LED Driver

General Description

The A5102 is a current mode PWM regulator for LED driving applications. With a 2A switch on board and wide input (4.5V to 40V) and/or output (up to 40V) ranges the A5102 can operate in Buck-Boost configuration.

With a 700 kHz operating frequency, the external PWM inductor and input/output capacitors can all be small. High efficiency is achieved with a 100mV current sensing.

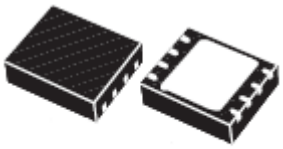
Features

- High Voltage: Vin and Vout Up to 40V.
- 2A Switch Current
- Buck-Boost Operation
- Current Mode PWM with 700KHz Switching Frequency.
- Soft Start to Avoid Inrush Current
- Thermal Shutdown, over current, and over voltage protection

Applications

- GPS, Portable DVD Backlight
- Desk Lights and Room Lighting
- Industrial Display Backlight
- MR16 Lamp

Pin Assignment



DFN8 (3 x 3 mm)

8 pin (DFN8)

Pin #	Name	Description
1	ISP	Current Sense Amplifier Positive Input
2	OVP	Over voltage protection. PWM converter turns off when V_{OVP} goes higher than about 1.2V
3	VSS	Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation
4	CS	This pin connects a current-sense resistor to sense the MOSFET current.
5,6	SW	PWM Boost Converter Switch Node
7	VIN	Power Supply of the Chip. For good bypass, a low ESR capacitor is required
8	ISN	Current Sense Amplifier Negative Input. Voltage threshold between ISP and ISN is 100mV.

TYPICAL APPLICATION CIRCUIT

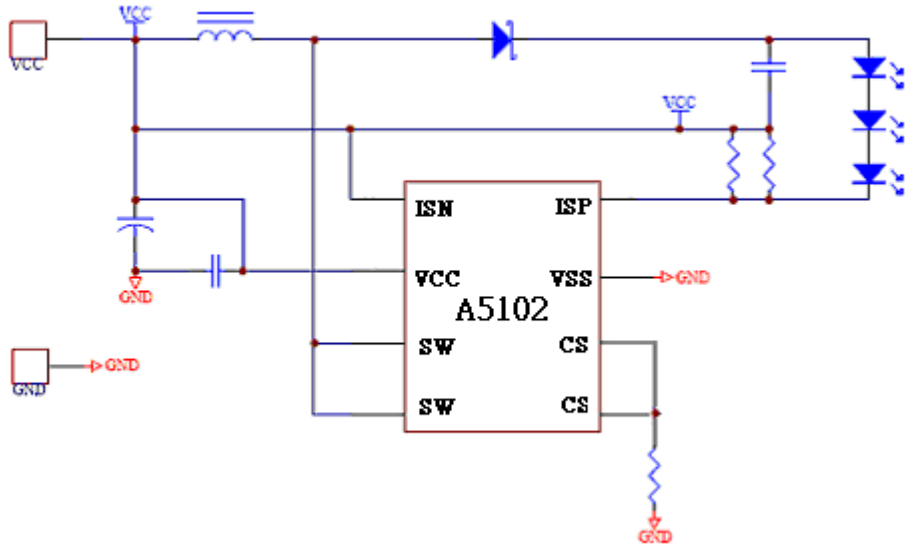
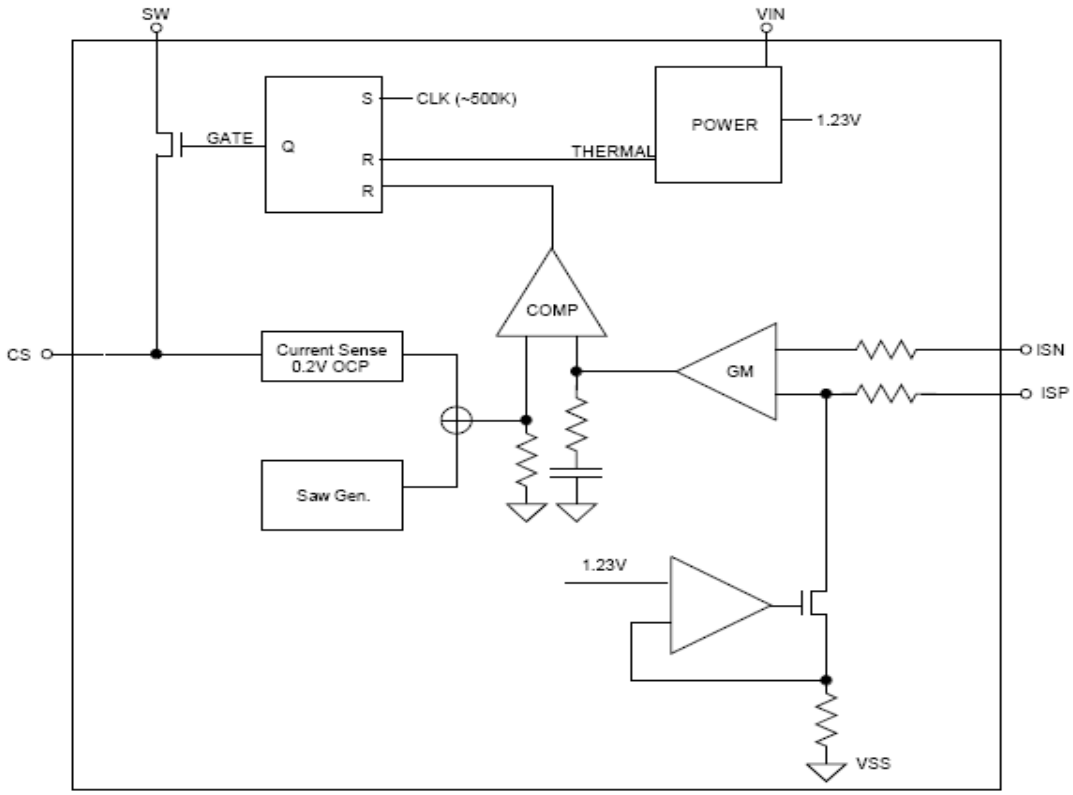


