

CUS30M Series

Instruction Manual

BEFORE USING THE POWER SUPPLY UNIT

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.

⚠ DANGER

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

⚠ INSTALLATION WARNING

- When installing, ensure that work is done in accordance with the instruction manual. When installation is improper, there is risk of electric shock and fire.
- Installation shall be done by Service personnel with necessary and appropriate technical training and experience. There is a risk of electric shock and fire.
- Do not cover the product with cloth or paper etc. Do not place anything flammable around. This might cause damage, electric shock or fire.

⚠ WARNING on USE

- Do not touch this product or its internal components while circuit in operation, or shortly after shutdown. You may receive a burn.
- While this product is operating, keep your hands and face away from it as you may be injured by an unexpected situation.
- For products with no cover, do not touch them as there are high-voltage and high temperature parts inside. Touching them might cause injury such as electric shock or burn.
- There are cases where high voltage charge remains inside the product. Therefore, do not touch even if they are not in operation as you might get injured due to high voltage and high temperature. You might also get electric shock or burn.
- Do not make unauthorized changes to this product nor remove the cover as you might get an electric shock or might damage the product. We will not be held responsible after the product has been modified, changed or dis-assembled.
- Do not use this product under unusual condition such as emission of smoke or abnormal smell and sound etc. Please stop using it immediately and shut off the product. It might lead to fire and electric shock. In such cases, please contact us. Do not attempt repair by yourself, as it is dangerous for the user.
- Do not operate and store these products in environments where condensation occurs due to moisture and humidity. It might lead fire and electric shock.
- Do not drop or apply shock to this product. It might cause failure. Do not operate these products mechanical stress is applied.

⚠ CAUTION on MOUNTING

- Confirm connections to input/output terminals are correct as indicated in the instruction manual before switching on.
- Input voltage, Output current, Output power, ambient temperature and ambient humidity should be kept within specifications, otherwise the product will be damaged.
- Input line, please use the wires as short and thick as possible.
- Do not use this product in special environment with strong electromagnetic field, corrosive gas 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 be properly be ventilated.
- Please shut down the input when connecting input and output of the product.

CAUTION on USE

- Product individual notes are shown in the instruction manual. If there is any difference with common notes individual notes shall have priority.
- Before using this product, be sure to read the catalog and instruction manual. There is risk of electric shock or damage to the product or fire due to improper use.
- Input voltage, Output current, Output power, ambient temperature and ambient humidity should be kept within specifications, otherwise the product will be damaged, or cause electric shock or fire.
- If the built-in fuse is blown, do not use the product even after replacing the fuse as there is risk of abnormality inside. Be sure to request repair to our company.
- For products without built-in protection circuit (element, fuse, etc.), insert fuse at the input to prevent smoke, fire during abnormal operation. As for products with built-in protection circuit, depending on usage conditions, built-in protection circuit might not work. It is recommended to provide separate proper protection circuit.
- For externally mounted fuse do not use other fuses aside from our specified and recommended fuse.
- This product was made for general purpose electronic equipment for standard industrial 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).
- When used in environments with strong electromagnetic field, there is possibility of product damage due to malfunction.
- When used in environment with corrosive gas (hydrogen sulfide, sulfur dioxide, etc.), there is possibility that they might penetrate the product and lead to failure.
- When used in environments where there is conductive foreign matter or dust, there is possibility of product failure or malfunction.
- Provide countermeasure for prevention of lightning surge voltage as there is risk of damage due to abnormal voltage.
- Connect together the frame ground terminal of the product and the ground terminal of the equipment for safety and noise reduction. If these ground is not connected together, there is risk of electric shock.
- Parts with lifetime specifications (built-in fan electrolytic capacitor) are required to be replaced periodically. Set the overhaul period depending on the environment of usage and perform maintenance. Also, note that there are cases when EOL products cannot be overhauled.
- Take care not to apply external abnormal voltage to the output. Especially, applying reverse voltage or overvoltage more than the rated voltage to the output might cause failure, electric shock or fire.
- Do not use in special environment such as places directly exposed to sunlight, dew condensation, moisture, rain, strong electro-magnetic field, or corrosive gas (hydrogen sulfide, sulfur dioxide).

Note

- Take note that traces of sheet metal processing be left in our power supplies.
- Consider storage of the product at normal temperature and humidity avoiding direct exposure to sunlight at environment with minimal temperature and humidity changes. Storage of product at high temperature, high humidity and environments with severe changes in temperature and humidity might cause deterioration, and occurrence of condensation in the product.
- When disposing product, follow disposal laws of each municipality.
- Published EMI (CE, RE) or immunity is the result when measured in 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.
- Catalogue, 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.
- CE Marking
CE Marking, when applied to a product covered by this handbook, indicates compliance with the low voltage directive.

Important safety instructions

Servicing

These products are not customer serviceable. Repairs can only be carried out by TDK-Lambda or their authorized agents. These products are not authorized for use as critical components in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the Managing Director of TDK-Lambda Corporation.

Safety Class of Protection

This power supply is a switching mode power supply for use in applications within a Pollution Degree 2, overvoltage category II environment. Material Group IIIb PCB is used within it.

