Application Note for High-Voltage Brick Modules (300V/375V input)

Typical Application Circuit

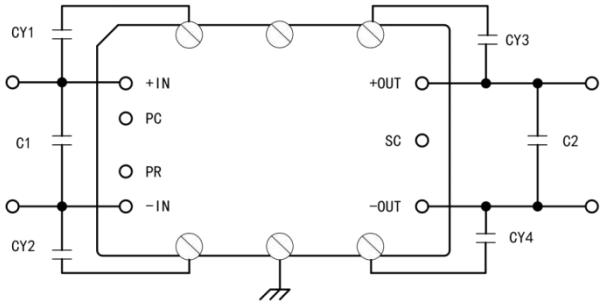

Figure 1 Typical Standalone Application Circuit

Capacitors C1, C2	
Capacitance Value	（10~20）μF/A
Recommended Capacitor Type(s)	Ceramic Capacitors, Solid Aluminum Electrolytic Capacitors,or Tantalum Capacitors
Safety Capacitors	
CY1、CY2 Capacitance Value	4.7nF
CY3、CY4 Capacitance Value	10nF

Note 1: It is recommended to select the output capacitor value based on the output current, typically (10~20) μF/A. For example, for a module output current of 10A, the recommended output capacitor is (100~200) μF.

Note 2: When using liquid aluminum electrolytic capacitors, the impact of temperature on capacitance must be fully considered to ensure the actual capacitance meets the above requirements across all temperature ranges. Improper capacitor value configuration may cause stability issues.

Note 3: The input and output capacitors specified above can ensure stable operation of the power supply under various conditions. If the application involves inductive or extreme dynamic loads, the output capacitance should be increased appropriately, and confirmation with the manufacturer's technical personnel is required.

Note 4: A single type of capacitor, such as ceramic capacitors, or a combination of capacitor types, such as ceramic capacitors paired with solid aluminum electrolytic or tantalum capacitors, can be used for both input and output capacitors.

Note 5: The temperature rise caused by the capacitor ESR must be fully considered when selecting the output filter capacitor.

Pin Functions

+IN, -IN

Input power pins. -IN also serves as the reference ground for the module control signals. To minimize the impact of voltage drop caused by current on -IN, it is recommended to use a Kelvin connection between the external control circuit and -IN.

+OUT, -OUT

Output power pins.

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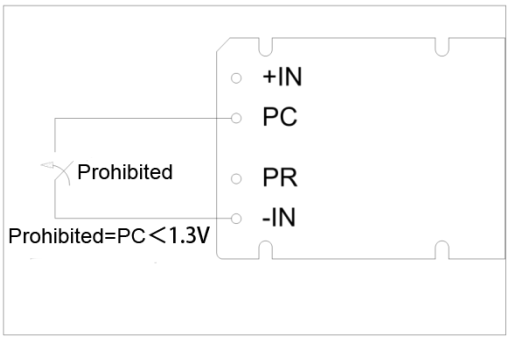
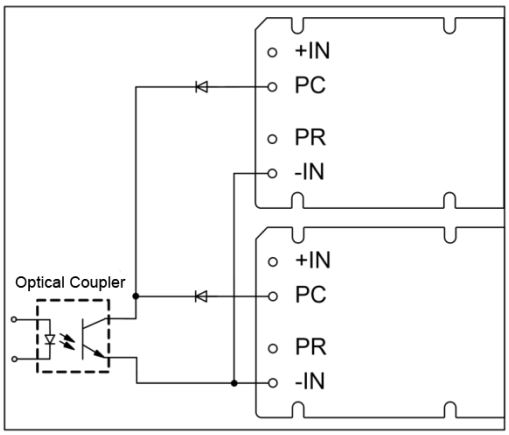
PC（Primary Control Pin）

Module Enable/Disable

The module is enabled when the PC pin is left floating. The module is disabled when the PC voltage is pulled below 1.3V (relative to -IN). This function can be implemented using a transistor, relay, or optocoupler. To disable multiple modules, redundant diodes can be used with a single optocoupler, transistor, or relay, refer to Figure 3. When using an optocoupler for control, ensure its secondary-side current capability is greater than the maximum PC current of 4mA to guarantee PC is reliably pulled low.



a) Single Module



b) Multiple Modules

Figure 3 Module Disable and Enable

Primary Auxiliary Power Supply

PC can provide a current no less than 1mA. In the example shown in Figure 4, PC supplies power to an LED to indicate module enable status.

