DC-DC Power Modules Application Guide

Generalization: The article is to present and analyze the following topics: typical applications of DC-DC power modules, voltage polarity conversion, external filter capacitor connection, over-load and short-circuit protection circuits, parallel and series connection,etc. The proper using methods prolong the converters' service life and avoid the defects caused by interference, superheat, self-activation, abnormal activation,etc and other irreparable damage.

Key words: DC-DC DC/DC filter capacitor module power power modules isolated power supply power distribution positive power over-load and short-circuit protection

I. General Applications

SUNYAUN DC-DC Converter can operate well in any conventional circuits without any external components. It realize the isolation between input and output, and provides one or more sets of isolated output power supply, or forms various voltage or polarity power supply circuits (see Fig. 1).

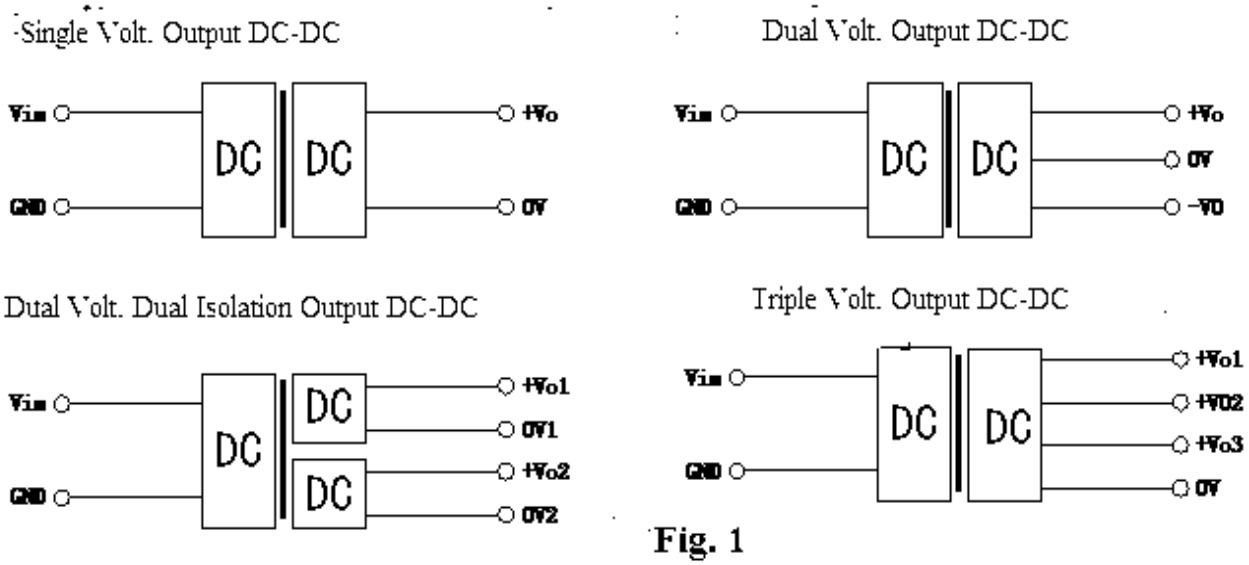
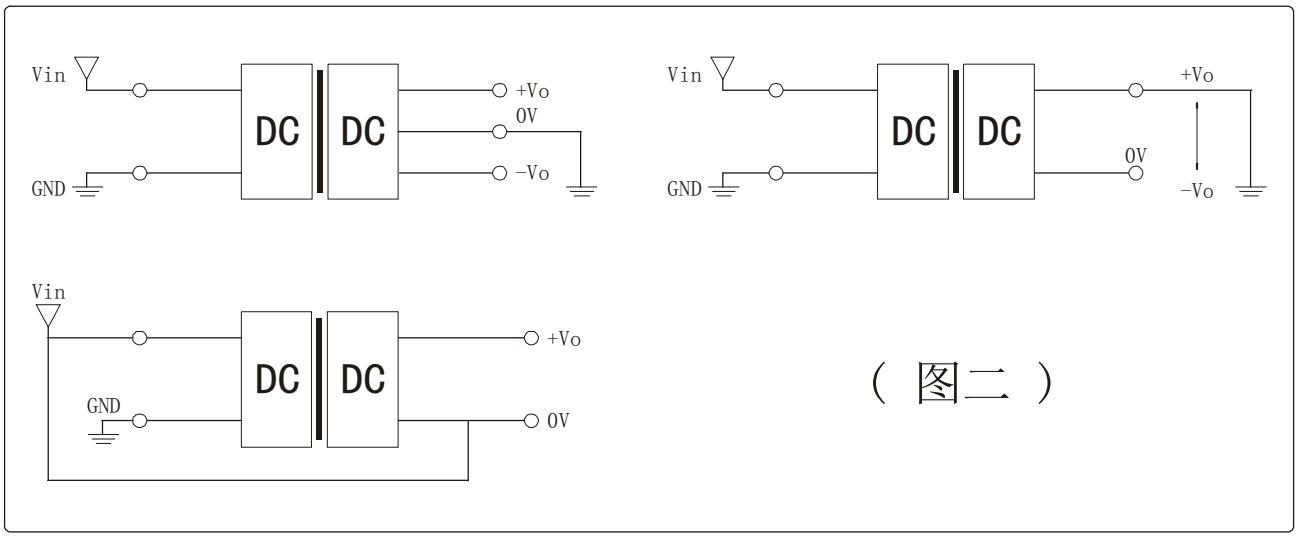


