



ZHEJIANG UNIU-NE Technology CO., LTD

浙江宇力微新能源科技有限公司



## U3507D Data Sheet

V 1.2

版权归浙江宇力微新能源科技有限公司

## 150V Input, Switching Current Limit Step-Down Converter

### General Description

The U3507D is a high voltage, step-down, switching regulator built-in MOSFET. It integrates a high-side, high-voltage, power MOSFET with a current limit of 10A(IPK) typically. The input ranges accommodates a variety of step-down applications, making it ideal for automotive, industry, and lighting applications. Hysteretic voltage-mode control is employed for very fast response. UNI-UI's proprietary feedback control scheme minimizes the number of required external components.

The switching frequency is 150KHz, allowing for small component size. Thermal shutdown and short-circuit protection (SCP) provide reliable and fault-tolerant operations. Low quiescent current allows the U3507D to be used in battery-powered applications.

The U3507D is available in a DFN5\*6-10 package with an exposed pad.

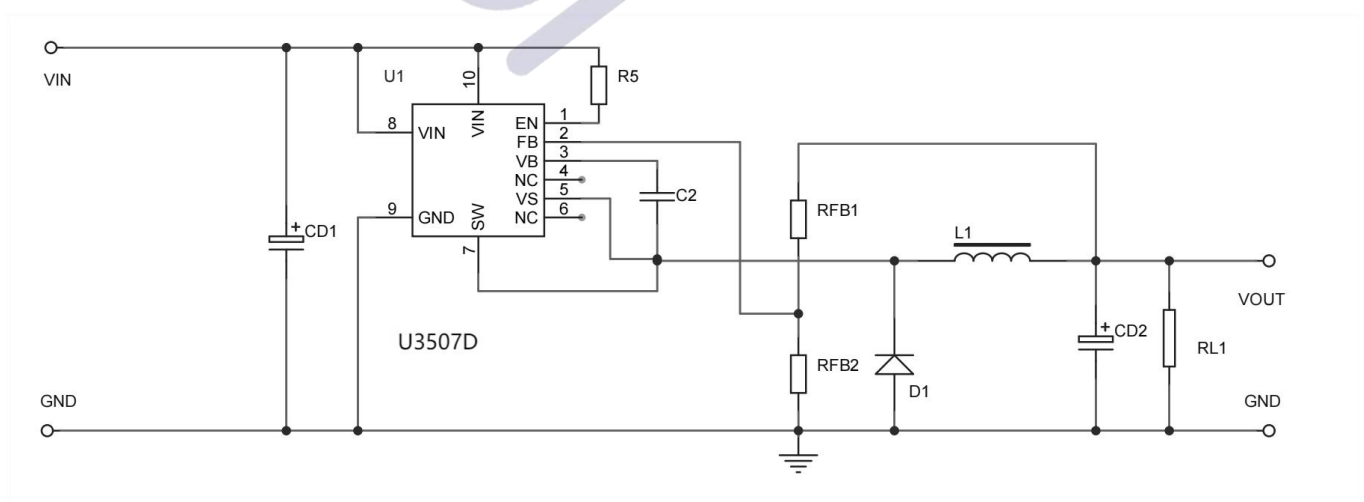
### Key Features

- Integrated 150V high voltage start circuit
- Built-In 150V/98 mΩ MOSFET
- Built-in Bootstrap Diode
- Hysteretic Control: No Compensation
- 150KHz Switching Frequency
- PWM Dimming Control Input for step-down Application
- Short-Circuit Protection (SCP) with Integrated High-Side MOSFET
- Low Quiescent Current
- Thermal Shutdown
- Available in a DFN5\*6-10 Package with an Exposed Pad

### Applications

- Scooters, E-Bike Control Power Supplies
- Solar Energy Systems
- Automotive System Power
- Industrial Power Supplies
- High-Power LED Drivers
- USB

