

HN9910

UNIVERSAL HIGH-VOLTAGE LED DRIVER

DESCRIPTION

The HN9910 is a PWM high-efficiency LED driver control IC.

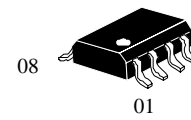
The IC is purposed for control of LED lighting as source of constant current

FEATURES

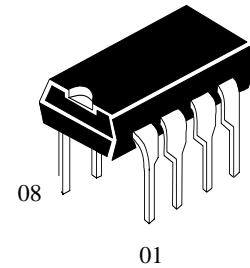
- 8V to 450V input range;
- V_{DD} pin output current I_{DDext} up to 1 μ A can be used for suppling of external components;
- Maximum external consumption current on V_{DD} pin $I_{DD(ext)}$ 1 mA;
- LED string current can be set from a few mA to more than 1A;
- Brightness control for LED string from one to hundreds of diodes;
- PWM low-frequency LED dimming;
- Linear LED dimming
- Operating temperature range -40 °C...+85°C

Applications

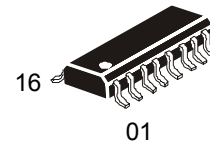
- DC/DC or AC/DC LED Driver applications
- RGB Backlighting LED Driver
- Back Lighting of Flat Panel Displays
- General purpose constant current source
- Signage and Decorative LED Lighting
- Automotive
- Chargers



M- suffix
SO-8 case



N- suffix
DIP-8 case



MH suffix
SO-16 case

HN9910EM – plastic SO-8 case
HN9910EN – plastic DIP-8 case
HN9910EMH - plastic SO-16 case

Fig.1 General view of ICs

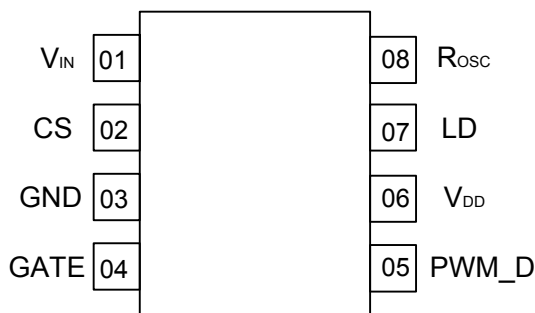
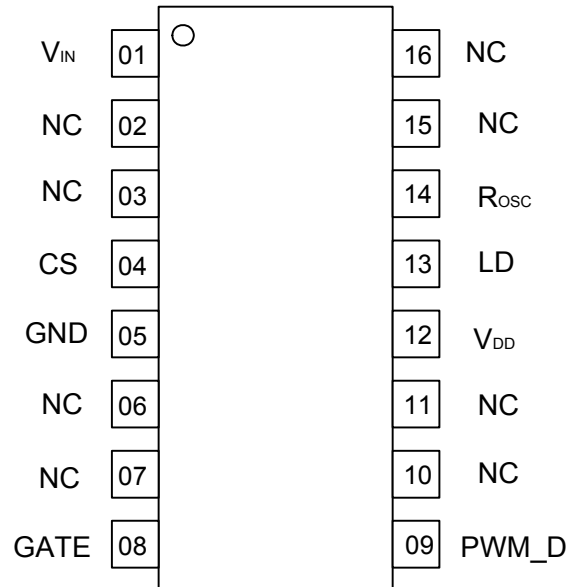


