Description

The VPE2501 is a current mode boost DC-DC converter. Its PWM circuitry with built-in 0.2Ω power MOSFET make this regulator highly power efficient. The internal compensation network also minimizes as much as 6 external component counts. The non-inverting input of error amplifier connects to a 0.6V precision reference voltage and internal soft-start function can reduce the inrush current.

The VPE2501 is available in the tiny package of SOT-23-6.

Key Features

- Adjustable Output up to 12V
- Internal Fixed PWM frequency: 1.0MHz
- Precision Feedback Reference Voltage: 0.6V (±2%)
- Internal 0.2Ω, 2.5A, 16V Power MOSFET
- Shutdown Current: 0.1μA
- Over Temperature Protection
- Over Voltage Protection
- Adjustable Over Current Protection: 0.5A ~ 2.5A
- Package: SOT-23-6L

Applications

- Chargers
- LCD Displays
- Digital Cameras
- Handheld Devices
- Portable Products

Typical Application

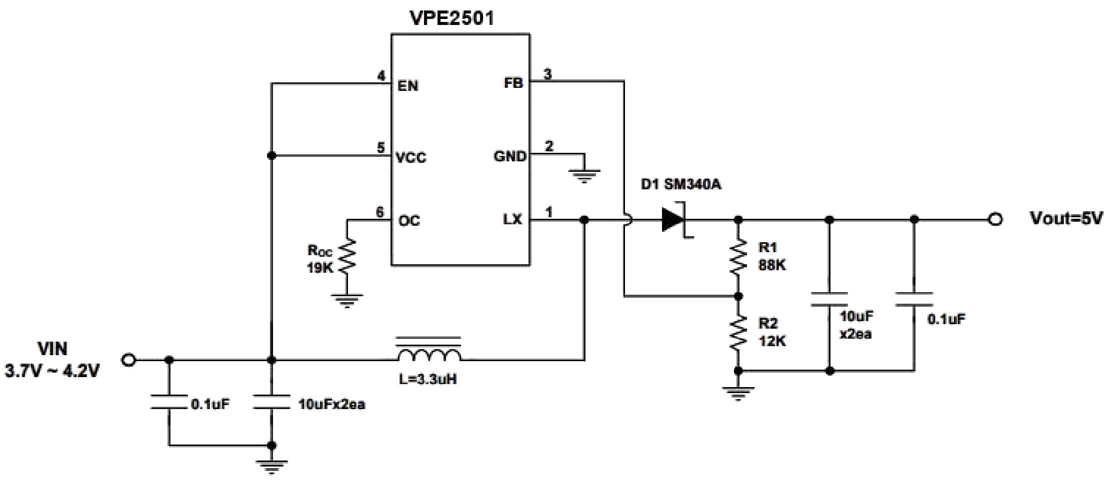
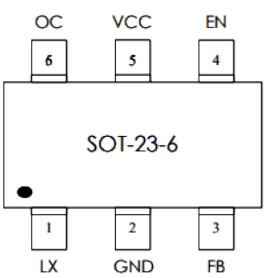


