Technical Explanation for Power Supplies

Introduction

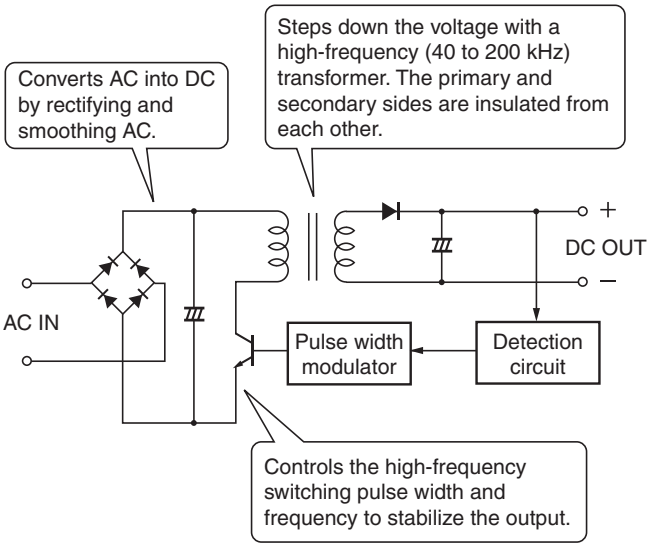
What Is a Power Supply?

To obtain electricity, we use commercial AC power that is sent from power plants. But the integrated circuits and electronic components used inside office automation equipment, factory automation equipment, and other electronics cannot be operated with the AC voltage, and they will be damaged by the high voltages.
Stable DC voltages are required to operate these integrated circuits and electronic components.
The device that converts commercial AC power to regulated DC power is called a regulated DC Power Supply.
There are two main methods for controlling regulated DC Power Supplies.
Switch-mode Power Supplies and Linear Power Supplies are regulated DC Power Supplies, which are generally referred to as Power Supplies. Currently, Switch-mode Power Supplies are the most common because they are compact, lightweight, and highly efficient.

Configuration and Principles

Switch-mode Power Supplies

Switch-mode Power Supplies take commercial AC power as the input and convert it to high-frequency power using the high-speed switching of semiconductors to obtain the required direct current. Switch-mode Power Supplies are used for most electronic devices as power supplies because they are compact, lightweight, and highly efficient.



Advantages

- Highly efficient.
- Compact, and light.
- A wide input voltage range.

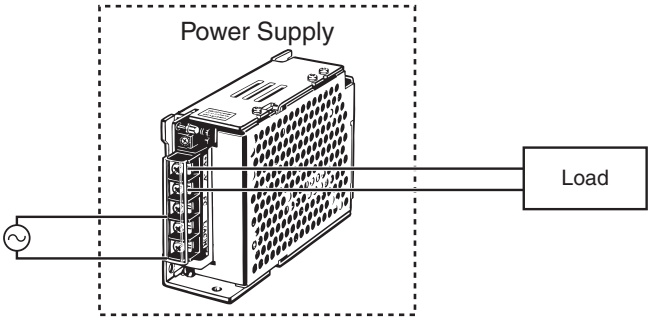
Disadvantages

- Noise is generated due to high-frequency switching.
- Large inrush current on the primary side.

* A Power Supply generally has a noise filter and inrush current control circuit to reduce the noise and inrush current.

Selection Methods

Select a model of Power Supply according to your application.



Input Voltage

Each Power Supply has an input voltage range. Select the Power Supply according to the available input voltage.

Output Capacity

Output capacity (W) = Output voltage (V) × Load current (I)
Select the Power Supply so that the maximum load capacity will be lower than the rated output capacity.

Note: The output of the Power Supply may not rise or may rise slowly due to the ambient temperature and the startup current and inrush current of the load connected to the Power Supply, even when the load is within the Power Supply capacity during normal operation.
There is a risk of damage to the Power Supply from internal heat generation and a reduction in the life expectancy if the Power Supply is used when the load current exceeds the rated current.

Operating Methods

Consider the operating methods to increase output capacity, voltage, and reliability. (Not all models of Power Supply support all of the operating methods.)

- ☐ Parallel operation — Increases the Power Supply capacity when the load current is insufficient.
- ☐ Series operation — Increases the Power Supply voltage when the load voltage is low.
- ☐ N+1 redundant system, ☐ Backup operation — Increase reliability by ensuring that the supply of voltage from the Power Supply does not stop.

Note: Refer to the Power Supply datasheets because external components or consideration of derating may be required depending on the operating method.

Additional Functions

Check the required functions.
(The availability of additional functions depends on the model.)

- ☐ Overload protection — Prevents damage to the Power Supply due to an overcurrent (including an output short circuit) of the load.
- ☐ Overvoltage protection — Prevents excessive voltage from being applied to the load when the output voltage increases due to a failure in the Power Supply.
- ☐ Harmonic current emissions ——— Suppresses harmonic current emissions in the Power Supply's input current (based on IEC standards).
- ☐ Alarm output ——— Outputs an alarm signal for undervoltage detection or maintenance forecast monitor.

Note: Alarm output terminals are available as open- collector outputs and relay outputs with voltage and current specifications. Refer to the Power Supply datasheets.

Protection Functions

All models are equipped with overvoltage protection and overload protection.

Note: The startup characteristics of the load are affected depends on the overload protection characteristics.

Shape and Mounting Method

Power Supplies of various shapes are available. Select the most suitable Power Supply according to the application. Various mounting brackets are also available.

Installation

The mounting direction and space requirements are specified for each model. Make sure that the Power Supply has sufficient space for airflow.

Note: The load rate may have to be reduced depending on the mounting directions.

Life Expectancy

The warranty period and life expectancy of the Power Supply depend on the model. Select a model with suitable specifications for your application.

Warranty Period:

This is the period during which the Power Supply will be exchanged or repaired at no charge if it fails when used under the specified usage conditions during the warranty period.

Life Expectancy:

This is the period during which the Power Supply will satisfy performances under conditions similar to those of actual usage. The life expectancy is not a guaranteed value. It has been calculated from temperature rise tests of the aluminum electrolytic capacitor when the Power Supply is used with the standard mounting and the rated input voltage, an ambient temperature of 40°C, and a load rate of 50%.

Note: Periodic maintenance is required for the cooling fan.

Safety Standards

Models are available that comply with either UL, CSA, and VDE standards or EN standards.
Refer to the Power Supply datasheets for certification and conforming standards.

Explanation of Terms

Efficiency

Efficiency (%)

The efficiency indicates how much of the effective input power is converted to the output power. The Power Supply does not have 100% conversion efficiency. A portion of power becomes heat. The efficiency listed in the Power Supply datasheets are for the rated input and output. Refer to the technical data for the actual values of each load rate.

Input Conditions

Input Voltage

The input voltage specifies the input voltage range at which the rated operations and performance can be maintained. Values are expressed as the effective values for an AC input.

Frequency

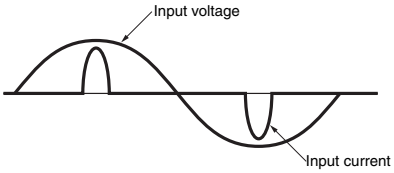
The frequency of the voltage applied to the AC input terminals.

Power Factor

The Power Supply's power factor is typically approx. 0.4 to 0.6 for models without a power factor improvement circuit and approx. 0.9 to 0.95 for models with a power factor improvement circuit.

Harmonic Current Control

Harmonic currents are the frequency components that are multiples (2 to about 40) of the 50/60 Hz sine wave of the basic AC current. Most Switch-mode Power Supplies incorporate capacitors, including Power Supplies on household appliances). As a result, the input voltage sine wave is transformed into a steep input current pulse that is not a sine wave and that includes harmonics.



The power factor for devices that contain a lot of harmonic currents is low. The apparent power (VA) is larger than the actually consumed power (W), which increases the current. If there are too many of this type of device connected, Power Supply facilities with more leeway are required.

There are standards that are designed to suppress harmonic currents in devices that are connected to public, low-voltage power grids. These include the international standard IEC 1000-3-2 and the EN 61000-3-2 standard (which mirrors the IEC 1000-3-2 standard) in the EU. These standards apply to devices with a rated input power of 75 W or higher that are connected to public, low-voltage grids.
In Japan, the Ministry of Economy, Trade and Industry undertakes activities to suppress harmonic currents and has issued the *Guideline of Harmonic Reduction for Consumers Who Have High or Ultra-high Voltage Power Receiving Facilities*.

