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PFM Step-Up DC-DC Controller IC

CN5309

General Description

The CN5309 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 CN5309 ideal for battery-powered applications.

The CN5309 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 CN5309 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 CN5309 into ultra-low-current shutdown mode.

The CN5309 is available in a space-saving 6-pin SOT23 package.

Applications

- Hand-held Devices
- LCD Bias
- Medical Equipment
- Charger

Features

- Operating voltage range：2.7V to 6.5V
- Low Operating Current: 32uA@5V
- Fixed Output Voltage of 9V
- High Output voltage accuracy：±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
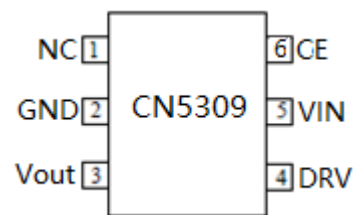
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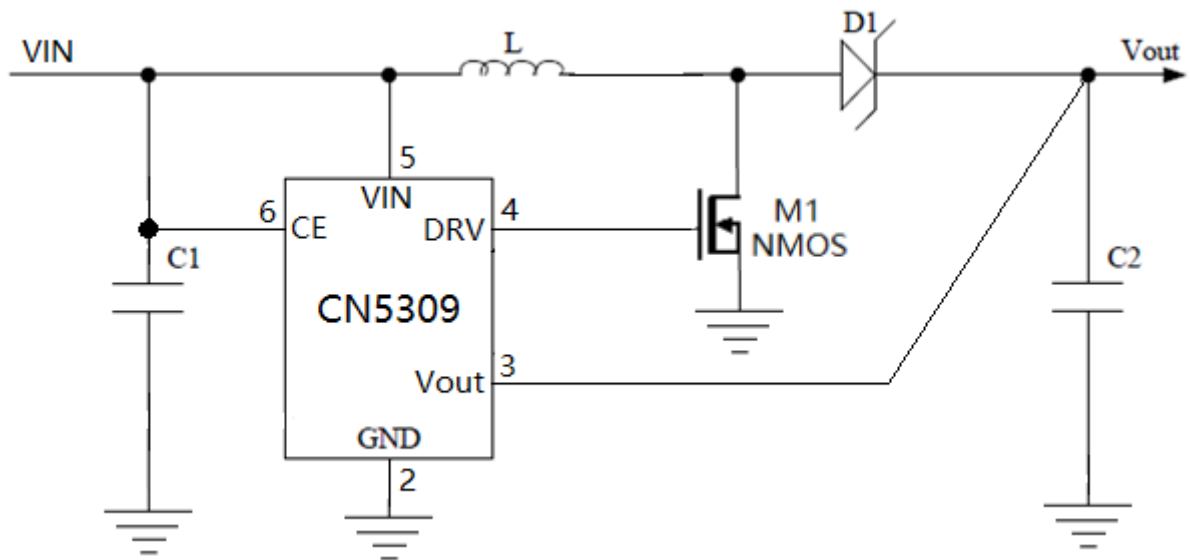**Typical Application Circuit**

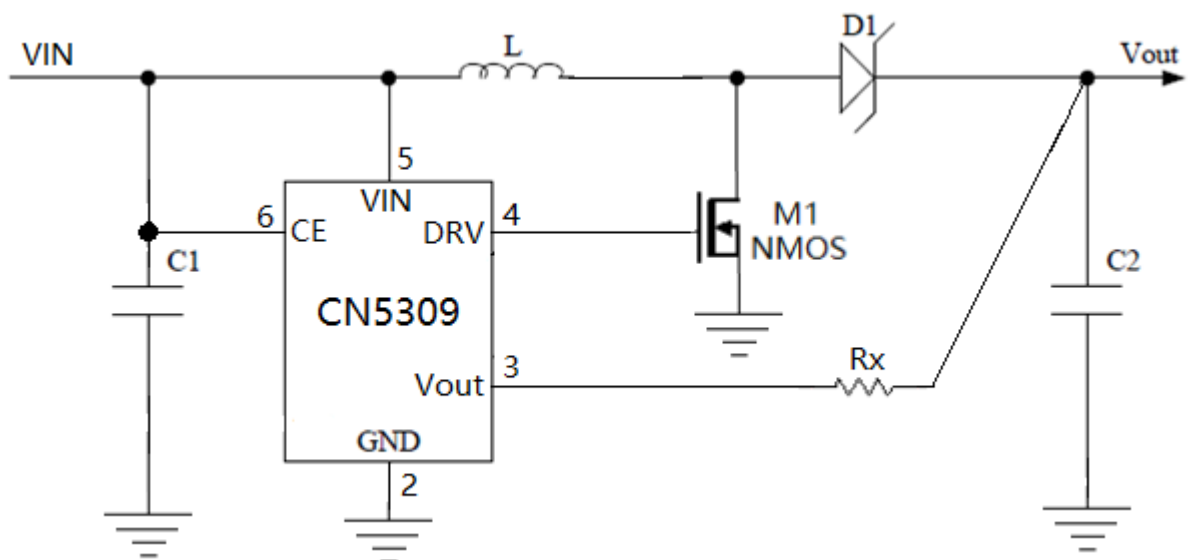Figure 1   Typical Application Circuit (Fixed Output Voltage)

