

## Universal High-Voltage LED Driver

### DESCRIPTION

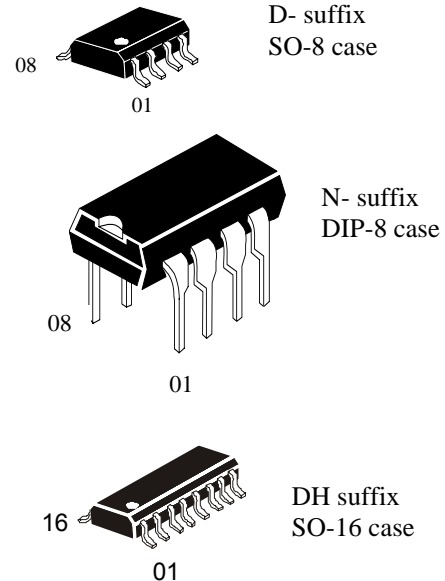
The IL9910D, (IL9910N, IL9910DH, IZ9910) is a PWM high-efficiency LED driver control IC. The IC is purposed for control of LED lighting as source of constant current

### FEATURES

- 8V to 450V input range;
- $V_{DD}$  pin output current  $I_{DDext}$  up to 1  $\mu$ 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

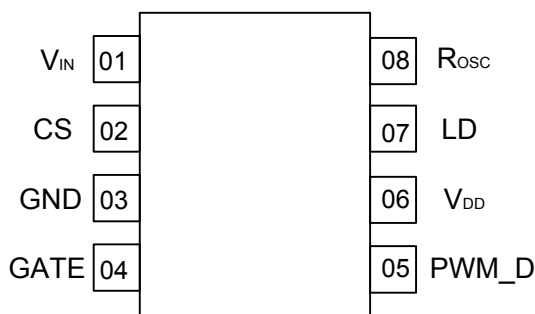
### Applications

- 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

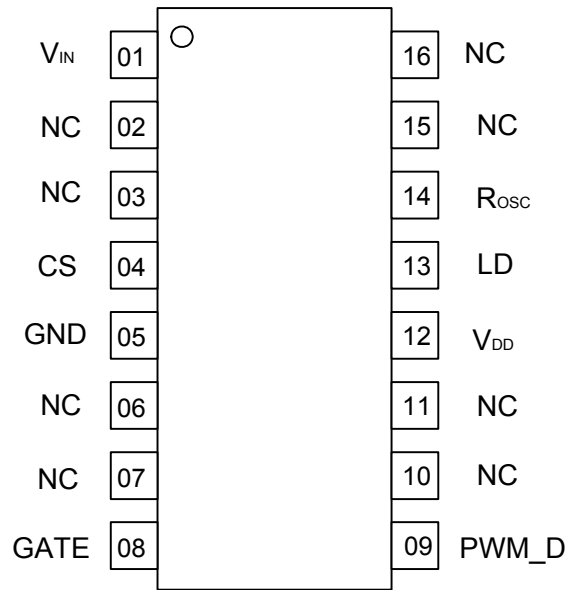


IL9910D – plastic SO-8 case  
 IL9910N – plastic DIP-8 case  
 IL9910DH - plastic SO-16 case  
 IZ9910 - dice