### Simplified Application



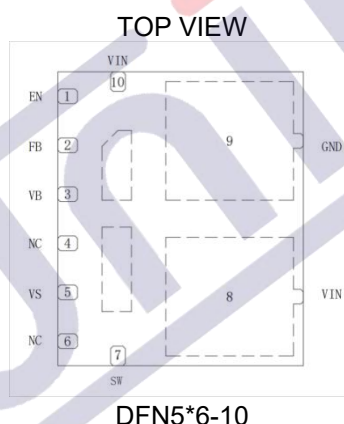
## ■ Ordering Information

Part Number	Package	Vo	VIN MAX	MOS IPK	Description
U3507D	DFN5*6-10	>2V	150V	10A	4000Pcs/Reel

## ■ Device Comparison Table

Part Number	Package	Switching Freq(Typ)	MOS	Special Function
U3501C	ESOP-8	150KHZ	60V/20A	LDO 5V
U3502C	ESOP-8	150KHZ	100V/15A	TE PIN
U3504C	ESOP-8	150KHZ	150V/1A	Default 5V output
U3504D	ESOP-8	150KHZ	150V/7A	Default 5V output
U3504E	ESOP-8	150KHZ	150V/10A	Default 5V output
U3507D	DFN5*6-10	150KHZ	150V/10A	/
U3506C	ESOP-8	150KHZ	200V/5A	/

## ■ Pin Description



## ■ Pin Functions

DFN5*6-10 Pin #	Name	Description
1	EN	En input. Pull EN below the specified threshold or leave EN floating to shut down the U3507D. Pull EN above the specified threshold to enable the U3507D.
2	FB	Feedback. FB is the input to the voltage hysteretic comparators.
3	VB	VB is the positive power supply for the internal, floating, high-side MOSFET driver. Connect a bypass capacitor between VB and SW.
5	VS	Switch source.Upper drive low potential
4、6	NC	NC
7	SW	Switching Pin.
9	GND	Ground.
8、10	VIN	Input supply. VIN supplies power toallofthe internal control circuitries.

## ■ Operation

### Hysteresis Current Control with Adaptive Threshold Adjustment

The U3507D operates in a hysteretic voltage-control mode to regulate the output voltage. FB is connected to the tap of a resistor divider, which determines the output voltage. The power MOSFET is turned on when the FB voltage ( $V_{FB}$ ) rises to  $F_{Bon}$  and remains on until  $V_{FB}$  rises to  $F_{Boff}$ . The power MOSFET is turned off when  $V_{FB}$  drops to  $F_{Boff}$  and remains off until  $V_{FB}$  falls to  $F_{Bon}$ . The two thresholds of  $F_{Bon}$  and  $F_{Boff}$  are adjusted adaptively to compensate for all the circuit delays, so the output voltage is regulated with an average 1.25V value at FB.

### Floating Driver and Bootstrap Charging

The floating power MOSFET driver is powered by an external bootstrap capacitor.

The bootstrap capacitor is charged and regulated to about 12V by the dedicated internal bootstrap regulator.

If the internal circuit does not have sufficient voltage, and the bootstrap capacitor is not sufficiently charged, extra external circuitry can be used to ensure that the bootstrap voltage is in the normal operating region. Refer to the External Bootstrap Diode section for more details.

### Fast charging Function for USB Applications

Because the FB reference of the U3507D is very flexible, it is recommended to use the U3507D for USB Fast charging Applications by connecting the current sense resistor between FB and GND.

### Thermal Shutdown

Thermal shutdown is implemented to prevent the chip from operating at exceedingly high temperatures. When the silicon die temperature is higher than its upper threshold, the entire chip shuts down. When the temperature is lower than its lower threshold, the chip is enabled again.

### Output Short Protection

The output voltage is well-regulated when  $V_{FB}$  is around 1.25V. If the output is pulled low in over-current protection (OCP) or is shorted to GND directly,  $V_{FB}$  is low, even though the power MOSFET is turned on. The U3507D regards the low  $V_{FB}$  as a failure. The power MOSFET shuts off if the failure time is longer than 10 $\mu$ s. The U3507D attempts operation again after a delay of about 300 $\mu$ s.

The power MOSFET current is also accurately sensed via a current sense MOSFET. If the current is over the current limit, the IC is shut down. This offers extra protection under output-short conditions.