Figure 1. BUCK-BOOST Configuration

Function Block Diagram



Absolute Maximum Ratings

- Supply Input Voltage, VIN ---------- 40V
- SW Pin Voltage at Switching Off, ISP, ISN ---------- 40V
- OVP Pin Voltage ---------- 6.5V
- Power Dissipation, PD @ TA = 25 C

  DFN-8 3x3 ---------- 1.667W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Storage Temperature Range ---------- -65°C to 150°C
- ESD Susceptibility (Note 2)

  HBM (Human Body Mode) ---------- 2kV

  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions

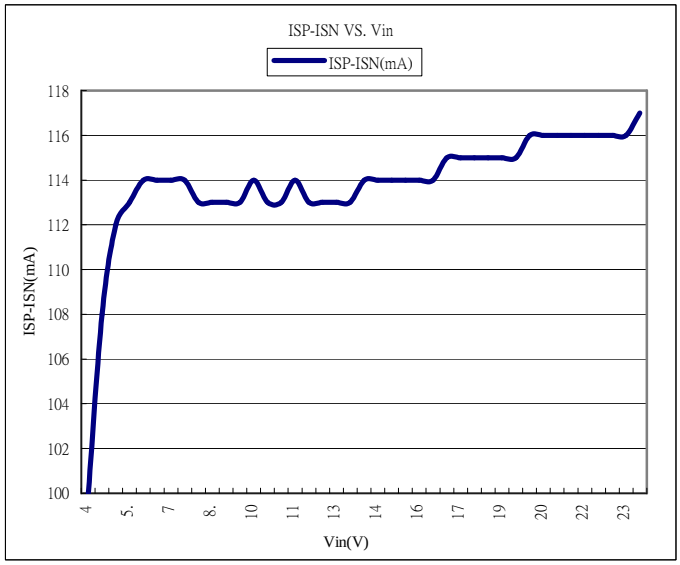
- Junction Temperature Range---------- -40°C to 125°C
- Ambient Temperature Range---------- -40°C to 85°C

