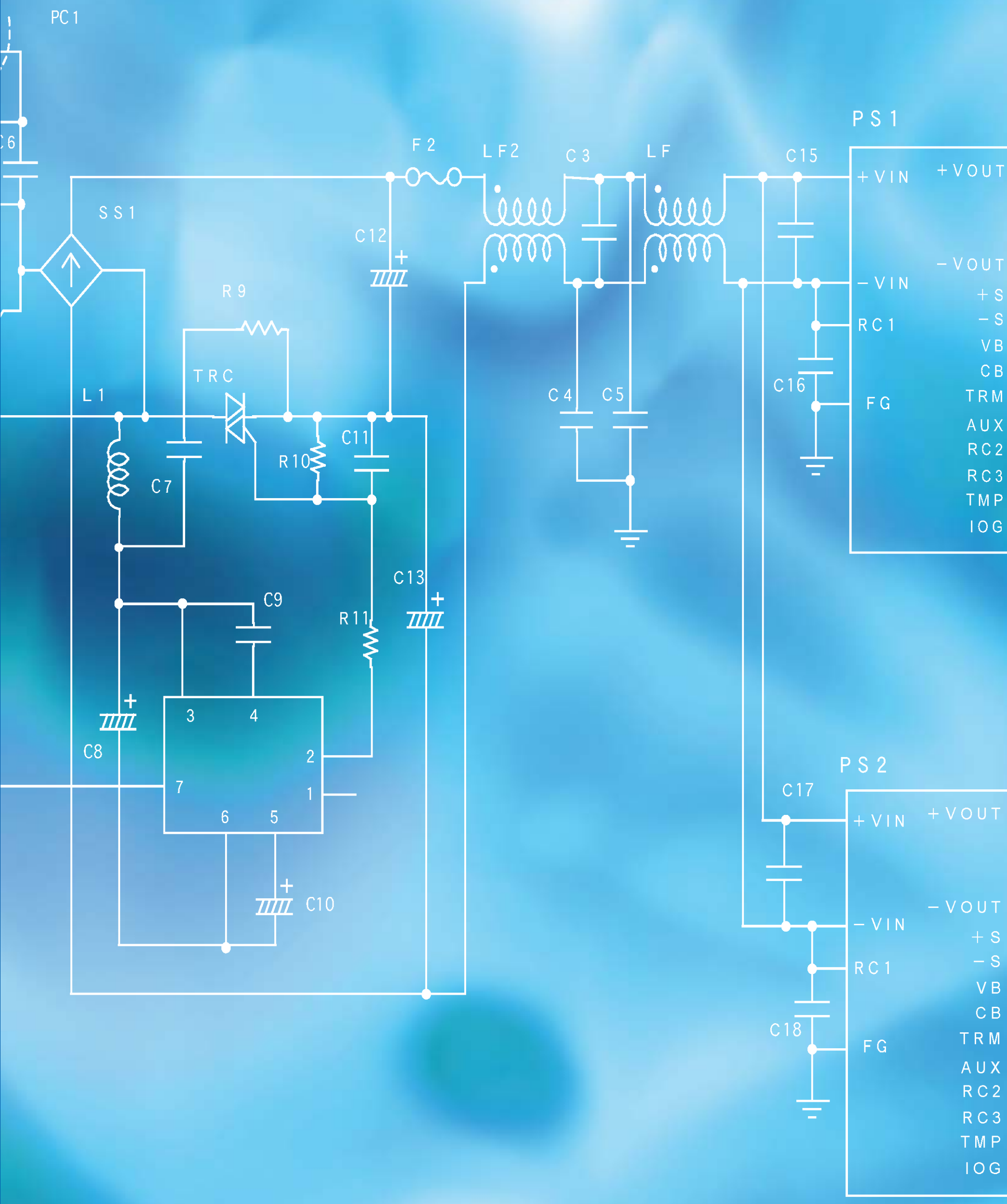
COSEL

COSEL CO.,LTD.

Applications Manual



COSEL

Applications Manual

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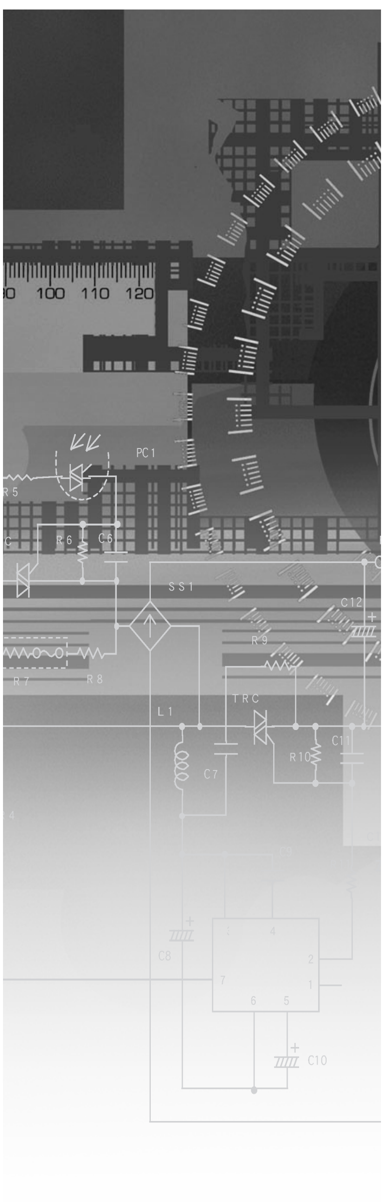

DBS series
CBS series
CDS series
Application Circuits
Input Rectifier Circuit
DPF and DPA series
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Thermal Considerations
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1. DBS series

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1.1 Pin configuration

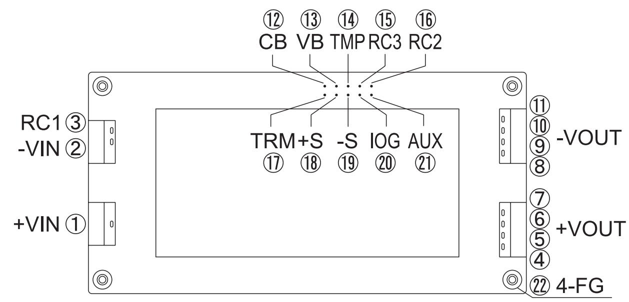


Fig.1.1.1
Pin configuration
(bottom view)

Table 1.1.1
Pin configuration and function

NO.	Pin Connection	Function	Reference
①	+VIN	+DC input	1.3 Connection method for standard use
②	-VIN	-DC input	
③	RC1	Remote ON/OFF(input side)	1.7 Remote ON/OFF (1)
④⑤⑥⑦	+VOUT	+DC output	1.3 Connection method for standard use
⑧⑨⑩⑪	-VOUT	-DC output	
⑫	CB	Current balance	1.11 Parallel operation / Master-slave operation
⑬	VB	Voltage balance	
⑭	TMP	Thermal detection signal	1.5 Protect circuit
⑮	RC3	Remote ON/OFF(output side)	1.7 Remote ON/OFF (2)
⑯	RC2		
⑰	TRM	Adjustment of output voltage	1.6 Adjustable voltage range
⑱	+S	+Remote sensing	1.8 Remote sensing
⑲	-S	-Remote sensing	
⑳	IOG	Inverter operation monitor	1.9 Inverter operation monitor
㉑	AUX	Auxiliary power supply	1.7 Remote ON/OFF (3)
㉒	FG	Mounting hole(FG)	1.3 Connection method for standard use

1.2 Do's and Don'ts for module

1.2.1 Isolation

■For a receiving inspection, such as Hi-Pot test, gradually in-crease (decrease) the voltage for a start (shut down). Avoid using Hi-Pot tester with the timer because it may generate voltage a few times higher than the applied voltage, at ON/OFF of a timer.

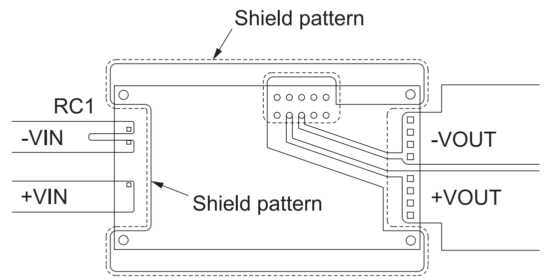
1.2.2 Mounting method

■The unit can be mounted in any direction. When two or more power supplies are used side by side, position them with proper intervals to allow enough air ventilation. Aluminum base temperature around each power supply should not exceed the temperature range shown in derating curve.

■Avoid placing the DC input line pattern lay out underneath the unit, it will increase the line conducted noise. Make sure to leave an ample distance between the line pattern lay out and the unit. Also avoid placing the DC output line pattern underneath the unit because it may increase the output noise. Lay out the pattern away from the unit.

■High-frequency noise radiates directly from the unit to the atmosphere. Therefore, design the shield pattern on the printed circuit board and connect its one to FG. The shield pattern prevents noise radiation. Fig.1.2.1 Examples of parallel operation when output voltage adjustment is not in use. TRM wiring, R1, R2 and VR are not necessary.

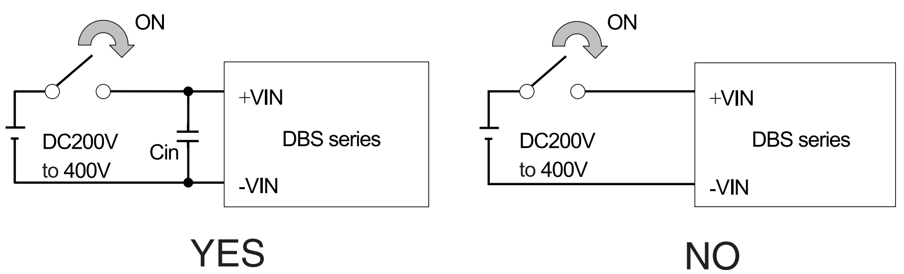
Fig.1.2.1
Shield pattern lay out
(bottom view)



1.2.3 External input capacitor

■When the line impedance is high or the input voltage rise quickly at start-up (less than 10μs), install a capacitor Cin between +VIN an -VIN input pins (within 50mm from pins).

Fig.1.2.2
External input capacitor



(DBS200B:more than 22μF
DBS400B:more than 47μF)

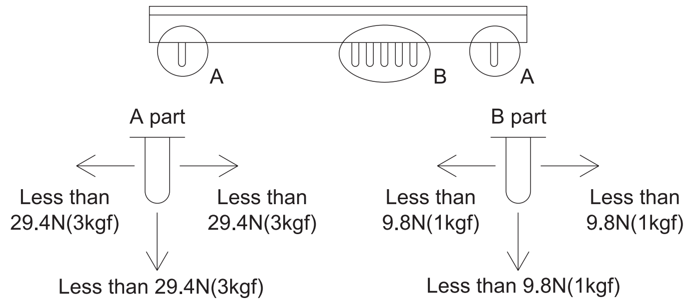
1.2.4 Stress onto the pins

■When too much stress is applied to the pins of the power supply, the internal connection may be weakened. As shown in Fig.1.2.3 avoid applying stress of more than 29.4N (3kgf) on the input pins/output pins (A part) and more than 9.8N (1kgf) to the signal pins (B part).

■The pins are soldered on PCB internally, therefore, do not pull or bend them with abnormal forces.

■Fix the unit on PCB (fixing fittings) to reduce the stress onto the pins.

Fig.1.2.3
Stress onto the pins



1.2.5 Cleaning

- ■Clean it with a brash. Prevent fluid from getting inside the unit.
- ■Do not apply pressure to the lead and name plate with a brush or scratch it during the cleaning.
- ■After cleaning, dry them enough.

1.2.6 Soldering

■Flow soldering : 260℃ less than 15 seconds.

■Soldering iron

DC IN/DC OUT/RC1 : 450℃ less than 5 seconds.

Signal pins : 350℃ less than 3 seconds (less than 20W).

1.2.7 Safety standard

- ■This unit must be used as a component of the end-use equipment.
- ■This unit must be provided with overall enclosure.
- ■Mounting holes must be connected to safety ground of the end-use equipment, as required for class I equipment.
- ■Input must be filtered and rectified.
- ■Safety approved fuse must be externally installed on input side.

1.3 Connection method for standard use

1.3.1 Connection for standard use

■In order to use the power supply, it is necessary to wire as shown in Fig.1.3.1.

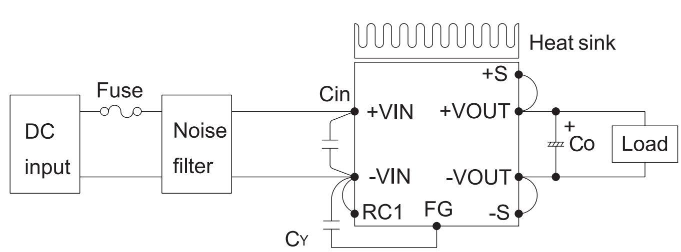
■Short the following pins to turn on the power supply.

-VIN ⇔ RC1, +VOUT ⇔ +S, -VOUT ⇔ -S

Reference : 1.7 Remote ON/OFF

1.8 Remote sensing

Fig.1.3.1 Connection for standard use



Cin : External capacitor on the input side

Co : External capacitor on the output side

CY : Primary decoupling capacitor

1.3.2 Input power source

(1) Operation with DC input

■Input voltage ripple should be less than 20Vp-p.

■Make sure that the voltage fluctuation, including the ripple voltage, will not exceed the input voltage range.

■Use a front-end unit with enough power, considering the start-up current Ip of this unit.

Fig.1.3.2
Input voltage ripple

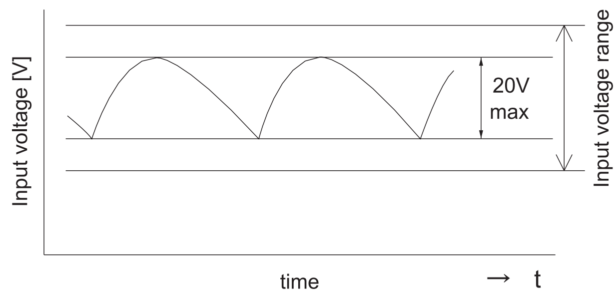
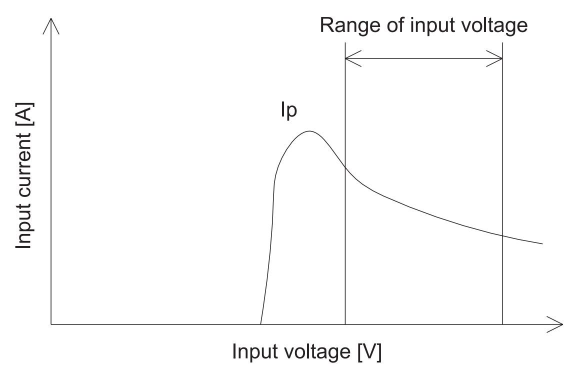


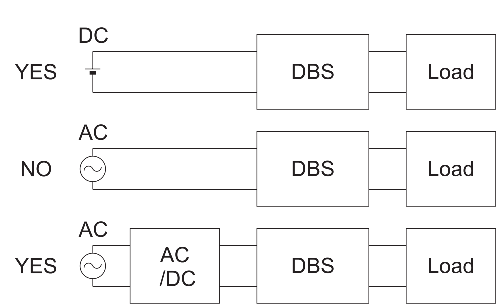
Fig.1.3.3
Input current characteristics



(2) Operation with AC input

■The DBS series handles only for the DC input. A front-end unit (AC/DC unit) is required when the DBS series is operated with AC input. In detail, Refer to 5. Input circuit.

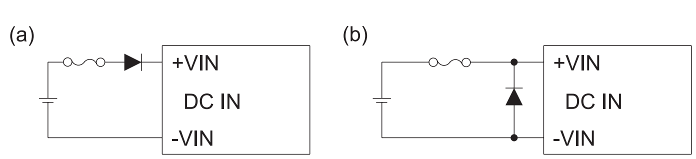
Fig.1.3.4
Operation with AC input



(3) Reverse input voltage protection

■Avoid the reverse polarity input voltage. It will break the power supply. It is possible to protect the unit from the reverse input voltage by installing an external diode.

Fig.1.3.5
Reverse input voltage protection



1.3.3 External fuse

■Fuse is not built-in on input side. In order to protect the unit, install the normal blow type fuse on input side.

■When the input voltage from a front-end unit is supplied to multiple units, install the normal-blow type fuse in each unit.

Table 1.3.1 Recommended fuse (normal-blow type)

Model	DBS200B	DBS400B
Rated current	3A	5A

1.3.4 Primary Y capacitor C_Y

■Install an external noise filter and a Y capacitor for low line-noise and for stable operation of the power supply.

■Install a correspondence filter, if a noise standard meeting is required or if the surge voltage may be applied to the unit.

■Install a primary Y capacitor, with more than 470pF, near the input pins (within 50mm from the pins).

■When the total capacitance of the primary Y capacitor is more than 8800pF, the nominal value in the specification may not be met by the Hi-Pot test between input and output. In this case, a capacitor should be installed between output and FG.

1.3.5 External capacitor on the input side Cin

■Install an external capacitor in between +VIN and -VIN input pins for low line-noise and for stable operation of the power supply.

(Cin DBS200B : more than 0.1 μF
DBS400B : more than 0.33 μF)

■Cin is within 50mm from pins. Make sure that ripple current of Cin should be less than rate.

1.3.6 External capacitor on the output side Co

■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 1.3.2.

■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.

■When output current change sharply, make sure that ripple current of Co should be less than rate.

■Install a capacitor Co near the output pins (within 100mm from the pins).

Table 1.3.2 Recommended capacitance Co [μF]

Model / Output voltage (V)	DBS200B	DBS400B
3.3	2200	6800
5	2200	4700
7.5	2200	4700
12	1000	2200
15	–	2200
18	–	2200
24	–	820
28	–	820

1.3.7 Thermal considerations

■Operate with the conduction cooling (e.g. heat radiation from the aluminum base plate to the attached heat sink).
Reference : 8. Thermal considerations

1.4 Derating

1.4.1 Cooling

■Use with the conduction cooling (e.g. heat radiation by conduction from the aluminum base plate to the attached heat sink).

■Fig.1.4.1 shows the derating curve based on the aluminum base plate temperature. In the hatched area, the specification of ripple and ripple noise is different from other areas.

■The aluminum base plate temperature can be measured at point A or point B.

Fig.1.4.1
Aluminum base plate temperature Tc [℃]

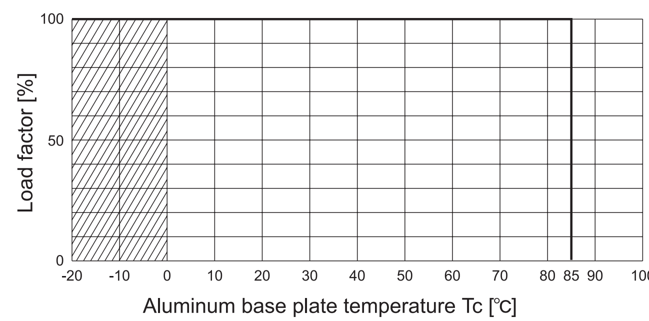
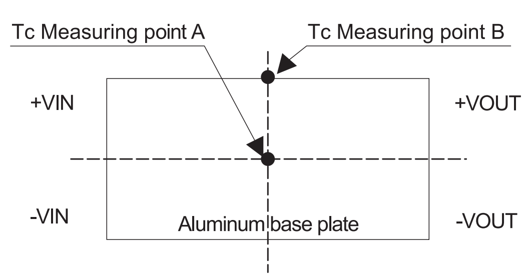


Fig.1.4.2
Measuring point



1.5 Protect circuit

1.5.1 Overvoltage protection

■The overvoltage protection circuit is built-in. The DC output should be shut down if overvoltage protection is activated. The minimum interval of DC ON/OFF for recovery is for 2 to 3 minutes.
＊The recovery time depends on input voltage and input capacity.
●Remarks :
Please note that devices inside the power supply might fail when voltage more than rated output voltage is applied to output terminal of the power supply. This could happen when the customer tests the overvoltage protection of the unit.

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1.5.2 Overcurrent protection

■Overcurrent protection is built-in and activated at over 105% of the rated current.
The unit automatically recovers when the fault condition is removed.

■Intermittent operation
When the overcurrent protection is activated, the average output current is reduced by intermittent operation of power supply to reduce heat of load and wiring.

1.5.3 Thermal protection

■Thermal detection (TMP) and protection circuit are built-in.

■When overheat is detected, thermal detection signal (TMP) turns "L" from "H". TMP circuit is designed as shown in Fig.1.5.1, and specification is shown as in Table 1.5.1.

■When overheating continues after detecting TMP signal, the output will be shut down by the thermal protection circuit.
When this function is activated, input voltage should be turned off, and remove all possible causes of overheat condition and cool down the unit to the normal level temperature.

■Overheat protection works around 100℃ at the base plate.

Fig.1.5.1
TMP circuit

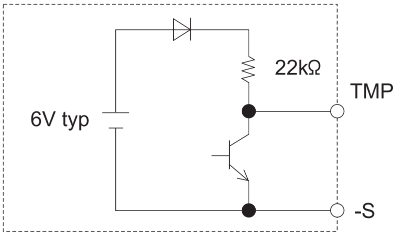


Table 1.5.1
Specification of TMP

No.	Item	TMP
1	Function	Normal "H"
		Overheat "L"
2	Base pin	-S
3	Level voltage "L"	0.5V max at 5mA
4	Level voltage "H"	5V typ
5	Maximum sink current	10mA max
6	Maximum applicable voltage	35V max

1.6 Adjustable voltage range

■Output voltage is adjustable by the external potentiometer or the external signal.

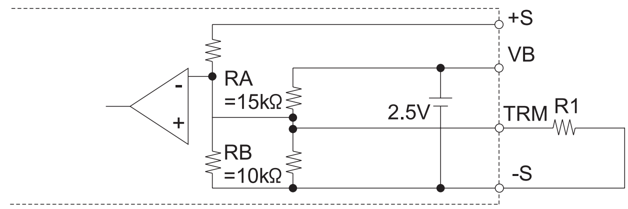
■When the output voltage adjustment is not used, leave the TRM pin and VB pin open.

■Do not set output voltage over 110% of rated, overvoltage protection might be activated.

1.6.1 Output voltage decreasing by external resistor

■By connecting the external resistor (R1) more than 1/10W, output voltage becomes adjustable to decrease as shown in Fig.1.6.1.

Fig.1.6.1
Output voltage control circuit



Output voltage is calculated by the following equation

Vn : Rated output voltage

Vo : Desire output voltage

$$R1[k\Omega] = \frac{Vo}{Vn - Vo} \times 6.0$$

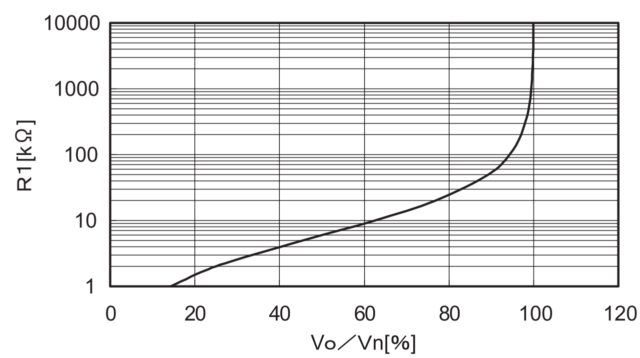
Example Vn = 5.0 [V]

Vo = 4.5 [V]

$$R1[k\Omega] = \frac{4.5}{5.0 - 4.5} \times 6.0$$

$$= 54\ [k\Omega]$$

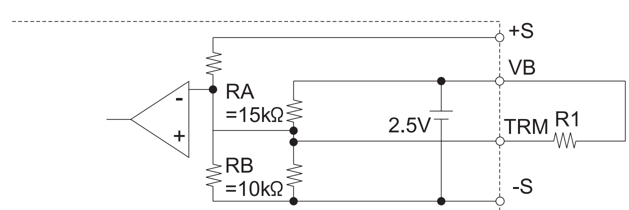
Fig.1.6.2
Resister selection for degreased output voltage



1.6.2 Output voltage increasing by external resistor

■By connecting the external resistor (R1) more than 1/10W, output voltage becomes adjustable to increase as shown in Fig.1.6.3.

Fig.1.6.3
Output voltage control circuit



Output voltage is calculated by the following equation.

Vn : Rated output voltage

Vo : Desire output voltage

$$R1[k\Omega] = \frac{2.5Vn - Vo}{Vo - Vn} \times 6.0$$

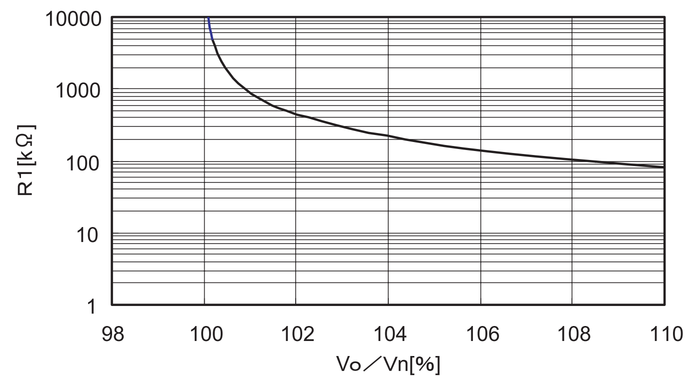
Example Vn = 5.0 [V]

Vo = 5.5 [V]

$$R1[k\Omega] = \frac{2.5 \times 5.0 - 5.5}{5.5 - 5.0} \times 6.0$$

$$= 84\ [k\Omega]$$

Fig.1.6.4
Resister selection for increased output voltage



1.6.3 Output voltage adjusting method by external potentiometer

■By connecting the external potentiometer (VR1) and resistors (R1, R2) more than 1/10W, output voltage becomes adjustable, as shown in Fig.1.6.5, recommended external parts are shown in Table 1.6.1.

■The wiring to the potentiometer should be as short as possible. The temperature coefficient becomes worse, depending on the type of a resistor and potentiometer. Following parts are recommended for the power supply.

Resistor Metal film type, coefficient of less than ±100ppm/℃

Potentiometer Cermet type, coefficient less than ±300ppm/℃

Fig.1.6.5
Output voltage control circuit

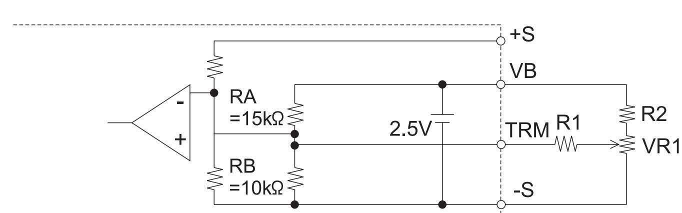


Table 1.6.1
Recommended value of external potentiometer and resistors more than 1/10W

No.	Adjustable range [%]	Number of unit	External parts value [Ω]		
			VR1	R1	R2
1	±5	Single	5k	75k	1k
2		2 sets		36k	
3		3 sets		24k	
4	±10	Single	5k	36k	910
5		2 sets		18k	
6		3 sets		12k	

1.6.4 Adjusting method by applying external voltage

■By applying the voltage externally at TRM, output voltage becomes adjustable. Output voltage is calculated by the following equation.

Output voltage = (Applied voltage externally) × (Rated output voltage)

1.7 Remote ON/OFF

■Remote ON/OFF circuit is built-in on both input (RC1) and output (RC2, RC3) side.

(1) Input side remote ON/OFF (RC1)

■The ground pin of input side remote ON/OFF circuit is ”-VIN” pin.

●Between RC1 and -VIN : Output voltage is ON at ”Low” level or short circuit (0 - 1.0V).

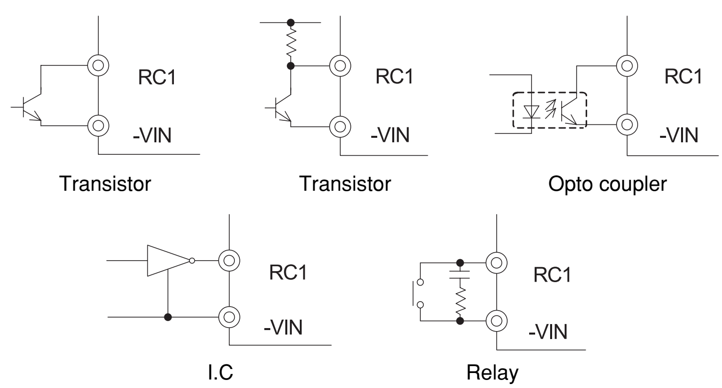
●Between RC1 and -VIN : Output voltage is OFF at ”High” level or applied voltage (3.5 - 7.0V).

■When RC1 is low level, fan out current is 0.3mA typ.

■When Vcc is applied, use 3.5 ≦ Vcc ≦ 7V.

■When remote ON/OFF function is not used, please connect between RC1 and -VIN.

Fig.1.7.1
RC connection example



(2) Output side remote ON/OFF (RC2, RC3)

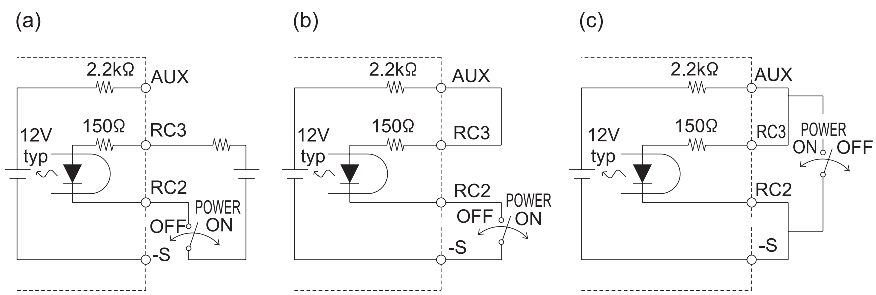
■Either ”Low active” or ”High active” is available by connecting method as following table.

Table 1.7.1
Output remote ON/OFF (RC2, RC3)

No.	Item	RC2, RC3		
1	Wiring method	Fig.1.7.2 (a)	Fig.1.7.2 (b)	Fig.1.7.2 (c)
2	Function	Power ON ”H”	Power ON ”H”	Power ON ”L”
3	Base pin	RC2	-S	-S and RC2
4	Power ON	Open (0.1mA max)		Short (0.5V max)
5	Power OFF	Short (3mA min)		Open (0.1mA max)

■Make sure that sink current of output side remote ON/OFF circuit should be less than 12mA.

Fig.1.7.2
Output side remote ON/OFF (RC2, RC3)



(3) Auxiliary power supply for remote ON/OFF (AUX)

■AUX is built-in for operating the output side remote ON/OFF (RC2, RC3).

■If AUX is not used for RC2, RC3, AUX can be used for IOG or TMP signal output using opt-coupler.

■Short protection resistance (2.2kΩ) is built-in.

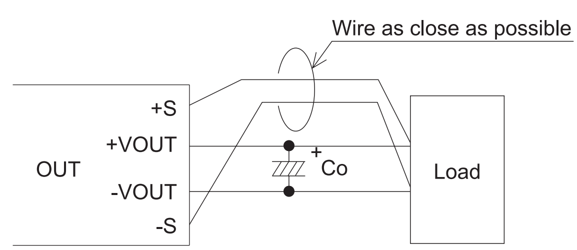
■AUX voltage at open circuit : 15V max.

1.8 Remote sensing

■This function compensate line voltage -drop.

1.8.1 When the remote sensing function is in use

Fig.1.8.1
Connection when the remote sensing is in use



■Twisted-pair wire or shield wire is recommended 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 be remaining within the output voltage adjustment range.

■The remote sensing leads must not be used to carry load current. Doing so will damage the module by drawing heavy current. Fuses or resistors should be fitted close to a load to prevent the module from this kind of failure.

(1) Case of long distance between load and power supply

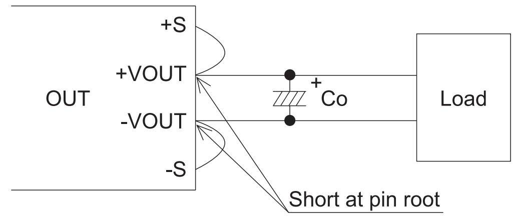
■Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 3m.

(2) When using remote sensing in parallel

■Connect the sensing line and the power line at one point connect each power supply's sensing line together first then (+S, -S).

1.8.2 When the remote sensing function is not in use

Fig.1.8.2
Connection when the remote sensing is not in use



■When the remote sensing function is not in use, make sure that pins between +S and +VOUT and between -S and -VOUT are connected.

■Connect between +S and +VOUT and between -S and -VOUT directly.
No loop wiring.
This power supply might become unstable by the noise coming from poor wiring.

1.9 Inverter operation monitor (IOG)

■Use IOG to monitor operation of the inverter. In the case of abnormal operation, status is changed from ”L” to ”H” within one second.

■IOG circuit is designed as shown in Fig.1.9.1 and specification is shown in Table 1.9.1.

Fig.1.9.1
IOG circuit

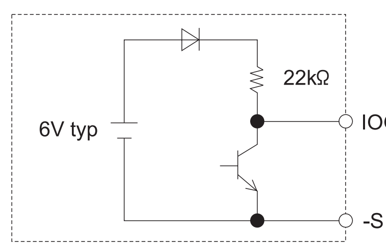


Table 1.9.1
Specification of IOG

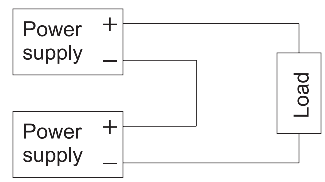
No.	Item	IOG
1	Function	Normal operation ”H”
		Malfunction of inverter ”L”
2	Base pin	-S
3	Level voltage ”L”	0.5Vmax at 5mA
4	Level voltage ”H”	5V typ
5	Maximum sink current	10mA max
6	Maximum applicable voltage	35V max

1.10 Series operation

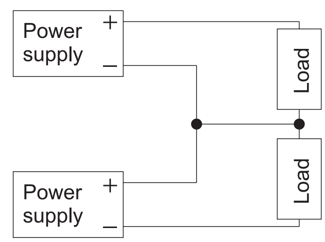
■Series operation is available by connecting the outputs of two or more power supplies, as shown Fig.1.10.1. Output current in series connection should be lower than the lowest rated current in each power supply.

Fig.1.10.1
Example of series operation

(a)



(b)



1.11 Parallel operation / Master-slave operation

■Parallel operation is available by connecting the units as shown Fig.1.11.1; also Master-slave operation adjust output voltage in parallel operation, is available.
When output voltage adjustment is not in use, TRM wiring, R1, R2 and VR are not necessary.

■As variance of output current draw from each power supply is maximum 10%, the total output current must not exceed the value determined by following equation.
(output current in parallel operation) = (the rated current per unit) × (number of unit) × 0.9

■In parallel operation, the maximum operative number of units is 11.

Fig.1.11.1
Example of parallel operation

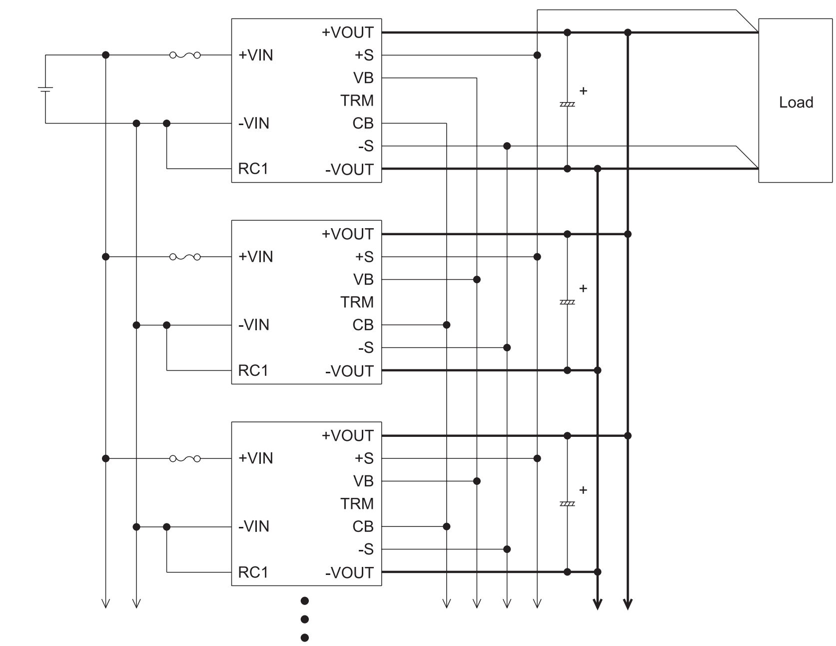
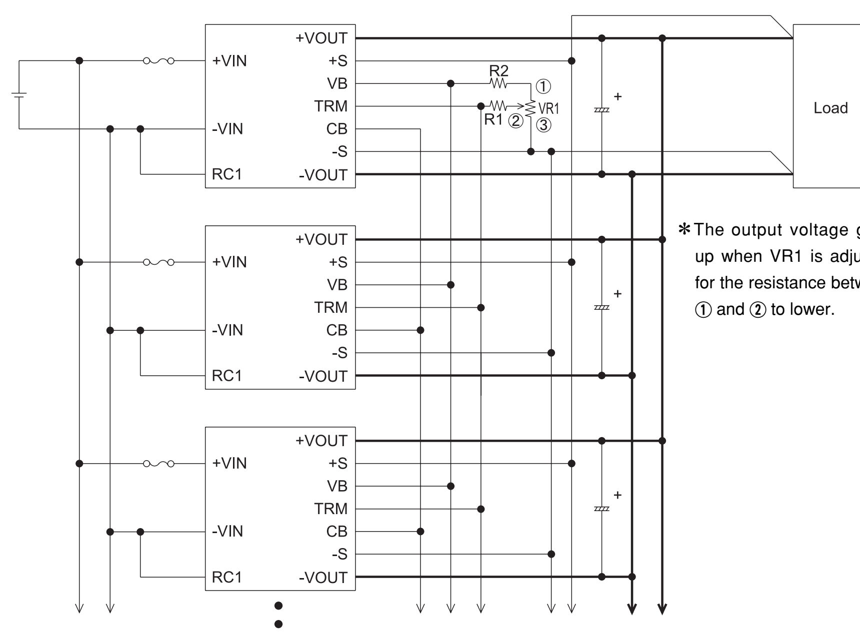


Fig.1.11.2
Example of master-slave operation



*The output voltage gose up when VR1 is adjusted for the resistance between ① and ② to lower.

(1) Wiring

■When the output-line impedance is high, the power supply become unstable. Use same length and thickness (width) wire (pattern) for the current balance improvement.

■Connect each input pin for the lowest possible impedance. When the number of the units in parallel operation increases, input current increases. Adequate wiring design is required for input circuitry such as circuit pattern, wiring and load current for equipment is required.

■Connect the sensing line and the power line at one point connect each power supply's sensing line together first then (+S, -S). In multiple operation, sensing wires should be connected same terminal in each unit.

(2) Thermal management of Base Plate

■If aluminum base plate temperature is different in each power supply, fluctuation of output voltage will be larger than nominal. Make sure to keep base plate temperature even by using one heat sink for all units.

(3) IOG signal

■Output current should be 10% or more of the total of the rated output current in parallel operation.
If less than 10%, the IOG signal might become unstable, and output voltage slightly increasing (max 5%).

■IOG signal might be unstable for one second when the units are turned on in parallel operation.

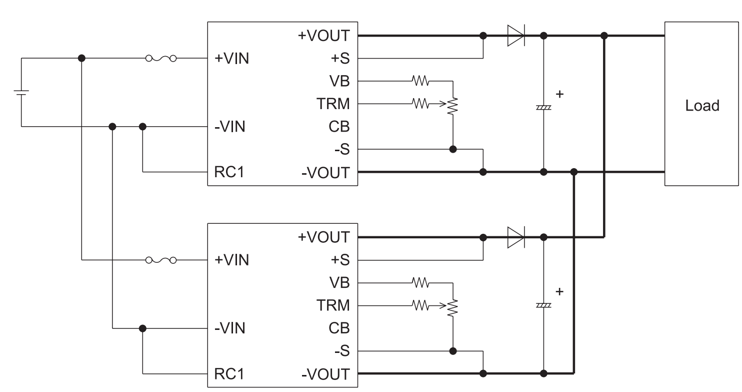
1.12 Redundant operation

1.12.1 Redundant operation

■Connecting method for external diode on the output side.

■In parallel operation, please connect diode to the +side of the output circuit. If the diode is connected to the - side, it will damage the unit or/and the balancing function will not work.

Fig.1.12.1
Example of redundant operation

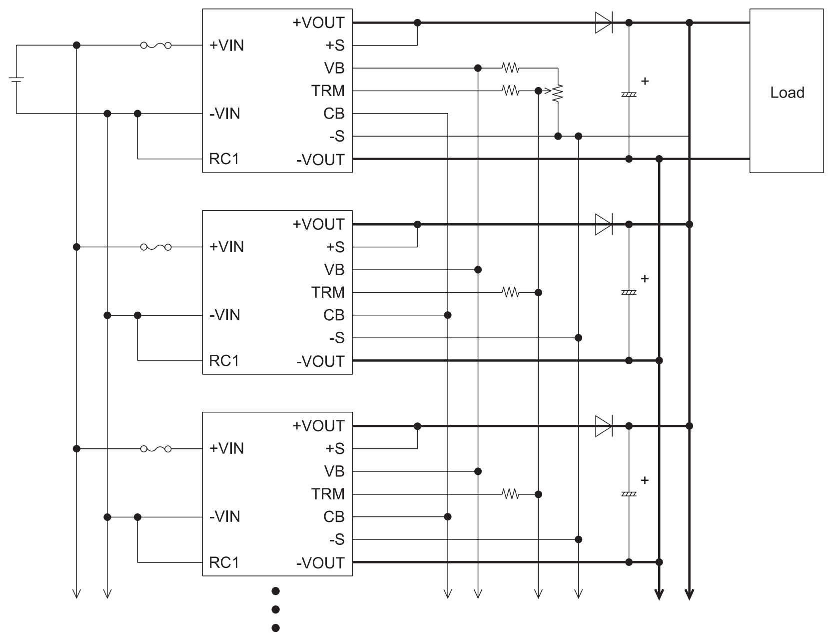


1.12.2 N+1 Redundant operation

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

■Purpose of redundant operation is to ensure stable operation in the event of single power supply failure.
Since extra power supply is reserved for the failure condition, so total power of redundant operation equal to N.

Fig.1.12.2
Example of N+1 redundant operation



1.13 EMC consideration

1.13.1 Line conducted noise

(1) Overview of the conducted noise

■The switch mode power supply generates the conducted noise to the input lines.
The conducted noise can be categorized into the common mode noise and the differential mode noise.
CISPR and FCC standards have been used as a world wide benchmark especially for line conducted interference levels.
If an EMI specification such as CISPR standard must be met, additional filtering may be needed.

■The common mode noise exists between the input terminals and FG (aluminum base plate).
The most effective way to reduce common mode noise are to bypass from the input lines to FG with Y capacitor (CY) and the common mode choke (L1).
Fig.1.13.1 shows the overview of the path of the common mode noise.

■The differential mode noise exists between the input terminals.
The most effective way to reduce differential mode noise are to bypass the input lines with X capacitors (Cx3, Cx4) and the normal mode choke (L2).
Fig.1.13.2 shows the overview of the path of the differential mode noise.

Fig.1.13.1
Common mode noise path

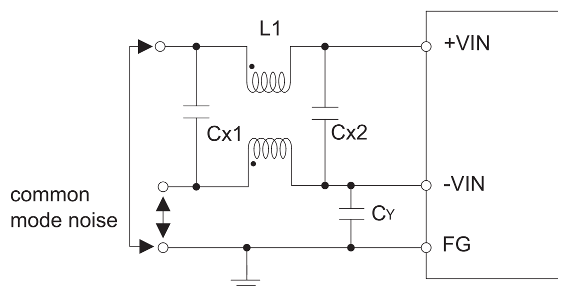
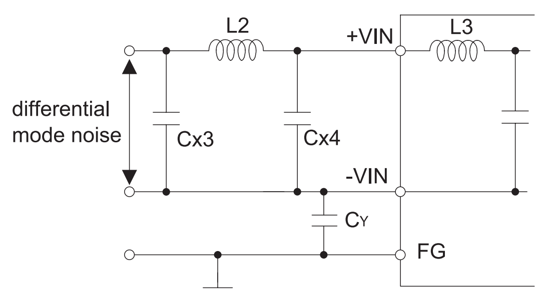


Fig.1.13.2
Differential mode noise path



■The DBS provide the normal mode choke (L3) to reduce the differential mode noise.
Install the capacitor (Cx4) to reduce the differential mode noise.
The most effective way to reduce the differential mode noise are to install since X capacitor (Cx3) and the normal mode choke (L2).

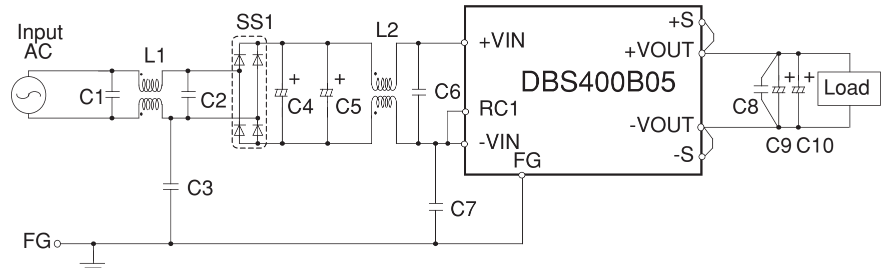
■The leakage inductance of the common mode choke (L1) works as the normal mode choke.
The normal mode choke (L2) is not necessary.

(2) Recommended of noise-filter

■Fig.1.13.3 shows the recommended circuit of noise-filter which meets CISPR Pub. 22 Class A and the noise level.

DBS400B05 : AC230V INPUT, 5V80A OUTPUT

Fig.1.13.3
Recommended circuit and noise level (CISPR Pub. 22 Class A)



L1=2mH (SC-05-20J : TOKIN)

L2=1mH (SC-03-10GJ : TOKIN)

C1, C2=0.47μF (CFJC22E474M : NITSUKO)

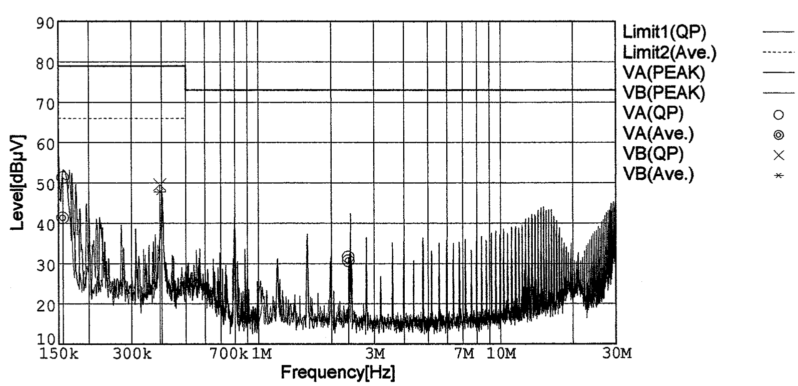
C3, C7=AC250V3300pF (KH series : MURATA)

C4, C5=400V220μF (GQ series : NICHICON)

C6=0.22μF (CFJC22E224M : NITSUKO)

C8=50V0.1μF (MDD21H104M : NITSUKO)

C9, C10=10V2200μF (LXZ series : NIPPON CHEMI-CON)

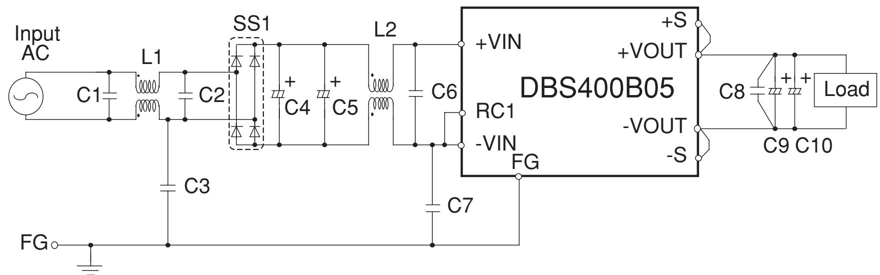


Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.1564	41.6	31.5	9.8	51.4	41.3	VA	79.0	66.0	27.6	24.7
2.3509	21.7	20.8	9.9	31.6	30.7	VA	73.0	60.0	41.4	29.3
0.3924	39.8	38.0	9.8	49.6	47.8	VB	79.0	66.0	29.4	18.2

■Fig.1.13.4 shows the recommended circuit of noise-filter which meets CISPR Pub. 22 Class B and the noise level.

DBS400B05 : AC230V INPUT, 5V80A OUTPUT

Fig.1.13.4 Recommended circuit and noise level (CISPR Pub. 22 Class B)



L1=2mH (SC-05-20J : TOKIN)

L2=4.5mH (SS28H-25045 : TOKIN)

C1, C2=0.47μF (CFJC22E474M : NITSUKO)

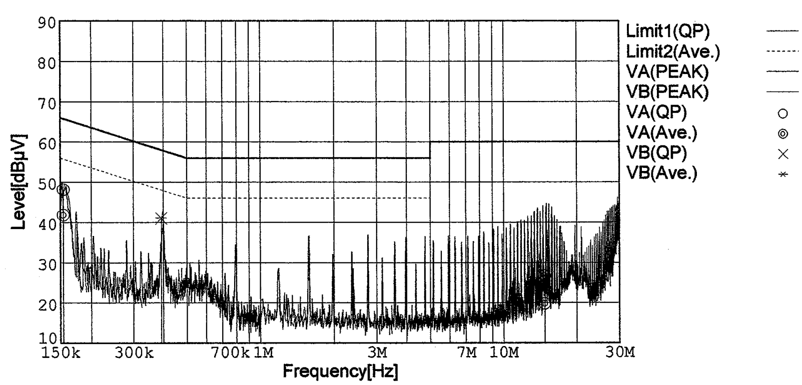
C3, C7=AC250V3300pF (KH series : MURATA)

C4, C5=400V220μF (GQ series : NICHICON)

C6=0.22μF (CFJC22E224M : NITSUKO)

C8=50V0.1μF (MDD21H104M : NITSUKO)

C9, C10=10V2200μF (LXZ series : NIPPON CHEMI-CON)



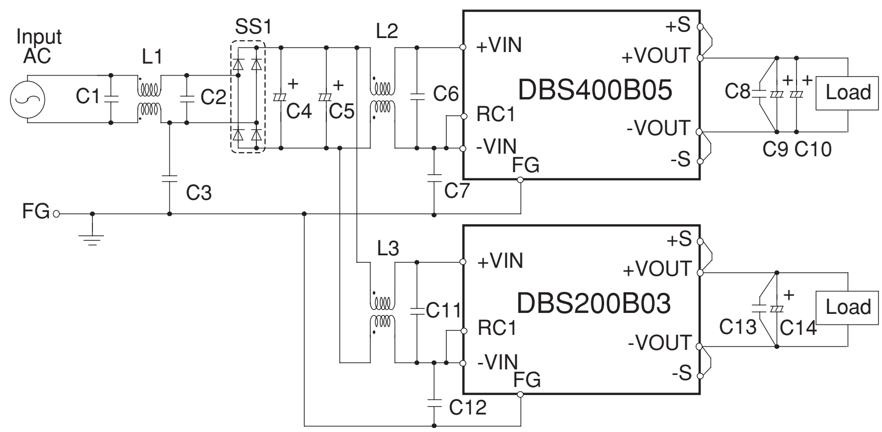
Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.1542	38.3	32.0	9.8	48.1	41.8	VA	65.8	55.8	17.7	14.0
14.8011	16.5	9.5	10.2	26.7	19.7	VA	60.0	50.0	33.3	30.3
0.3910	31.2	31.3	9.8	41.0	41.1	VB	58.1	48.1	17.1	7.0

■Fig.1.13.5 shows the recommended circuit of noise-filter which meets CISPR Pub. 22 Class A and the noise level with two modules.

