PVA Power Supply Application Guide 2022

I. Foreword

Improper installation and use of the product may result in dangerous situations such as electric shock, module damage or fire. Please read and confirm the following warnings and precautions carefully before using the power module.

A. Warnings

a) Handle with Care. Impact or dropping will cause damage to the module;

b) Do not open the module's case or touch internal devices to avoid static, device stress, and other easily damaged conditions;

c) It is forbidden to bend the pins of the product to prevent the internal PCB from breaking and causing the short circuit of electrical connection and abnormal work of product;

d) When the module power supply is operating, do not approach the module or touch the heat sink and case to avoid possible bodily injury in case of the module's abnormal operation.

B. Precautions

a) Make sure that the product's input/output terminals and necessary peripheral components are connected properly as the "design reference" and "Dimensions and Recommended Layout" in the datasheet before powering the product.

b) It is recommended to connect a fuse in the input line to meet the safety requirements in operation. Please refer to the datasheet for the recommended fuse part number.

c) The input voltage of the PVA power supply is high, it's necessary to ensure that the end user is not exposed to it to avoid danger. Also, the equipment manufacturers must ensure that the input and output of the module are not easily short-circuited by the operator or the left metal components.

d) Relevant application circuits and parameters are for reference only. The parameters and circuits must be verified before completing the circuit design.

e) If the converter is stored or does not work for more than half a year, it is suggested to have the converter aged for 1 hour with no load every half a year to ensure its lifetime and reliability.

f) If the equipment using the PVA power module does not work for a long time, it should be turned on and work for half an hour every six months to recharge the electrolytic capacitor (according to the capacitor datasheet) to ensure the power module's lifetime. The conventional PVA power module is not suitable to operate under a high temperature for a long time. If it is necessary, it is recommended to replace the product every one or two years. The power supply module should not be placed near large heating devices, such as CPU, motor, etc.

g) The module power supply may make a slight noise in no-load or light-load working status, which is normal.

h) The module power supply is a component. Please install and use it under the guidance of professional designers.

i) If operated in an enclosed environment, the case of the converter should be contacted the device shell with heat-conductive glue.

j) The withstand voltage test is limited destructive test and the converter should not be tested multiple times.

k) Changes to this Guide cannot be guaranteed to notify customers in time. In actual use, please pay attention to the latest instructions.

II. Selection Guide

Firstly, determine the specifications of the required power supply. Then, filter the power supply module according to the corresponding indicators, and confirm

whether to use standard modules or need customization.

Figure 2-1 is the basic selection block diagram of PVA power supply products.

