Application Guide for Non-Isolated Power Modules

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Room 1318, Building 1, Hengzhao Plaza, No. 3 Shuixi Fuye 1st Street, Huangpu District, Guangzhou City, Guangdong Province, China

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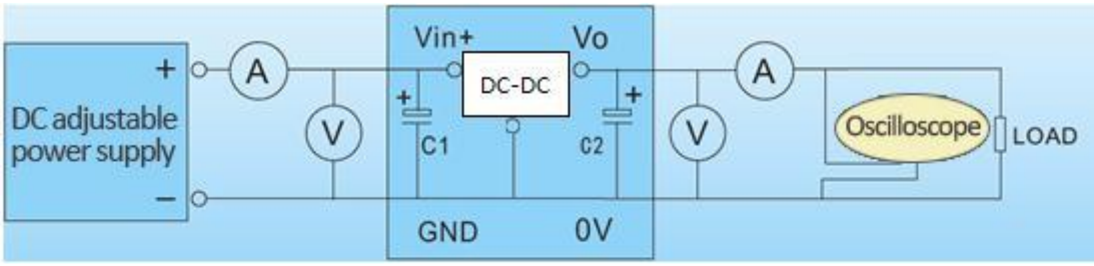
1. Power Module Testing

After selecting the appropriate power module, it is important to test its electrical performance in actual applications. The module must pass strict testing before being officially used. Below are the general testing methods for power modules.

1.1 Power Module Test Circuits and Methods

The power module uses the standard Kelvin test method, as shown in Figure Test conditions: Room temperature Ta=25°C, humidity <75%.



Test Instruments: DC adjustable power supply with a sufficient input voltage range, ammeter A (accuracy of 0.001A), voltmeter V (accuracy of 0.001V), electronic load, and oscilloscope.

Notes:

Connections: Minimize line loss, preferably using multi-strand copper wire with a diameter of 1mm to avoid excessive voltage drop. When the load current is large, shorten the distance between the output pins and the load, and increase the cross-sectional area of the connecting wires to reduce excessive voltage drop.

Measurement: It is recommended to use a single-channel probe to directly measure the output to avoid measurement errors caused by common ground and external interference.
Testing: Ensure that the current limit of the power supply is set reasonably. To ensure accurate voltage and ripple, the output capacitive load should not exceed the value specified in the technical manual.
Technical Parameters: Refer to the corresponding technical manual for specific parameters.

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1.2 Basic Performance Testing of Power Modules

After connecting the power module, performance testing and evaluation can be conducted to confirm whether the performance parameters meet the standards.

Output Voltage Accuracy:

$$\text{Output Voltage Accuracy} = \frac{V_{out} - V_{outnom}}{V_{outnom}} \times 100\%$$

if $V_{outnom} = 12V$ and the measured $V_{out} = 12.039V$,

Example: For module K7812-500R3, the output voltage accuracy is 0.325%.

Line Regulation:

$$\text{Line Regulation} = \frac{V_{outl} - V_{outmon}}{V_{outmon}} \times 100\%$$

if $V_{outl} = 5.00V$ and $V_{outmon} = 5.01V$,

Example: For module K7805-500R3, the line regulation is -0.2%.

Load Regulation:

$$\eta = \frac{I_{out} \times V_{out}}{I_{in} \times V_{in}} \times 100\%$$

if $V_{in} = 24V$, $V_{out} = 4.951V$, and $I_{in} = 113.7mA$,

Example: For module K7805-500R3,the efficiency is 90.72%.

Ripple and Noise:

Ripple and noise are periodic and random AC components superimposed on the DC output, affecting output accuracy. Peak-to-peak values are generally used for measurement.Test Method: Set the oscilloscope bandwidth to 20MHz to prevent high-frequency noise interference. Use the parallel line test method.

