2. CBS series

2.1 Pin configuration

Fig.2.1.1
Pin configuration

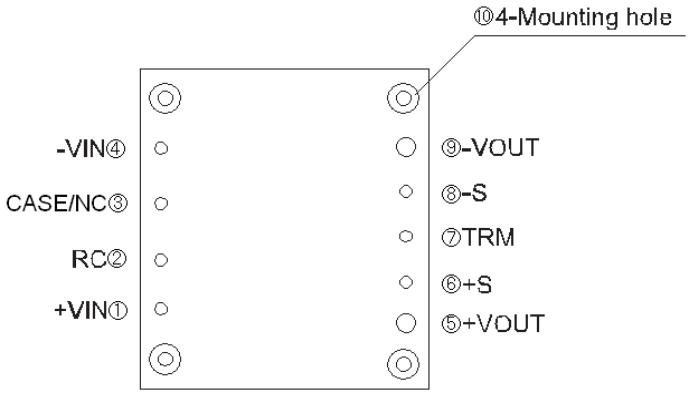


Table 2.1.1
Pin configuration and function

Pin №	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 / NC *	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

* CBS50, CBS100 and CBS200: CASE / CBS350: NC

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

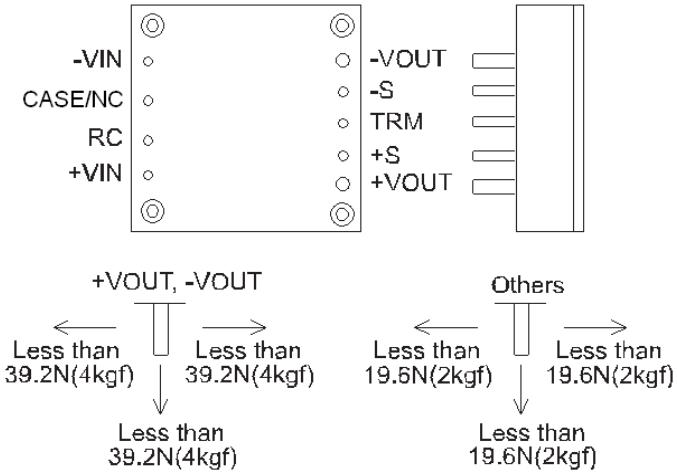
2.2.3 External input capacitor

- When the line impedance is high or the input voltage rise quickly at start-up (less than 10μs), install capacitor Cin between +VIN and -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 enough.

2.2.6 Soldering

- Flow soldering : 260°C less than 15 seconds.
- Soldering iron : 450°C less than 5 seconds (less than 26W).

2.2.7 Safety standard

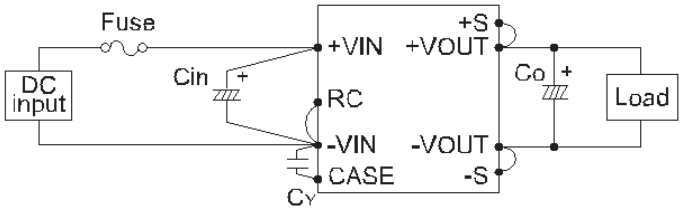
- This unit must be used as a component of the end-use equipment.
- The equipment does neither contain any basic nor double / reinforced insulation between input and output, and base plate.
  If the input voltage is greater than 60VDC, this has to be provided by the end-use equipment according to the final build in condition.
- Safety approved fuse must be externally installed on input side.

2.3 Connection method for 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	CBS5024/10024/20024/35024 : less than 2Vp-p	
	CBS5048/10048/20048/35048 : 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

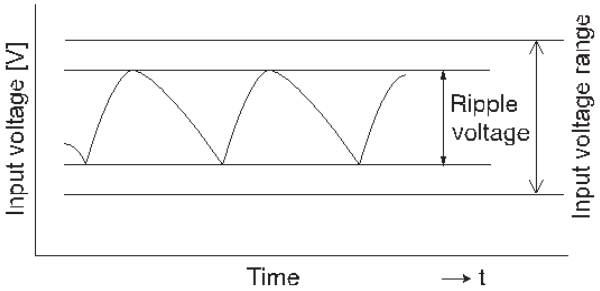
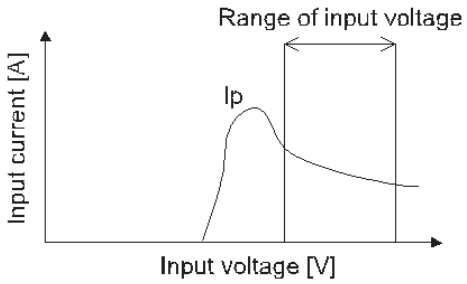
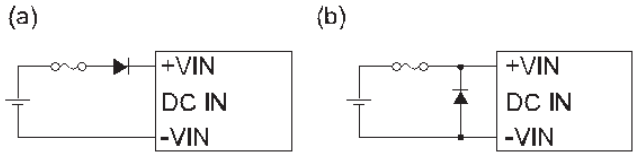


