5V, 2A High-Side Power Switch with Flag

General Description

The EHP6388 is a cost-effective, low voltage, single N-MOSFET high-side Power Switch IC for USB application. Low switch-on resistance and low supply current are realized in this IC. The EHP6388 integrates an over-current protection circuit, a short fold back circuit, a thermal shutdown circuit and an under-voltage lockout circuit for overall protection. Besides, a flag output is available to indicate fault conditions to the local USB controller. Furthermore, the chip also integrates an embedded delay function to prevent miss-operation from happening due to inrush-current. The EHP6388 is an ideal solution for USB power supply and can support flexible applications.

The EHP6388 is available in SOT-23- 5 pin package.

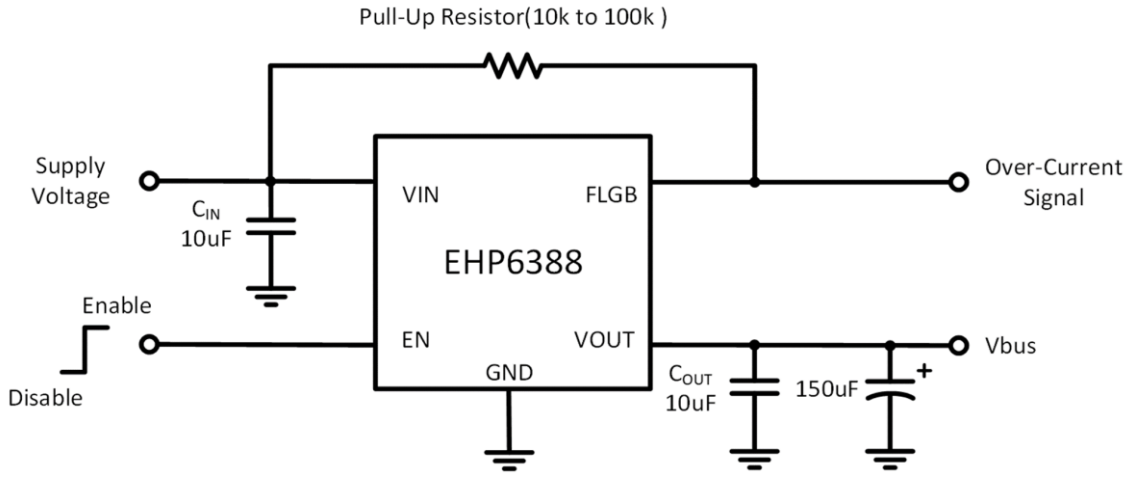
Features

- 58mΩ (typ.) N-MOSFET Switch
- Operating Range: 2.5V to 5.5V
- Reverse Blocking Current
- Under Voltage Lockout (Power On Reset)
- Deglitched Fault Report (FLGB)
- Thermal Protection
- Over Current Protection with Fold-back
- 2uS Response for Short Circuit Protection
- Soft Start and Fast Turn off

Applications

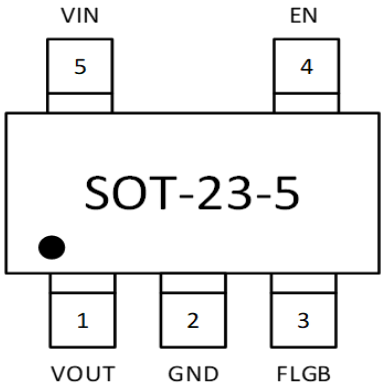
- USB Peripherals
- Notebook PCs

Typical Application



Part Number	Package	Note
EHP6388	SOT-23-5	EN (Active High)

