

PAH450S48 SERIES

Instruction Manual

BEFORE USING THE POWER SUPPLY UNIT

Be sure to read this instruction manual thoroughly before using this product. Pay attention to all cautions and warnings before using this product. Incorrect usage could lead to an electrical shock, damage to the unit or a fire hazard.

WARNING

- Do not make unauthorized changes to power supply unit, otherwise you may have electric shock and void your warranty.
- Do not touch this unit and the internal components in operation or shortly after shut down. They may have high voltage or high temperature and as the unit dissipates its heat so the surface of the unit is hot. You may receive electric shock or burn.
- When the unit is operating, keep your hands and face away from it; you may be injured by an accident
- Do not use unit under unusual condition such as emission of smoke or abnormal smell and sound etc. It might cause fire and electric shock. In such case, please contact us; do not repair by yourself, as it is dangerous for the user.
- Do not drop or insert anything into unit. It might cause failure and fire.
- Do not operate these units under condensation condition. It may cause fire and electric shock.

CAUTION

- As a component part, compliance with the standard will be based upon installation in the final application. This product must be installed in a restricted access location, accessible to authorized competent personnel only. These DC to DC converters have basic insulation between the input and the output. All models with an output 48V and above are considered to be non-SELV and must not be accessible to the operator. The installer must also provide protection against inadvertent contact by a service engineer.
- The input to this power supply must be isolated from the mains input by reinforced insulation.
- The equipment has been evaluated for use in a Pollution Degree 2 environment.
- This power supply is primarily designed and manufactured to be used and enclosed in other equipment.
- Confirm connections to input/output terminals and signal terminals are correct as indicated in the instruction manual.
- Attach a HBC external fuse to each module to ensure safety operation and compliance to each safety standard approval. The recommended input fuse rating within the instructions is as follows: 30A, 250V fast acting fuse. The breaking capacity and voltage rating of this fuse may be subject to the end use application.
- Input voltage, Output current, Output power, ambient temperature and ambient humidity should be used within specifications, otherwise the unit will be damaged.
- For application equipment, which requires very high reliability (Nuclear related equipment, traffic control equipment, medical equipment, etc.), please provide fail safety function in the equipment.
- Do not use the product in environment with strong electromagnetic field, corrosive gas and conductive substance.
- Do not operate and store this unit at an environment where condensation occurs. In such case, waterproof treatment is necessary
- Never operate the unit under over current or shorted conditions for 30 seconds or more and out of Input Voltage Range as specification. Insulation failure, smoking, burning or other damage may occur to the unit.
- The output voltage of this power supply unit is considered to be a hazardous energy level (The voltage is 2V or more and the electric power is 240VA or more). Prevention from direct contact with output terminal is highly necessary. While installing or servicing this power supply unit, avoid dropping tools by mistake or direct contact with output terminal. This might cause an electrical shock. While repairing this power supply unit, the DC input power must be switched off and the input and output voltage should be safe level.
- To maintain the SELV output for outputs 28V and below, under fault conditions, the output must be connected to earth in the final application. However, during installation please ensure both the input positive and output positive are not grounded .
- The application circuits and their parameter are for reference only. Be sure to verify effectiveness of application circuits and their parameters before finalizing circuit design.
- Do not inject abnormal voltage to output terminal and signal terminal from the outside. The injection of reverse voltage or over voltage exceeding nominal output voltage to output terminals might cause damage to internal components.
- This information in this document is subject to change without prior notice. For actual design-in, please refer to the latest publications of data sheet, etc., for the most up-to-date specifications of the unit.
- No part of this document may be copied or reproduced in any form without prior written consent of TDK-Lambda.

Note : CE MARKING

CE Marking, when applied to a product covered by this handbook, indicates compliance with the low voltage directive.

Table of Contents

■ Block Diagram

■ Sequence Time Chart

■ Terminal Explanation

■ Explanation on Specifications

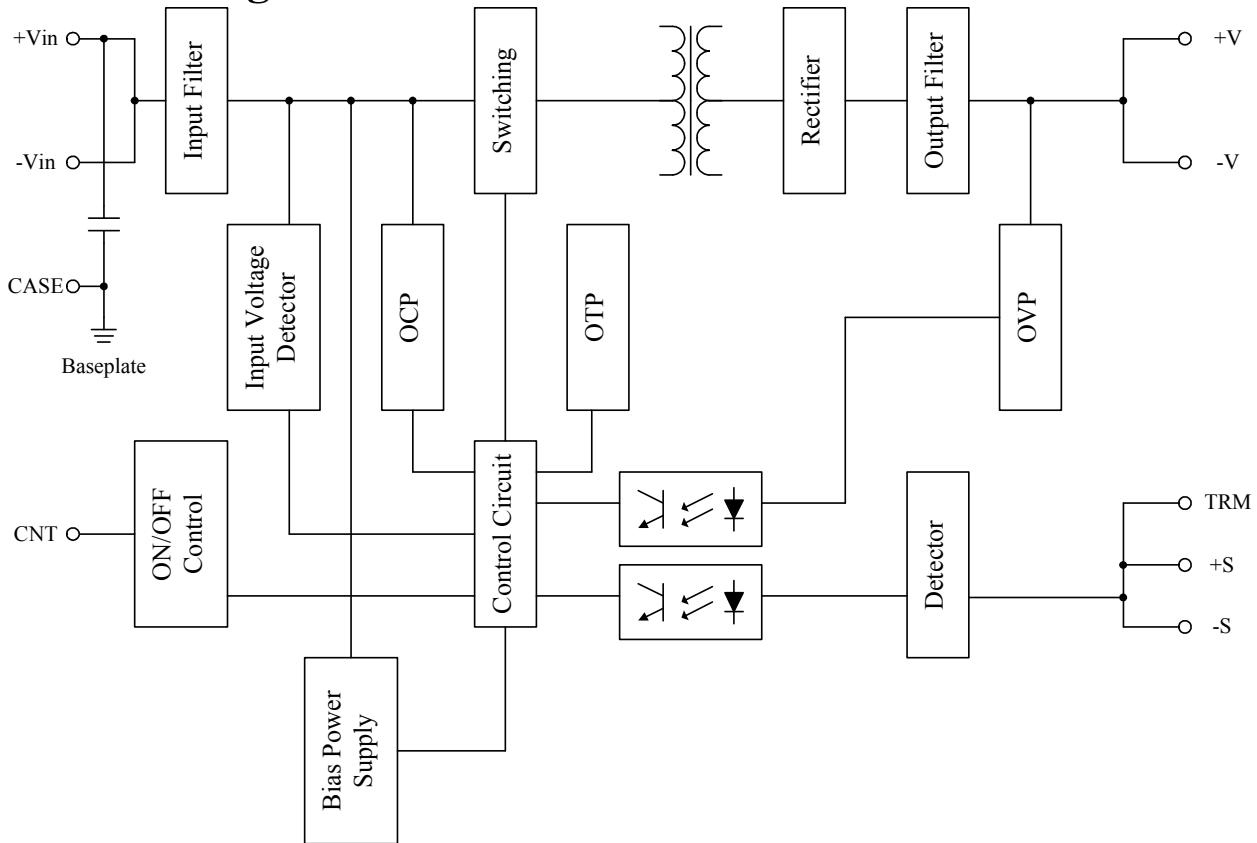
1. **Input Voltage Range**
2. **Output Voltage Adjust Range**
3. **Maximum Output Ripple and Noise**
4. **Maximum Line Regulation**
5. **Maximum Load Regulation**
6. **Over Current Protection (OCP)**
7. **Over Voltage Protection (OVP)**
8. **Over Temperature Protection (OTP)**
9. **Remote Sensing (+S, -S terminal)**
10. **ON/OFF Control (CNT terminal)**
11. **Parallel Operation**
12. **Series Operation**
13. **Operating Ambient Temperature**
14. **Operating Ambient Humidity**
15. **Storage Ambient Temperature**
16. **Storage Ambient Humidity**
17. **Cooling Method**
18. **Baseplate temperature vs. output voltage drift**
19. **Withstand Voltage**
20. **Insulation Resistance**
21. **Vibration**
22. **Shock**

