Small Package, High Performance, Asynchronies Boost for 10 WLED Driver

General Description

The Ac9293 s a high frequency, asynchronous boost converter. The internal MOSFET can support up to 10 White LEDs for backlighting and OLED power application, and the internal soft start function can reduce the inrush current. The device operates with 1-MHz fixed switching frequency to allow small external components and to simplify possible EMI problems. For the protection, the Ac9293 provides 39V OVP to allow inexpensive and small-output capacitors with lower voltage ratings.

The LED current is initially set with the external sense resistor R_{SET}. The Ac9293 is available in the tiny package type TSOT-23-6 provide the best solution for PCB space saving and total BOM cost.

Features

- **VIN Operating Range : 2.5V to 5.5V**
- **Internal Power N-MOSFET Switch**
- **Wide Range for PWM Dimming (100Hz to200kHz)**
- **Minimize the External Component Counts**
- **Internal Soft Start**
- **Internal Compensation**
- **Under Voltage Protection**
- **Over Voltage Protection**
- **Over Temperature Protection**
- **Small TSOT-23-6**
- **RoHS Compliant and Halogen Free**

Applications

- Cellular Phones
- Digital Cameras
- PDAs and Smart Phones and MP3 and OLED.
- Portable Instruments

Ordering Information

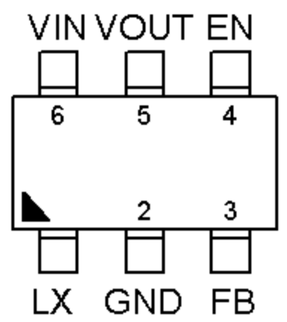
Ac9293□(-□□)□□

- Package Type
  J6 : TSOT-23-6
- Operating Temperature Range
  G : Green (Halogen Free with Commercial Standard)
- OVP Voltage
  Default : 39V Ac9293)
- Feedback Voltage Reference
  B : 300mV

Note :

Pin Configurations

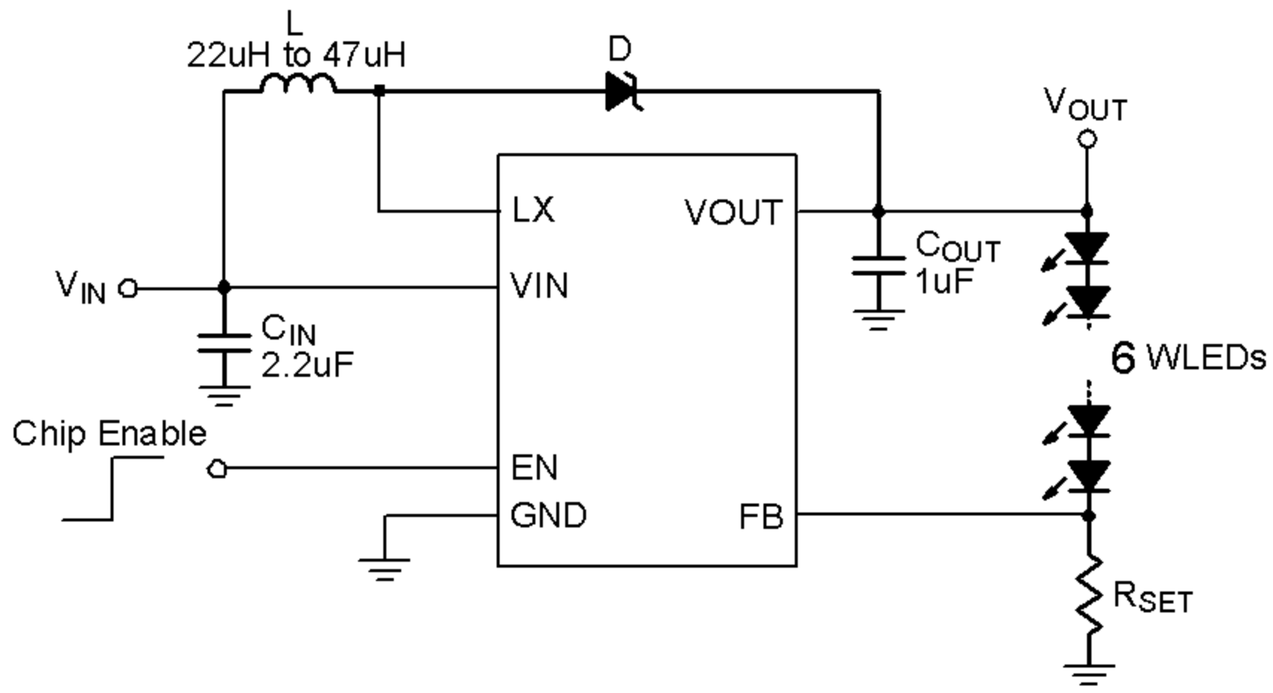
(TOP VIEW)