Fig. 1

II. Voltage and Polarity Conversion

One of the main features of SUNYUAN DC-DC Converter is that the high galvanic isolation, so user can only uses single DC-DC Converter to form various kinds of electric potential difference. If necessary, output positive can be connected with input GND, then the negative of output terminal has a negative voltage. The input terminal and output terminal are isolated, so the connection modes of output terminal has no special requirements. For example, add a single terminal connecting line, then new output emerged in the main power supply or divides into other different DC voltage.



(see Fig. 2). **Fig. 2**

III. Wave Filtering

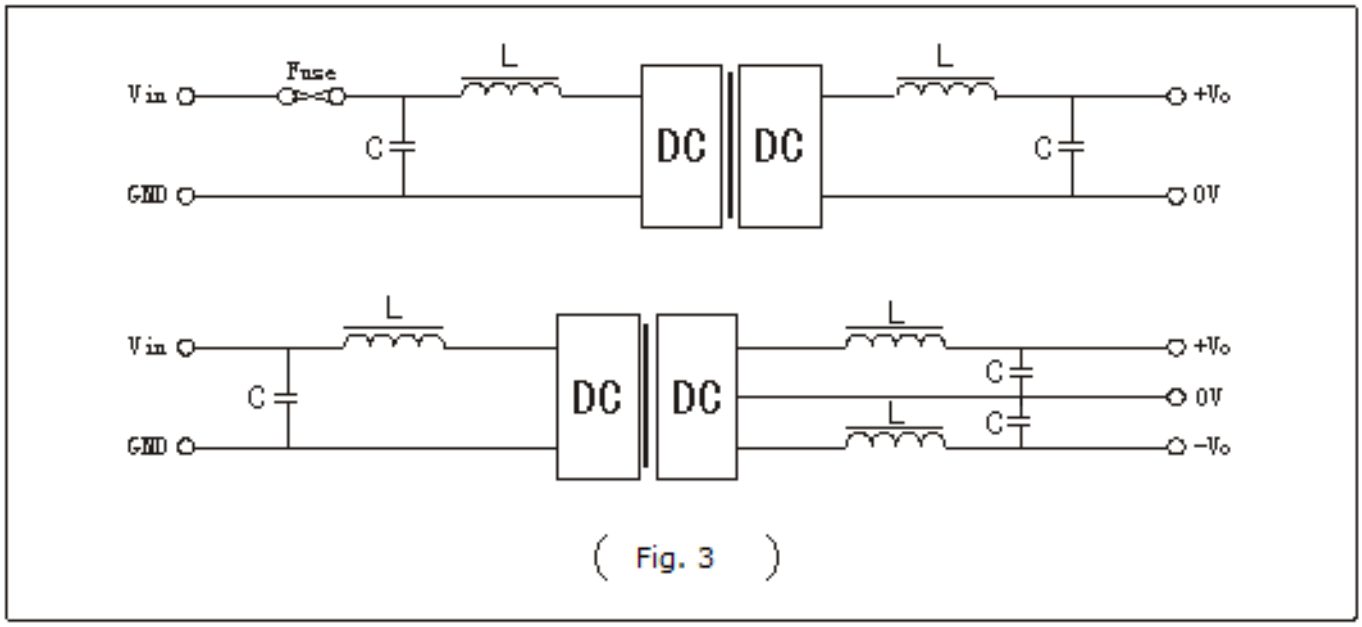
In using isolated DC-DC Converter in some circuits which are sensitive to noise or ripple wave, user can add the passive LC wave filtering network to the input and output terminals to reduce the ripple wave (see Fig. 3). This circuit configuration model is generally applied in measuring meters, data process and other noise sensitive circuits whicht require to isolate load and noise to avoid filtering or transmitting noise through power supply circuits and GND. External connecting the wave filtering components, especially input and output wave filtering capacitors can reduce the noise and also the output response time will be longer. For response time and noise norm, which is more important, it depends on the users in designing the circuits.