■ Installation

1. **Mounting Method**
2. **Heatsink Installation**
3. **Regarding Vibration**
4. **Recommended Soldering Condition**
5. **Recommended Cleaning Condition**

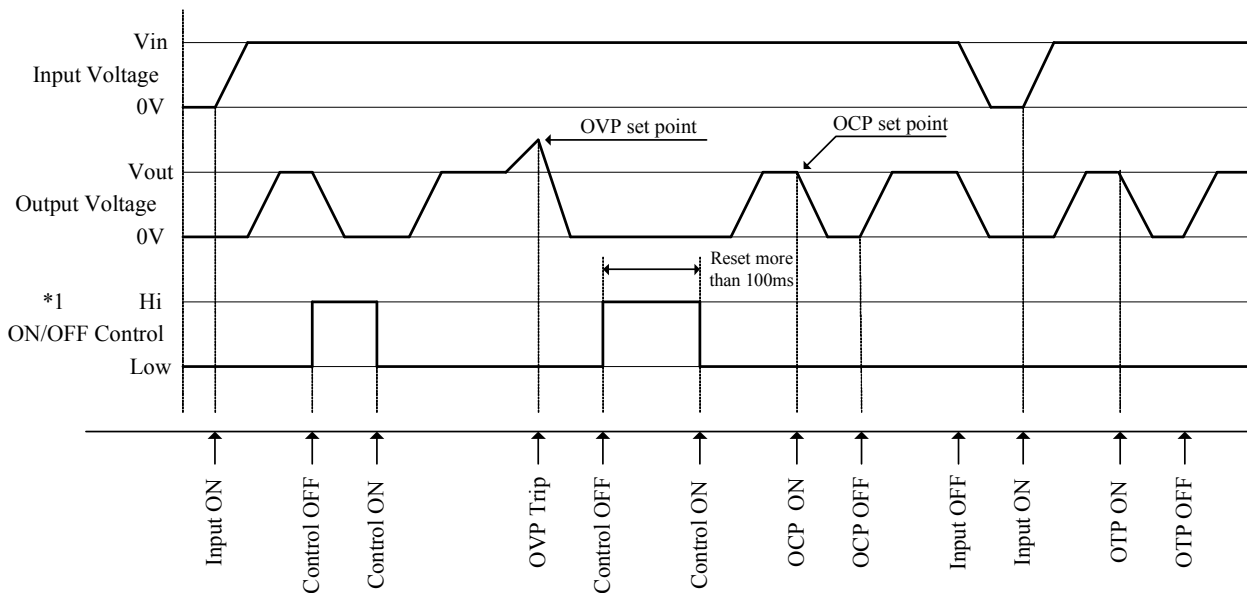
■ Before concluding module damage

Block Diagram



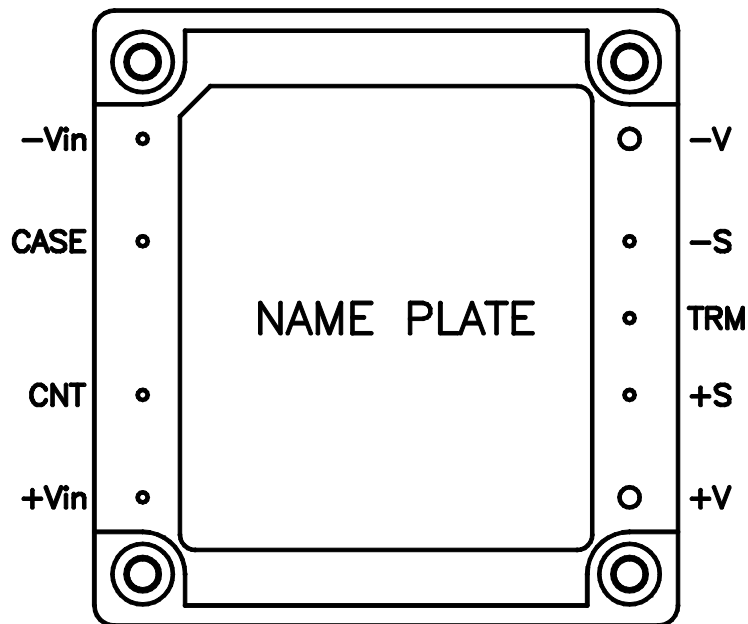
Switching Frequency (fixed) : 400kHz (typ.) for 28V Model, 460kHz (typ.) for 48V Model

Sequence Time Chart



*1 level : $4 \leq H \leq 35(V)$ or Open
 $0 \leq L \leq 0.8(V)$ or Short

Terminal Explanation



[Input Side Terminals]

-Vin : -Input Terminal
CASE : Baseplate Terminal
CNT : ON/OFF Control Terminal
+Vin : +Input Terminal

[Output Side Terminals]

-V : -Output Terminal
-S : -Remote Sensing Terminal
TRM : Output Voltage Trimming Terminal
+S : +Remote Sensing Terminal
+V : +Output Terminal

Baseplate can be connected to FG (frame ground) M3 threaded holes. (standard model)
Connect +Vin, -Vin, +V, -V with consideration of contacting resistance.

