

## PFM Step-Up DC-DC Controller IC

### HM5309

#### General Description

The HM5309 is a simple, compact PFM boost controller designed for applications where extremely low cost and small size are top priorities. The output voltage is fixed at 9V with 1% accuracy from an input voltage range of +2.7V to +6.5V.

Low current consumption of 32uA typical makes HM5309 ideal for battery-powered applications. The HM5309 is designed specifically to provide a simple application circuit and minimize the size and number of external components, making them ideal for consumer electronics applications.

The HM5309 adopts PFM operating mode, which provides excellent efficiency over a wide-range of input voltage and load currents. The on-time and off-time are tuned to permit optimization of external component size.

Chip enable input can make HM5309 into ultra-low-current shutdown mode.

The HM5309 is available in a space-saving 6-pin SOT23 package.

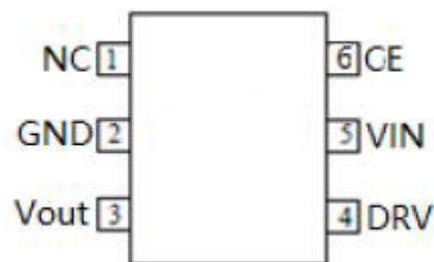
#### Applications

- Hand-held Devices
- LCD Bias
- Electric toys
- Charger

#### Features

- Operating voltage range: 2.7V to 6.5V
- Low Operating Current: 32uA@5V
- Fixed Output Voltage of 9V
- High Output voltage accuracy:  $\pm 1\%$
- No Feedback Resistor needed
- Output Voltage can be adjusted upwards with External Resistor
- Output Power: up to 40W
- High Efficiency: up to 94%
- Chip Enable Input
- Operating Temperature Range  
-40°C to +85°C
- Available in SOT23-6
- Pb-free, rohs-Compliant and Halogen-free

#### Pin Assignment



**Typical Application Circuit**

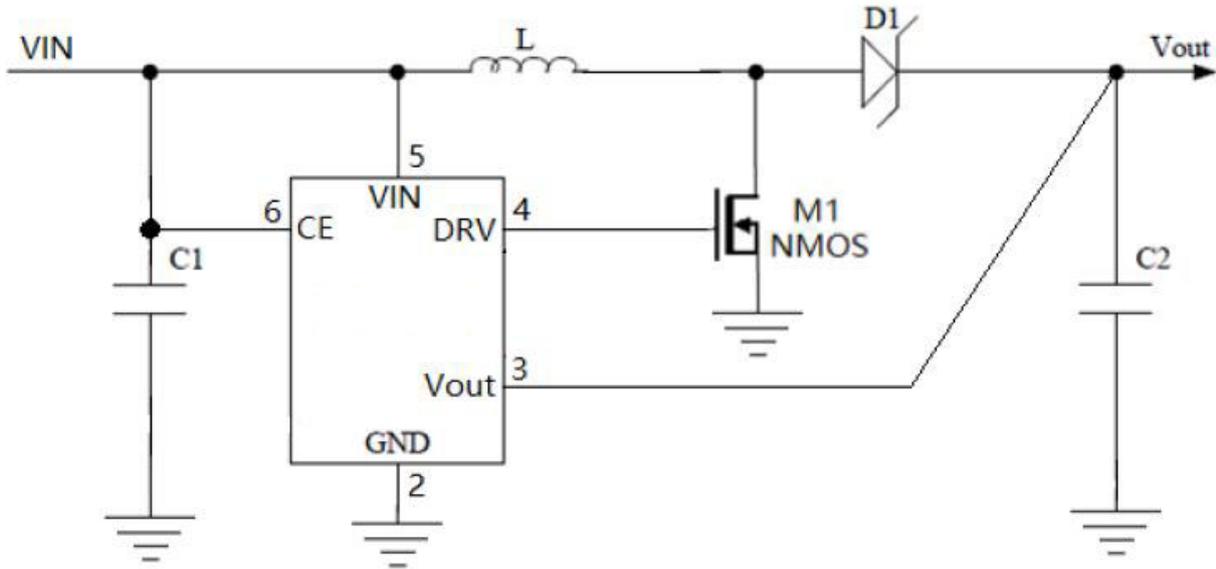


Figure 1 Typical Application Circuit (Fixed Output Voltage)

