ABR300 APPLICATION NOTE

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1. Pin Assignment

1.1 Pin Assignment

Fig. 1.1.1 Pin Assignment

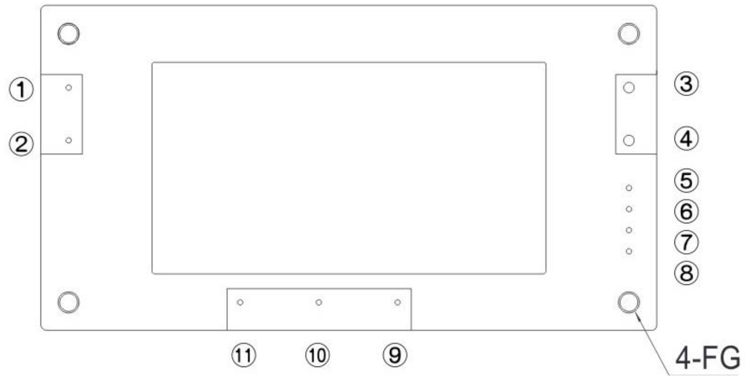


Table 1.1.1 Pin Configuration and Function

Pin No.	Pin Connection	Pin Description
1	AC IN (L)	AC (L) input
2	AC IN (N)	AC (N) input
3	-DC OUT	DC (-) output
4	+DC OUT	DC (+) output
5	-S	Remote sensing (-)
6	+S	Remote sensing (+)
7	TRIM	Adjustment of output voltage
8	ENA	Open collector (10mA sink current). Low when output is present.
9	-BC	Smoothing bulk capacitor (-)
10	+BC	Smoothing bulk capacitor (+)
11	R	External resistor for inrush current protection
–	FG	M3 screw mounting hole (FG)

2. Connection for Standard Use

2.1 Connection for Standard Use

(a).To Use the ABR300 series, external components should be connect as shown in Fig. 2.1.1.

(b).The ABR300 series should be conduction-cooled. Use a heatsink or fan to dissipate heat.

