

## 9V, 8A 高效异步升压转换器

## 9V,8A Non-Synchronous Boost Converter

## ■ FEATURES

- Input voltage range  $V_{IN}$ : 2.5V to 8.5V
  - Output voltage range  $V_{OUT}$ :  $V_{IN}$  to 9V
  - Internal Fixed PWM Frequency: 650kHz
  - Internal 60m $\Omega$ , 8A power MOSFET
  - High Efficiency
- 87% ( $V_{IN} = 3.7V$ ,  $V_{OUT}=7.5V$ ,  $I_{OUT} = 1A$ )
- Adjustable Current Limitation
  - Output overvoltage protection (at 9.5V), thermal shutdown protection
  - Pb-free Packages, SOP8L-PP

- 输入电压范围  $V_{IN} : 2.5V - 8.5V$
- 输出电压范围  $V_{OUT} : V_{IN} - 9V$
- 内置固定开关频率：650kHz
- 内置60mΩ, 8A功率开关管
- 高转换效率：  
87% ( $V_{IN} = 3.7V, V_{OUT} = 7.5V, I_{OUT} = 1A$ )
- 限流保护功能，外部可调节
- 输出过压 (9.5V)、热关断等保护
- SOP8L-PP，无铅封装

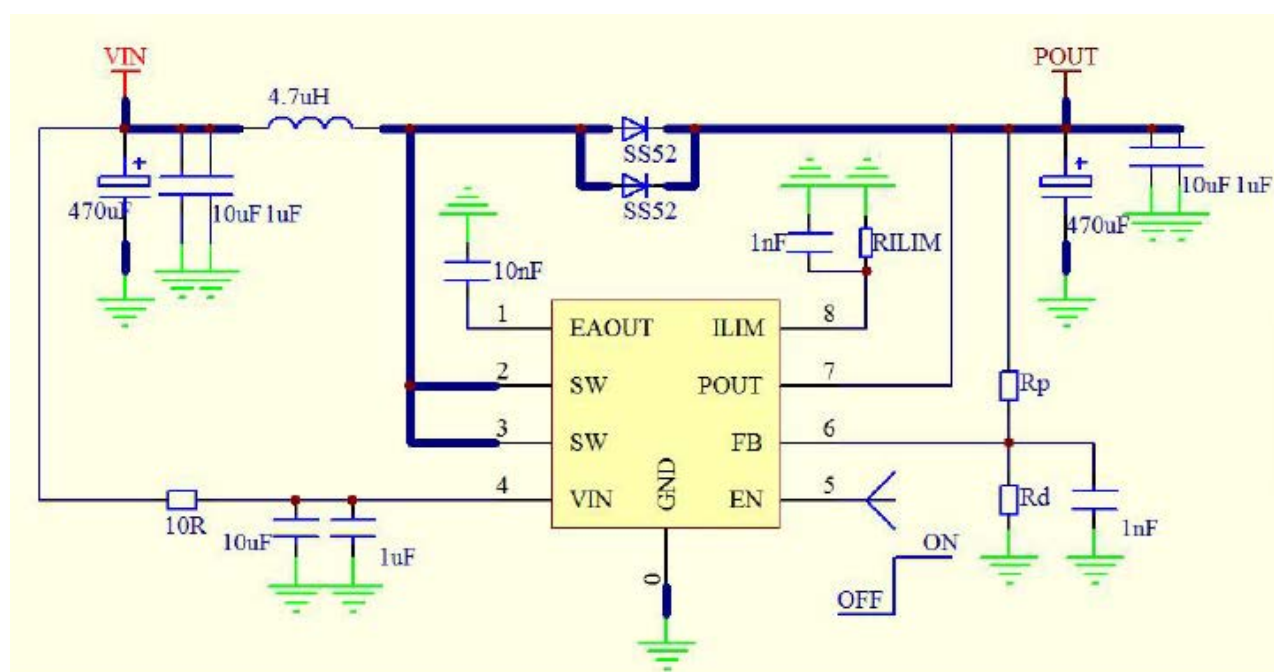
## ■ APPLICATIONS

- Smart Speakers
- Portable Speakers
- Power bank
- Wireless Speakers
- E-Cigarette
- Outdoor Speakers
- 智能音响
- 电子烟
- 无线音响
- 移动电源
- 便携式音箱
- 拉杆音箱

## ■ ORDERING INFORMATION

Part Number	Package Type	Marking	Operating Temperature Range	MOQ/Shipping Package
HM9230	SOP8L-PP	HM9230 YYWW <sup>1</sup>	-40℃~85℃	Tape and Reel 3000PCS

## ■ TYPICAL APPLICATION



<sup>1</sup> YYWW is production tracking code

### ■ DESCRIPTION

The HM9230 is a non-synchronous boost converter integrated with a 60mΩ power switch to provide a high efficiency and small size solution in portable systems.

The HM9230 has an input voltage range from 2.5 V to 8.5V to support applications with single cell and two cell Lithium batteries. The device has 8A switch current capability and can provide an output voltage up to 9V.

A function of adjustable Current limitation is available to protect HM9230 from over current during operation, and to prevent the battery from being over-pulled caused by an overload.

The HM9230 is available in SOP8L-PP, with very limited external components, so that it provides space-saving PCB for various applications.

The HM9230 provides 9.5V output overvoltage protection, and thermal shutdown protection.