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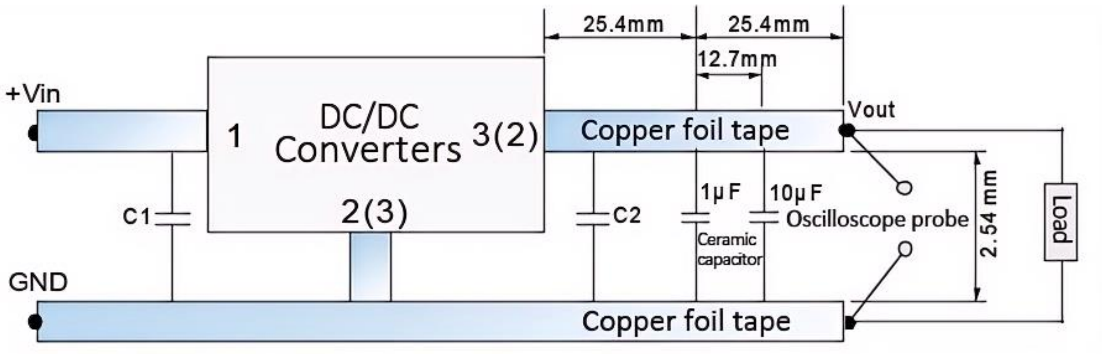
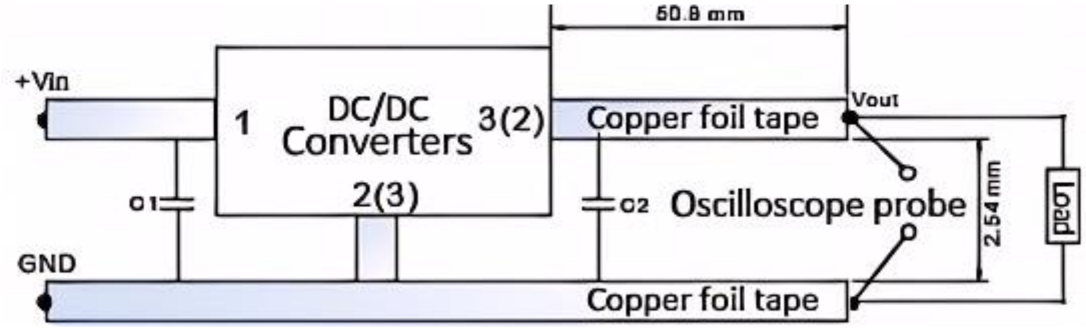


Dynamic Load:

Dynamic response measures the overshoot/undershoot magnitude and response time when the load changes suddenly. Common test methods include using an electronic load to simulate load changes. The specific measurement method involves using an electronic load to simulate sudden changes in the power load. The load is set to 25%-50%-25% and 50%-75%-50% of the rated load
current.



Startup Time:

Startup time is the delay between input power-on and output reaching the target voltage. It is generally measured under full load conditions.

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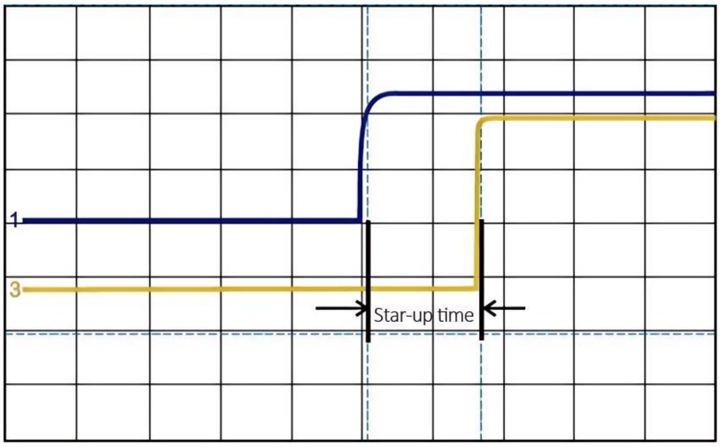


Module Case Temperature Rise Test:

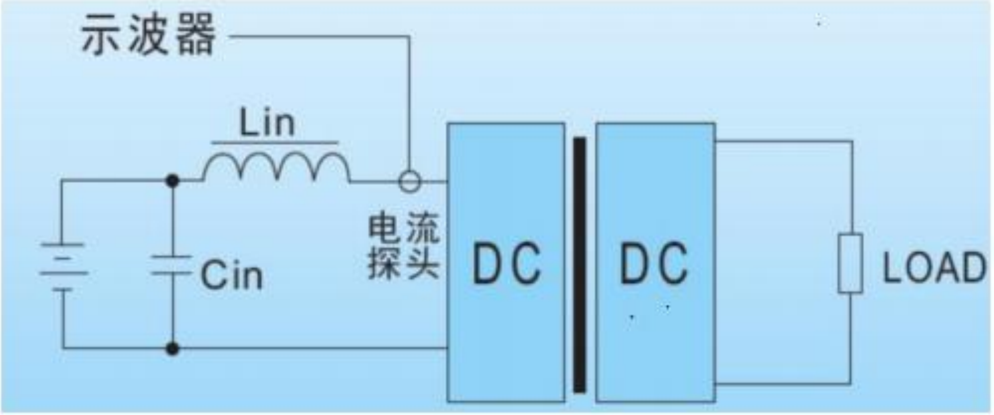
Measure the temperature rise of the module case using a thermal imager or thermocouple. The temperature rise is calculated as following; where T_C is the case temperature and Ta is the ambient temperature.

$$\Delta T = T_c - T_a,$$

Note: Due to differences in power, casing material, and internal design, the casing temperature of different modules can vary significantly. For enclosed usage environments where natural ventilation is absent, it is recommended to keep the power module as far away as possible from temperature-sensitive components or to isolate them into two separate spaces.

Reflected Ripple Current Test:

Use an oscilloscope with a current probe to measure the reflected ripple current at the input.



2. Power Module Applications

2.1 Typical Applications

The K78 series modules are typically used in BUCK step-down circuits, with recommended external capacitors of 10μF.

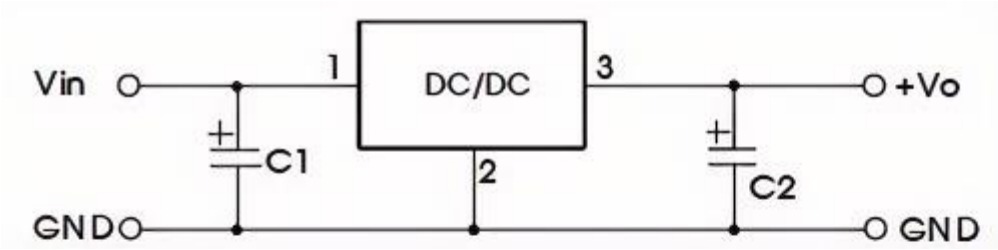


Diagram 2-1 Typical application

2.2 Negative Output Applications

Some non-isolated products support negative output. By changing the wiring of pin 2 and pin 3, negative voltage output can be achieved.

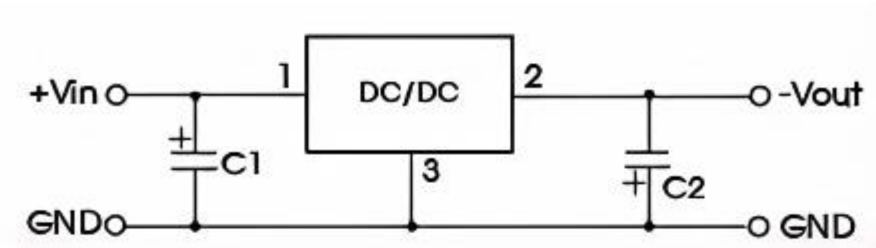


Diagram 2-2 Negative output application

2.3 Positive and Negative Output Applications

When positive and negative outputs are combined, two modules can be used to achieve positive and negative voltage output.