Fig.2 HN9910EM, HN9910EN pin diagramm



NC – not used

Fig.3 HN9910EMH pin diagramm

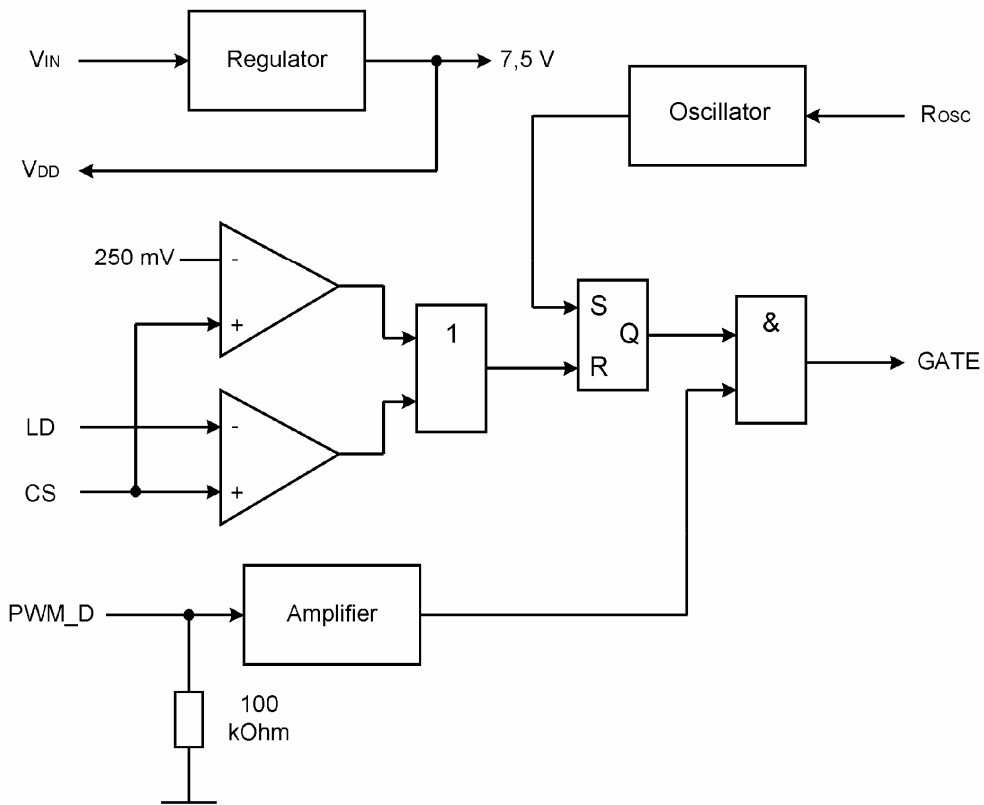


Fig.4 Block Diagram

Table 1 - Pin description table

Pin number			Symbol	Function
HN9910 EMH ¹⁾	HN9910EM	HN9910EN		
01	01	01	V _{IN}	Supply voltage input
04	02	02	CS	LED control current input
05	03	03	GND	Common pin
08	04	04	GATE	Output of control of external MOSFET
09	05	05	PWM_D	Input of PWM Low-Frequency LED Dimming ³⁾
12	06	06	V _{DD}	Pin of internally adjusted supply voltage ³⁾
13	07	07	LD	Linear Dimming input
14	08	08	R _{OSC}	Input of internal oscillator control

¹⁾ Pins 02, 03, 06, 07, 10, 11, 15, 16 of HN9910EMH are not used.
²⁾ Can be used as enable input.
³⁾ Can be used as supply voltage output for external circuit.

Table 2 - Maximum Ratings

Symbol	Parameter	Value		Unit
		Min	Max	
V _{IN}	Input voltage	-0,5	470	V
V _{DDMAX}	Maximum voltage applied to V _{DD} pin	-	13,5	V
V _{CS}	CS pin voltage	-0,3	V _{DD} + 0,3	V
V _{LD}	LD pin voltage	-0,3	V _{DD} - 0,3	V
V _{PWM_D}	PWM_D	-0,3	V _{DD} - 0,3	V
V _{GATE}	GATE pin voltage	-0,3	V _{DD} + 0,3	V
T _a	Ambient temperature	-60	125	°C

Table 3 - Recommended operation conditions

Symbol	Parameter	Value		Unit
		Min	Max	
V _{IN}	Input voltage	8	450	V
T _a	Ambient operating temperature	-40	85	°C

Table 4 - Electric parameters

Symbol	Parameter	Testing mode	Value		Ambient temperature, °C	Unit
			Min	Max		
V_{DD}	Internally regulated voltage	$V_{IN} = 8\text{ V}$ $V_{IN} = 450\text{ V}$	$\frac{7,0}{6,6}$	$\frac{8,0}{8,6}$	25 ± 10 -40 ... 85	V
$I_{DD(ext)}$	V_{DD} pin current available for external circuit	$V_{IN} = 8\text{ V}$ $V_{IN} = 100\text{ V}$	-	1,0		mA
V_{vlo}	Undervoltage lockout threshold	V_{IN} rise from 5 to 8 V	$\frac{6,45}{6,15}$	$\frac{6,95}{6,95}$		V
$V_{EN(hi)}$	PWM_D pin high level input voltage	$V_{IN} = 8\text{ V}$ $V_{IN} = 450\text{ V}$	2,4	-		V
R_{EN}	PWM_D pin pull-down resistance	$V_{EN} = 5\text{ V}$	$\frac{50}{50}$	$\frac{150}{150}$		kOhm
$V_{CS(hi)}$	Current sence pull-in threshold voltage	$V_{IN} = 8\text{ V}$	$\frac{225}{225}$	$\frac{275}{275}$		mV
f_{OSC}	Internal oscillator frequency	$V_{IN} = 8\text{ V}$ $R_{OSC} = 1\text{ MOhm}$	$\frac{20}{19}$	$\frac{30}{36}$		kHz
		$V_{IN} = 8\text{ V}$ $R_{OSC} = 226\text{ kOhm}$	$\frac{80}{75}$	$\frac{120}{125}$		
I_{INsd}	Shutdown mode consumption current	PWM_D pin is connected to GND, $V_{IN} = 8\text{ V}$, $V_{IN} = 450\text{ V}$	-	$\frac{1,0}{1,2}$		mA
$V_{GATE(hi)}$	Gate high level output voltage	PWM_D pin is connected to V_{DD} , $V_{IN} = 8\text{ V}$ $V_{IN} = 450\text{ V}$	$V_{DD}-0,3$	-		V
$V_{GATE(lo)}$	Gate low level output voltage	PWM_D pin is connected to GND, $V_{IN} = 8\text{ V}$ $V_{IN} = 450\text{ V}$	-	$\frac{0,3}{0,36}$		V

