1.3A Fixed Frequency White LED Driver

DESCRIPTION

The HY7001 is a step-up converter designed for Driving white LEDs array. The HY7001 uses current mode, fixed frequency architecture to regulate the LED current, which is measured through an external current sense resistor. Its low 200mV feedback voltage reduces power loss and improves efficiency.The HY7001 is turned off if an over-voltage condition is present due to an open circuit condition.

The HY7001 includes under-voltage lockout, current limiting and thermal overload protection preventing damage in the event of an output overload.

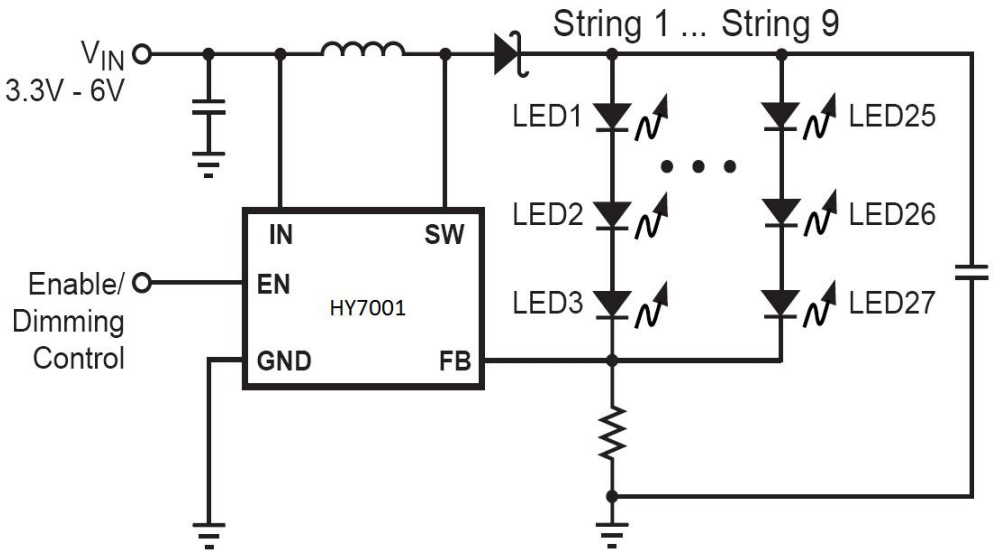
FEATURES

- Internal Power MOSFET
- Drives up to 10 Series White LEDs
- Up to 87% Efficiency
- 1.3MHz Fixed Switching Frequency
- Open Load Shutdown
- Low 200mV Feedback Voltage
- UVLO, Thermal Shutdown
- Internal 1.3A Current Limit

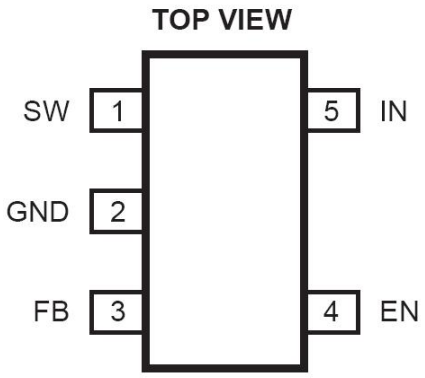
APPLICATIONS

- LCD Panels
- Digital Still Cameras
- Small LCD Displays
- Handheld Computers and PDAs

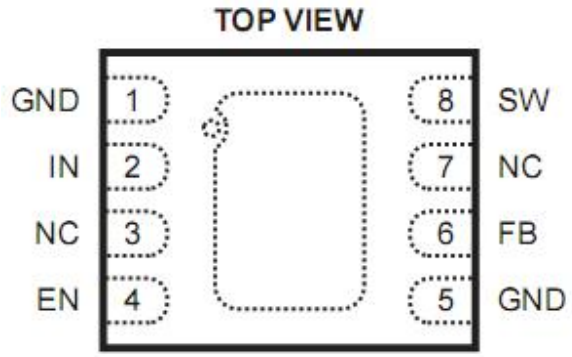
TYPICAL APPLICATIONS



PIN INTRODUCED



SOT23-5



DFN8（ 2mm x 3mm ）

MAXIMUM RATING

Items	Symbol	Range	Units
SW Pin		−0.5～+35	V
All Other Pins		−0.3～+6.5	V
Operating Temperature		-40～＋85	℃
Storage Temperature	T_{stg}	-55～＋150	℃