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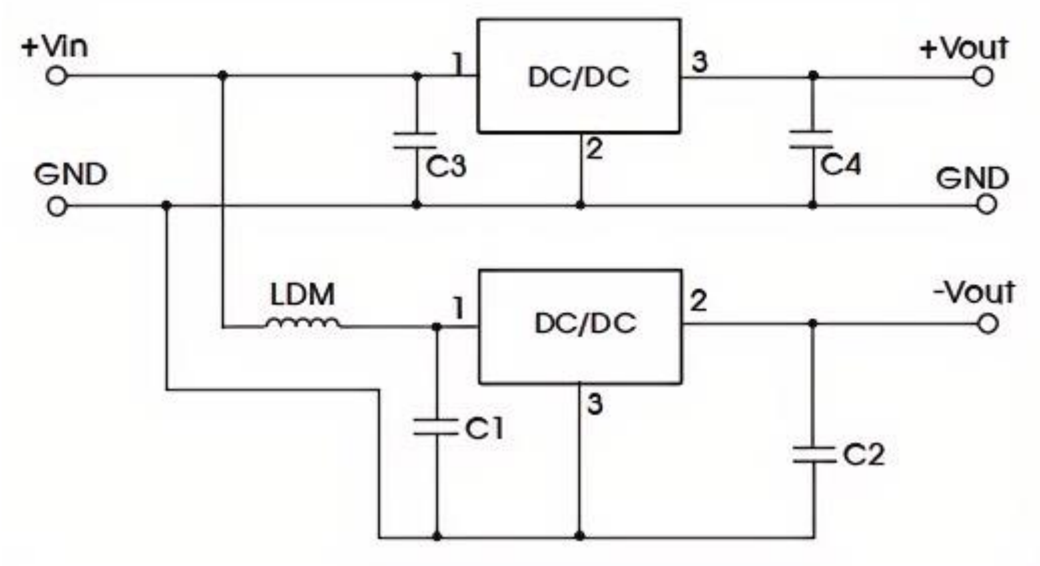
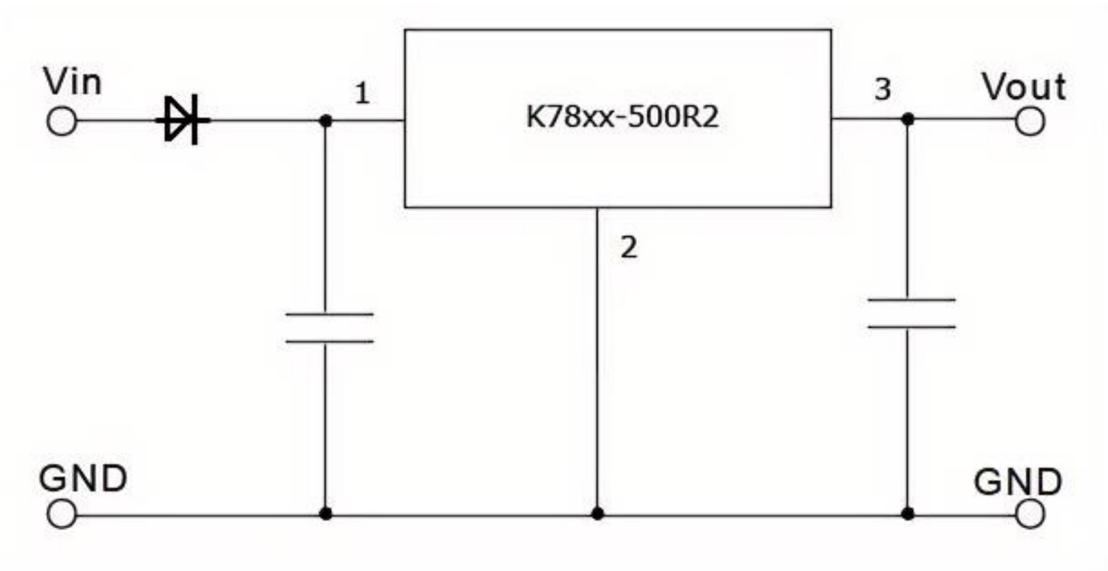


2.4 Input Reverse Polarity Protection

If the input polarity is uncertain, it is recommended to add input reverse polarity protection, such as a diode in series at the input.



2.5 Input and Output Filter Circuits

In circuits sensitive to ripple and noise, filters can be added at the input and output of the module to reduce ripple and noise.

