

PH Series

Instruction Manual

This instruction Manual is for model below.

PH50S24

PH100F24, PH300F24

PH50S48, PH75S48, PH100S48, PH150S48

PH75F48, PH150F48, PH300F48

PH50S110, PH75S110, PH150S110

PH75F110, PH150F110, PH300F110

PH50S280, PH75S280, PH100S280, PH150S280

PH75F280, PH150F280, PH300F280

* For PH300S,PH600S series, please refer to Individual Instruction manual.

DWG NO. : C074-04-01C		
APPD	CHK	DWG
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<i>24. Dec. '03</i>	<i>24. Dec. '03</i>	<i>24. Dec. '03</i>

DENSEI-LAMBDA

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Before Using The Power Supply

Pay attention to all warnings and cautions before using the unit. Incorrect usage could lead to an electrical shock, damage to unit, or a fire hazard. Be sure read below **warning** and **caution** before using the power module.

Warning

- Do not touch heatsink and case which may be hot.
- Do not open the case and touch the internal components. They may have high temperature or high voltage which may get you in electrical shock or burned.
- When the unit is operating, keep your hands and face away from the unit. You may get injured by an accidents.

Caution

- Confirm that connections to input/output terminals and signal terminals are correct as indicated in the instruction manual.
- Attach a fast blow type external fuse to each module to ensure safety operation and to acquire each safety approval.
- This power supply is designed for professional installation within an end user equipment.
- For 48V input voltage, use isolated voltage by reinforced insulation at primary power supply or double insulation as input power source.
- The output from this power module must be considered as an energy hazard (>240VA power and 2V voltage) and must not be accesible to an end user. End equipment manufacturers must provide protection against inadvertent contact with the output terminals on this product by a service engineer or by service engineer dropping a tool into them.
- The application circuits and their parameters are for reference only. Be sure to verify effectiveness of application circuits and their parameters before finalizing circuit design.
- The information on this document is subject to change without notice. For actual design-in, please refer to the latest publications of data sheet, etc., for the most up-to-date specifications of this unit.
- No part of this document may be copied or reproduced in any form or by any means without prior written consent of Densai-Lambda.

Note : CE Marking

CE Marking, when applied to a product covered by this instruction manual indicates compliance with the low voltage directive (73/23/EEC) as modified by the CE Marking Directive (93/68/EEC) in that it is complies with EN60950.

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1. INPUT VOLTAGE RANGE

Input voltage ranges of PH series are as follows.

- 24VDC Input : 18 ~ 36VDC
- 48VDC Input : 36 ~ 76VDC
- 110VDC Input : 82 ~ 185VDC
- 280VDC Input : 200 ~ 400VDC

For 110VDC input model, it is necessary to derate the output power when the input voltage range is in the range of 82 ~ 88V.

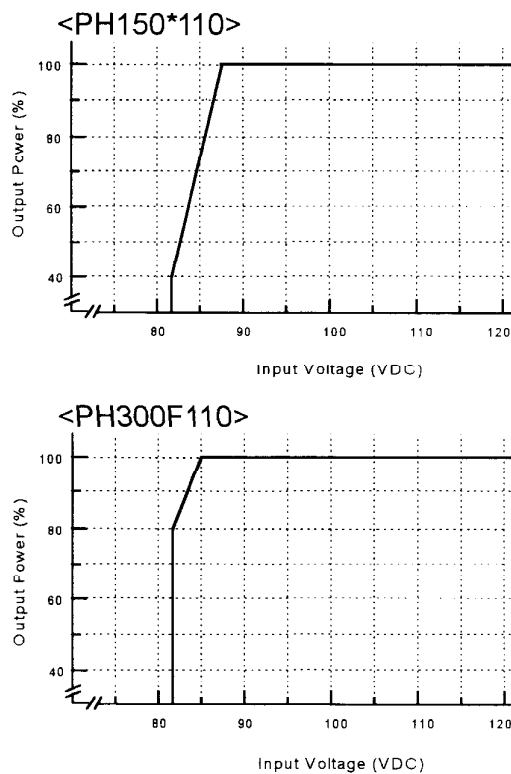


Figure1-1 : PH110 Series Output Derating

Input voltage normally includes the ripple voltage (V_{rpl}) as shown in Figure1-2. The ripple voltage shall be less than the following values.

- 24VDC Input : 2V
- 48VDC Input : 4V
- 110VDC Input : 10V
- 280VDC Input : 20V

When ripple voltage exceeds the above value, the output ripple voltage may become larger. Also, the output voltage may rise as the input voltage is fluctuated in dynamic line. The peak of input voltage wave shall be within the input voltage range.

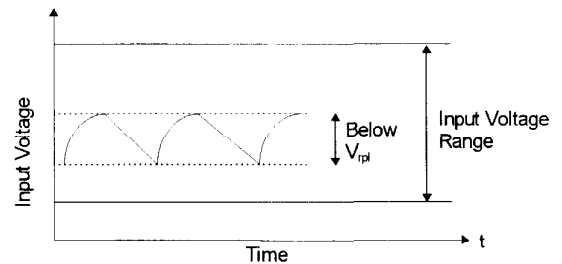


Figure1-2 : Input Ripple Voltage

● Basic Connection

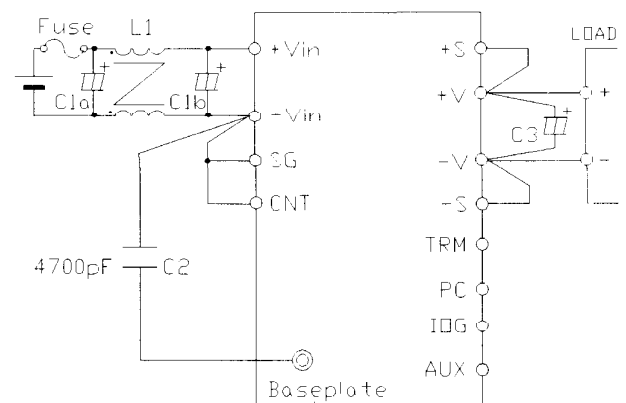


Figure1-3 : Basic Connection Circuit

Input Fuse

No internal fuse is provided in power module. To ensure safety operation and to acquire safety standard approvals, attach an external fuse. The external fuse must be fast blow type and shall be attached to each power module individually.