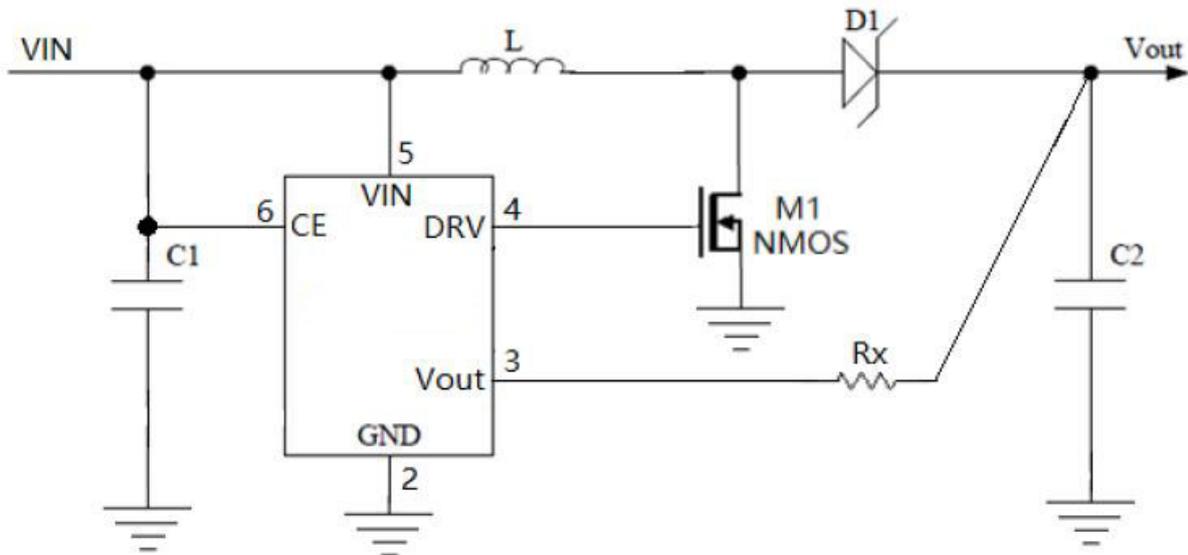


Figure 2 Typical Application Circuit (Adjust Output Voltage with Rx)

In the application circuit of Figure 2, the output voltage is determined by the following equation:

$$V_{out} = 9 + 10.7 \times 10^{-6} \times R_x \text{ (V)} \quad \text{(Typical)}$$

Where, Rx is the resistance in ohm

The resistance of Rx can not be over 20K ohm.

**Block Diagram**

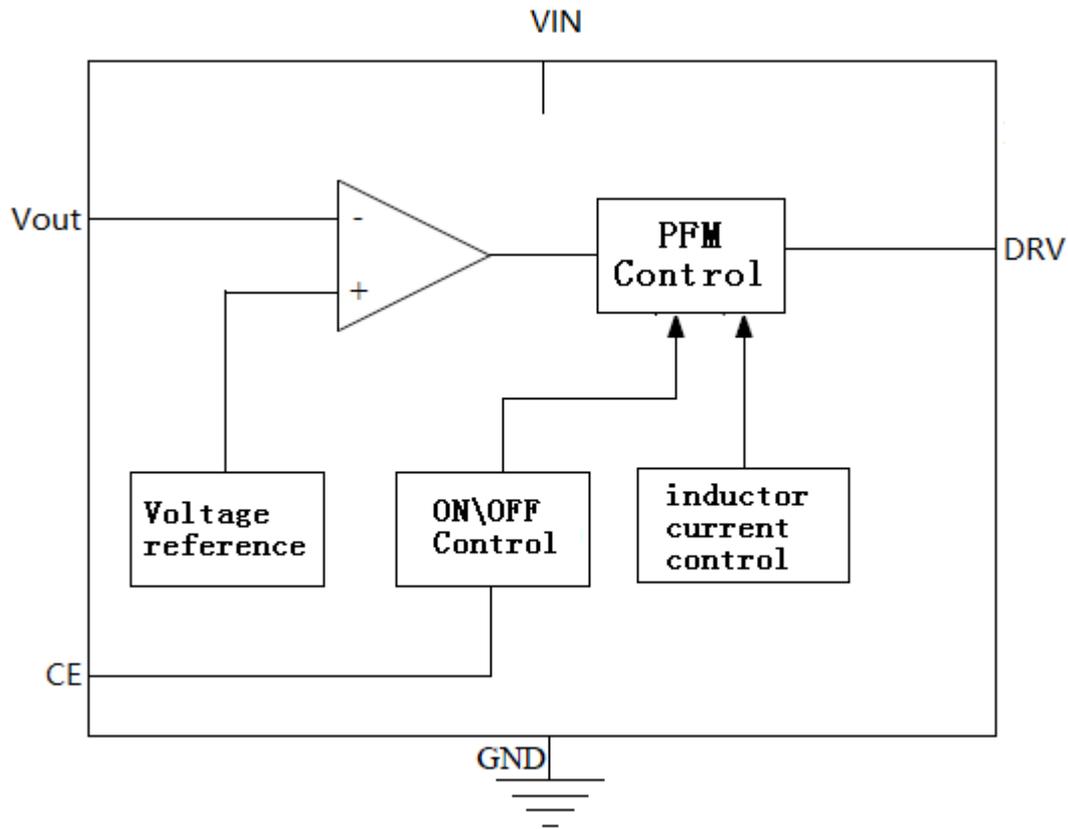


Figure 3 Block Diagram

**Ordering Information**

Part No.	Mark	Shipping	Operating Ambient Temperature
HM5309	HM5309	Tape and Reel, 3000/reel	-40°C to 85°C

