COSEL

Applications Manual
TUHS series

Rev. 1.10E 2019/7/25

Contents

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
(top view)

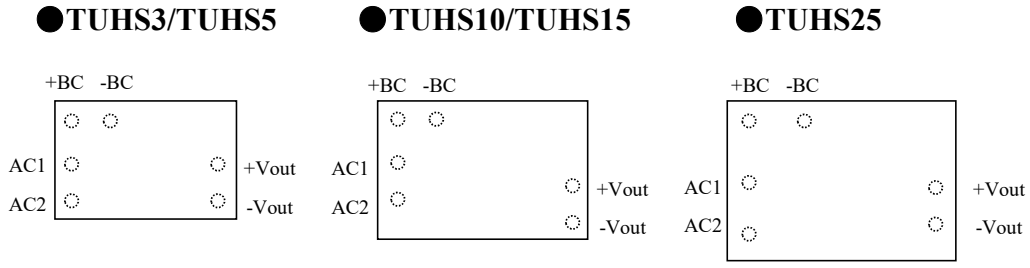
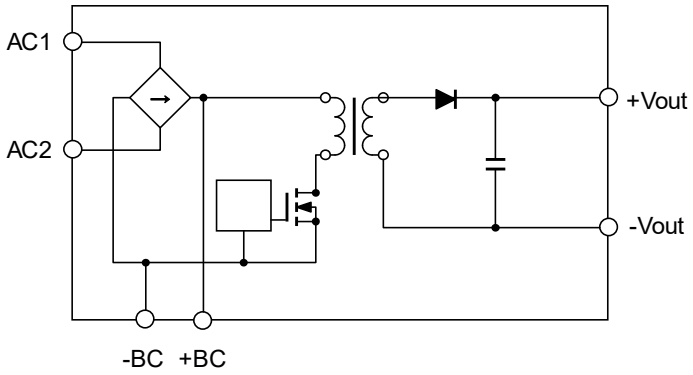


Table.1.1
Pin connection
and function

No.	Pin Connection	Function
1	AC1	AC input
2	AC2	
3	+BC	+BC output
4	-BC	-BC output
5	+VOUT	+DC output
6	-VOUT	-DC output

Fig.1.2
Block Diagram

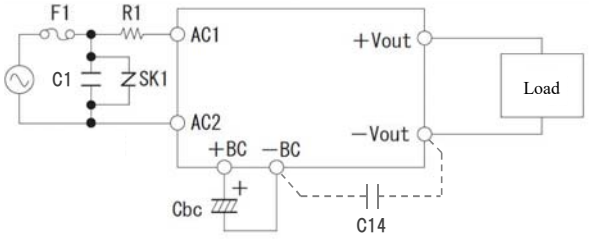


2 Connection for Standard Use

2.1 Connection for Standard Use

■ To use the TUHS series, connection shown in Figure 2.1 and external components are required.

Fig. 2.1 Connection for standard use



■ Parts name are shown in Table 2.1 as reference.
■ 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.

■ Depending on the wiring conditions, a capacitor C14 between the primary and secondary may be required for line conduction. If mounted, please use reinforced insulation (Y1 class certified).

Table 2.1 Parts name

No.	symbol	Item	TUHS3		TUHS5	
			Rating	Part name	Rating	Part name
1	F1	Input fuse	AC250V/2A	SLT 250V 2A (Nippon Seisen Cable.,Ltd.)	AC250V/2A	SLT 250V 2A (Nippon Seisen Cable.,Ltd.)
2	R1	Inrush current limiting Resistor	10Ω	A2JD-100J (Uchihashi Estec Co.,Ltd.)	10Ω	A2JD-100J (Uchihashi Estec Co.,Ltd.)
				CWFS23C□□□□100J (KOA Corporation)		CWFS23C□□□□100J (KOA Corporation)
3	Cbc	Smoothing capacitor for input voltage	DC400V/18uF	EKXJ401□□□180□□□□S (Nippon Chemi-Con)	DC400V/22uF	EKXJ401□□□220□□□□S (Nippon Chemi-Con)
4	SK1	Varistor	AC385V	S10K385E2K1 (TDK EPCOS)	AC385V	S10K385E2K1 (TDK EPCOS)
5	C1	Input capacitor	AC250V	ECQU3A104MG (Panasonic)	AC250V	ECQU3A104MG (Panasonic)
6	C14	Primary to secondary capacitor	AC250V/1000pF	DE1E3RA102M (Murata Manufacturing)	AC250V/1000pF	DE1E3RA102M (Murata Manufacturing)

No.	symbol	Item	TUHS10		TUHS15	
			Rating	Part name	Rating	Part name
1	F1	Input fuse	AC250V/2A	SLT 250V 2A (Nippon Seisen Cable.,Ltd.)	AC250V/2A	SLT 250V 2A (Nippon Seisen Cable.,Ltd.)
2	R1	Inrush current limiting Resistor	10Ω	A2JD-100J (Uchihashi Estec Co.,Ltd.)	10Ω	CW3C□□□□□10R0J (KOA Corporation)
				CWFS23C□□□□100J (KOA Corporation)		CWFS23C□□□□100J (KOA Corporation)
3	Cbc	Smoothing capacitor for input voltage	DC400V/47uF	EKXJ401□□□470□□□□S (Nippon Chemi-Con)	DC400V/68uF	EKXJ401□□□680□□□□S (Nippon Chemi-Con)
4	SK1	Varistor	AC385V	S10K385E2K1 (TDK EPCOS)	AC385V	S10K385E2K1 (TDK EPCOS)
5	C1	Input capacitor	AC250V	ECQU3A104MG (Panasonic)	AC250V	ECQU3A104MG (Panasonic)
6	C14	Primary to secondary capacitor	AC250V/1000pF	DE1E3RA102M (Murata Manufacturing)	AC250V/1000pF	DE1E3RA102M (Murata Manufacturing)

No.	symbol	Item	TUHS25	
			Rating	Part name
1	F1	Input fuse	AC250V/3.15A	SLT 250V 3.15A (Nippon Seisen Cable.,Ltd.)
2	R1	Inrush current limiting Resistor	10Ω	10D2-08LC (SEMITEC)
3	Cbc	Smoothing capacitor for input voltage	DC400V/120uF	EKXJ401□□□121□□□□S (Nippon Chemi-Con)
4	SK1	Varistor	AC385V	S10K385E2K1 (TDK EPCOS)
5	C1	Input capacitor	AC250V	ECQU3A104MG (Panasonic)
6	C14	Primary to secondary capacitor	AC250V/1000pF	DE1E3RA102M (Murata Manufacturing)

※ Thermistor R1 recommended by TUHS25 can be used with other models

■ When connect the output to FG of an equipment, a noise may become big. The noise can be reduced by connecting external filter and grounding capacitor on the input side. Refer to Fig2.2.
■ Parts name are shown in Table 2.2 as reference of connecting output to FG.