Input markings and symbols

 Caution refer to supplementary documents

EMC performance

Immunity

Test	Standard	Passed	Comments
Electrostatic discharge	IEC61000-4-2	Level 4,3	Input/Output Air discharge 8kV FG Air discharge 15kV FG Contact discharge 8kV
Electromagnetic field	IEC61000-4-3	Level 3	10V/m
Fast / burst transient	IEC61000-4-4	Level 3	2.0kV (100kHz)
Surge immunity	IEC61000-4-5	Level 3 Level 4	Normal mode 2.0kV Common mode 4.0kV
Conducted RF immunity	IEC61000-4-6	Level 3	10V
Power frequency magnetic field	IEC61000-4-8	Level 4	30A/m
Voltage dips, variations, interruptions	IEC61000-4-11	Pass	

Emissions

Test	Standard	Comments
EMI	EN55032	Class B (as per CISPR 22)
Conducted harmonics	IEC61000-3-2	Meet Class A

General installation instructions

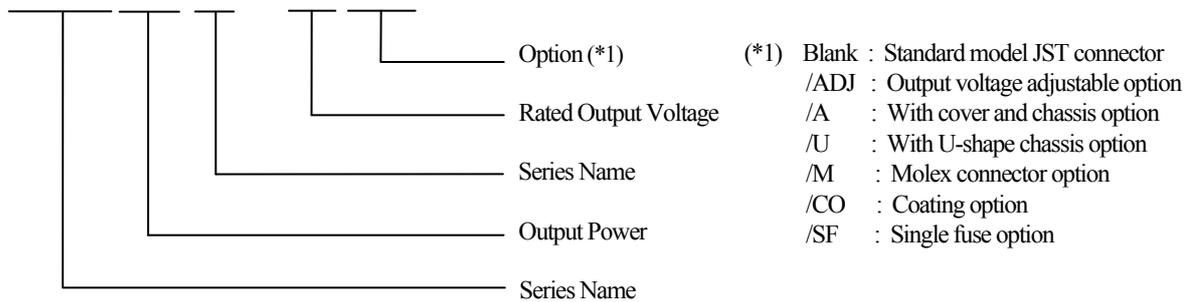
- 1) CUS30M Series is optional for installation in Class I or Class II end equipment, and for Class I must be reliable earthed and professionally installed, and for Class II no earthing connection to the power supply is required.
- 2) These products are IPX0, and therefore chemicals/solvents, cleaning agents and other liquids must not be used.
- 3) The first protective earth connection in the final installation must be marked with the protective earth symbol.

Special Instructions for IEC/UL/ 60601-1

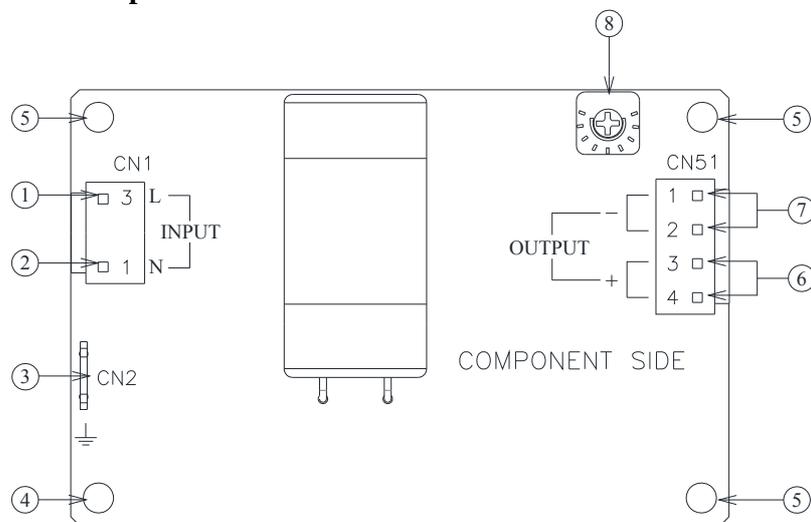
- 1) These products are designed for continuous operation within an overall enclosure, and must be mounted such that access to the mains terminals is restricted. See Clause 16, IEC/UL60601-1.
- 2) These products are NOT suitable for use in the presence of flammable anaesthetic mixtures with air or with oxygen or with nitrous oxide.
- 3) These products are classed as ordinary equipment according to IEC/UL60601-1 and are NOT protected against the ingress of water.
- 4) Reference should be made to local regulations concerning the disposal of these products at out of their useful life.
- 5) For Class II installation, the product needs to be fixed such that they are isolated from unearthed accessible conductive parts by at least 2 MOPP's.
- 6) For IEC/EN 60601-1 3rd Edition, ANSI/AAMI ES 60601-1, CSA 22.2 No 60601-1, these products provide reinforced insulation between input and outputs of 2 MOPPs. 1 MOPP from input to earth and 1 MOPP from output to earth.
- 7) All outputs have basic spacing's to earth rated for mains - 250Vac, and due consideration must be given to this in the end product design.
- 8) Products have SELV outputs.

1. Model name identification method

CUS 30 M – 12 / □



2. Terminal Explanation



- ① L : AC Input terminal Live line (Fuse in line.)
- ② N : AC Input terminal Neutral line (Fuse in line.)
- ③ \perp : \perp Terminal CN2(Protective Earth)
- ④ Mounting hole (hole diameter : ϕ 3.5mm)
This hole is electrically connected to CN2.
- ⑤ Mounting hole (hole diameter : ϕ 3.5mm)
This hole is used for support the unit.
- ⑥ + : + Output Terminal
- ⑦ - : - Output Terminal
- ⑧ V.ADJ : /ADJ model only. Output voltage adjust trimmer. The output voltage rises when the trimmer is turned clockwise.

3. Terminal Connection Method

Pay attention to the input wiring. If it is connected to wrong terminal, the power supply will be damaged.

- Input must be off when making connections.
- \perp terminal must be connected to protective earth of the equipment in Class I installation.
- Output current of each terminal pin must be less than 7A.
- The output load line and input line shall be separated to improve noise sensitivity.
- Do not apply stress to PCB, when connecting or removing connector.
- Use input/output connector (housing) specified by the table below.
- Use recommended crimping tool. Connector is not included with this product. (Refer to the following)

Input/Output Connector

	Model	Connector	Housing	Terminal Pin	Maker
Input (CN1)	Common	B2P3-VH(LF)(SN)	VAR-2 / VHR-3N	SVH-41T-P1.1 BVH-41T-P1.1	J.S.T.
Output (CN51)	Common	B4P-VH(LF)(SN)	VHR-4N		
FG TAB (CN2)	Common	---	22~18AWG: STO-21T-250N 18~14AWG: STO-61T-250N	---	J.S.T.

