1MHz, 2.5A Step-Up Current Mode PWM Converter

General Description

The EMH7070 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 EMH7070 is available in the tiny package of SOT-23-6.

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

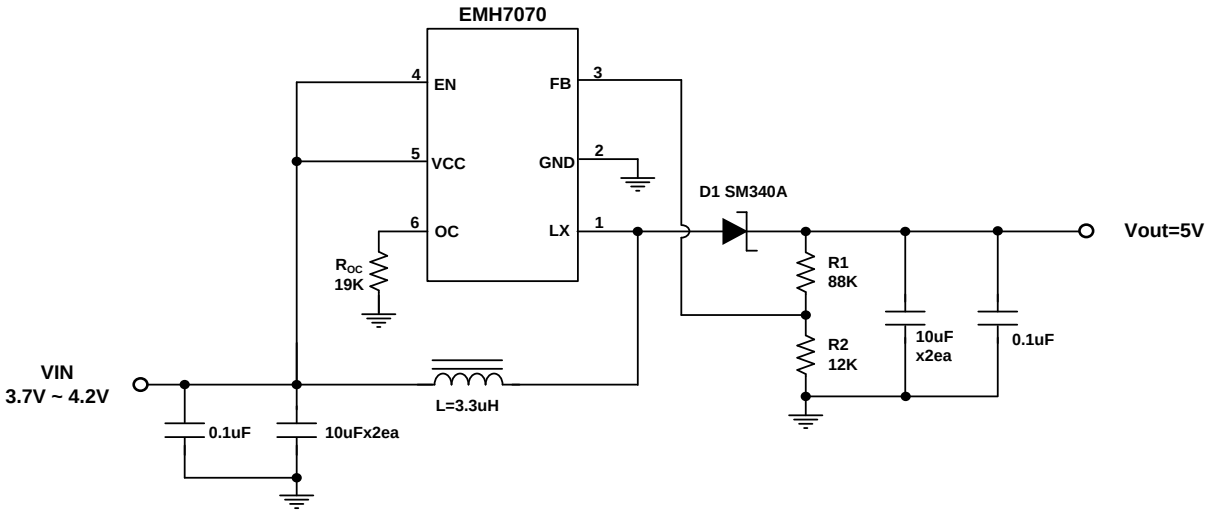
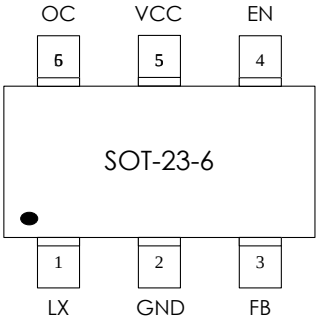


Fig. 1 EMH7070 application circuit

Package Configuration

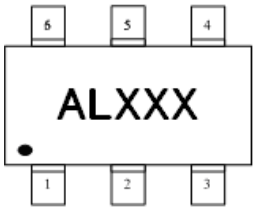


SOT-23-6

EMH7070-00VN06NRR

00	Adjustable Output
VN06	SOT-23-6 Package
NRR	RoHS & Halogen free package Commercial Grade Temperature Rating: -40 to 85°C Package in Tape & Reel

Order, Mark & Packing information

Package	Vout(V)	Product ID	Marking	Packing
SOT-23-6	Adjustable	EMH7070-00VN06NRR	 XXX: Tracking code	Tape & Reel 3K units

