

TUNS50F, TUNS100F

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1 Connection for Standard Use

- To use TUNS series, connection shown in Fig.1.1 and external components are required.
- This product uses conduction cooling method (e.g. heat radiation from the aluminum base plate to the attached heat sink).
Reference: "Derating"

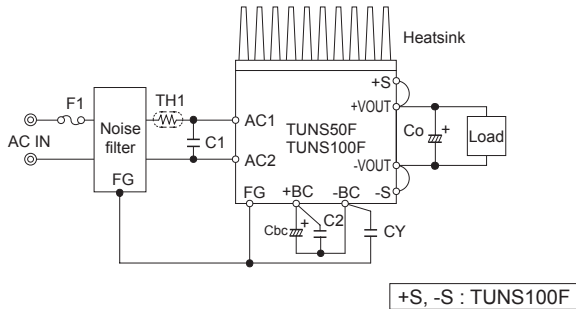


Fig.1.1 Connection for standard use

Table 1.1 External components

No.	Symbol	Components	Reference
1	F1	Input fuse	2.1 "Wiring input pin (1)"
2	C1	Input Capacitor	2.1 "Wiring input pin (2)"
3	-	Noise Filter	2.1 "Wiring input pin (3)"
4	CY	Y capacitor	2.1 "Wiring input pin (3)"
5	TH1	Inrush current protection thermistor	2.1 "Wiring input pin (4)"
6	Co	Output capacitor	2.2 "Wiring output pin (1)"
7	Cbc	Smoothing Capacitor for boost voltage	2.3 "Wiring +BC/-BC pins (1)"
8	C2	Capacitor for boost voltage	2.3 "Wiring +BC/-BC pins (2)"
9	-	Heatsink	"option parts" *

*Please refer to website.

2 Wiring Input/Output Pin

2.1 Wiring input pin

(1) F1 : External fuse

- Fuse is not built-in on input side. In order to protect the unit, install the slow-blow type fuse on input side (as shown in Table 2.1).

Table 2.1 Recommended fuse (Slow-blow type)

Model	TUNS50F	TUNS100F
Rated current	2A	3.15A

(2) C1 : External Capacitor for input side

- Install a film capacitor as input capacitor C1 of which the capacitance and ripple current capability are above the values shown in Table 2.2.
- Use a safety approved capacitor with 250V ac rated voltage.
- If C1 is not connected, it may cause the failure of the power supply or external components.

Table 2.2 Input Capacitor C1

No.	Model	Voltage	Capacitance	Rated ripple current
1	TUNS50F	AC250V	1 μ F or more	3A or more
2	TUNS100F		1 μ F or more	3A or more

(3) CY : Noise filter/Decoupling capacitor

- The product doesn't have noise filter internally.
Please connect external noise filter and primary decoupling capacitor CY for low line noise and stable operation of the power supply.
- The operation of the power supply may be unstable due to the resonance of the filter or inductance.
- Install a correspondence filter, if it is required to meet a noise standard or if the surge voltage may be applied to the unit.
- Install a primary decoupling capacitor CY, with more than 470pF, near the input pins (within 50mm from the pins).
- When the total capacitance of the primary decoupling capacitor is more than 8800pF, the nominal value in the specification may not be met by the Hi-Pot test between input and output. A capacitor should be installed between output and FG.

(4) TH1 : Inrush current limiting thermistor

- It has a possibility that internal components fail by inrush current, so please use power thermistor or inrush current limiting circuit to keep input current below 60A.
- If you use power thermistor and turn the power ON/OFF repeatedly within a short period of time, please have enough intervals so that a power supply cools down before being turned on. And appropriate intervals should be set even if inrush current limiting circuit except power thermistor is used.

■ The output voltage may become unstable at low temperature due to the ESR of power thermistor. In this case, increase the capacitance of Cbc more than recommended value or connect same capacitors in parallel. Please evaluate before use.

2.2 Wiring output pin

(1) Co : Output capacitor

■ Install an external capacitor Co between +VOUT and -VOUT pins for stable operation of the power supply (Fig.1.1).

Recommended capacitance of Co is shown in Table 2.3.

■ Select the high frequency type capacitor. Output ripple and start-up waveform may be influenced by ESR-ESL of the capacitor and the wiring impedance.

■ Install a capacitor Co near the output pins (within 50mm from the pins).

■ When the power supply is used under 0°C ambient temperature, output ripple voltage increases. In this case, connect 3 capacitors Co in parallel connection.

Table 2.3 Recommended capacitance Co[μF]

Model	Temperature of base plate			
	Tc=0 to +100°C		Tc=40 to +100°C	
	TUNS50F	TUNS100F	TUNS50F	TUNS100F
Output voltage (V)				
5	2200	2200	2200×3	2200×3
12	470	470	470×3	470×3
24	220	220	220×3	220×3

The specified ripple and ripple noise are measured by the method introduced in Fig.2.1.

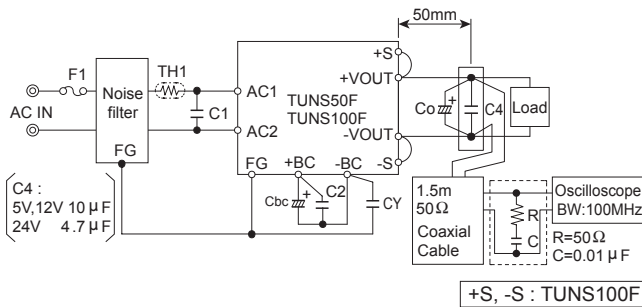


Fig.2.1 Method of Measuring Output Ripple and Ripple Noise

2.3 Wiring +BC/-BC pins

(1) Cbc : Smoothing capacitor for boost voltage

■ In order to smooth boost voltage, connect Cbc between +BC and -BC. Recommended capacitance of Cbc is shown in Table 2.4.

■ Note that +BC and -BC terminals have high voltage (DC385V typ).

■ Keep the capacitance within the allowable external capacitance.

■ Select a capacitor of which the boost voltage ripple voltage does not exceed 30Vp-p.

■ When the power supply is operated under -20°C, it may make the boost voltage unstable due to the characteristic of equivalent series resistor. Please choose the capacitor which has more than recommended capacitance.

Table 2.4 Recommended capacitance Cbc

No.	Model	Voltage	Cbc	Allowable capacitance range
1	TUNS50F	DC420V	82μF	47 to 150μF
2	TUNS100F	or more	120μF	68 to 220μF

(2) C2 : Capacitor for boost voltage

■ Install external capacitors C2 with capacitance shown in table 2.5.

■ If capacitors C2 are not installed, it may cause the failure of the power supply or external components.