Fig. 2.1.1 Connection for standard use

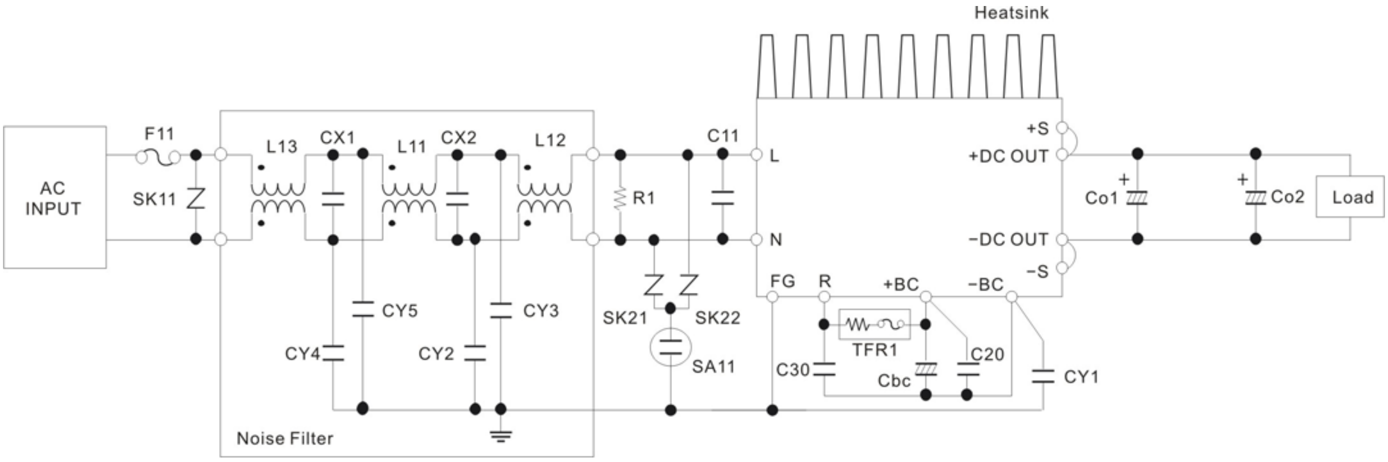


Table 2.1.1 List of Components

No.	Symbol	Item		Rating	Remark
1	F11	Input fuse (SLO-BLO)		AC250V / 10A	–
2	C11	Input capacitor		AC275V / 1uF	Class X1 or X2
3	CY1	Y capacitor		AC250V / 1000pF	Class Y1
4	L11	Noise filter	Line Filter	Min. 9mH	–
5	L12			Min. 12mH	–
6	L13			Min. 100uH	–
7	CX1		X capacitor	AC275V / 0.68uF	Class X1 or X2
8	CX2			AC275V / 1uF	Class X1 or X2
9	CY2, CY3		Y capacitor	AC250V / 2200pF	Class Y1 or Y2
10	CY4, CY5			AC250V / 1000pF	Class Y1 or Y2
11	Co1	Output pi filter	12S	DC16V / 1500uF x2	Conductive Polymer
			24S, 28S	DC35V / 1000uF x3	Electrolytic capacitor
			48S	DC63V / 390uF x3	Electrolytic capacitor
12	Co2		12S	DC16V / 2200uF x2	Electrolytic capacitor
			24S, 28S	NC	Electrolytic capacitor
			48S	NC	Electrolytic capacitor
13	Cbc	Smoothing capacitor for boost voltage		DC450V / 470uF	Electrolytic capacitor
14	C20,C30	Capacitor for boost voltage		DC450V / 0.68uF ×2 (parallel)	Film capacitor
15	TFR1	Inrush current limiting resistor		10Ω	Thermal fuse build-in resistor
16	R1	Discharging resistor		470K Ω	1/4W resistor
17	SK21 / SK22	Varistor		NC	–
18	SA11	Surge absorber		NC	–
19	SK11	Varistor		620V	300Vac / 3500A (8/20µS)

2.2 Output Capacitors: Co1, Co2

(a).Install several external capacitor, Co, between +DC OUT and –DC OUT pins for stable operation of the power supply. Recommend capacitance of Co is shown in Table 2.2.1.

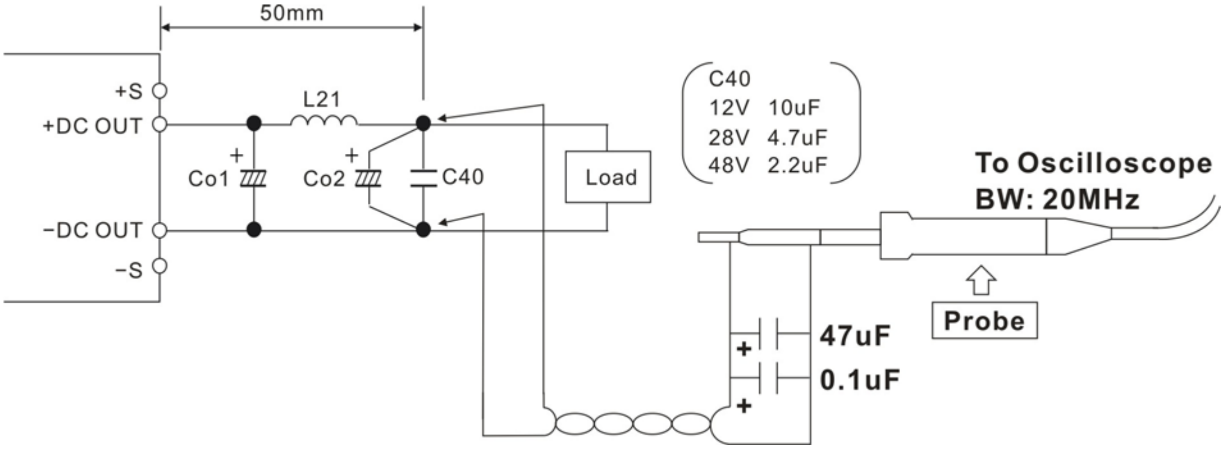
(b).Use low impedance capacitors with excellent temperature characteristics.

(c).Specifications, output ripple and ripple noise as evaluation data values are measured according to Fig. 2.2.1.

Table 2.2.1 Recommended capacitance Co

Output Voltage	Co1	Co2	Remark
12V	DC16V / 1500uF x3	DC16V / 1800uF x3	Co1: Conductive Polymer Aluminum Solid Capacitors Co2: Electrolytic capacitor
24V	DC35V / 1000uF x3	DC35V / 1000uF x1	Electrolytic capacitor
28V	DC35V / 1000uF x3	DC35V / 1000uF x1	Electrolytic capacitor
48V	DC63V / 390uF x3	DC63V / 390uF x1	Electrolytic capacitor

Fig. 2.2.1 Measuring environment



2.3 Smoothing Capacitor for Boost Voltage: Cbc

(a).In order to smooth boost voltage, connect Cbc between +BC and –BC.