Package Configuration

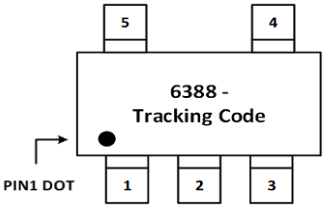


EHP6388-VF05NRR

VF05 SOT-23-5 Package

NRR RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel

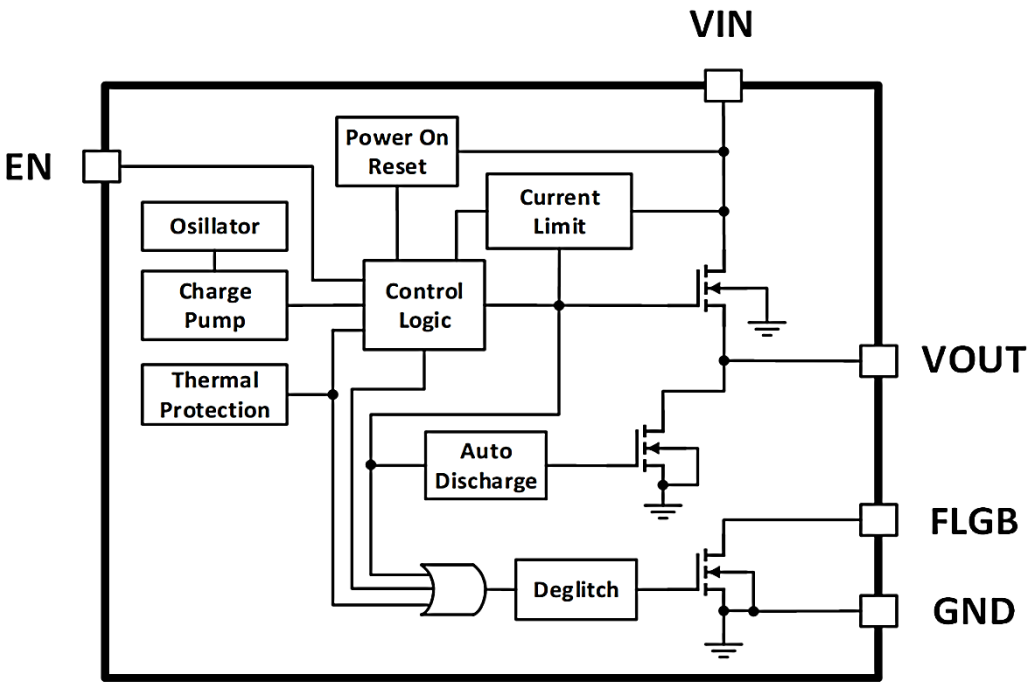
Order, Marking and Packing Information

Package	ON/OFF Control	Product ID.	Marking	Packing
SOT-23-5	EN (Active High)	EHP6388-VF05NRR		Tape & Reel 3K pcs

Pin Functions

Name	SOT-23-5	Function
VOUT	1	Output Voltage
GND	2	Ground
FLGB	3	Fault FLAG Output Bar
EN	4	ON/OFF control. Don't float this pin.
VIN	5	Power Input Voltage

Functional Block Diagram



Functional Block Diagram of EHP6388

Absolute Maximum Ratings (Note1,2)

VIN, EN	-0.3V to +6V	Lead Temperature (Soldering, 10 sec.)	260°C
Others pins	-0.3V to (VIN+0.3)V	ESD Rating : Human Body Model	2KV
Junction Temperature	150°C		
Storage Temperature Range	-65°C to 150°C		

Recommended Operating Conditions

VIN	2.5V to 5.5V	Operating Temperature Range	-40°C to 85°C
Junction Temperature Range	-40°C to 125°C		

Thermal Resistance:

Symbol	θ_{JA}(Note3)	θ_{JC}(Note4)
SOT-23-5	152(°C/W)	81(°C/W)

Electrical Characteristics

VIN=5V, C_{IN}=10uF, C_{OUT}=0.1uF, T_a=25℃, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}		2.5	--	5.5	V
VIN POR Threshold	V_{INPOR}		--	2.2	2.5	V
Quiescent Current	I_Q	I_{OUT} = 0mA	--	60	80	uA
Shutdown Current	I_{SD}	EN = 0V	--	0.1	1	uA
Switch-on resistance	R_{DSON}	Iout = 500mA	--	58	78	mΩ
Reverse Leakage Current	I_{REV}	V_{IN} = 0V, V_{OUT} = 5V	--	0.1	2	uA
Soft Start Time	T_{SS}		--	1.5	2.5	mS
Enable High Level	V_{EN}		1.2	--	--	V
Shutdown Low Level	V_{SD}		--	--	0.5	V
EN Input Current	I_{EN}	V_{IN}=EN=5V, I_{OUT}=0A	--	0.1	1	uA
FLGB Output Resistor	R_{FLGB}	I_{SINK} = 1mA	--	20	80	Ω
FLGB Off Current	I_{FLGB_OFF}	V_{FLGB} = 5V	--	0.1	1	uA
FLGB Delay Time	T_{DELAY}		8	15	22	mS
VOUT Discharge Resistor	R_{DIS}		--	100	--	Ω
Over Current Threshold	I_{OCP}		2.4	3.2	--	A
VOUT Short Circuit Current	I_{SC}		1.2	1.7	--	A
Thermal Shutdown	T_{SD}		--	160	--	°C
Thermal Shutdown Hysteresis	T_{SDHY}		--	30	--	°C

Note 1: Absolute Maximum ratings indicate limits beyond which damage may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.

