Ultra-wide High Input Voltage PV Power Supply Application Guide 2022

I. Foreword

Please carefully read and confirm following warnings and precautions before using the module power supply, in case electric shock, damaging the module, fire and other dangerous situations due to improper installation operation.

A. Warnings

a) Handle with Care. To impact or drop 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 vulnerable circumstances;

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) Be not close to the module or touch the radiator and case when it's working, to avoid harms to human body in case of the module's abnormal operation.

B. Precautions

a) Make sure that the product's input/output pins and necessary peripheral devices are connected correctly as the "design reference" and "outline drawing" of product technical manual before powering the product.

b) Connect a fuse at the input terminal in order to meet the safety requirements. Fuse selection please refer to datasheet.

c) Ensure that end-users cannot touch the input terminal of PV power converter because of the high voltage danger. Manufacturers must ensure that the module's input/output will not cause short circuit due to engineers' mistakes.

d) Relevant application circuit and parameters are for reference only. They must

be verified before the application circuit design is completed.

e) If it is stored or not working for more than half a year, it is recommended that customers give it no-load burn-in for 1 hour every six months to ensure the service life and application reliability of the product;

f) If the equipment using PV 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 (the basis of capacitor charging is provided by the capacitor specification) to ensure the life of the module. Conventional PV products are not suitable for long-term work in an excessively high temperature environment. If it must be used in this way, it is recommended to replace new products regularly every two years. And there should be no large heating devices near the power module, such as CPU, motor;

g) When the module power supply is no-load or light-load, if there is a slight noise inside the module, it is normal;

h) The module power supply is a component, and its installation and use must be designed and guided by professional designers;

i) When it is applied in a closed environment, the shell of the module should be close to the shell of the device, and thermally conductive glue should be added;

j) The electric strength test has extreme destructive effect, so it is not allowed to do it for many times;

k) Please note that guide's subject to alterations without notice. In practical application, please refer to the latest instructions.

II. Selection Guide

The first step is to confirm specifications of the power supply and then determine to choose a standard power converter or a customized one according to requested parameters. Diagram 2-1 shows MORNSUN PV series.

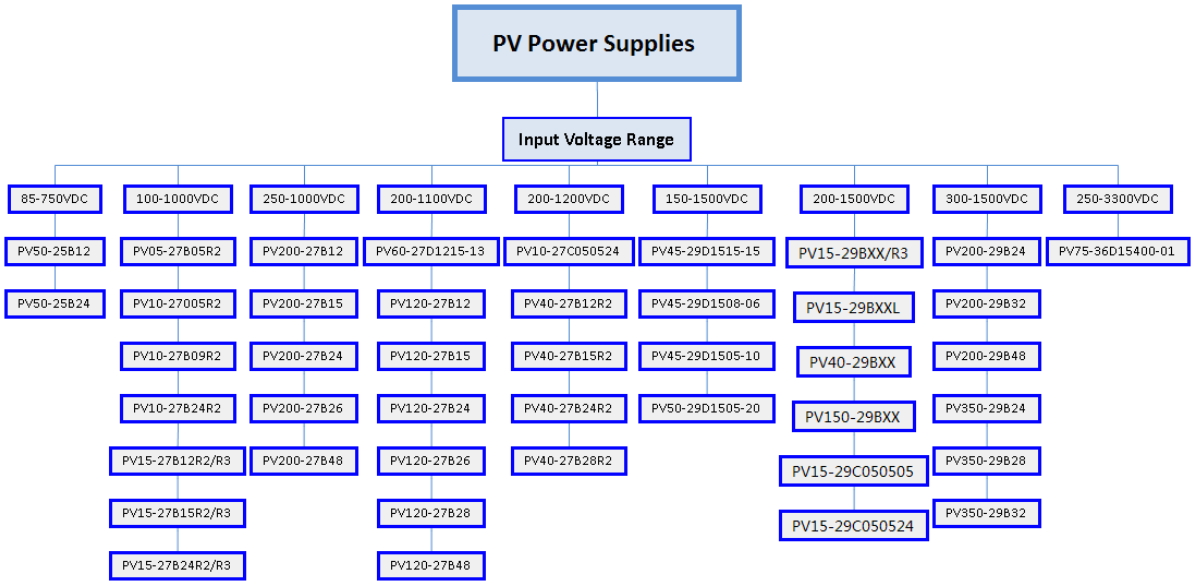

Diagram 2-1 Selection Block Diagram

Note: Above diagram will be updated with the company's continuous development and technological innovation.