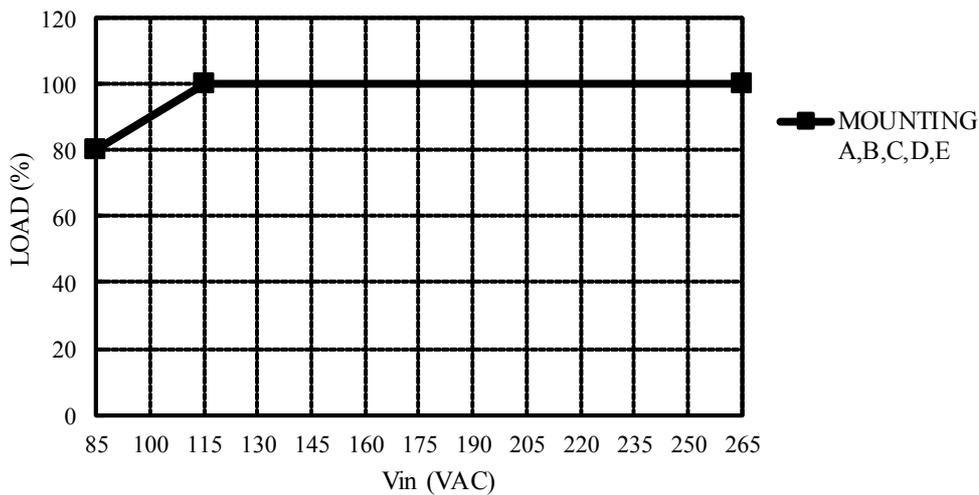
Hand Crimping Tool : YC-930R,YC-931R (J.S.T.)

4. Explanation of Function and Precautions

4-1. Input Voltage Range

Input voltage range is single phase 85-265VAC(47-63Hz). Never operate the unit out of the specified input voltage range to avoid unit failure. For cases where conformance to various safeties required, input voltage range will be 100-240VAC (50-60Hz). If input voltage is less than 115VAC, output power need to be derated.

Derating curve of the Input voltage



4-2. Output Voltage Range

Output voltage is set the rated value at shipment. For /ADJ model, V.ADJ trimmer (VR51) can be used to adjust the Output voltage within the specification range. To turn the trimmer clockwise, The output voltage will be increased. Take note when the output voltage is increased excessively, over voltage protection (OVP) function may be triggered and voltage will be shut down. While increasing the output voltage, reduce the maximum output current so as not to exceed the maximum output power.

4-3. Inrush Current

These products equipped power thermistor to limit the inrush current. Higher inrush current will flow at higher ambient temperature or re-input condition. Please select input switch and fuse carefully in consider of the high temperature and re-input the power condition. The Inrush Current value is under cold start at 25°C in the specification.

4-4. Over Voltage Protection (OVP)

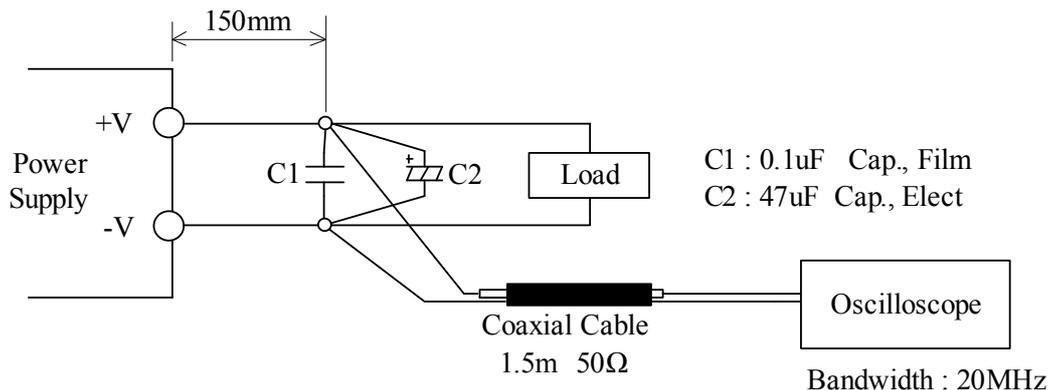
The OVP function (Inverter shut down method, manual reset type) is provided. Please refer to its specification for OVP operating range. When OVP triggers, the output will be shut down. To reset OVP, remove the input of power supply for a few minutes, and then re-input. In addition, the setting value of OVP is fixed and not adjustable. Pay attention not to apply higher voltage externally to the output terminal to avoid unit failure. In case of inductive load, put protective diode in series to the output power line. In heavy load condition, OCP may triggered before output reach OVP threshold.

4-5. Over Current Protection (OCP)

OCP is hiccup mode with automatic recovery. Outputs will be automatically recovered when the overload condition is canceled. OCP function operates when the output current exceeds 105% of maximum DC output current of specification. Never operate the unit under over current or shorted conditions for more than 30seconds, which may lead to damage or insulation failure. OCP setting is not adjustable externally.

