Ultra-low quiescent current boost

regulated power supply circuit

SSP8018

General Description

SSP8018 is a synchronous boost converter designed for battery-powered devices. The device supports a variety of battery types, including alkaline, nickel-metal hydride rechargeable batteries, lithium-manganese batteries, and lithium-ion rechargeable batteries. Its standout advantage lies in its high efficiency under light load conditions, a characteristic crucial for extending battery life.

In the application scenario of 3.3V boost to 5V, the chip is able to output current up to 300mA. Of particular note is the system achieving up to 90% conversion efficiency at a load current of 200mA.

SSP8018 chip offers two operating modes to suit different application scenarios: buck mode and pass-through mode. In buck mode, when the input voltage is higher than the output voltage (VOUT<VIN<VOUT + 0.3V), the chip can still accurately adjust the output voltage to the target value. This mode is suitable for scenarios where a stable output voltage is required. When the input voltage exceeds the output voltage by more than 0.3V (VIN>VOUT + 0.3V), the chip automatically switches from buck mode to pass-through mode. In pass-through mode, the output voltage will follow the input voltage.

SSP8018 has a true shutdown function that completely disconnects the load from the input power supply when the device is disabled, significantly reducing current consumption.

SSP8018 is available in a fixed output voltage version..

Features

- Operating input voltage range: 0.9V~5.2V
- Ultra-low quiescent current
  - Low shutdown mode current: <1μA
  - Ultra-low VIN quiescent current: <2μA
- 1MHz fixed operating frequency
- Fixed output voltage (output voltage 2.5V, 3.0V, 3.3V, 3.6V, 4.5V, 5V).
- Power saving mode for improved efficiency at low output power
- Buck mode adjusts the output voltage (VOUT<VIN<VOUT + 0.3V).
- Shutdown mode is truly disconnected (Vout = 0@EN=0).
- Operating environment temperature range: -40°C ~ +85°C
- Package form: SOT23-5L

Applications

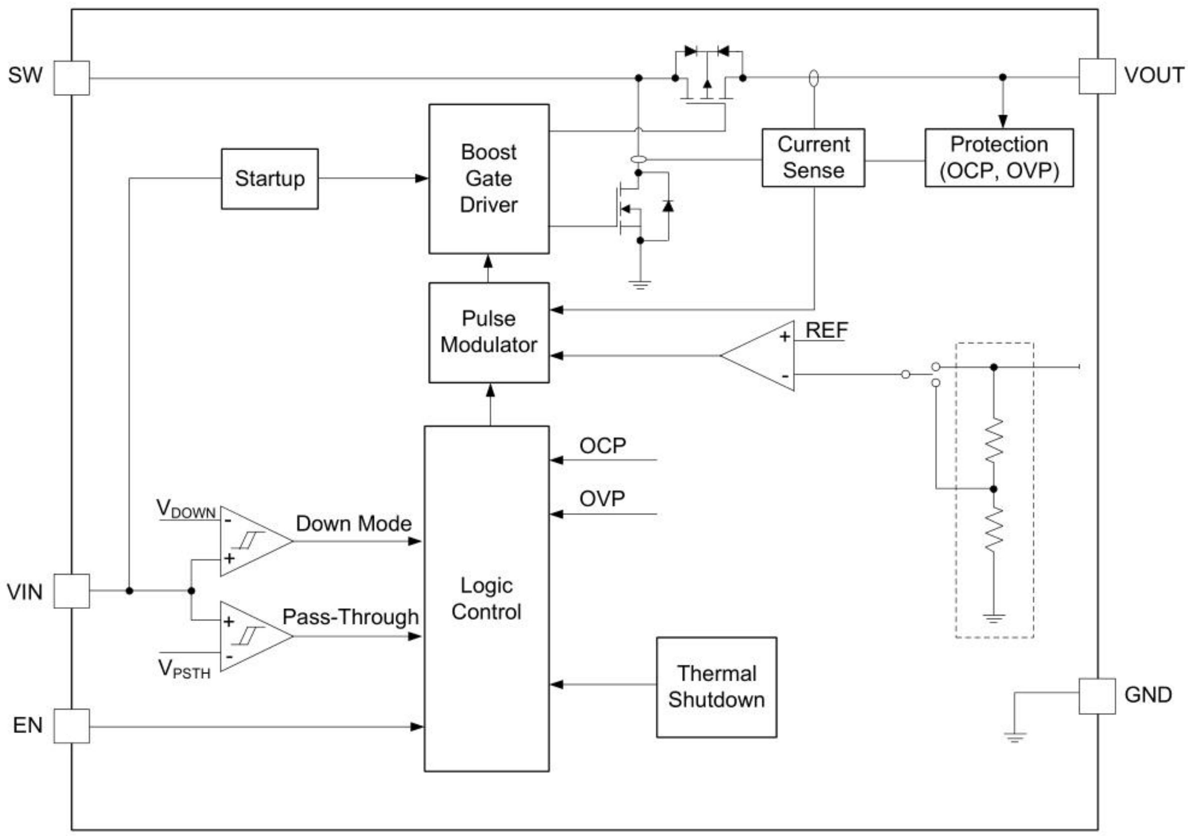
- Single lithium battery 5V converter
- Handheld instruments
- Wearable applications
- Low-power wireless applications
- Battery-powered system

