Application manual
TUNS1200F

Rev. 1.0J 2020/7/31

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Note: Information contained in this document is subject to change without notice for improvement.
The materials are intended as a reference design, component values and circuit examples described in this document varies depending on operating conditions and component variations.
Please select the components and design under consideration of usage condition etc.

1. Pin Assignment

1.1 Pin Assignment

Fig.1.1
Pin Assignment

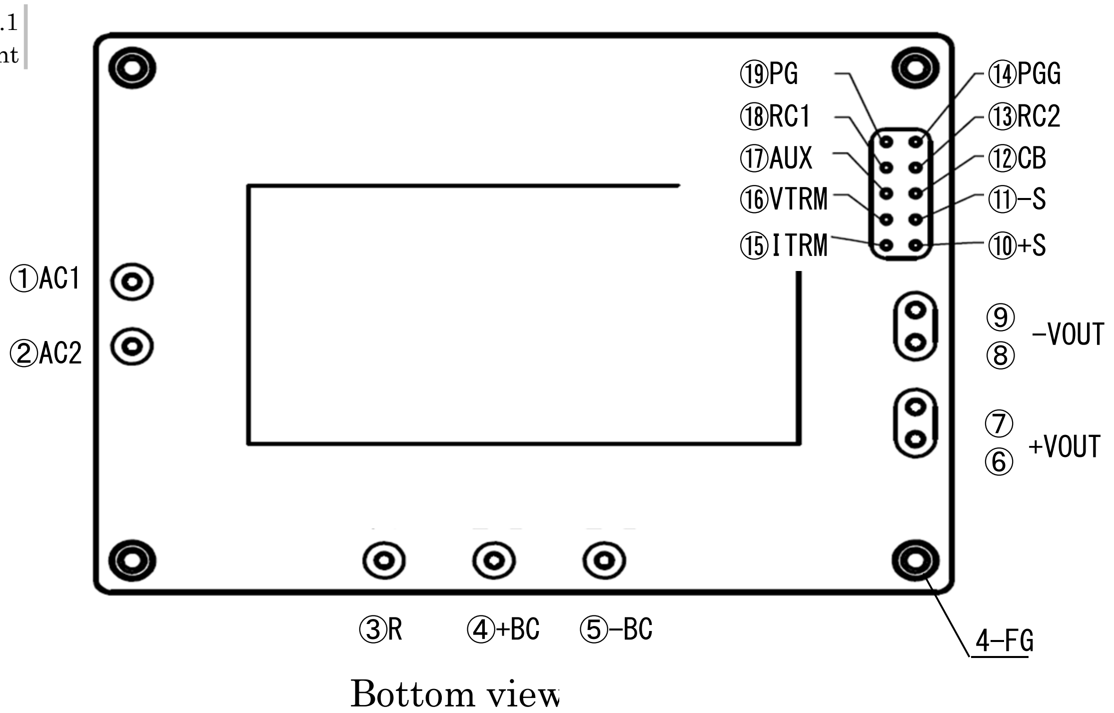


Table 1.1
Pin configuration and function

No.	Pin Connection	Function
①	AC1	AC input
②	AC2	
③	R	External resistor for inrush current protection
④	+BC	+BC output
⑤	-BC	-BC output
⑥⑦	+VOUT	+DC output
⑧⑨	-VOUT	-DC output
⑩	+S	Remote sensing(-)
⑪	-S	Remote sensing(+)
⑫	CB	Current balance
⑬	RC2	Remote ON/OFF ground
⑭	PGG	Alarm ground
⑮	ITRM	Adjustment of output current
⑯	VTRM	Adjustment of output voltage
⑰	AUX	Auxiliary output for remote ON/OFF
⑱	RC1	Remote ON/OFF
⑲	PG	Alarm
-	FG	Mounting hole(FG)

2. Connection for Standard Use

2.1 Connection for standard use

■To use the TUNS1200 series, external components should be connected as shown in Fig.2.1.
■The TUNS1200 series should be conduction-cooled. Use a heatsink or fan to dissipate heat.

Fig.2.1
Connection for standard use

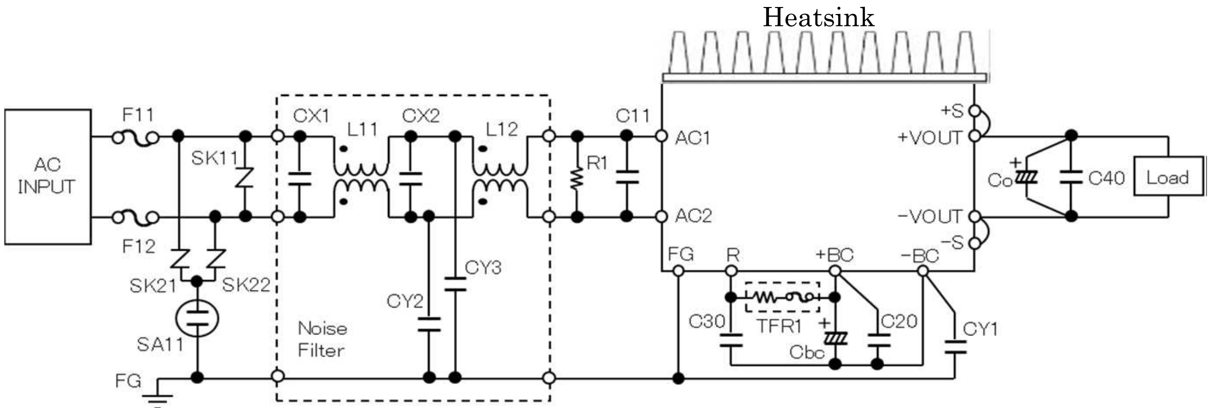


Table 2.1
Components list

No.	Symbol	Item			Vin = 85～264VAC Rating	Vin = 85～264VAC Part name	Vin = 85～305VAC Rating	Vin = 85～305VAC Part name	Note
1	F11	Input fuse			AC250V/25A	0325025 (Littelfuse)	AC500V/25A	0505025 (Littelfuse)	
2	F12	Input fuse			AC250V/25A	0325025 (Littelfuse)	AC500V/25A	0505025 (Littelfuse)	For medical standard application
3	C11	Input capacitor			AC310V/1.5uF ×2parallel	LE155-MX×2parallel (OKAYA ELECTRIC INDUSTRIES)	AC310V/1.5uF ×2parallel	LE155-MX×2parallel (OKAYA ELECTRIC INDUSTRIES)	
4	CY1	Y capacitor			AC400V /2200pF	CD45-E2GA222M (TDK)	AC400V /2200pF	CD45-E2GA222M (TDK)	
5	L11	Noise filter	AC Line filter		0.8mH/20A	SCR25-200-1R7A008JH (TOKIN)	2.4mH/15A	SCR25B-150-1R4A024J (TOKIN)	
6	L12	Noise filter	AC Line filter		3.5mH/15A	SC15-E350H (TOKIN)	2.4mH/15A	SCR25B-150-1R4A024J (TOKIN)	
7	CX1	Noise filter	X capacitor		AC310V/1.5uF	LE155-MX (OKAYA ELECTRIC INDUSTRIES)	AC310V/1.5uF	LE155-MX (OKAYA ELECTRIC INDUSTRIES)	
8	CX2	Noise filter	X capacitor		AC310V/1.5uF	LE155-MX (OKAYA ELECTRIC INDUSTRIES)	AC310V/1.5uF	LE155-MX (OKAYA ELECTRIC INDUSTRIES)	
9	CY2	Noise filter	Y capacitor		AC400V/1500pF	CD45-E2GA152M (TDK)	AC400V/1500pF	CD45-E2GA152M (TDK)	
10	CY3	Noise filter	Y capacitor		AC400V/1500pF	CD45-E2GA152M (TDK)	AC400V/1500pF	CD45-E2GA152M (TDK)	
11	Co	Output capacitor		F12	DC25V/2200uF	ELXZ250ELL222 (Nippon Chemi-Con)	DC25V/2200uF	ELXZ250ELL222 (Nippon Chemi-Con)	
				F28	DC50V/1000uF	ELXZ500ELL102 (Nippon Chemi-Con)	DC50V/1000uF	ELXZ500ELL102 (Nippon Chemi-Con)	
				F48	DC63V/470uF	ELXZ630ELL471 (Nippon Chemi-Con)	DC63V/470uF	ELXZ630ELL471 (Nippon Chemi-Con)	
12	C40	Bypass capacitor		F12	DC50V/1uF	C3216X7R1H105 (TDK)	DC50V/1uF	C3216X7R1H105 (TDK)	
				F28	DC50V/1uF	C3216X7R1H105 (TDK)	DC50V/1uF	C3216X7R1H105 (TDK)	
				F48	DC100V/1uF	C3216X7R2A105 (TDK)	DC100V/1uF	C3216X7R2A105 (TDK)	
13	Cbc	Smoothing capacitor			DC450V/470uF ×3parallel	ELXS451VSN471×3parallel (Nippon Chemi-Con)	DC500V/470uF ×3parallel	ELXS501VSN471×3parallel (Nippon Chemi-Con)	
14	C20	Capacitor for boost voltage			DC450V/1.0uF ×2parallel	ECWFE2W105JA×2parallel (Panasonic Electronic Components)	DC630V/1.0uF ×2parallel	ECWFE2J105JA×2parallel (Panasonic Electronic Components)	
15	C30	Capacitor for boost voltage			DC450V/1.0uF ×2parallel	ECWFE2W105JA×2parallel (Panasonic Electronic Components)	DC630V/1.0uF ×2parallel	ECWFE2J105JA×2parallel (Panasonic Electronic Components)	
16	TFR1	Inrush current protection resistor			5.1Ω×2series	A5MC-5R1JK×2series (UCHIBASHI ESTEC)	5.1Ω×2series	A5MC-5R1JK×2series (UCHIBASHI ESTEC)	
17	R1	Discharging resistor			68kΩ ×3series x 2parallel	CRS32 683 (HOKURIKU ELECTRIC INDUSTRY)	68kΩ ×3series x 2parallel	CRS32 683 (HOKURIKU ELECTRIC INDUSTRY)	
18	SK11 SK21 SK22	Varistor			620V	TND14V-621K (Nippon Chemi-Con)	620V	TND14V-621K (Nippon Chemi-Con)	
19	SA11	Surge absorber			4kV	DSA-402MA (Mitsubishi Materials)	4kV	DSA-402MA (Mitsubishi Materials)	

・External parts should be changed according to the ambient temperature, and input and output conditions.
For details, refer to the selection method of individual parts.

2.2 Input fuse: F11,F12

■Fuse is not build-in on input side. In order to protect the unit, install a fuse (as shown in Table 2.2)
■When applying for the medical electrical equipment standard, please install F11 and F12.

