High Efficiency, High Power White-LED Driver

FEATURES

- On Board Power MOSFET
- Drives up to 4 strings of parallel LEDs
- Up to 87% Efficiency
- 1.4MHz Fixed Switching Frequency
- Open Load Shutdown
- Low 100mV Feedback Voltage
- Soft Start
- PWM Dimming Control
- UVLO, Thermal Shutdown
- Internal Circuit Limit
- Available in SOT26 Package

APPLICATIONS

- WLED Backlight
- Cell Phones
- Handheld Computers and PDAs
- Digital Cameras
- Small LCD Displays
- LED Module
- Game Devices

DESCRIPTION

The PS1313 is a step up converter designed for driving up to 4 branches with 4 white LEDs in series in each branch, providing backlight in cell phones, PDAs, and other hand-held devices. The PS1313 uses current mode, fixed frequency architecture to regulate the LED current, which is measured through an external current sense resistor. Its low 100mV feedback voltage reduces power loss and improves efficiency. The OV pin monitors the output voltage and turns off the converter if an over-voltage condition is present due to an open circuit condition.

The PS1313 includes under-voltage lockout, current limiting and thermal overload protection preventing damage in the event of an output overload. The PS1313 is available in small 6-pin SOT26 Package.

TYPICAL APPLICATION CIRCUIT

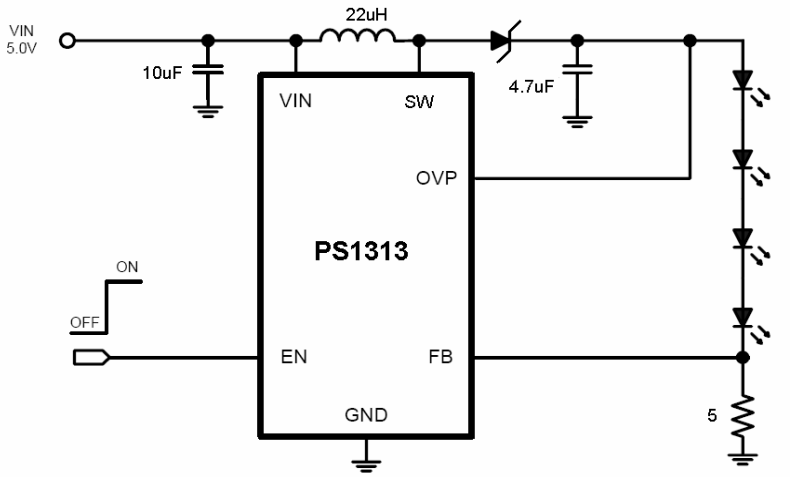


Fig: Typical Application Circuit with 20mA Output

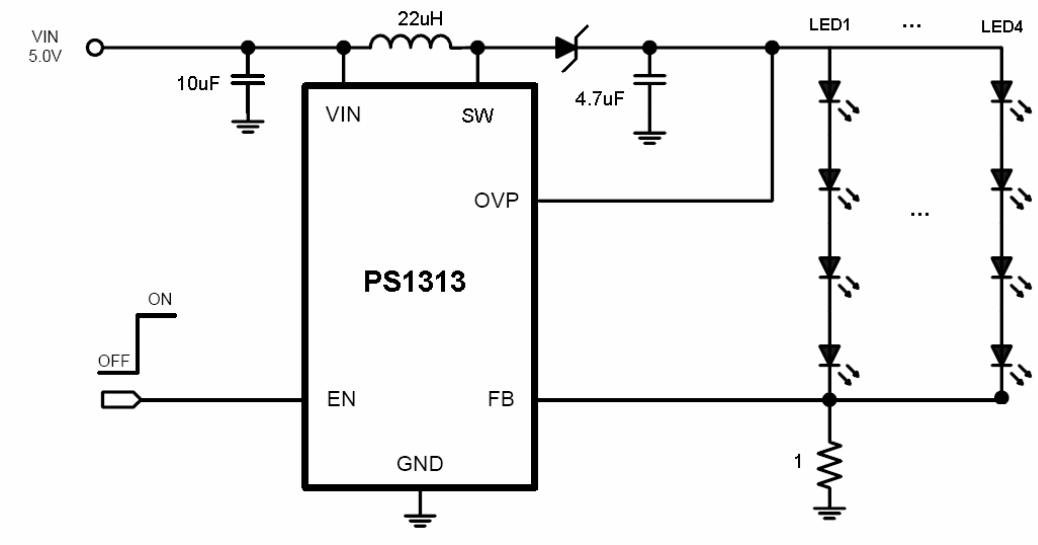
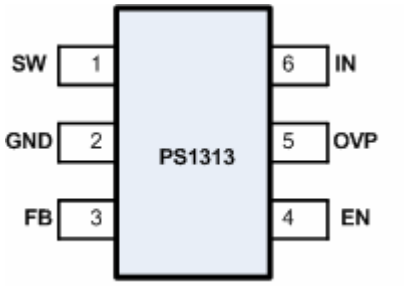