DBS400B05 : AC230V INPUT, 5V80A OUTPUT

DBS200B03 : AC230V INPUT, 3.3V50A OUTPUT

Fig.1.13.5 Recommended circuit and noise level with two modules (CISPR Pub. 22 Class A)



L1=2mH (SC-05-20J : TOKIN)

L2, L3=4.5mH (SS28H-25045 : TOKIN)

C1, C2=0.47μF (CFJC22E474M : NITSUKO)

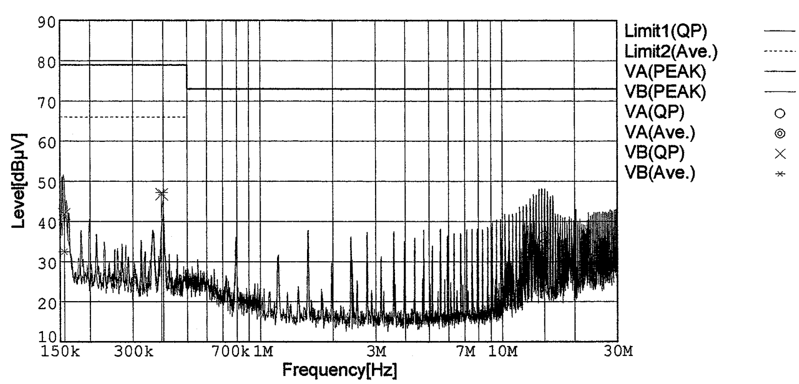
C3, C7, C12=AC250V3300pF (KH series : MURATA)

C4, C5=400V220μF (GQ series : NICHICON)

C6, C11=0.22μF (CFJC22E224M : NITSUKO)

C8, C13=50V0.1μF (MDD21H104M : NITSUKO)

C9, C10, C14=10V2200μF (LXZ series : NIPPON CHEMI-CON)



Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
14.9952	25.8	23.8	10.2	36.0	34.0	VA	73.0	60.0	37.0	26.0
0.1563	32.0	22.7	9.8	41.8	32.5	VB	79.0	66.0	37.2	33.5
0.3923	37.0	37.4	9.8	46.8	47.2	VB	79.0	66.0	32.2	18.8

1.13.2 Radiated noise

■High-frequency noise is radiated directly from the module, the input lines and the output lines to the atmosphere.

The noise-filter (EMC component) is required to reduce the radiated noise.

■The effective ways to reduce the radiated noise are to cover units with the metal plate or film.

1.13.3 Output noise

■Install an external capacitor Co between +VOUT and -VOUT for stable operation and low output noise.
Recommended capacitance of Co is shown in Table1.13.1.

■Install a capacitor Cn=0.1μF (film or ceramic capacitor) for low output high-frequency noise.

■Install a capacitor C_Y, with more than 2200pF, for stable operation and low output noise.

Fig.1.13.6
Measuring method of the output noise

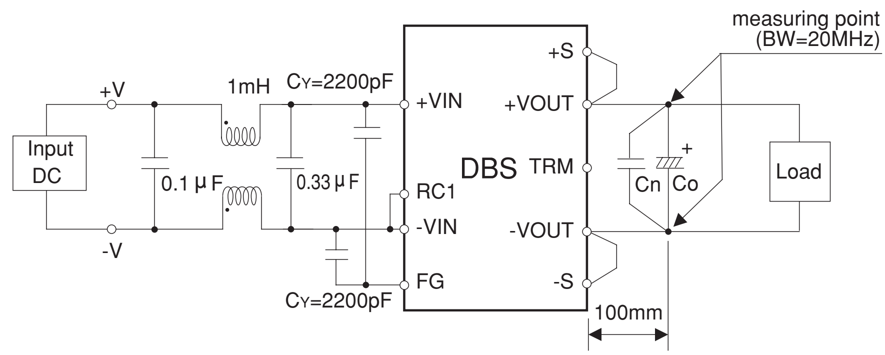


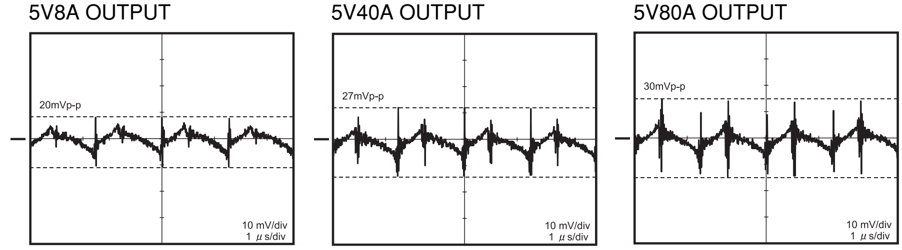
Table 1.13.1
Recommended capacitance Co

VOUT	DBS200B	DBS400B
3.3V	2200μF	6800μF
5V	2200μF	4700μF
7.5V	2200μF	4700μF
12V	1000μF	2200μF
15V	-	2200μF
18V	-	2200μF
24V	-	820μF
28V	-	820μF

■Fig.1.13.7 and Fig.1.13.8 show the output noise level.
DBS400B05 : DC280V INPUT

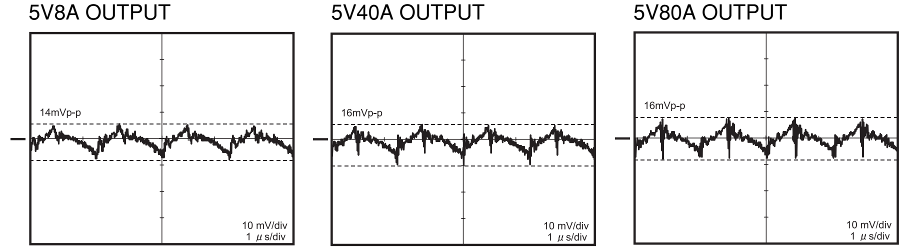
5V8A OUTPUT 5V40A OUTPUT 5V80A OUTPUT

Fig.1.13.7
Output noise level (Cn none)



5V8A OUTPUT 5V40A OUTPUT 5V80A OUTPUT

Fig.1.13.8
Output noise level (Cn=0.1μF)



2. CBS series

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2.1 Pin configuration

Fig.2.1.1
Pin configuration

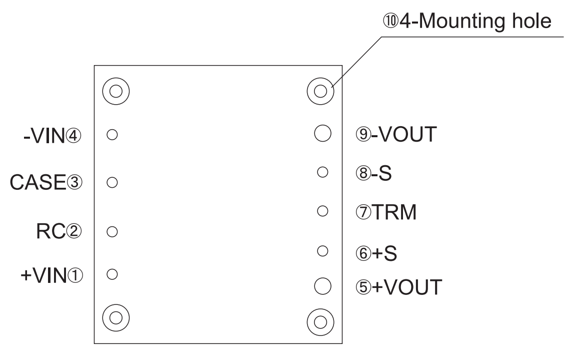


Table 2.1.1
Pin configuration and function

No.	Pin Name	Function	Reference
①	+VIN	+DC input	2.3 Connection method for standard use
②	RC	Remote ON/OFF	2.7 Remote ON/OFF
③	CASE	Wiring base plate	2.3 Connection method for standard use
④	-VIN	-DC input	2.3 Connection method for standard use
⑤	+VOUT	+DC output	2.3 Connection method for standard use
⑥	+S	+Remote sensing	2.8 Remote sensing
⑦	TRM	Adjustment of output voltage	2.6 Adjustment of output voltage
⑧	-S	-Remote sensing	2.8 Remote sensing
⑨	-VOUT	-DC output	2.3 Connection method for standard use
⑩	Mounting hole	Mounting hole	2.3 Connection method for standard use

2.2 Do's and Don'ts for module

2.2.1 Isolation

■For receiving inspection, such as Hi-Pot test, gradually increase (decrease) the voltage for start (shut down). Avoid using Hi-Pot tester with the time because it may generate voltage a few times higher than the applied voltage, at ON/OFF of a timer.

2.2.2 Mounting method

■The unit can be mounted in any direction. When two or more power supplies are used side by side, position them with proper intervals to allow enough air ventilation. Aluminum base plate temperature around each power supply should not exceed the temperature range shown in derating curve.

Avoid placing the DC input line pattern lay out underneath the unit, it will increase the line conducted noise. Make sure to leave an ample distance between the line pattern lay out and the unit. Also avoid placing the DC output line pattern underneath the unit because it may increase the output noise. Lay out the pattern away from the unit.

■High-frequency noise radiates directly from the unit to the atmosphere. Therefore, design the shield pattern on the printed wiring board and connect its one to CASE pin.

The shield pattern prevents noise radiation.

■Option"-T" is available, as shown in Table 2.2.1

Table 2.2.1
Mounting hole

	Mounting hole
Standard	M3 tapped
Optional : "-T"	ϕ3.4 thru

2.2.3 External input capacitor

■When the line impedance is high or the input voltage rise quickly at start-up (less than 10μs), install capacitor Cin between +VIN an -VIN input pins (within 50mm from pins).

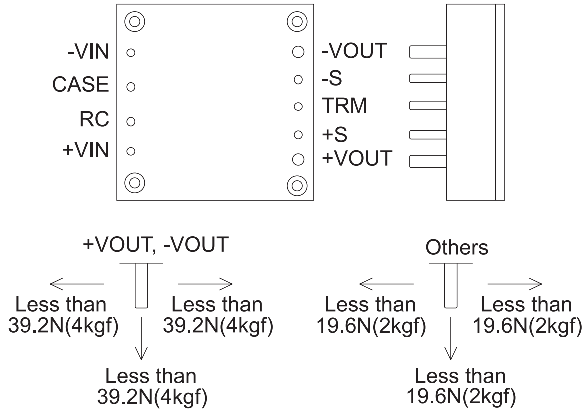
2.2.4 Stress onto the pins

■When excess stress or bending force is applied the pins of the power supply, the internal connection may be weakened.
As shown in Fig.2.2.1 avoid applying stress of more than 39.2N (4kgf) on +VOUT/-VOUT pins and more than 19.6N (2kgf) to the other pins.

■The pins are soldered on PWB internally, therefore, do not pull or bend them with abnormal forces.

■Fix the unit on PWB (fixing fittings) to reduce the stress onto the pins.

Fig.2.2.1
Stress onto the pins



2.2.5 Cleaning

■Clean it with a brash. Prevent fluid from getting inside the unit.

■Do not apply pressure to the lead and name plate with a brush or scratch it during the cleaning.

■After cleaning, dry them out.

2.2.6 Soldering

■Flow soldering : 260℃ less than 15 seconds.

■Soldering iron : 450℃ less than 5 seconds (less than 26W).

2.2.7 Safety standard

■This unit must be used as a component of the end-use equipment.

■The equipment does neither contain any basic nor double / reinforced insulation between input and output, and base plate.
If the input voltage is greater than 60VDC, this has to be provided by the end-use equipment according to the final build in condition.

■Safety approved fuse must be externally installed on input side.

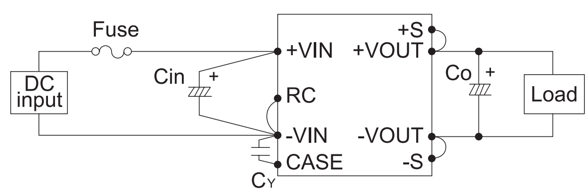
2.3 Connection method for standard use

2.3.1 Connection for standard use

■In order to use power supply, it is necessary to wire as shown in Fig.2.3.1.

■Short the following pins to turn on the power supply.
Reference : 2.7

Fig.2.3.1
Connection method for standard use



Cin : External capacitor on the input side
Co : External capacitor on the output side
CY : Y capacitor

2.3.2 Input power source

■The specification of input ripple voltage is shown as below.

(Ripple voltage CBS50/100/20024 : less than 2Vp-p
CBS50/100/20048 : less than 4Vp-p)

■Make sure that the voltage fluctuation, including the ripple voltage, will not exceed the input voltage range.

■Use a front end unit with enough power, considering the start-up current Ip of this unit.

Fig.2.3.2
Input voltage ripple

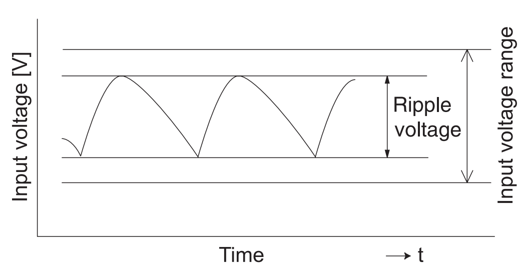
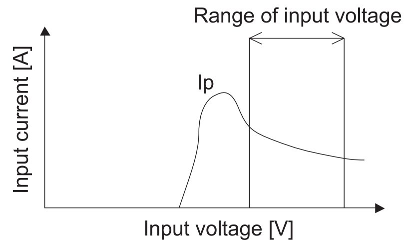
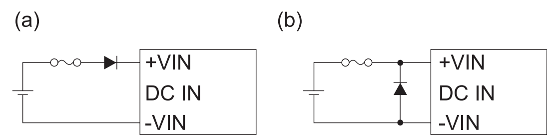


Fig.2.3.3
Input current characteristics



■Reverse input voltage protection
Avoid the reverse polarity input voltage. It will damage the power supply.
It is possible to protect the unit from the reverse input voltage by installing an external diode as shown in Fig.2.3.4.

Fig.2.3.4
Reverse input voltage protection



2.3.3 External fuse

■Fuse is not built-in on input side. In order to protect the unit, install the normal-blow type fuse on input side.
■When the input voltage from a front end unit is supplied to multiple units, install a normal-blow type fuse in each unit.

Table 2.3.1
Recommended fuse (normal-blow type)

Model	CBS5024	CBS10024	CBS20024	
			03/05	12/15/24/28
Rated current	6A	12A	20A	25A
Model	CBS5048	CBS10048	CBS20048	
			03/05	12/15/24/28
Rated current	3A	6A	10A	12A

2.3.4 Primary Y capacitor C_Y

■Install a Y capacitor C_Y for low line-noise and for stable operation of the power supply.
■Install a correspondence filter, if a noise standard meeting is required or if the surge voltage may be applied to the unit.
■Install a primary Y capacitor C_Y, with more than 4700pF, near the input pins (within 50mm from the pins).
■When the total capacitance of the primary Y capacitor is more than 15000pF, the nominal value in the specification may not be met by the Hi-Pot test between input and output.
In this case, capacitor should be installed between output and CASE pin.
The total capacitance is not limited if Hi-pot test voltage between input and output is less than AC500V (1 minute).

2.3.5 External capacitor on the input side Cin

■Install an external capacitor Cin between +VIN and -VIN input pins for stable operation of the power supply.

Cin CBS50/100/20024 : more than 68μF
CBS50/100/20048 : more than 33μF
Tc = -20 to +100 ℃ : Electrolytic or Ceramic capacitor
Tc = -40 to +100 ℃ : Ceramic capacitor

■Cin is within 50mm from pins. Make sure that ripple current of Cin should be less than rate.

2.3.6 External capacitor on the output side Co

■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 2.3.2.

■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.

■When output current change sharply, make sure that ripple current of Co should be less than rate.

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

Table 2.3.2 Recommended capacitance Co

Base plate temperature : Tc = -20 to +100℃						
Output Voltage	3.3V	5V	12V	15V	24V	28V
CBS50	2200μF		470μF		220μF	
CBS100	2200μF		470μF		220μF	
CBS200	2200μF		1000μF		470μF	
Base plate temperature : Tc = -40 to +100℃						
Output Voltage	3.3V	5V	12V	15V	24V	28V
CBS50	2200μF X 2		470μF X 2		220μF X 2	
CBS100	2200μF X 2		470μF X 2		220μF X 2	
CBS200	2200μF X 2		1000μF X 2		470μF X 2	

2.3.7 Thermal considerations

■Operate with the conduction cooling (e.g. heat radiation from the aluminum base plate to the attached heat sink).
Reference : 8. Thermal considerations

2.4 Derating

2.4.1 Cooling

■Use with the conduction cooling (e.g. heat radiation by conduction from the aluminum base plate to the attached heat sink).

■Derating curve based on the aluminum base plate temperature. In the hatched area, the specification of Ripple and Ripple Noise is different from other areas.

■Measuring point of aluminum base plate temperature is Point A or Point B at Fig.2.4.2.

Fig.2.4.1
Derating curve

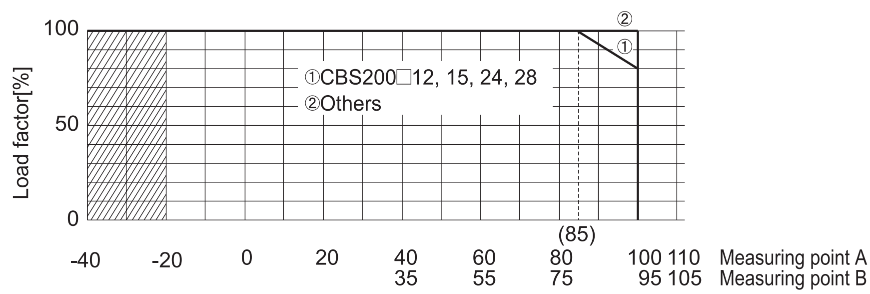
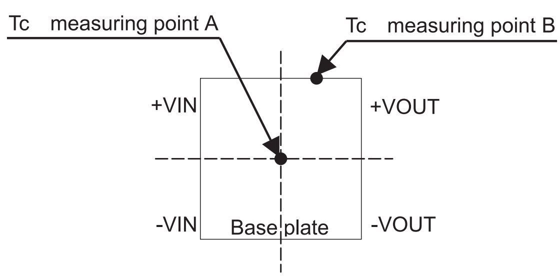


Fig.2.4.2
Aluminum base plate temperature Tc[℃]



2.5 Protect circuit

2.5.1 Overvoltage protection

■The overvoltage protection circuit is built-in. The DC input should be turned off if overvoltage protection is activated.

In this case, to recover from overvoltage protection turn the DC input power off for at least 1 second (✻), and turn on or toggling Remote ON/OFF signal.

✻The recovery time varies depending on input voltage and input capacity.

●Remarks :

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

2.5.2 Overcurrent protection

■Overcurrent protection is built-in and activated at 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 removed.
When the overcurrent protection is activated, the average output current is reduced by intermittent operation of power supply.

2.5.3 Thermal protection

■When the base plate temperature excess over 100℃, the thermal protection will be activated and simultaneously shut off the output.
When this function is activated, remove all possible causes of overheat condition and cooldown the unit to the normal level temperature.
By cycling the DC input power off for at least 1 second, or toggling Remote ON/OFF signal for at least 1 second.
■Overheat protection works around 120℃ at the base plate.

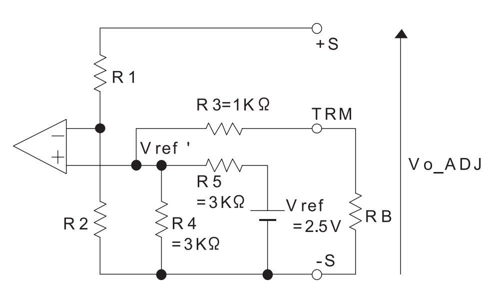
2.6 Adjustable voltage range

■Output voltage is adjustable by the external potentiometer.
The adjustable range is 60 to 110% of the rated output voltage.
When the input voltage is in the range of DC18 to 20V (CBS50/100/20024), DC36 to 40V (CBS50/100/20048), output voltage adjustment range is 60 to 105%.
■When the output voltage adjustment is not in leave use, TRM pin open.
■Do not set output voltage too high, overvoltage protection might be activated.

2.6.1 Output voltage decreasing by external resistor

■By connecting the external resistor (RB) more than 1/10W, output voltage becomes adjustable to decrease as shown in Fig.2.6.1.

Fig.2.6.1
Vo / Vn − RB



$$RB = \frac{2.5 \times \left(\frac{Vo}{Vn}\right) - 1}{1 - \left(\frac{Vo}{Vn}\right)} \ [K\Omega]$$

(Vn : Nominal output voltage)

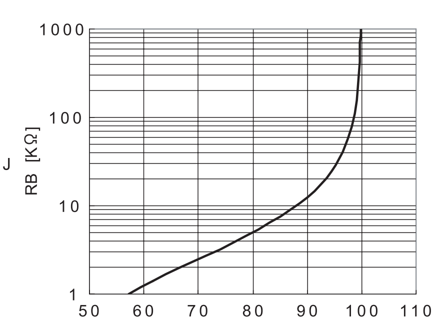
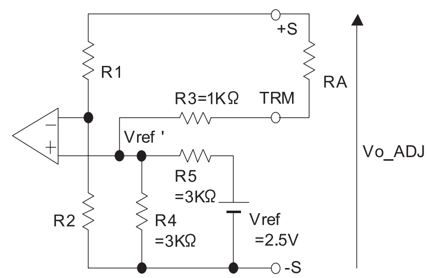


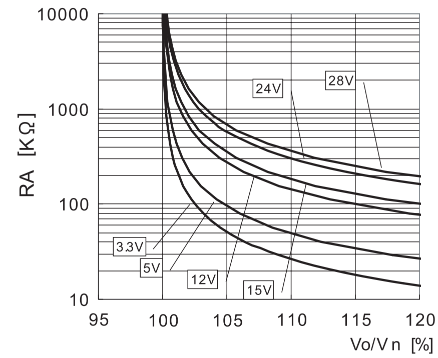
Fig.2.6.1 Vo / Vn − RB

2.6.2 Output voltage increasing by external resistor

■By connecting the external resistor (RA) more than 1/10W, output voltage becomes adjustable to Increase as shown in Fig.2.6.2.

Fig.2.6.2
Vo / Vn − RA
Characteristic





$$RA = \frac{1-(2.5-1.2\times Vn)\times\left(\frac{Vo}{Vn}\right)}{\left(\frac{Vo}{Vn}\right)-1}\ [K\Omega]$$

Fig.2.6.2 Vo / Vn − RA

(Vn : Nominal output voltage)

2.6.3 Output voltage adjusting method by external potentiometer

■By connecting the external potentiometer (VR1) and resistors (R1, R2) more than 1/10W, output voltage becomes adjustable, as shown in Fig.2.6.3, recommended external parts are shown in Table 2.6.1.

■The wiring to the potentiometer should be as short as possible. The temperature coefficient becomes worse, depending on the type of a resistor and potentiometer. Following parts are recommended for the power supply.

Resistor : Metal film type, coefficient of less than ±100ppm/℃
Potentiometer : Cermet type, coefficient less than ±300ppm/℃

Fig.2.6.3
Output voltage control circuit

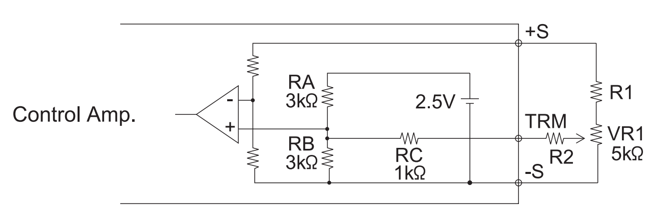


Table 2.6.1
Recommended value of external resistor

No.	VOUT	Adjustable range			
		VOUT ±5%		VOUT ±10%	
		R1	R2	R1	R2
1	3.3V	2.4kΩ	11kΩ	2.4kΩ	6.8kΩ
2	5V	5.6kΩ		5.6kΩ	
3	12V	18kΩ		18kΩ	
4	15V	24kΩ		24kΩ	
5	24V	43kΩ		39kΩ	
6	28V	51kΩ		47kΩ	

2.7 Remote ON/OFF

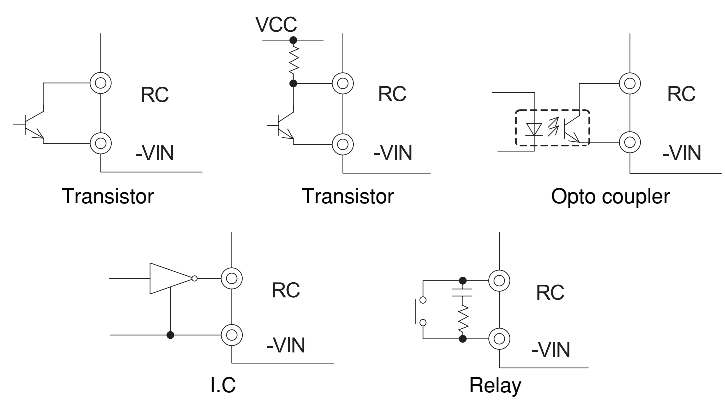
■Remote ON/OFF circuit is built-in on input side.

Table 2.7.1
Specification of Remote ON/OFF

	ON/OFF logic	Between RC and -VIN	Output voltage
Standard	Negative	"L" level(0 - 1.2V) or short	ON
		"H" level(3.5 - 7.0V) or open	OFF
Optional -R	Positive	"L" level(0 - 1.2V) or short	OFF
		"H" level(3.5 - 7.0V) or open	ON

When RC is "Low" level, fan out current is 0.5mA typ. When Vcc is applied, use 3.5≦Vcc≦7V.
When remote ON/OFF function is not used, please short between RC and -VIN (-R : Open between RC and -VIN).

Fig.2.7.1
RC connection example

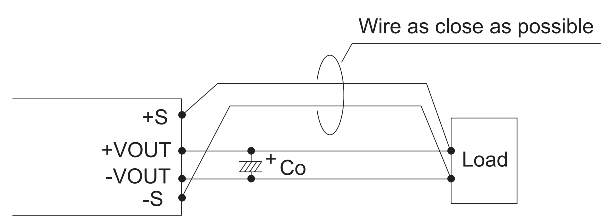


2.8 Remote sensing

■This function compensate line voltage drop.

2.8.1 When the remote sensing function is in use

Fig.2.8.1
Connection when the remote sensing is in use



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

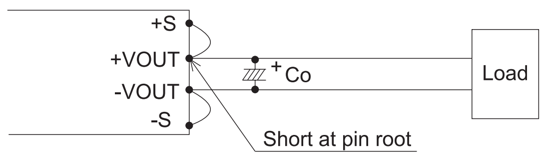
■Thick wire should be used for wiring between the power supply and a load. Line drop should be less than 0.3V. Voltage between +VOUT and -VOUT should be remain within the output voltage adjustment range.

■If output voltage is trimmed down below 60% of the rated output voltage, ripple and noise will increase occasionally and/or over shoot occurs when start-up.
External filter attach to the output is effective to reduce ripple and noise and remote ON/OFF is effective to avoid over shoot when start-up.

■Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 2m.

2.8.2 When the remote sensing function is not in use

Fig. 2.8.2 Connection when the remote sensing is not in use



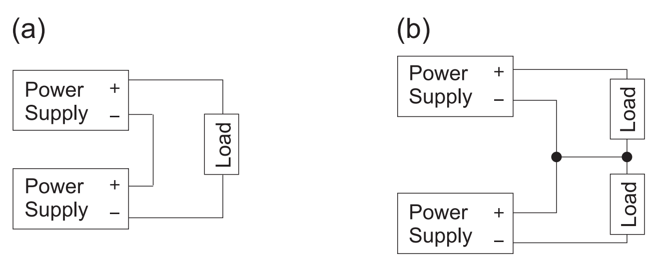
■When the remote sensing function is not in use, Make sure that pins are shorted between +S and +VOUT and between -S and -VOUT are connected.

■Connect between +S and +VOUT and between -S and -VOUT directly.
No loop wiring.
This power supply might become unstable by the noise coming from poor wiring.

2.9 Series operation

■Series operation is available by connecting the outputs of two or more power supplies, as shown Fig.2.9.1. Output current in series connection should be lower than the lowest rated current in each power supply.

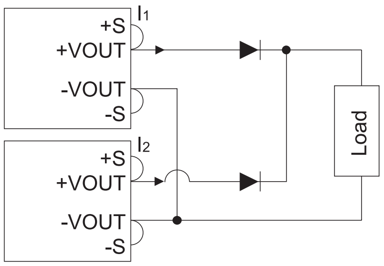
Fig. 2.9.1 Examples of serial operation



2.10 Parallel operation / Redundant operation

■Parallel redundancy operation is available by connecting the units as shown Fig.2.10.1 and can be adjust able each unit output voltage with TRM function.

Fig.2.10.1
Parallel redundancy operation



■I_1 and I_2 become unbalance by a slight difference of each output voltage.
The output current from each power supply does not exceed the rated current.

I_1, $I_2 \leqq$ the rated current value

2.11 EMC consideration

2.11.1 Line conducted noise

(1) Overview of the conducted noise

■The switch mode power supply generates the conducted noise to the input lines.
The conducted noise can be categorized into the common mode noise and the differential mode noise.
CISPR and FCC standards have been used as a world wide benchmark especially for line conducted interference levels.
If an EMI specification such as CISPR standard must be met, additional filtering may be needed.

■The common mode noise exists between the input terminals and CASE pin.
The most effective way to reduce common mode noise are to bypass from the input lines to CASE pin with Y capacitor (C_Y) and the common mode choke (L1).
Fig.2.11.1 shows the overview of the path of the common mode noise.

■The differential mode noise exists between the input terminals.
The most effective means to reduce differential mode noise are to bypass the input lines with X capacitors (Cx3, Cx4) and the normal mode choke (L2).
Fig.2.11.2 shows the overview of the path of the differential mode noise.

Fig.2.11.1
Common mode noise path

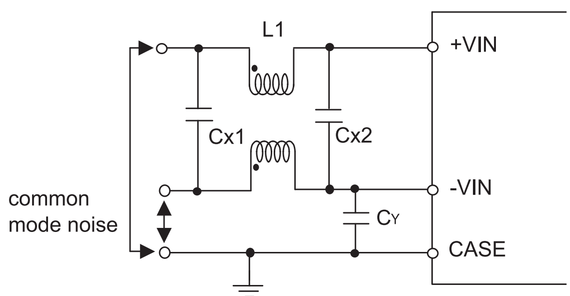
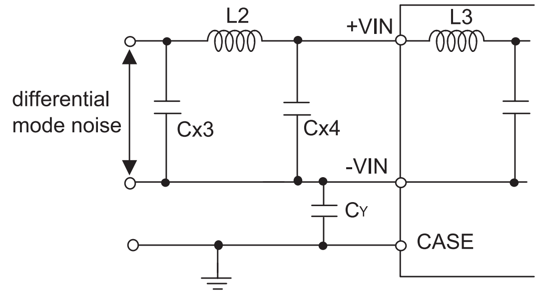


Fig.2.11.2
Differential mode noise path



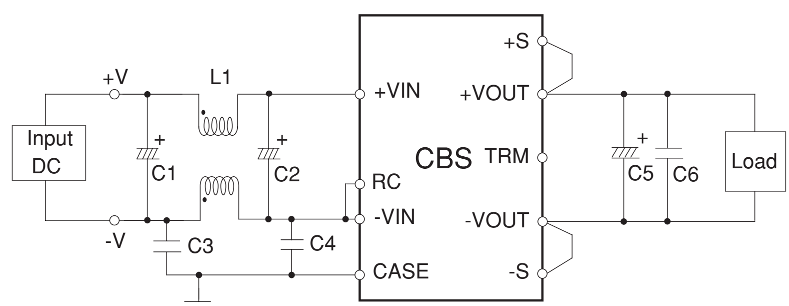
■The CBS provide the normal mode choke (L3) to reduce the differential mode noise.
Install the capacitor (Cx4) to reduce the differential mode noise.
The most effective way to reduce the differential mode noise are to install since X capacitor (Cx3) and the normal mode choke (L2).

■The leakage inductance of the common mode choke (L1) works as the normal mode choke.
The normal mode choke (L2) is not necessary.

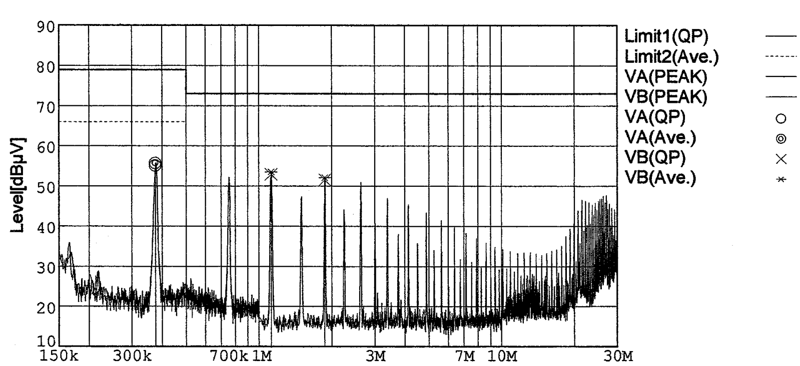
(2) Recommended of noise-filter

■Fig.2.11.3 shows the recommended circuit of noise-filter which meets CISPR Pub. 22 Class A and the noise level.
CBS2004805 : DC48V INPUT, 5V30A OUTPUT

Fig.2.11.3
Recommended circuit and noise level
(CISPR Pub. 22 Class A)



L1=3mH (SC-05-30J : TOKIN)
C1, C2=100V33 μ F (PM series : NICHICON)
C3, C4=AC250V4700pF (KH series : MURATA)
C5=10V2200 μ F (LXZ series : NIPPON CHEMI-CON)
C6=50V0.1 μ F (MDD21H104M : NITSUKO)

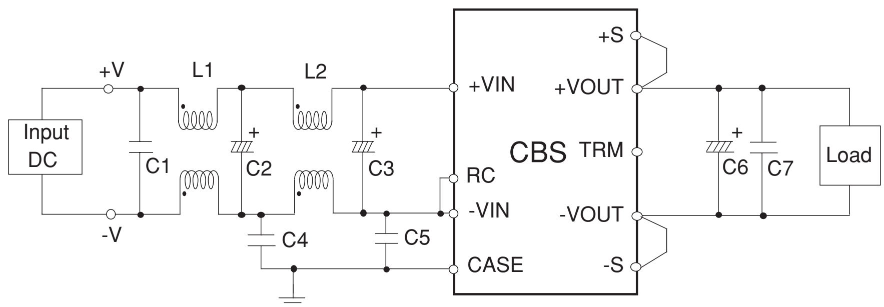


Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3751	45.2	45.9	9.8	55.0	55.7	VA	79.0	66.0	24.0	10.3
1.1244	43.0	43.6	9.9	52.9	53.5	VB	73.0	60.0	20.1	6.5
1.8737	41.7	42.2	9.9	51.6	52.1	VB	73.0	60.0	21.4	7.9

■Fig.2.11.4 and Fig.2.11.5 show the recommended circuit of noise-filter which meets CISPR Pub. 22 Class B and the noise level.

CBS2004805 : DC48V INPUT, 5V30A OUTPUT

Fig.2.11.4
Recommended circuit and noise level (CISPR Pub. 22 Class B)



L1, L2=1mH (SC-05-10J : TOKIN)

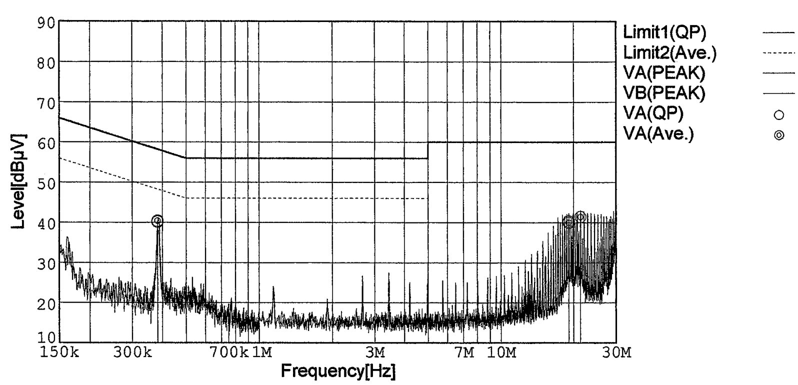
C1=0.33μF (CFJC22E334M : NITSUKO)

C2, C3=100V33μF (PM series : NICHICON)

C4, C5=AC250V4700pF (KH series : MURATA)

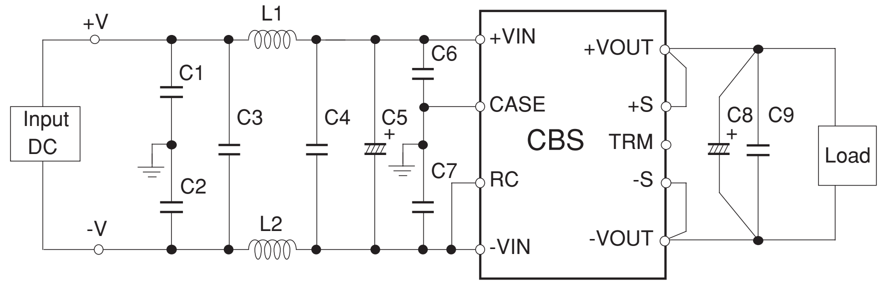
C6=10V2200μF (LXZ series : NIPPON CHEMI-CON)

C7=50V0.1μF (MDD21H104M : NITSUKO)



Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3817	30.4	30.6	9.8	40.2	40.4	VA	58.3	48.3	18.1	7.9
19.0808	30.1	29.7	10.2	40.3	39.9	VA	60.0	50.0	19.7	10.1
21.3637	31.1	31.1	10.3	41.4	41.4	VA	60.0	50.0	18.6	8.6

Fig.2.11.5 Recommended circuit and noise level (CISPR Pub. 22 Class B)



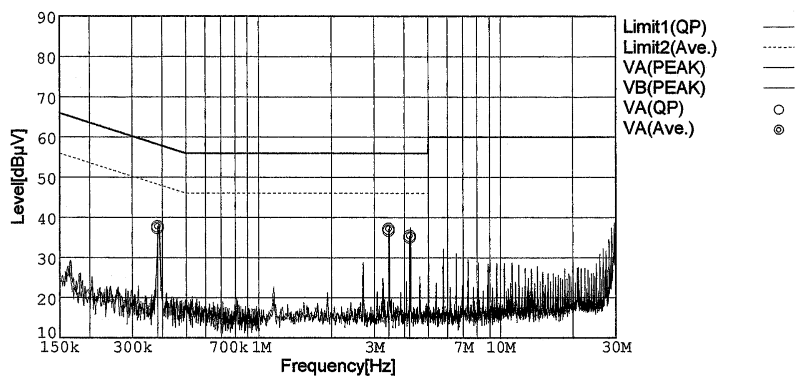
L1, L2=1.3μH (ETQP6F1R3LFA : MATSUSHITA)

C1, C2, C3, C4, C6, C7=100V3μF (CY55Y5P2A305M : TOKIN)

C5=100V220μF (PM series : NICHICON)

C8=10V2200μF (LXZ series : NIPPON CHEMI-CON)

C9=50V0.1μF (MDD21H104M : NITSUKO)



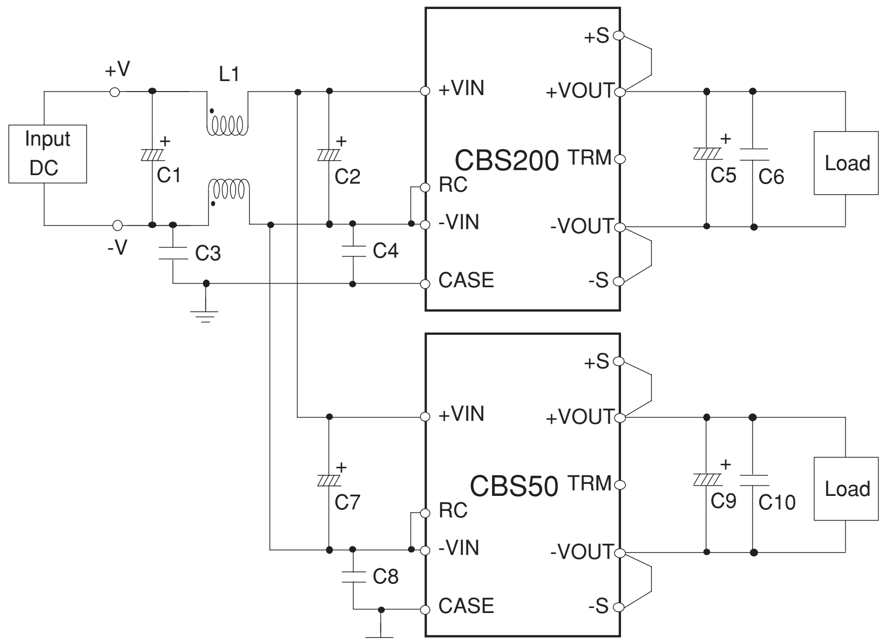
Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3821	27.6	28.0	9.8	37.4	37.8	VA	58.2	48.2	20.8	10.4
3.4365	26.8	27.3	9.9	36.7	37.2	VA	56.0	46.0	19.3	8.8
4.1972	25.0	25.4	10.0	35.0	35.4	VA	56.0	46.0	21.0	10.6

■Fig.2.11.6 shows the recommended circuit of noise-filter which meets CISPR Pub. 22 Class A and the noise level with two modules.

CBS2004805 : DC48V INPUT, 5V30A OUTPUT

CBS504812 : DC48V INPUT, 12V4.2A OUTPUT

Fig.2.11.6
Recommended circuit and noise level with two modules (CISPR Pub. 22 Class A)



L1=3mH (SC-05-30J : TOKIN)

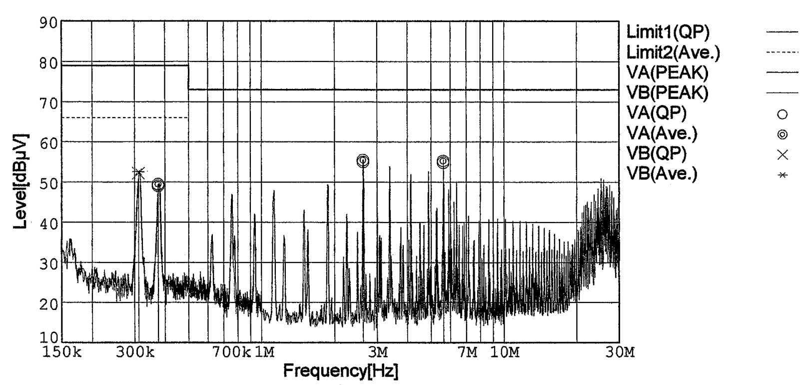
C1, C2, C7=100V33μF (PM series : NICHICON)

C3, C4, C8=AC250V4700pF (KH series : MURATA)

C5=10V2200μF (LXZ series : NIPPON CHEMI-CON)

C6, C10=50V0.1μF (MDD21H104M : NITSUKO)

C9=25V470μF (LXZ series : NIPPON CHEMI-CON)



Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3749	39.2	39.6	9.8	49.0	49.4	VA	79.0	66.0	30.0	16.6
2.6255	45.1	45.6	9.9	55.0	55.5	VA	73.0	60.0	18.0	4.5
5.6259	44.8	45.3	10.0	54.8	55.3	VA	73.0	60.0	18.2	4.7
0.3109	42.4	42.8	9.8	52.2	52.6	VB	79.0	66.0	26.8	13.4

2.11.2 Radiated noise

■High-frequency noise is radiated directly from the module, the input lines and the output lines to the atmosphere.
The noise-filter (EMC component) is required to reduce the radiated noise.

■The effective ways to reduce the radiated noise are to cover units with the metal plate or film.

2.11.3 Output noise

■Install an external capacitor Co between +VOUT and -VOUT for stable operation and low output noise.
Recommended capacitance of Co is shown in Table 2.11.1.

■Install a capacitor Cn=0.1μF (film or ceramic capacitor) for low output high-frequency noise.

■Install a capacitor C_Y, with more than 4700pF, for stable operation and low output noise.

Fig.2.11.7
Measuring method of
the output noise

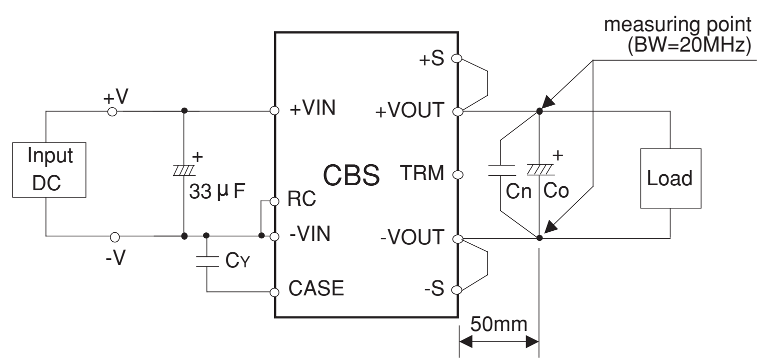


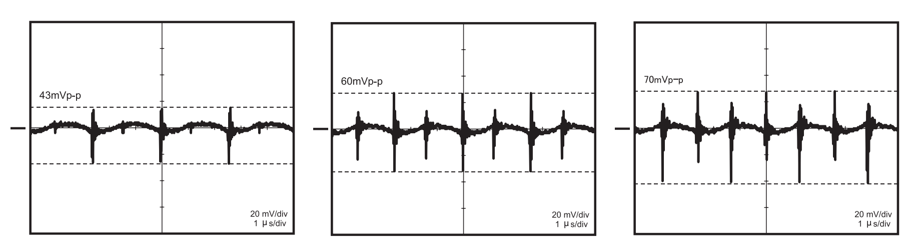
Table 2.11.1
Recommended
capacitance Co

VOUT	CBS50	CBS100	CBS200
3.3V	2200μF	2200μF	2200μF
5V	2200μF	2200μF	2200μF
12V	470μF	470μF	1000μF
15V	470μF	470μF	1000μF
24V	220μF	220μF	470μF
28V	220μF	220μF	470μF

■Fig.2.11.8 and Fig.2.11.9 show the output noise level.
CBS2004805 : DC48V INPUT

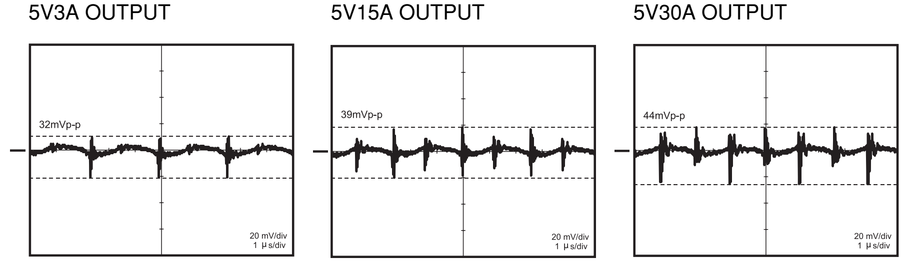
5V3A OUTPUT　5V15A OUTPUT　5V30A OUTPUT

Fig.2.11.8
Output noise level
(Cn none)



5V3A OUTPUT　5V15A OUTPUT　5V30A OUTPUT

Fig.2.11.9
Output noise level
(Cn=0.1μF)



MEMO

3. CDS series

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DBS series
CBS series
CDS series
Application Circuits
Input Rectifier Circuit
DPF and DPA series
STA series
Thermal Considerations
Agency Approvals
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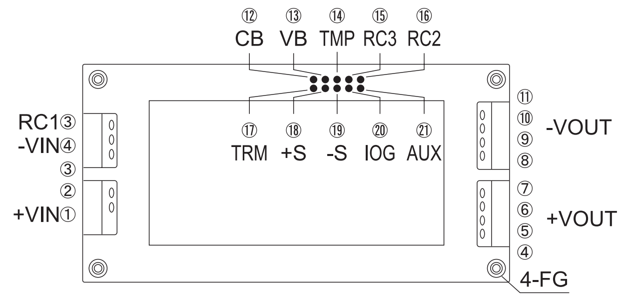
Glossary of Technical Terms

3.1 Pin configuration

Fig.3.1.1
Pin configuration
(bottom view)



＊No. ② and No. ③ are only provided CDS600 series.

Table 3.1.1
Pin configuration
and function

No.	Pin Connection	Function	Reference
①②	+VIN	+DC input	3.3 Connection method for standard use
③④	-VIN	-DC input	
⑤	RC1	Input side remote ON/OFF	3.7 Remote ON/OFF(1)
⑥⑦⑧⑨	+VOUT	+DC output	3.3 Connection method for standard use
⑩⑪⑫⑬	-VOUT	-DC output	
⑭	CB	Current balance	3.11 Parallel operation / Master-slave operation
⑮	VB	Voltage balance	
⑯	TMP	Thermal detection signal	3.5 Protect circuit
⑰	RC3	Remote ON/OFF(output side)	3.7 Remote ON/OFF(2)
⑱	RC2		
⑲	TRM	Adjustment of output voltage	3.6 Adjustable voltage range
⑳	+S	+Remote sensing	3.8 Remote sensing
㉑	-S	-Remote sensing	
㉒	IOG	Inverter operation monitor	3.9 Inverter operation monitor
㉓	AUX	Auxiliary power supply	3.7 Remote ON/OFF(3)
㉔	FG	Mounting hole(FG)	3.3 Connection method of standard use

3.2 Do's and Don'ts for module power supply

3.2.1 Isolation

■For a receiving inspection, such as Hi-Pot test, gradually increase (decrease) the voltage for a start (shut down). Avoid using Hi-Pot tester with the timer because it may generate voltage a few times higher than the applied voltage, at ON/OFF of a timer.

3.2.2 Mounting method

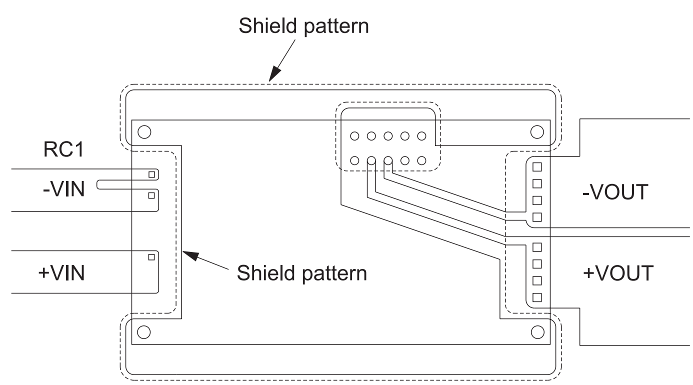
■The unit can be mounted in any direction. When two or more power supplies are used side by side, position them with proper intervals to allow enough air ventilation. Aluminum base temperature around each power supply should not exceed the temperature range shown in derating curve.

■Avoid placing the DC input line pattern lay out underneath the unit, it will increase the line conducted noise. Make sure to leave an ample distance between the line pattern lay out and the unit. Also avoid placing the DC output line pattern underneath the unit, because it may increase the output noise. Lay out the pattern away from the unit.

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

When output voltage adjustment is not in use, TRM wiring, R1, R2 and VR are not necessary.

Fig.3.2.1
Shield pattern lay out
(bottom view)



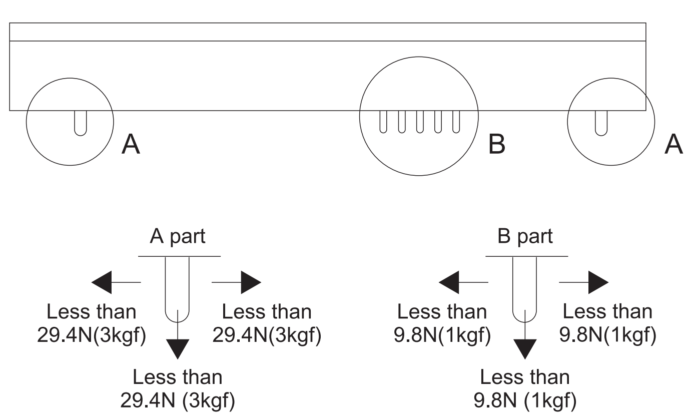
3.2.3 Stress onto the pins

■When too much stress is applied to the pins of the power supply, the internal connection may be weakened. As shown in Fig.3.2.2 avoid applying stress of more than 29.4N (3kgf) on the input pins/output pins (A part) and more than 9.8N (1kgf) to the signal pins (B part).

■The pins are soldered on PCB internally, therefore, do not pull or bend them with abnormal forces.

■Fix the unit on PCB (fixing fittings) to reduce the stress onto the pins.

Fig.3.2.2
Stress onto the pins



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3.2.4 Cleaning

■Clean it with a brash. Prevent fluid from getting inside the unit.
■Do not apply pressure to the lead and name plate with a brush or scratch it during the cleaning.
■After cleaning, dry them enough.

3.2.5 Soldering

■Flow soldering : 260 ℃ less than 15 seconds.
■Soldering iron
DC IN/DC OUT/RC1 : 450 ℃ less than 5 seconds.
Signal pins : 350 ℃ less than 3 seconds (less than 20w).

3.2.6 Safety standard

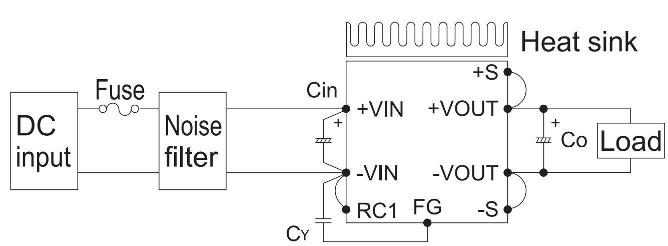
■This unit must be used as a component of the end-use equipment.
■This unit must be provided with overall enclosure.
■Mounting holes must be connected to safety ground of the end-use equipment, as required for class I equipment.
■Input must be filtered and rectified.
■Safety approved fuse must be externally installed on input side.