(b).Install a capacitor Cbc with a rated voltage of DC 450V or higher within the allowable capacitance.

(c).When operated below 0°C, operation may become unstable as boost ripple voltage increase due to ESR characteristics. Choose a capacitor which has higher capacitance than recommend. Select a capacitor so that the ripple voltage of the boost voltage is 30 Vp-p or below.

(d).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.

(e).The ripple current changes with PCB patterns, external parts, ambient temperature, etc. Check the actual ripple current value flowing through Cbc.

Table 2.3.1 Recommend Capacitance Cbc

Recommend Capacitance	Allowable capacitance range
470uF	330uF ~ 680uF

2.4 Inrush Current Limiting Resistor: TRF1

(a).The TFR1 must be connected, if TFR1 is not connect, the power supply will not operate.

(b).Connect TFR1 between R and +RC. Recommend resistance of TFR1 is shown in table 2.4.1

(c).The surge capacity is require TFR1.

(d).Wirewound resistor with thermal cut-offs type is required.

(e).The inrush current changes by PCB pattern, parts characteristic etc. Check the actual inrush current value flowing through the AC line.

Table 2.4.1 Recommended resistance TRF1

Model	Recommended resistance
ABR300	4.7 ~ 22 Ω

2.5 Discharging Resistor: R1

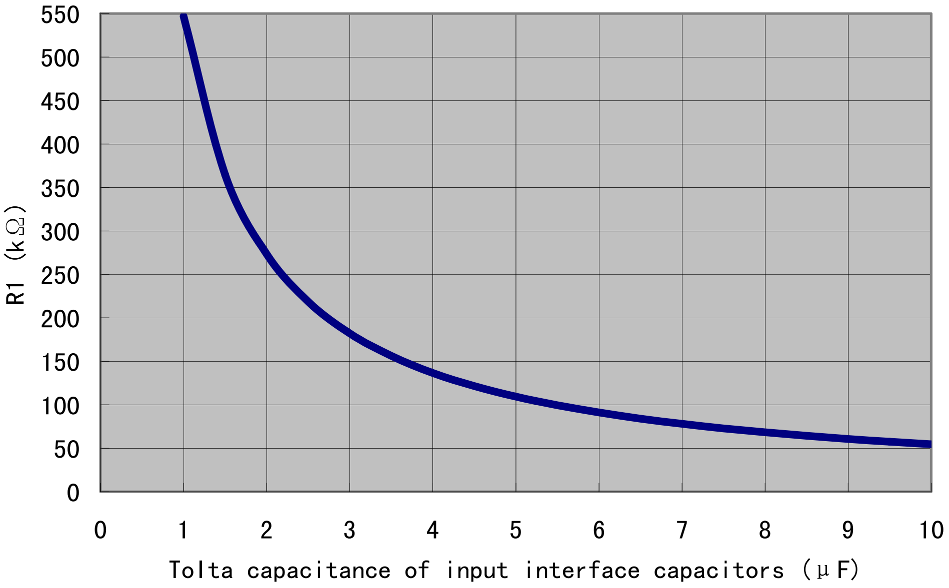
(a).If you need to meet the safety standards, connect a discharging resistor R1 between AC IN (L) and AC IN (N).

(b).Please select a resistor so that the voltage between AC IN (L) and AC IN (N) decreases in 42.4V or less at 1 second after turn off the input.

(c) Fig. 2.5.1 shows the relationship between a necessary resistance of R1 and total capacitance of input interface capacitors. And the data of Fig. 2.5.1 is the values that assumed the worst condition.

(d).Please keep margin for rated voltage and power of R1.

Fig. 2.5.1 Relationship between resistance of R1 and total capacitance of input interface capacitors



3. Output Voltage Adjustment

3.1 Output Voltage Adjustment Range

(a).The output voltage is adjustable in the output voltage variable range shown in Table 3.1.1

(b).Overvoltage protection may be activated if output voltage is set up over the certain level.

