

MS60 Series 175°C 24-120V Input, 36.0V/1A Output 1/16+ Brick Power Module

Introduction and application:

The MS60 series power supply modules are isolated modules with a wide range of inputs of 24-120V, maximum output power up to 40W and maximum efficiency up to 88%. All internal components are highly reliable and long-life components with a resistance of over 200°C. The MS60 can operate continuously or cumulatively for more than 500 or 1500 hours at a guaranteed failure rate of 0.5 per cent. Under the severe conditions of 175°C ambient temperature and 185°C case temperature, the MS60 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 MS60 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.

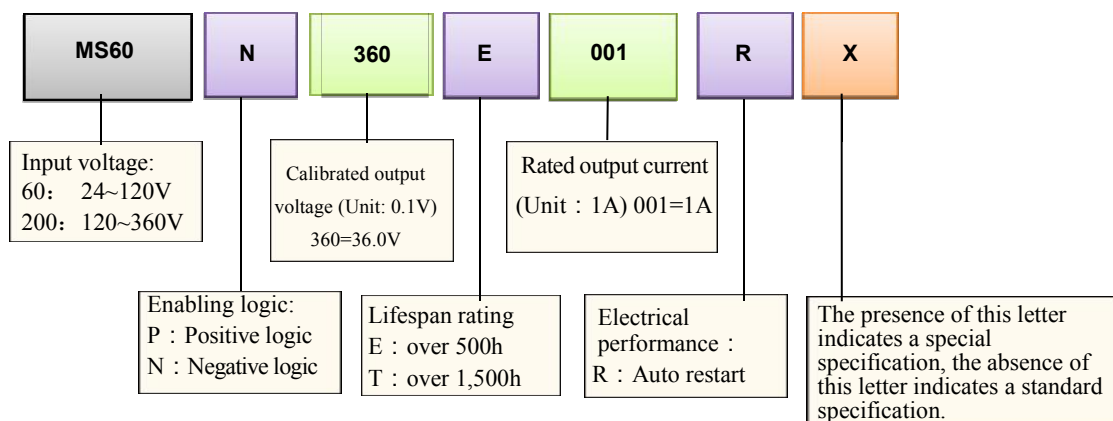
Properties:

- ◆ Wide range input voltage: 24-120V
- ◆ Output voltage range: 24.0V-48.0V
- ◆ Efficiency up to 88%
- ◆ Short-circuit, over-voltage, over-current, and over-temperature protection
- ◆ Excellent thermal performance

Optional functions:

- ◆ Positive and negative switching logic

Naming rules:



Electrical properties:

Typical conditions: $T_A=25^{\circ}\text{C}$, air flow rate=1.5m/s (300LFM), $V_{in}=60V_{DC}$

| Parameters | Min. value | Typical value | Max. value | Unit | Description /condition |
|--|------------|---------------|------------|----------------------|---|
| Maximum absolute rating | | | | | |
| Input voltage | | | | | |
| No working | | | 250 | V | |
| Working | | | 120 | V | |
| Surge working voltage | | | 150 | V | 100ms , square wave |
| Isolated voltage | | | | | |
| Input to output | | | 1000 | VDC | Within 1 minute |
| Input to base plate | | | 1000 | VDC | Within 1 minute |
| Output to base plate | | | 500 | VDC | Within 1 minute |
| Efficiency | | | | | |
| | | | | | For other relevant data, please refer to Figure 1 |
| 100% load | | 83 | | % | Output 24.0V |
| | | 85 | | | Output 36.0V |
| | | 88 | | | Output 48.0V |
| Working temperature | -55 | | 175 | $^{\circ}\text{C}$ | Max. case temperature 185°C |
| Storage temperature | -55 | | 125 | $^{\circ}\text{C}$ | |
| Input characteristics | | | | | |
| Input operating voltage range | 24 | 60 | 120 | V | |
| No-load input current | | 48 | 12 | mA | |
| No-load loss | | 0.8 | 1.0 | W | |
| Max. input current | | | 1.892 | A | $V_{in}=24V\sim 120V$, full load |
| Standby input current | | | 4 | mA | |
| Input reflected ripple (120Hz) | | | | mA | |
| Transient shock | | | 0.1 | A^2s | |
| Recommended fuse value | | | 4 | A | Fast fuse |
| Recommended external input capacity | | 10.0 | | μF | ESR0.1~0.2 Ω |
| Input undervoltage lockout | | | | | |
| Start-up input voltage threshold | 22 | 24 | 26 | V | |
| Close input voltage threshold | 21 | 23 | 25 | V | |
| Output characteristics | | | | | |
| Output voltage setting value | | 36.0 | | V | |
| Output voltage adjustment range | 66 | | 133 | % | |
| Output voltage remote compensation range | | | 10 | % | |
| Deviation of output voltage setting value | -5 | | +5 | % | Full condition range |
| Maximum output current | | | 1.6 | A | |
| Maximum output power | | | 40 | W | |

Electrical properties

Typical conditions: T_A =25°C, air flow rate=1.5m/s (300LFM)

| Parameters | Min. value | Typical value | Max. value | Unit | Description /condition |
|--|------------|---------------|------------|----------------------|---|
| Dynamic Characteristics | | | | | |
| Peak value deviation | | 6 | | % | Load 50%~75%~50% ; 50%~25%~50% ; Rate of change of load current 0.1A/us |
| Reset time | | 300 | | μs | |
| Output voltage rise time | | 15 | | ms | |
| Output voltage power-up delay time | | 25 | | ms | V _{IN} ~10% V _{OUT} |
| Output characteristics | | | | | |
| Output voltage ripple and noise | | | | | |
| Peak-peak value | | | 360 | mVp-p | Full load, 20MHz Oscilloscope bandwidth limit |
| Root mean square (rms) value | | | 50 | mVrms | Full load, 20MHz Oscilloscope bandwidth limit |
| Output overcurrent protection point | 1.67 | 1.88 | 2.08 | A | Output 24.0V |
| | 1.11 | 1.25 | 1.39 | | Output 36.0V |
| | 0.83 | 0.94 | 1.04 | | Output 48.0V |
| Capacitive load | 100 | | 470 | μF | |
| Output voltage adjustment rate | | | | | |
| Temperature adjustment rate | | 0.1 | | % | T _a = -55°C~175°C |
| Linear adjustment rate | | 0.2 | 0.5 | % | V _{in} =24V~120V, half load |
| Load adjustment rate | | 0.2 | 0.5 | % | No load~full load |
| Temperature limits for derating curves | | | | | |
| Semiconductor junction temperature | | | 205 | °C | |
| Transformer's temperature | | | 205 | °C | |
| Maximum heat dissipating substrate temperature | | | 185 | °C | |
| Printed circuit board temperature | | | 205 | °C | |
| Isolation characteristics | | | | | |
| Isolation voltage (dielectric strength) | | | | | Reference maximum absolute rating |
| Isolation Impedance | 10 | | | MΩ | |
| Isolated capacitance | | 1000 | | pF | |
| General characteristics | | | | | |
| Weight parameters | | 48 | | g | Error ±5g |
| Enabling Control | | | | | |
| Positive logic active level | 3.5 | | 15 | V | |
| Negative logic active level | -0.7 | | 1.2 | V | |
| Switching frequency | 150 | 155 | 160 | | |
| Mean Time Between Failure (MTBF) | | 8 | | 10 ⁵ hrs. | Substrate temperature 125°C |
| Over-temperature protection point | | 195 | | °C | Case temperature |

Function description

Output voltage adjustment (ADJ)

The voltage regulation pin ADJ is used to regulate the output voltage. Connecting an external resistor R1 between the regulating voltage pin ADJ and the output OUT+ can reduce the output voltage to a value between 24.0V and 36.0V; connecting an external resistor R2 between the regulating voltage pin ADJ and the output OUT- can raise the output voltage to a value between 36.0V and 48.0V. The output voltage can be adjusted from 66% to 140% of its nominal voltage. That is, the output can be adjusted down to 24.0V or up to 48.0V.

1. The formula for the resistance value of the external resistor to reduce the voltage:

$$V_{OUT} = (727.2 + 36 * R1) / (90 + R1) \quad \textcircled{1}$$

$$R1 = (90 * V_{OUT} - 727.2) / (36 - V_{OUT}) \quad \textcircled{2}$$
 VOUT is the actual output voltage after adjustment, unit:V;

R1 is an external resistor, unit:kΩ.

Wiring: When a resistor R1 (R1=120KΩ) is connected between ADJ and output OUT+, the single output voltage is minimum of 24.0V;

When a resistor R1 greater than 120KΩ is connected between ADJ and output OUT+ (R1 must be not lower than 120KΩ), the single voltage output value is higher than 24.0V and lower than 36.0V, refer to the calculation formula ①② above.

2. The formula for the resistance value of the external resistor to raise the voltage:

$$V_{OUT} = (727.2 + 36 * R2) / (15 + R2) \quad \textcircled{3}$$

$$R2 = (727.2 - 15 * V_{OUT}) / (V_{OUT} - 36) \quad \textcircled{4}$$
 VOUT is the actual output voltage after adjustment, unit:V;

R2 is an external resistor, unit:kΩ.

Wiring: When ADJ and output OUT- are shorted (R2=0Ω), the single output voltage is maximum of 48.0V;

When a resistor R2 is connected between ADJ and output OUT-, the single output voltage is higher than 36.0V and lower than 48.0V, refer to calculation formula ③④ above.

2. Note: the single output voltage is 36.0V when ADJ 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.

Enabling control

The converter can be switched on and off by changing the voltage between the ON/OFF pin and Vin(-). The MS series converter allows for a choice of positive logic control or negative logic control for the switching. Regarding 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 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

Over-voltage protection

When the output voltage exceeds the output over-voltage protection point, the converter will be shut down to protect the converter and the load. The module can start the converter by the ON/OFF switch or input voltage.