Firstly, Confirm the Input Power Range

As shown in Figure 2-1, our PV power supply is divided into 11 types: 100-1000VDC, 250-1000VDC, 200-1100VDC, 200-1200VDC, 150-1500VDC, 200-1500VDC, 300-1500VDC, and 250-3300VDC. Please choose the appropriate product for the actual voltage range used.

Secondly, Confirm Power and Package According to Load.

MORNSUN offers PV series products with powers of 5-200W, with various product packages including horizontal package, squirrel-cage package, open-frame package,

metal shell package, and non-horizontal package. Non-horizontal package is named with the original product's name plus a suffix. For 5-15W, products suffixed with A2 are chassis mounting, with A4 DIN-Rail mounting. For PV15-29BxxL and PV40-27Bxx series of products, products suffixed with A5 are chassis mounting, whose size is enlarged on the basis of A2, and with A6 are DIN-Rail mounting, whose size is enlarged on the basis of A4. Products suffix A7 are chassis mounting with integrated EMC circuits. For PV15/40-29Bxx series products, the suffix A8 is a DIN-Rail mounting with integrated EMC circuits, and the suffix A10 is a DIN-Rail mounting with non-integrated EMC circuits. Such as PV15-27B12R2A2 or PV15-27B12R2A4. For more details please refer to datasheet.

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

The output voltage of our products is generally 5V, 9V, 12V, 15V, 24V, 26V, 28V, 30V, 32V, 48V, etc. (some special voltages can be customized after consultation).

Fourthly, Confirm Isolation.

Isolation makes input and output of the converter completely separate from each other (separate ground connection). It helps rise the loop's resistance in industrial bus system, isolates noise in analog circuit and digital circuit in hybrid circuit and converts voltages in multiple voltage power system, achieving safely isolation in harsh environments (lightning, arc interference). MORNSUN PV series offer isolation of 4000VAC. For special applications, 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

PV power converter is mainly used in high-voltage application where the environment is relatively harsh, including photovoltaic power generation, high-voltage frequency conversion, SVG, high voltage energy storage, ultra-high voltage etc. It’s suggested to connect a necessary protection circuit in practical application as shown in diagram 3-1, whose both CE and RE meets CISPR22/EN55022 CLASS A, pulse group immunity IEC/EN61000-4-4 ± 4KV and surge immunity IEC/EN61000-4-5 ± 2KV. Diagram 3-2 shows recommended circuit-layout and details please refer to datasheet. Please note the safety requirements of wiring.