When Switch-mode Power Supplies are used for industrial applications, countermeasures for harmonic currents are often implemented in the power receiving facilities of the factory or other sites. Therefore, there is little need for harmonic current control in the Switch-mode Power Supplies themselves. If you are connecting to a public, low-voltage power grid, such as a general household Power Supply, or you need to suppress harmonics from the Switch-mode Power Supply for any other reason, use a Power Supply that conforms to IEC 61000-3-2.

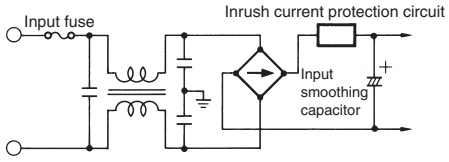
Input Current

Standard Switch-mode Power Supplies directly rectify AC input current. Usually, rectification is achieved using capacitor inputs and a smoothing capacitor through which a reactive current is allowed to flow. Therefore, the input current depends on the output power, input voltage, power factor, and efficiency, as follows:

$$\text{Input current} = \frac{\text{Output power}}{\text{Input voltage} \times \text{Power factor} \times \text{Efficiency}}$$

Refer to the Power Supply datasheets for the efficiency.

Input Rectifier/Smoothing Circuit

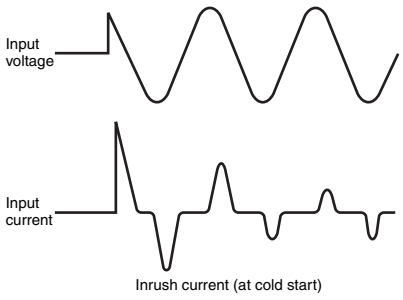


Leakage Current

Switch-mode Power Supplies have an internal noise filter circuit that prevents switching noise from being fed back to the input lines and protects the internal circuit from external noise. Leakage current is largely due to the current that flows through the capacitors (C1 or C2) of the input filter circuit.
Leakage current increases by the number of Power Supplies that you install. You must be careful when using more than one Power Supplies.

Inrush Current

When a Switch-mode Power Supply is turned on, a surge of current flows into the input smoothing capacitor to charge the capacitor. This current surge is called the "inrush current." The inrush current varies depending on the application timing and the presence of an inrush current protection circuit, but is usually several to several tens of times greater than the steady-state input current.



When two or more Switch-mode Power Supplies are used, the inrush current is the sum of the inrush currents for each Power Supply. Check the fusing characteristics of fuses and the operating characteristics of breakers, and select fuses and breakers so that external fuses will not burn out and breakers will not be activated by the inrush current.

Output Characteristics

Voltage Adjustment Range

The range over which the output voltage can be adjusted while maintaining specific output characteristics.

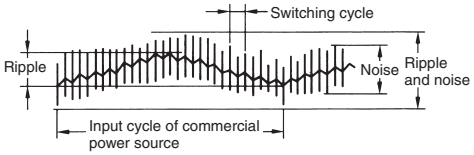
Note: 1. The output voltage can effectively be converted to a value above the specified range. When adjusting the voltage, however, check the actual output voltage and make sure it is within the specified output voltage range.

2. Make sure that the output voltage × output current does not exceed the rated output capacity and that the output current does not exceed the rated output current.

3. Do not apply unnecessarily strong force to the Output Voltage Adjuster (V.ADJ). Doing so may damage the V.ADJ.

Ripple and Noise

Since Switch-mode Power Supplies operate at high frequencies (i.e., as high as 20 kHz or more), the DC output will contain ripple and noise. The following figure shows a representative waveform for ripple and noise.



Since ripple and noise contain high-frequency components, the ground line of the oscilloscope must be shortened when making measurements. If the ground line is too long, it acts as an antenna which is influenced by radian waves and, consequently, the correct values of ripple and noise cannot be measured.

Static Input Variation Influence

The variation in the output voltage occurring when only the input voltage is changed slowly over the input range while maintaining constant output conditions.

Static Load Variation Influence

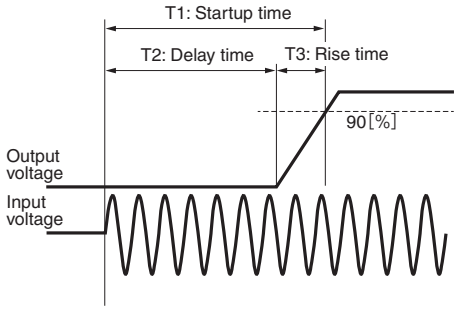
The variation in the output voltage occurring when the output current is changed slowly over a specified range while maintaining constant input conditions.

Temperature Variation Influence

The variation in the output voltage occurring when only the ambient operating temperature is changed.

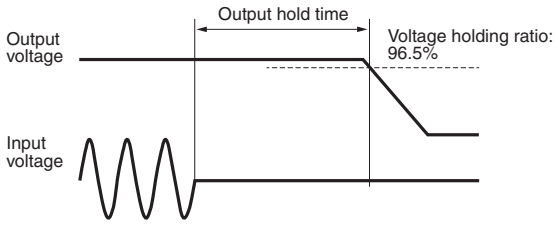
Startup Time

The time from when the input voltage is turned ON until the output voltage reaches 90% of the rated output voltage.



Output Hold Time

The time after the input voltage is shut off during which the output voltage maintains the voltage precision range.



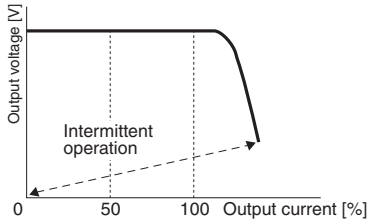
Functions

Peak Current Output

For a Switch-mode Power Supply that has overcurrent protection, the peak current that flows can be as high as the current at the overcurrent protection point.

If the current exceeds the overcurrent protection point, the output voltage will drop.

If the peak current is required, select an Switch-mode Power Supply so that the overcurrent protection point is larger than the peak current.



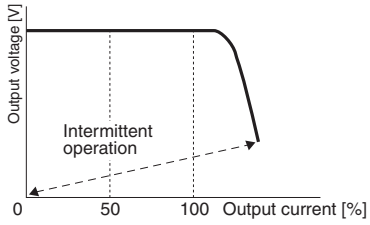
Overload Protection

This protection function prevents damage to the Power Supply itself due to overcurrent (including output short-circuits). The protection function is activated and the output current is limited when the load current is greater than the overcurrent detection value (this value depends on the model).

The output voltage will also drop according to the overload (load impedance).

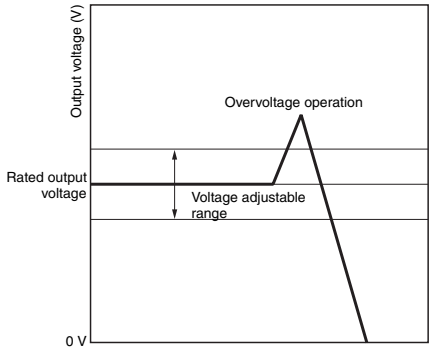
The drop level depends on the overload conditions and load line impedance. Continuing to use the Power Supply with an output short-circuit or in overcurrent status may cause the internal parts to be deteriorated or damaged.

The actual characteristics, such as the output current and voltage, will differ for each model. Refer to the values in the technical data and datasheets.



Overvoltage Protection

This protection function detects overvoltage and interrupts output to prevent sensors or other loads from being subjected to excessive voltage due to failure of the Power Supply's internal recovery circuit.
To resume operation, turn OFF the input power, and wait for a fixed period of time before turning ON the input power again. Check the datasheet for the OFF time.

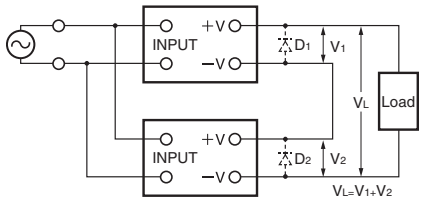


(When the overvoltage protection circuit operates, the Power Supply itself may be malfunctioning. When restarting the input power after the overvoltage protection circuit has operated, turn the input power ON with the load line disconnected and check the output voltage.)
The overvoltage protection circuit may operate if surge or other external overvoltage (e.g., from the load) is applied to the output side.