**Pin Description**

Pin No.	Symbol	Description
1	NC	<b>No Connection.</b>
2	GND	<b>GND.</b> Ground, namely the negative terminal of input supply and output voltage.
3	Vout	<b>Positive Terminal of Output.</b> The output voltage is sensed through this pin.
4	DRV	<b>Gate Drive for external N-Channel MOSFET.</b> Connect DRV pin to the gate of external N-Channel MOSFET.
5	VIN	<b>Positive Terminal of Power Supply.</b> The internal circuits of HM5309 are powered from this pin.
6	CE	<b>Chip Enable Input.</b> A high input will put the HM5309 in the normal operating mode. Pulling the CE pin to low level will put the HM5309 into disable mode. The CE pin can be driven by TTL or CMOS logic level.

**ABSOLUTE MAXIMUM RATINGS**

Terminal Voltage (With respect to GND)	Thermal Resistance.....300°C /W
VIN.....-0.3V to +6.5V	Operating Temperature.....-40 to +85°C
Vout Voltage..... -0.3V to 18V	Maximum Junction Temperature..... 150°C
DRV and CE voltage.....-0.3V to VIN	Storage Temperature.....-65 to +150°C
Lead Temperature (soldering, 10s) .....+260°C	

*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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## Electrical Characteristics

(VIN = 3.7V, TA = -40°C to +85°C, Typical values are at TA = +25°C, unless otherwise noted)

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	VIN		2.7		6.5	V
Operating current	IVIN1	VOUT=9.5V	27	32	37	uA
Quiescent current	IVIN2	No loading		50		
Vout pin input current	IVout		10	11.7	13	uA
Output Voltage	Vout	Normal Operation	8.91	9.0	9.09	V
<b>DRV Pin</b>						
DRV Source Current				0.65		A
DRV Sink Current		VOUT=VIN-0.2V, VDRV=0.5×VIN		0.65		A
DRV Output High	VOH	IDRV=5mA	VIN-0.3			V
DRV Output Low	VOL	IDRV=-5mA			0.3	V
<b>CE Pin</b>						
Input Low Voltage	VCEL	CE voltage falls			0.7	V
Input High Voltage	VCEH	CE voltage rises	2.2			V
Input Current	ICEL	CE=GND, VIN=6V	-1			uA
	ICEH	CE=VIN=6V			1	

## Detailed Description

The HM5309 is a simple, compact PFM boost controller designed for DC-DC conversion topologies including step-up, SEPIC, and flyback applications. The device is designed specifically to provide a simple application circuit with a minimum of external components and is ideal for portable devices and other low-cost consumer electronics applications.

The output voltage of HM5309 is fixed at 9V with 1% accuracy. The low operating current of 32uA makes the HM5309 ideal for battery-powered applications.

The HM5309 uses a unique variable on-time and off-time architecture, which provides excellent efficiency over a wide range of input voltage and load currents.

The chip enable input can bring the chip into ultra-low current shutdown mode, in which current consumption is only 1uA maximum.

## Applications Information

### Input Voltage Range

The HM5309 functions well when the input voltage is between 2.7V to 6.5V. On-chip UVLO circuit will shut down the HM5309 if input voltage falls below UVLO threshold (2.65V Max.).

### Chip Enable/Disable

There is a chip enable input CE pin. When the voltage at CE pin is above 2.2V, HM5309 functions normally; When the voltage at CE pin is below 0.7V, HM5309 is turned off. In turn-off mode, the operating current is quite small (1uA Max.).

Do not apply a voltage between 0.7V and 2.2V on CE pin, otherwise HM5309 may be in uncertain state and draw more current.

### Adjust Output Voltage with External Resistor

The output voltage can be adjusted upwards with an external resistor, Rx as shown in Figure 2. In this case the output voltage is:

$$V_{out} = 9 + 10.7 \times 10^{-6} \times R_x \text{ (V)} \quad \text{(Typical)}$$

Where, Rx is the resistance in ohm

The resistance of Rx can not be over 20K ohm.