VIN= VEN = 5V , TA = +25℃ （ unless otherwise noted ）

Parameters	Symbol	Condition	Min	Typ	Max	Units
Operating Input Voltage	V_{IN}		2.5		6	V
Supply Current (Shutdown)		V_{EN} = 0V		135	150	uA
Supply Current (Quiescent)		V_{FB} = 0.15V		690	850	uA
Switching Frequency	f_{sw}		1.0	1.3	1.5	MHZ
Maximum Duty Cycle		V_{FB} = 0V	92			%
Under Voltage Lockout						
IN Under Voltage	UVLO	Vin Rising		2.25	2.45	V

Lockout						
Under Voltage Lockout Hysteresis				92		mV
Open Lamp Shutdown Threshold	V_{OV}	V_{OV} Rising	40	42	44	V
Enable						
EN OFF Threshold		V_{EN} Falling	0.4			V
EN ON Threshold		V_{EN} Rising			0.6	V
Feedback						
FB Voltage	V_{FB}	V_{EN}=1.5V	185	200	215	mV
FB Input Bias Current		V_{FB} = 0.1V	-600	-300		nA
Output Switch						
SW On-Resistance	$R_{DS(ON)}$			0.5		Ω
SW Current Limit		Duty Cycle=60%		1.33		A
Thermal Shutdown				150		℃

PIN DESIGNATIONS

SOT23-5 Pin#	DFN8 Pin#	Name	Description
1	8	SW	Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 36V.
2	1，5	GND	GND.
3	6	FB	Feedback Input. The HY7001 regulates the voltage across the current sense resistor between FB and GND. Connect a current sense resistor from the bottom of the LED string to GND. Connect the bottom of the LED string to FB. The regulation voltage is 200mV.
4	4	EN	ON/OFF Control and Dimming Command Input. A voltage greater than 0.6V will turn the part on and less than 0.4V will turn the part off. If the EN pin voltage is between 0.7V and 1.4V, VFB is regulated between 0V and 200mV.
5	2	VIN	Input Supply Pin. Must be locally bypassed.
	3	NC	No Connect.

FUNCTION OPERATION

The HY7001 uses a constant frequency, peak current mode boost regulator architecture to regulate the series string of white LEDs. The HY7001's block diagram of Figure 1.