Table 2.5 Recommended capacitance C2

No.	Model	Voltage	Capacitance	Rated ripple current
1	TUNS50F	DC450V	0.47μF or more	1A or more
2	TUNS100F		0.47μF or more	1A or more

3 Function

3.1 Input voltage range

■ The input voltage range is from 85 VAC to 264 VAC.

■ In cases that conform with safety standard, input voltage range is AC100-AC240V(50/60Hz).

■ Be aware that use of voltages other than those listed above may result in the unit not operating according to specifications, or may cause damage. Avoid square waveform input voltage, commonly used in UPS and inverters.

3.2 Overcurrent protection

■ Overcurrent protection is built-in and comes into effect over 105% of the rated current.

Overcurrent protection prevents the unit from short circuit and overcurrent condition. The unit automatically recovers when the fault condition is cleared.

■ When the output voltage drops at overcurrent, the average output current is reduced by hiccup operation of power supply.

3.3 Overvoltage protection

■ Overvoltage protection circuit is built-in. If the overvoltage protection circuit is activated, shut down the input voltage, wait more than 3 minutes and turn on the AC input again to recover the output voltage. Recovery time varies depending on such factors as input voltage value at the time of the operation.

Remarks:

Please note that devices inside the power supply might fail when voltage of more than rated output voltage is applied to output terminal of the power supply. This could happen when the customer tests the overvoltage performance of the unit.

To check the function of overvoltage protection, adjust the output voltage by changing TRM voltage. Please contact us for details.

3.4 Thermal protection

■When the power supply temperature is kept above 100°C, the thermal protection will be activated and simultaneously shut down the output.

When the thermal protection is activated, shut off the input voltage and eliminate all the overheating conditions. To recover the output voltage, keep enough time to cool down the power supply before turning on the input voltage again.

3.5 Remote sensing

●TUNS50F

■Remote sensing is not built-in.

●TUNS100F

■Remote sensing is built-in.

(1) When the remote sensing function is not in use

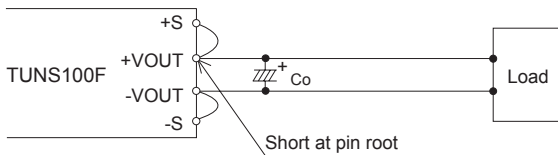


Fig. 3.1 Connection when the remote sensing is not in use

■When the remote sensing function is not in use, it is necessary to confirm that pins are shorted between +S & +VOUT and between -S & -VOUT.

■Wire between +S & +VOUT and between -S & -VOUT as short as possible.

Loop wiring should be avoided.

This power supply might become unstable by the noise coming from poor wiring.

(2) When the remote sensing function is in use

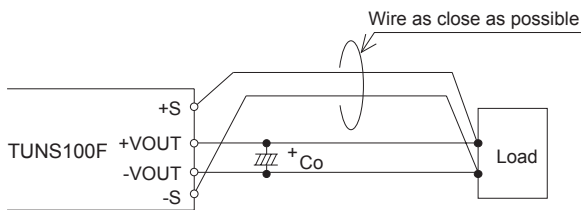


Fig. 3.2 Connection when the remote sensing is in use

■Twisted-pair wire or shield wire should be used for sensing wire.

■Thick wire should be used for wiring between the power supply and a load.

Line drop should be less than 0.5V.

Voltage between +VOUT and -VOUT should remain within the output voltage adjustment range.

■If the sensing patterns are short, heavy-current is drawn and the pattern may be damaged.

The pattern disconnection can be prevented by installing the protection parts as close as a load.

■As wiring or load impedance may generate oscillation or large fluctuations in output voltage, make sure enough evaluation is given advance.

3.6 Adjustable voltage range

■Output voltage between +VOUT and -VOUT can be adjusted by connecting external resistors to TRM.

■When the output voltage adjustment is not used, open the TRM pin respectively.

■When the output voltage adjustment is used, note that the over-voltage protection circuit operates when output voltage is set too high.

■The wiring to the potentiometer should be as short as possible.

As the ambient temperature fluctuation characteristics deteriorate depending on the types of resistors and potentiometers, please use resistors and potentiometers of the following specifications:

Resistors..... Metal film type, coefficient less than $\pm 100\text{ppm}/^\circ\text{C}$

Potentiometers ... Cermet type, coefficient less than $\pm 300\text{ppm}/^\circ\text{C}$

■Output voltage can be adjusted by connecting an external potentiometer (VR1) and resistors (R1 and R2) as shown in Fig. 3.3.

Output voltage will increase if the resistance between ② and ③ is reduced by turning the potentiometer.

Recommended values for external components are shown in Table 3.1.

Consult us if the power module is used in a different configuration.

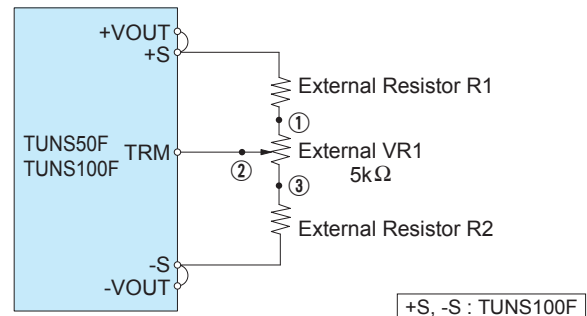


Fig. 3.3 Connecting External Devices (TUNS50F/TUNS100F)

Table 3.1 Recommended Values of External Resistors (TUNS50F, TUNS100F)

No.	Output Voltage	Adjustable Range			
		$V_{OUT} \pm 5\%$		$V_{OUT} \pm 10\%$	
		R1	R2	R1	R2
1	5V	10k Ω	2.7k Ω	4.7k Ω	1k Ω
2	12V	12k Ω	2.2k Ω	5.6k Ω	560 Ω
3	24V	27k Ω	1.8k Ω	15k Ω	470 Ω

3.7 Withstanding Voltage / Isolation Voltage

■When testing the withstanding voltage, make sure the voltage is increased gradually. When turning off, reduce the voltage gradually by using the dial of the hi-pot tester. Do not use a voltage tester with a timer as it may generate voltage several times as large as the applied voltage.

4 Series and Parallel Operation

4.1 Series operation

■ Series operation is available by connecting the outputs of two or more power supplies as shown below. Output current in series connection should be lower than the lowest rated current in each unit.

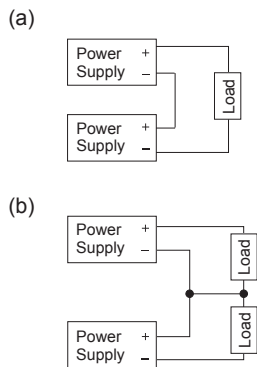


Fig. 4.1 Examples of series operation

4.2 Parallel operation

■ Parallel operation is not possible.
 ■ Redundancy operation is available by wiring as shown below.

