PT4117B

Small Package, High Performance Step-Up WLED Driver

GENERAL DESCRIPTION

The PT4117B is a small package, high performance step-up DC/DC converter designed for driving up to 7 white LEDs in series with constant output current from a single cell Lithium Ion battery. Because the PT4117B directly regulates output current, it is ideal for driving light emitting diodes (LEDs) whose light intensity is proportional to the current passing through them, instead of the voltage across their terminals. A single external resistor sets the LED current, which can then be easily adjusted using either a DC voltage or a pulse width modulated (PWM) signal from 100Hz to 100 KHz. Its low 200mV feedback voltage reduces power loss and improves efficiency. The VOUT pin monitors the output voltage and turns off the converter if an over-voltage condition happens due to an open circuit condition. The PT4117B is available in SOT23-6 package.

FEATURES

- VIN Operating Range: 2.5~6.0V
- Up to 92% Efficiency
- 1.2MHz Fixed Switching Frequency
- Low 200mV Feedback Voltage
- Output Over Voltage Protection
- VIN Under Voltage Lockout
- Internal Soft-Start
- SOT23-6 Package

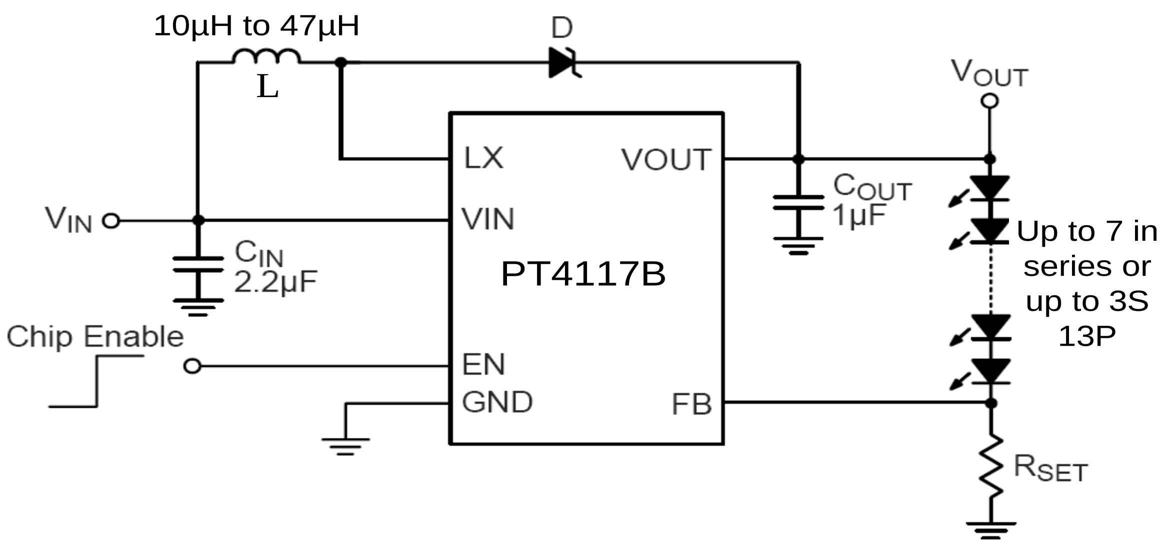
APPLICATIONS

- Cell Phones
- Handheld Computers, PDAs and Smart Phones
- Digital Cameras
- Small LCD Displays and OLED

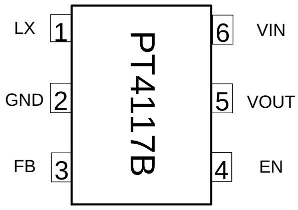
ORDERING INFORMATION

PACKAGE	TEMPERATURE RANGE	ORDERING PART NUMBER	TRANSPORT MEDIA	MARKING
SOT23-6	-40˚C to 85˚C	PT4117BE23F	Tape and Reel 3000 units	4117B

TYPICAL APPLICATIONS



PIN ASSIGNMENT



SOT23-6

PIN DESCRIPTION

SOT23-6 Pin No.	PIN NAMES	DESCRIPTION
1	LX	Power Switch Output. Connect the inductor and the blocking Schottky diode to LX.
2	GND	Ground
3	FB	Feedback input pin. The reference voltage at this pin is 200mV. Connect the cathode of the lowest LED to FB and a current sense resistor between FB and GND.
4	EN	Enable pin. A high input at EN enables the device and a low input disables the devices. When not used, connect EN to the input source for automatic startup.
5	VOUT	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	VIN	Input Supply Pin. Must be locally bypassed.

