1. Functional Description of the AMG-LL9910B

The AMG-LL9910B is a universal high voltage LED driver IC. Both buck and boost topologies are possible. It has one current regulated channel.

The AMG-LL9910B controls an external MOSFET at fixed switching frequencies up to 300 kHz. The frequency can be programmed by using a single resistor. The LED string is driven at a constant current rather than a constant voltage, thus providing constant light output and enhanced reliability. The output current to a LED string can be programmed to any value between 0 and 100% by applying an external control voltage at the linear dimming control input. The IC provides a low-frequency PWM dimming input that can accept an external control signal with a duty ratio between 0% and 100% and a frequency of up to a few kilohertz.

2. Features

- ❑ Supply voltage 8VDC … 450VDC
- ❑ >90 % efficiency
- ❑ 8 – 450V input voltage
- ❑ Peak current mode converter
- ❑ Linear and PWM dimming capability
- ❑ Buck and Boost topology
- ❑ Pin compatible with other HV LED drivers
- ❑ SOP8 Package with exposed pad for a lower thermal resistance

3. Application

The AMG-LL9910B is suitable for:

- ❑ DC/DC or AC/DC LED driver applications
- ❑ LED backlighting
- ❑ General-purpose LED lighting
- ❑ General-purpose constant current source
- ❑ Battery chargers