Furthermore, attach the fuse at $+V_{in}$ side if the ground terminal is at $-V_{in}$ side and at $-V_{in}$ side if the ground terminal is at $+V_{in}$ side.

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When the in-rush current causes some trouble at low impedance, use in-rush limiting circuit if necessary.

	50/75W	100W	150W	300W
24V	7A	15A	—	30A
48V	5A	7A	10A	20A
110V	2A	—	5A	10A
280V	1A	1.5A	2A	5A

Table1-2 : Recommended Rating Current of Input Fuse

C1 : C1a / C1b

Attach capacitor(s) either between +V_{in} terminal and -V_{in} terminal or before L1.

As shown in Table1-3, location of the capacitor will be either C1a or C1b depending on each input voltage.

	50/75W	100W	150W	300W
24V C1a	—	—	—	1000 μ F
24V C1b	470 μ F	470 μ F	—	—
48V C1b	100 μ F	220 μ F	220 μ F	470 μ F
110V C1a	220 μ F	—	220 μ F	470 μ F
280V C1a	10 μ F	22 μ F	22 μ F	47 μ F

Table1-3 : Recommended Values of Input filter Capacitor

Because the ripple current flows in the capacitor, confirm the allowance of the ripple current prior to selection of the component.

In addition, attaching a film capacitor C1b (several μ F) which can withstand large ripple currents is very effective in reducing the ripple current for 110V and 280V input models.

The following low ESR type Nippon Chemicon capacitors, or equivalent are recommended:

For 24V input, use LXY Series

For 48V input, use LXV Series

For 110V and 280V input, use KMG Series

L1 :

To reduce ripple current at C1 and output spike noise, attach common mode choke coil(s) in each power module individually.

Recommended Impedance Values:

24, 48, 110VDC Input : 1 mH

280VDC Input : 2 mH

Note : Depending on input filter

construction, noise level

might exceed noise speci-

fication and mis-operation

might occur due to reso-

nance of the filter.

To avoid mis-operation and spike noise problem, use an inductance which has a few tens μ H of normal component.

C2 : 4700 ρ F

To improve the noise characteristics, use a ceramic capacitor which has high withstand voltage when safety standard is necessary to acquire.

24VDC Input : more than 2kVAC

48VDC Input : more than 3kVAC

110VDC Input : more than 3kVAC

280VDC Input : more than 3kVAC

During withstand voltage test, test voltage is applied across this capacitor. Therefore, select components with above recommended withstand voltage.

C2 shall be connected in between -V_{in} and baseplate as short as possible.

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C3 :

To avoid the effects of the output line impedance to the power module, attach a capacitor between +V terminal and -V terminal. Equivalent series resistance and equivalent series impedance of the electrolytic capacitor wiring may have some influence at the output during shutdown, or at the output ripple. The output ripple voltage may vary depending on the wiring method of printed circuit board. See the table shown at the end of this section (Reference table for C3 Value).

C4 :

In case switch and connectors are used between the input power source and input terminals of the PH series, transient surge voltage may occur when switch is turned on/off, or during hot swap at active input line. Therefore, attach a capacitor C4 as shown in Figure1-4.

Recommended Capacitor Values:

- 24VDC Input : 470 μ F
- 48VDC Input : 100 μ F ~ 470 μ F
- 110VDC Input : 220 μ F ~ 470 μ F
- 280VDC Input : 10 μ F ~ 47 μ F

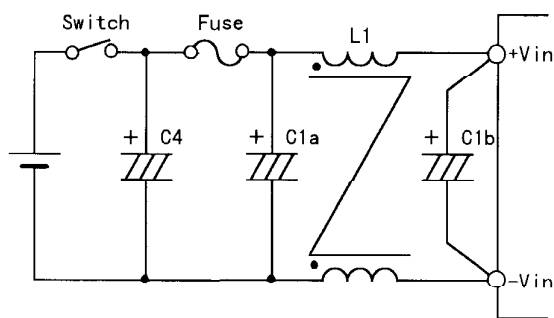


Figure1-4 : Input Filter with Input Switch

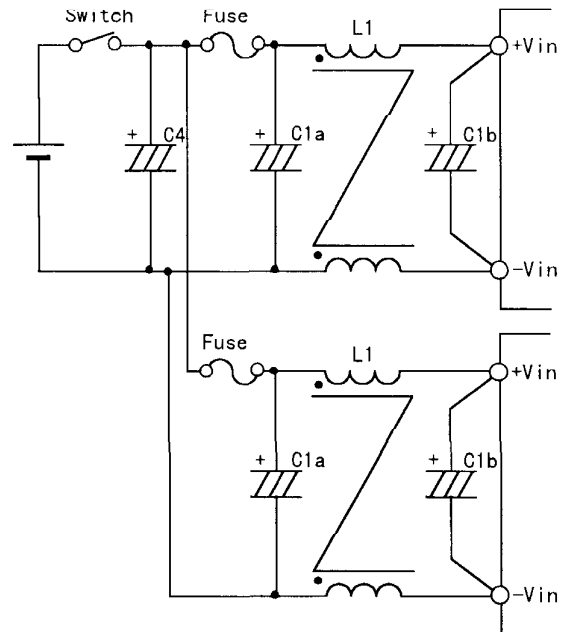


Figure1-5 : Input Filter when several power modules are connected

Reversed Connection of Input

Reverse (-, + electrodes) connection of the input may cause damage to the power module. Whenever there is a possibility for a reverse input connection, attach a protective diode and an input fuse. The rated voltage of the protective diode shall be higher than input voltage, and the maximum in-rush current shall be higher than external fuse rating.