ABSOLUTE MAXIMUM RATINGS (Note 1,2)

SYMBOL	ITEMS	VALUE	UNIT
V_{IN}	Input Voltage	-0.3～7	V
V_{LX}	Voltage at LX Pin	-0.5～45	V
V_{IO}	All Other I/O Pins	GND-0.3 to VDD+0.3	V
P_{DMAX}	Power Dissipation (Note 2)	Internally Limited	W
P_{TR1}	Thermal Resistance，SOT-23-6, Θ_{JA}	220	˚C /W
Tstg	Storage Temperature	-55 to 150	˚C
Tsolder	Package Lead Soldering Temperature	260˚C, 10s	

RECOMMENDED OPERATING RANGE

SYMBOL	ITEMS	VALUE	UNIT
VIN	VIN Supply Voltage	3.0 to 6.0	V
VOUT	Output Voltage	V_{IN} to 20	V
TOPT	Operating Temperature	-40 to +85	˚C

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended Operating Range indicates conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Range. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{JA}, and the ambient temperature T_A. The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX} - T_A)/ \theta_{JA}$ or the number given in Absolute Maximum Ratings, whichever is lower.

ELECTRICAL CHARACTERISTICS (Note 3,4)

The following specifications apply for V_{IN}= V_{EN} =3.6V, C_{IN}=2.2µF, C_{OUT}=1.0µF, I_{OUT}=20mA, L=10µH, T_A=25˚C, unless specified otherwise.

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Input Voltage	V_{IN}		2.5		6.0	V
Under Voltage Lock Out	V_{UVLO}	V_{IN} Rising		2.20	2.45	V
UVLO Hysteresis				0.1		V
Quiescent Current	I_Q	FB=0.15V, No Switching		250	500	µA
Supply Current	I_{IN}	FB=0 V, Switching		1	2	mA
Shut Down Current	I_{SHDN}	V_{EN}<0.4V		0.1	1	µA
Line Regulation		V_{IN}=2.5 to 6.0V		1		%
Load Regulation		Load=1mA to 20mA		1		%
Operation Frequency	F_S		1.00	1.20	1.40	MHz
Maximum Duty Cycle			90	95		%
Dimming Clock Rate			0.1		200	KHz
Feedback Reference Voltage	V_{REF}	Nominal	185	200	215	mV
On Resistance	$R_{DS(ON)}$			0.4	0.7	Ω
EN Threshold Voltage	V_{IH}		1.40			V
	V_{IL}				0.4	V
EN Hysteresis Voltage	V_{IH} - V_{IL}			0.1		V
EN Sink Current	I_{EN}			1		µA
Over-Voltage Threshold	V_{OVP}	Nominal		22		V
Over-Current Threshold	I_{OCP}	V_{IN}=5V	1.2	1.5		A
Thermal Shut-Down	T_{SD}			170		˚C
Thermal Shut-Down Hysteresis				30		
Shut Down Delay	T_{SHDN}			5		ms

Note 3: Typical parameters are measured at 25˚C and represent the parametric norm.