Figure. 1 VPE2501 application circuit

Package Configuration



VPE2501-00VN06NRR

00 Adjustable Output

VN06 SOT-23-6 Package

NRR RoHS & Halogen free package

Commercial Grade Temperature

Rating: -40 to 85℃

Package in Tape & Reel

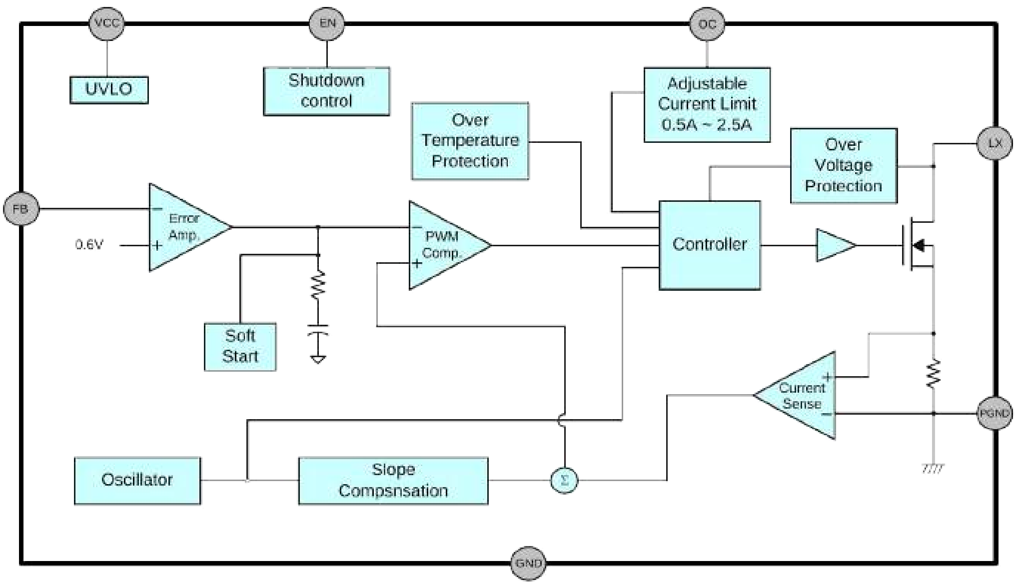
Order, Mark & Packing information

Package	Vout(V)	Product ID	Marking Code	Packing
SOT-23-6	Adjustable	VPE2501-00VN06NRR	2501	Tape & Reel 3K units

Pin Functions

Name	SOT-23-6L	Function
LX	1	**Switch Pin.** Must be connected an Inductor from VCC pin to LX pin for boost and rectifying switches.
GND	2	**Power Switch Ground Pin.**
FB	3	**Feedback Pin.** Receives the feedback voltage from an external resistive divider across the output.
EN	4	**Enable Pin.** Chip enable pin (1:Enable; 0:Disable).
VCC	5	**Power Supply Pin.** Must be closely decoupled to GND pin with 10μF*2 or greater ceramic capacitor.
OC	6	**OC Adjustable Pin.** OC adjustable via a resister from OC pin to GND (floating is available, the default OC level is 2.5A while the OC pin keep floating).

Functional Block Diagram



Absolute Maximum Ratings

Devices are subjected to fail if they stay above absolute maximum ratings.

Supply Voltage (VCC) .... –0.3V to 6.0V
EN, FB Voltages .... –0.3V to V_{IN}
LX Voltage .... –0.3V to (16V + 0.3V)
Lead Temperature (Soldering, 10 sec) .... 260°C
Operating Temperature Range .... –40°C to 85°C
Junction Temperature (Note 1) .... 150°C
Storage Temperature Range .... –65°C to 150°C

Thermal data

Package	Thermal Resistance	Parameter	Value
SOT-23-6	θ_{JA} (Note 2)	Junction-ambient	220°C/W
	θ_{JT} (Note 3)	Junction-top of package	80°C/W

- **Note 1:** T_J is a function of the ambient temperature T_A and power dissipation P_D ($T_J = T_A + (P_D * \theta_{JA})$).
- **Note 2:** θ_{JA} is measured in the natural convection at T_A=25°C on a highly effective thermal conductivity test board (2 layers, 2SOP) according to the JEDEC 51-3 thermal measurement standard.
- **Note 3:** θ_{JT} represents the heat resistance between the chip and the package top surface.