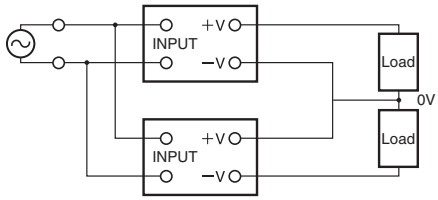
Series Operation

There are two application methods available when the outputs from multiple Power Supplies are connected in series:
(1) Increasing the output voltage
(2) Creating positive/negative outputs

(1) Increasing the Output Voltage



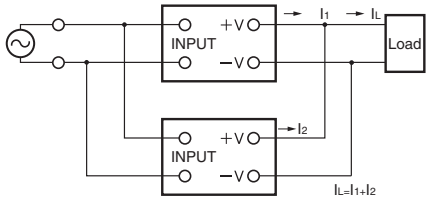
(2) Creating Positive/Negative Outputs



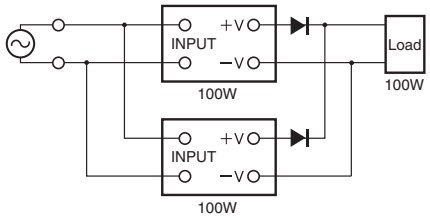
● Parallel Operation

There are two application methods available when the outputs of multiple Power Supplies are connected in parallel:
(1) Increasing the output current
(2) Backing up operation

(1) Increasing the Output Current



(2) Backing Up Operation



Remote Sensing Function

Remote sensing compensates for the voltage drop due to resistance in the wires from the Power Supply output terminals to the load.

Remote Control Function

The output voltage of the Power Supply can be turned ON and OFF from an external signal while the input voltage is being applied to the Power Supply.

Ambient Operating Temperature

The allowable range for the ambient temperature in which continuous operation is possible. The ambient temperature is the temperature that is not affected by the heat generated by the Power Supply itself.

Note: As a general rule, the ambient temperature is measured at 50 mm below the Power Supply. (There are exceptions for some models.)

Storage Temperature

The allowable range for the ambient temperature in which performance will not deteriorate due to long-term storage. The Power Supply itself must be in a non-operational state.

Ambient Operating Humidity

The allowable ambient humidity range in which the Power Supply can be used continuously.

Vibration Resistance

The vibration resistance indicates the mechanical strength against vibration when the Power Supply receives vibration due to a periodic force during transport, storage, or operation. The datasheet gives the vibration test conditions that the Power Supply will withstand.
Use the following formula to find the acceleration from the amplitude and frequency.

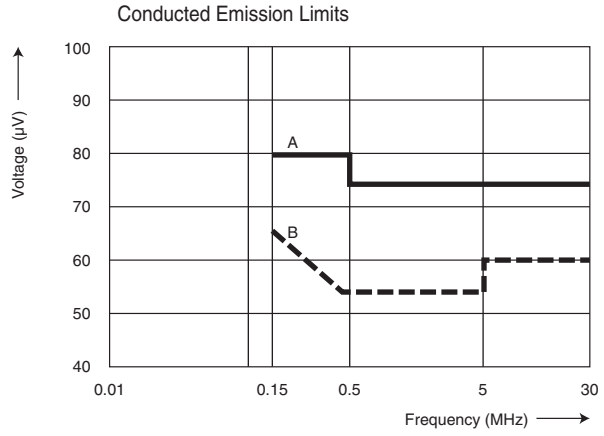
Acceleration [m/s^2] = 0.02 × (Half amplitude [mm] × 2) × (Frequency [Hz])^2
Acceleration [G]= Acceleration [m/s^2]/9.8 [m/s^2]

Shock Resistance

The shock resistance indicates the mechanical strength against shock when the Power Supply receives shock during transport, storage, or operation.
The datasheet gives the shock test conditions that the Power Supply will withstand.

Conducted Emissions

Noise voltage that enters through the Switch-mode Power Supply's AC input terminals.



As of December 2015.

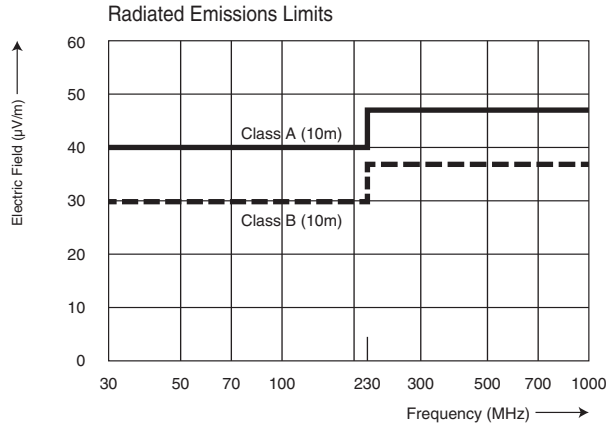
A: Devices Used in Industrial Areas and Environments
CISPR Pub. 11 Class A
(ISM devices (industrial, scientific, and medical equipment))
CISPR Pub. 22 Class A
(ITE devices (information technology equipment))
VCCI Class A, EN 55022 Class A

B: Devices Used in Residential Areas and Environments
CISPR Pub. 11 Class B
(ISM devices (industrial, scientific, and medical equipment))
CISPR Pub. 22 Class B
(ITE devices (information technology equipment))
VCCI Class B, EN 55022 Class B

Conducted Emission limits in
FCC standards Part 15 and Part 18 were unified with
CISPR Pub. 22 and Pub. 11 on September 9, 2002.

Radiated Emissions

The strength of the electric field (i.e., the amount of noise) that is radiated directly into the environment from the Switch-mode Power Supply.



As of December 2015.

Further Information

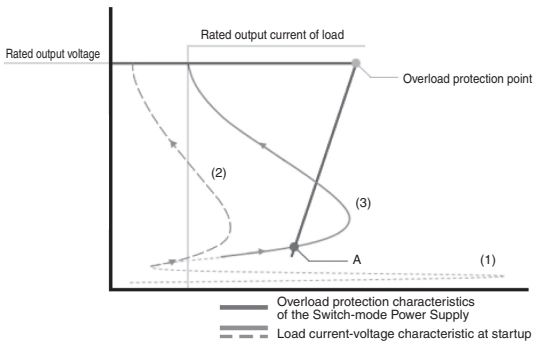
Overload Protection Characteristics and Loads That Will Not Start

If the rated load is connected or if a capacitive load with inrush current is connected, the output may be difficult to start or may not start.
Also, if the Power Supply is connected to a load with a built-in DC-DC converter, the Power Supply may not reach the rated output voltage even if a Power Supply with a rated output current that exceeds the load is connected.

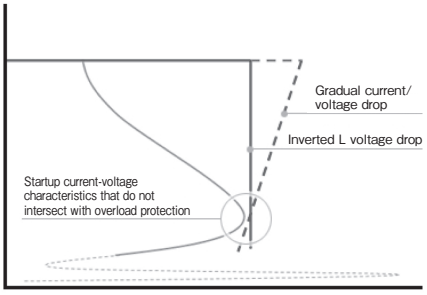
When power is turned ON, a current of two to several tens of times higher than the rated current may flow, as shown by (1) in Figure a.
This is generally called the inrush current of the load, and is caused by charging capacitors in the electronic devices on the load side.
With a capacitive load, the inrush current is very large and it tends to flow for a long period of time, which means that time is required for the output to start.
If the load is a DC-DC converter and the Power Supply starts from a low voltage, the load current-voltage characteristics at startup will be as shown by (2) in Figure a. Two to several tens of times the rated current will flow before the current returns to the rated current.
The voltage at startup depends on the specifications of the DC-DC converter, but some will start as low as approx. 3 to 4 V.