Note 4: Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

SIMPLIFIED BLOCK DIAGRAM

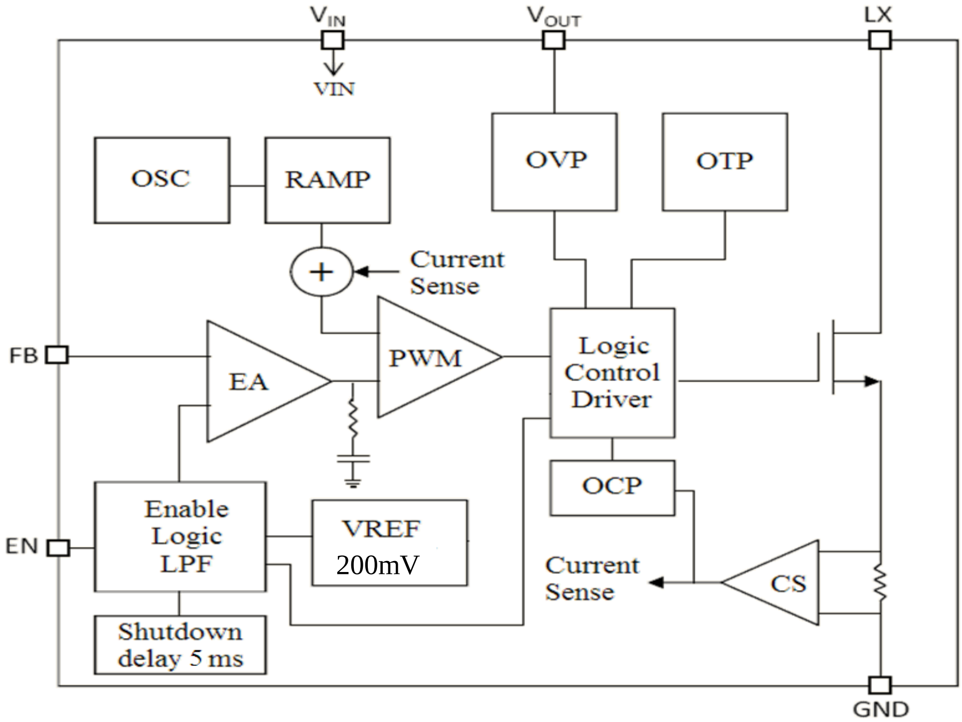


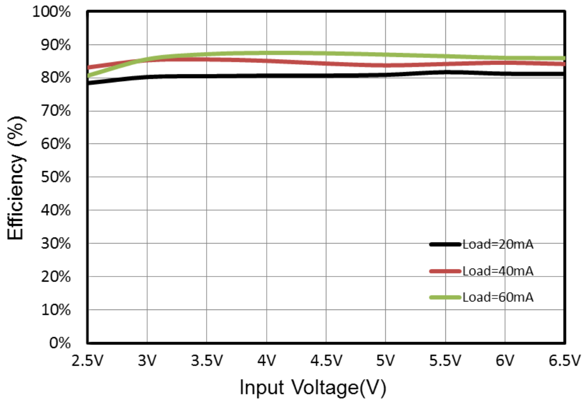
Figure 3. Simplified Block Diagram of the PT4117B

OPERATION DESCRIPTION

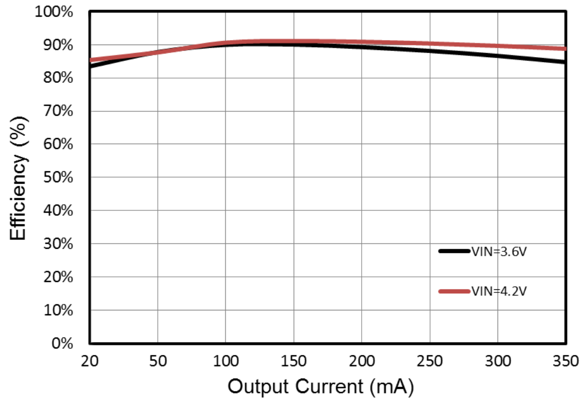
The PT4117B uses a constant frequency, peak current mode boost regulator architecture to regulate the series string of white LED. The operation of the PT4117B can be understood by referring to the block diagram. At the start of each oscillator cycle the power MOSFET is turned on through the control circuitry. 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 MOSFET 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 MOSFET, thus increasing the power delivered to the output.