Fig: PS1313 for Innolux 8" Panel LED Back light unit

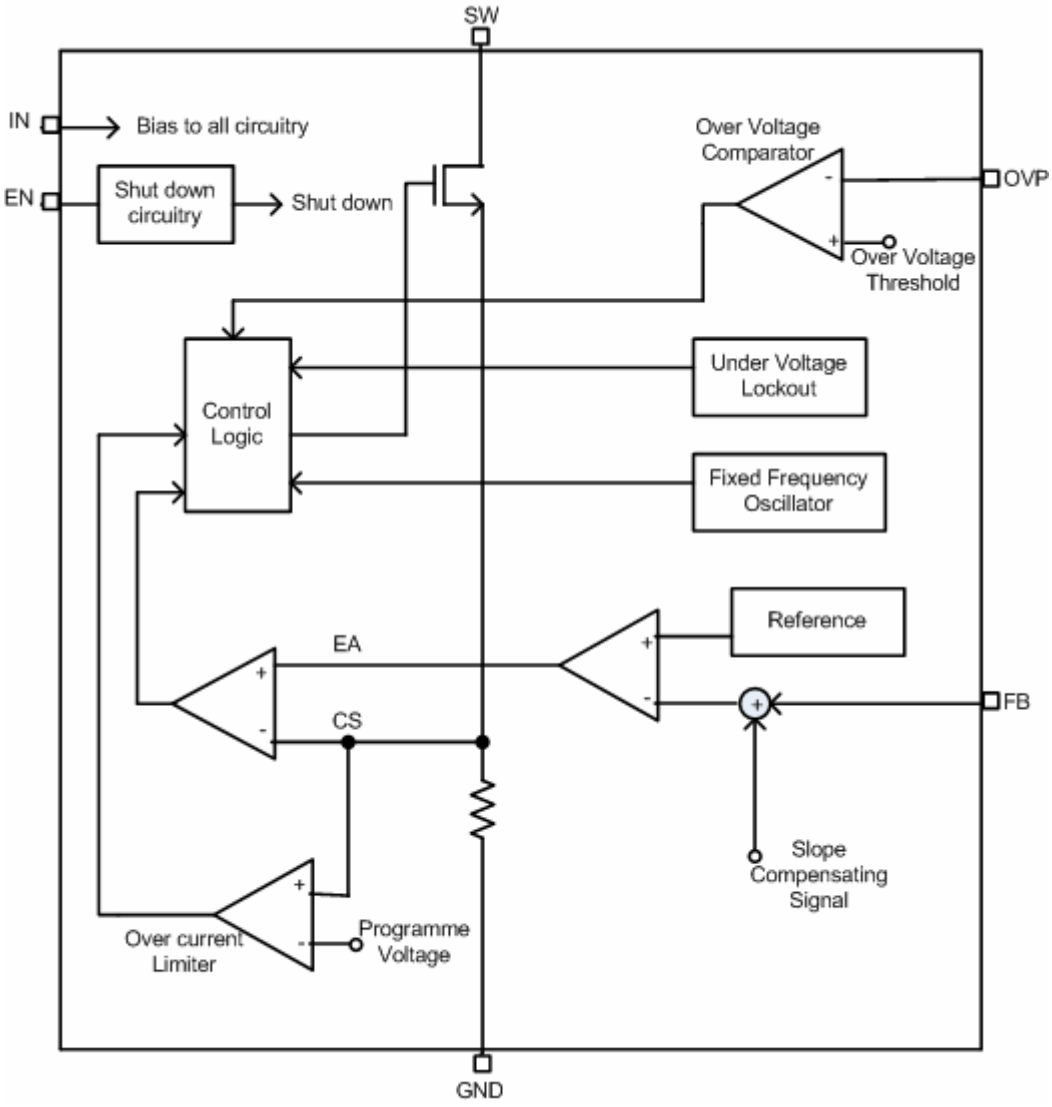
PIN CONFIGURATION



PIN DESIGNATOR

Name	Pin	Type	Function
SW	1	Switch	Connect inductor between SW and IN.
GND	2	Ground	Ground pin
FB	3	Feedback	Adjustable feedback input, connect to resistor voltage divider.
EN	4	Enable input.	EN=High: normal operation. (Supports both TTL and CMOS Logic).
OVP	5	Over voltage input.	Measures the output voltage for over voltage protection.
IN	6	Battery input.	Boost regulator input.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{SW}	DC Voltage at Pin 1	-0.5 to +28	V
V_{EN}	Enable Input Voltage at Pin 2	-0.3 to +6.0	V
P_D	Continuous Power Dissipation	Internally limited	W
T_{STG}	Storage Temperature Range	-65 to +150	°C
$R_{\theta JA}$	Thermal Resistance, Junction-To-Air	235	°C /W
$T_{J,MAX}$	Operating Junction Temperature	-40 to +125	°C
T_L	Lead Temperature (Soldering, 5sec)	260	°C
ESD	ESD Capability, HBM model	2.0	kV

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{IN}	DC Supply Voltage at Pin 1	+2.5 to 6	V