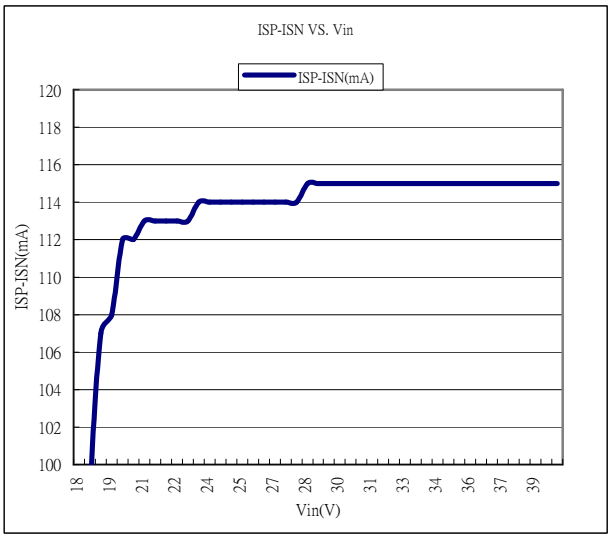
Electrical Characteristics

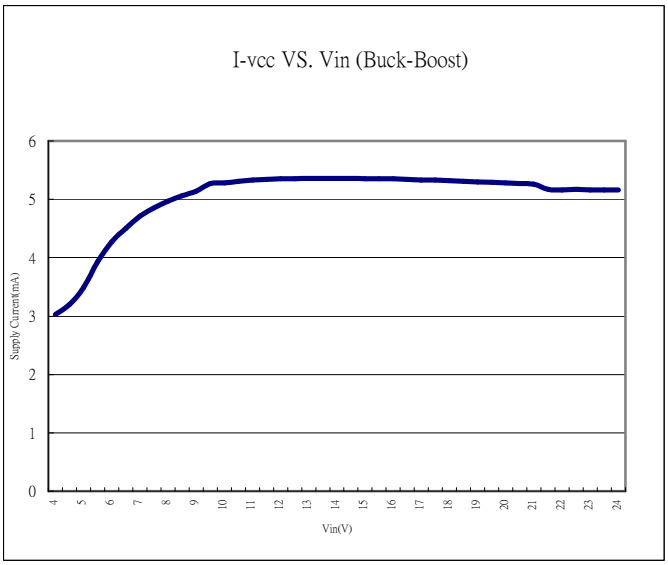
(VIN = 12V, No Load on any Output, TA = 25^{0}C, unless otherwise specified)

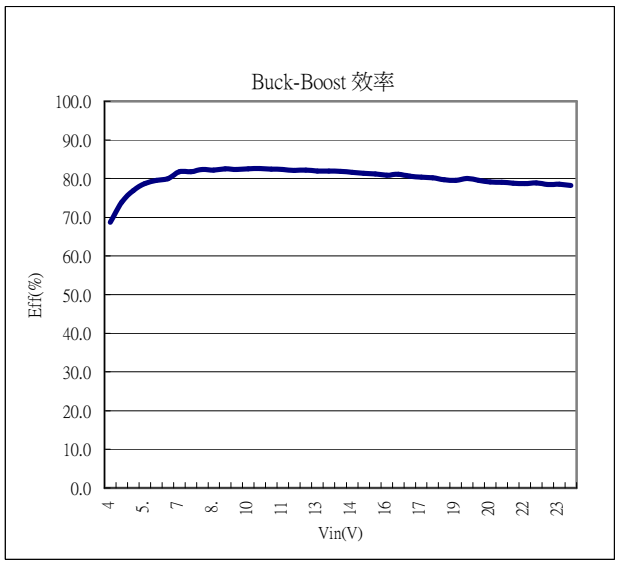
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Overall						
Supply Voltage	V_{IN}		4.5		40	V
Supply Current	I_{VIN}	Switching off		3		mA
Current Sense Amplifier						
Input Threshold (VISP - VISN)		4.5V < common mode < 50V	80		120	mV
Input Current	I_{ISP}			10		uA
Input Current	I_{ISN}			10		uA
PWM Converter						
Switching Frequency	f_{SW}	Duty Cycle = 50%	550	700	850	kHz
Maximum Duty Cycle	D_{MAX}			80		%
Minimum on Time				250		ns
SW On-Voltage	V_{SW}	ISW = 0.5A		0.4		V
SW Current Limit	$I_{LIM\ SW}$	RCS= 0.1Ω	1.5	2	2.5	A
OVP and Soft Start						
OVP Threshold	V_{OVP}			1.2		V