3.3 Connection method for standard use

3.3.1 Connection for standard use

■In order to use the power supply, it is necessary to wire as shown in Fig.3.3.1.
■Short the following pins to turn on the power supply.
-VIN ⇔ RC1, +VOUT ⇔ +S, -VOUT ⇔ -S
Reference : 3.7 Remote ON/OFF
3.8 Remote sensing

Fig.3.3.1
Connection for standard use



Cin : External capacitor on the input side
Co : External capacitor on the output side
CY : Primary Y capacitor

3.3.2 Input power source

(1) Operation with DC input

■Input voltage ripple should be less than 5Vp-p.

■Make sure that the voltage fluctuation, including the ripple voltage, will not exceed the input voltage range.

■Use a front end unit with enough power, considering the start-up current Ip of this unit.

Fig.3.3.2
Input voltage ripple

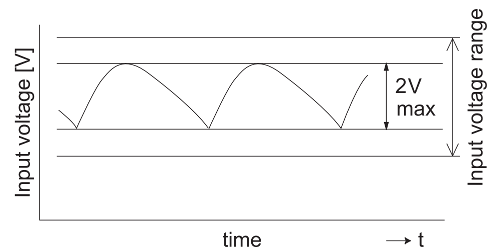
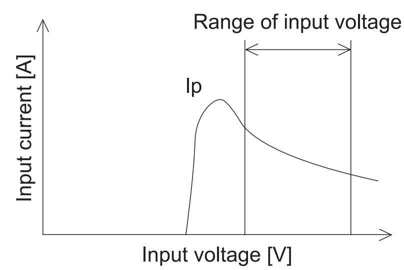


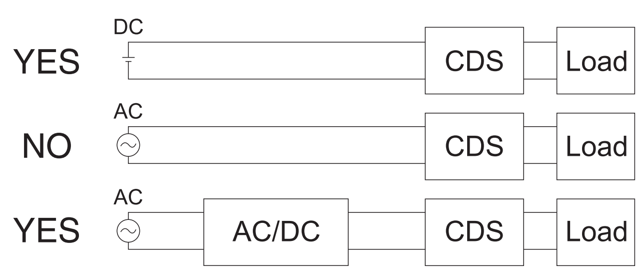
Fig.3.3.3
Input current characteristics



(2) Operation with AC input

■The CDS series handles only for the DC input. A front end unit (AC/DC unit) is required when the CDS series is operated with AC input. In detail, Refer to 5. Input circuit.

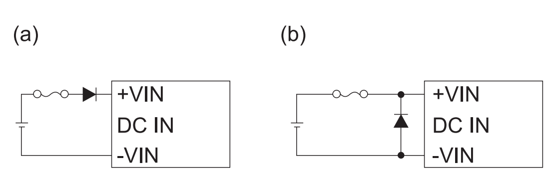
Fig.3.3.4
Operation with AC input



(3) Reverse input voltage protection

■Avoid the reverse polarity input voltage. It will break the power supply. It is possible to protect the unit from the reverse input voltage by installing an external diode.

Fig.3.3.5
Reverse input voltage protection



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3.3.3 External fuse

■In order to use the power supply, it is necessary to wire as shown in Fig.3.3.1.

■Fuse is not built-in on input side. In order to protect the unit, install the normal blow type fuse on input side.

■When the input voltage from a front-end unit is supplied to multiple units, install the normal-blow type fuse in each unit.

Table 3.3.1
Recommended fuse
(Normal-blow type)

Model	CDS40048	CDS60024	CDS60048
Rated current	30A	75A	30A

3.3.4 Primary Y capacitor C_Y

■Install an external noise filter and a Y capacitor C_Y for low line-noise and for stable operation of the power supply.

■Install a correspondence filter, if a noise standard meeting is required or if the surge voltage may be applied to the unit.

■Install a primary Y capacitor C_Y, with more than 0.1μF, near the input pins (within 50mm from the pins).

3.3.5 External capacitor on the input side Cin

■Install an external capacitor Cin between +VIN and -VIN input pins for low line-noise and for stable operation of the power supply.

Capacitor CDS400 : more than 100μF
CDS60024 : more than 1000μF
CDS60048 : more than 470μF

■Cin is within 50mm from pins. Make sure that ripple current of Cin should be less than its rating.

3.3.6 External capacitor on the output side Co

■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 3.3.2.

■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.

■When output current change sharply, make sure that ripple current of Co should be less than its rating.

■Install a capacitor Co near the output pins (within 100mm from the pins).

Table 3.3.2
Recommended
capacitance Co

Output voltage	Model	
	CDS400	CDS600
2V	10000μF	–
3.3V	10000μF	–
5V	4700μF	–
7.5V	4700μF	–
12.5V	470μF	1000μF
15V	330μF	–
24V	220μF	–
28V	220μF	470μF

3.3.7 Thermal considerations

■Operate with the conduction cooling (e.g. heat radiation from the aluminum base plate to the attached heat sink).
Reference : 8. Thermal considerations

3.4 Derating

3.4.1 Cooling

■Use with the conduction cooling (e.g. heat radiation by conduction from the aluminum base plate to the attached heat sink).

■Fig.3.4.1 shows the derating curve based on the aluminum base plate temperature. In the hatched area, the specification of ripple and ripple noise is different from other areas.

■The aluminum base plate temperature can be measured at point A or point B.

Fig.3.4.1
Aluminum base plate temperature Tc [℃]

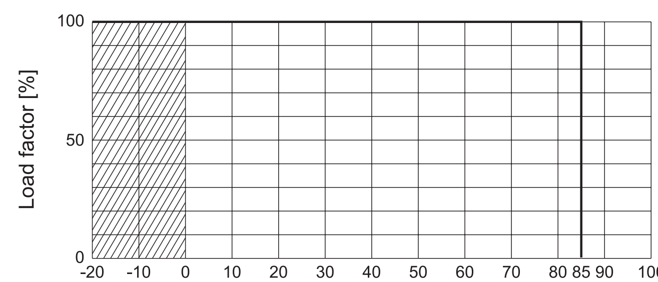
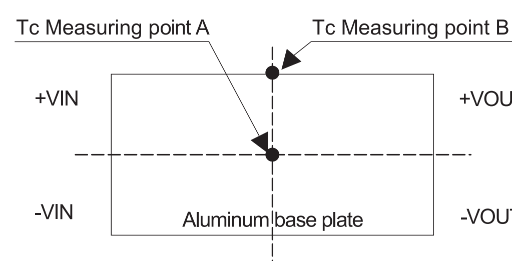


Fig.3.4.2
Measuring point



3.5 Protect circuit

3.5.1 Overvoltage protection

■The overvoltage protection circuit is built-in. The DC input should be turned off if overvoltage protection is activated. The minimum interval of DC ON/OFF for recovery is for 2 to 3 minutes (＊).

＊The recovery time varies depends on input voltage and input capacity.

●Remarks :

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

3.5.2 Overcurrent protection

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

The unit automatically recovers when the fault condition is removed.

■Intermittent operation

When the overcurrent protection is activated, the average output current is reduced by intermittent operation of power supply reduce heat of load and wiring.

3.5.3 Thermal protection

■Thermal detection (TMP) and protection circuit are built-in.

■When overheat is detected, thermal detection signal (TMP) turns ”L” from ”H”. TMP circuit is designed as shown in Fig.3.5.1, and specification is shown as in Table 3.5.1.

■When overheating continues after detecting TMP signal, the output will be shut down by the thermal protection circuit.

When this function is activated, input voltage should be turned off, and remove all possible causes of overheat condition and cool down the unit to the normal level temperature.

■Overheat protection works around 115℃ at the base plate.

Fig.3.5.1
TMP circuit

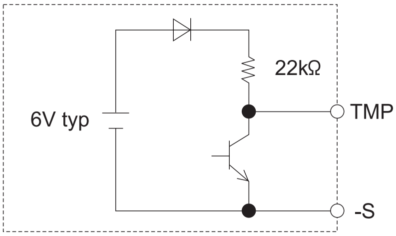


Table 3.5.1
Specification of TMP

No.	Item	TMP
1	Function	Normal ”H”
		Overheat ”L”
2	Base pin	-S
3	Voltage level ”L”	0.5V max at 5mA
4	Voltage level ”H”	5V typ
5	Maximum sink current	10mA max
6	Maximum applied voltage	35V max

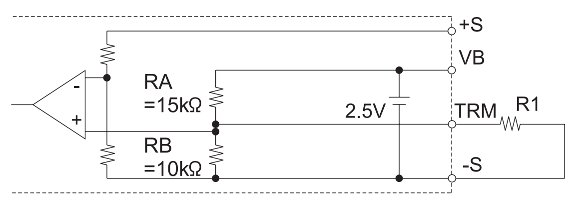
3.6 Adjustable voltage range

■Output voltage is adjustable by the external potentiometer or the external signal.
■When the output voltage adjustment is not used, leave the TRM pin and VB pin open.
■Do not set output voltage too high, overvoltage protection might be activated.

3.6.1 Output voltage decreasing by external resistor

■By connecting the external resistor (R1) more than 1/10W, output voltage becomes adjustable to decrease as shown in Fig.3.6.1.

Fig.3.6.1
Output voltage control circuit



Output voltage is calculated by the following equation
Vn : Rated output voltage
Vo : Output voltage needed to set up

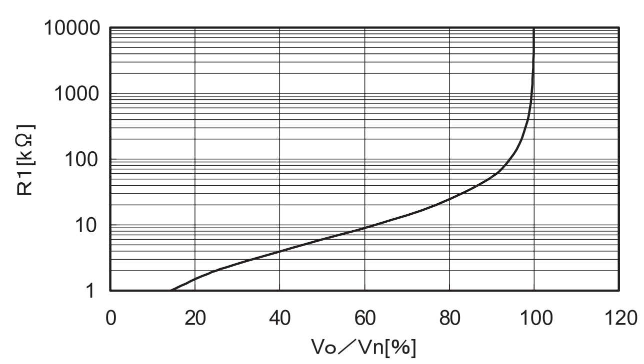
$$R1[k\Omega] = \frac{Vo}{Vn - Vo} \times 6.0$$

Example Vn = 5.0 [V]
Vo = 4.5 [V]

$$R1[k\Omega] = \frac{4.5}{5.0 - 4.5} \times 6.0$$

$$= 54\ [k\Omega]$$

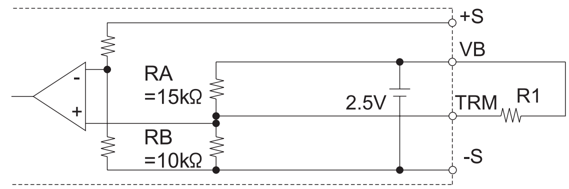
Fig.3.6.2
Resister selection for degreasing output voltage



3.6.2 Output voltage increasing by external resistor

■By connecting the external resistor (R1) more than 1/10W, output voltage becomes adjustable to increase as shown in Fig.3.6.3.

Fig.3.6.3
Output voltage control circuit



Output voltage is calculated by the following equation.

Vn : Rated output voltage

Vo : Output voltage needed set up

$$R1[k\Omega] = \frac{2.5Vn - Vo}{Vo - Vn} \times 6.0$$

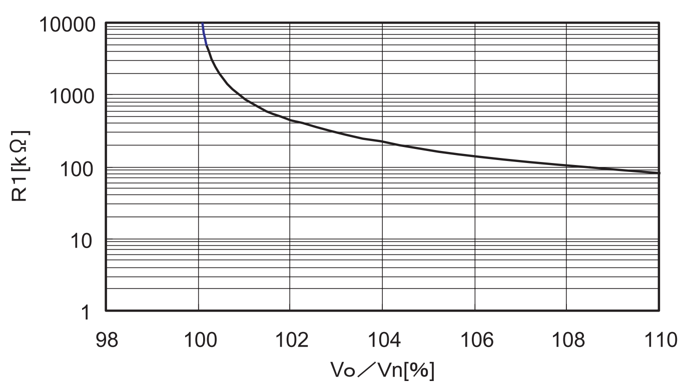
Example Vn = 5.0 [V]

Vo = 5.5 [V]

$$R1[k\Omega] = \frac{2.5 \times 5.0 - 5.5}{5.5 - 5.0} \times 6.0$$

$$= 84\ [k\Omega]$$

Fig.3.6.4
Resistor selection for increasing output voltage



3.6.3 Output voltage adjusting method by external potentiometer

■By connecting the external potentiometer (VR1) and resistors (R1, R2) more than 1/10W, output voltage becomes adjustable, as shown in Fig.3.6.5, recommended external parts are shown in Table 3.6.1.

■The wiring to the potentiometer should be as short as possible. The temperature coefficient becomes worse, depending on the type of a resistor and potentiometer. Following parts are recommended for the power supply.

Resistor Metal film type, coefficient of less than ±100ppm/℃

Potentiometer Cermet type, coefficient less than ±300ppm/℃

Fig.3.6.5
Output voltage
control circuit

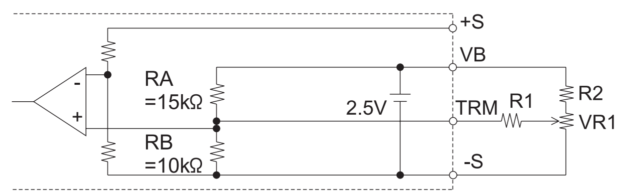


Table 3.6.1
Recommended value of external potentiometer and resistors (more than 1/10W)

No.	Adjustable range [%]	Number of unit	External parts value [Ω]		
			VR1	R1	R2
1	±5	Single	5k	75k	1k
2		2sets		36k	
3		3sets		24k	
4	±10	Single	5k	36k	910
5		2sets		18k	
6		3sets		12k	

3.6.4 Output voltage adjusting method by applying external voltage

■By applying the voltage externally at TRM, output voltage becomes adjustable. Output voltage is calculated by the following equation.

Output voltage = (Applied voltage externally) × (Rated output voltage)

3.7 Remote ON/OFF

■Remote ON/OFF circuit is built-in on both side of input (RC1) and output (RC2, RC3) side.

3.7.1 Input side remote ON/OFF (RC1)

■The ground pin of input side remote ON/OFF circuit is "-VIN" pin.

●Between RC1 and -VIN : Output voltage is ON at "Low" level or short circuit (0-1.0V).

●Between RC1 and -VIN : Output voltage is OFF at "High" level or applied voltage (3.5 - 7.0V).

■When RC1 is low level, fan out current is 0.3mA typ.

■When Vcc is applied, use 3.5 ≦ Vcc ≦ 7V.

■When remote ON/OFF function is not used, please connect between RC1 and -VIN.

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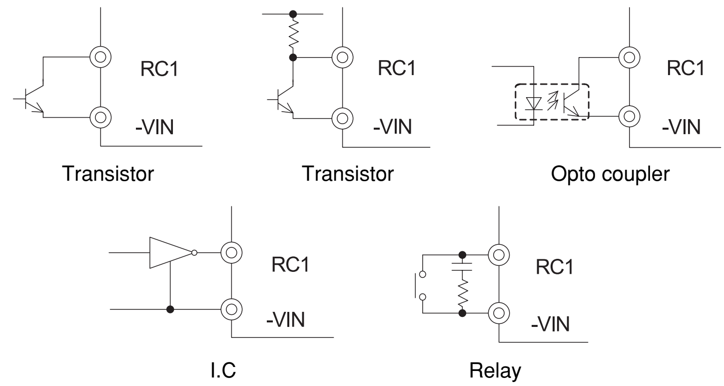
Fig.3.7.1
RC connection example



3.7.2 Output side remote ON/OFF (RC2, RC3)

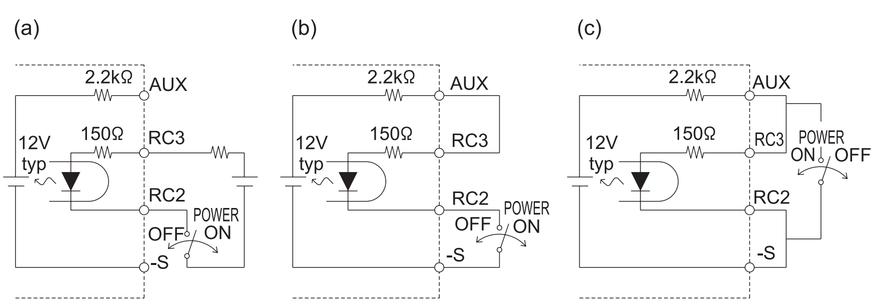
■Either ”Low active” or ”High active” logic is available by connecting method as following table.

Table 3.7.1
Output side remote ON/OFF (RC2,RC3)

No.	Item	RC2, RC3		
1	Wiring method	Fig.3.7.2 (a)	Fig.3.7.2 (b)	Fig.3.7.2 (c)
2	Function	Power ON ”H”	Power ON ”H”	Power ON ”L”
3	Base pin	RC2	-S	-S and RC2
4	Power ON	Open (0.1mA max)		Short (0.5V max)
5	Power OFF	Short (3mA min)		Open (0.1mA max)

■Make sure that sink current of output side remote ON/OFF circuit should be less than 12mA.

Fig.3.7.2
Output side remote ON/OFF (RC2, RC3)



3.7.3 Auxiliary power supply for remote ON/OFF (AUX)

■AUX is built-in for operating the output side remote ON/OFF (RC2, RC3).

■If AUX is not used for RC2, RC3, AUX can be used for IOG or TMP signal output using opt-coupler.

■Short protection resistance (2.2kΩ) is built-in.

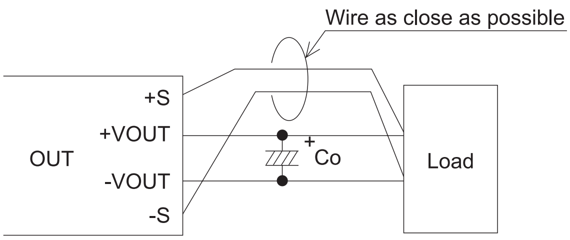
■AUX voltage at open circuit : 15V max.

3.8 Remote sensing

■Remote sensing this function compensate line voltage drop.

3.8.1 When the remote sensing function is in use

Fig.3.8.1
Connection when the remote sensing is in use



■Wire as close as possible. Twisted-pair wire or shield wire is recommended 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 be remained within the output voltage adjustment range.

■The remote sensing leads must not be used to carry load current. Doing so will damage the module by drawing heavy current. Fuses or resistors should be fitted close to a load to prevent the module from the kind of failure.

(1) Case of long distance between load and power supply

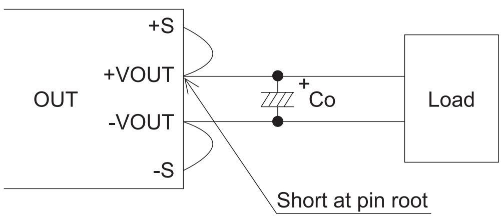
■Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 3m.

(2) When using remote sensing in parallel

■Connecting each power supply's sensing line (+s, -s) together first then connect the sensing line and the power line at one point.

3.8.2 When the remote sensing function is not in use

Fig.3.8.2
Connection when the remote sensing is not in use



■When the remote sensing function is not in use, make sure that pins between +S and +VOUT and between -S and -VOUT are connected.

■Connect between +S and +VOUT and between -S and -VOUT directly.
No loop wiring.
This power supply might become unstable by the noise coming from poor wiring.

3.9 Inverter operation monitor (IOG)

■Use IOG to monitor operation of the inverter, in the case of abnormal operation, status is changed from "L" to "H" within one second.

■IOG circuit is designed as shown in Fig.3.9.1 and specification is shown in Table 3.9.1.

Fig.3.9.1
IOG circuit

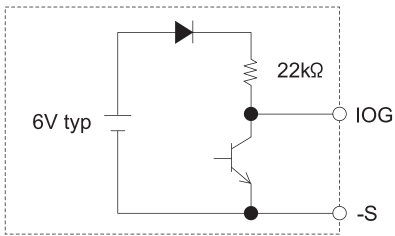


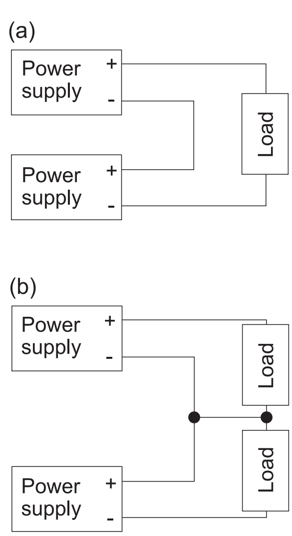
Table 3.9.1
Specification of IOG

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

3.10 Series operation

■Series operation is available by connecting the outputs of two or more power supplies, as shown Fig.3.10.1. Output current in series connection should be lower than the lowest rated current in each power supply.

Fig.3.10.1
Example of series operation



3.11 Parallel operation /Master-slave operation

■Parallel operation is available by connecting the units as shown Fig.3.11.1, also Master-slave operation, adjust output voltage in parallel operation, are available.
When output voltage adjustment is not in use, TRM wiring, R1, R2 and VR are not necessary.

■As variance of output current drew from each power supply is maximum 10%, the total output current must not exceed the value determined by following equation.
(output current in parallel operation) = (the rated current per unit) × (number of unit) ×0.9

■In parallel operation, the maximum operative number of units is 11.

Fig.3.11.1
Example of parallel operation

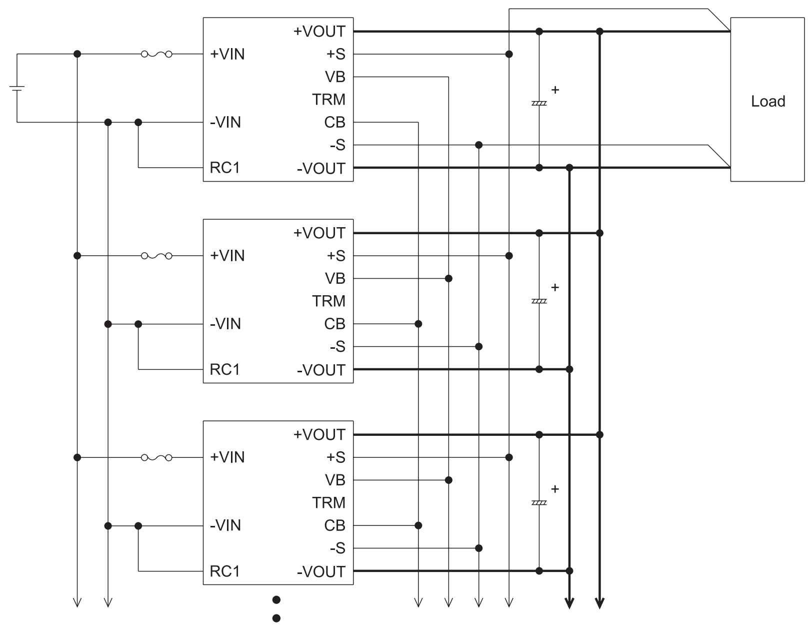
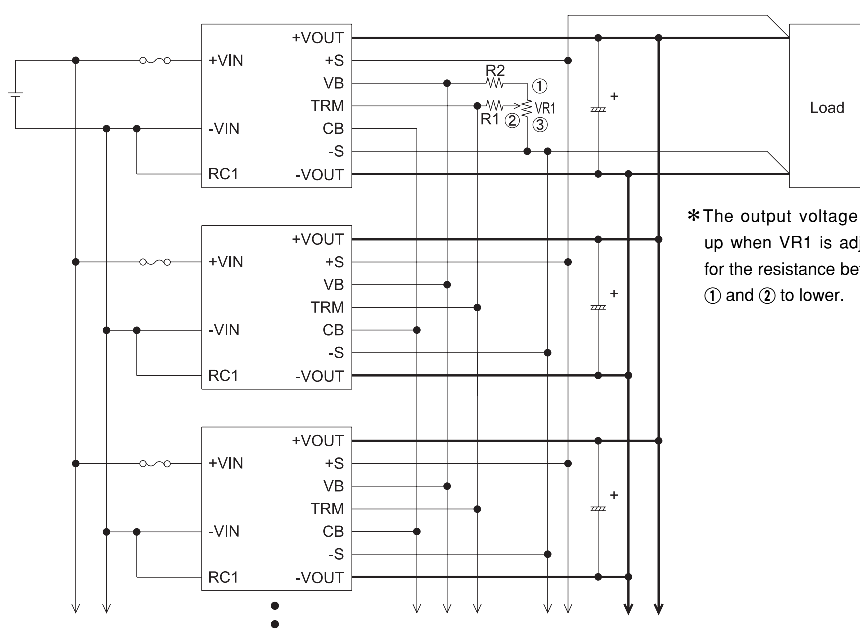


Fig.3.11.2
Example of master-slave operation



*The output voltage gose up when VR1 is adjusted for the resistance between ① and ② to lower.

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(1) Wiring

■When the output-line impedance is high, the power supply become unstable. Use same length and thickness (width) wire (pattern) for the current balance improvement.

■Connect each input pin for the lowest possible impedance. When the number of the units in parallel operation increases, input current increases, Adequate wiring design is required for input circuitry such as circuit pattern, wiring and load current for equipment is required.

■Connecting each power supply's sensing line (+s, -s) together first then connect the sensing line and the power line at one point. In multiple operation, sensing wires should be connected same terminal in each unit.

(2) Thermal management of Base Plate

■If aluminum base plate temperature is different in each power supply, fluctuation of output voltage will be larger than nominal. Make sure to keep base plate temperature even by using one heat sink for all units.

(3) IOG signal

■Output current should be 10% or more of the total of the rated output current in parallel operation. If less than 10%, the IOG signal might become unstable, and output voltage slightly increase (5% max).

■IOG signal might be unstable for one second when the units are turned on in parallel operation.

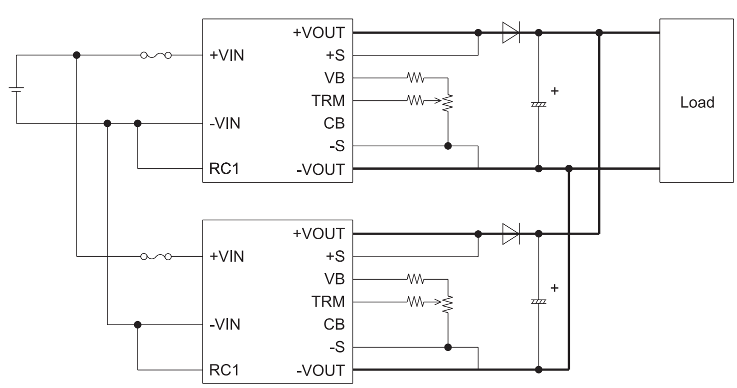
3.12 Redundant operation

3.12.1 Redundant operation

■Connecting method for external diode on the output side.

■In parallel operation, please connect diode to the + side of the output circuit. If the diode is connected to the - side, it will damage the unit or/and the balancing function will not work.

Fig.3.12.1
Example of redundant operation

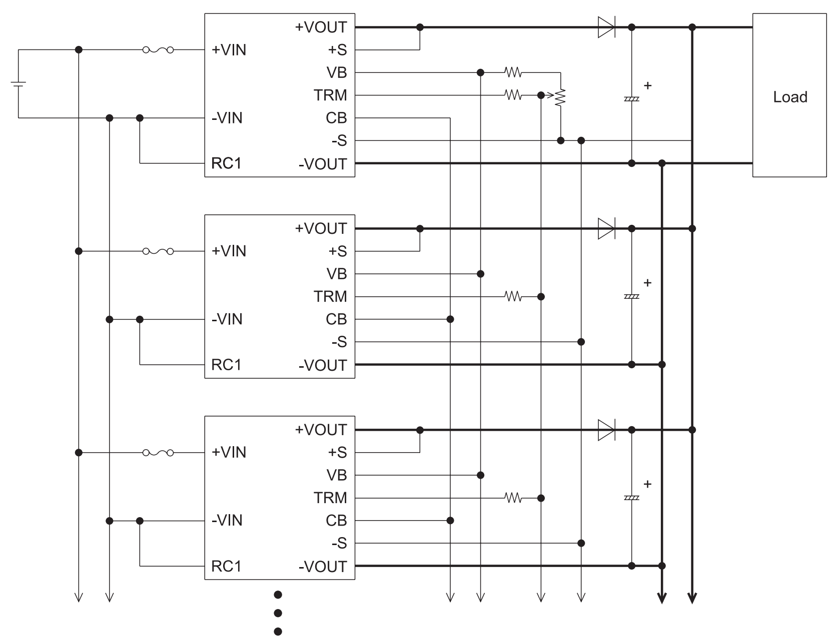


3.12.2 N+1 Redundant operation

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

■Purpose of redundant operation is to ensure stable operation in the event of single power supply failure. Since extra power supply is reserved for the failure condition, so total power of redundant operation equal to N.

Fig.3.12.2
Example of N+1
redundant operation



3.13 EMC consideration

3.13.1 Line conducted noise

(1) Overview of the conducted noise

■The switch mode power supply generates the conducted noise to the input lines.

The conducted noise can be categorized into the common mode noise and the differential mode noise.

CISPR and FCC standards have been used as a world wide benchmark especially for line conducted interference levels.

If an EMI specification such as CISPR standard must be met, additional filtering may be needed.

■The common mode noise exists between the input terminals and FG (aluminum base plate).

The most effective way to reduce common mode noise are to bypass from the input lines to FG with Y capacitor (C_Y) and the common mode choke (L1).

Fig.3.13.1 shows the overview of the path of the common mode noise.

■The differential mode noise exists between the input terminals.

The most effective way to reduce differential mode noise are to bypass the input lines with X capacitors (Cx3, Cx4) and the normal mode choke (L2).

Fig.3.13.2 shows the overview of the path of the differential mode noise.

Fig.3.13.1
Common mode noise path

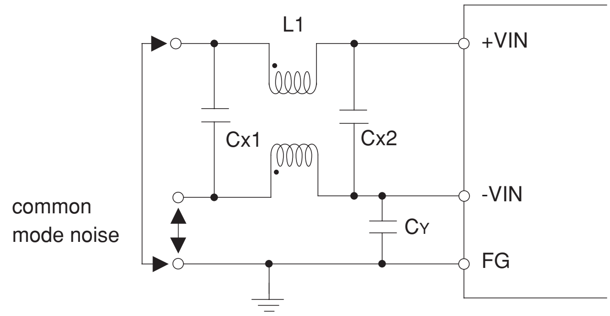
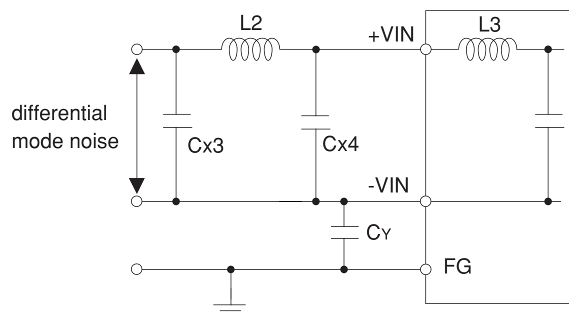


Fig.3.13.2
Differential mode noise path



■The CDS provide the normal mode choke (L3) to reduce the differential mode noise.
Install the capacitor (Cx4) to reduce the differential mode noise.
The most effective way to reduce the differential mode noise are to install since X capacitor (Cx3) and the normal mode choke (L2).

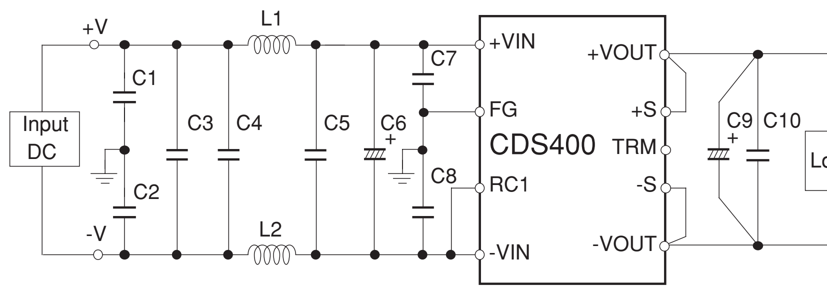
■The leakage inductance of the common mode choke (L1) works as the normal mode choke.
The normal mode choke (L2) is not necessary.

(2) Recommended of noise-filter

■Fig.3.13.3, Fig.3.13.4 and Fig.3.13.5 show the recommended circuit of noise-filter which meets CISPR Pub. 22 Class A and the noise level.

CDS4004828 : DC48V INPUT, 28V18A OUTPUT

Fig.3.13.3 Recommended circuit and noise level (CISPR Pub. 22 Class A)



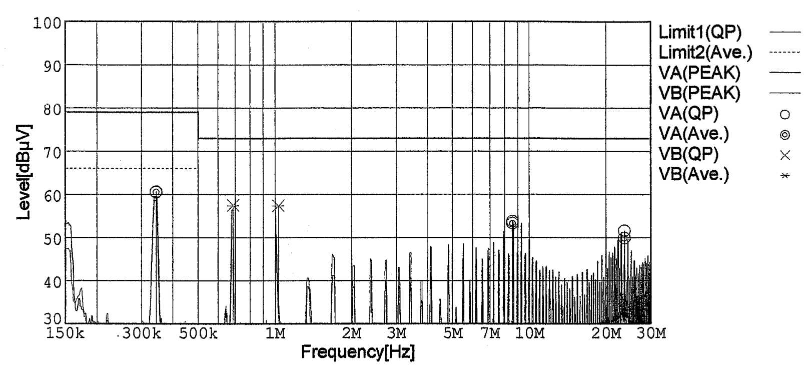
L1, L2=0.8μH (ETQP6F0R8LFA : MATSUSHITA)

C1, C2, C3, C4, C5, C7, C8=100V3μF (CY55Y5P2A305M : TOKIN)

C6=100V220μF (PM series : NICHICON)

C9=35V220μF (PW series : NICHICON)

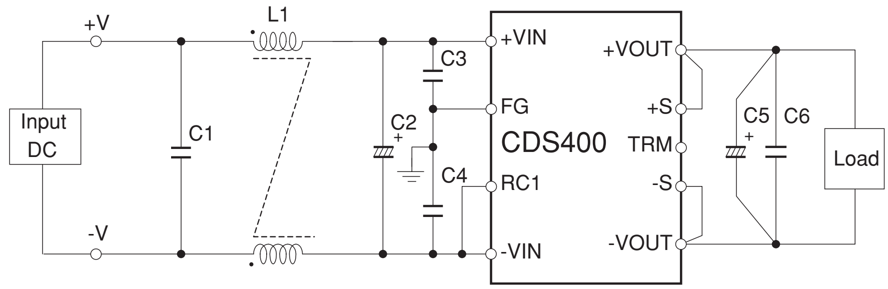
C10=50V0.1μF (MDD21H104M : NITSUKO)



Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3423	50.2	50.1	10.3	60.5	60.4	VA	79.0	66.0	18.5	5.6
8.5622	43.3	42.8	10.4	53.7	53.2	VA	73.0	60.0	19.3	6.8
23.6199	40.6	39.0	10.9	51.5	49.9	VA	73.0	60.0	21.5	10.1
0.6844	47.3	47.2	10.2	57.5	57.4	VB	73.0	60.0	15.5	2.6
1.0265	47.3	47.2	10.1	57.4	57.3	VB	73.0	60.0	15.6	2.7

CDS4004828 : DC48V INPUT, 28V18A OUTPUT

Fig.3.13.4
Recommended circuit and noise level (CISPR Pub. 22 Class A)



L1=1mH (SC15-10JH : TOKIN)

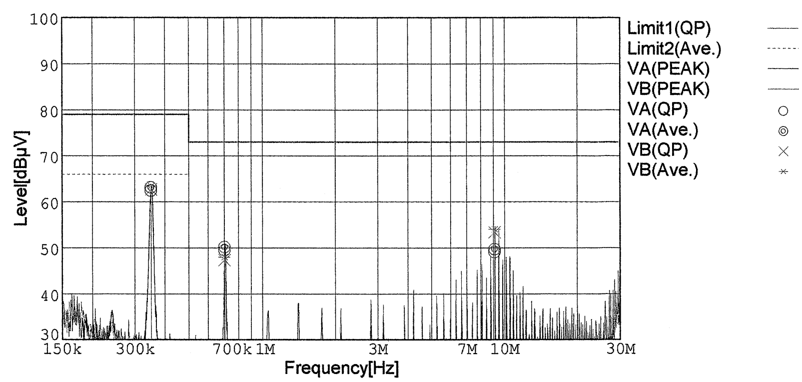
C1=0.68 μ F (CFJC22E684M : NITSUKO)

C2=100V470 μ F (PM series : NICHICON)

C3, C4=630V0.033 μ F(MDS22J333K : NITSUKO)

C5=35V220 μ F (PW series : NICHICON)

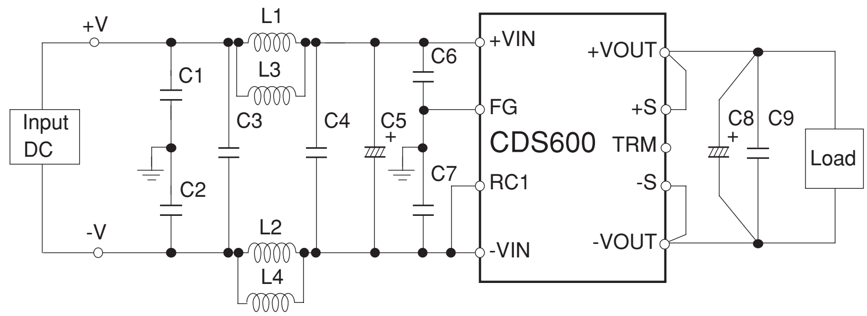
C6=50V0.1 μ F (MDD21H104M : NITSUKO)



Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3500	52.6	53.3	9.8	62.4	63.1	VA	79.0	66.0	16.6	2.9
0.7006	39.6	40.4	9.8	49.4	50.2	VA	73.0	60.0	23.6	9.8
9.1006	39.0	39.6	10.1	49.1	49.7	VA	73.0	60.0	23.9	10.3
0.3503	52.9	53.6	9.8	62.7	63.4	VB	79.0	66.0	16.3	2.6
0.7008	37.5	38.2	9.8	47.3	48.0	VB	73.0	60.0	25.7	12.0
9.0955	43.3	43.9	10.1	53.4	54.0	VB	73.0	60.0	19.6	6.0

Fig.3.13.5
Recommended circuit and noise level (CISPR Pub. 22 Class A)

CDS6004828 : DC48V INPUT, 28V25A OUTPUT



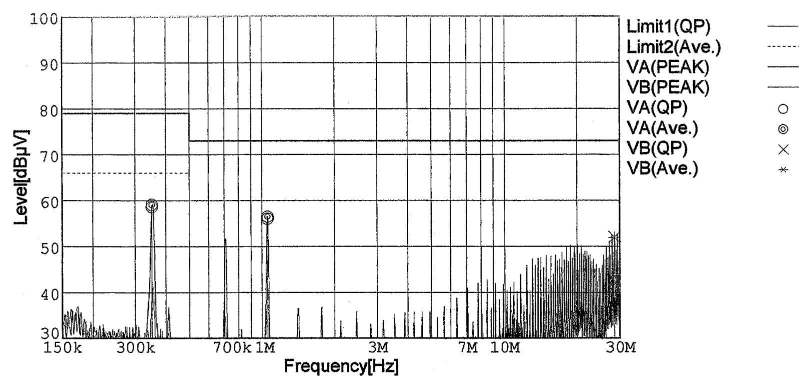
L1, L2, L3, L4=1.8μH (ETQP6F1R8BFA : MATSUSHITA)

C1, C2, C3, C4, C6, C7=100V3μF (CY55Y5P2A305M : TOKIN)

C5=100V470μF (PM series : NICHICON)

C8=35V470μF (PW series : NICHICON)

C9=50V0.1μF (MDD21H104M : NITSUKO)



Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3520	48.8	49.3	9.8	58.6	59.1	VA	79.0	66.0	20.4	6.9
1.0573	46.1	46.6	9.9	56.0	56.5	VA	73.0	60.0	17.0	3.5
28.5397	41.6	41.5	10.4	52.0	51.9	VB	73.0	60.0	21.0	8.1

3.13.2 Radiated noise

■High-frequency noise is radiated directly from the module, the input lines and the output lines to the atmosphere.
The noise-filter (EMC component) is required to reduce the radiated noise.

■The effective ways to reduce the radiated noise are to cover units with the metal plate or film.

3.13.3 Output noise

■Install an external capacitor Co between +VOUT and -VOUT for stable operation and low output noise. Recommended capacitance of Co is shown in Table 3.13.1.

■Install a capacitor Cn=0.1μF (film or ceramic capacitor) for low output high-frequency noise.

■Install a capacitor C_Y, with more than 0.1μF, for low output noise.

Fig.3.13.6
Measuring method of the output noise

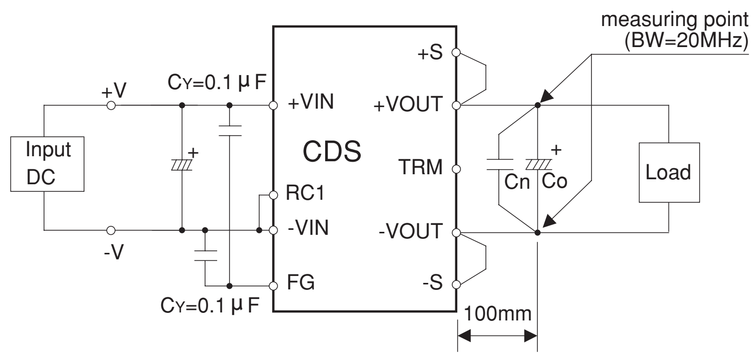


Table 3.13.1
Recommended capacitance Co

VOUT	CDS400	CDS600
2V	10000μF	-
3.3V	10000μF	-
5V	4700μF	-
7.5V	4700μF	-
12.5V	470μF	1000μF
15V	330μF	-
24V	220μF	-
28V	220μF	470μF

■Fig.3.13.7 and Fig.3.13.8 show the output noise level.

CDS4004805 : DC48V INPUT

5V8A OUTPUT 5V40A OUTPUT 5V80A OUTPUT

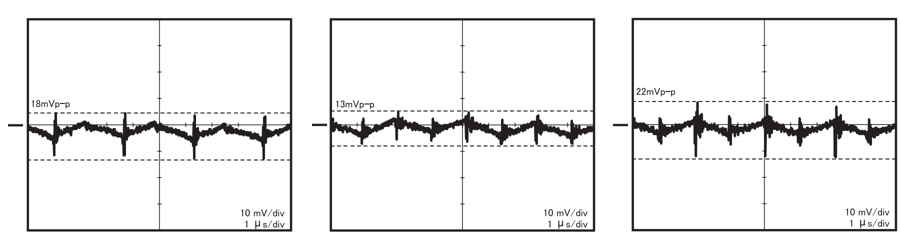


Fig.3.13.7
Output noise level
(Cn none)

5V8A OUTPUT 5V40A OUTPUT 5V80A OUTPUT

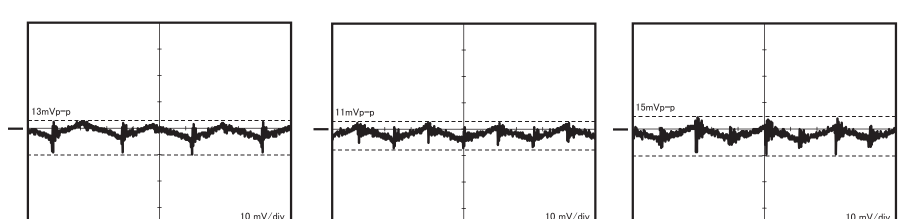


Fig.3.13.8
Output noise level
(Cn=0.1μF)

4. Application Circuits

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4.5 Inrush current limiting for CBS	72

DBS series
CBS series
CDS series
Application Circuits
Input Rectifier Circuit
DPF and DPA series
STA series
Thermal Considerations
Agency Approvals
Product Weights
Glossary of Technical Terms

4.1 Output voltage trimming for DBS/CDS

■Adjusting method by applying external voltage.
By applying the voltage to TRM pin, output voltage can be adjusted.

Output voltage Vo[V] = External voltage Vi[V] × Rated output voltage[V]

Fig.4.1.1 is basic connection of output voltage control. Fig.4.1.2 is output voltage characteristic of the trimming circuit.

Fig.4.1.1
Output voltage trimming (basic)

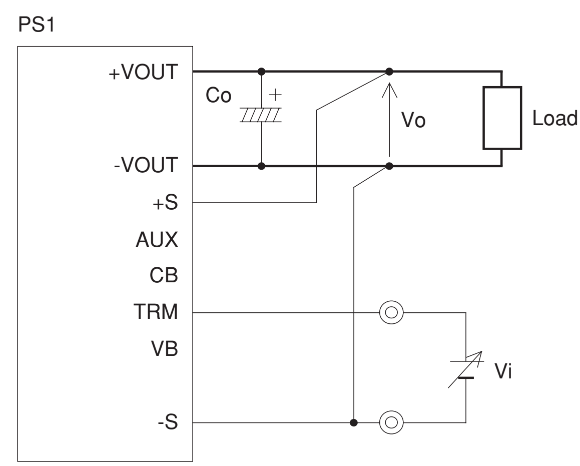
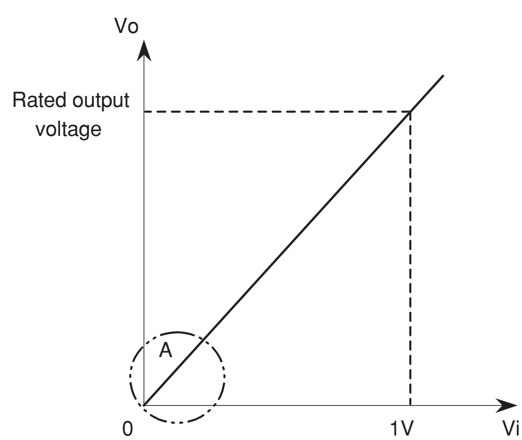


Fig.4.1.2
Voltage trimming characteristic



*If output voltage is trimmed down below 60% of the rated output voltage, ripple and noise will increase occasionally and/or over shoot occurs when start-up. External filter attached to the output is effective to avoid over shoot when start-up.

■In connection as shown in Fig.4.1.1, output voltage can not reach zero completely made. In case of 12V output module, it remain approximately 0.1-0.2V.
Zero voltage is completely made by connecting AUX and CB, and connecting TRM and -S as shown in Fig.4.1.3.

Fig.4.1.3
Output voltage trimming (improvement)

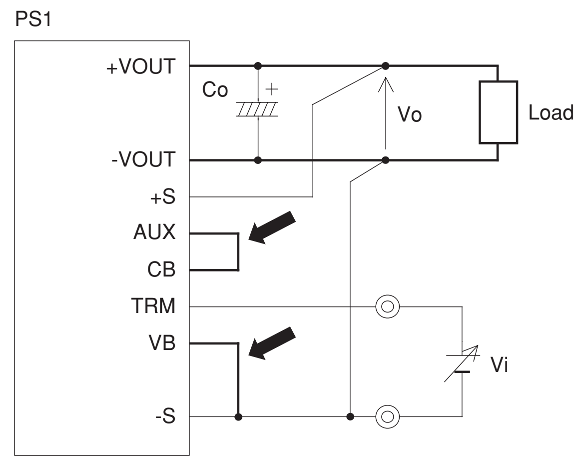
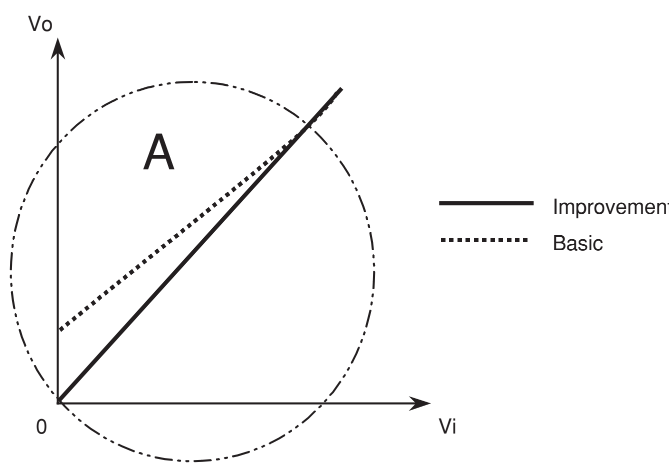


Fig.4.1.4
Voltage trimming characteristic (enlarge the A)



4.2 Remote ON/OFF circuit for DBS/CDS

(1) Remote ON/OFF circuit at output side in series and parallel operation

■Please refer to item 1.7 and 3.7 for a basic circuit structure.

■Remote ON/OFF circuit (RC2, RC3) is isolated from input and output circuit.
Therefore, the modules can be controlled by easy connections.

■When auxiliary power source (AUX pin) is available for Remote ON/OFF by connecting the modules as shown in Fig.4.2.1 and Fig.4.2.2.
The maximum operative number of units is 3 in series operation.

Fig.4.2.1
Remote ON/OFF of series operation

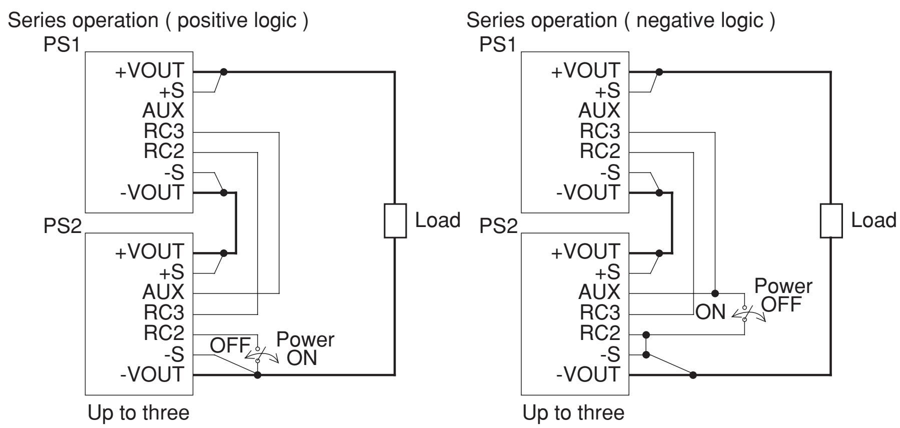
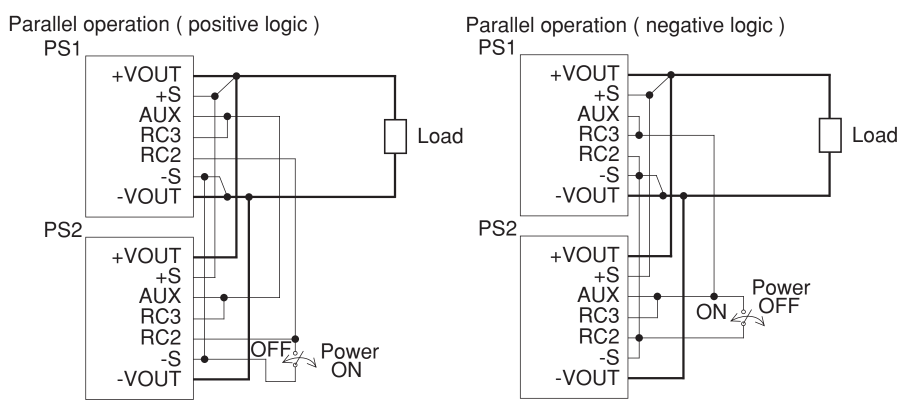


Fig.4.2.2
Remote ON/OFF of parallel operation



■An external power supply can be used for Remote ON/OFF by connecting the modules as shown in Fig.4.2.3 and Fig.4.2.4.
Current limiting resistance R must be required.
The limit resistor can be calculated by the following equaition.

$$R[\Omega] = \frac{(Vcc - 1.1) \times 500 - 150}{N}$$

N : Number of modules
The dissipated power of the limit resistor can be calculated by the following equation.

$$P_R[W] = \frac{(Vcc)^2}{R}$$

Fig.4.2.3
Remote ON/OFF of series operation

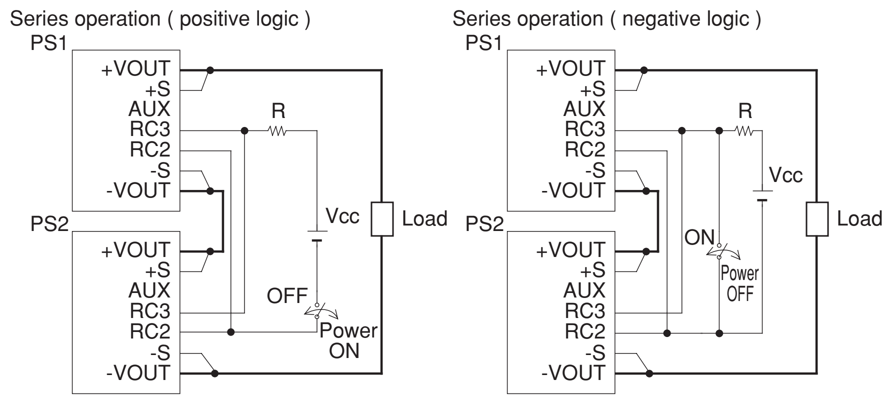
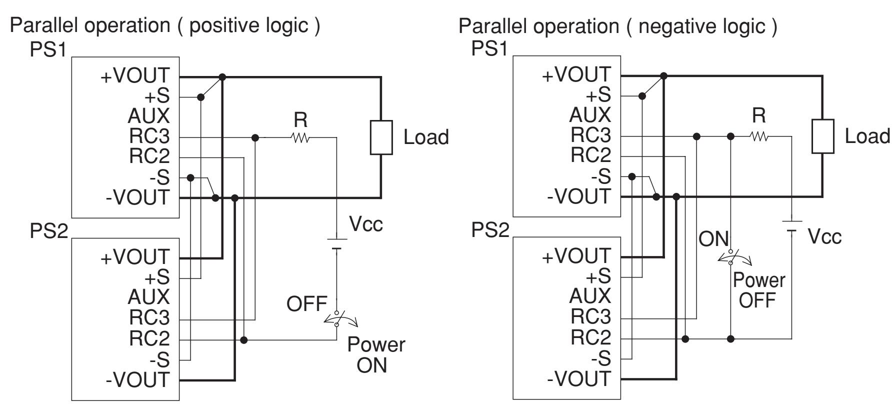


Fig.4.2.4
Remote ON/OFF of parallel operation



(2) Applications of Remote ON/OFF

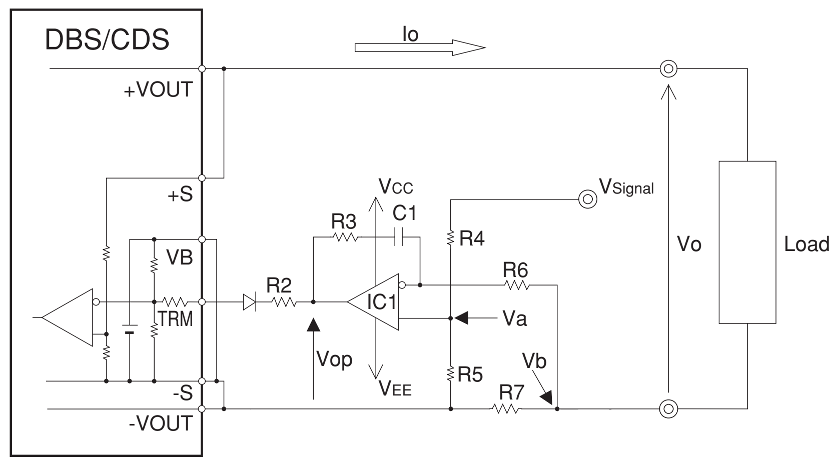
■Remote ON/OFF circuit is built-in on both side of input (RC1) and output (RC2, RC3).
Table 4.2.1 shows the application of Remote ON/OFF.

