HBLED Driver for High Current Applications

General Description

VAS1210 is an step-down constant-current high-brightness LED (HB LED) drivers provide a cost-effective solution for exterior lighting, architectural and ambient lighting, LED bulbs such as MR16 and other LED illumination applications.

The VAS1210 operate from a 4.5V to hundreds of volts input range and feature a 10V/100mA on-board regulator. A high-side current-sense resistor adjusts the output current and a dedicated analog/PWM input (ADJ) enables a wide range of pulsed dimming.

The VAS1210 is well suited for applications requiring a wide input voltage range. The high-side current-sensing and an integrated current setting circuitry minimize the number of external components while delivering an LED current with ±5% accuracy. A novel control algorithm ensures excellent input-supply rejection and fast response during load transients and PWM dimming. The devices operate up to 1MHz switching frequency, thus allowing for small component size.

The VAS1210 operate over the -40°C to +85°C temperature range and available in SOT23-6L packages.

Application

- Architectural, Industrial and Ambient Lighting
- MR16 and Other LED Bulbs
- Indictors and Emergency Lighting

Features

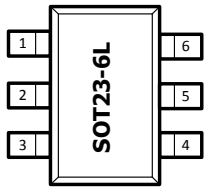
- 10V MOSFET Gate Driver
- Wide supply range from 4.5 V to hundreds of volts
- High-Side Current Sense
- Auto Adapt Analog or PWM Dimming Control Input
- 20kHz Maximum PWM Dimming Frequency
- No Compensation Capacitor
- Up to 1MHz Switching Frequency
- ±5% LED Current Accuracy
- Adjustable Constant LED Current
- -40°C to +85°C Operating Temperature Range

Ordering Information

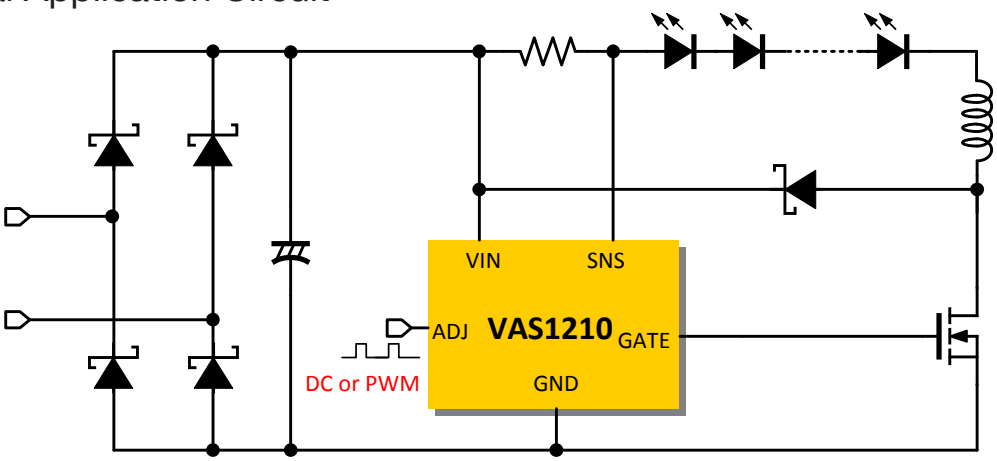
Order Number	Package Type	Temp. Range
VAS1210IC06E	SOT23-6L	-40 °C to 85°C

