FSC FOSLINK

FIXED FREQUENCY WHITE LED DRIVER

FSP3301

■ FEATURES

- On Board Power Transistor
- Drives up to 6 Series White LEDs
- Up to 87% Efficiency
- Over 1 MHz Fixed Switching Frequency
- Open Load protection
- Low 104mV Feedback Voltage
- PWM Dimming
- UVLO
- Internal Current Limit
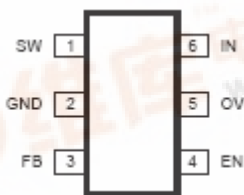- Available in TSOT23-6L and QFN8L Packages

■ APPLICATIONS

- Cell Phones
- Handheld Computers and PDAs
- Digital Still Cameras
- Small LCD Displays

■ GENERAL DESCRIPTION
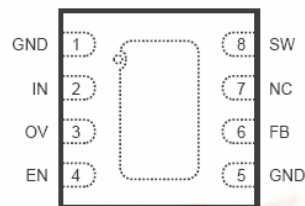
The FSP3301 is a step-up converter designed for driving up to 6 series white LEDs from a single cell Lithium Ion battery. The FSP3301 uses current mode, fixed frequency architecture to regulate the LED current, which is measured through an external current sense resistor. Its low 104mV feedback voltage reduces power loss and improves efficiency. The OV pin monitors the output voltage and hold the output voltage equal Vov if an over-voltage condition is present due to an open circuit condition.

The FSP3301 includes under-voltage lockout, current limiting and thermal overload protection preventing damage in the event of an output overload.

The FSP3301 is available in small 6-pin TSOT23 or 8-pin QFN (2mm x 2mm) packages.

■ PIN CONFIGURATION

(1) TSOT23-6L

(Top View)

(2) QFN8L

(Top View)

Symbol		Name	Descriptions
TSOT23-6L	QFN8L		
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 29V.
2	1，5	GND	Ground.
3	6	FB	Feedback Input. The FSP3301 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 104mV.
4	4	EN	Regulator On/Off Control Input. A high input at EN turns on the converter, and a low input turns it off. When not used, connect EN to the input source for automatic startup. The EN pin cannot be left floating.
5	3	OV	Over Voltage Input. OV measures the output voltage for open circuit protection. Connect OV to the output at the top of the LED string.
6	2	IN	Input Supply Pin. Must be locally bypassed.

■ ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Symbol	Parameter		Rating	Unit
	SW, OV Pins		-0.5 to +29	V
	All Other Pins		-0.3 to +10	V
Tstg	Storage Temperature Range		-65 to +150	℃
θ_{JC}	Thermal Resistance (Note 2)	TSOT23-6L	110	℃/W
		QFN8L	16	
θ_{JA}		TSOT23-6L	220	℃/W
		QFN8L	80	

Note 1: Exceeding these ratings may damage the device.
Note 2: Measured on approximately 1" square of 1 oz copper.

■ RECOMMENDED OPERATING CONDITIONS (NOTE 3)

Symbol	Parameter	Rating	Unit
	Input Supply Voltage	+2.5 to +10	V
	Output Voltage	VIN to +29	V
T_{OP}	Operating Temperature Range	-40 to +85	℃

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

■ ELECTRICAL CHARACTERISTICS

(VIN = VEN = 5V, TA = +25°C, unless otherwise noted.)

Parameters	Symbol	Condition	Min	Typ	Max	Units
Operating Input Voltage	V_{IN}		2.5		10	V
Supply Current (Shutdown)		V_{EN} = 0V		0.1	1	µA
Supply Current (Quiescent)		V_{FB} = 0.15V		2.0	2.6	mA
Switching Frequency	f_{SW}		0.9	1.2	1.5	MHz
Maximum Duty Cycle		V_{FB} = 0V	85	90		%
Under Voltage Lockout						
IN Under Voltage Lockout	UVLO	V_{IN} Rising		2.10	2.18	V
Under Voltage Lockout Hysteresis				80		mV
Open Lamp Shutdown Threshold	V_{OV}	V_{OV} Rising		29		V
Enable						
EN Threshold		V_{EN} Rising		0.77		V
EN Threshold		V_{EN} Rising, V_{IN} = 2.5V		0.76		V
EN Hysteresis				30		mV
EN Input Bias Current		V_{EN} = 0V, 5V			65	µA
Feedback						
FB Voltage			94	104	114	mV
FB Input Bias Current		V_{FB} = 0.1V	-0.01	-0.045	-1	µA
Output Switch						
SW Current Limit (Note 4)		Duty Cycle =60%		320		mA
Switch V_{CEAST}	B_{VCES}	I_{SW}=250mA		350		mV
Switch Leakage Current		V_{SW}=5V		0.01	5	uA

