DESCRIPTION

The A9910 is a PWM high-efficiency LED driver control IC. It allows efficient operation of high-brightness (HB) LEDs from voltage sources ranging from 10VDC up to 600VDC. The A9910 controls an external MOSFET at fixed switching frequencies up to 300kHz. 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 enhanced reliability. The current output can be programmed between a few milliamps and up to more than 1.0A. The A9910 uses a rugged high-voltage junction isolated process that can withstand an input voltage surge of up to 600V. The current output 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 A9910. The A9910 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 kHz. The A9910 is available in the SOP8 package.

FEATURES

- Over 90% efficiency
- 10V to 600V input range
- Constant-current LED driver
- Applications from a few mA to more than 1A output
- LED string from one to hundreds of diodes
- Linear and PWM dimming capability
- Input voltage surge ratings up to 600V
- Available in SOP8 Package

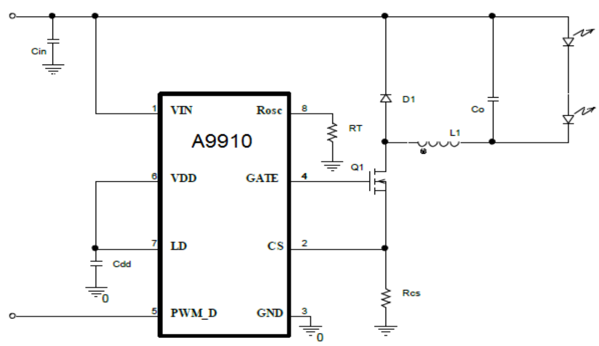
APPLICATION

- DC/DC or AC/DC LED driver applications
- RGB backlighting LED driver
- Backlighting of flat panel displays
- General-purpose constant current source
- Signage and decorative LED lighting
- Automotive
- Chargers

ORDERING INFORMATION

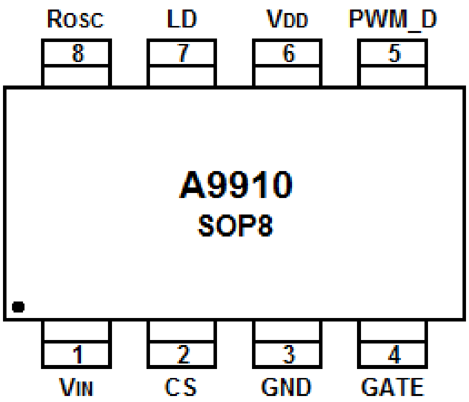
Package Type	Part Number	
SOP8 SPQ: 4,000pcs/Reel	M8	A9910M8R
		A9910M8VR
Note	R: Tape & Reel V: Halogen free Package	
AiT provides all RoHS products		

TYPICAL APPLICATION



- 1 -

PIN DESCRIPTION



SOP8, M8

Top View

Pin #	Symbol	Function
1	V_{IN}	Power Supply
2	CS	Senses LED string current.
3	GND	Ground
4	GATE	Drives the gate of the external MOSFET
5	PWM_D	Low Frequency PWM Dimming pin
6	V_{DD}	Internally regulated supply voltage
7	LD	Linear Dimming by changing the current limit threshold at current sense comparator-
8	R_{OSC}	Oscillator control

ABSOLUTE MAXIMUM RATINGS

V_{IN} to GND	-0.5V ~ +600V
CS, LD, PWM_D, GATE to GND	-0.3V ~ V_{DD}+0.3V
Continuous power dissipation (T_A = +25°C)NOTE1	-
SOP8(derate 6.3mW/°C above +25°C)	630mW
Operating Temperature Range	-40°C ~ +85°C
Junction Temperature	+125°C
Storage Temperature Range	-65°C ~ +150°C

Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE1: Also limited by package power dissipation limit, whichever is lower.