Fig. 2.2 Recomemended circuit of connect output to FG

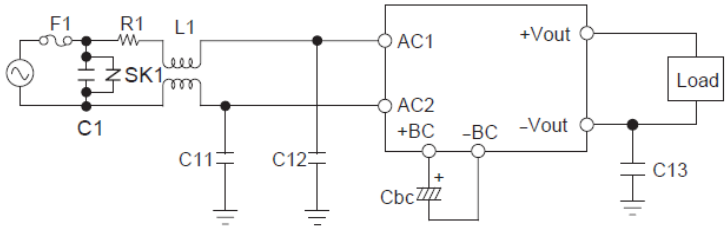


Table 2.2 Parts name (connect output to FG)

No.	symbol	Item	TUHS3		TUHS5	
			Rating	Part name	Rating	Part name
1	L1	AC line filter	25.0mH/0.4A	SU10VFC-R04250 (TOKIN)	25.0mH/0.4A	SU10VFC-R04250 (TOKIN)
2	C11,C12	Y capacitors	AC250V/2200pF	CD45-E2GA222M (TDK)	AC250V/2200pF	CD45-E2GA222M (TDK)
3	C13		AC250V/0.022uF	LE223 (Okaya Elecotric Industries)	AC250V/0.022uF	LE223 (Okaya Elecotric Industries)

No.	symbol	Item	TUHS10		TUHS15	
			Rating	Part name	Rating	Part name
1	L1	AC line filter	25.0mH/0.4A	SU10VFC-R04250 (TOKIN)	35.0mH/0.5A	SS11VL-R05350 (TOKIN)
2	C11,C12	Y capacitors	AC250V/2200pF	CD45-E2GA222M (TDK)	AC250V/2200pF	CD45-E2GA222M (TDK)
3	C13		AC250V/0.022uF	LE223 (Okaya Elecotric Industries)	AC250V/0.022uF	LE223 (Okaya Elecotric Industries)

No.	symbol	Item	TUHS25	
			Rating	Part name
1	L1	AC line filter	35.0mH/0.5A	SS11VL-R05350 (TOKIN)
2	C11,C12	Y capacitors	AC250V/2200pF	CD45-E2GA222M (TDK)
3	C13		AC250V/0.022uF	LE223 (Okaya Elecotric Industries)

※Refer to Table 2.1 for F1, R1, Cbc, SK1,and C1.

■ When using multiple power supplies, a noise filter separately from the above circuit may be required

2.2 Input fuse ：F1

- No protective fuse is preinstalled on the input side. To protect the unit, install a slow-blow type fuse shown in Table 2.2 in the input circuit.
- In the case of using DC input, please use a DC fuse.
  The reference DC fuse type name is shown follow.
  DC fuse type name· · ·BD20 (DC400V 2A)
  (Daito Communication Apparatus Co., Ltd.)

- When the fuse is blown out, the input voltage is applied to the both ends of fuse terminals. If the TUHS is used in the equipment which need to comply safety standard certification, please keep the distance (2.5mm or more) between the terminals of fuse to satisfy the requirement of safety standard.

Table 2.3 Recommended fuse

Item	TUHS3	TUHS5	TUHS10	TUHS15	TUHS25
AC Rated current	2A	2A	2A	2A	3.15A
DC Rated current	2A	2A	2A	2A	2A

2.3 Smoothing capacitor for input voltage: Cbc

- In order to smooth input voltage, connect aluminum electrolytic capacitor Cbc between +BC and -BC. Recommended capacitance of Cbc is shown in Table 2.4.
- Please select the voltage rating of the aluminum electrolytic capacitor to match the specification of the input voltage range.
  AC100V system · · · DC200V or more
  AC200V system · · · DC400V or more
- Ripple voltage and hold-up time will vary depending on input and output conditions
  Please select the smoothing capacitor capacity refer to the table 2.4.
- Please do not exceed allowable capacity of Cbc to avoid the power supply failure.
- If you would like to confirm hold-up time for selecting the capacity of Cbc, please refer to Section 5 Hold-up Time.
- When the power supply is operated under -20℃, it may cause the smoothing capacitor ripple voltage increase due to the characteristic of equivalent seies resistor.
  Choose the capacitor which has 3 times or more than recommended capacitance.
- When a small capacitor than the recommended capacity is selected, ripple voltage of the smoothing voltage will increase.
  Select a capacitor of which the ripple voltage does not exceed 25 Vp-p.
  There is a possibility of more than ripple current rating of the smoothing capacitor, please parts selection after confirming the allowable ripple current of the capacitor.

Table 2.4 Recommended capacitance Cbc

Model	Allowable max capacitance	Recommended capacitance（Ta>=-20℃、20msec or more on AC100V）				
		Input condition	Io<=25%	Io<=50%	Io<=75%	Io<=100%
TUHS3	68uF	AC100V system ※1	4.7uF	10uF	15uF	18uF
		Only AC200V system	2.2uF	4.7uF	6.8uF	10uF
TUHS5	68uF	AC100V system ※1	10uF	15uF	18uF	22uF
		Only AC200V system	4.7uF	6.8uF	10uF	15uF
TUHS10	150uF	AC100V system ※1	22uF	27uF	33uF	47uF
		Only AC200V system	10uF	15uF	18uF	22uF
TUHS15	220uF	AC100V system ※1	27uF	33uF	47uF	68uF
		Only AC200V system	15uF	18uF	22uF	33uF
TUHS25	390uF	AC100V system ※1	47uF	68uF	82uF	120uF
		Only AC200V system	22uF	33uF	47uF	68uF

※1 Including wide input of AC100V/AC200V

- Electrolytic capacitor has lifetime. So make sure that the lifetime is no problem under the usage condition.
- Detail formula is different by capacitor manufacturer.
  When calculating the lifetime, follow the instruction of capacitor manufacturers.
- The temperature of the electrolytic capacitor is required for lifetime calculation.
- Please measure the point of the electrolytic capacitor at which the temperature is maximum.
- High frequency ripple current does not flow through to Cbc.
  The ripple current which has twice of input frequency and depends on the output load (shown in Fig2.3) flows into Cbc.
- The relationship between effective ripple current of Cbc and load factor is shown in Fig2.4 (A),(B),(C),(D),(E).
- The ripple current changes approximately 1.5 times depending on PCB patterns, external parts, ambient temperature, etc.
  If the ripple current value which 1.5 times of the data shown in Fig.2.4, exceed the allowable ripple current of electrolytic capacitor, please measure the actual ripple current value, then calculate the lifetime.

Fig. 2.3 Current of Cbc

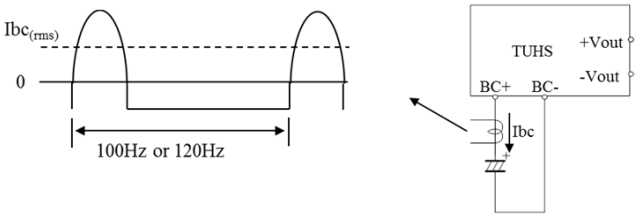
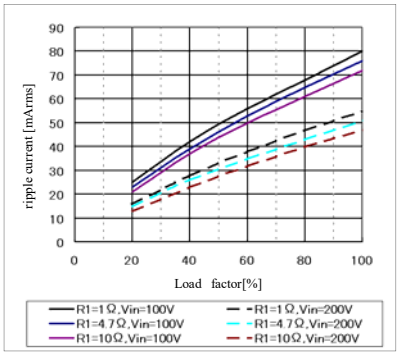
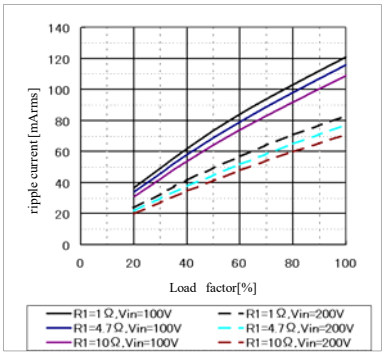