Typical Operating Characteristics









Applications Information

The A5102 is designed operate in Buck-Boost topology applications. This device uses a fixed frequency, current mode control scheme to provide excellent line and load regulation. The control loop has a current sense amplifier to sense the voltage between the ISP and ISN pins. A PWM comparator then turns off the internal power switch when the sensed power switch current exceeds the compensated voltage. The programmed voltage across the sense resistor is regulated by the control loop. The current through the sense resistor is setting by the programmed voltage and the sense resistance.

The protection schemes in A5102 include over temperature, and switch current-limit to prevent the abnormal situation.

Soft Start

The A5102 built-in soft-start circuits to reduce the start-up current spike and output voltage overshoot. The soft-start time is about 4ms.

Current-Limit Protection

The A5102 can limit the peak switch current by internal over current protection feature. In normal operation, the power switch is turned off when the switch current hits the loop-set value. The over current protection function will turn off the power switch independent of the loop control when the peak switch voltage reaches around 0.2V.

Over Temperature Protection

The A5102 has over temperature protection (OTP) function to prevent the excessive power dissipation from overheating. The OTP function will shut down switching operation when the die junction temperature exceeds 145℃ . The chip will automatically start to switch again when the junction temperature cools off.

Output Over Voltage Setting

The A5102 is equipped with over voltage protection (OVP) function. When the voltage at OVP pin exceeds a threshold of approximately1.2V, the power switch is turned off. The power switch can be turned on again once the voltage at OVP pin drops below 1.2V. For the Buck-Boost application, the output voltage could be clamped at a certain voltage level. The OVP voltage can be set by the following equation :

$$Vovp = 1.2(1+R3/R4)$$

Where R3 and R4 are the voltage divider from V_{OUT} to GND with the divider center node connected to OVP pin.

LED current Setting

The LED current can be calculated by the following equation :

LED(MAX)=(Visp-Visn)/R

Where, Visp − Visn is the voltage between ISP and ISN (100mV typ.) and the R is the resister between ISP and ISN.

Inductor Selection

Choose an inductor that can handle the necessary peak current without saturating, and ensure that the inductor has a low DCR (copper-wire resistance) to minimize I2R power losses. A 4.7μH to 10μH inductor will meet the demand for most of the A5102 applications. Inductor manufacturers specify the maximum current rating as the current where the inductance falls to certain percentage of its nominal value—typically 65%.

In Boost application where the transition between discontinuous and continuous modes occurs, the value of the required output inductor (L), can be approximated by the following equation :

$$L = \frac{V_{OUT} \times D \times (1-D)^2}{2 \times I_{OUT} \times f}$$

The Duty Cycle (D) could be calculated as follows :

$$D = \frac{V_{OUT} - V_{IN}}{V_{OUT}}$$

Where

VOUT = maximum output voltage.

VIN = minimum input voltage.

f = operating frequency.

IOUT = sum of current from all LED strings.

With an inductance value greater than L, the converter will operate in continuous mode at the minimum input voltage and maybe operate in discontinuous mode at higher voltages.

