Application Note: AN_SY8703

High Efficiency, 1MHz, 1A, 30V Step Down White LED Driver

Preliminary Specification

General Description

SY8703 is a high efficiency step down regulator capable of driving 1.0A white LED from up to 30V input. It integrates the low R_{ON} MOSFET and internal compensation. The 1MHz switching frequency allows the use of very small inductor. This, along with the small SOT23-6 package, achieves an extremely small LED driver design.

Features

- Wide input range: 2.5-30 V
- 1 MHz switching frequency
- Very low R_{ON}: 200mΩ
- Enable and dimming control available
- Compact 6 pin SOT23 package
- RoHS Compliant and Halogen Free

Ordering Information

SY8703□(□□)□

- Temperature Code
- Package Code
- Optional Spec Code

Temperature Range: -40°C to 85°C

Ordering Number	Package type	Note
SY8703ABC	SOT23-6	1A

Applications

- Flash light
- Display cabinet lamp
- LED sign

Typical Applications

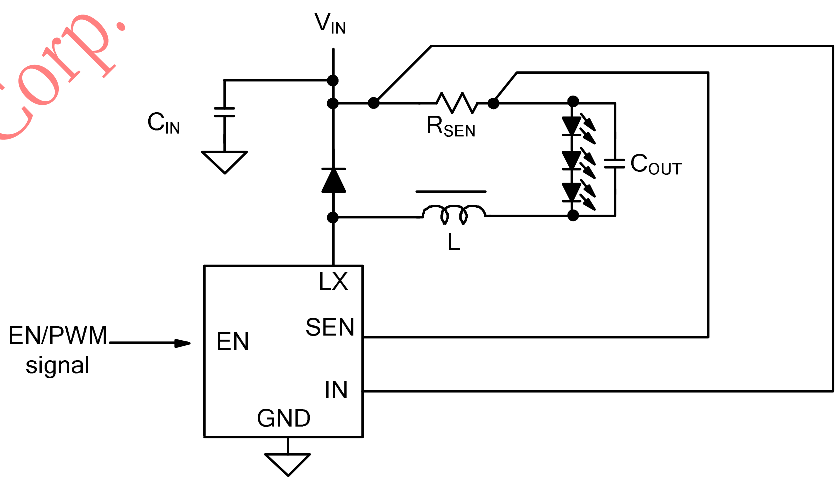
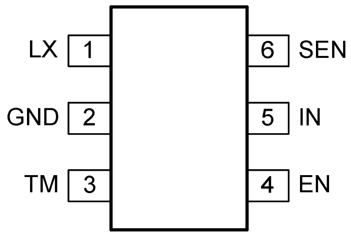


Figure 1. Schematic diagram

Pinout (top view)



SOT23-6

Top Mark:EF*xyz* (device code: EF, ***x=year code, y=week code, z= lot number code***)

Pin Name	Pin Number	Pin Description
IN	5	Input pin. Decouple this pin to GND pin with 1uF ceramic cap. Also used as the positive current sense pin.
SEN	6	Negative Current Sense Pin.
GND	2	Ground pin
LX	1	Inductor node. Connect an inductor between IN pin and LX pin.
EN	4	Enable control pin. Can also apply digital signal to achieve PWM dimming function.
TM	3	Test mode pin. Ground this pin in the real application.

Absolute Maximum Ratings (Note 1)

LX, IN-------------------------------- --- 33V
SEN -- $V_{IN} \pm 0.7V$
All other pins------------------------ -- 4V
Power Dissipation, PD @ TA = 25°C SOT-23-6, --- 0.6W
Package Thermal Resistance (Note 2)
θ_{JA} --- 250°C/W
θ_{JC} --- 130°C/W
Junction Temperature Range -- 150°C
Lead Temperature (Soldering, 10 sec.) --- 260°C
Storage Temperature Range -- -65°C to 150°C

Recommended Operating Conditions (Note 3)

