Universal High Voltage Single Channel LED Driver

1. Functional Description of the AMG-LL9910

The AMG-LL9910 is a universal high voltage LED driver. Buck and boost topologies are possible. It has one current regulated channel.

The AMG-LL9910 controls an external MOSFET at fixed switching frequencies up to 300 kHz. The frequency can be programmed using a single resistor. The LED string is driven at a constant current rather than a constant voltage, thus providing a constant light output and an enhanced reliability. The output current to an 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 of 0-100% and a frequency of up to a few kilohertz.

2. Features

- >90 % efficiency
- 10 – 600V
- Peak current mode converter
- Linear and PWM dimming capability
- Buck and Boost topology
- Pin compatible with other HV LED drivers
- Available as bundle with MOSFET

3. Application

The AMG-LL9910 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

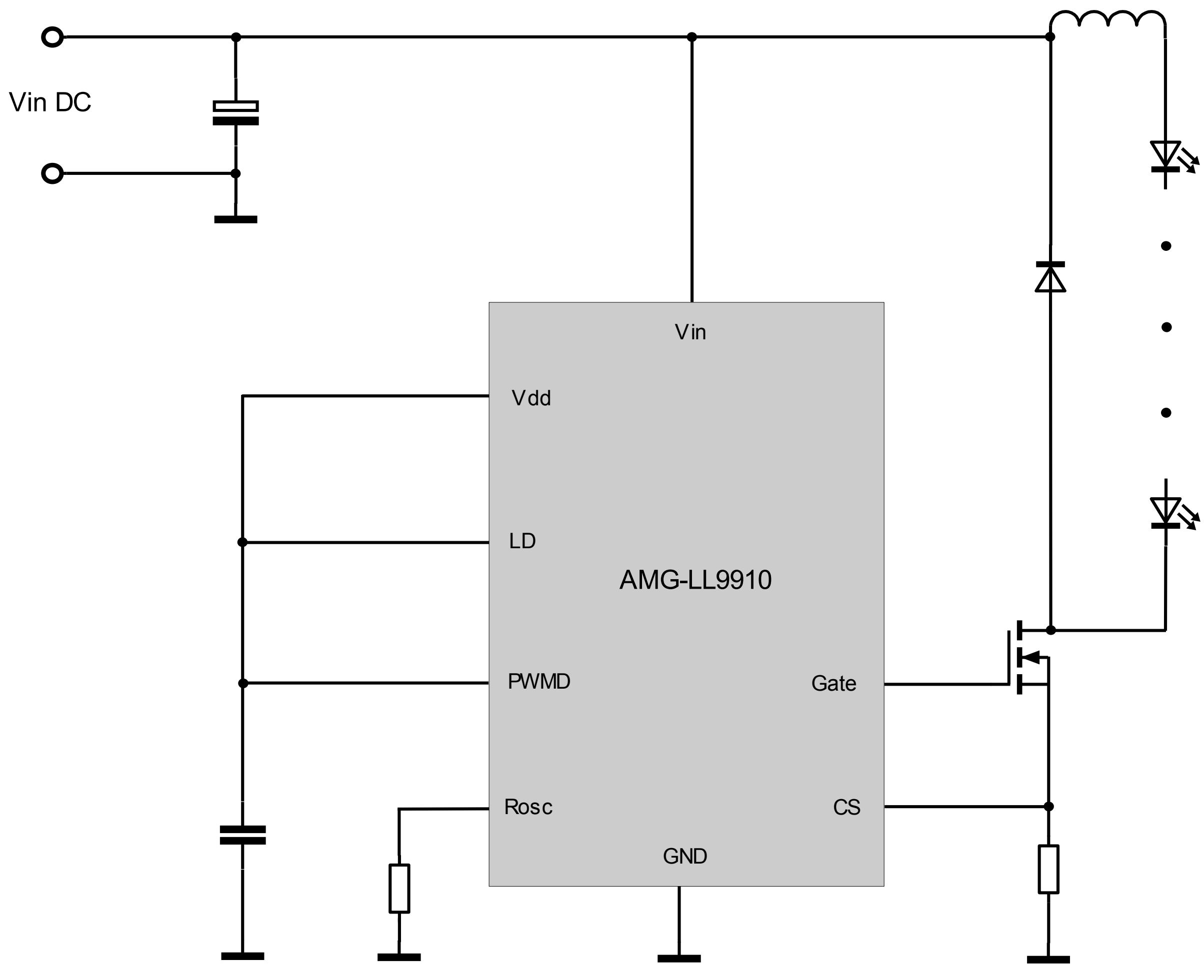

Figure 1: Buck LED Driver

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4. Block Diagram

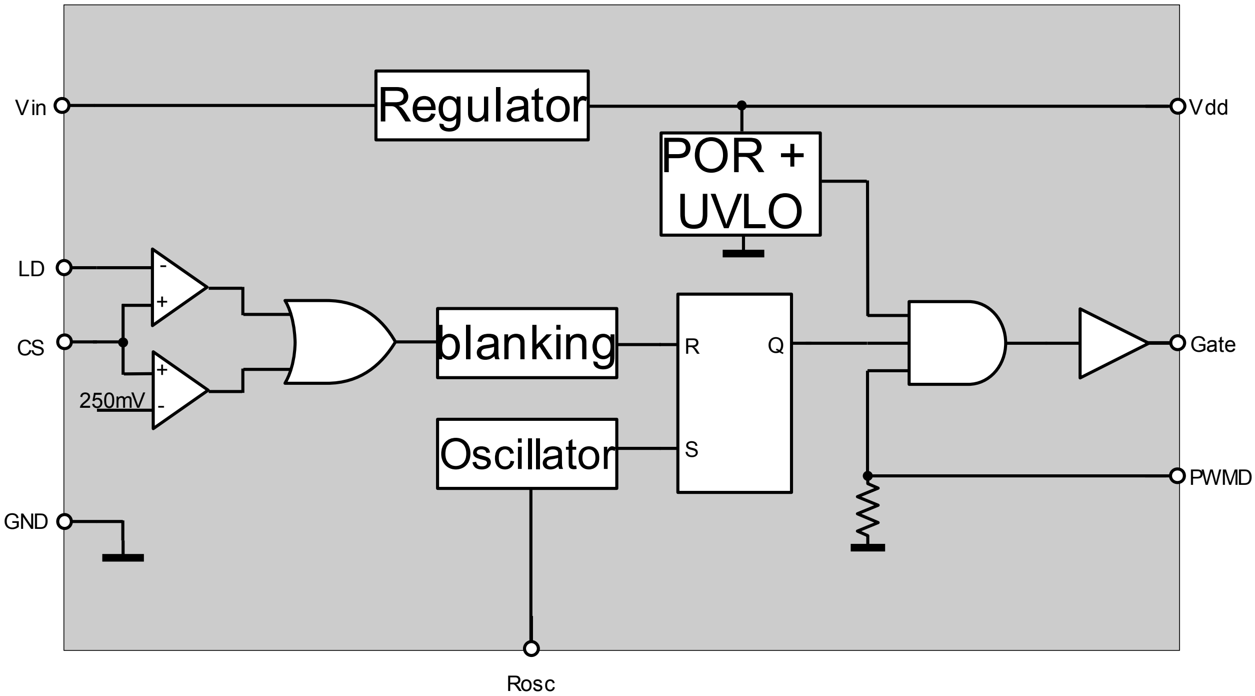


Figure 2: Block Diagram

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. IC is released from reset, after Vdd rises above the UVLO voltage.

Linear Dimming Comparator

Manual setting of V_{CS} threshold.

Current Sense Comparator

Current limiting comparator

Blanking Timer

Inserts time delay from CS trip to Gate low, so to enable 100% duty cycle

RS Flip Flop

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

Gate Driver

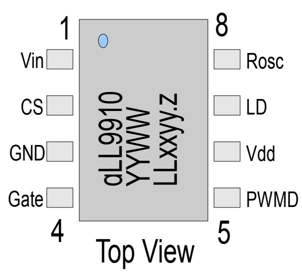
Drives external MOSFET. Gated by external PWM or enable signal.