Order specification

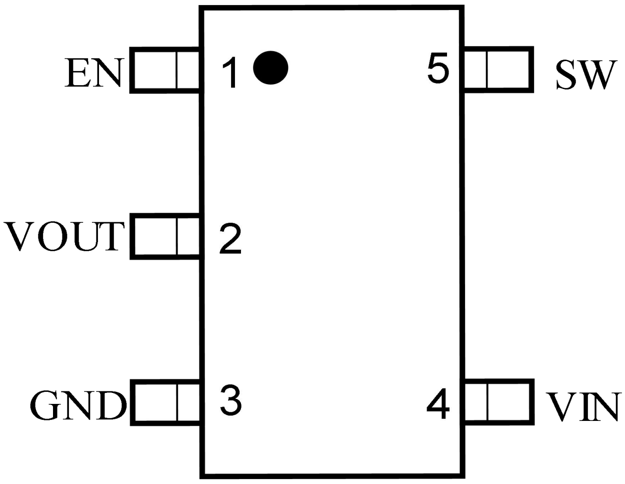
Part No	Package	Manner of Packing	Devices per bag/reel
SSP8018AXXM5R	SOT23-5L	Reel	3000

Note: "XX" stands for output voltage. Output Voltage: 2.5V, 3.0V, 3.3V, 3.6V, 4.5V, 5.0V. SSP8018A50M5R, which indicates a 5V output.

Block Diagram



Pin Assignment

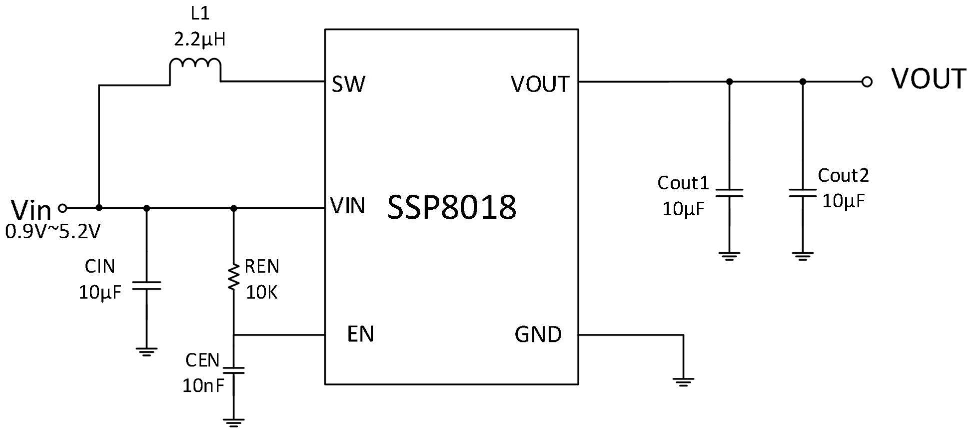


SOT23-5L（Top View）

Pin No.	Pin Name	IO	Function
4	VIN	P	Power.
3	GND	G	Ground.
5	SW	O	Switch pin. Connect the inductor to the SW.
2	VOUT	O	Boost converter output
1	EN	I	Enable pin. Active-high enable, must not be left floating.