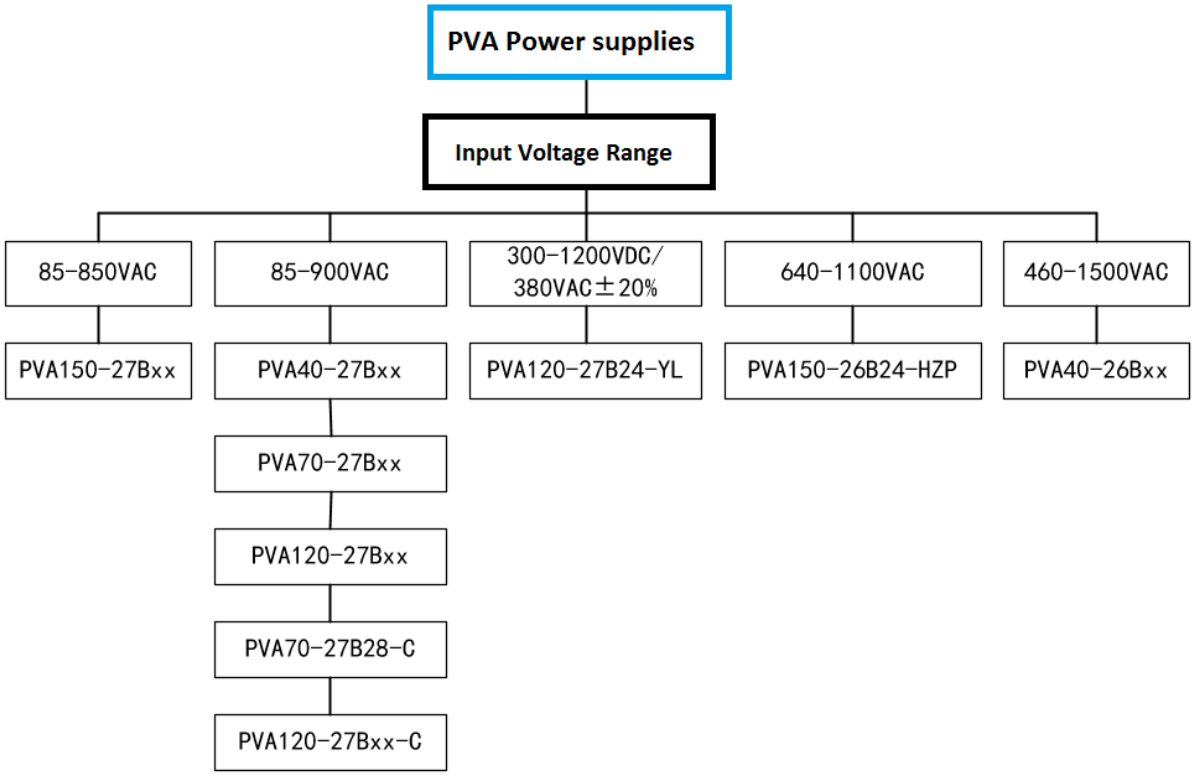

Diagram 2-1 Selection Block Diagram

Note: Due to the company's continuous development and technological breakthroughs and innovations, the launch of new products will inevitably lead to an update of the selection diagram.

Firstly, Confirm the Input Power Range

As shown in Figure 2-1, our PVA power supply is divided into 5 types of input ranges: 85-850VAC, 85-900VAC, 300-1200VDC/380VAC ± 20%, 640-1100VAC, 460-1500VAC. Please choose the appropriate product for the actual input voltage range.

Secondly, Confirm Power and Package According to Load.

MORNSUN offers PVA series products with powers of 40-150W, with the packages of

enclosed or open-frame.

Thirdly, Confirm Output Voltage According to The Type of Load.

The output voltages of our PVA products are generally 12V, 18V, 24V, 28V, 30V, 35V, etc. (some special voltages can be customized).

Fourthly, Select the isolation characteristic of the module.

The isolation characteristic of the module enables the input and the output of the module as two completely separate (non-common ground) power supplies. When the system faces a harsh environment (lightning, arc interference) to be safe isolation, isolation characteristics play a role in eliminating ground loops. In hybrid circuits, the isolation characteristic is applied to isolate the noise from sensitive analog and digital circuits. In a multi-voltage power supply system, it helps the conversion of the voltage. The isolation voltage of PVA series products is 4000VAC. For special products, please refer to datasheet.

It's recommended to use standard power converter, to ensure that the product is more cost-effective, reliable and shorter sample delivery time. For higher isolation, wide input voltage range, high temperature environment, EMC and other requirements, please consult MORNSUN FAEs.

III. Peripheral Circuit Descriptions

PVA power converter is mainly used in high-voltage applications such as coal mines where the electromagnetic environment is relatively harsh, mainly need to consider the EMS protection. Generally, the PVA power converter has an integrated EMC protection circuit, so only needs to add a fuse and a current limiting resistor to the peripheral circuit (for details, please refer to the datasheet). As shown in diagram 3-1, the typical protection circuit basically meets EFT IEC/EN61000-4-4 ± 4KV, Surge immunity IEC/EN61000-4-5 ± 2KV and ESD IEC/EN61000-4-2 Contact ± 6KV.