■ Explanations on Specifications

1. Input Voltage Range

Input voltage range for PAH450S48 Series is indicated below.

Input Voltage Range : 36~76VDC

Basically, ripple voltage (V_{rpl}) which results from rectification and filtering of commercial AC line is included within the input voltage as shown in Fig. 1-1. Ripple voltage must be limited within the voltage described below.

Allowable input ripple voltage : 4Vp-p

When this value is exceeded, the output ripple voltage becomes large.

Note that sudden input voltage change may cause variation of output voltage transitionally.

Also, input voltage waveform peak value must not exceed above input voltage range.

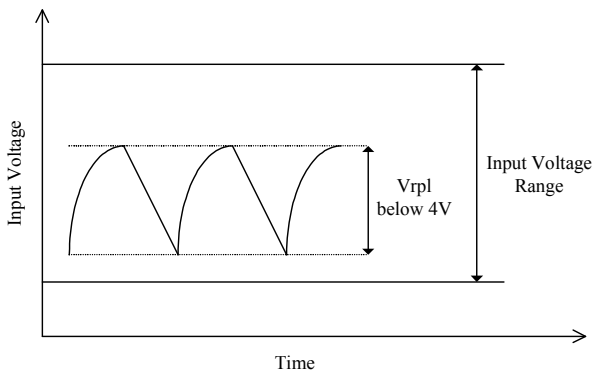


Fig.1-1 Input Ripple Voltage

● Basic Connection

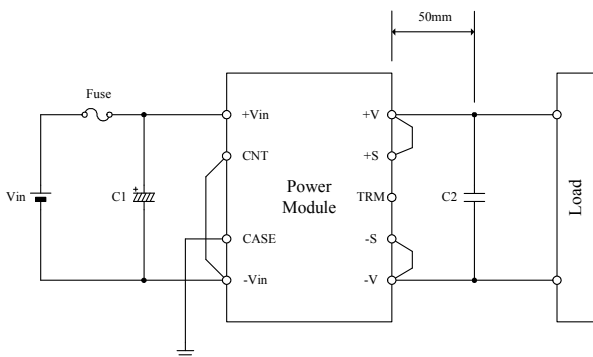


Fig.1-2 Basic Connection

Input Fuse

This power module has no built-in fuse. Use external fuse to acquire various Safety Standards and to improve safety. Also, use fast-blow type for every module.

Furthermore, fuse must be connected to the $+V_{in}$ side if $-V_{in}$ side is used as ground, or fuse must be connected to $-V_{in}$ side if $+V_{in}$ side is used as a ground.

**Input Fuse recommended current rating:
PAH450S48 : 30A**

C1 : 100 μ F

To prevent the effect of input line inductance to the power module, connect electrolytic capacitor or ceramic capacitor between $+V_{in}$ and $-V_{in}$ terminals.

Furthermore, use electrolytic capacitor with small ESR value. Especially take note that during line turn off at low ambient temperature, power module output will not normally shut down due to unstable C1 voltage.

Also, ripple current flows across this capacitor. Therefore, verify maximum allowable ripple current this capacitor when selecting component. Verify actual ripple current value by actual measurement.

**Recommended capacitor value : 100 μ F and above
(Voltage Rating 100V and above)**

Notes

1. Use low impedance electrolytic capacitor with excellent temperature characteristics.
(Nippon Chemi-con LXV Series or equivalent)
2. When input line inductance becomes excessively high due to insertion of choke coil, operation of the power module could become unstable. For this case, increase C1 value more than the value indicated above.

C2 :

For stable operation, connect a ceramic capacitor between +V and -V within 50mm distance from the output terminals.

Take note that output ripple and output shutdown could be affected by ceramic capacitor, equivalent impedance and inductance characteristics of wiring.

Take note that output ripple voltage could vary according to PCB wiring design.

For cases of abrupt changes in load current or input voltage, increasing capacitance value of the external capacitors could reduce the voltage fluctuation.

| Vout | C2 |
|------|-------------------------------------|
| 28V | 50V 22 μ F \times 4parallel |
| 48V | 100V 4.7 μ F \times 6parallel |

Table1-1 C4 Recommended Values of External Output Capacitor

Maximum capacitance (electrolytic capacitor) that can be connected between +V and -V, is shown below.

Maximum capacitance of output capacitor
 28V : 10,000 μ F
 48V : 2,000 μ F

Notes

Take note of the allowable ripple current of the capacitor to be used. Especially, when load adding capacitors for abrupt current changes, be sure to verify that ripple current does not exceed allowable ripple current before use.

C3 :

When switches or connectors are used between input source and PAH450S48 Series input terminals, impulse surge voltage is generated due to input throw-in by switch on/off or due to inserting/ removing of power module from the active line. For this case, connect an additional electrolytic capacitor C3 as shown in fig.1-3 and fig. 1-4.

Recommended Capacitance Value : 100 μ F and above
(Voltage Rating 100V and above)

Also, in-rush current flows at line throw-in. Therefore, be sure to verify capability of switch or fuse to withstand I^2t at line throw-in.