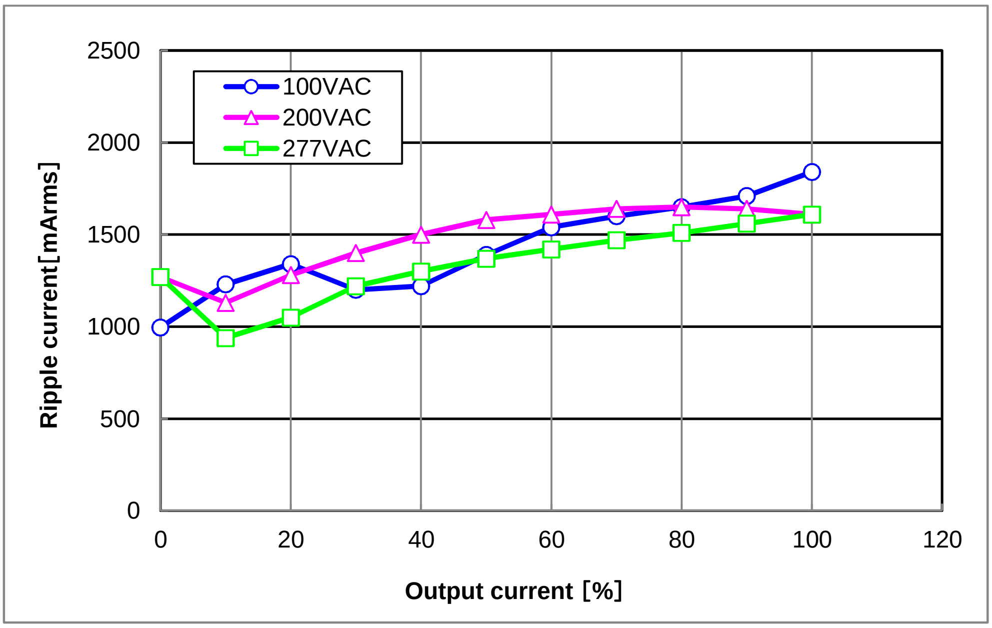
Table 2.2 Recommended fuse

Input voltage range	Rated Voltage	Rated current
85 ～264VAC	AC250V以上	25A
85 ～305VAC	AC300V以上	25A

2.3 Input capacitor: C11

■Install a film capacitor of 3μF or higher as input capacitor C11.
■Use a safety approved capacitor.
■If C11 is not connected, that may cause failure of the power supply or external components.
■When selecting a capacitor, check the maximum allowable ripple current.
■Ripple current includes low frequency component (input frequency) and high frequency component (100kHz).
■Ripple current values flowing into C11 as listed in Table 2.1 are shown in Fig.2.2.
■The ripple current changes with PCB patterns, external parts, ambient temperature, etc. Check the actual ripple current value flowing through C11.

Fig.2.2 Ripple current values C11



2.4 Y Capacitors and noise filters: CY, CX, L11, L12

■The TUNS1200 doesn't have noise filter internally
Install an external noise filter and capacitor (CY) to reduce conducted noise and stabilize the operation of the power supply.
■Noise filters should be properly designed when the unit must conform to the EMI/EMS standards or when surge voltage may be applied to the unit.
■Install the primary Y capacitor (CY1) as close as possible to the input pins (within 50 mm from the pins).
A capacitance of 470 pF or more is required.
■When the total capacitance of CYs exceeds 8,800 pF, input-output withstanding voltage may be dropped. In this case, either reduce the capacitance of Y capacitors or install a grounding capacitor between output and FG.
■Use capacitors that comply with safety standards as CY.

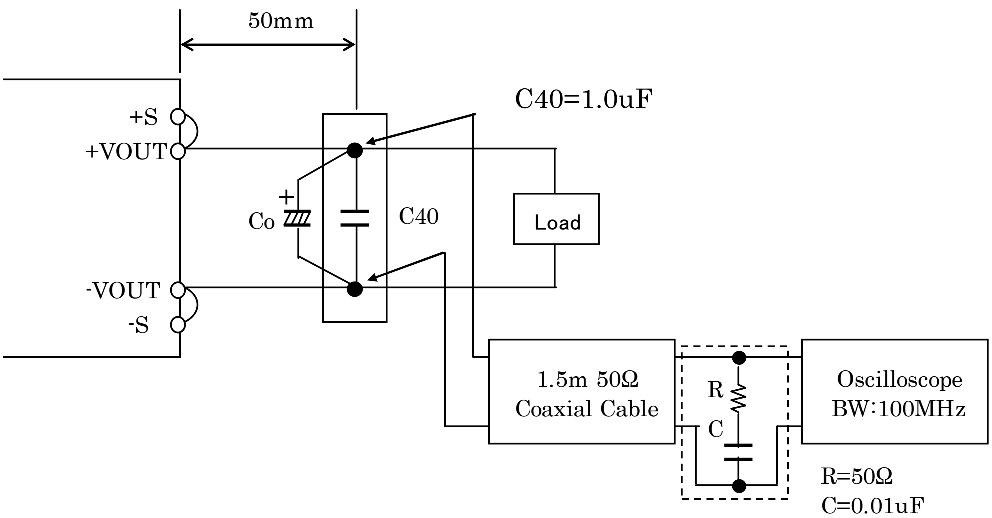
2.5 Output capacitors: Co, C40

■Install an external capacitor, Co, between +VOUT and -VOUT pins for stable operation of the power supply. Recommended capacitance of Co is shown in Table 2.3.
■Use low impedance electrolytic capacitors with excellent temperature characteristics.
■When Using at ambient temperatures below 0 °C, the output ripple voltage increases due to the characteristics of equivalent series resistor (ESR). In this case, connect three capacitors, Co, of recommended capacitance in parallel connection.
■Specifications, output ripple and ripple noise as evaluation data values are measured according to Fig.2.3.

Table 2.3 Recommended capacitance Co

Output Voltage	Tc = 0～100℃	Tc = -40～100℃
12V	2,200uF	2,200uF×3parallel
28V	1,000uF	1,000uF×3parallel
48V	470uF	470uF×3parallel

Fig.2.3 Measuring environment



2.6 Smoothing capacitor for boost voltage: Cbc

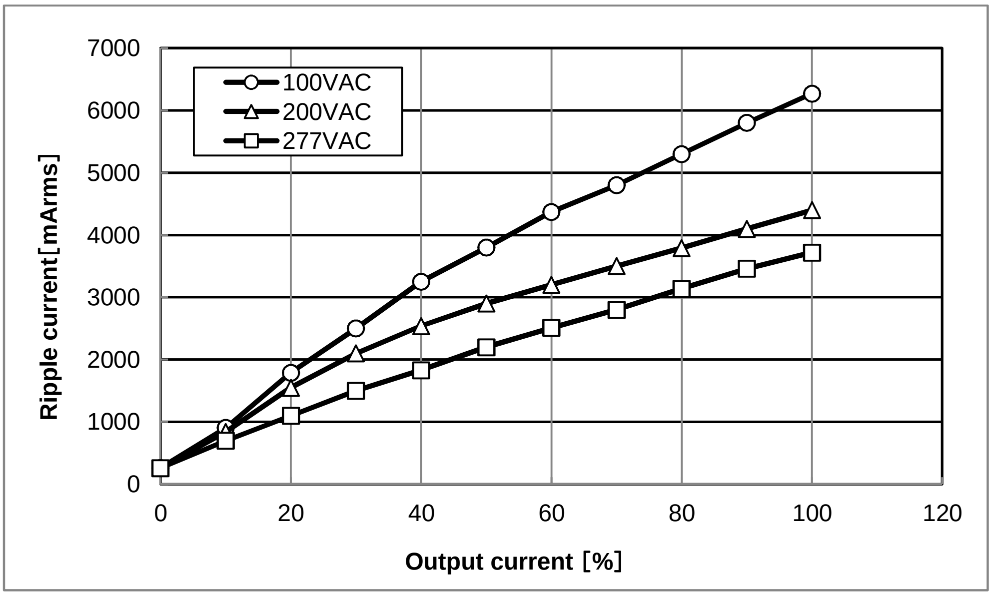
■In order to smooth boost voltage, connect Cbc between +BC and -BC.
Recommended capacitance of Cbc is shown in Table 2.4.
■If the capacity is not within the allowable external capacity, the module may be damaged.
■When operated below 0°C, operation may become unstable as boost ripple voltage increases due to ESR characteristics. Choose a capacitor which has higher capacitance than recommended.
Select a capacitor so that the ripple voltage of the boost voltage is 30 Vp-p or below.
■If the ripple voltage of the boost voltage increases, the ripple current rating of the smoothing capacitor may be exceeded. Check the maximum allowable ripple current of the capacitor.
■The ripple current changes with PCB patterns, external parts, ambient temperature, etc. Check the actual ripple current value flowing through Cbc.
■The boost voltage varies depending on the input voltage. (See item 3.1)

Table 2.4 Recommended capacitance Cbc

Input voltage range	Rated voltage	Recommended capacitor	Allowable capacitance range
85 ～264VAC	DC420V以上	470uF×3 parallel	780uF ～ 3,300uF
85 ～305VAC	DC500V以上	470uF×3 parallel	780uF ～ 2,200uF

※ Refer to item 3 and 4 for selection method of Cbc.

Fig.2.4 Ripple current values Cbc

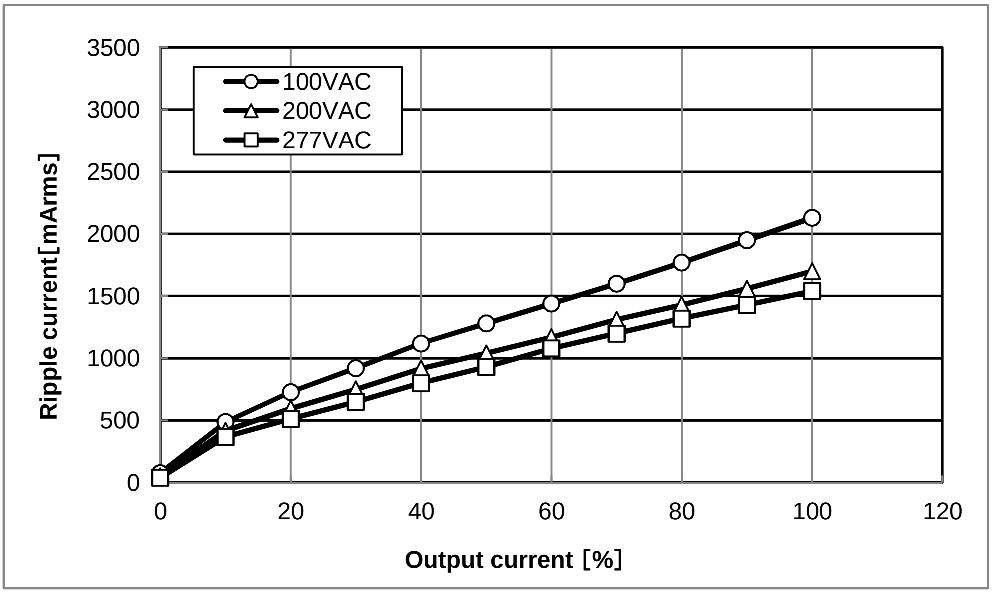


※Ripple current value is the sum of parallel capacitors.