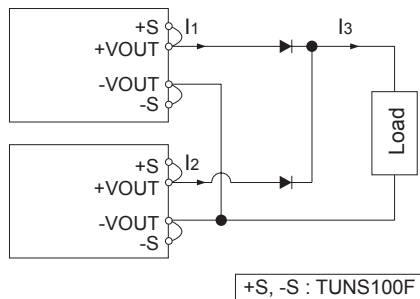


Fig. 4.2 Example of Redundancy Operation

■ Even a slight difference in output voltage can affect the balance between the values of I_1 and I_2 .
 Please make sure that the value of I_3 does not exceed the rated current of a power supply.

$$I_3 \leq \text{the rated current value}$$

5 Cleaning

- Clean the product with a brush. Prevent liquid from getting into the product.
 Do not soak the product into liquid.
- Do not stick solvent to a name plate or a resin case.
 (If solvent sticks to a name plate or a resin case, it will cause to change the color of the case or to fade letters on name plate away.)
- After cleaning, dry them enough.

6 Lifetime expectancy depends on stress by temperature difference

- Regarding lifetime expectancy design of solder joint, following contents must be considered.
 It must be careful that the soldering joint is stressed by temperature rise and down which is occurred by self-heating and ambient temperature change.
 The stress is accelerated by thermal-cycling, therefore the temperature difference should be minimized as much as possible if temperature rise and down is occurred frequently.
- Product lifetime expectancy depends on the aluminum base plate central temperature difference (ΔT_c) and number of cycling in a day is shown in Fig.6.1.
 If the aluminum base plate center part temperature changes frequently by changing output load factor etc., the above the lifetime expectancy design should be applied as well.

Please contact us for details.

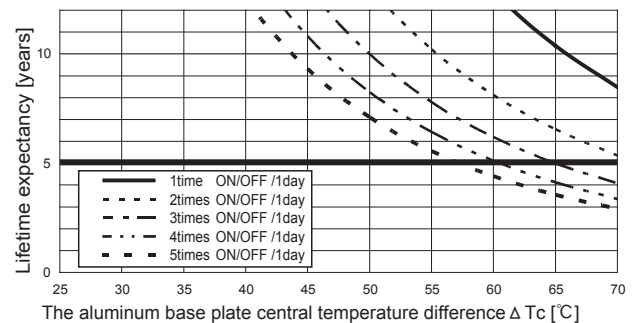


Fig.6.1 Lifetime expectancy against rise/fall temperature difference

Application manuals available at our website.
 Recommended external components are also introduced for your reference.

1 Connection for Standard Use

- To use TUNS series, connection shown in Fig.1.1 and external components are required.
- This product uses conduction cooling method (e.g. heat radiation from the aluminum base plate to the attached heat sink).
Reference: "Derating"

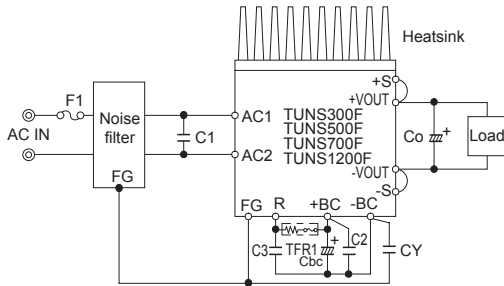


Fig.1.1 Connection for standard use

Table 1.1 External components

No.	Symbol	Components	Reference
1	F1	Input fuse	2.1 "Wiring input pin (1)"
2	C1	Input Capacitor	2.1 "Wiring input pin (2)"
3	-	Noise Filter	
4	CY	Y capacitor	2.1 "Wiring input pin (3)"
5	Co	Output capacitor	2.2 "Wiring output pin (1)"
6	Cbc	Smoothing Capacitor for boost voltage	2.3 "+BC/-BC pins (1)"
7	C2,C3	Capacitor for boost voltage	2.3 "+BC/-BC pins (2)"
8	TFR1	Inrush current protection resistor	2.3 "+BC/-BC pins (3)"
9	-	Heatsink	-

2 Wiring Input/Output Pin

2.1 Wiring input pin

(1) F1 : External fuse

- Fuse is not built-in on input side. In order to protect the unit, install the fuse on input side (as shown in Table 2.1).

Table 2.1 Recommended fuse (Slow-blow type)

Model	TUNS300F	TUNS500F/ 700F	TUNS1200F (85 - 264Vin)	TUNS1200F (85 - 305Vin)
Rated voltage	AC250V			AC300V
Rated current	10A	15A	25A	25A

(2) C1 : External Capacitor for input side

- Install a film capacitor as input capacitor C1 of which the capacitance and ripple current capability are above the values shown in Table 2.2.
- Use a safety approved capacitor.
- If C1 is not connected, it may cause the failure of the power supply or external components.

Table 2.2 Input Capacitor C1

No.	Model	Voltage	Capacitance	Rated ripple current
1	TUNS300F	AC250V	2 μ F or more	5A or more
2	TUNS500F		2 μ F or more	5A or more
3	TUNS700F		3 μ F or more	5A or more
4	TUNS1200F (85 to 264Vin)		3 μ F or more	5A or more
5	TUNS1200F (85 to 305Vin)	AC300V	3 μ F or more	5A or more

(3) CY : Noise filter/Decoupling capacitor

- The product doesn't have noise filter internally.
Please connect external noise filter and primary decoupling capacitor CY for low line noise and stable operation of the power supply.
- The operation of the power supply may be unstable due to the resonance of the filter or inductance.
- Install a correspondence filter, if it is required to meet a noise standard or if the surge voltage may be applied to the unit.
- Install a primary decoupling capacitor CY, with more than 470pF, near the input pins (within 50mm from the pins).
- When the total capacitance of the primary decoupling capacitor is more than 8800pF, the nominal value in the specification may not be met by the Hi-Pot test between input and output. A capacitor should be installed between output and FG.

2.2 Wiring output pin

(1) Co : Output capacitor

- 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.
- Select the high frequency type capacitor. Output ripple and start-up waveform may be influenced by ESR-ESL of the capacitor and the wiring impedance.
- Install a capacitor Co near the output pins (within 50mm from the pins).
- When the power supply is used under 0°C ambient temperature, output ripple voltage increases. In this case, connect 3 capacitors Co in parallel connection.

 Table 2.3 Recommended capacitance Co[μ F]

Model	Temperature of base plate	
	Tc=0 to +100°C	Tc=-40 to +100°C
Output voltage (V)	TUNS300F/TUNS500F TUNS700F/TUNS1200F	TUNS300F/TUNS500F TUNS700F/TUNS1200F
12	2200	2200×3parallel
28	1000	1000×3parallel
48	470	470×3parallel

- The specified ripple and ripple noise are measured by the method introduced in Fig.2.1.