The self-resonance frequency of wave filtering inductor is greatly higher than the characteristic frequency of DC-DC Converter (the typical value of characteristic frequency from DC-DC Converter is 100KHz). And users be advised the current rated value of inductor should be about two times bigger than that the real current in usage.

The capacitance value of output wave filtering capacitor should be proper. If the output capacitance value is too big, it may cause activating problems. For each output channel, the max. capacitance value should not be bigger than 10uF in absolute safe and reliable conditions. Generally recommended value 4.7uF. If requires very low ripple wave value, user can connect an inductor in series, the capacitance value of output filtering capacitor is not too big.

The table below lists the recommended values for the inductor and the capacitor in forming the waver filter. The recommended values listed here are to make sure that the input capacitor or output capacitor can be matched to form a π type wave filter and greatly reduce the characteristic frequence.

Input Volt. (V)	Input Filter Inductance Value (uH)	Input Filter Capacitance Value (uF)	Output Vot. (V)	Output Filter Inductance Value (uH)	Output Filter Capacitance Value (uF)
3.3	33	1.5	3.3	33	1.5
5	47	1.0	5	47	1.0
9	100	1.0	9	100	1.0
12	220	1.0	12	220	1.0
15	330	0.68	15	330	1.0
24	470	0.47	24	470	0.47
48	680	0.18	48	680	0.18



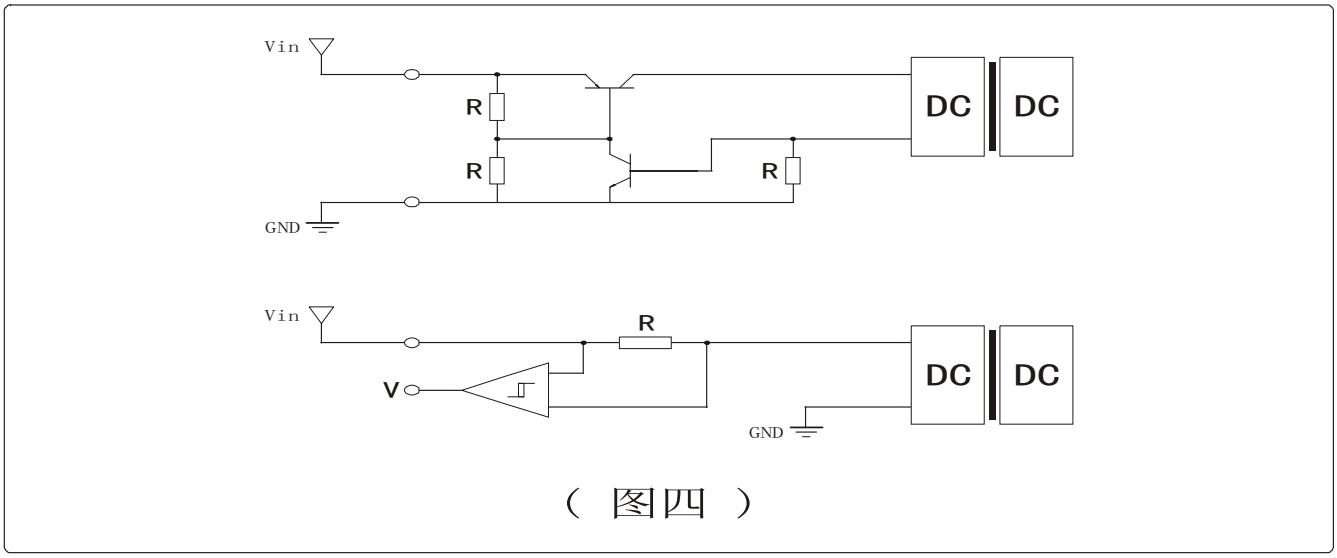
(Fig. 3)

IV. Over-load Protection

Using the series connection of inductance can prevent generating over-current when connecting the power supply. But in normal operating conditions, output circuits have no protection functions for the over-current and short-circuit, so if there exists over-current or short-circuit conditions, the input terminal of DC-DC Converter will generate very heavy current to meet the requirements from the output terminal. If these conditions cannot be adjusted for a long time, the converter will be burnt because of over-heat. Here presents some protection solutions of DC-DC Converter in the case of over-load in the output terminal.