Table 4.2.1
Application of remote ON/OFF

No.	Remote ON/OFF pin	Application
1	RC1(input side)	Remote ON/OFF on the input side Shutdown in abnormal circumstances
2	RC2, RC3(output side)	Remote ON/OFF on the output side

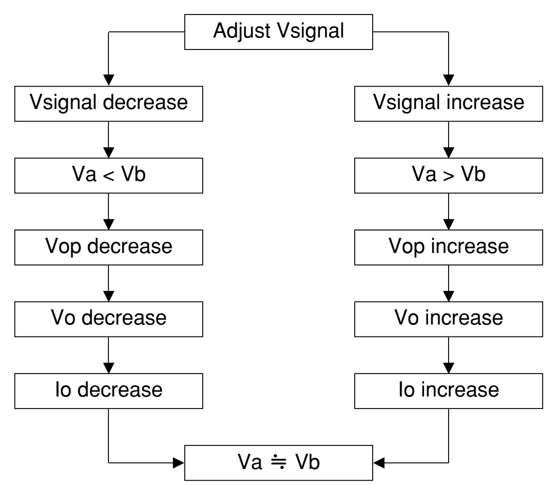
4.3 Current source operation for DBS/CDS

Fig.4.3.1
Example of current source by DBS/CDS



■Operation like current source is possible by external circuit in Fig.4.3.1.
Behavior by circuit is refer to Fig.4.3.2.

Fig.4.3.2
Behavior of current source



Io (Constant current) is calculated by the following equation Io = Va/R7

$$Va = Vsignal \times \frac{R5}{R5 + R4}$$

[Notice]

(1) R7 should be a high accuracy resistor.

(2) Output characteristics is determined by R3, R6 and C1 with consideration.

Ex. R3 = 10 [kΩ]
R6 = 1 [kΩ]
C1 = 1 [μF]

(3) R4 and R5 are calculated by the following equation.

$$\frac{R5}{R4 + R5} \leqq \frac{Io}{Vsignal} \times R7$$

Please evaluate under end-use condition before using.

4.4 O.C.P. (Over Current Protection) point adjustment for DBS/CDS

■O.C.P. point can be adjusted by external circuit in Fig.4.4.1.

■Component value in Table 4.4.1 may set the O.C.P. point range at 30% to 105% of rated current.
O.C.P. characteristics is straight-line current limiting type, recovers automatically when the fault condition is removed.

Fig.4.4.1
Output current adjusting circuit

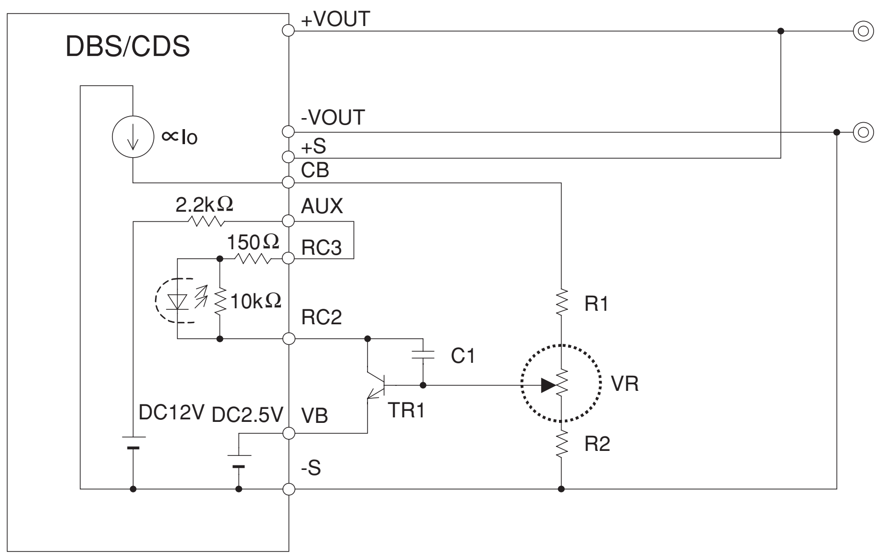


Table 4.4.1
Example of value

No.	Parts No.	Value/model name	Remarks
1	C1	0.1μF	
2	R1	4.7kΩ	
3	R2	10kΩ	
4	VR	10kΩ	
5	TR1	2SC1815	Manufacture : Toshiba

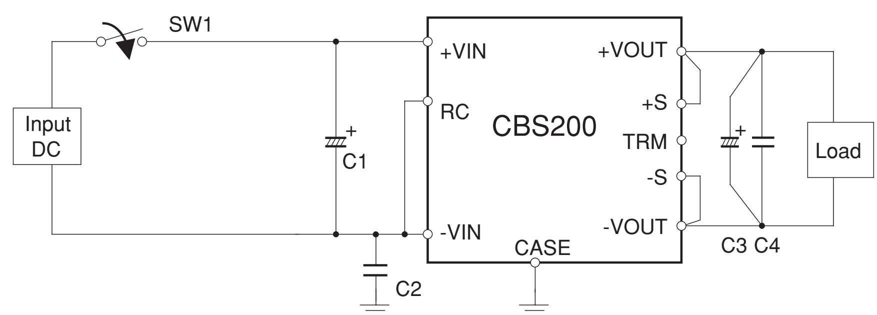
Applications
(1) To make pattern wise on P.C.B., value of parts, etc. well suited for actual output power.
(2) For gilding machine, water resolving machine, battery charger.

4.5 Inrush current limiting for CBS

■Large input capacitors is required for stable operation of DC-DC converter.
The inrush current caused by this capacitor could be large.
Fig.4.5.1 shows the inrush current when an inrush limiting circuit is not installed.

■To reduce the inrush current, install an inrush limiting circuit shown in Fig.4.5.2.
Fig.4.5.2 shows the inrush current when an inrush limiting circuit is installed.

Fig.4.5.1
Inrush current of
normal circuit



C1=100V33μF (PM series : NICHICON)
C2=AC250V4700pF (KH series : MURATA)
C3=25V1000μF (LXZ series : NIPPON CHEMI-CON)
C4=50V0.1μF (MDD21H104M : NITSUKO)

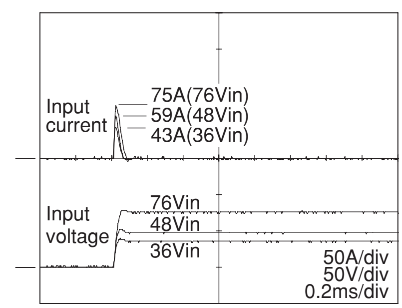
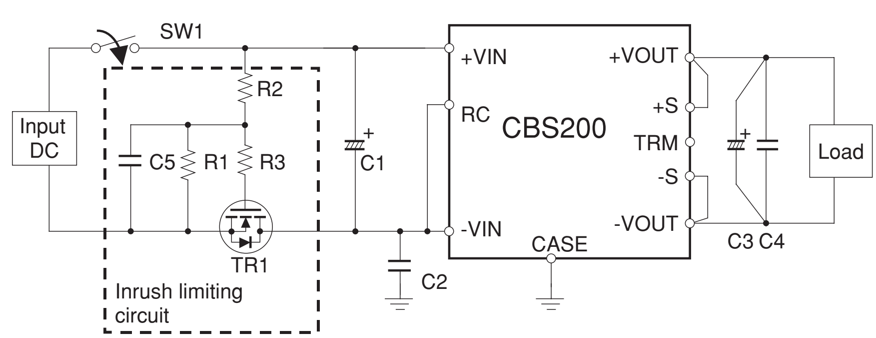
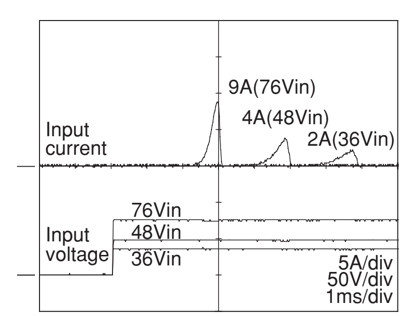


Fig.4.5.2
Inrush current limiting
circuit



C1=100V33μF (PM series : NICHICON)
C2=AC250V4700pF (KH series : MURATA)
C3=25V1000μF (LXZ series : NIPPON CHEMI-CON)
C4=50V0.1μF (MDD21H104M : NITSUKO)
C5=50V1μF (MDD21H105M : NITSUKO)
R1=1/4W15kΩ
R2=1/4W62kΩ
R3=1/4W1kΩ
TR1=100V50A, 34mΩ (2SK3480 : NEC)



5. Input Rectifier Circuit

5.1 Single phase input rectifier circuit		74
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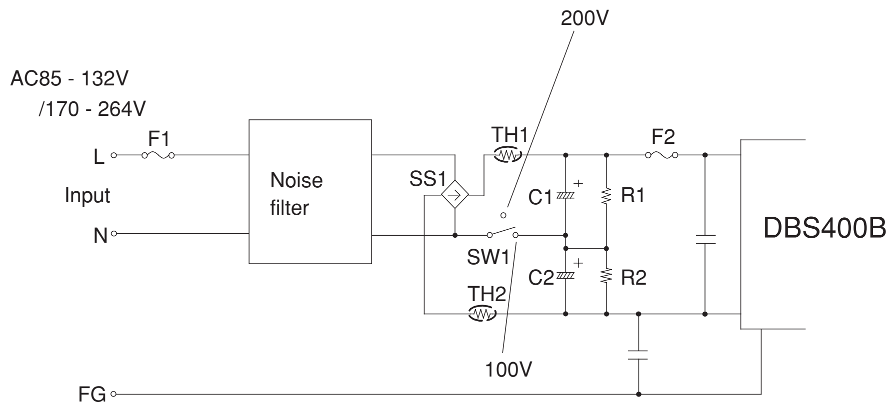
5.2.2	Input fuse	77
5.2.3	Rectifier (SS1, SS2, SS3)	78
5.2.4	Inrush current limiting	78
5.2.5	Filtering circuit (Filtering capacitor) (C1)	78

5.1 Single phase input rectifier circuit

[Example]

Fig.5.1.1
Single phase input filter
+ rectifier circuit



Voltage doubler circuit : 100V : SW1 is ON
200V : SW1 is OFF

5.1.1 Input fuse

■To avoid any damage or failure, install either an input circuit breakeruor a fuse. When selecting these parts, consider the continuous current and the inrush current. Use a normal-blow or slowblow type fuse.

(1) AC fuse (F1)

Table 5.1.1
Recommended value
of AC fuse

Input Voltage	Output power of module			
	200W	400W	600W	800W
100V	6.3A	10A	15A	20A
200V	3.15A	5A	8A	10A

(2) DC fuse (F2)

Table 5.1.2
Recommended value
of DC fuse

	Output power of module			
	200W	400W	600W	800W
Current	3.15A	5A	6.3A	8A

5.1.2 Noise filters

■In order to reduce the conducted noise from the unit to the AC line and to increase the immunity level against the external noises, a noise filter should be installed. Refer to ”Section 12Noise Filter Design” for details.

5.1.3 Rectifier (SS1)

■It rectifies the AC input to DC. The rated voltage is 600V and the rated current is as follows.

Table 5.1.3
Recommendation rectifier

Output Power	The example of combination of a power supply	Current of Rectifier
200W	DBS200B	4−6A type
400W	DBS200B×2	8−10A type
600W	DBS200B+DBS400B	12−15A type
800W	DBS400B×2	18−20A type

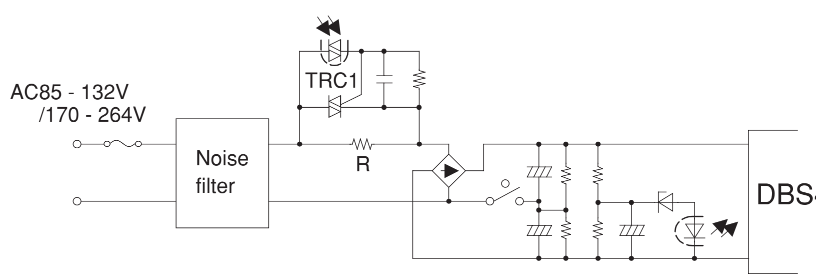
5.1.4 Inrush current limiting

■This rectification filtering circuit employs a capacitor input type. When input voltage is applied, an inrush current flows to charge the capacitor. To avoid the damage, an inrush current limiting is required. This resistance limits inrush current by the thermistor when the input is turned on, and resistance usually suppresses the lower loss dueto the characteristic of thermistor (thermistor method).

■When temperature is low, the start-up time is getting longer dueto characteristic of thermistor. Please select thermistor which can be used at actual.

■When the output power grows, inrush current protection circuit used to be buid-in (SCR method and TRC method) using the thyristor or triac. Inrush current is limited by the resistance connected with thyristor or triac in parallel when the input is turned on. Then once input current gose to continuously, thyristor or triac is turned on toreduce power loss of resistor. In this circuit needed consideration about serge capacity of thyristor and add thermal fuse or use resistor which includes thermal fuse inside.

Fig.5.1.2
Inrush current limiting with TRC



PC1 is the extra low trigger current opto coupler.

(Ex.TLP668J : "TOSHIBA"
I = 3mA (MAX))

The inrush current can be calculated at the following formula.

$$\text{Inrush current value (at AC200V)} = \frac{200 \times \sqrt{2}}{R}$$

＊Please note, input current protection might not beactivated, if input ON/OFF interval is short.

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5.1.5 Filtering circuit (Filtering capacitor) (C1, C2)

■The selection of the filtering capacitor depends on the output hold-up time and the ripple current flowing in the capacitor.

(1) Obtain the capacitance (Ch) from the output hold-up time as follows

$$Ch = \frac{2 \times Po \times Th}{(V1^2 - V2^2) \times \eta}$$

Ch : Capacity of the filtering capacitor
Po : Output power of module
Th : Hold-up time
V1 : Input DC voltage = Input AC voltage (rms) $\times \sqrt{2}$
V2 : Input DC voltage which can hold output voltage
η : Efficiency

[Calculation example]

(1) DBS400B is used with AC200V.
(2) The hold-up time is 20ms at AC200V.
(3) The efficiency of DBS400B is 85%.

$$Ch = \frac{2 \times 400W \times (20ms+5ms)}{\{(200 \times \sqrt{2})^2 - (165V)^2\} \times 0.85}$$
$$= 446 \mu F$$

*5ms in the formula above is added considering the ripple voltage of the filtering capacitor.

(2) Obtain the ripple current for selection of the capacitor as follows

[Calculation example]

$$\text{Ripple current} = \frac{2.5 \times 400W}{200V}$$
$$= 5A$$

Po : Output power of module
Vin : Input voltage

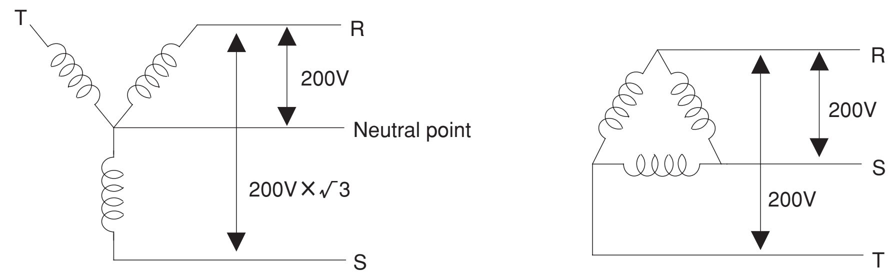
Table 5.1.4
Ripple current value

Output power of module	100V	200V
50W	1.25A	0.625A
100W	2.5A	1.25A
150W	3.75A	1.875A
200W	5.0A	2.5A
400W	10.0A	5.0A
600W	15.0A	7.5A
800W	20.0A	10.0A

5.2 Three phase input rectifier circuit

5.2.1 Three phase Y-connection and Δ connecting wires

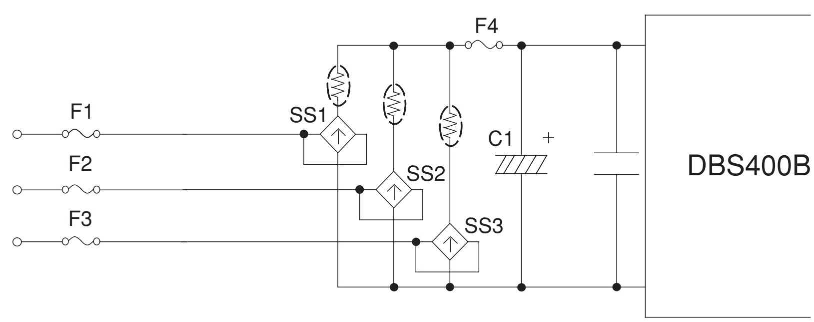
Fig.5.2.1
Y-connection (three phase four line type) and Δ connecting wires (three phase three line type)



■Do not use module power supply, if input line is Y-connection, because filtered DC voltage excess the input voltage range.
The example of connecting three phase input rictifier circuit is shown Fig.5.2.2.

[example]

Fig.5.2.2
Three phase input circuit



5.2.2 Input fuse

■To avoid any damage or failure, install either an input circuit breaker a fuse. When selecting these parts, consider the continuous current and the inrush current. Use a normal-blow or slowblow type fuse.

(1) AC fuse (F1, F2, F3)

Table 5.2.1
Recommended value of AC fuse

	Output power of module			
	200W	400W	600W	800W
Current	2A	3.15A	4A	6.3A

(2) DC fuse (F4)

Table 5.2.2
Recommended value of DC fuse

	Output power of module			
	200W	400W	600W	800W
Current	3.15A	5A	6.3A	8A

5.2.3 Rectifier (SS1, SS2, SS3)

■It rectifies the AC input to DC. The rated voltage is 600V and the rated current is as follows.

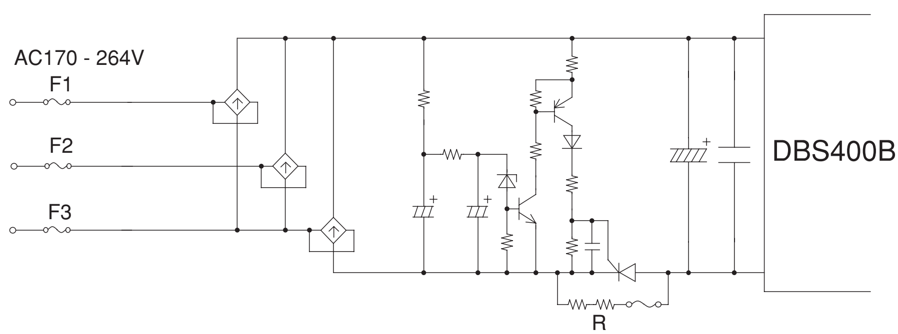
Table 5.2.3 Recommendation rectifier

Output Power	The example of combination of a power supply	Current of Rectifier
200W	DBS200B	1−2A type
400W	DBS200B×2	3−4A type
600W	DBS200B+DBS400B	4−5A type
800W	DBS400B×2	6−7A type

5.2.4 Inrush current limiting

■When the output power grows, inrush current protection circuit used to be buid-in (SCR method and TRC method) using the thyristor or triac. Inrush current is limited by the resistance connected with thyristor or triac in parallel when the input is turned on. Then once input current gose to continuously, thyristor or triac is turned on toreduce power loss of resistor. In this circuit needed consideration about serge capacity of thyristor and add thermal fuse or use resistor which includes thermal fuse inside.

Fig.5.2.3 Inrush current limiting with SCR



■The inrush current can be calculated from the following type.

$$\text{Inrush current value (at AC200V)} = \frac{200 \times \sqrt{2}}{R}$$

＊Please note, input current protection might not beactivated, if input ON/OFF interval is short.

5.2.5 Filtering circuit (Filtering capacitor) (C1)

■Becomes a calculation type same as the single phase input at three aspect input.
The expression is shown in the following.

■The selection of the filtering capacitor depends on the output hold-up time and the ripple current flowing in the capacitor.

■The hold-up time of three phase input is almost the same as the single phase input. The expression in the single phase input is used this time.

(1) Obtain the capacitance (Ch) from the output hold-up time as follows

$$Ch = \frac{2 \times Po \times Th}{(V1^2 - V2^2) \times \eta}$$

Ch : Capacity of the filtering capacitor
Po : Output power of module
Th : Hold-up time
V1 : Input DC voltage = Input potential (rms) $\times \sqrt{2}$
V2 : Input DC voltage which can hold output voltage
η : Efficiency of module

[Calculation example]
(1) DBS400B is used with AC200V.
(2) Hold-up time is assumed to be 20ms with AC200V.
(3) The efficiency of DBS400B is assumed to be 85%.

$$Ch = \frac{2 \times 400W \times (20ms+5ms)}{\{(200 \times \sqrt{2}V)^2 - (165V)^2\} \times 0.85}$$
$$= 446\mu F$$

*5ms in the formula above is added considering the ripple voltage of the filtering capacitor.

(2) Obtain the ripple current for selection of the capacitor as follows
[Calculation example]

$$\text{Ripple current} = \frac{2.5 \times 400W}{200V}$$
$$= 5A$$

Po : Output power of module
Vin : Input voltage

Table 5.2.4
Ripple current value

Output power of module	100V	200V
50W	1.25A	0.625A
100W	2.5A	1.25A
150W	3.75A	1.875A
200W	5.0A	2.5A
400W	10.0A	5.0A
600W	15.0A	7.5A
800W	20.0A	10.0A

MEMO

6. DPF and DPA series

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6.1 Overview

■DPF1000 and DPA500F are AC-DC front-end modules for DBS series. These modules have the power factor correction and the harmonic current reduction function.

■DPF1000 is able to output 1000W (AC100V) /1500W (AC200V), and DPA500F is able to output 500W (AC100V) /750W (AC200V). When DBS module's efficiency is 80%, 800W (AC100V) /1200W (AC200V) power supply system can be configured by using DPF1000.

■The power factor correction circuit of DPF1000 and DPA500F consist of boost converter.
The output voltage is higher than the input voltage. When power factor correction function is disabled, rectified input voltage can still be present at the module output.

■DPF1000 and DPA500F provide control signals for system design, these signals control the DBS operation as shown in Fig.6.1.5.

Fig.6.1.1
Input current waveform
(DPF1000 AC100V)

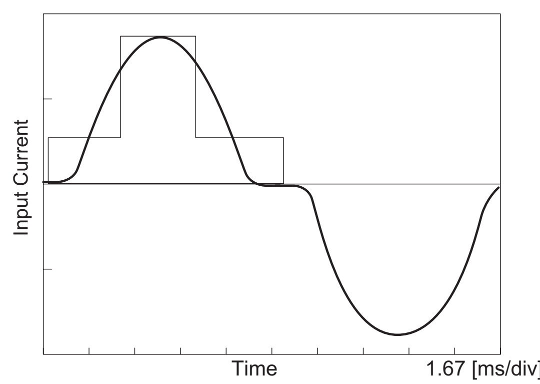


Fig.6.1.2
Harmonics current
(DPF1000 AC100V)

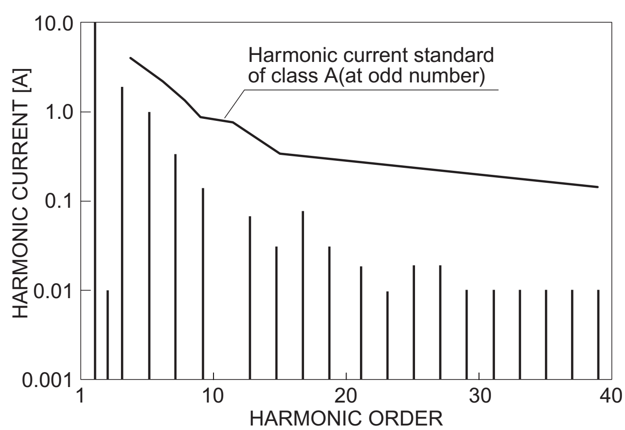


Fig.6.1.3
Maximum output power
by Input voltage

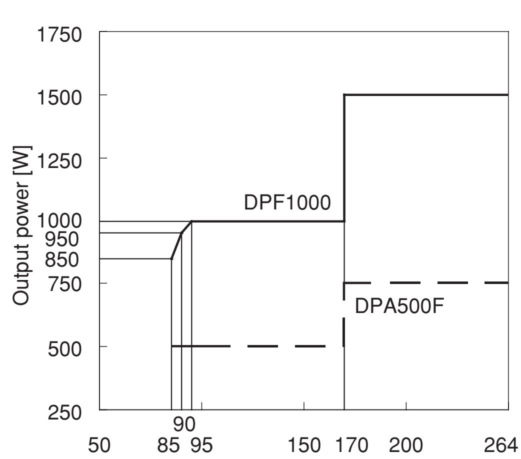


Fig.6.1.4
Output voltage
(Actual data)

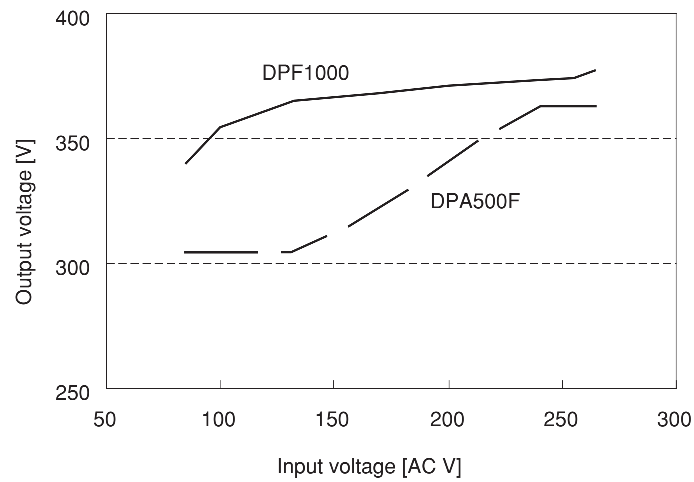
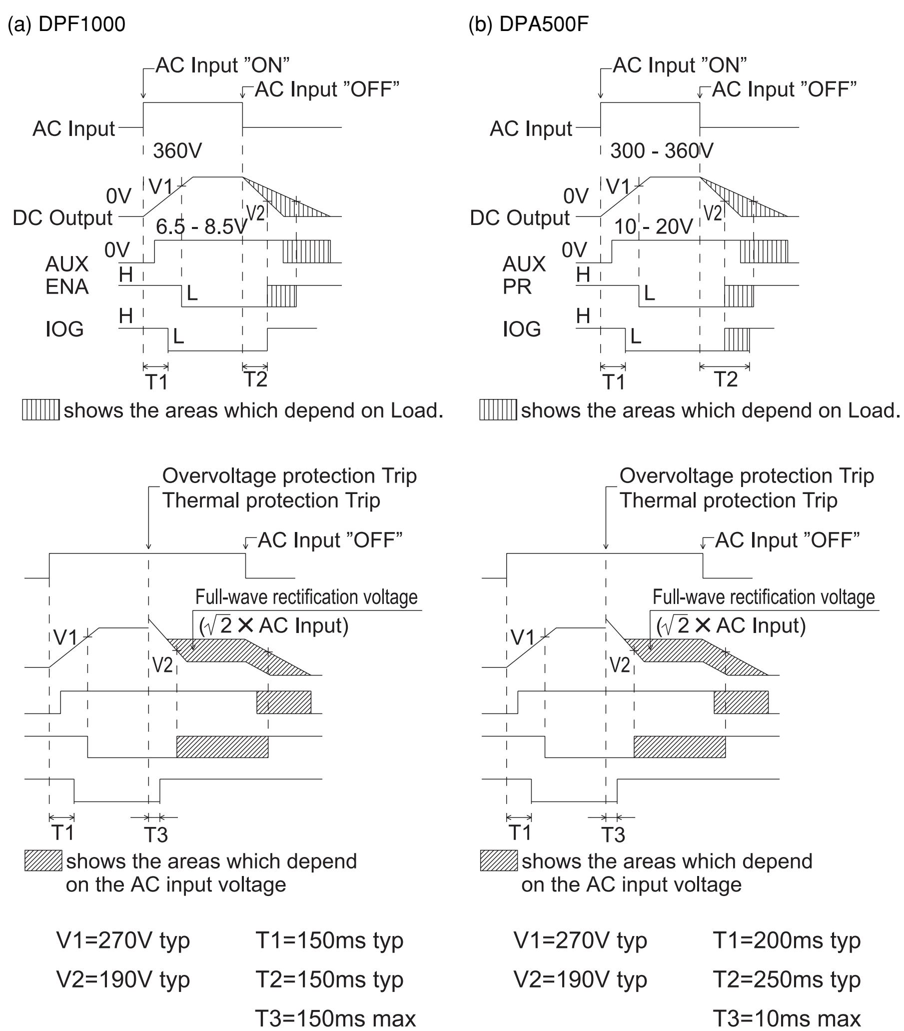


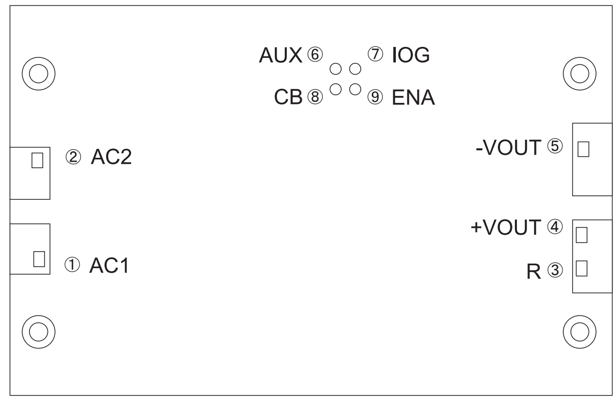
Fig.6.1.5
Sequence chart



DPF1000		DPA500F	
V1=270V typ	T1=150ms typ	V1=270V typ	T1=200ms typ
V2=190V typ	T2=150ms typ	V2=190V typ	T2=250ms typ
	T3=150ms max		T3=10ms max

Fig.6.1.6
Pin configuration
(bottom view)

(a) DPF1000



(b) DPA500F

Table 6.1.1
Pin configuration and
function (DPF1000)

No.	Pin connection	Function	Reference
①	AC1	AC Input	6.3.1 Wiring input pin
②	AC2		
③	R	External resistor for inrush current protection	6.3.2 Wiring output pin
④	+VOUT	+DC Output	
⑤	-VOUT	-DC Output	
⑥	AUX	Auxiliary power supply for external signal	6.4.2 Control signals
⑦	IOG	Inverter operation monitor	
⑧	CB	Current balance	6.5.2 Parallel operation
⑨	ENA	Enable signal	6.4.2 Control signals
─	FG	Frame ground	6.3 Wiring input / output pin

Table 6.1.2
Pin configuration and function (DPA500F)

No.	Pin connection	Function	Reference
①	CB	Current balance	6.5.2 Parallel operation
②	IOG	Inverter operation monitor	6.4.2 Control signals
③	AC	AC Input	6.3.1 Wiring input pin
④	AC		
⑤	SR	Inrush current protection	6.3.2 Wiring output pin
⑥	R	External resistor for inrush current protection	
⑦	DC OUT+V	+DC Output	
⑧	DC OUT−V	−DC Output	
⑨	PR	Power ready signal	6.4.2 Control signals
⑩	AUX	Auxiliary power supply for external signal	
−	FG	Frame ground	6.3 Wiring input / output pin

6.2 Connection for standard use

■DPF1000 and DPA500F must be used with some external components (fuse, noise filter, inrush current limiting resistor and heat sink).

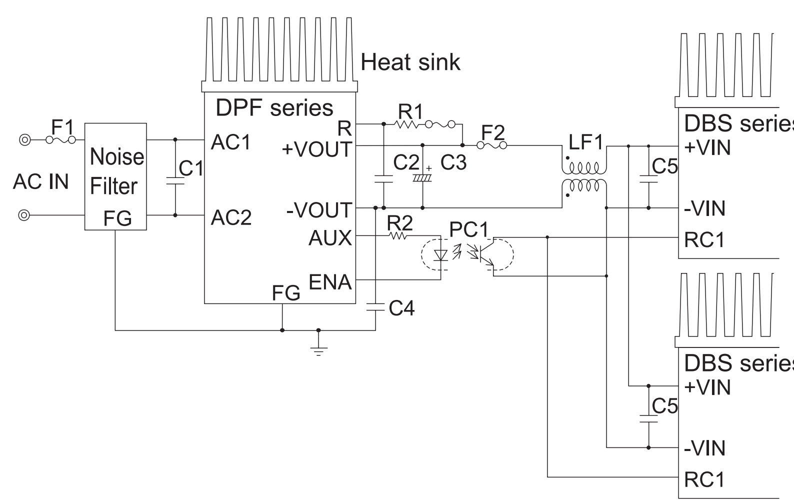
6.2.1 When the output power is exceed 400W

■Use the DPF1000 as shown in Fig.6.2.1 for applications require 400W or more from the power supply system.

■DPF1000 is non-isolated between input and output.

■The power supply adopts the conduction cooling system. Attach a heat sink onto the aluminum base plate to cool the power module for use.

Fig.6.2.1
Example of connection circuit, DPF1000/DBS.



6.2.2 When the output power is up to 400W

■Use the DPA500F as shown in Fig.6.2.2 for applications requiring less than 400W from the power supply system.

■DPA500F is non-isolated between input and output.

■The power supply adopts the conduction cooling system. Attach a heat sink onto the aluminum base plate to cool the power module for use.

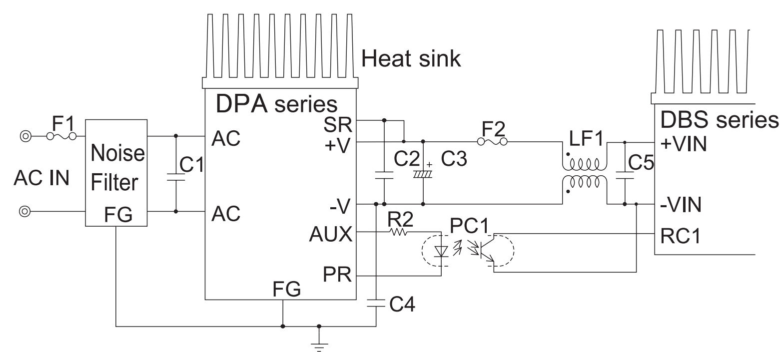


Fig.6.2.2 Example of connection circuit, DPA500F/DBS.

6.3 Wiring input / output pin

6.3.1 Wiring input pin

(1) Input fuse F1

■Fuse is not built-in at input side. In order to secure the safety of the unit, use the slow-blow type fuse as shown in Table 6.3.1 on the input line.

■When two or more units are used, such as a parallel operation, install a fuse for each unit.

Table 6.3.1 Input fuse

No.	Module	Recommended fuse	
		AC100V	AC200V
1	DPA500F	10A/AC250V	7.5A/AC250V
2	DPF1000	20A/AC250V	15A/AC250V

(2) Noise filter NF1

■Noise filter is not built-in at input side. Install an external noise filter to reduce the line-noise and to keep stable operation of the module.

■Install a correspondence filter as shown in chapter 6.6, if a EMI standard is required.

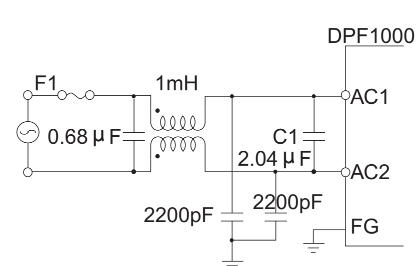
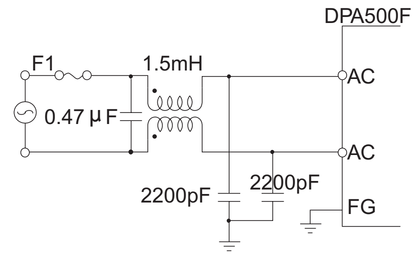


Fig.6.3.1 Recommended filter for DPF1000

Fig.6.3.2
Recommended filter
for DPA500F



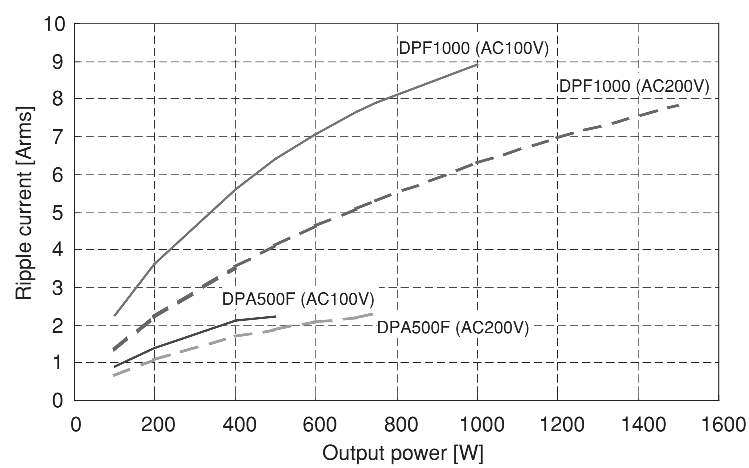
(3) External capacitor on the input side C1

■Install an external capacitor C1 as shown in Table 6.3.2 to reduce the line-noise and to keep stable operation of the module.
Use a film capacitor with rated AC250V to meet the safety standards.
Rated ripple current must be more than Fig.6.3.3.

Table 6.3.2
External capacitor on
the input side

No.	Module	Capacitance	Recommended capacitor
1	DPA500F	0.47μF min	OKAYA RE series
2	DPF1000	2μF min	

Fig.6.3.3
Ripple current C1



6.3.2 Wiring output pin

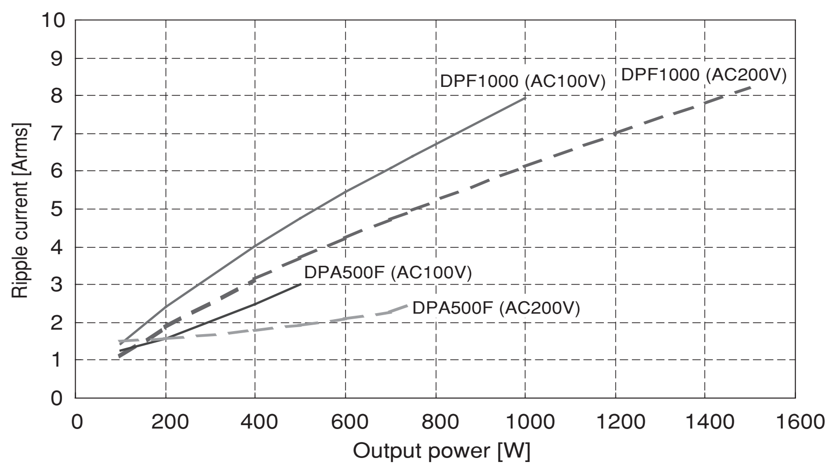
(1) External capacitor on the output side C2

■Install an external capacitor C2 as close as possible to the output pins for stable operation of the module.
Use a film capacitor with rated over DC400V.
Rated ripple current must be more than Fig.6.3.4.
Recommended capacitance of C2 is shown in Table 6.3.3.

Table 6.3.3
External capacitor on the output side

No.	Module	Capacitance	Recommended capacitor
1	DPA500F	0.1μF min	OKAYA HCE series RUBICON MMW-HP series
2	DPF1000	1μF min	

Fig.6.3.4
Ripple current C1



(2) Decoupling capacitor C4

■Install a decoupling capacitor C4, as shown in Table 6.3.4, as close as possible to the output pins for stable operation of the module. Use the Y capacitor with rated AC250V to meet the safety standards.

Table 6.3.4
Decoupling capacitor

No.	Module	Capacitance
1	DPA500F	1000pF min
2	DPF1000	2200pF min

(3) Holdup capacitor C3

■DPF1000 and DPA500F do not provide holdup capacitor.
Connect the electrolytic capacitor near the output pins.
Follow the guidelines below to select an electrolytic capacitor with an appropriate capacitance and ripple current rating considering the output ripple voltage, holdup time and life.

■The capacity should be with in range of Table 6.3.5.
Do not exceed the total capacity shown in Table 6.3.5 including capacitance of back-end.
It may cause severe damage.

Table 6.3.5
Holdup capacitor

No.	Module	Capacitance
1	DPA500F	120 - 1000μF
2	DPF1000	220 - 2200μF

■Design procedure of holdup capacitor

1) Output ripple voltage

Obtain the required capacity from the output ripple voltage.
Make sure that the output ripple voltage is less than 15Vp-p.

$$Co \geqq \frac{Po}{2\pi f \times Vrpl \times Vo} \quad \cdots (1)$$

Co: Capacitance of the holdup capacitor [F]
Vrpl: Output ripple voltage [Vp-p]
Po: DPA500F, DPF1000 output power [W]
f: Input frequency (50Hz/60Hz) [Hz]
Vo: Output voltage (Refer to Fig.6.3.5) [V]

2) Holdup time

Obtain the required capacity from the holdup time required for the system.

$$Co \geqq \frac{2 \times Po \times Th}{(Vo - Vrpl/2)^2 - Vmin^2} \quad \cdots (2)$$

Co: Capacitance of the holdup capacitor [F]
Th: Holdup time [S]
Po: DPA500F-360 output power [W]
Vo: Output voltage (Refer to Fig.6.3.5) [V]
Vrpl: Output ripple voltage [Vp-p]
Vmin: Minimum input voltage of DC-DC converter [V]

3) Ripple current

Obtain the ripple current for low frequency and high frequency from Fig.6.3.6. Use Formula (3) to calculate the total ripple current. Use a capacitor with the ripple current rating above the resulting value. Since the correction factor of allowable ripple current frequency (K) varies depending on the capacitor, check the exact value in the catalog of the capacitor.

$$Ir = \sqrt{I_L^2 + (I_H/K)^2} \quad \cdots\cdots\cdots (3)$$

Ir: Ripple current flowing into the holdup capacitor [Arms]
I_L: Low frequency ripple current (Refer to Fig.6.3.6) [Arms]
I_H: High frequency ripple current (Refer to Fig.6.3.6) [Arms]
K: Correction factor of the allowable ripple current frequency

Fig.6.3.5
Output voltage
(Actually measured data)

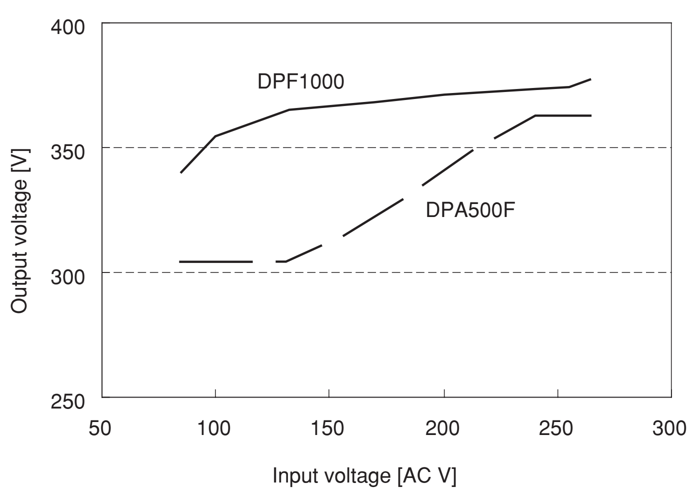
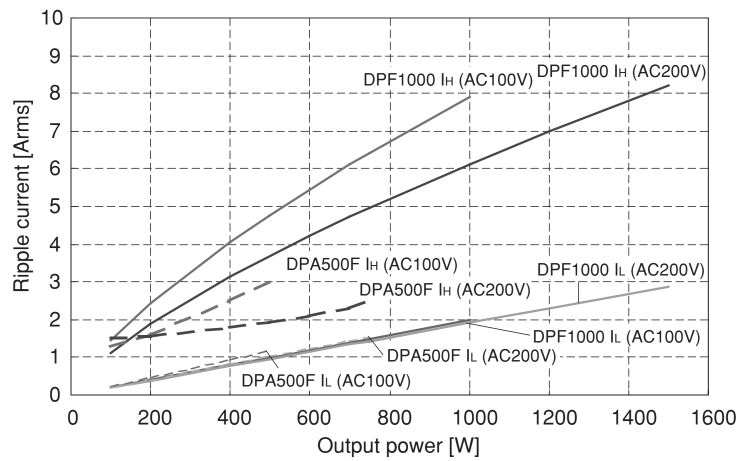


Fig.6.3.6
Output ripple current



4) Selection of electrolytic capacitor

Use the electrolytic capacitor which meets the capacitance calculated in (1) and (2) above and the ripple current rating obtained in (3). When selecting the electrolytic capacitor, take into consideration the tolerance of the capacitor. Note that an electrolytic capacitor has a limited lifetime. The lifetime of the electrolytic capacitor is determined by the capacitor temperature, which can be estimated by the formula (4) below. To improve the reliability of the system, select an electrolytic capacitor which has a long enough lifetime (Lo).

$$Lx = Lo \times 2^{(To-Tx)/10} \quad \cdots\cdots\cdots\cdots (4)$$

Lx: Expected life time [H]

Lo: Guaranteed lifetime of the electrolytic capacitor [H]

To: Maximum rated operating temperature Lo [℃]

Tx: Electrolytic capacitor temperature for use [℃]

5) Example calculation result

The following values are calculated in a similar manner :

Table 6.3.6
Example of holdup capacitor

No.	Module	Front-end output power	AC100V, TH=20ms		AC200V, TH=20ms	
			Co	Ir	Co	Ir
1	DPA500F	250W	270μF min	1.6A	220μF min	1.4A
2		500W	560μF min	2.5A	390μF min	1.8A
3		750W	—	—	560μF min	2.4A
4	DPF1000	1000W	680μF min	6.0A	680μF min	4.8A
5		1500W	—	—	820μF min	6.6A

This example is calculated as K=1.4.

(4) Inrush current limiting resistor R1

■Use of the following pins (SR or R) will reduce the inrush current when AC input voltage is applied. They prevent blowing the input fuse, welding of the switches and relays, and cutting off the no-fuse-breaker. Note either of the following pins must be connected to the +V pin to start the unit.

■R pin

In order to set the inrush current at desired level, connect an inrush current limiting resistor R1 between the R pin and the +V pin, and open the SR pin. Also, use the resistor which has a capacity to withstand a large enough surge and which has a built-in thermal fuse. Consult to your parts manufacturer regarding the surge current withstanding capacity of the external resistor.

■SR pin (for DPA500F only)

By connecting the SR pin and the +V pin, the inrush current can be reduced when the AC input voltage is applied. The interval the AC input ON/OFF must be more than 7 seconds each time the AC input is applied.

Fig.6.3.7
Inrush current limiting circuit using an external resistance R1

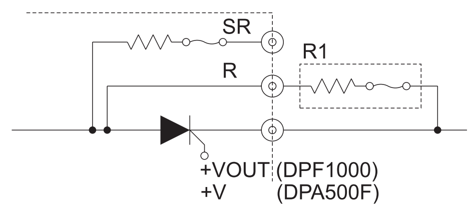


Fig.6.3.8
Inrush current limiting circuit using the SR pin

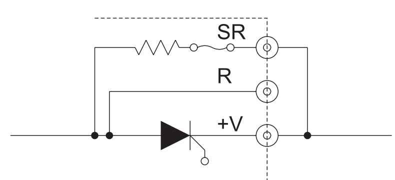


Table 6.3.7
Example of inrush current limiting resistor

No.	Module	Front-end output power	Holdup capacitor Co	Inrush current limiting resistor R1	Inrush current	
					AC100Vin	AC200Vin
1	DPA500F	250W	470μF	10Ω	15Atyp	30Atyp
2		500W	1000μF	10Ω	15Atyp	30Atyp
3		750W	1000μF	10Ω	15Atyp	30Atyp
4	DPF1000	1000W	2000μF	4.7Ω	30Atyp	60Atyp
5		1500W	2000μF	4.7Ω	30Atyp	60Atyp

Note : Use the resistor which has a capacity to withstand a large enough surge and which has a built-in thermal fuse.

■The overcurrent protection circuit is not built-in. In order to secure the safety of the unit, use the normal-blow type fuse as shown in Table 6.3.8 on the output line.

Table 6.3.8
Output fuse

No.	Module	Recommended fuse
1	DPA500F	10A/DC400V
2	DPF1000	10A/DC400V

DBS series CBS series CDS series Application Circuits Input Rectifier Circuit DPF and DPA series STA series Thermal Considerations Agency Approvals Product Weights Glossary of Technical Terms

6.4 Function

6.4.1 Protection circuit

(1) Overcurrent protection

■The overcurrent protection circuit is not built-in.
In order to secure the safety of the unit, use the normal-blow type fuse as shown in Table 6.3.8 on the output line.

(2) Overvoltage protection

■The overvoltage protection circuit is built-in. The AC input should be turned off if overvoltage protection is activated. The minimum interval of AC ON/OFF for recovery is a few minutes which output voltage drops below 20V.
When this function operates, the power factor corrector function does not operate, and output voltage becomes the full-wave rectified AC input voltage.

●Remarks :
Please note that the unit's internal components may be damaged if excessive voltage (over rated voltage) is applied to output terminal of power supply. This could happen when the customer tests the overvoltage protection of the unit.

(3) Thermal protection

■Thermal protection circuit is built-in and it works at 100±15 at base plate.
When this function operates, the power factor corrector function does not operate, and output voltage becomes the full-wave rectified AC input voltage.

■When this function is activated, input voltage should be turned and remove all possible causes of overheating, and cool down the temperature to normal level. To prevent the unit from overheating, avoid using the unit in a dusty, poorly ventilated environment.

6.4.2 Control signals

(1) Inverter operation monitor (IOG)

■IOG can be used for monitoring failures such as redundant operation.

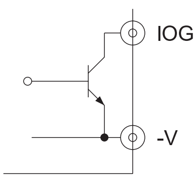
■Use IOG to monitor operation of the inverter. In the case of abnormal operation, status is changed from ”L” to ”H” within one second.

■IOG may become unstable in case of start-up or sudden change of load current. Set the timer with delay of more than 5 seconds.