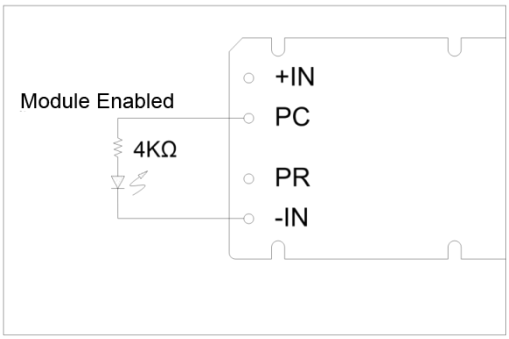


Figure 4 Power-On Indicator

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Module Alarm

The module incorporates comprehensive protection circuits to monitor input voltage, operating temperature, and internal operating parameters. If any of these parameters exceeds its allowable operating range, the module will stop operating, and SC will be pulled low. Except for output overvoltage protection, PC will also be pulled low. Once the anomaly is cleared, PC/SC will be reset high, and the module will resume operation (except for output overvoltage). Refer to Figures 5 and 6.

PC can provide power-on/off indication. For isolated power-on indication, refer to Figure 7.

SC can be used to monitor alarm signals, refer to Figure 8.

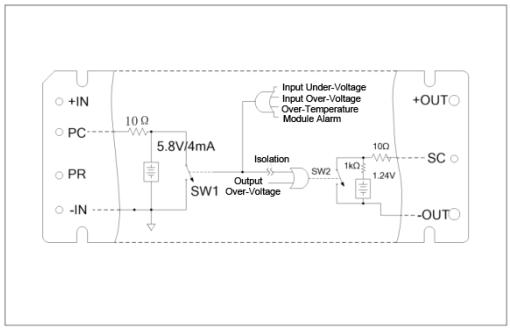

Figure 5 Protection Block Diagram

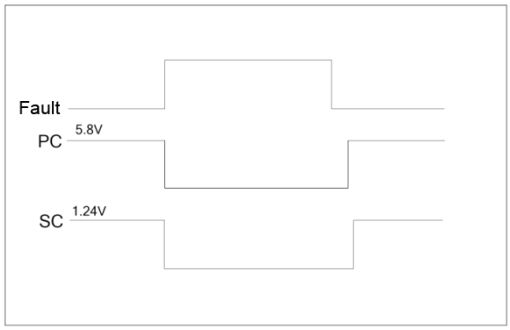

Figure 6 Protection Timing

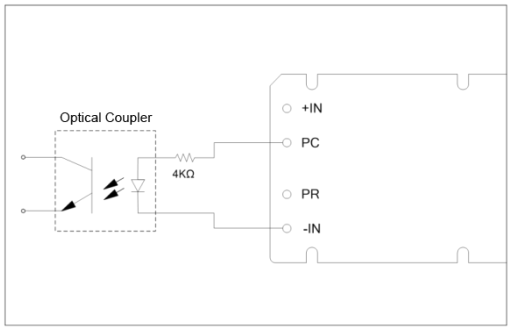

Figure 7 Isolated Power-On Indicator

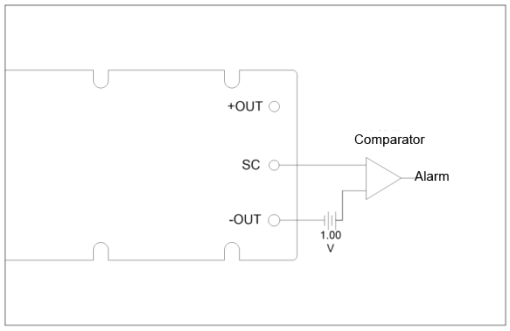

Figure 8 Alarm Signal Monitoring

PR（Parallel Pin）

Parallel Operation Description

The PR pin is a parallel function pin. Using the PR pins allows forming parallel arrays to increase output power. Properly connecting the PR pins of identical power supply modules enables current sharing. The PR pin is a bidirectional port capable of sending and receiving information between modules. The pulse signal on the parallel (PR) bus synchronizes the high-frequency switching within each power module, thereby achieving load current sharing. The modules in a parallel array can autonomously elect a master module. The master module sends synchronization pulses on the parallel bus, while other modules on the bus receive these pulses. If the master module fails, the parallel array will "elect" a new master without interrupting the output power.