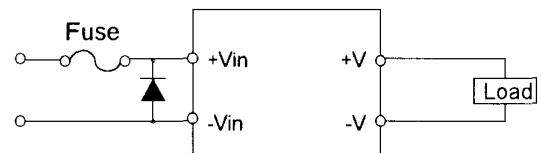


Figure1-5 : Protection for Reversed Connection of Input

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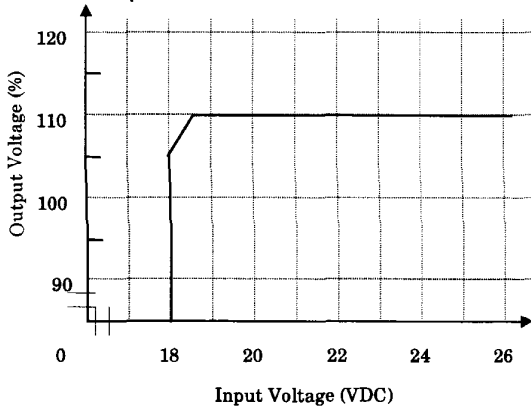
2-1. OUTPUT VOLTAGE RANGE <S type>

Output voltage can be adjusted within $\pm 10\%$ of the nominal voltage by adjusting the external trimmer (variable resistor.). However, note that OVP (Over Voltage Protection) will be activated when the output voltage is raised over specification range.

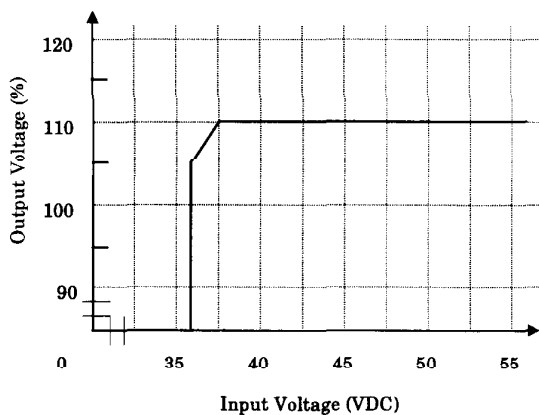
Furthermore, when the output voltage is adjusted to high, the output current shall be derated to a value that is prescribed by the maximum output power. Also, when output voltage is adjusted to high, there is a limitation on the input voltage range for each model as shown in Figure2-1.

Values and connection methods of external resistors and variable resistor (VR) are shown as follows.

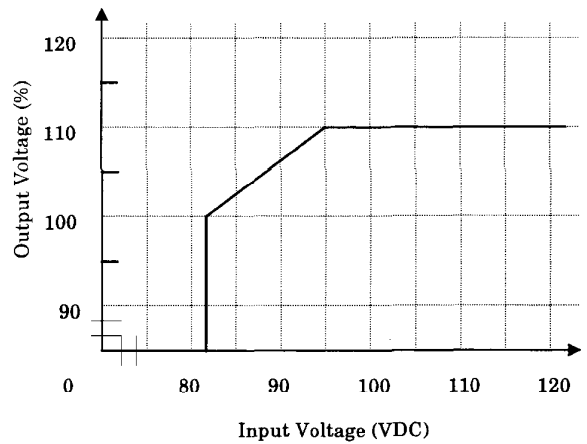
<24VDC Input>



<48VDC Input>



<110VDC Input>



<280VDC Input>

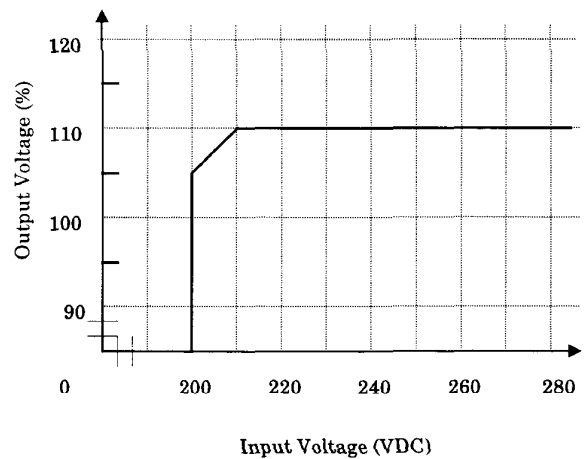


Figure2-1 : Limitation of Input Voltage Range

<Example 1, 2 : Values and Methods of Resistor and variable Resistor Networks

	3V	5V	12V	15V	24V	28V
R1	1.6k	820	3.9k	5.6k	10k	12k
R2	680	510	680	750	820	820
VR	1k	1k	1k	1k	1k	1k

R1, R2 : $\pm 5\%$ Tolerance

VR : $+20\%$ Total Tolerance

below 1% End Resistance

Table2-1 : Values for External Resistor and Variable Resistor of connection example 1 and 2

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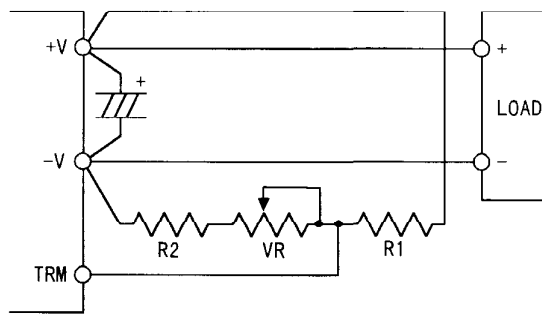


Figure2-2 : Connection Example of External Resistor Network #1 (no $\pm S$ Terminal)

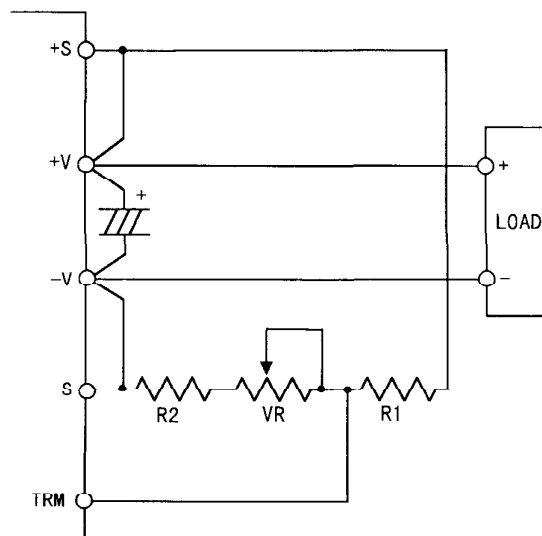


Figure2-3 : Connection Example of External Resistor Network #2 (with $\pm S$ Terminal)

In the same way, remote sensing wires can be connected to load.

<Example 3 : Values and Method of Resistor and variable Resistor Networks>

For S type model with remote sensing terminal, the following method can be used. Variable resistor is attached as remote programming resistor, and the output can be remotely programmed. Ratio of remote programming resistor is basically $1V/k\Omega$.