■During parallel operation, unstable condition may occur when load current becomes lower than 10% of rated value. (for DPF1000 only)

■The sequence of the IOG signal is shown in Fig.6.1.5.

Fig.6.4.1
IOG pin



(2) Enable signal (ENA) /Power Ready signal (PR)

■Use ENA or PR to control starting of the power supply as load.

■When inrush current protection circuit is released, ENA outputs "LOW".

■When inrush current protection circuit is released, PR outputs "LOW".

■If load current flows without releasing of the circuit, the resistor may be burnt.

Fig.6.4.2
ENA / PR pin

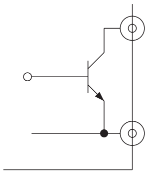
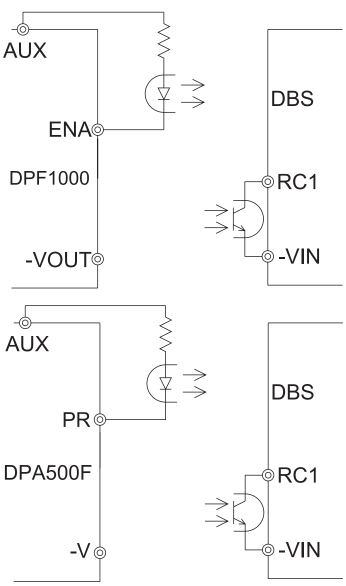


Fig.6.4.3
Example of connection to the DBS



(3) Auxiliary power supply circuit for external signal (AUX)

■The AUX pin can be used as the power source with the open collector output for IOG and ENA.

■When used with AUX pin of additional units of this model for parallel connection, make sure to install a diode and that the maximum output current must be up to 10mA.

■The AUX pin of DPA500F and DPF1000 are not able to connect in parallel. It may damage the unit.

■Never let a short circuit between the AUX pin and other pins. It may damage the unit.

Table 6.4.1
Auxiliary power supply circuit for external signal

No.	Module	Output voltage	Maximum output current
1	DPA500F	DC10 - 20V	10mA max
2	DPF1000	DC6.5 - 8.5V	10mA max

6.4.3 Others

(1) Isolation

■For a receiving inspection, such as Hi-Pot test, gradually increase (decrease) the voltage for a start (shut down). Avoid using Hi-Pot tester with the timer because it may generate voltage a few times higher than the applied voltage, at ON/OFF of a timer.

6.5 Series and parallel operation

6.5.1 Series operation

■As input and output are not isolated, series operation is not possible.

6.5.2 Parallel operation

■Parallel operation is available by connecting the units as shown in Fig.6.5.1 or Fig.6.5.2.

■As variance of output current drew from each power supply maximum 10%, the total output current must not exceed the value determined by the following equation.
(Output current in parallel operation) = (the rated current per unit) × (number of unit) × 0.9

■When the output-line impedance is high, the power supply become unstable. Use same length and thickness (width) wire (pattern) for the current balance improvement.

■Install an external capacitor C2 near the output pins for stable operation of the module.

■Connect between the input pins of each module for the lowest possible impedance. When the number of the units in parallel operation increases, input current increases. Adequate wiring design is required for input circuitry such as circuit pattern, wiring and load current.

■If temperatures of aluminum base plates are different in the power supply for parallel operation, output current will change greatly. Please note to equalize plate temperatures by attaching the same heat sinks.

■Output diode Di is not required if total holdup capacitor in parallel connection is smaller than value of below table.

Table 6.5.1
Output capacitance of
Di non-required

No.	Module	Total output capacitance
1	DPA500F	1000μF max
2	DPF1000	2500μF max

■In parallel operation, please connect diode to the +side of the output circuit. If diode is connected to the -side, it will damage the unit or/and, the balancing function will not work.

Fig.6.5.1
Connection for parallel operation (DPA500F)

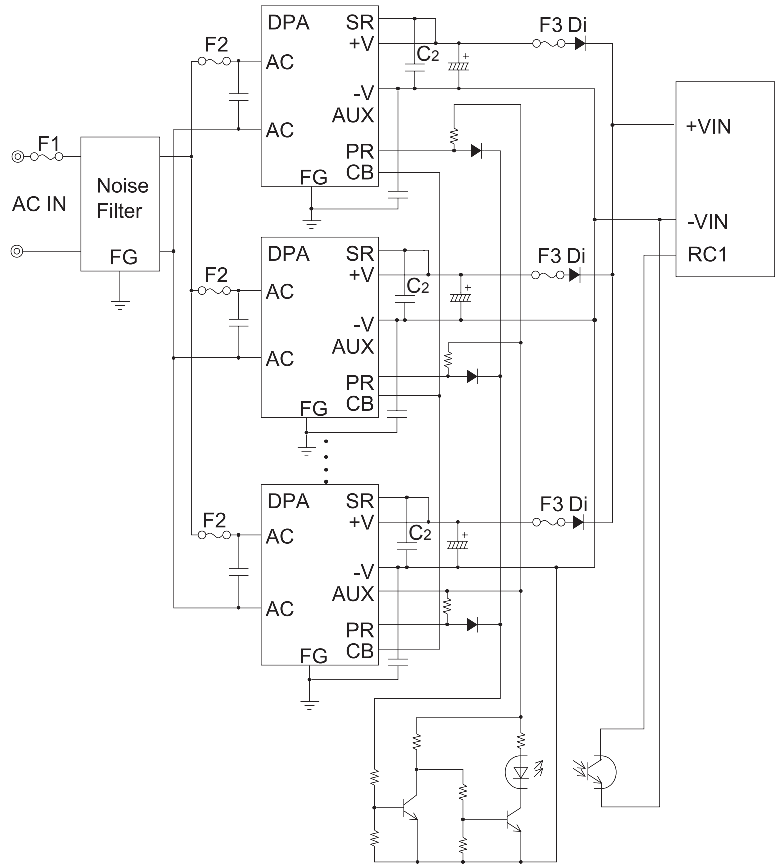
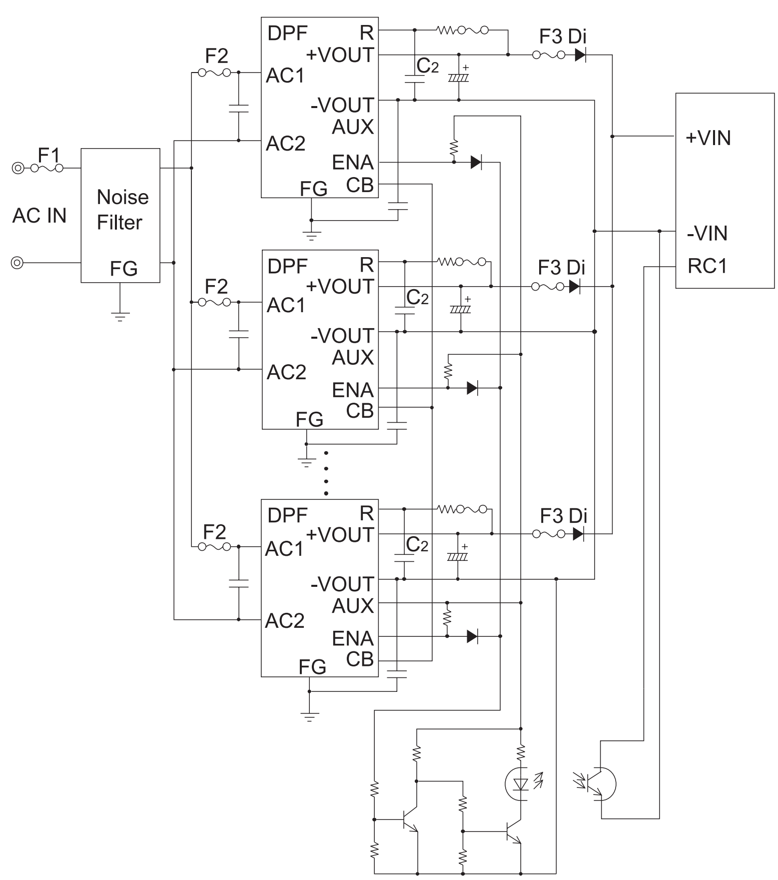


Fig.6.5.2
Connection for parallel operation (DPF1000)



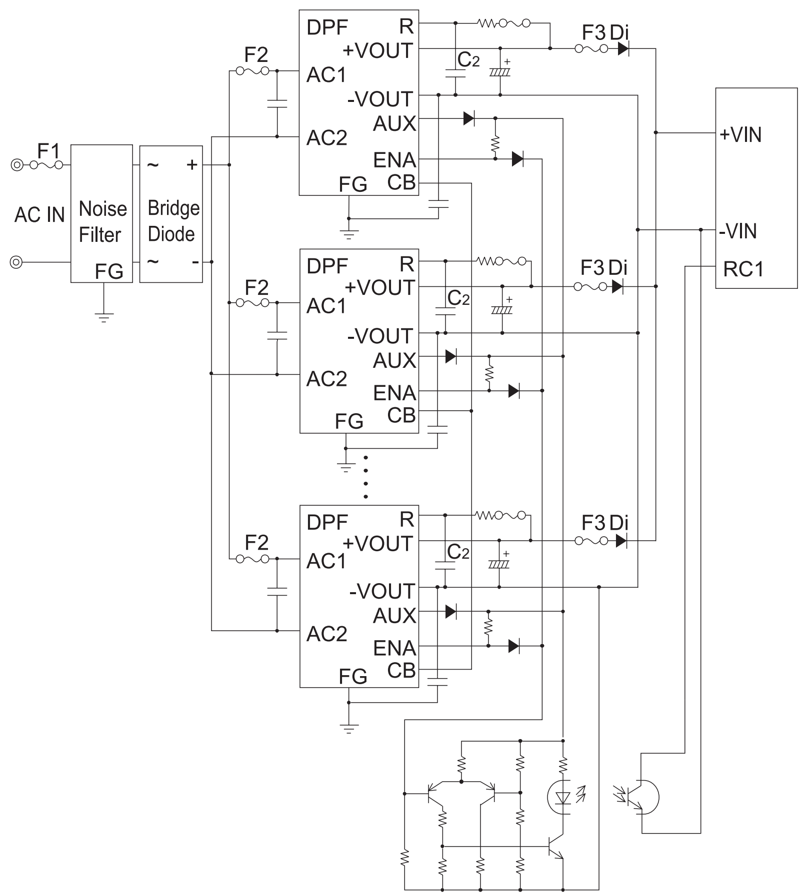
6.5.3 N+1 redundant operation

■DPF1000 provide set N+1 redundant operation for improving reliability of power supply system. Connect as shown in Fig.6.5.3.

■Purpose of redundant operation is to ensure stable operation the event of single power supply failure. Since extra power supply is reserved for the failure condition, so total power of redundant operation is equal to N.

■DPA500F dose not provide N+1 redundant operation.

Fig.6.5.3
N+1 redundant
operation (DPF1000)

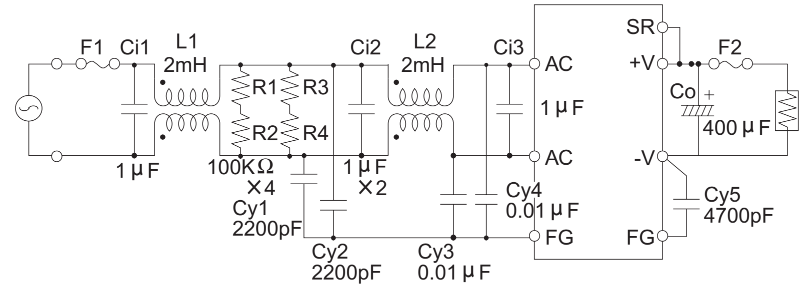


6.6 EMI

■The recommended circuit to meet noise standard CISPR Pub.22.

■The noise may vary greatly, depending on the implementation, being affected by the stray capacity, wiring inductance and leakage flux. Check if the noise filter is appropriate on the final product.

Fig.6.6.1
Recommended filter
(DPA500F)



Ci1, Ci2, Ci3 : 1.0μF (RE series : OKAYA)

Cy1, Cy2 : AC250V 2200pF (KH series : MURATA)

Cy3, Cy4 : AC250V 0.01μF (KH series : MURATA)

Cy5 : AC250V 4700pF (KH series : MURATA)

L1, L2 : 2mH (SC series : TOKIN)

AC100Vin 500Wout

Fig.6.6.2
Noise level (DPA500F)

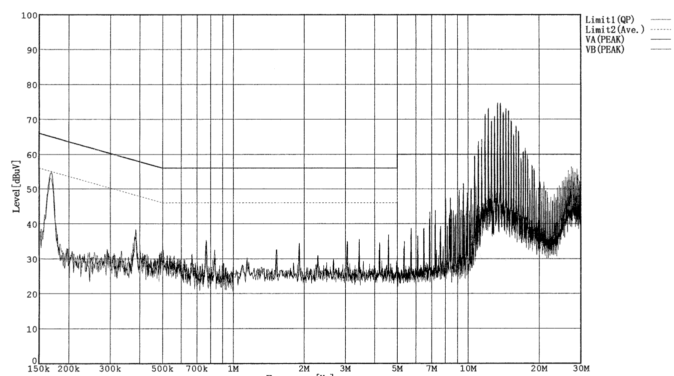
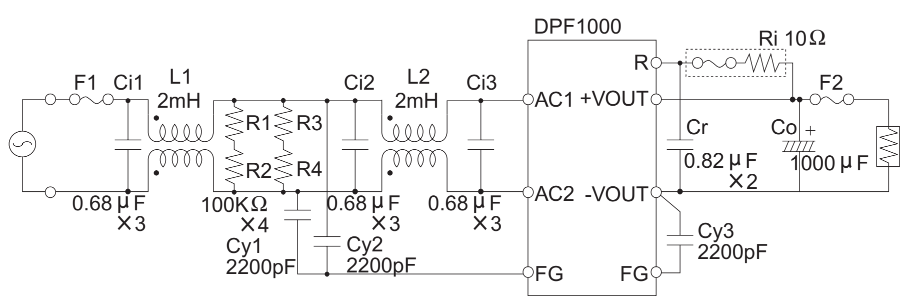


Fig.6.6.3
Recommended filter
(DPF1000)



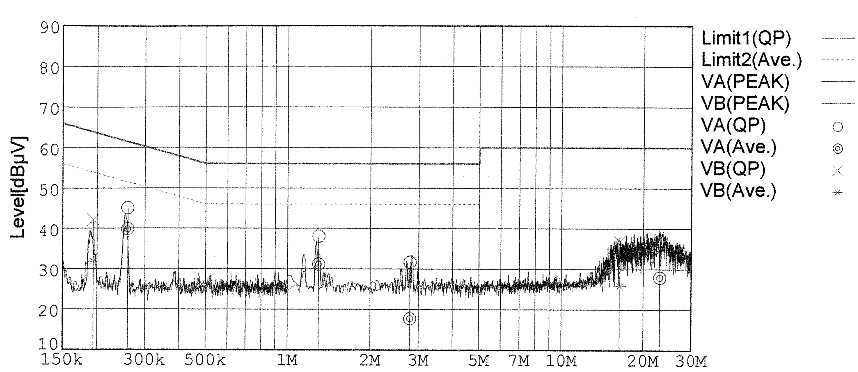
Ci1, Ci2, Ci3 : 0.68μF (RE series : OKAYA)

Cy1, Cy2, Cy3 : AC250V 2200pF (KH series : MURATA)

L1, L2 : 2mH (SC series : TOKIN)

AC100Vin 1000Wout

Fig.6.6.4
Noise level (DPF1000)



MEMO

7. STA series

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DBS series
CBS series
CDS series
Application Circuits
Input Rectifier Circuit
DPF and DPA series
STA series
Thermal Considerations
Agency Approvals
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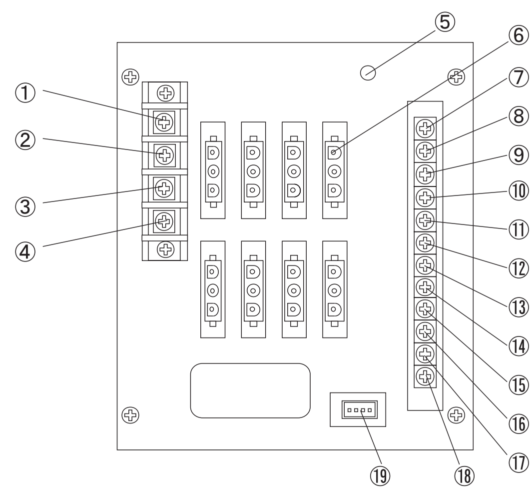
7.1 Overview

■STA5000T is an extremely small-sized AC front-end unit with three phase input and power factor correction for the power modules.
■Input voltage AC170V to AC264V, output 5,000W size 131.5 × 144 × 250 (W × H × D) [mm].
■Output sequence control unit is available as option (-R).

7.2 Terminal block

Fig.7.2.1
Terminal block connection



⑦ - ⑱are available only in STA5000T-R

①AC (R)	⑨SYSTEM ON/OFF (+)
②AC (S)	⑩SYSTEM ON/OFF (−)
③AC (T)	⑪REMOTE SIGNAL1 ON/OFF (+)
④Frame ground	⑫REMOTE SIGNAL1 ON/OFF (−)
⑤LED	⑬REMOTE SIGNAL2 ON/OFF (+)
⑥Output connector (Io=8A max each)	⑭REMOTE SIGNAL2 ON/OFF (−)
⑦ALM (+)	⑮REMOTE SIGNAL3 ON/OFF (+)
⑧ALM (−)	⑯REMOTE SIGNAL3 ON/OFF (−)
	⑰REMOTE SIGNAL4 ON/OFF (+)
	⑱REMOTE SIGNAL4 ON/OFF (−)
	⑲SIGNAL (AL OUT, REMOTE ON/OFF) connector

7.3 Function

7.3.1 Input voltage range

■Input voltage range is from AC175V to AC264V 3 phase.
If AC input voltage is out of the range, the unit will not operate properly and/or may be damaged.

7.3.2 Inrush current limiting

■Inrush current limiting circuit is built-in.
If a switch on the input side is installed, please consider the serge current rating of the switch.
The thyristor method is used to protect from inrush current.
When power is turned ON/OFF repeatedly within a short period of time, it is necessary to have enough time between power ON and OFF to operate resistance circuit for inrush current.
Do not repeat ON and OFF with in short period of time.
If do so, inrush current limiting might not work and cause damage.

7.3.3 Overcurrent protection

■The input fuse provides protection against overcurrent.
This fuse blows when the output is short-circuited.
Replace only with the same type and rating of fuse.

7.3.4 Isolation

■For a receiving inspection, such as Hi-Pot test, gradually increase (decrease) the voltage for the start (shut down).
Avoid using Hi-Pot tester with the timer because it may generate voltage a few times higher than the applied voltage, at ON/OFF of a timer.

7.3.5 Thermal protection

■Inside temperature of the power unit (due to stop-page of the external fan, etc.) rises high thermal protection is activated.
Shut off the input voltage and wait until the power unit inside has been thoroughly cooled down before turn on input to recover output.

7.3.6 REMOTE ON/OFF

■The power unit has a built-in REMOTE ON/OFF circuit for controlling the DC-DC modules.
When AC input is turned on, the REMOTE ON/OFF signal turns from ”H” to ”L” after caudle several hundreds of millisecond.
Under the following situations, however, the REMOTE ON/OFF signal turns from ”L” to ”H”.
1) 1 of 3 phases is missing.

Table 7.3.1 Specifications of REMOTE ON/OFF

No.	Item	Specifications
1	Normal operation	Voltage level ”L”(0.5V max)
2	Halt	Voltage level ”H”(open circuit)

7.3.7 AL OUT

■STA5000T has a built-in alarm signal output.
When it detects fail, the AL OUT (ALM for STA5000T-R) signal turns from ”L” to ”H”.
1) 1 of the 3 phase is missing, due to equipment failure.
2) Activation of the thermal detection.
Note that the output voltage will not stop even when the alarm circuit works.
Shut off the input, otherwise the power unit may be damaged.

Table 7.3.2 Specifications of AL OUT

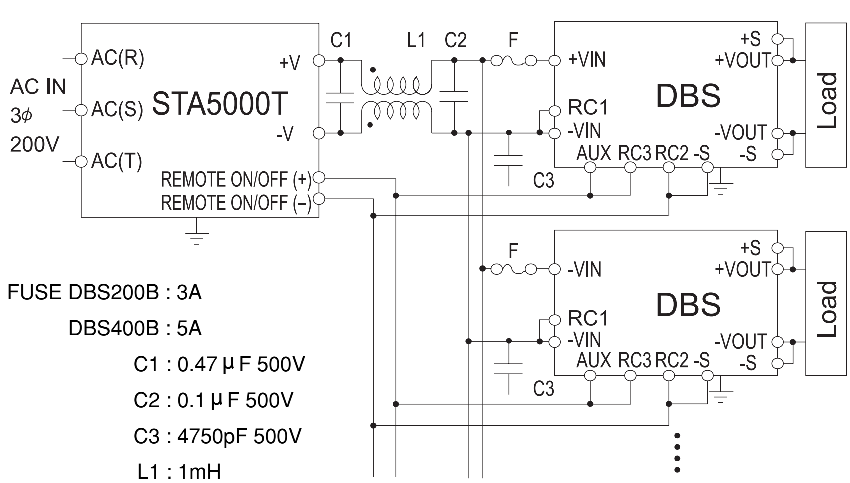
No.	Item	Specifications
1	Function	Normal operation ”L”
		Abnormal operation ”H”
2	Voltage level ”L”	0.5 V max at 5mA
3	Maximum applied voltage	35V max
4	Maximum sink current	70mA max

7.4 Connecting the unit to a DBS series

7.4.1 Connecting method

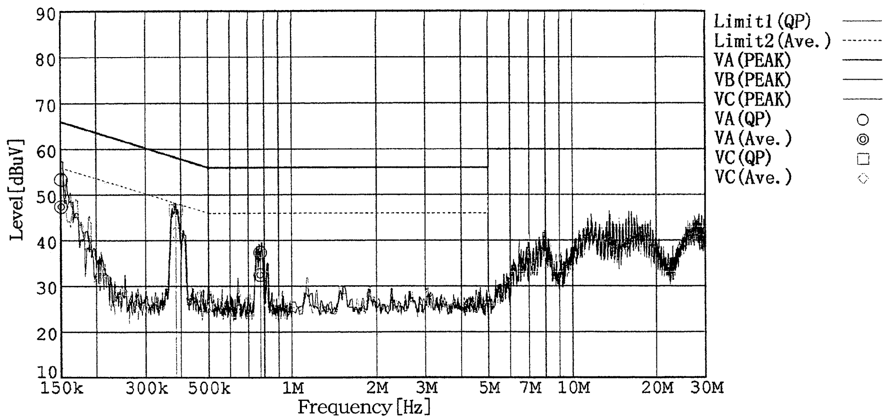
■Pay attention to these points when connecting a DBS series unit to the STA5000T.

Fig.7.4.1 Connection for standard use



FUSE DBS200B : 3A
DBS400B : 5A
C1 : 0.47μF 500V
C2 : 0.1μF 500V
C3 : 4750pF 500V
L1 : 1mH

Fig.7.4.2
Conducted noise level
(CISPR22-B)



Frequency	Measurement		Correction factor	Level		Line	CISPR22-B level		Margin	
[MHz]	(QP) [dBuV]	(Ave.) [dBuV]	[dB]	(QP) [dBuV]	(Ave.) [dBuV]	–	(QP) [dBuV]	(Ave.) [dBuV]	(QP) [dBuV]	(Ave.) [dBuV]
0.1506	43.0	37.0	10.3	53.3	47.3	VA	66.0	56.0	12.7	8.7
0.7718	27.2	22.4	10.1	37.3	32.5	VA	56.0	46.0	18.7	13.5
0.3842	36.0	31.4	10.2	46.2	41.6	VC	58.2	48.2	12.0	6.6

7.4.2 Sequence unit

■STA5000T can optionally be equipped with a sequence unit for controlling the DBS series unit's remote control circuits ON/OFF with a particular timing.

This sequence unit enables to control 4 DBS unit (max) start and stop with time difference.

The sequence unit operates by shorting the SYSTEM ON/OFF terminals to turn the status of the REMOTE SIGNAL 1 - 4 ON/OFF terminals from ”H” to ”L”.

Under the following situations, however, the signal from the REMOTE SIGNAL 1 - 4 ON/OFF terminals will change from ”L” to ”H”.

1) 1 of the 3 phases is missing, due to equipment failure, etc.

2) Activation of the thermal detection.

Power units equipped with a sequence unit have the model name ”STA5000T-R”.

＊1 For some users, external noise filter might be needed to meet noise regulation.

External noise filter is recommended to install to reduce radiation noise from the wiring, especially if the wiring is long.

＊2 Be sure to connect up the REMOTE ON/OFF terminals (or the REMOTE SIGNAL ON/OFF terminals in a STA5000T-R) before running the DBS.

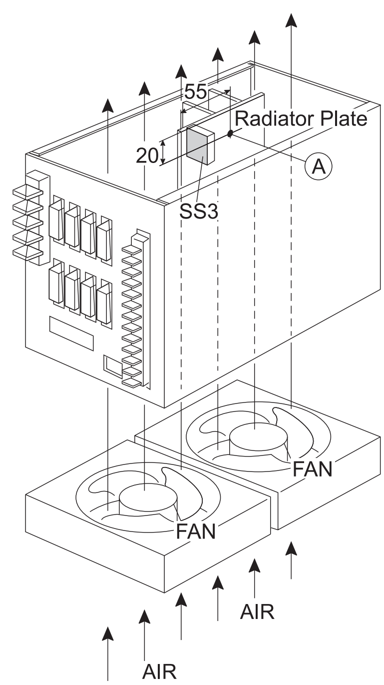
Using the DBS without those terminals connected could damage the STA5000T.

DBS series | CBS series | CDS series | Application Circuits | Input Rectifier Circuit | DPF and DPA series | STA series | Thermal Considerations | Agency Approvals | Product Weights | Glossary of Technical Terms

7.5 Cooling method

■The power unit is designed for use with forced cooling by external fans.
When the power unit is used, the temperature of part A of the unit should be below 75℃ by flowing cooling-air inside of unit uniformly.

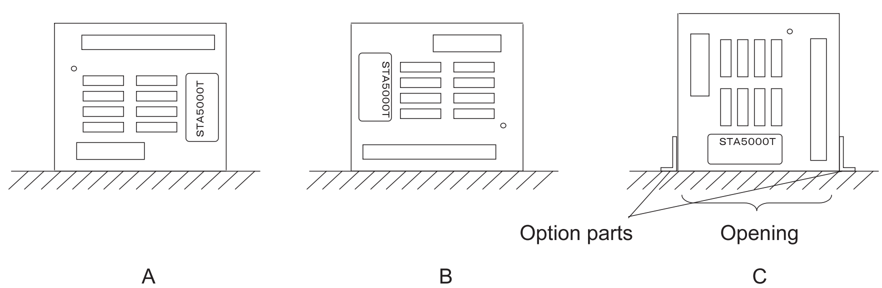
Fig.7.5.1
Cooling method



7.6 Installation method

(1) The mounting screw should be M4.
(2) Fix firmly, considering weight, impact and vibration.

Fig.7.6.1
Installation method



7.7 Options (-R)

7.7.1 SYSTEM ON/OFF

■REMOTE SIGNAL ON/OFF (R/S ON/OFF) can be controlled by SYSTEM ON/OFF signal.

Table 7.7.1
Specifications of
SYSTEM ON/OFF

No.	SYSTEM ON/OFF	Specifications	REMOTE SIGNAL
1	”L”	Short, 0 - 0.8V	”L”
2	”H”	Open(12V)	”H”

7.7.2 REMOTE SIGNAL ON/OFF (Terminal : REMOTE SIGNAL ON/OFF open collector)

■DC/DC converter ON/OFF is controlled by REMOTE SIGNAL ON/OFF.

Table 7.7.2
Specifications of
REMOTE SIGNAL
ON/OFF

No.	Item			Specifications
1	Function	DC-DC converter	Enable	”L”
			Disable	”H”
2	Voltage level ”L”			0.5V max at 5mA
3	Maximum applicable voltage			35V max
4	Maximum sink current			70mA max

7.7.3 ALM (Terminal : ALM open collector)

■Conditions of units are able to be monitored by ALM.

”L” indicates normal operation (short), and ”H” ALM signal indicates operating status of power supply operation is failed as explained below (open).

(1) ALM signal ”H” when the thermal protection is activated.

(2) ALM signal ”H” when 1 of 3 phase is missing.

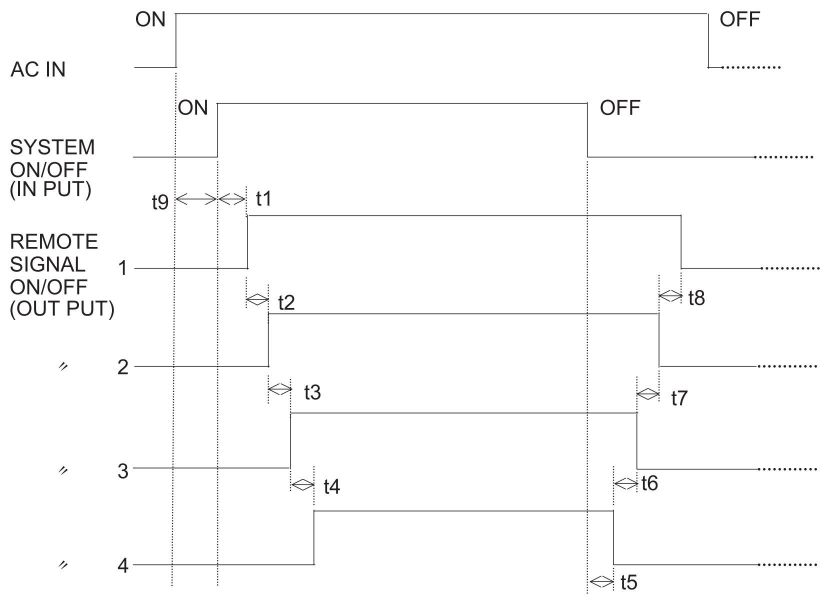
REMOTE SIGNAL ON/OFF is turned to ”H” when ALM signal is ”H” level.

Table 7.7.3
Specifications of ALM

No.	Item	Specifications
1	Function	Normal operation ”L”
		Abnormal operation ”H”
2	Voltage level ”L”	0.5V max at 5mA
3	Maximum applied voltage	35V max
4	Maximum sink current	70mA max

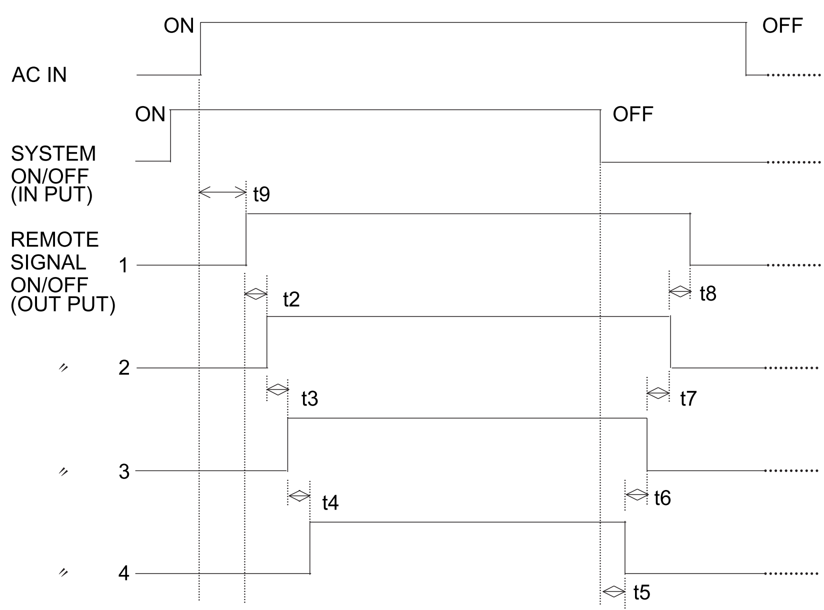
■Sequence chart (option)

Fig.7.7.1
SYSTEM ON/OFF
Input : "H"



t1:900ms max t2 - t4:600ms±25% t5:450ms max
t6 - t8:600ms±25% t9:1s max(Irregular area)

Fig.7.7.2
SYSTEM ON/OFF
Input : "L"



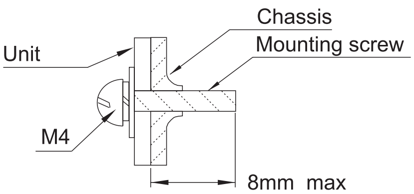
t2 - t4:600ms±25% t5:450ms max
t6 - t8:600ms±25% t9:1s max(Irregular area)

7.8 Do's and Don'ts

7.8.1 Mounting screw

■Keep isolation distance between screw and internal components as below chart.

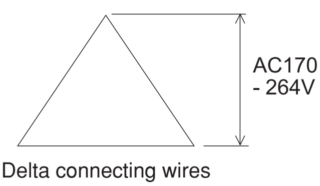
Fig.7.8.1
Mounting screw



7.8.2 Input voltage

■The input potential is three-phase AC200V (AC170 - 264V).
Voltage shown in Fig.7.8.2 must be applied to the input terminal.
Any phase ordering connection is acceptable.
Use only three-phase three-wire system for the input line (Fig.7.8.2).

Fig.7.8.2
Delta connection



MEMO

8. Thermal Considerations

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8.1 Overview

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

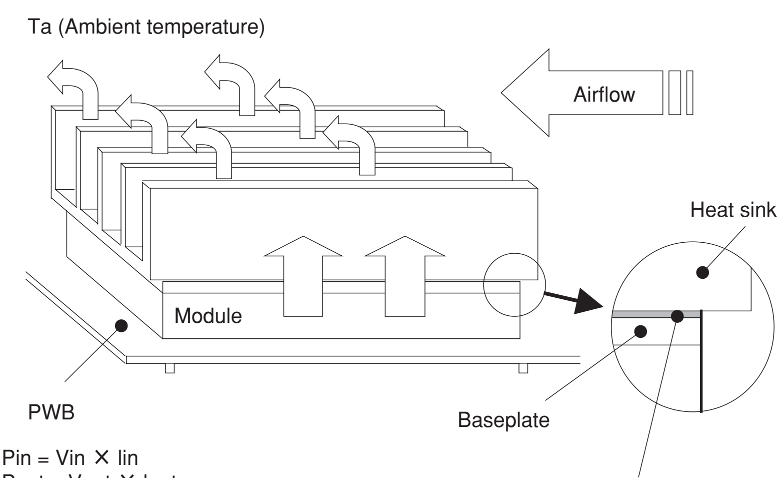
■Proper thermal design makes higher MTBF, smaller size and lower costs.

8.2 Efficiency and Dissipation power

■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 current.

■Efficiency is defined as percentage of Output power vs Input power. Efficiency (η) depends on input voltage and output current. Refer to the individual data. Here "Efficiency characteristic of CBS2004812" is shown in Fig.8.2.2 as an example.

Fig.8.2.1
Internal power dissipated



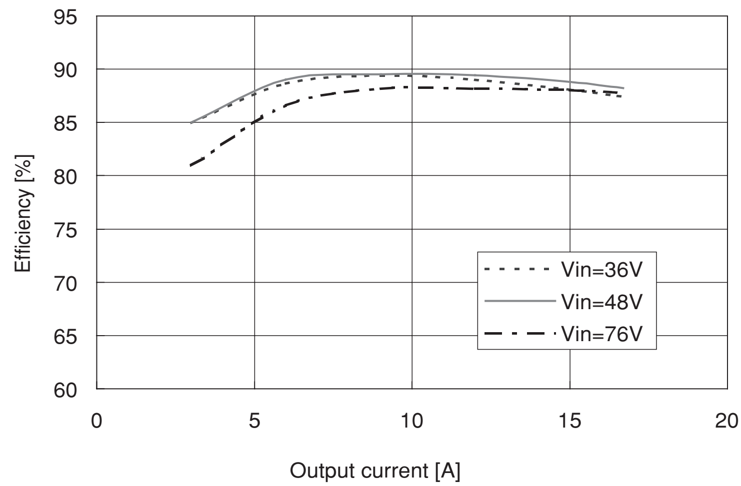
$$Pin = Vin \times Iin$$
$$Pout = Vout \times Iout$$

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

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

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

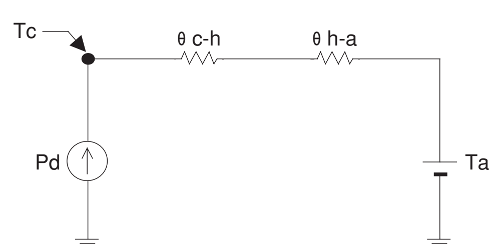
Fig.8.2.2
CBS2004812
Characteristics of
Efficiency vs.
Output current



8.3 Thermal resistance

■In most applications, heat will be conducted from the baseplate into an attached heat sink. Heat conducted across the interface between the baseplate and heat sink will result in a temperature drop which must be controlled. As shown in Fig.8.3.1, the interface can be modeled as a "thermal resistance" with the dissipated power flow.

Fig.8.3.1
Thermal resistance



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

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

θ h-a : Thermal resistance of Heat sink (℃/W) (Heat sink - Air)
θ c-h : Contact thermal resistance (℃/W) (Baseplate - Heat sink)
Pd : Internal power dissipated (W)
Tc : Baseplate temperature (℃)
Ta : Ambient temperature (℃)

■Contact thermal resistance is between baseplate 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.

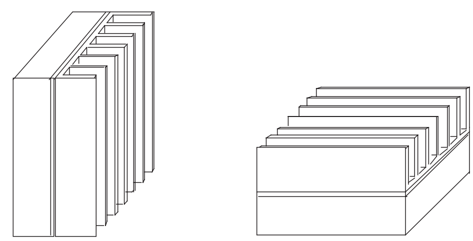
■The thermal grease and thermal pad have the following respective features.
(1) Thermal grease : low thermal resistance (0.2 - 0.3℃/W).
(2) Thermal pad : higher than thermal grease (0.3 - 0.4℃/W).

8.4 Convection cooling

■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 baseplate temperature. Thermal resistance depends on heat sink shape. Therefore, refer to the detailed thermal resistance data supplied by the manufacturer prior to the selection.

■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.8.4.1
Mounting method



(a) Vertical mounting (b) Horizontal mounting

8.5 Forced air cooling

■In forced air cooling method, heat dissipation ability of the heat sink improves much higher than convection cooling. Refer to 8.9 Heat sink size and Thermal resistance.
”Dirty” environments will require filters that must be changed regularly to maintain cooling efficiency, and neglecting to change a filter or the failure of the fan could cause the system to shut down or malfunction.

8.6 Notes on Thermal design

8.6.1 Baseplate temperature

■CBS series : Refer to Fig.8.6.1 for derating curve.
■DBS/CDS series : Refer to Fig.8.6.2 for derating curve.
■Measure the baseplate temperature at the center of the baseplate.

Fig.8.6.1
The CBS series
derating curve

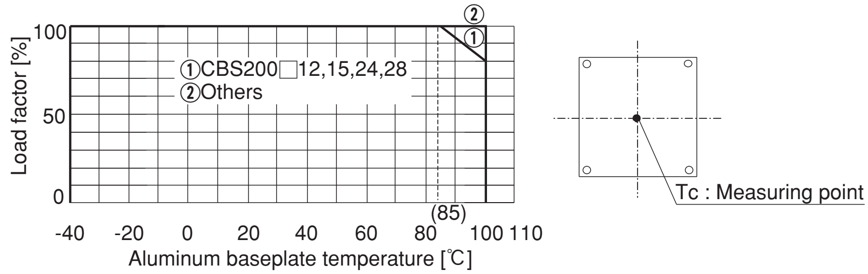
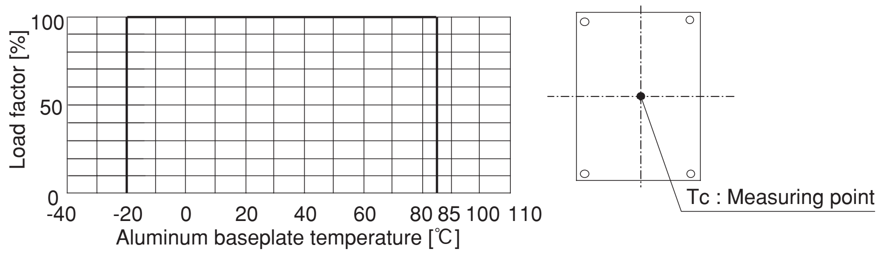


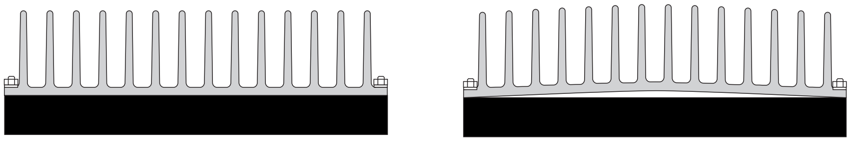
Fig.8.6.2
The DBS/CDS series
derating curve



8.6.2 Heat sink mounting

■The interface between the baseplate and heat sink is smooth, flat and free of debris.

■Unless the baseplate 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.



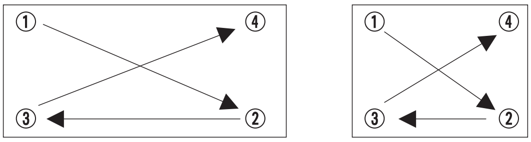
■To install the heat sink, fasten with screws through all four mounting holes.

■When mounting heat sinks to modules, use M3 screws torqued uniformly through the mounting holes provided. The following tightening sequence should be used.

(1) Lightly finger-tighten all screws.

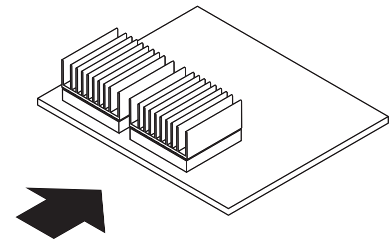
(2) Torque screws to 0.4N・m (5.0kg・cm) max as shown in Fig.8.6.3.

Fig.8.6.3
Torquing sequence

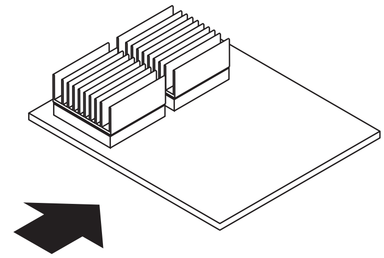


8.6.3 Installation of modules

■Stagger modules to improve cooling and facilitate even heat distribution between modules.

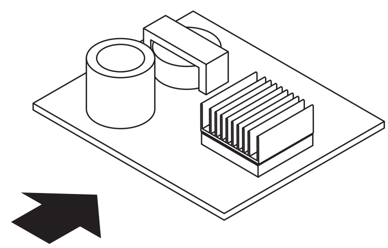


Good



Poor

■Avoid blocking the airflow to the modules with other components.



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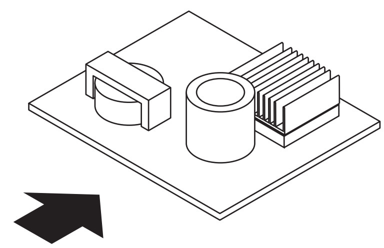
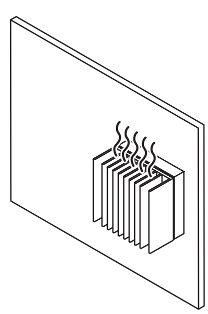


Poor

■Use a heat sink with fins running vertically for natural convection.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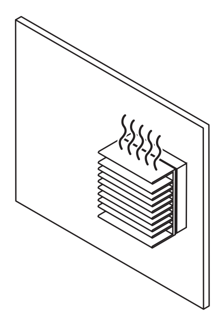

Poor

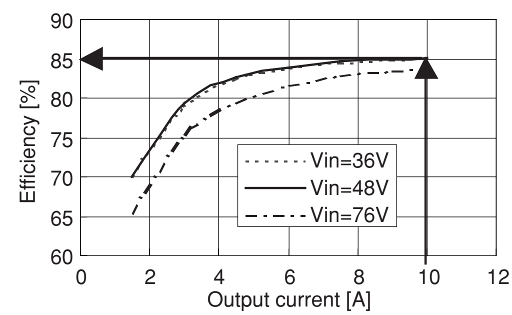
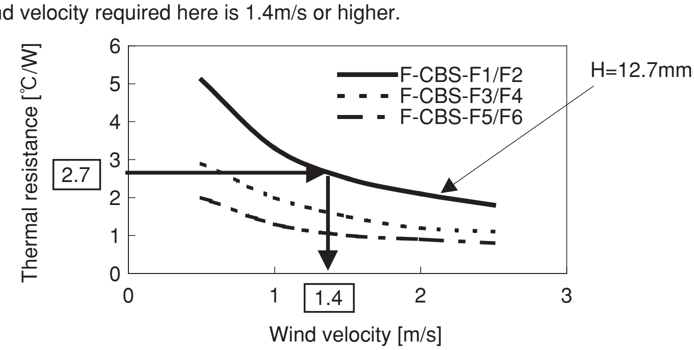
8.7 Thermal design example

■The process of thermal design is described through an example of CBS504805.

Conditions

Input voltage = 48 [V] Max. ambient temperature (Ta) = 50 [℃] Aluminum baseplate temperature (Tc) = 80 [℃]

Output voltage = 5 [V] Output current = 10 [A]

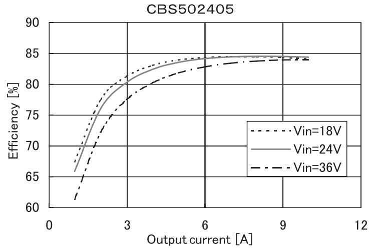
Step	Description	Design example
1	Determine the required output power (Pout) and ambient temperature (Ta) and aluminum baseplate temperature (Tc).	For higher reliability, the aluminum baseplate temperature is set up below 80℃. Ta = 50 [℃] Pout = 5 [V] × 10 [A] = 50 [W] Tc = 80 [℃]
2	Obtain the efficiency (η).	Efficiency (η) is obtained by Fig.8.7.1. Refer to 8.8 Efficiency vs. Output current. The efficiency of CBS504805 is obtained by operating at rated input (DC48V). The efficiency is 85% at DC48V input voltage and 100% output current. To give 2% efficiency will be : Efficiency (η) = 83 [%]  Fig.8.7.1 CBS504805 Characteristics of Efficiency vs. Output current
3	Calculate the internal power dissipation (Pd).	$Pd = \frac{1-0.83}{0.83} \times 50 = 10.2$ [W]
4	Obtain contact thermal resistance (θ c-h).	Use a thermal grease with a thermal resistance of 0.2℃/W.
5	Calculate thermal resistance of Heat sink (θ h-a).	$\theta h\text{-}a = \frac{80-50}{10.2} - 0.2 = 2.7$ [℃/W]
6	Choose the heat sink.	Use a heat sink with H = 12.7mm. Refer to Fig.8.9.1 F-CBS-F1.
7	Obtain the required wind velocity.	Wind velocity is obtained by Fig.8.7.2. The wind velocity required to reduce the resistance to set up 2.7℃/W or below. Refer to 8.9 Heat sink size and Thermal resistance. Wind velocity required here is 1.4m/s or higher.  Fig.8.7.2 Heat sink thermal resistance curves
8	Choose the fan.	Choose the fan capable of supplying air at a velocity of 1.4m/s or higher.
9	Check the design with actual equipment.	Experience shall be conducted with CBS504805. Measure the aluminum baseplate temperature at actual conditions (Pout = 50W, Ta = 50℃). Then confirm the baseplate temperature has been kept below 80℃. The thermal design is completed.