Electrical Characteristics

V_{CC}=3.3V, V_{OUT}=5.0V, L=3.3uH, C_{IN}=10uF*2, C_{OUT}=10uF*2, T_A=25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input Supply Range	V_{CC}	-	2.6	-	5.5	V
Under Voltage Lockout	V_{UVLO}	-	-	2.2	-	V
UVLO Hysteresis	-	-	-	0.1	-	V
Quiescent Current	I_{CC}	V_{FB}=0.66V, No switching	-	190	-	uA
Average Supply Current	I_{CC}	V_{FB}=0.55V, Switching	-	2.84	-	mA
Shutdown Supply Current	I_{CC}	V_{EN}=GND	-	0.1	-	uA
Operation Frequency	F_{OSC}	V_{FB}=1.0V	0.8	1.0	1.2	MHz
Frequency Change with Voltage	$\Delta f/\Delta V$	V_{CC}=2.6V to 5.5V	-	5	-	%
Maximum Duty Cycle	T_{DUTY}	-	-	90	-	%
Reference Voltage	V_{REF}	-	0.588	0.6	0.612	V
Line Regulation	-	V_{CC}=2.6V~5.5V	-	0.2	-	%/V
Enable Voltage	V_{EN}	-	0.96	-	-	V
Shutdown Voltage	V_{EN}	-	-	-	0.6	V
On Resistance of Driver	$R_{DS(ON)}$	I_{LX}=2A	-	0.2	-	Ω
OCP Current	I_{OCP}	-	-	2.5	-	A
Adjustable OCP Current	I_{OCP}	With External Resistor	0.5	-	2.5	A
OTP Temperature	T_{OTP}	-	-	150	-	°C

Typical Performance Characteristics

V_{CC}=3.3V, V_{OUT}=5.0V, T_A=25℃, L=3.3uH, C_{IN}=10UF*2, C_{OUT}=10UF*2, unless otherwise specified.