2.7 Capacitor for boost voltage :C20,C30

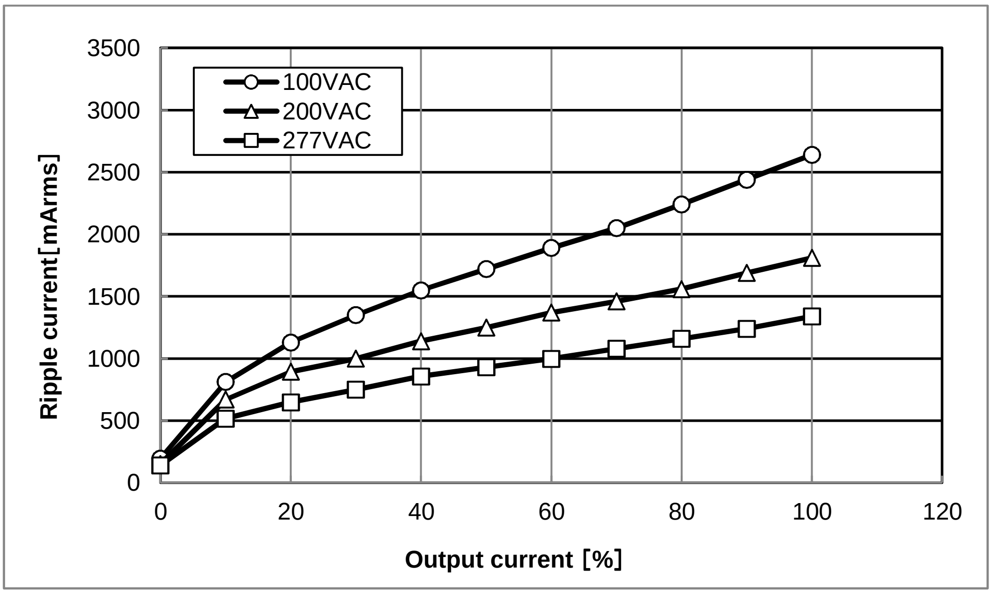
■Install a film capacitor of 2uF or more into C20 and C30.
■If C20 and C30 are not connected, the power supply or external components could be damaged.
■Ripple current flows in. Check the maximum allowable ripple current of the capacitor when selecting. The frequency of the ripple current is 100 kHz to 200 kHz.
■Ripple current values flowing into C20 and C30 as listed in Table 2.1 are shown in Fig.2.5 and Fig.2.6.
■The ripple current changes with PCB patterns, external parts, ambient temperature, etc. Check the actual ripple current values flowing through C20 and C30.
■The boost voltage varies depending on the input voltage. (See item 3.1)

Fig.2.5 Ripple current values C20



※Ripple current value is the sum of parallel capacitors.

Fig.2.6 Ripple current values C30



※Ripple current value is the sum of parallel capacitors.

2.8 Inrush current limiting resistor: TFR1

■Install inrush current limiting resistor(TFR1) between R terminal and +BC terminal.
■If TFR1 is not connected, the power supply will not work.
■The surge capacity is required for TFR1.
■Wirewound resistor with thermal cut-offs type is required.
■Inrush current limiting resistor can be used to limit the primary inrush current. However, the secondary inrush current can't be limited by increasing the resistor value of inrush current limiting resistor. The secondary inrush current is approx. 25 ~ 30A.
Therefore, we don't recommend connecting a large resistance as TFR1.
■The inrush current changes by PCB pattern, parts characteristic etc.
Check the actual inrush current value flowing through the AC line.

Table 2.5 Recommended resistor TFR1

Recommended resistance
4.7Ω ～ 22Ω

■The selection method of TFR1 is shown below.
・ Calculation of resistance
Resistance can be calculated using the following formula.

$$TFR1 = \frac{Vin \times \sqrt{2}}{Ip} - R_L [\Omega]$$

・Calculation of required surge capacity
Required surge capacity can be calculated using the following formula.
Please contact to the component manufacturer regarding the surge current withstanding capability.

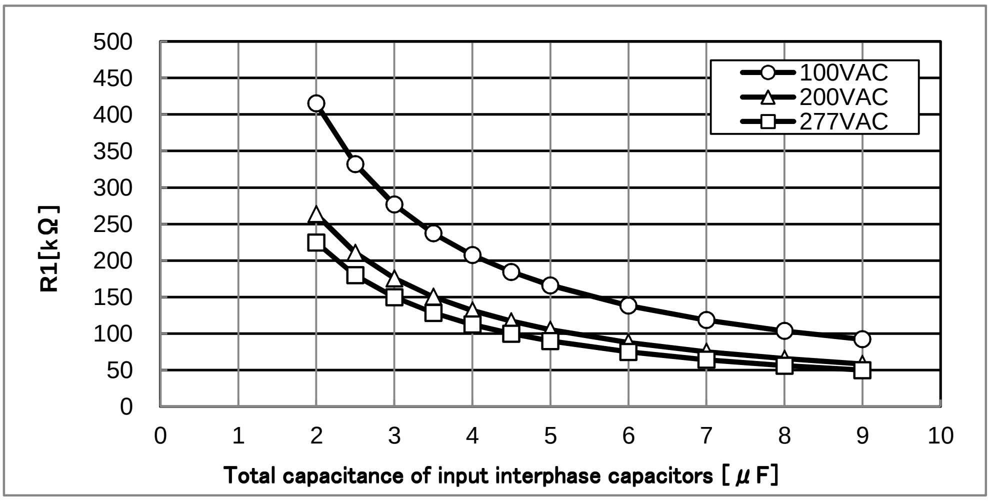
$$I^2 t = \frac{Cbc \times Vin^2}{TFR1} [A^2 s]$$

I2t ： Current squared times
TFR ： Inrush current limiting resistor
Cbc ： Smoothing capacitor for boost voltage
Vin ： Input voltage (rms)

2.9 Discharging resistor: R1

■If you need to meet the safety standards, install a discharging resistor R1 at input interphase capacitors.
■Please select a resistor so that the input interphase voltage decreases in 42.4V or less at 1 second after turn off the input.
■Fig.2.7 shows the relationship between a necessary resistance of R1 and total capacitance of input interphase capacitors. The data is the value assuming the worst condition.
■Please keep margin for rated voltage and power of R1.

Fig.2.7 Relationship between input interphase capacitors and discharging resistor R1.

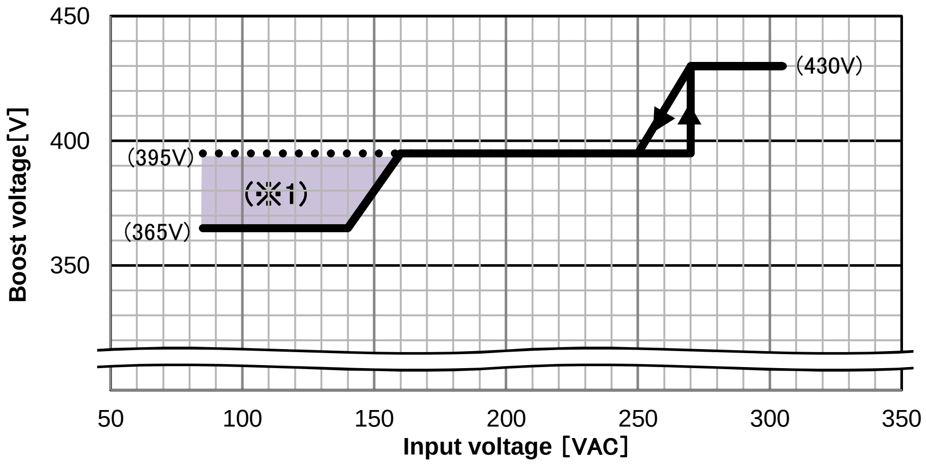


3. Holdup time

3.1 Input voltage characteristics of boosted voltage

■The boost voltage varies depending on the input voltage.

Fig.3.1 Input voltage characteristics of boosted voltage

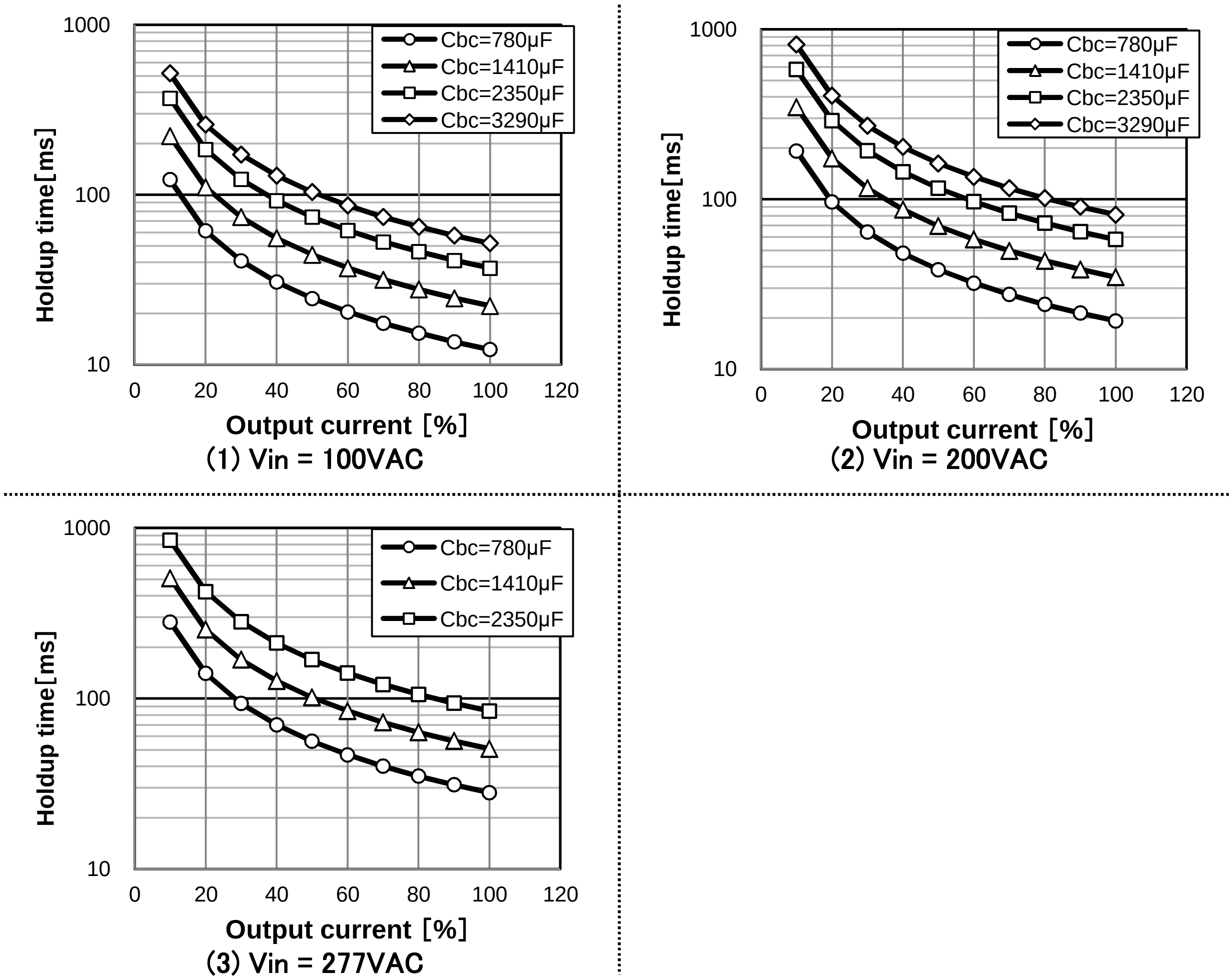


※1 : If you adjust the output voltage to +10% or more, the BC pin voltage will increase.

3.2 Holdup time

■Holdup time is determined by the capacitance of Cbc.
Figure 3.2 shows the relationship between holdup time and output current.