TSOT-23-6

Marking Information

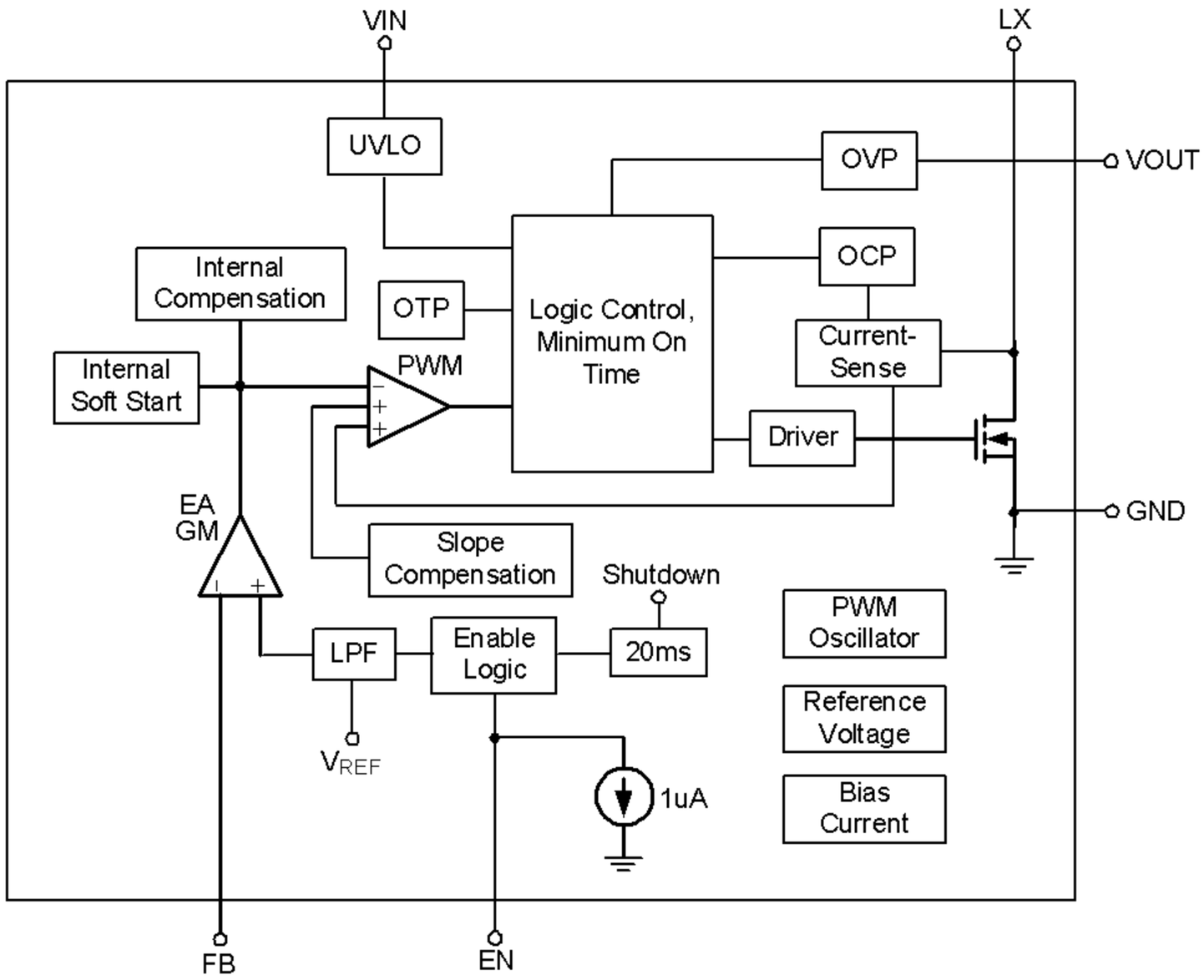
Typical Application Circuit



Functional Pin Description

Pin No.		Pin Name	Pin Function
9293□GJ6			
1		LX	Switching Pin.
2		GND	Ground Pin. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.
3		FB	Feedback Pin, put a resistor to GND to setting the current.
4		EN	Chip Enable (Active High).
5		VOUT	Output Voltage Pin.
6		VIN	Input Supply.
--		NC	No Internal Connection.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage, V_{IN} ---------- –0.3V to 6V
- Switching Pin, LX ---------- –0.3V to 39V
- VOUT ---------- –0.3V to 39V
- Other Pins ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  TSOT-23-6 ---------- 0.392W

- Package Thermal Resistance (Note 3)
  TSOT-23-6, θ_{JA} ---------- 255°C/W

- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C

Recommended Operating Conditions (Note 2)

- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = 3.7V, C_{IN} = 2.2uF, C_{OUT} = 0.47uF, I_{OUT} = 20mA, L = 22uH, T_A = 25°C, unless otherwise specified)

Parameter		Symbol	Conditions	Min	Typ	Max	Unit
Input Voltage		V_{IN}		2.5	--	5.5	V
Under Voltage Lock Out		V_{UVLO}		2	2.2	2.45	V
UVLO Hystersis				–	0.1	--	V
Quiescent Current		I_Q	FB = 1.5V, No Switching	–	400	600	uA
Supply Current		I_{IN}	FB = 0V, Switching	–	1	2	mA
Shutdown Current		I_{SHDN}	V_{EN} < 0.4V	–	1	4	uA
Line Regulation			V_{IN} = 3 to 4.3V	–	1	--	%
Load Regulation			1mA to 20mA	–	1	--	%
Operation Frequency		f_{OSC}		0.75	1	1.25	MHz
Maximum Duty Cycle				90	92	--	%
Clock Rate				0.1	--	200	kHz
Feedback Reference Voltage		V_{REF}					mV
	Ac9293			285	300	315	
On Resistance		$R_{DS(ON)}$		–	0.7	1.2	Ω

To be continued

Parameter		Symbol	Conditions	Min	Typ	Max	Unit
EN Threshold	Logic-High Voltage	V_{IH}		1.4	--	--	V
	Logic-Low Voltage	V_{IL}		--	--	0.5	V
EN Sink Current		I_{IH}		--	1	--	uA
EN Hystersis				--	0.1	--	V
Over-Voltage Threshold		V_{OVP}				--	V
				36	37.5	39V	
Over-Current Threshold		I_{OCP}		1	1.2	--	A