ELECTRICAL CHARACTERISTICS

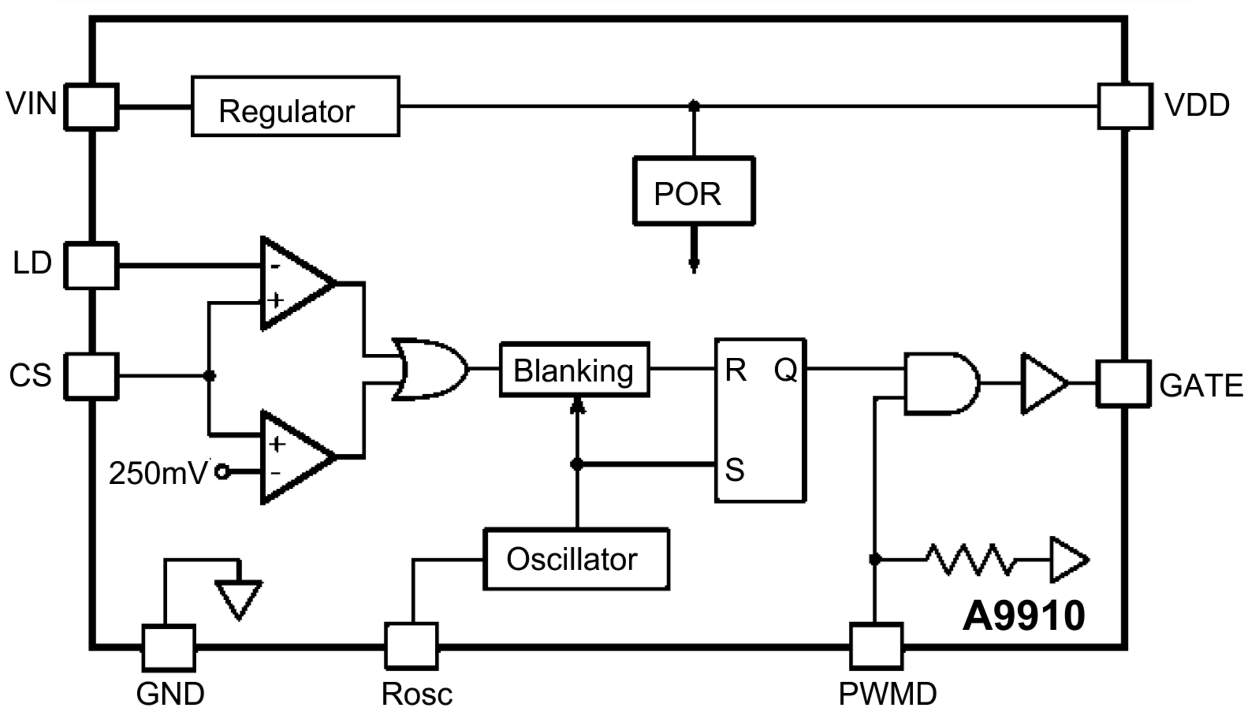
T_A = +25°C, unless noted otherwise

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input DC supply voltage range	V_{INDC}	DC input voltage	10.0	-	600	V
Shut-down mode supply current	I_{INSD}	Pin PWM_D to GND, V_{IN}=8V	0.5	-	1	mA
Internally regulated voltage	V_{DD}	V_{IN} = 10 to 600V, $I_{DD(ext)}$=0, pin Gate open	7.0	7.5	8.0	V
Load regulation of V_{DD}	$\Delta V_{DD,\ load}$	$I_{DD(ext)}$ = 0 to 1.0mA, 500pF at GATE; R_{OSC} = 226kΩ, PWM_D= V_{DD}	0	-	100	mV
Maximal pin V_{DD} voltage	$V_{DD,max}$	When an external voltage is applied to pin V_{DD}	-	-	10.0	V
V_{DD} current available for external circuitry	$I_{DD(ext)}$	V_{IN} = 10 to 100V	-	-	0.7	mA
V_{DD} Undervoltage lockout threshold	UVLO	V_{IN} rising	0.87* VDD	0.89* VDD	0.91* VDD	%
V_{DD} Undervoltage lockout hysteresis	ΔUVLO	V_{IN} falling	-	500	-	mV