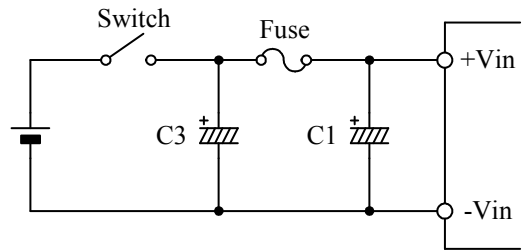


Fig.1-3 Input Filter with Input Switch

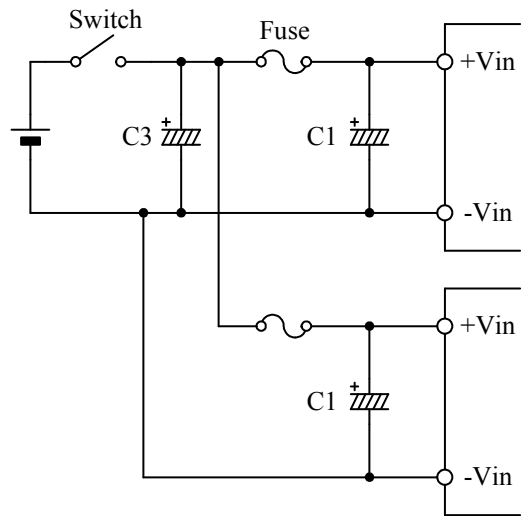


Fig.1-4 Input Filter when Plural Power Modules

Reverse input connection

Reverse input polarity would cause module damage. For cases where reverse connections are possible, connect a protective diode and fuse. Use protective diode with higher voltage rating than the input voltage, and with higher surge current rating than the fuse.

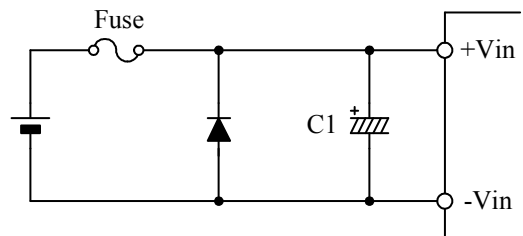
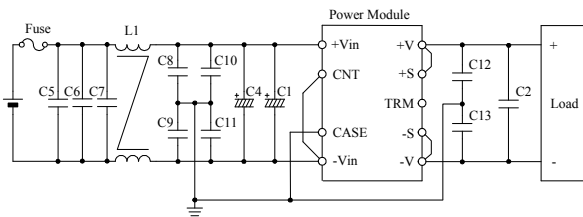


Fig.1-5 Protection for Reversed Connection of Input

● **Recommended application as EMI countermeasure
(compliant to VCCI Class 1, FCC class A)**

**(1) Recommended application
as EMI countermeasure**



**Fig.1-6 Recommended input filter
as EMI countermeasure**

Recommended Values:

- C1: 220 μ F (Electrolytic Capacitor)**
- C2: Apply C2 capacitance in Basic Connection.**
- C4: 220 μ F (Electrolytic Capacitor)**
- C5 – C7: 2.2 μ F (Ceramic Capacitor)**
- C8, C9: 0.22 μ F (Film Capacitor)**
- C10, C11: 4700pF (Film Capacitor)**
- C12, C13: 0.47 μ F (Film Capacitor)**
- L1 : 80 μ H (Common-mode choke coil)**

Notes

1. C4 (Electrolytic Capacitor) can be deleted if impedance of input line is lower and operation of power module is stable.
2. C12 and C13 (Film Capacitor) can be deleted when output is connected to earth.
3. VCCI Class 1, FCC Class A limits can be satisfied with the above recommended filter at Densai-Lambda measuring conditions. However, there are cases where above limits might not be satisfied due to input and output wiring method, as well as, peripheral circuits. When selecting input filter, be sure to verify actual EMI characteristics (CE and RE) before finalizing the filter. Refer to PAH450 S 48-* Evaluation Data for details.

2. Output Voltage Adjustment Range

Output voltage could be adjusted within the range described below by external resistor or variable resistor.

However, take note that OVP might trigger when output voltage adjustment exceeds the ranges indicated below.

Output Voltage Adjustment Range

- 28V : -40%~+18% of nominal output Voltage**
- 48V : -40%~+20% of nominal output Voltage**

When increasing the output voltage, reduce the output current accordingly so as not to exceed the maximum output power.

Take note that input voltage range is limited as shown in fig.2-1 when output voltage is increased.

Remote sensing is possible even when output voltage is varied. For details on remote sensing function, please refer to “9.Remote Sensing”

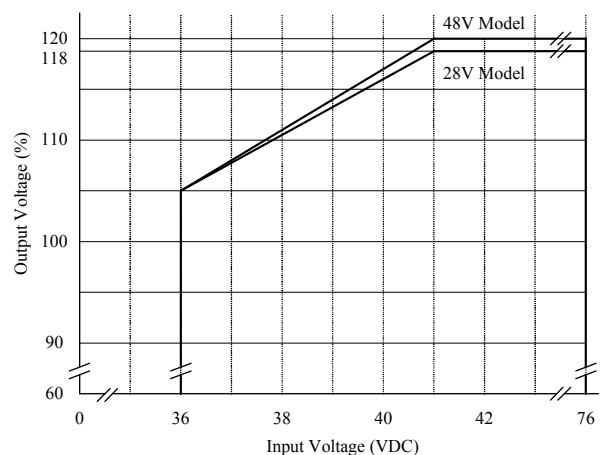


Fig.2-1 Limit of Input Voltage

● **Output Voltage Adjustment by external resistor or by variable resistor**

(1) In case of adjusting output voltage lower

(1-1) Available maximum output current = rated output current

(1-2) Connect an external resistor $R_{adj(down)}$ between the TRM terminal and -S terminal.

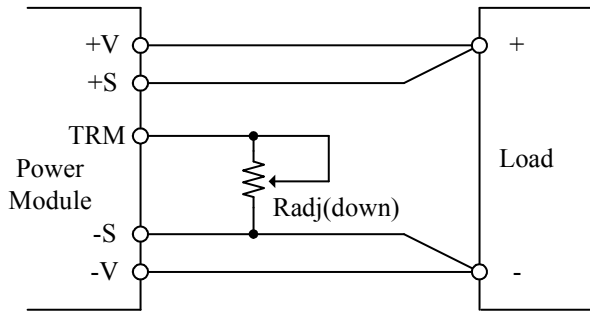


Fig.2-2 Connection for output voltage trim down

(1-3) Equation of external resistor and output voltage

$$R_{adj(down)} = \left(\frac{100\%}{\Delta\%} - 2 \right) [k\Omega]$$

$R_{adj(down)}$: Value of external resistor
 $\Delta(\%)$: Output voltage change rate against nominal output voltage

Below graph is relation $\Delta(\%)$ and value of external resistor.