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:

$$\text{Vout} = 9 + 10.7 \times 10^{-6} \times \text{Rx} \ (\text{V}) \qquad (\text{Typical})$$

Where, Rx is the resistance in ohm

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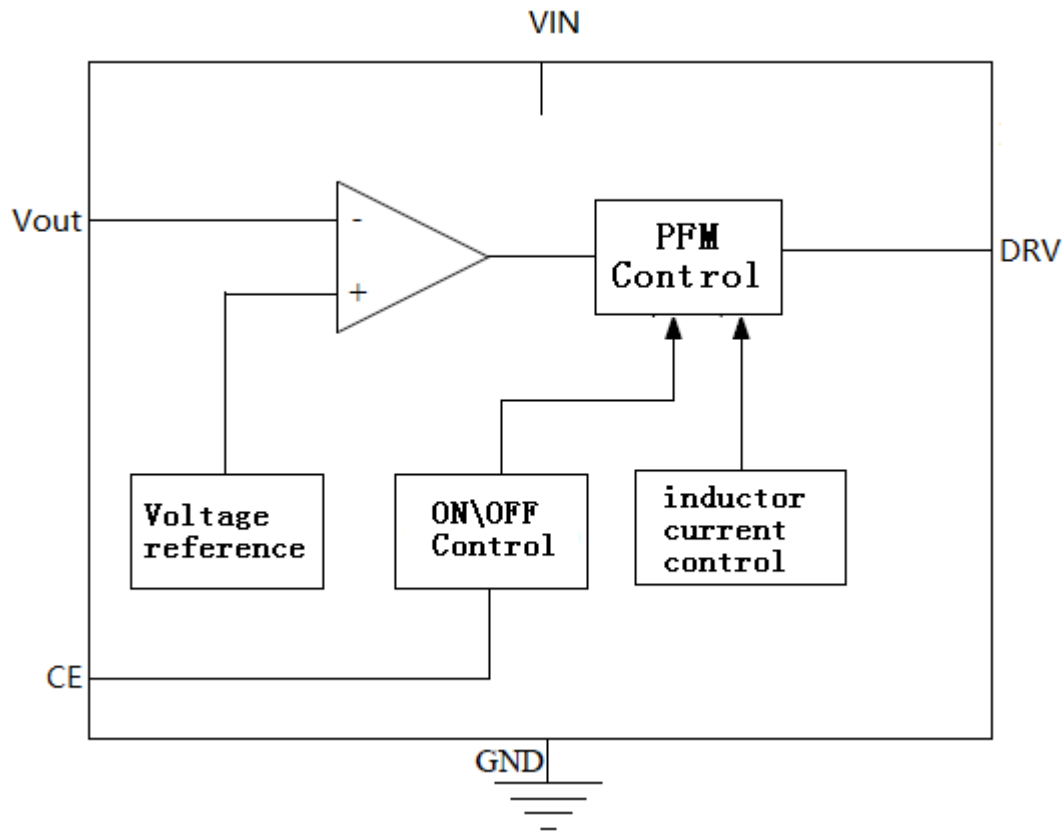
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Block Diagram

Figure 3   Block Diagram

Ordering Information

Part No.	Marking	Shipping	Operating Ambient Temperature
CN5309	5309	Tape and Reel, 3000/reel	－40℃ to 85℃

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Pin Description

Pin No.	Symbol	Description
1	NC	**No Connection.**
2	GND	**GND.** Ground, namely the negative terminal of input supply and output voltage.
3	Vout	**Positive Terminal of Output.** The output voltage is sensed through this pin.
4	DRV	**Gate Drive for external N-Channel MOSFET.** Connect DRV pin to the gate of external N-Channel MOSFET.
5	VIN	**Positive Terminal of Power Supply.** The internal circuits of CN5309 are powered from this pin.
6	CE	**Chip Enable Input.** A high input will put the CN5309 in the normal operating mode. Pulling the CE pin to low level will put the CN5309 into disable mode. The CE pin can be driven by TTL or CMOS logic level.

ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (With respect to GND)
VIN...............…..…………..........-0.3V to +6.5V
Vout Voltage……………..……－0.3V to 18V
DRV and CE voltage…………........-0.3V to VIN
Lead Temperature (soldering, 10s) .....+260°C

Thermal Resistance…………………..300°C/W
Operating Temperature…..……....-40 to +85°C
Maximum Junction Temperature............. 150°C
Storage Temperature........…........-65 to +150°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.