**Fig.1 General view of ICs**

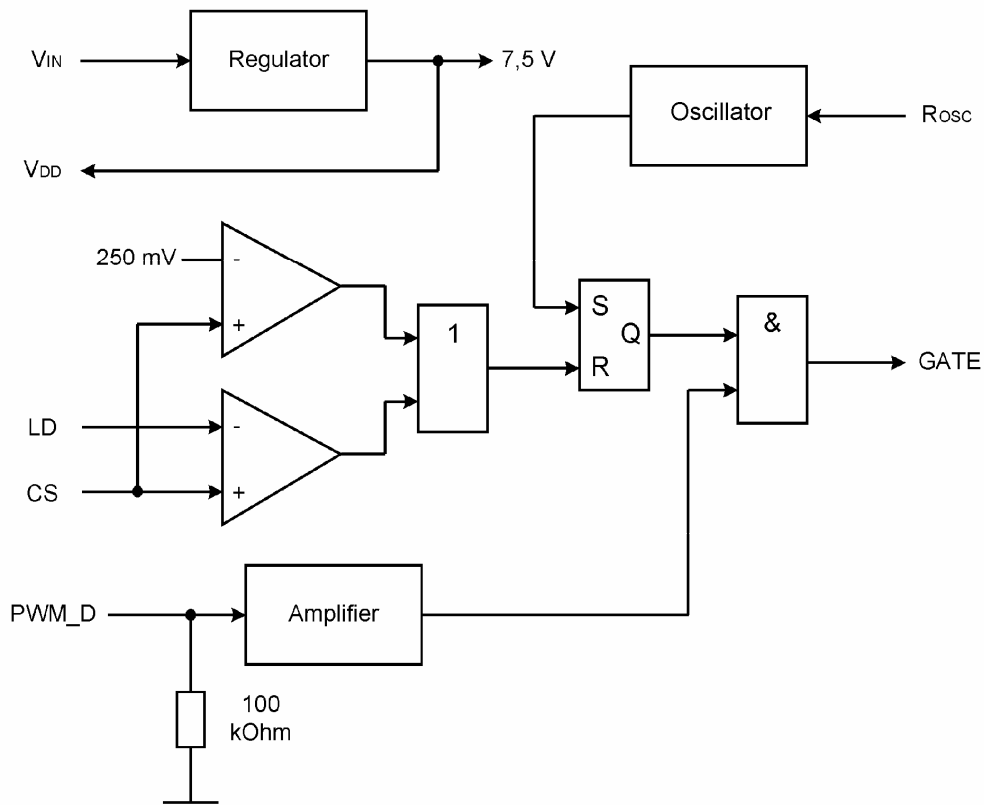


**Fig.2 IL9910D, IL9910N pin diagramm**



NC – not used

**Fig.3 IL9910DH pin diagramm**



**Fig.4 Block Diagram**

**Table 1 - Pin & pad description table**

Pin number		Pad number	Symbol	Function
IL9910D IL9910N	IL9910DH <sup>1)</sup>	IZ9910		
01	01	01	V <sub>IN</sub>	Supply voltage input
02	04	02	CS	LED control current input
03	05	03, 04	GND	Common pin
04	08	05	GATE	Output of control of external MOSFET
05	09	07	PWM_D	Input of PWM Low-Frequency LED Dimming <sup>3)</sup>
06	12	06, 08	V <sub>DD</sub>	Pin of internally adjusted supply voltage <sup>3)</sup>
07	13	09	LD	Linear Dimming input
08	14	10	R <sub>OSC</sub>	Input of internal oscillator control

<sup>1)</sup> Pins 02, 03, 06, 07, 10, 11, 15, 16 of IL9910DH are not used.  
<sup>2)</sup> Can be used as enable input.  
<sup>3)</sup> Can be used as supply voltage output for external circuit.

**Table 2 - Maximum Ratings**

Symbol	Parameter	Value		Unit
		Min	Max	
U <sub>IN</sub>	Input voltage	-0,5	470	V
U <sub>DDMAX</sub>	Maximum voltage applied to V <sub>DD</sub> pin	-	13,5	V
U <sub>CS</sub>	CS pin voltage	-0,3	U <sub>DD</sub> + 0,3	V
U <sub>LD</sub>	LD pin voltage	-0,3	U <sub>DD</sub> - 0,3	V
U <sub>PWM_D</sub>	PWM_D	-0,3	U <sub>DD</sub> - 0,3	V
U <sub>GATE</sub>	GATE pin voltage	-0,3	U <sub>DD</sub> + 0,3	V
T <sub>a</sub>	Ambient temperature	-60	125	°C