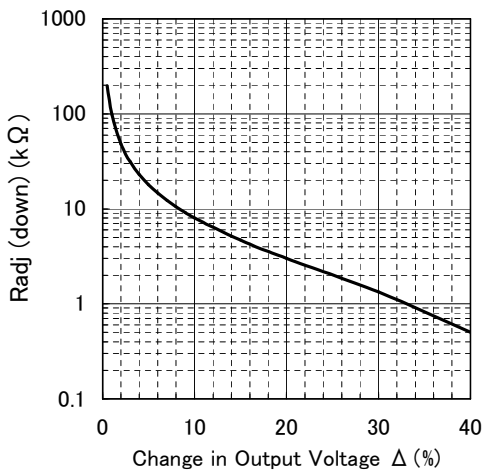


Fig.2-3 $\Delta(\%)$ vs. $R_{adj(down)}$ (1)

(2) In case of adjusting output voltage higher

(2-1) Allowable maximum output current = maximum output power \div output voltage (reduce maximum output current in specification.)

(2-2) Connect an external resistor $R_{adj(up)}$ between TRM terminal and +S terminal.

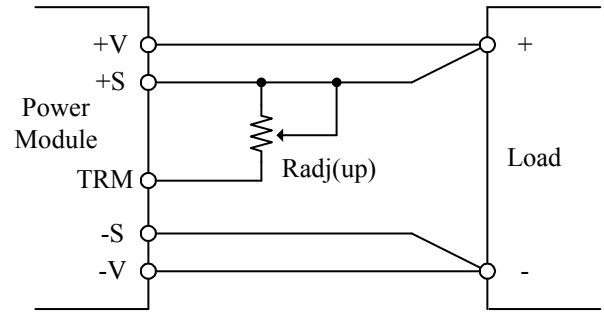


Fig.2-4 Connection for output voltage trim up

(2-3) Equation of external resistor and output voltage

$$R_{adj(up)} = \left(\frac{V_o(100\% + \Delta\%)}{1.225 \times \Delta\%} - \frac{100\% + 2 \times \Delta\%}{\Delta\%} \right) [k\Omega]$$

V_o : nominal output value of module
 $R_{adj(up)}$: external adjustment resistor
 $\Delta(\%)$: Output voltage change rate against nominal output voltage

Below graph is relation $\Delta(\%)$ and value of external resistor.

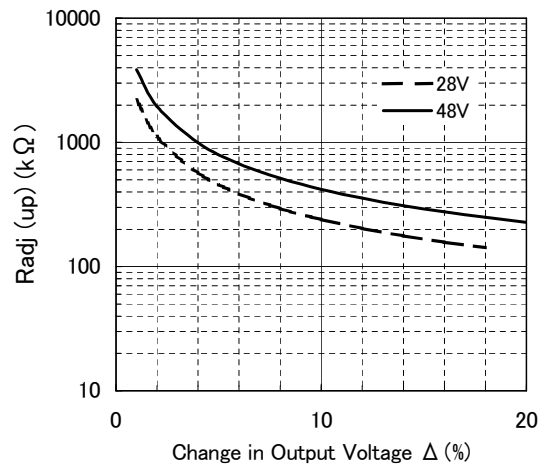


Fig.2-5 $\Delta(\%)$ vs. $R_{adj(up)}$ (2)

3. Maximum Ripple and Noise

Measured value according to the specified methods based on JEITA-9141 (Clause 7.12 and clause 7.13) which is described in the following.

Connect according to fig.3-1 and measure. Connect capacitors (C2: refer to table 1-1 for ceramic capacitor values) at 50mm distance from the output terminals. Measure at ceramic capacitor (C2) terminals as shown in fig. 3-1 using coaxial cable with JEITA attachment. Use oscilloscope with 100MHz frequency bandwidth or equivalent.

Take note that output ripple voltage and output spike noise may vary depending on PCB wiring design.

Generally, increasing capacitance value of external capacitor can reduce output ripple voltage and output spike noise.

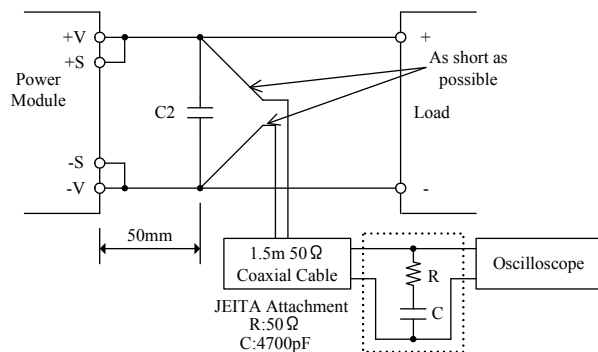


Fig.3-1 Measurement of Maximum Output Ripple & Noise

4. Maximum Line Regulation

Maximum value of output voltage change when input voltage is gradually varied (steady state) within specified input voltage range.

5. Maximum Load Regulation

Maximum value of output voltage change when output current is gradually varied (steady state) within specified output current range.

When using at dynamic load mode, audible noise could be heard from the power module and output voltage fluctuation might increase. A thorough pre-evaluation must be performed before using this power module.

6. Over Current Protection (OCP)

This power module has built-in OCP function.

Output will recover when short circuit or overload conditions are released. OCP setting value is fixed and therefore, cannot be externally adjusted.

Also, take note that power module might be damaged continuing output short circuit or over load conditions depending on thermal conditions.

7. Over Voltage Protection (OVP)

This power module has built-in OVP function.

OVP set point is relative to the rated output voltage value. OVP setting value is fixed and therefore, cannot be externally adjusted.

When OVP is triggered, output can be recovered by turning input line off and then turning it on again after lowering the input voltage below the voltage value indicated below, or by manual reset of the ON/OFF control terminal. Reset time for ON/OFF control terminal is 100ms or longer.

OVP release input voltage value : 10VDC and below

When verifying OVP function by applying external voltage at the output terminals, applied voltage value should not exceed specified OVP maximum value. Refer to specification table for OVP maximum value. Avoid applying external voltage that exceeds OVP maximum value because this will cause power module damage.

8. Over Temperature Protection (OTP)

This power module has built-in OTP function.

This function operates and shuts down the output when ambient temperature or internal temperature of power module abnormally rises. OTP operates at 105°C to 130°C baseplate temperature. OTP can be released when baseplate temperature drops down approximately to within 80°C to 95°C. However, take note that OTP will operate again unless the cause of abnormal heat of the power module is eliminated.

9. Remote Sensing (+S, -S terminal)

Remote sensing terminal is provided to compensate for voltage drop across the wirings from the power module output terminal to the load input terminal.

When remote sensing function is not used (local sensing), short +S terminal to +V terminal and, -S terminal to -V terminal.