	3V	5V	12V	15V	24V	28V
R1	1.5k	3.9k	30k	33k	68k	68k
VR	1k	2k	5k	10k	10k	20k

R1 : $\pm 5\%$ Tolerance

VR : $\pm 20\%$ Total Tolerance

below 1% End Resistance

Table2-1 : Values for External Resistor and Variable Resistor Networks ($\pm 10\%$ Output Voltage Change)

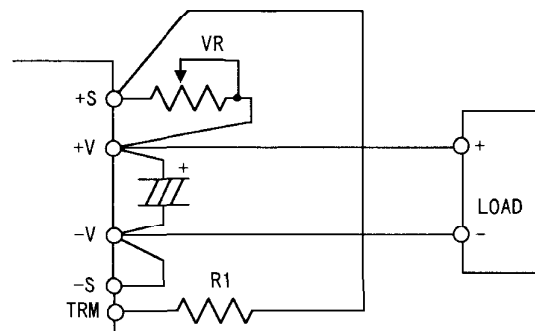


Figure2-4 : Connection Example of External Resistor Network #3

In the same way, remote sensing wire can be connected to load terminal input.

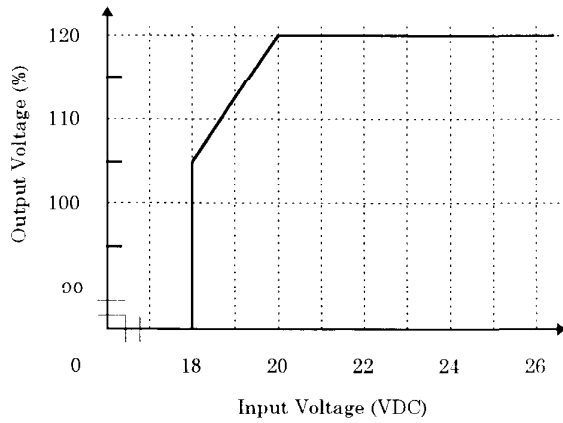
2-2. OUTPUT VOLTAGE RANGE <F type>

The output voltage can be adjusted within $-60\% \sim +20\%$ ($2V, 3V : \pm 20\%$) of nominal voltage range. However, note that OVP will be activated when output voltage is raised over specification range.

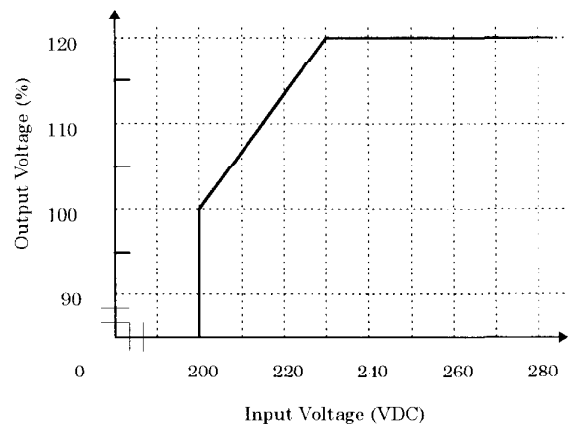
Furthermore, when the output voltage is adjusted to high, the output current shall be derated to a value that is prescribed by the maximum output power. Also, when output voltage is adjusted to high, there is a limitation on the input voltage range for each model as shown in Figure2-5, as well as, limitation on the minimum output current as shown in Figure 2-6 for each model.

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<24VDC Input>



<280VDC Input>



<48VDC Input>

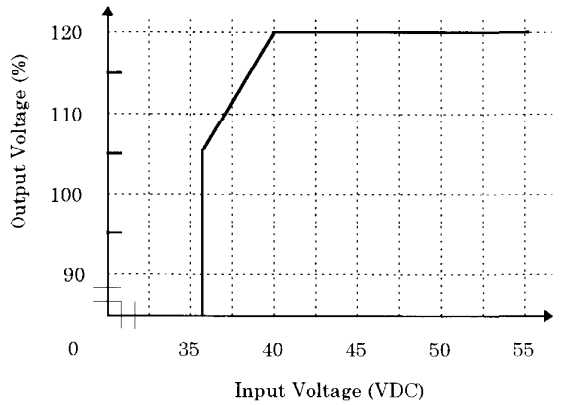
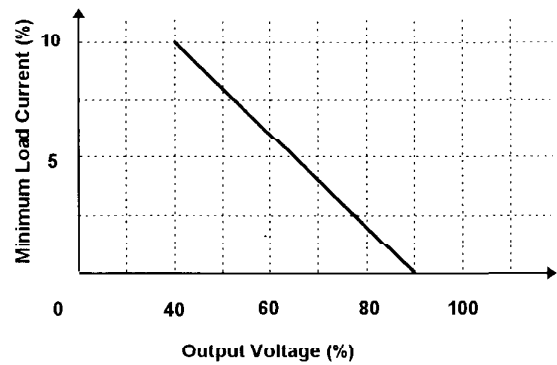


Figure2-5 : Limitation of Input Voltage



<110VDC Input>

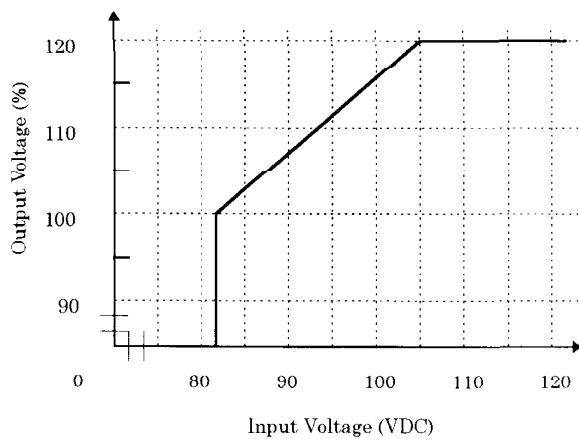


Figure2-6 : Minimum Output Current Limit

Resistance values and connection method of external resistor and variable resistor are shown as follows.

In this case, variable resistor is attached as remote programming resistor, and the output can be remotely programmed. Also, aside from remote programming resistor, remote programming can be done externally by voltage source.