**Table 3 - Recommended operation conditions**

Symbol	Parameter	Value		Unit
		Min	Max	
U <sub>IN</sub>	Input voltage	8	450	V
T <sub>a</sub>	Ambient operating temperature	-40	85	°C

Table 4 - Electric parameters

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

Table 4 - Electric parameters

Symbol	Parameter	Testing mode	Value		Ambient temperature, °C	Unit
			Min	Max		
$\Delta U_{VLO}$	Undervoltage lockout hysteresis	$U_{IN}$ falling from 8 to 5 V	-	600	$25 \pm 10$	mV
$D_{MAXhf}$	Maximum duty cycle	$U_{IN} = 8 V.$	0	100		%
$U_{LD}$	Linear dimming voltage range	$U_{IN} = 12 V.$	0	250	$25 \pm 10$	mV
$t_{DELAY}$	Switching delay from CS input to GATE output	$U_{IN} = 12 V.$	-	300		ns
$T_{BLANK}$	Current cense blanking	$U_{IN} = 12 V.$	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 IL9910 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 IL9910 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 IL9910 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 IL9910 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.

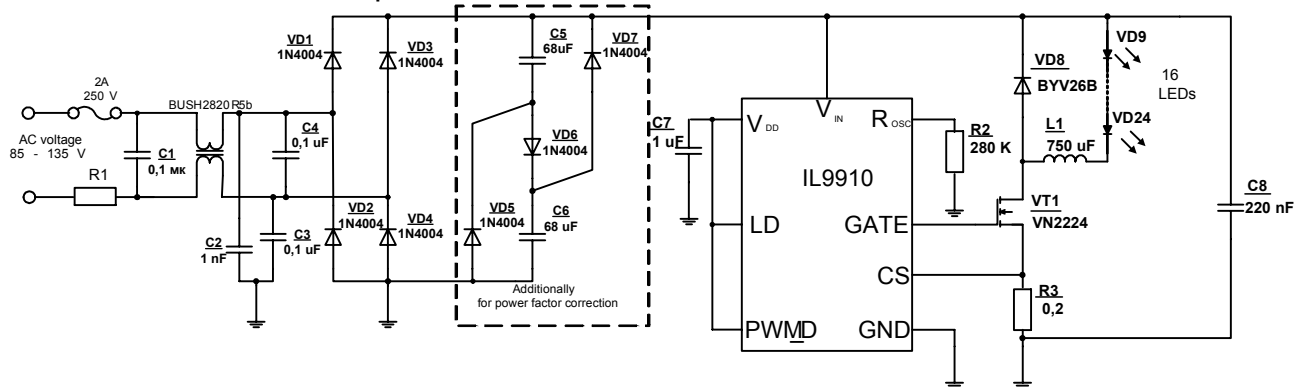
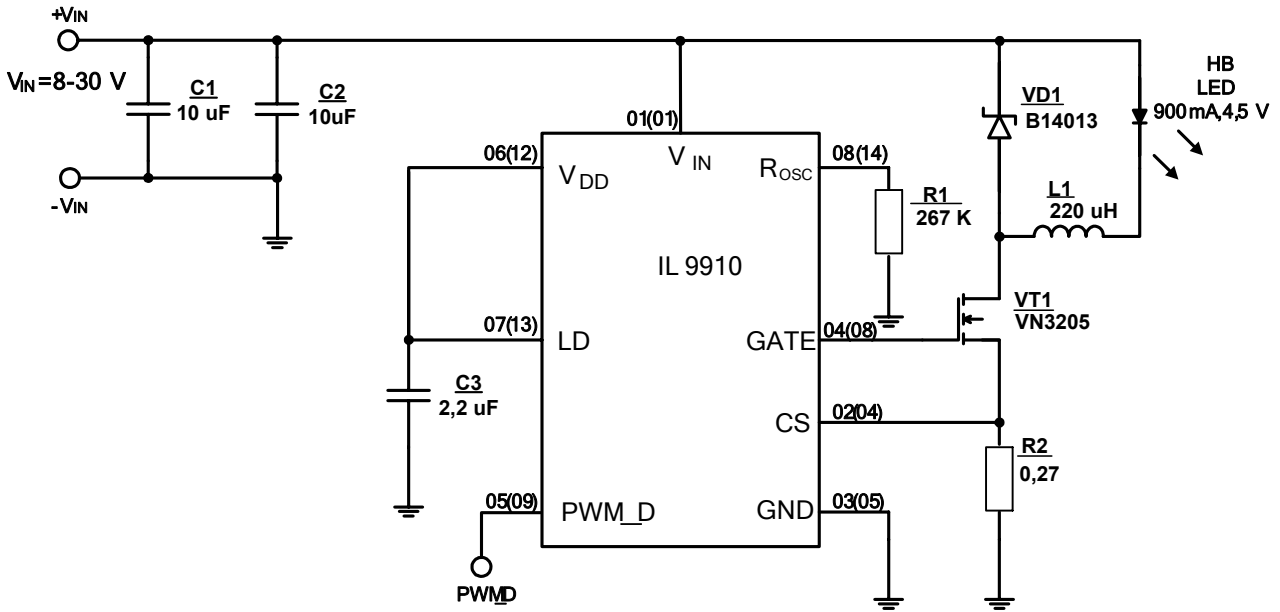
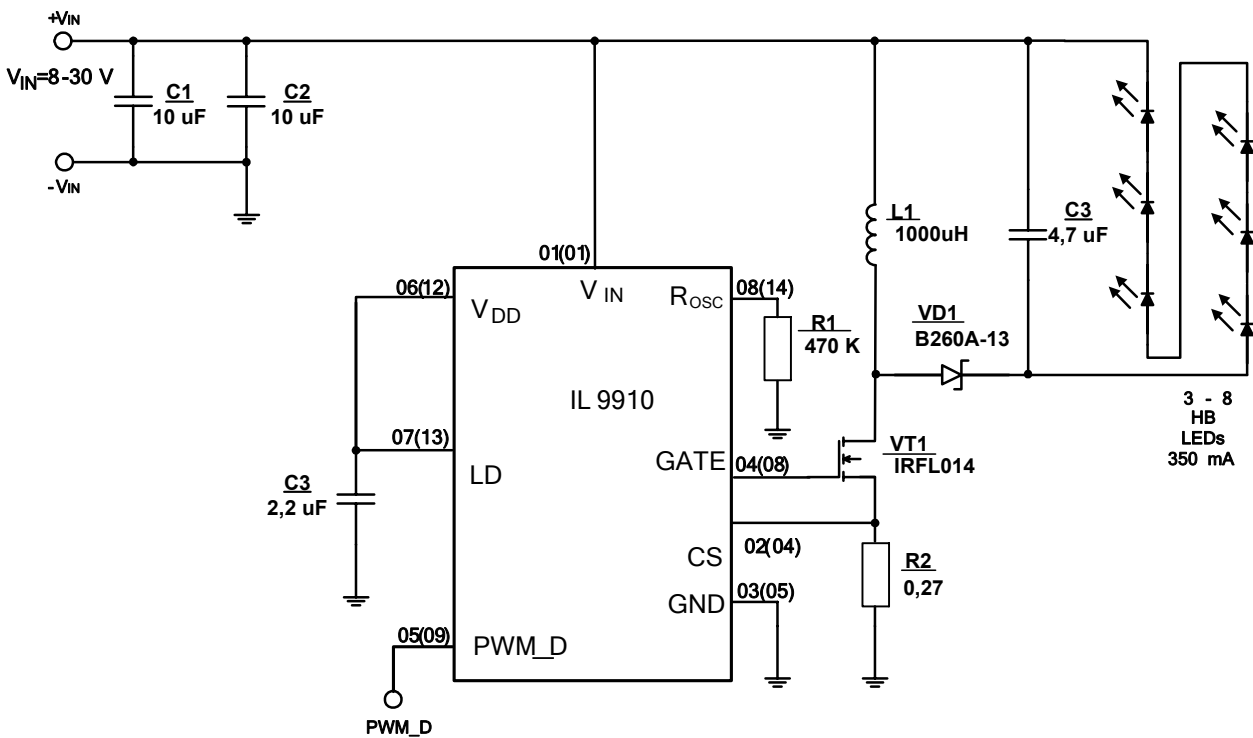


