Power Supply Glossary

■Glossary

● Ratings, Performance, and Functions

Item		Details
Efficiency (%)		Refer to *Efficiency* on page 3.
Input condition	**Voltage range**	Refer to *Input Voltage* on page 3.
	Frequency	---
	Input current	Refer to *Input Current* on page 3.
	Power factor	---
	Harmonic current control	Refer to *Harmonic Current Control* on page 3.
	Leakage current	Refer to *Leakage Current* on page 3.
	Inrush current	Refer to *Inrush Current* on page 4.
Output charac-teristics	**Voltage adjustment range**	Refer to *Voltage Adjustment Range* on page 4.
	Ripple	Refer to *Ripple and Noise* on page 4.
	Static input variation influence	Refer to *Static Input Variation Influence* on page 4.
	Static load variation influence (rated input voltage)	Refer to *Static Load Variation Influence* on page 4.
	Temperature variation	Refer to *Temperature Variation Influence* on page 4.
	Startup time	---
	Output hold time	---
Functions	**Overload protection**	Refer to *Overload Protection* on page 5.
	Overvoltage protection	Refer to *Overvoltage Protection* on page 6.
	Serial operation	Refer to *Series Operation* on page 6.
	Parallel operation	Refer to *Parallel Operation* on page 6.
	Remote sensing function	Refer to *Remote Sensing Function* on page 6.
	Remote control function	Refer to *Remote Control Function* on page 6.
Other	**Ambient operating temperature**	Refer to *Ambient Operating Temperature* on page 6.
	Storage temperature	Refer to *Storage Temperature* on page 6.
	Ambient operating humidity	Refer to *Ambient Operating Humidity* on page 6.
	Dielectric strength	Refer to *Dielectric Strength* on page 6.
	Insulation resistance	Refer to *Insulation Resistance Test* on page 6.
	Vibration resistance	Refer to *Vibration Resistance* on page 7.
	Shock resistance	Refer to *Shock Resistance* on page 7.
	Conducted emission	Refer to *Conducted Emissions* on page 7.
	Radiated emissions	Refer to *Radiated Emissions* on page 7.

Note. As a general rule, the ambient temperature is measured at 50 mm below from the Power Supply.

● Other Terms

Item	Details
Life expectancy	Refer to *Life Expectancy* on page 7.
Internal fuse	Refer to *Internal Fuse* on page 7.

■Efficiency

The output power divided by the effective input power. The higher the efficiency, the smaller the internal power loss of the Power Supply.

■Input Conditions

● Input Voltage

The input voltage specifies the input voltage and corresponding frequency range at which the rated operations and performance can be maintained.

● Frequency

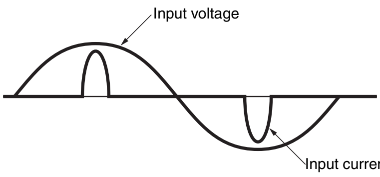
The frequency of the voltage applied to the AC input terminals.

● Power Factor

The effective input power divided by apparent power.

● 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.

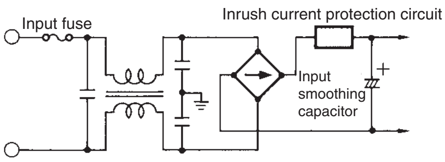
● Input Current

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:

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

Generally speaking, the power factors of switching power supplies that do not have power factor improvement functions are between approx. 0.4 and 0.6. The power factors of those with power factor improvement functions are 0.95 min. For details on efficiency, refer to the information in the datasheet for each model.

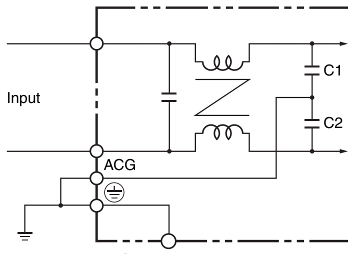
Input Rectifier/Smoothing Circuit



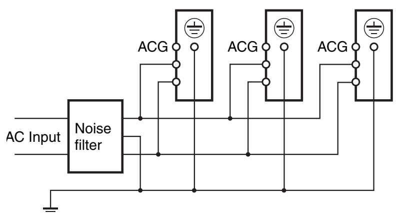
● Leakage Current

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 (C_1 or C_2) of the input filter circuit.
Depending on the Power Supply's configuration, leakage current can be reduced by incorporating an internal filter circuit.