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Pin PWM_D input low voltage	$V_{EN(lo)}$	V_{IN} = 10 to 600V	-	-	0.8	V
Pin PWM_D input high voltage	$V_{EN(hi)}$	V_{IN} = 10 to 600V	2.0	-	-	V
Pin PWM_D pull-down resistance	R_{EN}	V_{EN} = 5V	50	100	150	kΩ
Current sense pull-in threshold voltage	$V_{CS(hi)}$	T_A = -40 C to +85 C	238	250	262	mV
GATE high output voltage	$V_{GATE(hi)}$	I_{OUT} = 10mA	V_{DD} - 0.3	-	V_{DD}	V
GATE low output voltage	$V_{GATE(lo)}$	I_{OUT} = -10mA	0	-	0.3	V
Oscillator frequency	f_{OSC}	R_{OSC} = 1.00MΩ R_{OSC} = 226kΩ	20 80	25 100	30 120	kHz
Maximum Oscillator PWM Duty Cycle	$D_{MAX\ hf}$	$F_{PWM\ hf}$ = 25kHz, at GATE, CS to GND	-	-	100%	-
Pin LD (Linear Dimming) voltage range	V_{LD}	T_A = ≦85°C, V_{IN} = 12V	0	-	250	mV
Current sense blanking interval	T_{BLANK}	V_{CS} = 0.55V_{LD}, V_{LD} = V_{DD}	150	215	280	ns
Delay from CS to GATE lo	t_{DELAY}	V_{IN} = 12V, V_{LD} = 0.15, V_{CS} = 0 to 0.22V after T_{BLANK}	-	-	300	ns
GATE output rise time	t_{RISE}	C_{GATE} = 500pF, V_{DD} = 7.5V	30	-	50	ns
GATE output fall time	t_{FALL}	C_{GATE} = 500pF, V_{DD} = 7.5V	30	-	50	ns

- 4 -

BLOCK DIAGRAM



- 5 -

Application Note

Oscillator

The oscillator in the A9910 is controlled by a single resistor connected at the RT pin. The equation governing the oscillator time period tosc is given by:

$$t_{OSC}(\mu s) = \frac{R_T(k\Omega) + 22}{25}$$

If the resistor is connected between RT and GND, The A9910 operates in a constant frequency mode and the above equation determines the time period. If the resistor is connected between RT and GATE, the A9910 operates in a constant off-time mode and the above equation determines the off-time.

Current Sense Resistor

A resistor connected to the Rosc pin programs the frequency of operation. This current flows through the external sense resistor Rcs and produces a ramp voltage at the CS pin. The comparators are constantly comparing the CS pin voltage to both the voltage at the LD pin and the internal 250mV.

The formula for the calculation of Iled for 9910 in a typical application circuit is:

$$R_{CS} = \frac{0.25V \text{ (or } V_{LD})}{1.15 \cdot I_{LED} \text{ (A)}}$$

Input Voltage

The A9910 can be powered directly from its VIN pin. The A9910 maintains a constant 7.5V (typical) on the VDD pin when voltage is applied to the VIN pin. This voltage is used to power the IC as well as any external resistor divider required to control the IC and the VDD pin must be bypassed with a low ESR capacitor.

Please note that the external voltage on the VDD pin should not exceed 12V.

Linear and PWM Dimming.

Use the linear dimming pin to control the LED current. There are two situations where the linear dimming pin may be required.

1. Unable to find the exact Rcs value required to obtain the LED current. In this case, an external voltage divider from the VDD pin can be connected to the LD pin to obtain a voltage corresponding to the desired voltage on Rcs (when less than 250mV).

2. Linear dimming may be required to adjust the current level to reduce the intensity of the LED. It can connect an external 0-250mV voltage to the LD pin to adjust the LED current.

PWM dimming can be achieved by driving the PWMD pin with a low-frequency PWM signal. The PWMD signal does not shut down the rest of the IC, so the rise and fall rates of the LED current are determined only by the rise and fall times of the inductor current. To disable PWM dimming and permanently enable the A9910, connect the PWMD pin to VDD.

Inductor

When the CCM mode operates in A9910, the DC conversion between the input and output voltage is:

Vout = Vin*D/(1-D)   D=Vout/(Vin+Vout)

D =Duty cycle   Vout = Voltage difference across the LEDs

If set the $I_{(LED)}$ =350mA. and the Fosc= 50Khz. Vin=12V and Vout =9V

D = 9/(12-9) =0.43

Ton=D/ Fosc =8.6 uS

The required value of the inductor is calculated:

$L = Vin * Ton/(0.3 * I_{(LED)}) = 0.98mH \cong 1mH$

Capacitors Cin and Co:

Cin: The minimum capacity in the capacitor value can be calculated as:

$Cin \geq (V_{(LED)MAX} \cdot I_{(LED)MAX}) /((2 \cdot V^2_{MIN,AC} \cdot V^2_{MIN,DC}) \cdot efficiency \cdot Fosc)$.