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	2V	3V	5V	12V	15V	24V	48V
R1	20k	20k	3.3k	3.3k	3.3k	3.3k	3.3k
VR	2k	2k	20k	50k	50k	100k	100k

R1 : ±5% Tolerance

VR : ±20% Total Tolerance

below 1% End Resistance

Table2-3 : Values of External Resistor and

Variable Resistor

(-60--+20% Output Voltage Change, ±20% for 2V 3V)

	2V	3V	5V	12V	15V	24V	48V
R1	43k	43k	43k	43k	43k	43k	43k
VR	1k	1k	2k	5k	5k	10k	10k

R1 : ±5% Tolerance

VR : ±20% Total Tolerance

End Resistance below 1%

Table2-4 : Values of External Resistor and

Variable Resistor

(±10% Output Voltage Change)

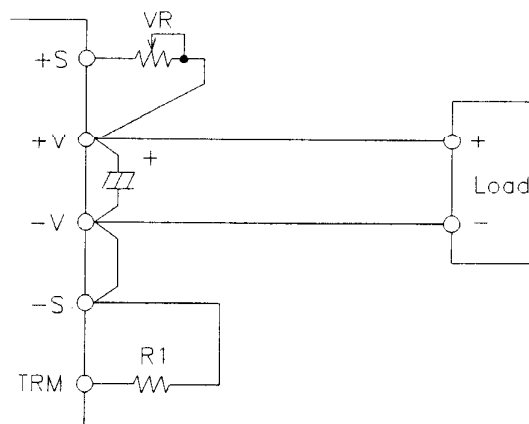


Figure2-7 . Connection Example of External Resistor

In the same way, remote sensing wires can be connected to load terminal input.

<Changing Output Voltage by Applying External Reference Voltage; F type only>

On F type power module, the output voltage can be adjusted within the same range as remote programming with variable resistor by applying external voltage to TRM terminal. The output voltage for this case can be calculated by the following equation.

Output Voltage =

$$\text{TRM Voltage} \times \text{nominal Output Voltage}$$

<Reference> Trim Circuit

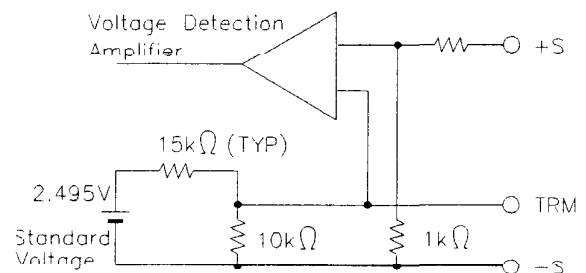


Figure2-8 : Network of Trim Circuit

Reference voltage for Voltage Detection Amplifier is the TRM terminal voltage. When TRM terminal is 1.0V (TYP), output is nominal voltage.

For other applications not described here, use this value as a reference when selecting external component values.

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<Application Example of External Voltage>

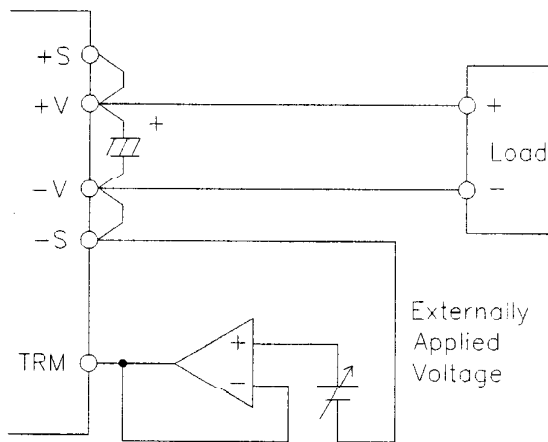


Figure2-9 : Example of Applied Voltage

3. MAXIMUM OUTPUT RIPPLE & NOISE

The maximum output ripple and noise are measured by the following prescribed method based on EIAJ RC-9141.

The connection is shown in Figure3-1. Attach a film capacitor ($1\mu\text{F}$) to a point 50mm from the output terminal. Then attach a coaxial cable with EIAJ attachment to both sides of the film capacitor as shown in Figure3-1. Oscilloscope shall be set at 100MHz band width.

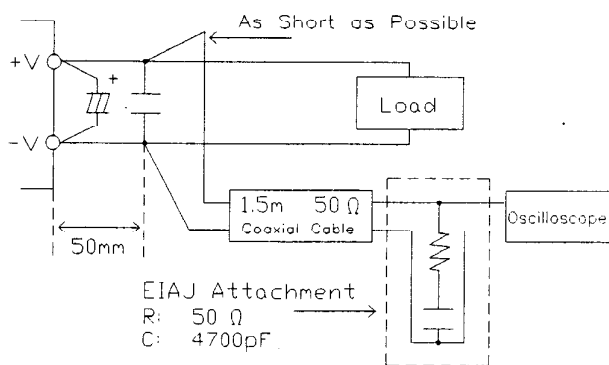


Figure3-1 : Measurement Method of Maximum Output Ripple Voltage (including Noise)

4. MAXIMUM LINE REGULATION

Maximum line regulation is defined as the output voltage deviation when the input voltage is slowly varied (steady-state) within the input voltage range.

5. MAXIMUM LOAD REGULATION

Maximum load regulation is defined as the output voltage deviation when the output current is slowly varied (steady-state) within the output current range.

< S type >

A minimum load current of more than 3% (4% for PH50S) of the nominal output current shall be taken when the load current is dynamically changed. In case the load current is changed from less than the above minimum load current value, the output voltage may dynamically fluctuate.

When using module in dynamic load mode, audible noise could be heard and output voltage fluctuation will increase. Therefore, please evaluate thoroughly when using this module.

6. OVER CURRENT PROTECTION (OCP)

OCP function is provided.

Output will automatically recover when short or overload condition is released. This setting value is fixed and cannot be change externally.

Note that the module may be damaged depending on thermal conditions when operating continuously under short or overload condition for a long period.

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7. OVER VOLTAGE PROTECTION (OVP)

OVP function is provided.

The setting value is relative to the nominal output voltage and is fixed. Therefore, it cannot be changed externally.

To recover the output voltage after OVP function activates, wait until input voltage becomes less than the following voltage values and then reapply input voltage.