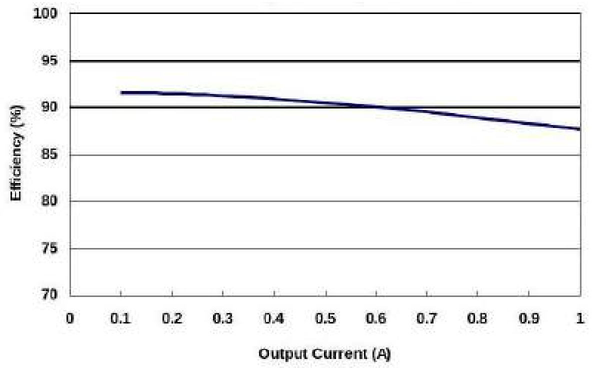


Figure 3. Efficiency

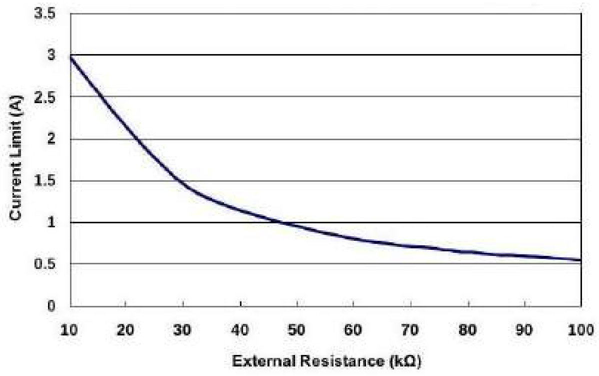


Figure 4. Adjustable Current Limit

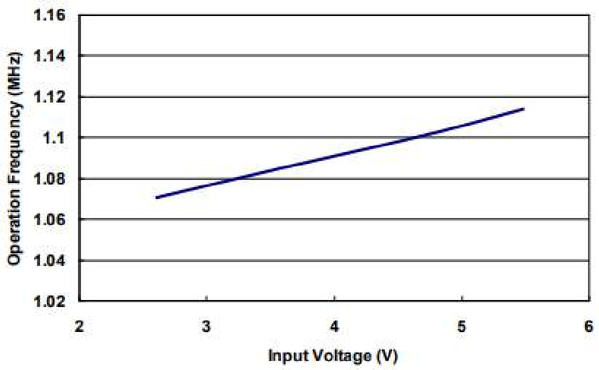


Figure 5. Operation Frequency vs. Input Voltage

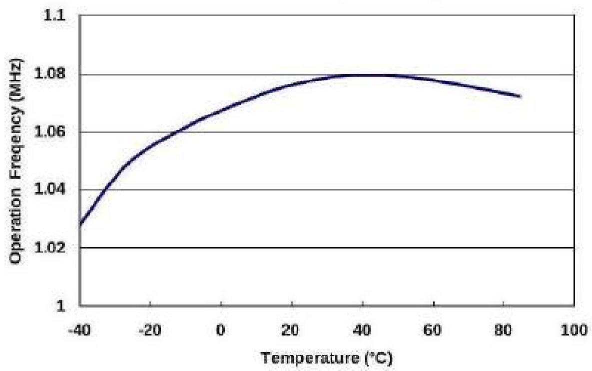


Figure 6. Operation Frequency vs. Temperature

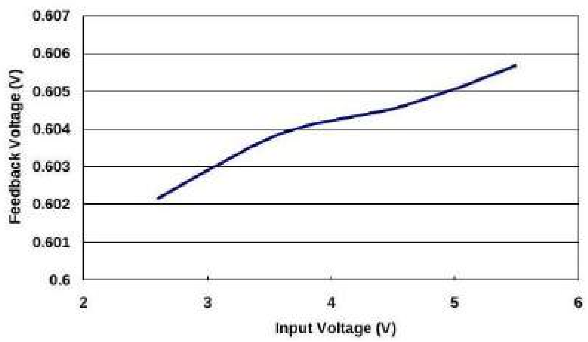


Figure 7. VFB vs. Input Voltage

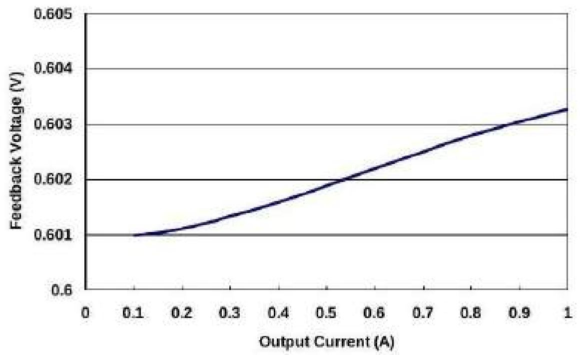


Figure 8. VFB vs. Output Current

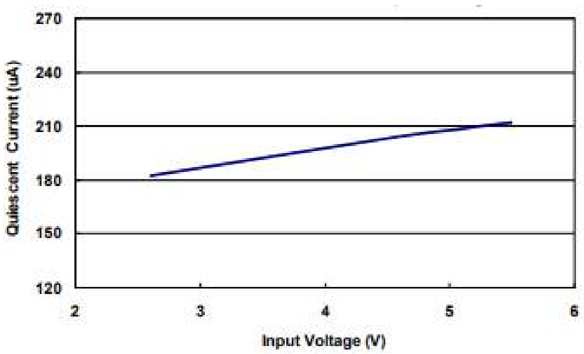


Figure 9. Quiescent Current vs. Input Voltage

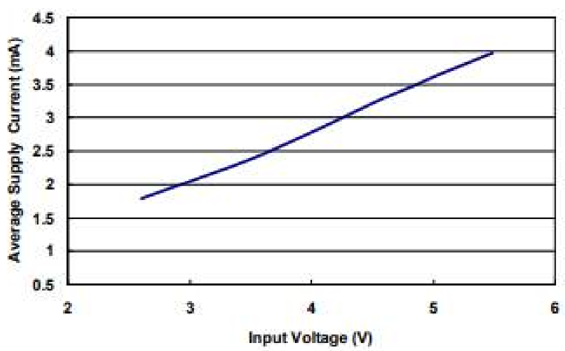


Figure 10. Supply Current vs. Input Voltage

Function Description

Detailed Description

The VPE2501 is a current mode boost converter with a constant switching frequency of 1MHz operating with pulse width modulation (PWM). It features a built-in 16V / 2.5A MOSFET that provides a high output voltage. The control loop architecture is peak current mode control, and a slope compensation circuit is added to the current signal to allow stable operation for duty cycles larger than 50%.

Soft Start

Soft start circuitry is integrated into the VPE2501 to prevent inrush current during power-on. After the IC is enabled, the output of the error amplifier is clamped by an internal soft-start function, which causes the PWM pulse width to increase slowly, thereby reducing input surge current.