Table 4 - Electric parameters

Symbol	Parameter	Testing mode	Value		Ambient temperature, °C	Unit
			Min	Max		
ΔV_{vlo}	Undervoltage lockout hysteresis	V_{IN} falling from 8 to 5 V	-	600	25 ± 10	mV
D_{MAXhf}	Maximum duty cycle	$V_{IN} = 8 V.$	0	100		%
V_{LD}	Linear dimming voltage range	$V_{IN} = 12 V.$	0	250	25 ± 10	mV
t_{DELAY}	Switching delay from CS input to GATE output	$V_{IN} = 12 V.$	-	300		ns
T_{BLANK}	Current sense blanking	$V_{IN} = 12 V.$	150	280		ns
t_{RISE}	GATE output rise time	$C_{GATE}=500pF$	-	50		ns
t_{FALL}	GATE output fall time	$C_{GATE}=500pF$	-	50		ns

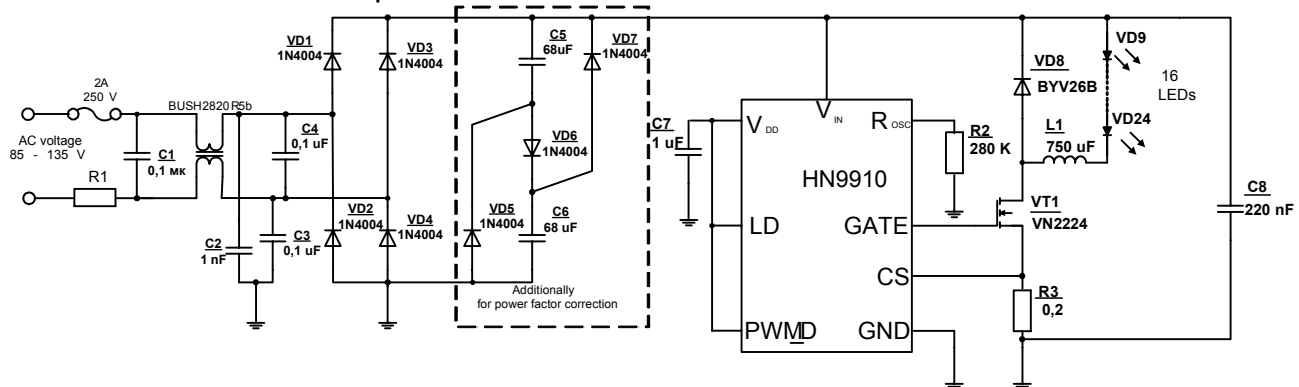
Short description

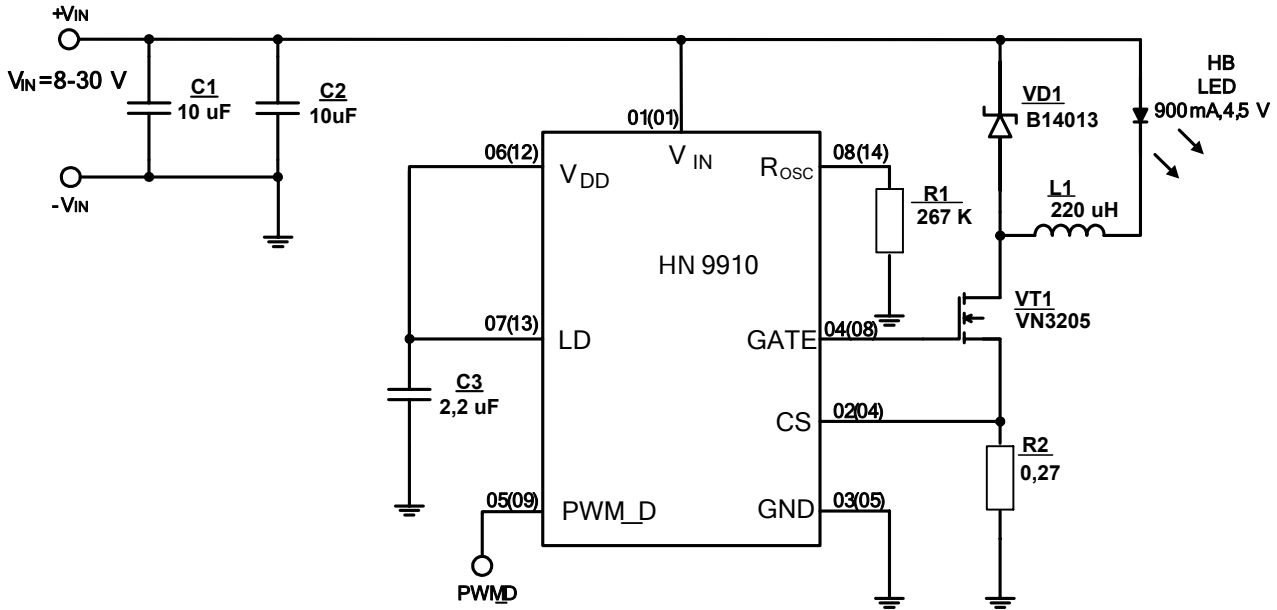
The HN9910 is a high efficient LED driver specifically designed for driving multi-LED strings or arrays, supplied from either universal AC line or any DC voltage range 8 - 450V. IC drives external MOSFET-gate with fixed frequency up to 300kHz. The operating frequency can be set using an external