8.8 Efficiency vs. Output current

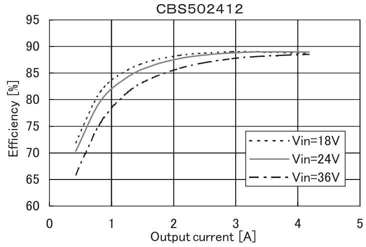
■CBS series

CBS5024

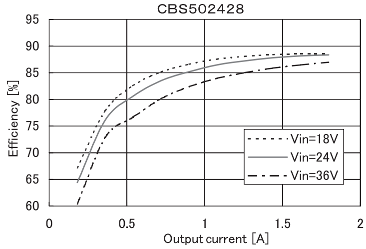
CBS502405



CBS502412

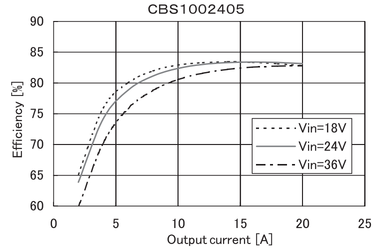


CBS502428

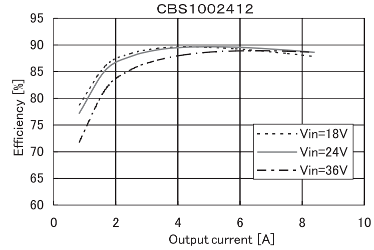


CBS10024

CBS1002405



CBS1002412



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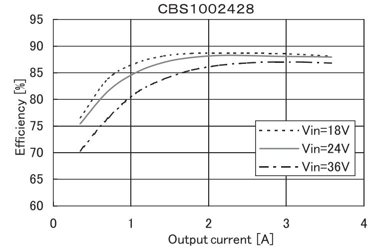
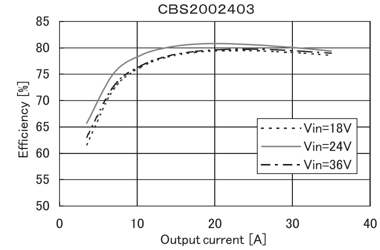
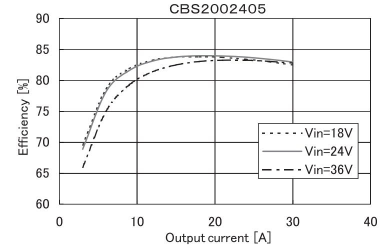


CBS20024

CBS2002403



CBS2002405



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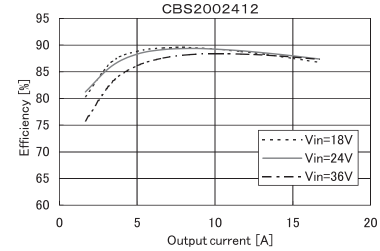

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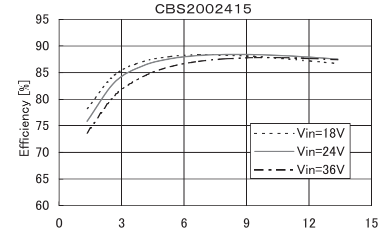
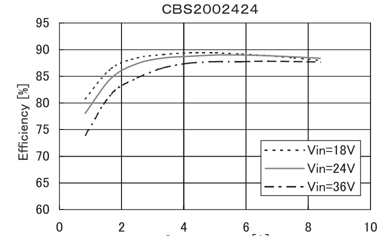


CBS2002424



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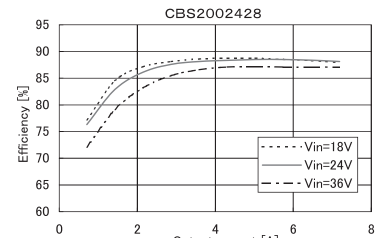
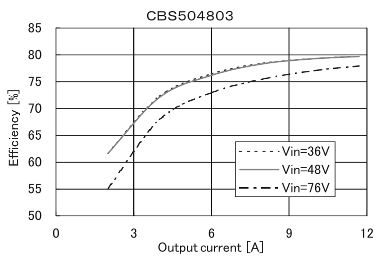
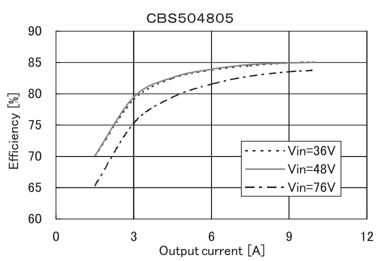
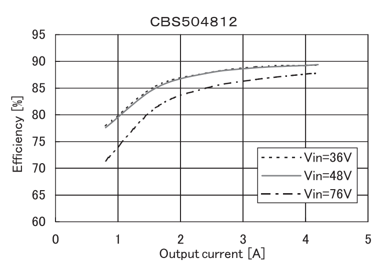
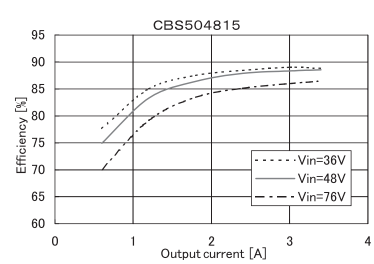


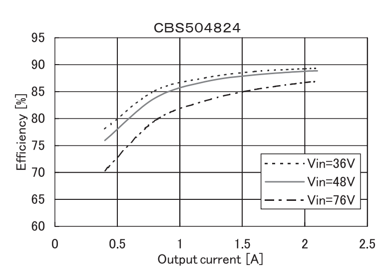
CBS5048

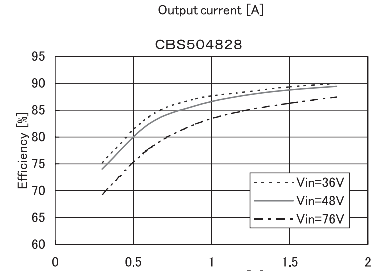












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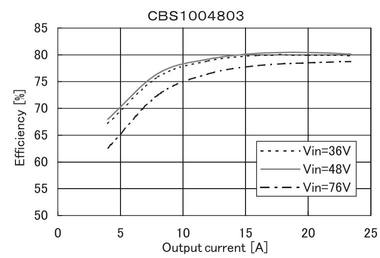

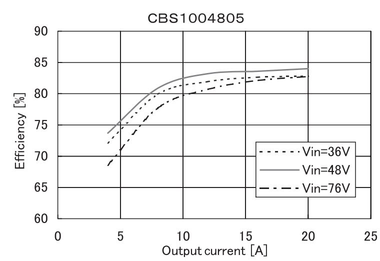

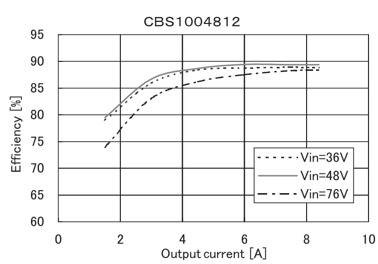

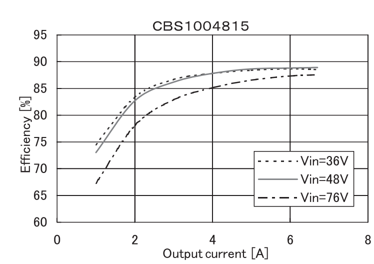

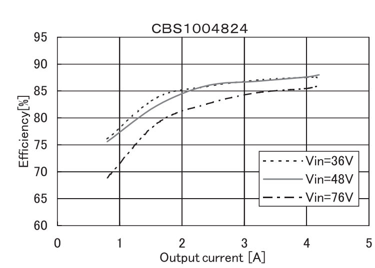

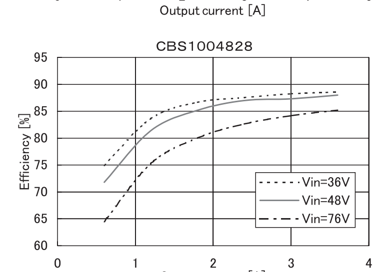

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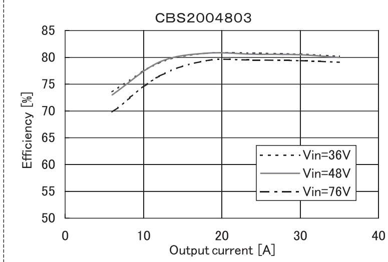
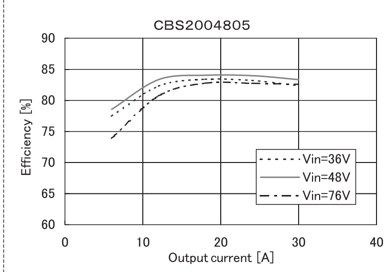
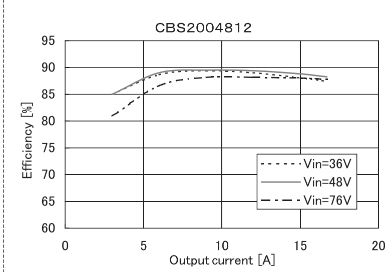
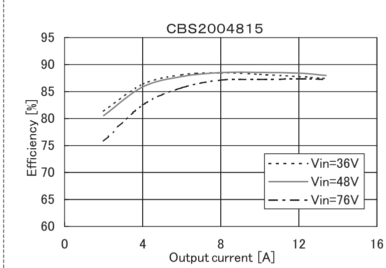
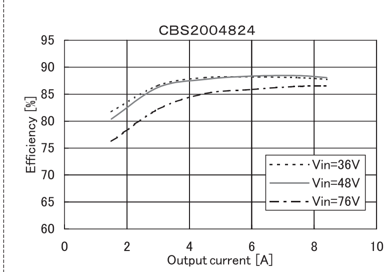
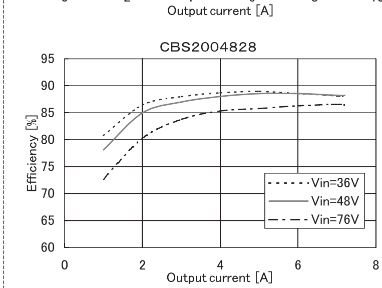








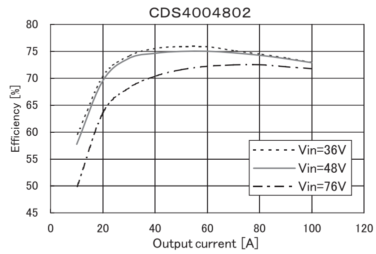


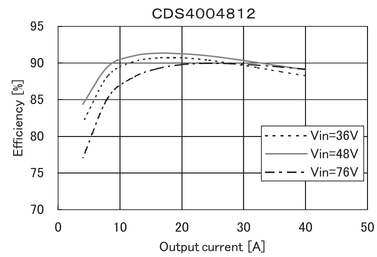


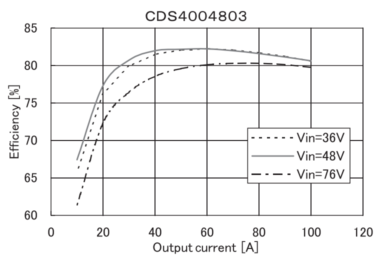
Thermal Considerations

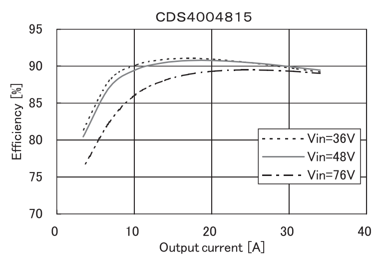
■CDS series

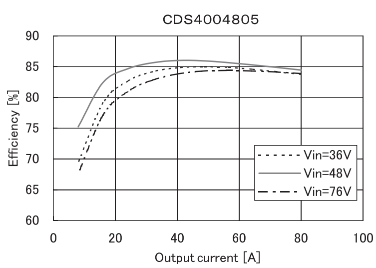
CDS400

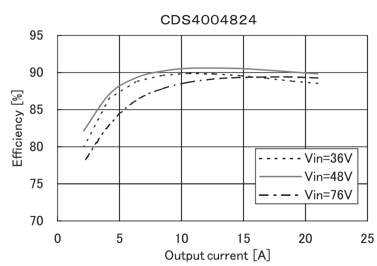


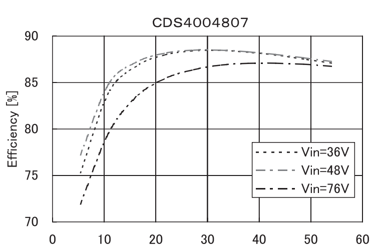


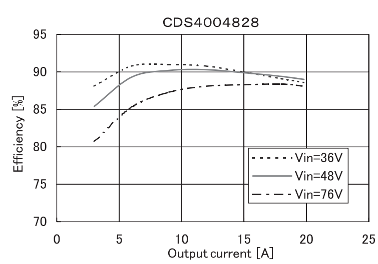












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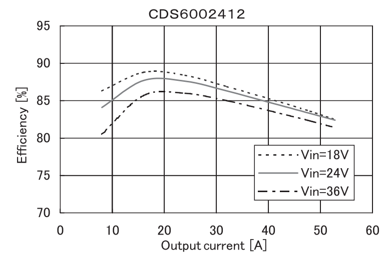
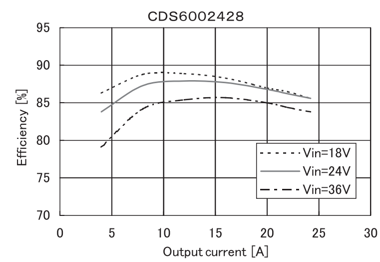
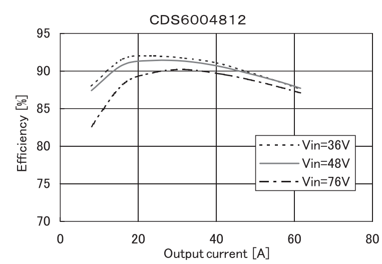
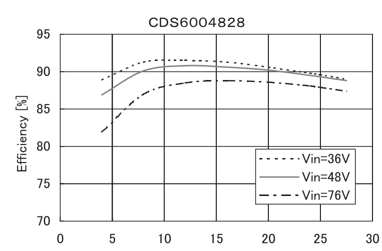




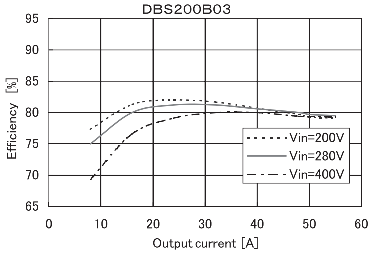




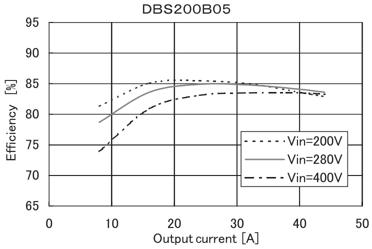
■DBS series

DBS200B

DBS200B03



DBS200B05



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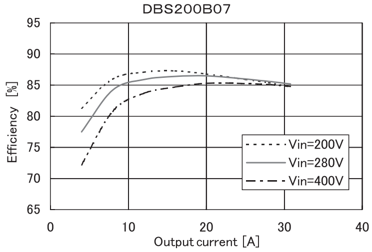
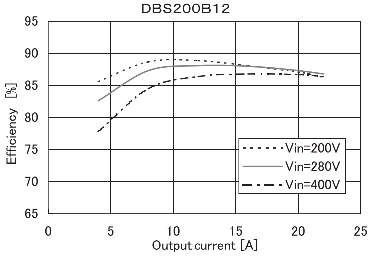
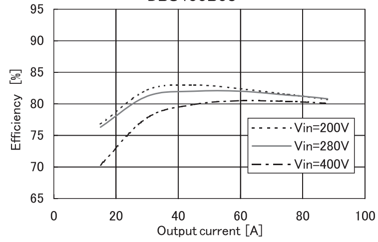


DBS200B12



DBS400B

DBS400B03



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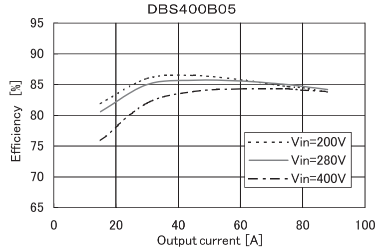

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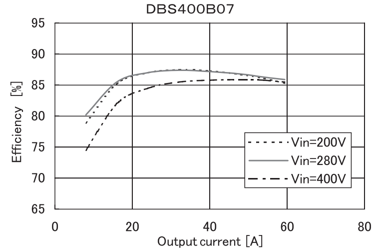

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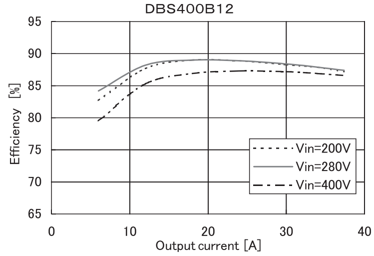
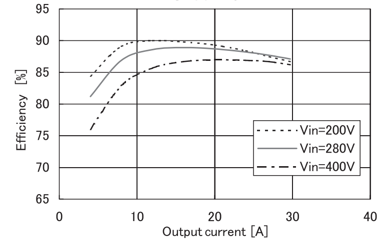
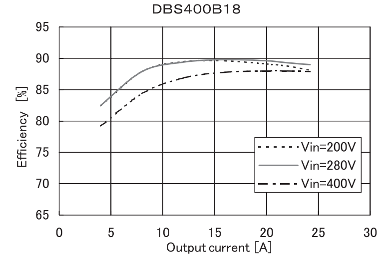


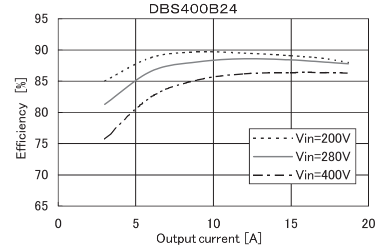
DBS400B15



DBS400B18



DBS400B24



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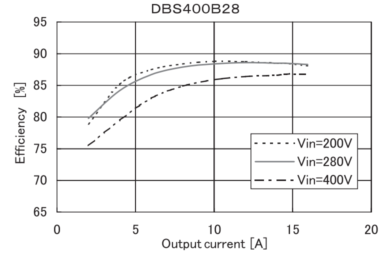


8.9 Heat sink size and Thermal resistance

■Half Brick size

Heat sink is prepared in CBS series Optional Parts.

Chart : List of Heat sink for CBS series

No.	Model	Size [mm]			Thermal resistance [℃/W]		Style
		H	W	D	Convection (0.1m/s)	Forced Air	
1	F-CBS-F1	12.7	57.9	61.5	7.5	Refer Fig.8.9.7	Vertical
2	F-CBS-F2	12.7	58.4	61.0			Horizontal
3	F-CBS-F3	25.4	57.9	61.5	4.6		Vertical
4	F-CBS-F4	25.4	58.4	61.0			Horizontal
5	F-CBS-F5	38.1	57.9	61.5	3.0		Vertical
6	F-CBS-F6	38.1	58.4	61.0			Horizontal

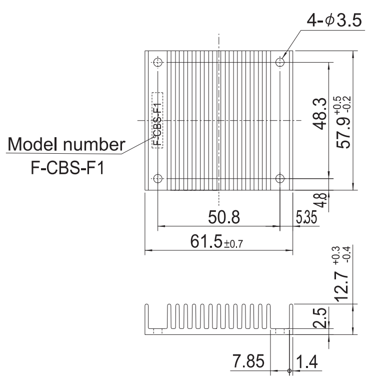


Fig.8.9.1 F-CBS-F1 (external view)

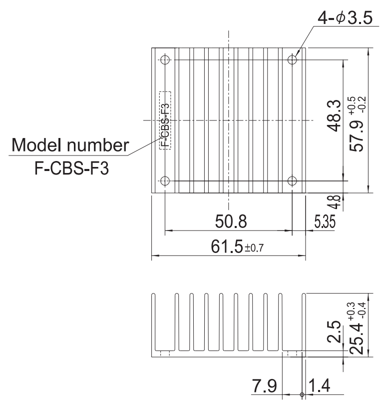


Fig.8.9.2 F-CBS-F3 (external view)

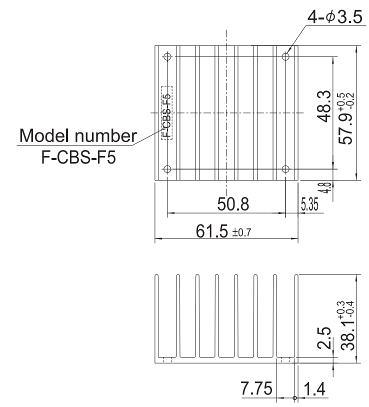


Fig.8.9.3 F-CBS-F5 (external view)

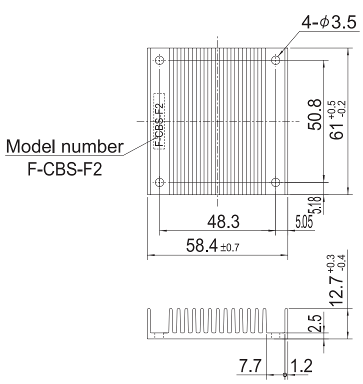


Fig.8.9.4 F-CBS-F2 (external view)

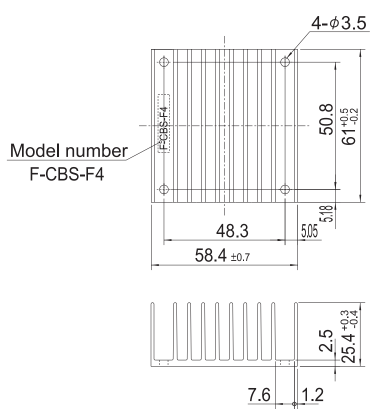


Fig.8.9.5 F-CBS-F4 (external view)

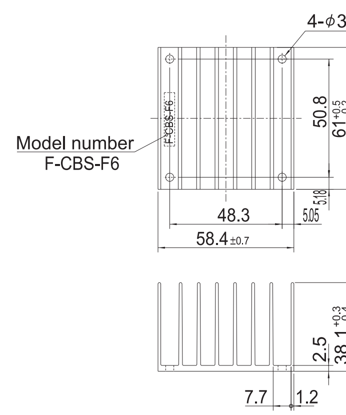
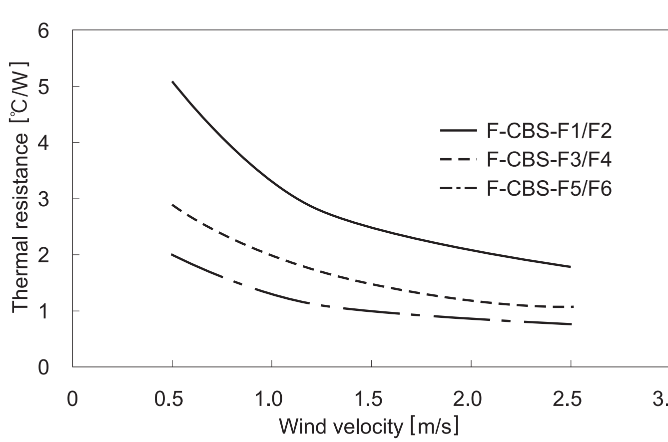


Fig.8.9.6 F-CBS-F6 (external view)

Fig.8.9.7
Heat sink thermal resistance curves



■Full Brick size

Chart: List of Heat sink for DBS/CDS series

No.	Model	Size [mm]			Thermal resistance [℃/W]		Style
		H	W	D	Convection (0.1m/s)	Forced Air	
1	Heat sink A	20.0	60.5	116.0	3.0	Refer Fig.8.9.10	Vertical
2	Heat sink B	20.0	60.5	116.0	2.7		Horizontal

＊ Heat sink A and B are not sold in our company.

Fig.8.9.8
Heat sink A
(external view)

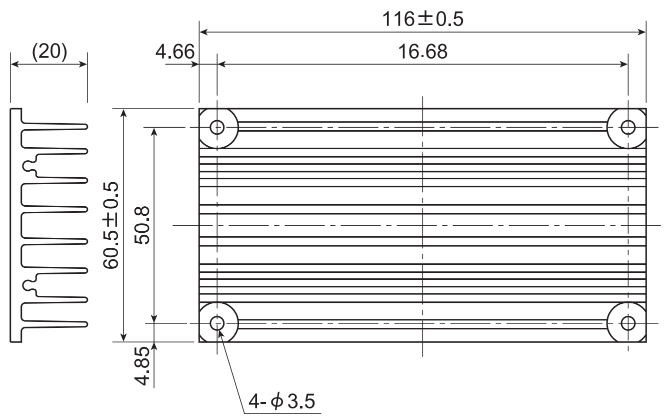


Fig.8.9.9
Heat sink B
(external view)

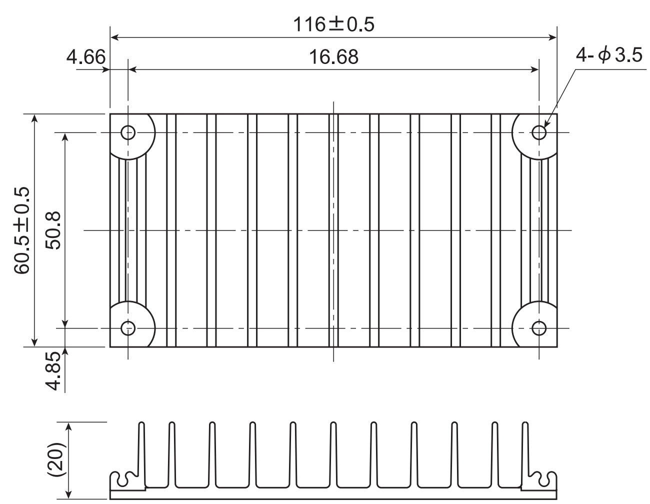
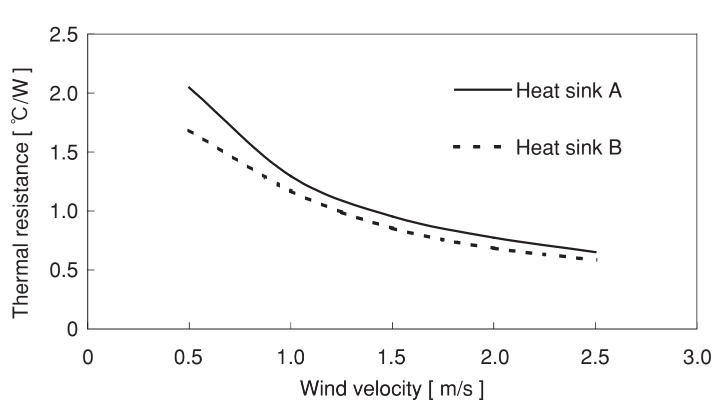


Fig.8.9.10
Heat sink thermal
resistance curves



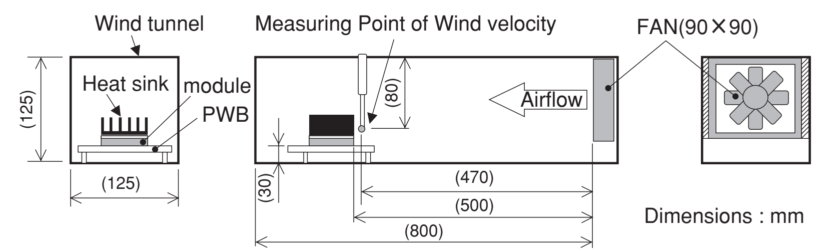
8.10 Thermal curves

Shown the Thermal curve with measuring environment as shown below.
Verify final design by actual temperature measurement.

8.10.1 Measuring environment

■CBS series (Half Brick size)

Fig.8.10.1
Measuring environment
(CBS series)



■DBS/CDS series (Full Brick size)

Fig.8.10.2
Measuring environment
(DBS/CDS series)

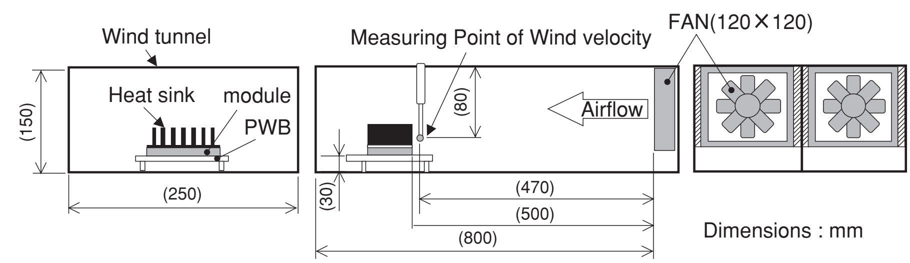
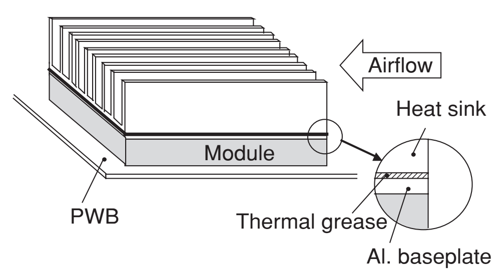


Fig.8.10.3
Measuring method

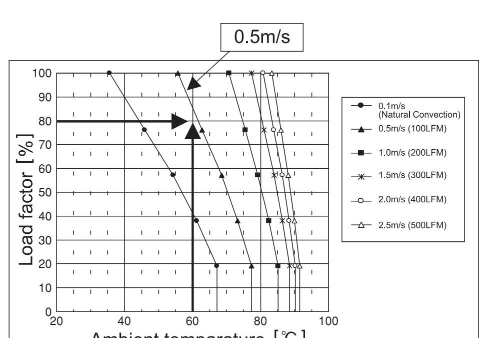


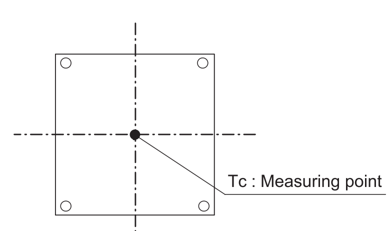
■Example of CBS504812

Conditions Load factor : 80 [%]
Ambient temperature : 60 [℃]

Shown in Fig.8.10.4, it is necessary to keep the wind velocity more than 0.5m/s. Refer to 8.10.2 Thermal Curves. Keep the baseplate temperature is lower than its derating curve temperature. Refer to 8.6.1 Baseplate temperature.
Measure the baseplate temperature at the center of the baseplate.

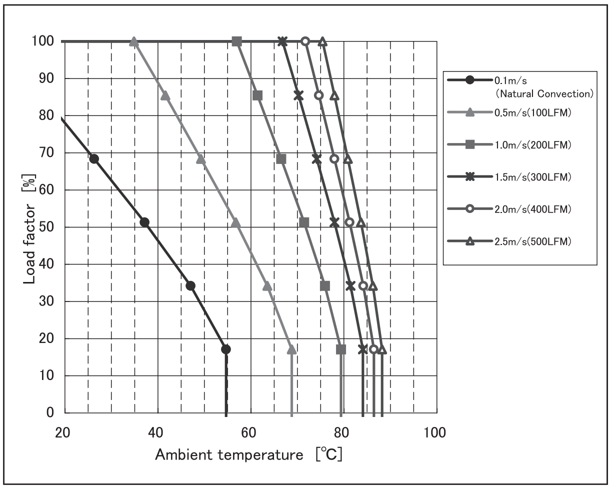
Fig.8.10.4
Example of Thermal curves



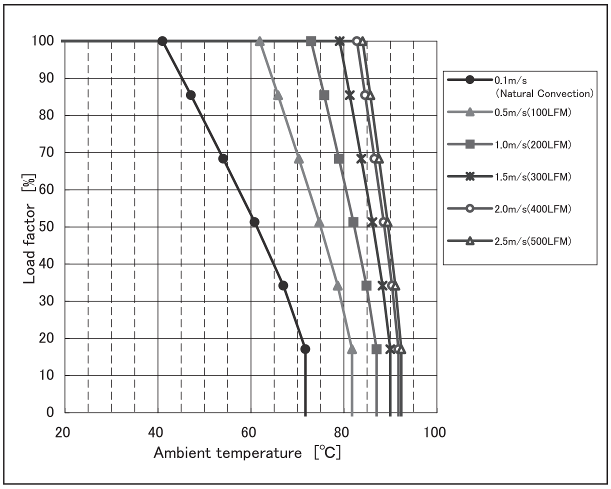


8.10.2 Thermal curves

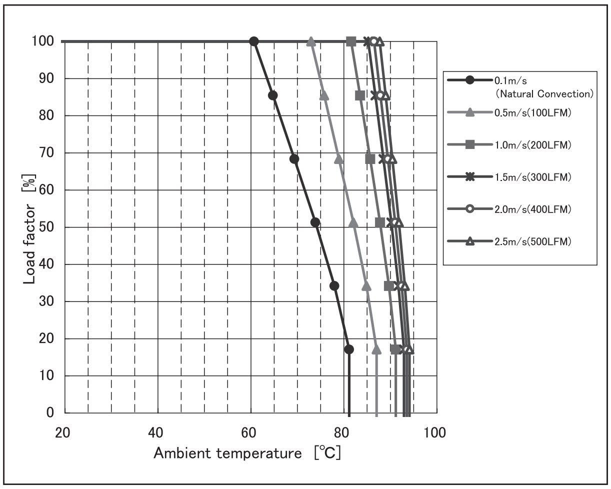
CBS50□03



F-CBS-F1/F2 (H = 12.7mm)

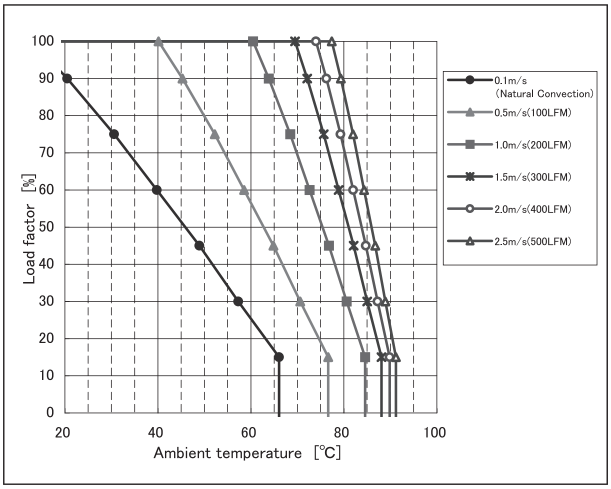


F-CBS-F3/F4 (H = 25.4mm)

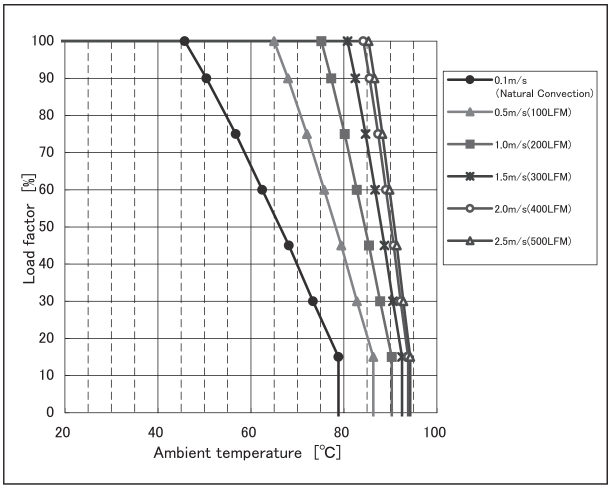


F-CBS-F5/F6 (H = 38.1mm)

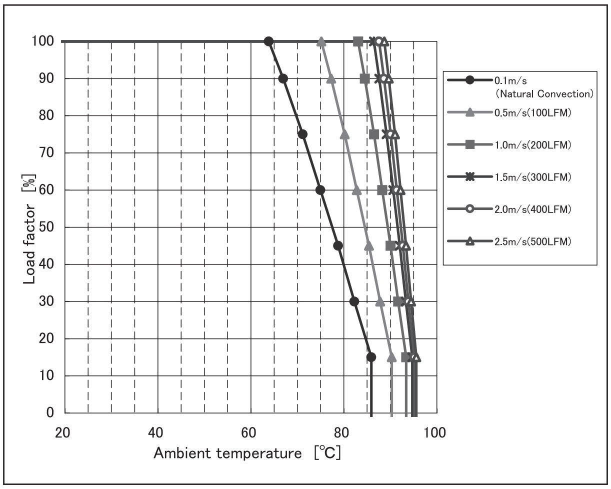
CBS50□05



F-CBS-F1/F2 (H = 12.7mm)



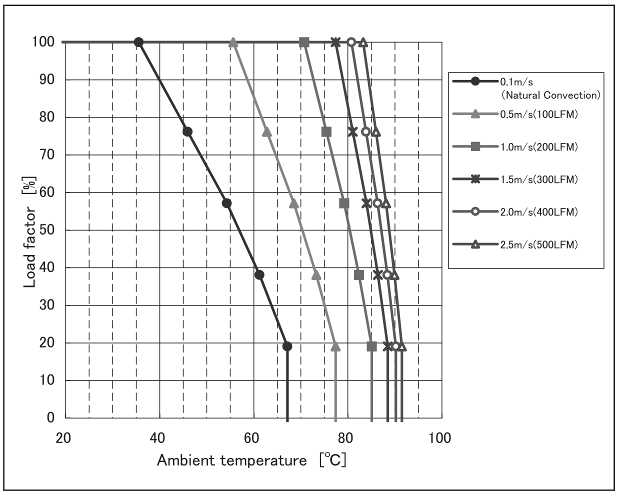
F-CBS-F3/F4 (H = 25.4mm)



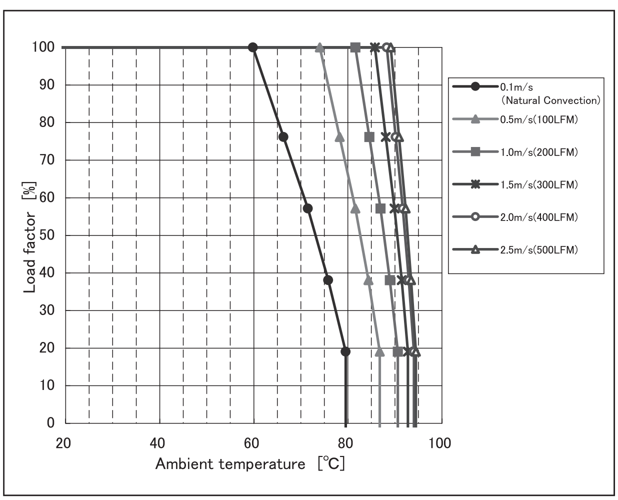
F-CBS-F5/F6 (H = 38.1mm)

Thermal Considerations

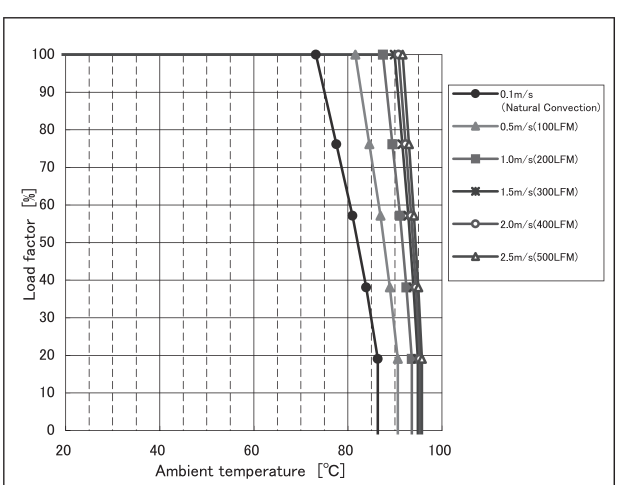
CBS50□12



F-CBS-F1/F2 (H = 12.7mm)

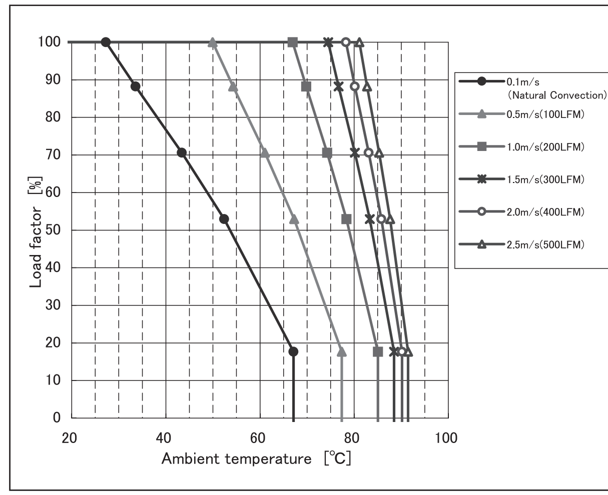


F-CBS-F3/F4 (H = 25.4mm)

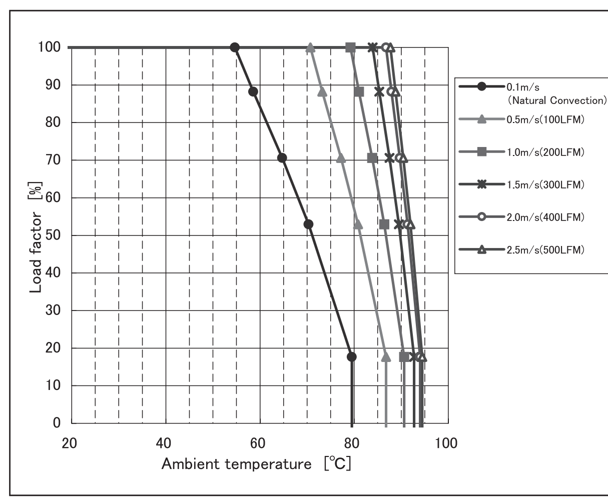


F-CBS-F5/F6 (H = 38.1mm)

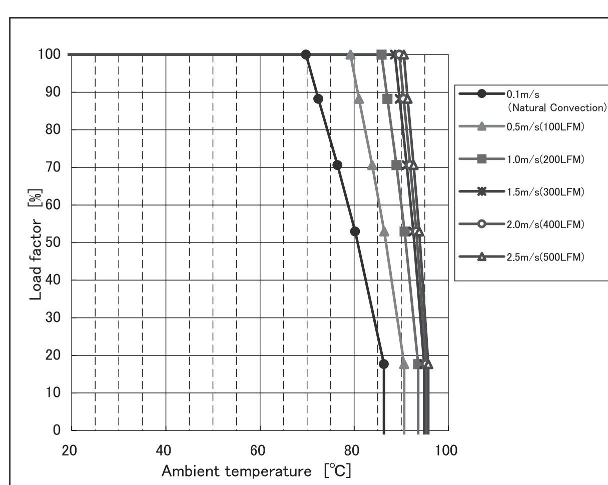
CBS50□15



F-CBS-F1/F2 (H = 12.7mm)

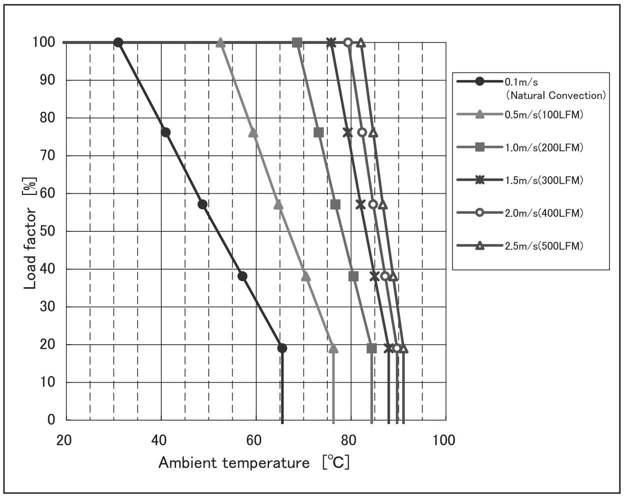


F-CBS-F3/F4 (H = 25.4mm)

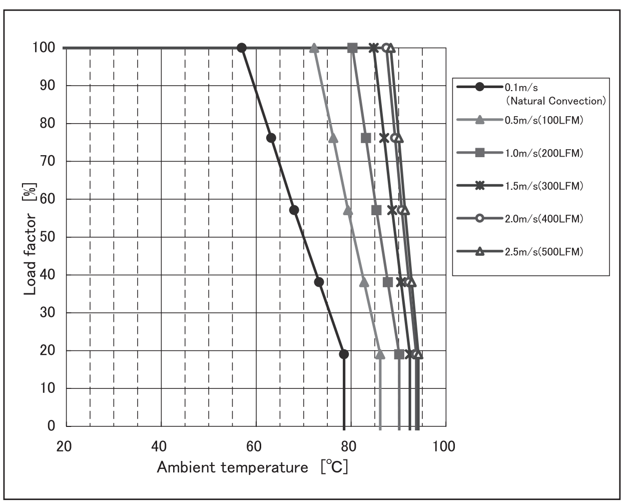


F-CBS-F5/F6 (H = 38.1mm)

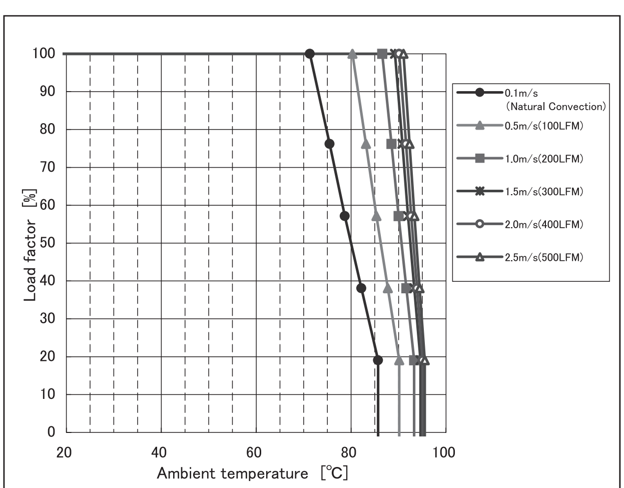
CBS50□24



F-CBS-F1/F2 (H = 12.7mm)

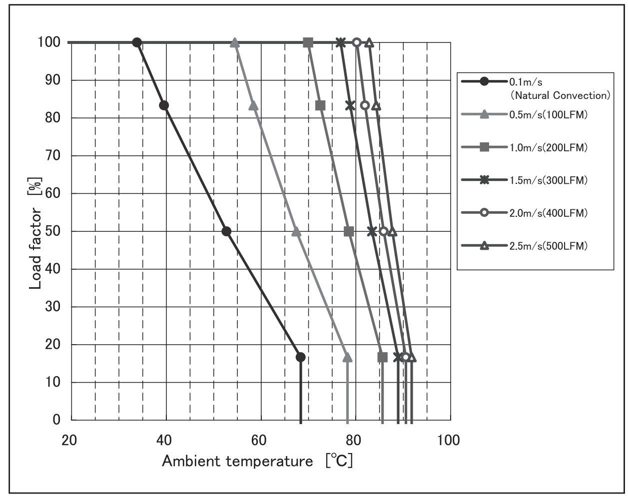


F-CBS-F3/F4 (H = 25.4mm)

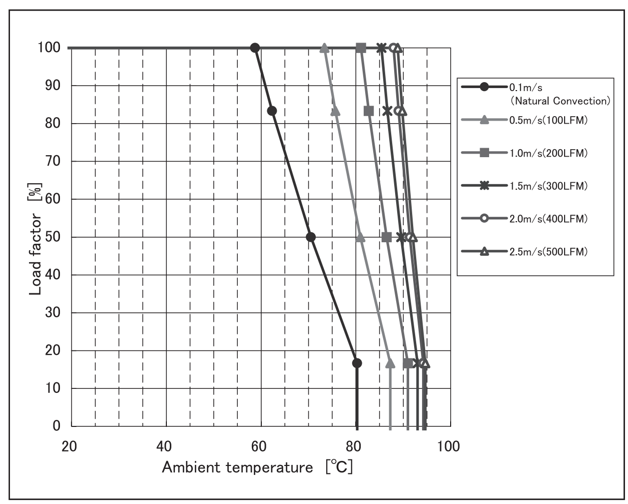


F-CBS-F5/F6 (H = 38.1mm)

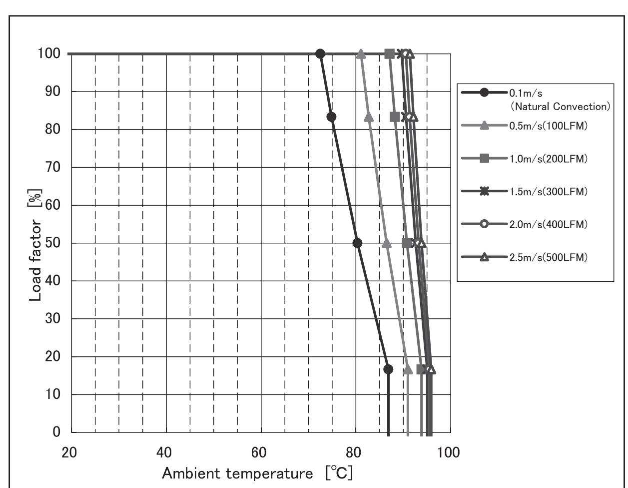
CBS50□28



F-CBS-F1/F2 (H = 12.7mm)



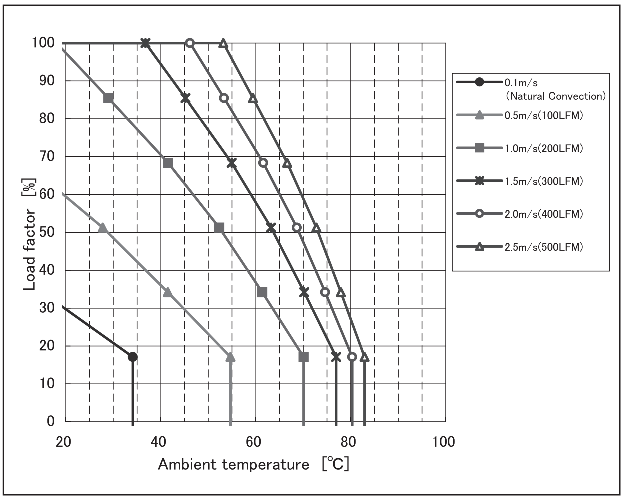
F-CBS-F3/F4 (H = 25.4mm)



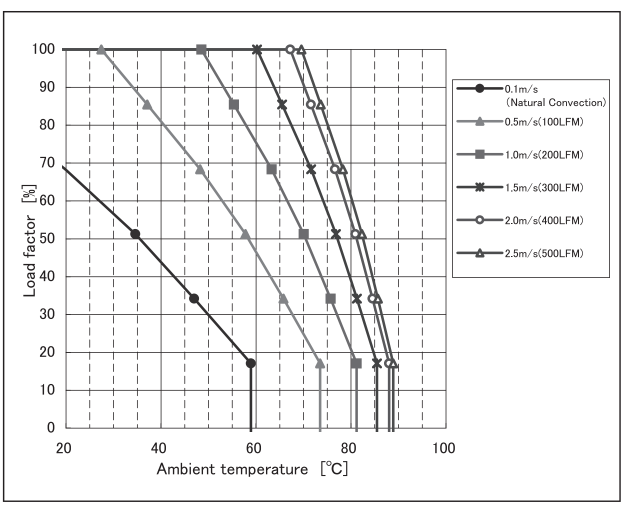
F-CBS-F5/F6 (H = 38.1mm)

Thermal Considerations

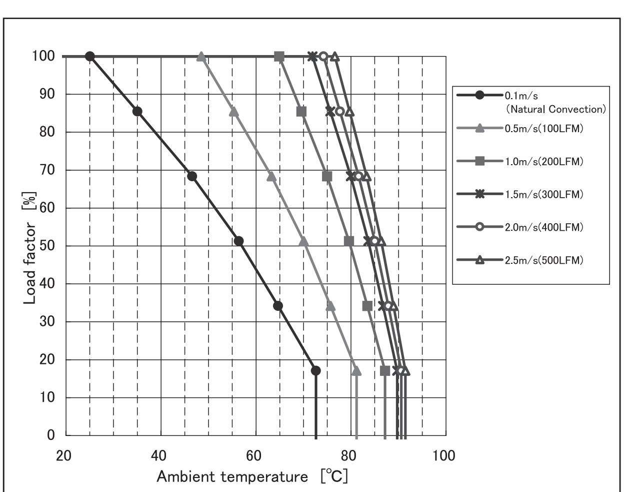
CBS100□03



F-CBS-F1/F2 (H = 12.7mm)

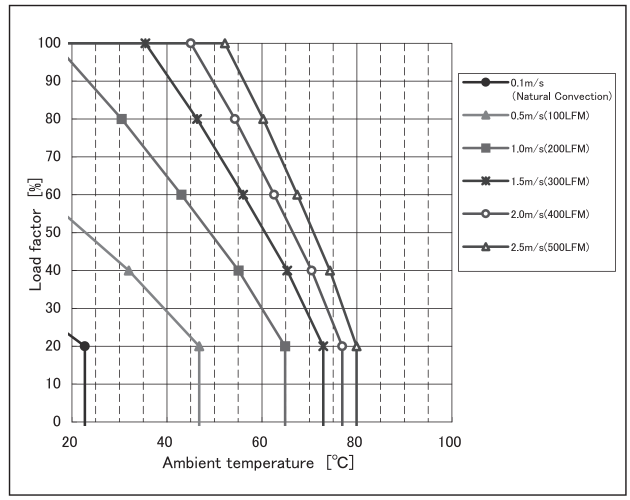


F-CBS-F3/F4 (H = 25.4mm)

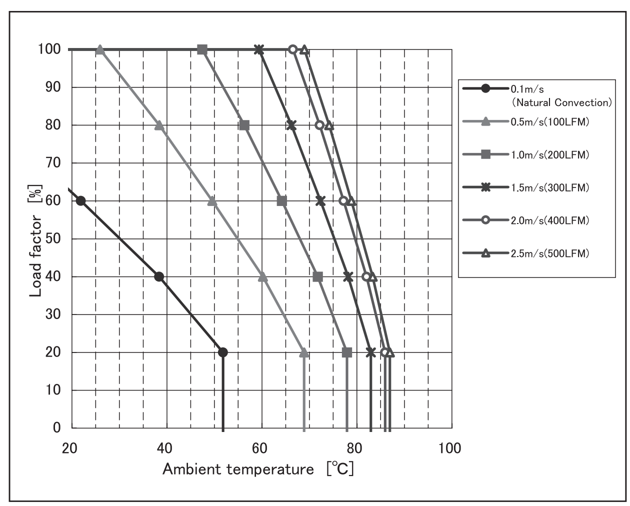


F-CBS-F5/F6 (H = 38.1mm)

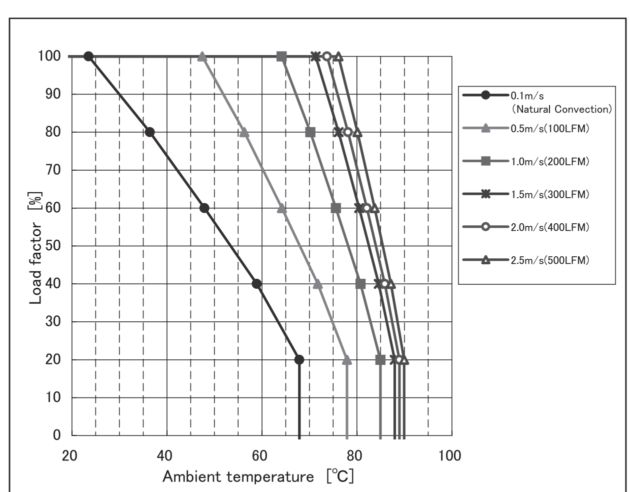
CBS100□05



F-CBS-F1/F2 (H = 12.7mm)

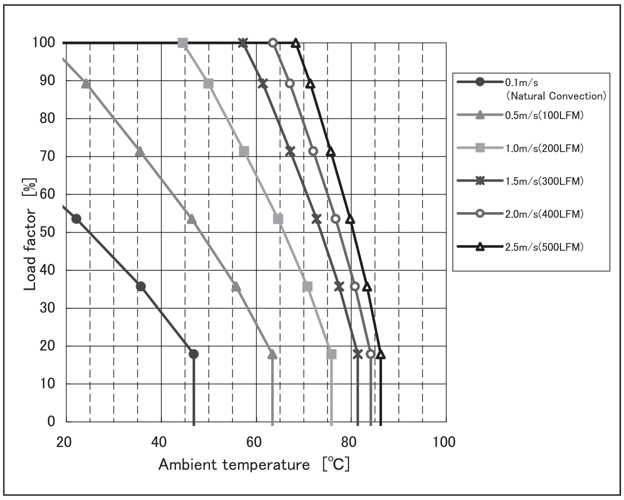


F-CBS-F3/F4 (H = 25.4mm)

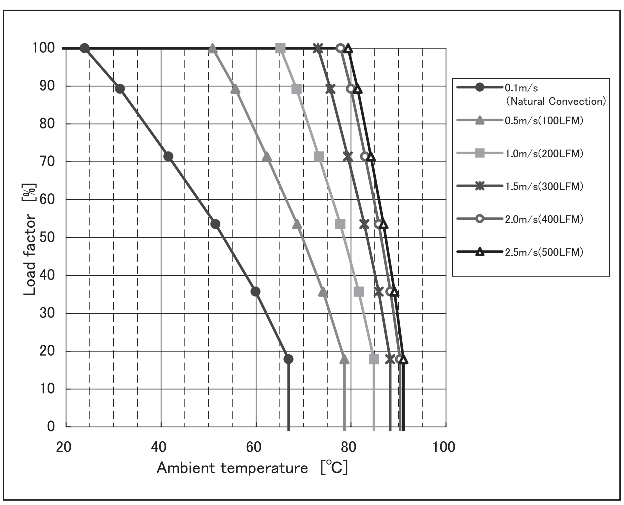


F-CBS-F5/F6 (H = 38.1mm)