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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	I_{VIN1}	V_{OUT}=9.5V	27	32	37	uA
Quiescent current	I_{VIN2}	No loading		50		
Vout pin input current	I_{Vout}		10	11.7	13	uA
Output Voltage	V_{out}	Normal Operation	8.91	9.0	9.09	V
DRV Pin						
DRV Source Current				0.65		A
DRV Sink Current		V_{OUT}＝VIN−0.2V, V_{DRV}＝0.5×VIN		0.65		A
DRV Output High	V_{OH}	I_{DRV}＝5mA	VIN−0.3			V
DRV Output Low	V_{OL}	I_{DRV}＝−5mA			0.3	V
CE Pin						
Input Low Voltage	V_{CEL}	CE voltage falls			0.7	V
Input High Voltage	V_{CEH}	CE voltage rises	2.2			V
Input Current	I_{CEL}	CE=GND，VIN=6V	−1			uA
	I_{CEH}	CE=VIN=6V			1	

Detailed Description

The CN5309 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 CN5309 is fixed at 9V with 1% accuracy. The low operating current of 32uA makes the CN5309 ideal for battery-powered applications.

The CN5309 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 CN5309 functions well when the input voltage is between 2.7V to 6.5V. On-chip UVLO circuit will shut down the CN5309 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, CN5309 functions normally; When the voltage at CE pin is below 0.7V, CN5309 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 CN5309 may be in uncertain state and draw more current.

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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:

$$Vout = 9 + 10.7 \times 10^{-6} \times Rx \ (V) \qquad (Typical)$$

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 and be rounded up to the nearest standard value.

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

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:

$$\triangle I_L = 30\% \times \frac{Vout \times Iomax}{0.9 \times VIN}$$

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

The inductor value should meet the requirement of the following equation and be rounded down to the nearest standard value.

$$L \leqslant \frac{VIN \times 1.5 \times 10^{-6}}{\triangle I_L}$$

The Selection of N-channel MOSFET

The CN5309'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

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operated at the low end(2.7V) of the input-voltage operating range.

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.

PCB Considerations

A good PCB design is very important to efficiency and performance. When laying out the printed circuit board, the following considerations should be taken to ensure proper operation of the IC.

- Use double-layer PCB for better performance.
- The ground connections of output capacitor and the source of N-channel MOSFET need to feed into same copper that connects to the input capacitor ground before tying back into system ground. This copper should be as wide as possible, and back to system ground separately.
- To minimize radiation, the diode, inductor, N-channel MOSFET, the input bypass capacitor and the output bypass capacitor traces should be kept as short as possible and wide enough.

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Package Information

SOT-23-6L(12R) PACKAGE OUTLINE DIMENSIONS
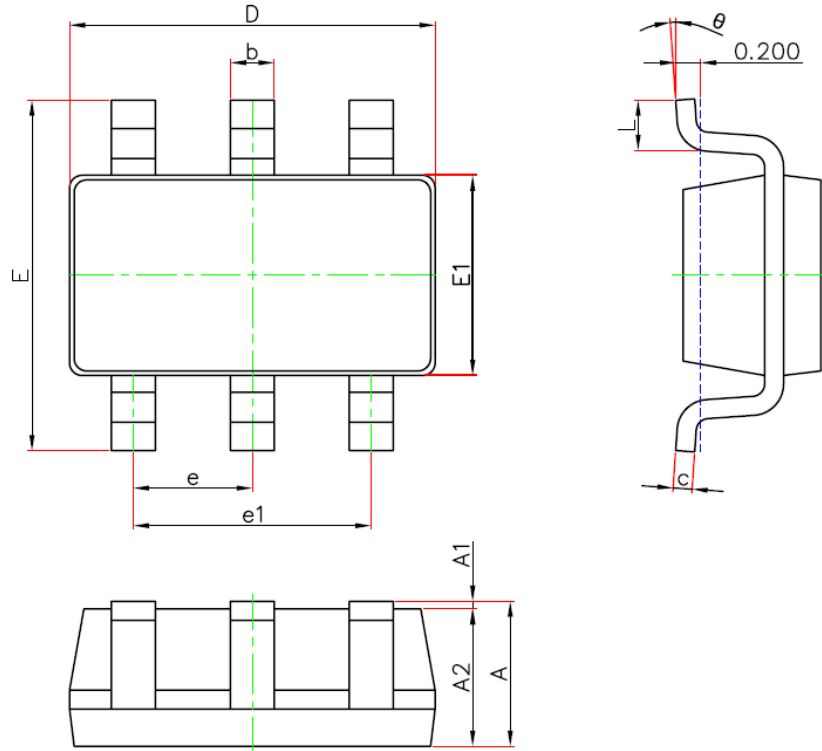
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.950(BSC)		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°

Consonance does not assume any responsibility for use of any circuitry described. Consonance reserves the right to change the circuitry and specifications without prior notice at any time.