Adjustable Current Limit

A resistor between the OC and GND pins programs the peak switch current. The recommended resistor value is between 10kΩ and 96kΩ. The peak switch current can be set from 2.5A to 0.5A using an external R_{OC} resistor. The peak switch current level has a $\pm$20% variation due to silicon process variation. Keep traces at this pin as short as possible and avoid capacitance at this pin. To set the over current trip point according to the following equation:

$$I_{OCP} = \frac{48000}{R_{OC}}$$

Over Temperature Protection

The VPE2501 will automatically turn off the power MOSFET if the internal junction temperature exceeds 150°C. The power MOSFET will reactivate when the junction temperature drops 30°C below the OTP threshold temperature.

Over Voltage Protection

In some conditions, the resistive divider may be disconnected, which will cause the PWM signal to operate at maximum duty cycle, boosting the output voltage higher and higher. The power MOSFET will be turned off immediately if the output voltage exceeds the OVP threshold level, which for the VPE2501 is 16V.

Application Information

Inductor Selection

Inductance value is decided based on different conditions. 3.3μH to 4.7μH inductor value is recommended for general application circuit. There are three important inductor specifications: DC resistance, saturation current, and core loss. Low DC resistance has better power efficiency. Also, it avoids inductor saturation which will cause circuit system unstable and lower core loss at 1 MHz.

Capacitor Selection

The output capacitor is required to maintain the DC voltage. Low ESR capacitors are preferred to reduce the output voltage ripple. Ceramic capacitors of X5R and X7R are recommended, which have low equivalent series resistance (ESR) and wider operation temperature range.

Diode Selection

Schottky diodes with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the output voltage.

Output Voltage Setting

The output voltage of VPE2501 can be adjusted by a resistive divider according to the following formula:

$$V_{OUT} = V_{REF}\left(1 + \frac{R_1}{R_2}\right) = 0.6\left(1 + \frac{R_1}{R_2}\right)$$

The resistive divider senses a fraction of the output voltage (see Fig. 11). A large feedback resistor can increase efficiency, but too large a value can affect accuracy due to leakage current into the device's FB pin. It is recommended that R_2 be in the range of 10~20kΩ.