Take note that voltage compensation range for line drop (voltage drop due to wiring) is determined such that output voltage at the output terminals is within output voltage range and that voltage between -V and -S terminals is within 2V or less. Even for remote sensing case, use power module such that output power is within specified maximum output power.

Furthermore, reduce noise effect by using shield wire, twist pair, or parallel pattern.

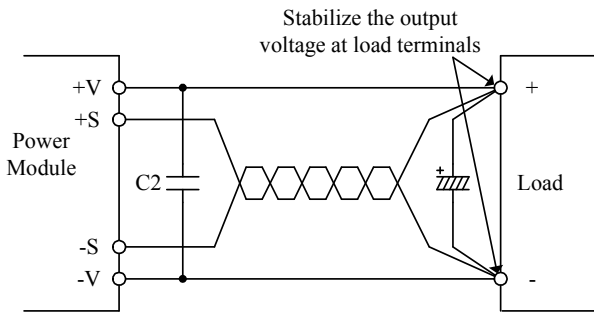


Fig.9-1 Remote Sensing is in Use

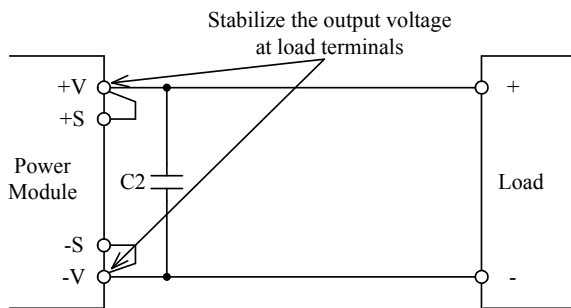


Fig.9-2 Remote Sensing is Not in Use

10. ON/OFF Control (CNT terminal)

Without turning the input supply on and off, the output can be enabled and disabled using this function. This function also can be used for output sequence of plural power modules.

ON/OFF control circuit is on the primary side (the input side). For secondary control, isolation can be achieved through the use of an opto-coupler or relay.

Notes

1. When ON/OFF control function is not used for the Standard and /T option, CNT terminal should be shorted to $-V_{in}$ terminal.
2. When using long wiring, for prevention of noise, attach a $0.1\mu\text{F}$ capacitor between CNT terminal and $-V_{in}$ terminal.
3. At L level, maximum source current from CNT terminal to $-V_{in}$ terminal is 0.5mA
4. The maximum CNT terminal voltage is 35V .

(1) Output ON/OFF control

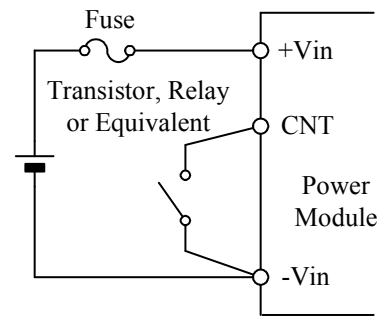


Fig.10-1 CNT Connection (1)

(2) Secondary (output side) control

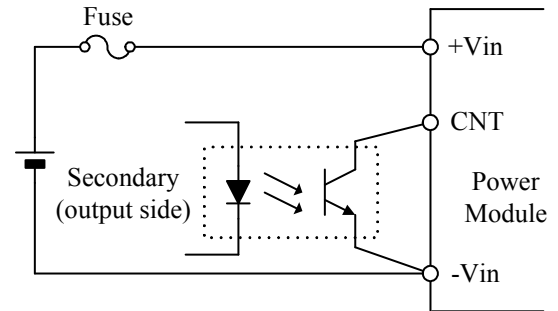


Fig.10-2 CNT Connection (2)

11. Parallel Operation

Parallel Operation can not be used.

12. Series Operation

Series operation is possible for PAH450S48 series. Connections shown fig. 12-1 and fig. 12-2 are possible.

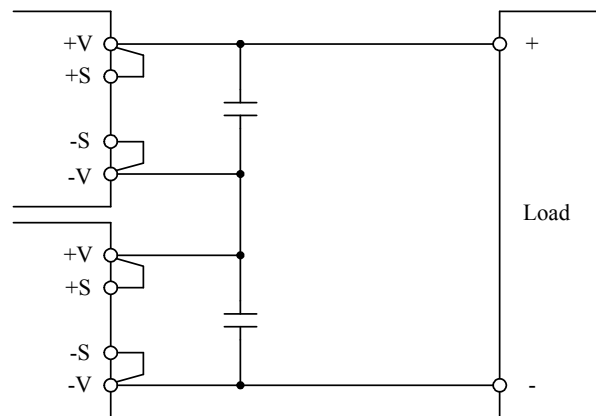


Fig.12-1 Series Operation due to High Output Voltage

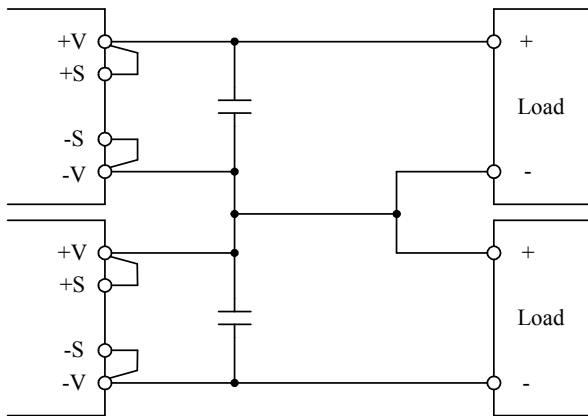


Fig.12-2 Series Operation due to \pm Output

13. Operating ambient temperature

There is no restriction on mounting direction but there should be enough consideration for airflow so that heat does not accumulate around the power module vicinity. Determine external components configuration and mounting direction on PCB such that air could flow through the heatsink at forced cooling and conventional cooling.

By maintaining actual baseplate temperature below 100°C, operation is possible.

For details on thermal design, refer to Application Notes “Thermal Design”.

Note :

Maximum baseplate temperature is 100°C. For worst case operating condition, verify baseplate temperature at measurement point indicated in fig. 13-1.