HM9230是一款采用CMOS工艺的升压转换器，内部集成了60mΩ,8A功率开关管。

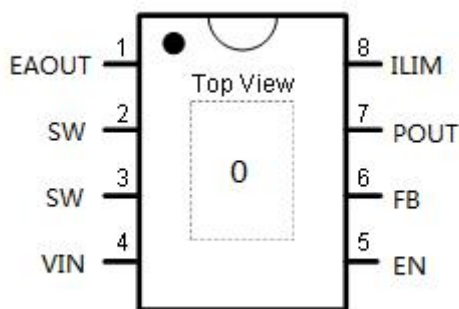
HM9230具有2.5V至8.5V的输入电压范围，可为采用单节或两节锂电池的应用提供支持。该器件具备8A开关电流能力，并且能够提供最高9V的输出电压。

HM9230具有可外部调节的限流保护功能，不仅可保护芯片过流，亦可有效防止电池被拉死。

HM9230外围精简，采用SOP8L-PP封装，使用和测试简单，为便携式系统提供了高效的小尺寸解决方案。

HM9230内置了9.5V的过压保护和过热关断保护功能。

## ■ TERMINAL CONFIGURATION



## ■ TERMINAL FUNCTION

Terminal No.	Name	I/O <sup>1</sup>	Description
1	EAOUT	O	Error amplifier output. Connect a 10nF capacity to GND. 误差放大器输出端，接10nF电容到地。
2,3	SW	P	The switching node pin of the converter. 升压整流管输入端。
4	VIN	I	IC power supply input. 芯片电源输入端
5	EN	I	Enable logic input. Logic high level enables the device. Logic low level disables the device. 芯片使能端，高电平使能，低电平关断。
6	FB	I	Regulator Feedback Input. 升压调节反馈输入端。
7	POUT	I	Boost Converter voltage detect pin. 升压输出检测端。
8	ILIM	O	Adjustable switch peak current limit. An external resister paralleled with a 1nF capacitor should be connected between this pin and the GND pin. 最大限流值设置端，外接电阻并联1nF到地。
0	GND	G	Power ground. Also provides thermal connection from the device to the board. A matching ground pad should be provided on the PCB and the device connected to it via solder. 芯片地，同时提供器件向板级散热的路径。PCB 板上需要留有足够的铺地露铜与之良好焊接。

<sup>1</sup> I: Input; O: Output; G: Ground; P: Power

## SPECIFICATIONS<sup>1</sup>

### Absolute Maximum Ratings<sup>2</sup>

PARAMETER		Symbol	MIN	MAX	UNIT
Voltage range	SW	/	-0.3	11	V
	V <sub>IN</sub> , V <sub>OUT</sub>		-0.3	10	
Operating temperature range		T <sub>A</sub>	-40	85	°C
Operating junction temperature range		T <sub>J</sub>	-40	150	°C
Storage temperature range		T <sub>STG</sub>	-50	150	°C

### Recommended Operating Conditions

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
IC power supply voltage range	V <sub>IN</sub>		2.5		9	V
Output voltage range	V <sub>OUT</sub>		2.5		9	V
Inductance, effective value	L		2.2	4.7	10	μH
Input capacitance, effective value	C <sub>I</sub>			470		μF
Output capacitance, effective value	C <sub>O</sub>			470		μF
Operating temperature	T <sub>a</sub>		-40	25	85	°C
Operating junction temperature	T <sub>J</sub>		-40		125	°C

### Electrical Characteristics<sup>3</sup>

Condition: T<sub>a</sub> = 25°C, V<sub>IN</sub> = 2.7V-8.5V, V<sub>POUT</sub>=4.5-9V, unless otherwise specified.

#### Power Supply

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Input power voltage range	V <sub>PIN</sub>		2.7		8.5	V
Under-voltage lockout (UVLO) threshold	V <sub>IN_UVLO</sub>	V <sub>IN</sub> rising	2.4			V
		V <sub>IN</sub> falling	2.1			V
V <sub>IN</sub> UVLO hysteresis	V <sub>IN_HYS</sub>			300		mV
Quiescent current	I <sub>Q_VIN</sub>	V <sub>IN</sub> = 3.7V, V <sub>POUT</sub> = 7.5V, no SW switching		0.5		mA
	I <sub>Q_POUT</sub>			2.5		mA
Shutdown current	I <sub>SD</sub>	IC disabled, V <sub>IN</sub> = 3.7 V, without current consumed by FB resistors.		1		μA

#### Input and Output

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
EN high threshold voltage	V <sub>ENH</sub>		1.5			V
EN low threshold voltage	V <sub>ENL</sub>				0.4	V
EN internal pull-down resistance	R <sub>EN</sub>			300		kΩ
EN delay time	T <sub>delay</sub>			4.5		ms
Output voltage range	V <sub>OUT</sub>		V <sub>IN</sub>		9	V
Output overvoltage protection	V <sub>OVP</sub>			9.5		V
Reference voltage at the FB pin	V <sub>REF</sub>	At light load		1.24		V
		Out-off light load		1.2		V

<sup>1</sup> Depending on parts and PCB layout, characteristics may be changed.

<sup>2</sup> Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

<sup>3</sup> Depending on parts and pattern layout, characteristics may be changed.