IN, LX -- 2.5V to 30V
SEN --- $V_{IN} \pm 0.5V$
All other pins -- 0-3.6V
Junction Temperature Range -- -40°C to 125°C
Ambient Temperature Range -- -40°C to 85°C

Electrical Characteristics

(V_{IN} = 5V, I_{OUT}=100mA, T_A = 25°C unless otherwise specified)

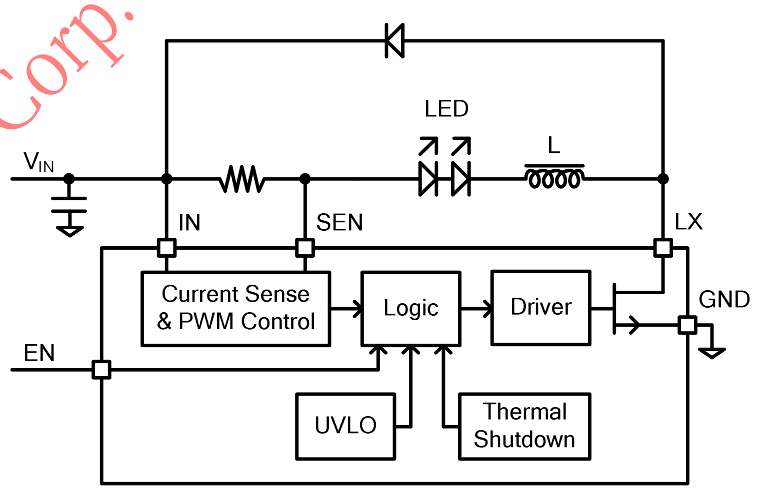
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		30	V
Shutdown Current	I_{SHDN}	EN=0		5	10	µA
Low Side Main FET R_{ON}	$R_{DS(ON)1}$			200		mΩ
Main FET Current Limit	I_{LIM1}		1.3			A
Switching Frequency	F_{SW}		0.8	1	1.2	MHz
Current Sense Limit	V_{IN-SEN}		96	100	104	mV
EN Rising Threshold	V_{ENH}		1.5			
EN Falling Threshold	V_{ENL}				0.4	
IN UVLO Rising Threshold	$V_{IN,UVLO}$				2.5	V
UVLO Hysteresis	$V_{UVLO,HYS}$			0.1		V
Thermal Shutdown Temperature	T_{SD}			150		C
Max Duty Cycle			88	90		%
Min Duty Cycle				10	12	%

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: θ_{JA} is measured in the natural convection at TA = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

Note 3. The device is not guaranteed to function outside its operating conditions

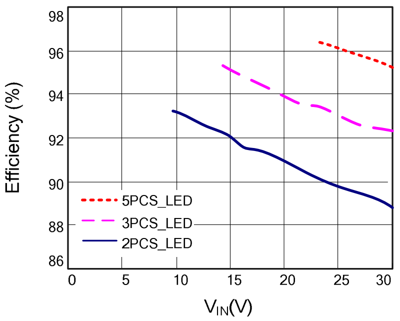
Block Diagram



Typical Operation Characteristics

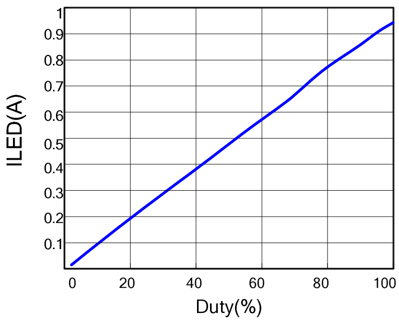
Efficiency vs. Input Voltage

(L=33uH Io=1A)



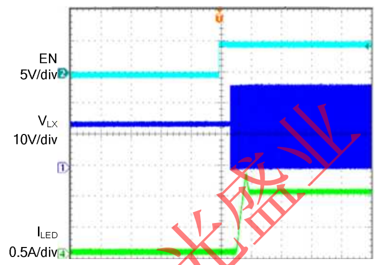
Duty vs. Led Current

(L=33uH Io=1A, 5pcs LED Series)