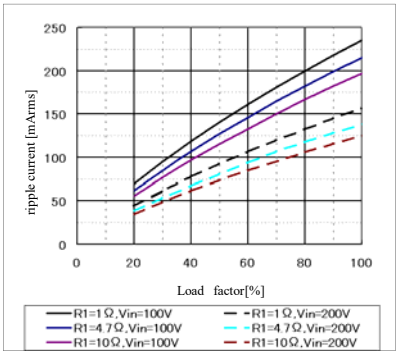
Fig. 2.4 Effective ripple current of Cbc



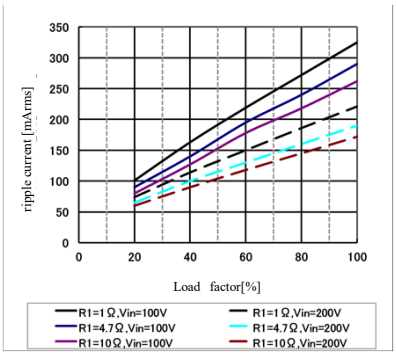
(A) TUHS3(Reference) 120Hz



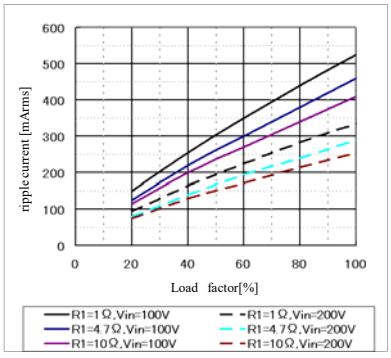
(B) TUHS5(Reference) 120Hz



(C) TUHS10(Reference) 120Hz



(D) TUHS15(Reference) 120Hz



(E) TUHS25(Reference) 120Hz

2.4 Inrush current limiting Resistor: R1

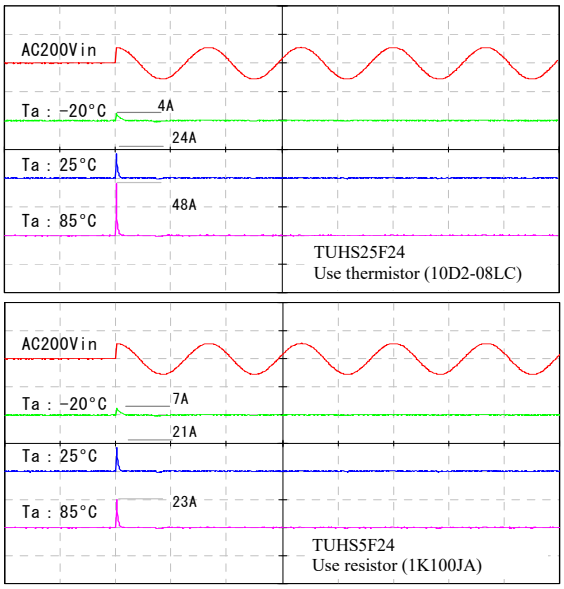
- The TUHS series have no internal inrush current limiting circuit.
- Connect resistor R1 between AC input and power supply to limit inrush current up to 50A(TUHS3/5/10/15) and 60A(TUHS25). Select a resistor which has enough permissible current capability.
- Fomula of inrush current is shown below. Please calculate the inrush current from this equation.

$$I_p = \frac{V_{in} * \sqrt{2}}{R_1 + R_L}$$

Ip : Inrush current[peak]
Vin : Input voltage[rms]
R1 : Inrush current limiting Resistor

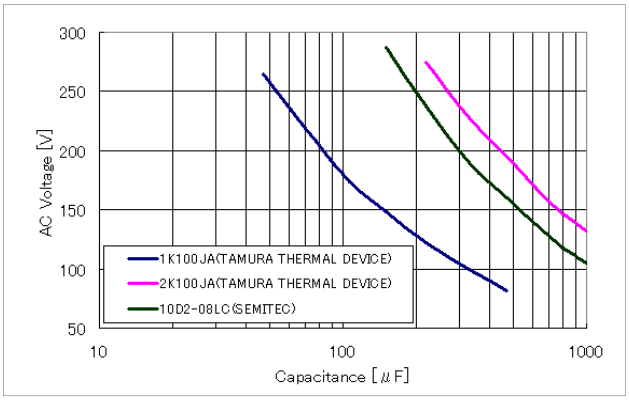
- Inrush current prevention element has power loss and genetates heat by input current. Please select the power thermistor if the power loss of the resistor and efficiency drop are not acceptable.
- When a power thermistor is used, inrush current will increase at high ambient temperature because of the reduction of the resistance of the thermistor. Please do not turn on/off the input repeatedly within a short period of time. Keep appropriate intervals to allow the power supply to cool down sufficiently before turning on.
- The inrush current value, with the parts shown in Table 2.1, shown in Fig 2.5.

Fig. 2.5 Inrush current values



- Available AC voltage for inrush current prevention element varies by the smoothing capacitor value. The relationship between the value of smoothing capacitor and AC voltage of the recommended inrush current prevention element to reference is shown in Figure 2.6.

Fig. 2.6 Characteristics of power thermistor resistor R1



- Under low temperature conditions, the output of power supply may be unstable due to high ESR values of the power thermistor and Cbc. Check with the actual device before use.
※Refer to page A-8 for operation under low temperature conditions.

2.5 Input capacitor : C1(TUHS25)

- To comply with conducterd noise CISPR22-B, EN55022-B, connect capacitor C1 which is 0.1μF between AC input terminals.
- Use a capacitor with a rated voltage of AC250V which complies with the safety standards.
- If 0.11μF or more capacitor is connected, the discharge resistor is necessary in order to comply UL60950-1. Please connect the discharge resistor which satisfy the following formula.

$$R \leqq \frac{1}{C_1 \times \log_e(V_{in} \times \sqrt{2} / 42.4)}$$

R : Discharge resistor
C1 : Input capacitance
Vin : Input voltage 120V or 240V[rms]

2.6 Varistor : SK1

- In order to comply with IEC61000-4-5 Level 3 (surge immunity), coonnect a surge protective device.
- Overvoltage category changes depending on the location for installing the power supply.
  Recommended components is complying to the overvoltage category II.
  For example, home electronics and information equipment corresponds the installation category II.
  And they are installed the primary part of the equipment which is connected to outlet by power cable.
  If installation category III (required to connect distribution panel directly) is required, the varistor must be bigger than recommended varistor.
  Please confirm whether the components comply the standards.

2.7 Output capacitor : Co

- In the TUHS series, the output capacitor is basically unnecessary. Reduce the ripple voltage or suppress fluctuation in an output voltage by connecting the output electorolytic capacitor or ceramic capacitor.
  The connection example is shown in Fig 2.7.
- When the pulse load is connected, the output voltage will change transiently.
  Please check the level of the fluctuation in your situation.
  And if the transient output voltage change is not acceptable, please connect the output capacitor Co.