V_{EN}	Enable Input Voltage at Pin 2	0 to V_{IN}	V
T_J	Operating Junction Temperature	-40 to +125	°C

ELECTRICAL CHARACTERISTICS

(Vin = 2.5V, T_A = +25°C, unless otherwise noted. Typical values are at T_A = +25°C.)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{IN}	Operating Input Voltage		2.5		5.5	V
UVLO	Under Voltage Lock-out	Vin going Lo.	2.05	2.15	2.25	V
	UVLO Hysteresis			80		mV
I_G	Supply Current (quiescent)	No Switching (Vin=5V, V_{FB}= 270mV)		235	240	μA
	Supply Current	Switching FB=0		1935		μA
I_{SH}	Supply Current (shut-down)	V_{EN} =0			0.15	μA
F_{OSC}	Operation Frequency		1.3	1.4	1.5	MHz
D_{MAX}	Maximum Duty Cycle			94		%
V_{FB}	Feedback Voltage		90	100	110	mV
	Feedback Input Bias Current	V_{FB}=270mV			1.5	μA
$R_{DS(ON)}$	MOSFET ON resistance			0.63		Ω
I_{LIM}	Current Limit	Vin=3		1.18		A
V_{EN}	Enable Threshold	Turn ON	1			V
		Turn OFF			0.4	V
I_{EN}	Enable Input Bias Current	V_{EN} =0, 5V			6	μA
	Thermal Shut-down			160		C
V_{OV}	Over Voltage Threshold	V_{OV} rising		18		V
	OV Hysteresis			2.6		V