Model with ACG Terminals

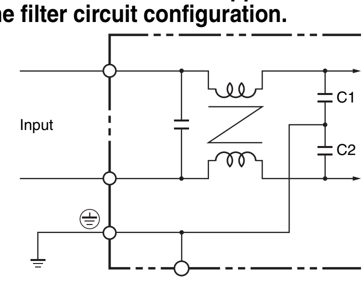


The ACG terminal on the S82W Power Supply, which is connected between capacitors C_1 and C_2 of the filter circuit, is short-circuited to the ⏚ terminal by the short bar. Leakage current can be reduced by removing the short bar.
When the leakage current poses a problem, such as when using more than one Power Supply, remove the short bar from each Power Supply.
To prevent electric shock, however, be sure to ground the ⏚ terminal.
In this case, however, the input filter cannot function effectively, resulting in greater output ripple noise and feedback noise. To suppress this noise, connect an external noise filter circuit as shown below.



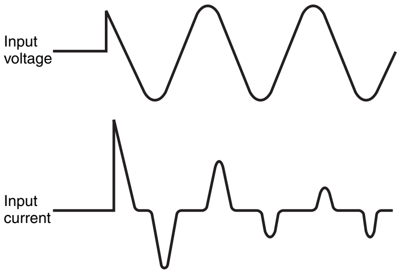
Leakage current cannot be reduced in Power Supplies without an ACG terminal due to the filter circuit configuration.

Model without ACG Terminals



● Inrush Current

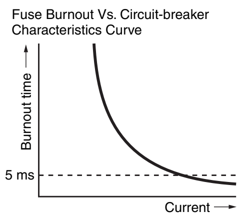
When a Switch-mode Power Supply is turned on, a surge of current flows into the input smoothing capacitor to charge the capacitor. This current surge is called the “inrush current.” The inrush current varies depending on the application timing and the presence of an inrush current protection circuit,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

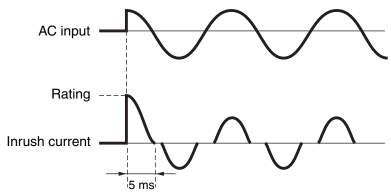


Inrush current (at cold start)

When two or more Switch-mode Power Supplies are connected to the same input, the inrush current is the sum of the inrush currents for each Power Supply. Therefore, check the fusing characteristics of fuses and operating characteristics of breakers making sure that the external fuses will not burn out and the circuit breakers will not be activated by the inrush current. The inrush current pulse width can be considered to be about 5 ms. (Refer to the following diagram.)
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.

■Output Characteristics

● Voltage Adjustment Range

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

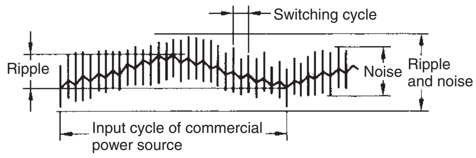
Note 1. The output voltage can effectively be converted to a value above the specified range. When adjusting the voltage, however, check the actual output voltage and make sure it is within the specified output voltage range.

Note 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.

Note 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.