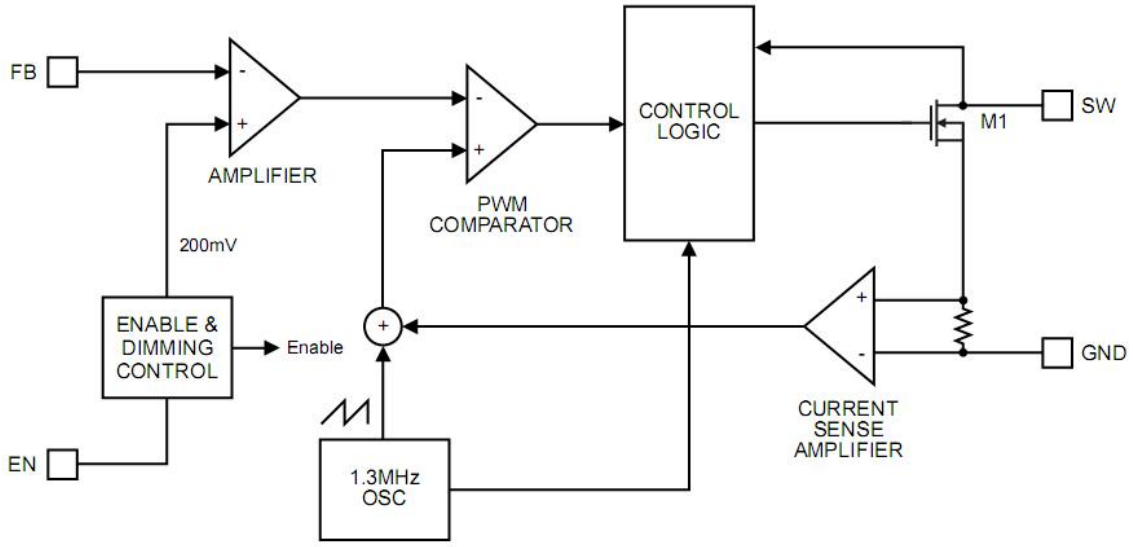


Figure 1—HY7001 Functional Block Diagram

At the start of each oscillator cycle the FET is turned on through the control circuitry. To prevent sub-harmonic oscillations at duty cycles greater than 50 percent, a stabilizing ramp is added to the output of the current sense amplifier and the result is fed into the positive input of the PWM comparator. When this voltage equals the output voltage of the error amplifier the power FET is turned off.

The voltage at the output of the error amplifier is an amplified version of the difference between the 200mV reference voltage and the feedback voltage. In this way the peak current level keeps the output in regulation.

If the feedback voltage starts to drop, the output of the error amplifier increases. This results in more current flowing through the power FET, thus increasing the power delivered to the Output.

APPLICATION INFORMATION

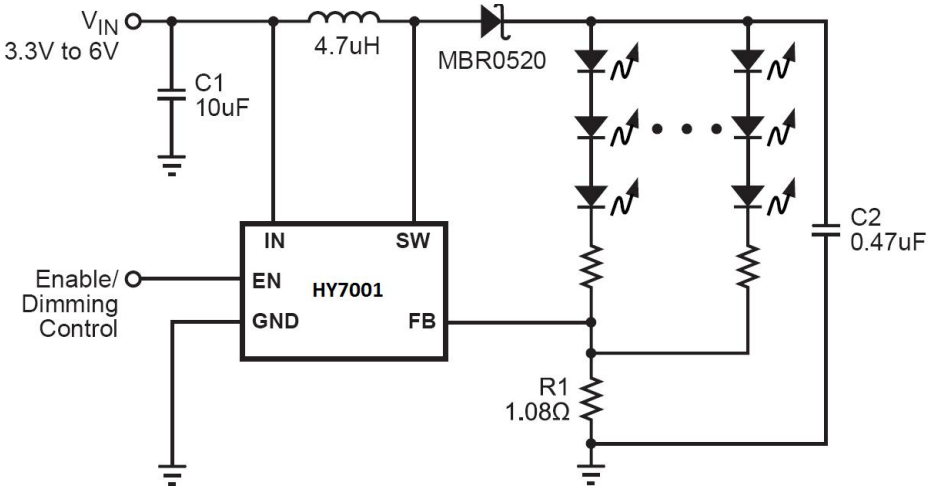


Figure 2— The typical application of driving circuit

A typical application circuit can be seen in Figure 2. The 9 strings of 3 white LEDs can be driven from a voltage supply range of 3.3V to 6V at an output current of 180mA. A 0.47μF output capacitor is sufficient for most applications. A 4.7μH inductor with low DCR (Inductor DC resistance) is recommended to improve efficiency. A 10μF ceramic capacitor is recommended for the input capacitance in the real system. Schottky diodes have fast recovery and a low forward voltage and are recommended. Schottky diodes rated with 500mA are sufficient for the HY7001. The HY7001 has internal soft-start to limit the amount of current through VIN at startup and to also limit the amount of overshoot on the output.
The ramped voltage that is added to the current sense amplifier reduces the current output as the duty cycle increases. As more LEDs are added, the output voltage rises but the current that can be delivered to the load is reduced as well.

Setting the LED Current

As shown in figure 2, the feedback resistor R1 control of light emitting diode current. Light emitting diode current is decided by the following equation:

$$ILED=200mV/R1$$

Table 1 shows the selection of resistors for a given LED current.