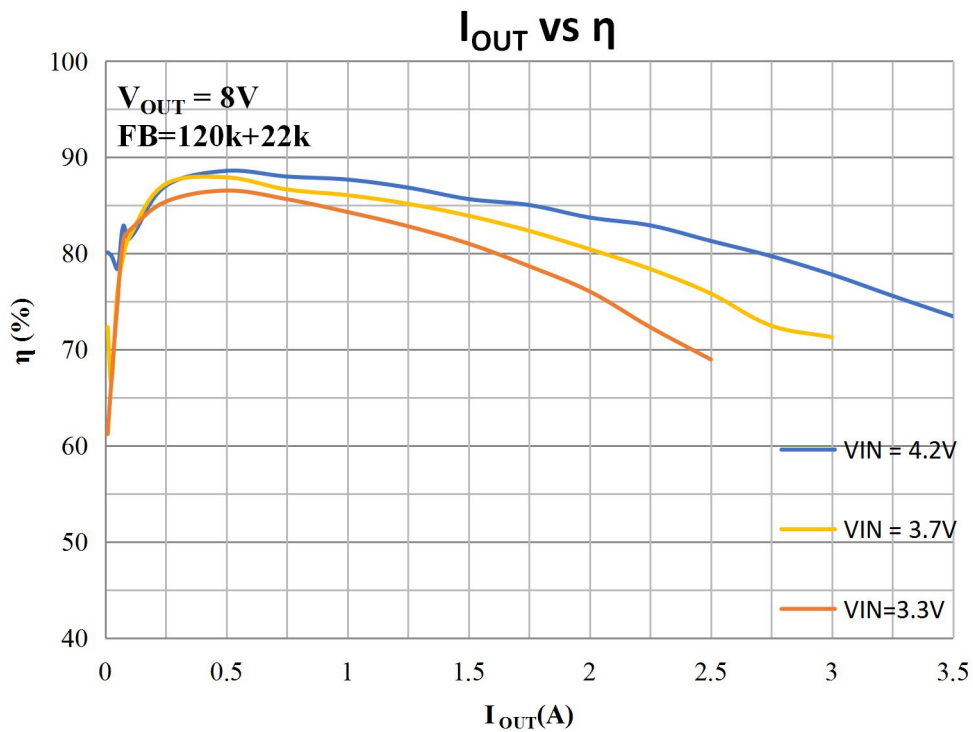
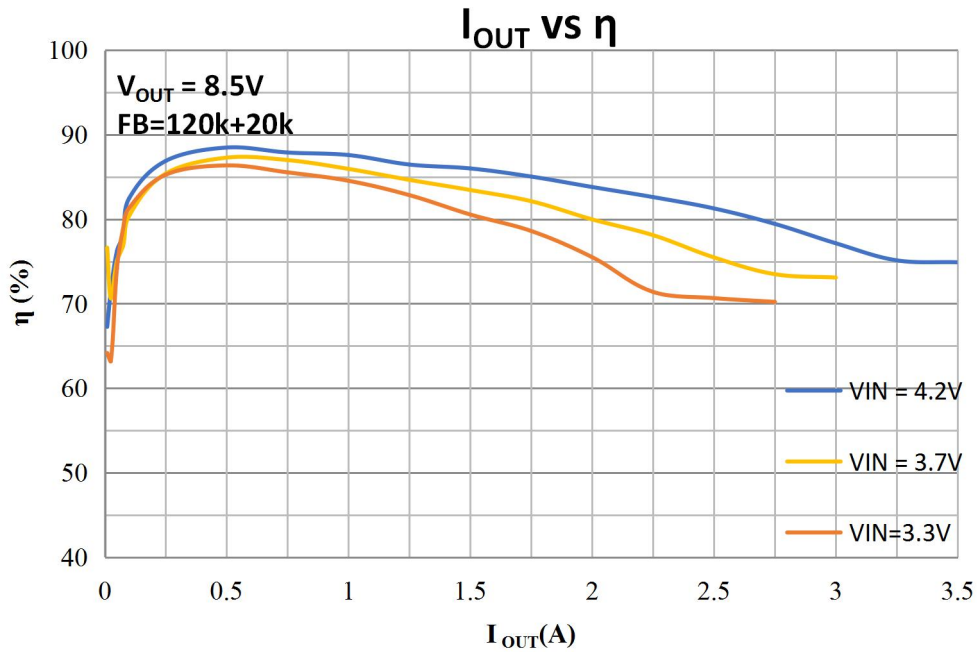
**Other characteristics**

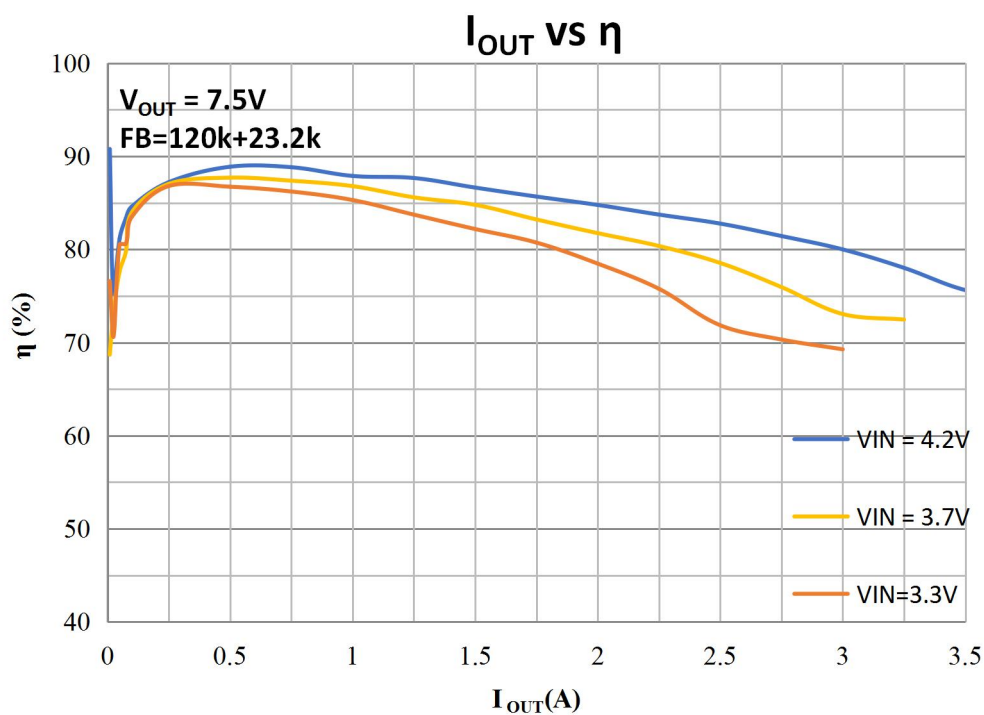
PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
<b>POWER SWITCH</b>						
MOSFET on-resistance	$R_{DS(on)}$			60		mΩ
<b>CURRENT LIMIT</b>						
Peak switch current limit	$I_{LIM}$	$R_{LIM} = 510\text{ k}\Omega$		8		A
Boost converter start-up limit				4		A
Reference voltage at the ILIM pin	$V_{ILIM}$			1.24		V
<b>SWITCHING FREQUENCY</b>						
Switching frequency	$f_{sw}$			650		kHz
<b>Protection</b>						
Thermal shutdown threshold	$T_{SD}$			150		°C
Thermal shutdown hysteresis	$T_{SD\_HYS}$			20		°C

