)}$	mV
Current sense blanking interval	V_{CS} = 0.55V_{LD}, V_{LD} = V_{DD}	T_{BLANK}	200	280	360	ns
Delay from CS trip to GATE lo	Vin = 20V, V_{LD} = 0.15, V_{CS} = 0 to 0.22V after T_{BLANK}	t_{DELAY}			300	ns
GATE output rise time	C_{GATE} = 500pF	t_{RISE}		25	50	ns
GATE output fall time	C_{GATE} = 500pF	t_{FALL}		20	50	ns
Thermal shut down		T_{SD}		150		°C

PACKAGE DESCRIPTION Dimensions in inches (millimeters) unless otherwise specified

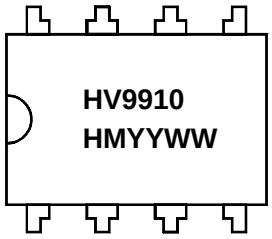
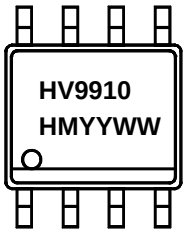
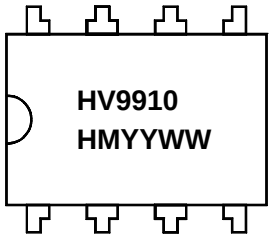
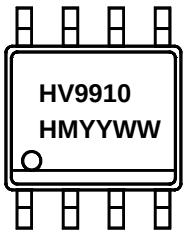
SO 8



DIP 8



MARKING DIAGRAM

DIP 8	SO 8
	
	

YY = Year, WW = Working Week

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APPLICATIONS

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_ General purpose constant current source

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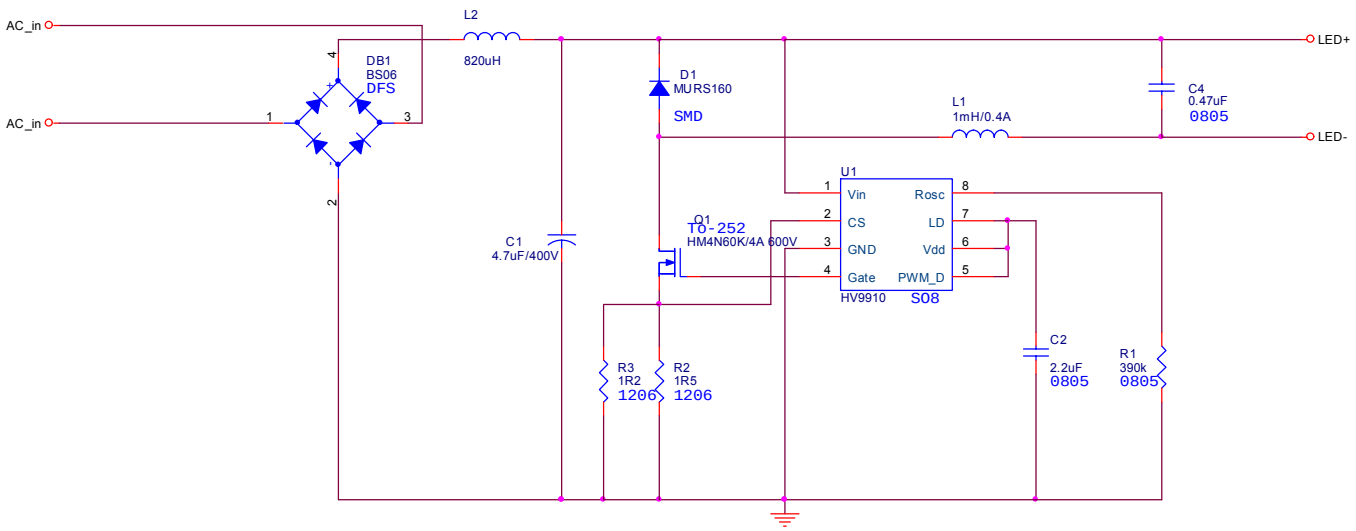
1. Demo board circuit for E-27：



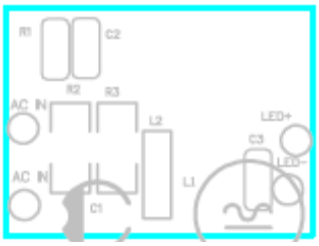
Note：R1 shall be 820KΩ~1MΩ for the case of V_{out}＜7V because it has to satisfy the condition of T_{on}＞T_{BLANK}. The efficiency can be improved as well.