Table1 I_{LED} — R1

I_{LED} (mA)	R1 (Ω)
1	200
5	40
10	20
20	10
60	3.33
180	1.11

LED Current

Applying a DC voltage between 0.7V and 1.4V to EN pin programs a feedback voltage between 0V and 200mV. Thus the analog dimming of LED current can be achieved. The DC dimming voltage must be locally bypassed to prevent noise interfering with the feedback reference level.

PWM Dimming

Apply a 200Hz to 1kHz square waveform to the EN pin to implement PWM dimming of the LEDs. The minimum recommended amplitude of the PWM signal is 1.5V.

For high frequency PWM dimming (>1kHz), it is also recommended that the dimming control be implemented as shown in Figure 3. The cut off frequency of the RC filter should be 10 times lower than that of the input PWM signal. For example, when the PWM frequency is 20kHz, a 20kΩ resistor and 100nF capacitor can be used. The DC voltage on EN pin is then equal to the PWM high level voltage multiplies the PWM duty. The DC voltage from 0.7V to 1.4V programs the output current from 0~100%.

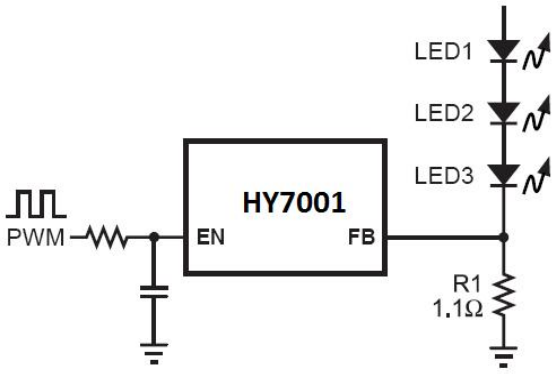


Figure 3—High Frequency PWM Dimming Control

Open Load Protection

Open Load protection will shut off the HY7001 if the output voltage goes too high. In some cases an LED may fail, this will result in the feedback voltage always being zero. The part will run at maximum duty cycle boosting the output voltage higher and higher. If the output ever exceeds 28V, the HY7001 will shut down. The part will not switch again until the power is recycled.

Layout Considerations

Layout Considerations Careful attention must be paid to the PCB board layout and components placement. Proper layout of the high frequency switching path is critical to prevent noise and electromagnetic interference problems. The current loop of IC, output diode, and output capacitor should be as short as possible.

The IN pin of the IC must be locally bypassed. A RC filter is highly recommended for eliminating the noise on IN pin. It could be implemented as shown in Figure 4.