PR Bus Connection Methods

Direct Coupling Connection: The PR pin of a power module is directly connected to the PR pin of another module. Although this method achieves load sharing, it is not fault-tolerant. The input negative terminals (-IN) of all parallel modules must be connected to the same potential. This method is typically used for parallel operation of up to three modules.

Capacitive Coupling Connection: The PR pins of parallel modules are connected to a communication bus via 10 nF capacitors. This connection method provides load sharing and fault tolerance. If the internal circuit of a module's PR pin fails, the blocking action of the coupling capacitor prevents it from affecting the normal operation of the remaining modules. This method is typically used for parallel operation of up to three modules. See Figure 9.

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Transformer Coupling Connection: For parallel operation of four or more modules or for "board-to-board" parallel applications (maximum of 6 modules), transformer coupling connection is recommended. See Figure 10. This method isolates the parallel bus from primary signals, and the negative input (-IN) pins of the parallel modules do not require excessive concern about having identical reference potentials. Our company can provide coupling transformers; please contact your sales manager for procurement if needed.

The purpose of resistor Z1 in Figures 9 and 10 is to improve the PR waveform. It is not mandatory but it is recommended to reserve a footprint for a surface-mount resistor during design. Selection during the debugging phase can be based on actual PR measurements. Recommended resistance value is 5-15Ω.

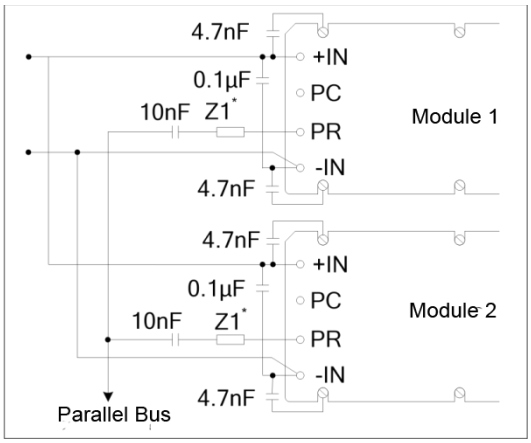

Figure 9 Capacitive Coupling PR Connection Method

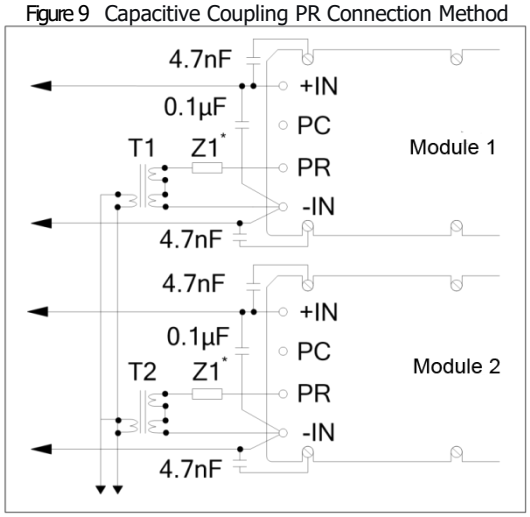

Figure 10 Transformer Coupling PR Connection Method

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Output Connection Method

Parallel modules can form N+1 or N+M arrays. Figure 11 shows the output connection method for an N+1 module array. The +OUT and -OUT output power bus layout on the PCB should minimize and balance the parasitic impedance from each module's output to the load. If necessary, the SC pin of some modules can be shorted to the -OUT pin to configure them as slave modules.