Fig. 5 – IL9910 LED Buck driver with AC power supply



IL9910D & IL9910N pin numbers displayed without brackets, brackets contain pin numbers for IL9910DH.

**Fig. 6 – IL9910 LED Buck driver for single HB LED**



IL9910D & IL9910N pin numbers displayed without brackets, brackets contain pin numbers for IL9910DH.

**Fig.7 – IL9910 buck-boost LED driver**

The IL9910 feature is PWM\_D pin that allows PWM control of brightness. The IL9910 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 IL9910 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).

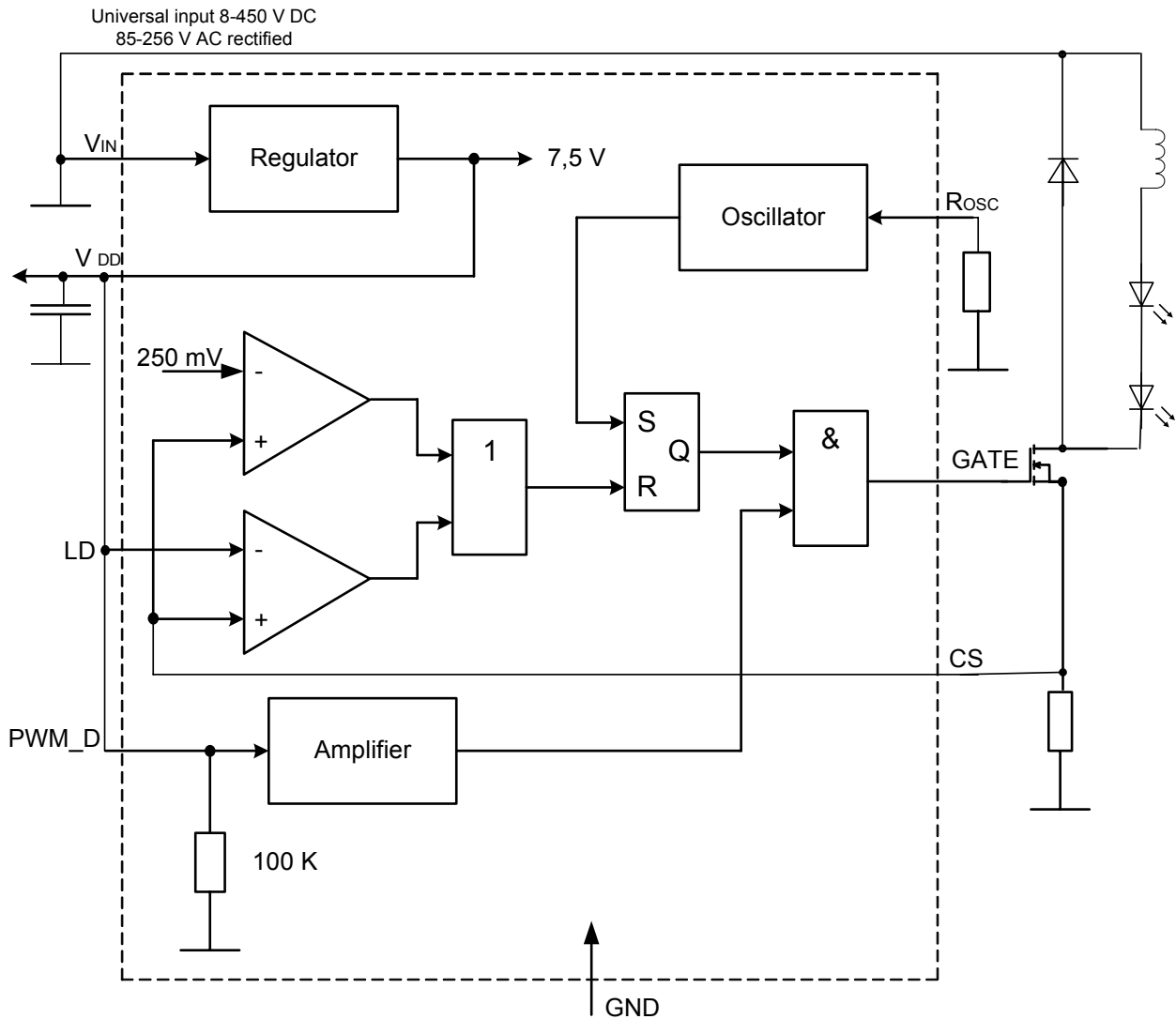


Fig. 8 – Block diagram & typical application IL9910

When the voltage at the VDD pin exceeds the UVLO 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 a resistor, connected in series with the source pin of the MOSFET, is applied to the CS pin of the IL9910. 