Fig.3.2 Relationship between holdup time and Cbc



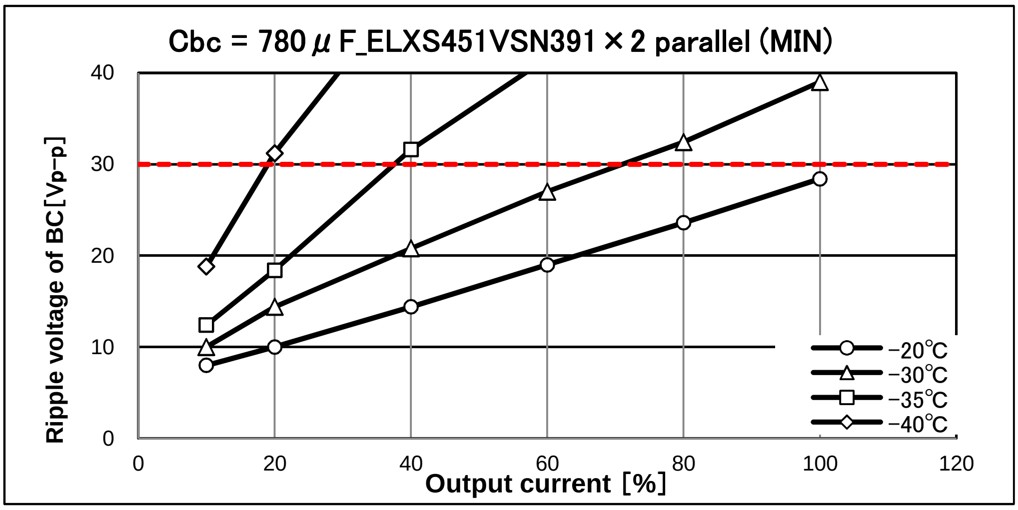
4. Operation Under Low Temperature Conditions

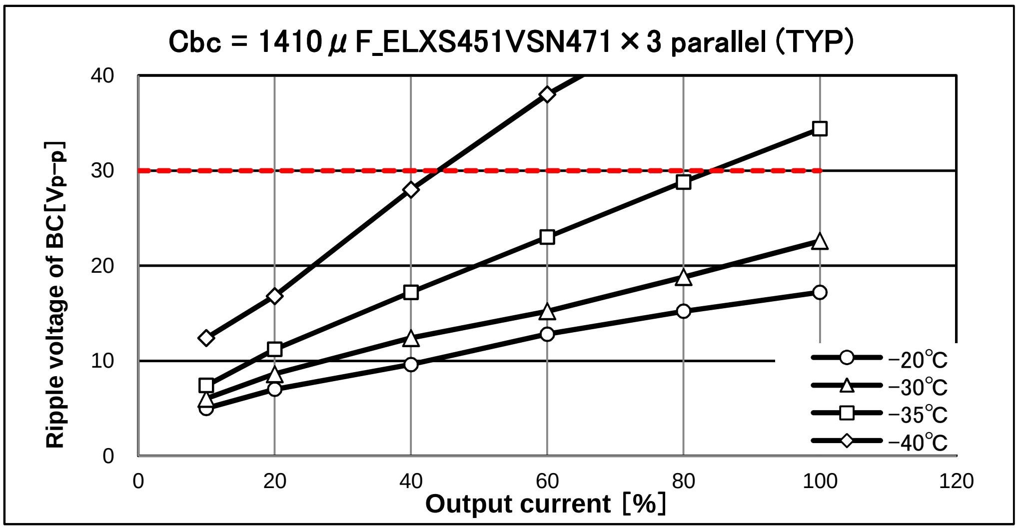
4.1 Ripple voltage of boost voltage

■At low temperature, ripple voltage of boost voltage increases due to Cbc freezes.
Select a capacitor of which ripple voltage of boost voltage does not exceed 30Vp-p on an actual operating condition.
■And check the maximum allowable ripple current of the capacitor.
■Fig.4.1 to 4.3 shows the relationship between ripple voltage of BC and temperature.

Fig.4.1
Ripple voltage of BC by Ambient temperature
AC200V

Input voltage range
85~264VAC





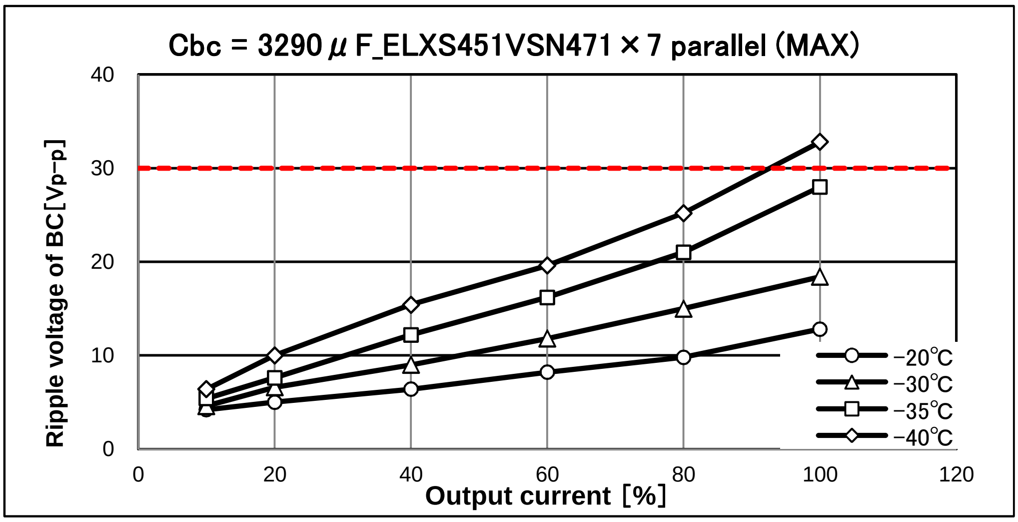
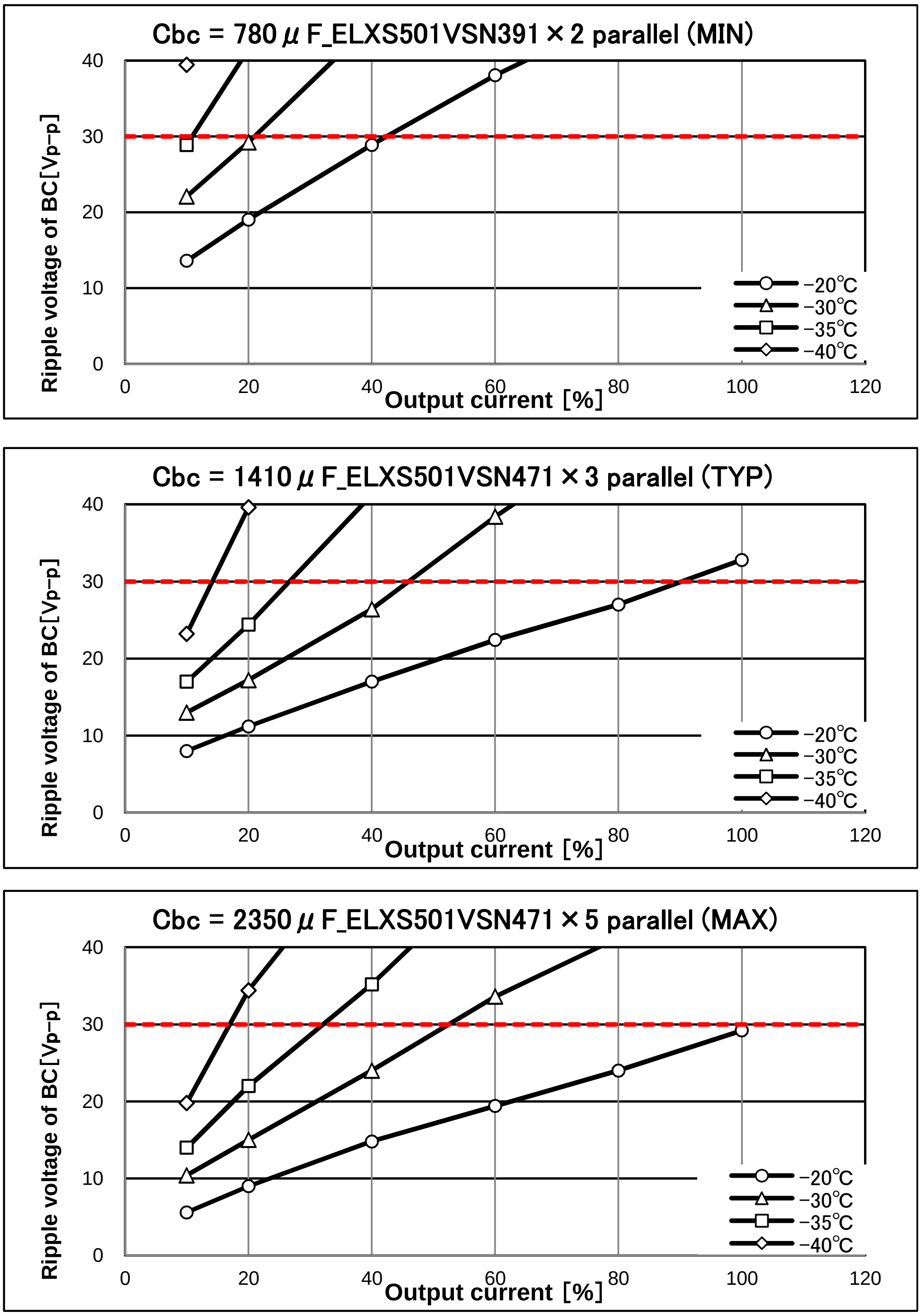


Fig.4.2
Ripple voltage of BC by Ambient temperature
AC200V

Input voltage range
85~305VAC



5. Parallel operation

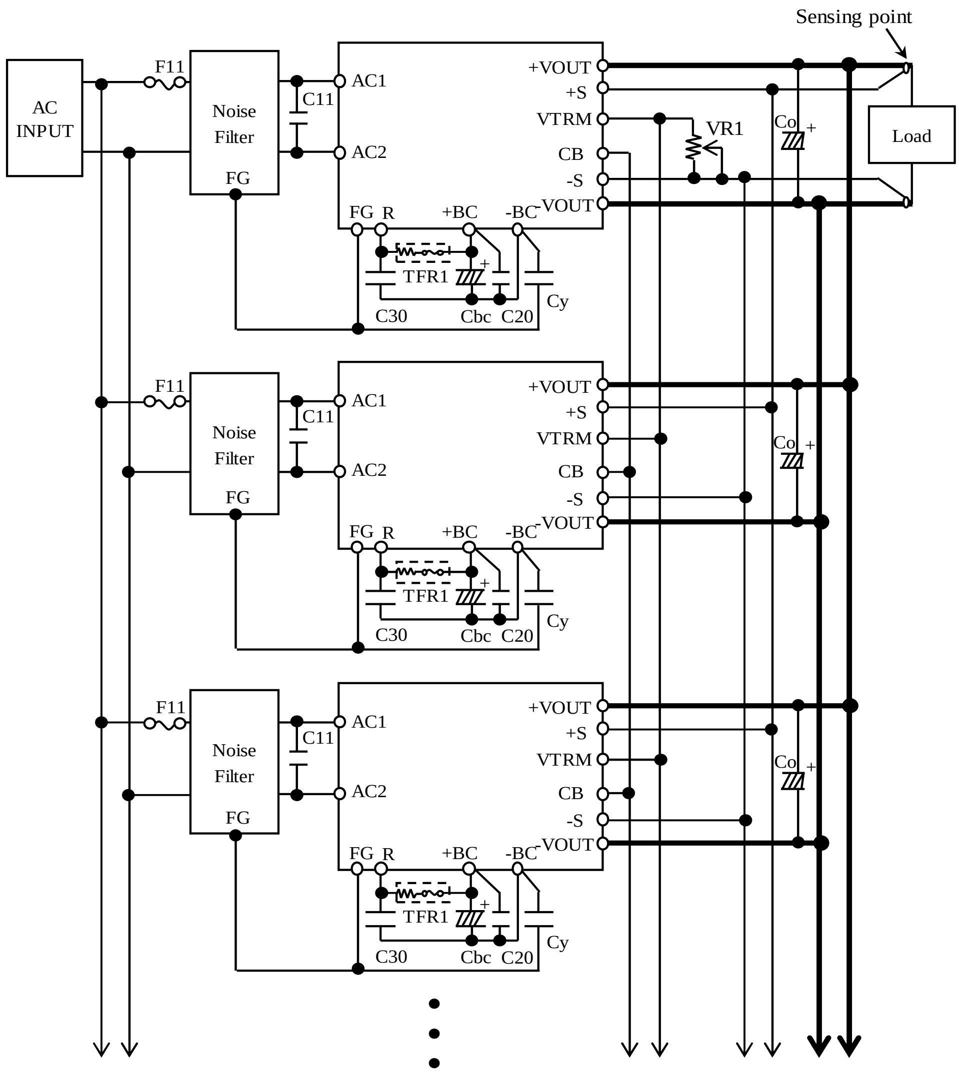
5.1 Wiring for parallel operation

■Parallel operation is available by connecting the units as shown in Fig 5.1.
■Input capacitor C11, boost voltage circuit capacitor (Cbc, C20, C30) and Inrush current limiting resistor TFR1 cannot be used together. Please wire for each power supply .
■Total current should not exceed the value calculated by the following equation, and total number of unit should be no more than 9 pieces.