Note 4: Guaranteed by design.

FUNCTIONAL BLOCK DIAGRAM
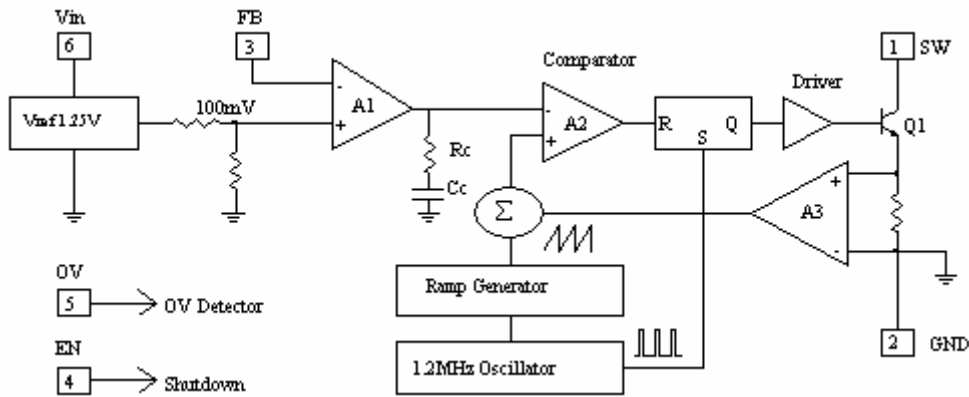
FUNCTION DESCRIPTION

The FSP3301 uses a constant frequency, current mode control scheme to provide excellent line and load regulation. operation can be best understood by referring to the block diagram. At the start of each oscillator cycle, the SR latch is set, which turns on the power switch Q1. A voltage proportional to the switch current is added to a stabilizing ramp and the resulting sum is fed into the positive terminal of the PWM comparator A2. When this voltage exceeds the level at the negative input of A2, the SR latch is reset turning off the power switch. The level at the negative input of A2 is set by the error amplifier A1, and is simply an amplified version of the difference between the negative input of A3 is set by the difference between the feedback voltage and the reference voltage of 100mV. In this manner, the error amplifier sets the correct peak current level to keep the output in regulation. If the error amplifier's output increases, more current is delivered to the output; if it decreases, less current is delivered.