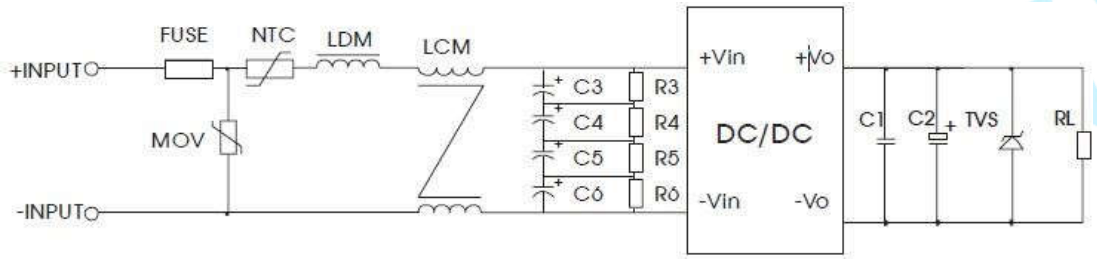

Diagram 3-1 EMC Solution-recommended Circuit

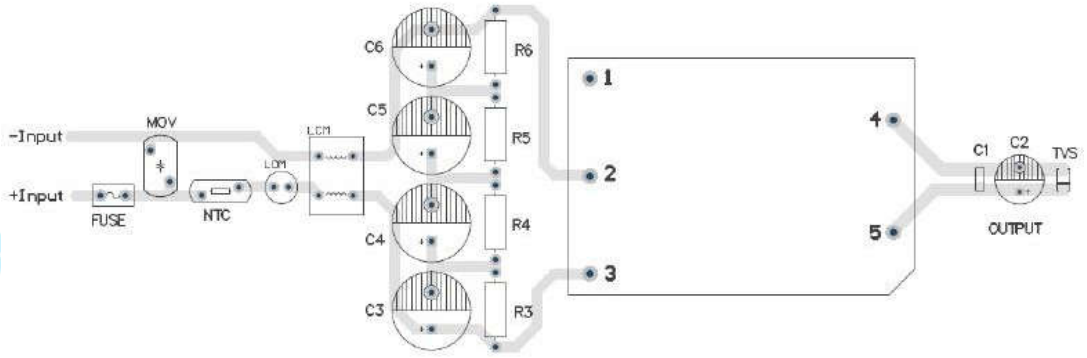

Diagram 3-2 Recommended Circuit Layout

Note: Safety and width recommendations for wiring: width ⩾3mm, distance of wires ⩾6mm, and distance from the ground ⩾6mm.

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	Load regulation $= \frac{V_b - V_{b0}}{V_{b0}} \times 100\%$
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	

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.

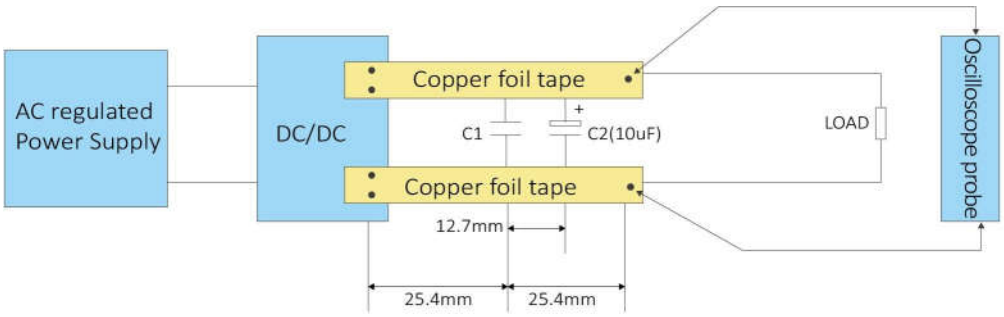

Diagram 4-1 Parallel cable measuring method

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.

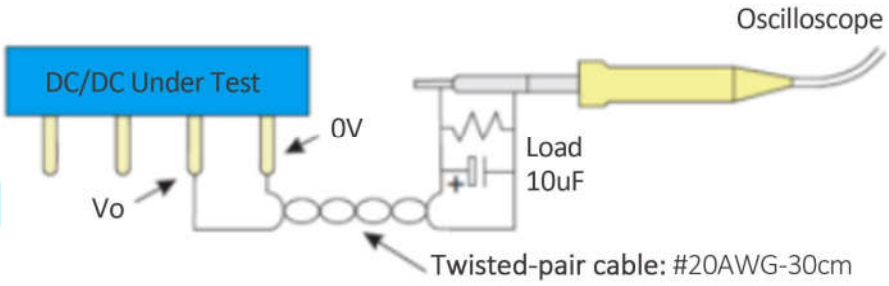

Diagram 4-2 Twisted-pair cable measuring method

Another is with twisted-pair cable measuring method as shown above in diagram 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 oscilloscope's probe at one terminal and connects the ground at the other.

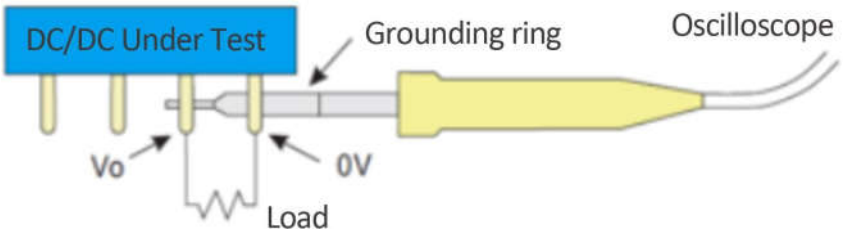

Diagram 4-3 Contact measuring method

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 noise, affecting test results. The actual tested ripple and noise varies depending on different circuit and external components. Diagram 4-4 shows the actual tested ripple and noise waveform.