Fig.2.3.3
Input current
characteristics



- 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		CBS35024
			1R8/2R5/03/05	12/15/24/28	
Rated current	6A	12A	20A	25A	30A
MODEL	CBS5048	CBS10048	CBS20048		CBS35048
			03/05	12/15/24/28/48	
Rated current	3A	6A	10A	12A	20A

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
CBS35024 : more than 220μF x 2
CBS35048 : more than 68μF x 2
Tc = -20 to +100°C : Electrolytic or Ceramic capacitor
Tc = -40 to +100°C : 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°C										
VOUT	1.8V	2.5V	3.3V	5V	12V	15V	24V	28V	32V	48V
CBS50	2200μF				470μF		220μF		-	
CBS100	2200μF				470μF		220μF		-	
CBS200	2200μF				1000μF		470μF		-	330μF
CBS350	-				470μF	-	220μF		220μF	-
Base plate temperature : Tc=-40 to +100°C										
VOUT	1.8V	2.5V	3.3V	5V	12V	15V	24V	28V	32V	48V
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		-	330μF x 2
CBS350	-				470μF x 3	-	220μF x 3		220μF	-

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 at Fig.2.4.2.

Fig.2.4.1
Derating curve
for CBS50/100/200

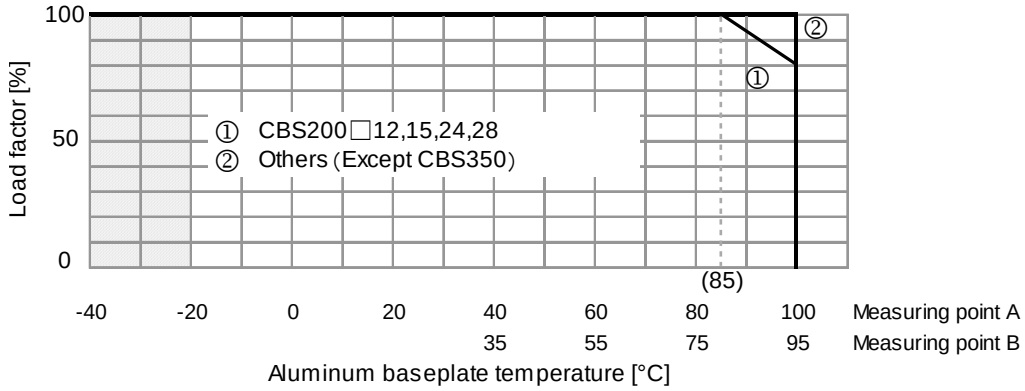


Fig.2.4.2
Derating curve
for CBS350

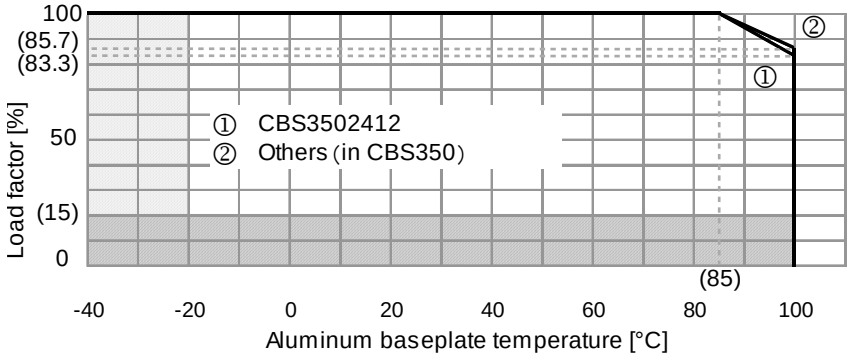
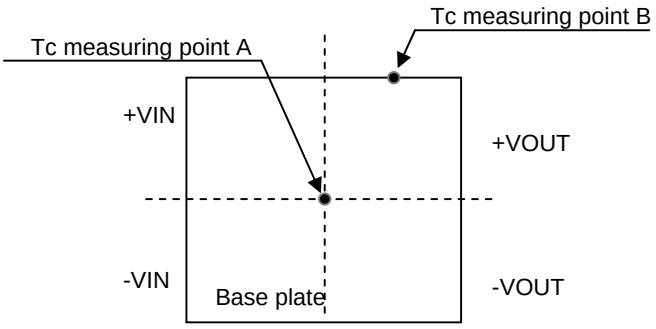