resistor. LED strings is controlled by DC voltage that ensures stable brightness and extends their lifetime.. LED string output current can be set from a few mA to more than 1A by external voltage applied to Linear Dimming (LD) input. The HN9910 feature is PWM_D pin that allows PWM control of brightness with duty cycle from 0 to 100 % and frequency up to few kHz.

Application information

The HN9910 is a high efficient LED driver, used in boost or buck-boost converter circuits, specifically designed for driving multi-LED strings or arrays.

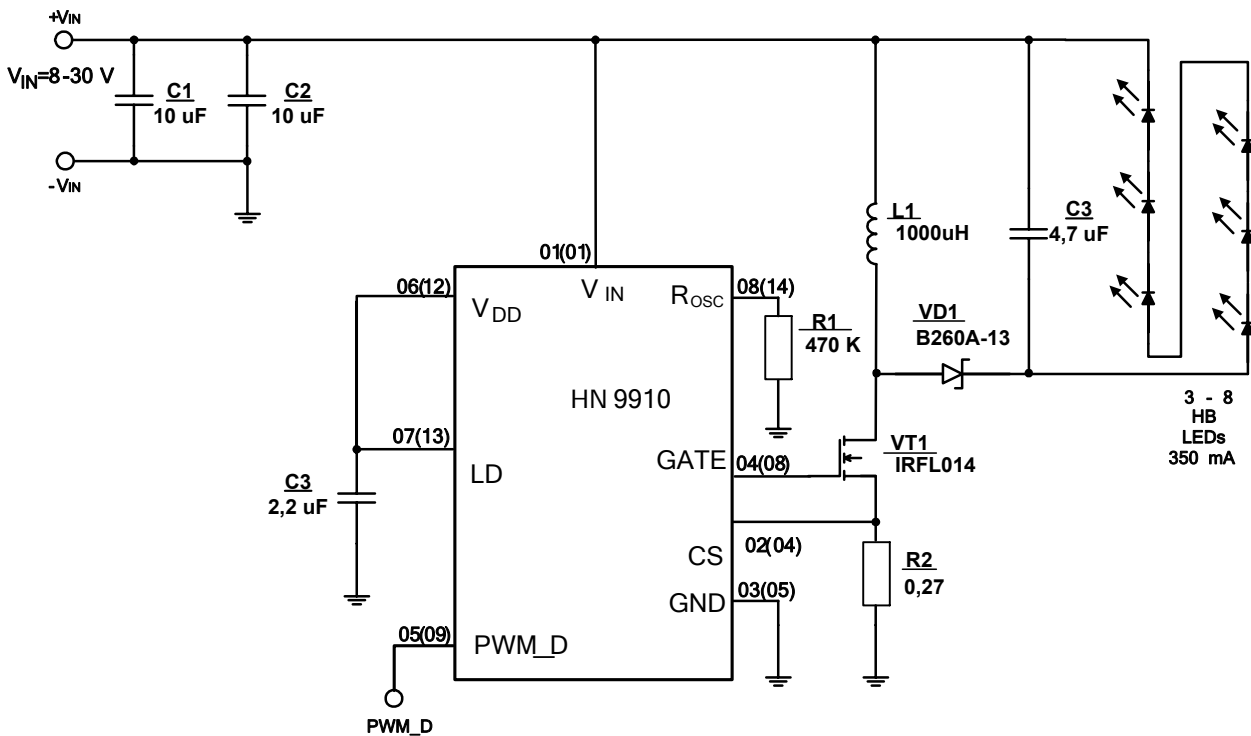
It can be operated from either universal AC line or any DC voltage between 8-450V. When the input power to the light equipment does not exceed 25W, a power factor correction circuit can be used to filter AC pulsations. The HN9910 can drive up to hundreds of High-Brightness (HB) LEDs or multiple strings of HB LEDs. The LED arrays can be configured as a series or series/parallel connection.