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	Rosc	Oscillator resistor
6	LD	Linear Dimming
7	Vdd	Linear regulator output
8	PWMD	PMW dimming input



7. Absolute Maximum Ratings

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

#	Symbol	Parameter	Min	Max	Unit
1	V_{in}	Supply input voltage	-0.5	625	V
2	V_{logic}	Voltage on CS, LD, PWMD, Gate	-0.3	V_{dd} + 0.3	V
3	T_j	Junction temperature		125	C
4	T_S	Storage temperature	-65	150	C
5	ESD	Electrostatic discharge voltage		1000	V
6	V_{ddmax}	Max. voltage on Vdd	-0.3	10	V

Note: All voltages are with respect to GND

8. Electrical Characteristics

8.1. Operational Range

#	Symbol	Parameter	Min	Max	Unit
1	Vin	Supply	10	600	V
2	To	Operating ambient temperature	-40	85	C
3	PWM	Duty Cycle	0	100	%
4	Rth	Thermal resistance junction ambient		45	C/W

Note:

8.2. DC Characteristics

#	Symbol	Parameter	Min	Typ	Max	Unit
1	Vdd	Regulator output voltage	7	7.5	8	V
2	I_{ext}	Current for ext. circuitry			0.7	mA
3	ΔVdd	Load regulation	0		100	mV
4	UVLO	Undervoltage lockout (Vdd rising)	6.45	6.7	6.95	V
5	ΔUVLO	Undervoltage lockout hysteresis (Vdd falling)		500		mV
6	$V_{in\ low}$	Input voltage logic low (PWMD)			0.8	V
7	$V_{in\ high}$	Input voltage logic high (PWMD)	2			V
8	R_{PWMD}	Pull down on PWMD pin	50	100	150	kΩ
9	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)	0.5		1	mA

Note:

8.3. AC Characteristics

#	Symbol	Parameter	Min	Typ	Max	Unit
1	fosc	Oscillator frequency	20		300	kHz
2	V_{LD}	Linear dimming voltage range	0		Vcs	mV
3	t_{blank}	Current sense blanking time	150	215	280	ns
4	t_{delay}	Time from CS trip to Gate low			300	ns
5	t_{rise}	Gate driver output rise time (Cgate = 500pF)	30		50	ns
6	t_{fall}	Gate driver output fall time (Cgate = 500pF)	30		50	ns

Note:

9. Application

9.1. Example Application Circuit(s)

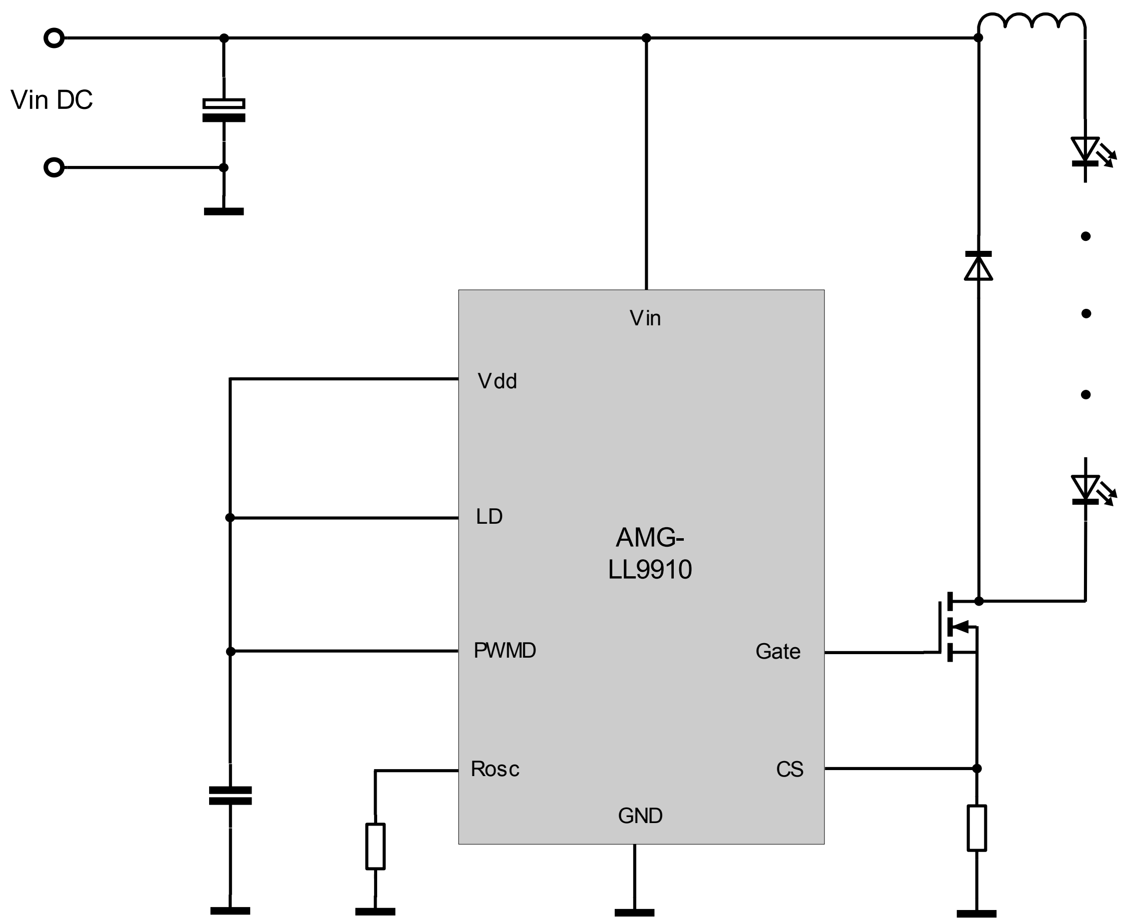


Figure 3: Buck LED Driver

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 the sense resistor R_{CS} reaches the current limit, the current sense comparator will trip and after the 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 case, highest light intensity is desired the ripple should be maximized and the LED driven to it's specified peak current limit.

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

b) LED Current

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

If a peak current for highest light intensity is desired, the resistor value may 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 may 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, the output voltage, the 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 in the string times the LED forward voltage.

$V_{out} = n * V_F$

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

Please bare in mind, that the forward LED voltage is a function of the LED current. The LED data sheet should provide for the corresponding forward voltage for a given LED current.

D = Vout/Vin

For a buck design, D has to be lower than 1.

Then we need to determine the ripple of the LED current which leads us to the actual inductor value.

For 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 for 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 at 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 (i.e. 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, when during the off-time of the external PWM signal.

The external PWM frequency needs to be much smaller than the PWM frequency of the AMG-LL9910. The external PWM frequency should be at least 10x smaller, otherwise fluctuation effects might happen.

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:

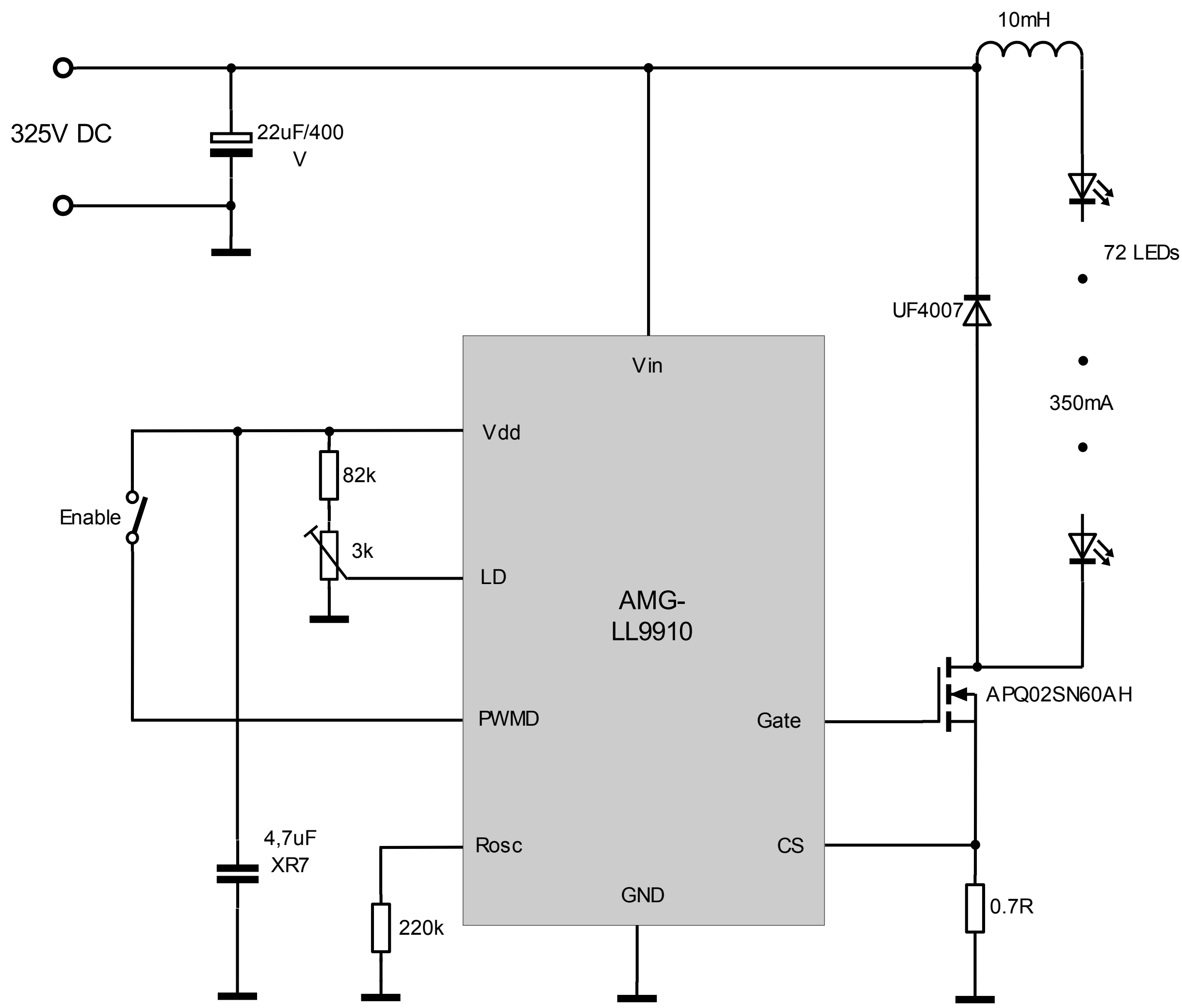
f) PWM Frequency

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

g) PFC

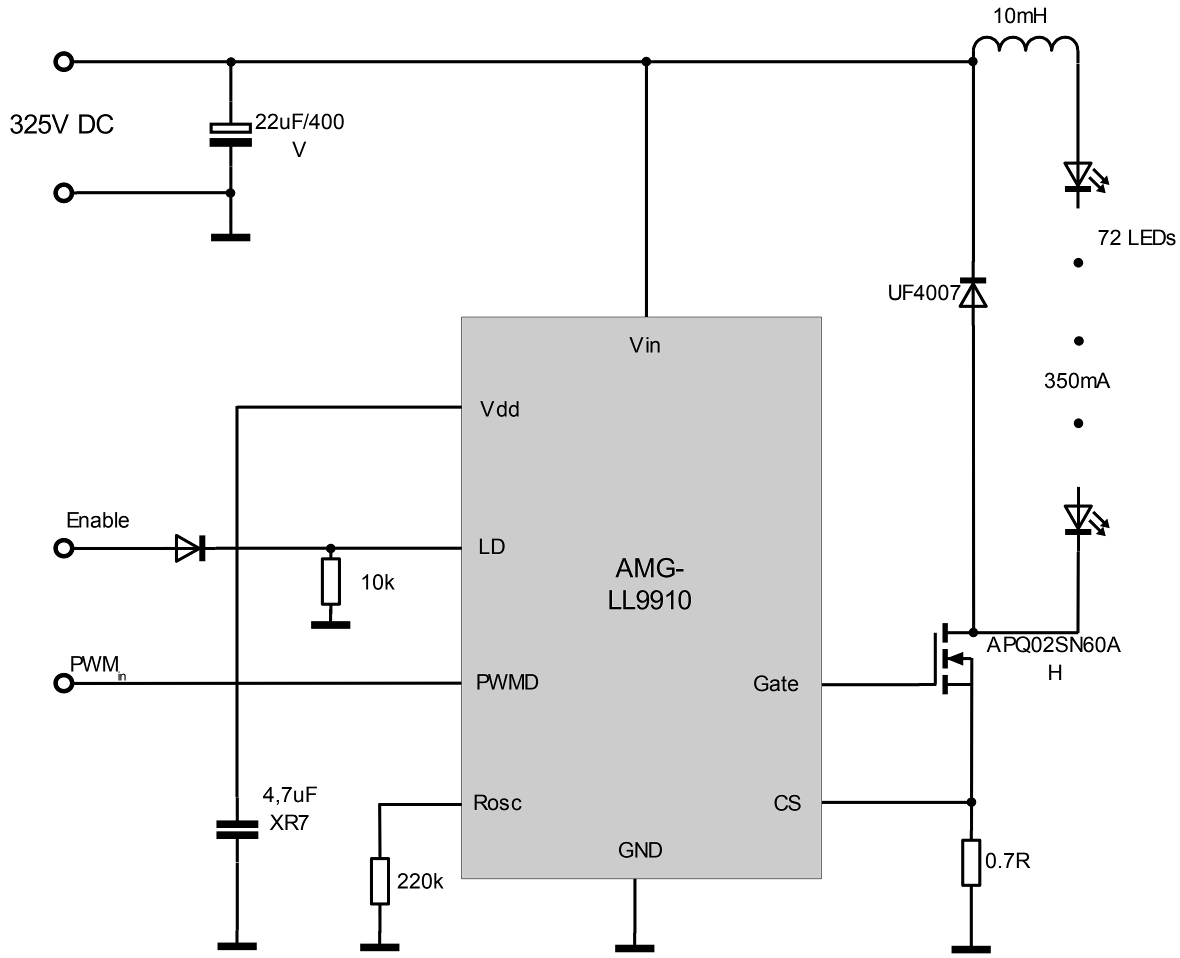
The AMG-LL9910 does not have a PFC stage integrated. As such a PFC is usually necessary for off line LED drivers. This can be either a passive PFC or even an active one, when the power grows relatively high.