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 IL9910. As shown on Fig.8, this current is internally generated in IL9910 without using bulky startup resistors typically required in the offline



applications. Moreover, in many applications the IL9910 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 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  $250\text{mV}/(900\text{mA} + 0.5 \cdot 270\text{mA}) = 0.24\Omega$ .

## 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 IL9910, 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:

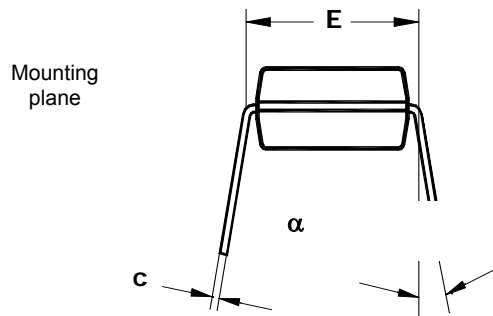
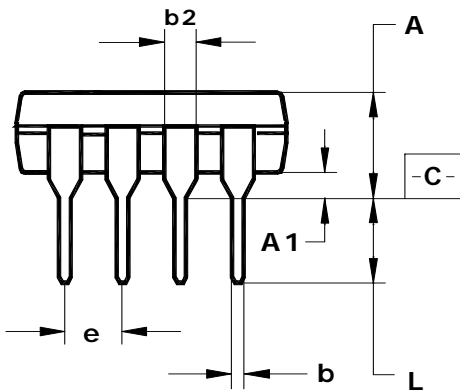
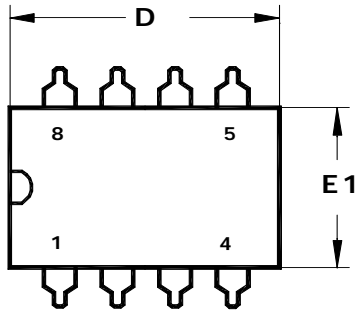
$$F_{osc} = \frac{25000}{R_{osc}},$$

$R_{OSC}$  – external resistor value, k $\Omega$ .

