GS5903

1A, Boost for 10 White LED Driver

Product Description

The GS5903 is designed to drive up to 10 white LEDs in series with a 3.6V cell Li-Ion battery. It works as a boost converter using current mode, 1.2MHz PWM frequency with the measure of an external current sense resistor to regulate the LED current. In order to minimize the power loss and keep the efficiency, the feedback voltage is designed as low as 300mV. With the DC voltage dimming control, it is easily to adjust the brightness of LEDs in either analog method or PWM duty control.

The GS5903 features many protection schemes such as UVLO, open load protection, 1A current limit and over-temperature protection.

GS5903 is packaged with the popular SOT23-5 small package.

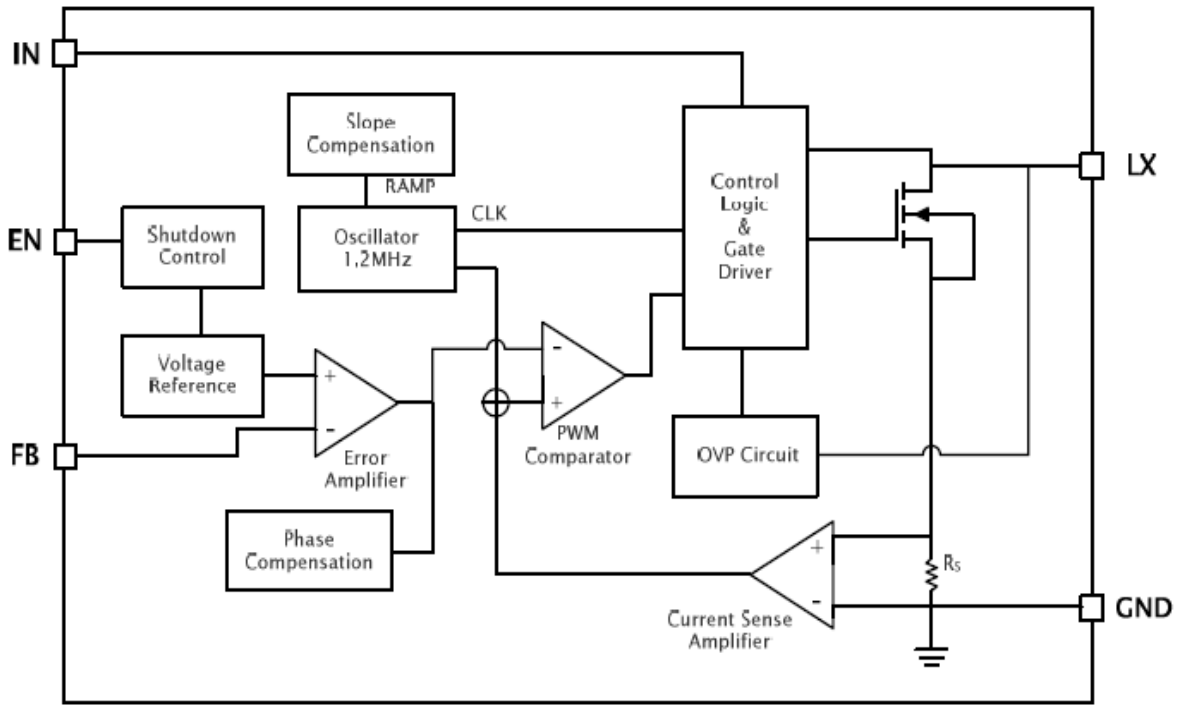
Features

- Wide Input Voltage from 2.75V to 6V
- 300mV Feed-Back Voltage
- 40V Open Load Protection
- DC Voltage/PWM Dimming Control
- 1A Maximum Driving Current
- Integrated 400mΩ MOSFET Switch
- 1.2MHz Switching Frequency
- 2.75V UVLO Protection
- 5μA Low Shutdown Current
- Over Temperature Protection
- RoHS Compliant, 100%Pb & Halogen Free

Applications

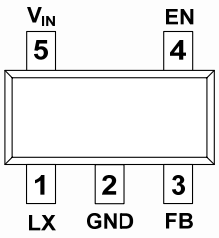
- LCD Panel
- MID/PND/GPS
- Digital Still Camera/Photo Frame
- Smart Phone
- Portable Instruments