## ■ Application Information

### Setting the Output Voltage

The output voltage ( $V_{OUT}$ ) is set by a resistor divider ( $R1$  and  $R2$ ) (see the Typical Application on page 1). To achieve good noise immunity and low power loss,  $R2$  is recommended to be in the range of 1k $\Omega$  to 50k $\Omega$ .  $R1$  can then be determined with Equation (1):

$$R1 = \frac{V_{OUT} - V_{FB}}{V_{FB}} \times R2 \quad (1)$$

Where  $V_{FB}$  is 1.25V, typically.

### Output Capacitor and Frequency Setting

The output capacitor ( $C_{OUT}$ ) is necessary for achieving a smooth output voltage. The ESR of the capacitor should be sufficiently large compared to the capacitance; otherwise, the system may behave in an unexpected way, and the current ripple may be very high.  $V_{FB}$  changes from 1.22V to 1.28V when the power MOSFET switches on. To charge the capacitor and generate 1.28V at FB, the system needs ESR and some inductor current. For example, for a 5V  $V_{OUT}$ , if the forward capacitor is 0.1 $\mu$ F, the suggested ESR range of the output capacitor is 100m $\Omega$  to 250m $\Omega$ . Tantalum or aluminum electrolytic capacitors with a small ceramic capacitor are recommended.

A forward capacitor across  $R1$  is recommended when the output capacitor is tantalum or aluminum electrolytic, which can set the desired frequency if the output capacitor and ESR cannot be changed. The forward capacitor can reduce the output voltage ripple.

In some application, simply a forward capacitor may not get proper frequency, then we can add a forward resistor in series with the forward capacitor or even more add a ceramic on the output.

### Selecting the Inductor

The inductor ( $L$ ) is required to convert the switching voltage to a smooth current to the load. Although the output current is low, it is recommended that the inductor current be continuous in each switching period to prevent reaching the current limit. Calculate the inductor value with Equation (2):

$$L = \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{F_{SW} \times I_{OUT} \times V_{IN} \times K} \quad (2)$$

Where  $K$  is a coefficient of about 0.15 ~ 0.85

### Output Rectifier Diode

The output rectifier diode supplies current to the inductor when the high-side switch is off. To reduce losses due to the diode forward voltage and recovery times, use a Schottky diode. The average current through the diode can be approximated with Equation (3):

$$I_D = I_{OUT} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \quad (3)$$

Choose a diode with a maximum reverse voltage rating greater than the maximum input voltage and a current rating is greater than the average diode current.

### Peak current regulation

Current estimation formula(4)

$$I_{PK} = \frac{V_{IPK}}{R_{CS}} = \frac{0.23V}{R_{CS}} \quad (4)$$

Note: The voltage calculation will be affected by the freewheeling diode, and the actual debugging shall prevail.

### Input Capacitor (C<sub>IN</sub>)

The input current to the step-down converter is discontinuous and therefore requires a capacitor to supply AC current to the step-down converter while maintaining the DC input voltage. Use low ESR capacitors for the best performance, especially under high switching frequency applications. The RMS current through the input capacitor can be calculated with Equation (5):

$$I_{IN\_AC} = I_{OUT} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)} \quad (5)$$

With low ESR capacitors, the input voltage ripple can be estimated with Equation (6):

$$\Delta V_{IN} = \frac{I_{OUT} \times V_{OUT}}{F_{SW} \times C_{IN} \times V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \quad (6)$$

Choose an input capacitor with enough RMS current rating and enough capacitance for small input voltage ripples.

When electrolytic or tantalum capacitors are applied, a small, high-quality ceramic capacitor (i.e.: 0.1μF) should be placed as close to the IC as possible.

### External Bootstrap Diode

An external bootstrap diode may enhance the efficiency of the converter (see Figure 2).

The bootstrap diode can be a low-cost one, Optimize circuit structure, save cost, and reduce error rate for peripheral circuit configuration.