OPERATION DESCRIPTION

The PS1313 is a high efficiency, fixed frequency, peak current mode boost regulator. It has the architecture to regulate the voltage at the feedback pin, so that a regulated fixed current is achieved to drive white LEDs. The power MOS is turned ON through the control circuitry, at the start of each oscillator cycle and thus the charging phase is initiated. The error amplifier, consisting of a voltage comparator and current sense amplifier, is basically, a PWM comparator. The voltage comparator amplifies the difference between the reference and feed back voltage. When the output of the current sense amplifier, reaches the output of the voltage comparator, the POWER MOS is turned OFF and thus the charging phase is terminated. To prevent sub-harmonic oscillations at duty cycles greater than 50 percent, a stabilizing ramp is added to the current sense signal. In this way the peak current level keeps the output in regulation. The PS1313 has internal soft start mechanism, to limit the inrush current at startup and to limit the amount of overshoot on the output, also. An internal blanking time is provided during start up, to prevent the start of switching before all the circuitry become ready for operation. The current limit is increased by a fourth every 60µs giving a total soft start time of 240µs.

Setting the LED current :

The LED current can be set, according to the requirement, by feedback to ground resistor, R1. The current through the LEDs is selected by the following equation:

$$I_{LED}=100mV/R1$$

Current Limit :

The PS1313 includes a current limiter. It monitors the peak current through the inductor and controls gate of the power device.

Enable Input :

The PS1313 features an active-high Enable input (EN) pin that allows on/off control of the regulator. The PS1313 bias current reduces to less than microampere when it is shutdown. The output remains at a schottky forward voltage lower than the SW pin, if a schottky diode is connected between SW and OV pin, at shut. The Enable input is TTL/CMOS compatible.

Under Voltage Lockout:

When the input supply goes too low (below 2.15V) the PS1313 produces an internal UVLO (under voltage lockout) signal that shuts down the chip. This mechanism protects the chip from producing false logic due to low input supply.

Thermal Overload Protection:

Thermal-overload protection limits total power dissipation in the PS1313. When the junction temperature exceeds T_j= +160°C, the thermal sensor signals the shutdown logic and turning off most of the internal circuitry. The thermal sensor turns internal circuitry on again after the IC's junction temperature drops by 20°C. The regulator then starts functioning in the required mode based on the supply voltage.

Thermal-Overload protection is designed to protect the PS1313 in the event of a fault condition. For continual operation, do not exceed the absolute maximum junction temperature rating of Tj = +150°C.

Open Load Protection:

Open load protection in PS1313, protects the chip from destruction, due to excessive high voltage. When, in any case, one or more LEDs in the LED string fails, the feedback pin is pulled down to zero. As a result, the chip runs at maximum duty cycle, boosting the output voltage higher and higher. The open load protection mechanism, checks this condition, if OV pin is tied to the top of the LED string. If the output voltage exceeds the OV threshold (18V) and persists there for a certain span of time (15µS), the switching stops, allowing the output to discharge. The open load protection mechanism includes a hysteretic comparator. The switching is enabled again, when the output voltage has fallen to a certain level. Because the chip doesn't turn OFF fully, no power recycling is necessary, when this condition takes place. But it's highly recommended, not to use the chip in that mode of operation for longer span of time.

Dimming Control:

LED is a current driven device. Hence, current through the LED needs to be controlled to have dimming control. Different ways are there to control dimming for PS1313, in the normal mode of operation. In the first way, the feedback voltage is controlled using an external voltage source. As shown in the figure-8, current starts flowing down R1, R2 and R3, as the external voltage increases. The loop will continue to regulate the feedback voltage to 100mV, and as a result, the current through the LEDs has to decrease as the same amount of that being injected from the external source. With the external voltage from 0 to 2V, the resistor values shown for R2 and R3 can control LED current from 0 to 20mA.