3.1. Example Application Drawing

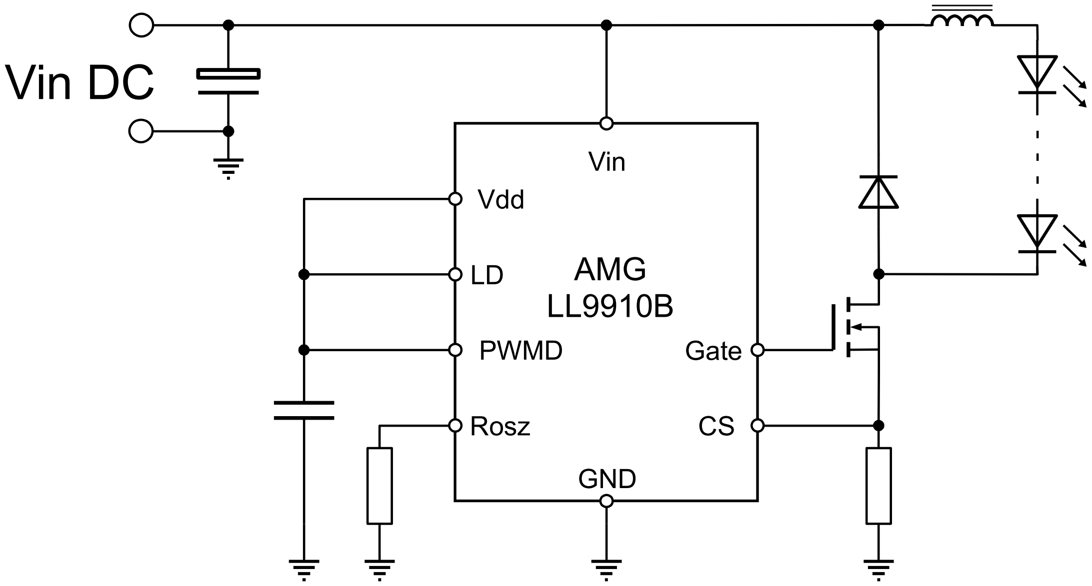

Figure 1: Buck LED Driver

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4. Block Diagram

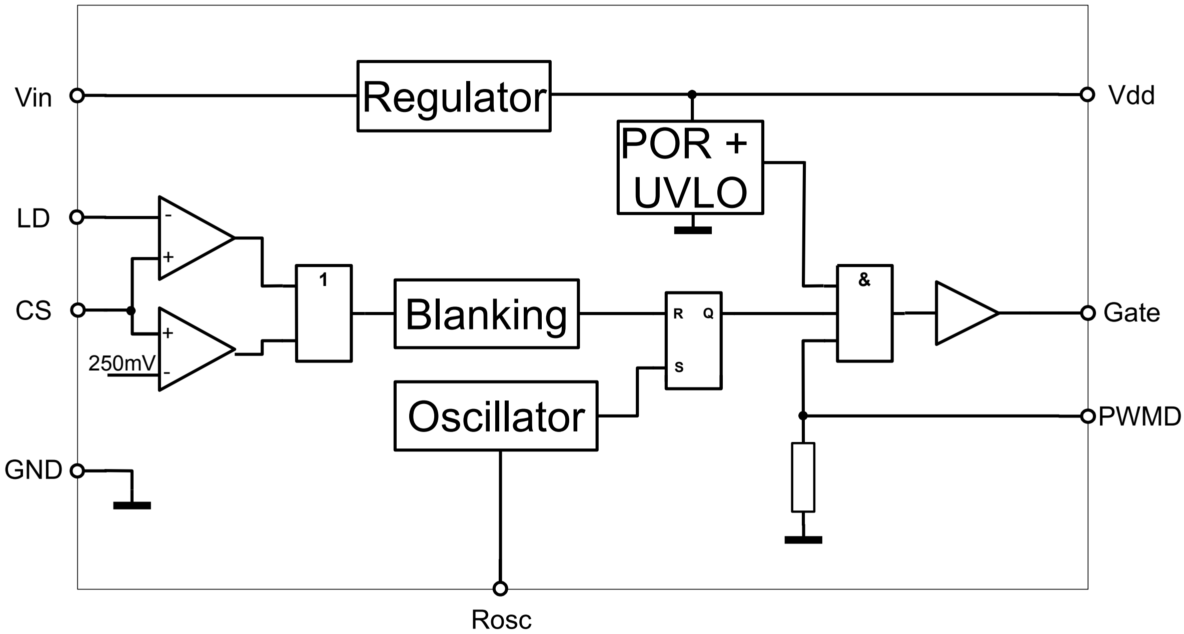


Figure 2: Block Diagram

5. Block Descriptions

Linear Regulator

Generates a stable supply for the logic. May also supply external circuitry.

POR + UVLO

Power on Reset and Under Voltage lockout. The IC is released from reset, after the Vdd rises above the UVLO voltage.

Linear Dimming Comparator

Manual setting of the V_{CS} threshold.

Current Sense Comparator

Current limiting comparator.

Blanking Timer

Inserts a time delay from CS trip to Gate low, in order to enable100% duty cycle.

RS Flip Flop

Enables and disables the gate driver. Set by the oscillator, reset by current limit.

Gate Driver

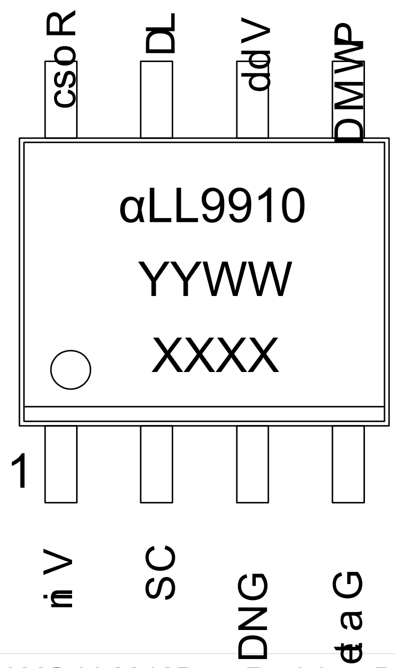
Drives external MOSFET. Gated by external PWM or enable signal.

Oscillator

Determines PWM frequency.

6. Pinning

PIN#	Symbol	Description
1	Vin	Supply input
2	CS	Current Sense
3	GND	Ground
4	Gate	Driver output for external MOSFET
5	PWMD	PMW dimming input
6	Vdd	Linear regulator output
7	LD	Linear Dimming
8	Rosc	Resistor to GND setting Oscillator Frequency
EP	-	Thermal conductive pad on the bottom. Connect this pad to Ground, and provide sufficient thermal coupling to remove heat from the package.



7. Absolute Maximum Ratings

The Absolute Maximum Ratings may not be exceeded under any circumstances.

#	Symbol	Parameter	Min	Max	Unit
1	Vin	Supply input voltage	-0.5	470	V
2	V_{logic}	Voltage on CS, LD, PWMD, Gate	-0.3	V_{dd} + 0.3	V
3	T_j	Junction temperature		150	°C
4	T_S	Storage temperature	-65	150	°C
5	V_{ddmax}	Max. voltage at Vdd	-0.3	12	V
6	R_{thja}	Thermal resistance junction ambient		42	K/W
7	P_{tot}@25°C	Total power dissipation		2.5	W

Note: All voltages are with respect to GND

8. Electrical Characteristics

8.1. Operational Range

(Ta=25°C unless noted otherwise)

#	Symbol	Parameter	Min	Max	Unit
1	Vin [1)]	Supply input voltage	10	450	V
2	Ta	Operating ambient temperature	-40	125 [1) 2)]	°C
3	PWM	Duty Cycle		100	%

Note: [1)] Also limited by maximum power dissipation, whichever is lower.