9.3. Off Line LED Driver



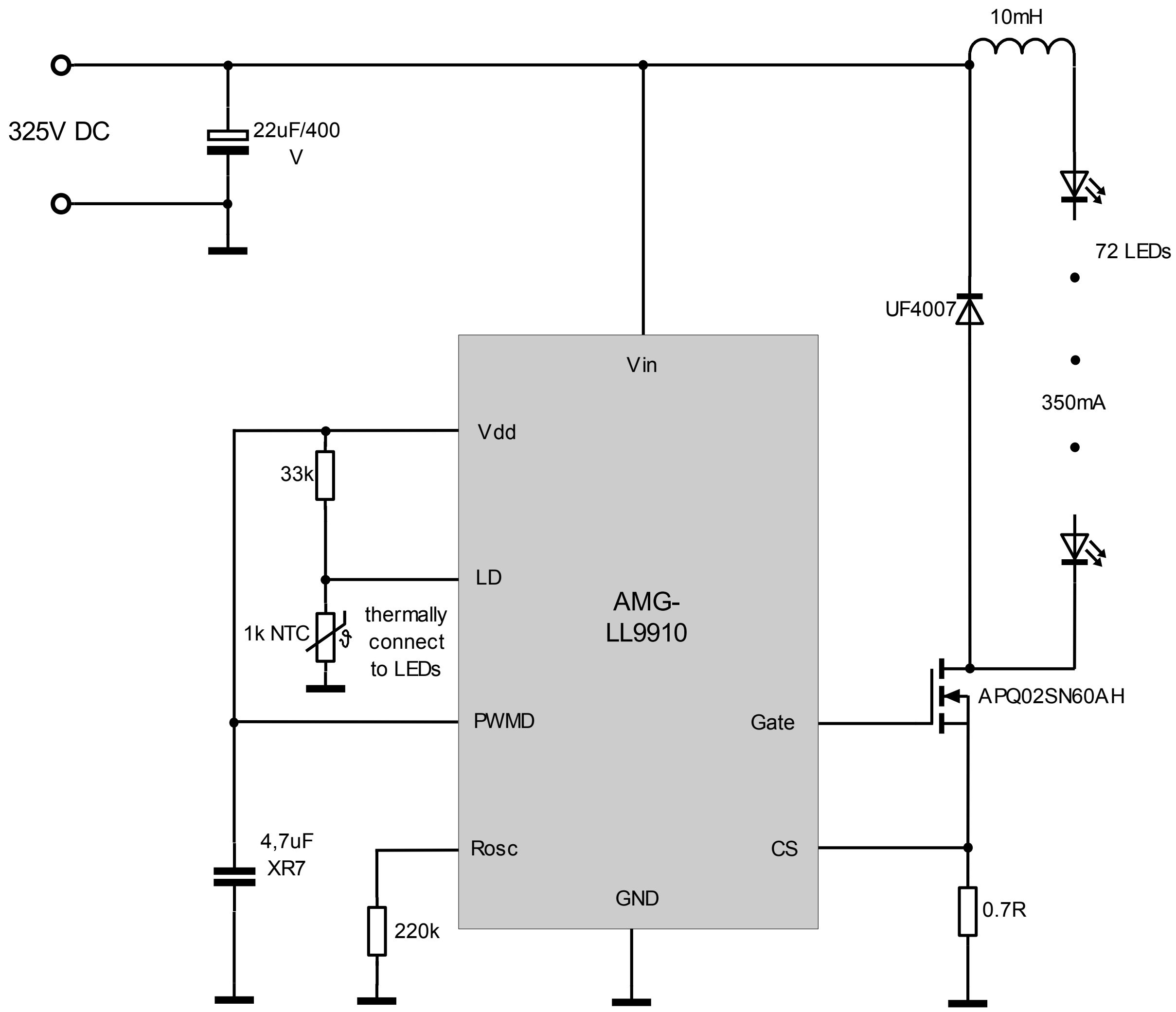
Buck topology, linear dimming, enable switch