The most simple method is that connecting the fuse in series. The fuse here must have enough capacity to ensure that it will not be damaged by surge current when connecting the power supply (see Fig. 3). Another method is that add a circuit breaker (see Fig.4 , Fig. 5). If there exists intelligent power management system in the input terminal, an electric resistance (to replace the inductor connected in series) can be connected in series in input terminal to detect the voltage drop coming through, in that case, power management system can function well. The similar circuit can also be used in output terminal to detect its output circuit, but if the power management system is in the input terminal, the detector should be isolated. The temperature of the electric resistance in output terminal can indicate the over-load exist or not and prevent isolation defects of the system.

If the thermal resistors or other heat sensitive devices are close to the electric resistance, the over-load case can be detected. But the temperature of the whole system should be considered to set proper switching rated values for different operating conditions (see Fig. 6).



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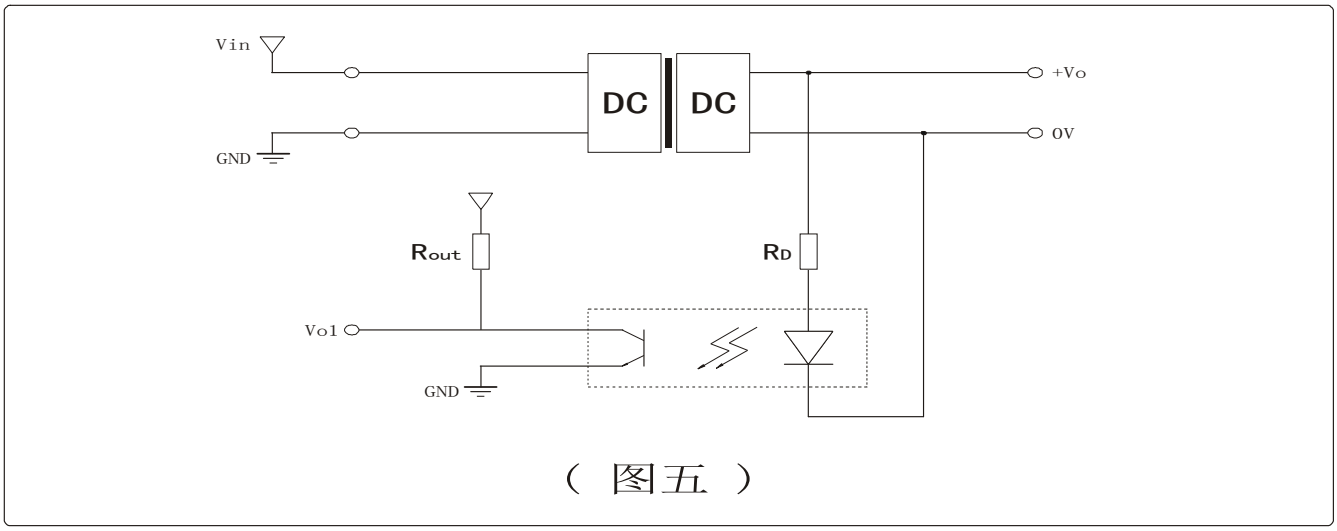