TYPICAL APPLICATIONS CIRCUIT
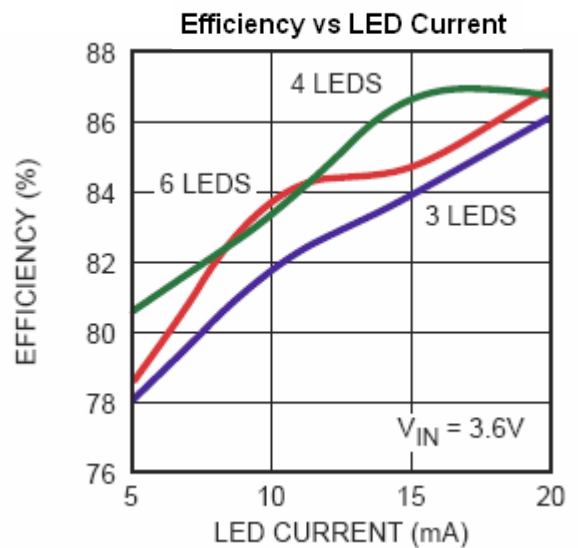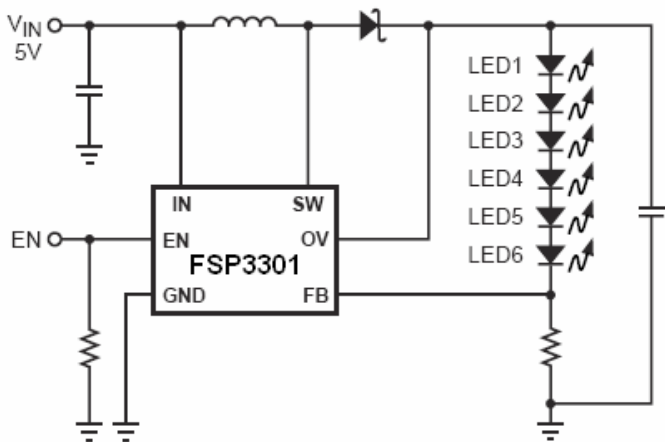
■ **APPLICATION INFORMATION**
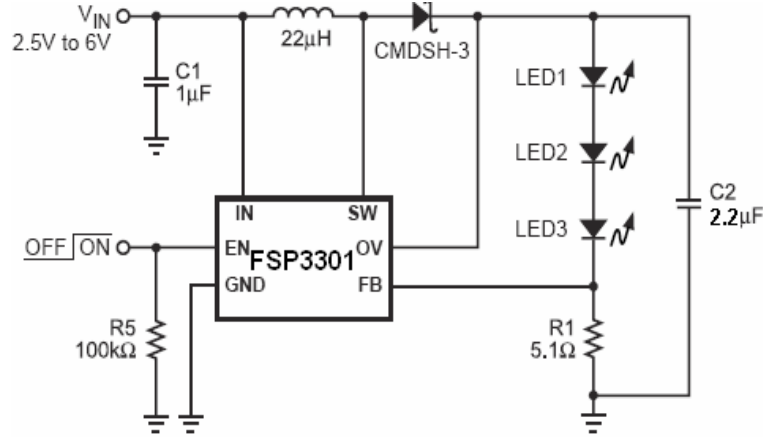
Figure 1 Circuit For Driving 3W LEDS

A typical application circuit can be seen in Figure 1. The 3 white LEDs can be driven from a voltage supply range of 2.5V to 10V at an output current of 20mA. A 0.22µF output capacitor is sufficient for most applications but an output capacitor up to 1 µF may be used. A 22µH inductor with low DCR (Inductor resistance) is recommended to improve efficiency. A 1µF 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 100mA to 200mA are sufficient for the FSP3301. The switching characteristics during normal operation can be seen in Figure 2.
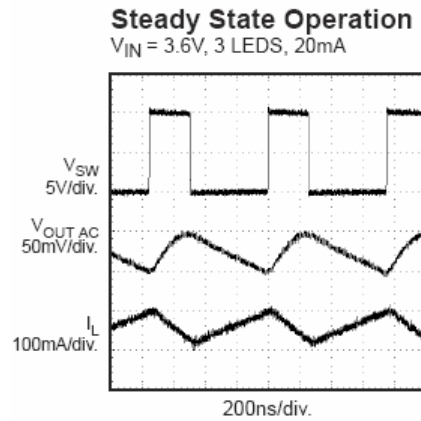
Figure 2 Steady State Operation

Figure 3 shows the startup behavior of the FSP3301. 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.
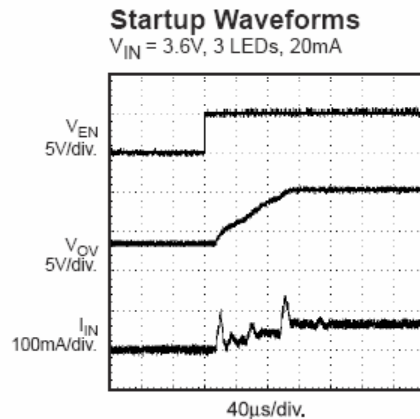