Pin Configuration

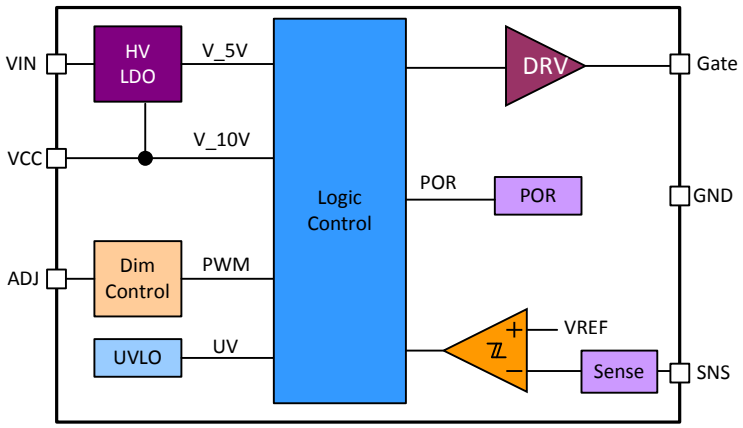
SOT23-6L



Typical Application Circuit



Block Diagram



PIN Description

PIN NO.	Name	Description
1	Gate	Gate Drive Output. Connect to the gate of an external N-MOSFET
2	GND	Ground
3	ADJ	Multi-function On/Off and brightness control pin: • Drive to voltage below 0.2V to turn off output current • Leave floating for normal operation, output current $I_{OUTNOM}=0.2/R_S$) • Drive with DC voltage ($0.25V<V_{ADJ}<1.2V$) to adjust output current from 20% to 100% of I_{OUTNOM} • Drive with a PWM signal to adjust output current: Adjustment range 25% to 100% of I_{OUTNOM} for f >10kHz and 1% to 100% of I_{OUTNOM} for f <500Hz
4	SNS	Current Sense Input
5	VCC	10V Voltage Regulator Output. Connect a 1uF capacitor from VCC to GND
6	VIN	Positive Supply Voltage Input. Bypass with a 1μF or higher value capacitor to GND.

Absolute Maximum Ratings (Note1)

Parameters	Maximum Ratings
VIN, SNS to GND	-0.3V to 44V
VIN to SNS	-0.3V to +0.3V
ADJ to GND	-0.3V to 6V
VCC, Gate to GND	-0.3V to 18V
Operating temperature range	-40°C to +85°C
Junction temperature	-40°C to +150°C
Storage temperature range	-65°C to +150°C

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Electrical Characteristics

Test Condition(note 2): VIN=12V, T_A=25°C (unless otherwise specified)

Symbol	Parameter	Condition	SPEC			Unit
			Min.	Typ.	Max.	
VIN	Input voltage range		4.5		40	V
I_{CC}	Quiescent current	V_{ADJ}>1.2V, all external devices open		400		uA
I_{SD}	Shutdown supply current	V_{ADJ}<0.2V		40		uA
UVLO	Under-voltage Lockout			4.3		V
UVLO-HYS	UVLO Hysteresis			0.2		V
SENSE COMPARATOR						
V_{SNSHI}	Sense Voltage Threshold High	(V_{IN}-V_{SNS}) rising from 0V until Gate < 0.5V		220		mV
V_{SNSLO}	Sense Voltage Threshold Low	(V_{IN}-V_{SNS}) falling from 0.22V until Gate > V_{CC}-0.5V		180		mV
T_{DPDN}	Propagation Delay to Output High			50		ns
T_{DPDL}	Propagation Delay to Output Low			50		ns
I_{SNS}	Current Sense Input Curret	VIN-VSNS=100mV			10	uA
GATE DRIVER						
$I_{Gate-SRC}$	Gate Driver Source Current	V_{SNS}=V_{IN}, VGate=0.5*VCC		0.2		A
$I_{Gate-SINK}$	Gate Driver Sink Current	V_{SNS}=V_{IN}-220mV, VGate=0.5*VCC		0.4		A
DIMMING INPUT						
$F_{PWM-MAX}$	Maximum PWM Dimming Frequency				20	kHz

V_{IH}	PWM Dimming Input-Voltage-High				1.2	V
V_{IL}	PWM Dimming Input-Voltage-Low		0.2			V
T_{PWMON}	PWM Dimming Minimum Turn-On Time			3		us
T_{PWMOFF}	PWM Dimming Maximum Turn-Off time				15	ms
VCC REGULATOR						
VCC	Regulator Output Voltage			10		V

Note 2: Production testing of the device is performed at 25°C. Functional operation of the device and parameters specified over other temperature range, are guaranteed by design, characterization and process control.