OTP		T_{OTP}		--	160	--	°C
OTP Hystersis				--	30	--	°C
Shutdown Delay		T_{SHDN}		--	20	--	ms

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. The device is not guaranteed to function outside its operating conditions.

Applications Information

LED Current Setting

The loop of Boost structure will keep the FB pin voltage equal to the reference voltage V_{REF}. Therefore, when R_{SET} connects FB pin and GND, the current flows from V_{OUT} through LED and R_{SET} to GND will be decided by the current on R_{SET}, which is equal to following equation.

$$I_{LED} = \frac{V_{REF}}{R_{SET}}$$

Dimming Control

a. Using a PWM Signal to EN Pin

For the brightness dimming control of the Ac9293, the IC provides typically 300mV feedback voltage when the EN pin is pulled constantly high. However, EN pin allows a PWM signal to reduce this regulation voltage by changing the PWM duty cycle to achieve LED brightness dimming control. The relationship between the duty cycle and FB voltage can be calculated as following equation.

V_{FB} = Duty x 300mV

Where

Duty = duty cycle of the PWM signal

300mV = internal reference voltage

As shown in Figure 1, the duty cycle of the PWM signal is used to cut the internal 300mV reference voltage. An internal low pass filter is used to filter the pulse signal. And then the reference voltage can be made by connecting the output of the filter to the error amplifier for the FB pin voltage regulation.

However, the internal low pass filter 3db frequency is 500Hz. When the dimming frequency is lower then 500Hz, V_A is also a PWM signal and the LED current is controlled directly by this signal. When the frequency is higher than 500Hz, PWM is filtered by the internal low pass filter and the V_A approach a DC signal. And the LED current is a DC current which elimate the audio noise. Two figures of PWM Dimming from EN are shown in Typical Operating Characteristics section and the PWM dimming frequency is 200Hz and 20kHz respectively.