	S type	F type
24VDC Input	10VDC	10VDC
48VDC Input	13.5VDC	4.5VDC
110VDC Input	25VDC	10VDC
280VDC Input	90VDC	25VDC

Table7-1 : Input Voltage to Release OVP

8. THERMAL PROTECTION

Thermal protection is provided.

This function activates for abnormal ambient temperature rise and abnormal internal temperature rise of power supply and shuts the output off. Thermal protection will activate at $100 \pm 15^\circ\text{C}$ baseplate temperature.

To recover the output, shut off the input once, and then reapply input after the baseplate temperature has been cooled down sufficiently.

9. REMOTE SENSING (+S, -S TERMINALS)

In the power modules except S type of 50W and 75W, there are remote sensing terminals to compensate the voltage drop caused by wiring to load terminal from output terminal of the power supply. If the remote sensing function is unnecessary (i.e. local sensing is used), shorten with wires +S terminal to +V terminal, and -S terminal to -V terminal.

terminal, and -S terminal to -V terminal.

Compensated voltage range of line drop (voltage drop by wiring) shall be set such that output voltage between +V and -V does not exceed specified output voltage range and output must be within the maximum output power value. Also, line drop voltage between -V and -S (-V and negative side of the load) shall be less than 2V. To avoid and to decrease the noise affects, shield wire, twist wire, and parallel pattern wire etc. shall be used as remote sensing wire.

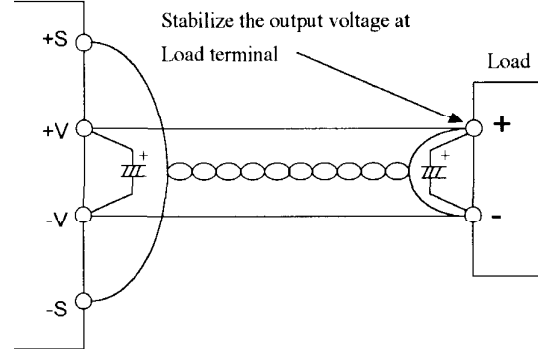


Figure9-1 : Using Remote Sensing

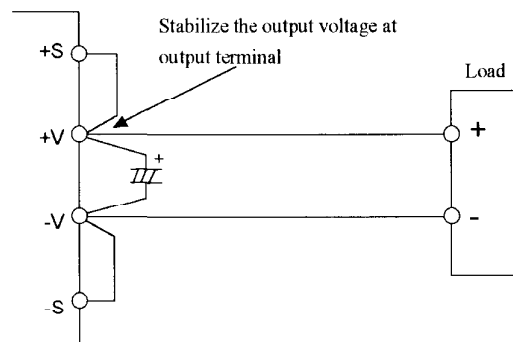


Figure9-2 : Without Remote Sensing

10. ON/OFF CONTROL (CNT TERMINAL)

The output can be turned on or off without shutting down the input.

The control circuit is in the input side (primary side), and CNT terminal is used. The ground of CNT terminal is SG terminal for a module with SG terminal, and -V_{in} terminal for a module without SG terminal. -V terminal and

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SG terminal is connected inside of the module. If this function is unnecessary, short CNT and SG terminals.

- 1) The maximum applied voltage to CNT terminal is 35V, and the reversed voltage is -0.7V maximum. Source current of CNT terminal is approximately 0.5mA. If the wire would be long, attach 0.1μF capacitor between CNT terminal and SG terminal.
 - 2) ON/OFF control can be controlled by the device switching on/off of the contact point (switch or relay) or photocoupler. The ON/OFF control circuit shall be insulated by relay or photocoupler.
- * When using photocoupler, connect CNT and SG terminals as short as possible at transistor side.

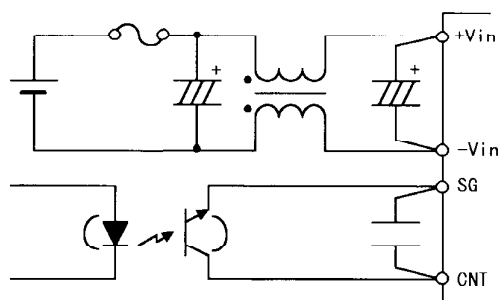


Figure10-1 : Connection of CNT Terminal

Table10-1 : ON/OFF Control Mode

CNT Level for Input- V_{in} (SG)	Output Status
$4V \leq H \leq 35V$ or Open	OFF
$0 \leq L \leq 0.8V$ or Short	ON

— **Caution** —

If $-V_{in}$ is not connected, or improperly connected, internal circuit of power module could be damaged when input is applied. For example, CNT terminal could blow out when current flows through an abnormal path such as $+V_{in}$ to CNT created by improper con-

nection.

To avoid such a damage, ensure all the terminals are connected before input is applied.

11. PARALLEL OPERATION (PC TERMINAL)

Only F type power modules provide PC terminal. By connecting PC terminal of each module, up to 11 units of same model (same output voltage and current) can be connected in parallel, and the output current is equally shared among each power module.

Note that maximum output power of each module should not exceed specifications.

By setting accuracy of output voltage of each power module in parallel operation within $\pm 1\%$, the maximum load current can be used up to 95% of nominal output current value.

(Example)

2 units of PH300F48-5 are to be used in parallel operation.

The total nominal output current is 120A, then

$$120 \times 0.95 = 114 \text{ (A)}$$

will be calculated as the maximum load current.

For details of parallel connection and redundant operation, refer to Application Note "Parallel Operation."

12. SERIES OPERATION

Series operation is available for all PH series models.

Contact us for maximum allowable units that can be used in series operation.

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(A) Series Operation for High Output Voltage
 In series operation for high output voltage configurations, attach a by-pass diode to avoid to applying reverse voltage.