Application Information

The VAS1210 is a step-down, constant- current, high-brightness LED (HB LED) drivers. These devices operate from a 4.5V to 40V input voltage range and provide up to 0.5A of source and 1A of sink drive capability to the gate of an external MOSFET. A high- side current-sense resistor sets the output current and a dedicated analog or PWM dimming input (ADJ) allows for a wide range of independent pulsed dimming.

The high-side current-sensing scheme and on-board current setting circuitry minimize the number of external components while delivering LED current with a ±5% accuracy, using a 1% sense resistor. See the Functional Diagram.

1. Under-Voltage Lockout (UVLO)

The VAS1210 include a 4.3V under-voltage lockout (UVLO) with 700mV hysteresis. When V_{IN} falls below 4.3V, Gate goes low, turning off the external n-channel MOSFET. Gate goes high once V_{IN} is 5V or higher.

2. 10V Regulator

VCC is the output of a 10V regulator capable of sourcing 100mA. Bypass VCC to GND with a 1uF capacitor.

3. ADJ Input

The VAS1210 allow both analog and PWM dimming.

When a external PWM signal is added at the ADJ input. A logic level below 0.2V at DIM forces the VAS1210 DRV output low, turning off the LED current. To turn the LED current on, the logic level at DIM must be at least 1.2V.

When a analog with 0.25V to 1.2V range is apply to ADJ pin, the LED current will be adjusted from 20% to 100% full brightness.

4. Selecting R_{SNS} to Set the LED Current

The VAS1210 feature a programmable LED current using a resistor connected between VIN and SNS. Use the following equation to calculate the sense resistor:

$$R_{SENSE}(\Omega) = \frac{1}{2}\frac{(V_{SNSHI} + V_{SNSLO})(V)}{I_{LED}(A)}$$

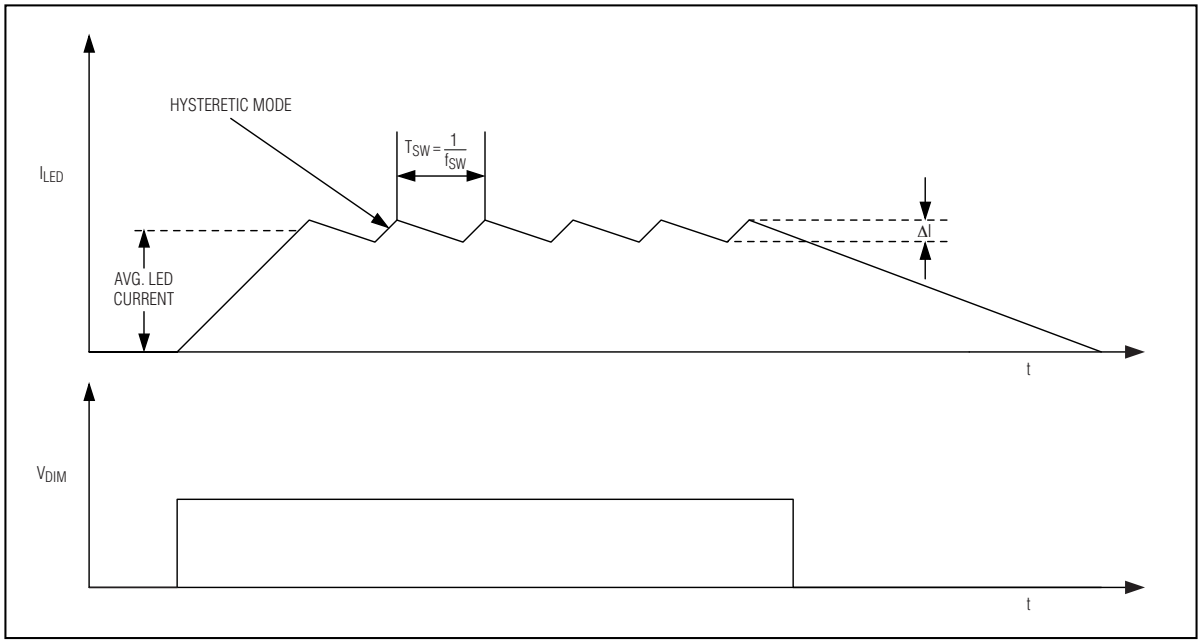
5. Current Regulator Operations

The VAS1210 regulate the LED output current using an input comparator with hysteresis (Figure 1).