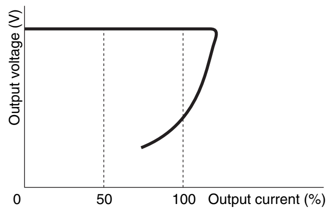
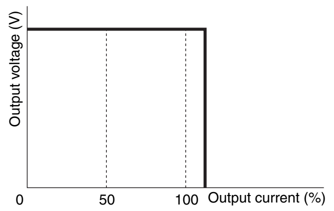
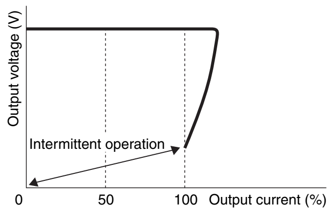
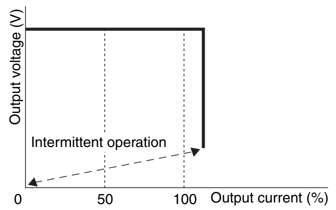
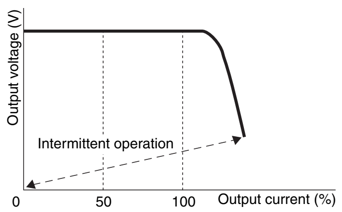
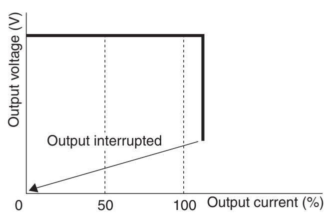
■Functions

● Overload Protection

Applicable Models: All Models

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.
The following table shows the six types of output voltage drop characteristics for main models when the overcurrent protection function is operating.

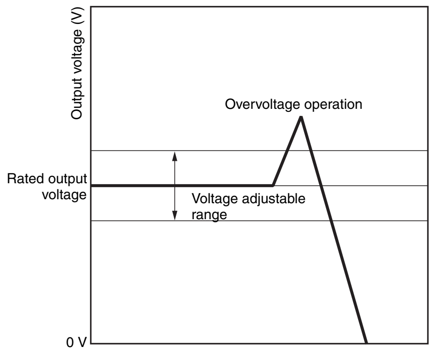
These drop characteristics can be seen as indicating the limit on the output current that can be supplied to the load effectively in the process in which the output voltage starts when the AC input turns ON. When connecting a load (with built-in DC-DC converter) that starts operating from a low voltage or a capacitive load in which inrush current can flow easily, consider the trend in overcurrent protection drop characteristics and the startup characteristics on the load side when selecting the Power Supply.
Generally, an inverted L voltage drop is considered favorable at startup.

Overcurrent drop characteristics	Relationship between output voltage and output current	Trend
Gradual current/ voltage drop		When a voltage drop occurs, the output current also gradually drops, and the output returns to the normal level automatically (automatic recovery) when the overcurrent status is cleared.
Inverted L voltage drop		When a voltage drop occurs, the output current remains essentially constant. The output returns to the normal level automatically (automatic recovery) when the overcurrent status is cleared.
Voltage/current drop Intermittent operation		When a voltage drop occurs, the output current also gradually drops, and the load of the Power Supply itself is reduced (automatic recovery) using intermittent output when the voltage drops to a certain level or lower.
Inverted L voltage drop Intermittent operation		When a voltage drop occurs, the output current remains essentially constant. The load of the Power Supply itself is reduced (automatic recovery) using intermittent output when the voltage drops to a certain level or lower.
Gradual current increase/ voltage drop Intermittent operation		When a voltage drop occurs, the output current increases as the voltage drops, maintaining constant power, and the load of the Power Supply itself is reduced (automatic recovery) using intermittent output when the voltage drops to a certain level or lower.
Inverted L voltage drop Shut off		When a voltage drop occurs, the output current remains essentially constant. If, however, the overcurrent status continues for longer than a fixed time, the output will be interrupted and the power will need to be turned ON again to recover.

Note 1. Loads with built-in DC-DC converters (PLCs, digital panel meters and other electronic devices) and capacitive loads are connected, the overcurrent protection function will be activated at startup, which may prevent the Power Supply's output from turning ON.
Note 2. 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.
Note 3. If a load short-circuit occurs, the actual drop in voltage depends on the impedance of the load lines being used.
Note 4. Even if the inclination of the drop characteristics is the same, the actual characteristics (output current/voltage, etc.) depend on the model.
Note 5. Specific precautions apply to some models. For details, refer to the separate information in the datasheet for each model.

● 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.