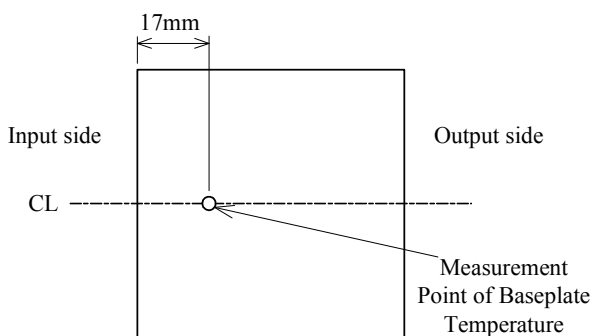


Fig.13-1 Measurement Point of Baseplate Temperature

For better improvement of power module reliability, derating of baseplate temperature when using is recommended.

14. Operating Ambient Humidity

Take note that moisture could lead to power module abnormal operation or damage.

15. Storage Ambient Temperature

Abrupt temperature change would cause moisture formation that leads to poor solderability of each terminal of the power module.

16. Storage Ambient Humidity

Take enough care when storing the power module because rust which causes poor solderability would form in each terminal when stored in high temperature, high humidity environment.

17. Cooling Method

Operating temperature range is specified by the baseplate temperature. Therefore, several methods of heat dissipation are possible.

For details on thermal design, refer to Application Notes “Thermal Design”.

18. Baseplate Temperature vs. Output Voltage Drift

Output voltage drift is defined as the rate of voltage change when baseplate temperature only is changed during operation.

19. Withstand Voltage

This power module is designed to have a withstand voltage of 1.5kVDC between input and baseplate, 1.5kVDC between input and output and 500VDC between output and baseplate for 1 minute. When conducting withstand voltage test during incoming inspection, be sure to apply DC voltage. Also, set the current limit value of the withstand voltage testing equipment to 10mA.

Be sure to avoid conducting test with AC voltage because this would cause power module damage.

Furthermore, avoid throw in or shut off of the testing equipment when applying or when shutting down the test voltage. Instead, gradually increase or decrease the applied voltage. Take note especially not to use the timer of the test equipment because when the timer switches the applied voltage off, impulse voltage which has several times the magnitude of the applied voltage is generated causing damage to the power module.

Connect the terminals as shown in the diagram below.

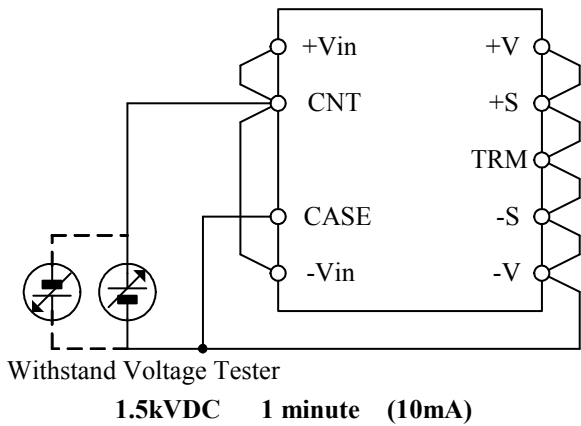


Fig.19-1 Withstand Voltage Test for Input-Output and Input - Baseplate

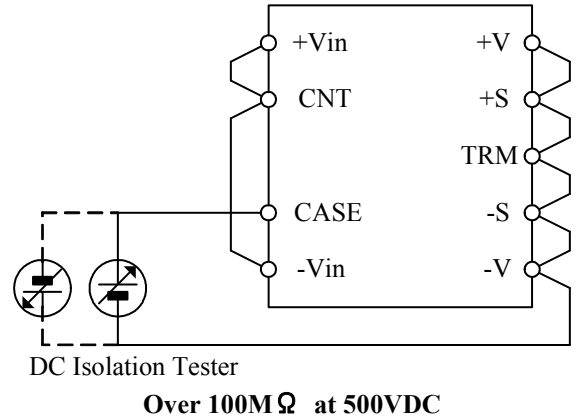


Fig.20-1 Isolation Test

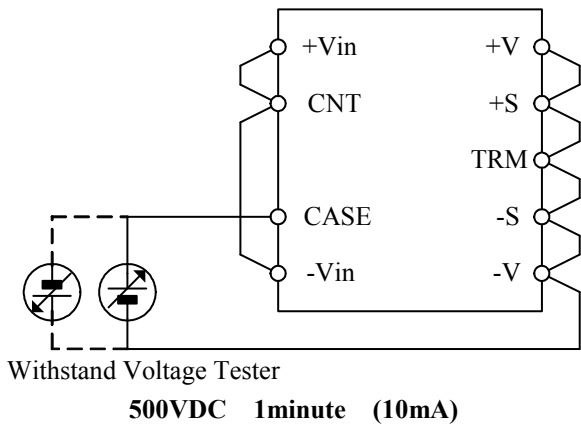


Fig.19-2 Withstand Voltage Test for Output-Baseplate

20. Isolation Resistance

Use DC isolation tester (MAX 500V) between output and baseplate. Isolation resistance value is 100MΩ and above at 500VDC applied voltage. Also take note that depending on the isolation tester used, some testers generate high voltage pulse. Discharge the power module after test using a resistor, etc.

21. Vibration

Vibration of power module is defined in case of mounting on printed circuit board.

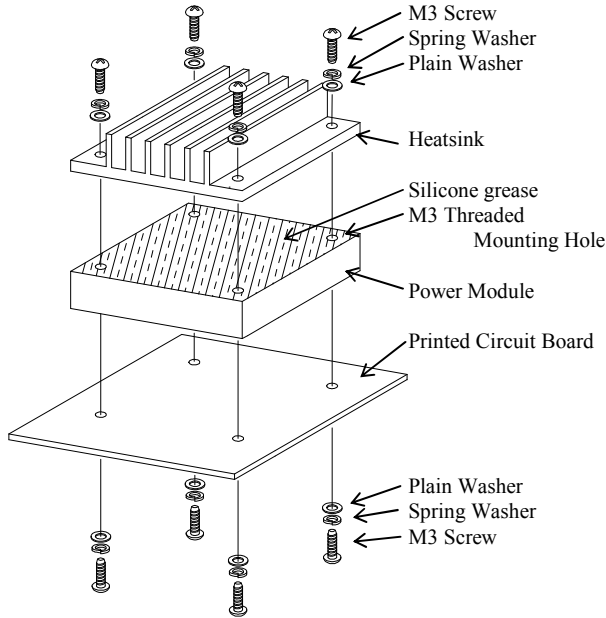
22. Shock

Withstand shock value is defined to be the value at Densai - Lambda shipment and packaging conditions.