EN ON

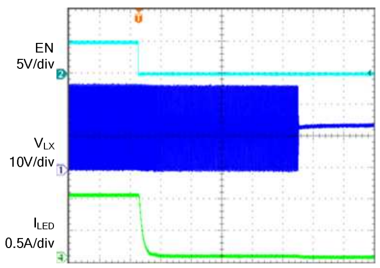
(V_{IN}=25V, I_{OUT}=1A, 5pcs LED Series)



Time (200us/div)

EN OFF

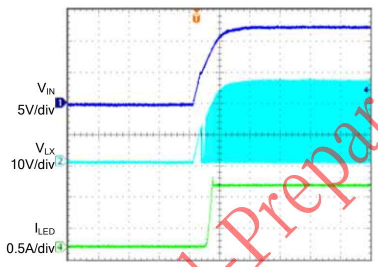
(V_{IN}=25V, I_{OUT}=1A, 5pcs LED Series)



Time (400us/div)

Startup

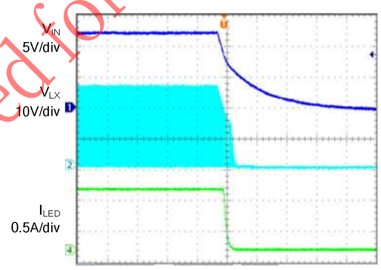
(V_{IN}=25V, I_{OUT}=1A, 5pcs LED Series)



Time (2ms/div)

Shutdown

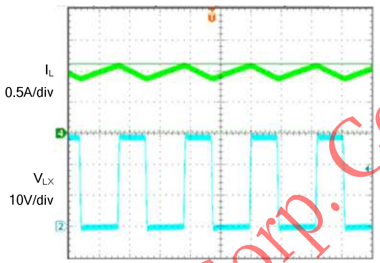
(V_{IN}=25V, I_{OUT}=1A, 5pcs LED Series)



Time (10ms/div)

Stable Waveform

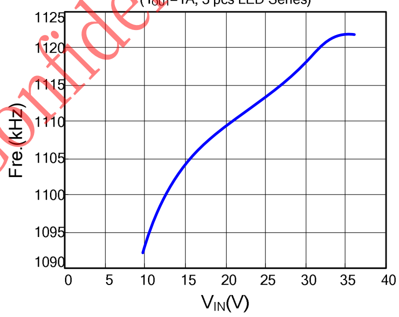
(V_{IN}=25V, I_{OUT}=1A, 5pcs LED Series)



Time (400ns/div)

Frequency vs. Input Voltage

(I_{OUT}=1A, 3 pcs LED Series)



Operation

SY8703 is a floating buck regulator IC that integrates the PWM control, power MOSFET on the same die to minimize the switching transition loss and conduction loss. With ultra low $R_{DS(ON)}$ power switches and proprietary PWM control, this regulator IC can achieve the high efficiency and the high switch frequency simultaneously to minimize the external inductor and capacitor size, and thus achieving the minimum solution footprint.

Applications Information

Because of the high integration in the SY8703 IC , the application circuit based on this regulator IC is rather simple. Only input capacitor C_{IN}, output capacitor C_{OUT}, output inductor L and current sense resistor R_{SEN} need to be selected for the targeted applications specifications.

Current sense resistor R_{SEN}:
Choose R_{SEN} to program the proper output Current:

$$I_{LED}(A) = \frac{0.1(V)}{R_{SEN}(\Omega)}$$

Input capacitor C_{IN}:
The ripple current through input capacitor is calculated as:

$$I_{CIN\_RMS} = I_{OUT} \cdot \sqrt{D(1-D)}$$

A typical X7R or better grade ceramic capacitor with suitable capacitance should be choosen to handle this ripple current well. To minimize the potential noise problem, place this ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by C_{IN}, and IN/GND pins.