## ■ TYPICAL OPERATING CHARACTERISTICS

Condition:  $L = 4.7\mu\text{H}$ ,  $D = 2 \times \text{SS54}$ ,  $\text{FB} = 120\text{k} + 20\text{k} // 1\text{nF}$ ,  $R_{\text{ILIM}} = 510\text{k} // 1\text{nF}$ ,  $C_{\text{EAOUT}} = 10\text{nF}$ ,

$V_{\text{IN}} = 3.7\text{V}$ , Input Capacitor = Output Capacitor =  $1\mu\text{F} // 10\mu\text{F} // 470\mu\text{F}$ , otherwise specified.





## ■ APPLICATION INFORMATION

### 1. Feature Description

#### 1.1 Operation

The non-synchronous boost converter HM9230 operates at a quasi-constant frequency pulse width modulation (PWM) in moderate to heavy load condition. The switching frequency is around 650kHz. It is optimized for single Li-Ion and Li-polymer battery powered products, in a wide range of wireless speakers, power bank and other portable devices. The converter integrates 60-mΩ power switches and is capable of delivering up to 3-A output current for 3.7V to 7.5V conversion.

HM9230 为异步升压转换 IC。当处于轻载状态，HM9230 工作在非连续的 PFM 模式；当负载加重，工作于连续的 PWM 模式，PWM 开关频率约为 650kHz。HM9230 适用于单节锂电或者双节锂电的宽电压范围应用。HM9230 内置 60mΩ MOS 开关，可以从 3.7V 升压到 7.5V 并提供 3A 稳定输出。

#### 1.2 Current Limit Program

A resistor paralleled with a capacitor between ILIM and GND pin determines the peak switch current. The resistor value should be not smaller than 500kohm, so that the current limit will be set below 9A.

ILIM，输入限流设定端，接一个电阻和一个电容到地。一般电阻不小于 500k，这样峰值电流不超 9A。

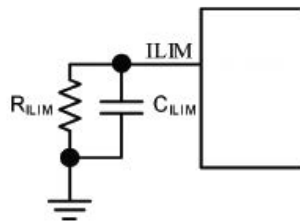


Figure 2 ILIM Terminal Configuration

Recommended values for  $R_{ILIM}$  and  $C_{ILIM}$  are shown in the following table.

推荐  $R_{ILIM}$  和  $C_{ILIM}$  如下表。

Table. 1 Recommended values for  $R_{ILIM}$  and  $C_{ILIM}$

Peak current value (A)	$R_{ILIM}$ (ohm)	$C_{ILIM}$ (ohm)
8A	510k	1nF
6.8A	560k	1nF
5.8A	620k	1nF
4.5A	680k	1nF

#### 1.3 Enable (EN pin)

When the EN pin is pulled into logic low (below 0.4V), the HM9230 goes into the shutdown mode and stops switching. Only when EN pin is pulled into logic high (above 1.5V), the HM9230 works.

当 EN 脚输入低电平(<0.4V)，HM9230 进入低功耗休眠状态。只有当 EN 脚输入高电平(>1.5V)，HM9230 才正常工作。



### 1.4 Output Voltage Setting (FB pin)

The output voltage is set by an external resistor divider ( $R_{UP}$ ,  $R_{DN}$  in the Typical Application Circuit). Make sure that a 1nF capacitor should be paralleled with  $R_{DN}$ . To get the output voltage  $V_{OUT}$ , the Value of  $R_{UP}$  and  $R_{DN}$  can be calculated as following. Some typical output voltages can be set as the following table.

升压输出电压由 FB 上分压电阻( $R_p/R_d$ )决定。请并联 1nF 电容在  $R_d$  电阻上。升压值  $P_{OUT}$  由下公式决定：

$$V_{OUT} = V_{REF} \times (1 + \frac{R_{UP}}{R_{DN}}),$$

where  $V_{REF} \approx 1.24V$  at light load, and  $V_{REF} \approx 1.2V$  at heavy load

Table. 3 Internal input resistors and feedback resistors

$V_{OUT}$ (V)		$R_{UP}$ (ohm)	$R_{DN}$ (ohm)
Light load	Heavy load		
9	8.7	150k	24k
8.7	8.4	120k	20k
8	7.8	120k	22k
7.6	7.4	120k	23.2k

### 1.5 Inductor Selection (SW pin)

Because the selection of the inductor affects the power supply's steady state operation, transient behavior, loop stability, and boost converter efficiency, the inductor is the most important component in switching power regulator design. Three most important specifications to the performance of the inductor are the inductor value, DC resistance, and saturation current.

电感的参数会影响电源的稳定性、转换效率以及环路稳定性。电感值、DC 电阻、饱和电流为电感的 3 个重要参数指标。

To be simplified, the inductor value can be set between 2.2uH ~ 6.8uH which can be used in most cases.

简单来说，电感值可以从 2.2uH 到 6.8uH 之间选择，可以满足绝大多数应用。

The rated current, especially the saturation current should be larger than the peak current during the whole operation. The peak current can be calculated as follows.

电感的饱和电流，需要大于应用中的最大峰值电流。峰值电流的计算如下：

$$I_{Lpeak} = I_{DC} + \frac{I_{PP}}{2}$$

$$I_{DC} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times \eta}$$

$$I_{PP} = \frac{1}{L \times (\frac{1}{V_{OUT} - V_{IN}} + \frac{1}{V_{IN}})} \times f_{SW}$$

Boost converter efficiency is affected significantly by the inductor's DC resistance (DCR), equivalent series resistance (ESR) at the switching frequency, and the core loss. An inductor with lower DCR and ESR would increase the efficiency significantly.