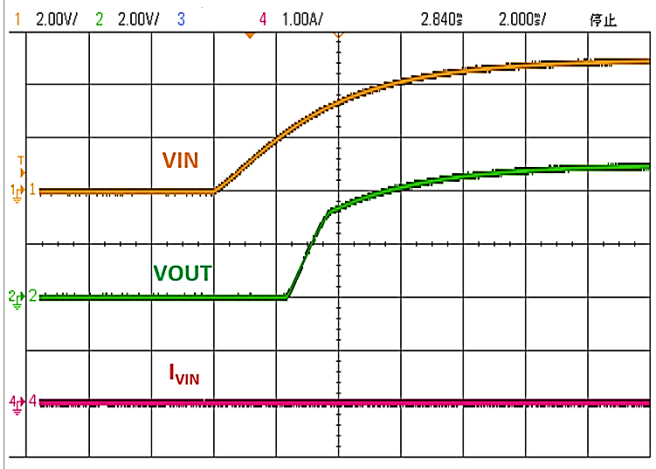
Note 2: All voltages are with respect to the potential at the ground pin.

Note 3: θ_{JA} is measured in the natural convection at T_J=25°C on a high effective thermal conductivity test board (2 layers, 2S0P).

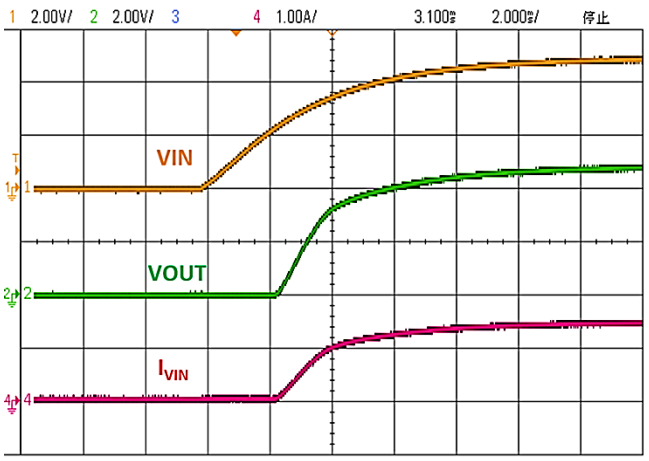
Note 4: θ_{JC} represents the resistance to the heat flows the chip to package top case.

Typical Performance Characteristics

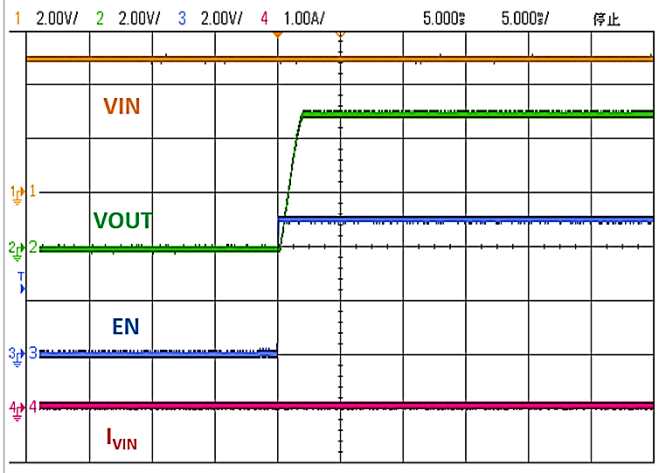
V_{IN}=5V, C_{IN}=10uF, C_{OUT}=0.1uF, T_a=25°C, unless otherwise specified



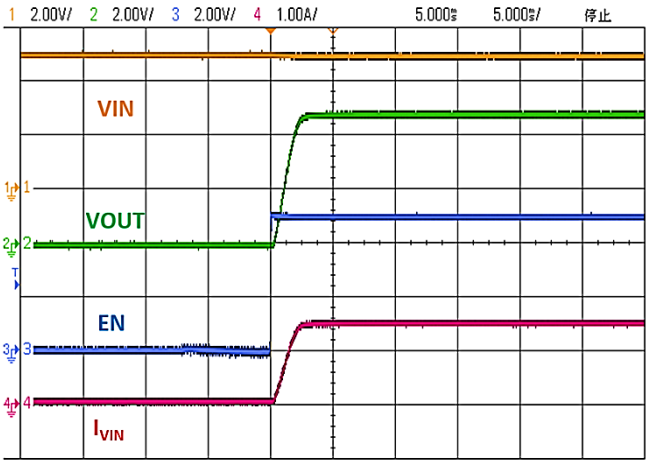
VIN Power ON (No load)