Output capacitor C_{OUT}:
The output capacitor is selected to handle the output current ripple noise requirements. For the best performance, it is recommended to use X7R or better grade ceramic capacitor greater than 1uF capacitance.

Output inductor L:
There are several considerations in choosing this inductor.

1) Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L = \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{F_{SW} \times I_{OUT,MAX} \times 40\%}$$

where Fsw is the switching frequency and $I_{OUT,MAX}$ is the LED current.
The SY8703 regulator IC is quite tolerant of different ripple current amplitude. Consequently, the final choice of inductance can be slightly off the calculation value without significantly impacting the performance.

2) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{2 \cdot F_{SW} \cdot L}$$

Layout Design:

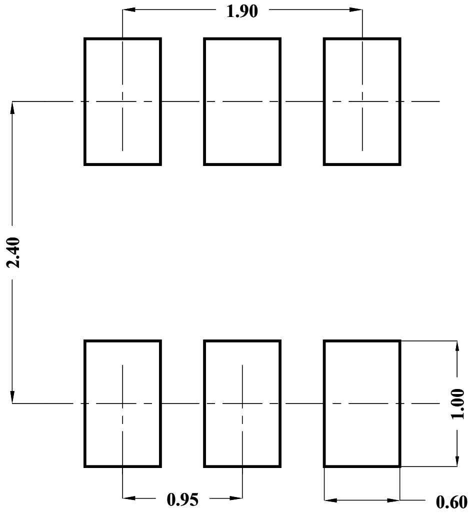
The layout design of SY8703 regulator is relatively simple. For the best efficiency and minimum noise problems, we should place the following components close to the IC: C_{IN}, L, C_{OUT} and R_{SEN}.

1) It is desirable to maximize the PCB copper area connecting to GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable.

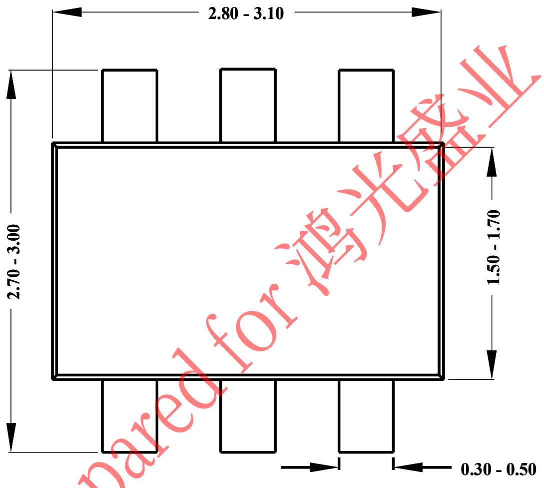
2) C_{IN} must be close to Pins IN and GND. The loop area formed by C_{IN} and GND must be minimized.

3) The PCB copper area associated with LX pin must be minimized to avoid the potential noise problem.

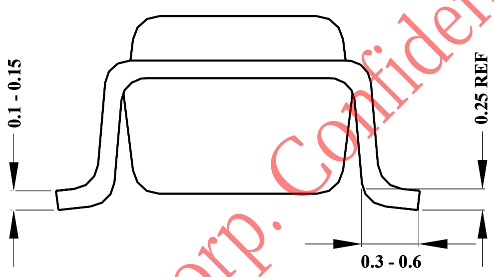
SOT23-6 Package Outline & PCB layout

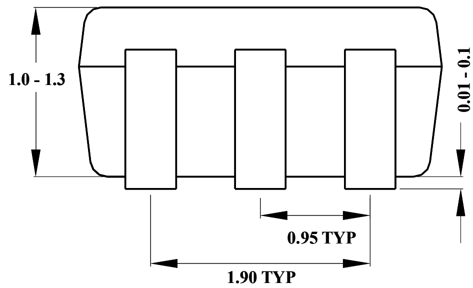


Recommended Pad Layout



Top View





Notes: All dimensions are in millimeters.
All dimensions don't include mold flash & metal burr.