电感的 DCR 严重影响升压转换效率，在开关当中，等效电阻发热，损失效率。低 DCR 的电感可有效改善升压效率。

The inductor should be placed as close as possible to the SW pin

电感摆放位置请尽量靠近 SW 管脚。

### 1.6 Input Capacitor Selection

For good input voltage filtering and small voltage ripple (less than 100mV is required), we recommend low-ESR capacitors of 1uF//10uF//470uF (“//” represents paralleled) be placed as close as possible to the inductor.

The  $V_{IN}$  pin is the power supply for the HM9230, a 1uF ceramic capacitor should be placed as close as possible to the  $V_{IN}$  pin..

### 1.7 Output Capacitor Selection ( $V_{OUT}$ pin)

To be simplified, we recommend low-ESR capacitors of 1uF//10uF//470uF (“//” represents paralleled) be placed as close as possible to DIODE for small output voltage ripple.

Capacitors can lose most of their capacitance at rated voltage. Therefore, leave margin on the voltage rating to ensure adequate effective capacitance.

### 1.8 Diode Selection

Schottky diode 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.

### 1.9 EAOUT pin

The HM9230 requires external compensation for the stability of boost converter. The EAOUT pin is the output of the internal error amplifier. An external ceramic capacitors 10nF is connected from the EAOUT pin to GND.

### 1.10 Protection Function

#### Under-voltage Lockout (UVLO)

The UVLO circuit prevents the device from malfunctioning at low input voltage and the battery from excessive discharge. It disables the device from switching when the falling voltage at the  $V_{IN}$  pin trips the UVLO threshold  $V_{IN\_UVLO}$ , which is typically 2.4V. The device starts operating when the rising voltage at the  $V_{IN}$  pin is 300mV above the  $V_{IN\_UVLO}$ .

#### Over-voltage Protection

If the output voltage at the  $V_{OUT}$  pin is detected above 9.5V (typical value), the HM9230 stops switching immediately until the voltage at the  $V_{OUT}$  pin drops the hysteresis value lower than the output overvoltage protection threshold. This function prevents overvoltage on the output and secures the circuits connected to the output from excessive overvoltage.

选择低ESR的输入滤波电容组合可有效减小输入纹波，我们推荐470uF//10uF//1uF的输入滤波电容组合。滤波电容尽量靠近电感。

$V_{IN}$  管脚为逻辑电源输入管脚，摆放 1uF 陶瓷电容滤波。

选择低ESR的输出滤波电容组合可有效减小输出纹波，我们推荐470uF//10uF//1uF的输出滤波电容组合。滤波电容尽量靠近肖特基二极管输出。

建议选用快恢复时间、低正向导通电压的肖特基二极管。确保二极管的平均电流和峰值电流参数大于实际应用中平均电流和峰值电流。另外，二极管的反向雪崩电压必须大于输出电压。

HM9230需要外部补偿电路来确保正常工作，在EAOUT管脚上并联一个10nF电容到地。

HM9230内含欠压保护电路，来防止输入电压过低或者电池过放。欠压状态，HM9230处于关断状态。 $V_{IN}$ 启动电压为2.4V，有300mV迟滞。

HM9230 内含过压保护电路。但  $V_{OUT}$  电压大于 9.5V，IC 立即停止开关工作。当  $V_{OUT}$  电压降低于迟滞电压后，HM9230 重新开始工作。过压保护功能保证输出电压的安全性。

## Thermal Shutdown

A thermal shutdown is implemented to prevent damages due to excessive heat and power dissipation. Typically, the thermal shutdown happens at a junction temperature of 150°C. When the thermal shutdown is triggered, the device stops switching until the junction temperature falls below typically 130°C, then the device starts switching again.

## 2. Application Notes

### 2.1 Radiated EMI Reduction

#### (1) Minimize High di/dt Path loop area

EMI Starts off from high di/dt loops. The high di/dt critical path locates as the thick circle showed in the application. The output capacitor should be placed as close to the DIODE as possible resulting in minimum area of the high di/dt loop.

#### (2) PCB Trace and Ground Plane

High trace inductance leads to poor radiation EMI. The inductance of a PCB trace is a function of its length and width. So, increase the trace width and decrease the trace length will significantly decrease the radiation EMI.

Meanwhile, good designed ground planes will help decrease the radiation EMI too:

- Placing a solid ground plane with minimum distance to the critical trace;
- Wider and bigger ground plane result in smaller signal trace inductance;
- Thinner insulation thickness between the ground plane and the signal traces also results in smaller inductance;

#### (3) RC Snubber

Adding an RC snubber across the SW pin and the power ground can help reduce the radiation EMI levels. The RC snubber should be placed as close as possible to the switching node and the power ground.

HM9230内含过温保护功能，保护IC因温度太高而损坏。当HM9230内部温度达到150°C，IC立即停止工作。当温度降低低于130°C，IC重新开始正常工作。

#### EMI 改善措施:

减小 di/dt 环路面积。大电流路径在应用图中以加粗标出。输出滤波电容尽量靠近整流二极管。

PCB 走线的寄生电感会恶化 EMI，影响寄生电感的因素是走线的长度和宽度。所以，增加大电流路径的走线宽度，减小走线长度可有效改善 EMI。

好的地平面设计，同样帮助减小 EMI:

完整的地平面，可以减小电流回路以及寄生电感。

RC 吸收电路，在 SW 上增加一个 RC 吸收电路，可较小 SW 上振铃来改善 EMI。

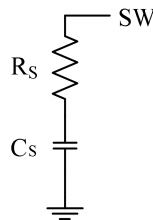


Figure 1 Placement of RC Snubber

The aim of the snubber resistor RS is to add sufficient damping to the parasitic resonant circuit. The value of RS depends on the desired damping factor and the parasitic inductor LP and parasitic capacitor CP of the circuit:

RC 吸收电路的选择如下:

$$R_S = \frac{1}{\xi} \times \sqrt{\frac{L_P}{C_P}}$$

Where  $\xi$  is the damping factor, normally can range from 0.5 to 1.