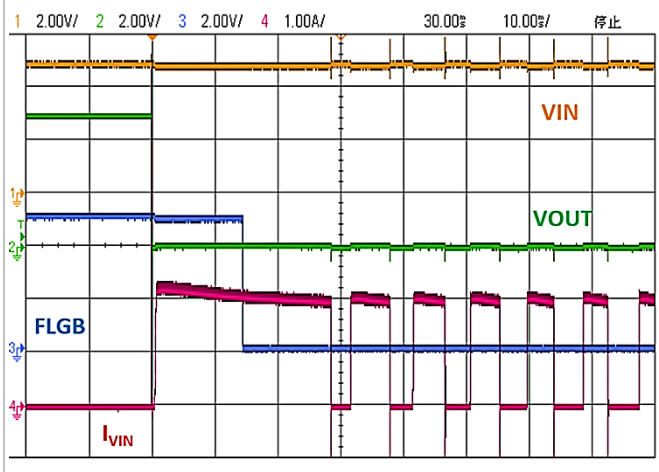
VIN Power ON (1.5A)



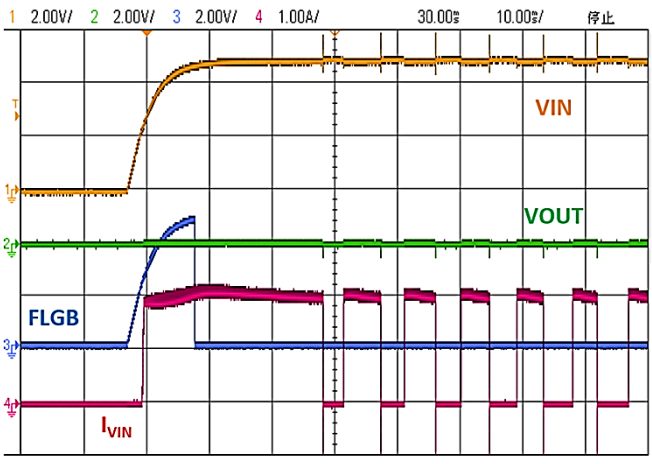
VIN Power ON (No load)



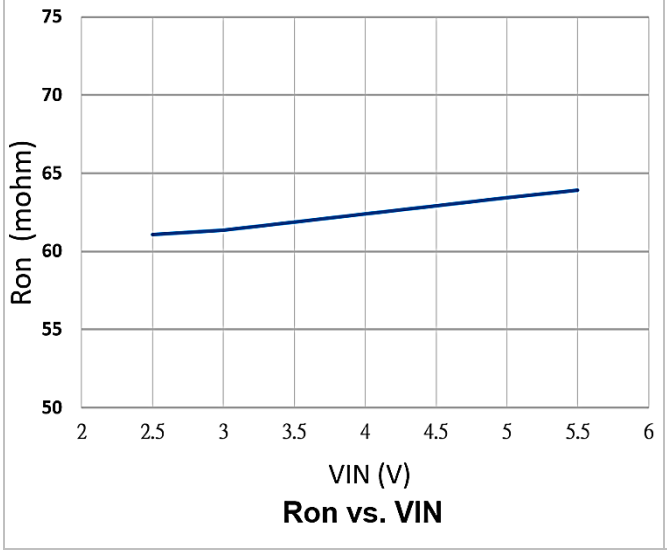
VIN Power ON (1.5A)