Fig.2.4.3
Measuring point



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°C, 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°C 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 (CBS5024/10024/20024/35024), DC36 to 40V (CBS5048/10048/20048/35048), 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
Characteristic

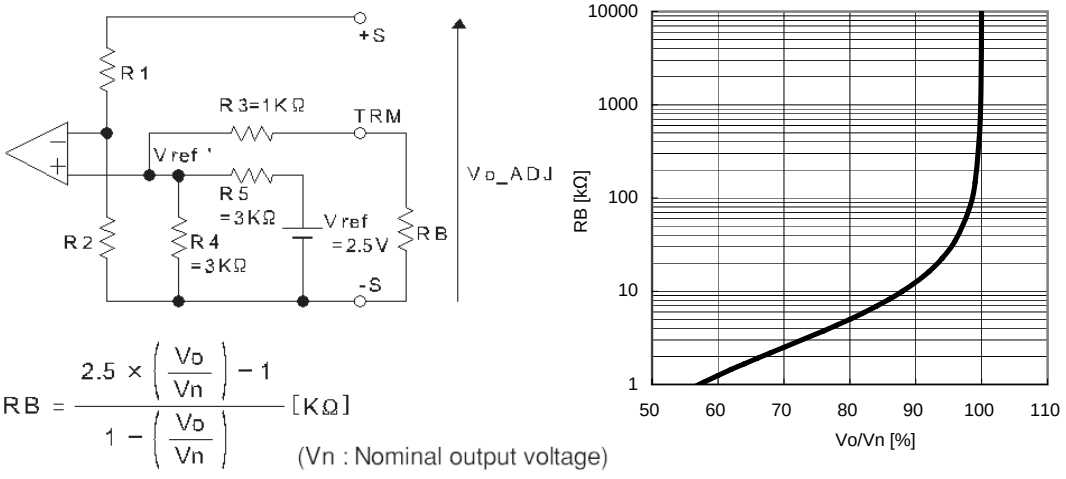
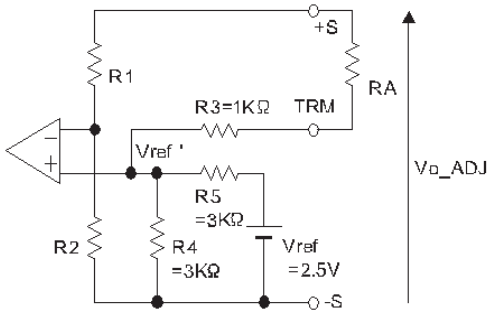


Fig.2.6.1 Vo / Vn - RB

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



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

(Vn : Nominal output voltage)

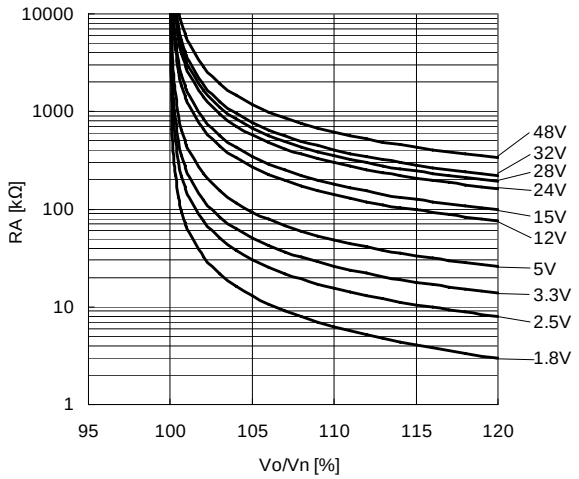


Fig.2.6.2 Vo/Vn - RA

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/°C
Potentiometer : Cermet type, coefficient less than ±300ppm/°C

Fig.2.6.3
Output voltage control
circuit

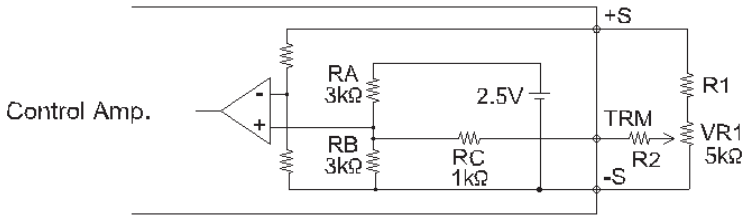


Table 2.6.1
Recommended value
of external resistor

№	VOUT	Adjustable range			
		VOUT ±5%		VOUT ±10%	
		R1	R2	R1	R2
1	1.8V	1.8kΩ	6.2kΩ	1.6kΩ	3.6kΩ
2	2.5V	2.7kΩ	7.5kΩ	2.4kΩ	4.7kΩ
3	3.3V	2.4kΩ	11kΩ	2.4kΩ	6.8kΩ
4	5V	5.6kΩ		5.6kΩ	
5	12V	18kΩ		18kΩ	
6	15V	24kΩ		24kΩ	
7	24V	43kΩ		39kΩ	
8	28V	51kΩ		47kΩ	
9	32V	56kΩ		56kΩ	
10	48V	82kΩ		82kΩ	

2.7 Remote ON/OFF

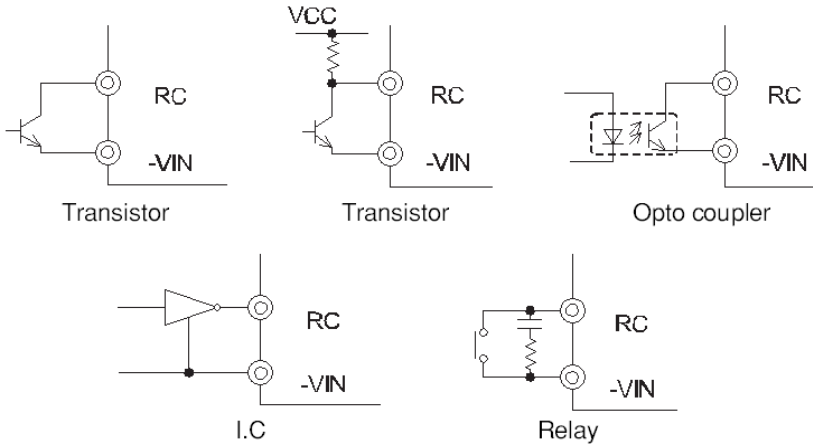
- Remote ON/OFF circuit is built-in on input side.

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, Sink current is 0.5mA typ. When Vcc is applied, use 3.5 ~ 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

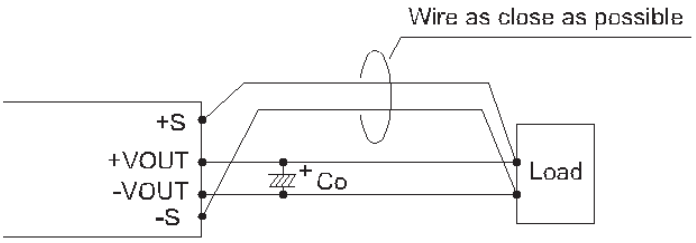


2.8 Remote sensing

- This function compensate line voltage drop.

2.8.1 When the remote sensing function is in use

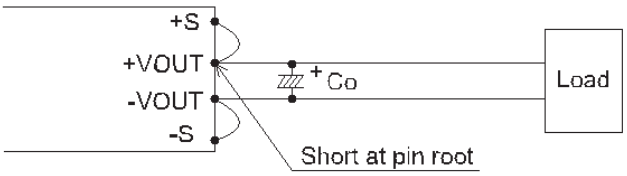
Fig.2.8.1 Connection when the remote sensing is in use



- Twisted-pair wire or shield wire is recommended 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

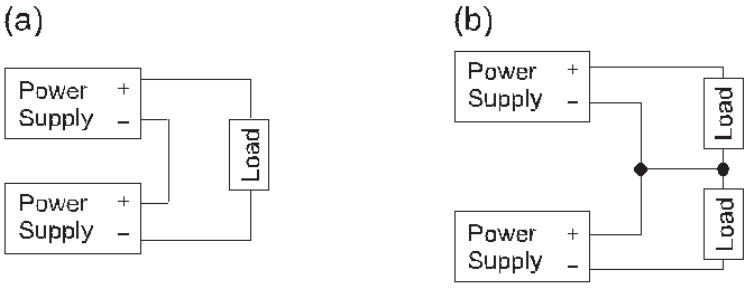


- When the remote sensing function is not in use, Make sure that pins are shorted between +S and +VOUT and between -S and -VOUT are connected.
- Connect between +S and +VOUT and between -S and -VOUT directly.
  No loop wiring.
  This power supply might become unstable by the noise coming from poor wiring.

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.

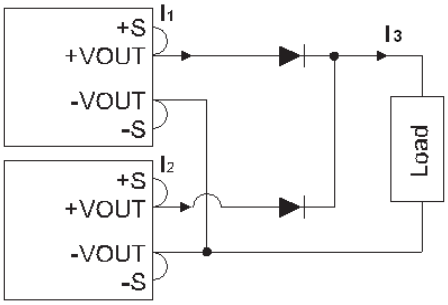
Fig. 2.9.1
Examples of serial operation



2.10 Parallel operation / Redundancy operation

- Parallel operaion is not possible.
  Redundancy operation is available by connecting the units as shown Fig.2.10.1.

Fig.2.10.1
Parallel redundancy operation



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

I_3 must be less than a 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

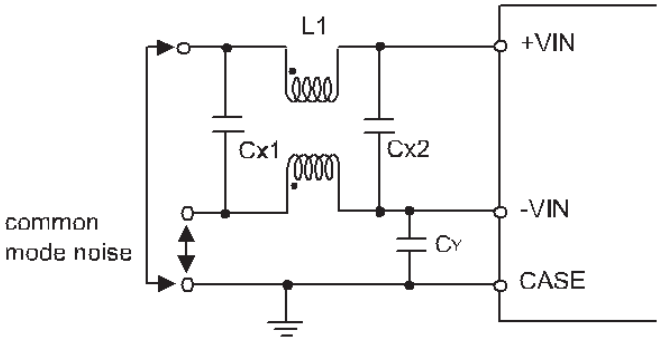
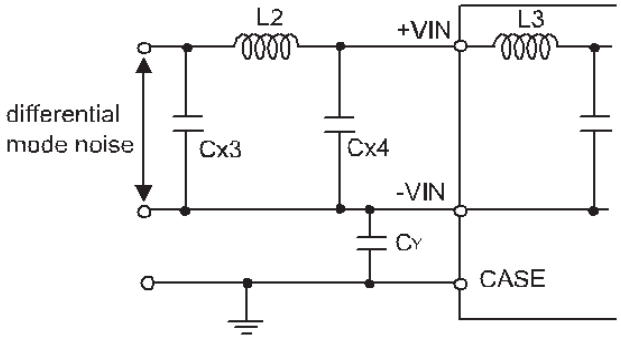


Fig.2.11.2
Differential mode
noise path

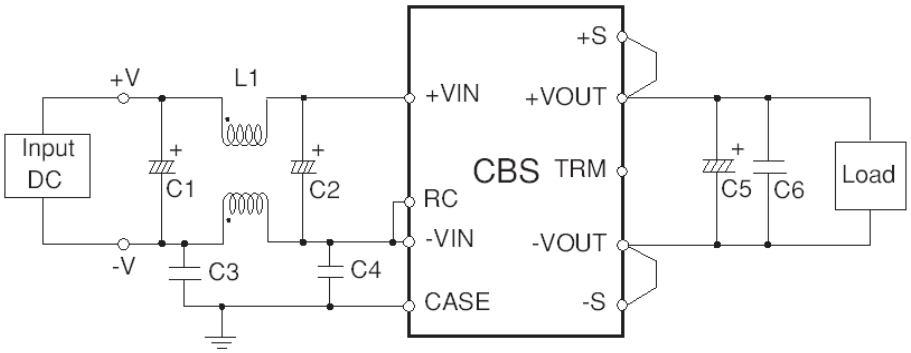


- The CBS provide the normal mode choke (L3) to reduce the differential mode noise.
  Install the capacitor (Cx4) to reduce the differential mode noise.
  The most effective way to reduce the differential mode noise are to install since X capacitor (Cx3) and the normal mode choke (L2).
- The leakage inductance of the common mode choke (L1) works as the normal mode choke.
  The normal mode choke (L2) is not necessary.

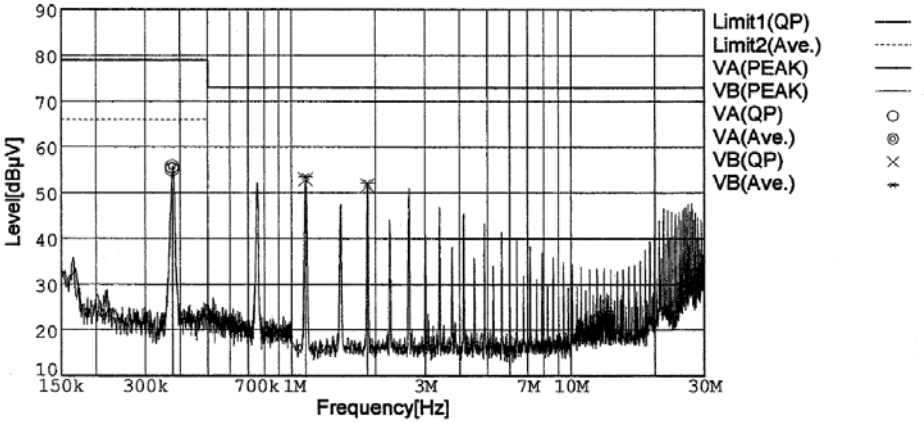
(2) Recommended of noise-filter

- 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)



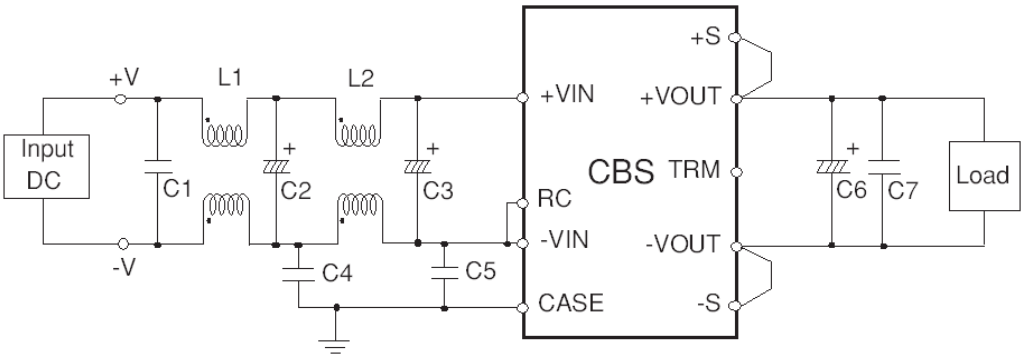
L1=3mH (SC-05-30J : NEC TOKIN)
C1, C2=100V33μF (LXV series : NIPPON CHEMI-CON)
C3, C4=AC250V4700pF (KH series : MURATA)
C5=10V2200μF (LXZ series : NIPPON CHEMI-CON)
C6=50V0.1μF (MDD21H104M : NITSUKO ELECTRONICS)



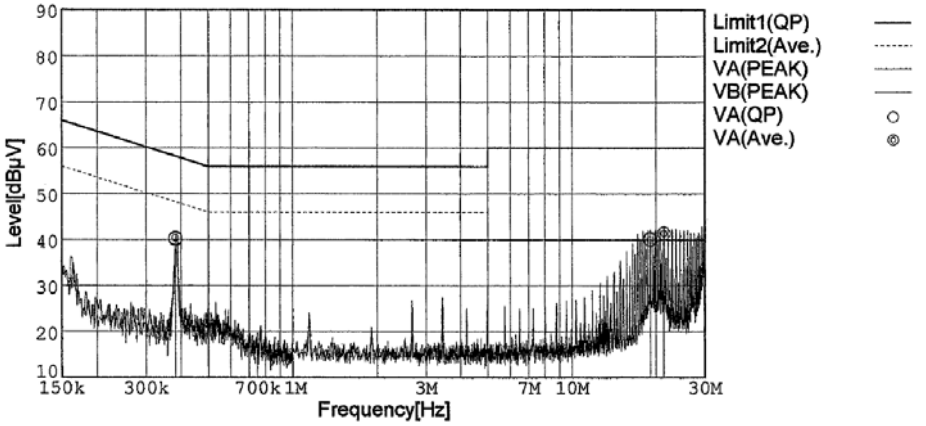
Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3751	45.2	45.9	9.8	55.0	55.7	VA	79.0	66.0	24.0	10.3
1.1244	43.0	43.6	9.9	52.9	53.5	VB	73.0	60.0	20.1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

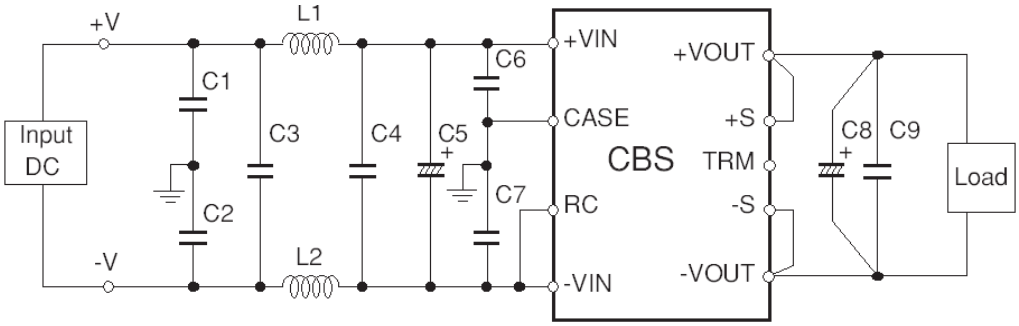


L1, L2=1mH (SC-05-10J : NEC TOKIN)
C1=0.33μF (CFJC22E334M : NITSUKO ELECTRONICS)
C2, C3=100V33μF (LXV series : NIPPON CHEMI-CON)
C4, C5=AC250V4700pF (KH series : MURATA)
C6=10V2200μF (LXZ series : NIPPON CHEMI-CON)
C7=50V0.1μF (MDD21H104M : NITSUKO ELECTRONICS)

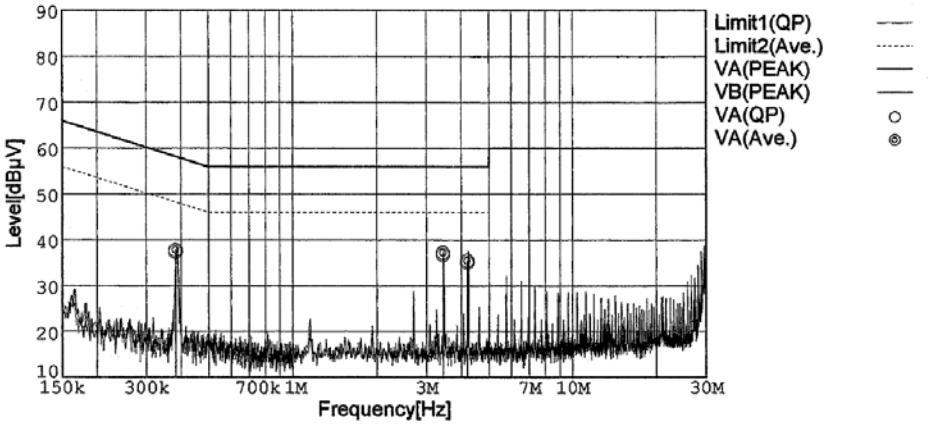


Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3817	30.4	30.6	9.8	40.2	40.4	VA	58.3	48.3	18.1	7.9
19.0808	30.1	29.7	10.2	40.3	39.9	VA	60.0	50.0	19.7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



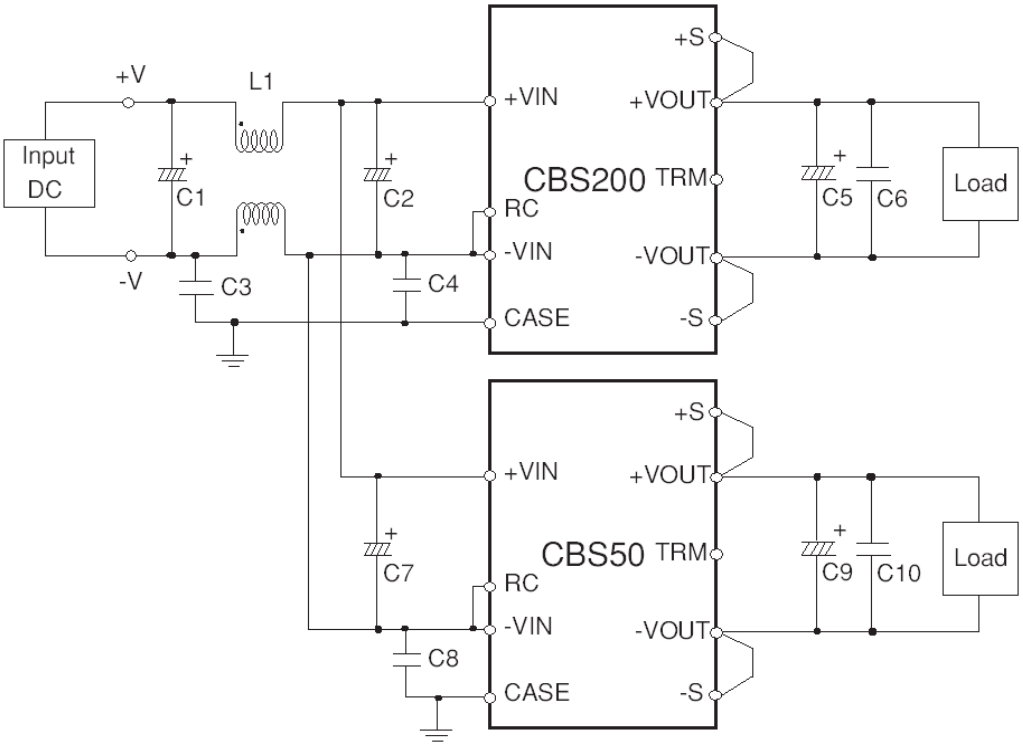
L1, L2=1.3mH (ETQP6F1R3LFA : PANASONIC)
C1, C2, C3, C4, C6, C7=100V3μF (CY55Y5P2A305M : NEC TOKIN)
C5=100V220μF (KZE series : NIPPON CHEMI-CON)
C8=10V2200μF (LXZ series : NIPPON CHEMI-CON)
C9=50V0.1μF (MDD21H104M : NITSUKO ELECTRONICS)