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Fig.4 - Fig.5

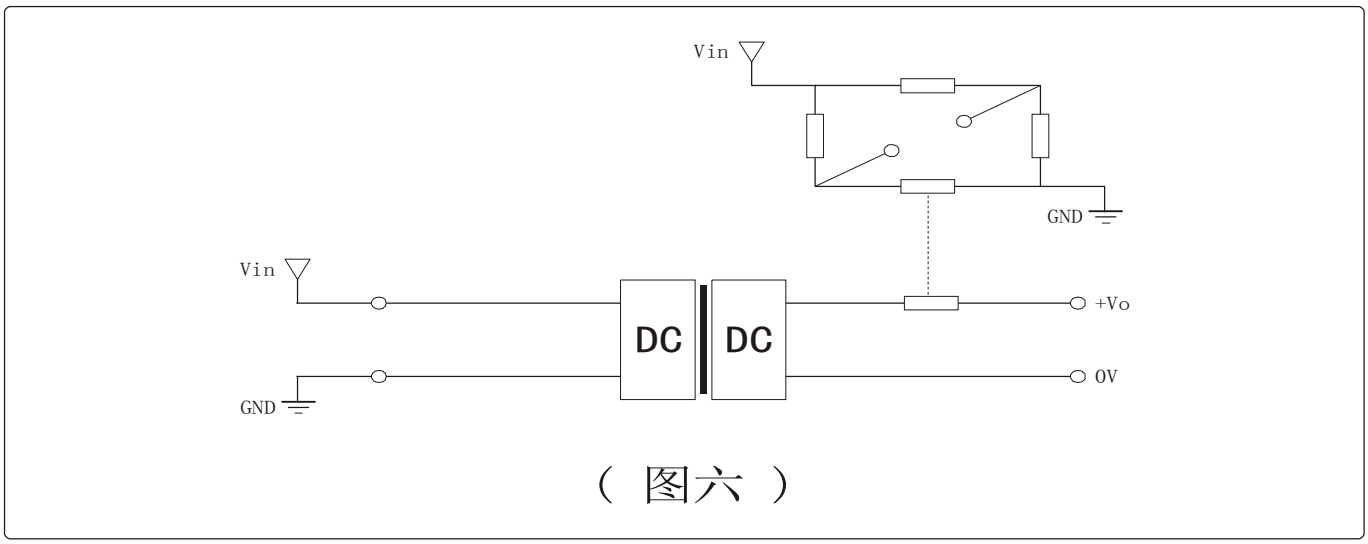


Fig. 6

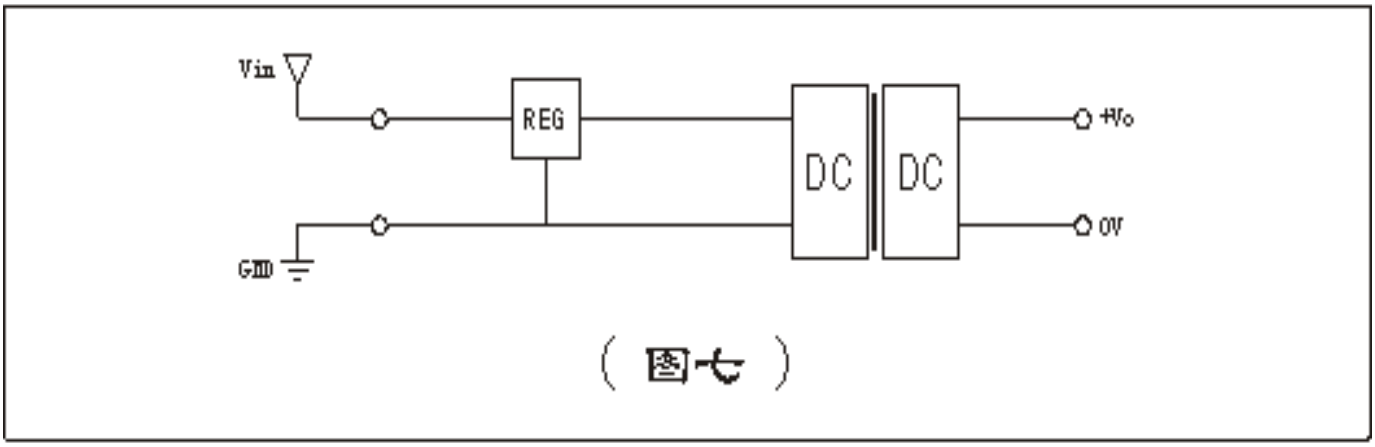
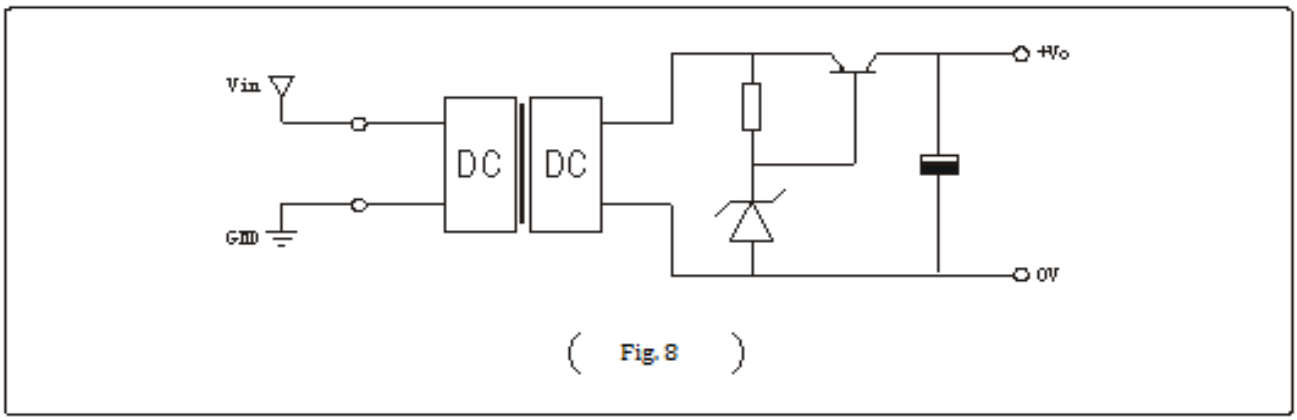