(Output current at parallel operation) = (the rated current per unit)× (number of unit) ×0.9

■Connect the sensing line and the power line by one point after connecting each power supply's sensing pin(+S,-S). Please do not connect the sensing from the individual power supply as it may cause unstable operation.
■Please make sure that the wiring impedance of a load from each power supply become even.
■Output voltage and constant current can be adjusted in parallel operation. (Refer to item 5.2, 5.3)
■When the input voltage is applied with remaining the voltage at boost capacitor Cbc, startup time would be different for each paralleled module. If all paralleled modules need to startup at the same time, remote control function shall be used.
■If the output current is less than 2% of the rated current, the output voltage ripple will be large. Therefore, it is recommended to use it with 2% load or more.

Fig5.1
Wiring for parallel operation



5.2 Output voltage adjustment in parallel operation(CV)

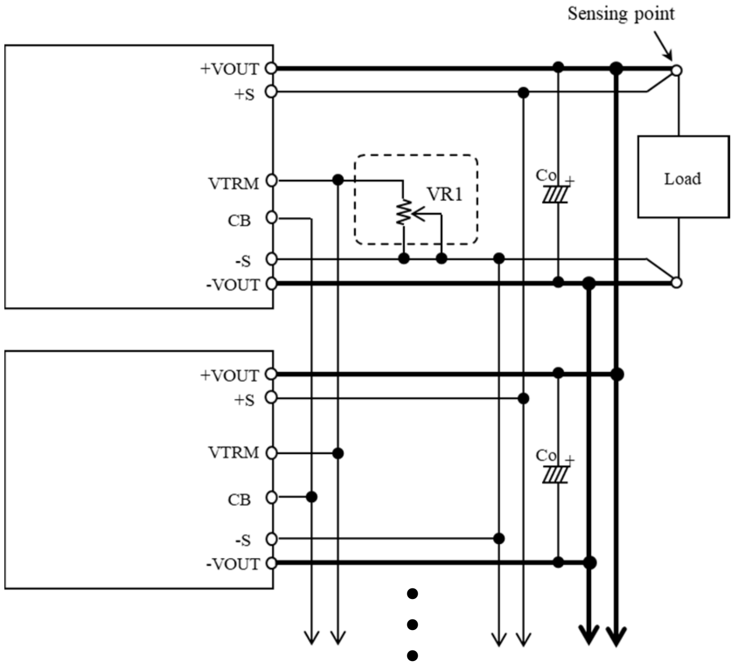
■When adjusting the output voltage in parallel operation, connect the VTRM terminals together and adjust them together.

■By connecting the external potentiometer(VR1) as shown in Fig.5.2.,output voltage becomes adjustable. See formula①

$$\text{Output voltage[V]} = \frac{2 \times \text{VR1 [k}\Omega\text{]}}{(\text{VR1} + 4.7 / N)\ [\text{k}\Omega]} \times \text{Rated output voltage [V]} \quad \cdots ①$$

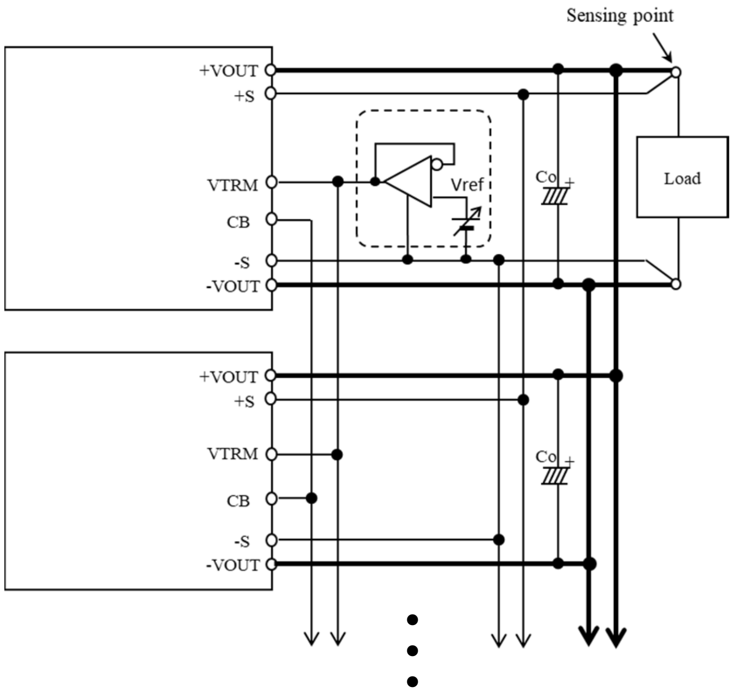
※ N: Parallel number of unit

Fig.5.2. Output voltage adjustment by external resistor



■By connecting the external power supply as shown in Fig.5.3.,output voltage becomes adjustable.

Fig.5.3. Output voltage adjustment by external power supply

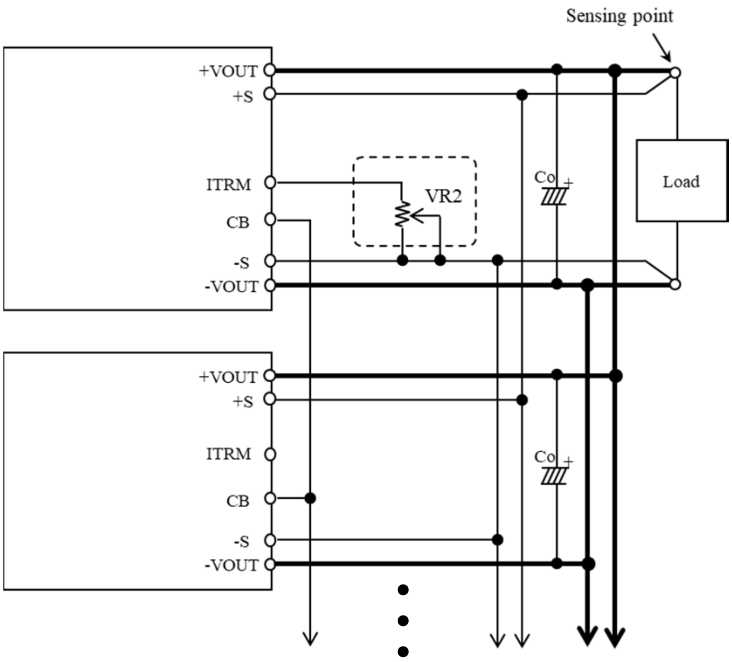


5.3 Constant current adjustment in parallel operation(CC)

■By adjusting the voltage of one ITRM, it is possible to adjust the constant current of all power supplies connected in parallel. It is not necessary to connect all ITRM terminals.
■By connecting the external potentiometer(VR2) as shown in Fig.5.4.,constant current becomes adjustable. See formula②

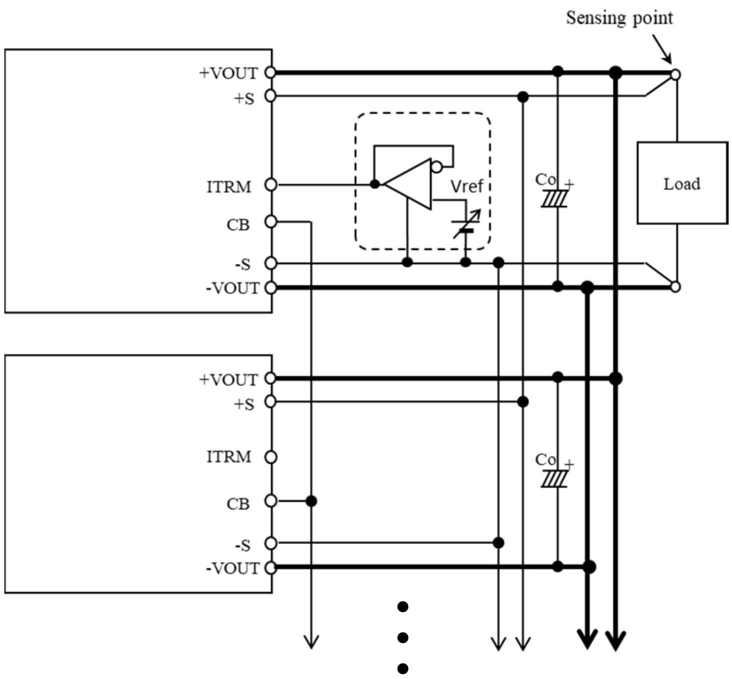
$$\text{Output current[A]} = \frac{2 \times \text{VR2 [k}\Omega]}{(\text{VR2} + 4.7)\ [\text{k}\Omega]} \times \text{Rated output current [A]} \quad \cdots ②$$

Fig.5.4. Constant current adjustment by external resistor



■By connecting the external power supply as shown in Fig.5.5.,constant current becomes adjustable.

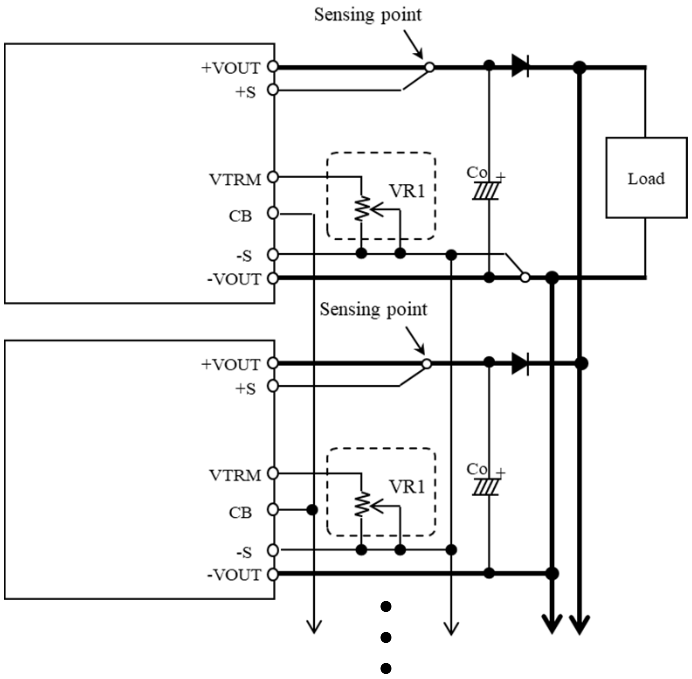
Fig.5.5. Constant current adjustment by external power supply