### The Selection of Input Bypass Capacitor

In most applications, a bypass capacitor at VIN is needed. An ceramic capacitor, placed in close proximity to VIN and GND pins, works well. The capacitance is chosen based on the input current, the power supply characteristics and cable length. The capacitor's breakdown voltage should be higher than the maximum input voltage.

Generally a capacitor between 4.7uF and 47uF works well, ceramic capacitor of X5R or X7R is highly recommended.

### The Selection of Output Capacitor

In a boost DC-DC converter, the output capacitor requirements are demanding due to the fact that the current waveform is pulsed. The choice of component is driven by the acceptable ripple voltage which is affected by the ESR, ESL and bulk capacitance.

The capacitance of the output capacitor should meet the requirement of the following formula:

$$C_{OUT} \geq 43 \times 10^{-6} \times I_{OMAX}$$

For many designs it is possible to choose a single capacitor type that satisfies both the ESR and bulk C requirements. In certain demanding applications, however, the ripple voltage can be improved significantly by connecting two or more types of capacitors in parallel. For example, using a low ESR ceramic capacitor can minimize the ESR step, while an electrolytic capacitor can be used to supply the required bulk C.

### The selection of Inductor

An inductor should be chosen that can carry the maximum input DC current which occurs at the minimum input voltage. The peak-to-peak ripple current is set by the inductance and a good starting point is to choose a ripple current of 30% of its maximum value:

$$\Delta I_L = 30\% \times \frac{V_{out} \times I_{omax}}{0.9 \times V_{IN}}$$

Where, Iomax is the maximum output current of the DC-DC converter.

The inductor value should meet the requirement of the following equation:

$$L \geq \frac{V_{IN} \times 1.5 \times 10^{-6}}{\Delta I_L}$$

### The Selection of N-channel MOSFET

The HM5309's gate driver is capable of sourcing 0.65A and sinking 0.65A of current. The N-channel MOSFET selection is based on the output voltage, inductor current and operating switching frequency. Choose an N-channel MOSFET that has a higher breakdown voltage than the output voltage, low Rds(ON), and low total gate charge(Qg) for better efficiency. MOSFET threshold voltage must be adequate if operated at the low end(2.7V) of the input-voltage operating range.

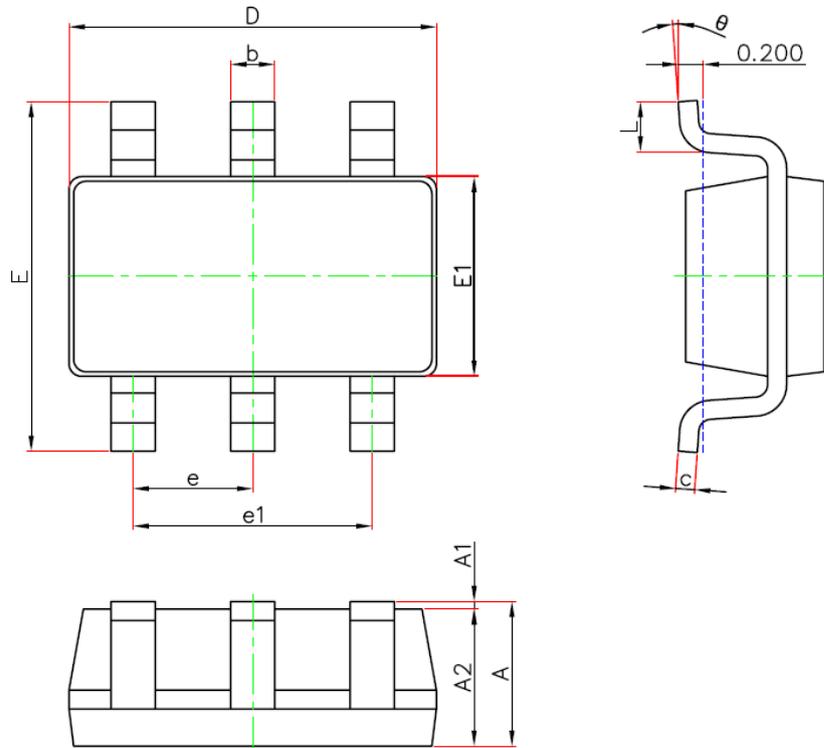
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## The Selection of Free-Wheeling Diode

The forward voltage of the freewheeling diode (D1 in Fig.1) should be as low as possible for better efficiency. A Schottky diode is a good choice as long as the breakdown voltage is high enough to withstand the output voltage. The forward current rating of the diode must be at least equal to the maximum output current.

**Package Information**

SOT-23-6L(12R) PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	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
E1	1.500	1.700	0.059	0.067
E	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°