If more than one load with these characteristics is connected, the startup current will attempt to exceed the vertical line of the overcurrent protection characteristics of the Switch-mode Power Supply (as shown by (3) in Figure a). The current and voltage will stabilize at point A in the figure, and the rated output voltage will not be achieved.
To prevent this, you need to select a Power Supply with a high enough capacity to supply the startup current, select a Power Supply with an inverted L voltage drop overcurrent protection characteristic that exceeds the startup current, or select a Power Supply with an gradual current/voltage drop for which the startup current-voltage characteristic of the DC-DC converter does not exceed the vertical drop characteristics of the overcurrent protection.

a



b



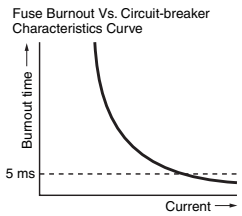
Internal Fuse

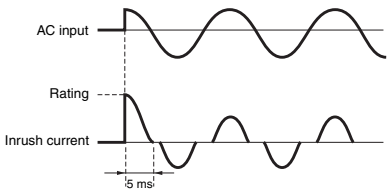
If the internal fuse has blown, it is very likely that internal circuits of the Power Supply have been damaged and that parts other than the fuse will also need to be replaced. If the fuse has blown, consult your OMRON representative.
Short-circuit current will not continue to flow on the primary side (i.e., the external side) of the Power Supply even if the fuse has blown. There is, however, no protection function for the input power lines.

Guideline for Selecting External Fuses and Breakers with Consideration for Inrush Currents

The inrush current pulse width can be considered to be about 5 ms. (See the following figure.)
In particular, models with 100-to-240 VAC input have higher inrush current energy than models with single rated inputs or models with switching inputs. Therefore, consider the coordination with the breaker.
The following table provides guidelines for fuse and breaker selection.

Selection points	External fuses	Circuit breakers
Rated voltage	Sufficient for the input voltage of the Power Supply	
Rated current	Same as that of internal fuses *	Sufficient for the rated current of the Power Supply
Inrush current	Must not be burnt or tripped at the Power Supply inrush current (pulse width: approx. 5 ms).	
Fuse type	Normal burning or semi-time lag.	---





Note: The duration of the inrush current is 5 ms max. Therefore, the fusing characteristics require the inrush current to flow sufficiently for up to 5 ms.

* Refer to the block diagram in the datasheet for the current capacity of the internal fuse.

Power Supply Heat Generation

Use the following formula to find the amount of heat generated by the Power Supply (W).

$$\text{Heat value (W)} = \text{Input power} - \text{Output power}$$

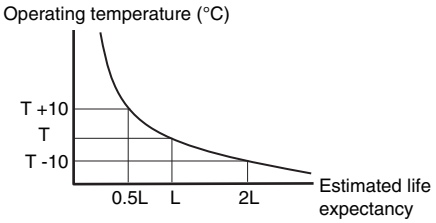
$$= \frac{\text{Output power}}{\text{Efficiency}} - \text{Output power}$$

The efficiency in the datasheets are for a load rate of 100%. Check the technical data for the actual values of each load rate.

Power Supply Life Expectancy and Life Expectancy Curve

The life of the Power Supply is determined by the life of the electrolytic capacitor that is used internally. The capacitor follows the Arrhenius law, i.e., the life is halved by every 10°C increase in temperature and double for every 10°C decrease in temperature. The life of the Power Supply can thus be extended by lowering the internal temperature of the Power Supply.

Estimated Life Expectancy of Electrolytic Capacitors Using the Arrhenius Law (Major example)



$$L = L_0 \times 2^{\frac{T - T_0}{10}}$$

T: Operating temperature (ambient temperature + rise in self temperature) (°C)
T0: Maximum operating temperature (°C)
L: Estimated life expectancy at operating temperature (hours)
L0: Life expectancy at the maximum operating temperature (hours)

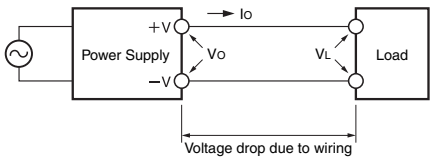
For every 10°C that the operating temperature increases, the life expectancy is halved.
For every 10°C that the operating temperature decreases, the life expectancy is doubled.

The life expectancy for ambient temperatures and load rates can be found in the *Life Expectancy Curve* in the technical data.

Wiring

Wiring in Consideration of Voltage Drop

Make the input and output wiring as thick and short as possible to minimize voltage drop.



(1) Select a wire diameter suitable for the load current Io.
(2) Make sure that the Power Supply's output voltage Vo does not exceed the specified output fluctuation range.
(3) Consider the allowable current for load short-circuits (guideline: 1.6 times the Power Supply's rated output current or higher).

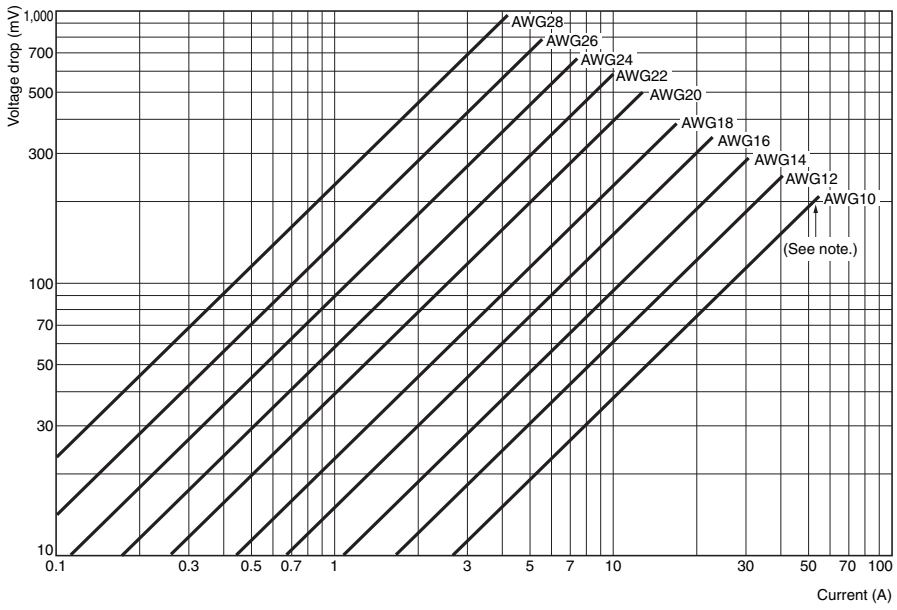
Selection of Wires

Select wires for the Power Supply carefully. Refer to this table when selecting the wires.

AWG No.	Cross-sectional area (mm^2)	Configuration (number of conductors/mm)	Voltage drop per 1 A (mV/meter)	Recommended maximum current (A)	
				UL1007 (300 V 80°C)	UL1015 (600 V 105°C)
30	0.051	7/0.102	358	0.12	---
28	0.081	7/0.127	222	0.15	0.2
26	0.129	7/0.16	140	0.35	0.5
24	0.205	11/0.16	88.9	0.7	1.0
22	0.326	17/0.16	57.5	1.4	2.0
20	0.517	26/0.16	37.6	2.8	4.0
18	0.823	43/0.16	22.8	4.2	6.0
16	1.309	54/0.18	14.9	5.6	8.0
14	2.081	41/0.26	9.5	---	12.0
12	3.309	65/0.26	6.0	---	22.0
10	5.262	104/0.26	3.8	---	35.0

Recommended Maximum Current:
Current The table is applicable to wires with 1 to 4 conductors. Keep the current value to within 80% of the values shown in this table when using wires having 5 or more conductors. The following chart shows the voltage drop per meter in terms of the relationship between the current and conductor diameter. Make sure that the current value does not exceed the recommended maximum current value.

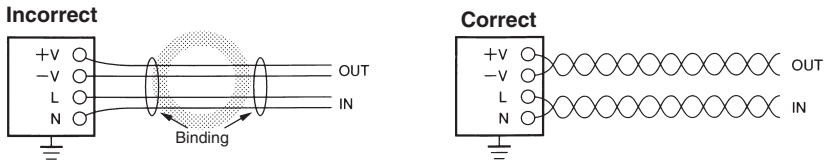
Voltage Drop per Meter (UL1015 Vinyl-sheathed Wires for Heat-resistant Equipment)



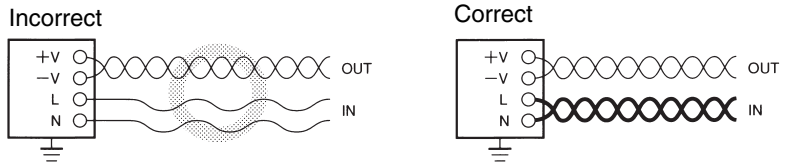
Note: The current indicates the allowable current. In practice, application must be below the recommended current values.