As the current through the inductor ramps up and the voltage across the sense resistor reaches the upper threshold, the voltage at Gate goes low, turning off the external MOSFET. The MOSFET turns on again when the inductor current ramps down through the freewheeling diode until the voltage across the sense resistor equals the lower threshold. Use the following equation to determine the operating frequency:

$$f_{SW} = \frac{(V_{IN} - n \times V_{LED}) \times n \times V_{LED} \times R_{SENSE}}{V_{IN} \times \Delta V \times L}$$

where n = number of LEDs, V_{LED} = forward voltage drop of one LED, and ΔV = (V_{SNSHI} - V_{SNSLO}).



6. MOSFET Selection

The VAS1210's gate driver is capable of sourcing 0.5A and sinking 1A of current. MOSFET selection is based on the maximum input operating voltage V_{IN}, output current I_{LED}, and operating switching frequency. Choose a MOSFET that has a higher breakdown voltage than the maximum operation voltage, low $R_{DS(ON)}$, and low total charge for better efficiency. MOSFET threshold voltage must be adequate if operated at the low end of the input-voltage operating range.

7. Schottky Diode Selection

The Schottky diode breakdown voltage should high enough to withstand the maximum operating voltage and its forward current rating must be at least equal to the maximum LED current.

8. LED Current Ripple

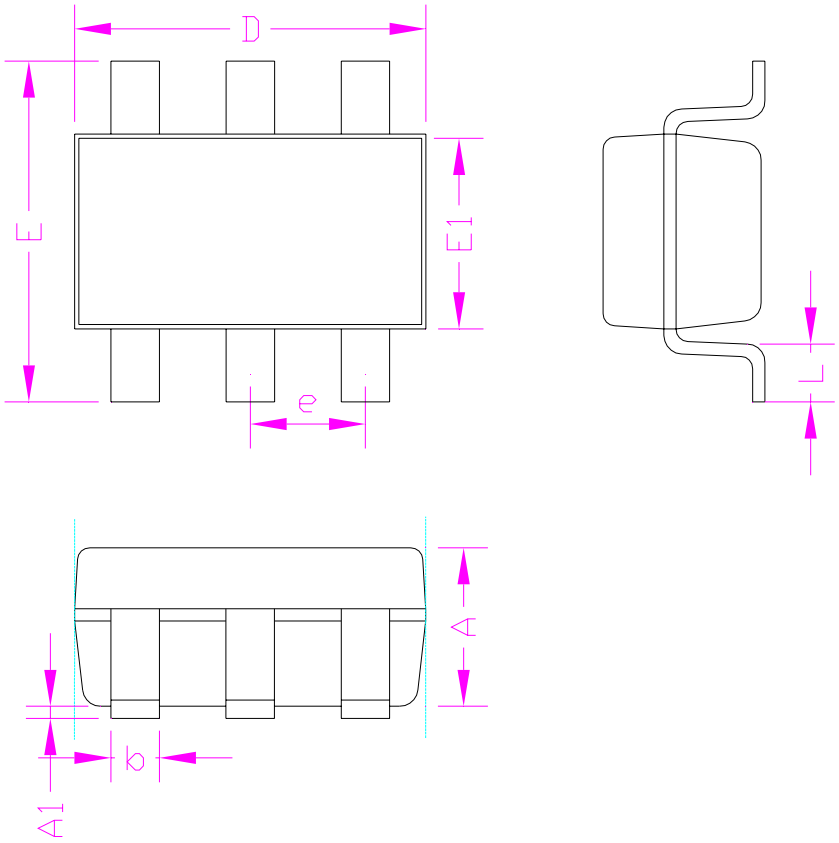
The LED current ripple is equal to the inductor current ripple. In cases when a lower LED current ripple is needed, a capacitor can be placed across the LED terminals.