Functional Block Diagram

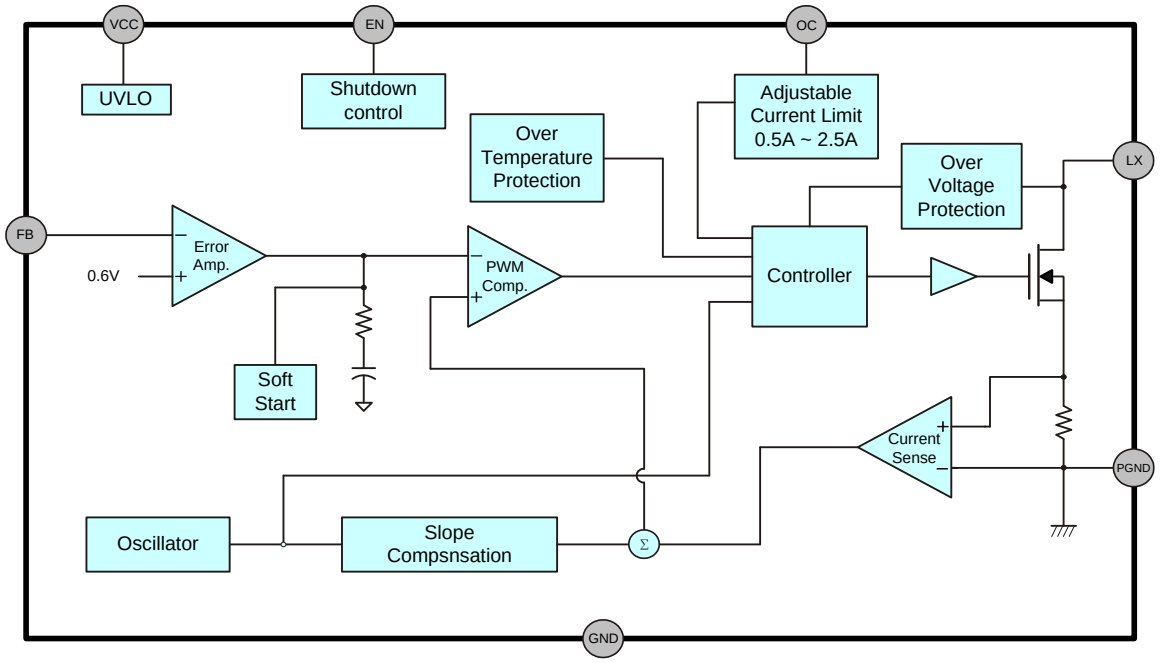


Fig. 2

Pin Functions

Pin 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).

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℃ on a highly effective thermal conductivity test board (2 layers , 2S0P) 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

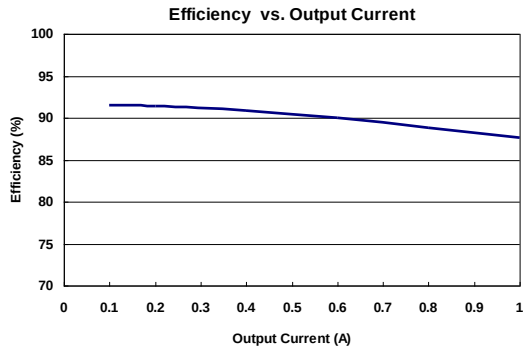
V_{CC}=3.3V, V_{OUT}=5.0V, L=3.3uH, C_{IN}=10uF*2, C_{OUT}=10uF*2, T_A = 25°C, unless otherwise noted.

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	MH_Z
Frequency Change with Voltage	△f / △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

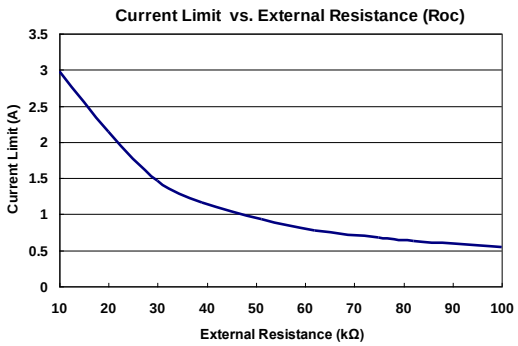
Typical Performance Characteristics

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

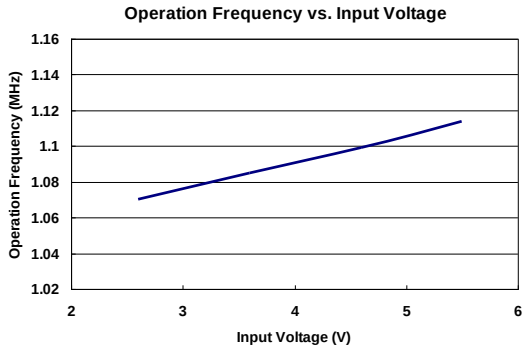
Efficiency (Fig. 3)