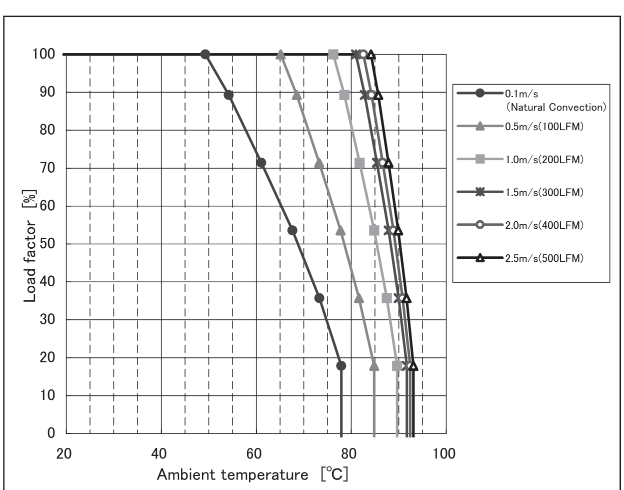
CBS100□12



F-CBS-F1/F2 (H = 12.7mm)

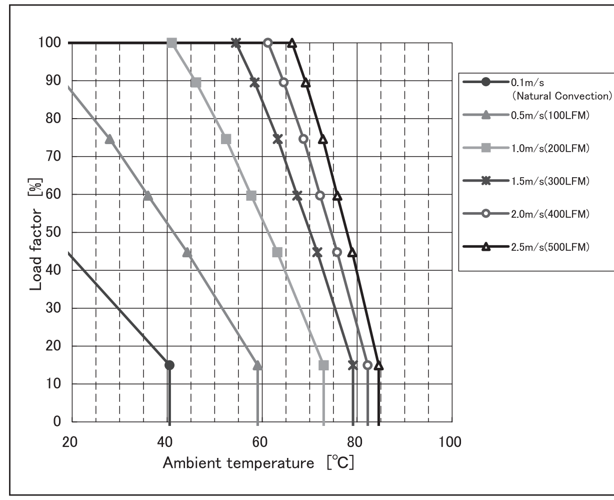


F-CBS-F3/F4 (H = 25.4mm)

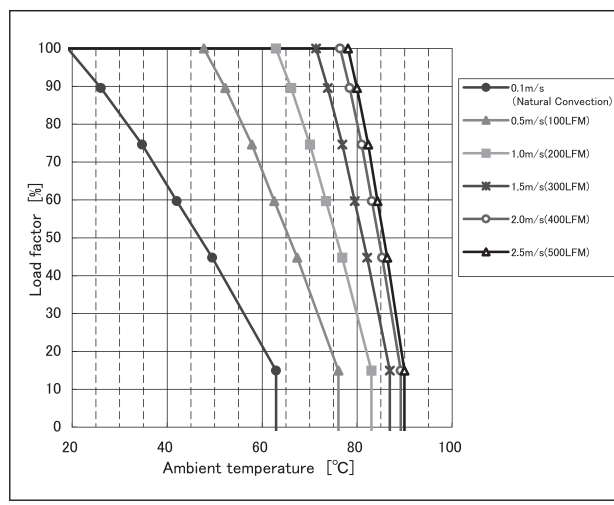


F-CBS-F5/F6 (H = 38.1mm)

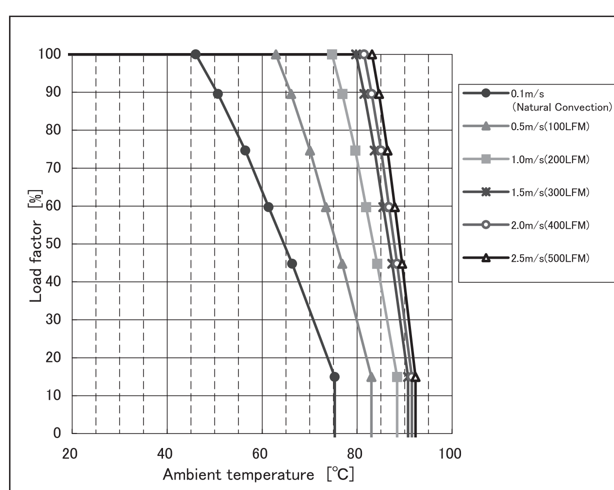
CBS100□15



F-CBS-F1/F2 (H = 12.7mm)

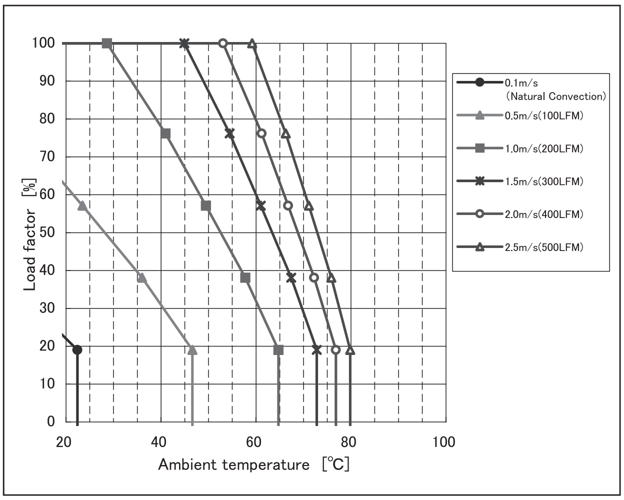


F-CBS-F3/F4 (H = 25.4mm)

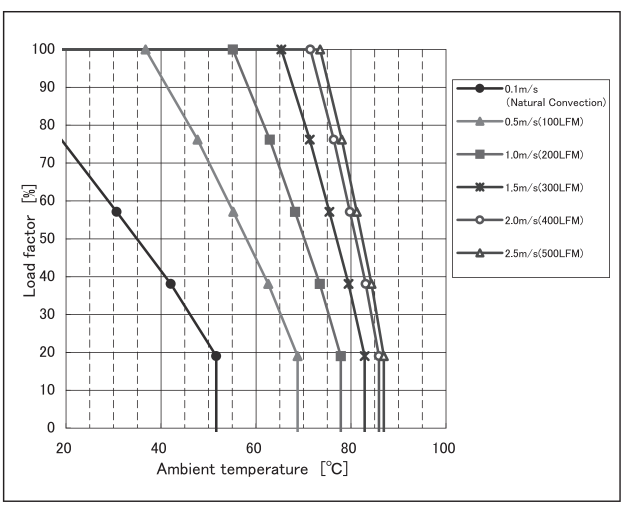


F-CBS-F5/F6 (H = 38.1mm)

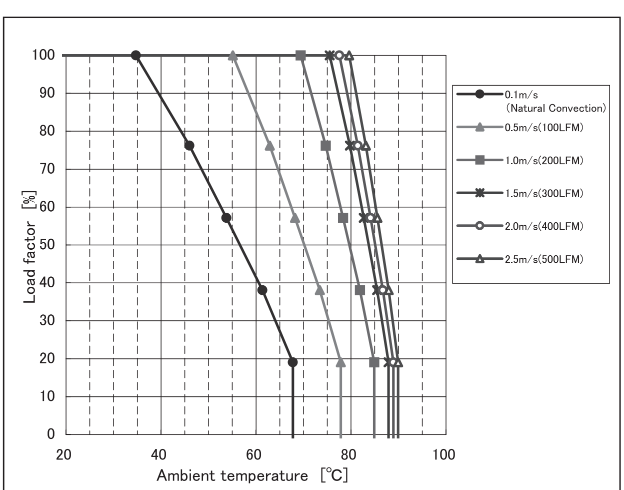
CBS100□24



F-CBS-F1/F2 (H = 12.7mm)

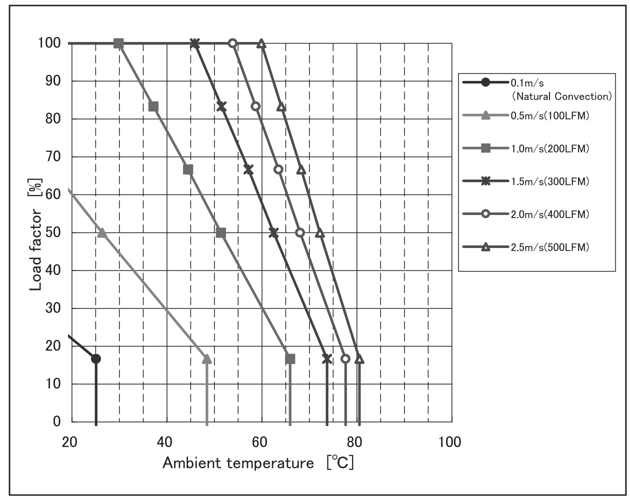


F-CBS-F3/F4 (H = 25.4mm)

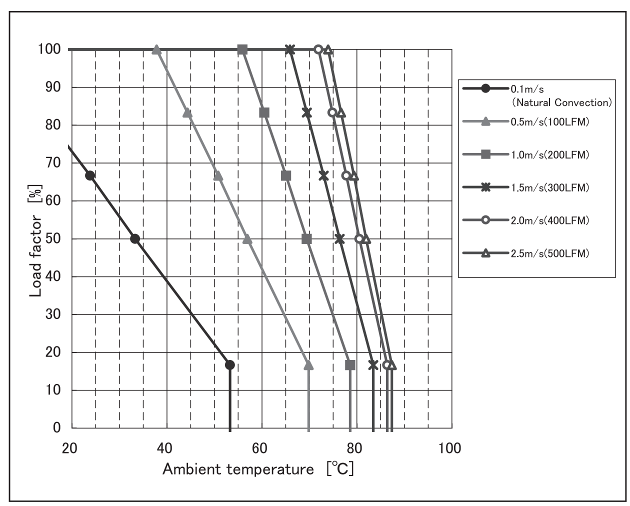


F-CBS-F5/F6 (H = 38.1mm)

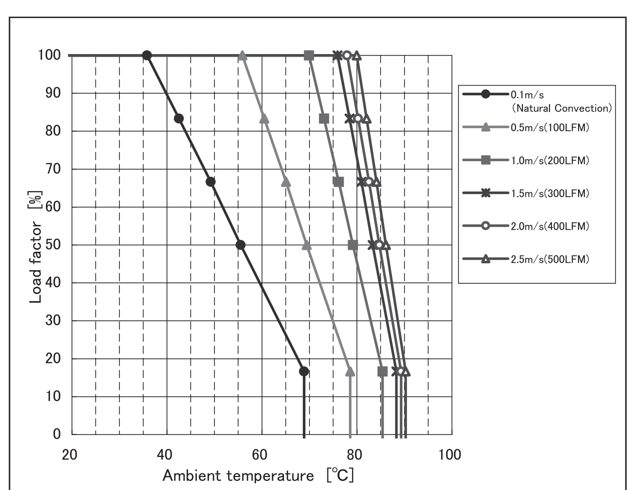
CBS100□28



F-CBS-F1/F2 (H = 12.7mm)

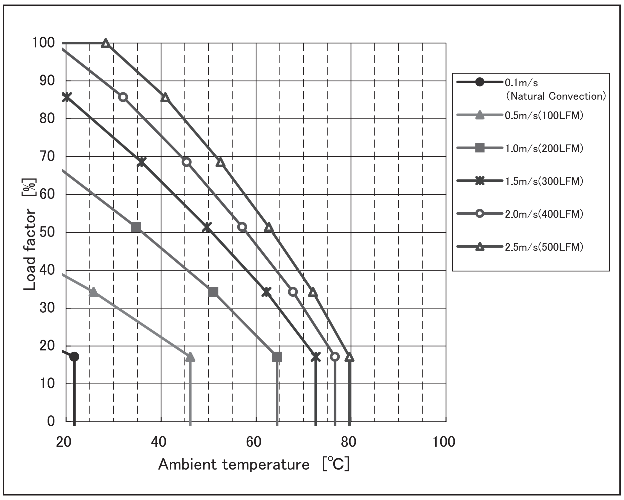


F-CBS-F3/F4 (H = 25.4mm)

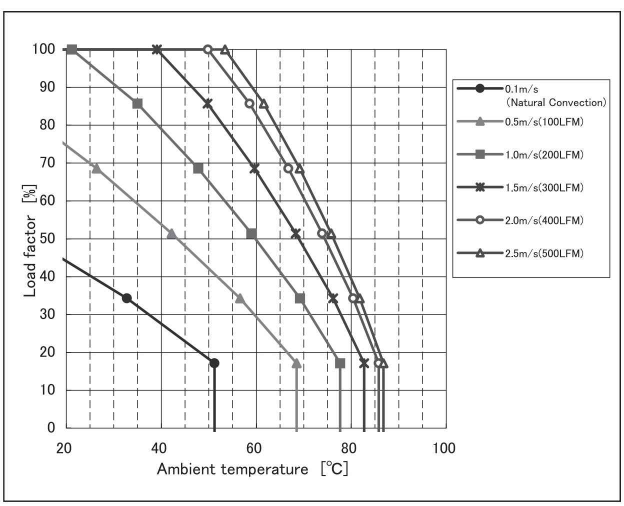


F-CBS-F5/F6 (H = 38.1mm)

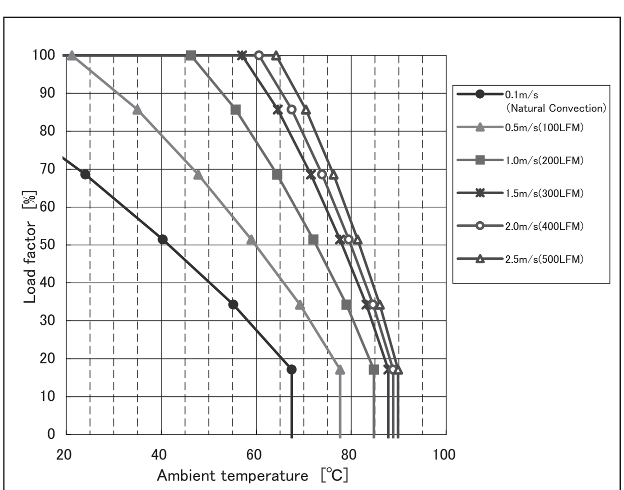
CBS200□03



F-CBS-F1/F2 (H = 12.7mm)

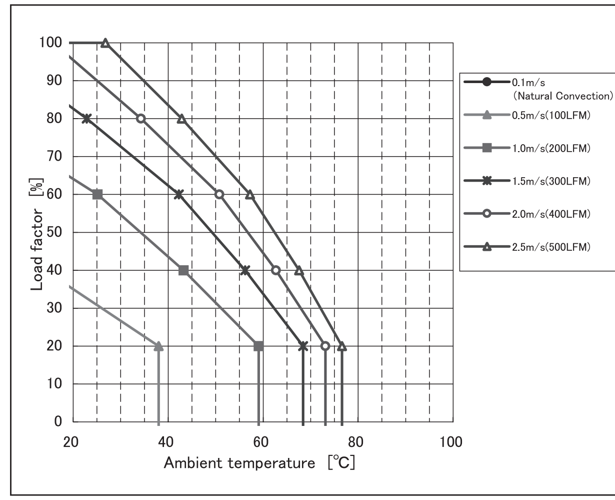


F-CBS-F3/F4 (H = 25.4mm)

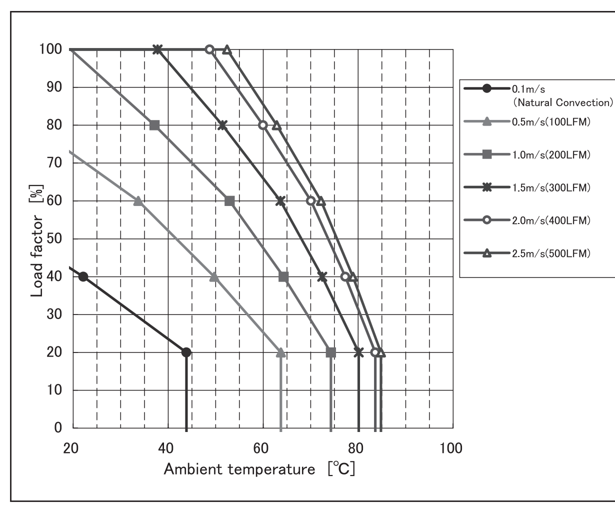


F-CBS-F5/F6 (H = 38.1mm)

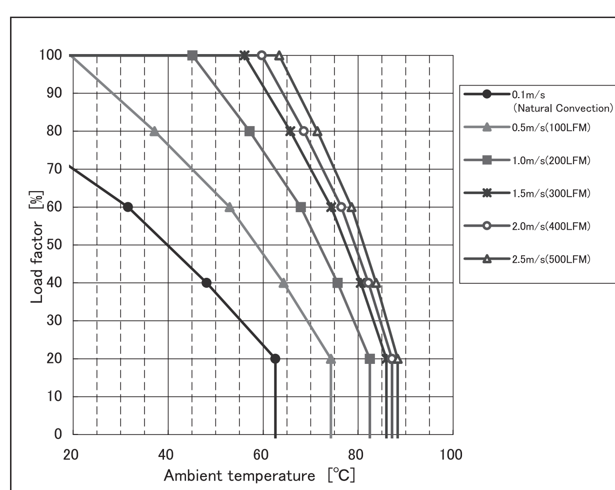
CBS200□05



F-CBS-F1/F2 (H = 12.7mm)



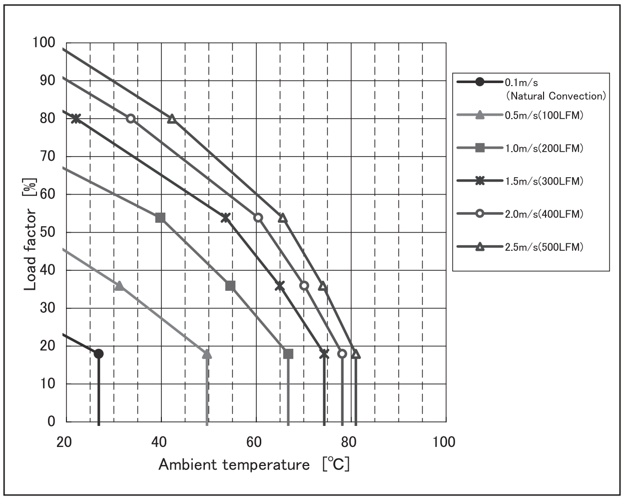
F-CBS-F3/F4 (H = 25.4mm)



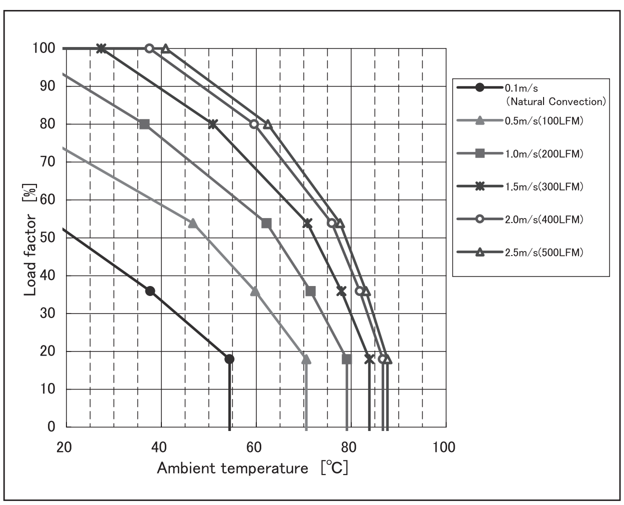
F-CBS-F5/F6 (H = 38.1mm)

Thermal Considerations

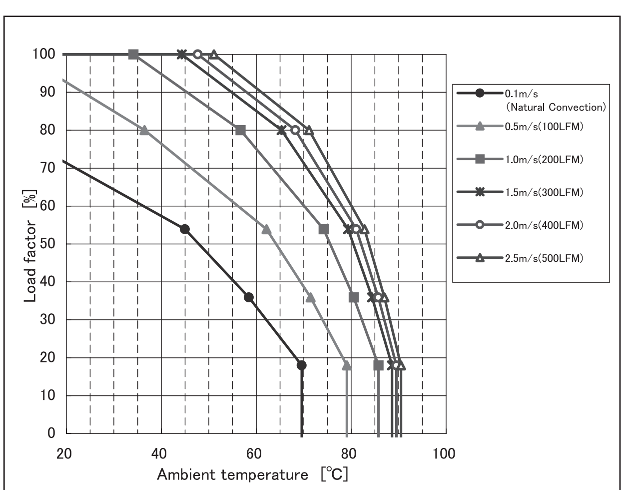
CBS200□12



F-CBS-F1/F2 (H = 12.7mm)

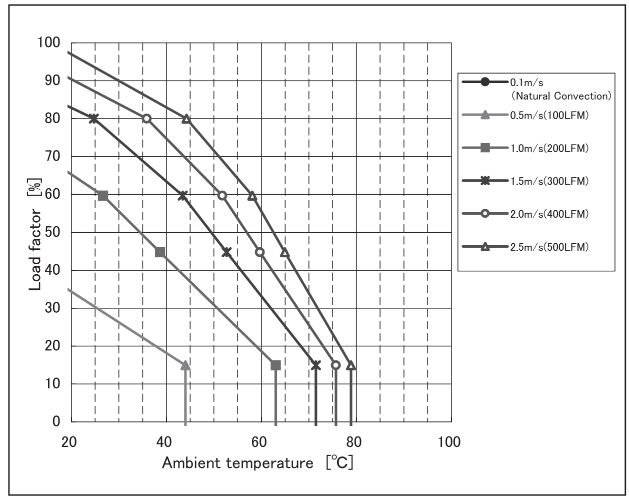


F-CBS-F3/F4 (H = 25.4mm)

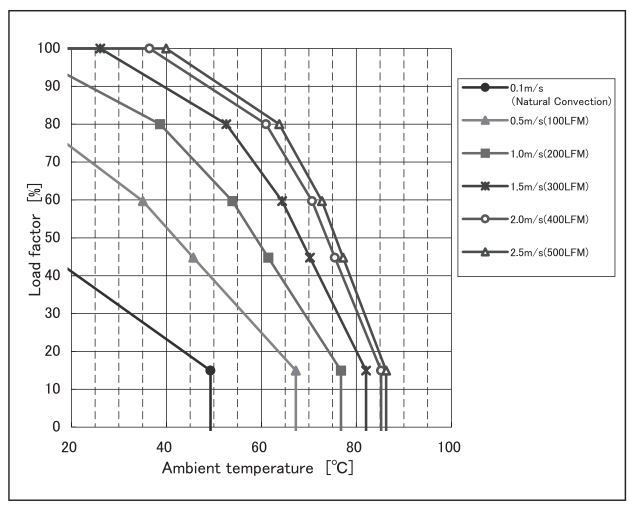


F-CBS-F5/F6 (H = 38.1mm)

CBS200□15



F-CBS-F1/F2 (H = 12.7mm)



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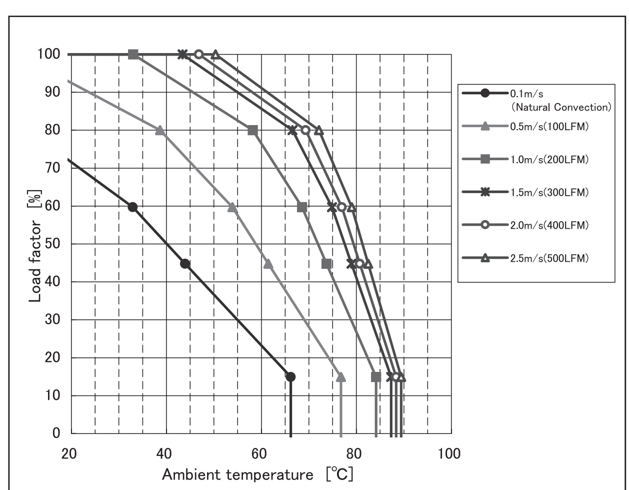
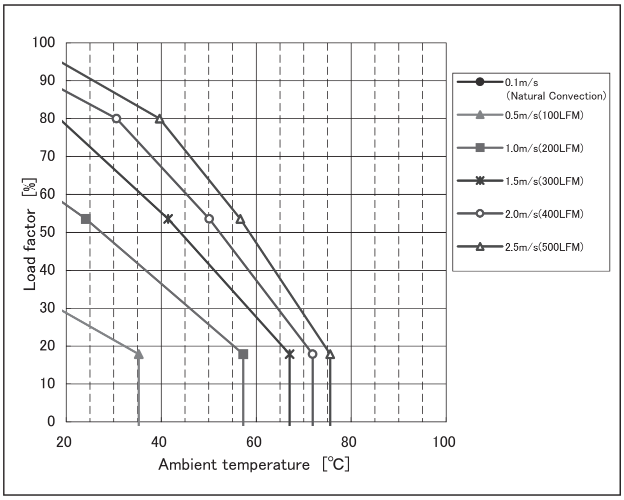


F-CBS-F5/F6 (H = 38.1mm)

CBS200□24



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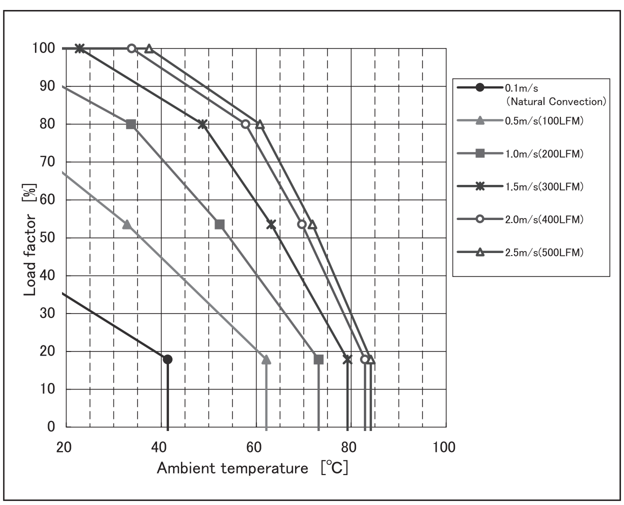
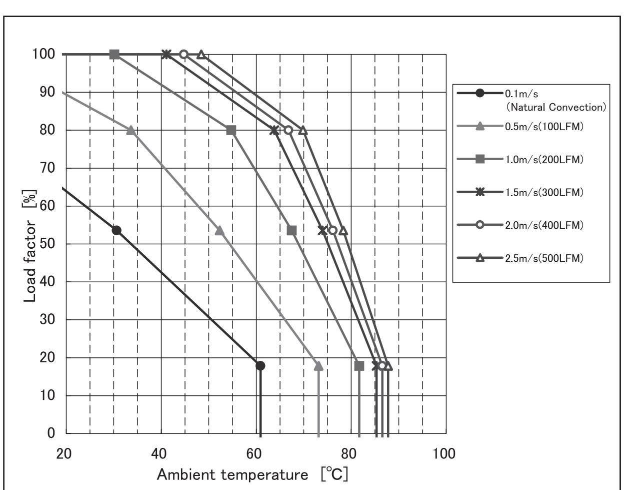
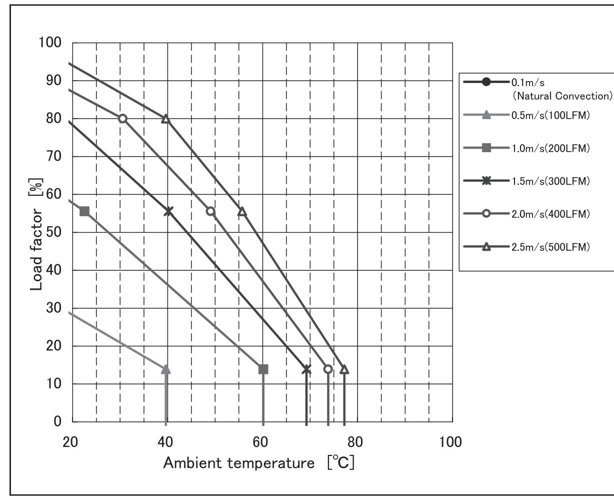


F-CBS-F3/F4 (H = 25.4mm)



F-CBS-F5/F6 (H = 38.1mm)

CBS200□28



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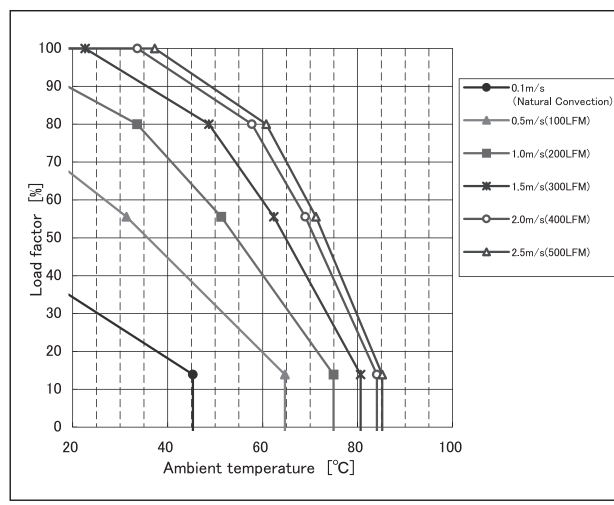

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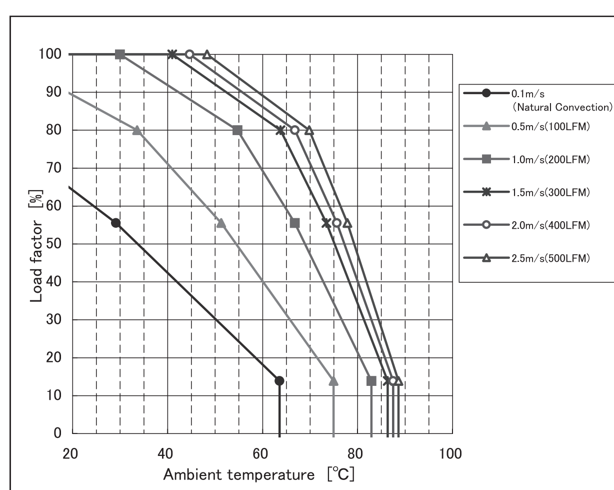
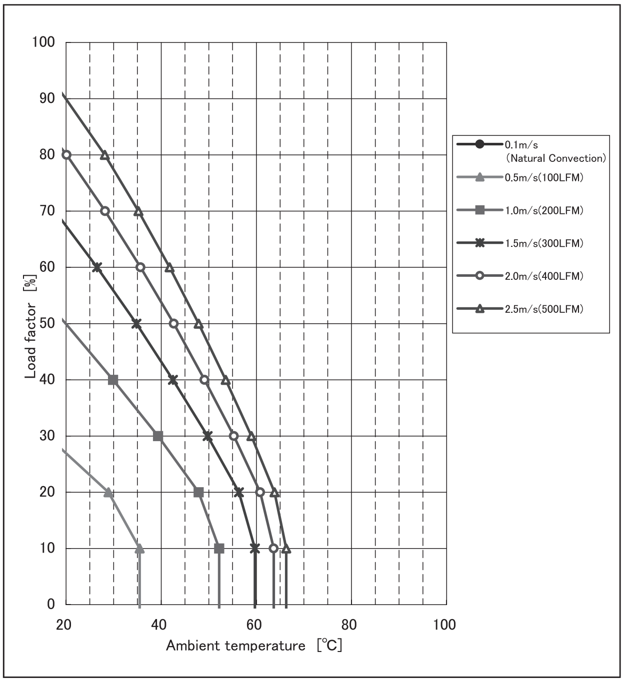


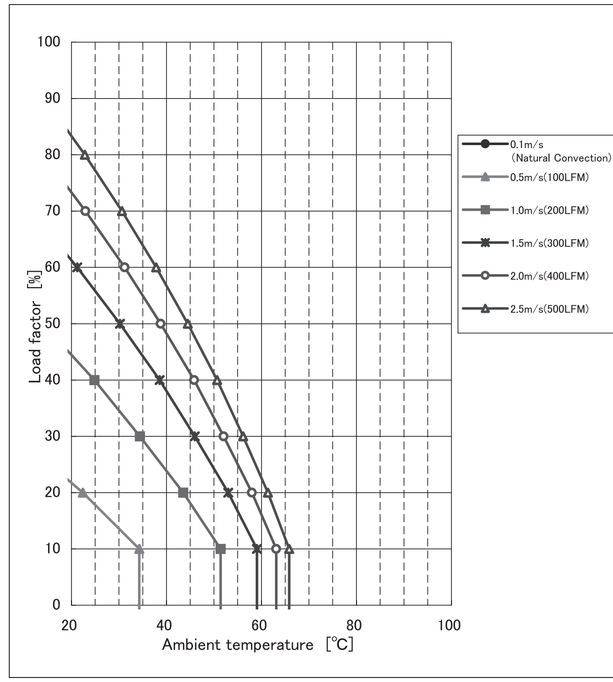
F-CBS-F5/F6 (H = 38.1mm)

CDS4004802

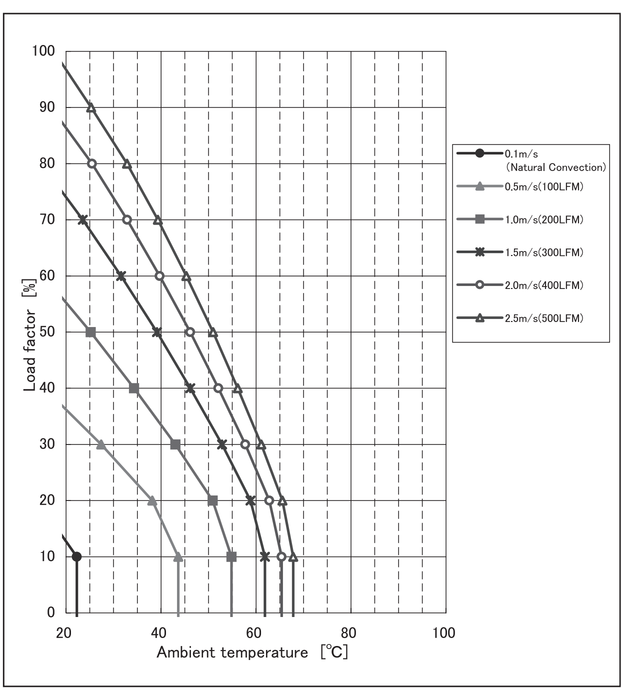


Heat sink A

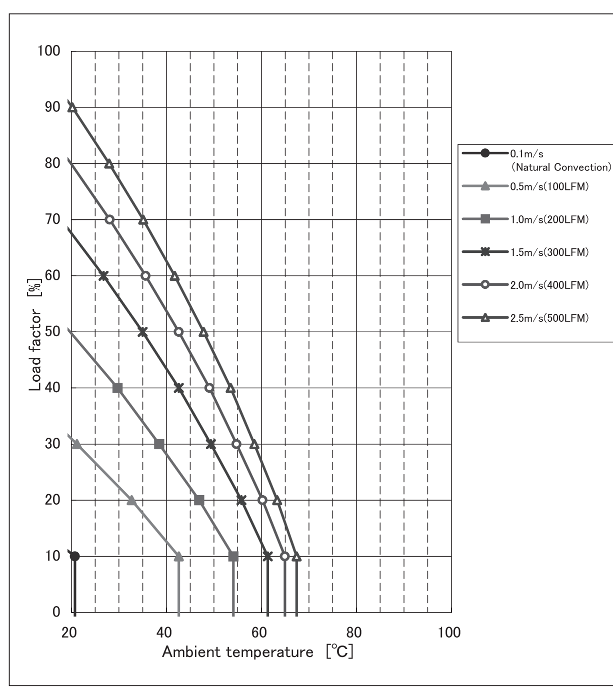
CDS4004803



Heat sink A



Heat sink B



Heat sink B

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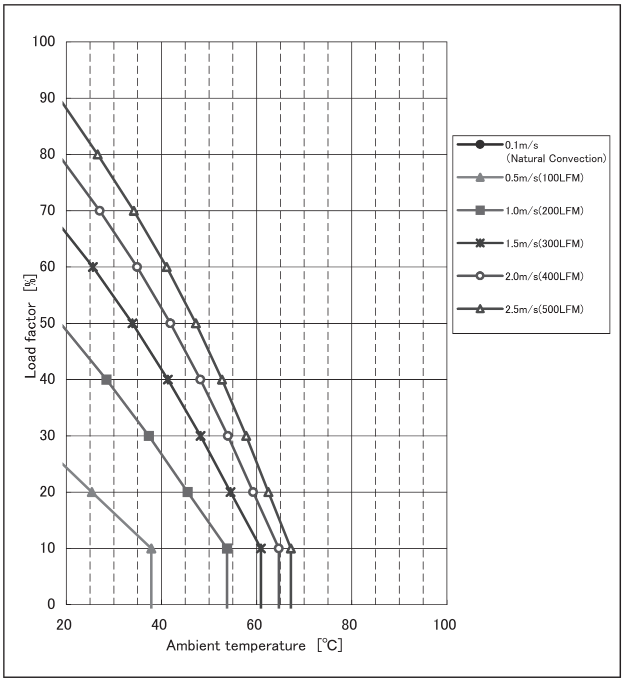
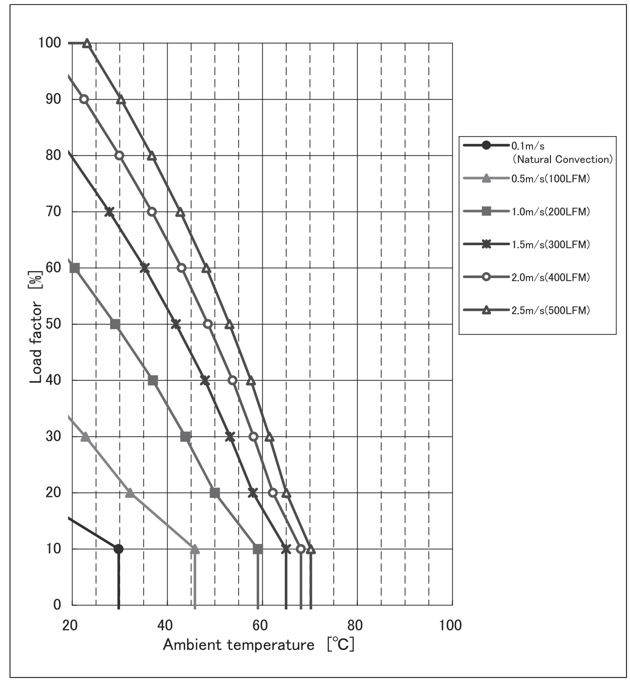
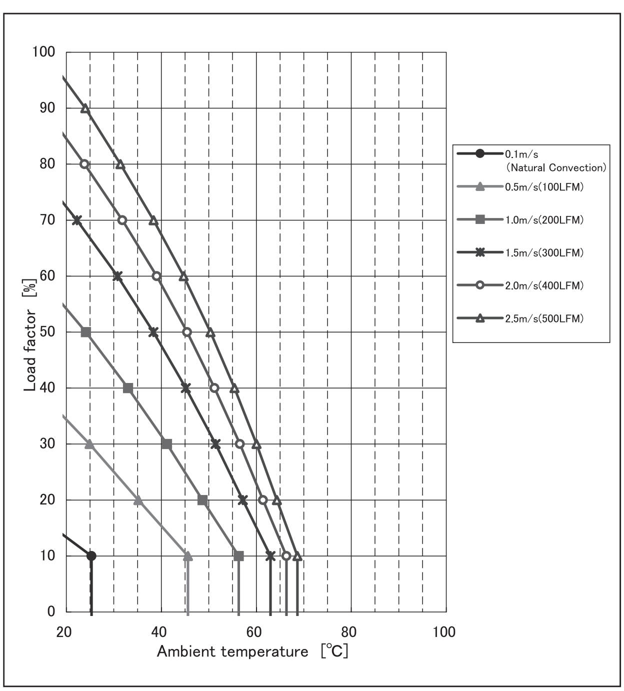