But there is an offset in error amplifier which will cause the V_A variation. In low PWM duty signal situation, the filtered reference voltage is low and the offset can cause bigger variation of the output current. For the Ac9293B, the minimum duty vs frequency is listed in following table.

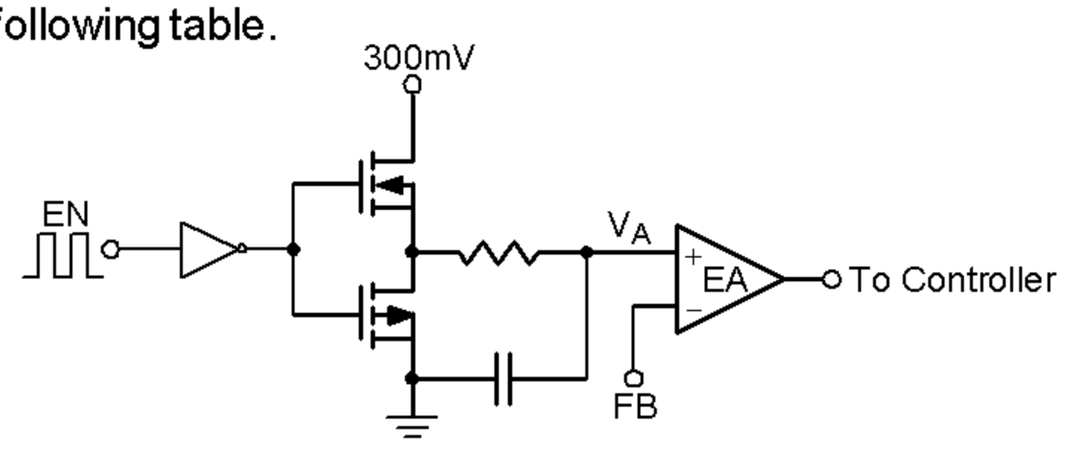


Figure 1. Block Diagram of Programmable FB Voltage Using PWM Signal

	Duty Minimum
Dimming frequency < 500Hz	4%
Dimming frequency > 500Hz	10%

b. Using a DC Voltage

Using a variable DC voltage to adjust the brightness is a popular method in some applications. The dimming control using a DC voltage circuit is shown in Figure 2. As the DC voltage increases, the current flows through R3 increasingly and the voltage drop on R3 increase, i.e. the LED current decreases. For example, if the VDC range is from 0V to 2.8V and assume the Ac9293 is selected which V_{REF} is equal to 0.3V, the selection of resistors in Figure 2 sets the LED current from 21mA to 0mA. The LED current can be calculated by the following equation.