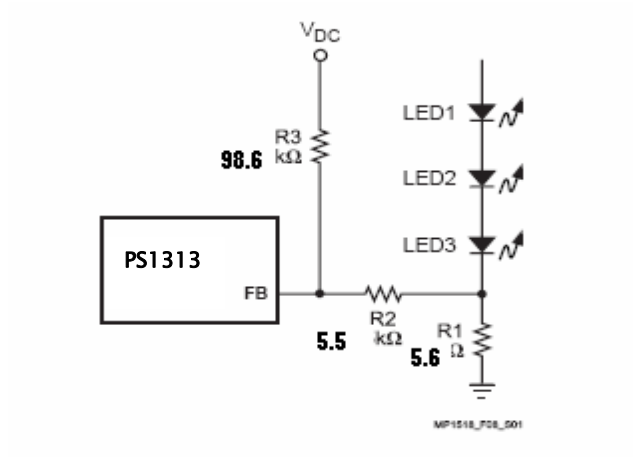


Figure 8: Dimming control using a DC voltage

Dimming can also be achieved using logic signal to EN pin. As shown in Figure-9, the PWM signal can be applied to the EN pin of PS1313. The LEDs will switch between full load to completely shut down state. The average current through the LEDs will be proportional to the duty cycle of PWM. The PWM signal in figure-9 should be of 1 KHz or less, because of the presence of the soft-start mechanism.

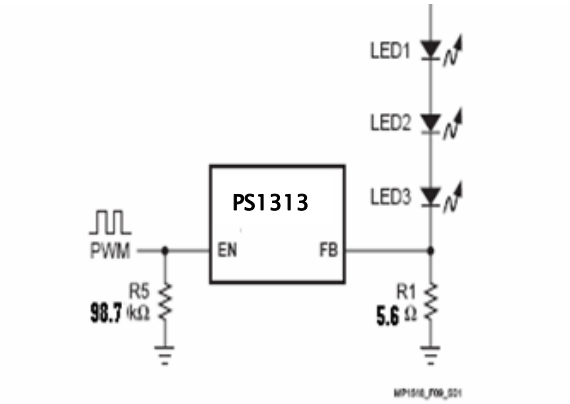
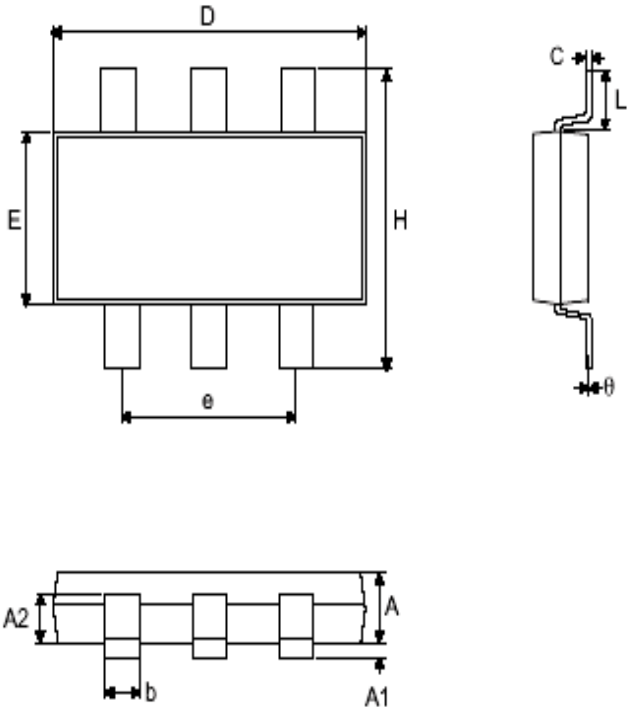


Figure 9: PWM dimming control using Logic signal

PACKAGE INFORMATION

SOT-26 Outline Dimensions (Unit: mm)



Pin	Parameter										
	A	A1	A2	b	C	D	E	e	H	L	θ
6	1~1.3	0.1 max.	0.7~0.9	0.35~0.5	0.1~0.25	2.7~3.1	1.4~1.8	1.9 typ.	2.6~3	0.37 min.	1°~9°

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