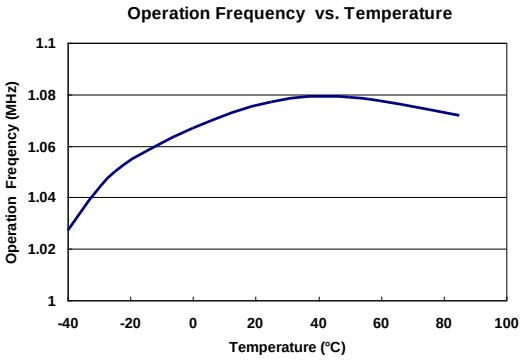
Adjustable Current Limit (Fig. 4)



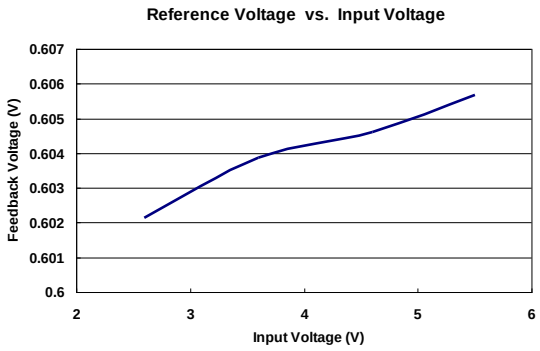
Operation Frequency vs. Input Voltage (Fig. 5)



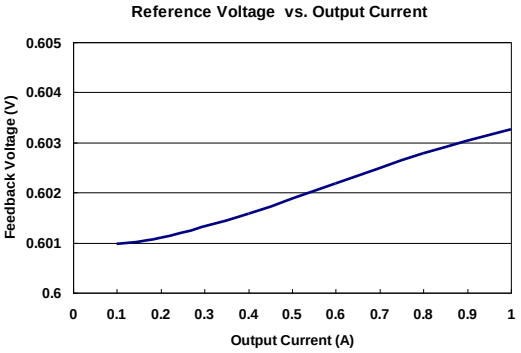
Operation Frequency vs. Temperature (Fig. 6)



VFB vs. Input Voltage (Fig. 7)

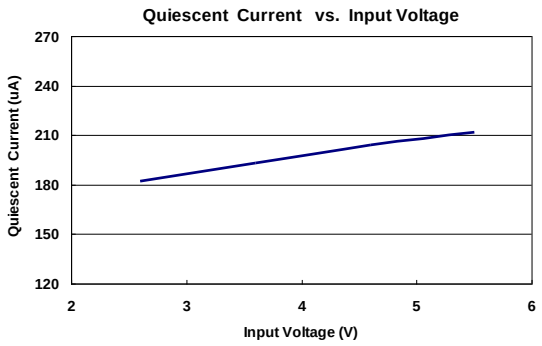
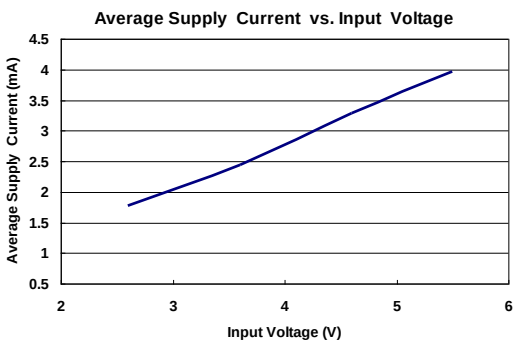


VFB vs. Output Current (Fig. 8)



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

Quiescent Current vs. Input Voltage (Fig. 9)	Supply Current vs. Input Voltage (Fig. 10)
	

Function Description

Detailed Description

The EMH70701 is a current mode boost converter. The constant switching frequency is 1MHz and operates with pulse width modulation (PWM). Build-in 16V / 2.5A MOSFET provides a high output voltage. The control loop architecture is peak current mode control; therefore 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 EMH7070 to avoid inrush current during power on. After the IC is enabled, the output of error amplifier is clamped by the internal soft-start function, which causes PWM pulse width increasing slowly and thus reducing input surge current.