Wiring to Prevent Noise Interference

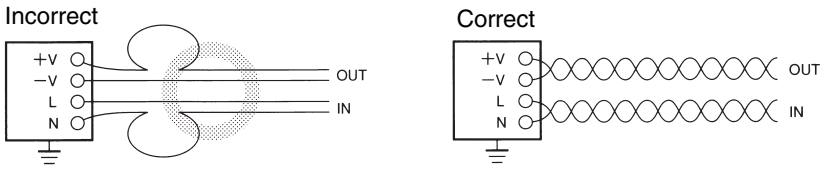
• Separate input lines and output lines, and use twisted cables.
Noise will be induced on the output lines if they are laid together with or close to input lines.



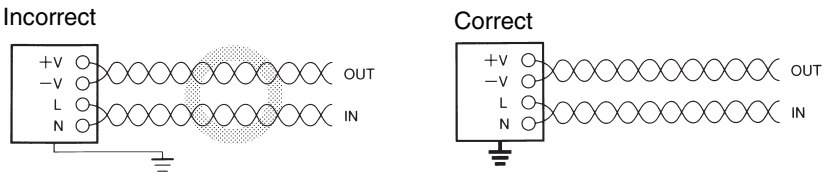
• Use short, thick input lines.
Input lines radiate noise, and must therefore be as short and thick as possible.



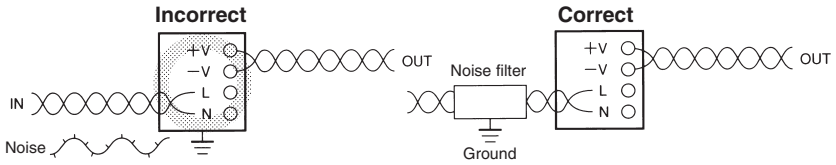
• Do not loop input or output lines.
Loops in lines can radiate noise to other devices or can function as antennas inducing high-frequency noise.



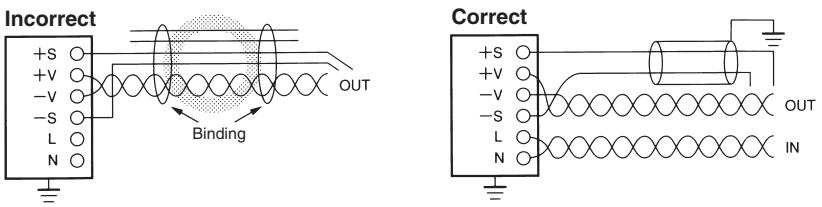
• Use short, thick ground wires.
The damping effect of the noise filter built into the Power Supply will be reduced if a long ground wire is used. Always make ground wires as short and as thick as possible.



• Connect a noise filter.
Include a noise filter on the input side of the Power Supply if faulty operation in electric circuits connected to the output from the Power Supply are being caused by sources of surge on the AC input line, such as large magnetic relays.
Ground the noise filter with a thick, short wire.



• Use shielded cables for the remote sensing and remote control signal lines.
Remote sensing and remote control signal lines must always be wired separately using shielded cables to prevent faulty operation caused by the induction of noise. Noise can be induced when these signal lines are laid together with input lines or power lines, which often carry noise.



Dielectric Strength Tests

When a high voltage is applied between the input terminals and case (FG), energy builds up through the inductor L and capacitor C of the internal noise filter.
When a high voltage of a dielectric strength test is applied to the Power Supply by a switch or timer, impulse voltage may generate and internal components may be damaged.
To prevent this impulse voltage, gradually change the applied voltage using the variable resistor on the dielectric strength testing equipment, or apply the voltage so that it crosses the zero point when it rises or falls.

Maintenance

Life Expectancy and Recommended Replacement Period

The life expectancies of OMRON Switch-mode Power Supplies are defined under the following conditions and are designed to be 8 or 10 years minimum.

Note: The life expectancy does not apply to the fan.

- Rated input voltage
- Load at 50%
- Ambient operating temperature of 40°C
- Standard mounting conditions

The replacement period and life expectancy are reference values only and do not imply a warranty of any kind. Use them as guidelines in designs and applications.

Fan Life and Replacement

Some Switch-mode Power Supplies have built-in fans for forced-air cooling.
The fans in these Switch-mode Power Supplies also have limited lives in addition to the lives of the Power Supplies themselves. The fans must be replaced periodically.
The replacement period for the fans varies with the Power Supply model. Refer to the datasheets for details.

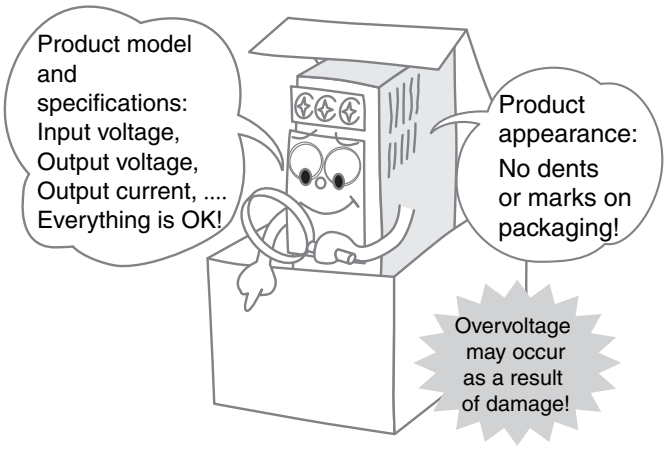
Foreign Matter and Dust

There are slits in the Power Supplies that allow internally generated heat to escape to the exterior.
Foreign matter or dust can enter through these slits, causing the output to be reduced or to stop.
We recommend that you remove foreign matter and dust from around the Power Supply during periodic maintenance.

Troubleshooting

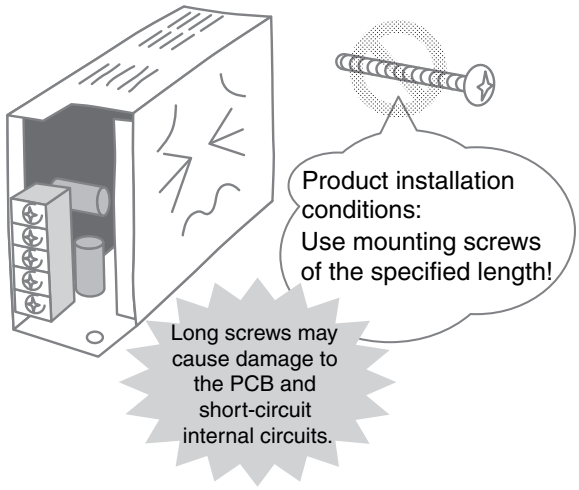
Before Use

Purchase
External Appearance, Model, and Specifications



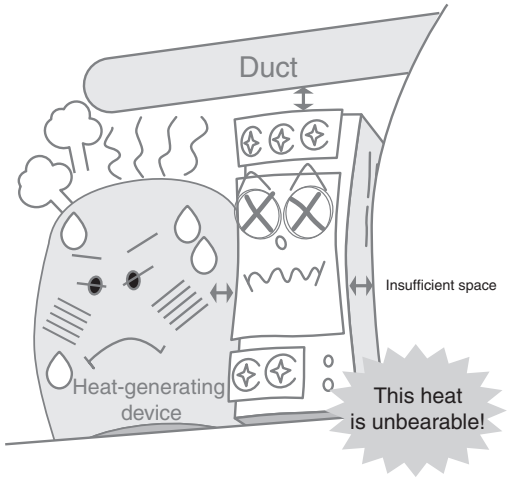
* For details, refer to *External appearance* and *Model and specifications* in the *Check point* column of the table on page 13.