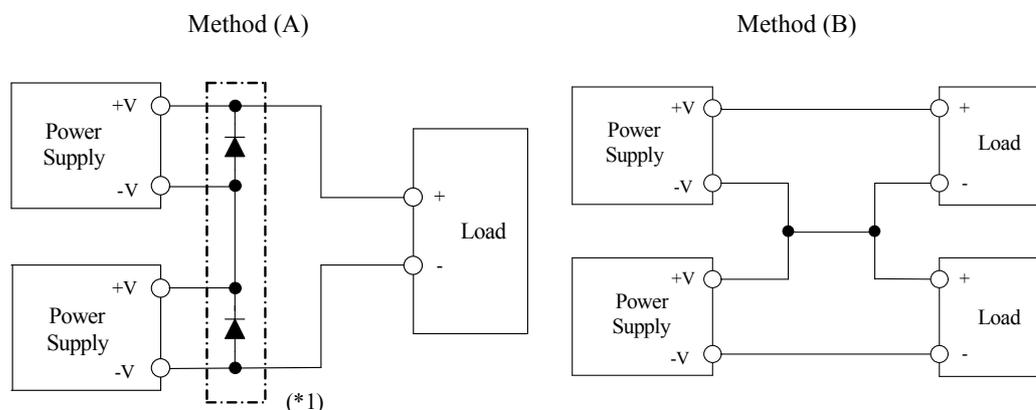
4-6. Output Ripple & Noise

The standard specification for maximum ripple value is measured according to measurement circuit specified as below. When load lines are longer, ripple will become larger. In this case, electrolytic capacitor, film capacitor, etc. might be necessary to use across the load terminal. The output ripple cannot be measured accurately if the probe ground lead of oscilloscope is too long. A circuit reducing light load input power consumption is built in this model. When output current is within 0-35% of rated load, the internal switch element is intermittent operated, to decrease switching loss. The specification of the Ripple & Noise changes by this intermittent operation. The dynamic load response characteristic changes by this intermittent operation too. Different input voltage and dynamic load condition has different dynamic load response characteristic. Please contact us for details.



4-7. Series Operation

For series operation, either method (A) or (B) is possible.

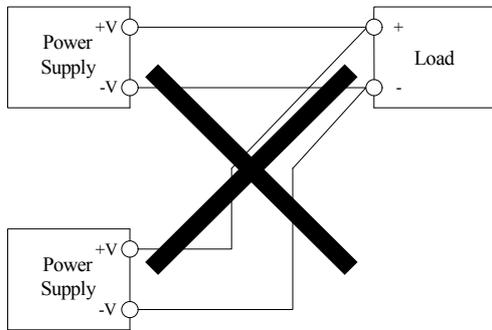


(*1) Please select a bypass diode with maximum forward current rating more than output load current. And maximum reverse voltage must withstand each power supply output voltage.

4-8. Parallel Operation

For parallel operation, method (B) is possible.

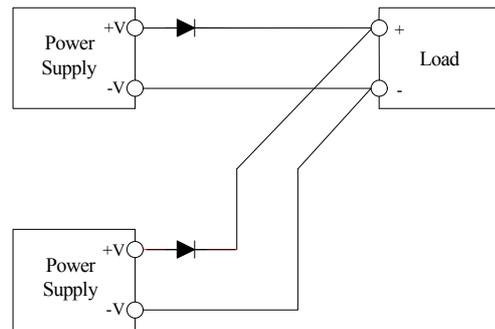
(A) To increase the Output Current is not possible.



(B) To use as Backup Power Supply.

1. Adjust the output voltage of each power supply to be the same.
2. Set power supply output voltage higher by the forward voltage drop (Vf) of diode.

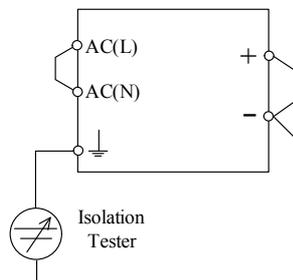
Use within the specification for output voltage and output power.



4-9. Isolation Test

Isolation resistance between Output and \perp (Protective Earth) is more than 100M Ω at 500VDC. For safety operation, voltage setting of DC isolation tester must be done before the test. Ensure that the unit is fully discharged after the test.

Output - \perp (Protective Earth) : 500VDC More than 100M Ω



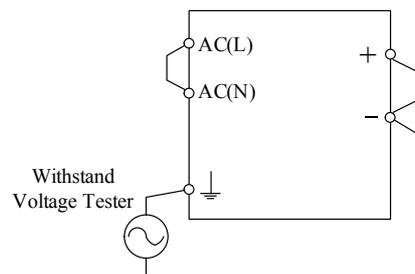
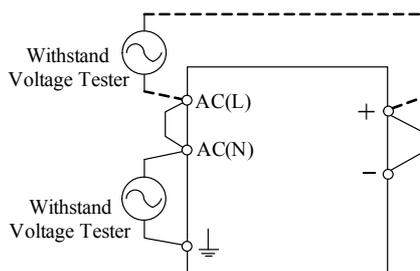
4-10. Withstand Voltage

These products are designed to withstand 4.0kVAC between input and output, 2.0kVAC between input and \perp , and 1.5kVAC between output and \perp each for 1 minute. When testing withstand voltage, set current limit of the withstand voltage test equipment to 20mA. The applied voltage must be gradually increased from zero to the testing value and then gradually decreased for shut down. When timer is used, the power supply may be damaged by high impulse voltage at timer switch on and off. Connect input and output as follows.

Input - Output(Dashed line) : 4.0kVAC 1min(20mA)

Input - \perp (Protective Earth)(Solid line) : 2.0kVAC 1min(20mA)

Output - \perp (Protective Earth) : 1.5kVAC 1min(20mA)



Instructions for using the power supply in customer's system

1. If the output of power supply is connected to FG in the application, the withstand voltage test between input and output (FG) should be tested at 2kVAC.
2. If there is external noise filter and Y-caps connected at the input and output of the power supply, the voltage distribution between primary and secondary circuit will be changed during the withstand voltage test, and may cause test fail. In this case, please contact TDK-Lambda for the technical support and instructions.

5. Mounting

5-1. Mounting Directions

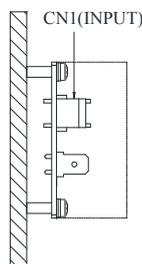
5-1-1. Mounting directions for models (except CUS30M/A,CUS30M/U)

Recommended standard mounting direction is (A). Mounting direction (B)-(E) are also possible.

