MCB Series 175℃, Four-output Combined Power Module

Introduction and application:

The MCB series is a power module that combines the MC series DC/DC isolated three-output power module and the non-isolated BUCK step-down power module FHNB1.0A. This combined power module features a wide range of voltage input, with a maximum output power of 20W and a maximum efficiency of up to 85% . The MCB combined power module has 4 output voltages, of which 3 are output by the MCB, which are isolated outputs. It has three isolated outputs with the same voltage or common ground output, with the voltage range of each output from +12.0 to +24.0V, and the maximum output power of each output up to 6.5W. The outputs can be combined into a single output, with the voltage range of +12.0V to +24.0V, and power up to 20W. The outputs can also be connected in series into an one-output mode, with the voltage range from +12.0V to +24.0V, and power up to 20W. The three-way isolated outputs can be connected to form a dual-way output with symmetry of positive and negative voltages, with the voltage ranging from ±12.0 to ±24.0V and a total output power of 20W. It can be connected to a dual output with symmetry of positive and negative outputs plus a single to realize the isolated/common ground output of the same voltage, with a voltage range of ±12.0 to ±24.0V; It also can be connected to form a dual output with two outputs connected in series plus a single output. The voltage of the output connected in series ranges from±24.0 to ±48.0V, and the voltage of the single output ranges from ±12.0 to ±24.0V. The fourth output is provided by the FHNB1.0A board, with its input terminal connected to any one of the first three outputs: the input voltage ranges from 12.0V to 24.0V, and the output voltage ranges from 1.0V to 19.0V. These two lines are common-grounded for input and output. The maximum output voltage is required to be 80% of the input voltage, and ensure that the input voltage and the output voltage have a pressure difference of 2V. Customers can reduce the types of orders according to needs.

All internal components are highly reliable and long-life components with a resistance of over 200°C. Under the severe conditions of 175°C ambient temperature and 185°C case temperature, the MCB can work continuously or cumulatively for more than 500 or 1,500 hours (E: 500 hours, T: 1,500 hours) under the condition that the failure rate is guaranteed to be no more than 0.5 per cent. The MCB features a few protective functions for output over-voltage, over-current, short-circuit and input under-voltage and over-temperature. The environmental performance meets the requirements of GJB150-86, and the electrical performance index is in accordance with GJB-181A-2003 standard. Its elaborate design ensures excellent thermal performance and high stability, and it can meet the requirements of size, weight, power density, environment and other high demands, so that it is widely used in a variety of electronic systems with stringent requirements on environment and quality.

Properties:

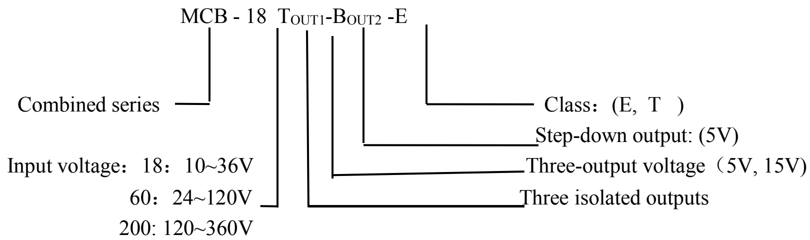
- Wide range input voltage:10～ 36V, 24～ 120V, 120～ 360V;
- Wide operating ambient temperature:-55℃ ~ +175℃(case temperature: -55℃ ~ +185℃);
- Three isolated outputs of the same voltage; one common-grounded step-down voltage output
- Input and output isolation 1000V. 500V between outputs isolated from each other;

- Output voltage range: three outputs 12V-24V; one output 1.0V～19.0V
- Efficiency up to 85%;
- Short circuit, under-voltage, over-current, and over-temperature protection;
- Excellent thermal performance;

Optional functions:

- Positive and negative switching logic

Naming rules:



Symbol — means isolation；

T_{OUT1} has three isolated independent outputs, each of which can output independently; they can be connected in parallel for output; connected in series for output; or a combination of parallel and series connections for output; each individual output ranges from 12.0V to 24.0V.

B_{OUT2} provides a single step-down output, with the voltage ranging from 1.0 to 19.0V. Its input is supplied by any one of the outputs from T_{OUT1}, forming two common-grounded voltage outputs with different values.

The MCB can achieve a maximum power of 20W, and T_{OUT1} and B_{OUT2} can be combined in any order to form 4 outputs, 3 outputs, 2 outputs, or a single output.

Function description

The MCB's output has two adjustment terminals, ADJ1 and ADJ2. ADJ1 adjusts the three outputs of T_{OUT1} with the output voltage ranging from 12.0V to 24.0V. ADJ2 adjusts the B_{OUT2}'s output with the output voltage ranging from 1.0V to 19.0V.

Output voltage adjustment (ADJ1)

The voltage regulation pin ADJ1 is used to regulate the three-output voltage. Connecting an external resistor R1 between the regulating voltage pin ADJ1 and the positive output OUT of T_{OUT1} can reduce the output voltage to a value between 12V and 15V; connecting an external resistor R2 between the regulating voltage pin ADJ1 and the output GND can raise the output voltage to a value between 15V and 24V. The output voltage can be adjusted from 80% to 160% of its nominal voltage. That is, the output can be adjusted down to 12V or up to 24V.

1. The formula for the resistance value of the external resistor to reduce the voltage (output voltage 12V-15V):

   VOUT=（137.75+15*R1）/(27.1+R1) ①

   R1=(27.1*VOUT-137.75)/(15-VOUT) ② VOUT is the actual output voltage after adjustment, unit:V;

   R1 is an external resistor, unit: kΩ.

   Wiring: When a resistor R1 (R1=62kΩ) is connected between ADJ1 and positive output OUT, the three outputs of the isolated voltage is minimum of 12V；

   When a resistor R1 with its value greater than R1=62kΩ (R1 must not be lower than 62kΩ) is connected between ADJ1 and positive output OUT, the three outputs of the same isolated voltage are higher than 12V and lower than 15V, refer to the calculation formula ①② above.

2. The formula for the resistance value of the external resistor to raise the voltage (output voltage 15V-24V)

VOUT=(137.75+15*R2）/(5.6+R2) ③

R2=(137.75-5.6*VOUT)/(VOUT-15) ④ VOUT is the actual output voltage after adjustment, unit: V;

R2 is an external resistor, unit: kΩ.

Wiring: When a resistor R2 (R2=0.4kΩ) is connected between ADJ1 and output GND , the three outputs of the same isolated voltage are maximum of 24V;

When a resistor R2 with its value greater than 0.4kΩ is connected between ADJ1 and output GND, the three outputs of the same isolated voltage are higher than 15V and lower than 24V, refer to the calculation formula ③④ above.

3. Note：The three outputs of the same isolated voltage are 15V when ADJ1 is suspended

The power for the external resistors R1 and R2 requires above 10mW, and the precision is determined according to the accuracy of the VOUT.

When using the function of increasing output voltage or telemetry to make the converter's output voltage higher than the set voltage, please note not to exceed the maximum output power specified in the output specification table.

Output voltage adjustment (ADJ2)

The voltage regulation pin ADJ2 is used to regulate the voltage of the fourth output. Connecting an external resistor R3 between the regulating voltage pin ADJ2 and the positive output B_{OUT2} can reduce the output voltage to a value between 1.0V and 5.0V; connecting an external resistor R4 between the regulating voltage pin ADJ2 and the output GND can raise the output voltage to a value between 5.0V and 19.0V. The range of output voltage regulation is up to 80% of the input voltage and 2V less than the input voltage. That is, the output can be adjusted down to 1.0V or up to 19.0V.

1.The formula for the resistance value of the external resistor R3 to reduce the voltage (output voltage 1.0V-5.0V):

VOUT=（165.3+5*R3）/(175+R3) ①

R3=(175*VOUT-165.3)/(5-VOUT) ② VOUT is the actual output voltage after adjustment, unit:V;

R3 is an external resistor, unit: kΩ.

Wiring: When a resistor R3 (R1=0kΩ) is connected between ADJ2 and output B_{OUT2}, the single output voltage is minimum of 0.94V；

When a resistor R3 with its value greater than R3=0kΩ is connected between ADJ2 and output B_{OUT2}, the single output voltage is higher than 1.0V and lower than 5.0V, refer to the calculation formula ①② above.

2. The formula for the resistance value of the external resistor R4 to raise the voltage (output voltage 5.0V-19.0V)

VOUT=(165.3+5*R4）/(10+R4) ③

R4=(165.3-10*VOUT)/(VOUT-5) ④ VOUT is the actual output voltage after adjustment, unit: V;

R4 is an external resistor, unit: kΩ.

Wiring: When a resistor R4 (R4=0kΩ) is connected between ADJ2 and output GND, the single output voltage is maximum of 19.0V;

When a resistor R4 with its value greater than 0kΩ is connected between ADJ2 and output GND, the single output voltage is higher than 5V and lower than 19.0V, refer to the calculation formula ③④ above.

4. Note：The three outputs of the same isolated voltage are 5.0V when ADJ2 is suspended

The power for the external resistors R3 and R4 requires above 10mW, and the precision is determined according to the accuracy of the VOUT.

Enabling control

The converter can be switched on and off by changing the voltage between the ON/OFF pin and Vin(-). The MCB series converter allows for a choice of positive logic control or negative logic control for the switching. Regarding the negative logic control, the converter is turned on when the ON/OFF pin is at a logic low level, and the converter is turned off when the ON/OFF pin is at a logic high level. For the positive logic control, the converter is turned on when the ON/OFF pin is at a logical high level; and the converter is turned off when the ON/OFF pin is at a logical low level. Due to the internal pull-up circuit, connecting a small external switch between the ON/OFF pin and Vin(-) allows you to control the converter.

The logic low-level range is 0V to 1.2V, with a maximum external sourcing current of 1mA. The external switch must be able to maintain the logic low level of the ON/OFF pin while sourcing a current of 1mA; the logic high-level range is 3.5V to 12V. The internal circuit of the converter can generate a maximum voltage on the ON/OFF pin that does not exceed 15V, and when the ON/OFF pin is at a high voltage level, the maximum allowable leakage current is 2mA.

Protective functions

Input under-voltage lockout

The converter starts when the input voltage rises to the startup input voltage threshold; it shuts down when the input voltage falls to the shutdown input voltage threshold. The hysteresis voltage effectively prevents the converter from oscillating between on and off.

Over-temperature protection

The temperature sensor is mounted on the converter circuit board at a location that reflects the temperature of the main components. If an over-temperature condition is detected, the converter will shut down. For self-locking protected modules, the module can start the converter by pressing the ON/OFF switch or inputting voltage. For modules with automatic restart, the module resumes operation on its own after the over-temperature condition disappears.

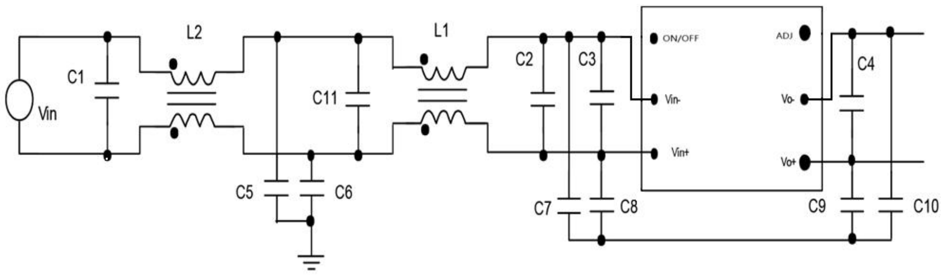
Over-current protection

The converter shuts down when the load current is higher than the overcurrent value. For self-locking protected modules, the module can start the converter by pressing ON/OFF switch or inputting voltage. For modules with automatic restart, the converter shuts down and keep trying to restart when the load current is higher than the overcurrent value. When the overcurrent condition disappears, the module automatically resumes operation.