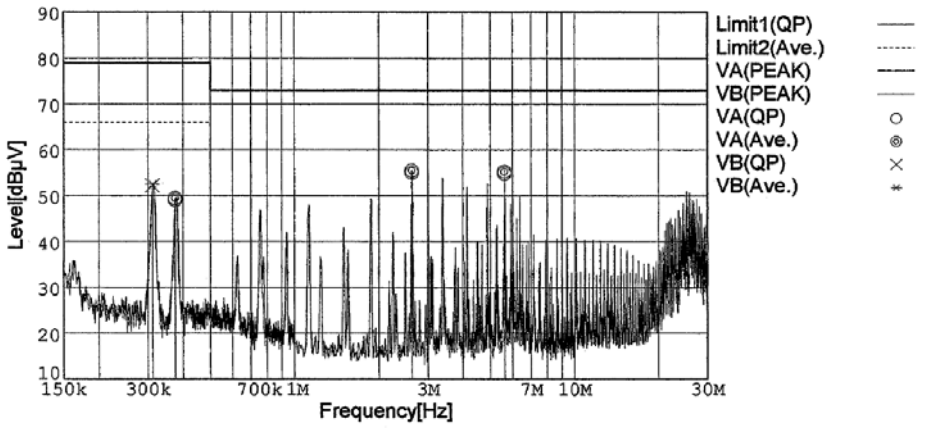
Frequency [MHz]	Meter Reading (QP) [dBμV]	Meter Reading (Ave.) [dBμV]	Factor [dB]	Level (QP) [dBμV]	Level (Ave.) [dBμV]	Line	Limit (QP) [dBμV]	Limit (Ave.) [dBμV]	Margin (QP)[dB]	Margin (Ave.) [dB]
0.3821	27.6	28.0	9.8	37.4	37.8	VA	58.2	48.2	20.8	10.4
3.4365	26.8	27.3	9.9	36.7	37.2	VA	56.0	46.0	19.3	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 B)



L1=3mH (SC-05-30J : NEC TOKIN)
C1, C2, C7=100V33μF (LXV series : NIPPON CHEMI-CON)
C3, C4, C8=AC250V4700pF (KH series : MURATA)
C5=10V2200μF (LXZ series : NIPPON CHEMI-CON)
C6, C10=50V0.1μF (MDD21H104M : NITSUKO ELECTRONICS)
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

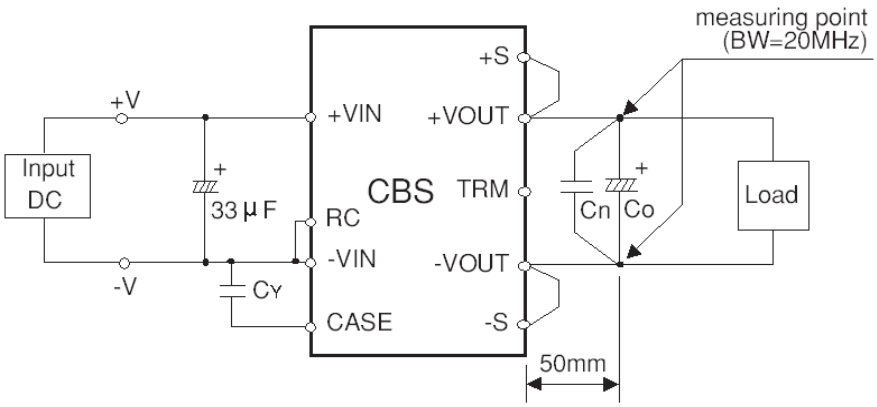


Table 2.11.1
Recommended capacitance Co

VOUT	1.8V	2.5V	3.3V	5V	12V	15V	24V	28V	32V	48V
CBS50	2200μF				470μF		220μF		-	
CBS100	2200μF				470μF		220μF		-	
CBS200	2200μF				1000μF		470μF		-	330μF
CBS350	-				470μF	-	220μF		220μF	-

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

Table 2.11.8
Output noise level
(Cn none)

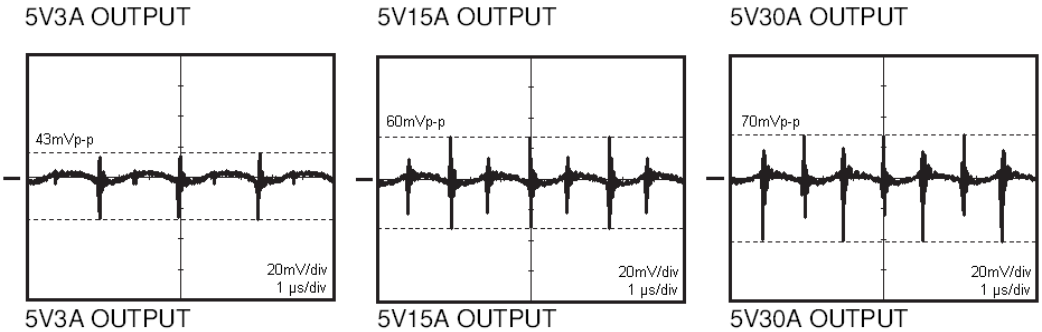


Fig.2.11.9
Output noise level
(Cn=0.1μF)