Fig.2.7 Connecting Example of an External Capacitor to the Output Side

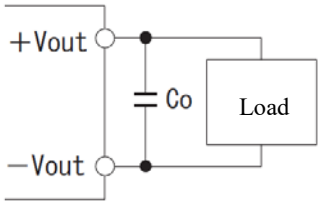


Table 2.5 Recommended capacitance Co

Output voltage	TUHS3	TUHS5	TUHS10	TUHS15	TUHS25
5V	0～100μF	0～100μF	0～330μF	-	0～1000μF
12V	0～47μF	0～47μF	0～150μF	0～150μF	0～470μF
15V	0～47μF	0～47μF	0～120μF	0～120μF	0～390μF
24V	0～22μF	0～22μF	0～68μF	0～68μF	0～220μF

2.8 AC line filter : L1

- The commom mode choke coil should be selected with confirmation because there are wire grade and rated temperature of bobbin.

2.9 Y Capacitors : C11,C12,C13

- Please choose safety certified capacitor (Y1, Y2 class approved) to C11 and C12. However, if secondary circuit is shorted to FG, not connected by capacitor, please choose Y1 class capacitor as C11 and C12.
- During high voltage test, the voltage applied to C13 is determined by the value of C11, C12 and C13. Please note the rated voltage of the capacitor. Fomula of the voltage applied to C13 is shown below.

$$V_{C13} = \frac{C_{11} + C_{12}}{C_{11} + C_{12} + C_{13}} \times V_{test}$$

V_{C13} : Voltage applied to C12
C11,C12 : Y capacitor on the primary side
C13 : Y capacitor on the secondary side
V_{test} : Test voltage

- The noise reduction level depends on the location of the grounding capacitor.
  Please connect the capacitor as close as possible to the power supply.

3.Derating

3.1 Output derating

- Please have sufficient ventilation to keep the temperature of point A in Fig.3.1 at Table 3.1 or below. Please also make sure that the ambient temperature does not exceed 85℃
- Derating curve is shown Fig.3.2.
  Note: In the hatched area, the specification of Ripple, Ripple Noise is different form other area.

Table 3.1
Point A Temperature

Model	TUHS3	TUHS5	TUHS10	TUHS15		TUHS25
Output voltage	all	all	all	12V,24V	15V	all
Point A	105℃	105℃	105℃	100℃	95℃	100℃

Fig. 3.1
Temperature measuring point on the case (Top view)

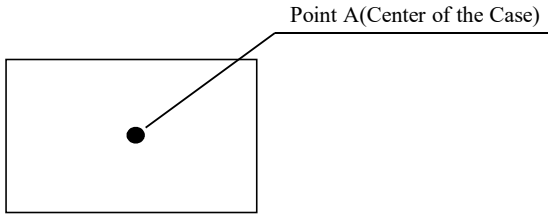
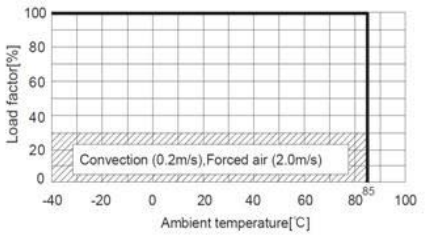
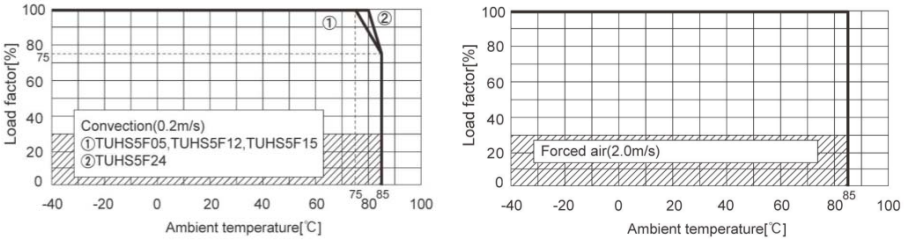


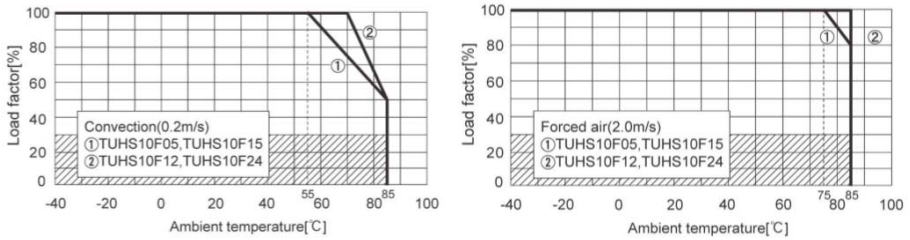
Fig. 3.2
Output derating



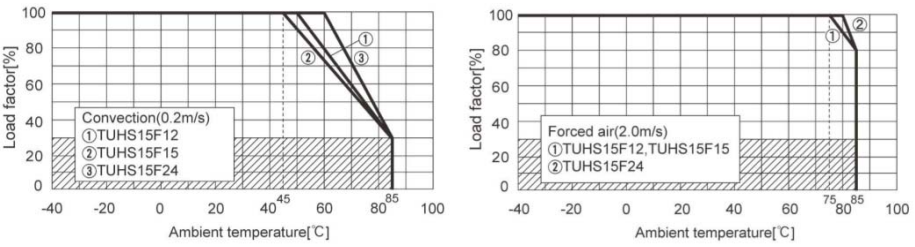
(A) TUHS3 Derating curve(Reference)



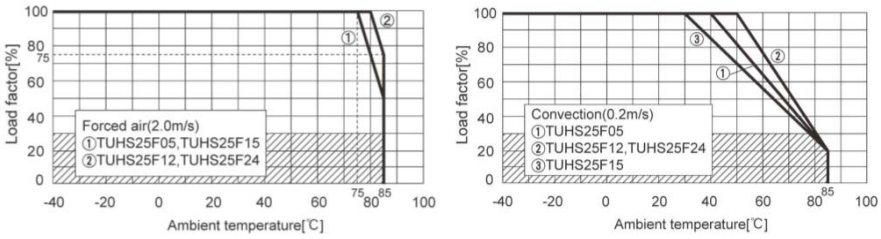
(B) TUHS5 Derating curve(Reference)



(C) TUHS10 Derating curve(Reference)



(D) TUHS15 Derating curve(Reference)

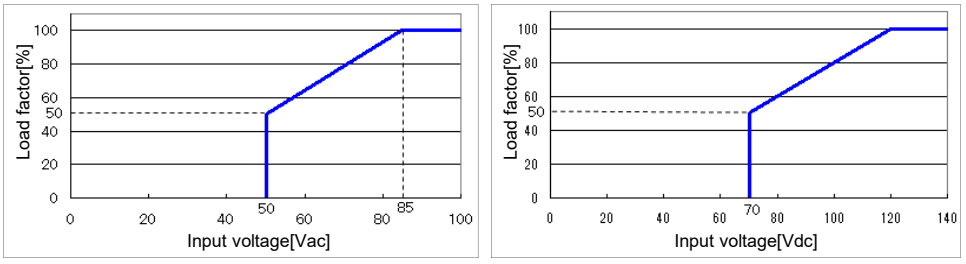


(E) TUHS25 Derating curve(Reference)

3.2 Input derating

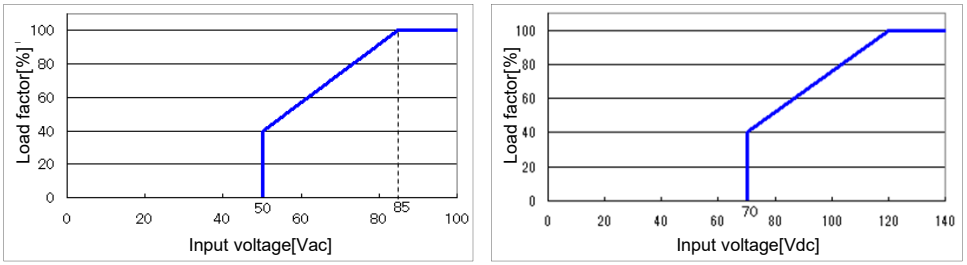
- Input derating curve is shown Fig.3.3.
  In cases that conform with safety standard, input voltage range is AC100-AC240V (50/60Hz) and DC120-DC370V.
- The operating temperature range, please refer to Section 3.1.