Note: I: Input
O: Output
G: Ground
P: Circuit power

Application Circuits



Absolute Maximum Ratings

VIN, SW, VOUT, EN to GND .... -0.3V to 6.0V
Junction temperature ....+150°C
Storage temperature ....-65°C to +150°C
Soldering temperature (Soldering, 10s) .... +260°C
ESD electrostatic protection
HBM 2000V

Recommended Operating Conditions

Input Voltage .... 0.9V(1) to 5.2V
Output Voltage .... 2.5V to 5.2V
Operating ambient temperature ....-40°C to +85°C
Operating junction temperature ....-40°C to +125°C
Note (1): For detailed instructions, see "Start-up and Low Voltage Operation".

Electrical Characteristics

(VIN = 0.9V to 5.2V, C_{IN} = 10μF, C_{OUT} = 20μF, Full = -40°C to +85°C, typical values are VIN = 3.7V, T_A = +25°C, unless otherwise noted).

Parameters	Symbol	Test conditions	Temperature	Min	Typ	Max	Unit
Power supply							
Input voltage range	VIN		+25℃	0.9		5.2	V
VIN quiescent current	I_Q	IC Enable, No load, no switch (VIN=VOUT).	Full		0.05	0.2	μA
		IC Enable, No load, no switching, boost or buck mode	Full		1	2	μA
VIN shutdown current	I_{SD}	EN = GND, VIN = 3.6V	Full		0.1	1	μA
Output							
Output voltage range	VOUT		Full	2.5		5.2	V
Output voltage		SSP8018A50, VIN < VOUT, PWM mode	Full	4.85	5.00	5.09	V
		SSP8018A50, VIN < VOUT, PFM mode	+25℃		5.08		V
		SSP8018A45, VIN < VOUT, PWM mode	Full	4.37	4.50	4.58	V
		SSP8018A45, VIN < VOUT, PFM mode	+25℃		4.57		V
		SSP8018A36, VIN < VOUT, PWM mode	Full	3.50	3.60	3.67	V
		SSP8018A36, VIN < VOUT, PFM mode	+25℃		3.65		V
		SSP8018A33, VIN < VOUT, PWM mode	Full	3.21	3.30	3.35	V
		SSP8018A33, VIN < VOUT, PFM mode	+25℃		3.35		V
		SSP8018A30, VIN < VOUT, PWM mode	Full	2.92	3.00	3.05	V
		SSP8018A30, VIN < VOUT, PFM mode	+25℃		3.04		V
		SSP8018A25, VIN < VOUT, PWM mode	Full	2.44	2.50	2.54	V
		SSP8018A25, VIN < VOUT, PFM mode	+25℃		2.54		V

Parameters	Symbol	Test conditions	Temperature	Min	Typ	Max	Unit
Output over-voltage protection threshold	V_{OVP}	VOUT rise	+25°C	5.50	5.8	5.95	V
OVP hysteresis			+25°C		100		mV
Switch							
Switching frequency	f_{SW}	VIN = 3.7V	Full		1.0		MHz
Power switch							
low-side MOSFET Rds(on)	$R_{DS(ON)\_LS}$	VOUT = 5.0V	+25°C		280	400	mΩ
		VOUT = 3.3V	+25°C		340	480	mΩ
Rectifier on-resistance	$R_{DS(ON)\_HS}$	VOUT = 5.0V	+25°C		270	350	mΩ
		VOUT = 3.3V	+25°C		350		mΩ
Current limit threshold	I_{LIM}	VOUT > 2.5V, boost mode	+25°C	0.89	1.3	1.62	A
		VOUT = 2.5V, boost mode	+25°C	0.57	0.8	1.06	A
Control logic							
EN input low voltage threshold	V_{IL}	VIN ≤ 1.5V	Full			0.8 × VIN	V
		VIN > 1.5V	Full			0.4	V
EN input high voltage threshold	V_{IH}	VIN ≤ 1.5V	Full	0.8 × VIN			V
		VIN > 1.5V	Full	1.2			V
EN leakage current	I_{EN_LKG}	V_{EN} = 5.0V	+25°C			300	nA