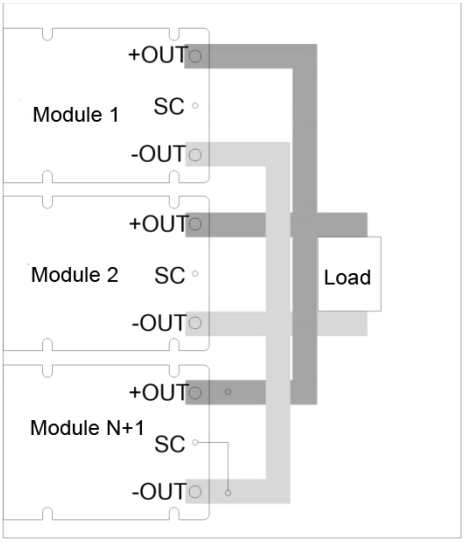

Figure 11 N+1 Module Array Output Pin Connection Method

Parallel Operation Notes

Connect a (0.1-0.47) μF ceramic or film capacitor across the input (+IN and -IN pins) of each module to shunt high-frequency input ripple current and prevent interference noise from coupling onto the parallel bus.

When operating in parallel, it is recommended to connect all PC pins to ensure all modules start simultaneously. Alternatively, use an external circuit to control the PC pins of all modules within the parallel array, enabling them at the same time, as shown in Figure 3. All modules in a parallel array must be of the same model. Mixing modules from different manufacturers in parallel is strictly prohibited, as it may trigger output overvoltage protection. Parallel operation with our company's non-through-hole domestic alternative modules is not recommended, as it may affect current sharing accuracy. If mixed parallel use is absolutely necessary, please consult the manufacturer.

Redundancy Circuit

If the module is used in a redundancy backup circuit, connect the +S pin of the module to the anode of the redundancy diode, as shown in Figure 12. The module output voltage can be increased by adjusting the trim resistor Ru to compensate for the redundancy diode voltage drop. D1a and D1b can be standard diodes or MOSFETs implemented with a redundancy controller.

In a redundancy circuit, the PR pin can be left floating, as shown in Figure 12 a). It must not be directly connected, otherwise it may trigger the module's output overvoltage protection. This application method cannot achieve current sharing.

For redundancy designs where PR-based current sharing is absolutely required, the circuit can be designed as shown in Figure 12 b), adding a delay output circuit to the PR connection to avoid triggering the module's output overvoltage protection. Component selection for the PR delay circuit can refer to the example shown. Parameters in the example can be fine-tuned during actual circuit testing for optimal performance. Diodes D2a and D2b should be Schottky diodes with a forward voltage drop lower than 0.5V to prevent significant negative voltage on the PR pin from damaging the power module. A dummy load Rd must be added at the parallel output to avoid potential output voltage overshoot under no-load conditions. The dummy load typically requires (1-2)W.

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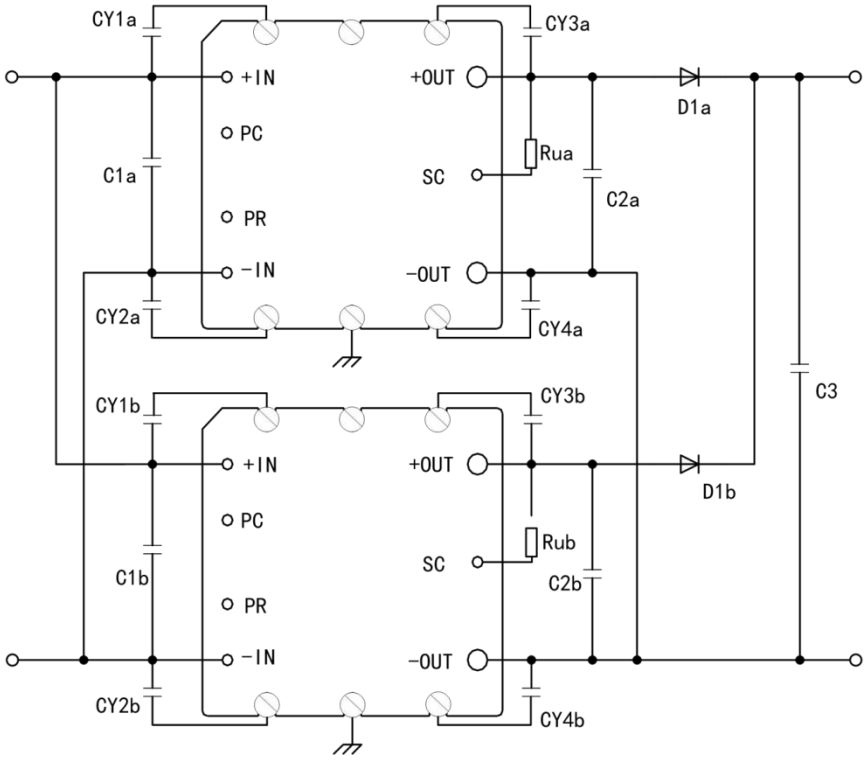
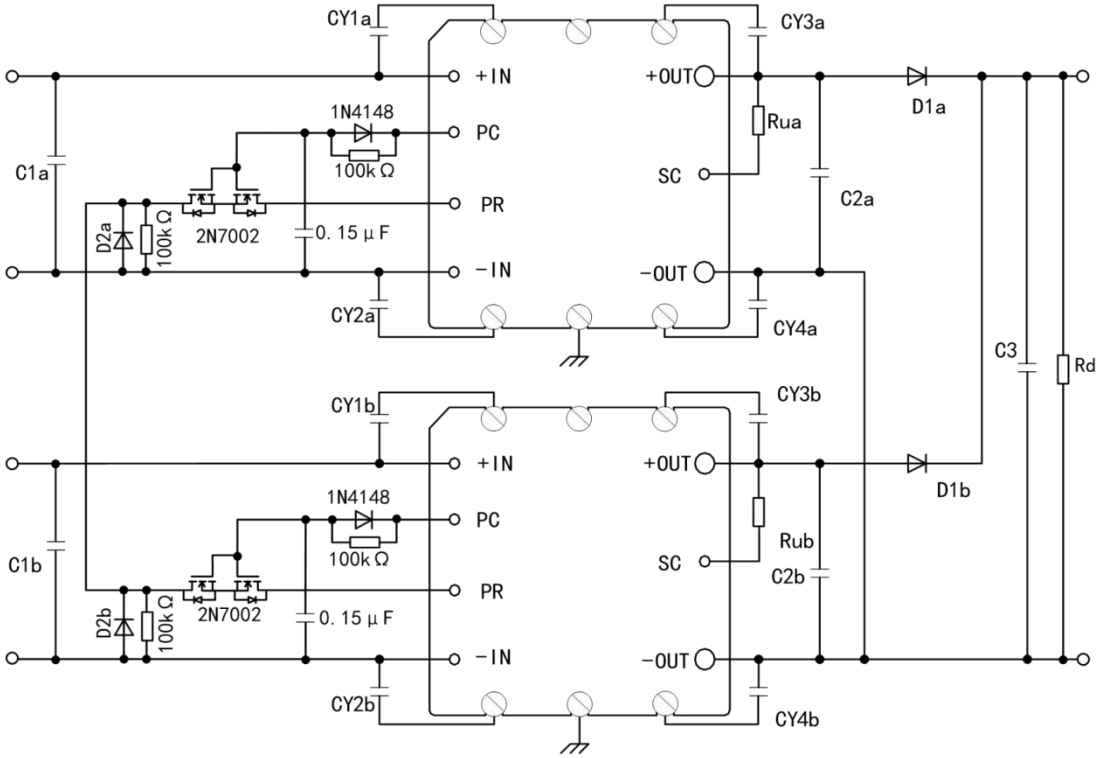


a) PR Pin Floating



b) Using PR Pin

Figure 12 Redundancy Connection Methods

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SC（Secondary Control Pin）

Output Voltage Adjustment

The output voltage can be adjusted using fixed resistors, a potentiometer, DAC output voltage, or programmable power supply module output voltage.

Decrease (Trim Down)

The power module does not have constant output power; it has a maximum output current limit. Therefore, when decreasing the output voltage, the output power decreases by the same percentage. Exceeding the maximum rated operating current is prohibited. The trim-down resistor must be connected to the -OUT pin. Refer to Figure 13.