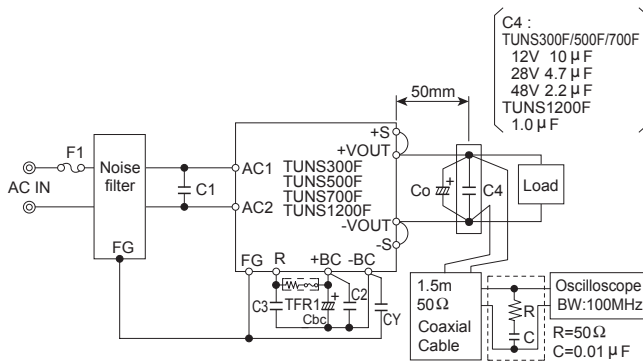


Fig.2.1 Method of Measuring Output Ripple and Ripple Noise

2.3 Wiring +BC/-BC pins

(1) Cbc : Smoothing capacitor for boost voltage

- In order to smooth boost voltage, connect Cbc between +BC and -BC. Recommended capacitance of Cbc is shown in Table 2.4.
- Note that +BC and -BC terminals have high voltage (DC380V typ).
- When the input voltage is AC264V or higher, the voltage between +BC, R and -BC will rise to about 430V.
- Keep the capacitance within the allowable external capacitance.
- Select a capacitor of which the boost voltage ripple voltage does not exceed 30Vp-p.
- When the power supply is operated under -20°C, it may make the boost voltage unstable due to the characteristic of equivalent series resistor. Please choose the capacitor which has more than recommended capacitance.

Table 2.4 Recommended capacitance Cbc

No.	Model	Voltage	Cbc	Allowable capacitance range
1	TUNS300F	DC420V or more	470µF	390 to 2200µF
2	TUNS500F		390µF × 2	390 to 2200µF
3	TUNS700F		390µF × 2	470 to 2200µF
4	TUNS1200F (85 to 264V _{in})	DC500V or more	470µF × 3	780 to 3300µF
5	TUNS1200F (85 to 305V _{in})		470µF × 3	780 to 2200µF

(2) C2, C3 : Capacitor for boost voltage

- Install external capacitors C2, C3 with capacitance shown in table 2.5.
- If capacitors C2, C3 are not installed, it may cause the failure of the power supply or external components.

Table 2.5 Recommended capacitance C2 and C3

No.	Model	Voltage	Capacitance	Rated ripple current
1	TUNS300F	DC450V or more	1µF or more	3A or more
2	TUNS500F		1µF or more	3A or more
3	TUNS700F		1µF or more	3A or more
4	TUNS1200F (85 to 264V _{in})	DC500V or more	2µF or more	5A or more
5	TUNS1200F (85 to 305V _{in})		2µF or more	5A or more

(3) TFR1 : Inrush current limiting resistor 4.7ohm - 22ohm

- Connect a resistor between R pin and +BC pin for inrush current protection. The surge capacity is required for TFR1, please contact component mfg. Wirewound resistor with thermal cut-offs type is required.

3 Function

3.1 Input voltage range

● TUNS300F/500F/700F

- The input voltage range is from 85 VAC to 264 VAC.
- In cases that conform with safety standard, input voltage range is AC100-AC240V(50/60Hz).

● TUNS1200F

- The input voltage range is from 85 VAC to 305 VAC.
- In cases that conform with safety standard, input voltage range is AC100-AC277V (50/60Hz).

Remarks:

Be aware that use of voltages other than those listed above may result in the unit not operating according to specifications, or may cause damage. Avoid square waveform input voltage, commonly used in UPS and inverters.

3.2 Overcurrent protection

● TUNS300F/TUNS700F/TUNS1200

- Overcurrent protection is built-in and comes into effect over 105% of the rated current.
- Overcurrent protection prevents the unit from short circuit and overcurrent condition. The unit automatically recovers when the fault condition is cleared.
- When the output voltage drops at overcurrent, the average output current is reduced by hiccup operation of power supply.

● TUNS500F

- Overcurrent protection is built-in and comes into effect over 101% of the peak current.
- Overcurrent protection prevents the unit from short circuit and overcurrent condition. The unit automatically recovers when the fault condition is cleared.
- When the output voltage drops at overcurrent, the average output current is reduced by hiccup operation of power supply.

3.3 Peak current protection

● TUNS500F

- Peak current protection is built-in. When the power supply is operated over peak load based on section 7 (Peak current), this function comes into effect and reduce the output.
- A few seconds later, a unit automatically recovers. But if the overcurrent condition has not been released, the output will reduced again (hiccup operation mode).

3.4 Overvoltage protection

Overvoltage protection circuit is built-in. If the overvoltage protection circuit is activated, shut down the input voltage, wait a certain time and turn on the AC input again to recover the output voltage. The recovery time is 3 minutes or more for TUNS300F/500F/700F, and 10 seconds or more for TUNS1200F. However, it varies depending on such factors as input voltage value at the time of the operation.

Remarks:

Please note that devices inside the power supply might fail when voltage of more than rated output voltage is applied to output terminal of the power supply. This could happen when the customer tests the overvoltage performance of the unit.

3.5 Thermal protection

When it exceeds the Derating, the thermal protection will be activated and simultaneously shut down the output. When the thermal protection is activated, shut off the input voltage and eliminate all the overheating conditions. To recover the output voltage, keep enough time to cool down the power supply before turning on the input voltage again.

3.6 Remote ON/OFF

●TUNS300F/500F/700F

Remote ON/OFF is not built-in.

●TUNS1200F

Remote ON/OFF is built-in

Remote ON/OFF is possible by applying a voltage between RC1 and RC2 pin.

When power supply shut off by over voltage protection or thermal protection, it can be recovered by toggling Remote ON/OFF signal.

Remote ON/OFF circuit (RC1, RC2) is isolated from input, output, FG, AUX and various function terminals.

Sink current of RC1 must be kept up to 12mA.

If positive logic control is required, order the power supply with "-R3" option.

Table 3.1 Remote ON/OFF connection

No.	ITEM	RC1, RC2		
		Fig.3.1 (a)	Fig.3.1 (b)	Fig.3.1 (c)
1	Connection method	INPUT - RC	INPUT - RC OUTPUT - RC	INPUT - RC
2	Isolation	INPUT - RC	INPUT - RC OUTPUT - RC	INPUT - RC
3	Base pin	-S	RC2	-S, RC2
4	Standard : Negative	Output ON	SW OPEN (0.1mA max)	SW SHORT (0.5V max)
		Output OFF	SW SHORT (2mA min)	SW OPEN (0.1mA max)
6	Optional -R3 : Positive	Output ON	SW SHORT (2mA min)	SW OPEN (0.1mA max)
		Output OFF	SW OPEN (0.1mA max)	SW SHORT (0.5V max)

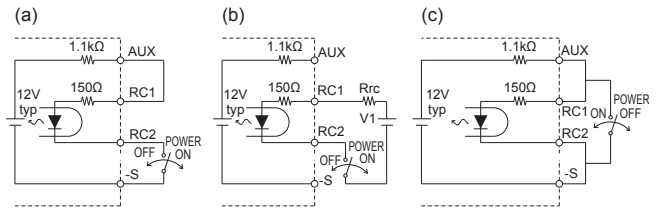


Fig.3.1 Examples of connecting remote ON/OFF circuit

●-R1, -R3 (TUNS300F/500F/700F)

Remote ON/OFF is possible by applying a voltage between RC1 and RC2 pin. External DC power source is necessary to operate remote control.