Fig. 3.3
Input derating



(AC input) (DC input)

(A) TUHS3



(AC input) (DC input)

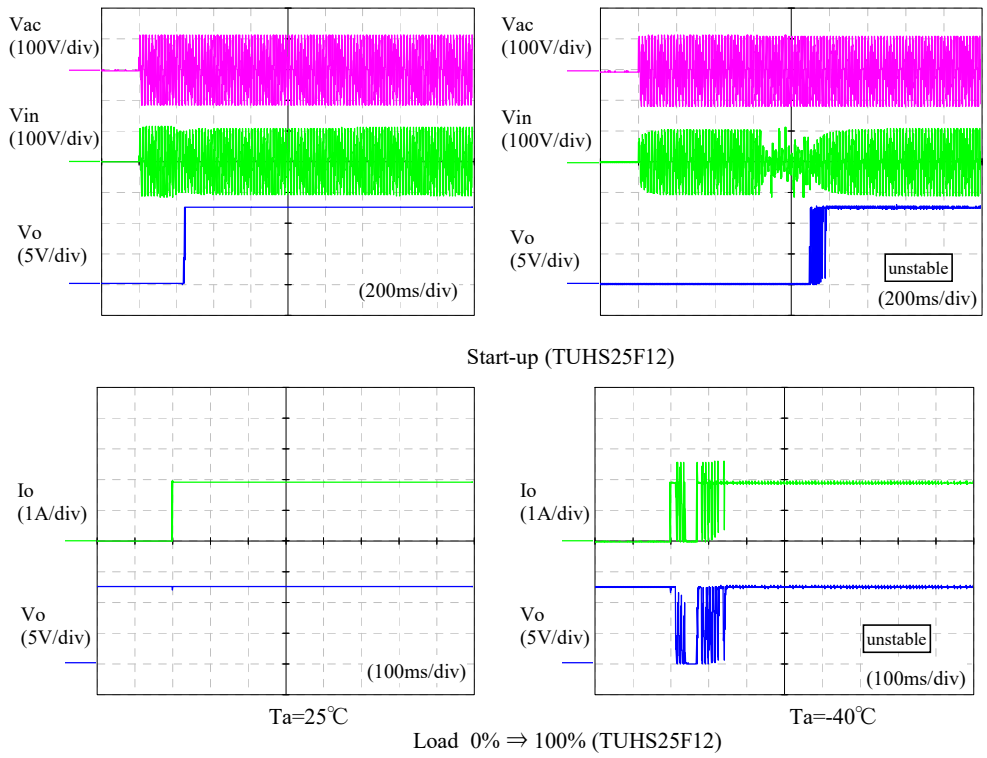
(B) TUHS5/TUHS10/TUHS15/TUHS25

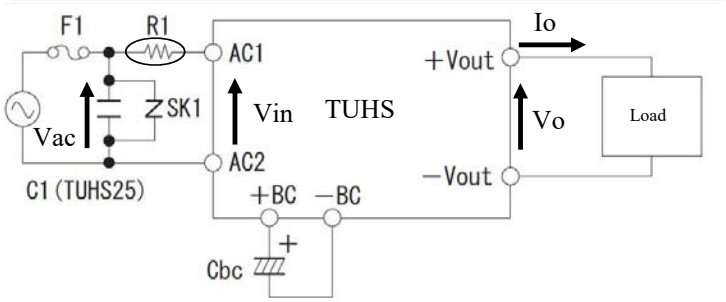
4. Operation Under Low Temperature Conditions

4.1 Outline of unstable operation at low temperature and countermeasures

- At low temperatures, ESR of Cbc and power thermistor become high.
  At this condition, the output voltage may become unstable due to the voltage drop on the inrush current limiting components and Cbc. Please select the appropriate Cbc and R1.
- The output voltage becomes unstable easily when the components temperature is low and startup or dynamic load change.
  Fig. 4.1 shows stable operation at 25ºC and unstable operation at -40ºC after startup and at dynamic load changes. The power supply is repeatedly starting and stopping if unstable operation is happened.

Fig.4.1 Difference of operation with temperature





- The operation is improved by increasing the temperature of the component.

<Notes for operation at ambient temperatures between -20ºC and -40ºC>

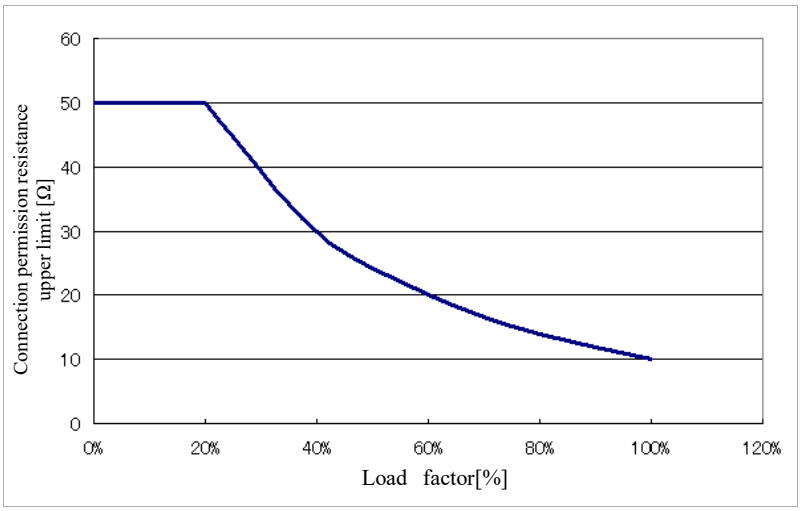
* Output voltage may be unstable continuously at low load current. In this case, minimum load current is necessary.

* The output becomes stable after a few minutes operation because the characteristics of thermistor and Cbc become stable.

■ In order to avoid unstable operation, please reduce the input ripple voltage of the BC terminal. Please be three times or more of the recommended capacity in connection permission capacity within the capacity of the Cbc.
Please select the capacitor with low ESR and excellent temperature characteristics.

■ In order to avoid unstable operation, please reduce the voltage drop due to inrush current prevention element.
Please select the value of inrush current limiting resistor R1 depending on the load factor.
Fig. 4.2 shows the upper limit of the resistance of inrush current limiting resistor.
Please select the resistance of power thermistor or resistor to be less than the value of upper limit.
Note that the resistance should be lower than the value shown in Fig.4.2 if the temperature characteristic of Cbc is bad or high ESR type is used.