Table 3.1.1 Output voltage variable range

Output voltage	12S	24S	28S	48S
Output voltage Variable range	10.8V ~ 13.2V	21.6V ~ 26.4V	25.2V ~ 30.8V	43.2V ~ 52.8V

3.2 Output Voltage Adjustment

Typical Output voltage	12S	24S	28S	48S
Trim → -V	0% ~ +10%	0% ~ +10%	0% ~ +10%	0% ~ +10%
	∞ ~ 25k	∞ ~ 33k	∞ ~ 31k	∞ ~ 29k
Trim → +V	-10% ~ 0%	-10% ~ 0%	-10% ~ 0%	-10% ~ 0%
	96k ~ ∞	250k ~ ∞	312k ~ ∞	655k ~ ∞

4. Hold Up Time

4.1 Hold Up Time

Hold up time is affected by the capacitance of Cbc. Table 4.1.1 show the relationship between hold up time and output current within the allowable capacitance of Cbc.

Table 4.1.1 Hold up time with 100 Vac input

Capacitance of Cbc (uF)	Hold up time with 100% load (ms)	Hold up time with 75% load (ms)	Hold up time with 50% load (ms)	Hold up time with 25% load (ms)
330	11	30	60	65
470	15	42	65	65
680	21	60	65	65

5. Thermal Design

5.1 Overview

To ensure operation of power module, it is necessary to keep aluminum base plate temperature within the allowable temperature limit. The reliability of the power module depends on the temperature of the base plate. In order to obtain maximum reliability, keep the aluminum base plate temperature low.

5.2 Efficiency and Dissipation Power

(a).Not all of the input power is converted to output power, some loss is dissipated as heat power module inside. To determine the internal power dissipation, give 1 – 2 % margin of the efficiency value which is calculated by Characteristics of Efficiency vs. Output Power.

(b).Efficiency is defined as percentage of Output power vs. Input power. Efficiency depends on input voltage and output current.

Fig. 5.1.1 Internal power dissipation calculating

$$\mathrm{Pin} = \mathrm{Vin} \times \mathrm{Iin}$$

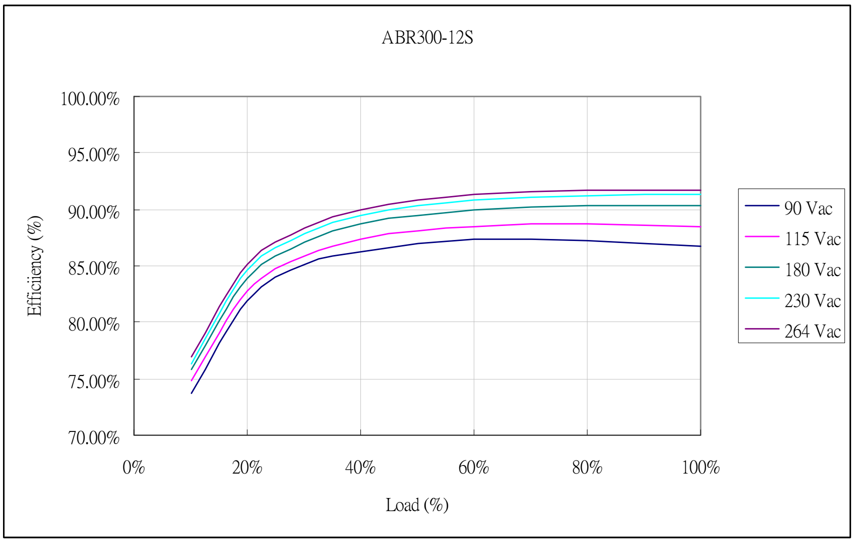
$$\mathrm{Pout} = \mathrm{Vout} \times \mathrm{Iout}$$