External current limiting resistor R_{rc} is necessary.

When power supply shut off by over voltage protection or overheating protection, it can be recovered by toggling Remote ON/OFF signal.

Table 3.2 Remote ON/OFF connection specification

No.	ITEM	RC1, RC2	
1	Optional	-R1	-R3
2	ON/OFF Logic	Negative	Positive
3	Function	Output is ON in "L"	Output is ON in "H"
4	Base pin	RC2	RC2
5	Output ON	SW OPEN (0.5V max 0.1mA max)	SW SHORT (5mA typ 3mA min)
6	Output OFF	SW SHORT (5mA typ 3mA min)	SW OPEN (0.5V max 0.1mA max)

Sink current of RC1 must be kept up to 12mA.

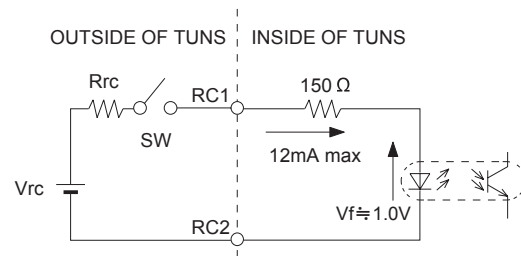


Fig.3.2 RC Connection Example

* Please be careful not to connect RC1 and RC2 opposite.

It may cause a failure of power supply.

Remote ON/OFF circuit (RC1, RC2) is isolated from the input and output and FG.

●-R2 (TUNS300F/500F/700F)

"-R2" can reduce standby power than "-R1".

The usage is same as option "-R1".

Please refer to option "-R1"

Standby power

0.5Wtyp (AC100V), 1.2Wtyp (AC200V)

3.7 AUX for Remote ON/OFF circuit

●TUNS1200F

The AUX can be used as the power source for Remote ON/OFF circuit.

■AUX is designed as shown in Fig.3.3, and a resistor (1.1kΩ) is built in to protect the short circuit. Output voltage decreases as the output current increases.

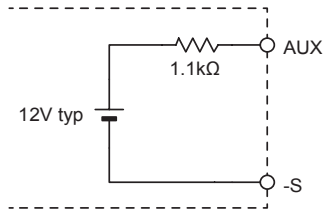


Fig.3.3 AUX circuit

3.8 Remote sensing

■Remote sensing is built-in.

(1) When the remote sensing function is not in use

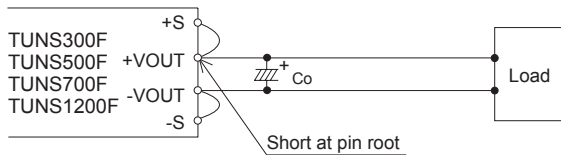


Fig. 3.4 Connection when the remote sensing is not in use

■When the remote sensing function is not in use, it is necessary to confirm that pins are shorted between +S & +VOUT and between -S & -VOUT.

■Wire between +S & +VOUT and between -S & -VOUT as short as possible.

Loop wiring should be avoided.

This power supply might become unstable by the noise coming from poor wiring.

(2) When the remote sensing function is in use

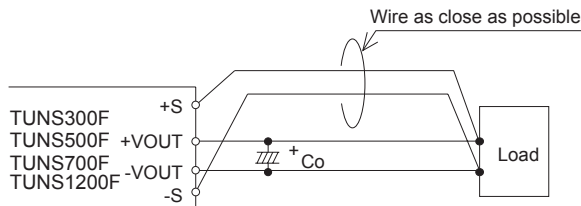


Fig. 3.5 Connection when the remote sensing is in use

■Twisted-pair wire or shield wire should be used for sensing wire.

■Thick wire should be used for wiring between the power supply and a load.

Line drop should be less than 0.5V.

Voltage between +VOUT and -VOUT should remain within the output voltage adjustment range.

■If the sensing patterns are short, heavy-current is drawn and the pattern may be damaged.

The pattern disconnection can be prevented by installing the protection parts as close as a load.

■As wiring or load impedance may generate oscillation or large fluctuations in output voltage, make sure enough evaluation is given advance.

3.9 Adjustable voltage range

●TUNS300F/500F/700F (TRM)

■Output voltage between +VOUT and -VOUT can be adjusted by connecting external resistors to TRM.

■When the output voltage adjustment is not used, open the TRM pin respectively.

■When the output voltage adjustment is used, note that the overvoltage protection circuit operates when output voltage is set too high.

■The wiring to the potentiometer should be as short as possible.

As the ambient temperature fluctuation characteristics deteriorate depending on the types of resistors and potentiometers, please use resistors and potentiometers of the following specifications:

Resistors..... Metal film type, coefficient less than ±100ppm/°C

Potentiometers ... Cermet type, coefficient less than ±300ppm/°C

■Output voltage can be adjusted by connecting an external potentiometer (VR1) and resistors (R1 and R2) as shown in Fig. 3.6.

Output voltage will increase if the resistance between ② and ③ is reduced by turning the potentiometer.

Recommended values for external components are shown in Table 3.3.

Consult us if the power module is used in a different configuration.

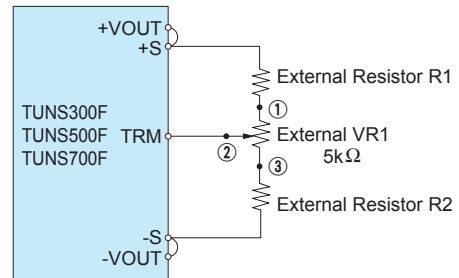


Fig. 3.6 Connecting External Devices (TUNS300F/TUNS500F/TUNS700F)

Table 3.3 Recommended Values of External Resistors (TUNS300F/TUNS500F/TUNS700F)

No.	Output Voltage	Adjustable Range			
		VOUT±5%		VOUT±10%	
		R1	R2	R1	R2
1	12V	12kΩ	2.2kΩ	6.8kΩ	1.0kΩ
2	28V	39kΩ		27kΩ	
3	48V	68kΩ		47kΩ	

●TUNS1200F (VTRM)

■Output voltage between +VOUT and -VOUT can be adjusted by connecting external resistors to VTRM or by applied voltage externally.