Fig. 5 – HN9910 LED Buck driver with AC power supply



HN9910EM & HN9910EN pin numbers displayed without brackets, brackets contain pin numbers for HN9910EMH.

Fig. 6 – HN9910 LED Buck driver for single HB LED



HN9910EM & HN9910EN pin numbers displayed without brackets, brackets contain pin numbers for HN9910EMH.

Fig.7 – HN9910 buck-boost LED driver

The HN9910 feature is PWM_D pin that allows PWM control of brightness. The HN9910 can also control brightness of LEDs by programming continuous output current of the LED driver (so-called linear dimming) when a control voltage is applied to the LD pin.

LED Driver Operation

The HN9910 can control all basic types of converters, isolated or non-isolated, operating in continuous or discontinuous conduction mode. When the gate signal enhances the external power MOSFET, the LED driver stores the input energy in an inductor or in the primary inductance of a transformer and, depending on the converter type, may partially deliver the energy directly to LEDs. The energy stored in the magnetic component is further delivered to the output during the off-cycle of the power MOSFET producing current through the string of LEDs (Flyback mode of operation).

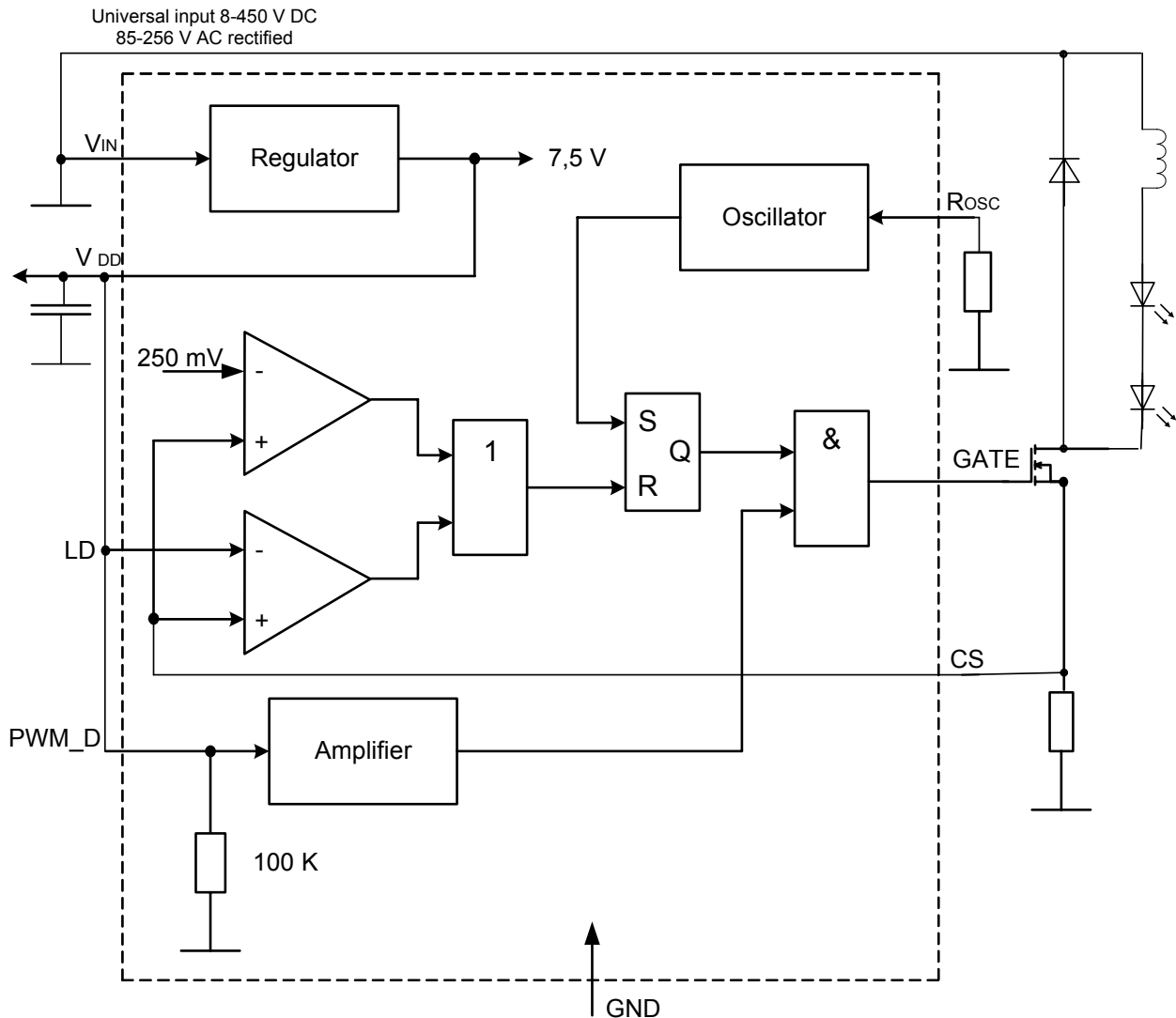


Fig. 8 – Block diagram & typical application HN9910

When the voltage at the VDD pin exceeds the V_{VLO} threshold the GATE pin voltage increases and enables the external power MOSFET. The output current is controlled by means of limiting peak current in the external power MOSFET. The voltage on resistor, connected in series with the source pin of the MOSFET, is applied to the CS pin of the HN9910. When the voltage at CS pin exceeds a comparator threshold voltage, the GATE pin voltage decreases, and the power MOSFET turns off. The comparator threshold voltage is internally set to 250mV, or it can be set externally by applying voltage to the LD pin.

Supply current

A current of 1mA is needed to start the HN9910. As shown on Fig.8, this current is internally generated in HN9910 without using bulky startup resistors typically required in the offline

applications. Moreover, in many applications the HN9910 can be continuously powered using its internal linear regulator that provides a regulated voltage of 7.5V for all external circuits connected to pin V_{DD} .

Light output setting