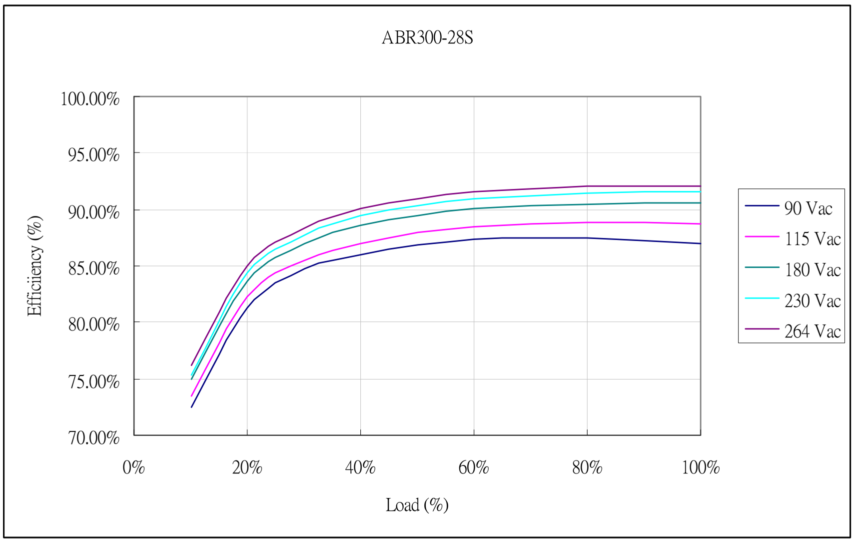
$$\eta = \frac{\mathrm{Pout}}{\mathrm{Pin}} \times 100$$

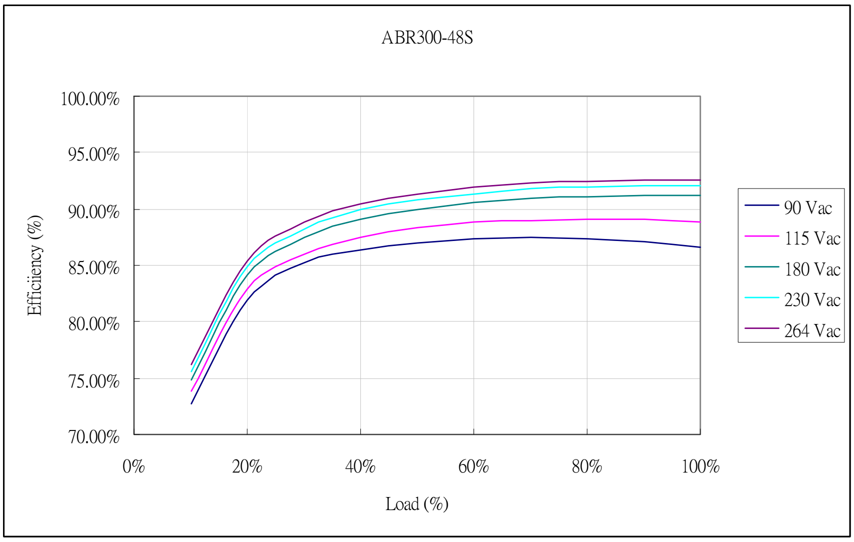
$$\mathrm{Pd} = \frac{1 - \eta}{\eta} \times \mathrm{Pout}$$

Pin : Input power (W)
Pout : Output power (W)
Pd : Internal power dissipated (W)
η : Efficiency (%)

5.3 Relationship Between Efficiency and Output Power



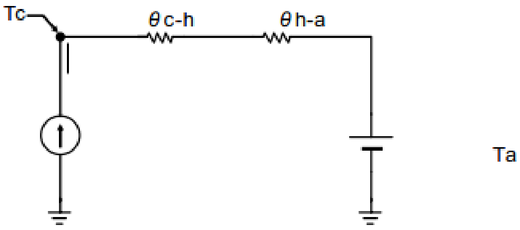




5.4 Thermal Resistance

(a).In most applications, heat will be conducted from the base plate into an attached heat sink. Heat conducted across the interface between the base plate and heat sink will result in a temperature drop which must be controlled. As shown in Fig. 5.4.1, the interface can be modeled as thermal resistance with the dissipated power flow.

Fig. 5.4.1 Thermal resistance



The thermal resistance of heat sink is calculated by following equation.

$$\theta h\text{-}a = \frac{Tc - Ta}{Pd} - \theta c\text{-}h$$

(b).Contact thermal resistance is between base plate and heat sink. To decrease the contact thermal resistance, use thermal grease and thermal pad. When using thermal grease, apply in a uniform thin coat.

(c).The thermal grease and thermal pad have the following respective features.

(i) Thermal grease: low thermal resistance (0.2 – 0.3°C/W).

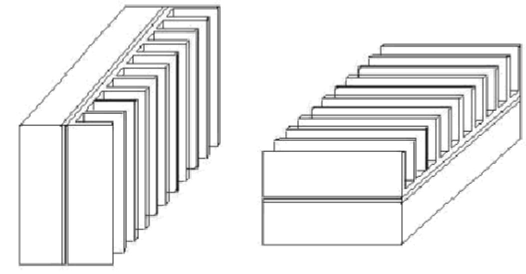
(ii) Thermal pad : higher than thermal grease (0.3 – 0.4°C/W).