■When the output voltage is adjusted to less than the adjustment voltage range, the output ripple voltage might increase.

■When the output voltage adjustment is not used, open the VTRM pin.

(1) Output voltage adjustment by potentiometer

■By connecting the external potentiometer (VR1) as shown in Fig.3.7., output voltage becomes adjustable.

■The wiring to the potentiometer should be as short as possible.

As the ambient temperature fluctuation characteristics deteriorate depending on the types of resistors and potentiometers, please

use resistors and potentiometers of the following specifications:
 PotentiometersCermet type, coefficient less than $\pm 300\text{ppm}/^\circ\text{C}$

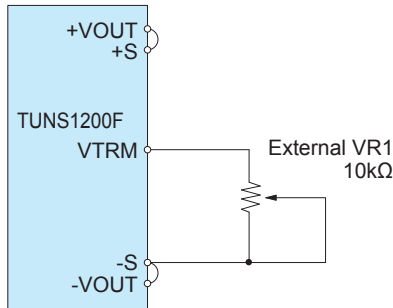


Fig.3.7 Connecting External Devices (TUNS1200F)

(2) Output voltage adjustment by external voltage

■By applying a voltage externally to VTRM, output voltage becomes adjustable.

Output level is able to be calculated by following equation when the VTRM terminal voltage. However, it cannot be set beyond the upper limit of the output voltage variable range.

$$\text{Output voltage [V]} = \frac{\text{The voltage between VTRM and -S[V]}}{2.5 \text{ [V]}} \times \text{Rated output voltage [V]} \dots \textcircled{1}$$

■Do not set the external applied voltage of the terminal to -0.3V or less, and 5.0V or more.

■When the VTRM terminal voltage is 4.5V or higher, the rated voltage is output.

■Do not set the VTRM terminal voltage within the range of 4.0 to 4.5V, because the output voltage to be indefinite.

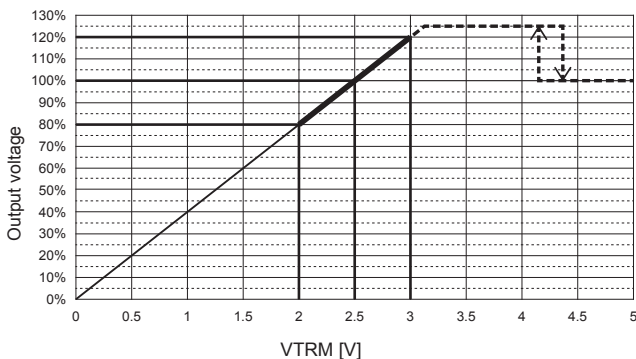


Fig.3.8 VTRM-Output Voltage (TUNS1200F12, TUNS1200F28)

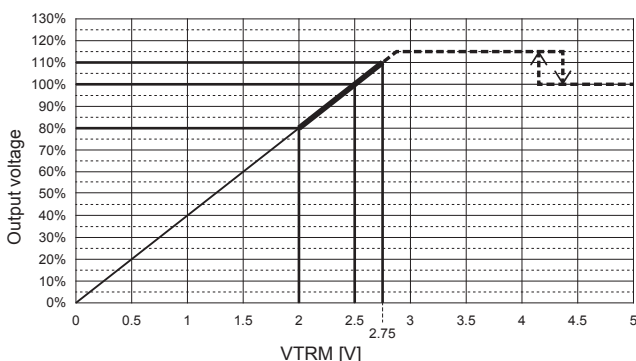


Fig.3.9 VTRM-Output Voltage (TUNS1200F48)

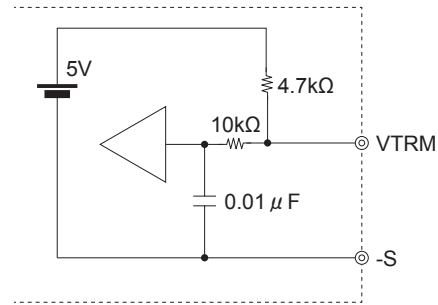


Fig.3.10 VTRM circuit

●-Y1 (TUNS300F/500F/700F/1200F)

■Adjustable voltage range of 48V output is changed to $\pm 20\%$.

*Adjustable voltage range of standard type except 48V output is $\pm 20\%$.

■Safety standard, is considered as Non SELV output.

3.10 Adjustable constant current range

●TUNS1200F (ITRM)

■Output current for the constant current can be adjusted by connecting external resistors to ITRM or by applied voltage externally.

■When the output current is adjusted to around 0A, the unit might be unstable.

■When the output current adjustment is not used, open the ITRM pin.

(1) Constant current adjustment by potentiometer

■By connecting the external potentiometer (VR2) as shown in Fig.3.11, output current for constant current becomes adjustable.

■The wiring to the potentiometer should be as short as possible.

As the ambient temperature fluctuation characteristics deteriorate depending on the types of resistors and potentiometers, please use resistors and potentiometers of the following specifications:

PotentiometersCermet type, coefficient less than $\pm 300\text{ppm}/^\circ\text{C}$

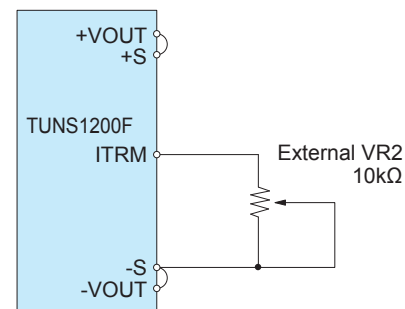


Fig.3.11 Connecting External Devices (TUNS1200F)

(2) Constant current adjustment by external voltage

■By applying a voltage externally to ITRM, output current for constant current becomes adjustable.

When the ITRM terminal voltage is set at less than 2.5 V, the constant current set value can be changed.

$$\text{Output current [A]} = \frac{\text{The voltage between ITRM and -S[V]}}{2.5 \text{ [V]}} \times \text{Rated output current [A]} \dots \textcircled{2}$$

■Do not set the external applied voltage of the terminal to -0.3 V or less, and 5.0 V or more.

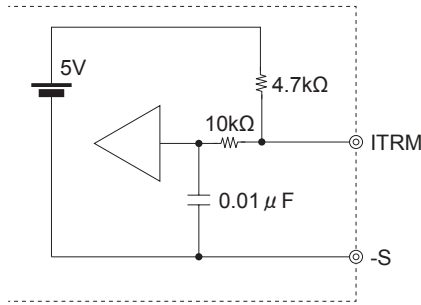


Fig.3.12 ITRM circuit

Note :

■If the output voltage becomes less than 5% of the rated voltage during constant current operation, the output may become unstable.

3.11 Inverter operation monitor (IOG)

●TUNS300F/500F/700F

■By using the inverter operation monitor (IOG), condition of the inverter can be monitored.