Detailed description

SSP8018 synchronous boost converter is a power management chip designed for battery-powered systems, especially suitable for applications such as alkaline batteries, nickel-metal hydride rechargeable batteries, lithium-manganese batteries, or lithium-ion rechargeable batteries. The device offers notable features such as firstly, its wide input voltage range (0.9V to 5.2V) allows it to accommodate a wide range of battery types. Secondly, the optimized circuit design allows for longer battery runtime. Finally, its compact peripheral size makes it particularly suitable for space-constrained applications.

SSP8018 operates in peak current mode, with a typical peak switching current limit of 1.3A. The device has a true shutdown function that completely disconnects the load from the input, minimizing current consumption. In addition, when the input voltage approaches or exceeds the regulated output voltage, SSP8018 can automatically switch to buck mode or pass-through mode to operate.

A fixed output voltage version of SSP8018 is available.

Enable and shutdown

The working status of SSP8018 is controlled by EN pins. When the EN pin is pulled up, the device enters the enabling state; When the EN pin is pulled down, the device enters shutdown mode. In shutdown mode, the device completely stops switching and the rectified PMOS is completely shut down. At this point, the input current of the device is less than 1μA.

Start-up and low voltage operation

SSP8018 can start up normally at an input voltage of 0.9V and a load greater than 3kΩ. However, if the load during the startup process is too heavy and the chip cannot charge the output voltage above 2.2V, the startup will not be successful.

When the supply voltage is below 0.85V, the SSP8018 may not shut down properly by pulling EN to logic low.

Flow limit

SSP8018 features cycle-by-cycle over-current protection (OCP). If the inductor peak current reaches the current limit threshold ILIM, the main switch is disconnected to prevent further increase in input current. In this case, the output voltage will be reduced until a power balance between the input and output is achieved. If the output drops below the input voltage, SSP8018 will go into buck mode. In buck mode, the peak current is still limited by the ILIM cycle-by-cycle. If the output drops below 2.2V, SSP8018 will go into the boot process again. In pass-through mode, the throttling feature is not enabled.

Output short-circuit protection

In the event of a short circuit to the ground, the switching current is limited to about 200mA. Once the short circuit is released, SSP8018 return to soft start again and regulate the output voltage.

Over-voltage protection

SSP8018 has output over-voltage protection (OVP). When the output voltage of the SSP8018 exceeds the OVP threshold of 5.8V, the chip stops working. When the output voltage falls below the OVP threshold of 0.1V, the chip starts working again.

Power saving mode under light load conditions

SSP8018 boost converter enters power saving mode to work under light load.

Buck mode and pass-through mode

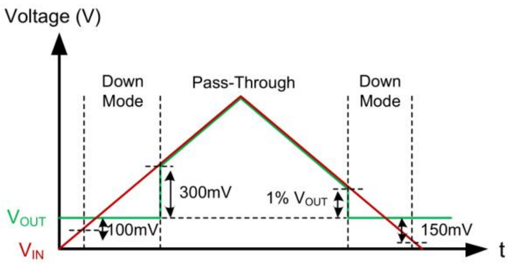
In buck mode, the output voltage can still be adjusted to the target value even if the input voltage is higher than the output voltage (VOUT<VIN<VOUT + 0.3V). In pass-through mode, the output voltage follows the input voltage. When VIN > VOUT + 0.3V, SSP8018 exit buck mode and enter pass-through mode.