2. BOM：

Item	Quantity	Reference	Part
1	1	C1	4.7uF/400V
2	1	C2	2.2uF
3	1	C4	0.47uF
4	1	DB1	BS06
5	1	D1	MURS160
6	1	L1	4.7mH/0.4A
7	1	L2	820uH
8	1	Q1	HM4N60K/4A 600V
9	1	R1	390K
10	1	R2	1R5
11	1	R3	1R2
12	1	U1	HV9910

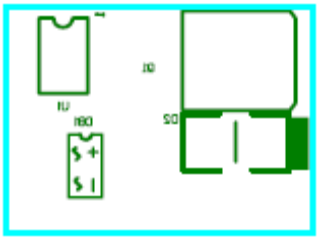
3. PCB Layout：

Top-Silkscreen

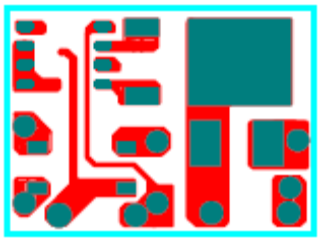


Top-side

Bottom-Silkscreen



Bottom-side



4. Critical Inductance：

The buck power stages have been for continuous and discontinuous conduction modes of steady-state operation. The conduction mode of a power stage is a function of input voltage, output voltage, output current, and the value of the inductor. A buck power stage can be designed to operate in continuous mode for load currents above a certain level usually 15% to 30% of full load. Usually, the input voltage range, the output voltage and load current are defined by the power stage specification. This leaves the inductor value as the design parameter to maintain continuous conduction mode.

The minimum value of inductor to maintain continuous conduction mode can be determined by the following procedure.

Equation：

$$D = \frac{V_{LEDs(VF)}}{V_{in}}$$

$$T_{on} = \frac{D}{F_{osc}}$$

$$L \geq \frac{(V_{in} - V_{LEDs(VF)}) \times T_{on}}{0.3 \times I_{LED}}$$

$$R_{sense} = \frac{0.25}{I_{LED} + (0.5 \times (I_{LED} \times 0.2))}$$

$$F_{osc} = \frac{25000}{R_{osc} + 22}$$

5. **Input** Capacitance：

An input filter capacitor should be designed to hold the rectified AC voltage above twice the LED string voltage throughout the AC line cycle. Assuming 15% relative voltage ripple across the capacitor, a simplified formula for the minimum value of the bulk input capacitor is given by：

Equation：

$$C_{in} \geq \frac{P_{in} \times (1 - D_{ch})}{\sqrt{2V_{Line\_\min}} \times 2 f_L \times \Delta V_{DC\_\max}}$$

Among them D_{ch} is that C_{in} capacity charges work period, it is generally about 0.2~0.25, f_L is input frequency, at input the full range voltage(85~265V_{rms}), $\Delta V_{DC\_\max}$ should be set 10~15% of $\sqrt{2V_{Line\_\min}}$.

6. Dimming control：

This terminal can be used to either enable/disable the converter or to apply a PWM dimming signal.

To just enable the converter, connect the PWMD pin to the V_{DD} pin.

Disconnecting the PWMD pin will cause the circuit to stop.

PWM dimming of the LED light can be achieved by turning on and off the converter with low frequency 50Hz to 1000Hz TTL logic level signal.

Changing the Duty Ratio of the signal changes the effective average current via the LEDs, changing the light emission.

Note：In the case of PWM dimming, the PWM_D pin should not be connected to the V_{DD} pin! Also, the signal generator or the device applying the signal to PWM_D pin must be isolated from the input mains.