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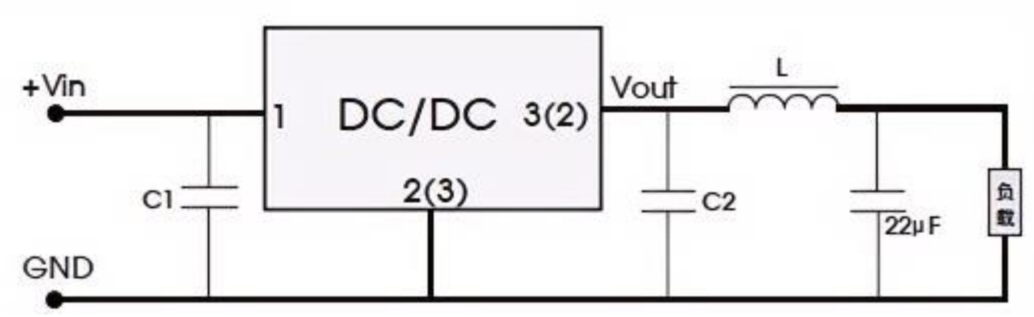

Capacitors C1 and C2 should be selected according to the recommended parameters in the specification sheet, and the recommended value for inductor L is 10μH to 47μH.

2.6 Electromagnetic Interference and Compatibility

Electromagnetic Compatibility (EMC) refers to the ability of electronic devices and power supplies to operate reliably in an electromagnetic interference environment while limiting their own electromagnetic interference and avoiding interference with other surrounding electronic devices. Improving EMC can be approached from the following three aspects:

- **Reduce the radiation from electromagnetic interference sources**.
- **Shield the propagation paths of electromagnetic interference**.
- **Enhance the anti-electromagnetic interference capability of electronic devices and power supplies**.

Based on the propagation method, electromagnetic interference is divided into the following two types:

Type 1: Conducted Interference
Conducted interference refers to noise generated by the system that enters the DC input lines or signal lines, with a frequency range of 150 kHz to 30MHz. Conducted interference can be both common-mode and differential-mode. LC networks are commonly used to suppress conducted interference.

Type 2: Radiated Interference
Radiated interference propagates directly in the form of electromagnetic waves, acting as a transmitting antenna, with a frequency range of 30 MHz to 1 GHz. Radiated interference can be suppressed through metal shielding.

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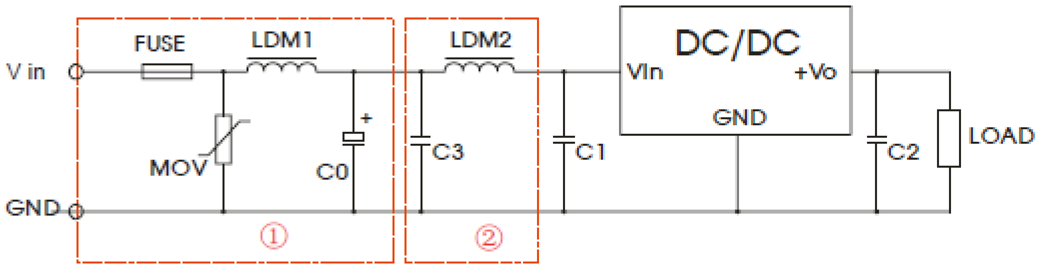
Recommended EMC Circuit

Since DC/DC modules are secondary power sources, external protection circuits are generally added to the DC/DC ports or signal ports to ensure the entire system passes EMS tests. The protection circuit for the power section is shown in the figure below:



Part ① is used for the peripheral recommended circuit diagram for EMS testing;

Part ② is used for EMI filtering and can be selected based on requirements. For specific peripheral recommended circuit parameters, please refer to the technical manual of the corresponding product.

2.7 Capacitive Load

Most switching power modules have a maximum capacitive load requirement. Excessive capacitance may cause instability or startup failure.

3. Frequently Asked Questions

3.1 Can the Module Support Hot-Swapping?

Hot-swapping is not allowed during module operation, as it can generate large current and voltage spikes that may damage the module.

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3.2 Can the Module Operate Under No-Load or Light Load Conditions?

The module can operate under no-load or light load conditions, but efficiency may be lower, and some performance indicators may not meet the technical manual requirements. It is recommended to operate the module at 30-80% load.

3.3 Possible Causes of Module Startup Failure

Excessive capacitive load exceeding the maximum specified in the technical manual. Insufficient power from the power supply during startup. Inductive load causing high startup current. Input voltage below the module's operating voltage.

3.4 Causes of Module Damage

Input power polarity reversed. Input voltage exceeds the maximum specified in the technical manual. Voltage spikes from hot-swapping or input power overshoot. Severe overload. Poor common ground connection (especially under heavy load).

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