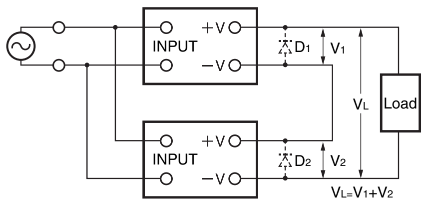


Note 1. When the overvoltage protection circuit operates, the Power Supply itself may be malfunctioning. When restarting the input power after the overvoltage protection circuit has operated, turn the input power ON with the load line disconnected and check the output voltage.
Note 2. The overvoltage protection circuit may operate if surge or other external overvoltage (e.g., from the load) is applied to the output side.

Models with the Zener-diode clamp system do not restart after the protection circuit operates. Send the product for repair.
* For further details, refer to the datasheet for individual models.

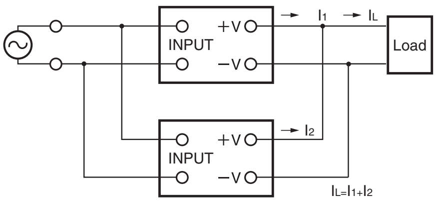
● Series Operation

- **Connect the Power Supplies in series to increase the output voltage.**



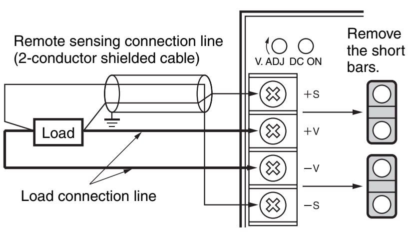
● Parallel Operation

- **Connect Power Supplies in parallel to increase the output current if sufficient output current for the load cannot be obtained from one Power Supply.**



● Remote Sensing Function

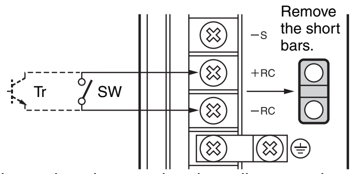
Remote sensing can be used to compensate for a voltage drop on the load lines. (The compensation range is ±10% of the rated output voltage.)
To use remote sensing, remove the short bars from the remote sensing terminals (short-circuited in standard shipments) and wire as shown in the following diagram.
Make sure that the remote sensing screws are not loose. Loose screws will prevent output of the output voltage.
To ensure stable operation, it is advisable to thicken the load connection line and compensate for the amount of voltage drop using the Power Supply's voltage adjuster (V.ADJ).



Note 1. When the voltage drop in the load lines is large, the overvoltage protection function may activate due to the increase in voltage to correct the voltage drop, so be sure to use as thick as a wire as possible.
Note 2. Be sure that $V_{OUT} \times I_{OUT}$ does not exceed the rating of the Power Supply.

● 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. To use this function, remove the short bars from the remote control terminals (short-circuited in standard shipments) and connect the switch or transistor as shown in the following diagram. The output voltage will stop when the remote control terminals are open.
If the remote control screws become loose, output voltage may not be produced. Make sure that the screws are tight.



When a transistor is used, make sure that the collector-emitter voltage V_{CE} of the transistor is 20 V or higher and that the collector current I_C is 5 mA or higher.

● 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. The ambient temperature is measured at 50 mm below from the Power Supply.

● Storage Temperature

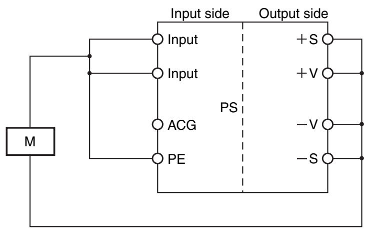
The allowable range for the ambient temperature in which performance will not deteriorate due to long-term storage. The Power Supply itself must be in a non-operational state.

● Ambient Operating Humidity

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

● Insulation Resistance Test

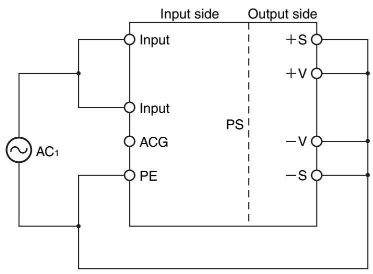
To protect the Power Supply from an input voltage surge, surge absorbers are inserted between the input lines and between the input terminals and the ACG terminal. When testing the insulation resistance of the Power Supply, remove the short bar between the PE and ACG terminals on the front panel. Otherwise, the measured resistance will be lower than the actual value. (See following diagram.)