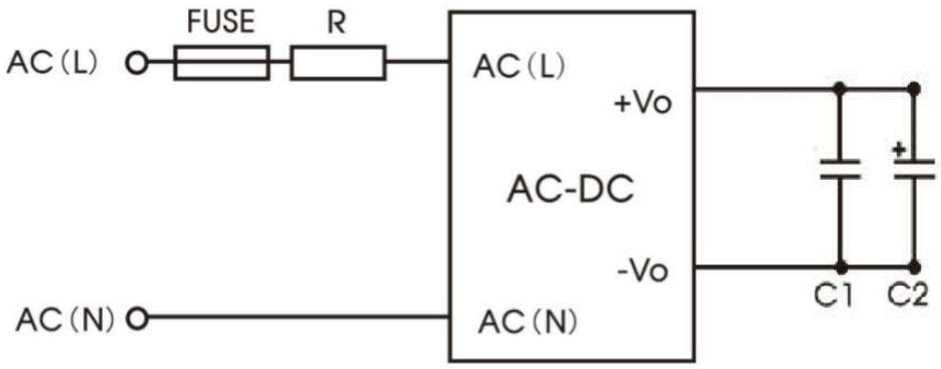

Diagram 3-1 EMC Solution-recommended Circuit

IV. Basic Electrical Performance Testing Suggestions

A. Output Voltage Accuracy:

V_{nom} : output voltage at nominal input voltage and full load V_{out} : tested output voltage at nominal input voltage	Output voltage accuracy $= \frac{V_{out} - V_{nom}}{V_{nom}} \times 100\%$

B. Line Regulation:

V_{outn} : output voltage at nominal input voltage and rated load V_{outh} : output voltage at rated load when input voltage at its upper limit V_{outl} : output voltage at rated load when input voltage at its lower limit V_{mdev} : V_{outh} or V_{outl} which is deviated from V_{outn} more	Line regulation $= \frac{V_{outn} - V_{mdev}}{V_{outn}} \times 100\%$

C. Load Regulation:

V_{b1} : output voltage at nominal input voltage and 10% load V_{b2} : output voltage at nominal input voltage and 100% load V_{b0} : output voltage at nominal input voltage and 50% load V_b : V_{b1} or V_{b2} which is deviated from V_{b0} more	Load regulation $= \frac{V_b - V_{b0}}{V_{b0}} \times 100\%$

D. Efficiency:

V_{in} : nominal input voltage I_{out} : output current at full load V_{out} : output voltage at full load I_{in} : input current	Efficiency $\eta = \frac{Iout \times Vout}{Iin \times Vin} \times 100\%$

E. Ripple & Noise:

Ripple and noise is the periodic and random AC variation superimposed on DC output, which affects output accuracy and usually is calculated with peak-to-peak (mV$_{P-P}$).

Firstly, set oscilloscope bandwidth 20MHz to effectively prevent high-frequency noise.

Secondly, test with parallel cable measuring method, twisted-pair cable measuring method, or contact measuring method as shown in diagram 4-1.

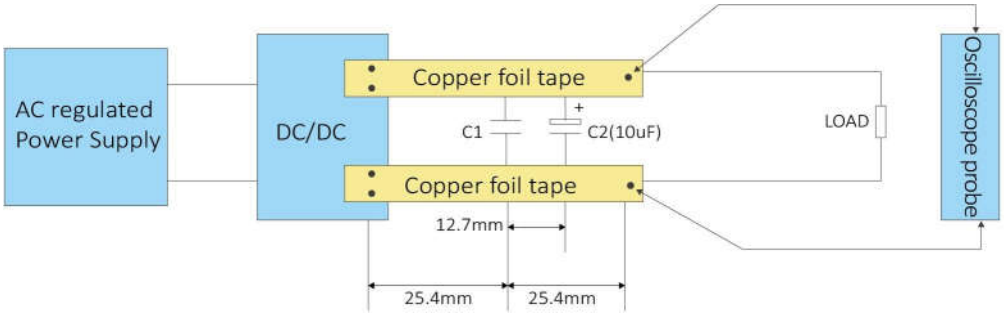

Diagram 4-1 Parallel cable measuring method

Notes:

a) C1= 1uF (high-frequency ceramic capacitor).

b) C2: an electrolytic capacitor with 10uF capacitance. The withstand voltage should derate 80% or more, consistent with datasheet.

c) Distance between two paralleled copper foils is 2.5 mm and, of which the sum of voltage drops should be less than 2% of nominal output voltage.