Fig.4.2
Connection permission inrush current limiting resistance upper limit



*Allowable resistance with 3 times capacitance from recommended value of Cbc by using KXJ series (Nippon Chemi-Con)

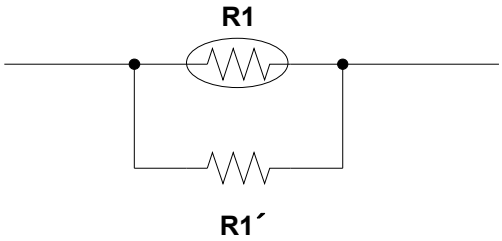
■ If the resistance of power thermistor which may exceed the value shown in Fig.4.2, thermal resistor which the resistance doesn't change by ambient temperature should be connected in parallel with the thermistor (shown in Fig.4.3).
Fomula of resistance value of R1 and R1' is shown below.

$$R_1 // R_1' = \frac{R_1 \times R_1'}{R_1 + R_1'}$$

R1 : Inrush current limiting power thermistor
R1´ : Inrush current limiting resistor to be connected in parallel

■ By connecting R1 and R1' thermally by silicone rubber etc., the power loss of inrush current limiting element can be reduced efficiently because the resistance of power thermistor reduces due to the heat from the resistor R1'.

Fig.4.3
The inrush current parallel limiting resistor in low temperature



5. Hold-up Time, Hold-up Voltage

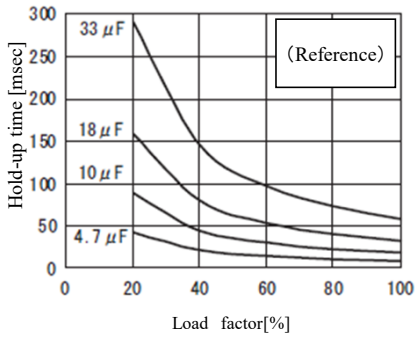
5.1 Hold-up time

- Hold-up time is determined by the capacitance of Cbc. Fig. 5.1 shows the relationship between hold-up time and load within the allowable capacitance of Cbc.
- Fomula of capacitance of Cbc is shown below.

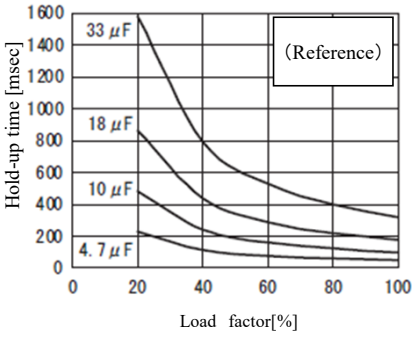
$$Cbc = \frac{Po \times t_{hold}}{\eta \times (V_{in}^2 - V_h^2)}$$

t_{hold}[sec] : Hold-up time
V_{in}[V] : Input Voltage
V_h [V] : Minimum input voltage for regulated output voltage
Po [W] : Output power
η [%] : Power supply efficiency

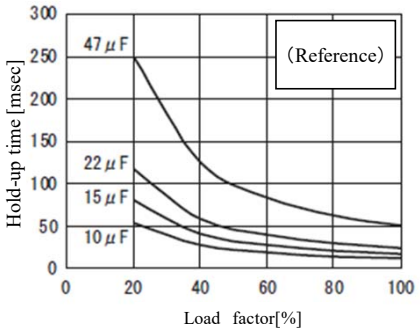
Fig. 5.1 Relationship between hold-up time and Cbc



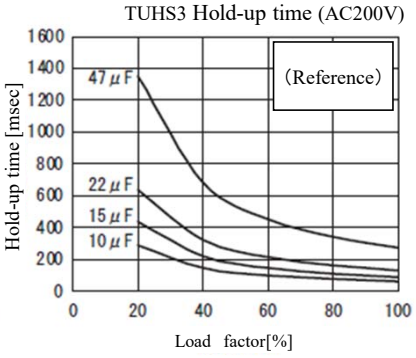
TUHS3 Hold-up time (AC100V)



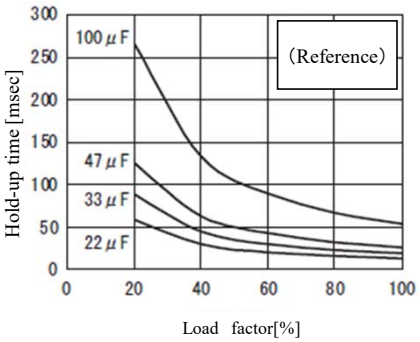
TUHS3 Hold-up time (AC200V)



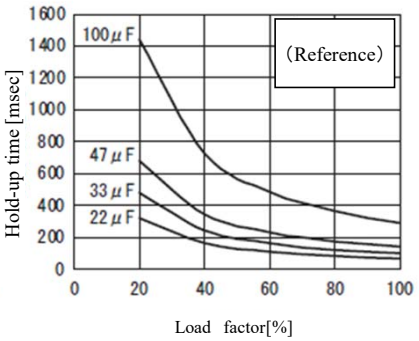
TUHS5 Hold-up time (AC100V)



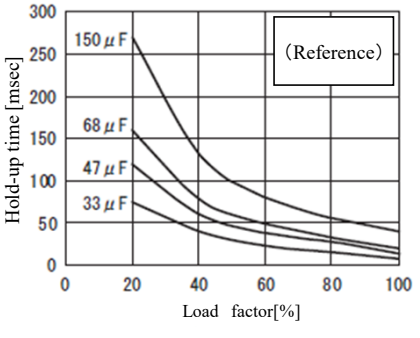
TUHS5 Hold-up time (AC200V)



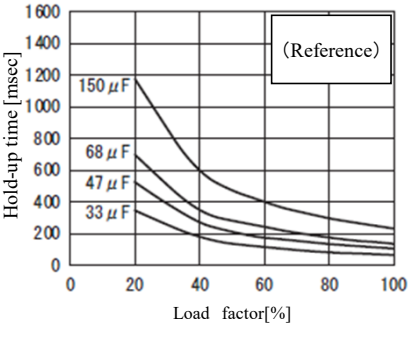
TUHS10 Hold-up time (AC100V)



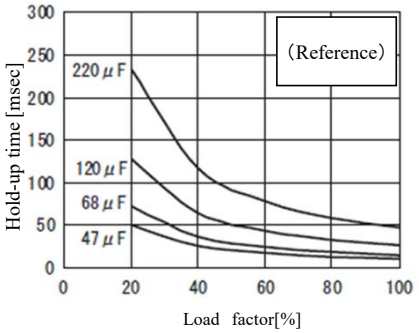
TUHS10 Hold-up time (AC200V)



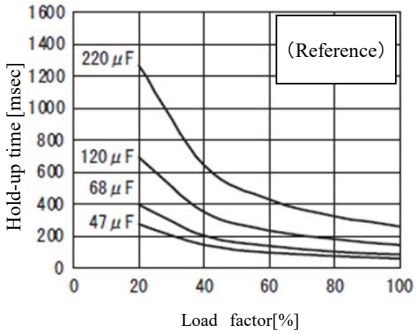
TUHS15 Hold-up time (AC100V)