5.5 Convection Cooling and Forced Air Cooling

(a).The benefits of convection cooling is low cost implementation, no need for fans, and the inherent reliability of the cooling process. Compared to forced air cooling, convection cooling needs more heat sink volume to cool down an equivalent base plate temperature. Thermal resistance depends on heat sink shape. Therefore, refer to the detailed thermal resistance data supplied by the manufacturer prior to the selection.

(b).Heat sink data is almost always given for vertical fin orientation. Orienting the fins horizontally will reduce cooling effectiveness. If horizontal mounting is required, obtain relevant heat sink performance data or use forced air cooling.

Fig. 5.5.1 Convection cooling mounting method



(a) Vertical mounting (b) Horizontal mounting

(c).In forced air cooling method, heat dissipation ability of the heat sink improves much higher than convection cooling.

5.6 Notes on Thermal Design

(a).Base plate temperature should be measured at the center of the base plate.

(b).The interface between base plate and heat sink is smooth, flat and free of debris.

(c).Unless the base plate and the heat sink are placed in close contact with each other, contact thermal resistance will increase until heat radiation becomes insufficient. Always use either thermal grease or thermal pads.

(d).Avoid blocking the airflow to the module with other components.

(e).Use a heat sink with fins running vertically for natural convection.

5.7 Thermal Design Example

Conditions:

Input voltage = 230 Vac, Max. ambient temperature(Ta) = 50°C, Aluminum base plate temperature(Tc) = 80°C

Output voltage = 48 V, Output current = 5 A

Table 5.7.1

Step	Description	Design example
1	Determine the required output power(Pout), maximum ambient temperature(Tc) and aluminum base plate temperature(Tc).	For higher reliability, the aluminum base plate temperature is set up below 80 °C. Ta = 50 °C Pout = 48 (V) × 5 (A) = 240 (W) Tc = 80 °C
2	Obtain the efficiency (η)	Efficiency is obtained by Fig. 5.3.1 η=89%, to give 2% efficiency will be 87%
3	Calculate the internal power dissipation	Power dissipation(Pd) = (1 – 0.87) ÷ 0.87 × 240 = 35.86 (W)
4	Obtain contact thermal resistance (θc-h)	Use a thermal grease with a thermal resistance of 0.2°C/W
5	Calculate thermal resistance of Heat sink (θh-a)	θh-a = (80 – 50) ÷ 35.86 – 0.2 = 0.64
6	Choose the heat sink	Use a heat sink with R378ABR00001
7	Obtain the required wind velocity	The wind velocity required to reduce the resistance to set up 0.64 or below. Refer to table 5.8.1, the wind velocity required up over 2.0 m/s with airflow direction A.
8	Choose the fan	Choose the fan capable of supplying air at a velocity of 2.5 m/s or higher.
9	Check the design with actual equipment	Measure the aluminum base plate temperature at actual conditions. Ta = 50 °C, Pout = 240 W Then confirm the base plate temperature below 80 °C.