The following ① or ② conditions make the IOG signal turns "H" from "L" within 1 second.

- ① Malfunction of inverter
- ② Output voltage is rapidly dropped by adjusting output voltage

Specification of IOG is shown in Table 3.4.

Table 3.4 Specification of IOG

No.	Item	IOG
		Normal operation "L" Malfunction of inverter "H"
2	Base pin	-S
3	Level voltage "L"	0.5V max at 10mA
4	Level voltage "H"	Open corrector
5	Maximum sink current	10mA max
6	Maximum applied voltage	35V max

3.12 Power good (PG)

●TUNS1200F

■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.

■PG circuit is designed as shown in Fig.3.13. Sink current of PG is 1mA max.

■Circuit of the PG (PG, PGG) is isolated from input, output, FG and various function terminals.

Notes when you use PG signal are shown below.

- ① The PG signal is "High" when the output voltage is 20% or less of the rated output voltage or 60% or less of the output voltage setting value,
- ② The PG signal is "Low" when the power supply operates during constant current.

Table 3.5 Specification of PG

No.	Item	PG
1	Function	Normal operation "Low"
		The power supply stops "High"
2	Base pin	PGG
3	Level voltage "L"	0.5V max at 1mA
4	Level voltage "H"	Open corrector
5	Maximum sink current	1mA max
6	Maximum applied voltage	50V max

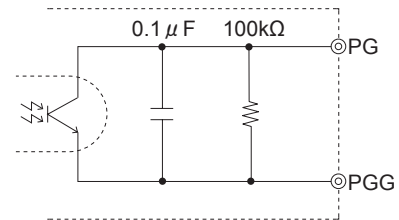


Fig.3.13 Internal circuit of PG

3.13 Withstanding Voltage/Isolation Voltage

■When testing the withstanding voltage, make sure the voltage is increased gradually. When turning off, reduce the voltage gradually by using the dial of the hi-pot tester. Do not use a voltage tester with a timer as it may generate voltage several times as large as the applied voltage.

4 Series and Parallel Operation

4.1 Series operation

■ Series operation is available by connecting the outputs of two or more power supplies as shown below. Output current in series connection should be lower than the lowest rated current in each unit.

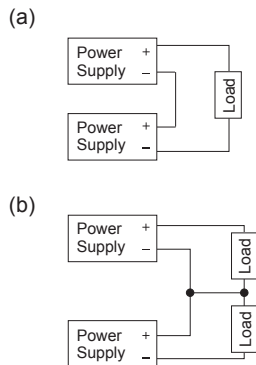


Fig. 4.1 Examples of series operation

4.2 Parallel operation

● TUNS300F/500F/700F

■ Parallel operation is not possible.

● TUNS1200F

■ Parallel operation is available by connecting the units as shown in Fig. 4.2. With this wiring, it is possible to adjust all output in module by single potentiometer. When output voltage adjustment is not in use, VTRM wiring, VR1 are not necessary.

■ Constant current adjustment can be used, even in parallel operation. By changing the ITRM voltage of one power supply, constant current adjustable for all power supplies. It is not necessary to connect the ITRM terminals together.

■ Total current should not exceed the value calculated by the following equation, and total number of units should be no more than 9 pieces.

$$\begin{aligned} & \text{(Output current at parallel operation)} \\ & = (\text{the rated current per unit}) \times (\text{number of unit}) \times 0.9 \end{aligned}$$

■ Please make sure that the wiring impedance of a load from each power supply becomes even.

■ Voltage drop from a power supply to the sensing point should be less than 0.5V for stable control.

■ If temperatures of aluminum base plates are different in the power supply for parallel operation, the difference in output current becomes large. Design radiation to equalize plate temperatures by attaching the same heat sinks.

■ Connect the sensing line and the power line by one point after connecting each power supply's sensing pins(+S, -S).

■ If the output current is less than 2% of the rated current, the output

voltage ripple will be large.

■ 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.

■ Examples of connecting remote ON/OFF circuit during parallel operation is shown in Fig.4.3.

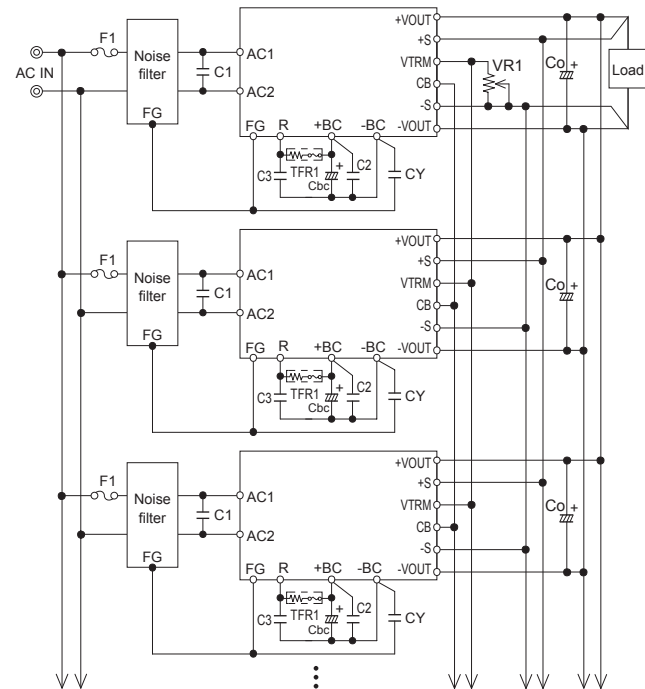


Fig.4.2 Examples of parallel operation (TUNS1200F)

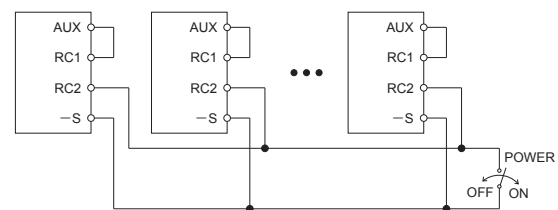


Fig.4.3 Examples of connecting remote ON/OFF circuit during parallel operation

■ Please refer to the application manuals for details of parallel operation.

Application manual is on our web site.

● -P (TUNS700F)

■ This option is for parallel operation.

■ Sensing and adjustment of the output voltage are not possible at the time of the use with this option.

■ As variance of output current drew from each power supply is maximum 10%, the total output current must not exceed the value determined by the following equation.

$$\begin{aligned} & \text{(Output current in parallel operation)} \\ & = (\text{the rated current per unit}) \times (\text{number of unit}) \times 0.9 \end{aligned}$$

Total number of units should be no more than 5 pieces.

■ To improve the load sharing of each unit, please use the same length from each unit to the load.