Figure 3 Startup Waveforms

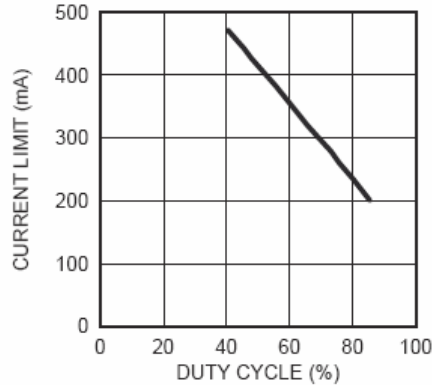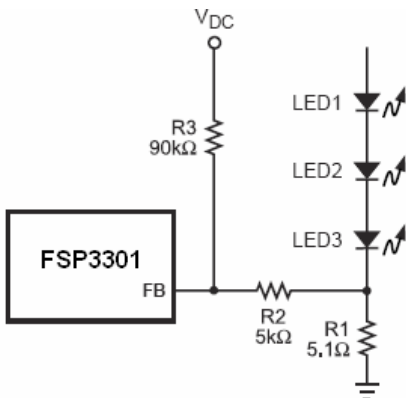Figure 4 shows the dependence on current limit versus duty cycle.

Figure 4 Current Limit vs Duty Cycle

Setting the LED Current

The LED current is controlled by the feedback resistor, R1, in Figure 5. The current through the LEDs is given by the equation 104mV/R1. Table 2 shows the selection of resistors for a given LED current.

ILED (mA)	R1 (Ω)
1	104
5	20.8
10	10.4
15	6.93
20	5.2

Figure 5 Dimming Control Using a DC Voltage

Table 1 LED vs R

Analog and Digital Dimming

There are three different ways to control dimming for the FSP3301 during normal operation. The first way uses a DC voltage to control the feedback voltage. This can be seen in Figure 5. As the DC voltage increases, current starts flowing down R1, R2 and R3. The loop will continue to regulate the feedback voltage to 104mV. Thus the current has to decrease through the LEDs by the same amount of current as is being injected from the DC voltage source. With a VDC from 0V to 2V, the resistor values shown for R2 and R3 can control the LED current from 0mA to 20mA.

Other applications need to use a logic signal to do the dimming. This can be seen in Figure 6. The PWM signal is applied to the EN pin of the FSP3301. The LEDs will switch between full load to completely shut off. The average current through the LEDs will increase proportionally to the duty cycle of the PWM signal.
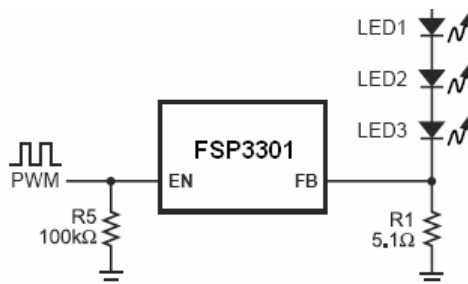

Figure 6 PWM Dimming Control Using a Logic Signal

If the PWM signal is above 1 KHz, dimming can be achieved by using the circuit shown in Figure 7
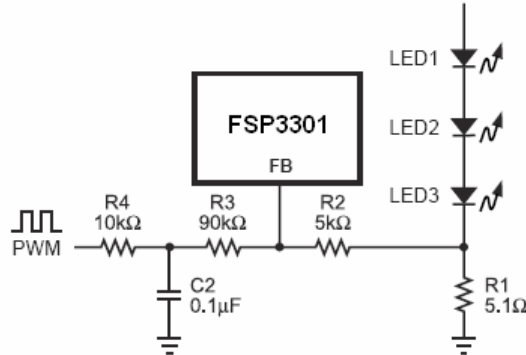
Figure 7 Dimming Control Using a Filtered PWM Signal