5.8 Heat Sink Size and Thermal Resistance

Fig. 5.8.1 Heat sink size and thermal resistance

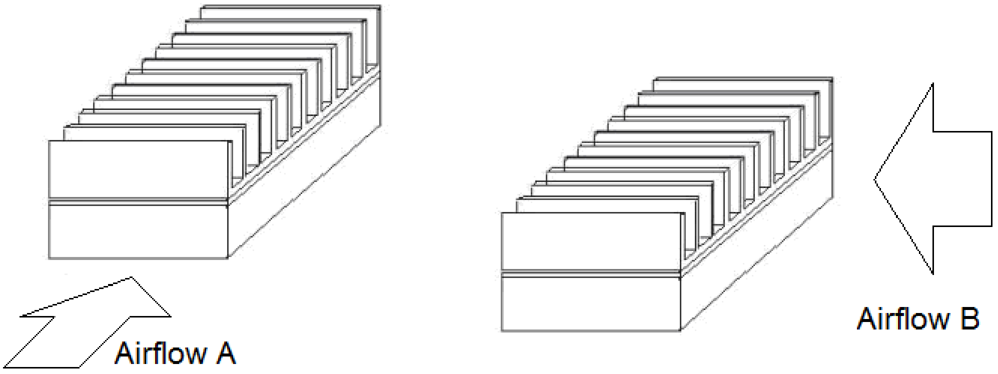
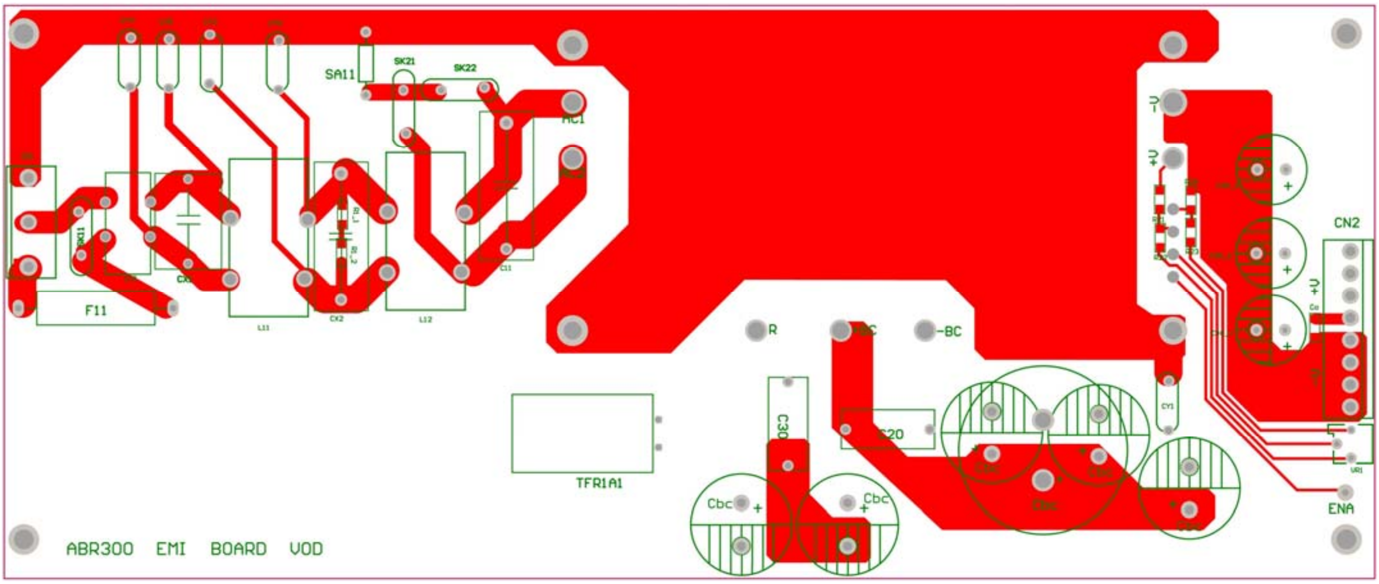