$$I_{LED} = \frac{V_{REF} - \frac{R3 \times (V_{DC} - V_{REF})}{R4}}{R_{SET}}$$

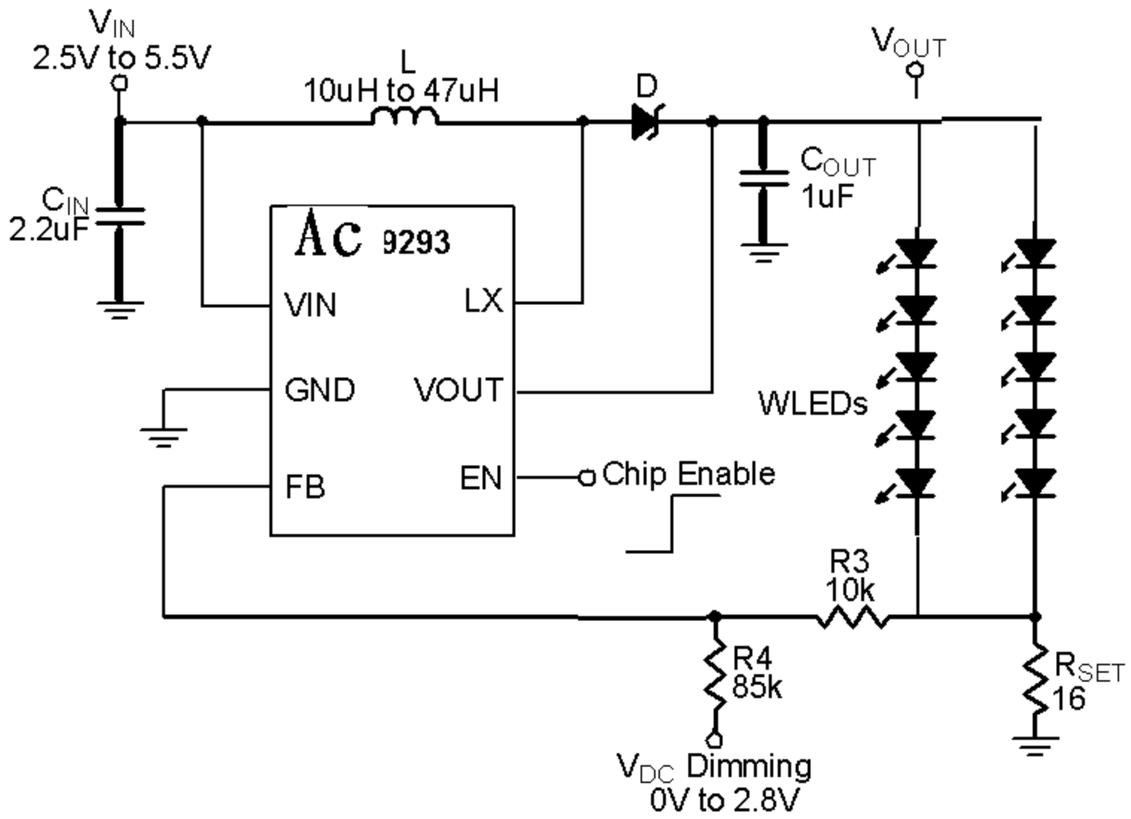
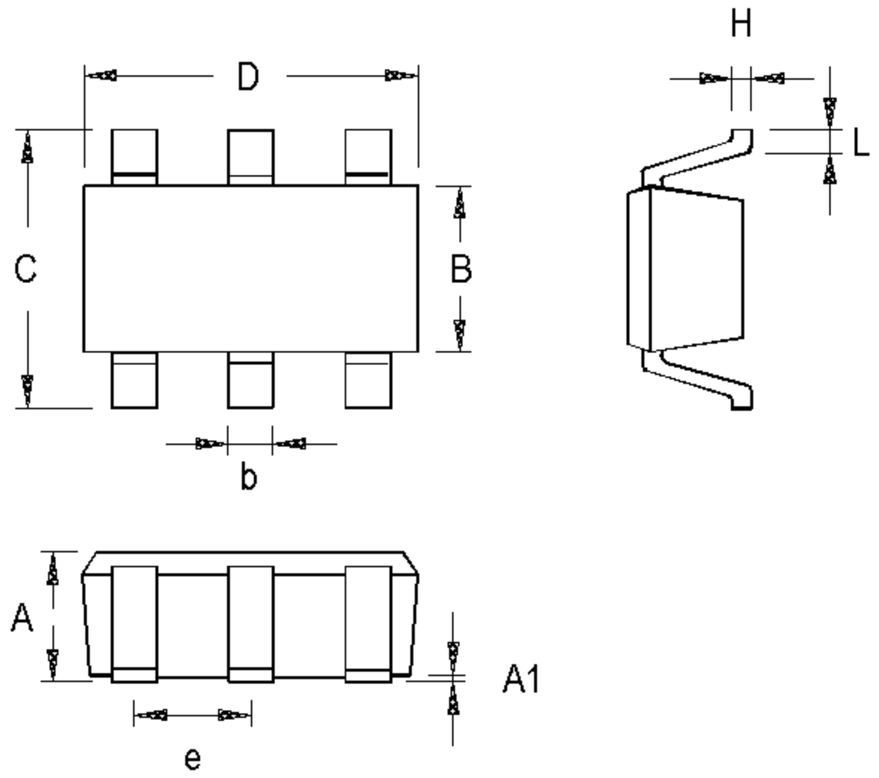


Figure 2. Dimming Control Using a DC Voltage

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	1.000	0.028	0.039
A1	0.000	0.100	0.000	0.004
B	1.397	1.803	0.055	0.071
b	0.300	0.559	0.012	0.022
C	2.591	3.000	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

TSOT-23-6 Surface Mount Package