The inductor must be selected with a saturation current rating greater than the peak current provided by the following equation :

$$I_{PEAK} = \frac{V_{OUT} \times I_{LED}}{\eta \times V_{IN}} + \frac{V_{IN} \times D \times T}{2 \times L}$$

Where η is the efficiency of the power converter.

Schottky Diode Selection

The Schottky diode, with low forward voltage drop and fast switching speed, is necessary for the A5102 applications. In addition, power dissipation, reverse voltage rating and pulsating peak current are the important parameters of the Schottky diode that must be considered.

Choose a suitable Schottky diode whose reverse voltage rating is greater than the maximum output voltage. The diode's average current rating must exceed the average output current. The diode conducts current only when the power switch is turned off (typically less than 50% duty cycle).

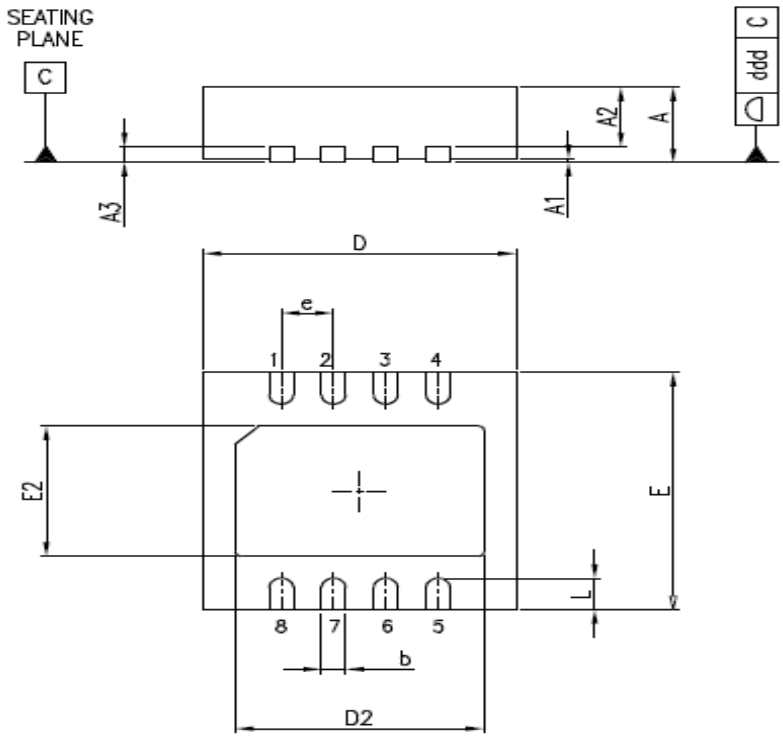
Capacitor Selection

The input capacitor reduces current spikes from the input supply and minimizes noise injection to the converter. For most A5102 applications, a 4.7μF ceramic capacitor is sufficient. A value higher or lower may be used depending on the noise level from the input supply and the input current to the converter.

In Boost Application, the output capacitor is typically a ceramic capacitor and is selected based on the output voltage ripple requirements. The minimum value of the output capacitor COUT is approximately given by the following equation :

$$C_{OUT} = \frac{I_{LED} \times D \times T}{V_{RIPPLE}}$$

Outline Dimension



DIMMENSIONS						
REF	mm			inch		
	MIN.	TYP.	MAX	MIN.	TYP.	MAX
A	0.80	0.90	1.00	31.5	35.4	39.4
A1		0.02	0.05		0.8	2.0
A2		0.70			27.6	
A3		0.20			7.9	
b	0.18	0.23	0.30	7.1	9.1	11.8
D		3.00			118.1	
D2	2.23	2.38	2.48	87.8	93.7	97.7
E		3.00			118.1	
E2	1.49	1.64	1.74	58.7	64.6	68.5
e		0.50			19.7	
L	0.30	0.40	0.50	11.8	15.7	19.7