CCG60
Instruction Manual

BEFORE USING THE POWER SUPPLY

- Be sure to read this instruction manual thoroughly before using this product. Pay attention to all cautions and warnings before using this product. Incorrect usage could lead to an electrical shock, damage to the unit or a fire hazard.
- Product individual notes are shown in the instruction manual.
  If there is any difference with common notes individual notes shall have priority.

⚠ DANGER

Never use this product in locations where flammable gas or ignitable substances are present.

⚠ INSTALLATION WARNING

There is a risk of electric shock, fire or damage, if you do not follow the instructions below.

- When installing this product, ensure that work is done in accordance with the instruction manual.
  Installation shall be done by Service personnel with necessary and appropriate technical training and experience.
- Do not cover the product with cloth, paper and etc. Do not place anything flammable object around the product.
- Do not operate and store these products in environments where condensation occurs due to moisture and humidity.

⚠ WARNING ON USE

There is a risk of electric shock, fire, burn or damage, if you do not follow the instructions below.

- Do not touch this product or its internal components while product is in operation, or shortly after shutdown.
- Prepare for the unexpected, keep your face and hands away from the product while it is in operation.
- Do not make unauthorized change to this product or remove the cover.
  We will not be held responsible if the product was modified, changed or disassembled.
- Do not use this product under unusual conditions such as emission of smoke or abnormal smell and sound etc.
  Please stop using it immediately and shut off the product. In such cases, please contact us.
- Do not attempt any repair by yourself, as it is dangerous for the user.
  This product will be repaired by our company or an authorized agent designated by our company.
- Please do not use products that have been dropped or subjected to impact.
- Please use within specifications standards for input voltage, output current, output power, ambient temperature, humidity, etc.
- This product was made for general purpose electronic equipment use and is not designed for applications requiring High safety (such as extremely high reliability and safety requirements. Even though high reliability and safety are not required, this product should not be used directly for applications that have serious risk for life and physical safety.
  Take sufficient consideration in fail-safe design (such as providing protective circuit or protective device inside the system, providing redundant circuit to ensure no instability when single device failure occurs).
- It is important that this product must not be used in hazardous environments or facilities such as nuclear power control system or life support equipment without our written consent.

⚠ CAUTION ON MOUNTING

- Ensure connections to input/output terminals are correct as indicated in the instruction manual before switching on.
- Please use the wires as short and thick as possible.
- Do not use this product in special environment with strong electromagnetic field, corrosive gas (hydrogen sulfide, sulfur dioxide, etc.) or conductive substances and direct sunlight, or places where product is exposed to water or rain.
- Mount this product properly in accordance with the instruction manual, mounting direction and shall properly be ventilated.
- Please shut down the input when connecting input and output of the product.
- When installing in environment where conductive foreign, dust and liquid may be present, please take care to avoid penetration of these foreign material in the power supply by installing filter, to prevent trouble or malfunction.

⚠ CAUTION ON USE

- Please insert a fuse at the input, taking into account inrush current values, to prevent smoke, fire during abnormal operation, or to comply with various safety standards, for products without built-in protection circuits (protection elements, fuses, etc.). Please refer to the instruction manual when selecting a fuse.
- Provide countermeasure for prevention of lightning surge voltage as there is risk of damage due to abnormal voltage.
- Take care not to apply abnormal voltage to the output. It might cause failure, smoke or fire.
- Please connect a DC voltage that is insulated with reinforced or double insulation from the primary power source to the input terminals.

⚠ OTHER NOTES OF CAUTION

- If your fingers come into direct contact with the metal edges, there is a risk of injury. When handling, please take sufficient care, such as wearing protective gloves, and work carefully.
- When disposing product, follow disposal laws of each municipality.
- Published EMI (CE, RE) or immunity is the result of measuring the power supply unit under our standard measurement conditions and might not satisfy specification when mounted and wired inside end-user equipment. Use the product after sufficiently evaluating at actual end-user equipment.
- When exporting our products, apply for necessary permissions as required by rules and regulations of Foreign Exchange and Foreign Trade Control Act.
- Take note that traces of sheet metal processing be left in our power supplies. Also, partial discoloration or oxidation may be observed on the sheet metal surface of the product depending on storage conditions, such as in warehouses, but this does not affect the characteristics or reliability of the product.
- Catalogue or contents of the instruction manual may be changed without a prior notice. Refer to latest catalogue or instruction manual.
- Reproduction or reprinting the instruction manual or its portion is forbidden without our permission unless with TDK-Lambda authorization.

⚠ STORAGE METHOD AND STORAGE PERIOD BFFORE IMPLEMENTATION

- Please keep the product in carton box.
- Please do not apply excessive vibration, shock or mechanical stress to the product.
- Please keep away from direct sunlight.
- For storage temperature and humidity, the following conditions shall be used as a guideline :
  Temperature range : 5~30℃
  Humidity range : 40~60%RH
  Avoid places where its temperature and humidity can change drastically.
  It might cause product degradation or condensation on the product.
- For products that have been received for more than 1 year, please check lead oxidation and solderability.

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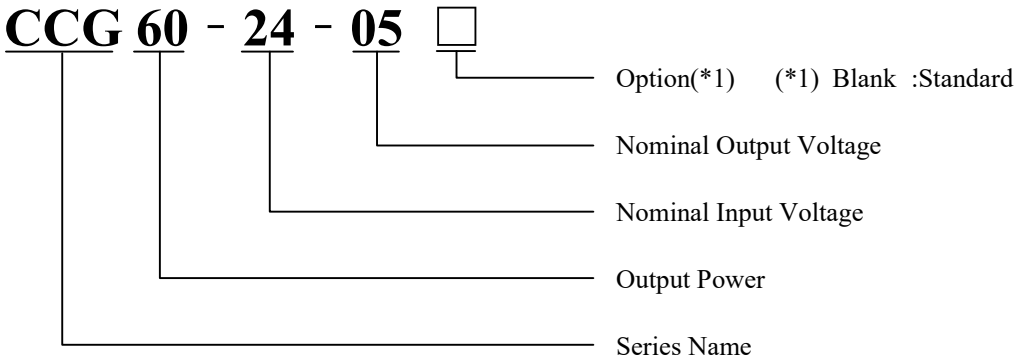
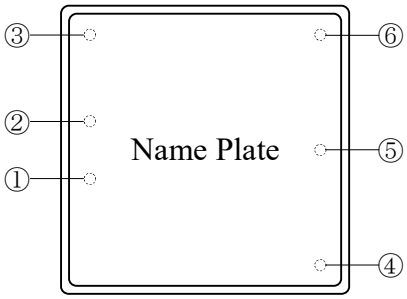
1. Model name identification method

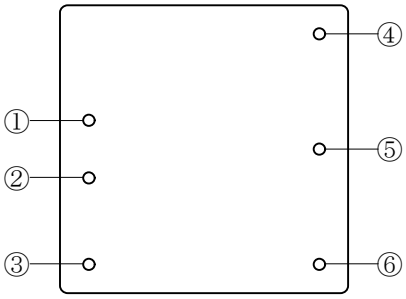


2. Terminal Explanation

Top view

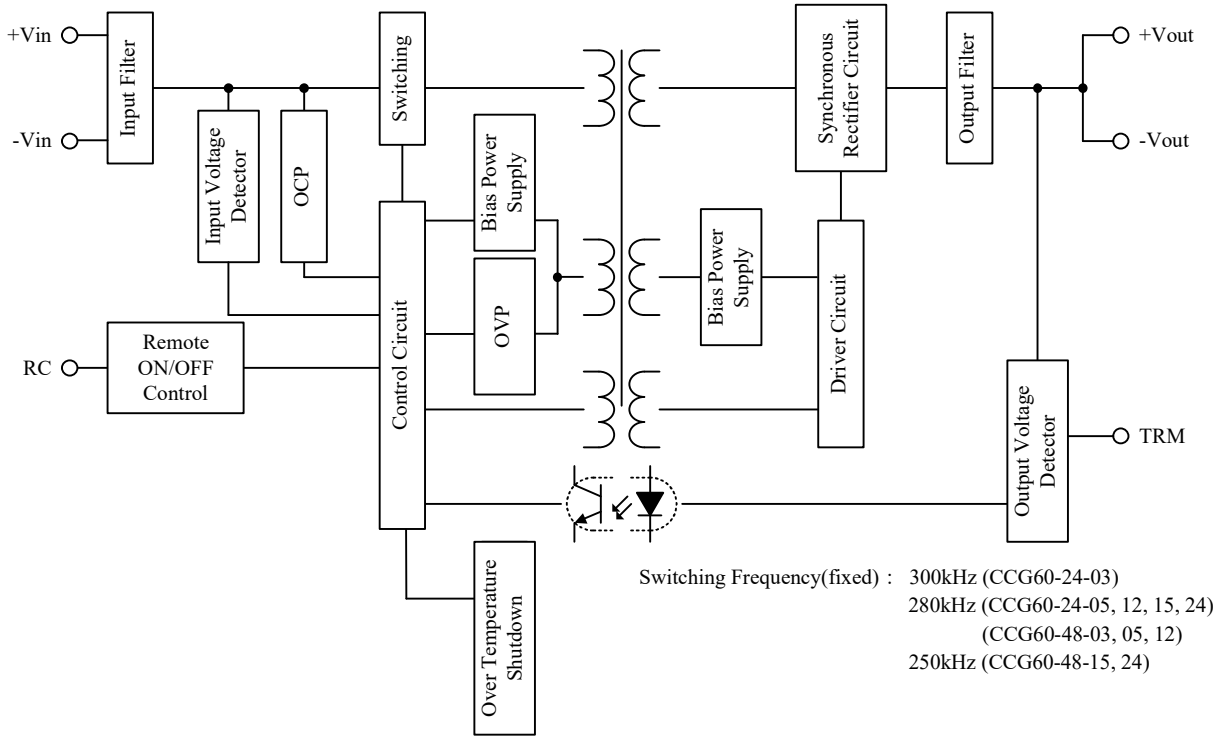


Bottom view

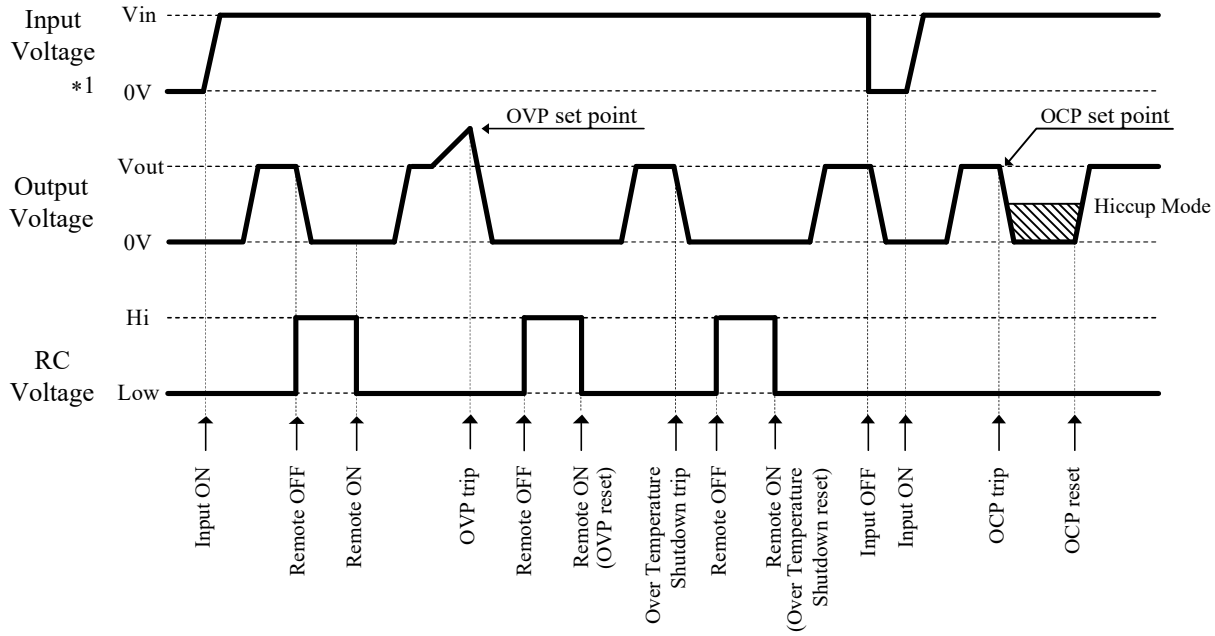


① +Vin : +Input Terminal
② -Vin : -Input Terminal
③ RC : Remote ON/OFF Control Terminal
④ +Vout : +Output Terminal
⑤ TRM : Output Voltage Trimming Terminal
⑥ -Vout : -Output Terminal

3. Block Diagram



4. Sequence Time Chart



*1 Restrictions apply when performing input recycling after an input shutdown or a momentary input voltage drop (shutdown). For details, refer to "12.Input Recycling Precautions" section.

5. Terminal Connecting Method

In order to use the CCG60, this power supply must be connected with external components according to Fig.5-1.
If it is connected to wrong terminal, the power supply will be damaged. Pay attention to each wiring.
When using at the nominal output voltage, the TRM terminal must be open.
External application should be connected in order to meet various EMI and EMS requirement.
Refer to Evaluation data, Reliability data and IEC61000 Test data.

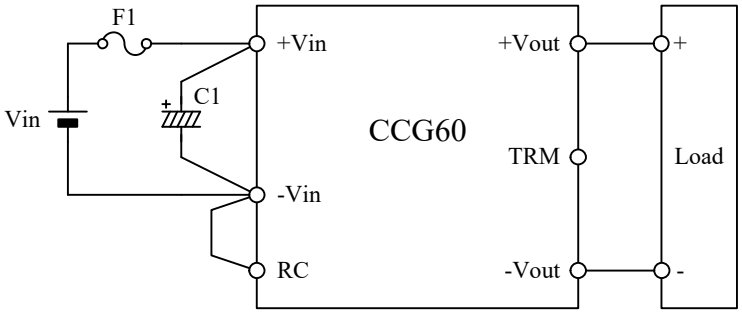


Fig.5-1 Basic connection

F1 : Input Fuse
CCG60 has no internal fuse.
Use external fuse for each power supply to comply various Safety Standards and to improve safety.
Please select a DC fuse.
Consider margin over the maximum input voltage to be actually used when selecting fuse. Moreover, consider I^2t fuse rating for surge current (inrush current) during line throw-in.
Please select a fuse from the recommended products listed below or an equivalent. Please use it after sufficient pre-evaluation on the actual system. Depending on the input power supply device used, the fuse may not work, so please select the fuse according to the specifications and application.

Recommended item and current rating for input fuse

Recommended item 25CF series (SOC)

CCG60-24-xx : 18A or lower
CCG60-48-xx : 10A or lower

C1 : External Input Capacitor

To prevent the effect of input line inductance to the power supply, connect electrolytic capacitor between +Vin and -Vin terminals.

Recommended Capacitance

CCG60-24-xx : 150μF or more (Nippon Chemi-Con EKZM series or equivalent)
CCG60-48-xx : 56μF or more (Nippon Chemi-Con EKZN series or equivalent)

Note) 1.Use low impedance electrolytic capacitor with excellent temperature characteristics.
2.When using the power supply at an ambient temperature of −20°C or below, connect two or more of the above capacitors in parallel to reduce ESR, or use a low-impedance electrolytic capacitor with excellent temperature characteristics, such as the HHXC series from Nippon Chemi-Con or an equivalent. Please use it after sufficient pre-evaluation on the actual system.
3.The operation of power supply may become unstable if inductance of the input line is large when the input line is long or a choke coil is inserted in the line.
For this case, connect a capacitor with a capacitance sufficiently larger than the recommended value.
4.When steeply to open the input line by using the relay etc. when the power supply is operating, there is possibility of the power supply restarts due to the power input voltage rises.
It is influenced by the impedance characteristics of pattern on printed circuit board, C1 and choke coil etc. Please use it after sufficient pre-evaluation on the actual system.

● External Output Capacitor

This power supply is capable of operating without external output capacitor.
External output capacitor can reduce output ripple noise and output voltage fluctuation due to sudden change in load current. If necessary, add external output capacitor as shown in Fig.5-2.
Output ripple and noise were measured with capacitors having the recommended capacitance values shown in Table 5-1 connected.
For details, refer to "6-3.Measurement Method of Output Ripple and Noise" section.
Maximum capacitance of external output capacitor is shown in Table 5-2.

Table 5-1 Recommended Capacitance of External Output Capacitor
(Nippon Chemi-Con HHXC series or equivalent)

Output voltage	Recommended capacitance
3.3V, 5V	470μF
12V	150μF
15V	100μF
24V	82μF

Table 5-2 Maximum Capacitance of External Output Capacitor

Output voltage	Maximum capacitance
3.3V, 5V	10,000μF
12V	2,200μF
15V	1,800μF
24V	680μF

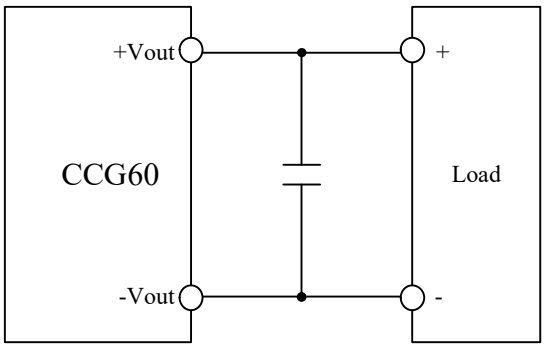


Fig.5-2 External output capacitor connection

Note) 1. The operation of power supply may become unstable when external filter circuit with inductance such as choke coil to the output side. Please connect them after sufficient pre-evaluation on the actual system.

2. The operation of power supply may become unstable when external output capacitors with low ESR, such as MLCC and conductive polymer electrolytic capacitors, are connected in parallel. Please connect them after sufficient pre-evaluation on the actual system.

● Protection for Reversed Input Connection

Reverse input polarity would cause power supply damage. If there is a possibility of reverse connection, connect a protective diode and fuse. Use protective diode with higher voltage rating than the input voltage, and with higher surge current rating than fuse current rating.

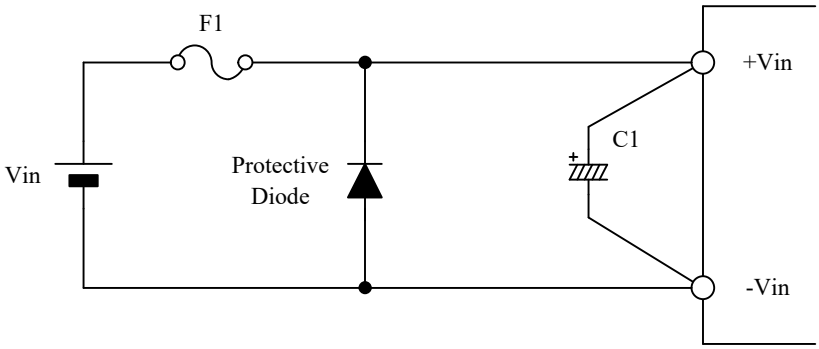


Fig.5-3 Protection for Reversed Input Connection

● Protection During Momentary Input Voltage Drop or Shutdown

When input voltage drops momentarily and shut down, the output voltage may become unstable. In particular, in the case of input voltage recover before output voltage drops to 0V after the momentary input voltage drop or shutdown, the output voltage may overshoot.
In this case, it is possible to stabilize the output voltage by connecting input voltage retention diode and capacitor C1 as shown in Fig.5-4.
The appropriate capacitance value of C1 is influenced by load factor used, capacitance of capacitor connected to output side and expected time that dips or short interruption.
Please choose it after sufficient pre-evaluation on the actual system.
Use input voltage retention diode with higher current rating than fuse current rating.

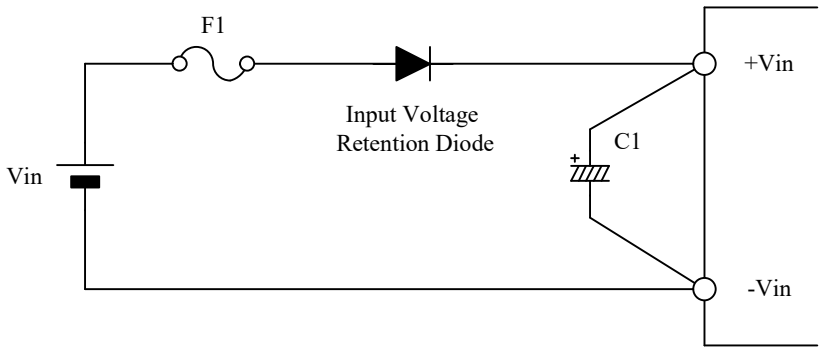


Fig.5-4 Protection of Instantaneous Input Voltage Drop

Restrictions apply when performing input recycling after an input shutdown or a momentary input voltage drop (shutdown). For details, refer to "12.Input Recycling Precautions" section.

6. Explanation of Functions and Precautions

6-1. Input Voltage Range

Input voltage range for CCG60 is indicated below.

Input Voltage Range
CCG60-24-xx : 9 ~ 36VDC
CCG60-48-xx : 18 ~ 76VDC

Take note that power supply might be damaged when applied input voltage which is out of specified range.
Take note that variation range of the input voltage and maximum and minimum values of ripple voltage do not out of above input voltage range.
Output ripple voltage may increase by level of ripple voltage or frequency about input voltage. Please use it after sufficient pre-evaluation on the actual system.
Take note that sudden change of input voltage may cause variation of output voltage transitionally.

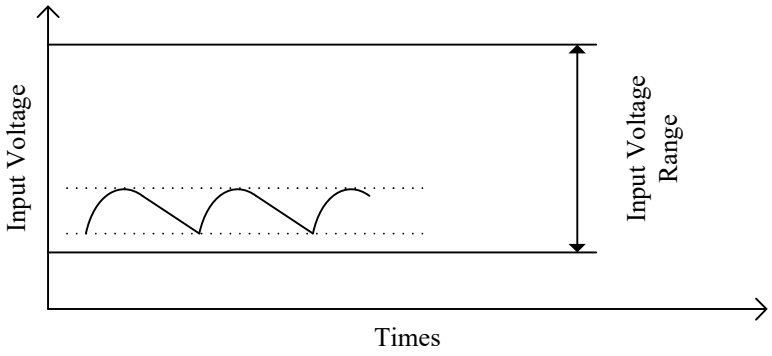


Fig.6-1 Input Ripple Voltage

6-2. Output Voltage Adjustable Range

Output voltage could be adjusted within the range described below by connecting external resistor or variable resistor.
However, take note that power supply might be damaged when output voltage exceeds the range described below.

Output Voltage Adjustable Range :
0% ~ +10% of Nominal Output Voltage (Output Voltage : 3.3V)
-10% ~ +10% of Nominal Output Voltage (Output Voltage : 5V, 12V, 15V, 24V)

● Output Voltage Adjustment by External Resistor or Variable Resistor

(1) In case of adjusting output voltage lower

(1-1) Maximum output current

Take note that when output voltage is decreased, do not over the maximum output current of specification.

ex)In case of CCG60-xx-05

When setting 5V Model to 4.5V output, maximum output power = 4.5V×12A = 54W.

(1-2) External resister connecting method

Connect an external resistor or variable resister Ra between TRM and +Vout terminal as shown in Fig.6-2.

To prevent the effect of noise or other, wire as short as possible because TRM terminal is relatively high impedance.

Please refer to Table 6-1 when adjusting output voltage.

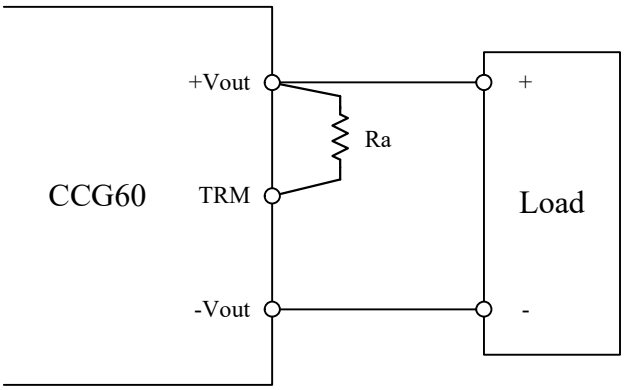


Fig.6-2 Basic Connection for Output Voltage Trim Down

Table 6-1 Equation of External Resistor and Output Voltage

Unit (Output Voltage : Vout [V], External Resistor : Ra [kΩ])

Model	Equation	
CCG60-xx-03	–	–
CCG60-xx-05	$Vout = 5.02 - \frac{31.04}{12.12 + Ra}$	$Ra = \frac{31.04}{5.02 - Vout} - 12.12$
CCG60-xx-12	$Vout = 12.08 - \frac{255.63}{28.29 + Ra}$	$Ra = \frac{255.63}{12.08 - Vout} - 28.29$
CCG60-xx-15	$Vout = 15.15 - \frac{420.9}{34.97 + Ra}$	$Ra = \frac{420.9}{15.15 - Vout} - 34.97$
CCG60-xx-24	$Vout = 24.26 - \frac{511.43}{28.2 + Ra}$	$Ra = \frac{511.43}{24.26 - Vout} - 28.2$

Output voltage could be adjusted within the -10% of nominal output voltage by external resistor Ra. (Excluding the 3.3 V output model)

(2) In case of adjusting output voltage higher

(2-1) Maximum output current

When increasing the output voltage, reduce the output current accordingly so as not to exceed the maximum output power.

ex)In case of CCG60-xx-05

When setting 5V Model to 5.5V output, maximum output current = 60W÷5.5V = 10.9A.

(2-2) External resister connecting method

Connect an external resistor or variable resister Rb between TRM and -Vout terminal as shown in Fig.6-3.

To prevent the effect of noise or other, wire as short as possible because TRM terminal is relatively high impedance. Please refer to Table 6-2 when adjusting output voltage.

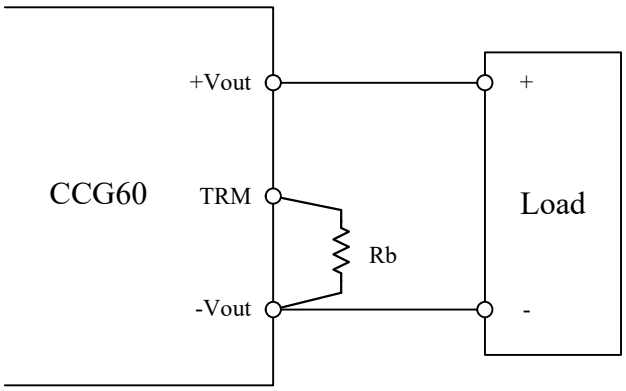


Fig.6-3 Basic Connection for Output Voltage Trim Up

Table 6-2 Equation of External Resistor and Output Voltage

Unit (Output Voltage : Vout [V], External Resistor : Rb [kΩ])

Model	Equation	
CCG60-xx-03	$Vout = 3.31 + \frac{5.58}{3.3 + Rb}$	$Rb = \frac{5.58}{Vout - 3.31} - 3.3$
CCG60-xx-05	$Vout = 5.02 + \frac{10.2}{3.9 + Rb}$	$Rb = \frac{10.2}{Vout - 5.02} - 3.9$
CCG60-xx-12	$Vout = 12.08 + \frac{29.25}{4.7 + Rb}$	$Rb = \frac{29.25}{Vout - 12.08} - 4.7$
CCG60-xx-15	$Vout = 15.15 + \frac{37.54}{4.7 + Rb}$	$Rb = \frac{37.54}{Vout - 15.15} - 4.7$
CCG60-xx-24	$Vout = 24.26 + \frac{58.64}{4.7 + Rb}$	$Rb = \frac{58.64}{Vout - 24.26} - 4.7$

Output voltage could be adjusted within the +10% of nominal output voltage by external resistor Rb.

(3) In case of adjusting output voltage within adjustable range

(3-1) Maximum output current

Take note that when output voltage is decreased, do not over the maximum output current of specification.

When increasing the output voltage, reduce the output current accordingly so as not to exceed the maximum output power.

(3-2) External resister connecting method

Connect an external resistor Ra between +Vout and TRM terminal as shown in Fig.6-4, and connect an external resistor Rb and variable resister VR between TRM and -Vout terminal. To prevent the effect of noise or other, wire as short as possible because TRM terminal is relatively high impedance. Please refer to Table 6-3 when adjusting output voltage. Please refer to Table 6-4 when selecting external resistor.

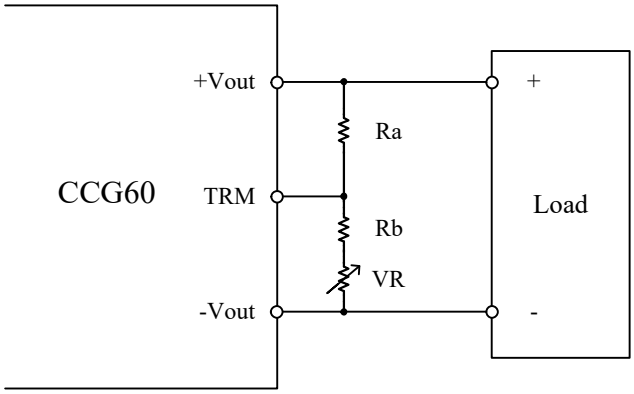


Fig.6-4 Basic connection for adjusting output voltage within adjustable range

Table 6-3 Equation of External Resistor and Output Voltage

Unit (Output Voltage : Vout [V], External Resistor : Ra Rb VR [kΩ])

Model	Equation
CCG60-xx-03	$Vout = 3.31 + \frac{5.58 \times Ra - 9.3(VR + Rb)}{(Ra + 7.8)(VR + Rb) + 3.3 \times Ra}$
CCG60-xx-05	$Vout = 5.02 + \frac{10.2 \times Ra - 31.04(VR + Rb)}{(Ra + 12.12)(VR + Rb) + 3.9 \times Ra}$
CCG60-xx-12	$Vout = 12.08 + \frac{29.26 \times Ra - 255.58(VR + Rb)}{(Ra + 28.29)(VR + Rb) + 4.7 \times Ra}$
CCG60-xx-15	$Vout = 15.15 + \frac{37.54 \times Ra - 420.81(VR + Rb)}{(Ra + 34.97)(VR + Rb) + 4.7 \times Ra}$
CCG60-xx-24	$Vout = 24.21 + \frac{58.64 \times Ra - 510.32(VR + Rb)}{(Ra + 28.2)(VR + Rb) + 4.7 \times Ra}$

Output voltage can be adjusted within the -10% ~ +10% of nominal output voltage by external resistor Ra, Rb, VR. (3.3 V output model can be adjusted within the 0% ~ +10%)

Table 6-4 External Resistor (Reference Value)

Model	Ra(kΩ)	Rb(kΩ)	VR(kΩ)
CCG60-xx-03	18	3.9	10
CCG60-xx-05	15	2.7	10
CCG60-xx-12	47	2.7	10
CCG60-xx-15	68	3.3	10
CCG60-xx-24	47	2.7	10

6-3. Measurement Method of Output Ripple and Noise

Measurement method of output ripple and noise voltage is shown in Fig.6-5.
Connect capacitors (C2 : ceramic capacitor : 10μF, C3 : electrolytic capacitor : Refer to Table 6-5) at 50mm distance from the output terminals.
Measure at C2 terminals as shown in Fig.6-5 using coaxial cable with JEITA attachment.
Use oscilloscope with 20MHz frequency bandwidth or equivalent.

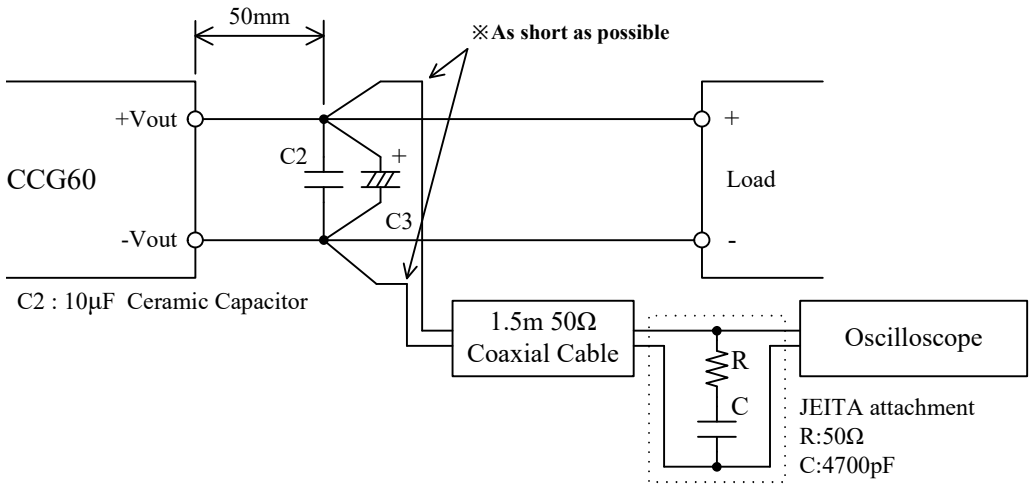


Fig.6-5 Measurement Method of Maximum Output Ripple and Noise

Table 6-5 C3 Capacitance of External Output Electrolytic Capacitor
(Nippon Chemi-Con HHXC series or equivalent)

Output voltage	Capacitance value
3.3V, 5V	470μF
12V	150μF
15V	100μF
24V	82μF

Take note that PCB wiring design might influence output ripple voltage and spike noise voltage.
Generally, increasing capacitance value of external capacitor can reduce output ripple voltage and connecting ceramic capacitor can reduce output spike noise voltage.

6-4. Line Regulation

Line regulation of specification is the variation value of output voltage when input voltage is gradually varied (steady state) within specified input voltage range.
Please consider to connect the protection circuit as shown in Fig.5-4 if there is a possibility that instantaneous drop of input voltage might happen.
Please use it after sufficient pre-evaluation on the actual system.

6-5. Load Regulation

Load regulation of specification is the variation value of output voltage when output current is gradually varied (steady state) within specified output current range.
When using at dynamic load mode, output voltage fluctuation might increase.

6-6. Over Current Protection (OCP)

This power supply has built-in OCP function.
When short circuit or output current is in overload condition, it becomes intermittent operation.
Output will recover when short circuit or overload conditions are released.
Take note that power supply might be damaged at continuous overload conditions depending on thermal conditions.

6-7. Over Voltage Protection (OVP)

This power supply has built-in OVP function.
When output voltage exceed OVP set point, output voltage shut down.
When OVP is triggered, output can be recovered by i) manual reset of the RC terminal, or ii) turning the input line off and then turning it on again after one second.
OVP setting value is fixed and therefore, cannot be externally adjusted.
To test the OVP function, short the TRM terminal to the -Vout terminal using a relay or equivalent.
Please avoid applying an external voltage exceeding the specified output voltage range across the output terminals or applying any voltage to the TRM terminal, as this may damage the power supply.

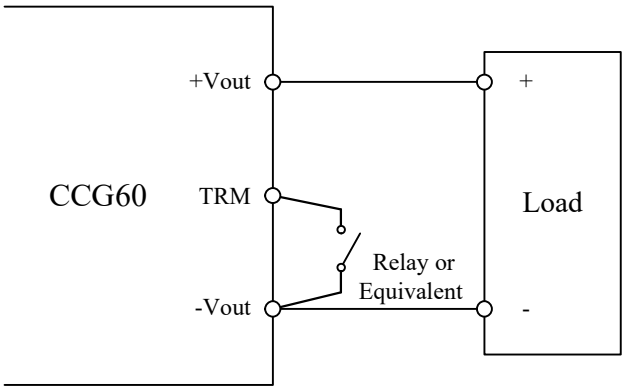


Fig.6-6 OVP Test Method

6-8. Over Temperature Shutdown

When the ambient temperature or internal component temperature rises abnormally, the over temperature shutdown will be triggered and the output will shut down.
When the over temperature shutdown is triggered, the output can be recovered after the unit has cooled sufficiently by i) manual reset of the RC terminal, or ii) turning the input line off and then turning it on again after one second.
However, take note that over temperature shutdown will operate again unless the cause of abnormal heat of the power supply is eliminated. The over temperature shutdown function is intended to operate when the unit is used outside its specified operating conditions. This function may not activate depending on operating conditions, and even if it activates, it may not prevent damage to the power supply.

6-9. Remote ON/OFF Control (RC terminal)

The output can be enabled/disabled by RC terminal without turning the input supply on and off.
This function is Negative Logic.
In order to use remote ON/OFF control function, attach transistor, relay or equivalent switch between RC and -Vin terminal as shown in Fig.6-7.
For secondary control, isolation can be achieved through the use of a opto-coupler or equivalent as shown in Fig.6-8.

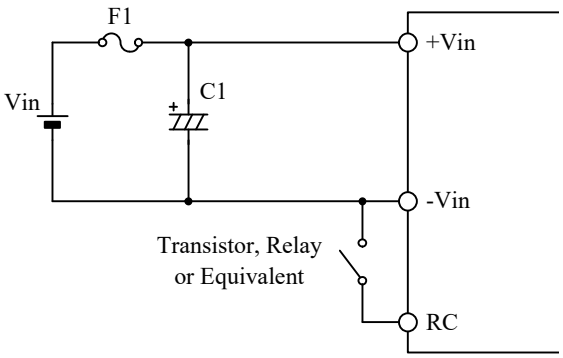


Fig.6-7 RC Connection (1)

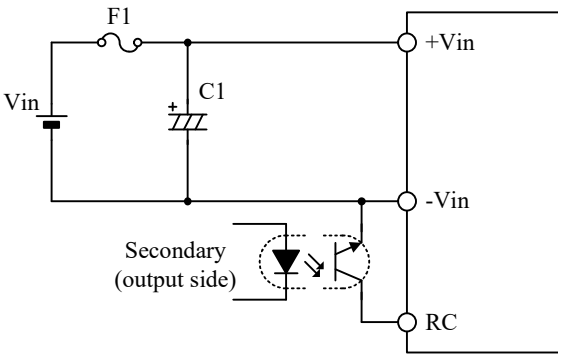


Fig.6-8 RC Connection (2)

Table 6-6 Specification of Remote ON/OFF Control

Connection of RC and -Vin terminal	RC Voltage Range	Output Status
Short	$0V \leqq V_{RC} \leqq 0.5V$	ON
Open	-	OFF

Note) 1. When remote ON/OFF control function is not used, between RC and -Vin terminals should be shorted.
2. In case of applying external voltage into RC terminal, please contact us.
3. When the wiring from RC terminal to -Vin terminal is long or it is affected by noise, attach capacitor between RC terminal and -Vin terminal. The maximum capacitance of it is 1,000pF.
4. When selecting external component for using ON/OFF circuit, refer to Table 6-7.
5. When using opto-coupler for ON/OFF circuit, select one with a small dark current.
Select opto-coupler with a dark current 50μA or less at 25℃ (ambient temperature)
and 100μA or less at 100℃ (ambient temperature).
6. Take note that if control ON operation applied before output voltage drops to 0V after control OFF operation, over shoot may occur in the output voltage.

Table 6-7 The Maximum Value of Open Voltage of RC Terminal and Source Current
(When RC Terminal and -Vin Terminal are Shorted).

Open Voltage	Source Current
5V	1mA

6-10. Redundant Operation

Redundant operation is possible for loads that are within the maximum output power of one power supply. When one power supply is shutdown by the power failure etc., another one can continue to provide power.

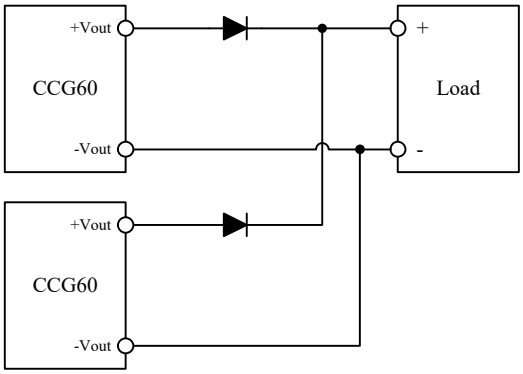


Fig.6-9 Redundant Operation Connection

6-11. Parallel Operation

Parallel operation cannot be used.

6-12. Series Operation

Series operation is possible for CCG60.
Connections shown in Fig.6-10 and Fig.6-11 are possible.
When power supplies are connected as method (Fig.6-10), the bypass diode is required to avoid reverse bias. The bypass diode must be selected with a maximum forward current rating higher than the output current and a maximum reverse voltage rating higher than the output voltage.

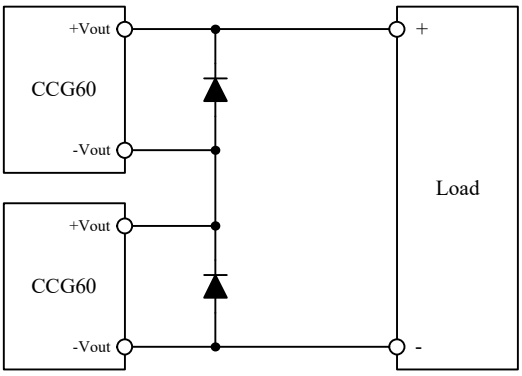


Fig.6-10 Series Operation for High Output Voltage

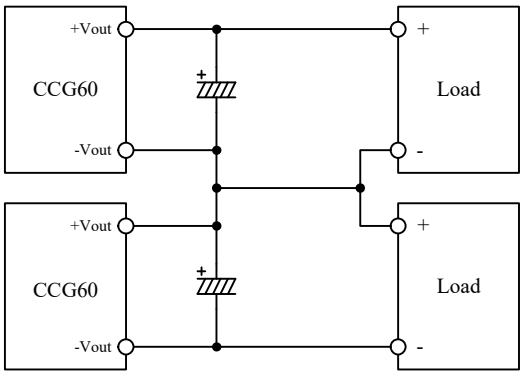


Fig.6-11 ±Output Series Operation

6-13. Operating Ambient Temperature

Output load needs to be derated depending on the ambient temperature. There is no restriction on mounting direction but there should be enough consideration for airflow so that heat does not accumulate around the power supply vicinity. Determine external components configuration and mounting direction on PCB such that air could flow around the power supply at forced cooling and convection cooling. For better improvement of power supply reliability, derating of ambient temperature is recommended. For details, refer to "7.Output Derating" section.

6-14. Operating Ambient Humidity

Take note that condensation could lead to power supply abnormal operation or damage.

6-15. Storage Ambient Temperature

Take note that sudden temperature change can cause dew condensation.

6-16. Storage Ambient Humidity

Take note that rust would occurred on terminals when stored in high temperature and high humidity environment.

6-17. Withstand Voltage

This power supply is designed to have a withstand voltage of 1.5kVDC between input and output, 1.0kVDC between input and case and 1.0kVDC between output and case for 1 minute. When conducting withstand voltage test during incoming inspection, set the current limit value of the withstand voltage testing equipment to 10mA. Furthermore, avoid throw in or shut off of the testing equipment when applying or when shutting down the test voltage. Instead, gradually increase or decrease the applied voltage. Take note especially when using the timer of the test equipment because when the timer switches the applied voltage off, impulse voltage which has several times the magnitude of the applied voltage is generated causing damage to the power supply. Connect the terminals as shown in the diagram below.

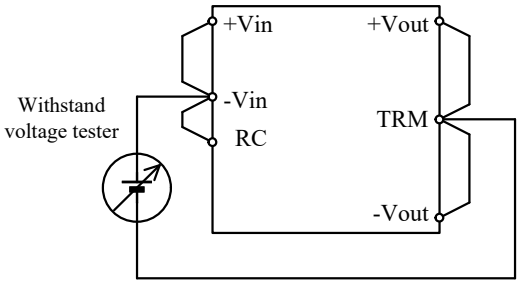


Fig.6-12 Withstand Voltage Test for Input - Output

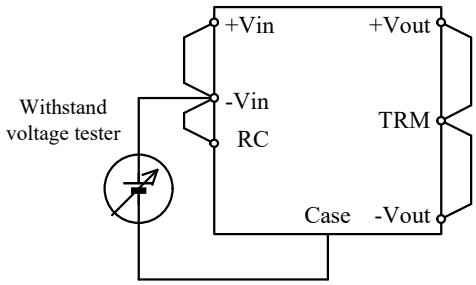


Fig.6-13 Withstand Voltage Test for Input - Case

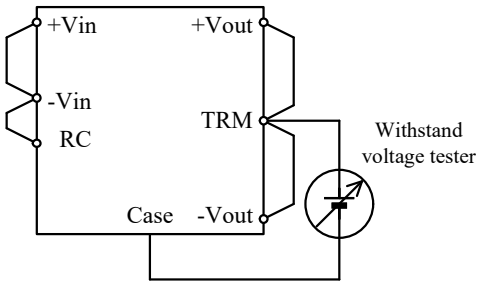


Fig.6-14 Withstand Voltage Test for Output - Case

6-18. Isolation Resistance

Isolation resistance value is 100MΩ and above at 500VDC applied voltage.
Use DC isolation tester (MAX 500V) between output and case.
Make sure that during testing, the isolation testers do not generate a high pulse when the applied voltage is varied. Ensure that the tester is fully discharged after the test.

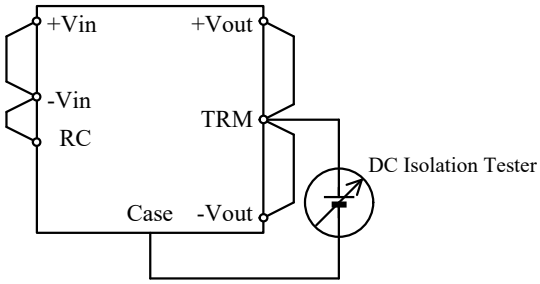


Fig.6-15 Isolation Resistance Test

6-19. Vibration

Vibration of power supply is defined when mounted on PCB.

6-20. Shock

Withstand shock value is define to be the value at TDK-Lambda shipment and packaging conditions, or when mounted on PCB.

6-21. Capacitance of Input - Output

This product has internal capacitor connected between input and output.

Capacitance of input - output : 470pF

In case that high level and high frequency AC voltage is applied, loss of internal capacitor increase and the product might be damaged.
In case that voltage between input and output changes suddenly on the application or the load of high frequency pulse is connected to the output side, please contact us.

7. Output Derating

7-1. Output Derating Measurement Method

There is no restriction on mounting direction but there should be enough consideration for airflow so that heat dose not accumulate around the power supply vicinity. Determine external components configuration and mounting direction on PCB such that air could flow around the power supply at forced cooling and conventional cooling. The derating of the output current is necessary when the ambient temperature is high. (Refer to "7-2. Output Derating Curve" section.)
Measurement method of Output Current vs. Ambient Temperature is according to Fig.7-1.

When mounting on actual system, do actual measurement based on measurement points shown in Fig.7-1. Moreover take note that component temperature shown in Fig.7-2 not to exceed the criterion value.

(1) Output Current vs. Ambient Temperature Measurement Method

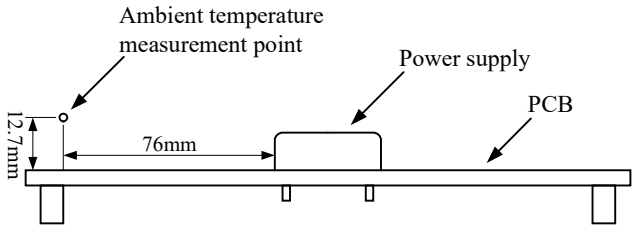


Fig.7-1 Output Current vs. Ambient Temperature Measurement Method

(2) Temperature Measurement Point on The Case
Confirm the temperature of measurement points (Tc) shown in Fig.7-2 is below derating curve refer to "7-2. Output Derating Curve" section.

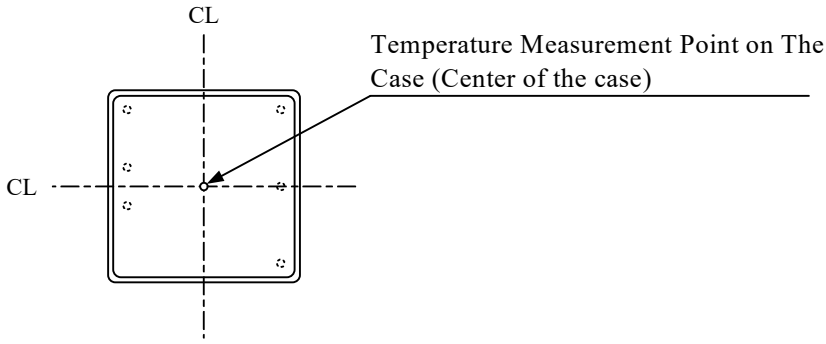


Fig.7-2 Temperature Measurement Point on The Case

7-2. Output Derating Curve (Reference)

The output derating curves shown on the following pages are measurement data obtained when the power supply was mounted on our evaluation PCB (Fig.7-3 and Fig.7-4).
The output derating is affected by the mounting board, external components, and ambient conditions. Therefore, when operating the power supply in the actual application, make sure that the case temperature Tc (at the center of the top surface) and the maximum ambient temperature Ta (MAX) do not exceed the values indicated by the derating curves on the following pages.
If input voltage fluctuations are expected, use the lower derating curve.

*Evaluation PCB Specification

Size	180mm×90mm t = 1.6mm
Material	FR-4（Double sided）
Copper	70μm

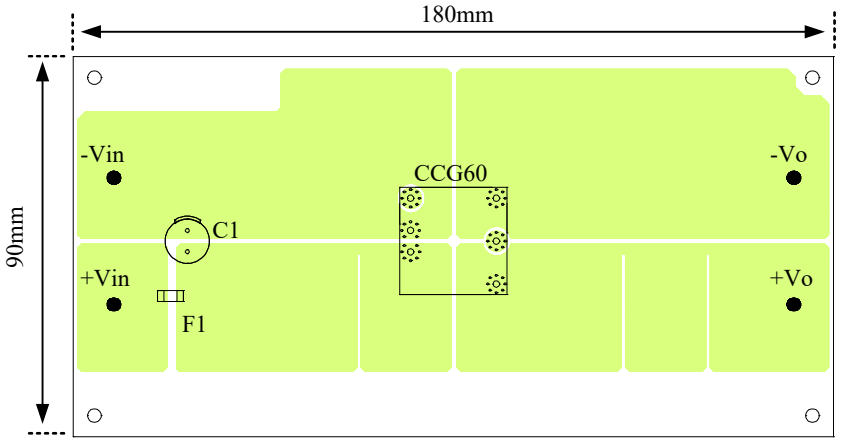


Fig.7-3 Evaluation PCB Top side (Power Supply Mounting side)

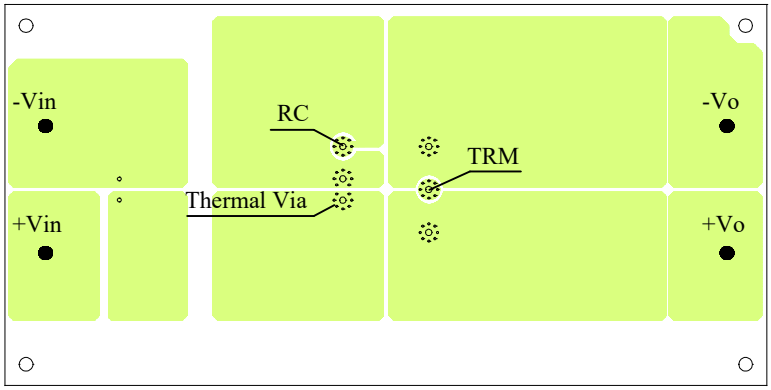
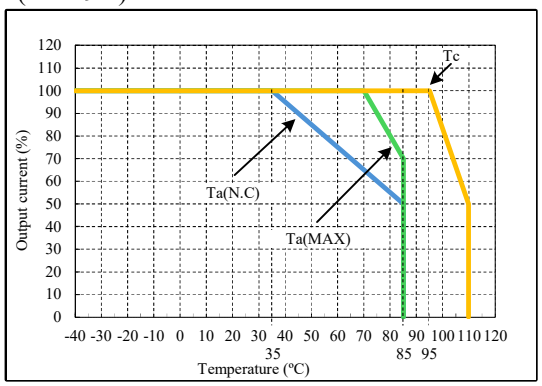


Fig.7-4 Evaluation PCB Bottom side

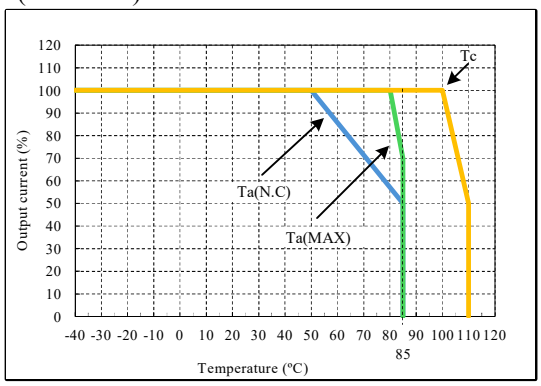
Note) The rise in case temperature (Tc) is affected by the mounting board design, including the copper thickness, the pattern area around the product mounting holes, and the presence or absence of thermal vias. Therefore, referring to Fig.7-3 and Fig.7-4, design the mounting board with due consideration for heat dissipation from the product.

◆CCG60-24-03

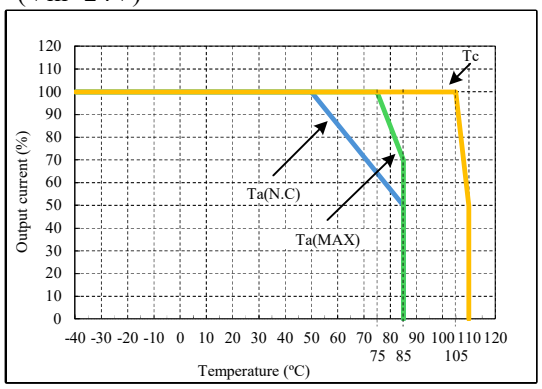
(Vin=9V)



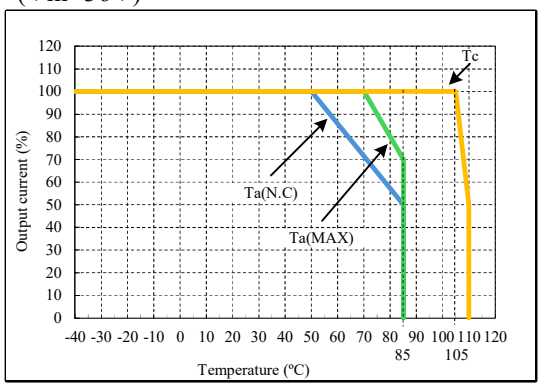
(Vin=12V)



(Vin=24V)

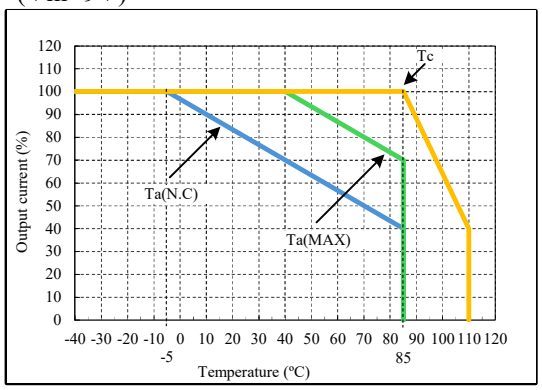


(Vin=36V)

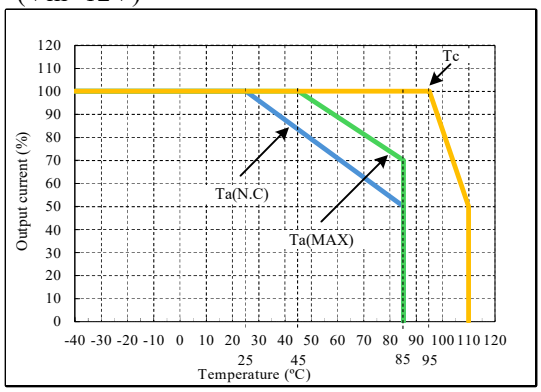


◆CCG60-24-05

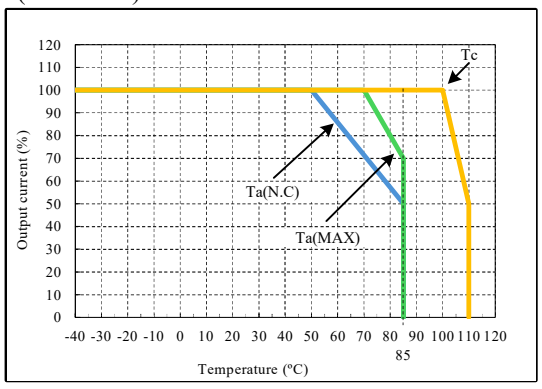
(Vin=9V)



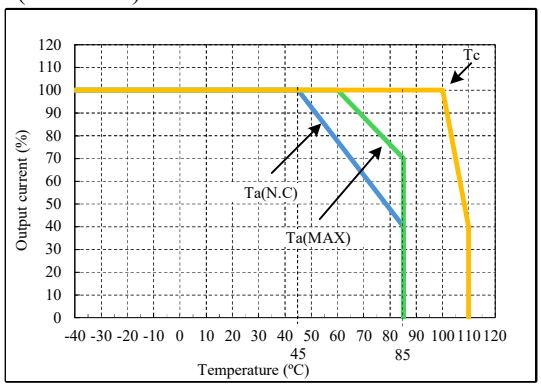
(Vin=12V)



(Vin=24V)



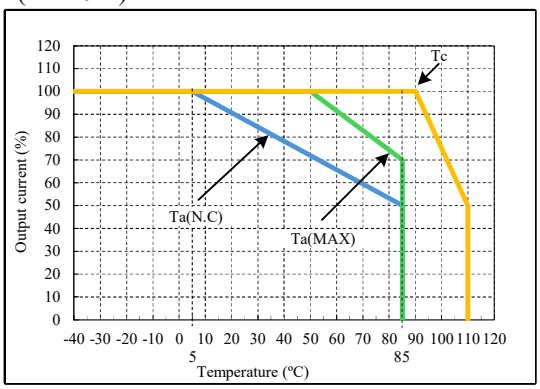
(Vin=36V)



Ta (N.C) : Reference ambient temperatures measured under natural convection cooling (Our measurement environment).
Ta (MAX) : Maximum ambient temperature achievable with proper heat dissipation or air cooling design.
Ensure that the case temperature (Tc) remains within the limits of the derating curve.

◆CCG60-24-12

(Vin=9V)



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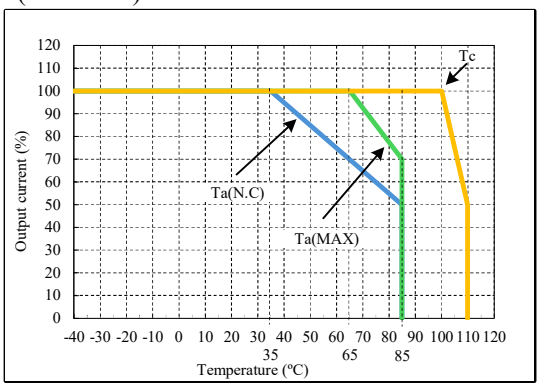
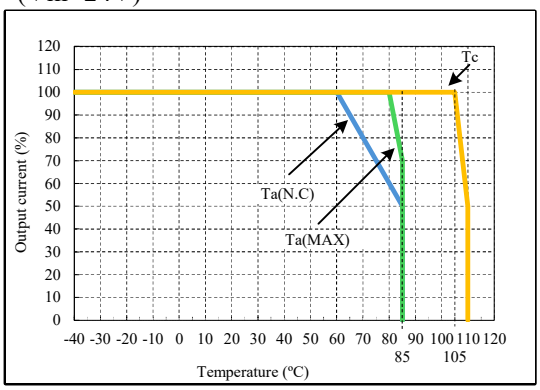
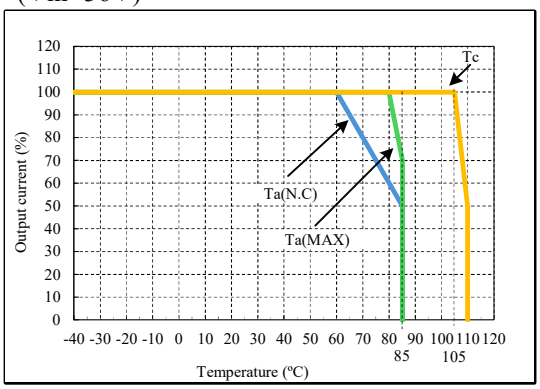


(Vin=24V)

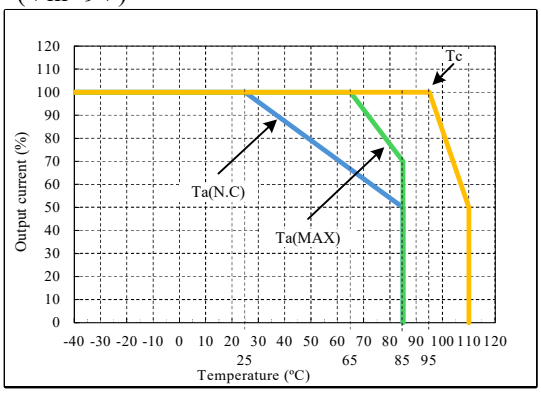


(Vin=36V)

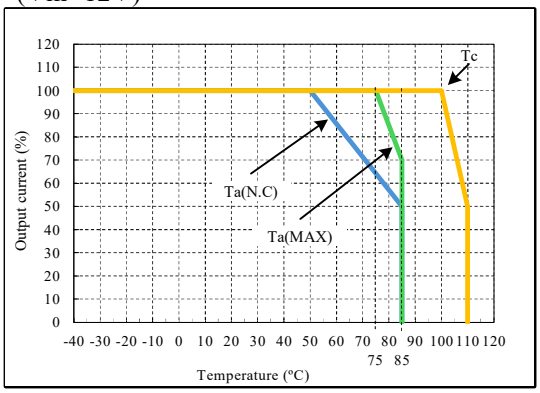


◆CCG60-24-15

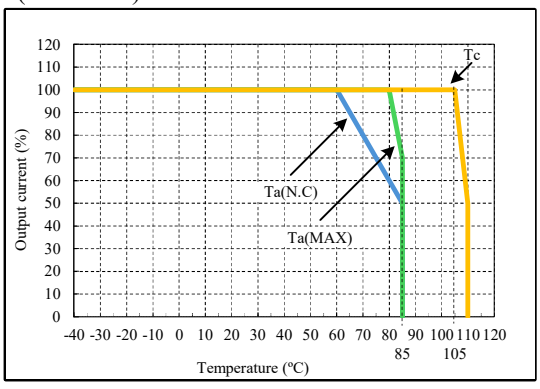
(Vin=9V)



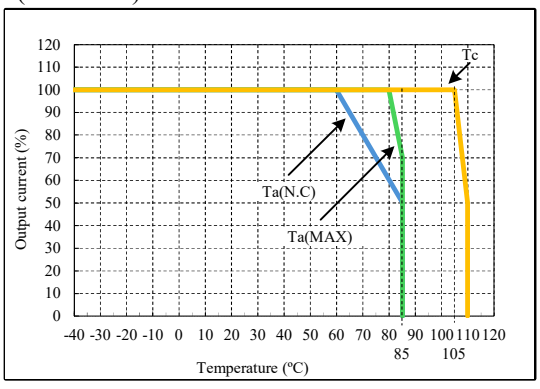
(Vin=12V)



(Vin=24V)



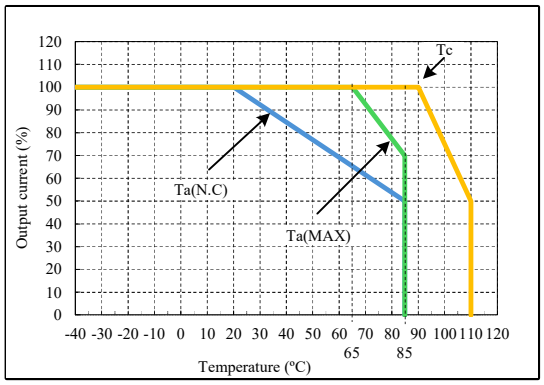
(Vin=36V)



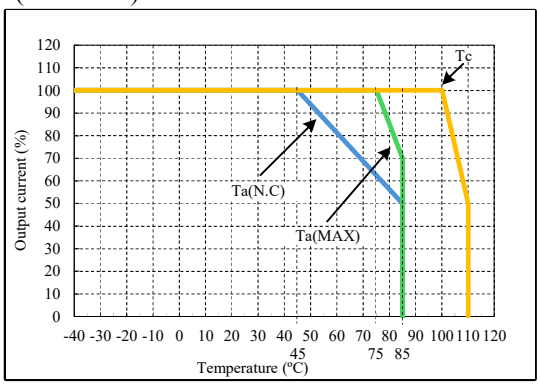
Ta (N.C) : Reference ambient temperatures measured under natural convection cooling (Our measurement environment).
Ta (MAX) : Maximum ambient temperature achievable with proper heat dissipation or air cooling design.
Ensure that the case temperature (Tc) remains within the limits of the derating curve.

◆CCG60-24-24

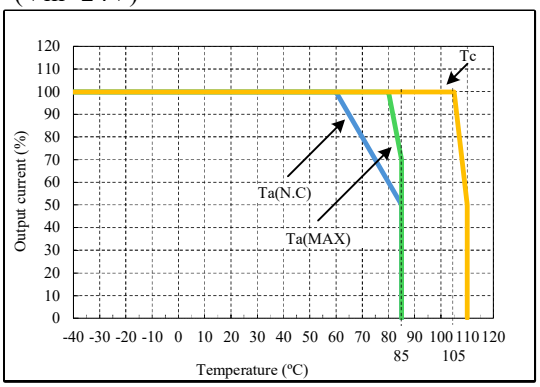
(Vin=9V)



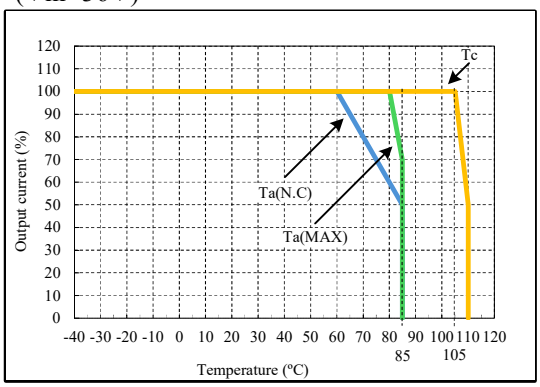
(Vin=12V)



(Vin=24V)

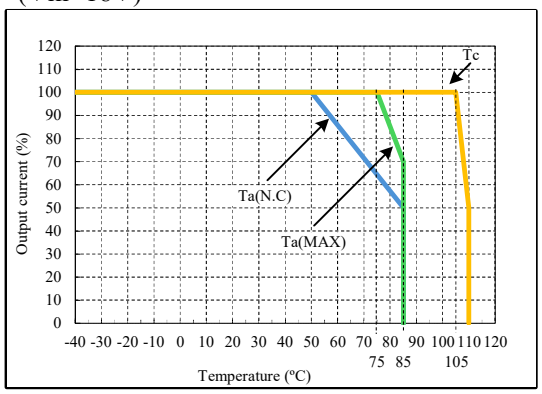


(Vin=36V)

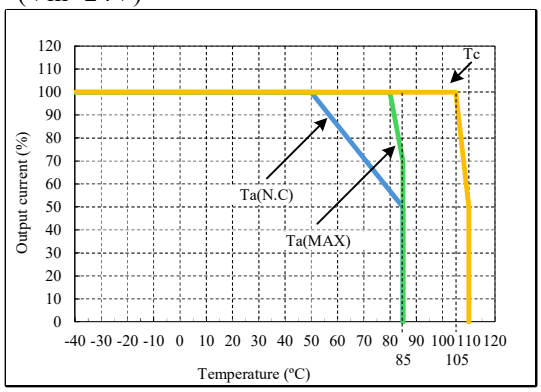


◆CCG60-48-03

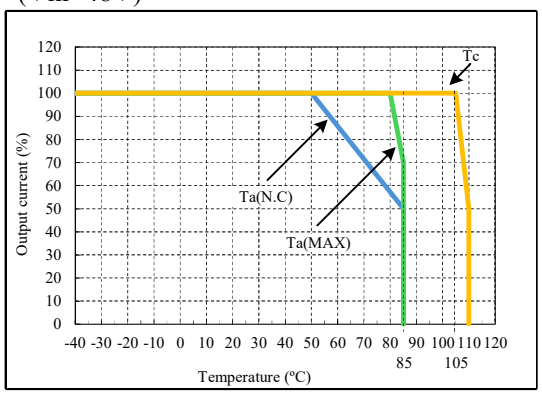
(Vin=18V)



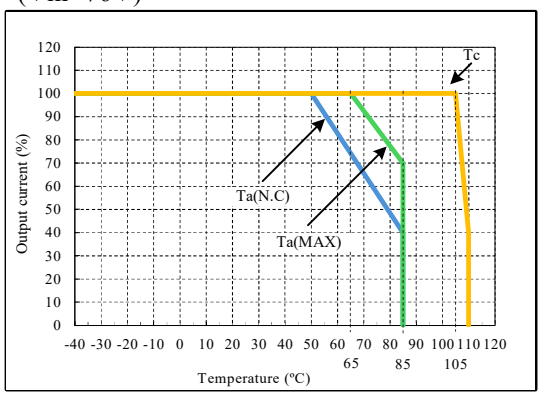
(Vin=24V)



(Vin=48V)



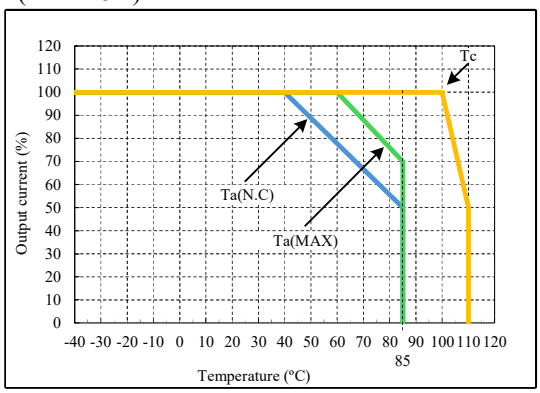
(Vin=76V)



Ta (N.C) : Reference ambient temperatures measured under natural convection cooling (Our measurement environment).
Ta (MAX) : Maximum ambient temperature achievable with proper heat dissipation or air cooling design.
Ensure that the case temperature (Tc) remains within the limits of the derating curve.

◆CCG60-48-05

(Vin=18V)



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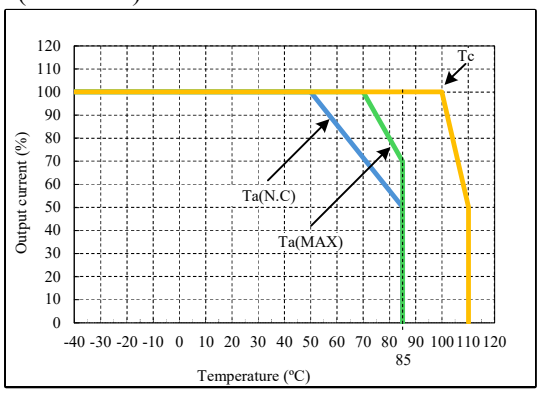
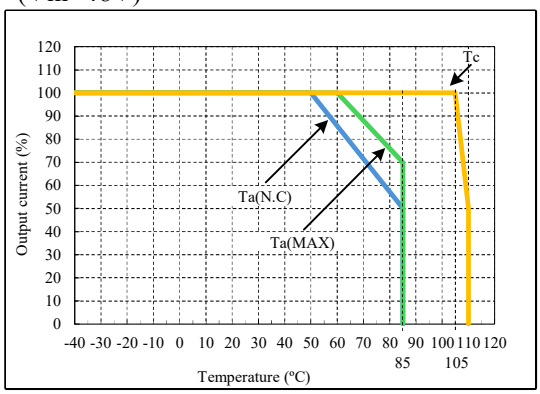
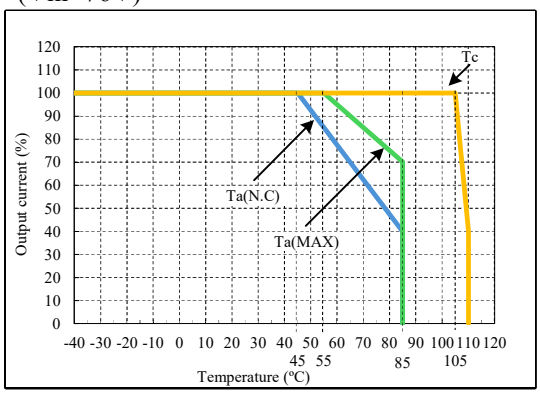


(Vin=48V)

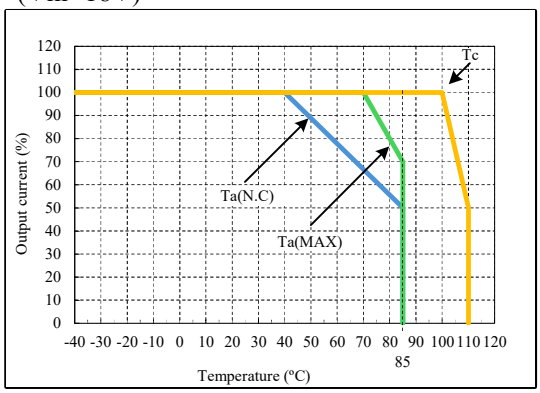


(Vin=76V)

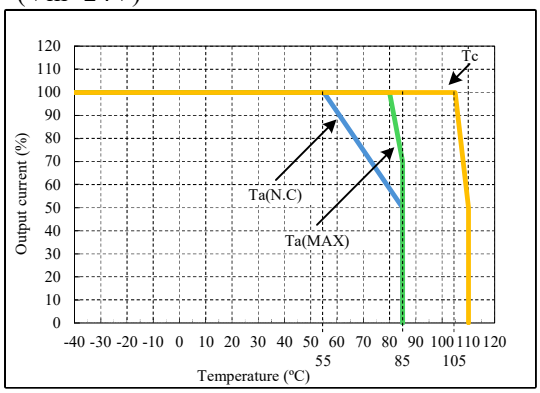


◆CCG60-48-12

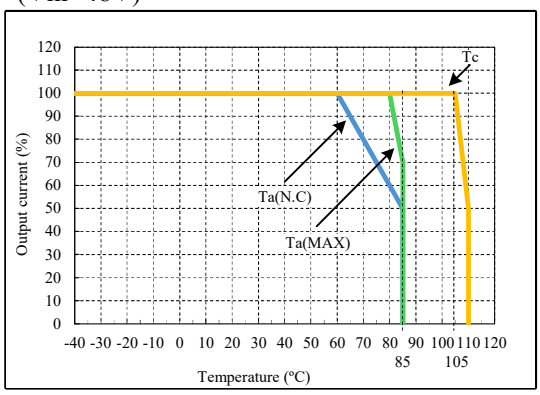
(Vin=18V)



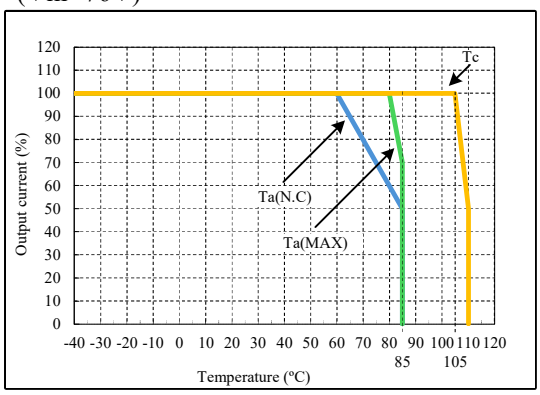
(Vin=24V)



(Vin=48V)



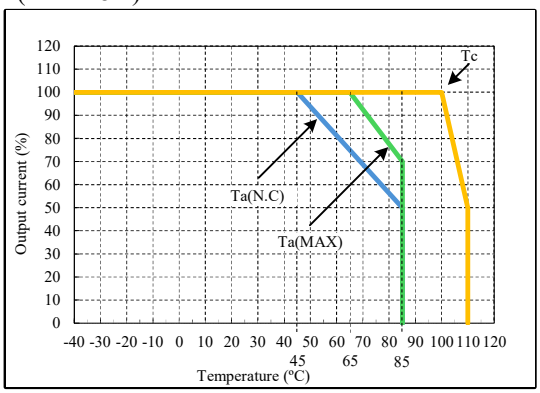
(Vin=76V)



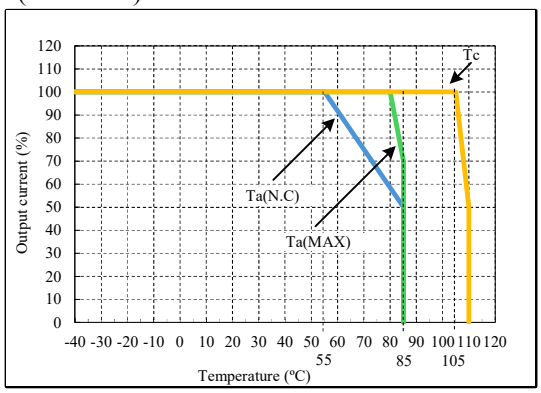
Ta (N.C) : Reference ambient temperatures measured under natural convection cooling (Our measurement environment).
Ta (MAX) : Maximum ambient temperature achievable with proper heat dissipation or air cooling design.
Ensure that the case temperature (Tc) remains within the limits of the derating curve.

◆CCG60-48-15

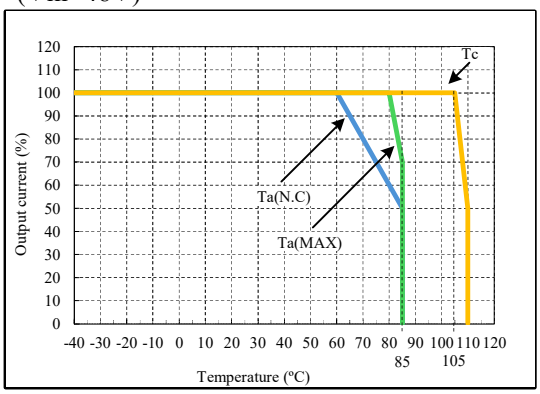
(Vin=18V)



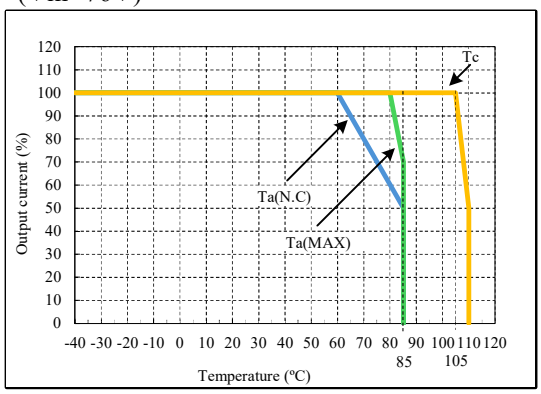
(Vin=24V)



(Vin=48V)

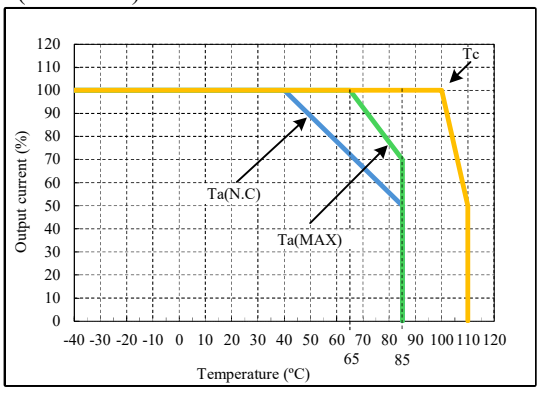


(Vin=76V)

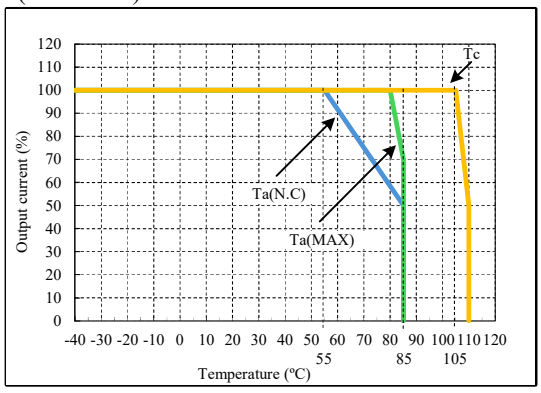


◆CCG60-48-24

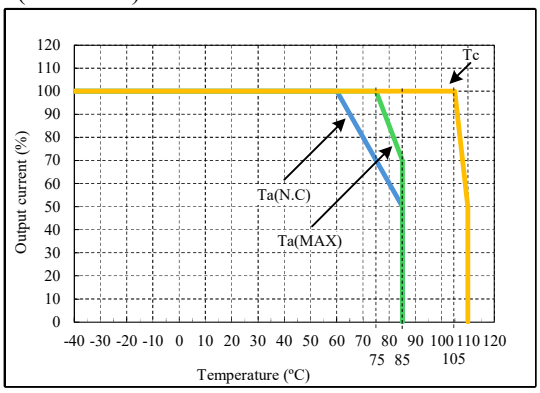
(Vin=18V)



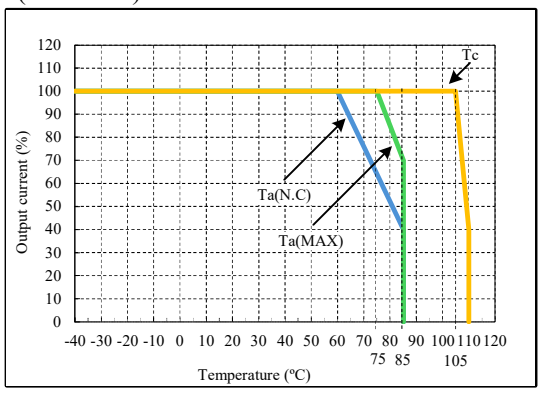
(Vin=24V)



(Vin=48V)



(Vin=76V)



Ta (N.C) : Reference ambient temperatures measured under natural convection cooling (Our measurement environment).
Ta (MAX) : Maximum ambient temperature achievable with proper heat dissipation or air cooling design.
Ensure that the case temperature (Tc) remains within the limits of the derating curve.

8. Mounting Method, Soldering and Cleaning Condition

8-1. Mounting Method

(1) Mounting Dimension

Below is the recommended size of hole and land of PCB in Table 8-1.
The mounting hole position is shown in Fig.8-1.
Also, see outline drawing for outline of the power supply.

Table 8-1 Recommended Diameter of Hole and Land

	Input / Output terminals
Terminal pin size	ϕ 1.0mm
Hole diameter	ϕ 1.5mm
Land diameter	ϕ 2.8mm

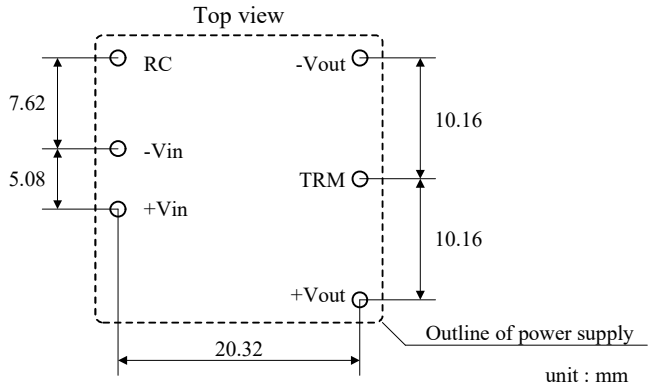


Fig.8-1 Recommended Mounting Dimension

(2) Recommended Material of PCB

Recommended materials of the printed circuit board is double sided glass epoxy with through holes.
(thickness : 1.6mm, copper : 70µm or more)

(3) Input / Output Pattern Width

Large current flows through input and output pattern. If pattern width is too narrow, heat on pattern will increase because of voltage drop of pattern. Relationship between allowable current and pattern width varies depending on materials of printed circuit board, thickness of conductor and allowable temperature rise of pattern, etc. It is definitely necessary to confirm on manufactures of printed circuit board for designing pattern.

(4) Method of Connecting Terminals

Connect +Vin, -Vin, RC, +Vout, -Vout, TRM with consideration of contact resistance.

8-2. Recommended Soldering Condition

Recommended soldering conditions are as follows.
Soldering is guaranteed only one time under either (1) or (2) below.
It is without guarantee and please evaluate enough if soldering twice or more.

(1) Soldering Dip
Dip condition : 260ºC within 10 seconds
Pre-heat condition : 110ºC for 30 - 40 seconds or less

(2) Soldering Iron
350ºC within 3 seconds

Note) Soldering time changes according to heat capacity of soldering iron, pattern on printed circuit board etc. Please confirm actual performance.

8-3. Recommended Cleaning Condition

Recommended cleaning condition after soldering is as follows.
(1) Cleaning Solvent
IPA (isopropyl alcohol)

(2) Cleaning Procedure
Use brush and dry the solvent completely before use.

9. Before Concluding Power Supply Damage

Verify following items before concluding power supply damage.

(1) No output voltage

- Is specified input voltage applied?
- Are the remote ON/OFF control terminal (RC), output voltage trimming terminal (TRM) correctly connected?
- For case where output voltage adjustment is used, is resistor or variable resister setting, connections correctly done?
- Are there no abnormalities in the output load used?
- Is the case temperature within the specified temperature range?
- Is the ambient temperature within the specified temperature range?

(2) Output voltage is high

- For case where output voltage adjustment is used, is resistor or variable resister setting, connections correctly done?

(3) Output voltage is low

- Is specified input voltage applied?
- For cases where output voltage adjustment is used, is resistor or variable resistor setting, connections correctly done?
- Are there no abnormalities in the output load used?

(4) Load regulation or line regulation is large

- Is specified input voltage applied?
- Are the input terminals and the output terminals firmly connected?
- Is the input or output wire too thin?
- Is the input or output wire too long?

(5) Output ripple voltage is large

- Is the measurement done according to methods described in the Instruction Manual or is it an equivalent method?

10. Warranty Period

Warranty period is 5 years.
For damages occurring at normal operation within this warranty period, exchange is free of charge.
Please read the General Safety Instruction before using the products.

11. CE MARKING / UKCA MARKING

CE MARKING
CE Marking, when applied to a product or packing material for a product covered by this handbook,
CCG60-24-xx indicates compliance with RoHS Directive,
CCG60-48-xx indicates compliance with Low Voltage Directive and RoHS Directive.

UKCA MARKING
UKCA Marking, when applied to a product or packing material for a product covered by this handbook, indicates compliance with the Electrical Equipment (Safety) Regulations (For CCG60-48-xx only) and Restriction of the Use of Certain Hazardous Substances in Electrical & Electronic Equipment Regulations.

*CCG60-24-05 : When Vin is less than 12 V, the operating range covered by safety standard certification is limited to Io ≤ 85%.
*CCG60-24-12 : When Vin is less than 12 V, the operating range covered by safety standard certification is limited to Io ≤ 90%.

12. Input Recycling Precautions

When performing input recycling, make sure that the following conditions are met.
Otherwise, the internal circuit reset operation may become unstable, and the output may fail to recover.

[CCG60-24-xx]

When the input voltage falls below 7.4 V, the internal circuit shuts down the unit and keeps it in the shutdown state. After the input voltage falls below 4.9 V, wait at least 10 ms before performing input recycling. Then, perform input recycling at an input voltage slew rate of 0.5 V/ms or higher.

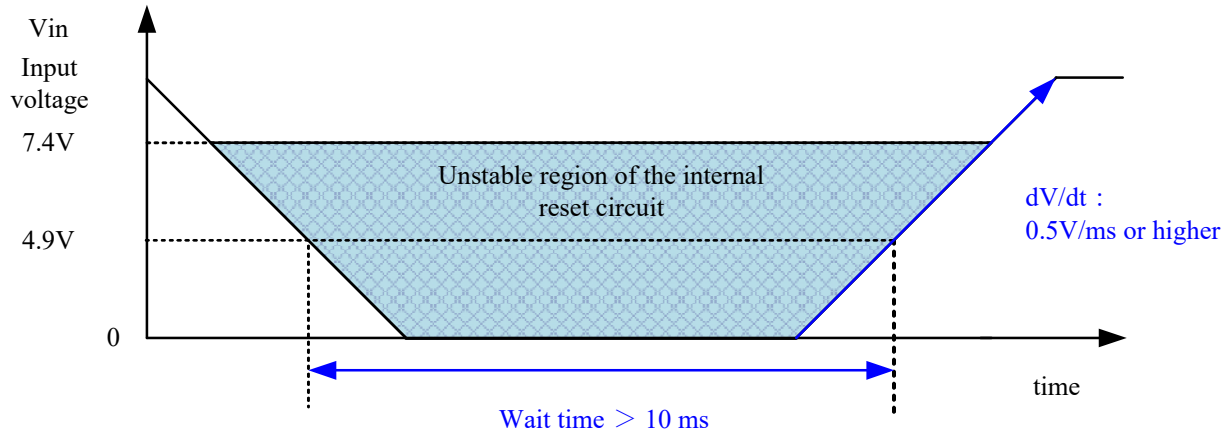


Fig.12-1 Input Recycling Conditions (CCG60-24-xx)

[CCG60-48-xx]

After the input voltage falls below 9.4 V, wait at least 10 ms before performing Input recycling. Input voltage slew rate is not restricted.

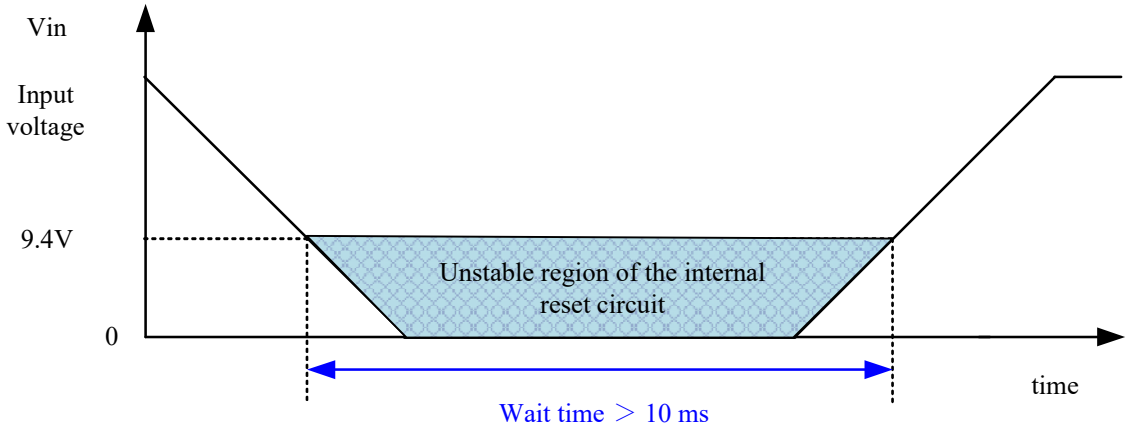


Fig.12-2 Input Recycling Conditions (CCG60-48-xx)

If input voltage shutdown or momentary input voltage drop cannot be predicted, or above conditions cannot be met, please contact us.