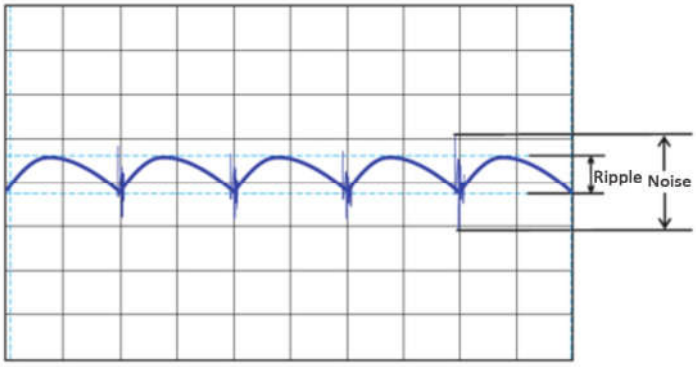

Diagram 4-4 Waveform of Ripple & Noise Test

F. Isolation and Insulation:

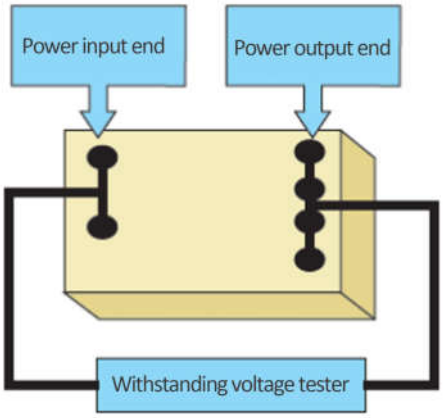

Diagram 4-5 Method of Withstand Test

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 input and output pins, then apply isolation voltage between them and test it for 1 minute.

V.FAQs

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

The input terminal of PV power supply is of high voltage, and its highest voltage may reach the upper limit of the input range voltage. As a result, it's strict to the fuse. To meet the safety requirements, the fuse should withstand the high voltage and be selected according to practical application (environment, product model), in addition to the power. Fuse parameters corresponding to the PV power converter please refer to datasheet.

B. Input Under-voltage Protection

PV power supply is widely used in the photovoltaic power generation system, whose solar array panels' output voltage is related to sunshine intensity. If the intensity is strong, then the output voltage is high. On the contrary, output voltage is low. Therefore, the output voltage bus of solar array panels to the PV power supply is unstable and can affect the stability of PV power supply's output voltage when supply voltage is extremely low. MORNSUN PV series are designed with input under-voltage protection at the input terminal which can protect system stability from low input voltage. When the input voltage is lower than the value of under-voltage protection, the product will directly shutdown and ensure the safety of system. MORNSUN PV power supply has various series with wide operating voltage range, such as 200~1000VDC， 200~1200VDC、 250~1000VDC、 200~1500VDC、 250-1500VDC、300~1500VDC、250~3300VDC, all of which and some of 150~1500VDC

product models are all designed with input under-voltage protection.

C. May AC Power Cause Start-up Failure

PV power supply's input is powered by DC power. If it's powered by AC power, it should add a rectifier at the input terminal to convert into DC power and to power the PV power supply. The easiest way is to add a rectifier bridge and capacitor at the input terminal together. Because it may cause power poor starting and even power failure even though the input is 220V AC, if only added the rectifier bridge without the capacitor or with the capacitor offering small capacity.

D. Operating Temperature

The temperature of product's internal components is much higher than the ambient temperature in the high temperature environment. In order to ensure the product works reliable, the highest ambient temperature of common products' is 50℃and will derate when it reaches 50℃. For more details please refer to datasheet. Following diagram 5-1 shows typical working environment temperature derating curve of PV series with 100-1000VDC input. There will be some differences for special models, for example, PV45-27D1515-15-JX derates from 60℃ and its highest ambient operating temperature is 85℃.