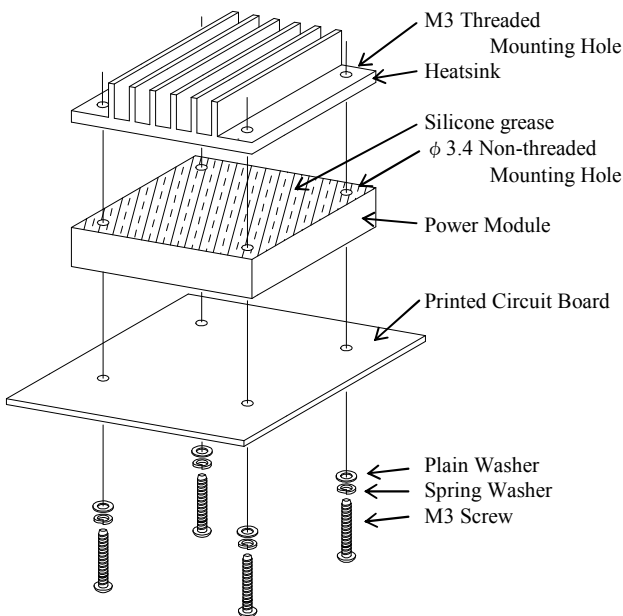
■ Installation

1. Mounting Method

By the following instruction shown in Fig.1-1 and Fig.1-2, mount power module onto printed circuit board.



**Fig.1-1 Mounting method
for standard model**



**Fig.1-2 Mounting method
for /T option model**

(1) Method to Fix

(1-1) Standard model

To fix a power module onto printed circuit board, use M3 screws and mount it to the M3 threaded holes (4 places) of the power module. Recommended torque is 0.54N·m.

(1-2) /T option model

To fix a power module onto printed circuit board, use M3 screws and mount it to the M3 threaded holes of the heatsink (4 places) through the φ 3.4 non-threaded holes (4 places) of the power module. Recommended torque is 0.54N·m

(2) Mounting Holes

Mounting holes of the power module are connected to baseplate. Connect baseplate to FG (Frame Ground) by using this mounting holes.

(3) Mounting Holes on Printed Circuit Board

Refer to the following sizes when determining diameter of hole and land diameter of printed circuit board.

Input / Signal terminals (φ 1.0 mm)

Hole diameter : φ 1.5 mm

Land diameter : φ 3.0 mm

Output terminals (φ 2.0 mm)

Hole diameter : φ 2.5 mm

Land diameter : φ 4.5 mm

Mounting Holes (FG)

Hole diameter : φ 3.5 mm

Land diameter : φ 5.5 mm

For position of the holes, see outline drawing of the power module.

(4) Recommended Material of PCB

Recommended materials of the printed circuit board is double sided glass epoxy with through holes. (thickness t:1.6mm , copper 35 μ m).

(5) Input / Output terminal pin

Connect +Vin, -Vin, +V, -V terminals such that contact resistance is minimal. Note that if contact resistance is high, efficiency will drop and power module will be damaged by abnormal heat.

(6) Input / Output Pattern Width

Large current flows through input and output pattern. If pattern width is too narrow, heat on pattern will increase because of voltage drop of pattern. Relationship between allowable current and pattern width varies depending on materials of printed circuit board, thickness of conductor. It is definitely necessary to confirm on manufacturers of printed circuit board for designing pattern.

2. Heatsink Installation Method

(1) Method to Fix

(1-1) Standard model

To fix the heatsink onto power module, use M3 screws and mount it to the M3 threaded holes (4 places) at the baseplate side. Recommended torque is 0.54 N·m.

(1-2) /T option model

To fix the heatsink onto power module, use M3 screws those are the same screws for mounting power module onto printed circuit board.

Use silicone grease or thermal conductive sheet in between heatsink and baseplate to minimize the contact thermal resistance and to enhance the heat conductivity. Also use the no-warped heatsink and make sure good contact between baseplate and heatsink.

(2) Mounting Hole of Heatsink

Recommended mounting hole is as follows.

(2-1) Standard model

φ 3.5 Non-threaded hole

(2-2) /T option model

M3 Threaded hole

3. Regarding Vibration

The vibration specification of the module is determined assuming that only the power module is mounted on printed circuit board. To prevent excessive force to the module and the printed circuit board, fix the heatsink to the chassis as well as to the module when a large size of heatsink is used.

4. Recommended Soldering Method

Recommended soldering conditions are as follows.

(1) Soldering dip

Dip condition : 260°C within 10 seconds

Pre-heat condition : 100~130°C for 30~60 seconds

(2) Soldering iron

φ 1.0 mm : 350°C (60W) within 3 seconds

φ 2.0 mm : 350°C (150W) within 20 seconds

※Soldering time changes according to heat capacity of soldering iron, pattern on printed circuit board, etc. Please confirm actual performance.

5. Recommended Cleaning Condition

Recommended cleaning condition after soldering is as follows.

(1) Cleaning solvent

IPA (isopropyl alcohol)

(2) Cleaning Procedure

Use brush and dry the solvent completely.

■ Before concluding power module damage

Verify following items before concluding power module damage.

1) No output voltage

- Is specified input voltage applied?
- Are the ON/OFF control terminal (CNT), remote sensing terminal (+S, -S), output voltage trimming terminal (TRM) correctly connected?
- For cases where output voltage adjustment is used, is the resistor or variable resistor setting, connections correctly done?
- Are there no abnormalities in the output load used?
- Is the baseplate temperature within the specified temperature range?

2) Output voltage is high

- Are the remote sensing terminals (+S, -S) correctly connected?
- Is the measurement done at the sensing points?
- For cases where output voltage adjustment is used, is the resistor or volume setting, connections correctly done?

3) Output voltage is low

- Is specified input voltage applied?
- Are the remote sensing terminals (+S, -S) correctly connected?
- Is the measurement done at the sensing points?
- For cases where output voltage adjustment is used, is the resistor or variable resistor setting, connections correctly done?
- Are there no abnormalities in the output load used?

4) Load regulation and line regulation is large

- Is specified input voltage applied?
- Are the input terminals and the output terminals firmly connected?
- Is the measurement done at the sensing points?
- Is the input or output wire too thin?

5) Output ripple voltage is large

- Is the measuring method used the same or equivalent with the specified method in the Application Notes?
- Is the input ripple voltage value within the specified value?