Detailed description

In buck mode, the output voltage is adjusted to the target value even if VIN > VOUT. The control circuit changes the behavior of the rectified PMOS by pulling the gate to the input voltage instead of ground. In this way, the voltage drop across the PMOS increases to the point where the output voltage can be adjusted. In this mode, power losses also increase, which needs to be taken into account thermal factors.

In pass-through mode, the working state of the boost converter changes significantly: first, the switching operation stops completely; Second, the rectified PMOS enters a continuous conduction state, while the low-side switch remains continuously shut off. The direct result of this mode of operation is a change in the composition of the output voltage, which is manifested as the input voltage minus two key voltage drops: the voltage drop caused by the inductive direct current resistor (DCR) and the voltage drop caused by the rectified PMOS on-resistor.

SSP8018's operating mode conversion process is as follows：When the input voltage VIN rises to more than the output voltage VOUT minus 100mV, the device first enters buck mode. In this mode, the SSP8018 will continue to work until the VIN exceeds the VOUT by 0.3V, at which point it will switch to pass - through mode. In pass-through mode, the output voltage will change with the input voltage. When the VIN drops to 101% of the target output voltage, the SSP8018 exits pass-through mode and re-enters buck mode. The buck mode will continue to operate until the input voltage drops to 150mV below the output voltage, and the device will eventually return to boost mode.



Down Mode and Pass-Through Operation

Design requirements

A typical application example is LCD, which typically requires a 5V output as its bias voltage and draws less than 1mA. The following design requirements can be used to select external component values for SSP8018.

Table 1. Design requirements

Parameters	value
Input voltage	2.7V ~ 4.2V
Output voltage	5V
Output current	1mA
Output voltage ripple	±50mV

Output voltage regulation

SSP8018 are available in a variety of fixed voltage versions.

In this case, a 5V output voltage is required to bias the LCD.

Maximum output current

The maximum output capability of the SSP8018 is determined by the input-output ratio and the current limit of the boost converter. It can be estimated from Equation 1.

$$I_{OUT(MAX)}=VIN*(I_{LIM}-I_{LH}/2)*\eta/VOUT \quad (1)$$

where η is the conversion efficiency, estimated by 85%; I_{LH} is the current ripple value, and I_{LIM} is the switching current limit.

The minimum input voltage, maximum boost output voltage, and minimum current I_{LIM} should be used as estimated worst-case conditions.

Application Information

Selection of inductors

As a core component of voltage regulator design, the choice of inductor directly affects the steady-state performance, transient response, and loop stability of the voltage regulator. During the inductor selection process, three key parameters need to be focused: inductance value, saturation current, and direct current resistance (DCR).

The device is optimized to operate between 1μH ~ 2.2μH. For optimal stability, a 2.2μH inductor is recommended for VOUT > 3.0V and a 1μH inductor for VOUT ≤3.0V.

VOUT (V)	Induction (μH)	Saturated current (A)	DC resistance (MΩ)	Size: (L × W × H)	Product model	Producer
> 3.0	2.2	1.95	80	2.5 × 2.0 × 1.2	74404024022	Würth Elektronik
	2.2	1.7	92	2.5 × 2.0 × 1.1	LQH2HPN2R2 MJR	muRata
	2.2	1.45	163	2.0 × 1.6 × 1.0	VLS201610CX -2R2M	TDK
≤ 3.0	1.0	2.6	37	2.5 × 2.0 × 1.2	74404024010	Würth Elektronik
	1.0	2.3	48	2.5 × 2.0 × 1.0	MLP2520W1R 0MT0S1	TDK
	1.0	1.5	80	2.0 × 1.2 × 1.0	LQM21PN1R0 MGH	muRata

Selection of capacitors

For optimal output and input voltage filtering, it is recommended to use low-ESR X5R or X7R ceramic capacitors.