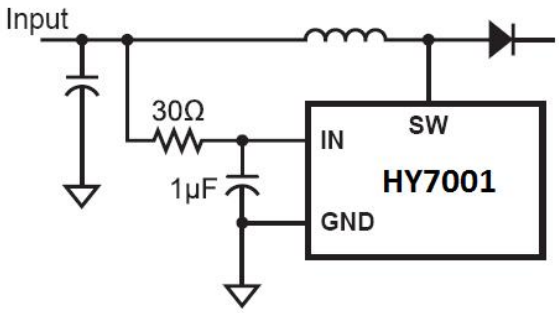


Figure 4—Input Bias Filtering

TYPICAL APPLICATION CIRCUITS

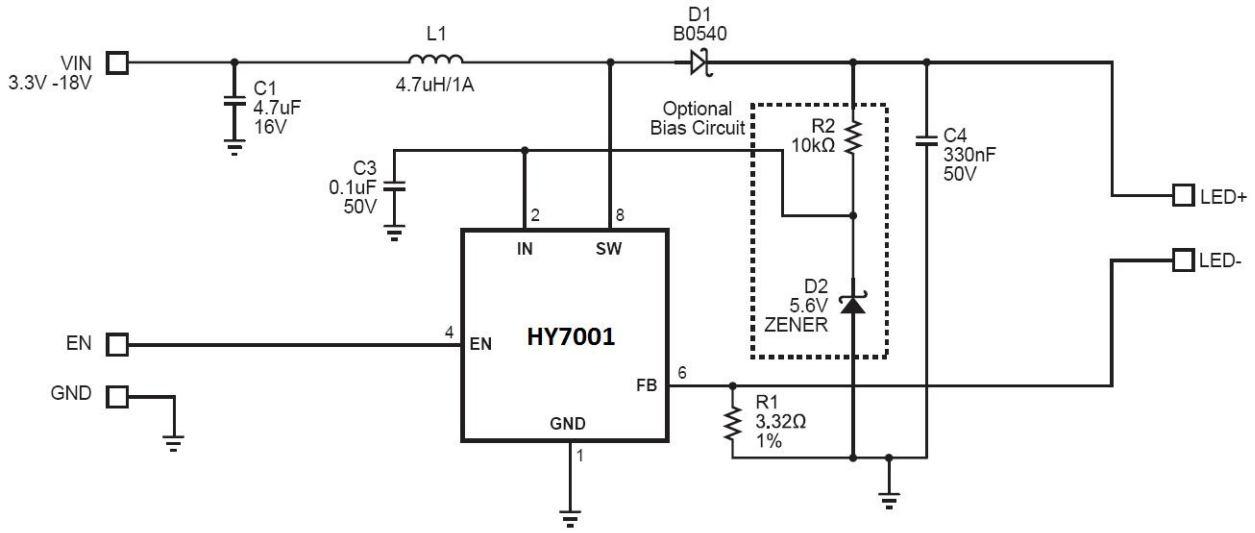
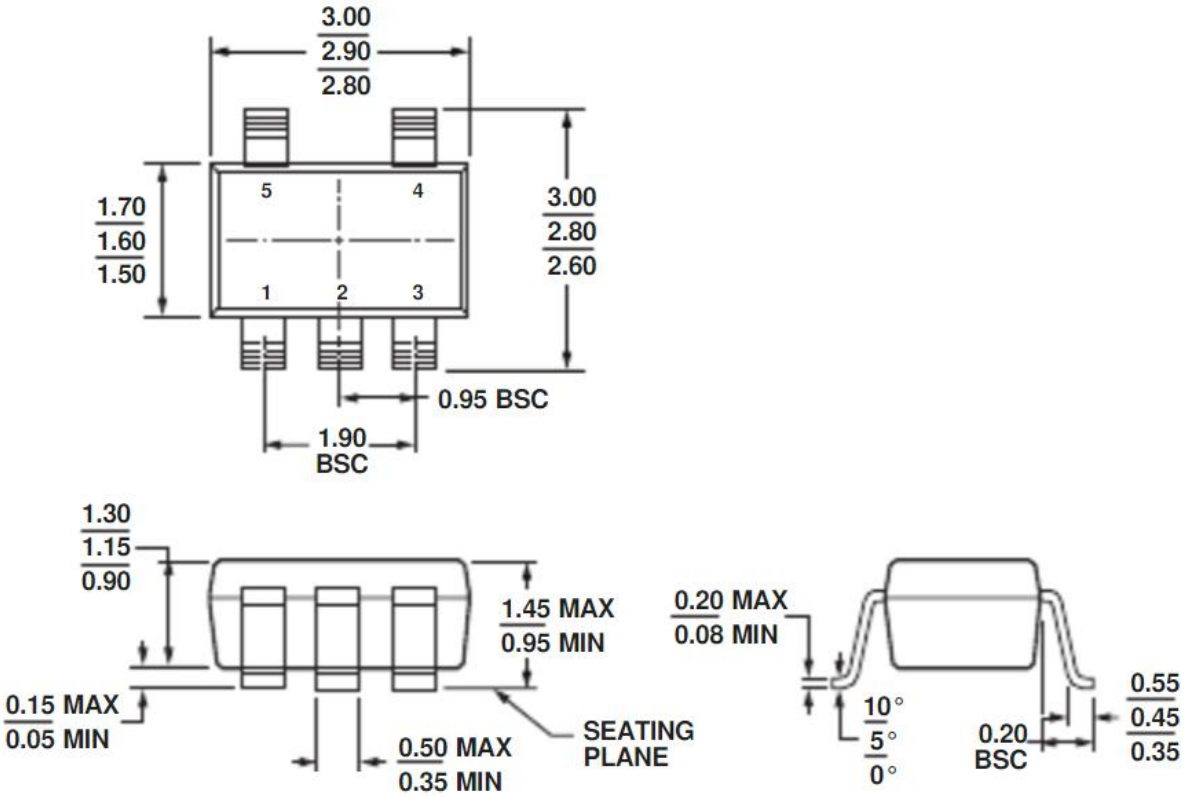