TYPICAL PERFORMANCE CHARACTERISTICS

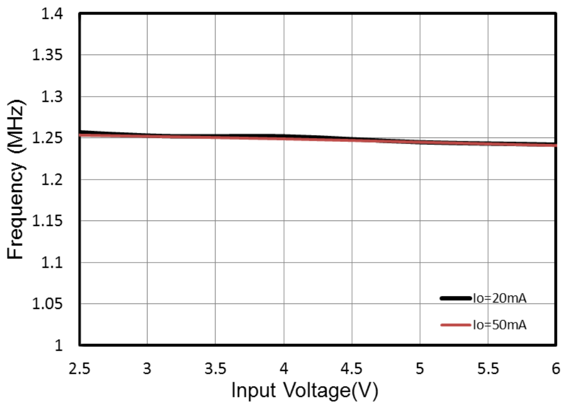
Efficiency vs. Input Voltage



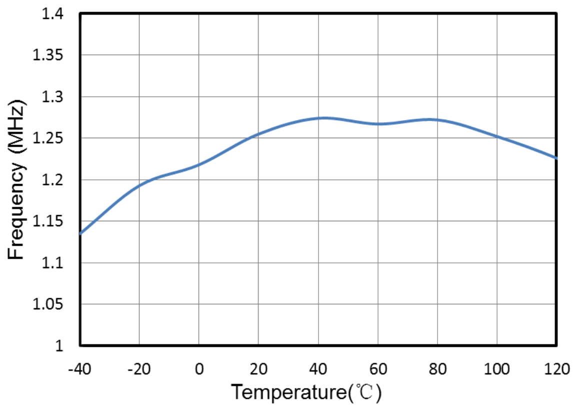
Efficiency vs. Output Current



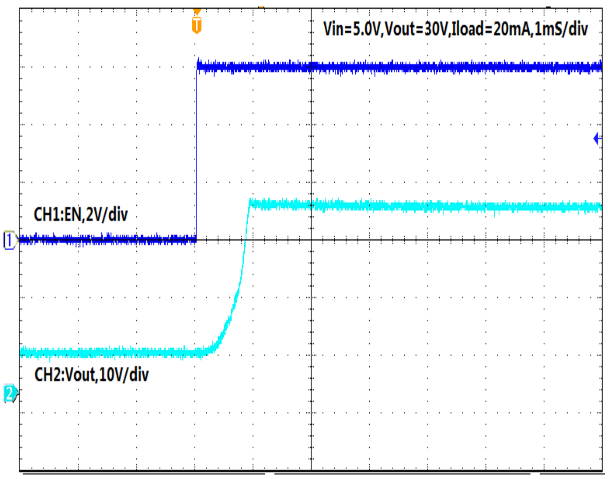
Frequency vs. Input Voltage



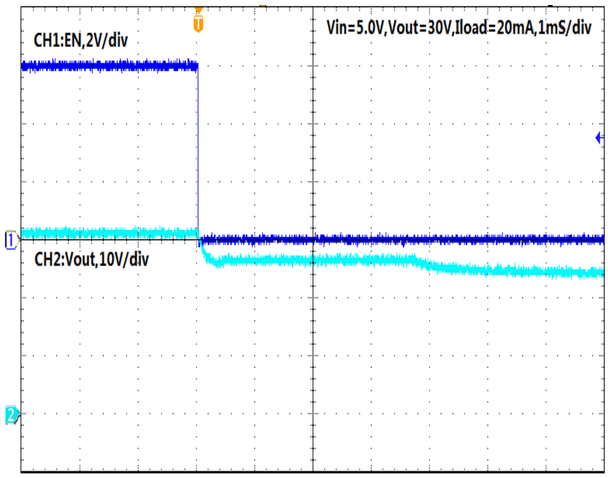
Frequency vs. Temperature



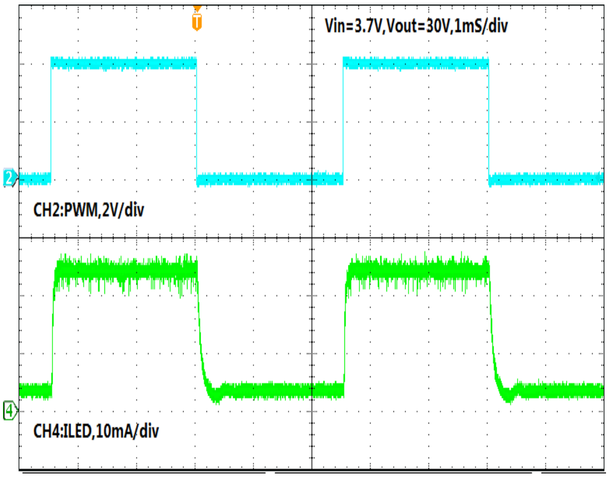
Turn-on



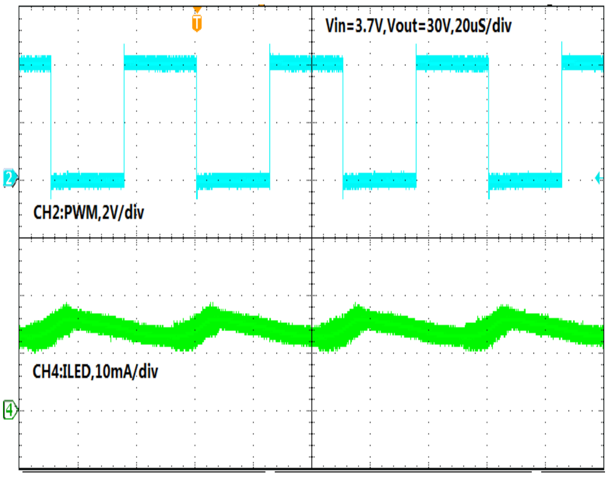
Turn-off



PWM Dimming (200Hz)



PWM Dimming (20kHz)



APPLICATION INFORMATION

Setting the LED current

The LED current is controlled by the feedback resistor. The feedback reference is 200mV. The LED current is $200mV/R_{FB}$. In order to have accuracy LED current, precision resistor is preferred. (1% is recommended).

Selecting the inductor

Choose an inductor that does not saturate under the worst-case load transient and startup conditions. A good rule for determining the inductance is to allow the peak-to-peak ripple current to be approximately 30% to 50% of the maximum input current. Make sure that the peak inductor current is below 1.2A to prevent loss of regulation due to the current limit. For most of the applications of the PT4117B, it is recommended to use an inductor from 10μH to 47μH.

Selecting the Input Capacitor