9.4. Off Line LED Driver with Digital I/F

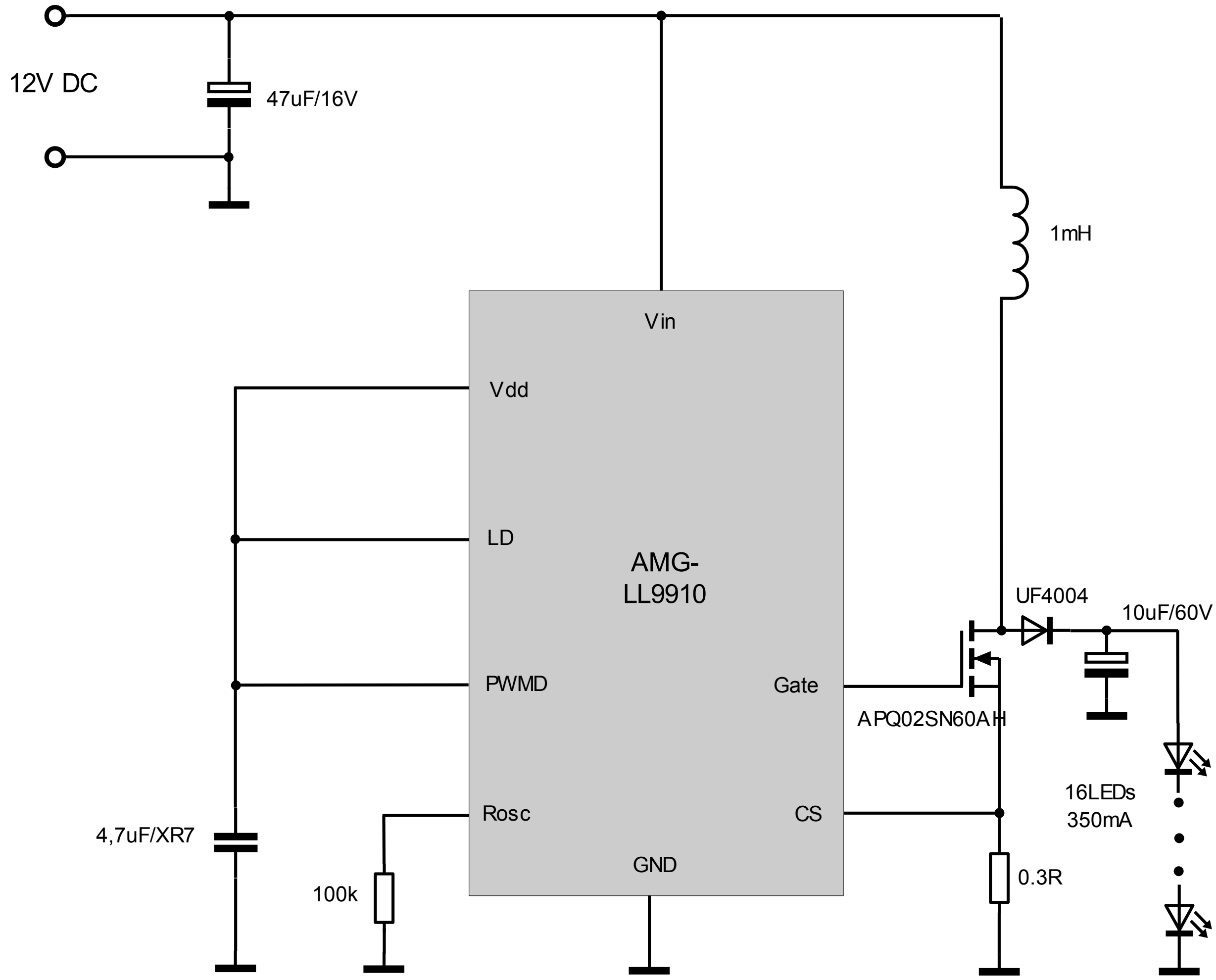


Buck topology, digital dimming, enable signal

9.5. Off Line LED Driver with Temp-Protection



9.6. Battery Powered LED Driver



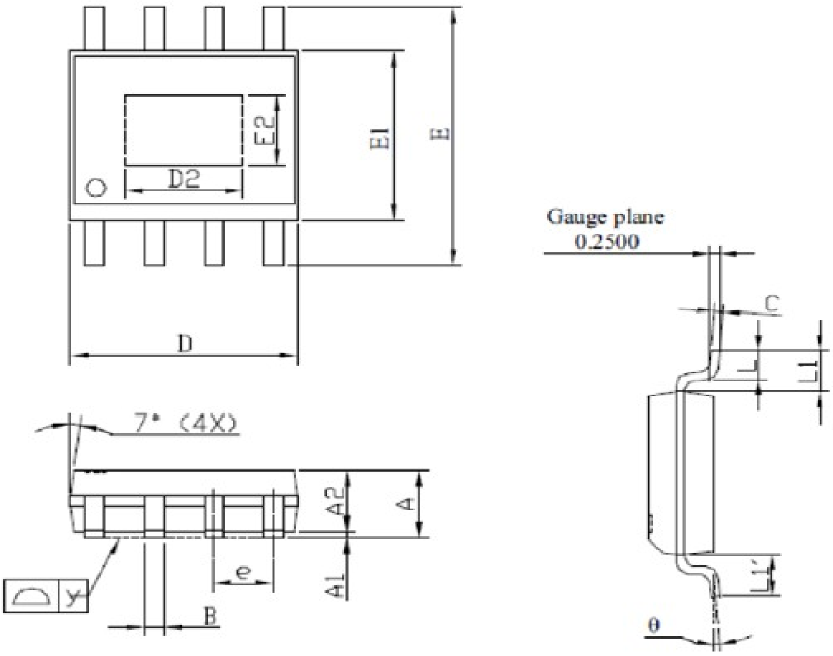
Boost topology

10. Ordering Information

AMG-LL9910-ISO08U	SO8 in tubes
AMG-LL9910-ISO08R	SO8 in tape and reel
AMG-LL9910-bundle1	with 400V/5A MOSFET in tubes
AMG-LL9910-bundle2	with 600V/2A MOSFET in tubes

11. IC-Package

SO8



DIMENSIONS						
DIM	mm			Inches		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.4	1.5	1.6	0.055	0.059	0.063
A1	0		0.1	0.00		0.004
A2		1.45			0.057	
B	0.33		0.51	0.013		0.02
C	0.19		0.25	0.007		0.01
D	4.8		5.0	0.189		0.197
D2	3.2	3.3	3.4	0.126	0.13	0.134
E	5.8	6.0	6.2	0.228	0.236	0.244
E1	3.8	3.9	4.0	0.15	0.153	0.157
E2	2.3	2.4	2.5	0.091	0.095	0.099
e		1.27			0.05	
L	0.4		1.27	0.016		0.05
y			0.1			0.004
θ	0°		8°	0°		8°
L1-L1'			0.12			0.005
L1	1.04REF			0.041REF		

12. IC-Marking

αLL9910

4 digit date code

7 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 for the purpose designed grounded wrist strap with at least 1MΩ resistance and direct skin contact.
- ❑ Operators must at all times wear ESD protective shoes or the area should be surrounded by for ESD protection intended floor mats.
- ❑ Opening of the protective ESD package that the device is delivered in must only occur at 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.
- ❑ Work only with qualified and grounded tools, measuring equipment, casing and workbenches.
- ❑ Outside properly protected ESD-areas the device or any electronic assembly that it may be part of should always be transported in EGB/ESD shielded packaging.

13.2. Storage conditions

The AMG-LL9910 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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