5.4 N+1 redundant operation

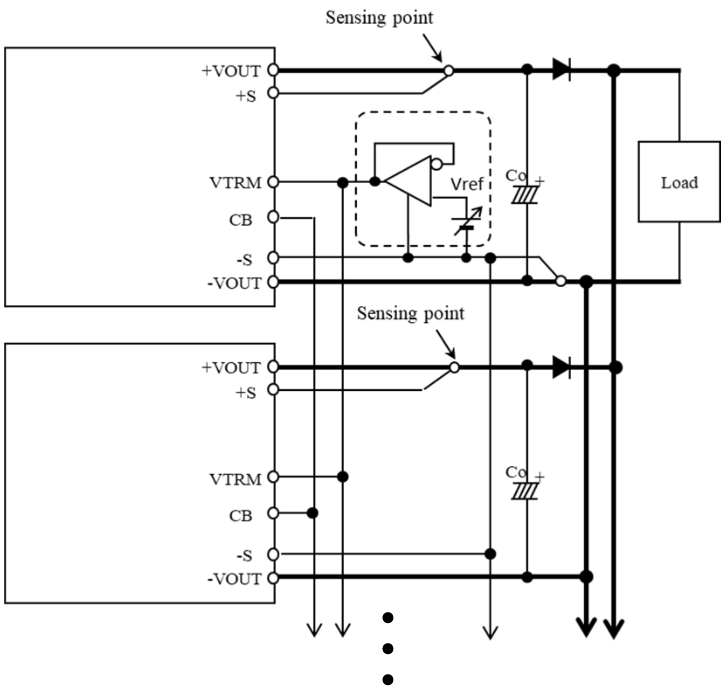
■If you add one extra power supply in parallel operation, even if one of the power supplies in your system fails, the remaining powersupplies continue to function.
■Use the load current with N power supplies, and keep the current per unit below the rated current x 0.9 or less.
■Constant current control cannot be used in N+1 redundant operation.
■The remote sensing function cannot be used in N+1 redundant operation.
■At the load end, the voltage drops due to the forward voltage (Vf) of the diode
■When the output voltage is adjusted by the volume in N+1 redundant operation, connect the volume to each power supply as shown in Fig.5.6.

Fig5.6 Wiring for N+1 redundant operation



■By connecting the external power supply as shown in Fig.5.7.,output voltage becomes adjustable.

Fig5.7 Wiring for N+1 redundant operation

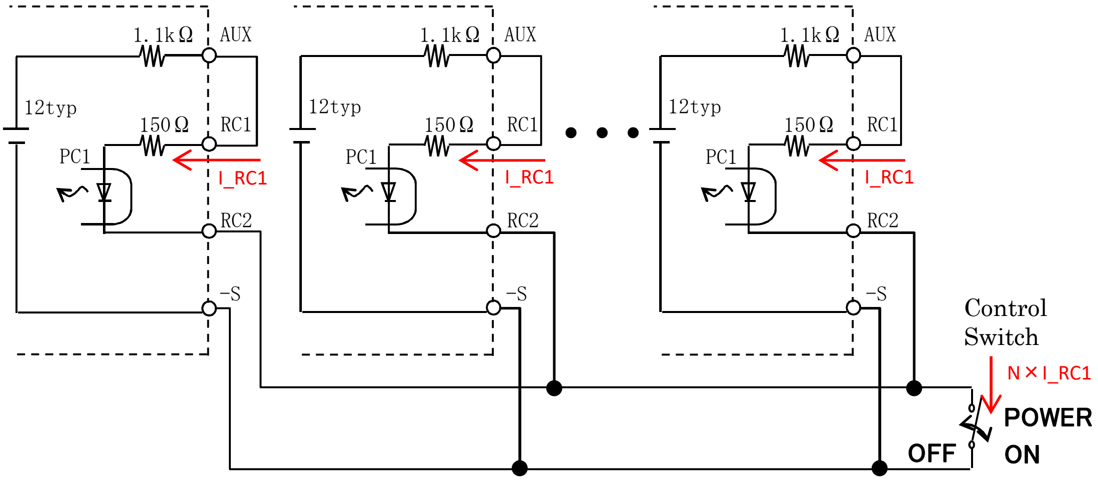


5.5 Remote control

■ When using remote control in parallel operation, control the remote control terminals of the power supplies in parallel at the same time, as shown in Fig.5.8 and 5.9.

Fig.5.8. Remote control wiring example

Ex.1) When the power output terminal and the remote control circuit are not isolated

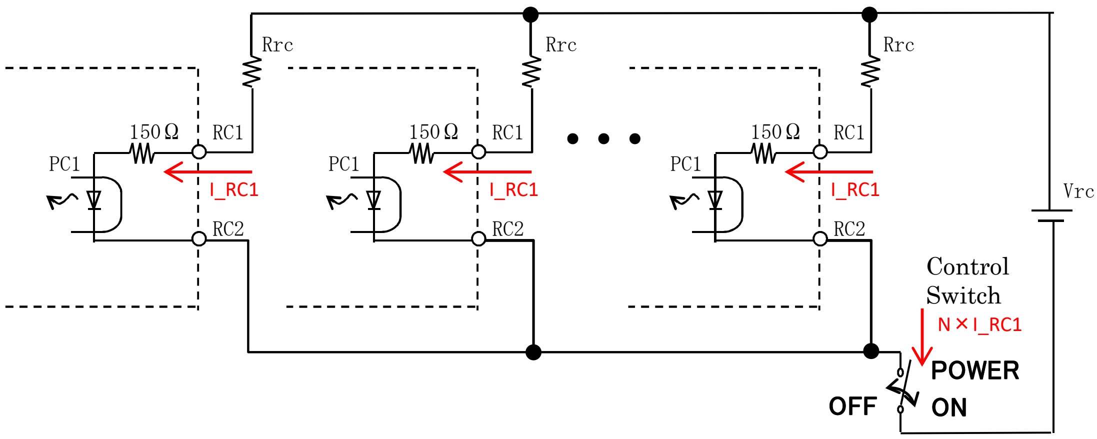


※ In the case of this connection example, the control current (I_RC1) flows up to 9.7mA. Current (N×I_RC1) for parallel connection (N) flows to the control switch.

Control current (I_RC1) = 9.7mA ···①

Fig.5.9. Remote control wiring example

Ex.2) When the power output terminal and the remote control circuit are isolated



※ When determining Vrc and Rrc, the current (I_RC1) flowing through each remote control circuit must satisfy the following formulas (2) and (3). Current (N×I_RC1) for parallel connection (N) flows to the control switch.

Control current (I_RC1) $= \dfrac{(Vrc - Vf\_MIN)}{(Rrc + 150)} \leqq 12\ mA$ ···②

Control current (I_RC1) $= \dfrac{(Vrc - Vf\_MAX)}{(Rrc + 150)} \geqq 2\ mA$ ···③

Vrc : External power supply voltage
Vf(PC1) : Vf_MIN = 0.9V
: Vf_MAX = 1.4V
Rrc : I_RC1current limiting resistor

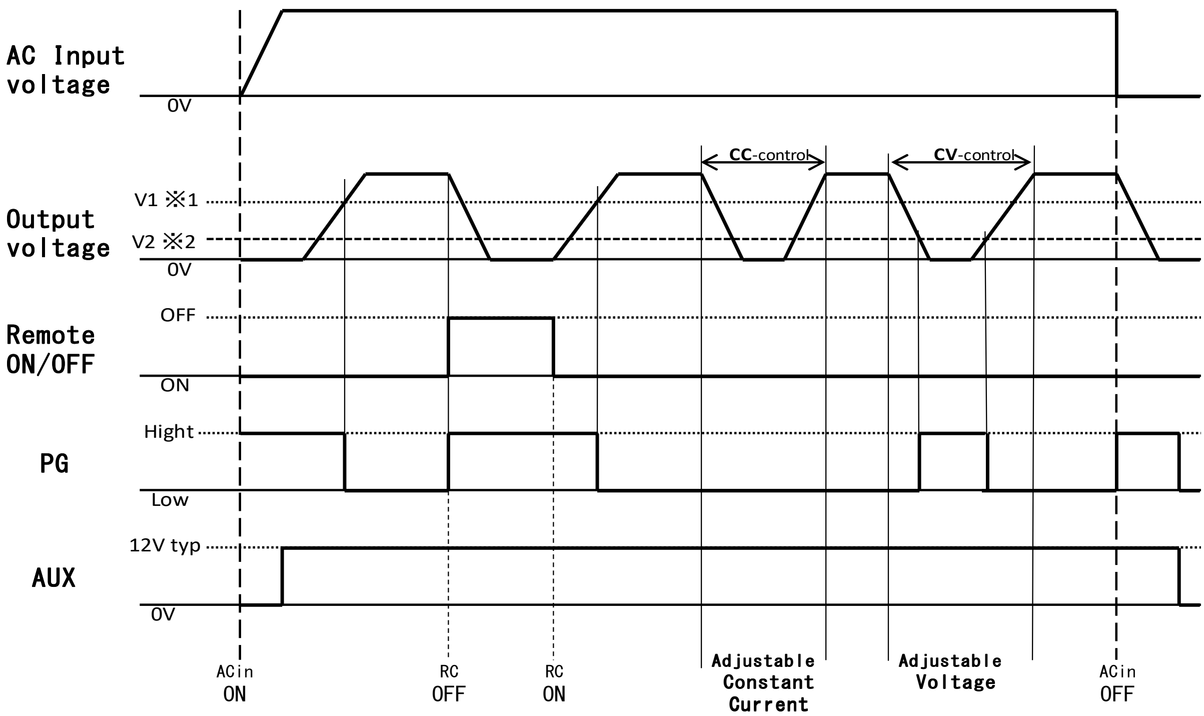
6. Other functions

6.1 Power Good

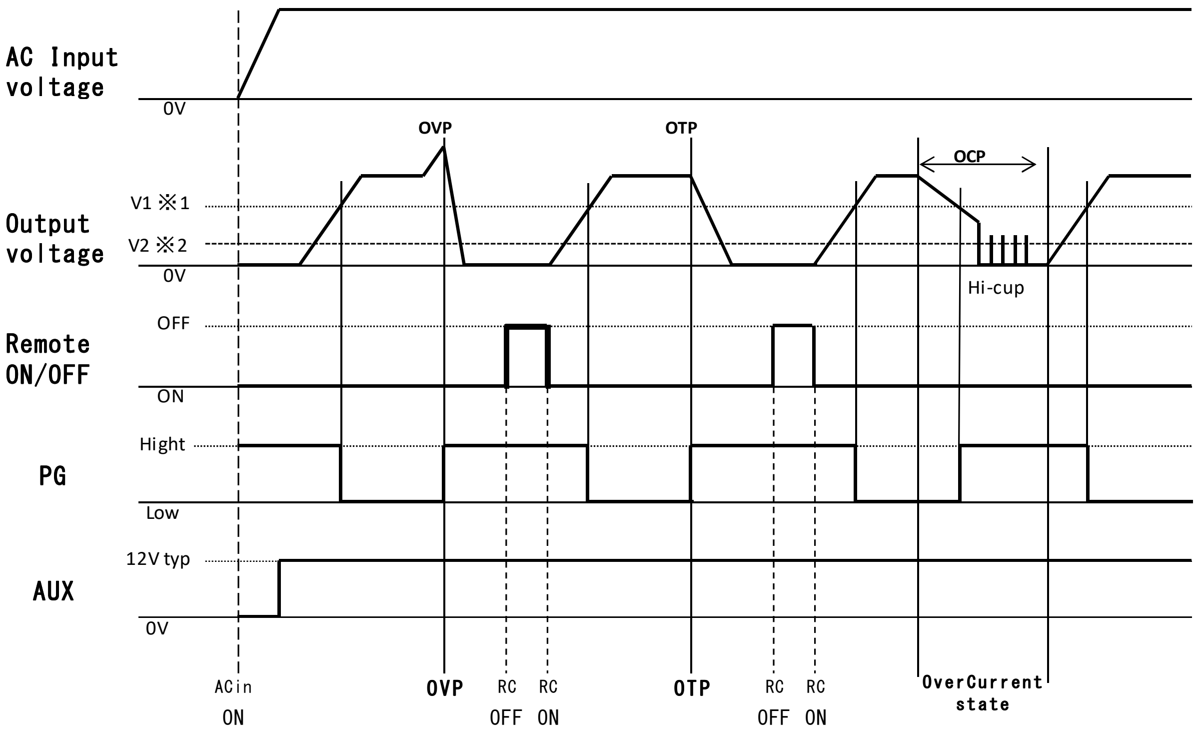
■By using PG, it is possible to monitor power supply whether normal operation or abnormal operation. The PG signal is "Low" when the power supply operates correctly. The signal turns to "High" when the power supply stops.