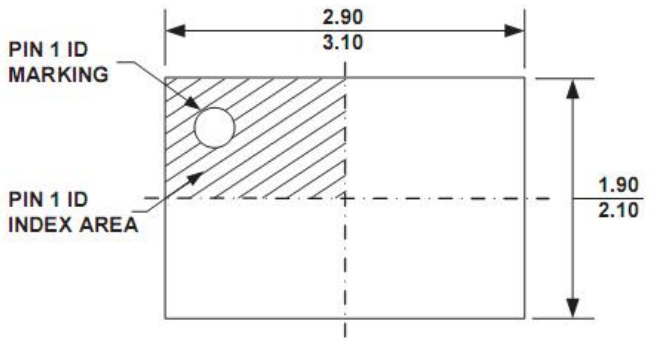
Figure 5 — Driving 27 WLEDs

PACKAGE INFORMATION：

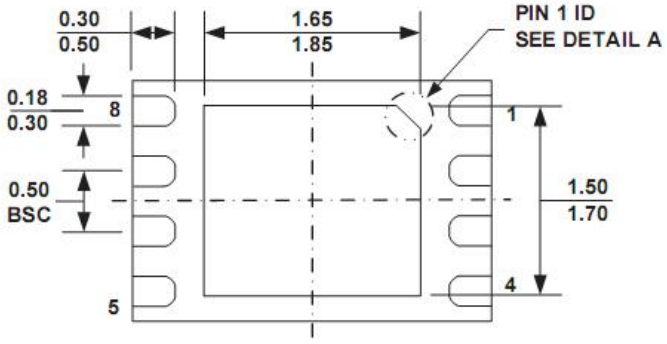
SOT23-5



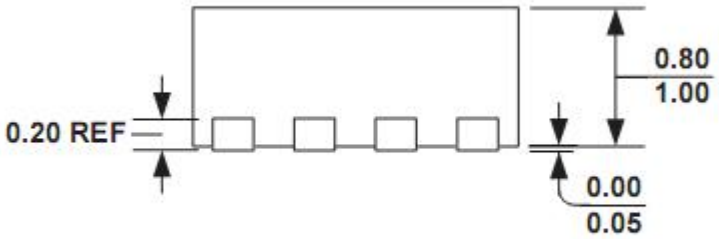
DFN8(2mm x 3mm)



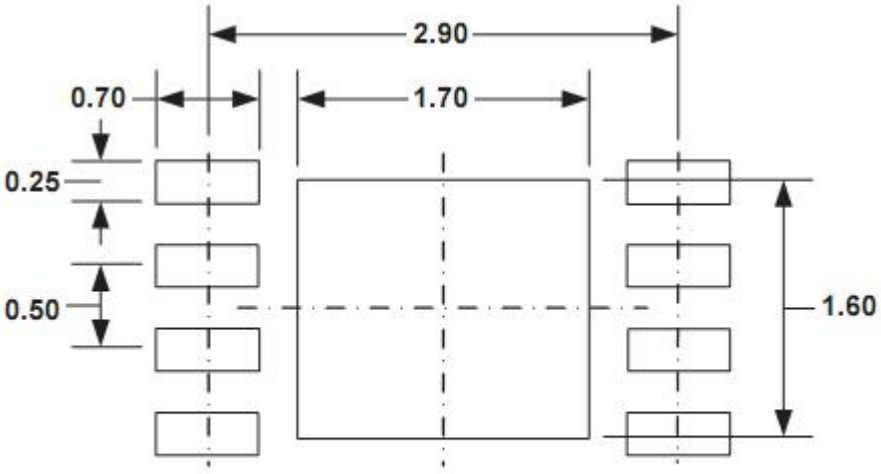
TOP VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN