Enclosed & DIN-Rail AC/DC Converters Application Guide 2022

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1. Introduction

Before using the enclosed switching AC/DC power supply, please pay attention to the following warnings and precautions. Incorrect installation and operation of the product may cause dangerous situations like electric shock, product damage or on fire. Please read and confirm the relevant warnings and precautions carefully.

1.1.Warning

(1) The power supply should be handled with care to avoid damage to the product caused by impact or falling;

(2) It is forbidden to open the product shell or touch the internal components of the power supply to prevent the product from being easily damaged by static electricity and component stress;

(3) For the built-in DIP switch products, the product has been debugged for the customer for factory setting. It is recommended not to arbitrarily toggle the product switch in the later period. If the switch is wrong, it will cause damage to the product. For details, please read the technical manual operation guide carefully, or consult our technicians operator later;

(4) When the power supply is power on, please do not approach the power supply or touch the radiator and power supply case in order to avoid possible injury to the body in case that the power supply works abnormally.

1.2.Cautions

(1) Before powering on the product, please confirm that the input, output and signal pins of the product, as well as the necessary peripheral components have been correctly connected in accordance with the product technical manual. At the same time, confirm whether the screws are tightened, and whether the wiring ends are clamped, and whether the indication LED light is on or not, after input power on;

(2) AC/DC power supply is a primary power supply, and it must be confirmed to comply with the corresponding safety regulations during application;

(3) The input end of the power supply is dangerous and must be inaccessible to the end user. The equipment manufacturer must also ensure that the input and output of the power supply are not easily short-circuited by the engineer or by the metal parts left around it;

(4) The relevant application circuits and parameters are for reference only, and the parameters and

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circuits must be verified before completing the application circuit design;

(5) If the equipment using AC/DC power supply does not work for a long time, it should be turned on for half an hour every six months to recharge the electrolytic capacitor to ensure the life of the power supply. **Conventional AC/DC products are not suitable for long-term working in high temperature environments. If you must use them in this way, it is recommended to replace them with new ones every two years.** There should be no large heating devices near the power supply, such as CPU, motor, etc.;

(6)The power supply may have a slight noise in no-load or light-load working status, which is normal and does not affect the reliability of the product.

(7) The power converter is one kinds of components, and the installation and use must be designed and guided by professional designers;

(8) When used in a closed environment, the housing of the power supply should be close to the housing of the device, and thermally conductive glue should be added;

(9) The withstand voltage test is the ultimate destructive test, it is suggested not conduct the test multiple times;

(10) The product output has a built-in LED indicator light, which can be viewed to identify the working status of the power supply. If the LED light is always on, it means the power supply is working normally, and the LED light is long off or flashing, which means the power supply is working abnormally;

(11) Changes to this guide cannot be guaranteed to notify customers immediately. In actual use, please pay attention to the latest instructions. For other issues, please refer to "Analysis of Common Failures of AC/DC Power Supply".

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2. MORNSUN Enclosed / DIN-Rail AC/DC Selection Guide

First of all, please determine the specifications of the required power supply, and screen according to the corresponding indicators to confirm whether the standard power supply is suitable or need to customize. Figure 2-1 is the basic block diagram of our AC/DC power supply products.

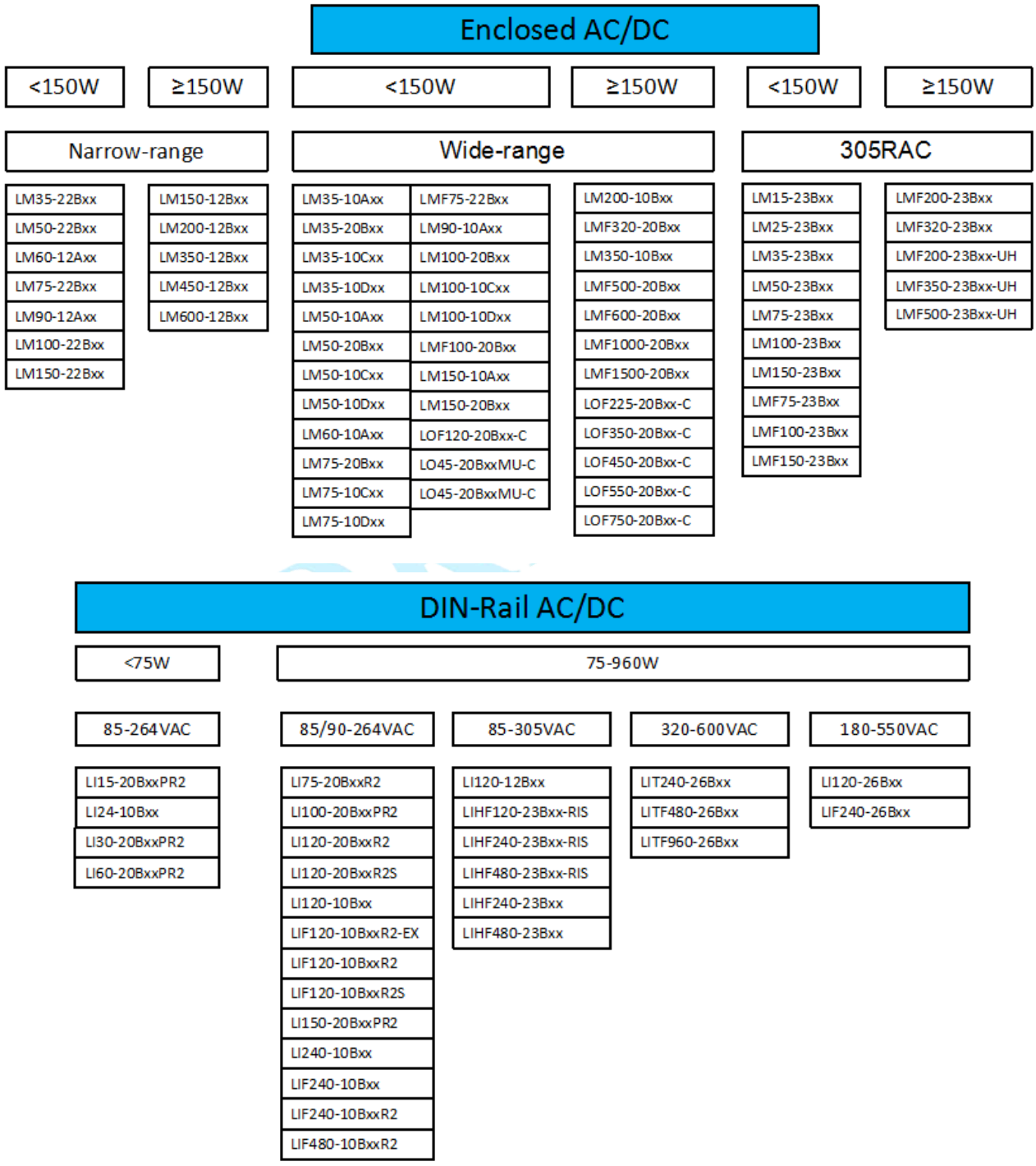

Figure 2-1 Enclosed/DIN-Rail AC/DC Selection Diagram

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Notes：

1.Part No. with an “F” is PFC function build-in, such as LMF100-20Bxx;

2.Part No. with the suffix “-Q” is with conformal coating;

3.Part No. with the suffix “-C” is with PIN cover;

4. Due to the continuous development, technological breakthroughs and innovations, the launching of new products will inevitably lead to the updates of the selection diagram.

According to the selection figure 2-1, select the product:

Step 1, Confirm the product package type.

There are two kinds of packages in this application guide, enclosed and DIN-Rail package to meet the different applications system environments;

Step 2, Confirm the power of the product.

The actual power should be lower than the rated power in order to leave some margins;

Step 3, Confirm the input voltage range of the module.

Generally, the AC input product also supports DC input. For the input voltage range, refer to Figure 2-1;

Step 4, Select the appropriate output voltage and number of channels according to the type of load.

The output voltage of our products generally include 5V, 12V, 15V, 24V, 27V, 36V, 48V, ±12V, ±15V, etc. Unconventional voltage requirements can also be achieved through series combination. For example, the series combination of two LM50-20B05 products can achieve 10VDC output, the series combination of LM50-20B05 and LM50-20B12 can achieve 17VDC output;

Step 5, Select the isolation nature of the module

The isolation makes the input and output of the module completely separated (non-common ground) from each other. In the industrial system, the safety isolation is required for facing harsh environments (lightning strikes, arc interference) and also help to eliminate ground loops. In hybrid circuits, noise isolation of sensitive analog circuits and digital circuits is achieved. In multi-voltage power supply, realizing voltage conversion in the system. The isolation voltage of our AC/DC products generally have 3000VAC and 4000VAC optional. Simple non-isolated design can choose our non-isolated products. It is recommended to use standard power supply as much as possible to

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ensure that the product has the advantages of higher price and performance ratio and reliability, and fast sample delivery. For higher isolation, ultra-wide input voltage range, high temperature environment, EMC certification and other special performance requirements, it is recommended to consult our FAE engineers.

2.1. AC/DC Power application description

2.2. Basic test circuit connection

Single output product testing connection as shown in Figure 3-1

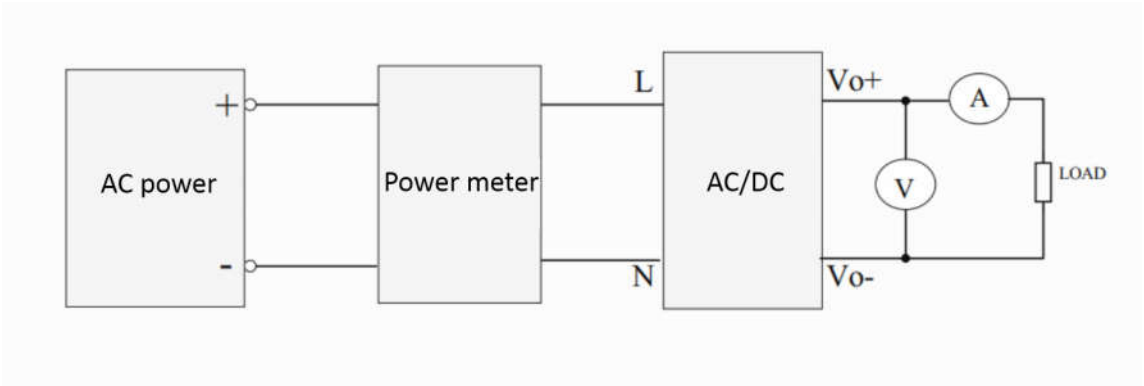

Figure 3-1 Single output product testing connection

Multi-output product test connection as shown in Figure 3-2

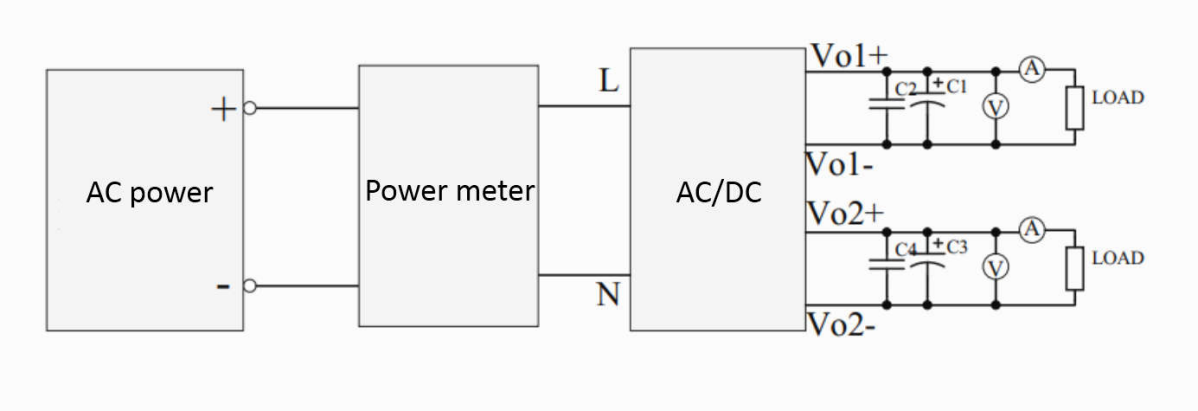

Figure 3-2 Multi-output basic test circuit connection

(1) C1 and C3 are output filter electrolytic capacitors. It is recommended to use high-frequency and low-resistance electrolytic capacitors. Refer to the recommended specifications in the technical manual for capacitance selection. The capacitor withstand voltage derating is greater than 80%.

(2) C2 and C4 are ceramic capacitors to remove high-frequency noise. Please refer to the datasheet to select their values.

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Note: For triple output or Multiple-output version, the primary side application circuit is the same, and the secondary side can be regarded as two or three independent converters to select filter parameters.

2.3. Product typical application circuit

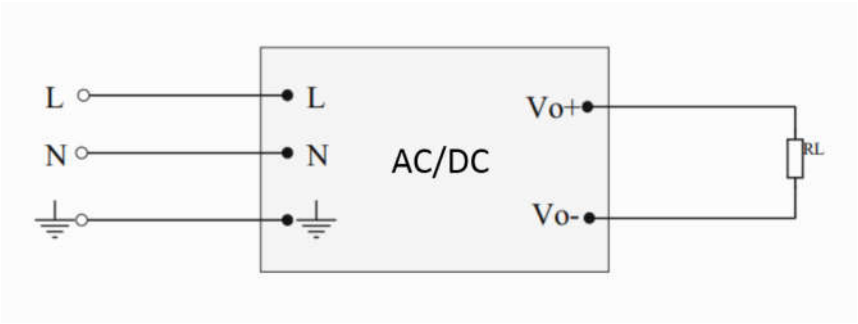

Figure 3-3 Application circuit diagram of conventional products

2.4. Load requirements for multiple outputs

For conventional multiple-output power supplies, generally only the main output is designed for voltage regulation, and the output voltage accuracy of each auxiliary output is greatly affected by the load. Therefore, each output of the product is required to have a balanced load of equal proportion.

e.g. The dual output product model is LM50-10D0512-20, the full load of main output is 6.0A, the full load of auxiliary output is 2.0A, if the customer's actual use of the main output load is 3.0A, then balance according to the load ratio, the auxiliary outputs that needs to be brought should be 1.0A.

If the customer has higher requirements for the accuracy of the auxiliary output voltage, please add a low-dropout linear regulator behind the auxiliary output (mainly used in the occasions where load of the auxiliary output is light and causes the output voltage rising). As shown in Figure3-4.

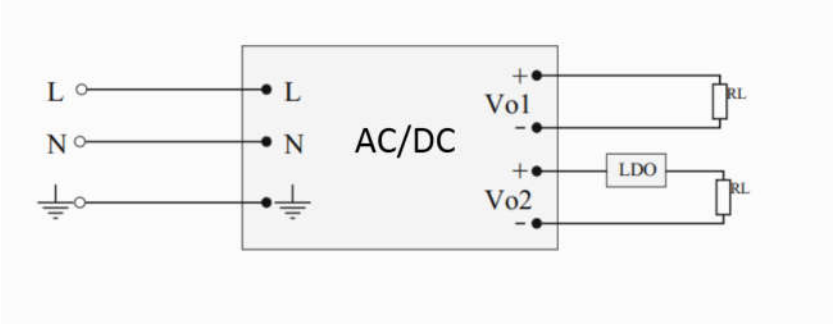

Figure 3-4 Typical application diagram of dual output

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3. Basic performance test

Note: The nominal input voltage of our AC/DC power supply products is 115VAC or 230VAC.

3.1.Output voltage accuracy

Under the conditions of nominal input voltage and full load output, the nominal output voltage required by the specifications is V_{nom}	$\text{Output voltage accuracy} = \frac{V_{out} - V_{nom}}{V_{nom}} \times 100\%$
Measured output voltage under nominal input voltage and full load output conditions V_{out}	

3.2.Linear voltage regulation rate

Under nominal voltage input and rated load, the measured output voltage is recorded as V_{outn}	$\text{Linear adjustment rate} = \frac{V_{outn} - V_{mdev}}{V_{outn}} \times 100\%$
Under the upper limit of input voltage and rated load, the measured output voltage is recorded as V_{outh}	
Under the lower limit of input voltage and rated load, the measured output voltage is recorded as V_{outl}	
Vdev takes the value that deviates from Voutn the most among Voutn and Voutl	

3.3.Load regulation

Under nominal voltage input and 10% load, the measured output voltage is recorded as **Vb1**	$\text{Load regulation rate} = \frac{V_b - V_{b0}}{V_{b0}} \times 100\%$
Under nominal voltage input and 100% load, the measured output voltage is recorded as **Vb2**	
Under nominal voltage input and 50% load, the nominal value of output voltage is recorded as Vb0	
Vb takes the value that deviates from **Vb0** the most among **Vb1** and **Vb2**	

3.4.Efficiency

Efficiency of AC/DC power supply: The input terminal cannot directly use the multimeter to test the

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product of voltage and current as the input power, and generally use a power meter to directly read the input power pin, the output terminal calculates the output power **Iout** through the actual output load value and output voltage value **Vout** (product output terminal).

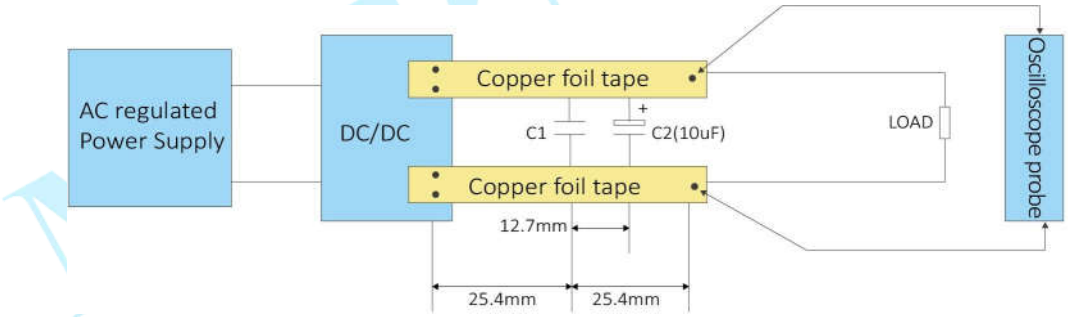
Under nominal input voltage Pin, under full load The test output voltage is recorded as V_{out}	$\text{Efficiency}\eta = \frac{I_{out} \times V_{out}}{P_{in}} \times 100\%$

Note: The input is AC mode. Due to the presence of inductance and capacitive reactance inside the product, the phase difference between the input voltage and current and the distortion of the input current waveform are caused.

3.5.Ripple Noise

3.5.1 Ripple and noise test method

Ripple and noise are periodic and random AC components superimposed on the DC output. It also affects the output accuracy. Generally, peak-to-peak measurement (mVp-p) is used for ripple and noise. It should be noted that the test methods and conditions used by different models are different. For details, refer to the product datasheet and select according to the data sheet.



Parallel cable measuring method

Since the ground clamp of the oscilloscope will receive various high-frequency noises and interfere with the measurement results, in order to reduce shielding interference and ground interference, the PE pin of the oscilloscope input line (power line) is not grounded, and use the power line of the LN two ends (no PE pin). Figure 4-2 shows the actual test ripple and noise waveform.

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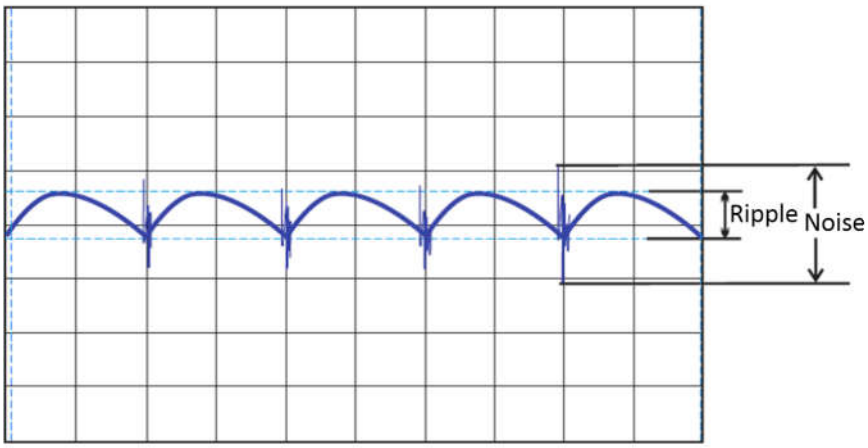

Figure 4-2 Waveform of Ripple and Noise Test

Note: The ripple and noise test methods include parallel line test method or twisted-pair cable measuring method. Since the product is wired, these two methods are not applicable. For detailed test methods, see "ACDC Power Module Application Guide".

3.6.Isolation and Insulation

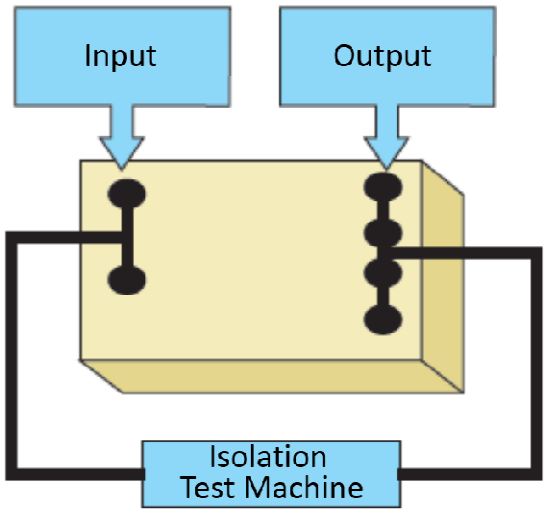

Figure 4-3 Isolation Test

Withstand Voltage Test Method：

The wiring diagram is shown in Figure 4-3. According to the withstand voltage test standard, slowly increase the withstand voltage value from 0V. When it is adjusted to the set value, keep it at the set value for 1 minute.

Insulation：

Short-circuit the input and output pins respectively, and add isolation voltage (DC or AC peak value,

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according to the isolation voltage given in the datasheet) between the input and output and test for 1 minute.

4.FAQ

4.1. Grounding Input and Output

Input Ground：

1. Generally speaking, there is 3 pins of input terminals of AC/DC power, live wire L, neutral wire N, and protective ground PE. PE is usually connected to the ground wire of the equipment or the power grid.

2. Some customers do not connect PE on their application. Products without PE can still work well, but it will mainly affect the EMC performance and leakage of the product, and the safety level of the product will be reduced (Fail to meet the certification standards). Therefore, it is not recommended that customers use it without PE.

Output Ground：

In practical applications, some customers directly connect the output ground to the protection ground, as shown in the left figure below. This connection may cause abnormal or damage to the product output due to interference from lightning surges, group pulses, etc. Therefore, it is not recommended to connect the output ground to the protection ground. The ground is directly connected, and the internal circuit of the product has been connected through a safety Y capacitor.

4.2.Inrush Current

There are 2 types of inrush current: peak current at the moment of product start up (usually called the product start up inrush current) and the current formed by the huge surge voltage induced during the working process. To suppress the peak current at the start of the product, the main solution is to add a protective device thermistor or winding resistance at the input to reduce the surge current, and the surge current generated by the high voltage is mainly protected by the varistor and vented through the varistor to release energy.

4.3.Leakage Current

There are two concepts of leakage current. One is the leakage current between the input end and the protective ground during the normal operation of the product; the other is the leakage current

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between the isolation bands during the withstand voltage test of the product.

4.4.AC and DC Input

AC/DC power input end generally uses full-bridge rectification to meet both AC and DC power supply modes.

4.5.Relationship between category I & II Equipment and protective ground PE

EN62368 has clear definitions for category I & II equipment:

Category I equipment refers to the use of basic insulation and a connecting device to connect conductive parts that will carry dangerous voltage, if the basic insulation fails to connect to the protective grounding conductor in the building wiring. Category I equipment has a protective ground PE pin, such as our other ACDC conventional LH series products.

Category II equipment refers to equipment that not only relies on basic insulation, but also takes additional safety protection measures (such as equipment with double insulation or reinforced insulation). This type of equipment does not rely on protective grounding or protection measures for installation conditions. Category II equipment does not have a protective ground PE pin, such as our other ACDC conventional LS\LD series products.

4.6.Input Transients

The voltage transient of the input power line is destructive to the power product. If the power transient at the input end is higher than the high limit of the product input, a protection circuit must be added to the input end.

4.7.Output without Load

The minimum load of a single-output product is no-load. For conventional multi-output power supplies, generally only the main output is designed for voltage regulation, and the output voltage of each auxiliary output will drift high. Therefore, products with multiple outputs will have output voltage exceeding when there is no load. The specifications may reach 20% or more. Therefore, in actual applications, the minimum load is recommended to be 10% of the full load. Refer to the product data sheet for actual use; if the no-load situation cannot be avoided, it can be used on the basis on the customer's application environment and other conditions. Customer can add a dummy load at the output end of the auxiliary output. For specific application parameters, please consult our FAE.

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4.8.Working Temperature

If the product works in a high temperature environment, the temperature of its internal components is much higher than that of the environment. In order to ensure the reliable operation of the product, the highest ambient operating temperature for conventional products is generally 70°C. When the ambient temperature reaches 50°C (according to the product's data sheet), derating is required; while working at low temperatures, due to the low temperature characteristics of internal electrolytic capacitors and other components, there are also power derating requirements. At the same time, the output ripple noise will be larger than the normal temperature value. For the specific content of the derating curve, please refer to the data sheet.

4.9.Voltage Printed on Product Casing

There are generally three types of product voltage indications:

(1) The product silk screen is marked as 100VAC-240VAC, why is the data sheet shows 85VAC-264VAC? Mainly for the consideration of safety certification. Generally, when testing products, certification agencies will test their performance according to the input voltage range on the product silk screen label by ±10% or even ±15%. Therefore, the product silk screen label in the industry generally indicates that the input voltage range is 100VAC- 240VAC;

(2) The product silk screen is marked as 185~240VAC. This is to meet the needs of some countries where the input voltage is about 220VAC. Due to the fluctuation of the input voltage, the data sheet is defined as 165~264VAC;

(3) The product silk screen is marked as 100~120VAC and 200~240VAC, and the side of the product is integrated with DIP switches to meet the input voltage requirements of different countries. For detailed operation instructions, please refer to the data sheet of the specific product;

4.10.Anti-Radiation Interference

The internal circuits of the switching power supply, such as the control circuit and loop regulation circuit, will affect its normal operation when encountering strong radiation. The radiated immunity test standard of switching power supply is IEC/EN61000-4-3 10V/m. Under this condition, the test power supply can work stably. When encountering strong radiated interference, such as walkie-talkie and other strong radiating equipment, when close to the switching power supply used, the radiation intensity generated is several times or even dozens of times more than the laboratory

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test conditions, so the switching power supply should be kept away from strong radiation equipment when using it.

4.11.EMC Recommended Peripheral Circuit

The front-end input of AC/DC power supply is with high voltage so the power supply environment at the input end is relatively complicated. The product has integrated EMC circuit, and the EMC level also meets industrial level 4, which meets most application environments. Therefore, there is generally no need to add EMC protection circuit at the input end. If you need to further improve the EMC level requirements, please communicate with our FAE.

4.12.Power Sequence Requirements

When there are multiple systems or multiple functional circuits starting to work together, the control circuit is generally required to work first to ensure the system can be initialized normally, and then all components are normally charged. Therefore, when selecting a power supply to supply power to various systems or functional circuits, if the system has high timing requirements, it is necessary to focus on the startup time of the power supply; and in the case of abnormal power supply, the control circuit is required to be powered down to ensure the entire system to close normally. Therefore, the retention time of the power supply also needs to be paid attention to.

4.13.Adjustable Output Voltage

If the output voltage of the product is adjustable, the adjusting range is generally ±10%. The actual range and operation are detailed in the product datasheet. If the output voltage is increased, the total output power of the product cannot exceed the rated power. Such as LM50-20B24, the rated power is 50W, output rated voltage 24V and output rated current 2.2A. If 28V is actually required, the output current is only 1.78A, and the power is still 50W; if the output voltage is lowered, and vice versa. For multi-output products, please pay attention to the main output change, the auxiliary output will change according to the output voltage ratio, such as LM50-10D0512-20, if the main output voltage is adjusted to 5.5V, the auxiliary output voltage will rise to about 13.2V;

5. AC/DC Power Supply Application Safety Design

5.1.Mark Requirements

At the protective ground and switch, the marking specifications and symbols must be clarified in

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accordance with the safety regulations, and the dangerous voltage and energy that can be touched are marked with danger warning signs.

5.2.Material Requirements.

The input L, N, PE connection wires use brown, blue and yellow-green wires respectively. Equipment (Class I equipment) that relies on basic insulation and protective ground to prevent electric shock needs to ensure that the grounding wire (yellow-green wire) is well connected to the ground, and the grounding resistance is less than 0.1Ω.

5.3.Electrical Clearance and Creepage Distance

Before the fuse, ensure that the electrical clearance between L and N is more than 2mm and the creepage distance is more than 2.5mm. The electrical clearance between the input and the metal shell or SELV circuit is more than 5mm and the creepage distance is more than 6.4mm (In high altitude applications, if you need to add additional creepage distance for electrical clearance, please contact our FAE for details)

6.Thermal Design for Power Applications

6.1.Air Cooling

Most of AC/DC power supply products use air cooling as the main heat dissipation method. Generally, there are mainly the following ways to dissipate heat:

(1) The heat is transferred from the power module housing and exposed surface to the air through natural convection. If there is a gap between the power metal bottoms, it will also be transferred to the surrounding environment through the channel;

(2) Radiation from the exposed shell of the module to the surface of surrounding objects or from the bottom of the power supply to the metal plate through radiation;

(3) It is transmitted to the metal plate through the screw by conduction

6.2.Add Forced Radiator Fan

(1) Some high-power products have their own fans. In many application systems, even if the products without fans are equipped with heat sinks, the working conditions of the power supply cannot be improved very well. In this kind of system with heat dissipation difficulty, it is necessary to add a forced radiator fan as the main heat dissipation method.

The general guideline for fan installation is that for long shape power modules, the blowing

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direction of the fan should be horizontal, and the blowing direction of the fan in the channel should be vertical to form a "chimney effect" and facilitate heat dissipation. In addition, a layer of thermal grease or other thermally conductive fillers can be applied between the fan and the power supply casing to make the connection between the fan and the power supply casing (or power supply metal substrate) tight to reduce thermal resistance, but do not cause the power supply due to excessive tightening The housing (or the metal substrate of the power supply) is deformed.

In high altitude conditions, due to thin air and atmospheric pressure, the heat dissipation of the system itself is relatively poor. In order to reduce the temperature rise of the system, mandatory heat dissipation or derating must be used.

(2) For products with a fan, the fan will not work when the product is under no load, light load, or just started (the internal temperature rise of the product is low). When the product has high internal temperature, the fan will automatically start to work, reducing the internal temperature rise.

7. Power Application Installation Method

7.1.Bottom Installation Method (Enclosed)

(1) There is a screw hole at the bottom of the power supply. Customers can match the corresponding screw installation according to the application environment. Please pay attention to the depth of the screw deepening into the power supply, to avoid damage to the product due to the screw piercing the internal insulating sheet of the power supply. The specific specifications need to be based on the product data sheet and the customer's application environment. In order to improve the heat dissipation coefficient, it is recommended to add heat dissipation paste between the bottom of the product and the mounting base.

(2) If you do not want to use the bottom screw hole for installation, our company can offer L-shaped accessories, which can be installed from both sides. Please refer to the datasheet for details.

7.2.Side Mounting Method (Enclosed)

There are screw holes on the side of the power supply. Customers can match the corresponding screw installation according to the application environment, similar to the rail installation. Please pay attention to the depth of the screw deepening into the power supply, to avoid damage to the product due to the screw piercing the internal insulation sheet of the power supply. The specific

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specifications need to be based on the product datasheet and depending on the customer's application environment. In order to improve the heat dissipation coefficient of the product, it is recommended to add heat dissipation paste between the side of the product and the mounting base.

7.3.DIN-Rail Installation Method (DIN-Rail)

The back of the power supply is equipped with a rail spring buckle, which can be directly installed on the rail metal. It is automatically locked and has screw holes on the side. If the long side of the product is close to the metal plate, in order to improve the heat dissipation coefficient, it is recommended to add thermal grease between the side of the product and the metal plate in between.

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