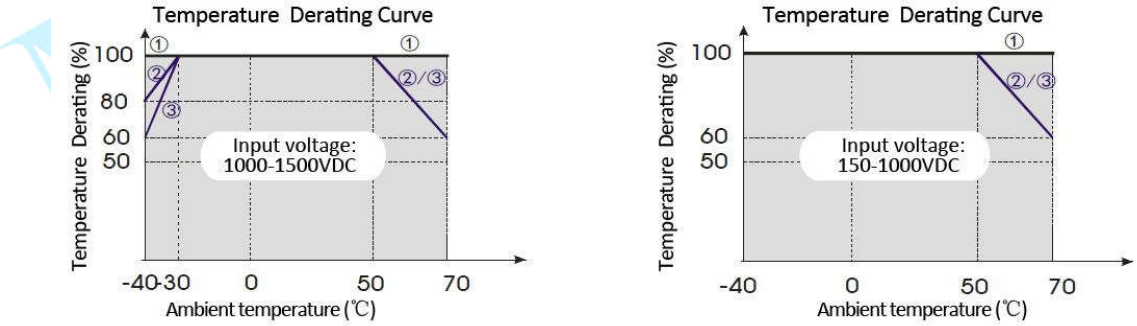

Diagram 5-1 Temperature derating curve

E. Radiated Susceptibility (RS)

Strong radiation will affect PV power supply's internal circuits such as control circuit, loop regulation circuit and so on. RS test standard is IEC/EN61000-4-3 10V/m, which is used to test whether the converter work normally. MORNSUN PV series totally meet the standard. However, when faced with stronger RS such as strong radiation

equipment walkie-talkie, the power supply should be far away from them for the equipment's RS, stronger several times or more than that tested in a laboratory, will seriously affect the power supply's performance.

F. EMC Peripheral Recommended Circuit

PV power supply is mainly used in high-voltage applications where the environment is relatively harsh, including photovoltaic power generation, high voltage inverter, SVG, high-voltage storage. In addition, its application and its electromagnetic environment are relatively harsh, so it's suggested to connect a necessary protection circuit based on actual application. For example, if the photovoltaic high-voltage bus is inverted after confluence, the bus is usually accompanied by conduction interference emitted by the inverter, which easily affects the stable operation of the power modules and the system connected in parallel to the high-voltage bus.

In the R&D and design of the power module, both EMI and EMS performance must be considered for EMC parameters. This type of high-voltage PV power module is basically used in high-power and strong magnetic fields such as photovoltaic power generation and high-voltage frequency conversion, and the impact of the power module's own EMI on the overall system is even negligible. Therefore, the application of this type of PV power supply should mainly focus on EMS performance. For specific recommendations, please refer to the corresponding technical manual.

VI. Thermal Design for Application

A. Natural Air Cooling

For power supply (mainly on-board power supply) in high power density and compact size, natural air cooling is usually adopted for volume, cost and other concerns. For high-power metal box shells, mesh shells and other products, the installation and heat dissipation methods that fit the cabinet can be directly adopted.

Common cooling methods of on-board power supply are the following ones:

a) Natural air convection: dissipate the heat from the power supply and exposed surface to the air through the natural convection. If there is a space between the supply and the PCB, the heat will be dissipated to its surroundings.

b) Radiation: dissipate the heat from exposed surface of the supply to its surroundings or from the bottom of the supply to the PCB via radiation.

c) Conduction: dissipate the heat through the supply's pins to the PCB via conduction.

B. Forced Air Cooling

In many applications, it's not so helpful even if it's installed a heat-sink. In this case, heat dissipation is more difficult and recommended to add a fan as the main cooling method.

General guiding principles for the fan's installation are, for rectangular power supply, blowing direction of the fan should be horizontal and blowing direction of channels within the fan should be vertical, in order to form a "chimney effect" conducive to heat. In addition, a thermal grease or other thermal filler material may be applied between the fan and the converter's case (or metal substrate) to tighten them to reduce thermal resistance. However, an attention is that over-tightening will cause the deformation of the converter's case (or metal substrate).