## Disabling

The IL9910 can be turned off by connecting the PWM\_D pin to ground. When disabled, the IL9910 draws quiescent current of less than 1mA

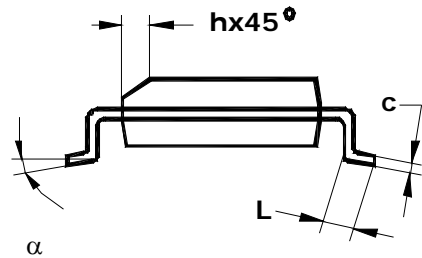
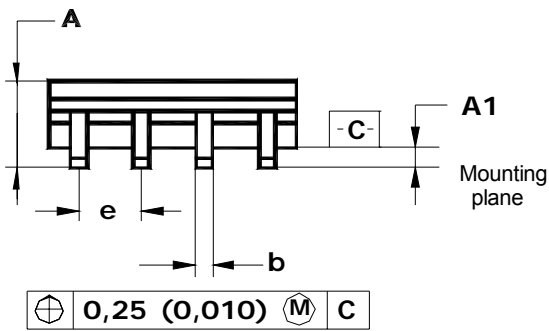
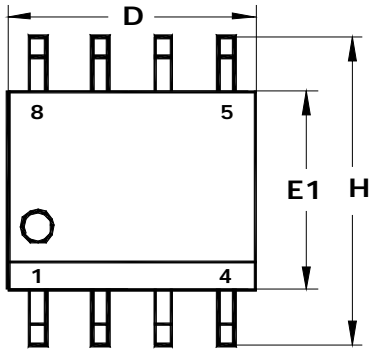
## N SUFFIX PLASTIC DIP (MS-001BA)



$\oplus$	0,25 (0,010)	$\textcircled{M}$	C
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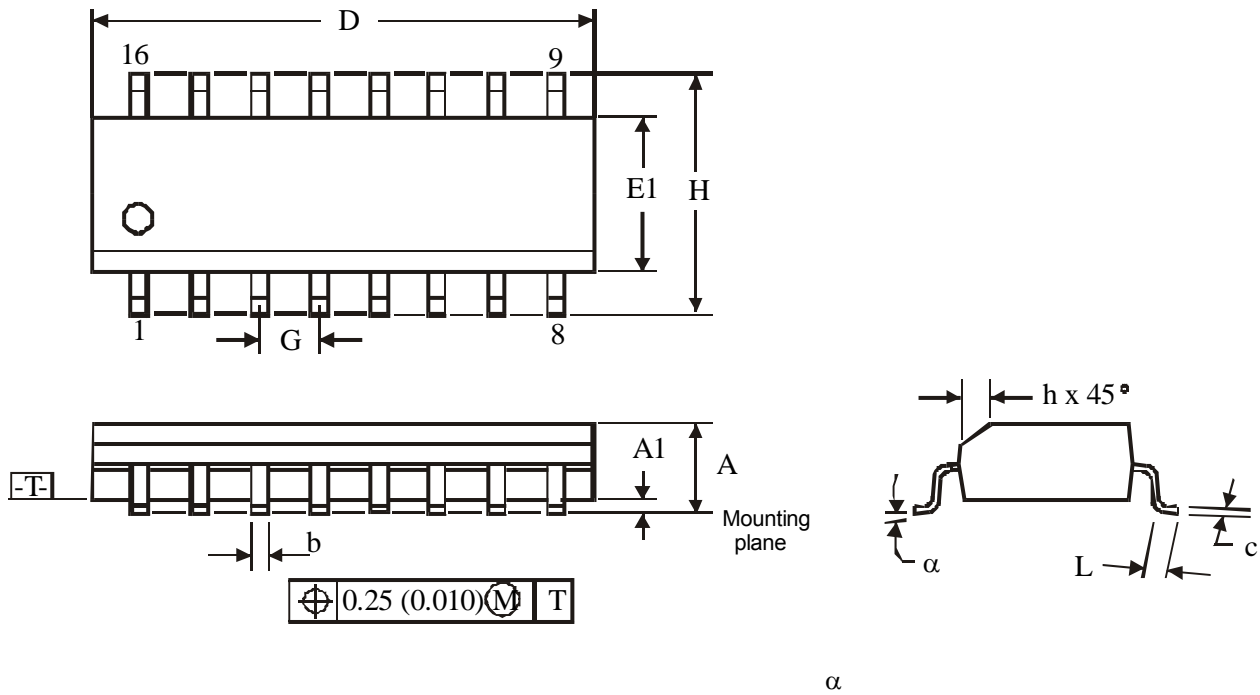
	D	E1	A	b	b2	e	$\alpha$	L	E	c	A1
<b>mm</b>											
min	9.02	6.07	—	0.36	1.14		0°	2.93	7.62	0.20	0.38
max	10.16	7.11	5.33	0.56	1.78	2.54	15°	3.81	8.26	0.36	—
<b>inches</b>											
min	0.355	0.240	—	0.014	0.045		0°	0.115	0.300	0.008	0.015
max	0.400	0.280	0.210	0.022	0.070	0.1	15°	0.150	0.325	0.014	—