[2)] $R_{thja} = (T_j - T_a) / P_{tot}$

8.2. DC Characteristics

(Ta=25°C unless noted otherwise)

#	Symbol	Parameter	Min	Typ	Max	Unit
1	Vdd	Regulator output voltage	7.25	7.5	7.75	V
2	I_{ext} [3)]	Current for ext. circuitry (10V < Vin < 100V)			0.7	mA
3	UVLO	Undervoltage lockout (Vdd rising)	6.45	6.7	6.95	V
4	ΔUVLO	Undervoltage lockout hysteresis (Vdd falling)		500		mV
5	$V_{in\ low}$	Input voltage logic low (PWMD)			0.8	V
6	$V_{in\ high}$	Input voltage logic high (PWMD)	2			V
7	R_{PWMD}	Pull down on PWMD pin	50	100	150	kΩ
8	Vcs	Current sense threshold	225	250	275	mV
10	$V_{gate\ low}$	Gate driver low output voltage (@10mA)	0		0.3	V
11	$V_{gate\ high}$	Gate driver high output voltage (@-10mA)	Vdd-0.3		Vdd	V
12	I_{dd}	Current consumption (shutdown), V_{PWM} =0V		0.5	1	mA

Note: [3)] Also limited by maximum power dissipation, whichever is lower.

8.3. AC Characteristics

(Ta=25°C unless noted otherwise)

#	Symbol	Parameter	Min	Typ	Max	Unit
1	f_{OSC}	Oscillator frequency @ R_{OSC}=1000kOhm	20	25	30	kHz
		Oscillator frequency @ R_{OSC}=226kOhm	80	100	120	kHz
2	t_{blank}	Minimal gate on time (Current sense blanking time)	150	215	280	ns
3	t_{delay}	Time from CS trip to Gate low		80	150	ns
4	t_{rise}	Gate driver output rise time (Cgate = 500pF)		30	50	ns
5	t_{fall}	Gate driver output fall time (Cgate = 500pF)		30	50	ns

9. Application

9.1. Example Application Circuit

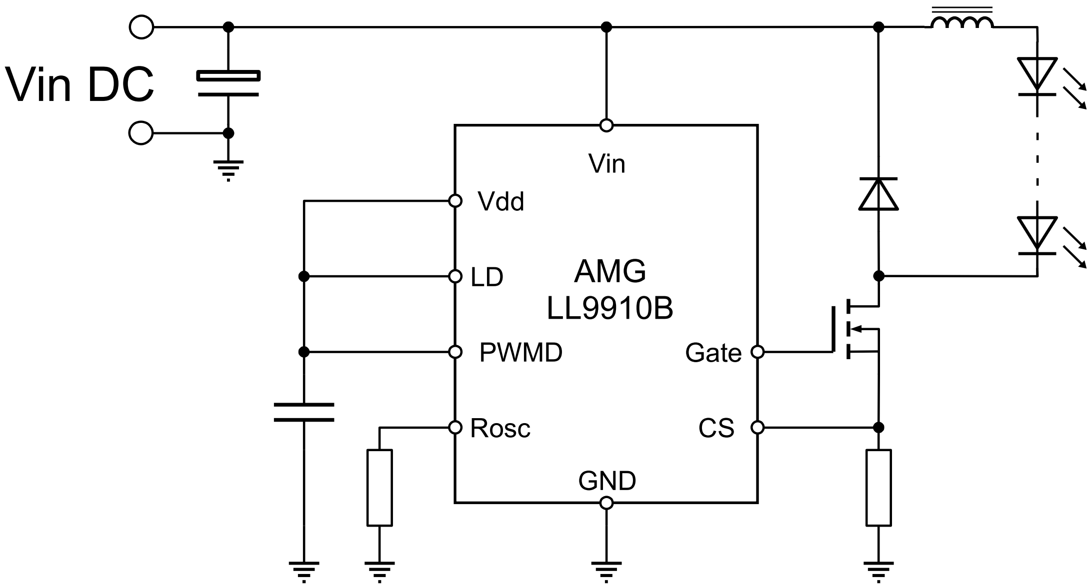


Figure 3: Buck LED Driver

9.2. Application Notes

a) Peak Current Regulation

The oscillator resistor sets the PWM frequency. After each oscillator period, the gate driver is pulled high and the duty cycle begins.