Installation
Product Installation Conditions



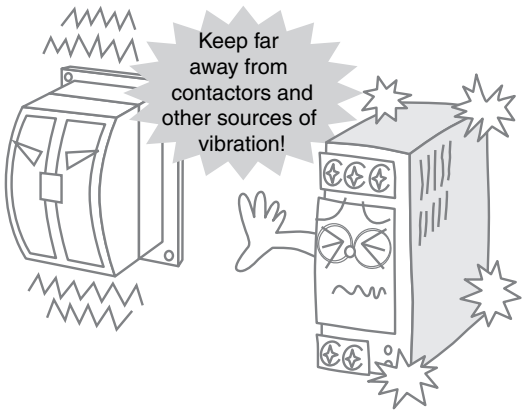
* For details, refer to *Installation conditions* in the *Check point* column of the table on page 13.

Installation Location



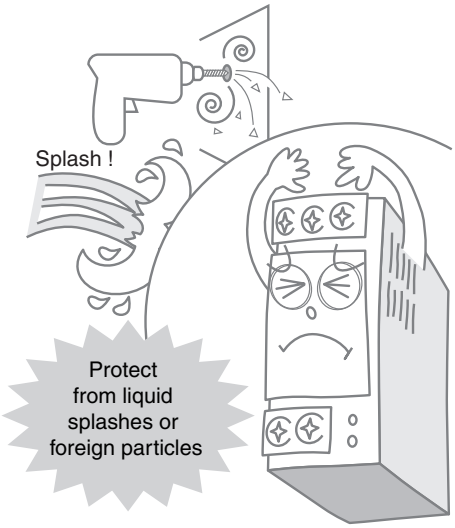
* For details, refer to *Installation location* in the *Check point* column of the table on page 13.

Operating Environment (1)



* For details, refer to *Operating environment* in the *Check point* column of the table on page 13.

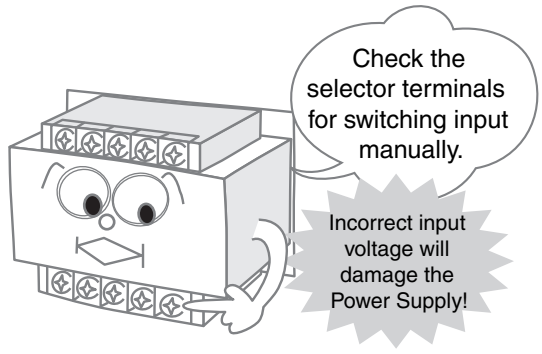
Operating Environment (2)



* For details, refer to *Operating environment* in the *Check point* column of the table on page 13.

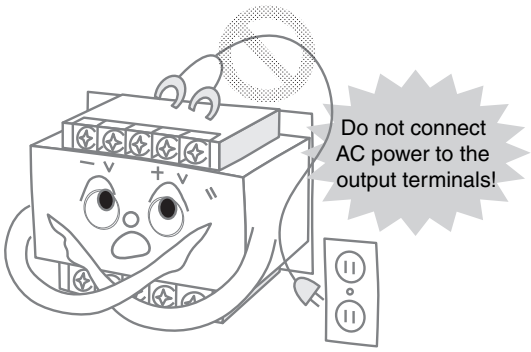
Wiring

Input Voltage Selector Terminals



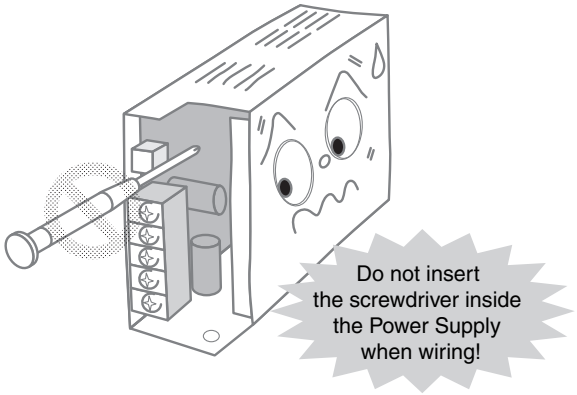
* For details, refer to *Input voltage selector terminals* in the *Check point* column of the table on page 13.

Input Terminals



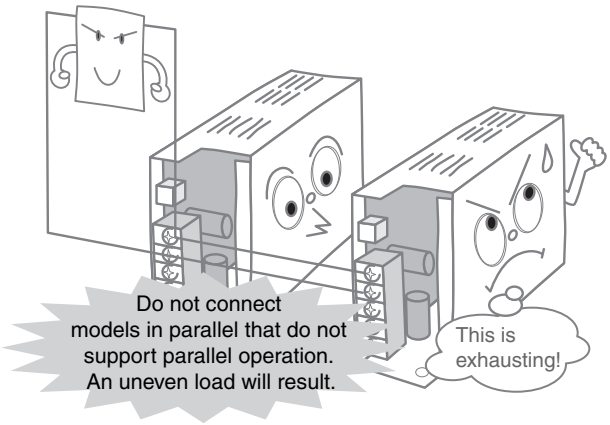
* For details, refer to *Input terminals* in the *Check point* column of the table on page 13.

Terminal Wiring



* For details, refer to *Terminal wiring* in the *Check point* column of the table on page 13.

Series, Parallel, and ± Output Operation



* For details, refer to *Series, parallel, and ± output operation* in the *Check point* column of the table on page 13.

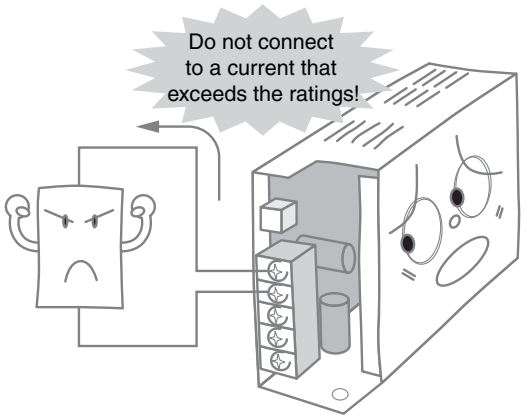
Read the operation manual provided with the Product, and check the following points, as applicable.

When	Check point	Details
Purchasing	External appearance	After purchase, make sure that the product and packaging have no dents or marks. Any internal damage may result in overvoltage depending on the location of the damage. (Stop using the product if dents, marks, or deformation is evident.)
	Model and specifications	Make sure that the input voltage, output voltage, and output current of the Power Supply purchased meet the requirements. (The I/O specifications are provided on the model label.)
Installing	Installation conditions	Be sure to use mounting screws of the specified length. Using longer screws may cause damage to the PCB, or short-circuit the internal circuits.
	Installation location	Ensure sufficient mounting space, taking heat dissipation into consideration.
	Operating environment	Make sure that the ambient temperature, and vibration in the installation environment satisfy the specified levels for each product being used. (Be sure to install the Power Supply as far as possible away from contactors, which will subject the Power Supply to vibration and shock if it is located in their vicinity.) Install the Power Supply in a location in which liquid or foreign particles will not enter the Power Supply.
Wiring	Input voltage selector terminals	Before turning ON the power, make sure that the voltage specifications are the same as the voltage of the device. The Power Supply is shipped with the input voltage selector terminals open (i.e., set to 200 VAC).
	Input terminals	Wire the Power Supply inputs correctly. Connecting the AC input wires to the output terminals or voltage selector terminals will cause damage to the internal circuits.
	Terminal wiring	Do not subject the terminals to excessive stress by using excessive force when tightening the terminal screws. After tightening the screws to the specified torque, make sure that none of the screws is loose. Make sure that the end of the screwdriver used to tighten the screws does not mark or damage the PCB or internal parts.
		Connect the ground terminal to prevent electric shock.
	Remote sensing terminals	Check whether remote sensing is securely connected. If remote sensing is not to be used, short-circuit using the short bar. (At shipment, these terminals are short-circuited with the short bar.)
	Remote control terminals	Check whether the remote control terminals are securely connected. If remote control is not to be used, short-circuit using the short bar. (At shipment, these terminals are short-circuited with the short bar.)
	Series, parallel, and ± output operation	Check whether series, parallel, or ±operation is supported. Refer to the wiring information in this guide.
Adjusting the output voltage	Output Voltage Adjuster	Do not apply unnecessarily strong force on the Output Voltage Adjuster (V.ADJ). Doing so may damage the V.ADJ. Make sure that the end of the screwdriver used to adjust the setting does not mark or damage the PCB.