Block Diagram



Packages & Pin Assignments

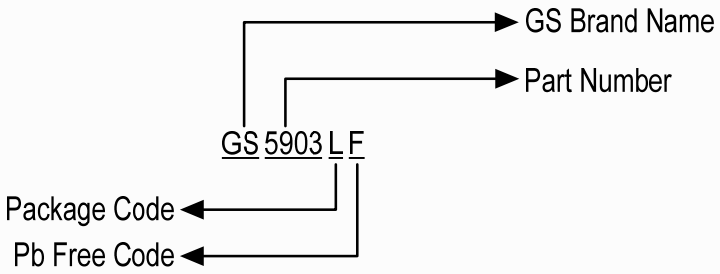
SOT-23-5



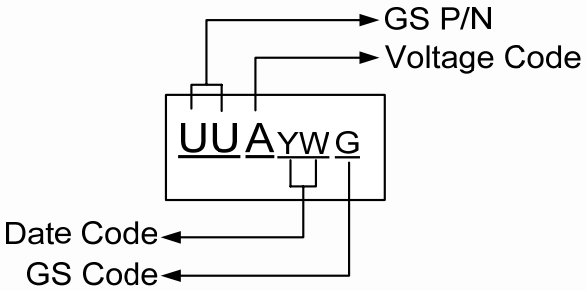
(Top View)

Pin Name	Function
LX	Switch Output. Connect this pin to the node between the inductor and the schottky diode.
GND	Power Ground.
FB	Feedback Input. FB monitors the feedback voltage to regulate the LED current. Connect a current sense resistor from the bottom of the LED string to ground to configure LED current.
EN	Chip Enable. Pull EN high to enable the regulator, pull it low to turn it off. Pull up with a 100kΩ resistor to start it up automatically.
V_{IN}	Power Input. Drive IN pin with a 2.75V to 6V power source to activate the LED driver.

Ordering Information



Marking Information



Part Number	Package	GS P/N	Voltage Code	Date Code
GS5903LF	SOT-23-5	UU	A	YW

Absolute Maximum Ratings

T_A=25°C

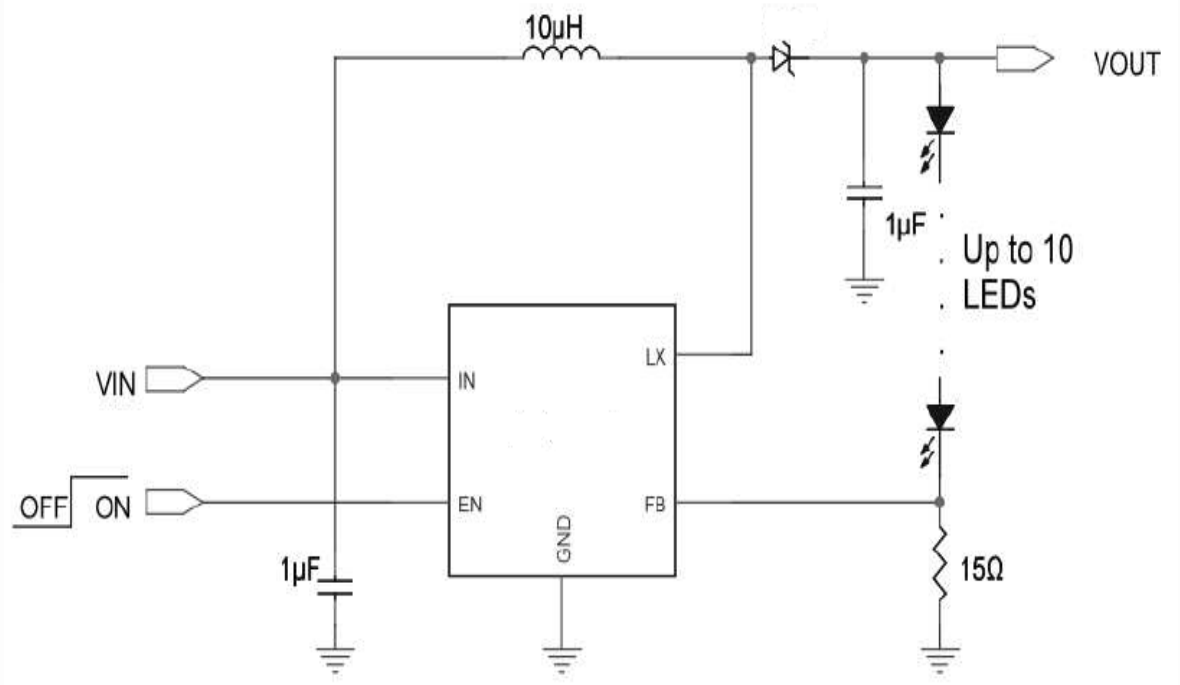
Symbol	Description	Value	Units
V_{IN}	Supply Voltage Range	-0.3 to 6.5	V
V_{LX}	Switch Voltage Range	-0.3 to 42	V
	EN, FB pins Voltage	-0.3 to 6.5	V
T_J	Operating Junction Temperature Range	-40 to +150	°C
T_{STG}	Storage Temperature Range	-65 to +150	°C
ESD	Human Body Model (HBM)	±2	KV
	Machine Model (MM)	±200	V
θ_{JC}	Thermal Resistance (Junction to Case)	110	°C/W
θ_{JA}	Thermal Resistance (Junction to Ambient)	220	°C/W

Note 1. Stress beyond those listed at “absolute maximum rating” table may cause permanent damage to the device. These are stress rating ONLY. For functional operation are strongly recommend follow up “recommended operation conditions” table.