Input capacitors play multiple key roles in circuit systems: firstly, they can effectively suppress input voltage ripple, secondly, they can eliminate input voltage spikes, and ultimately provide stable operating voltage for the device. In typical applications, an input capacitance value of 10μF is recommended, which significantly improves the transient response characteristics of the regulator while optimizing the electromagnetic compatibility of the entire power supply circuit. For optimal performance, it is recommended to place ceramic capacitors as close to the device's VIN and GND pins as possible.

For the output capacitors of the VOUT pins, it is recommended to use small ceramic capacitors and be as close to the VOUT and GND pins of the device as possible. If for some reason you need to use a large capacitor that cannot be placed close to the device, it is recommended to use a small ceramic capacitor with a capacitance value of 1μF in parallel with the large capacitor. This small capacitor should be as close as possible to the VOUT and GND pins of the device

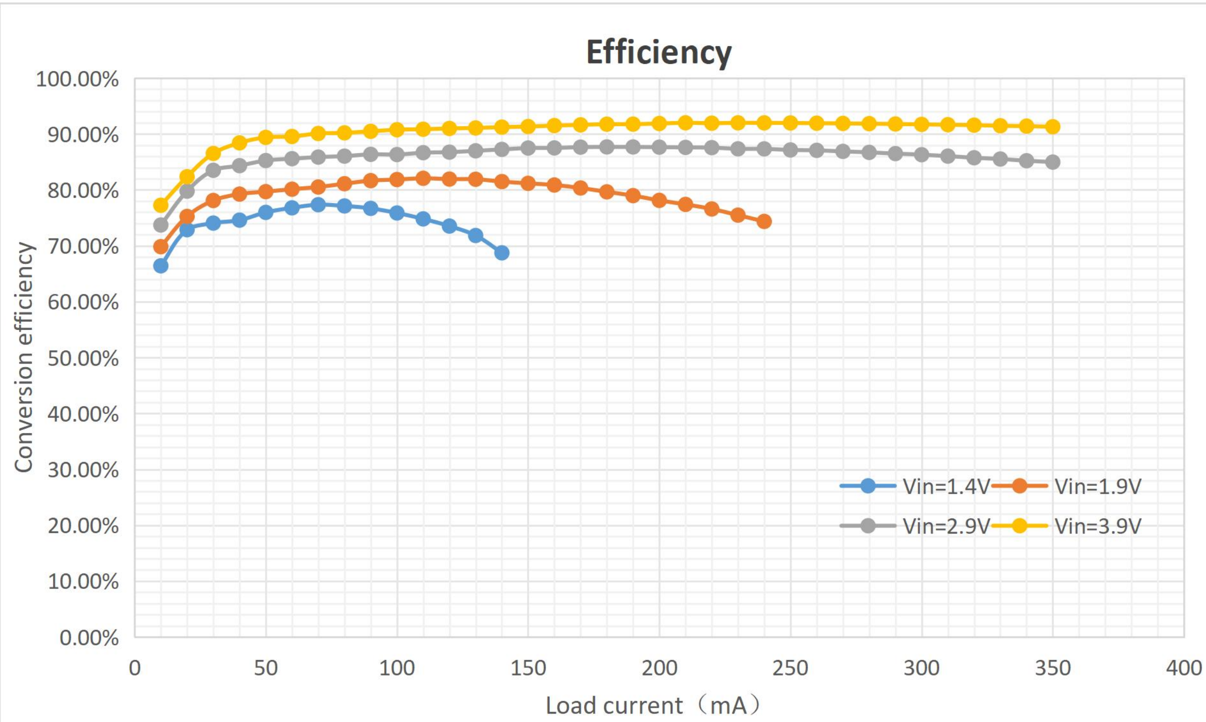
From the perspective of power stage design, the output capacitor mainly determines the angular frequency characteristics of the converter, while the inductor affects the generation of the right half-plane zero point (RHPZ). As the inductance value increases, the output capacitance must be increased accordingly to maintain system stability. The device has been optimally designed to use an inductance value in the range of 1μH to 2.2μH, where the corresponding minimum output capacitance is 20 μF. Increasing the output capacitance appropriately can effectively reduce the output ripple in PWM operating mode.