D SUFFIX PLASTIC SOP  
(MS-012AA)



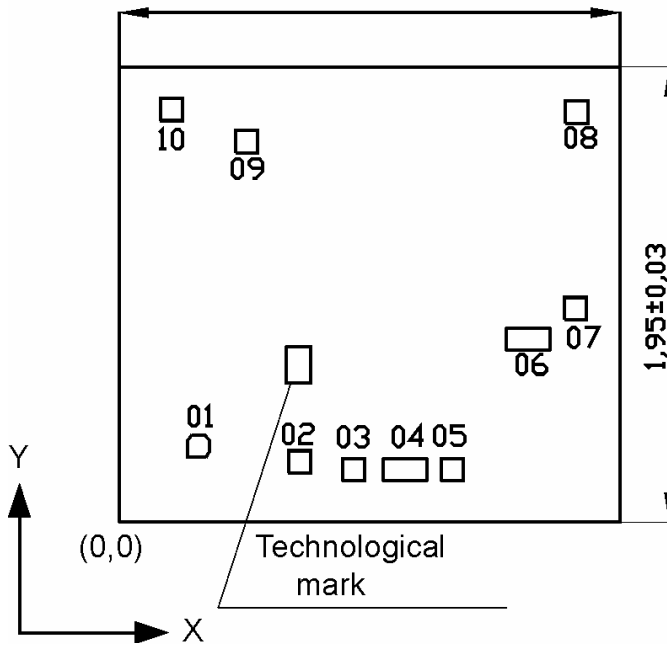
	D	E1	H	b	e	$\alpha$	A	A1	c	L	h
<b>mm</b>											
min	4.80	3.80	5.80	0.33		0°	1.35	0.10	0.19	0.41	0.25
max	5.00	4.00	6.20	0.51	1.27	8°	1.75	0.25	0.25	1.27	0.50
<b>inches</b>											
min	0.1890	0.1497	0.2284	0.013		0°	0.0532	0.0040	0.0075	0.016	0.0099
max	0.1968	0.1574	0.2440	0.020	0.100	8°	0.0688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

DH SUFFIX PLASTIC SOP  
(MS-012AC)



	D	E1	A	b	h	e	$\alpha$	L	H	c	A1
<b>mm</b>											
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
<b>inches</b>											
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

Contact pads location diagramm  
2,15±0,03



Die thickness  $0,46 \pm 0,02$  mm.

Technological mark coordinates, um:  $x = 698, y = 475$ .

Contact pads location table

Pad number	(Left bottom corner), um		Contact pad dimensions, um
	X	Y	
01	295	278	95 x 95
02	705	272	95 x 95
03	959	177	95 x 95
04	1132	177	190 x 95
05	1382	177	95 x 95
06	1660	737	175 x 95
07	1910	868	95 x 95
08	1915	1708	95 x 95
09	504	1583	95 x 95
10	177	1720	95 x 95

Note - Contact pad coordinates & dimensions are indicated according "passivation" layer