Recommended Operating Conditions

Symbol	Description	Value	Units
V_{IN}	Supply Voltage	2.75 to 6	V
T_A	Operating Ambient Temperature Range	-40 to +85	°C
T_J	Operating Junction Temperature Range	-40 to +125	°C

Typical Application Circuit



Electrical Characteristics

T_A=25°C, V_{IN}=3.6V, unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Supply Voltage	-	2.75	-	6	V
UVLO	Input UVLO	Rising	-	2.65	-	V
	UVLO Hysteresis	-	-	0.1	-	V
OVP	Load open protection threshold	V_{OVP} Rising	-	42	-	V
I_{SD}	Shutdown Current	V_{EN}=0V	-	1	5	uA
I_Q	Quiescent Current	V_{EN}=3.6V, V_{FB}=0.15V	-	1	2	mA
F_{SW}	Switching Frequency	-	1	1.2	1.4	MHz
I_{LIM}	Current Limit	Duty Cycle=60%	-	1	-	A
$D_{(MAX)}$	Maximum Duty Cycle	-	-	90	-	%
V_{ENH}	Chip enable threshold	V_{EN} Rising	-	1.0	-	V
V_{ENL}	Chip shutdown threshold	V_{EN} Falling	-	0.4	-	V
V_{FB}	FB Pin Voltage	V_{EN}=2V	0.270	0.300	0.330	V
I_{FB}	FB Pin Bias Current	V_{FB}=0.1V	-	0.05	1	uA
$R_{DS(ON)}$	SW On Resistance	I_{LX}=250mA	-	0.4	-	Ω
T_{SD}	Thermal Shutdown Threshold	-	-	160	-	°C
T_{SH}	Thermal Shutdown Hysteresis	-	-	20	-	°C

Applications Information

Functional Descriptions

The GS5903 is a compact high-efficiency boost converter with integrated switch specifically designed to drive up to 10 WLEDs in series. Series connection of the LEDs provides identical LED current resulting in uniform brightness. Fixed 1.2MHz operation allows possible smallest output ripple and external component size. With high conversion efficiency and small package, the GS5903 is ideally suitable for portable devices where PCB area is especially concerned.

Soft Start

The GS5903 limits the inrush current at start-up by increasing the current limit. This prevents unwanted shutdown otherwise may be triggered by voltage drop due to large inrush current.

Under Voltage Lockout (UVLO)

Once the V_{IN} becomes too low, the internal gate driver may not work well. The GS5903 internal circuit will remain disabled until V_{IN} exceeds the input UVLO threshold voltage. This function assures the boost converter works properly and protects the internal gate driver away from entering any unexpected state.

Open LED Protection

During each switching cycle, the GS5903 monitors the voltage at the LX pin. Once the LX voltage exceeds the OVP threshold voltage, the converter will turn off the switch and enter shutdown mode. Toggling EN pin from logic low to logic high will resume the fault state.

Chip Enable

Pull the EN pin higher than 1V to enable the device and initiate its soft start cycle. Pulling the EN pin lower than 0.4V disables the device and reduces it shutdown current to less than 1μA typically. Never let the EN pin floating as it will result the driver in unknown state.

Applications Information (Continue)

LED Current Setting

The LED current is constant and can be adjusted by setting the external current sense resistor in series with the LED string. It can be calculated by the following formula:

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

where I_{LED} is the output current of LEDs, VFB is the feedback reference voltage, R_{ISET} is the current sense resistor. Hence the offset of LED output current depends on the accuracy of V_{REF} and R_{ISET}.

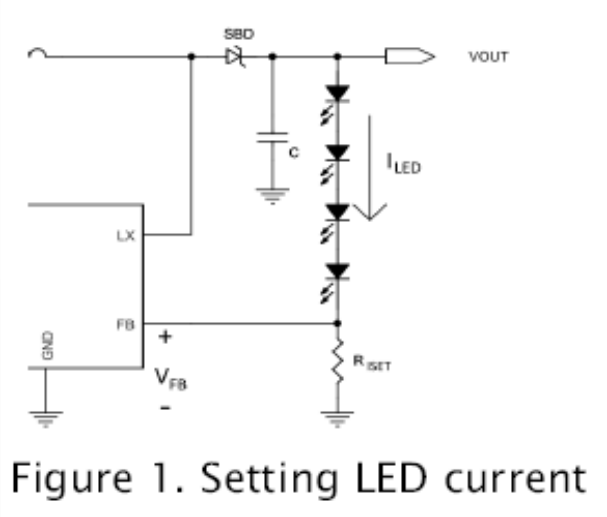


Figure 1. Setting LED current

Over Temperature Protection

The excessive internal dissipation of thermal protection will damage GS5903. The junction over temperature threshold is 160ºC. The output voltage resumes automatically when the temperature reduces more than the temperature hysteresis 20ºC.