TUHS15 Hold-up time (AC200V)



TUHS25 Hold-up time (AC100V)

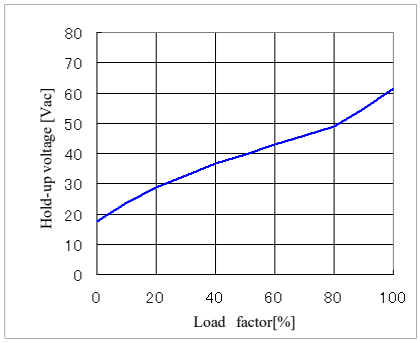


TUHS25 Hold-up time (AC200V)

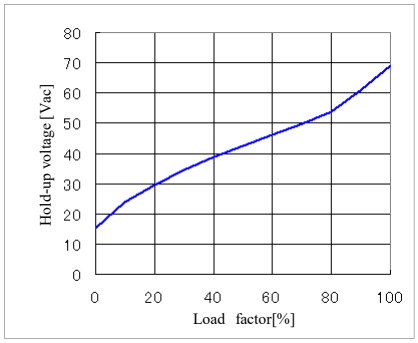
5.2 Hold-up voltage

■ Fig. 5.2 shows the relationship between hold-up voltage and load.
These data are the approximate indication for the hold-up voltage.

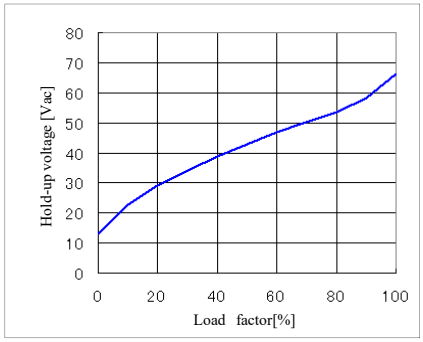
Fig. 5.2 Relationship between hold-up voltage and load



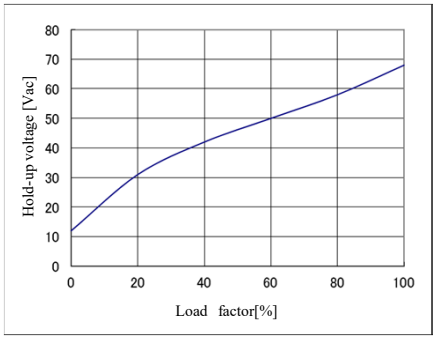
(A)TUHS3 hold-up voltage (Reference)



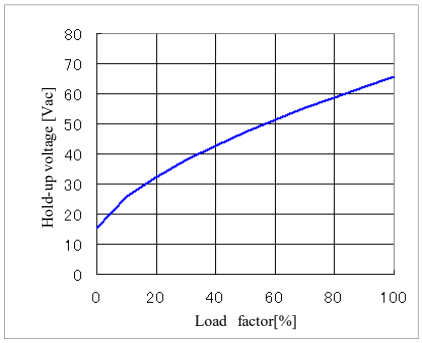
(B)TUHS5 hold-up voltage (Reference)



(C)TUHS10 hold-up voltage (Reference)



(D)TUHS15 hold-up voltage (Reference)



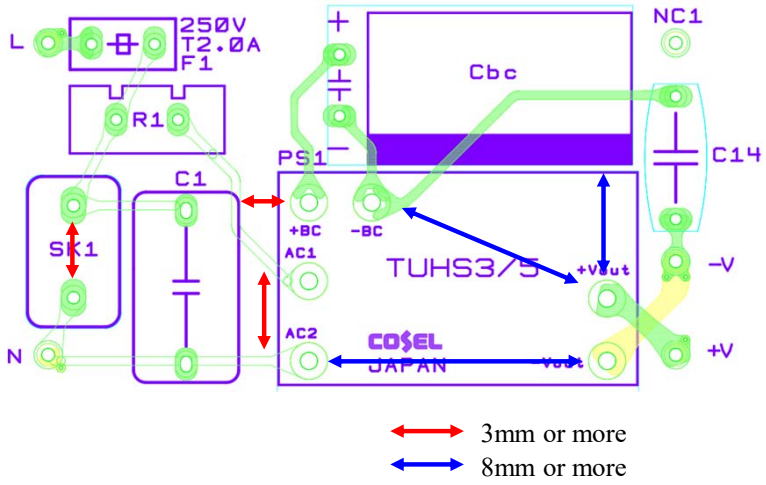
(E)TUHS25 hold-up voltage (Reference)

6.Board layout

6.1 Considerations for component placement and wiring pattern

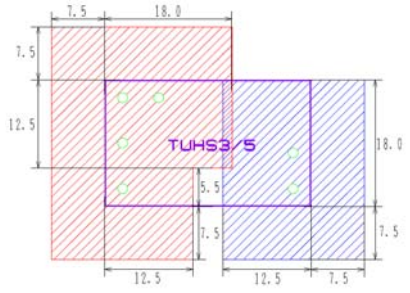
- Recommend not wire the high voltage line (AC and +BC voltage) on the surface of the primary components side.
- The distance between the pattern connected to AC and +BC must be separated 3mm or more.
- And the distance between primary elements (components and patterns) and secondary elements must be separated 8mm or more.
- Figure 6.1. shows the creepage distance as reference.
- Exterior of the electrolytic capacitor is considered as same potential as the negative terminal, it will be included in the primary component. Please note the distance between secondary side (including pattern) and exterior of the electrolytic capacitor.
- However, the clearance and creepage distance varies depending on the usage condition and the requirement of the safety standard, please confirm before the PCB design.

Fig.6.1
Creepage distance

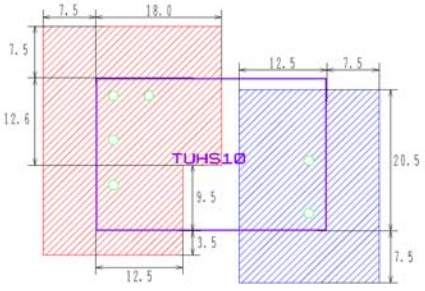


- Prohibited area of the wiring pattern and component placement is shown in Figure 6.2. (A), (B), (C).