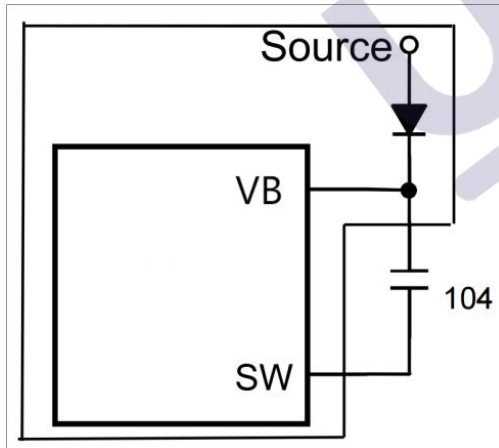


Figure 2: External Bootstrap Diode

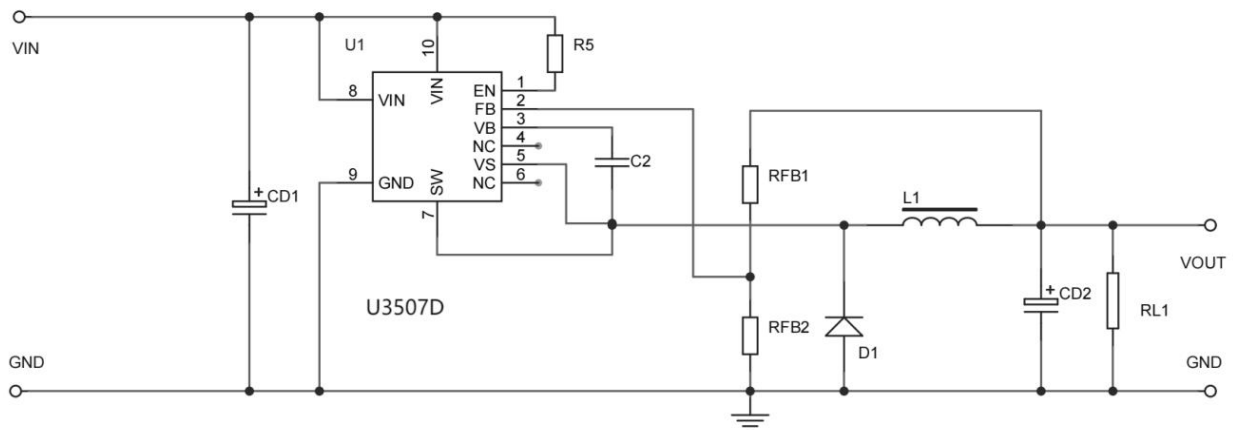
### PCB Layout Guidelines

Efficient PCB layout is critical for stable operation. For best results, follow the guidelines below.

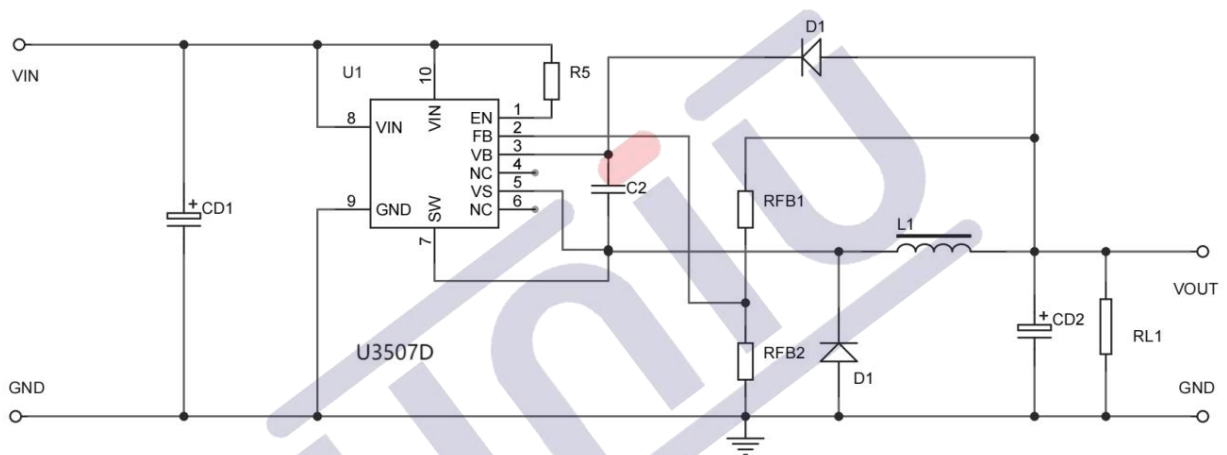
1. Place the input decoupling capacitor, catch diode, and the U3507D (VIN, SW, and PGND) as close to each other as possible.
2. Keep the power traces very short and fairly wide, especially for the SW node. This can help greatly reduce voltage spikes on the SW node and lower the EMI noise level.
3. Run the feedback trace as far from the inductor and noisy power traces (like the SW node) as possible.
4. Place thermal vias with 15mil barrel diameter and 40mil pitch (distance between the centers) under the exposed pad to improve thermal conduction.