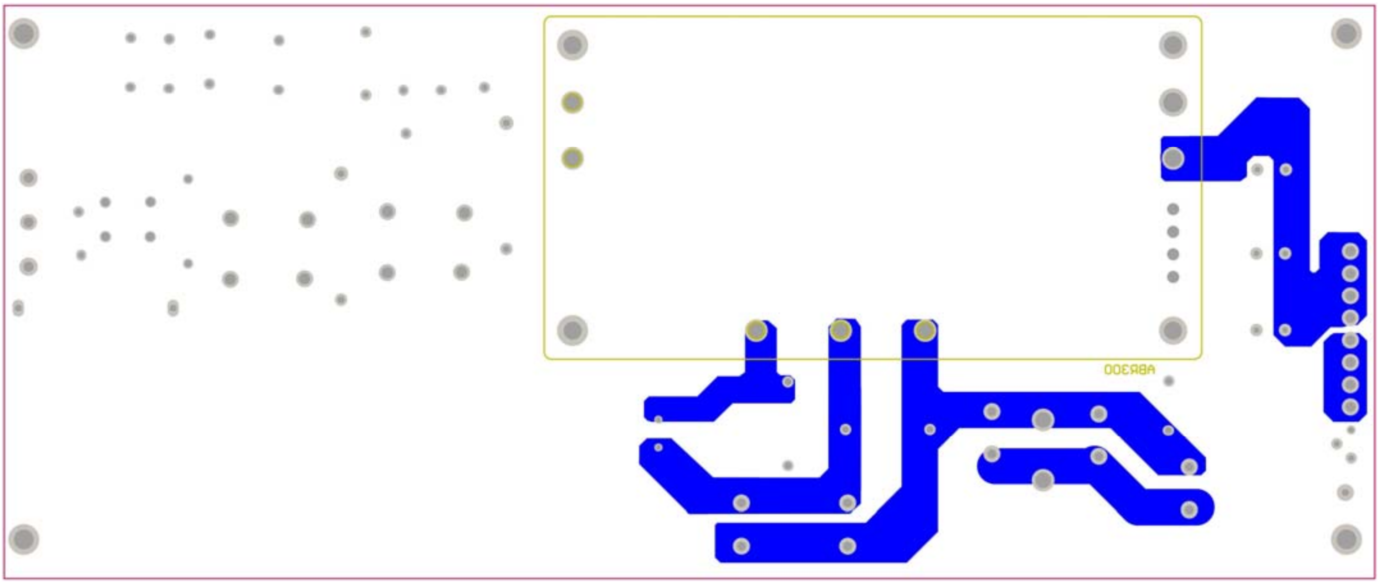
Table 5.8.1

Model	Size (mm)			Thermal resistance (°C/W)								
	H	W	D	Air convection		Airflow direction	Forced air cooling					
							0.5m/s	1.0m/s	1.5m/s	2.0m/s	2.5m/s	3.0m/s
R378ABR00001	25	117	61	Vertical	2.0	A	1.24	0.91	0.77	0.66	0.57	0.51
				Horizontal	1.91	B	0.79	0.58	0.44	0.38	0.33	0.30

6. Board Layout

6.1 Reference PCB Layout





7. Example of Which Reduce EMI

7.1 EMI Measure Example

Fig. 7.1.1 Circuit example for EMI solution

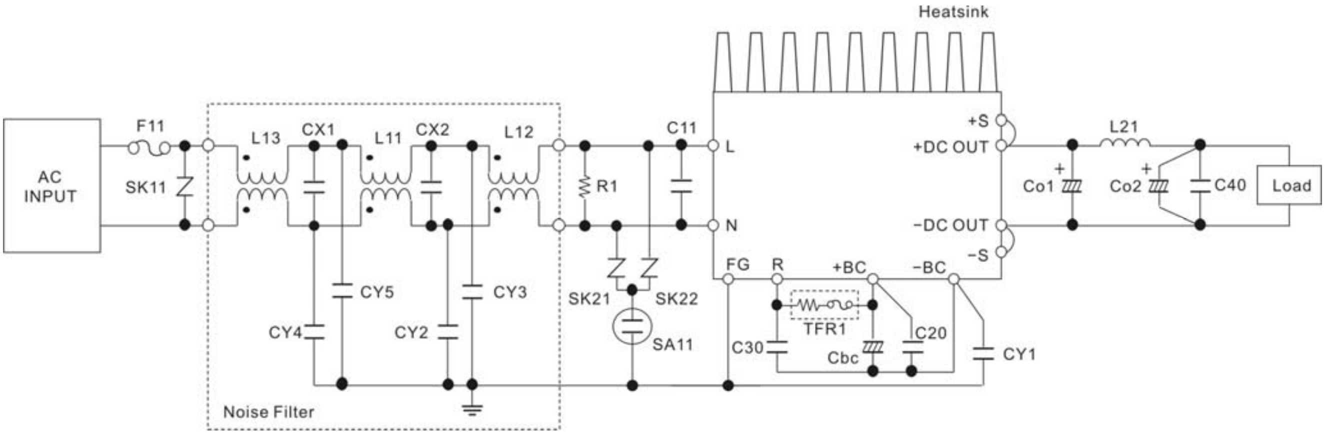


Table 7.1.1

No.	Symbol	Item		EN55022 Class B
				Rating
1	C11	Input capacitor		AC275V / 1uF
2	CY1	Y capacitor		AC250V / 1000pF
3	L11	Noise filter	Line Filter	Min. 9mH
4	L12			Min. 12mH
5	L13			Min. 100uH
6	CX1		X capacitor	AC275V / 0.68uF
7	CX2			AC275V / 1uF
8	CY2, CY3		Y capacitor	AC250V / 2200pF
9	CY4, CY5			AC250V / 1000pF