When the current over sense resistor R_{CS} reaches the current limit, the current sense comparator will trip and after blanking time the gate driver output is pulled low and the duty cycle ends.

Smaller inductors and lower PWM frequencies will provide for higher current ripple. In the case that the highest light intensity is desired, the ripple should be maximized and the LED driven to it's specified peak current limit.

In the case that the highest efficacy and longest LED lifetime is desired, the LED needs to be driven to the optimum current value only. In this situation, the ripple should be kept as low as possible. Bigger inductor values and higher PWM frequencies will help achieve this result.

b) LED Current

The maximum LED current is programmed with an external resistor R_{CS}.

If peak current for highest light intensity is desired, the resistor value should be calculated as follows:

$R_{CS} = 250mV/I_{LED\ peak}$

If an average current for highest efficacy and longest lifetime is desired, the resistor value should be calculated as follows:

$R_{CS} = 250mV/[I_{LED\ avg} + (0.5*\Delta I_L)]$

$\Delta I_L = I_{ripple}$

c) Inductor Value

The inductor value depends on the input voltage, output voltage, PWM frequency and the desired current ripple.

First , we calculate the ratio between input and output voltage and the voltage over the inductor. The input voltage is the average supply voltage for the IC while the output voltage is the number of LEDs on the string times the LED forward voltage.

$V_{out} = n * V_F$

$V_L = V_{in} - V_{out}$

Please note: that the forward LED voltage is a function of the LED current. The LED data sheet should provide the corresponding forward voltage for a given LED current.

D = Vout/Vin

For a buck design, D must be lower than 1.

Then, the ripple of the LED currents needs to be determined, which will then provide the actual inductor value.

For the maximum peak current (highest intensity), a current ripple higher than 50% (0.5) is desirable.

$\Delta I_L = ripple * I_{LED\ peak}$

Inductor values should be rounded down in this case.

For a stable average current (highest efficacy), a current ripple lower than 20% (0.2) is desirable.

$\Delta I_L = ripple * I_{LED\ avg}$

Inductor values should be rounded up for this case.

$L = (D/fosc) * (V_L/\Delta I_L)$

d) Linear Dimming

If the second comparator is provided with a threshold voltage lower than the internal threshold voltage of the first comparator, the current over the LED can be manually adjusted. This can be achieved with any analog voltage between 0 and the internal reference voltage (e.g. with a potentiometer).

e) Digital Dimming

With an external PWM signal at the PWMD pin, the gate driver can be gated. This means, the LED will light up during the duty cycle of the external PWM signal and vice versa, the LED will be off during the off-time of the external PWM signal.

The external PWM frequency needs to be much smaller than the frequency of the AMG-LL9910B. The external PWM frequency should be at least 10x smaller, otherwise fluctuation effects may occur.

The PWMD pin may also be used to enable or disable the device. The IC is enabled, when PWMD is pulled to Vcc. It is disabled, when PWMD is pulled to GND:

f) PWM Frequency

F_{PWM} [kHz] = 25000/(R_{osc} [kΩ]+22)

g) PFC

The AMG-LL9910B does not have a PFC integrated stage. As such, a PFC is usually necessary for off line LED drivers. This can be either a passive PFC or even an active one, when the power increases relatively high.