The buck converter circuit uses optimal setting of the average current in the LED by voltage drop on the sense resistor. But there is a certain error associated with this current sensing method that needs to be accounted for. This error is introduced by the difference between the peak and the average current in the inductor. For example if the peak-to-peak ripple current in the inductor is 270mA, to get a 900mA LED current, the sense resistor should be $250\text{mV}/(900\text{mA} + 0.5 \times 270\text{mA}) = 0.24\Omega$.

Dimming

Dimming can be accomplished in two ways, separately or combined, depending on the application. Light output of the LED can be controlled either by linear change of its current, or by switching the current on and off while maintaining it constant. The second dimming method (so-called PWM dimming) controls the LED brightness by varying the duty ratio of the output current.

The linear dimming can be implemented by applying a control voltage from 0 to 250mV to the LD pin.

This control voltage overrides the internally set 250mV threshold level of the CS pin and changes the comparator threshold and output current accordingly. A potentiometer connected between V_{DD} and ground can set the control voltage at the CS pin. Applying a control voltage higher than 250mV will not change the output current setting. To set higher current select a smaller sense resistor

The PWM dimming scheme can be implemented by applying an external PWM signal to the PWM_D pin. The PWM signal can be generated by a microcontroller or a pulse generator with a duty cycle proportional to the amount of desired light output. This signal enables and disables the converter modulating the LED current in the PWM fashion. In this mode, LED current can be in one of the two states: zero or the nominal current set by resistor connected to source pin of MOSFET. It is not possible to use this method to achieve average brightness levels higher than the one set by the comparator threshold level. By using the PWM control method of the HN9910, the light output can be adjusted between zero and 100%. The accuracy of the PWM dimming method is limited only by the minimum gate pulse width, which is a fraction of a percent of the duty cycle.

Setting of operating frequency

The operating frequency of the oscillator is set between 25 and 300kHz using an external resistor connected to the R_{OSC} pin:

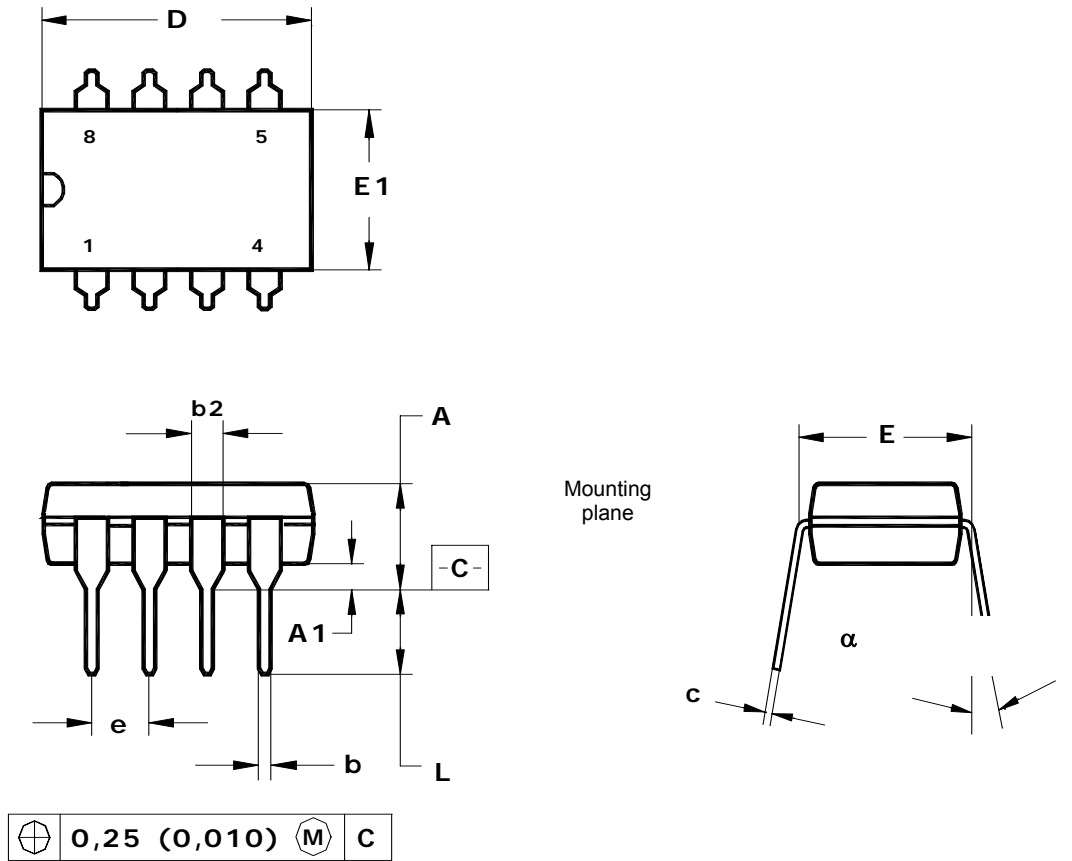
The operating frequency F_{osc} , kHz can be calculated by formula:

$$F_{osc} = \frac{25000}{R_{osc}},$$

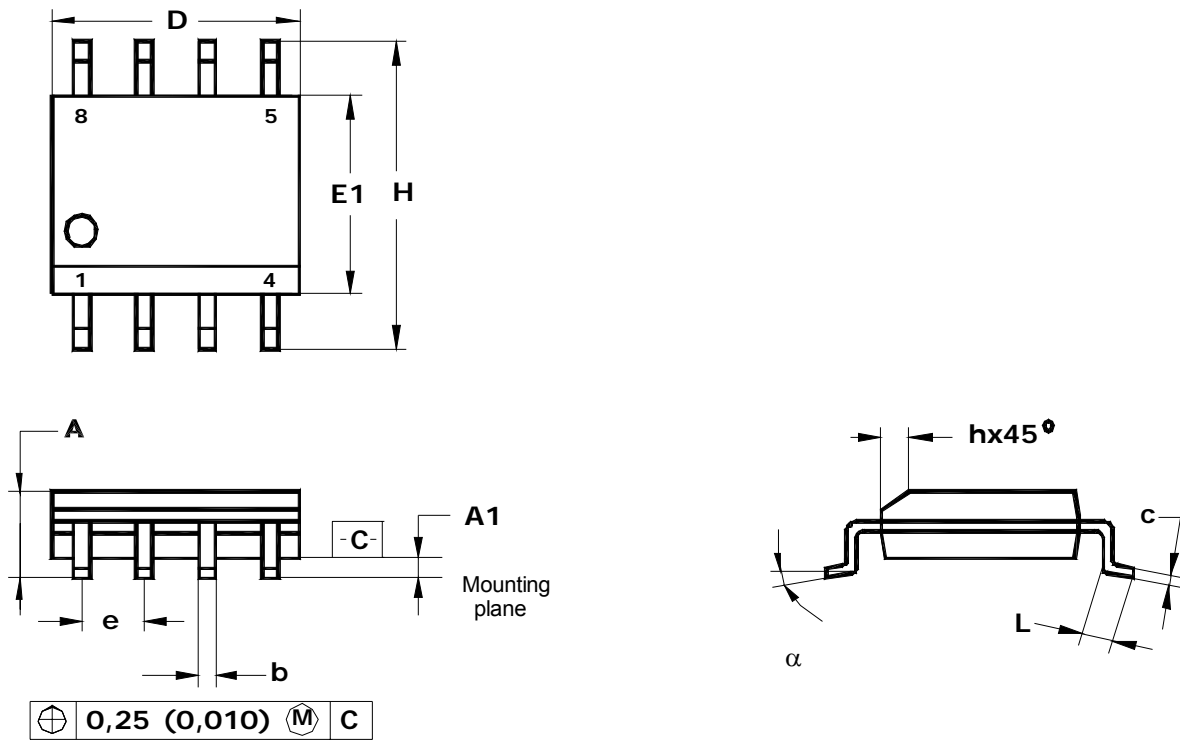
R_{OSC} – external resistor value, k Ω .