9. PCB Layout

Careful PCB layout is critical to achieve low switching losses and stable operation. Use a multilayer board whenever possible for better noise immunity. Minimize ground noise by connecting high-current ground returns, the input bypass-capacitor ground lead, and the output-filter ground lead to a single point (star ground configuration). In normal operation, there are two power loops. One is formed when the MOSFET is on and the high current flows through VIN—R_{SNS}— LEDs—Inductor—MOSFET—GND. The other loop is formed when the MOSFET is off when the high current circulates through R_{SNS}—LEDs—Inductor—Schottky diode. To minimize noise interaction, each loop area should be as small as possible.

Place R_{SNS} as close as possible to the input filter and VIN. For better noise immunity, a Kelvin connection is strongly recommended between SNS and R_{SNS}. Connect the exposed paddle to a large-area ground plane for improved power dissipation(DFN-6 package only).

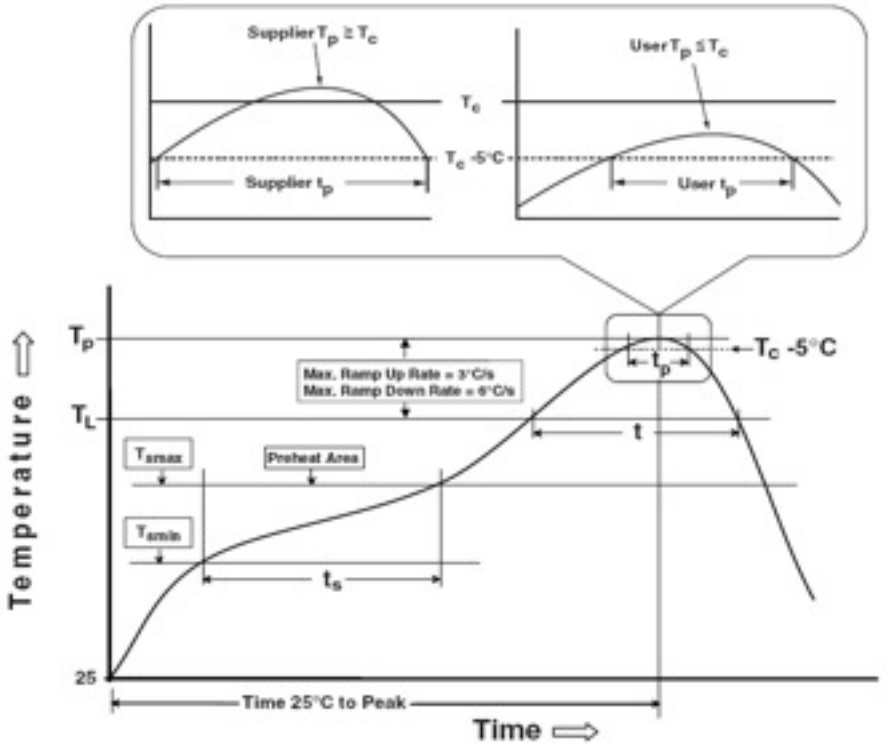
Package Information (SOT23-6L)



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	-	1.45	-	0.057
A1	0.00	0.15	0.000	0.006
b	0.30	0.50	0.012	0.020
D	2.90		0.114	
E1	1.60		0.063	
e	0.95		0.037	
E	2.60	3.00	0.102	0.118
L	0.3	0.60	0.012	0.024

Classification Reflow Profiles

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.



Classification Profile

⚠CAUTION

Storage Conditions

1) This product should be used within 12 months after delivered. Store in manufacturer's package keeping the seal of aluminum coated baggage or tightly re-closed box with the following conditions. [Temperature:8°C...30°C,Humidity:30%...70% R.H.]

2) Keep the seal of aluminum coated baggage immediately before usage.

3) After breaking the seal of aluminum coated baggage, this product should be used within 1 week on the following conditions.
[Temperature:≤30°C, Humidity: ≤60% R.H.]