Heat sink A

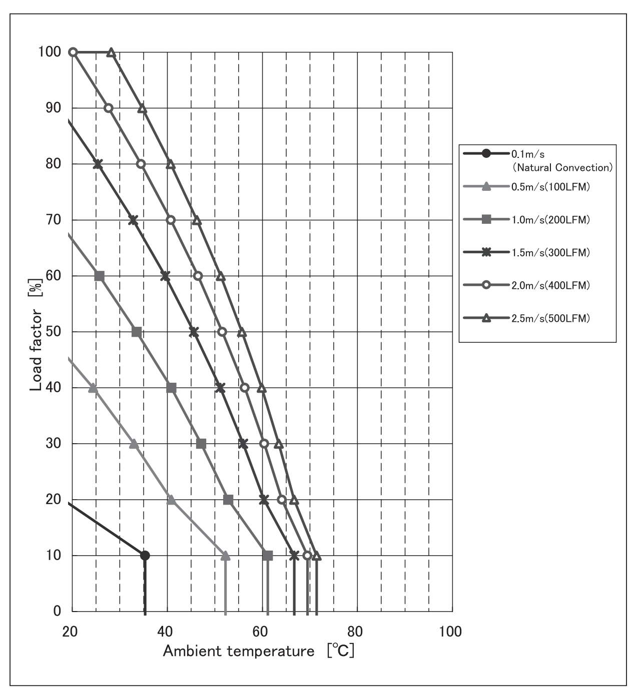
CDS4004807



Heat sink A

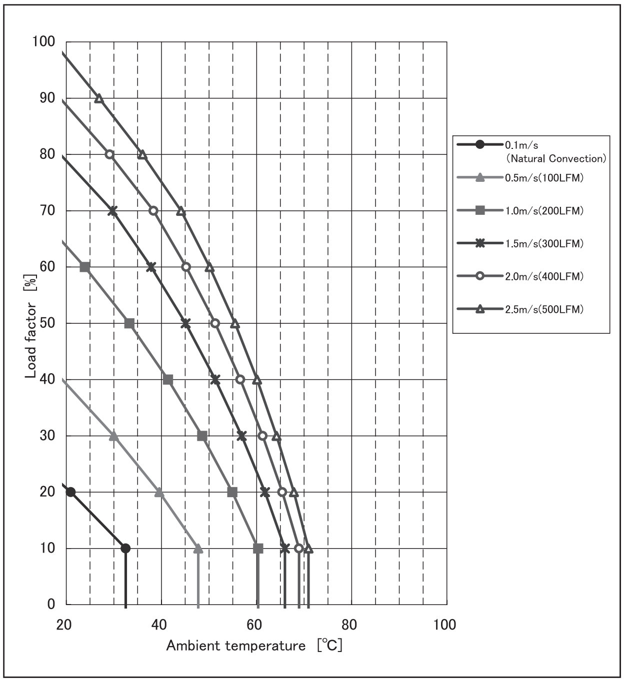


Heat sink B



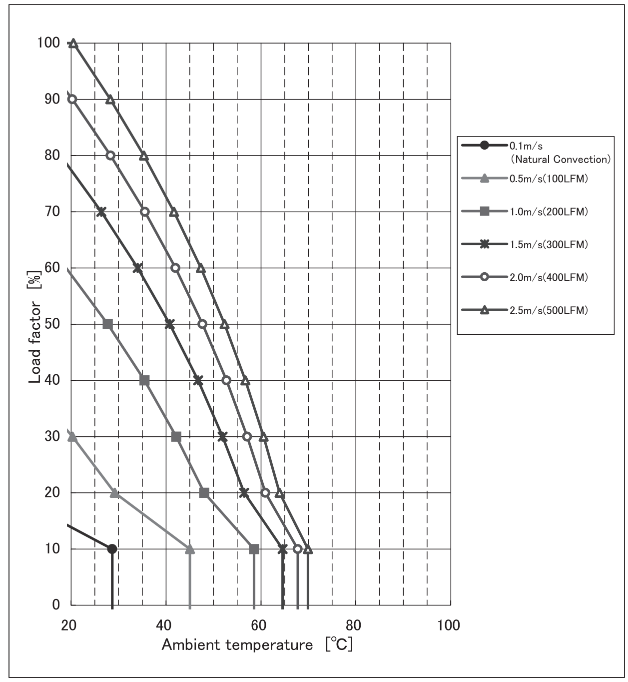
Heat sink B

CDS4004812

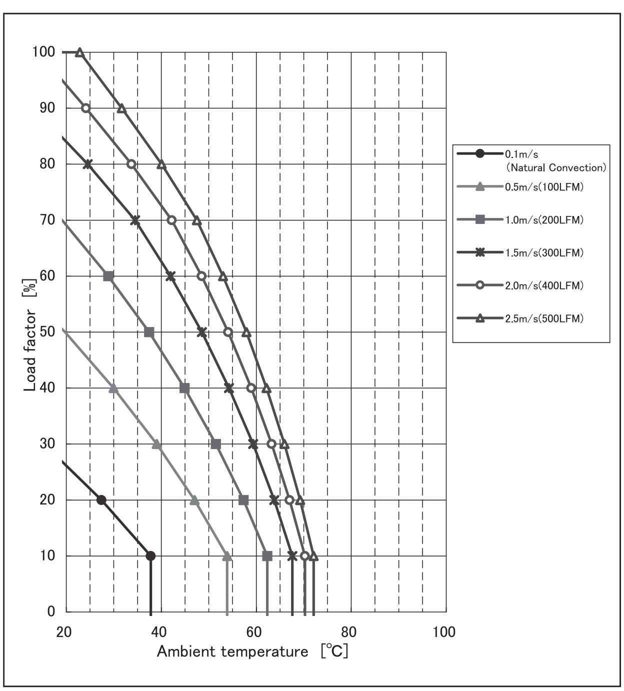


Heat sink A

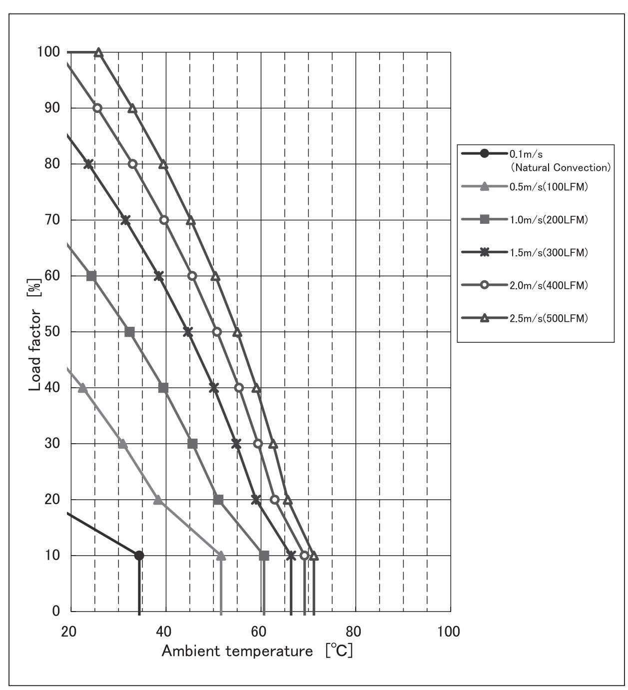
CDS4004815



Heat sink A

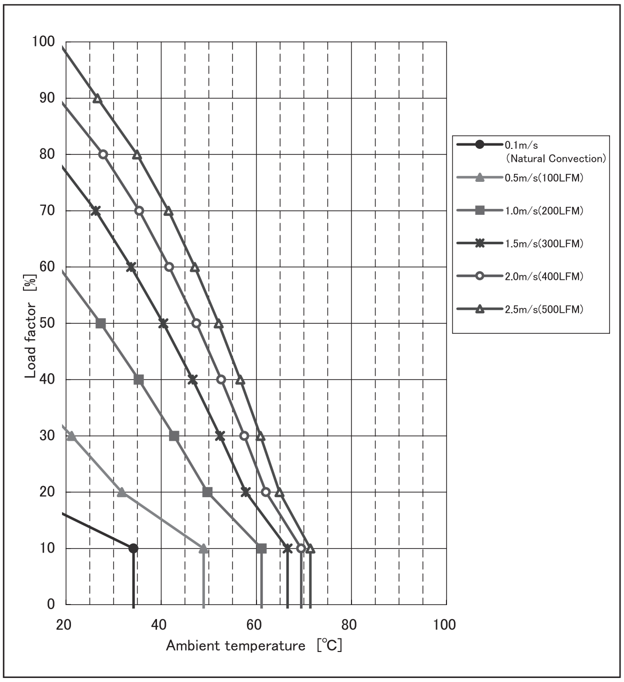


Heat sink B

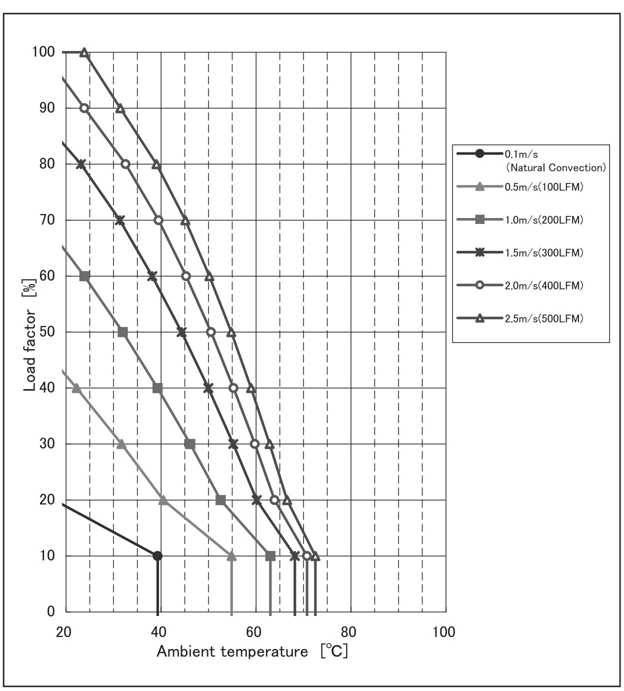


Heat sink B

CDS4004824

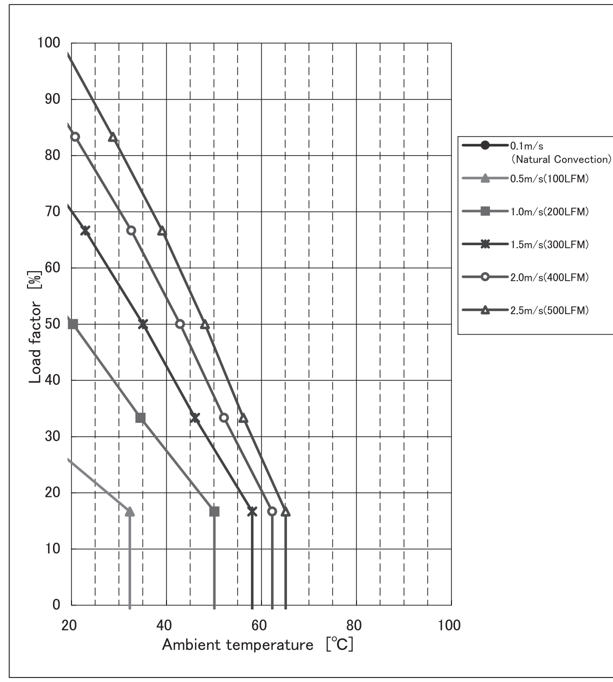


Heat sink A

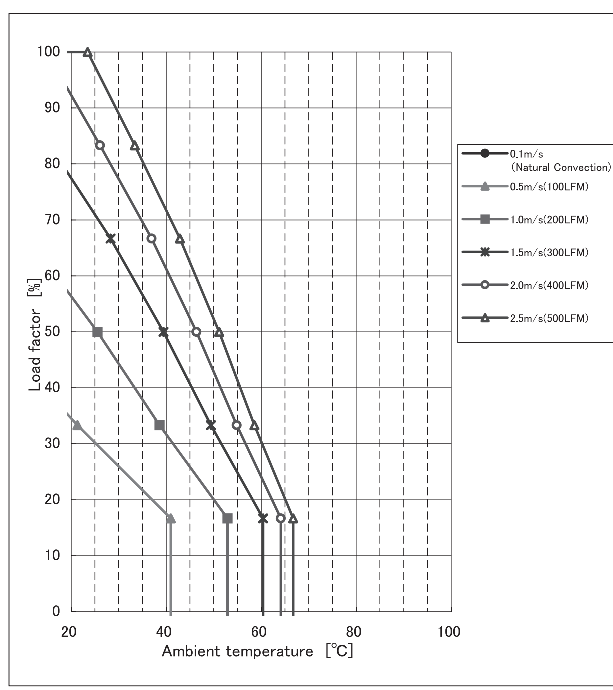


Heat sink B

CDS4004828



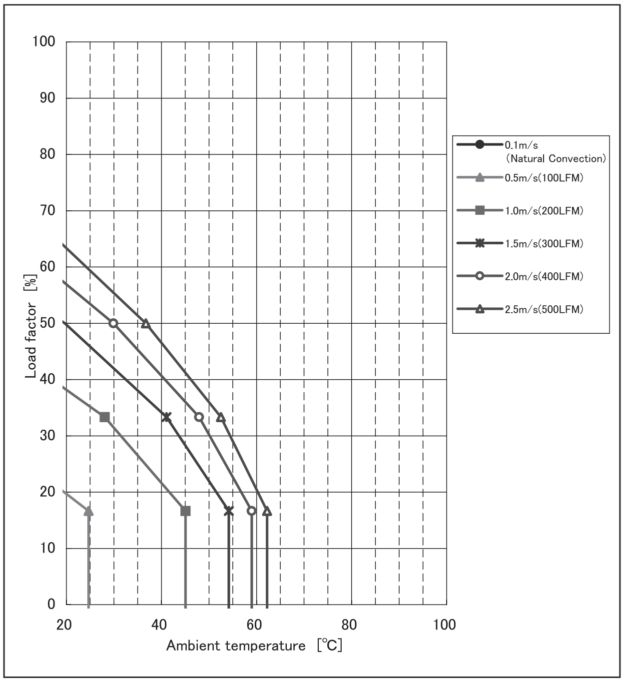
Heat sink A



Heat sink B

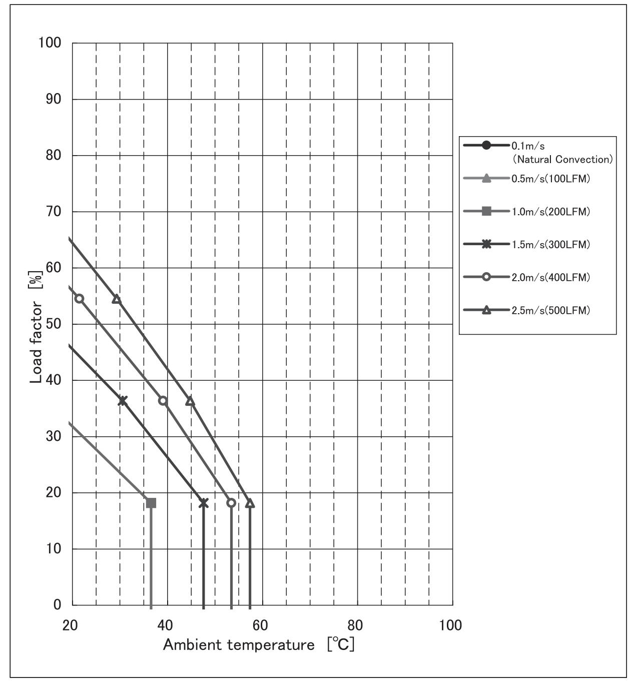
Thermal Considerations

CDS6002412

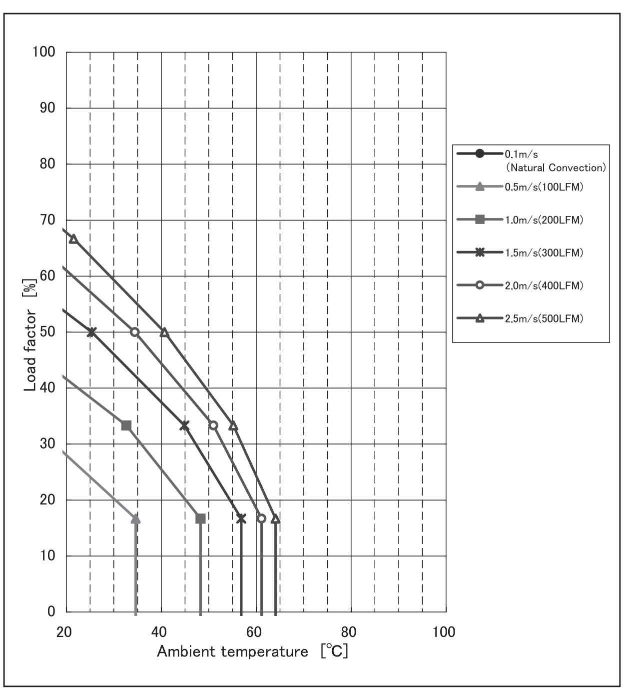


Heat sink A

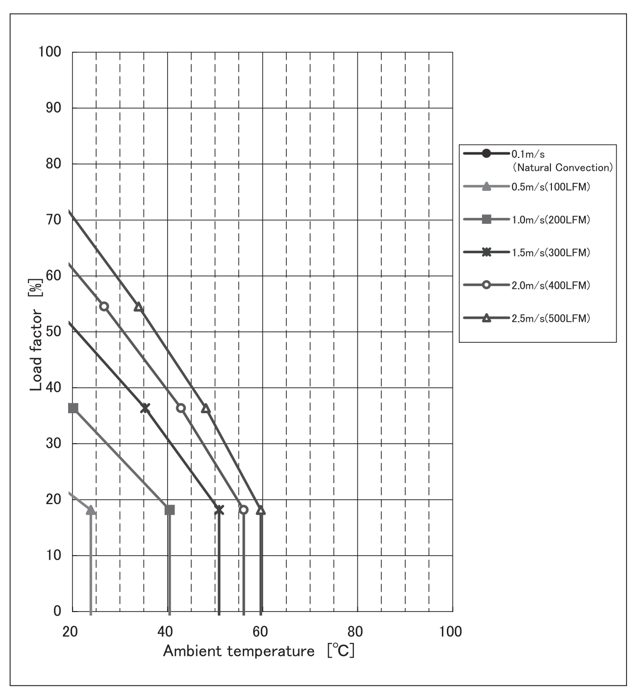
CDS6002428



Heat sink A

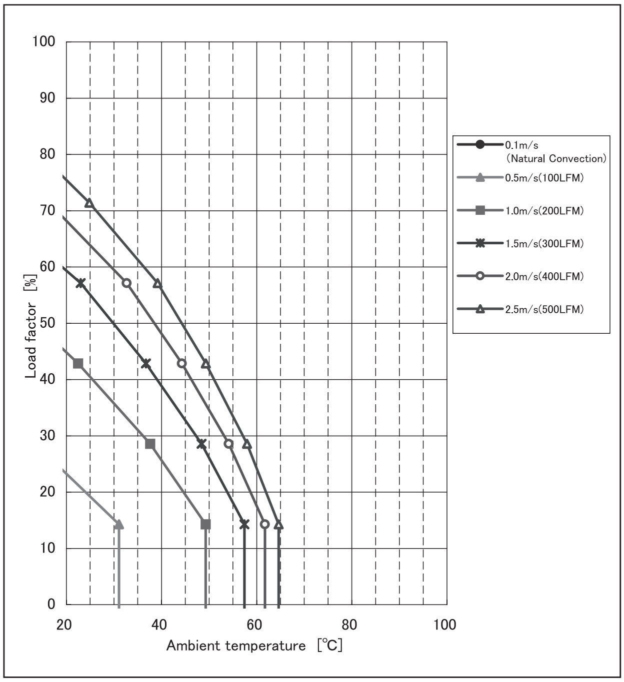


Heat sink B

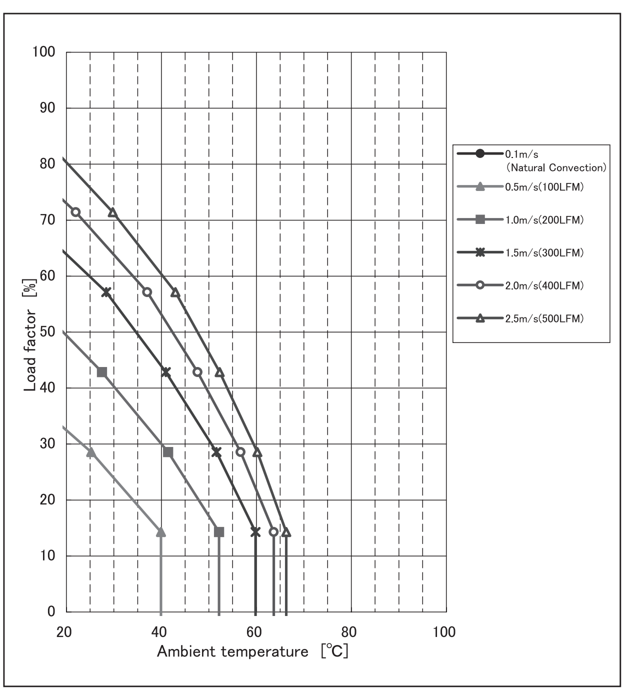


Heat sink B

CDS6004812

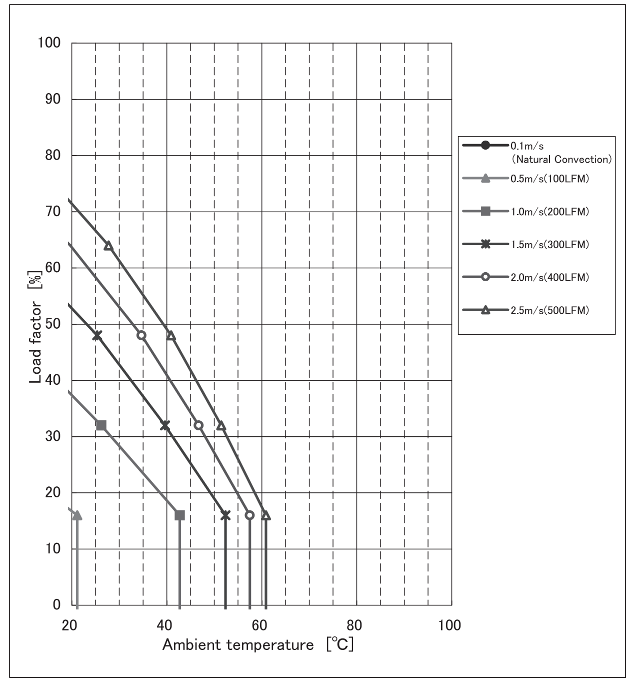


Heat sink A

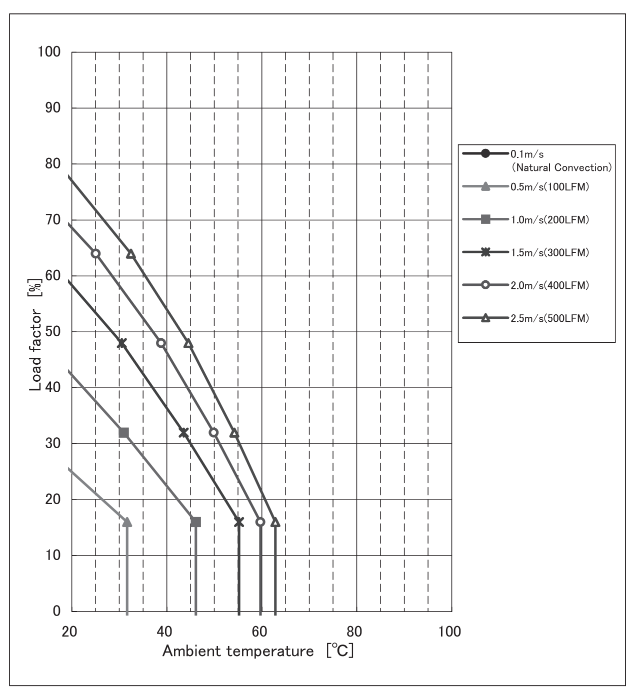


Heat sink B

CDS6004828

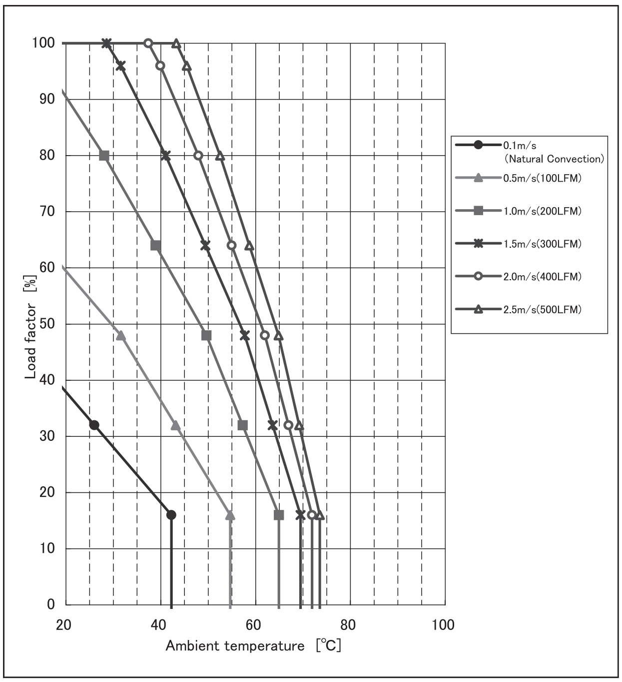


Heat sink A

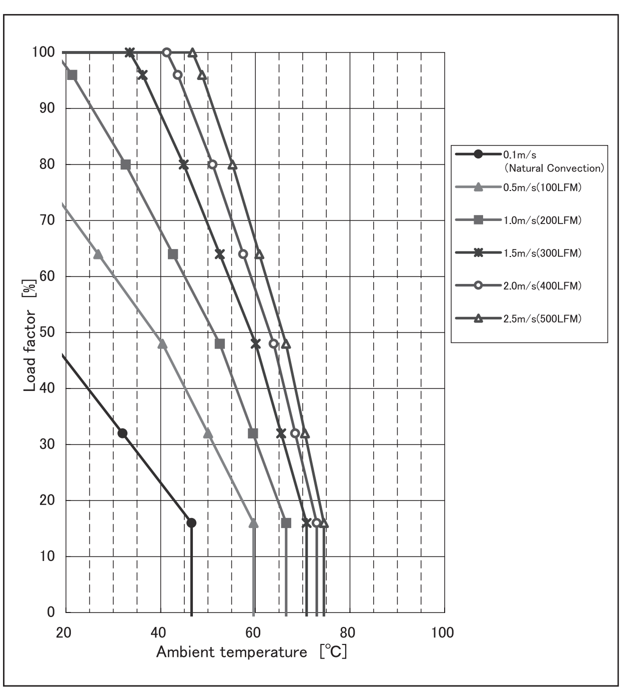


Heat sink B

DBS200B03

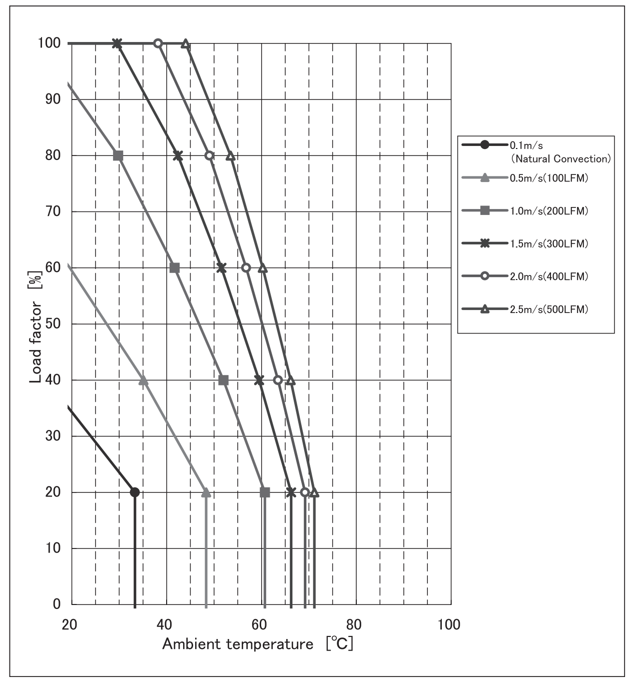


Heat sink A

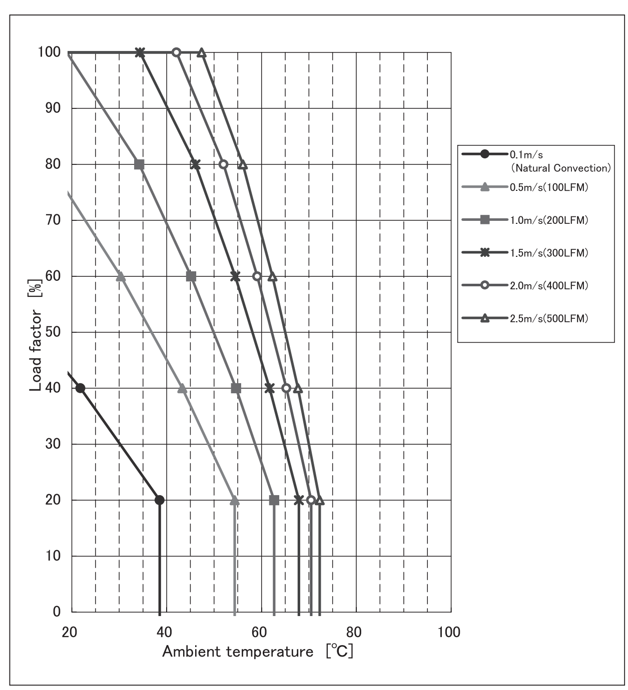


Heat sink B

DBS200B05

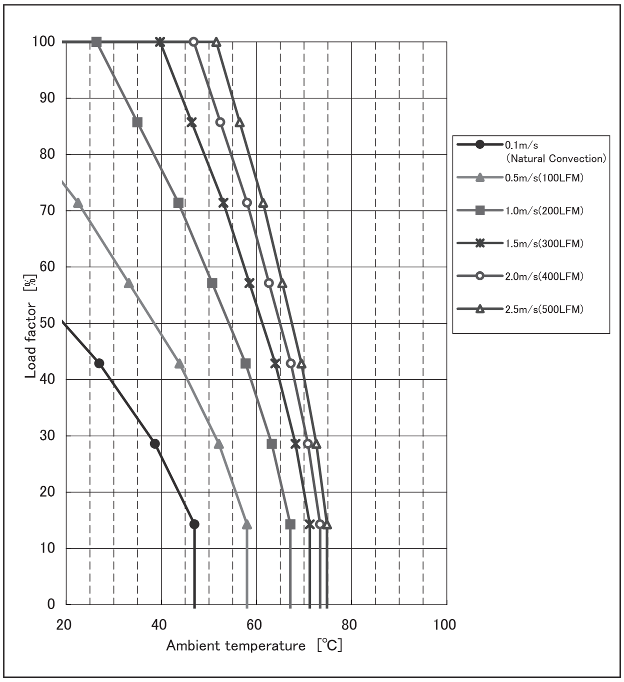


Heat sink A

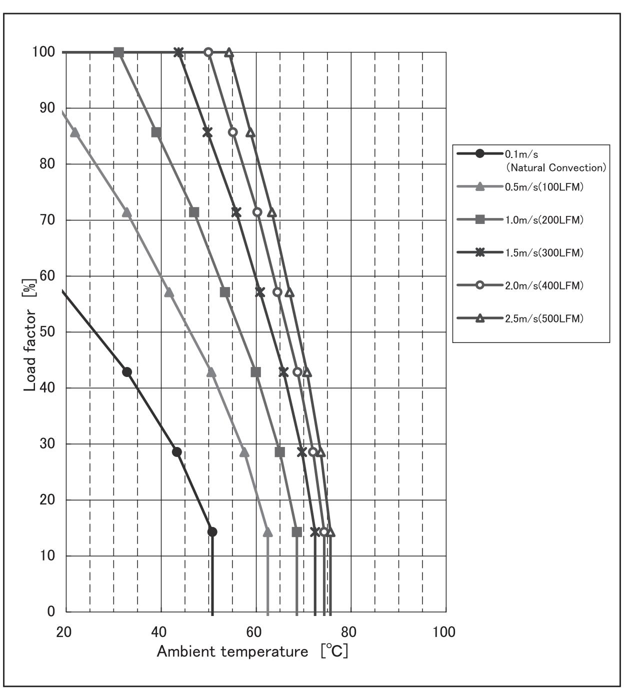


Heat sink B

DBS200B07

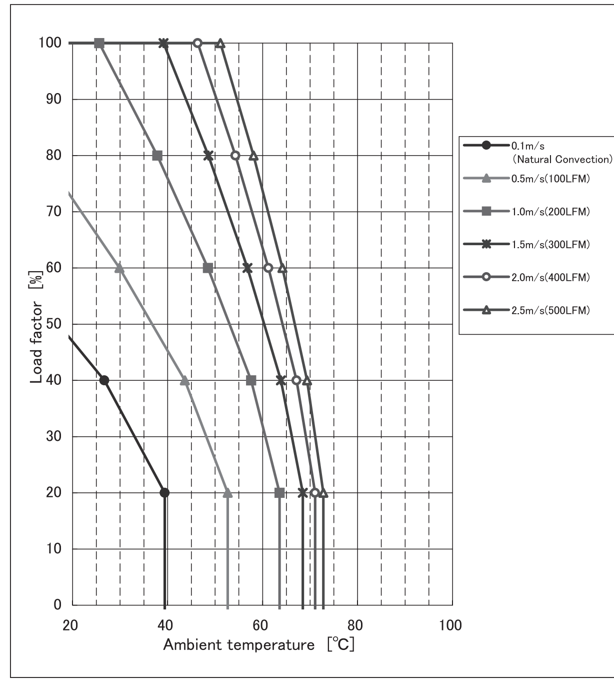


Heat sink A

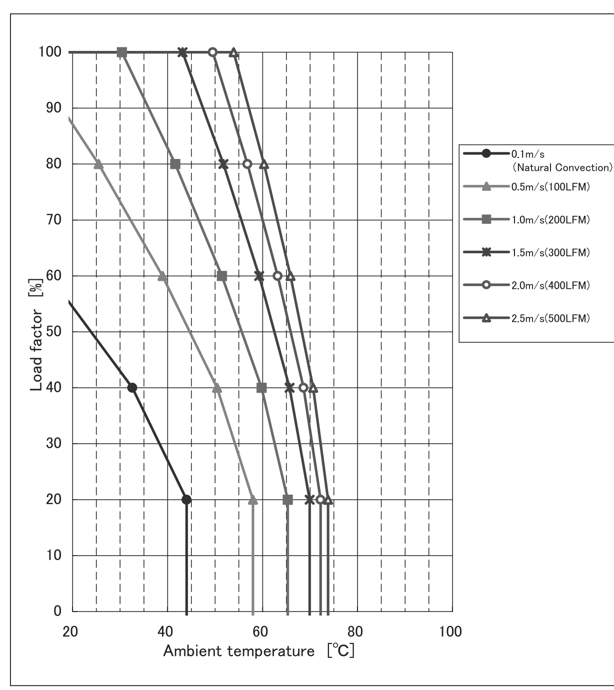


Heat sink B

DBS200B12



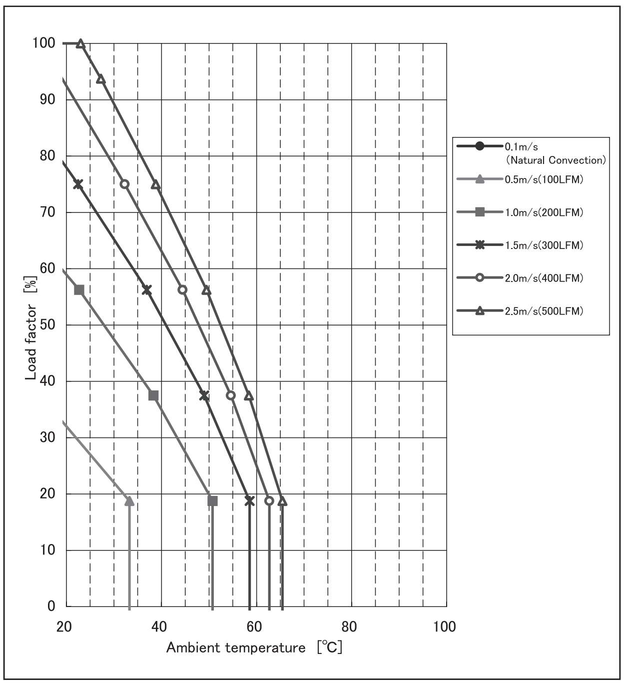
Heat sink A



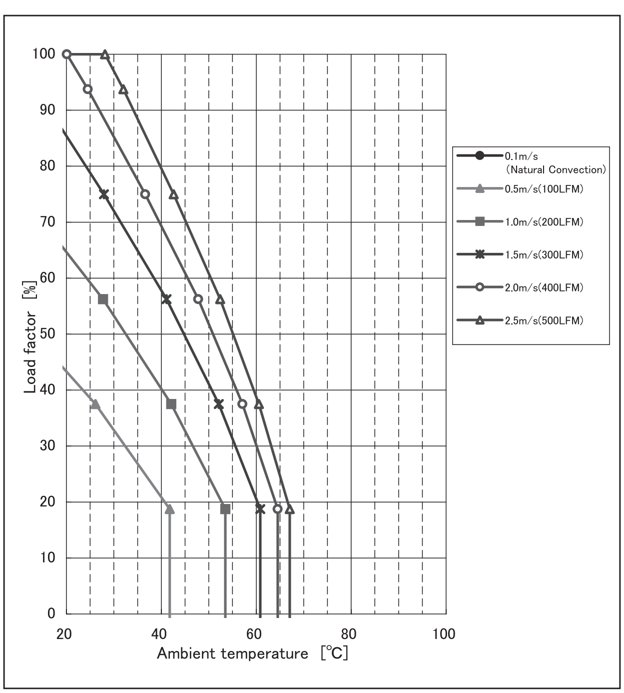
Heat sink B

Thermal Considerations

DBS400B03

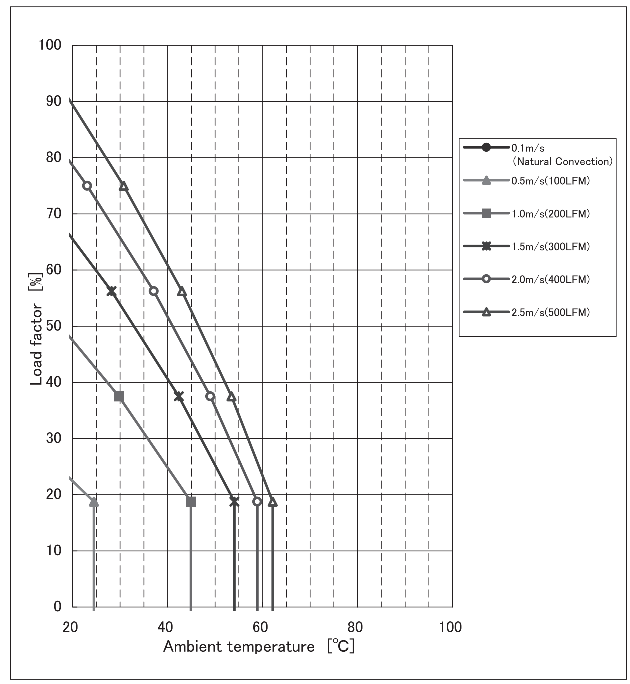


Heat sink A

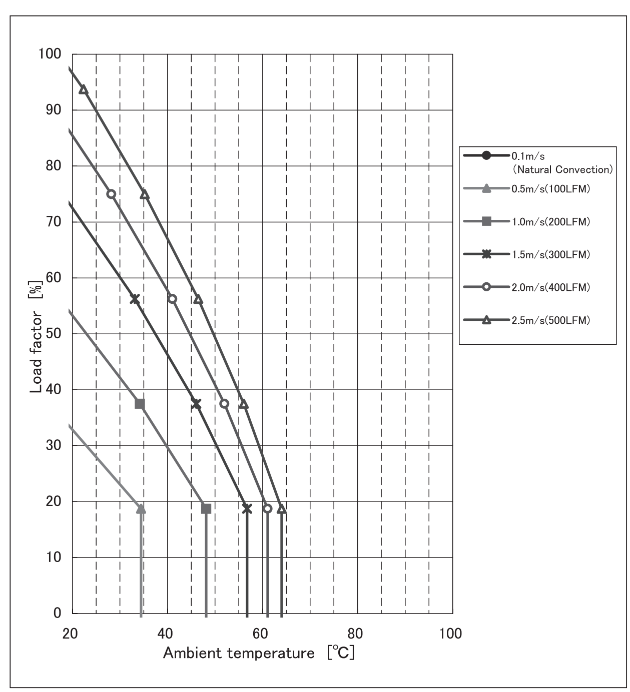


Heat sink B

DBS400B05

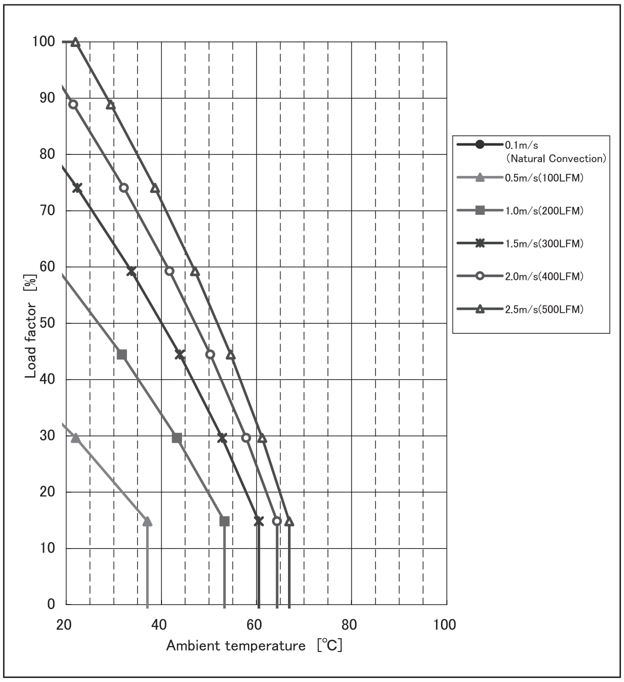


Heat sink A

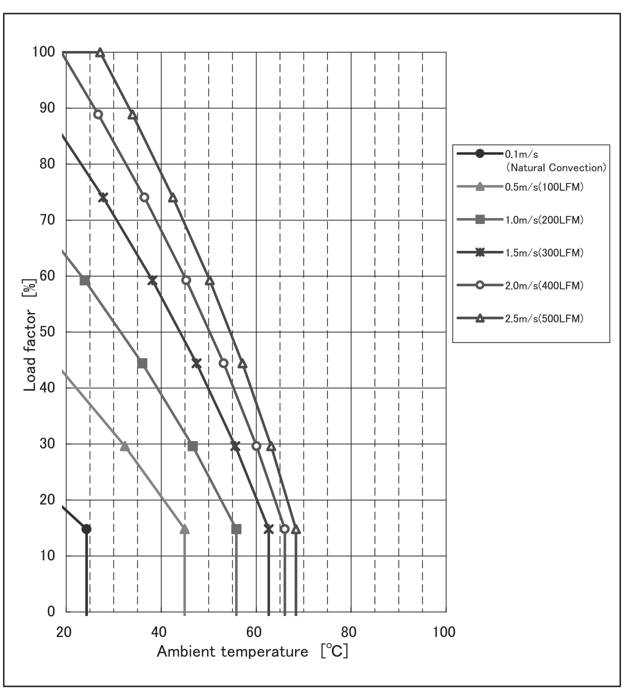


Heat sink B

DBS400B07

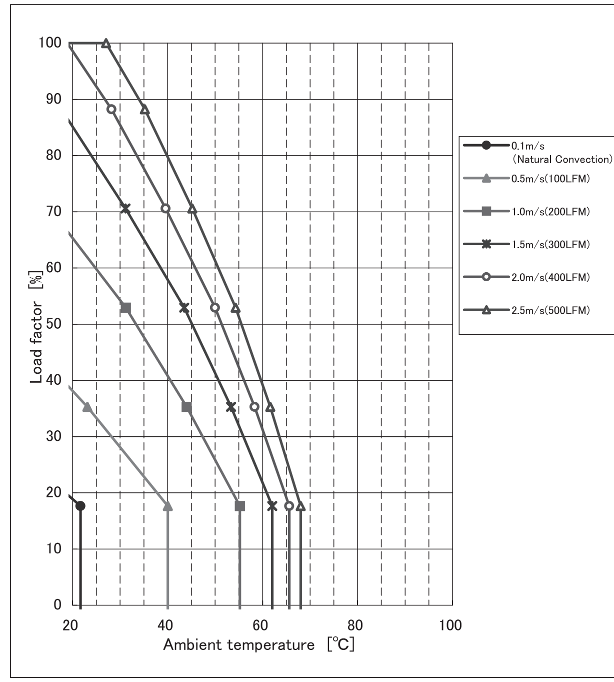


Heat sink A

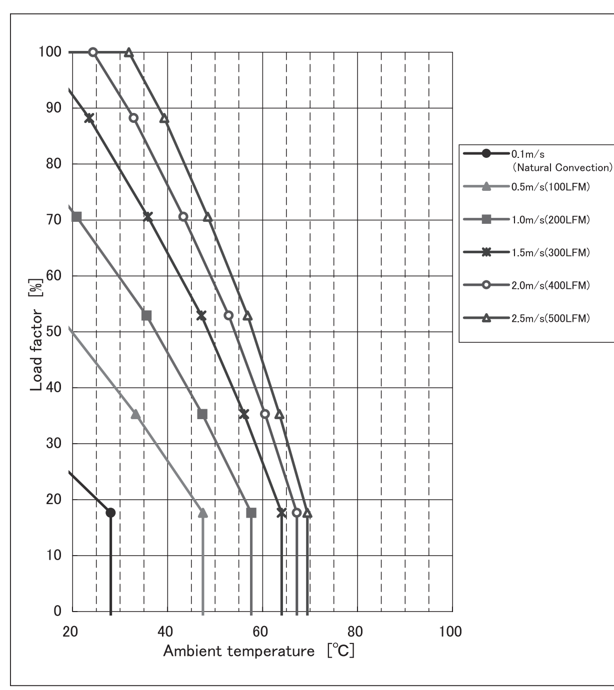


Heat sink B

DBS400B12



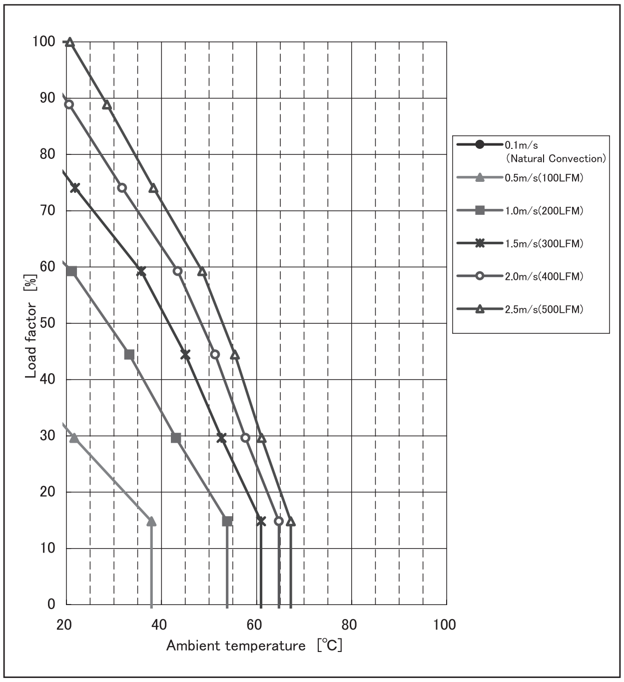
Heat sink A



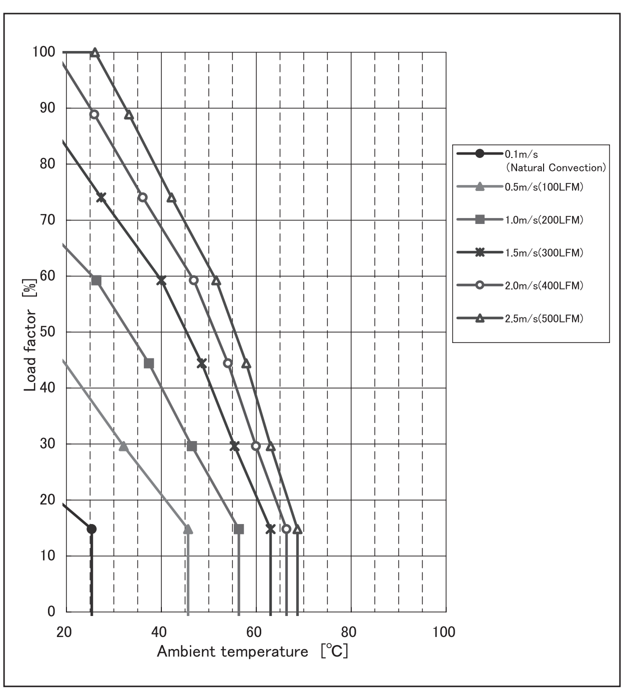
Heat sink B

Thermal Considerations

DBS400B15

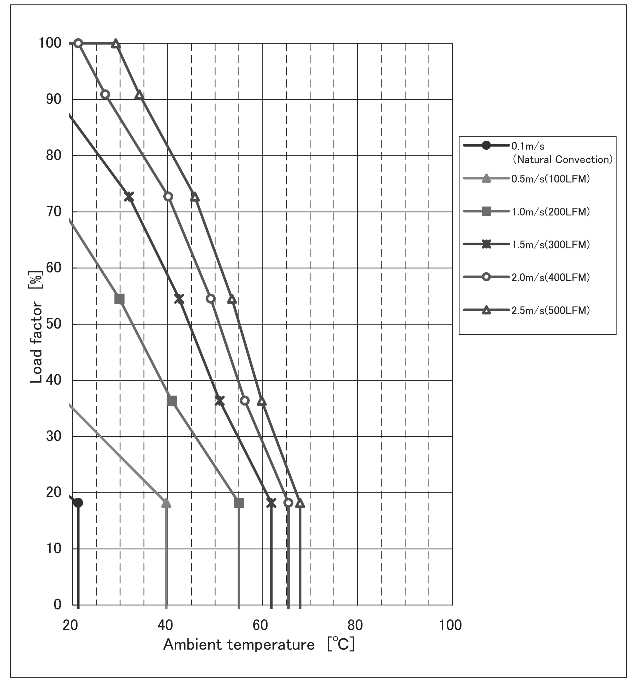


Heat sink A

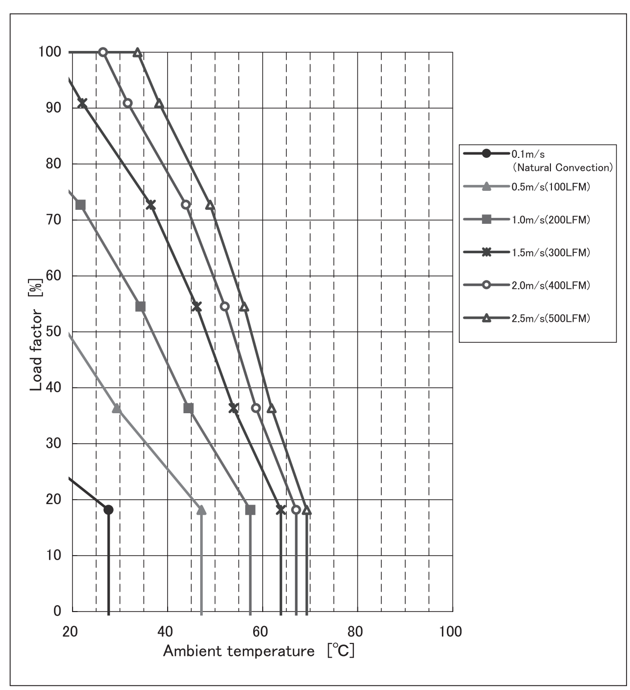


Heat sink B

DBS400B18

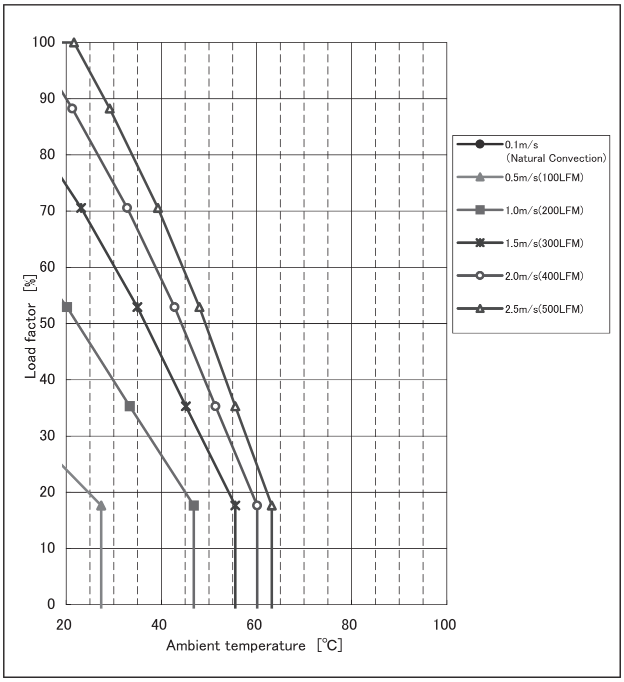


Heat sink A



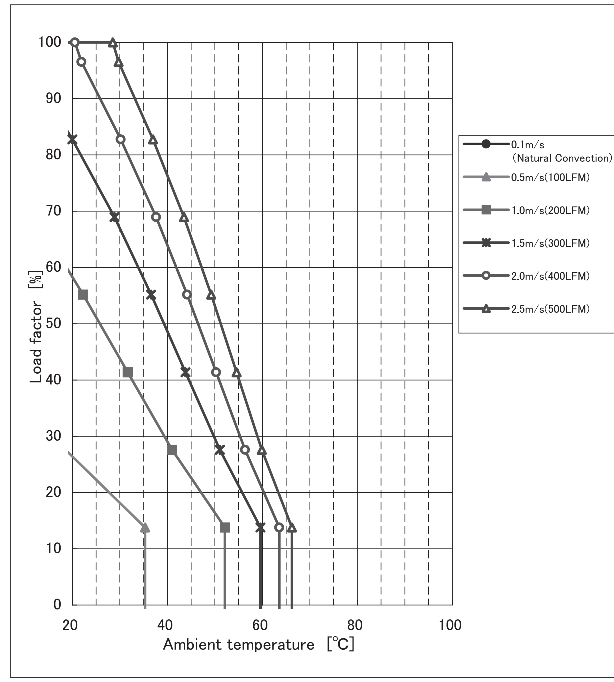
Heat sink B

DBS400B24

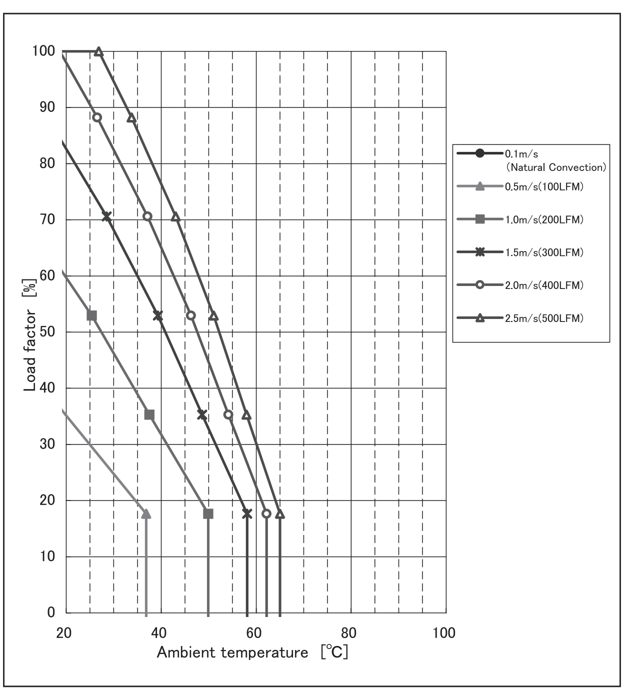


Heat sink A

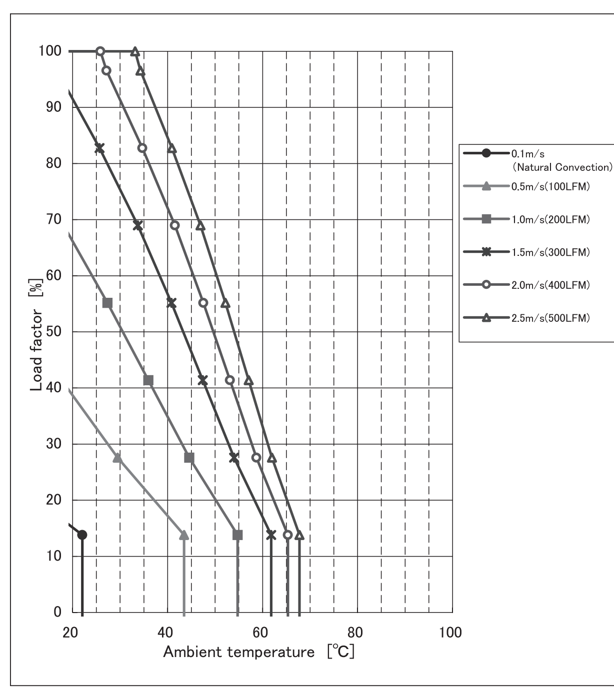
DBS400B28



Heat sink A



Heat sink B



Heat sink B

MEMO

9. Agency Approvals

9.1	DC/DC products	146
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9.3	Agency classifications	146

Agency Approvals

9.1 DC/DC products

	Approvals
●CBS series	UL : UL60950/c-UL TÜV : EN60950 CE : Low Voltage Directive (73/23/EEC, 93/68/EEC)
●CDS series	UL : UL60950/c-UL TÜV : EN60950 CE : Low Voltage Directive (73/23/EEC, 93/68/EEC)
●DBS series	UL : UL60950/c-UL TÜV : EN60950, VDE0160 CE : Low Voltage Directive (73/23/EEC, 93/68/EEC)

9.2 AC/DC products

	Approvals
●DPF series	UL : UL60950/c-UL TÜV : EN60950, EN50178 CE : Low Voltage Directive (73/23/EEC, 93/68/EEC)
●DPA series	UL : UL1950 CSA : C22.2 No.234 TÜV : EN60950, VDE0160
●STA series	UL : UL1950/c-UL TÜV : EN60950

9.3 Agency classifications

●UL	UL1950 UL60950	3rd Edition	Safety of Information Technology Equipment.
●TÜV	EN60950		Safety of Information Technology Equipment.
	EN50178		Electronic equipment for use in power installations.
	VDE0160		Electronic equipment for use in power installations. And their assembly into electrical power installations.
●CSA	C22.2 No.234		Safety of Component Power Supplies for use Information Technology and Business Equipment.

10. Product Weights

10.1 DC/DC products	148
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10.1 DC/DC products

	Weights	
●CBS series	50W type : 73 g typ	2.6 oz. typ
	100W type : 73 g typ	2.6 oz. typ
	200W type : 73 g typ	2.6 oz. typ
●CDS series	400W type : 158 g typ	5.6 oz. typ
	600W type : 180 g typ	6.4 oz. typ
●DBS series	200W type : 129 g typ	4.6 oz. typ
	400W type : 158 g typ	5.6 oz. typ

10.2 AC/DC products

●DPF series	1000W type : 175 g typ	6.2 oz. typ
●DPA series	500W type : 121 g typ	4.3 oz. typ
●STA series	5kW type : 4.56 kg typ	10 lbs. typ

11. Glossary of Technical Terms

Glossary of Technical Terms

1	AUX	Auxilary power supply for operating external circuit.
2	CB	Current balance pin
3	CE	Instruction to demand safety, quality control, and environmental destruction prevention of equipment sold in EU.
4	CISPR Public.22	International Standard of Line conduction and radiated noise.
5	CSA : C22.2 No.234	Canadian Standards Association, An indipendent Canadian organization concerned with testing for public safety. C22.2 No.234 is testing requirement for power supply.
6	C-UL	UL standard autholized in Canada.
7	EMC	Electro Magnetic Interference. Any electric disturbance that interrupts, obstructs, or otherwise impairs the performance of electric eqipment.
8	EN60950	Safety of information technology equipment including electrical business equipment apploved by CENELEC.
9	ENA	Enable signal pin
10	FCC class A/B	American Standard of Line conduction and radiated noise.
11	IOG	Inverter operation moniter pin
12	PR	Power Ready signal pin
13	SR	The pin for connecting an internal resistor to reduce inrush current.
14	TRM	Adjustment of output voltage pin
15	TÜV	German Standards Association, An indipendent German organization concerned with testing for public safety. EN60950 is testing requirement for power supply units.
16	UL	American Standards Association, An indipendent American organization concerned with testing for public safety. UL60950 is testing requirement for power supply.
17	VB	Voltage balance pin
18	Baseplate	All modular products have an aluminum mounting base at which Cosel specifies operating temperatures and which should be affixed to a thermally conductive surface for cooling.
19	Safety ground	A conductive path to earth that is designed to protect persons from electrical shock by shunting away any dangerous currents that might occur due to malfunction or accident.
20	Overvoltage protection	A circuit that either shuts down the power supply or crowbars the output in the event of an output overvoltage condition.
21	Overcurrent protection	A power supply protection circuit that limits the output current under overload condition.
22	Thermal protection	A power supply protection circuit that shuts the power supply down in the event of unacceptably high internal temperature.
23	Basic insulation	Insulation to provide basic protection againstelectric shock.
24	Reinforced insulation	A single insulation system which provides a degree of protection against electric shock equivalent to DOUBLE INSULATION.
25	Class I	Equipment where protection against electric shock is achieved by : a) Using BASIC INSULATION, and also b) Providing a means of connecting to the protective earthing conductor in the building wiring those conductive parts that are otherwise capable of assuming HAZARDOUS VOLTAGES if the BASIC INSULATION fails.
26	Harmonic current	Input current included higher harmonic element.
27	Efficency	The ratio of total output power to active power, expressed in percent. This is normally specified at full load and nominal input voltage.
28	Common mode noise	Noise present equally on two conductors with respect to some reference point ; often used specifically to refer to noise present on both the hot and neutral AC line with respect to ground.

29	The highest ambient temperature	The highest value of ambient temperature by which electric specification can be guaranteed when power supply operates.
30	Line conduction	The noise generated in the power supply means the amount which goes out to the input line.
31	Hold-up time	The time during which a power supply's output voltage remains within specification following the loss of input power.
32	Thermal grease	Grease of silicon. This used as a thermal interface between the converter and a heat sink or chassis.
33	Positive rosic	The signal is low. When Remote ON/OFF output voltage is able.
34	Series Operation	Connecting the outputs of two or more power supplies together for the purpose of obtaining a higher output voltage.
35	Low voltage instruction	The product driven by a low voltage of AC50V - AC1000V or DC75V - DC1500V is an object. Instruction to which thing that danger is not caused by electric cause is requested.
36	Derating	Reducing the output power of a power supply with increasing temperature to maintain reliable operation.
37	Inrush current	The peak instantaneous input current drawn by the power supply at switch ON.
38	Double insulation	Insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION.
39	Referencial made noise	Noise generated between line and line. Normal mode noise as a by name.
40	Heat sink	A medium of high thermal mass that can absorb (sink) heat indefinitely with negligible change in temperature. Heat sinks are not necessarily needed with Cosel modules, and their use is highly dependent on the individual application, power and ambient temperature.
41	Radiated noise	The noise generated in the power supply is an amount of which the power supply becomes an electric wave from the input line and the output line and goes out again.
42	Fuse	Blowing categry's are first blow, nomal blow, slow blowing.
43	Negative rosic	The signal is high. When Remote ON/OFF output voltage is able.
44	Parallel operation / master slave operation	(1) Connecting the outputs of two or more power supplies together for the purpose of obtaining a higher output current. This requires power supplies specially designed for load sharing. (2) Output voltage in parallel operation is adjustable by using the potentiometer of the "master" unit. Select one power supply to be the master, and turn the potentiometer of the other, "slave" power supplies, clockwise to the end. Then use the potentiometer of the master to adjust output voltage.
45	Hot swap	Insertion and extraction of a power supply into a system while power is applied.
46	line-drop	Phenomenon that voltage decreases with electric wire etc. Because the voltage reduction grows when the resistance of the electric wire is large, you should use the one with a large diameter of the line.
47	Ripple and noise	The amplitude of AC component on the DC output of a power supply usually expressed in millivolts peak-to-peak or rms. For a linear power supply it is usually at the frequency of the AC mains. For a switching power supply, it is usually at the switching frequency of converter stage.
48	Remote ON/OFF	(1) Converter shutdown into a standby or idle mode by application of an external signal to the Remote ON/OFF terminal. (2) Converter shut down by an external logic signal.
49	Remote sensing	A technique of regulating the output voltage of a power supply at the load by means of sensing leads which go from the load back to the regulator. This compensates for voltage drops in the load leads.
50	Power fail	The ratio of active power to apparent power in an AC circuit. In power conversion technology, power factor is used in conjunction with describing AC input current to the power supply.

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