Open Load Protection

Open Load protection will hold the output voltage equal Vov if an over-voltage condition is present due to an open circuit condition when the OV pin is tied to the output. In some cases an LED may fail, this will result in the feedback voltage always being zero.
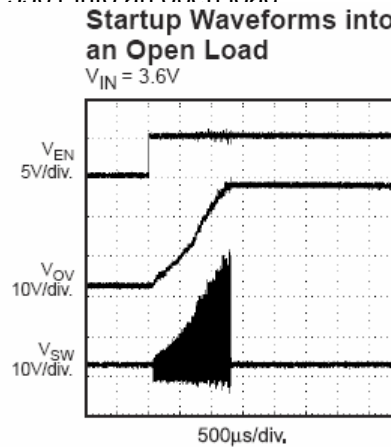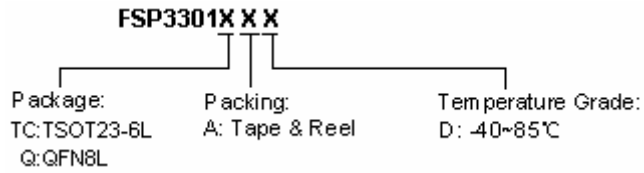
Figure 8 shows the behavior of the FSP3301 into an open load.

Figure 8 Startup Waveforms into an Open Load
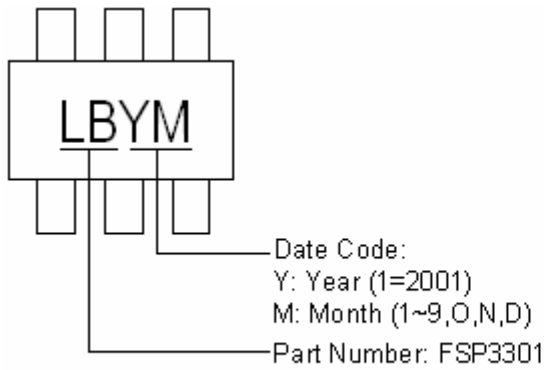
Layout Considerations

Careful attention must be paid to the PCB board layout and component placement. Proper layout of the high frequency switching path is critical to prevent noise and electromagnetic interference problems. Due to the high frequency switching the length and area of all the traces connected to the switch node should be minimized.
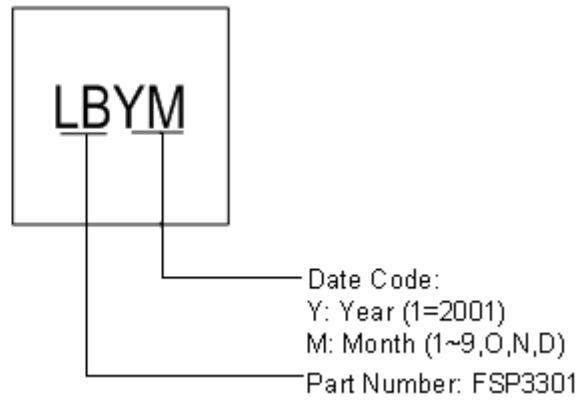
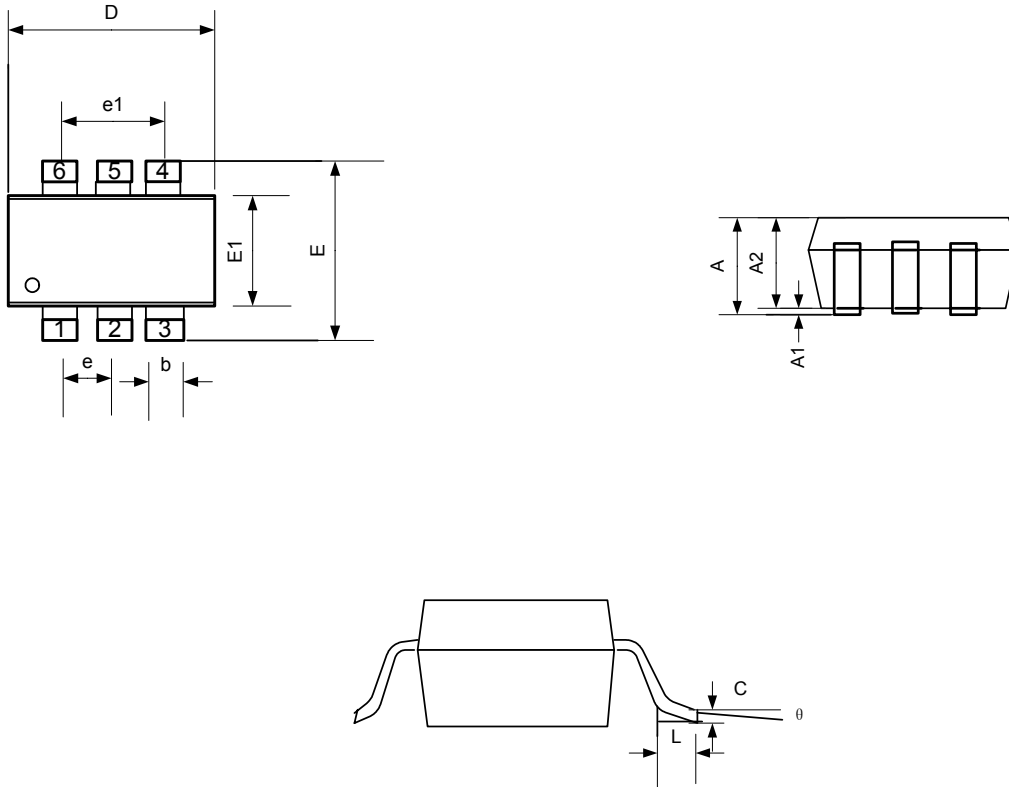■ **ORDERING INFORMATION**