The value of LP and CP can be measured by:

- Measure the original ringing frequency  $f_{RING}$ ;
- Add some small capacitance from switch node to ground. Keep increasing capacitance until the ringing frequency is 50% of the original ringing frequency  $f_{RING}$ , and the capacitance is  $C_S$ ,  $C_P = 1/(3C_S)$ ;
- $$L_P = \frac{1}{C_P \times (2\pi \times f_{RING})^2}$$

To be simplified, a resistor of 1ohm ( $R_S$ ) and a capacitor of 2.2nF ( $C_S$ ) can be used. However, notice that larger  $C_S$  results in higher power loss.

#### (4) Radiation from Cables

A longer input or output cables result in poor radiation EMI. So, make the length of input cable and output cable very close to the real application.

一般来说, 建议使用 1  $\Omega$  电阻和 2.2nF 电容。  
请记住, 电容越大, 静态消耗越大。

请尽量选择较短的输入与输出走线来改下 EMI。

## 2.2 Layout Guidelines

1. Minimize the length and area of all traces connected to the SW pin, and always use a ground plane under the switching regulator to minimize interplane coupling.

2. The input capacitor needs to be close to inductor L, and GND pin in order to reduce the input supply ripple. The output capacitor needs to be close to DIODE and GND pin in order to reduce the output supply ripple.

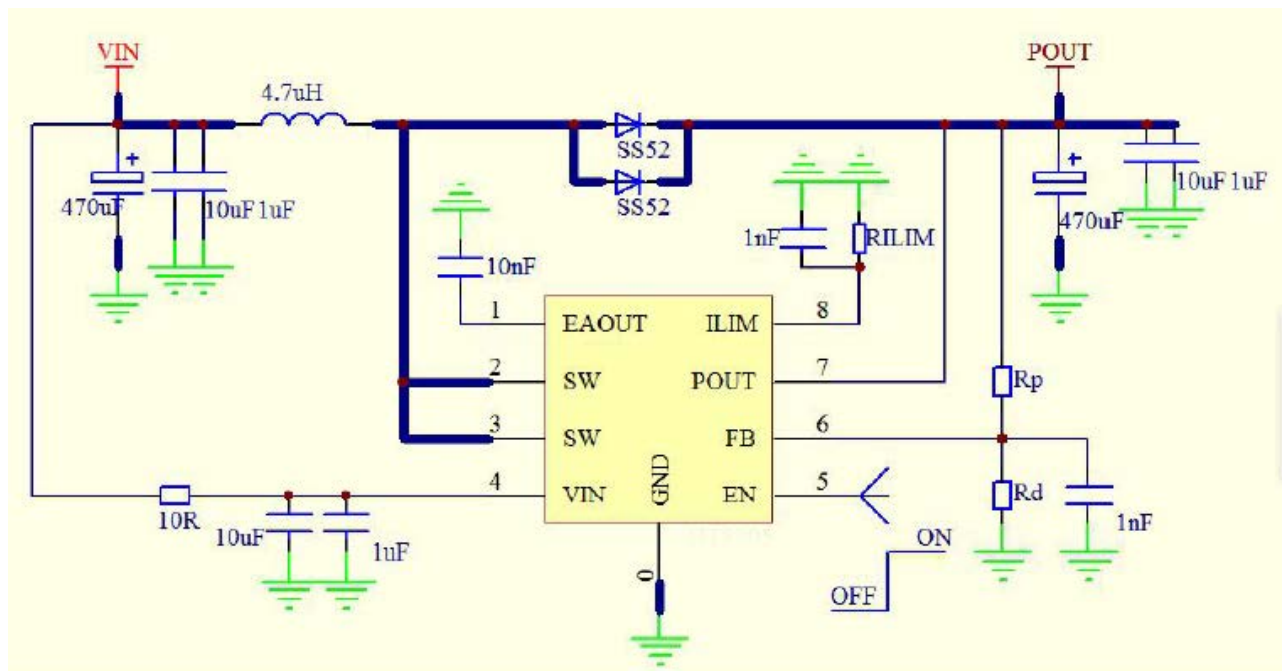
3. The layout should also be done with well consideration of the thermal as this is a high-power density device. A thermal pad that improves the thermal capabilities of the package should be soldered to the large ground plate, using thermal vias underneath the thermal pad.