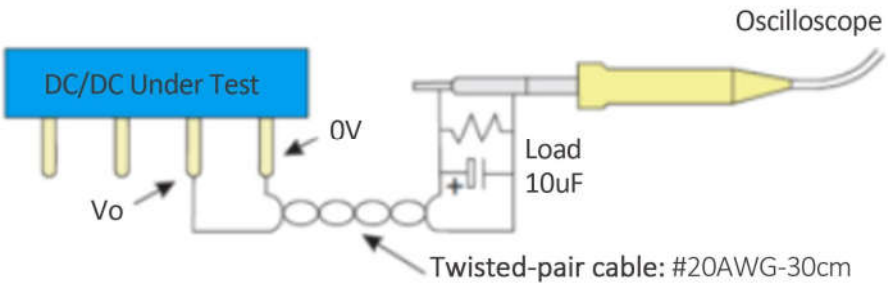

Diagram 4-2 Twisted-pair cable measuring method

Another is with the twisted-pair cable measuring method as shown above in diagrams 4-2. Connect tested power supply Vo and 0V with a twisted-pair cable which is composed of 30cm length and #20AWG, and then connect a dummy load between them. Next, connect a 10μF electrolytic capacitor at the end of the twisted-pair cable, which connects the end of the oscilloscope's probe at one terminal and connects to the ground at the other.

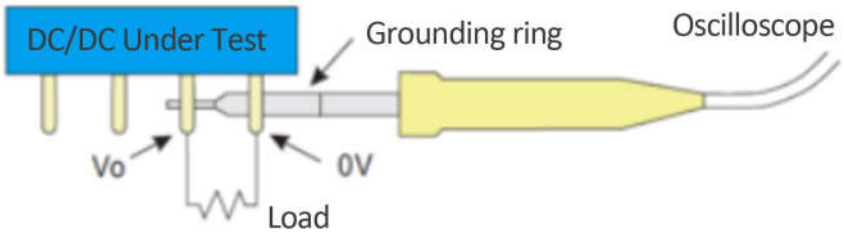

Diagram 4-3 Contact measuring method

The contact measuring method, as shown in diagram 4-3, is usually adopted for oscilloscope to shield interference. Because the oscilloscope's ground clip could absorb various high-frequency noises, affecting test results. The actual tested ripple and noise vary depending on a different circuit and external components. Diagram 4-4 shows the actual tested ripple and noise waveform.