## Typical Application Circuit

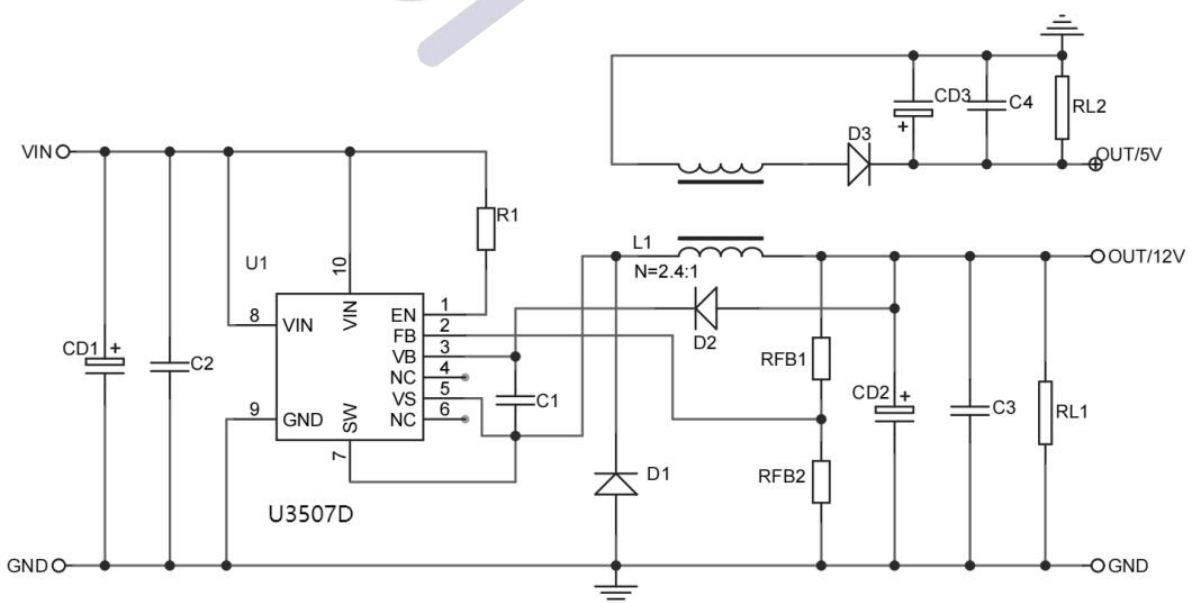
APP1:  $V_{OUT} < 10V$



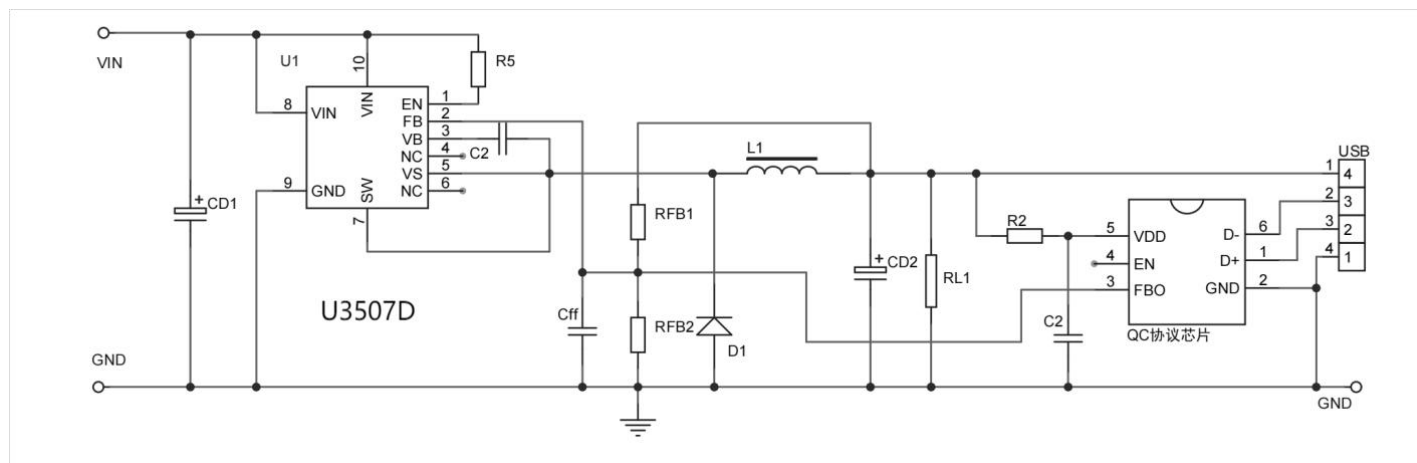
APP2:  $V_{OUT} > 10V$



APP3:  $V_{OUT} 12V/V_{OUT} 5V$



## APP4: QC2.0/QC3.0



Note: Typical application circuit and parameters for reference, the actual application circuit parameters please set on the basis of measurement, mass production please communicate with the original factory, other unknown please contact our engineers.



1、版本记录

Date	Rev.	Description
2023/9/25	1.0	First Release
2023/12/30	1.1	Add IPK Calculation Formula
2024/12/03	1.2	Add a Feature Comparison Table and Modify Some Parameters

2、联系我们

浙江宇力微新能源科技有限公司  
总部地址：绍兴市越城区斗门街道袍渚路25号中节能科创园45幢4/5楼  
电话：0575-85087896（研发部）  
传真：0575-88125157  
E-mail:htw@uni-semic.com

无锡地址：无锡市新吴区纺城大道299号深港都会广场9-1401  