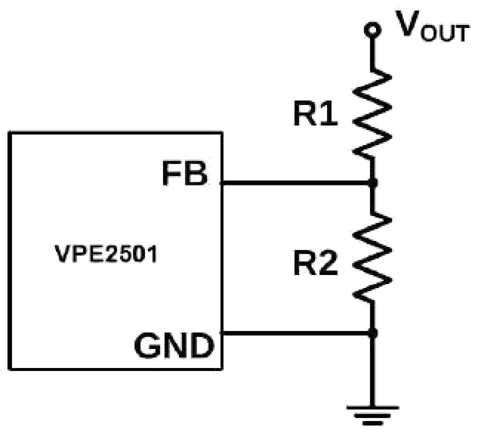


Fig. 11 Setting the Output Voltage

Applications

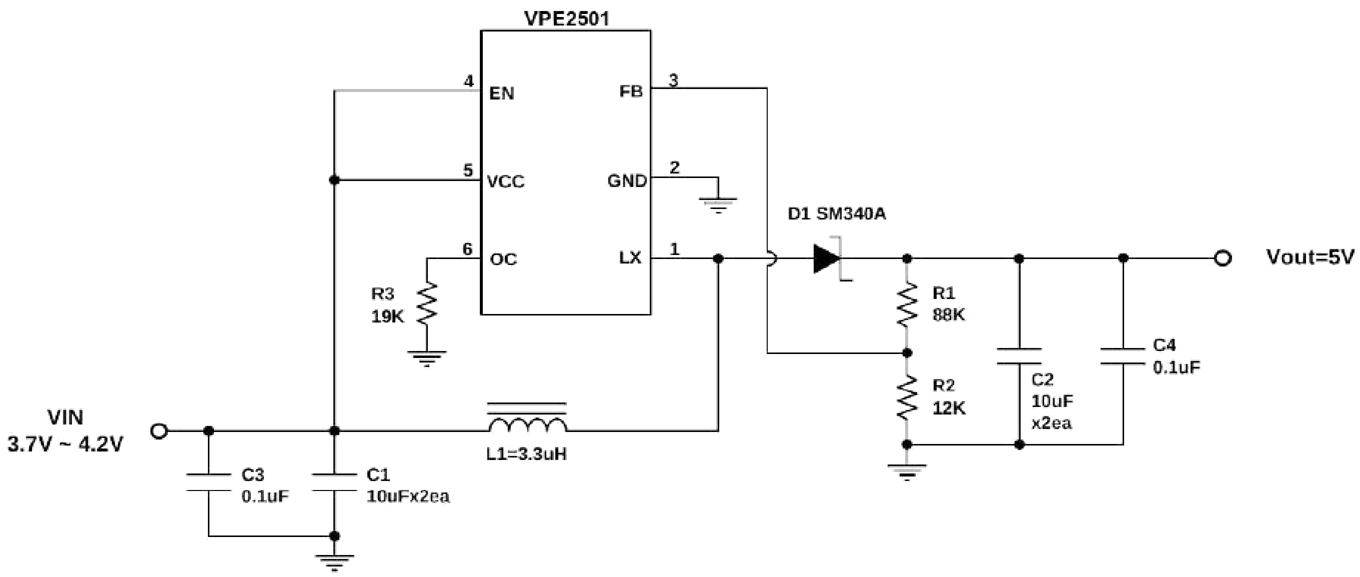


Figure 12. Typical Schematic for PCB layout

> - Note. Don't pull the Vout back to the VPE2501's Vcc pin. When the system receives the noise, it will lead to Vout ripple too high and over the absolute maximum rating of the VCC pin.

PCB Layout Guidelines

When laying out the printed circuit board, the following checklist should be used to optimize the performance ofVPE2501.

1. The power traces, consisting of the GND trace, the LX trace and the Vcc trace should be kept short, direct and wide.
2. LX, L and D switching node, wide and short trace to reduce EMI.
3. Place C_{IN} near VCC pin as closely as possible to maintain input voltage steady and filter out the pulsing input current.
4. The resistive divider R1and R2 must be connected to FB pin directly as closely as possible.
5. FB is a sensitive node. Please keep it away from switching node, LX.
6. The GND of the IC, C_{IN} and C_{OUT} should be connected close together directly to a ground plane.

Typical Schematic for PCB layout (cont.)