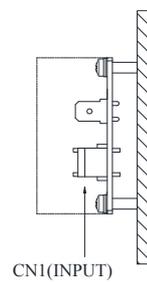
(A) Standard mounting



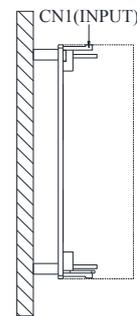
(B)



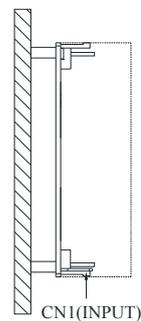
(C)



(D)



(E)

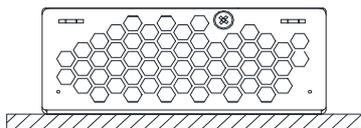


5-1-2. Mounting directions for CUS30M/A

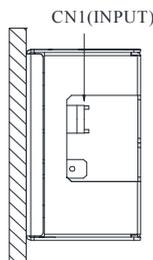
Recommended standard mounting direction is (A). Mounting direction (B)-(E) are also possible.

Please use the mounting holes on bottom side of the power supply, do not use the side of the chassis for power supply mounting.

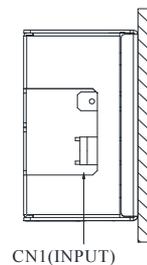
(A) Standard mounting



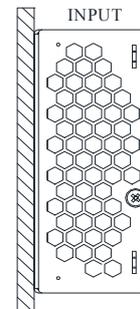
(B)



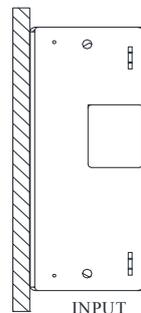
(C)



(D)



(E)

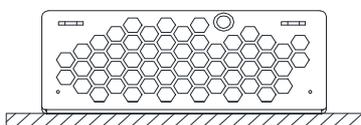


5-1-3. Mounting directions for CUS30M/U

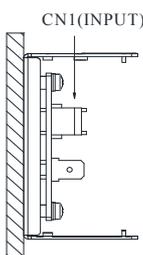
Recommended standard mounting direction is (A). Mounting direction (B)-(E) are also possible.

Please use the mounting holes on bottom side of the power supply, do not use the side of the chassis for power supply mounting.

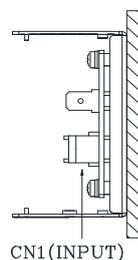
(A) Standard mounting



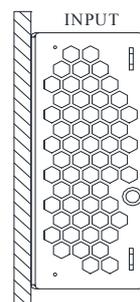
(B)



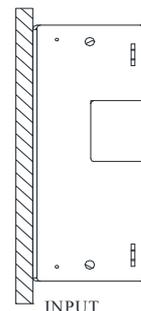
(C)



(D)



(E)



5-2. Output Derating

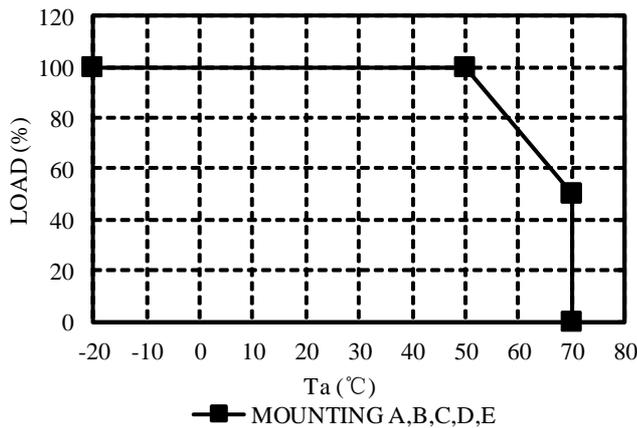
5-2-1. Output derating for CUS30M(except CUS30M/A)

Make sure that the specified temperature range is maintained.

(1) 12V,15V,24V,36V model

Convection Cooling: Mounting A,B,C,D,E

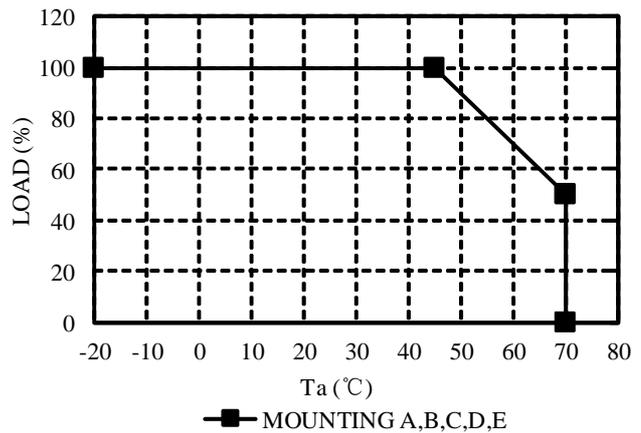
Ta (°C)	Load (%)
-20 - +50	100
70	50



(2)18V,48V model

Convection Cooling: Mounting A,B,C,D,E

Ta (°C)	Load (%)
-20 - +45	100
70	50



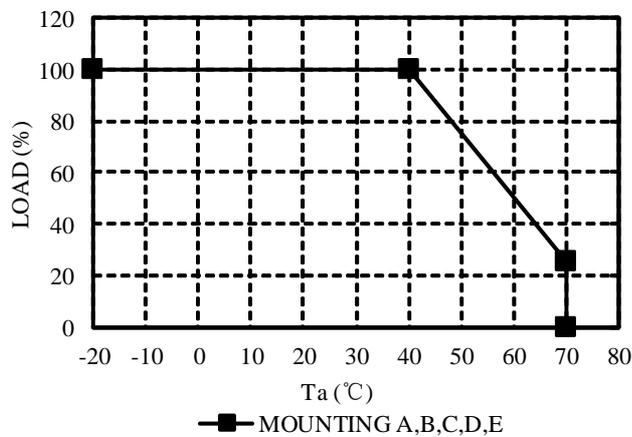
5-2-2. Output derating for CUS30M/A

Make sure that the specified temperature range is maintained.