电话:0510-85297939  
E-mail:zh@uni-semic.com

深圳地址：深圳市宝安区航城街道三围社区南昌路上合工业园B2栋501  
电话：0755-84510976  
E-mail:htw@uni-semic.com

**重要注意事项：**

- 1、绍兴宇力半导体有限公司和浙江宇力微新能源科技有限公司，简称“宇力”，宇力保留说明书、应用指导书等的更改权，不另行通知。客户在采购时应获取我司最新版本资料，并验证相关信息是否最新和完整。产品使用前请仔细阅读本说明书、应用指导书等相关资料和其中的注意事项。
- 2、本产品属于消费类电子产品，宇力对宇力产品的任何特定用途的适用性不做任何保证。产品也不得应用在被任何适用法律或法规禁止制造、使用或销售的任何设备或系统中。如果宇力的产品被用禁止产品或系统中，此类应用产品的全部风险由客户自行承担，宇力对此不承担任何责任。
- 3、本文件和产品的应用指导书等相关资料所描述的产品的应用仅用于说明参考，本文件提供的参数在不同应用中可能而且确实会有所不同，实际性能可能会随之变化。使用时需要进一步评估、测试和验证。宇力对产品应用或客户产品设计等方面的任何协助不承担责任。
- 4、客户须在产品的有效存储期内使用完毕，客户如对宇力产品的有效存储期有任何疑问的，请即时联系宇力对接销售人员或宇力客户服务支持，对于超过存储期使用的，宇力不承担任何责任。
- 5、未经宇力事先书面同意，不得对文件和产品进行拆解、更改、修改或者复制。
- 6、购买产品时请认清宇力商标和物料名称，如有疑问请联系宇力。第三方购买请注意是否为宇力授权的资质，同时在采购之前联系我司，以确认产品为宇力原厂正品。
- 7、客户在应用和使用产品时请务必遵守相关法规，包括但不限于贸易管制法规等。本产品为民用电子产品，请勿应用于非民用领域。
- 8、产品提升永无止境，我公司将竭诚为客户提供更优秀的产品！