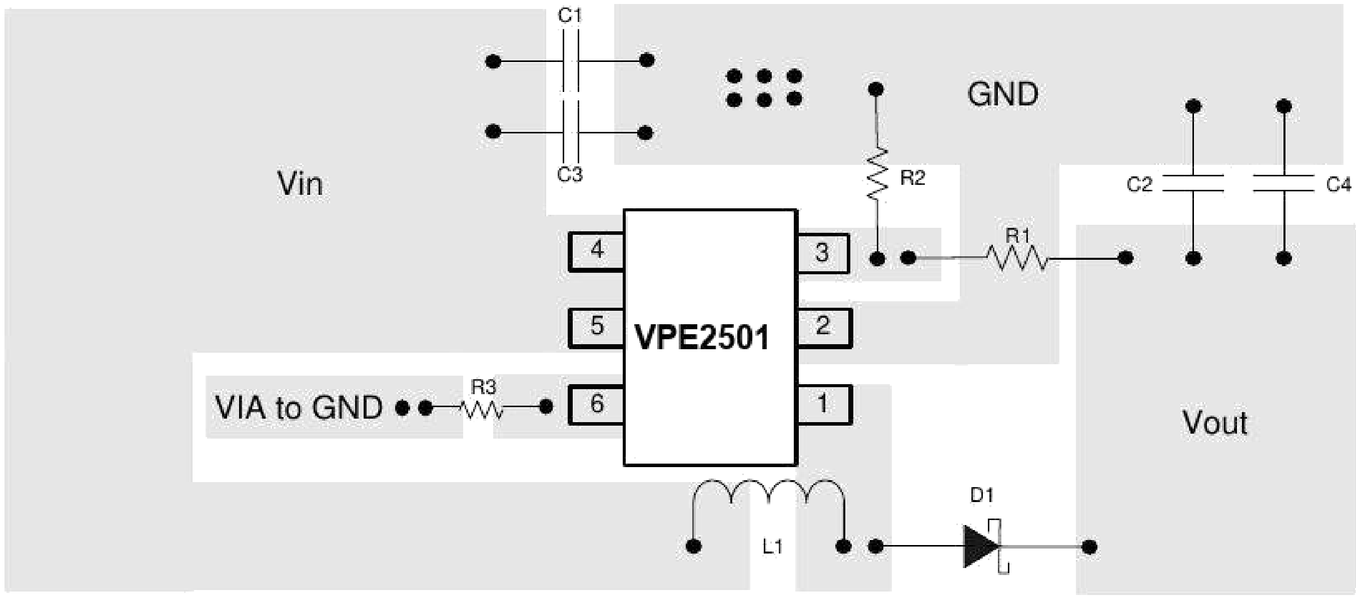
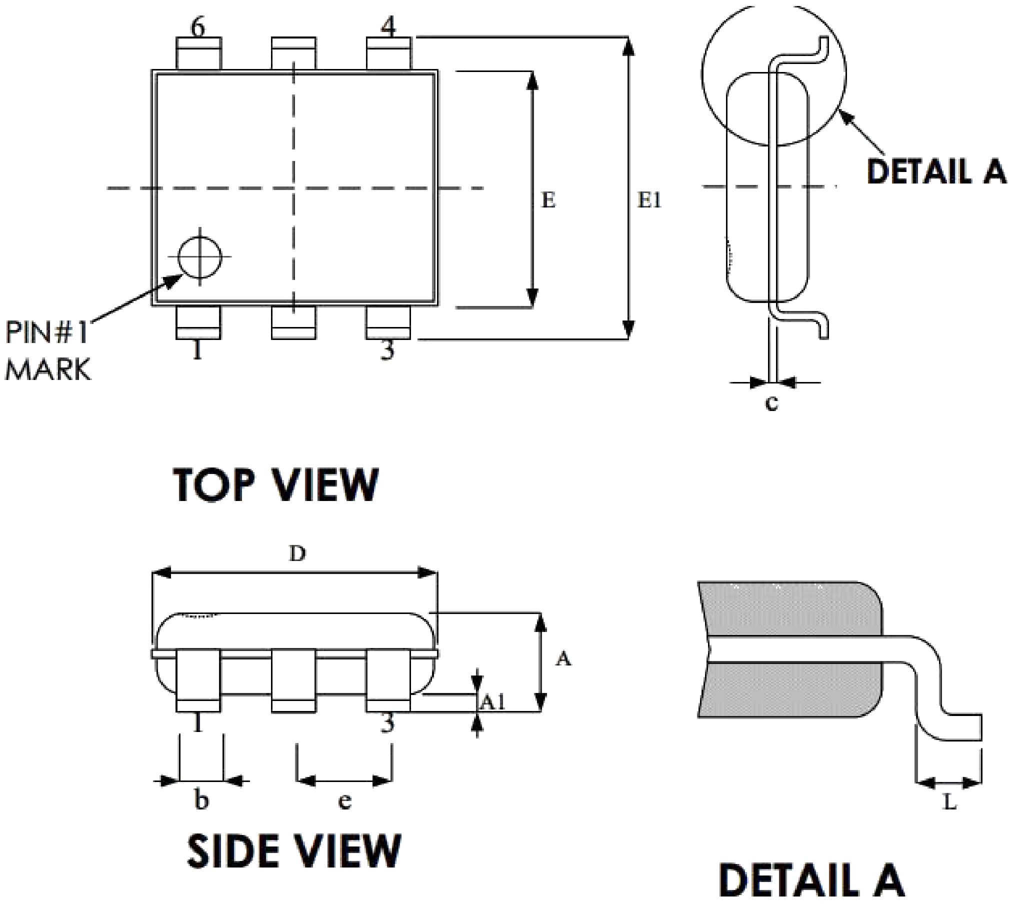


Figure 13. Top layer of PCB layout

Package Outline Drawing



SOT-23-6

Symbol	Dimension in mm	
	Min.	Max.
A	0.90	1.45
A1	0.00	0.15
b	0.30	0.50
c	0.08	0.25
D	2.70	3.10
E	1.40	1.80
E1	2.60	3.00
e	0.95 BSC	
L	0.30	0.60

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