EMI

When the power module is in operation, it will generate two types of electromagnetic interference noise: radiation and conduction. Radiation noise mainly originates from the rapid changes in voltage and current in the module, and the rapid changes in voltage and current are due to the turning on and off of power switching devices. At the same time, the mechanical structure of the module also has a certain impact on the radiation noise. In the design of general modules, a snubber is adopted to reduce the high-frequency oscillation generated by the rapid changes in voltage and current during the switching of power devices. When selecting a metal base plate, grounding the metal base plate or connecting it to a relatively stable potential point can achieve a certain shielding effect. Conductive noise can be further divided into differential mode noise and common mode noise. Differential mode noise appears between the positive and negative pins of the input and output, mainly at the input end. The pulse width modulation (PWM) of the power switching devices in the power supply module is the source of such noise. Modules usually contain input differential mode L-C filters. Common-mode noise appears between the input and output pins and the ground, and its strength is related to many internal and external factors. The module also contains common-mode filtering capacitors. To further reduce noise interference, external differential mode and common mode filters are generally required in the application. Electromagnetic interference is a system problem affected by many factors other than modules, such as cabinet design, wiring design of the circuit board using the module, etc. Therefore, the structure of the filter and the parameters of the filter components may vary to some extent due to different systems.

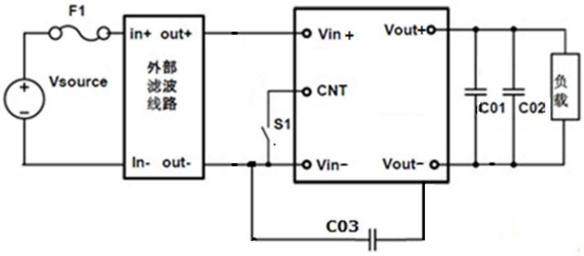
Recommended configuration parameters for EMC:



C1, C2, C3, and C4 are differential mode filtering capacitors. Among them, C2 should be a capacitor with a large capacity and a low equivalent series resistance (ESR), such as an electrolytic capacitor. Generally, C1, C3, and C4 are ceramic capacitors with very small equivalent series resistance (ESR) and equivalent series inductance (ESL), providing a low-impedance loop for high-frequency noise currents. Regarding the selection of C2 capacitance, for modules with a minimum input voltage of 120V, it is recommended to use 22-47uF per 100 watts of input power. For modules with a minimum input voltage of 30V, it is recommended to use 50-100uF per 100 watts of input power. For a module with a minimum input voltage of 18V, it is recommended to use 200-400uF per 100 watts of input power. The voltage rating of the capacitor should be greater than the maximum input voltage. Additionally, C2 must have a sufficient current rating to meet the needs of long-term operation under high temperatures and heavy loads. The main function of C2 is to prevent the output impedance of the power supply at the input end of the module from being too high, ensuring stable operation of the module under various practical conditions. If the output impedance of the power supply is relatively low and the distance to the module is short, the capacity of C2 can also be appropriately reduced. While ensuring stability, C2 also provides a path for the input ripple current generated by the module. Capacitors C7-C10 are common-mode high-frequency decoupling capacitors, with capacitance values typically ranging from 10nF to 0.1uF. Depending on the grounding method of input and output, some of these capacitors must be high-voltage capacitors. In most applications, increasing the output capacitor C4 can improve the output dynamic response and reduce voltage oscillations caused by output lead inductance. Generally, these output capacitors should also be capacitors with low equivalent series resistance (such as ceramic capacitors). The selection of L1 and L2 needs to be based on the actual input current and the system's actual EMC requirements, typically ranging from tens of uH to hundreds of uH.

Guide to application

Typical application circuit



F1: 4A fuse (fast fusing)

C01: 1uF ceramic capacitor is recommended;

C02: 47uF electrolytic capacitor is recommended;

C03: 1nF /3000Vdc ceramic capacitors are recommended. C03 cannot be used in most cases.

Installation and welding precautions

Module installation

Modules can be installed in different positions, but it must be ensured that the air duct is unobstructed. Generally, power devices are placed at the end of the air duct or have a separate air duct. This installation can ensure the cooling of the power supply module and increase the service life of the device.

If the module is used in a closed space without air ducts, a metal heat sink is required to dissipate the heat from the module. The MCB module does not have a heat dissipation base plate, and the internal heat is transmitted to its metal case, with a maximum of 3W of heat. During installation, it is necessary to dissipate the heat from the case. The general practice is to install the module on the back of the PCB, use the PCB to press the module onto the metal bracket, and place an elastic thermal conductive pad with a thickness of 0.5MM to 1.0MM between the top of the module and the metal bracket to maintain good thermal conductivity between the module and the metal bracket. The metal bracket of the instrument or equipment is used as a heat sink to dissipate the heat of 3W.

When used in a strong vibration environment, the four claws around the module shell should be welded onto the PCB to fix the module, rather than using the pins. This is done to increase the module's shock resistance and protect it.

Notice:

It must be ensured that there are no electrical connections between the module's base plate and safety ground, or between the base plate and other pins.

Module welding:

The module meets the standard wave soldering technology. During wave soldering, the module's pins must be preheated at 110℃ for 20 to 30 seconds, and the wave soldering should be done at 235℃ for less than 10 seconds. During manual soldering, the soldering iron should be set at 425℃, and it is necessary to ensure that the direct contact time with the pins does not exceed 3 seconds. Long-term high-temperature soldering can cause internal damage to the module. The module's solder joints can be cleaned using IPA or an appropriate solvent.

Special notes:

1. If the input voltage is repeatedly restarted several times quickly, the restart of the power supply module will cause the failure of the slow start circuit, which may lead to the damage of the module. The recommended restart interval for the input voltage should be greater than 1 second;

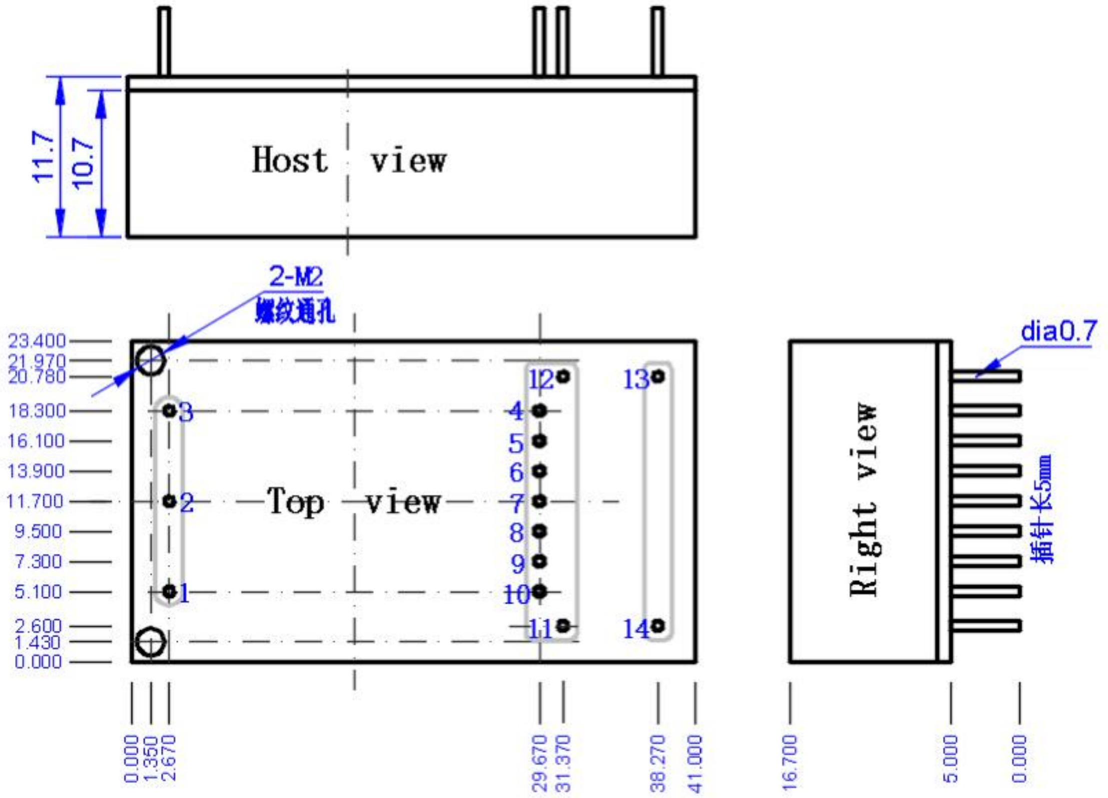
2. If the control voltage on the enable pin (ON/OFF) is repeatedly restarted quickly, the power supply module will cause the slow start circuit to fail when restarted, which may cause damage to the module. The recommended restart interval for the control voltage on the enable pin (ON/OFF) should be more than 1 second.

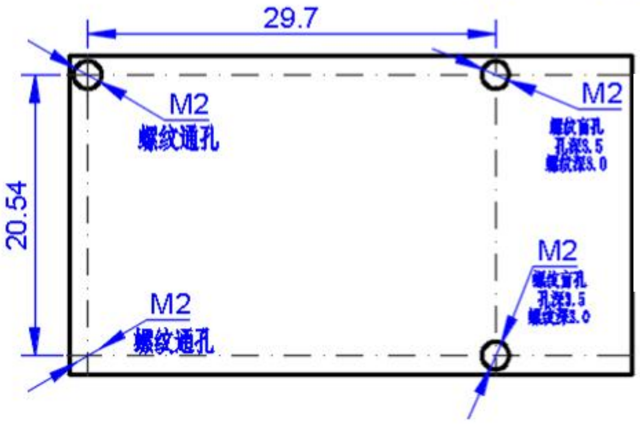
3. The voltage of each pin of the power supply module is not allowed to exceed the maximum voltage indicated in the specification, especially the input positive pin, otherwise the module will be damaged;

4. The power module requires an additional input capacitor for use. The specific input capacitance value can be recommended by the manufacturer, but if the input capacitance is too small or not available, it will cause the power module to oscillate, which will most likely lead to module failure.

5. The output end of the power module can be equipped with a filtering circuit to reduce the ripple effect at the module's output. It is recommended to use our company's filter FCP; adding filter capacitors before and after the filter will yield even better results, or using the FMP filter can reduce the ripple to below 100mV. The connection method can be found in the typical application circuits of the application guide. For specific parameters of FCP/FMP, please refer to our company's website.

Module’s dimension





Notes:

1. The tolerance of pin spacing and installation hole's dimension is ± 0.1mm.

2. The tolerance of dimension is ± 0.2mm.

Definition of wire leads:

Pin No.	Definition	Function
1	ON/OFF	Remote control terminal
2	Vin-	Input -
3	Vin+	Input +
4	OUT3	Third output +
5	GND3	Third output -
6	OUT2	Second output +
7	GND2	Second output -
8	OUT1	First output +
9	GND1	First output -

10	ADJ1	MC board output voltage regulation
11	OUT4	Fourth output +
12	V+	Fourth output -
13	GND4	Fourth input/output -
14	ADJ2	FHNB board output voltage regulation

Product performance, reliability and information are subject to change without prior notice.

April 10, 2023