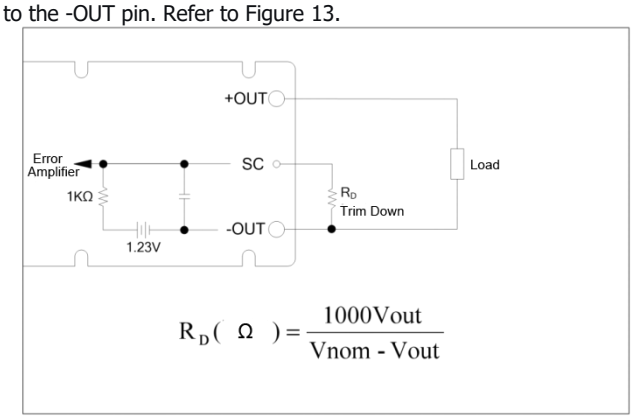

Figure 13 Output Voltage Trim-Down Circuit

Increase (Trim Up)

The module has a maximum rated output power. To ensure the output power does not exceed the rated value, when increasing the output voltage, the rated output current should be reduced proportionally by the same percentage. The trim-up resistor must be connected to the +OUT pin. Do not trim the module above the maximum adjustment range (+10%), as this may trigger the overvoltage protection function. Refer to Figure 14.

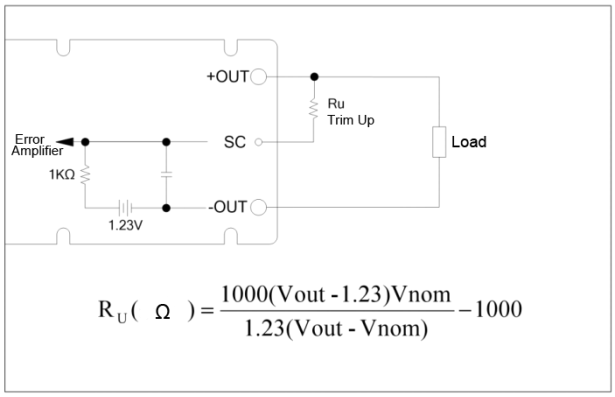

Figure 14 Output Voltage Trim-Up Circuit

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Protection Mode Description

Input Undervoltage Lockout(UVLO)

The module has input undervoltage lockout protection. If the input voltage is below the UVLO threshold, the module cannot be enabled/started until the input voltage rises above the UVLO recovery point. If the input voltage falls below the UVLO threshold during operation, the module enters a protection state and the output voltage will drop.

After entering the protection state, the output voltage is shut off until the input voltage climbs above the UVLO recovery point, at which point the protection state is cleared. If the module is in the enabled state, it will start normally.

Input Overvoltage Lockout (OVLO)

The module has input overvoltage lockout protection. If the input voltage is above the OVLO threshold, the module cannot be enabled/started until the input voltage falls below the OVLO recovery point. If the input voltage rises above the OVLO threshold during operation, the module enters a protection state and the output voltage will drop.

After entering the protection state, the output voltage is shut off until the input voltage decreases below the OVLO recovery point, at which point the protection state is cleared. If the module is in the enabled state, it will start normally.

Output Overvoltage Protection(OVP)

If the module detects that the output voltage is above the OVP threshold, it will enter an overvoltage protection state, and the output voltage will drop.

The module's output overvoltage protection is a latch-off type. The module cannot restart until the latch-off state is cleared. There are two methods to clear the latch-off state: disabling the module via the PC pin, or lowering the module's input voltage below the input undervoltage lockout (UVLO) point.

Output Current Limit Protection(OVP)

When the output current increases beyond the maximum current, the output voltage remains constant until the current limit point is reached, after which the output voltage drops, exhibiting current limit protection mode. Once the overcurrent condition is removed, the module automatically resumes operation.

Overtemperature Protection(OTP)

The module has overtemperature protection. If the internal temperature is detected to be above the OTP threshold, the module enters an overtemperature protection state and the output voltage will drop. When the internal temperature is detected to be below the OTP threshold, the protection state is cleared. If the module is in the enabled state, it will start normally.

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