An input capacitor of 2.2μF is required to supply the AC ripple current to the inductor, while limiting noise at the input source. A low ESR capacitor is required to keep the noise at the IC to a minimum. Ceramic capacitors are preferred, but tantalum or low-ESR electrolytic capacitors may also suffice. However since it absorbs the input switching current, it requires an adequate ripple current rating. Use a capacitor with RMS current rating greater than the inductor ripple current.

Selecting the Output Capacitor

The output capacitor is required to maintain the DC output voltage. Low ESR capacitors are preferred to keep the output voltage ripple to a minimum.

The characteristic of the output capacitor also affects the stability of the regulation control system. 1μF ceramic, tantalum, or low ESR electrolytic capacitors are recommended.

Selecting the Diode

The output rectifier diode supplies current to the inductor when the internal MOSFET is off. To reduce losses due to diode forward voltage and recovery time, use a Schottky diode. Choose a diode whose maximum reverse voltage rating is greater than the maximum output voltage. The rated average forward current needs to be equal to or greater than the load current.

OVP Circuit Protection

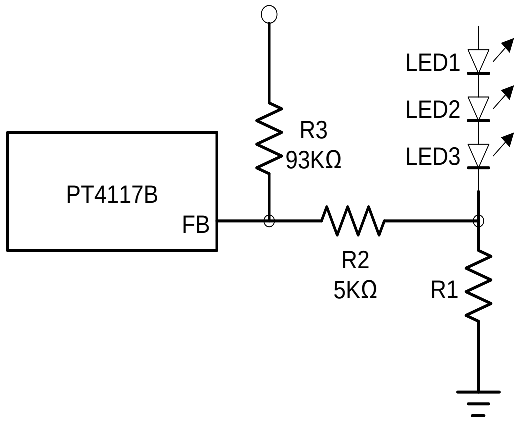
The over voltage protection will turn off the power MOSFET if the output voltage goes over the detecting voltage. In some cases an LED may fail, which will result in the feedback voltage always being zero. The PT4117B will then switch at its maximum duty cycle boosting the output voltage higher and higher. If the VOUT pin exceeds 22V for several periods, the power MOSFET will be turned off.