When selecting capacitors, special attention should be paid to the derating effect of ceramic capacitors under bias conditions. It is recommended to select the capacitor by first checking the DC bias characteristics of the capacitor, and then selecting the correct nominal capacitor according to actual needs. The recommended GRM188R60J106ME84D model is the 10μF ceramic capacitor that maintains a high effective capacitance value under DC bias conditions and has excellent performance.

When the load is hot-swapped, the input capacitance of the load device should be less than 1/10 of the output capacitance of the SSP8018.

Typical Performance Characteristics

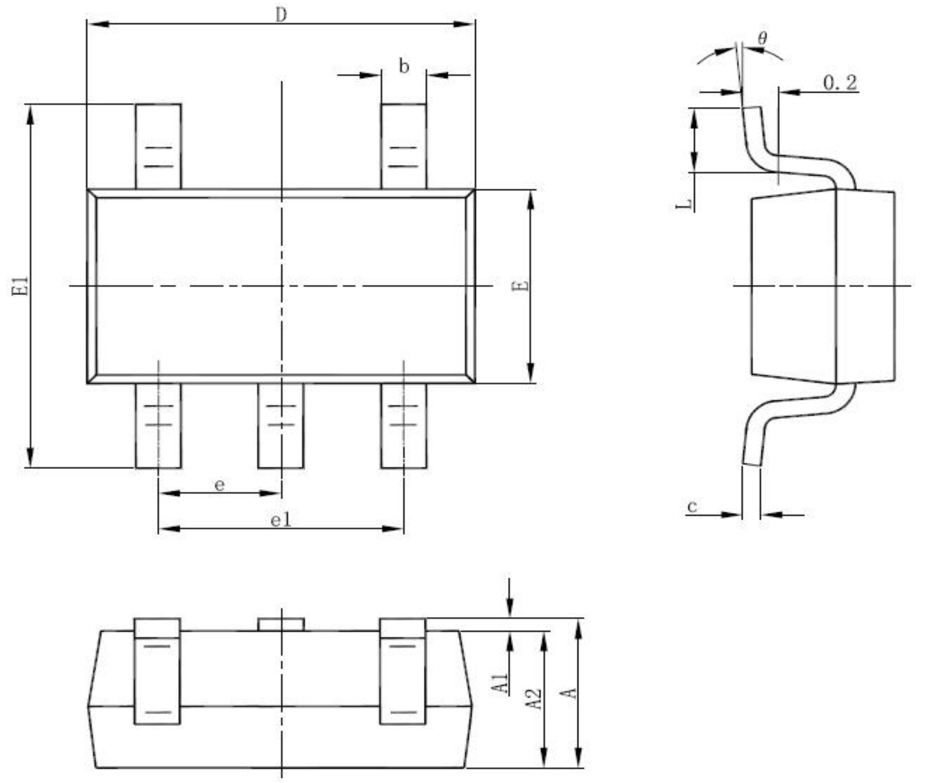
Test conditions: SSP8018A50M5R, Vout=5V, L=2.2μH, CIN=2*10μF, COUT=2*10μF, Ta=25°C, unless otherwise specified.



PCB layout

Layout is a crucial aspect of switching power supply design, especially in applications with high peak current and high switching frequency. Improper placement can lead to stability issues and electromagnetic interference (EMI) issues with the converter. In order to ensure circuit performance, the following principles should be followed during design: the main current path and the power supply grounding path should adopt wide and short traces; At the same time, key components such as input/output capacitors and inductors should be arranged as close to the relevant devices as possible.

Package Information (SOT23-5L).



Symbol	mm size		inch size	
	Minimum	Max	Minimum	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Special instructions

The final interpretation of this specification belongs to the company.

Version change notes

Version: V1.0 Author: Li Xinchun Time: 2025.12.18

Modify the record:

1. First edition

Statement

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