Fig. 7

Note: All the SUNYUAN power modules have the minimum load requirements, generally more than 10%, which can largely improve the reliability of the system. For the unregulated voltage converter, in the light load conditions, the output voltage will rise highly shortly or even in uncertain states, and for the regulated voltage products, the stability will decline when it is lower than the minimum load. If the power modules supply power to optical coupler, state relay, MOS tubes and low power consumption chips, the modules can be regarded as empty load or light load (the power consumption of the module is very low), so in that case a 10% of the power consumption of fake load (electric resistance) should be added to the output terminal to avoid the damage to the circuit which caused by the unregulated voltage and enhance its durability.

V. Output Voltage Regulation and Over-voltage Protection

The simplest device for the output voltage regulation and over-voltage protection is that the series connection of a linear voltage regulator in the output terminal (see Fig. 7). Some other application circuits for reference (Fig.8, Fig.9).



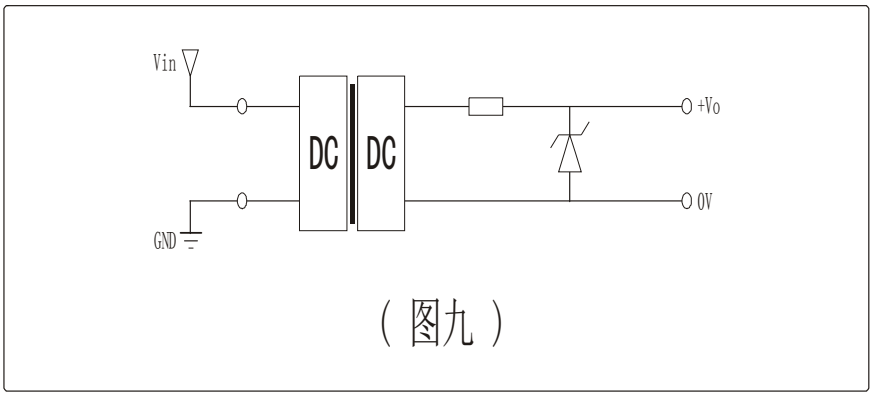


Fig. 9

VI. Series Connection of DC-DC Converter

The connection in series of the output terminals from a numbers of DC-DC Converters is allowed, because the output current of converters is isolated, in that case, user only requires to connect the positive of a converter to the negative of another converter (see Fig. 10), in that method some non-standard voltage generate. In that conditions, the total output current after the connections in series should not be more than the current values of the converter with minimum output current. In the series connection of the converters, the switching circuit of every converter is not synchronous, output ripple wave and noise will increase, so users are recommended to add a LC waver filter in output terminal.