(M: Insulation resistance meter)

● Dielectric Strength

When a high voltage is applied between the input terminals and the case (PE terminal), electric energy builds up across the inductor L and capacitor C of the internal noise filter. This energy may generate a voltage surge when a high voltage is applied to the Power Supply by a switch or timer, and as a result, the internal components of the Power Supply may be damaged. To prevent voltage impulses when testing, 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.
Some models of OMRON Switch-mode Power Supplies have surge absorbers between the input lines and between the input terminals and the ACG terminal. When testing the dielectric strength of these models, remove the short bar from the PE and ACG terminals. With the short bar attached to the terminals, the applied voltage may be cut off by the testing equipment.(See following diagram.)



● 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]

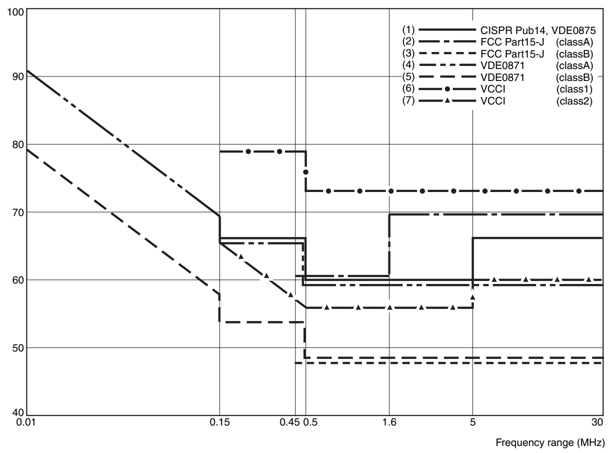
● Shock Resistance

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.

Values Stipulated for Conducted Emissions in Various Countries



	Frequency range (MHz)	Voltage dB (μV)
(1)	0.15 to 0.5, 0.5 to 5, 5 to 30	66, 60, 66
(2)	0.45 to 1.6, 1.6 to 30	60, 69.5
(3)	0.45 to 1.6, 1.6 to 30	48, 48
(4)	0.01 to 0.15, 0.15 to 0.5, 0.5 to 30	91 to 69.5, 66, 60
(5)	0.01 to 0.15, 0.15 to 0.5, 0.5 to 30	79 to 57.5, 5, 54, 48
(6)	0.15 to 0.5, 0.5 to 30	79, 73
(7)	0.15 to 0.5, 0.5 to 5, 5 to 30	66, 56, 60

CISPR: Applied to office equipment.
FCC: Noise regulation in U.S.A.
Class A: industrial equipment
Class B: household appliance and information equipment including communications equipment.
VDE: Noise regulation in Europe
(European version of the FCC used in U.S.A)
VCCI: Applied to data processing devices in Japan.

● Radiated Emissions

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

■Other Terms

● Life Expectancy

The life of a Power Supply is determined by conducting a temperature rise test of the built-in aluminum electrolytical capacitors, when using the Power Supply in a standard installation at the rated input voltage under an ambient temperature of 40°C and a load rate of 50%. The calculated life expectancy functions as a guide only is not a guaranteed value. Use this information as reference for performing maintenance and replacement.
Note. The life expectancy of the fan in models with fans is not included.

(Main Models)
Eight years or longer: S82J-D7 *, S82K, S82S, S82R *
Ten years or longer: S82J *, S8TS, S8VS, S8VM, S82W-102, S82W-103, S8AS, S8JX

* Discontinued models

● 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.