Disabling

The HN9910 can be turned off by connecting the PWM_D pin to ground. When disabled, the HN9910 draws quiescent current of less than 1mA

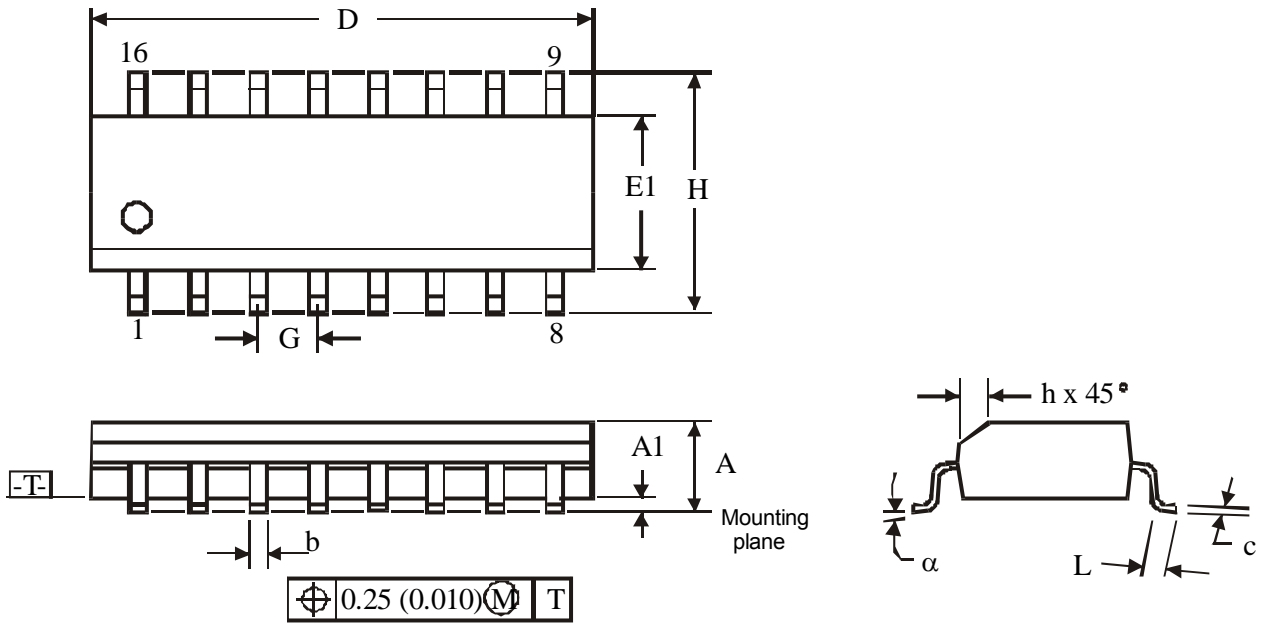
EN SUFFIX PLASTIC DIP8


	D	E1	A	b	b2	e	α	L	E	c	A1
mm											
min	9.02	6.07	—	0.36	1.14		0°	2.93	7.62	0.20	0.38
max	10.16	7.11	5.33	0.56	1.78	2.54	15°	3.81	8.26	0.36	—
inches											
min	0.355	0.240	—	0.014	0.045		0°	0.115	0.300	0.008	0.015
max	0.400	0.280	0.210	0.022	0.070	0.1	15°	0.150	0.325	0.014	—

EM SUFFIX PLASTIC SOP8


	D	E1	H	b	e	α	A	A1	c	L	h
mm											
min	4.80	3.80	5.80	0.33		0°	1.35	0.10	0.19	0.41	0.25
max	5.00	4.00	6.20	0.51	1.27	8°	1.75	0.25	0.25	1.27	0.50
inches											
min	0.1890	0.1497	0.2284	0.013		0°	0.0532	0.0040	0.0075	0.016	0.0099
max	0.1968	0.1574	0.2440	0.020	0.100	8°	0.0688	0.0090	0.0098	0.050	0.0196

EMH SUFFIX PLASTIC SOP16



α

	D	E1	A	b	h	e	α	L	H	c	A1
mm											
min	9,80	3,80	1,35	0,33	0,25	1,27	0°	0,40	5,80	0,19	0,10
max	10,00	4,00	1,75	0,51	0,50		8°	1,27	6,20	0,25	0,25
inches											
min	0,386	0,150	0,053	0,013	0,010	0,050	0°	0,016	0,228	0,007	0,004
max	0,394	0,157	0,069	0,020	0,020		8°	0,050	0,244	0,010	0,010