■ If temperatures of aluminum base plates are different in the power supply for parallel operation, values of output current will change greatly.

Design radiation to equalize plate temperatures by attaching the same heatsinks.

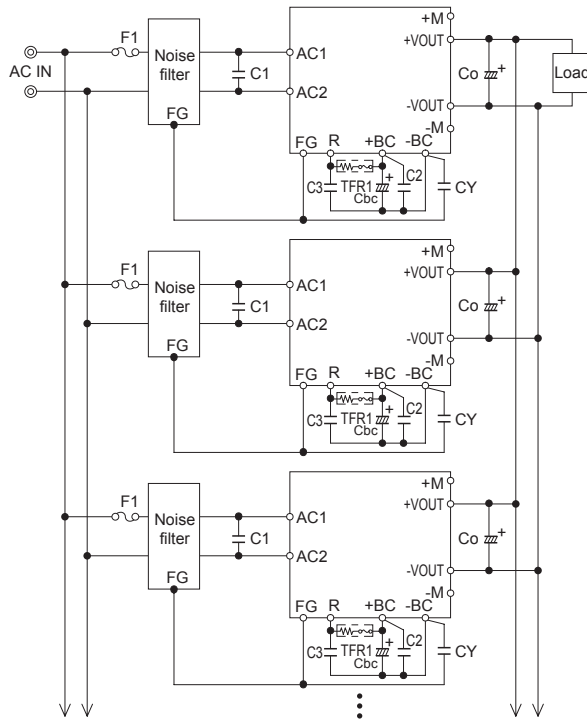


Fig. 4.4 Parallel operation (TUNS700F□□-P)

■ Please refer to the application manuals for details of -P type. Application manual is on our web site.

4.3 N+1 redundant operation

● TUNS1200F/TUNS700F□-P

■ It is possible to set N+1 redundant operation for improving reliability of power supply system.

■ If you add one extra power supply in parallel operation, even if one of the power supplies in your system fails, the remaining power supplies continue to function.

■ Wiring, specifications and precautions are the same as in parallel operation.

■ Depending on the failure mode of the power supply, redundant operation may not be performed.

When performing full redundant operation, customers should build up redundant functions such as adding diodes to the output of the power supply.

■ Please refer to the application manuals for parallel and N+1 redundancy operations. Application manual is on our web site.

5 Cleaning

■ Clean the product with a brush. Prevent liquid from getting into the product.

Do not soak the product into liquid.

■ Do not stick solvent to a name plate or a resin case.

(If solvent sticks to a name plate or a resin case, it will cause to change the color of the case or to fade letters on name plate away.)

■ After cleaning, dry them enough.

6 Peak current

● TUNS500F

■ The unit can generate the peak current under the following conditions.

- $t_1 \leq 10[\text{sec}]$
- $I_p \leq \text{Rated peak current}$
- $I_{\text{ave}} \leq \text{Rated current}$
- $\text{Duty} = t_1 / (t_1 + t_2) \times 100[\%] \leq 35\%$

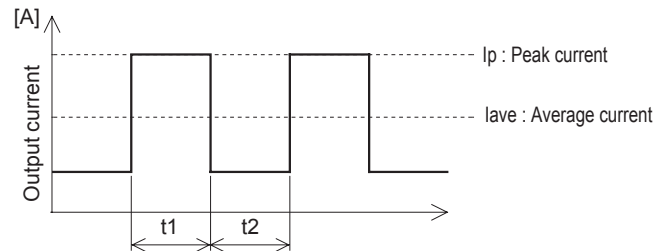


Fig. 6.1 Peak current

■ When aluminum baseplate temperature T_c is higher than 95°C , I_{ave} must be less than 95% of rated current. (TUNS500F28 and TUNS500F48)

7 Lifetime expectancy depends on stress by temperature difference

■ Regarding lifetime expectancy design of solder joint, following contents must be considered.

It must be careful that the soldering joint is stressed by temperature rise and down which is occurred by self-heating and ambient temperature change.

The stress is accelerated by thermal-cycling, therefore the temperature difference should be minimized as much as possible if temperature rise and down is occurred frequently.

■ Product lifetime expectancy depends on the aluminum base plate central temperature difference (ΔT_c) and number of cycling in a day is shown in Fig.7.1.

If the aluminum base plate center part temperature changes frequently by changing output load factor etc., the above the lifetime expectancy design should be applied as well.

Please contact us for details.

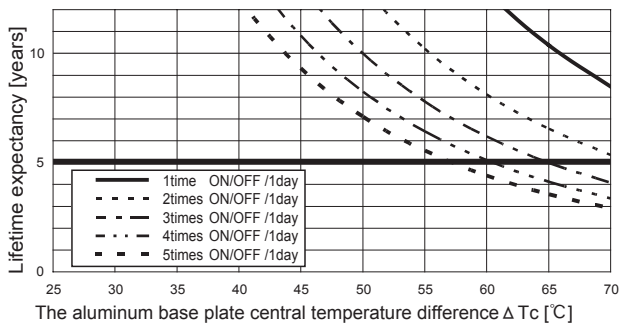


Fig.7.1 Lifetime expectancy against rise/fall temperature difference

Application manuals available at our website.

Recommended external components are also introduced for your reference.

8 Others

8.1 Medical electrical equipment

● TUNS1200F

■ TUNS1200F fit 2MOOP

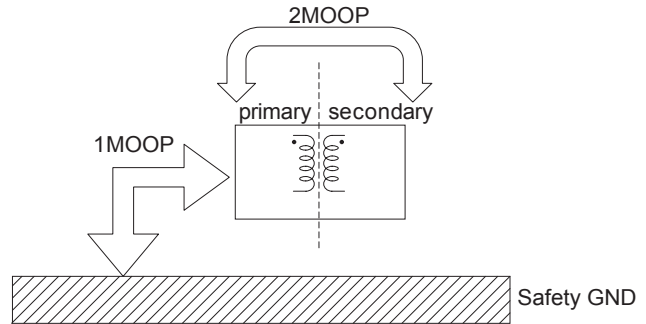


Fig.8.1 Medical Isolation Grade

■ It is required to have fuses on both line then applying for medical approvals.

■ Select the decoupling capacitor CY of which the leakage current does not exceed 0.5mA.

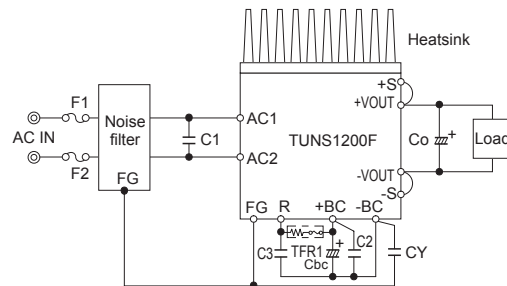


Fig.8.2 External components when applying for medical approvals