减小 SW 走线路径和面积, 在 SW 底部铺一块完整的地, 来减小耦合。

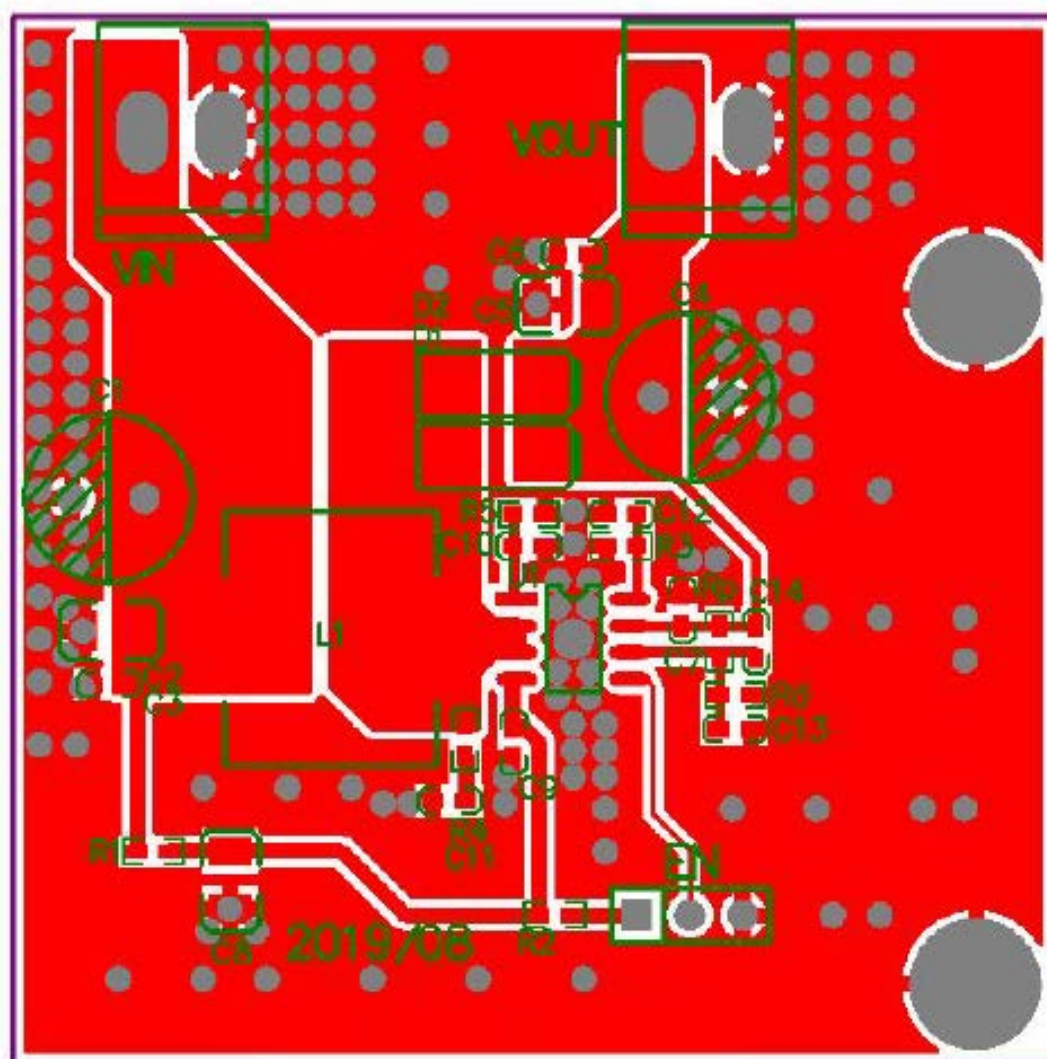
输入滤波电容尽量靠近电感和输入电源的地。输出滤波电容尽量靠近二极管整流输出。

PCB 布局同时考虑热耗散。芯片底部大的裸焊盘可有效改善散热, 同时增加过孔帮助散热。

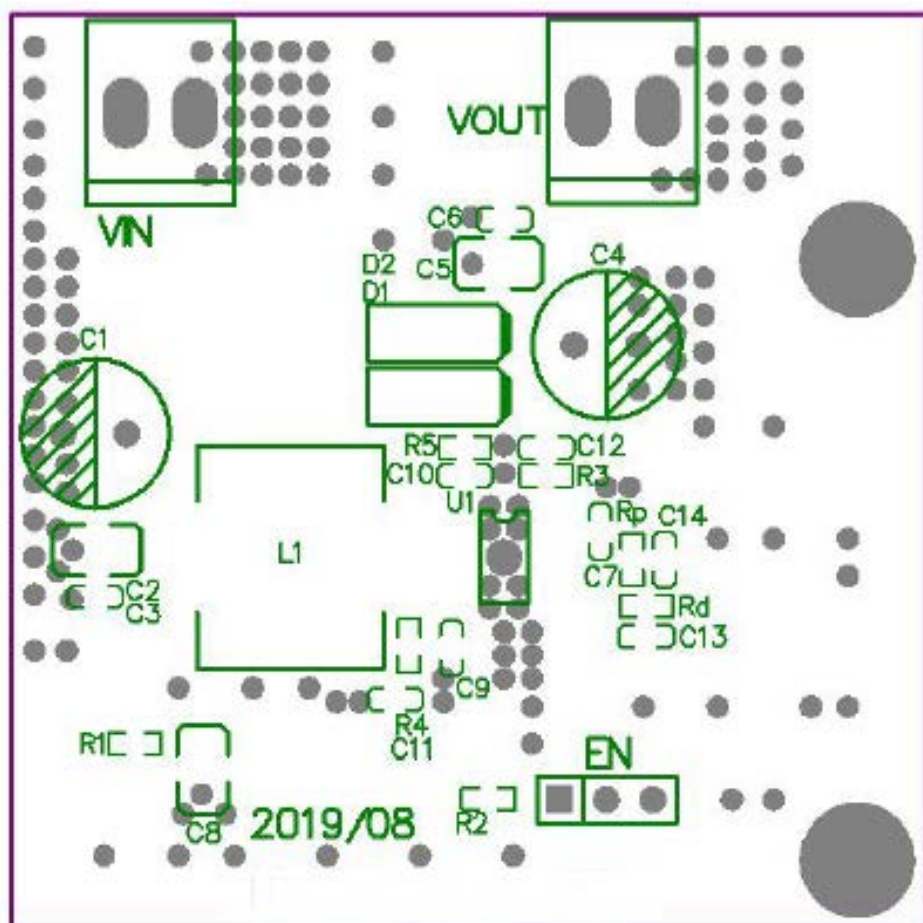
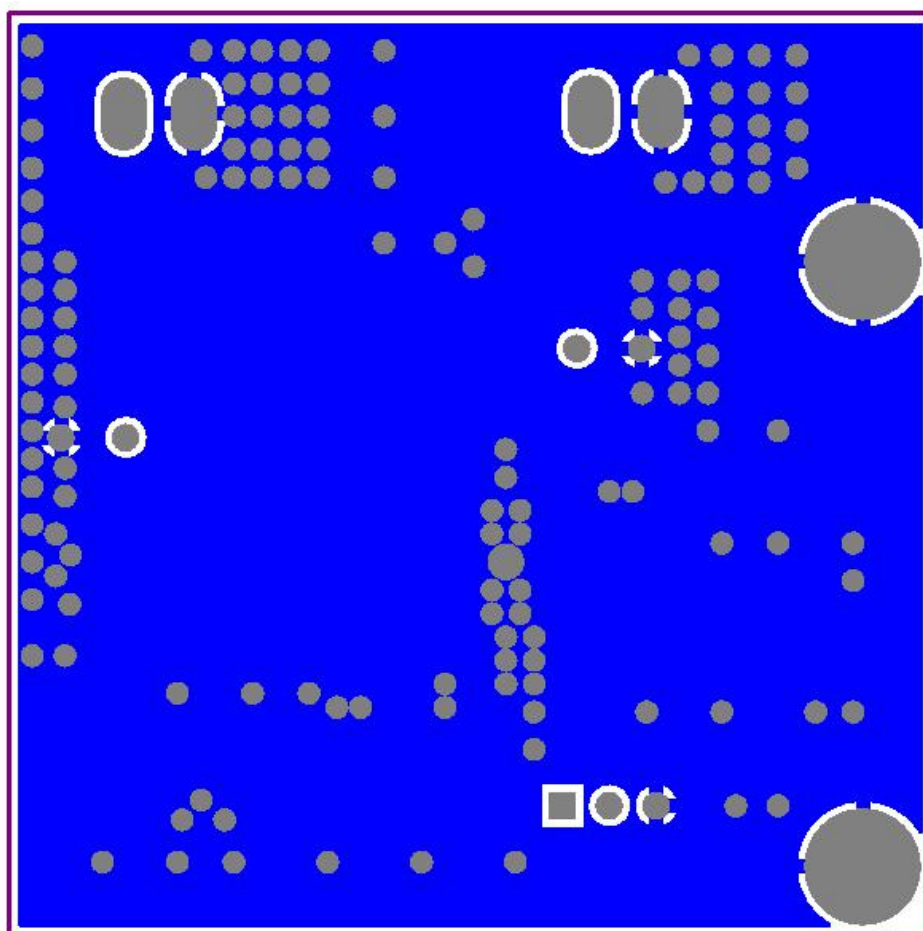
### 3. Typical Application Circuit