■The PG signal sequence is shown in Fig6.1.

Fig6.1
PG signal
sequence



※1 V1 : 60% of the set output voltage
※2 V2 : 20% of the rated output voltage



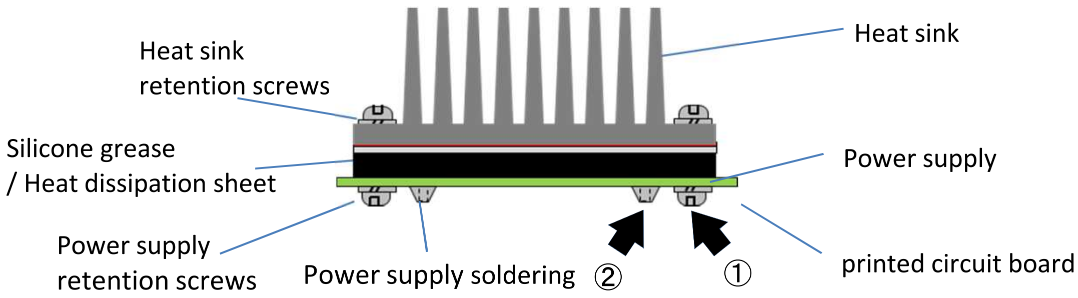
※1 V1 : 60% of the set output voltage
※2 V2 : 20% of the rated output voltage

7. Mounting method

7.1 Mounting method

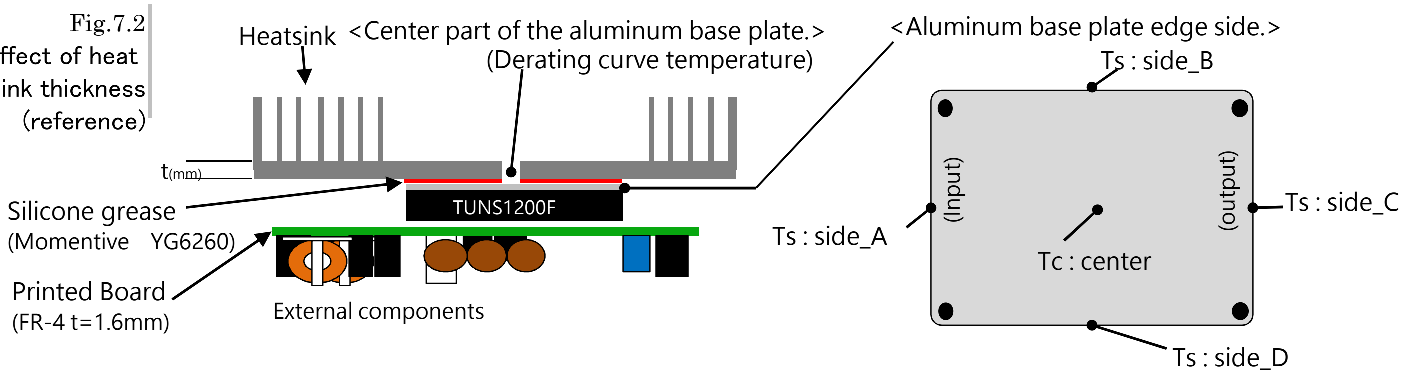
■When implementing the power supply to the printed circuit board, please fix the power supply to the printed circuit board by screw before the soldering.
If it is screwed to the substrate after soldering, there is a possibility of failure by adding mechanical stress to the soldering point and the internal connections of power supply.

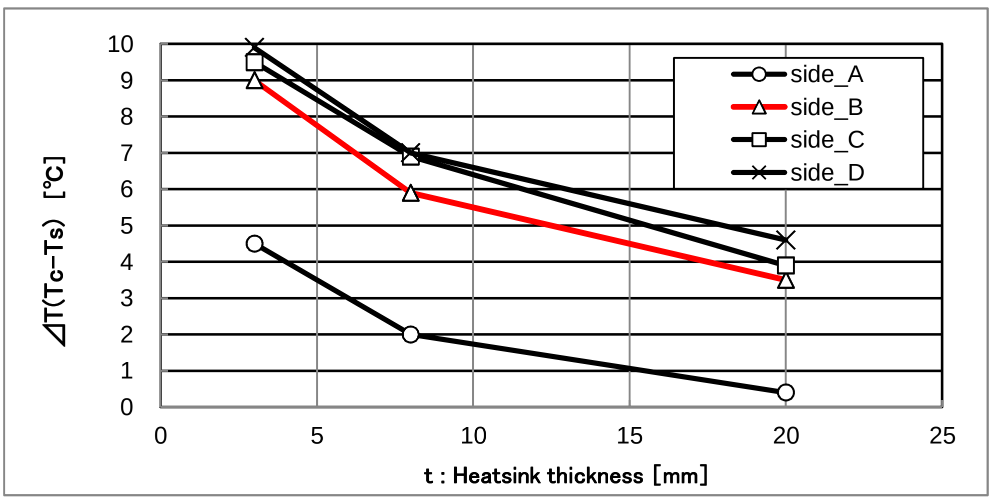
Fig.7.1
Mounting method



■Please measure the temperature on the aluminum base plate edge side when you cannot measure the temperature of the center part of the aluminum base plate. In this case, please take 5deg to 10deg temperature margin from the derating characteristics.
■Use a heat sink that larger than the power supply and has a large thickness so that the aluminum base plate can be cooled uniformly.
■The temperature distribution of the aluminum base plate varies depending on the model and input/output conditions. It is recommended to use the side_B as the reference because the temperature of the side_B varies little depending on the operating conditions.

Fig.7.2
Effect of heat sink thickness (reference)





※TUNS1200F28 at 100VAC and rated load

8. Board layout

8.1 Consideration for board layout

■ The potential voltage of each terminal is given below. External components that are connected to these terminals should be at same potential voltage.

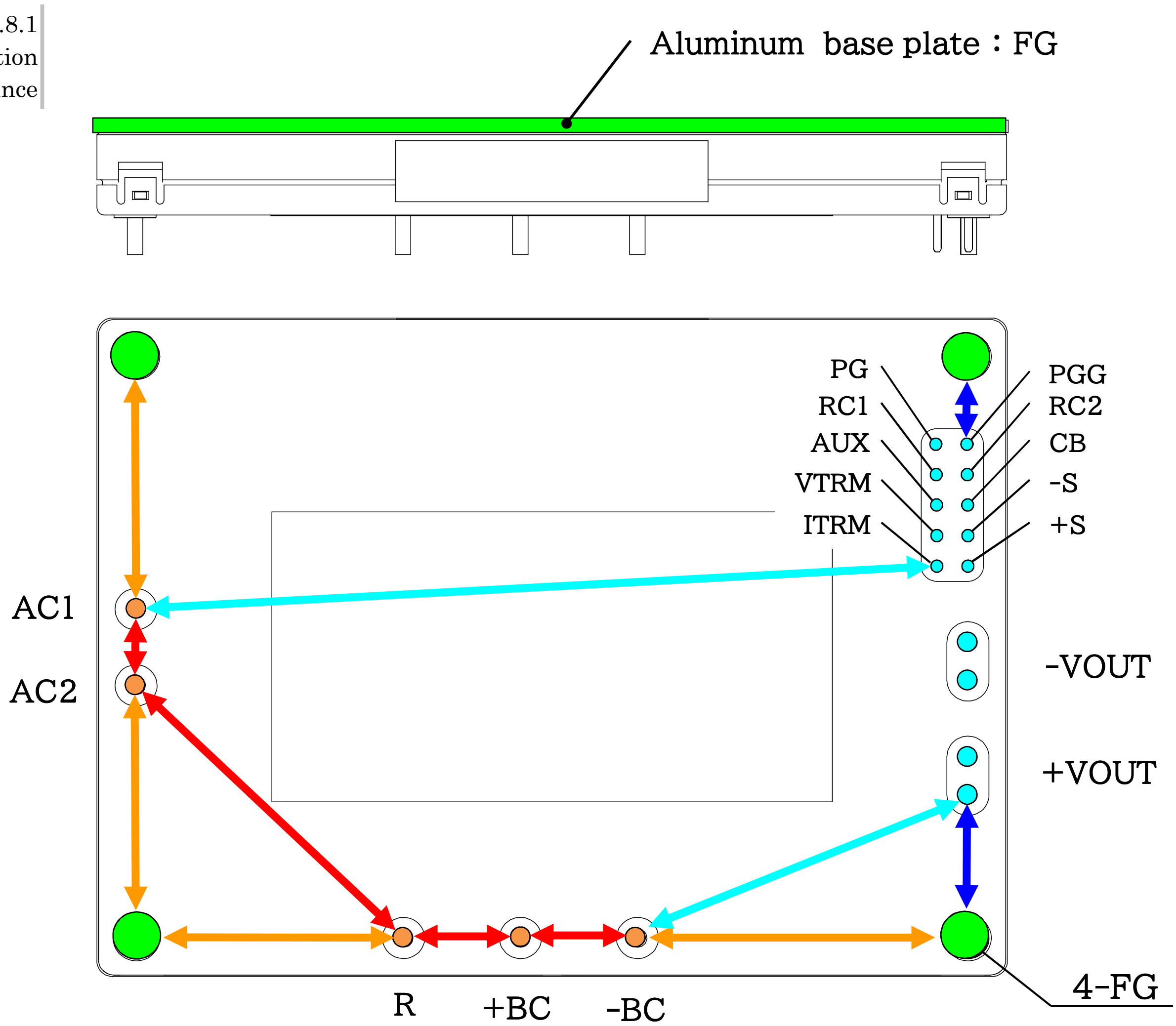
Primary side (Input line)	(orange) :	AC, BC, R pin
Secondary side (Output line)	(blue) :	VOUT, S, VTRM, ITRM, CB, AUX, RC, PG, PGG pin
FG(Aluminum base plate)	(green) :	Nut (4 places), Aluminum base plate, Heat sink

■In order to meet the breakdown voltage specification of products, insulation distance components and between patterns is recommended to ensure the following.

Primary circuit - Secondary circuit	(cyan arrow) :	8mm or more
Primary circuit - FG	(orange arrow) :	5mm or more
Secondary circuit - FG	(blue arrow) :	1.6mm or more
Primary circuit - Primary circuit	(red arrow) :	3mm or more
AC terminal line - BC terminal line	(red arrow) :	3mm or more

■Clearance and creepage requirements vary based on different safety standards and conditions of usage. Please place the components and wiring pattern according to those safety standards.