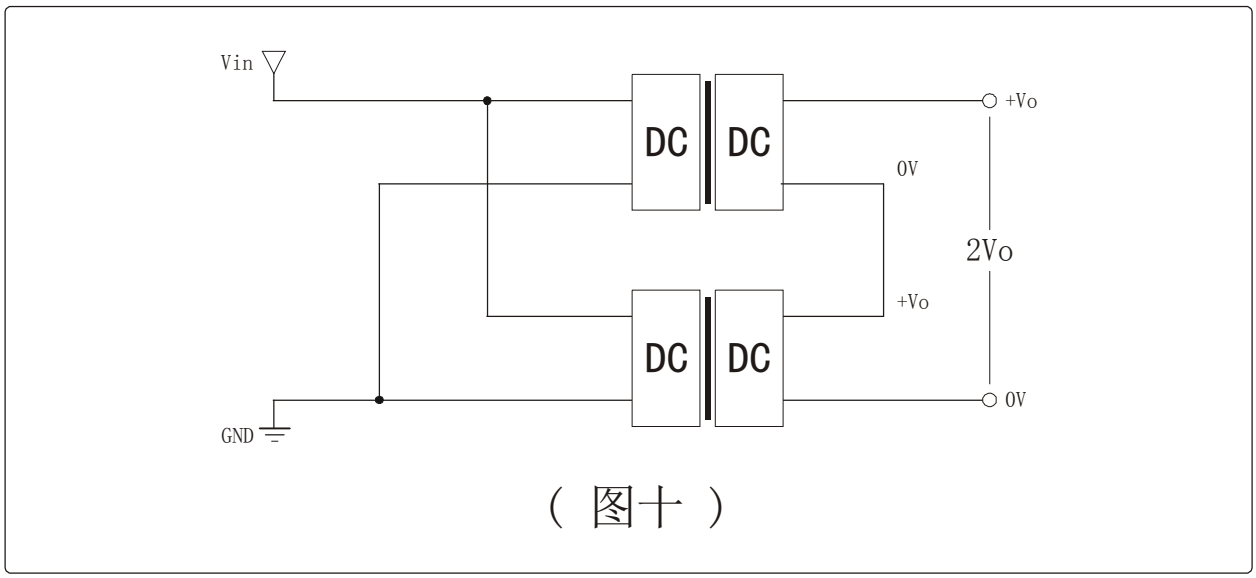


Fig. 10

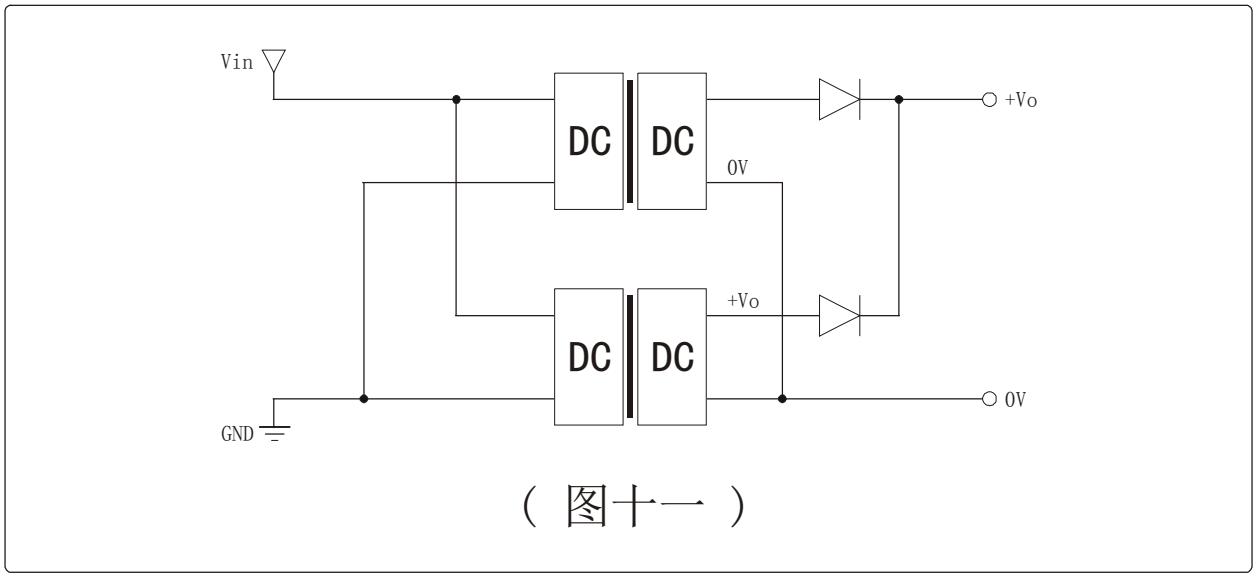
VII. Parallel Connection of DC-DC Converter

When the output power consumption of a single DC-DC Converter cannot meet the requirements, users can connect a number of converters in parallel to achieve much higher output power consumption.

In parallel connection, the same model of DC-DC Converters should be used to get better performance. For example, if output power consumption requires to arrive at 2.5W, the user can connect 2 pieces of 2W DC-DC Converter in parallel or 3 pieces of 1W DC-DC Converter in parallel, but cannot connect 1 piece of 2W converter and 1 piece of 1W converter in parallel. The reason is that the output voltage for different models of converter is not completely the same, so it cannot ensure the real output power consumption of 2W converters is exactly the 2 times of that from 1W converter. In actual use, 2W converter possibly only outputs 1W power consumption, while 1W converter outputs 1.5W power consumption. In parallel connection, even use the same model of DC-DC Converter, not every converter has the same load. The same model of converter has a good match in output voltage, the load of every converter in parallel connection only has 10% difference.