Rating of by-pass Diode, D1 and D2

1. Repetitive Reversed Voltage
 $V_{RRM} \geq 2$ times as rated output voltage
2. Average of Output Current
 $I_o \geq 2$ times as rated output current
3. Forward Voltage Drop
 $V_F \geq$ minimum

(Schottky barrier type)

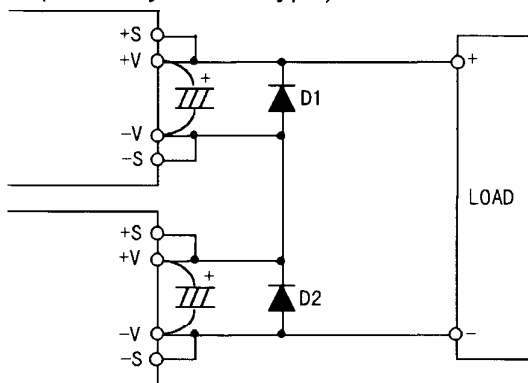


Figure12-1 : Series Operation for High Output Voltage Configurations

(B) Series Operation using \pm Output
 No diode is necessary if + side load and - side load are completely separated.

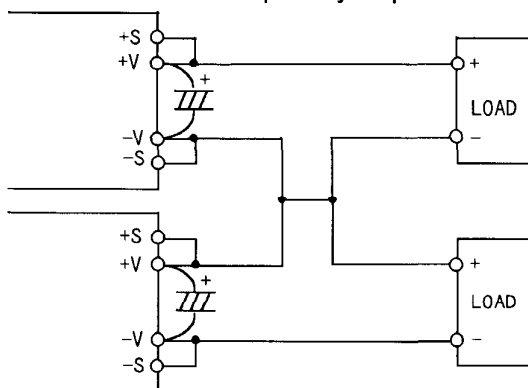


Figure12-2 : Series Operation using \pm Output

13. I.O.G. SIGNAL (IOG TERMINAL)

I.O.G. signal is provided in the F type power module. By using IOG terminal, good / no good operation can be monitored.

This monitoring signal output is in the secondary (output) side and is an open collector output.

At good inverter operation, IOG monitors LOW (maximum sink current = 5mA ; maximum applied voltage = 35V).

When OCP is operating, IOG signal becomes unstable.

Ground of IOG terminal is -S terminal.

In parallel operation as shown as Figure13-1, the minimum load current shall be more than 10% of the total nominal output current. Note that If load is less than 10%, IOG signal may be unstable.

In a parallel application where diode is used at the output of the power module, required minimum load current is not specified.

(Sensing point is at anode side of the diode.)

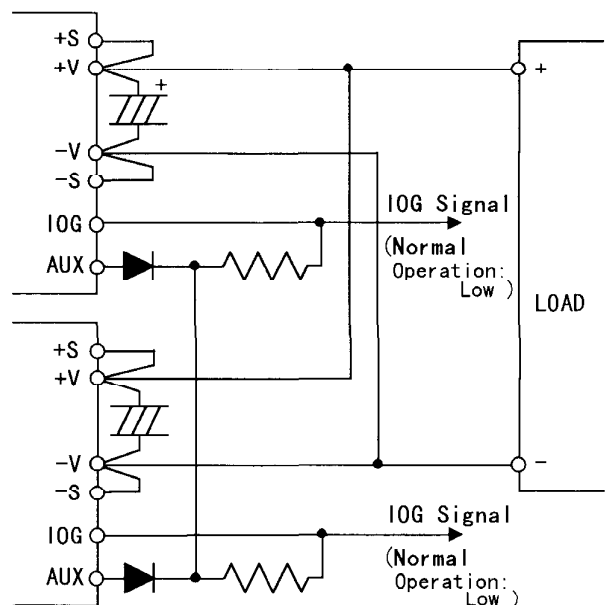


Figure13-1 : Example of IOG Terminal Connection

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(Example)

2 units of PH300F48-5 are to be used in parallel operation.

The total nominal output current is 120A, then

$$120 \times 0.1 = 12 \text{ (A)}$$

will be calculated as the minimum load current.

14. AUXILIARY POWER SUPPLY FOR EXTERNAL SIGNAL (AUX TERMINAL)

AUX terminal is provided inside the F type power module.

The output voltage of AUX terminal is in the range of 7 ~ 10VDC, and the maximum output current is 10mA.

When using this terminal in parallel connection with other AUX terminal in DC/DC power modules, a diode must be attached. See Fig13-1 for connection example. Even for this case, maximum output current should be 10mA.

Avoid connecting AUX terminal directly with other terminals of the module because this may damage the power module.

Ground of AUX terminal is -S terminal.

15. OPERATING TEMPERATURE

By maintaining baseplate temperature below 85°C at actual operating conditions, operation is possible. For details of thermal design, refer to Application Note "Thermal Design."

16. OPERATING HUMIDITY

Note that dew condensations may cause abnormal operation and damage to power

module.

17. STORAGE TEMPERATURE

Note that abrupt temperature changes may cause condensation and bad effects on soldering.

18. STORAGE HUMIDITY

Storing power modules in high temperature and high humidity creates oxidation on each terminals and causes soldering problems.

19. COOLING METHOD

Because the operating temperature range is prescribed by baseplate temperature, several cooling methods are possible.

For details of thermal design, refer to Application Note "Thermal Design."

20. BASEPLATE TEMPERATURE VS. OUTPUT REGULATION

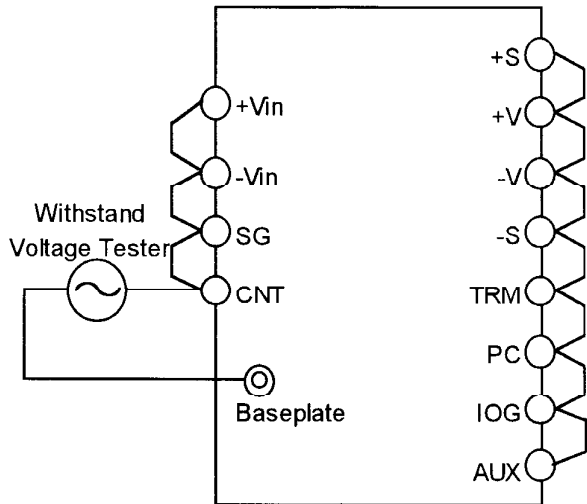
Baseplate temperature vs. output regulation is defined as the output voltage deviation ratio when operating baseplate temperature is changed.