Adjustable Current Limit

A resistor between OC and GND pin programs peak switch current. The resistor value should be between 10k and 96k. The peak switch current can be set from 2.5A to 0.5A by external R_{OC} resistor. The peak switch currently level with +-20% variation is possible due to the silicon process variation. Keep traces at this pin as short as possible. Do not put 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

EMH7070 will turn off the power MOSFET automatically when the internal junction temperature is over 150°C. The power MOSFET wake up when the junction temperature drops 30°C under the OTP threshold temperature.

Over Voltage Protection

In some condition, the resistive divider may be unconnected, which will cause PWM signal to operate with maximum duty cycle and output voltage is boosted higher and higher. The power MOSFET will be turned off immediately, when the output voltage exceeds the OVP threshold level. The EMH7070's OVP threshold is 16V.

Application Information

Inductor Selection

Inductance value is decided based on different condition. 3.3uH 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 capacitor 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 EMH7070 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 the fraction of the output voltage as shown in Fig.11 Using large feedback resistor can increase efficiency, but too large value affects the device's output accuracy because of leakage current going into device's FB pin. The recommended value for R2 is therefore in the range of 10~20KΩ.

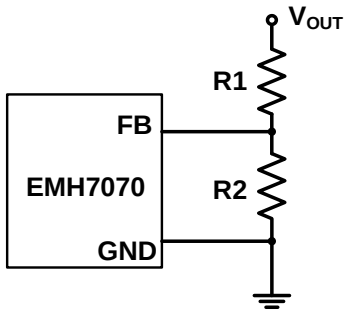
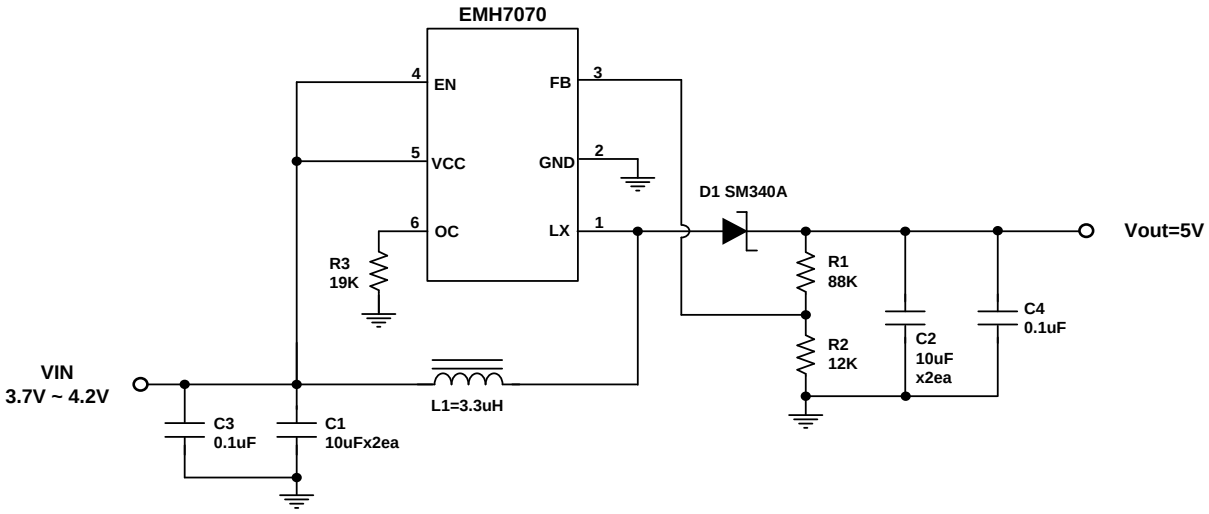


Fig. 11 Setting the Output Voltage

Applications

Typical Schematic for PCB layout



Note. Don't pull the Vout back to the EMH7070'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.

Fig. 12

PCB Layout Guidelines

When laying out the printed circuit board, the following checklist should be used to optimize the performance of EMH7070.

1. The power traces, consisting of the GND trace, the LX trace and the V_{CC} 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.)