Troubleshooting

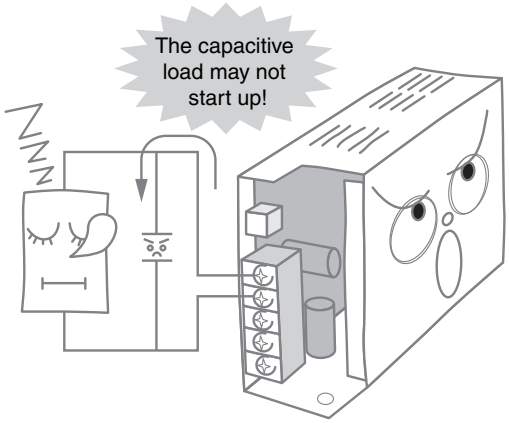
Example 1	No Output or Delay in Output Turning ON

Turning ON for the First Time
Output Does Not Turn ON



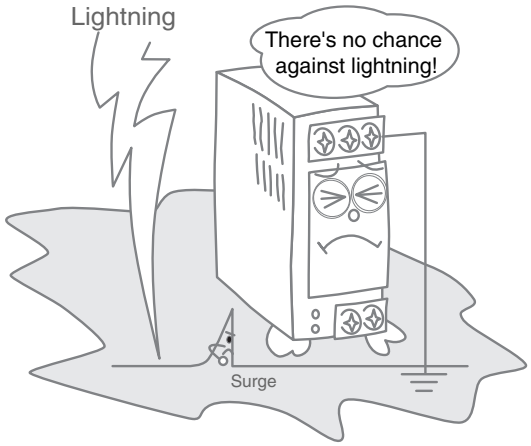
* For details, refer to *The output does not turn ON*.in the *Problem* column of the table on page 16.

Delay in Output Turning ON



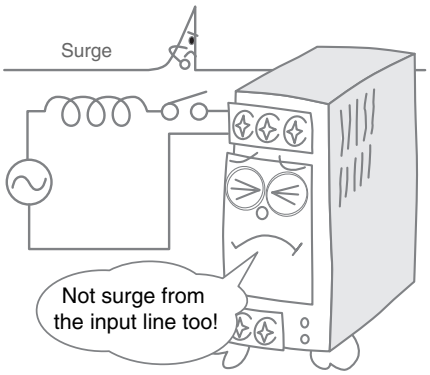
* For details, refer to *An output delay occurs in the output turning ON.* in the *Problem* column of the table on page 16.

During Operation
No Power Supply Output (Lightning Strike)



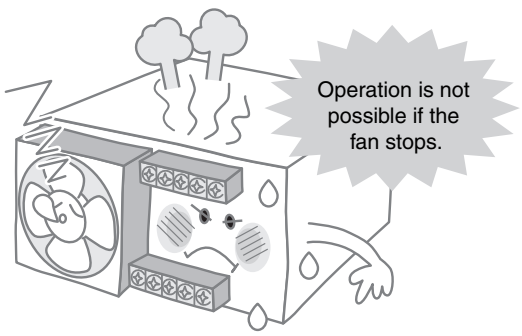
* For details, refer to *Output from the Power Supply has stopped (lightning occurred)* in the *Problem* column of the table on page 17.

No Power Supply Output
(Device Generating Strong, High-frequency Noise Nearby)



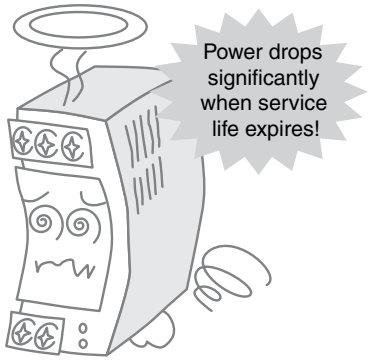
* For details, refer to *Output from the Power Supply has stopped (close to source of strong, high-frequency noise).* in the *Problem* column of the table on page 17.

Long-term Usage
No Power Supply Output (Fan Stopped)



* For details, refer to *Output from the Power Supply has stopped (the fan has stopped).* in the *Problem* column of the table on page 17.

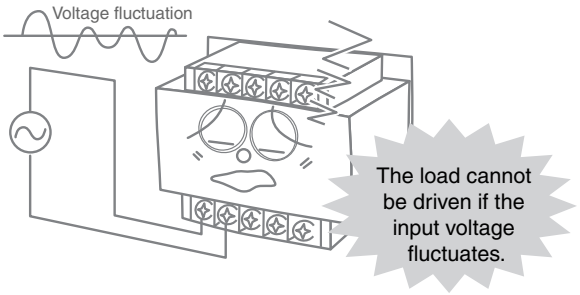
Low Output Power



* For details, refer to *The output drops.* in the *Problem* column of the table on page 17.

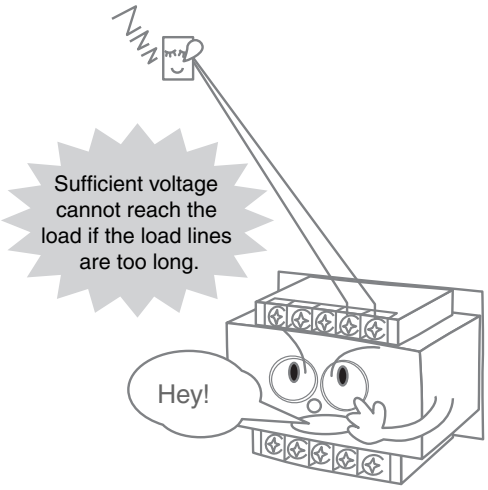
Example 2	Unstable Output

During Operation
Unstable Output Voltage



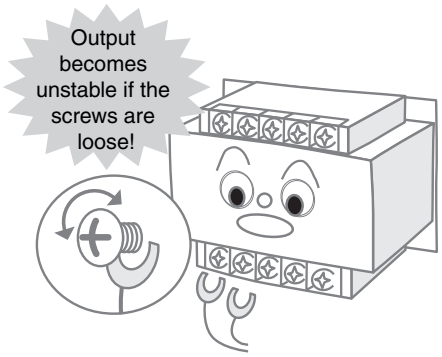
* For details, refer to *The output voltage is unstable.* in the *Problem* column of the table on page 17.

Low Voltage Applied to Load



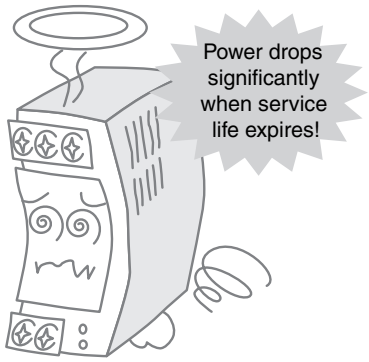
* For details, refer to *The voltage applied to the load is low.* in the *Problem* column of the table on page 17.

Long-term Usage
Unstable Output



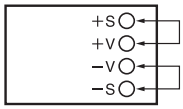
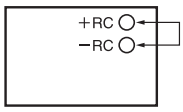
* For details, refer to *The output is unstable.* in the *Problem* column of the table on page 17.

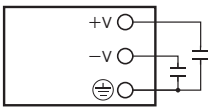
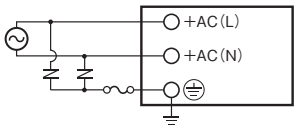
Low Output Power



* For details, refer to *The output drops.* in the *Problem* column of the table on page 17.

Be sure to check the following points if the Power Supply is not operating properly before requesting repairs.
If the Power Supply still does not operate normally, contact your OMRON representative.