Input under-voltage lockout

The converter turns on when the input voltage rises to the start-up input voltage threshold and it turns off when the input voltage drops to the shut-off input voltage threshold. The hysteresis voltage effectively prevents the converter from oscillating between on and off states.

Over-temperature protection

The temperature sensor installed on the converter circuit board can reflect the position of the main component's temperature. If an over-temperature condition is detected, the converter will shut down. For modules with self-locking protection, the converter can be started by the ON/OFF switch or input voltage. For modules with automatic restart, the module will resume operation automatically after the over-temperature condition disappears.

Over-current protection

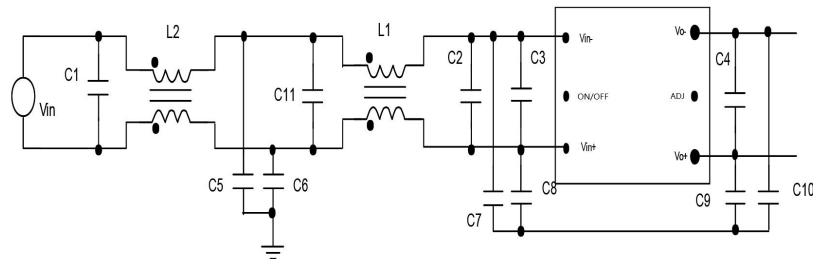
When the load current is higher than the over-current value, the converter will be shut down. For modules with self-locking protection, the converter can be started by the ON/OFF switch or input voltage. For modules with automatic restart, when the load current is higher than the over-current value, the converter will be shut down and continuously attempt to restart. After the over-current 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 substrate, grounding the metal substrate 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.

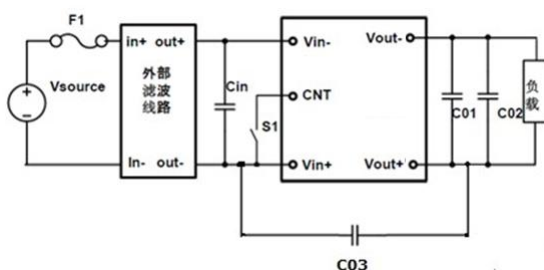
Recommended configuration parameters for EMC:



$C1$, $C2$, $C3$, 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 22-47 μ F per 100 watts of input power. For modules with a minimum input voltage of 30V, it is recommended to use 50-100 μ F per 100 watts of input power. For a module with a minimum input voltage of 18V, it is recommended to use 200-400 μ F 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 0.1 μ F. 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 μ H to hundreds of μ H.

Guide to application

Typical application circuit



F1: 2A fuse (fast fusing)

Cin: 47 μ F/250V high frequency low ESR electrolytic capacitors is recommended, plus a 1 μ F/250V ceramic capacitor connected in parallel;

C01: 1 μ F ceramic capacitor is recommended;

C02: 100 μ F electrolytic capacitor is recommended;

C03: 4.7nF /3000Vdc ceramic capacitors are recommended.

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.

Notice:

- 1. It must be ensured that there is no electrical connection between the substrate of the module and the safety ground, as well as between the substrate and other pins.**
- 2. If a heat sink is added to the substrate of the module, the fixing screws should not be too long. It is recommended to use screws with a thread length of 2mm extending into the substrate. Refer to the structural dimension diagram for the location and size of the screws.**

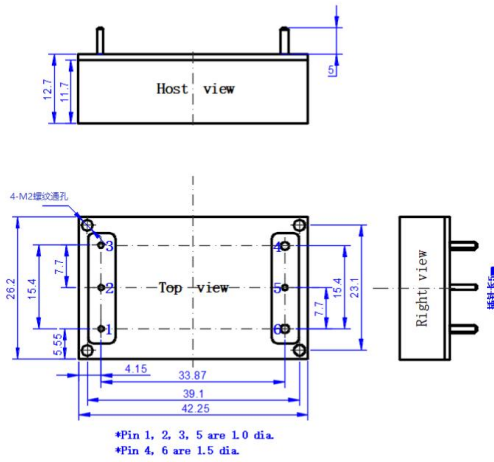
Module welding

The module meets the standard wave soldering technology. During wave soldering, the module's pins must be preheated at 110°C for 20 to 30 seconds, and the wave soldering should be done at 235°C for less than 10 seconds. During manual soldering, the soldering iron should be set at 425°C, 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.**

Module's dimension



注：1. 插针间距和安装孔尺寸公差为±0.1mm；
2. 外形尺寸公差为±0.2mm。

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 | Vin- | Input - |
| 2 | ON/OFF | Remote control terminal |
| 3 | Vin+ | Input + |
| 4 | OUT+ | Output + |
| 5 | ADJ | Output voltage regulation |
| 6 | OUT- | Output - |

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