Dimming Control

There are two different types of dimming control circuits:

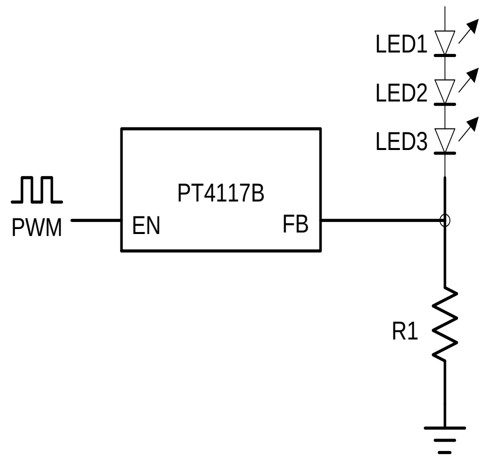
1. Using a DC Voltage

For some applications, the preferred method of brightness control is a variable DC voltage to adjust the LED current. The dimming control using a DC voltage is shown as below. As the DC voltage increases, the voltage drop on R2 increases and the voltage drop on R1 decreases. Thus, the LED current decreases. The selection of R2 and R3 will make the current from the variable DC source much smaller than the LED current and much larger than the FB pin bias current.



2. Using a PWM Signal to EN Pin

With the PWM signal applied to the EN pin, the reference of PT4117B is changed with the duty cycle of the PWM signal. The average LED current increases proportionally with the duty cycle of the PWM signal. A 0% duty cycle will turn off the PT4117B and corresponds to zero LED current. A 100% duty cycle corresponds to full current. The typical frequency range of the PWM signal is 200 Hz to100kHz.



Start-up and Inrush Current

The PT4117B 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 soft start is realized by gradually increasing the output voltage of error amplifier during start-up.

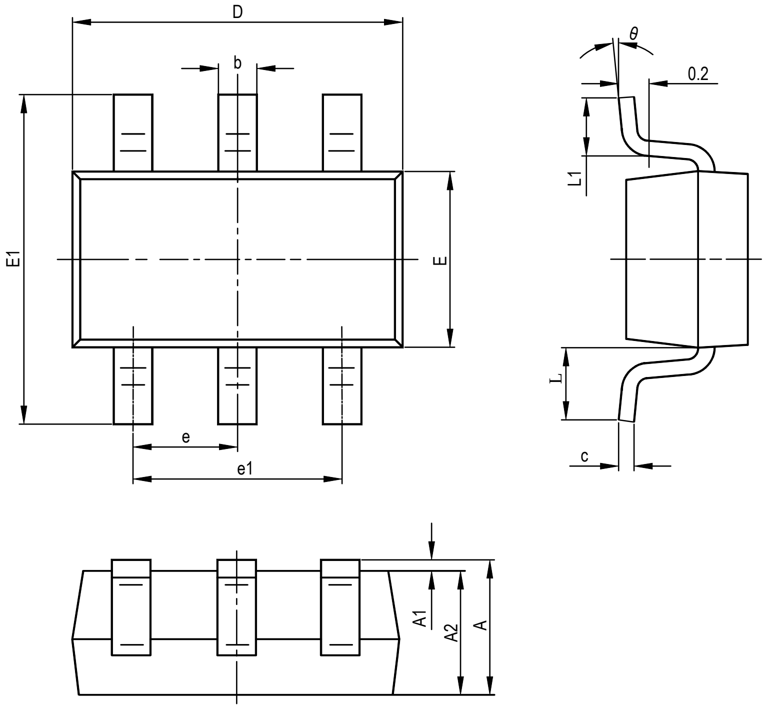
Board Layout Consideration

As with all switching regulators, careful attention must be paid to the PCB board layout and component placement. High frequency switching regulators require very careful layout for stable operation and low noise. To maximize efficiency, switch rise and fall times are made as short as possible. To prevent electromagnetic interference (EMI) problems, proper layout of the high frequency switching path is essential. The voltage

Signal of the LX pin has sharp rise and fall edges. Minimize the length and area of all traces connected to the LX pin and always use a ground plane under the switching regulator to minimize interplane coupling. In addition, the ground connection for the feedback resistor R1 should be tied directly to the GND pin and not shared with any other component, ensuring a clean, noise-free connection.

PACKAGE INFORMATION

SOT23-6



Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	-	1.450	-	0.057
A1	0.000	0.150	0.000	0.006
A2	0.900	1.300	0.035	0.051
b	0.300	0.500	0.012	0.020
c	0.080	0.220	0.003	0.009
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.600	2.950	0.102	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.600REF		0.024REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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