21. WITHSTAND VOLTAGE

This PH series is designed to withstand 2.5kVAC between input and baseplate, and 3kVAC between input and output for 1 minute each. (For 24VDC input model, it is designed to withstand 2kVAC between input and baseplate, and 2kVAC between input and output for 1 minute). When withstand voltage

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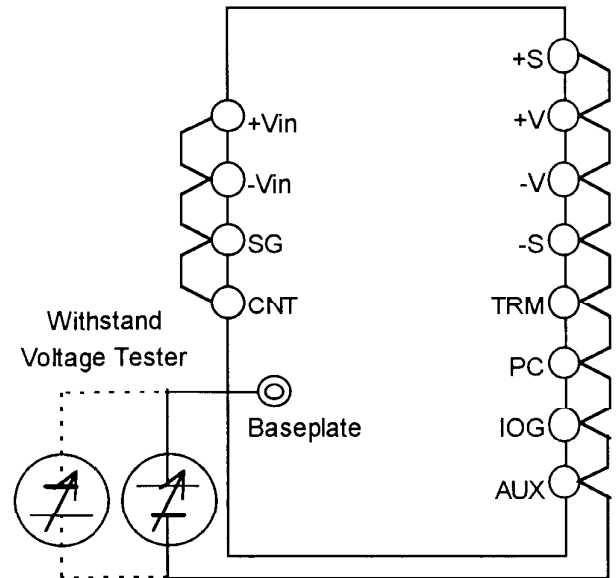
test would be carried out at incoming inspection etc., the limit value of the tester shall be set at 20mA.



2.5kVAC for 1 minute (20mA)
(24VDC Input model : 2kVAC)

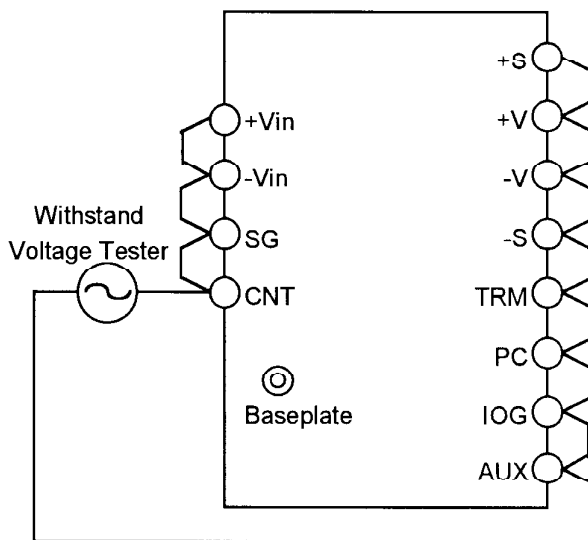
Figure21-1 : Withstand Voltage Test between Input and Baseplate

When the test would be carried out at incoming inspection etc., be sure not to apply AC voltage; apply DC voltage. In case AC voltage is applied, the power module might be damaged.



500VDC between output and baseplate
for 1 minute

Figure21-3 : Withstand Voltage Test between output and baseplate



3kVAC for 1 minute (20mA)
(24VDC Input model : 2kVAC)

Figure21-2 : Withstand Voltage Test between Input and output

Do not apply the test voltage by throw-in. Gradually raise the voltage from zero , and also gradually drop down the tester for shut off. Especially take care when using withstand voltage tester with timer because impulse is generated which is several times high as the applied voltage when the switch is turned off by the timer which might cause damage to the module.

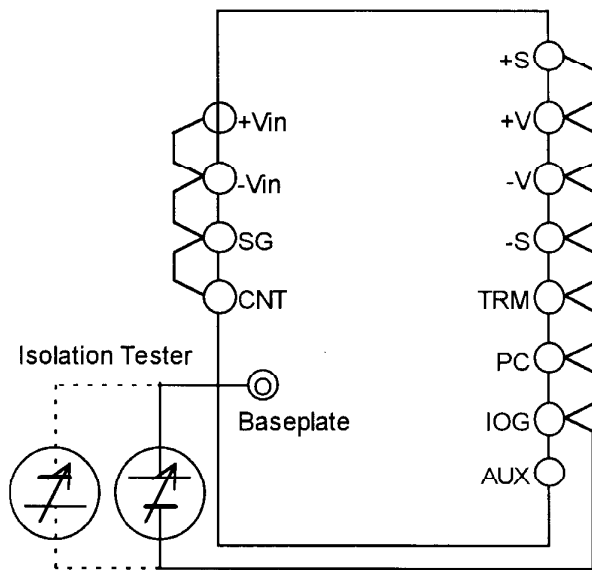
Short the output side as shown in Fig.21-1 to Fig.21-3.

This series is designed to withstand 500VDC between output and baseplate for 1 minute.

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22. INSULATED RESISTANCE

DC insulated tester (max. 500V) shall be set between output and baseplate. The insulated resistance is more than 100MΩ at 500VDC. Depending on insulation testers, high pulse may occur when the voltage is changed. Be sure that the tester is fully discharged by a resistor etc. after every test.



(more than 500MΩ between the output and baseplate at 500VDC)

Figure22-1 : Insulation Test

23. VIBRATION

Refer to Application Note "Installation."

24. SHOCK

Values are measured at our packing and shipping conditions.

Reference table for C3 Value

Model Vout	PH50S PH75S	PH75F	PH100S PH150S	PH100F PH150F	PH300F 48/110/ 280	PH300F 24
2V	-----	6.3V 1000μF	-----	6.3V 2200μF	6.3V 4700μF	-----
3V	6.3V 470μF	6.3V 1000μF	6.3V 1000μF	6.3V 2200μF	6.3V 4700μF	-----
5V	10V 470μF	10V 1000μF	10V 1000μF	10V 1000μF	10V 2200μF	-----
12V	25V 220μF	25V 220μF	25V 470μF	25V 470μF	25V 1000μF	25V 1000μF
15V	25V 220μF	25V 220μF	25V 470μF	25V 470μF	25V 1000μF	-----
24V	35V 120μF	35V 120μF	35V 220μF	35V 220μF	35V 560μF	-----
28V	50V 100μF	50V 100μF	50V 220μF	50V 220μF	50V 470μF	50V 1000μF

- Note)
1. Use the capacitor of good temperature characteristics and with low impedance.
 2. Connect the capacitor to module output terminal with as short leads as possible.
 3. Be aware of the ripple current tolerance of the capacitor.
 4. Using LXY series of Nippon Chemi-con or equivalent will meet design requirement in above 1 and 3.