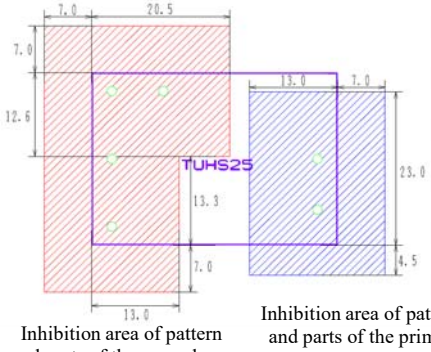
Fig.6.2
Prohibited area of
arround power supply



(A) TUHS3/TUHS5



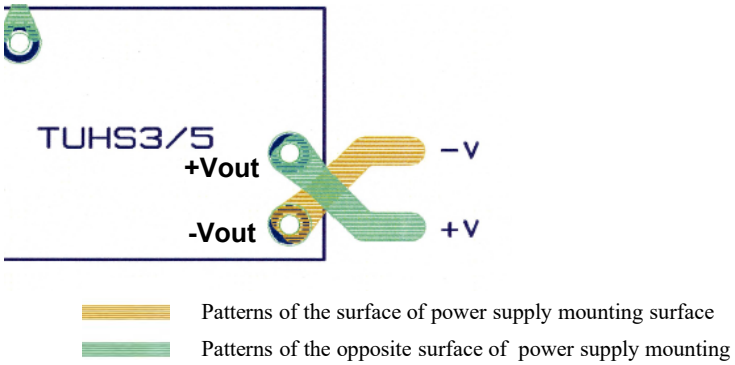
(B) TUHS10/TUHS15



(C) TUHS25

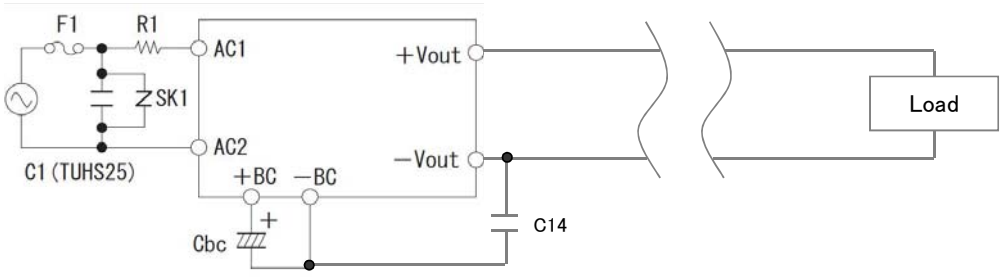
- There is the possibility that the significant radiation noise is generated, please connect input smoothing capacitor Cbc to the ± BC terminal as close as possible.
- If 2 layer or more substrate is used, the radiation noise can be reduced by crossing the output pattern (+Vo, -Vo) as shown in Fig.6.3.

Fig.6.3
Output wire reference



- Long output wiring may generate significant radiation noise, please wire it as short as possible.
- If it is difficult to be short the output wiring, 470~2200pF capacitor C14 should be connected between primary (+BC or -BC) and secondary (+Vout or -Vout) to reduce radiation noise. 10~100MHz radiation noise can be reduced by connecting C14.
- The capacitor C14 which is connected between primary and secondary must be Y1 class certified (reinforced insulation).
- Figure 6.4. shows the connection between primary and secondary capacitor C14.

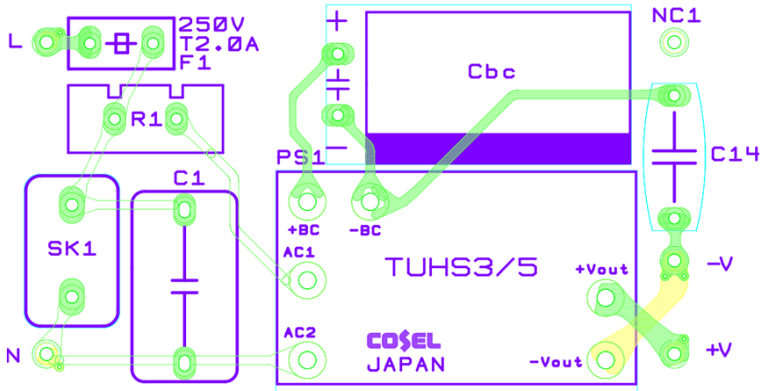
Fig.6.4
Circuit of connect capacitor between primary and secondary



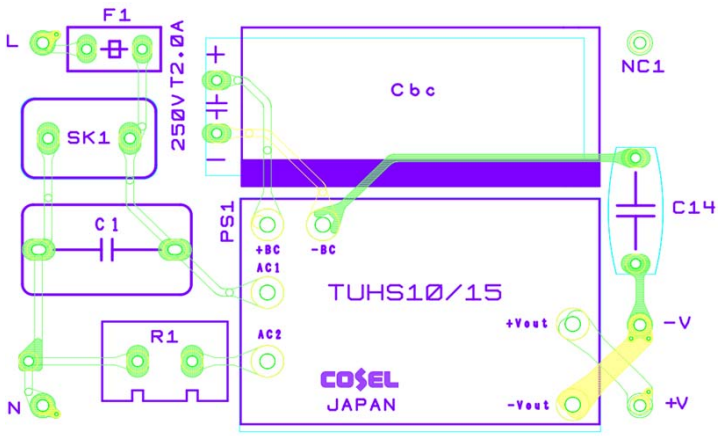
6.2 Reference PCB layout

■ Fig 6.5 (A),(B),(C) shows the reference PCB layout which is used the components listed in Table 2.1.

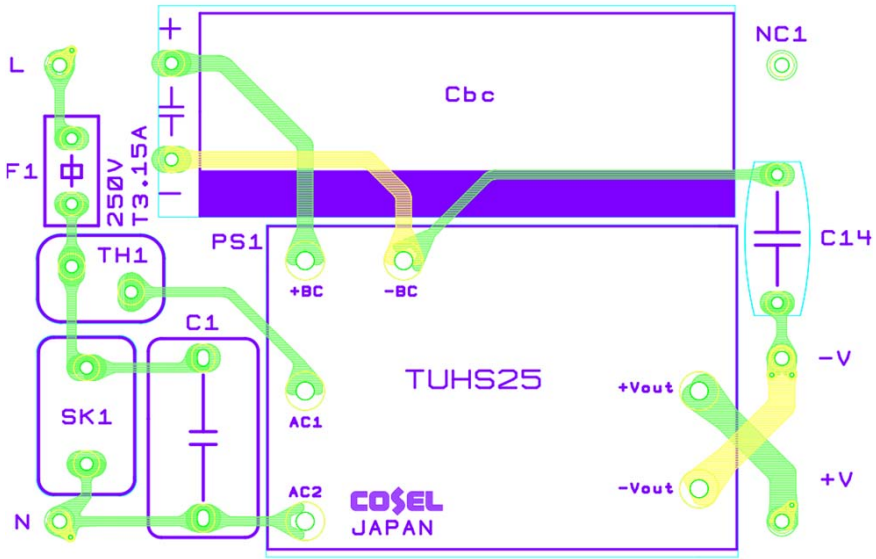
Fig.6.5
Reference PCB layout
(Double sided)



(A) TUHS3/TUHS5



(B) TUHS10/TUHS15



(C) TUHS25

Revision history

No.	date	page	content
1	2014.5.1	A-2 table2.1	Reference AC Fuse Type Name change
2	2014.5.1	A-3	Reference DC Fuse Type name added
3	2014.5.1	A-4	But, if the ripple current of・・・ deleted
4	2014.11.14	A-1	1.1 Block Diagram added
5	2014.11.14	A-8	3.2 input derating added
6	2015.1.23	A-2	Change of fig 2.2 and table 2.1
7	2015.5.20	-	Add items related to TUHS15F
8	2015.11.20	A-12	Changing the formula of Hold-up time
9	2017.9.20	-	Add items related to 15V
10	2019.07.25	A-2,A-7, A-14,A16	condenser for Line Conduction C1,C14・・・added
12	2019.07.25	A-2	Changed inrush limiting resistor to A2JD-100J L3.5（Uchihashi Estec Co.,Ltd.）、CWFS23C 10Ω（KOA corporation）
13	2019.07.25	A-3	Changed Y capacitors to CD45-E2GA222M（TDK）