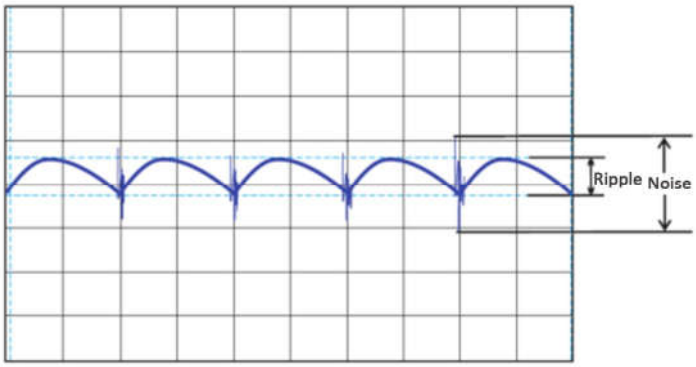

Diagram 4-4 Waveform of Ripple & Noise Test

F. Isolation and Insulation:

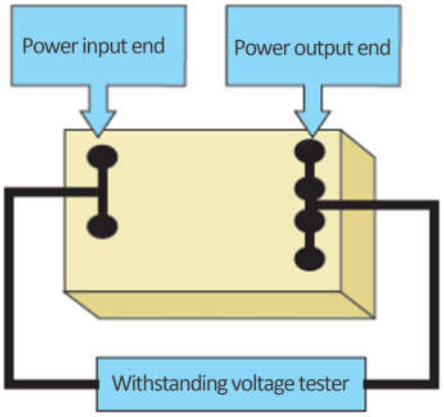

Diagram 4-5 Method of Withstand Test

Withstand test: According to withstand test standards, withstand value shall be set from 0 slowly upward and remain 1 minute at the set value. Diagram 4-5 shows the connection of wires.

Insulation test: Short circuit the input and output pins, then apply isolation voltage between them and test it for 1 minute.

G. Trim Function for Output Voltage Adjustment

The output voltage ± 10% around its rated value can be adjusted by adding a resistor at the TRIM terminal. Please refer to below schematic diagram 4-6.

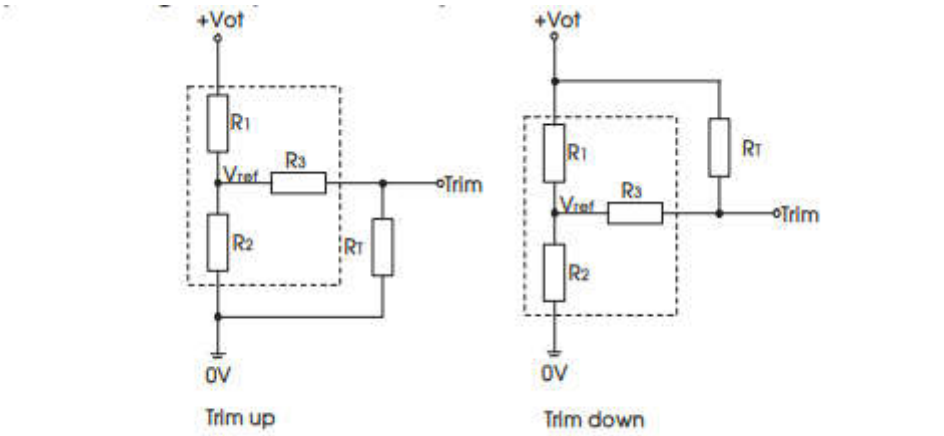

Diagram 4-6 Output Voltage Adjustment Schematic Diagram

"up" means output voltage increasing, "down" means output voltage decreasing, and the R_T's calculation method is as follows. R1, R2, R3 resistors are the internal resistors of the module, the parameters have been fixed, so does the Vref (please refer to the datasheet for their values).

Calculating Trim resistor values:

$$\text{up: } R_T = \frac{aR_2}{R_2 - a} - R_3 \qquad a = \frac{Vref}{Vot - Vref} \cdot R_1$$

$$\text{down: } R_T = \frac{aR_1}{R_1 - a} - R_3 \qquad a = \frac{Vot - Vref}{Vref} \cdot R_2$$

RT = Trim Resistor value;
a = Self-defined parameter;
Vot = Target output voltage

V.FAQs

A. How to Select a Fuse Used at The Input Terminal

The input terminal of the PVA power supply is a high voltage, and the highest voltage may reach the upper limit of the input range voltage. Therefore, the requirements for the fuse at the input terminal are very high. In addition to determining the

specifications of the fuse according to the power of the chosen power supply, in order to meet the requirements of safety regulations, the fuse can withstand the high voltage and be selected according to practical application and power supply model. For fuse parameters corresponding to the PVA power converter please refer to the datasheet.

B. Squeaking Noise

The power supply may have a slight noise in some kind of working status, which is normal and does not affect the reliability of the product.