9.3. Off Line LED Driver

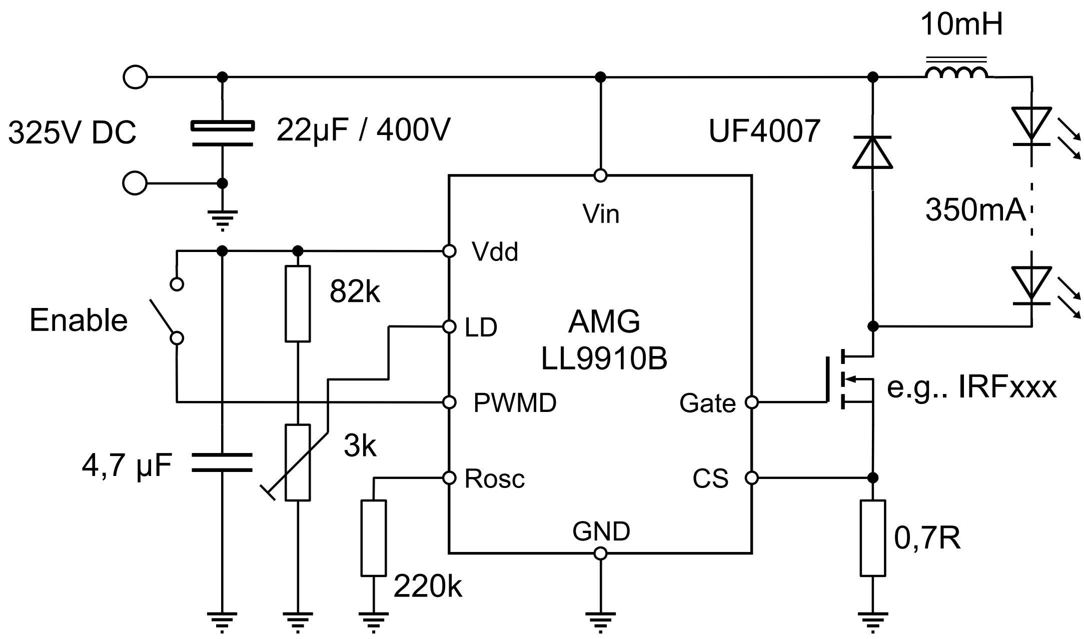


Figure4: Buck topology, linear dimming, enable switch

9.4. Off Line LED Driver with Digital I/F

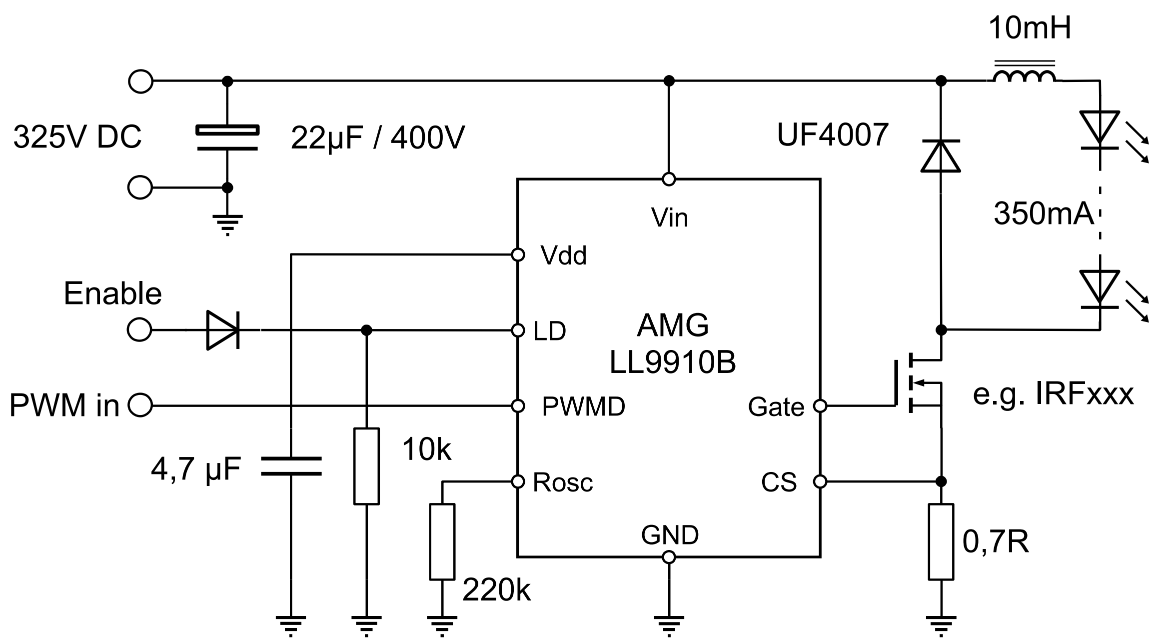


Figure 5: Buck topology, digital dimming, enable signal

9.5. Off Line LED Driver with Temp-Protection

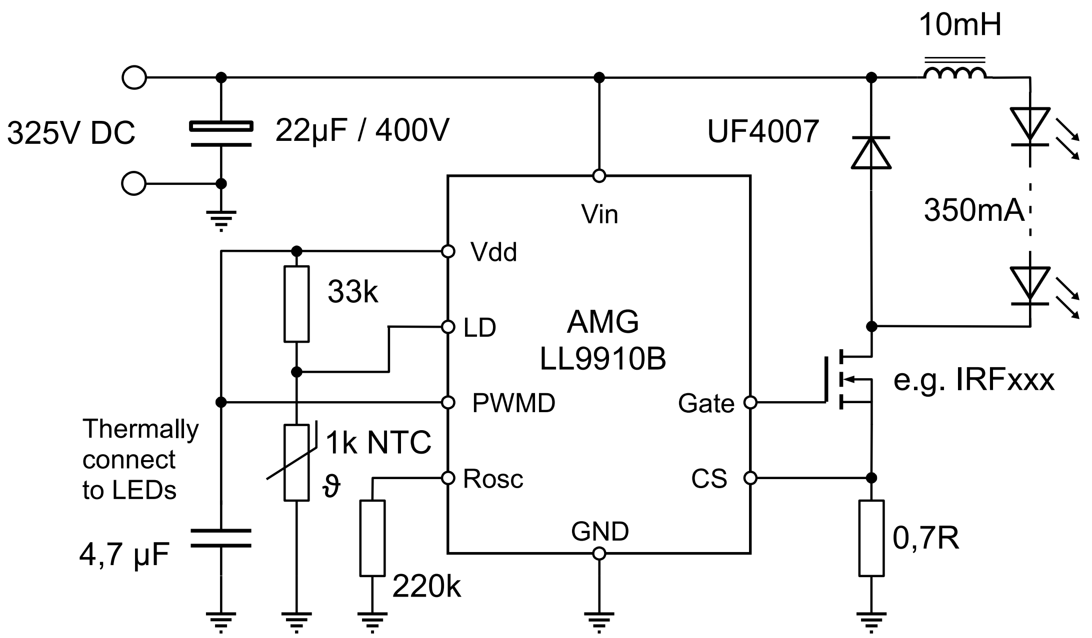


Figure 6: Buck topology, with Temp-Protection

9.6. Battery Powered LED Driver

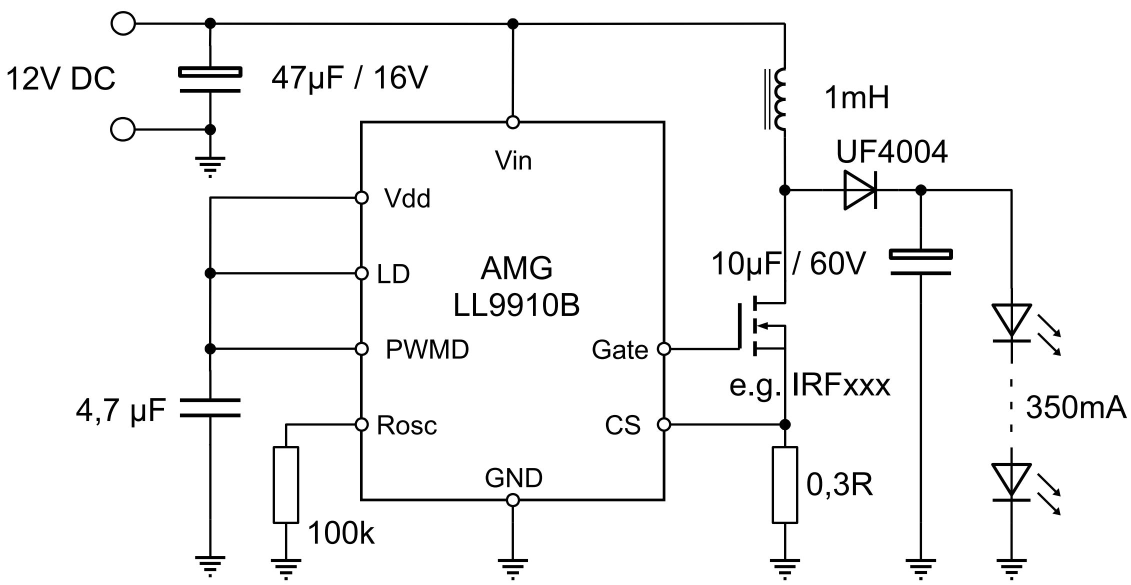


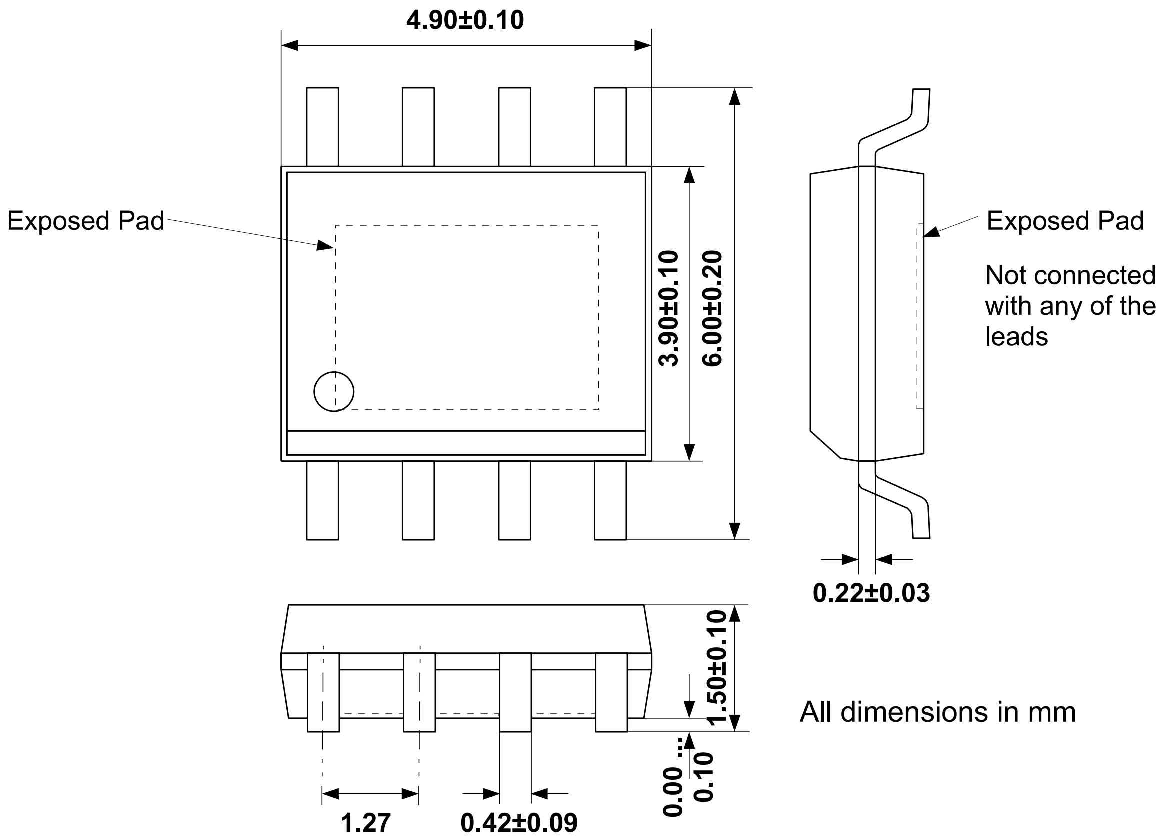
Figure 7: Boost topology

10. Ordering Information

AMG-LL9910B-ISO08U	SOP8 in tubes
AMG-LL9910B-ISO08R	SOP8 in tape and reel

11. IC-Package

SOP8 with exposed pad



All dimensions in mm

12. IC-Marking

αLL9910

4 digit date code

4 … 6 digit lot code

13. Notes and Cautions

13.1. ESD Protection

The Requirements for Handling Electrostatic Discharge Sensitive Devices are described in the JEDEC standard JESD625-A. Please note the following recommendations:

- ❑ When handling the device, operators must be grounded by wearing a grounded wrist strap with at least 1MΩ resistance with direct skin contact.
- ❑ Operators must at all times, wear ESD protective shoes or the area should be surrounded by ESD protected floor mats.
- ❑ The opening of an EDS protective package or device must only occur on a properly equipped ESD workbench. The tape with which the package is held together must be cut with a sharp cutting tool, never pulled or ripped off.
- ❑ Any unnecessary contact with the device or any unprotected conductive points should be avoided.
- ❑ Only work with qualified and grounded tools, measuring equipment, casings and workbenches.
- ❑ When outside of properly protected ESD-areas, the device or any electronic assembly must be protected and always be transported in EGB/ESD shielded packaging.

13.2. Storage conditions

The AMG-LL9910B corresponds to moisture sensitivity classification ML2, according to JEDEC standard J-STD-020, and should be handled and stored according to J-STD-033.

14. Disclaimer

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