FSP3301X X X

Package:
TC:TSOT23-6L
Q:QFN8L

Packing:
A: Tape & Reel

Temperature Grade:
D: -40~85℃

■ **Marking Information**

(1) TSOT23-6L

LBYM

Date Code:
Y: Year (1=2001)
M: Month (1~9,O,N,D)
Part Number: FSP3301

(2) QFN8L

LBYM

Date Code:
Y: Year (1=2001)
M: Month (1~9,O,N,D)
Part Number: FSP3301

■ PACKAGE INFORMATION

(1) TSOT23-6L

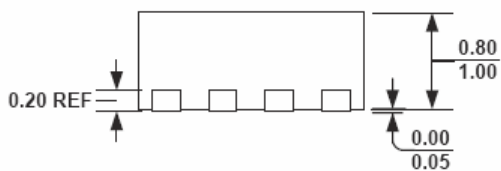| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.900	1.100	0.036	0.044
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.036	0.040
b	0.300	0.500	0.012	0.020
C	0.100	0.200	0.004	0.008
D	2.800	3.100	0.112	0.124
E	2.50	3.100	0.100	0.124
E1	1.500	1.700	0.060	0.068
L	0.200	0.550	0.002	0.022
e	0.95 Bsc.		0.038 Bsc.	
e1	1.90 Bsc.		0.076 Bsc.	
θ	0º	10º	0º	10º

(2) QFN8L
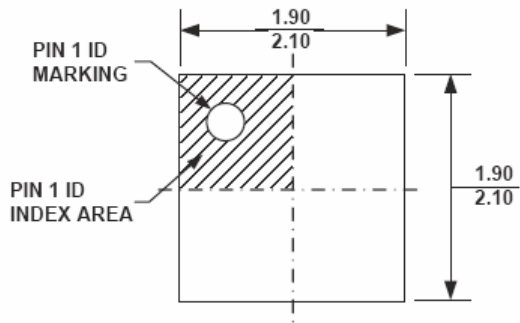
TOP VIEW
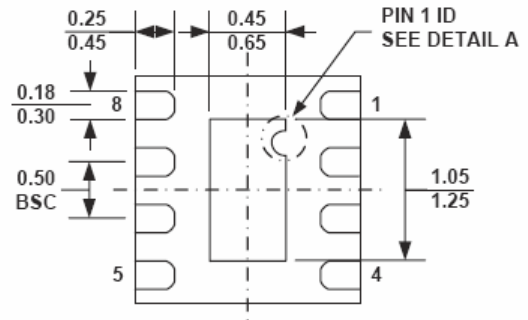
BOTTOM VIEW

SIDE VIEW

DETAIL A