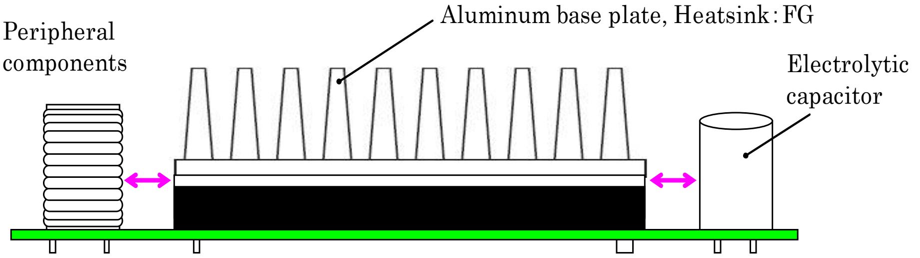
Fig.8.1 Insulation distance



■When installing the electrolytic capacitor and the power supply on the same surface of the printed circuit board, please pay attention to the distance between the base plate and electrolytic capacitor. Exterior of the electrolytic capacitor is assumed to be the same potential as the negative electrode.

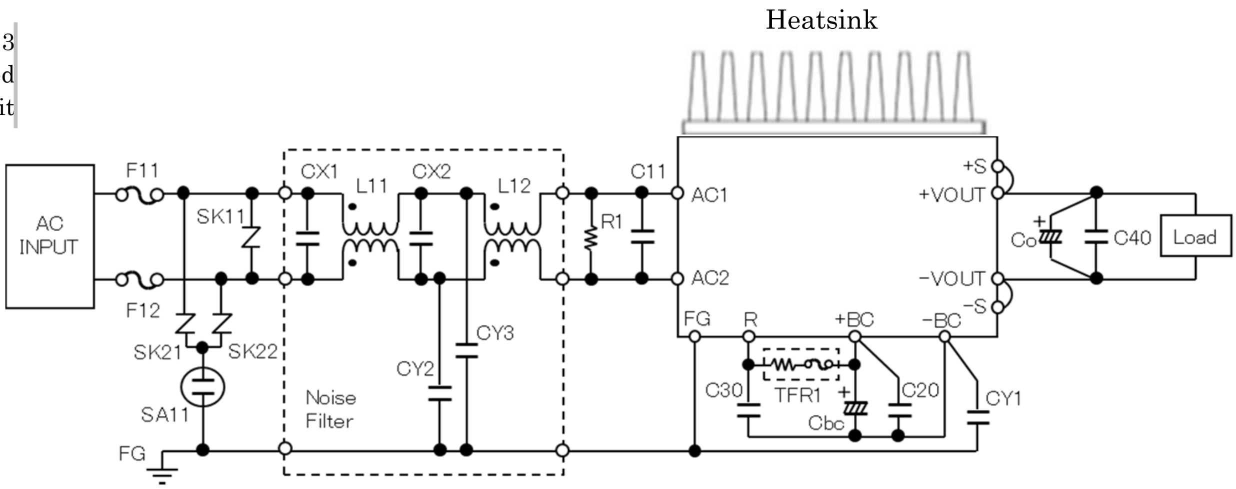
■High-frequency noise radiates directly from the unit to the atmosphere. Therefore, design the shield pattern on the printed circuit board and connect to FG. The shield pattern prevents noise radiation.

Fig.8.2 Same Surface Mount



■There are notes for printed circuit board design at recommended circuit in this applications manual. Please see below.

Fig.8.3 Recommended external circuit



① Input fuse : F11,F12
② Noise filters
- Line filter : L11、L12
- Interphase capacitor : CX1、CX2
- Y capacitor : CY2、CY3

③ Input capacitor : C11
④ Inrush current limiting resistor : TFR1
⑤ Capacitor for boost voltage
- Electrolytic capacitor : Cbc
- Film Capacitors : C20、C30

⑥ Y Capacitors : CY1
⑦ Output capacitors
- Electrolytic capacitor : Co
- Ceramic capacitor : C40

⑧ FG terminals
⑨ Surge Suppression
- Varistor : SK11、SK21、SK22
- Surge absorber : SA11

⑩ Discharging resistor : R1

① Input fuse : F11

When the fuse is blown out, input voltage would be applied between the terminals of the fuse F11.

Please keep the distance of the pattern between the terminals of the fuse more than 3mm if you must be complied safety approvals.

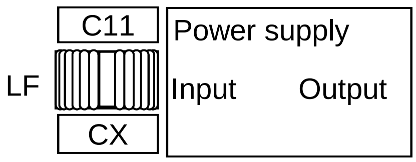
② Noise filter

Noise filter is build by Line filters (L11, L12), X capacitor (CX1, CX2) and Y capacitor (CY2,CY3). And the Noise filter is used to reduce conduction noise from power supply.

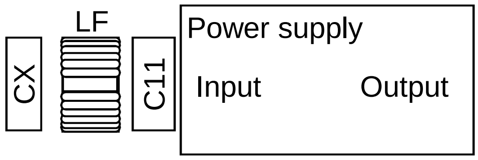
Off-the-shelf Noise filter is also available.

If the Line filter is placed near the components which is switching at high frequency, the conduction noise may be increased because the noise goes into the Line filter.

Therefore, the Line filter should be shielded or keep the distance from the source of noise.



× Not good



O Good

The effect of noise reduction by Y capacitor depends on the place of the FG connection. Recommend connecting Y capacitor to the FG terminal of the power supply as close as possible. Please evaluate before use.

③ Input capacitor : C11

Huge ripple current flows into the capacitor C11.
Place the capacitor C11 near the power supply as close as possible.

④ Inrush current limiting resistor : TFR1

Inrush current will flow through the Cbc TRF1 from the R pin. Please have a pattern width that is not damaged by the inrush current.

⑤ Capacitor for boost voltage : Cbc,C20 R pin connected capacitor : C30

The high voltage is appeared between +BC,R and -BC terminals.
The distance between +BC, R and -BC terminals must be 3mm or more.
Huge ripple current flows into the capacitor C20. Place C20 near the power supply as close as possible.

⑥ Y Capacitors : CY1

CY1 should be connected to the FG terminal of the power supply as close as possible.

⑦ Output capacitors : Co, C40

Connecting the output capacitor (Co,C40) to the power module as close as possible for stable operation and radiation noise reduction.
The output line impedance could cause unstable output voltage, which can be reduced by adding the output capacitor close to the load.
When the output ripple and ripple noise must be reduced, ceramic capacitor C40 which has good characteristics at high frequency should be used.
If through-hole type ceramic capacitor is used, the effect of the noise reduction would be reduced by the impedance of the lead frame of the components.
Please evaluate before using.

⑧ FG terminals of the power supply

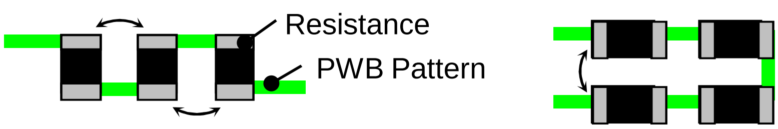
Connect the FG terminal of the power supply to the PWB by screw. If the FG terminals of the power supply is not connected properly, malfunction or failure could happen.
Expose the solder mask around the hole of the FG connection on the PWB to connect FG terminals by screws.

⑨ Surge Suppression Device: SK11,SK21,SK22, and SA11

In isolation test, test voltage is applied to the SA11. When the test voltage beyond the specification of the SA11 is applied, please remove the SA11 during the test, or lower the test voltage.
Note. When conducting isolation test between the primary and the secondary, high voltage is applied to SA11,SK11,SK21, and SK22, by the partial pressure of the Y capacitor.

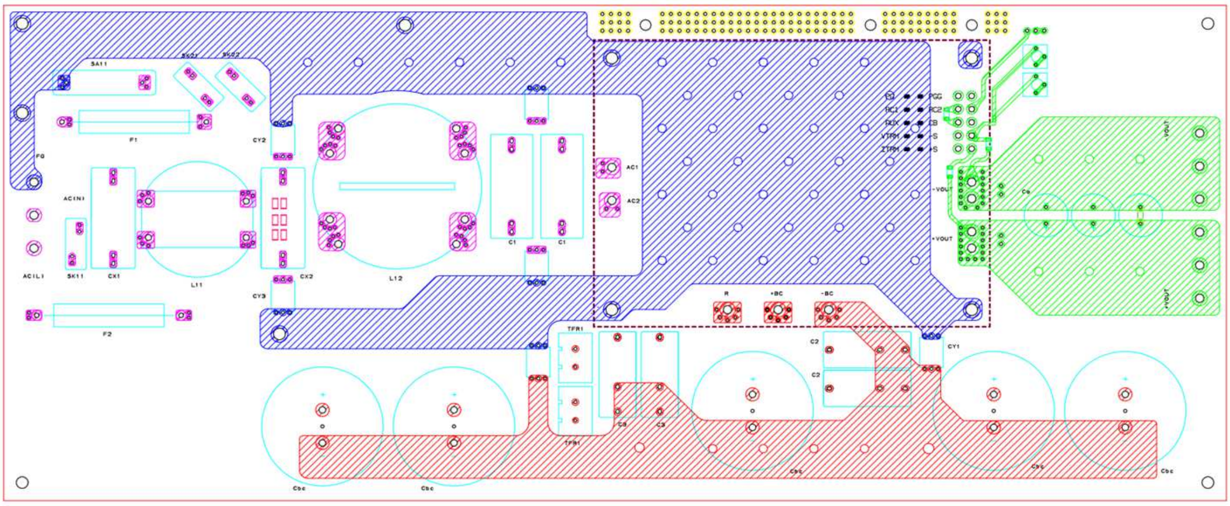
⑩ Discharging resistor : R1

Please keep distance between electrodes, when using multiple resistors as R1 due to the power loss dispersion.
In the case of obtaining safety standards, please keep insulation distance required by the standards.

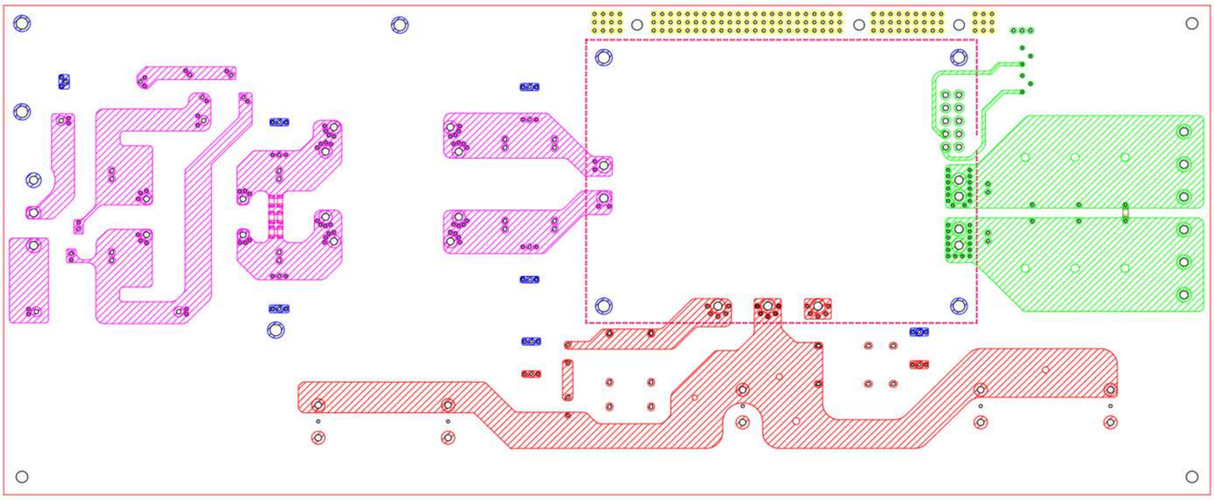


8.2 Reference PCB layout

Fig.8.4 Example of the pattern layout (Top view)



(a) Example of the pattern and components layout (Top layer)



(b) Example of the pattern and components layout (Bottom layer)