Reference Material for Power Supplies

■Typical Safety Standards for Noise

<table>
<tr><th></th><th>Japan</th><th colspan="2">Europe</th><th>U.S.A</th></tr>
<tr><th>Applicable law</th><th>Electric components regulation</th><th>CISPR Pub. 14 (for office equipment)</th><th>VDE0871 (for high-frequency applied equipment)</th><th>FCC Part 15 (for computers)</th></tr>
<tr><td>Permissible noise (noise terminal voltage)</td>
<td>
<table>
<tr><th>Frequency range (MHz)</th><th>Voltage dB (μV)</th></tr>
<tr><td>0.525 to 1.605</td><td>65</td></tr>
</table>
(max. value between one line and ground)
(equipment operating on 1 kW max.)
</td>
<td>
<table>
<tr><th>Frequency range (MHz)</th><th>Voltage dB (μV)</th></tr>
<tr><td>0.15 to 0.5
0.5 to 5
5 to 30</td><td>66
60
66</td></tr>
</table>
(max. value between one line and ground)
</td>
<td>
Class A
<table>
<tr><th>Frequency range (MHz)</th><th>Voltage dB (μV)</th></tr>
<tr><td>0.01 to 0.15
0.15 to 0.5
0.5 to 30</td><td>91 to 69.5
66
60</td></tr>
</table>
Class B
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<tr><th>Frequency range (MHz)</th><th>Voltage dB (μV)</th></tr>
<tr><td>0.01 to 0.15
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54
48</td></tr>
</table>
(max. value between one line and ground)
</td>
<td>
Class A
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</table>
Class B
<table>
<tr><th>Frequency range (MHz)</th><th>Voltage dB (μV)</th></tr>
<tr><td>0.45 to 1.6
1.6 to 30</td><td>48
48</td></tr>
</table>
(max. value between one line and ground)
</td></tr>
</table>

<table>
<tr><th>Applicable law</th><th>Electric components regulation (Table 8)</th><th>IEC 380 (for office equipment)</th><th>UL114 (for office equipment)</th></tr>
<tr><td>Leakage current</td>
<td>1 mA max. (measured at resistance of 1 kΩ)</td>
<td>
<table>
<tr><th>Class I (stationary type)</th><td>3.5 mA max.</td></tr>
<tr><th>Class I (portable type)</th><td>0.75 mA max.</td></tr>
<tr><th>Class II</th><td>0.2 5 mA max.</td></tr>
</table>
(measured at resistance of 1.5 kΩ and at 0.15 μF) (input: 106%)
</td>
<td>
<table>
<tr><th>general</th><td>5 mA max.</td></tr>
<tr><th>Double insulation</th><td>0.25 mA max.</td></tr>
</table>
(measured at resistance of 1.5 kΩ and at 0.15 μF) (input: 110%)
</td></tr>
<tr><td>Dielectric strength</td>
<td>
● General
• Between current-carrying parts and non-current-carrying metal parts
<table>
<tr><th>Up to 150 V</th><td>1,000 V</td></tr>
<tr><th>Over 150 V</th><td>1,500 V</td></tr>
</table>
• Between current-carrying parts
2.3 × rated voltage (AC, for 1 min)
● Double insulation: between current carrying parts and non-current-carrying metal parts
<table>
<tr><th></th><th>Up to 150 V</th><th>Over 150 V</th></tr>
<tr><th>Function insulation</th><td>1,000 V</td><td>1,500 V</td></tr>
<tr><th>Protection insulation</th><td>1,500 V</td><td>2,500 V</td></tr>
<tr><th>Reinforced insulation</th><td>2,500 V</td><td>4,000 V</td></tr>
</table>
(AC, 1 min)
</td>
<td>
● Between current-carrying parts and surface of insulated part
<table>
<tr><th></th><th>Class I</th><th>Class II</th></tr>
<tr><th>Function insulation</th><td>1,250 V</td><td>---</td></tr>
<tr><th>Reinforced insulation</th><td>1,250 V</td><td>1,250 V</td></tr>
</table>
(AC, for 1 min)
● Between current-carrying parts:
1,250 V (AC, for 1 min)
● Capacitor: (VDE0565)
• Evaporative X capacitor:
4.3 x rated voltage (DC, for 1 min)
• Film Y capacitor: 1,500 V (AC, for 1 min)
</td>
<td>
● Between primary non-current-carrying parts and across-the-line capacitor terminals
<table>
<tr><th>Up to 250 V</th><td>1,000 V</td></tr>
<tr><th>Over 250 V</th><td>1,000 V+2 U</td></tr>
</table>
(AC, for 1 min)
U: maximum indicated voltage
</td></tr>
</table>