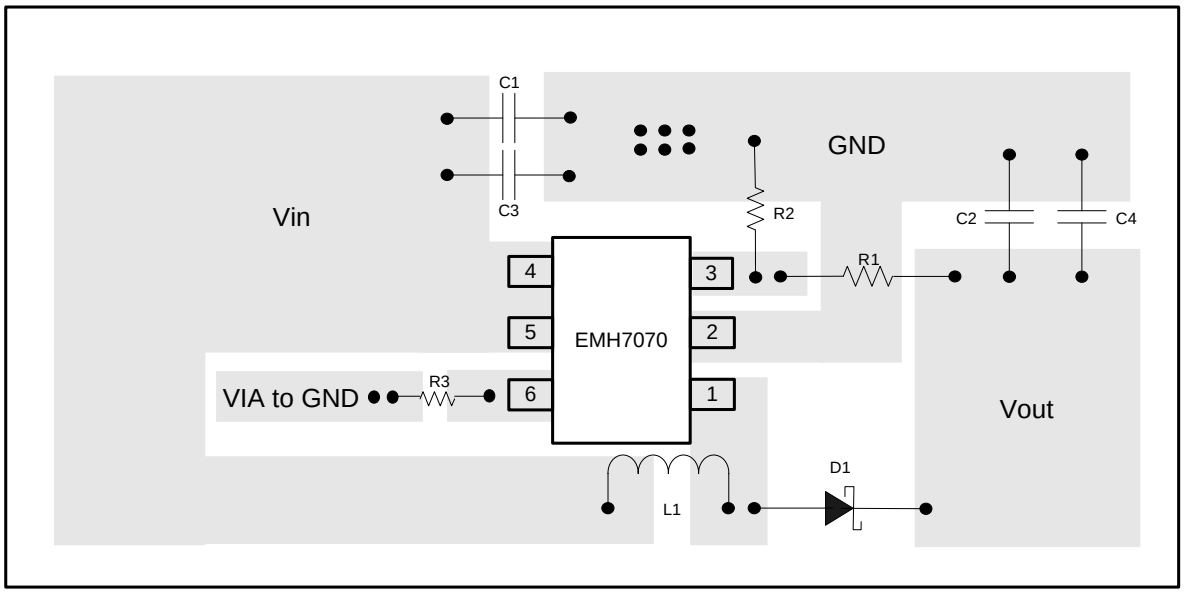
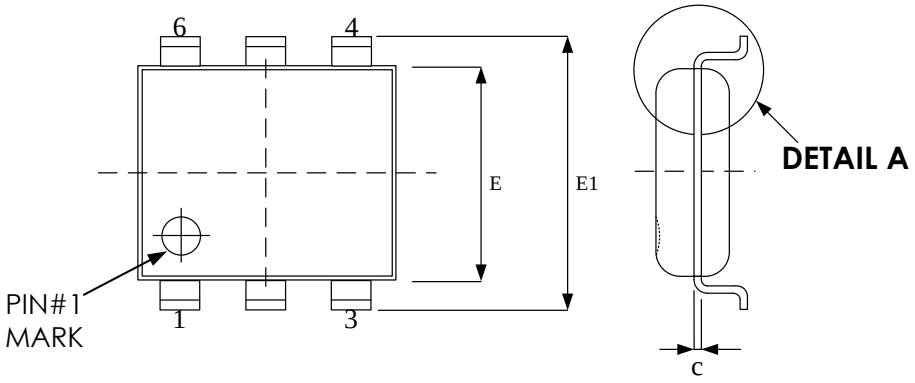
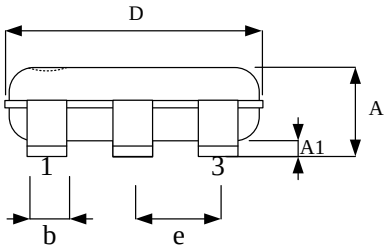


Fig. 13 Top Layer of PCB layout

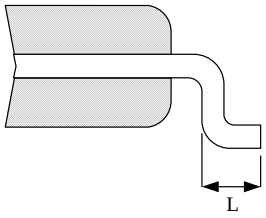
Package Outline Drawing
SOT-23-6



TOP VIEW



SIDE VIEW



DETAIL A

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

Revision History

Revision	Date	Description
0.1	2014.06.27	Initial version.
1.0	2014.11.20	Modified marking.
1.1	2015.08.24	Updated current limit description.

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