(1) 12V,15V,24V,36V model

Convection Cooling: Mounting A,B,C,D,E

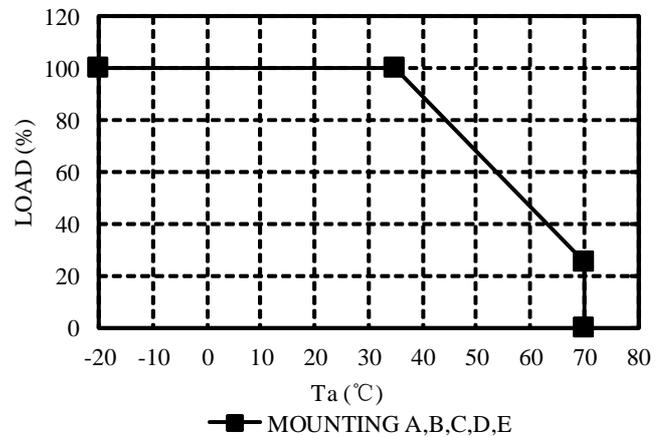
Ta (°C)	Load (%)
-20 - +40	100
70	25



(2)18V,48V model

Convection Cooling: Mounting A,B,C,D,E

Ta (°C)	Load (%)
-20 - +35	100
70	25



5-3. Mounting Method

5-3-1. Mounting method for standard model

Note: Except /A, /U.

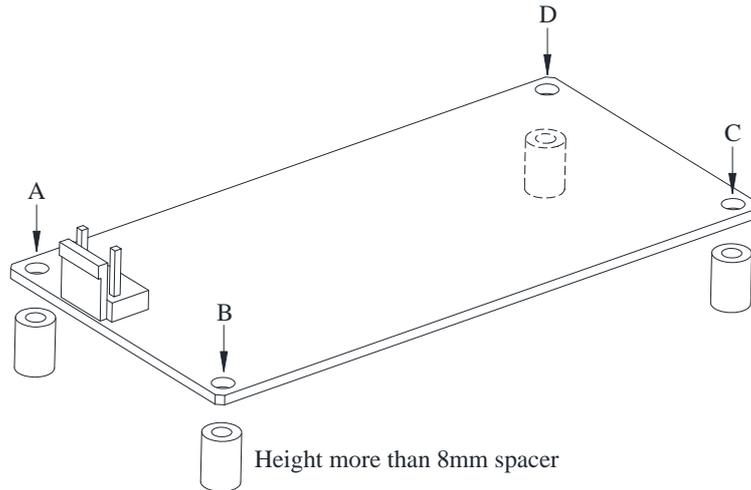
Insert the spacer (Max ϕ 6) of height more than 8mm to lift the unit. And use all mounting holes for the unit installation. The vibration specification is specified under this mounting condition.

All four mounting holes on this model should be utilized for best electrical and mechanical performance.

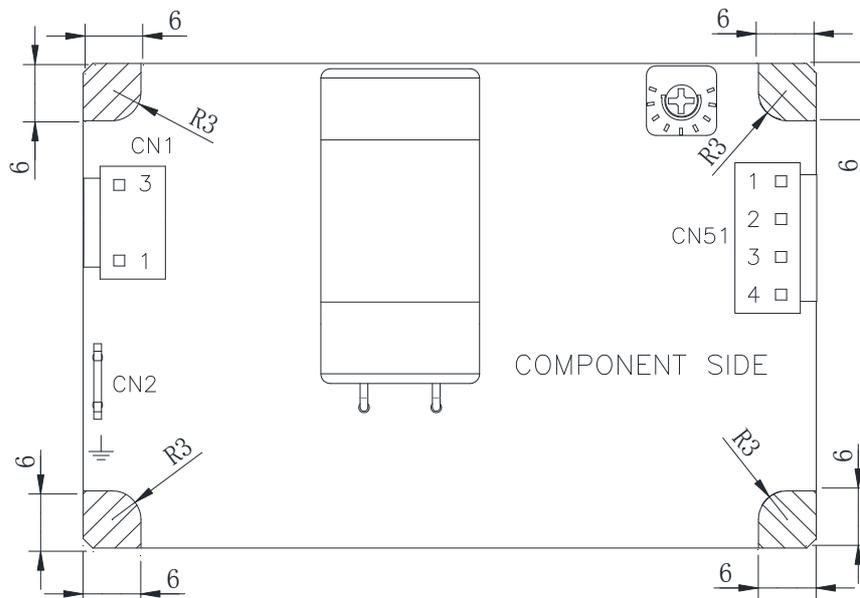
Recommended torque for mounting screw: M3 screw, 0.49N·m (5.0 kgf · cm).

- **Mounting Holes size**

4 holes ϕ 3.5mm.

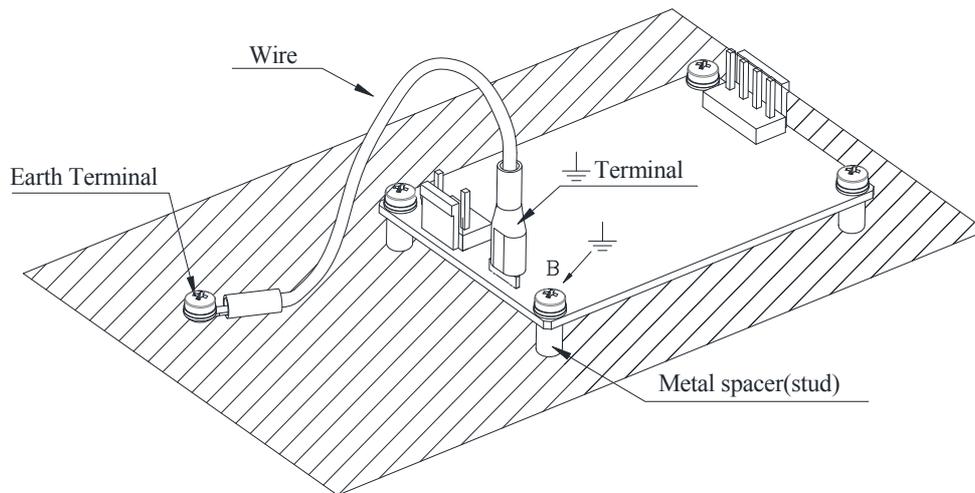


Refer to the shadow in the figure below for allowable area touched by conductive material on top and bottom side of the PCB.