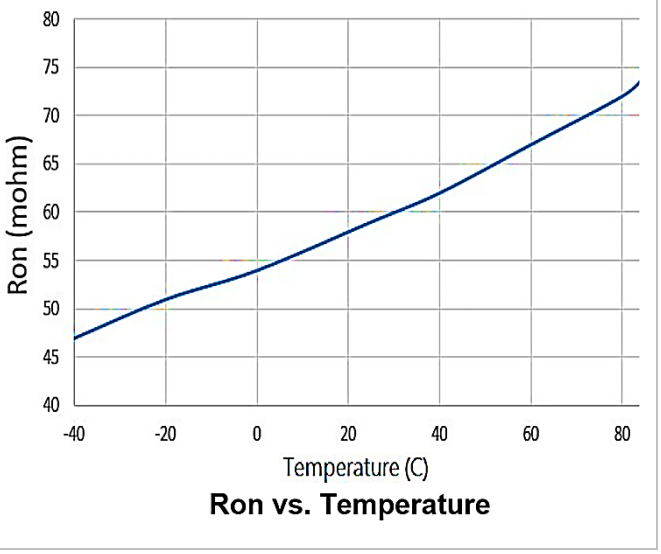
VOUT Short to GND



VOUT Short to GND Start up



Ron vs. VIN



Ron vs. Temperature

Application Information

Current Limit

The EHP6388 continuously monitors the output current for over-current protection to protect the system power, the power switch, and the load from damage during output short circuit. When an overload or short circuit occurs, the current-sense circuitry sends a control signal to the driver. The driver reduces the gate voltage and drives the power MOSFET into its saturation region, which switches the output into a constant-current mode and holds the current constant until the thermal shutdown occurs or the fault is removed.

Thermal Shutdown

The EHP6388 continuously monitors the operating temperature of the power switch for over-temperature protection. The EHP6388 turns off the power switch to prevent the device from damage if the junction temperature rises to approximately 160°C due to over-current or short circuit conditions. The pass element turns on again after the junction temperature cools to 130°C.

Fault Flag Output

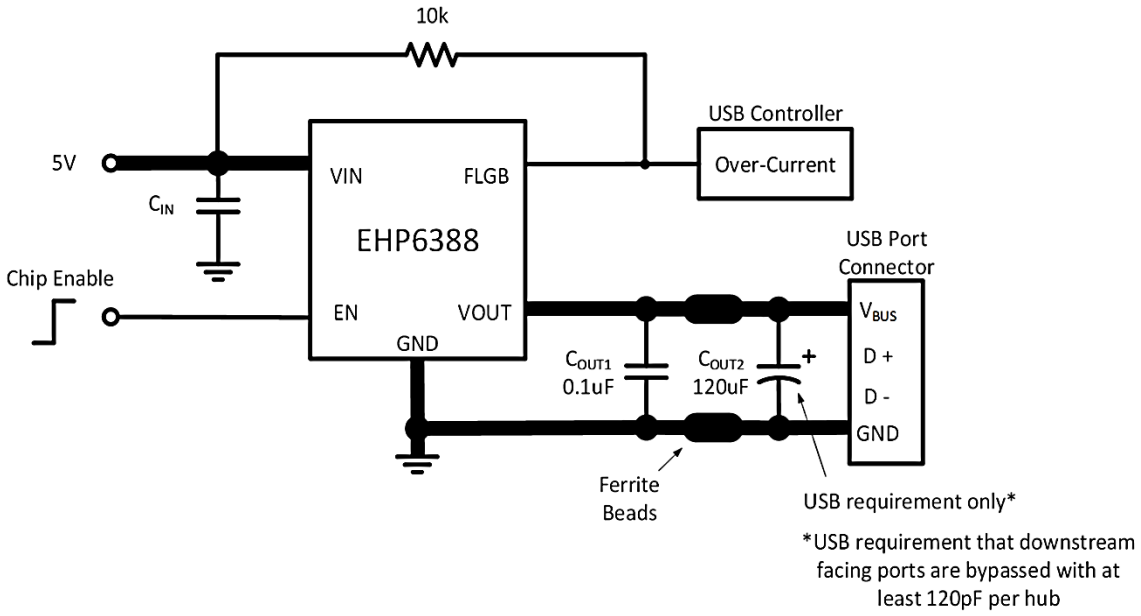
The EHP6388 pulls low the open drain output FLGB after over current or over temperature conditions.

Supply Filter/Bypass Capacitor

A 10uF low-ESR ceramic capacitor from VIN to GND, located at the device is strongly recommended to prevent the input voltage drooping during hot-plug events. However, higher capacitor values will further reduce the voltage droop on the input. Furthermore, without the bypass capacitor, an output short may cause sufficient ringing on the input (from source lead inductance) to destroy the internal control circuitry. The input transient must not exceed 6V of the absolute maximum supply voltage even for a short duration.