Such electrolytic capacitors that have a large ESR of these capacitors make it inappropriate to absorb the high-frequency ripple current generated by the buck converter. Thus, adding a small MLCC capacitor in parallel with the electrolytic capacitor is a good option.

The required high-frequency capacitance can be computed as:

$Cout= (I_{(LED)MAX} \cdot 25) / (Fosc \cdot 0.05 \cdot V_{MIN,DC})$.

Q1(MOSFET) and D1 (Diode)

Typically, a FET and a Diode with about 3 times the maximum current are chosen to minimize the resistive losses in the switch. For the FET, using a large power dissipation package and low R_{DS-ON} is usual.

The same selection as a Low V_F Schottky and a large power dissipation package diode as well.

The maximum rms current through the FET depends on the maximum duty cycle, which is 50% by design. Hence, the current rating of the FET is:

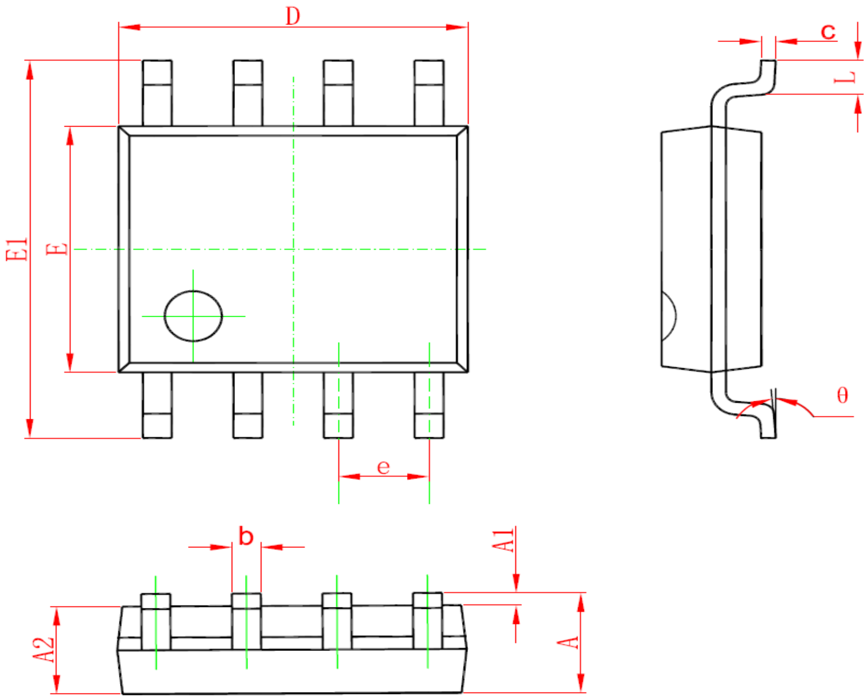
$$I_{FET} \cong I_{(LED)MAX} \cdot \sqrt{0.5}$$

The average current through the Diode is:

$$I_{Diode} \cong (I_{(LED)MAX}/ \sqrt{2}) \cdot \sqrt{0.5}$$

PACKAGE INFORMATION

Dimension in SOP8 (Unit: mm)



Symbol	Min	Max
A	1.350	1.750
A1	0.100	0.250
A2	1.350	1.550
b	0.330	0.510
c	0.170	0.250
D	4.700	5.100
E	3.800	4.000
E1	5.800	6.200
e	1.270(BSC)	
L	0.400	1.270
θ	0°	8°

IMPORTANT NOTICE

AiT Semiconductor Inc. (AiT) reserves the right to make changes to any its product, specifications, to discontinue any integrated circuit product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

AiT Semiconductor Inc.'s integrated circuit products are not designed, intended, authorized, or warranted to be suitable for use in life support applications, devices or systems or other critical applications. Use of AiT products in such applications is understood to be fully at the risk of the customer. As used herein may involve potential risks of death, personal injury, or servere property, or environmental damage. In order to minimize risks associated with the customer's applications, the customer should provide adequate design and operating safeguards.

AiT Semiconductor Inc. assumes to no liability to customer product design or application support. AiT warrants the performance of its products of the specifications applicable at the time of sale.

- 9 -