C. Operating Temperature

When the product works in a high-temperature environment, the temperature of its internal components is much higher than that of the environment. The reliable operation of conventional products allows the highest ambient working temperature of 70℃ . Generally, as the ambient temperature reaches 50℃, the power should be derating to use. Please refer to the datasheet corresponding to the product model for the specific content of the derating curve. Diagram 5-1 shows typical working environment temperature derating curve of PVA series with 460-1500VAC input. There will be some differences for specific models, please refer to the datasheet for more details.

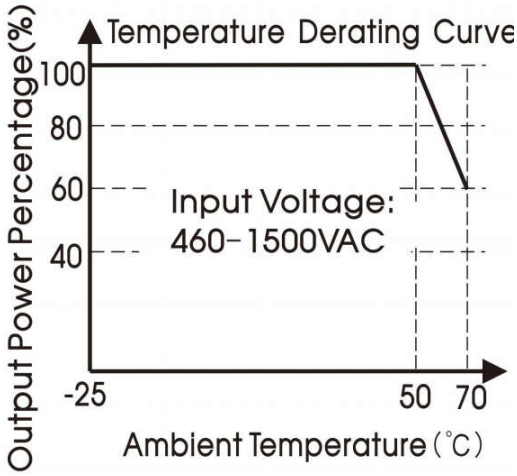

Diagram 5-1 Temperature derating curve

D.Anti-interference from the Radiation

The intense radiation would affect the working of the internal circuits of the PVA power supply, such as the control circuit and the loop adjustment circuit. The radiated immunity test standard of the switching power supply is IEC/EN61000-4-3 10V/m. Under this condition, the testing power supply can work stably. When interfered with intense radiation, such as walkie-talkies and other equipment with intense radiation, the radiation intensity is several times or even dozens of times higher beyond the laboratory test conditions. Therefore, the switching power supply should be kept away from intense radiation equipment while it is used.

E. The output voltage is lower or higher than the rated output

The output voltage of the PVA power supply is lower or higher. The possible reasons are: (1) The output line loss is too large due to the wire distance between the customer's load and the power supply being too long. (2) The adjustable resistor is accidentally touched.

The investigation methods are: (1) Test and compare the voltage of the power supply output terminal and the voltage of the customer's load input terminal. (2) Use a multimeter to directly measure the output terminal voltage to determine whether it is the standard output voltage.

The corresponding solutions are: (1) Shorten and thicken the wire between the power supply and the load; (2) Rotating the adjustable resistor according to the direction on the label, to appropriately adjust the output voltage to meet the actual demand.

VI. Thermal Design for Application

A. Natural Air Cooling

The miniaturized and high-power-density power modules (mainly on-board power modules) use natural air cooling as the primary heat dissipation method due to factors such as size and cost. For high-power modules with metal cases or mesh cases,

and other products, combining with the cabinet shell can be directly used as the installation and heat dissipation methods.

The following methods are generally used to dissipate heat for on-board power modules:

(1) Through the natural convection of air, the heat can be transferred from the power module enclosure and the exposed surface to the air. Even if there is a gap between the power module and the PCB, the heat would also be transferred to the surrounding environment through the channel;

(2) Through radiation, the heat can be radiated from the exposed enclosure of the module to the surface of surrounding objects or from the bottom of the module to the PCB board;

(3) The heat can also be transmitted to the PCB board through the module pins by conduction.

B. Add Mandatory radiator(fan)

In many application systems, even if the heat sink is installed, the working conditions of the power supply cannot be effectively improved. In such systems with difficulty in heat dissipation, adding a mandatory radiator (such as a fan) is necessary as the primary heat dissipation method.

The general guideline for fan installation is that for long power modules, the blowing 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 thereby facilitate heat dissipation. Besides, a layer of heat-conducting glue or other thermally conductive fillers can be applied between the fan and the module to make the fan and the module power supply enclosure (or power supply metal substrate) tightly combined to reduce thermal resistance. Please note that the over-tightened combination would cause the power supply enclosure (or power supply metal substrate) to be deformed.