Components Selection

External component selection begins with inductor value selection based on the considerations of the output voltage, output current, and the maximum/minimum input voltages. Catch diode and input/output capacitors can be selected according to the inductor value L.

Inductor Selection

Inductor selection should consider the inductor value, rated current, DC resistance, size, core material and cost. The inductor value is selected based on the consideration of inductor ripple current. The recommended value of inductor for 10 WLEDs applications is from 6.8μH to 10μH. The inductor should have low core loss at 1.2MHz and lower DC resistance for better efficiency. The inductor saturation current rating should be considered to cover the inductor peak current.

Diode Selection

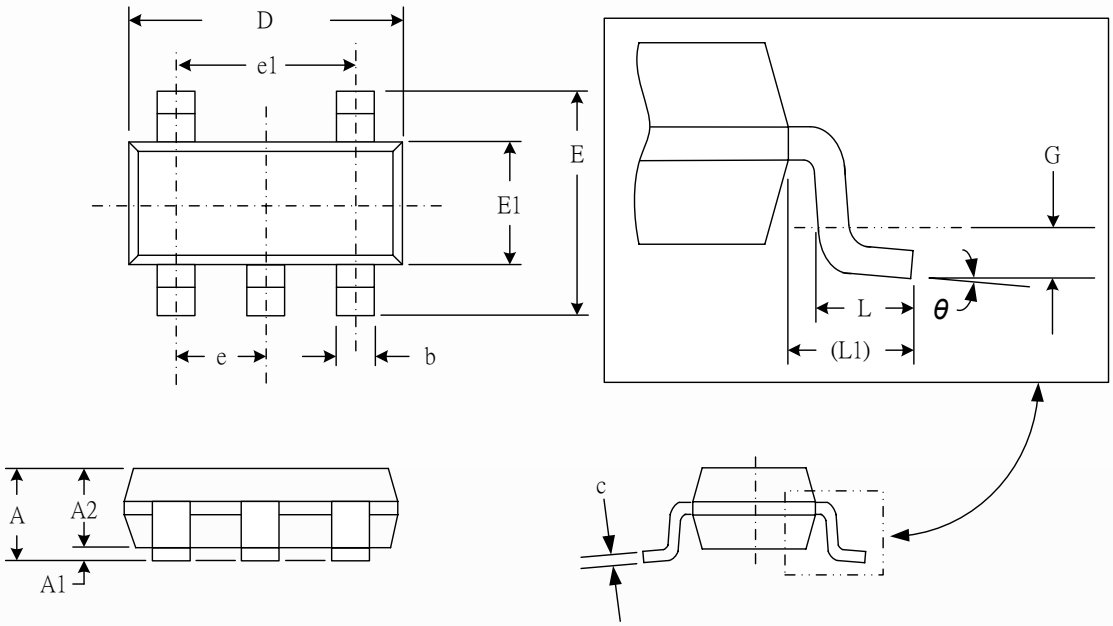
The catch diode should be capable of handling the output voltage and the peak switch current. Make sure that the diode peak current rating is at least $I_{LX(PEAK)}$ and that its breakdown voltage exceeds VOUT. Schottky diodes are recommended due to its low forward voltage and low reverse recovery current. The capability for handling power dissipation should be considered.

Layout Consideration

1. Input and output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
2. The GND should be connected to a strong ground plane for heat sinking and noise protection.
3. Keep the main current traces as possible as short and wide.
4. LX node of DC/DC converter is with high frequency voltage swing. It should be kept at a small area.
5. Place the feedback components as close as possible to the IC and keep away from the noisy devices.

Package Dimension

SOT-23-5



Dimensions				
SYMBOL	Millimeters		Inches	
	MIN	MAX	MIN	MAX
A	0.95	1.45	.037	.057
A1	0.05	0.15	.002	.006
A2	0.90	1.30	.035	.051
b	0.30	0.50	.012	.020
c	0.08	0.20	.003	.008
D	2.80	3.00	.110	.118
E	2.60	3.00	.102	.118
E1	1.50	1.70	.059	.067
e	0.95 (TYP)		.037 (TYP)	
e1	1.90 (TYP)		.075 (TYP)	
L	0.35	0.55	.014	.022
L1	0.60 (TYP)		.024 (TYP)	
G	0.25 (TYP)		.010 (TYP)	
θ	0°	8°	0°	8°

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