Location	Problem	Details	Countermeasures
Dielectric strength inspection	The result of dielectric strength test is NG.	Impulse occurred damaging the Power Supply when the dielectric strength was applied or shut off using a switch or other means.	Either gradually change the applied dielectric strength using a variable resistor or apply voltage at zero cross (applied from 0 V).
		Dielectric strength has been applied to the incorrect location.	The voltage value depends on the location at which dielectric strength is applied. Test using the dielectric strength value specific to each Power Supply.
Turning ON the power for the first time	The output does not turn ON. (• Output voltage is low. • Output indicator is not lit or dim.)	The overcurrent protection function has been activated by the startup current of the load that is connected to the Power Supply, even if the current was within the Power Supply's capacity when stationary.	Use inverse L overcurrent protection characteristics or consider raising the Power Supply's capacity by one rank.
		The Power Supply's load has exceeded the ratings, thereby activating the overcurrent protection function.	Select a Power Supply capacity that is sufficient for the load current.
		The Power Supply's outputs are short-circuited.	Remove the cause of the output short-circuit.
	A buzzing noise is heard when the input turns ON.	A buzzing noise can be heard when turning ON the input of models equipped with harmonic current suppression circuits due to the internal inrush current.	Models with harmonic current suppression circuits generate a noise when the input is turned ON but this is a transient noise that occurs until the internal voltage is stabilized, and does not indicate that any problem in the Power Supply.
	An output delay occurs in the output turning ON.	If a capacitive load (capacitor) is connected to the Power Supply's load, the inrush current on the load side will cause the output to enter the protection range when it turns ON.	If inrush current flows to the load, consider selecting a capacity that allows for the inrush current.
	The output voltage is high.	The adjuster setting is high.	Adjust the output voltage using the Output Voltage Adjuster (V.ADJ).
	The output voltage is high (caused damage to the load).	The damage to the internal parts has prevented the feedback control from performing properly.	The internal circuits are possibly damaged. Consult your OMRON representative.
	The output indicator turns ON but immediately goes out.	The remote sensing terminals are open.	When not using remote sensing, short-circuit terminals +V and +S, and also terminals −V and −S. The overvoltage protection function will operate, so turn OFF the input power and then turn it back ON again. 
		The internal control circuit has malfunctioned, thereby activating the overvoltage protection function.	Turn OFF the input power and then turn it back ON again. If the problem reoccurs, the internal circuits are possibly damaged. Consult your OMRON representative.
	An electric shock is felt when touching the Power Supply.	The casing may not be properly grounded.	Connect the ground terminal to the ground.
	The input breaker is operating. The external fuse is broken.	The Power Supply's inrush current has tripped the breaker.	Check the inrush current of each Power Supply and check the specifications of the external fuse and breaker. (The inrush current of the Power Supply is several times to several tens of times the normal current.)
	The Power Supply's fuse is broken.	The internal circuit has short-circuited due to wire clippings, or other foreign particles, or mounting screws.	The internal circuits are possibly damaged. Consult your OMRON representative.
	White smoke was emitted from the Power Supply.	The incorrect input power is being applied. The white smoke indicates the vaporization of the electrolytic fluid in the internal electrolytic capacitor due to overvoltage.	Check the input points and input voltage of the input Power Supply again. This problem indicates that the internal circuits are damaged. Replace the Power Supply.
	There is no output.	A load is connected to the remote sensing terminals.	The output current cannot be received from the remote sensing terminals +S and −S. Connect the load lines to the output terminals +V and −V. Alternatively, the overvoltage protection function is operating, so turn OFF the input power and then turn it ON again.
		The remote control terminals are open.	When not using remote control, short-circuit the terminals +RC and −RC. 

Location	Problem	Details	Countermeasures
Operation	The Power Supply's fuse is broken.	Foreign particles, liquids, condensation, or dust from the operating environment has entered the Power Supply and damaged the internal circuits.	Many holes are provided on the Product to assist with heat dissipation. Therefore, do not install the product in an environment where foreign particles, liquid, or other substance can enter the Power Supply. In this case, the internal circuits are damaged. Replace the Power Supply.
	The Power Supply is generating high heat.	The Power Supply's installation space is too confined and does not allow sufficient heat dissipation.	The Power Supply handles a large amount of power, so heat generation occurs even with normal use. Check the installation space, Power Supply load, and ambient temperature again. Particularly if the load current exceeds the ratings for the Power Supply, change so that the load current is within the ratings. Continuing to use as is may damage the Power Supply.
		The Power Supply's load exceeds the ratings.	
		The ambient temperature is too high.	
	The Power Supply is emitting a noise.	The load has exceeded the ratings, activating the overcurrent protection circuit and the internal oscillatory frequency is within audible range.	When the protection circuit is operating, a vibrating sound emitting from the Power Supply may be audible. Even during normal operation, slight sound is generated by the Power Supply circuit due to the oscillator. If the oscillating sound is too loud compared with that of the same Power Supply, the internal circuits may be damaged. Consult your OMRON representative.
	The connected Sensor is always ON. The display on the Digital Panel Meter is erratic. The analog sensor data is erratic.	The connected Sensor has malfunctioned due to noise from the Power Supply (noise between the outputs and ground).	The Power Supply has an internal oscillator that generates noise even during normal operation. Therefore, malfunction may result depending on the Sensor used. If the Sensor malfunctions, connect a film capacitor with a capacitance of approximately 0.1 μF and a dielectric strength of 500 VDC minimum between the output terminal (+V or −V) and the ground terminal (⏚). 
	Output from the Power Supply has stopped (lightning occurred)	Overvoltage is being applied to the Power Supply due to inductive impulse from the lightning. (Output may also have stopped due to the overvoltage protection function being activated.)	If overload protection is operating, turn OFF the input power and then turn it back ON again. If the output still does not recover, the internal components are possibly damaged due to the overvoltage. Replace the Power Supply.
	The output voltage is unstable.	Load fluctuation has activated the overcurrent protection function.	Select a Power Supply capacity that takes the load fluctuation into consideration so that the rated output current will not be exceeded.
		Sufficient load current cannot be supplied due to low input voltage, thereby activating the overcurrent protection function.	Use an input voltage within the allowable range.
	The voltage applied to the load is unstable.	The Power Supply's output voltage has dropped due to the load's inrush current.	If an inrush current is flowing to the load, consider selecting a capacity that allows for the inrush current.
	The voltage applied to the load is low.	The load lines are either too thin or too long, causing a voltage drop.	Use load lines with wire diameters that are suitable for the rated output current.
	Output from the Power Supply has stopped.	Surge or other overvoltage has been applied externally (e.g., load) to the output side, activating overvoltage protection.	Add a varistor and diode to the source of the surge, and make sure that overvoltage is not applied to the Power Supply's outputs.
		The incorrect input voltage (applying 100 V when the setting is 200 V) has been applied. (If 100 V is applied when the voltage is set to 200 V, although damage will not occur immediately, damage will occur if use is continued.)	Make sure that the input voltage is the same as the voltage set using the selector terminals. The internal circuits may be damaged. Replace the Power Supply.
	Output from the Power Supply has stopped (close to source of vibration or shock).	Cracks have occurred in the internal soldering due to vibration in the operating environment, preventing electrical conduction. (The vibration and shock are particularly close to the contactor.)	If vibration occurs during operation, check the installation location and reduce vibration or consider inserting vibration-proof rubber between the Power Supply and its mounting surface.
	Output from the Power Supply has stopped (close to source of strong, high-frequency noise).	Damage has occurred due to impulse from the input line.	If impulse occurs in the input line, separate the Power Supply's input line from the source of the impulse. If separation is not possible, connect a varistor either to the source of the noise or to the Power Supply's input terminals. Also incorporate a fuse that will provide protection if the varistor is short-circuited and damaged. 
Long-term use	Output from the Power Supply has stopped (the fan has stopped).	The fan's life has expired, preventing forced cooling, and the internal temperature has risen activating overheating protection.	Perform periodic maintenance on the forced cooling fan and replace the fan promptly if any fault in the fan is found.
		The fan bearings have been worn down due to the operating environment (e.g., dust or dirt).	Perform periodic maintenance on the forced cooling fan and make sure that there is no dust or dirt present in the operating environment.
	The output is unstable.	The terminals have become loose.	Retighten the terminals to the specified torque.
	The output drops.	The life of the internal components has expired.	The service life of the Power Supply's built-in electrolytic capacitor depends on the ambient temperature and load rate, and its structural life depends on the operating environment (vibration, shock). Replace the Power Supply together with other Power Supplies that were purchased at the same time.
	Ripple noise has increased.		