Output Filter Capacitor

The output capacitance should be optimized for the different applications. For the USB application, the minimum output capacitance between VOUT and GND has been determining. Each downstream facing port is required at least 120μF to meet the minimum drop voltage of VBUS (330mV). However, the maximum output capacitance is also constrained from the applications. The first is larger output capacitance causes higher inrush current during turn on period. Based on the acceptable inrush current and VOUT rising time, the maximum output capacitor is obtained. Second, the VIN spike is also considered as VOUT short-circuit occurring. Greater output capacitance induces greater VIN spike. Thus, the recommend output capacitance is defined from 120μF to 330μF. For the general application, bypassing the output with a 0.01μF to 0.1μF ceramic capacitor improves the immunity of the device to short-circuit transients.



Power Dissipation

Thermal overload results from excessive power dissipation that causes the IC junction temperature to increase beyond a safe operating level. The EHP6388 relies on dedicated thermal shutdown circuitry to limit its total power dissipation. The concept of thermal resistance Θ_{JA} (°C/W) is often used to describe an IC junction's relative readiness in allowing its thermal energy to dissipate to its ambient air. An IC junction with a low thermal resistance is preferred because it is relatively effective in dissipating its thermal energy to its ambient, thus resulting in a relatively low and desirable junction temperature. The relationship between Θ_{JA} and T_J is as follows:

$$T_J = \Theta_{JA} \times P_D + T_A$$

T_A is the ambient temperature, and P_D is the power generated by the IC and can be written as:

$$P_D = R_{DS(ON)} \times I_{OUT}^2$$

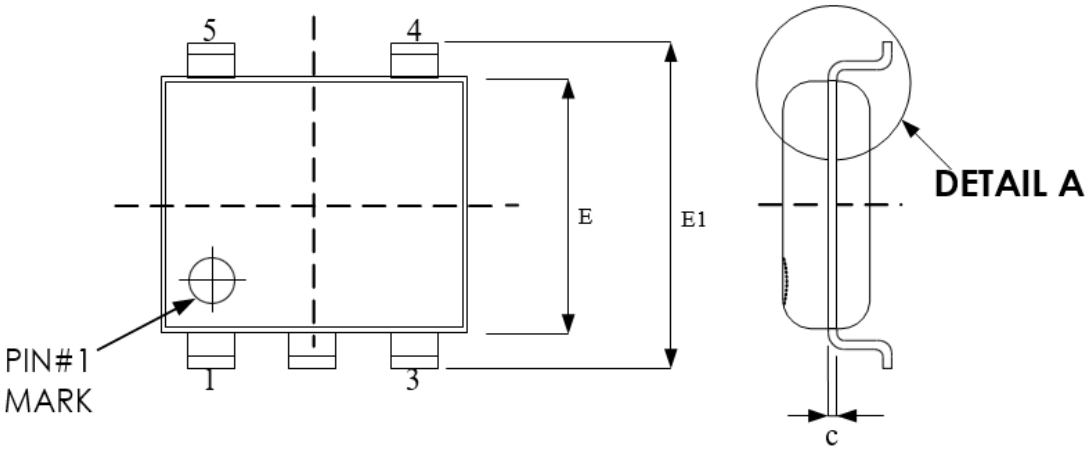
As the above equations show, it is desirable to work with ICs whose Θ_{JA} values are small such that T_J does not increase strongly with P_D. To avoid thermally overloading the EHP6388 refrain from exceeding the absolute maximum junction temperature rating of 125°C under continuous operating conditions. Maximum power dissipation for the device is calculated using the following equation:

$$PD = \frac{\mathrm{TJ(max)} - \mathrm{TA}}{\Theta\mathrm{JA}}$$

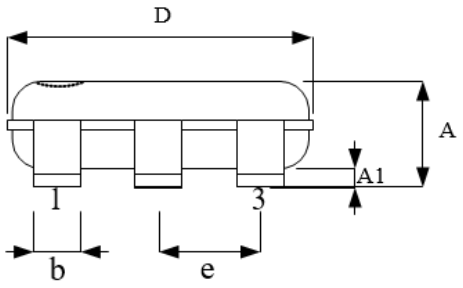
Where $T_{J(MAX)}$ is the recommended maximum junction temperature, T_A is the ambient temperature, and Θ_{JA} is the junction-to-ambient thermal resistance. For SOT-23-5 package, Θ_{JA}=152°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 0.65W.

Package Outline Drawing

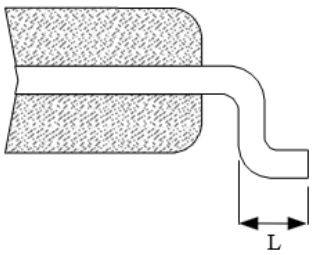
SOT-23-5



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
1.0	2024.5.28	Original

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