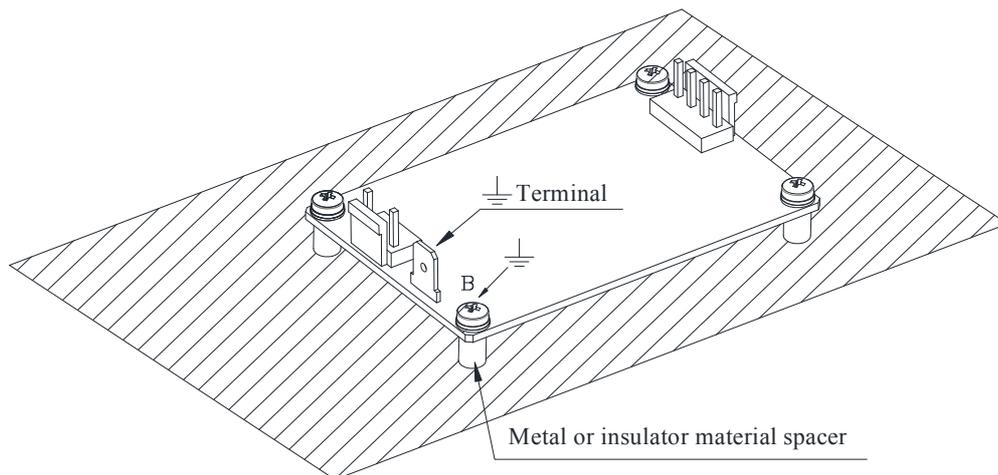


■ **Condition to meet EMC, Isolation, Withstand Voltage and Cooling requirement.**

- (1) Keep 4mm space minimum from the surface and sides of power supply, 8mm space minimum from the bottom side of PCB to meet safety requirement, or more space depend on safety requirement. If the space is not enough, the specification of isolation and withstand voltage will not be satisfied.
- (2) More space may be required in the surrounding of power supply and the upper area of components for effective cooling depends on the application conditions.
- (3) For installation in Class I end equipment, \perp terminal (Protective Earth) must be connected to the earth terminal of the equipment, also the mounting hole B (as shown below) needed to be connected to earthed metal plane or metal chassis of end product by metal spacer to ensure EMC performance. All equipment ideally should be mounted inside an earthed shielded metal box. Alternatively an earthed metal plate can be used to mount the power supply and load.



- (4) For Installation in Class II end equipment \perp terminal (Protective Earth) is unnecessary to be connected to earth terminal of the equipment.



5-3-2. Mounting method for /A model

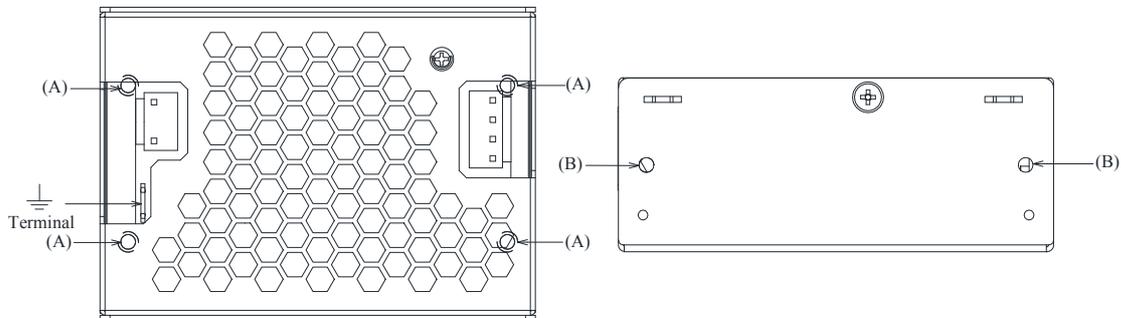
/A model is optional model with metal chassis and cover.

The mounting holes on the bottom(A) or on the side(B) of the chassis are for power supply fixing.

The maximum allowable penetration for screw into chassis is 4mm.

Recommended torque for mounting screw: M3 screw, 0.49N·m (5.0 kgf · cm).

Refer to the /A model outline drawings for the detailed dimensions.



■ Mounting Holes

A: 4-M3 tapped, embossed and countersink holes for mounting screws to fix the power supply from bottom.

B: 2-M3 tapped, embossed and countersink holes for mounting screws to fix the power supply from side.

■ Condition to meet EMC, Isolation, Withstand Voltage and Cooling.

- (1) This series is convection cooling type. In consideration of the heat radiation and safety, please keep a distance of more than 15mm between the power supply and the peripheral parts. When lining up multiple units, please make sure to leave 15mm or more apart from each other.
- (2) More space may be required in the surrounding of power supply and the upper area of components for effective cooling depends on the application conditions.
- (3) For installation in Class I end equipment \perp terminal (Protective Earth) must be connected to the earth terminal of the equipment. All equipment ideally should be mounted inside an earthed shielded metal box. Alternatively an earthed metal plate can be used to mount the power supply and load to ensure the EMC performance.
- (4) For installation in Class II end equipment(without ground connection), such as used inside of a plastic enclosure. \perp terminal(Protective Earth) no need to connected to earth terminal of the equipment.