In parallel connection of DC-DC Converter, users must pay attention that the switching action of every converter may not synchronous. Some matching methods are available: one is that adopts diode isolation which mainly used high voltage output conditions, such as 12V,15V. Because in that conditions, the breakover voltage drop (typical 0.6V) of diode does not have much impact on circuit output, while for 5V, 9V output converter, the power consumption of diode is too high to connect these DC-DC Converters.

Another parallel connection is that connecting an inductor in the output terminal for each DC-DC Converter (see Fig 12). Comparing this method with previous methods, this method consumpts less voltage, and a proper inductor is matched with a capacitor can reduce output ripple wave. The table above lists the inductance values for different voltage values, and use these inductors can reduce ripple wave value in the circuit.



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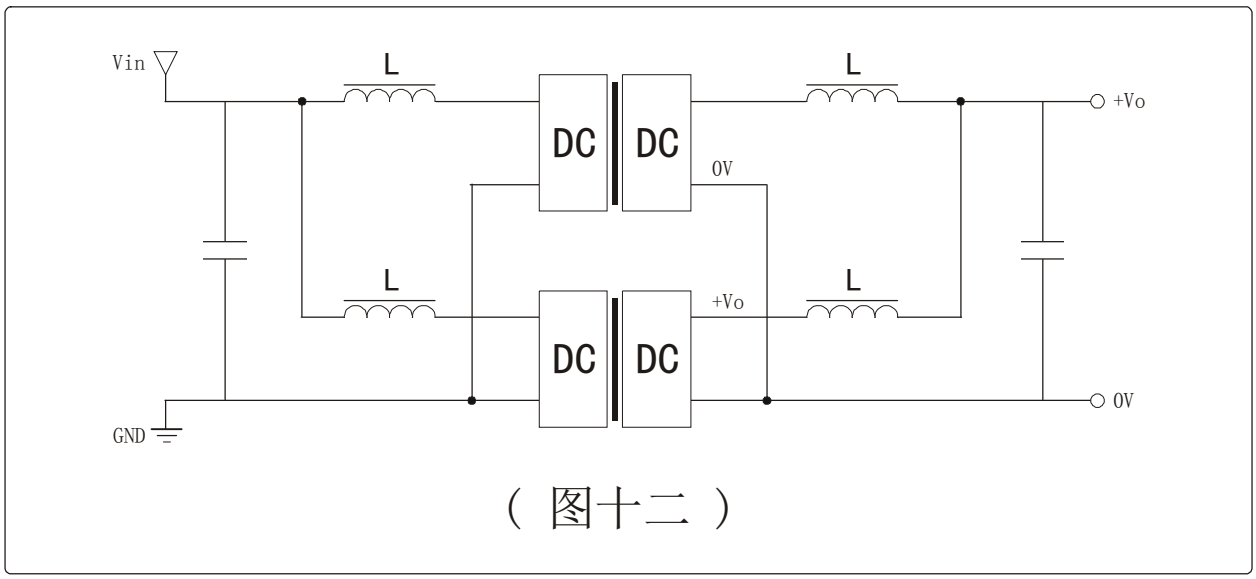

（ 图十二 ）

Fig.11- Fig.12

In parallel connection, the ripple wave value increase when more converters added, then user can add a filter capacitor in parallel connection output terminal to reduce ripple wave value. The capacitance value of filter capacitor which adds to each output terminal is about 1uF. For example: connecting two pieces of single voltage output DC-DC Converter in parallel, the filter capacitance value for the capacitor between the common positive and 0V should be 2uF.

This method also applies to display window input terminal, and for the values for the filter inductor in parallel connection input terminal and filter capacitor in parallel connection, check the table above for reference.

In conclusion, the parallel connection of DC-DC Converter is only used in some special situations. Using a single

high power consumption converter is better than that using DC-DC Converter group in parallel connection. When connecting converters in parallel, the output voltage mismatch degree for every converter should have appropriate ratio. Users are recommended to check the mismatching degree for every converter in full load to guarantee that the mismatching degree is within 1%-2%. Usually using the DC-DC Converter group in parallel connection with 0.9 power consumption ratio, in that method it can ensure consumption safety warranty for each converter. For example, connecting 2 pieces of 2W converter in parallel, the upper limit of output power consumption is 3.6W not 4W. In most cases, three DC-DC Converter are connected in parallel, users should consider that each converter must have much power consumption allowable degree.