#### 4. PCB Layout

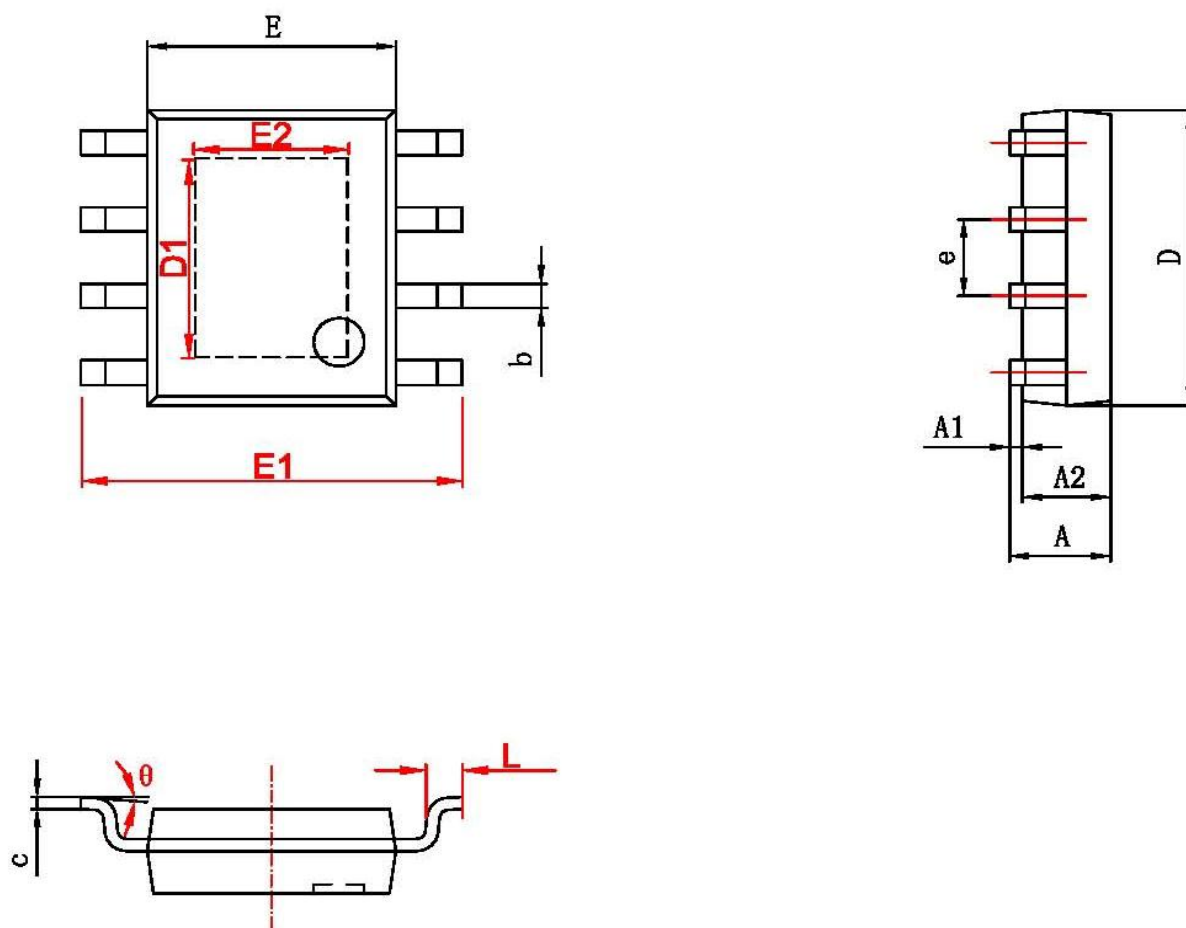






■ PACKAGE OUTLINE

**SOP8-PP(EXP PAD) PACKAGE OUTLINE DIMENSIONS**



字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.002	0.006
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°