5-3-3. Mounting method for /U model

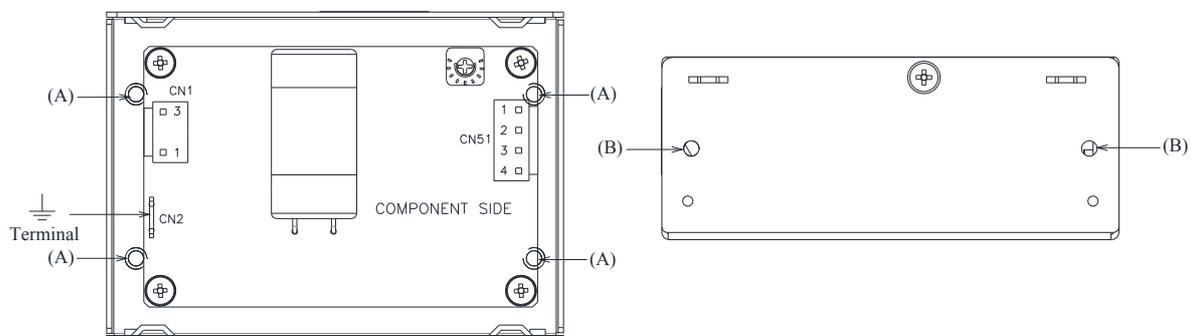
/U model is optional model With U-shape chassis.

The mounting holes on the bottom(A) or on the side(B) of the chassis are for power supply fixing.

The maximum allowable penetration for screw into chassis is 4mm.

Recommended torque for mounting screw: M3 screw, 0.49N·m (5.0 kgf · cm).

Refer to the /U model outline drawings for the detailed dimensions.



■ Mounting Holes

A: 4-M3 tapped, embossed and countersink holes for mounting screws to fix the power supply from bottom.

B: 2-M3 tapped, embossed and countersink holes for mounting screws to fix the power supply from side.

▪ **Condition to meet EMC, Isolation, Withstand Voltage and Cooling.**

- (1) This series is convection cooling type. In consideration of the heat radiation and safety, please keep a distance of more than 15mm between the power supply and the peripheral parts. When lining up multiple units, please make sure to place them 15mm or more apart from each other.
- (2) Keep more than 4mm space from the top of components to meet safety requirement. If the space is not enough, the specification of isolation and withstand voltage will not be satisfied.
- (3) More space may be required in the surrounding of power supply and the upper area of components for effective cooling depends on the application conditions.
- (4) For installation in Class I end equipment \perp terminal (Protective Earth) must be connected to the earth terminal of the equipment. All equipment ideally should be mounted inside an earthed shielded metal box. Alternatively an earthed metal plate can be used to mount the power supply and load to ensure the EMI and EMC performance.
- (5) For installation in Class II end equipment(without ground connection), such as being used inside of a plastic enclosure. \perp terminal(Protective Earth) is unnecessary to connected to earth terminal of the equipment.

6. EMC and Wiring Method

This power supply is primarily designed and manufactured to be used and enclosed in other equipment. The installation, wiring, grounding and end application of the switching power supply in the equipment system may influence its EMC characteristics. Therefore, the EMC performance has to be tested on end system level. Additional filtering may be required depends on application and installation methods.

Please refer to following application notes which may help to improve EMC performance.

- (1) The output load line and input line shall be separated each other and twisted individually to improve noise.
- (2) Use all lines as thick and short as possible to make lower impedance.
- (3) Noise can be reduced by attaching a capacitor to the load terminals.
- (4) For safety and EMI considerations, connect \perp (Protective Earth) terminal to Frame Ground terminal of equipment firmly.

7. External Fuse Rating

Refer to the following fuse rating when selecting the external fuses that are to be used on input line. Surge current flows when line turns on. Have to use slow-blow or time-lag type fuse, not fast-blow fuse. Fuse rating is considered by in-rush current value at line turn-on. Do not select the fuse according to input current (RMS.) values under the actual load condition.

CUS30M: 1.6A

8. Before concluding that the unit is at fault

- (1) Check if the rated input voltage is connected.
- (2) Check if the wiring of input and output is correct.
- (3) Check if the wire thickness is enough.
- (4) Check if the output current and output power does not over specification.
- (5) Check if the output voltage adjust trimmer (V.ADJ) is properly adjusted. OVP might be triggered and output is shut down.
- (6) Audible noise can be heard when input voltage waveform is not sinusoidal wave.
- (7) Audible noise can be heard during Dynamic-Load operation.
- (8) Ensure that a large capacitor is not connected across the output terminals. Please use within maximum capacitance shown below.

MODEL	maximum external capacitance					
	12V	15V	18V	24V	36V	48V
CUS30M	2500uF	2000uF	1700uF	1250uF	840uF	630uF

9. Altitude

CUS30M Series is safety approved for operation at below altitude.

- Up to 5000m by IEC60950-1 clearance requirement.
- Up to 5000m by IEC60601-1 clearance requirement (2MOPPs).

Thermal evaluation should be considered for products operating at elevated altitudes above 3000m. Derating 5°C /1000m above 3000m.

10. Warranty Condition

These products are under warranty for 3 years from the date of shipment. During the warranty period, TDK-Lambda will, either repair or replace products prove to be defective.

3 years warranty applies but not limited to the following.

- (1) Average operating temperature (ambient temperature of the power supply unit) is under 40°C.
- (2) 3 years warranty base on 24 hours/day operation at 100% load.

Please refer to electrolytic capacitor life time from reliability data for various application conditions such as mounting, load derating, operating ambient temperature etc.

Customer system design could be improved with better electrolytic capacitor life time by selecting proper application method.

Following cases are not covered by warranty.

- (1) Improper usage like dropping products, applying shock and defects from operation exceeding specification of the units.
- (2) Defects resulting from natural disaster (fire, flood etc.).
- (3) Unauthorized modifications or repair.