Basic Switches
Technical Information

■ Safety Precautions

For the individual precautions for each Switch, refer to the *Precautions* section of each Switch.

⚠ WARNING

Do not wire the Switch or touch any terminal of the Switch while power is being supplied to the Switch. Doing so may result in electric shock.

Electrical Conditions

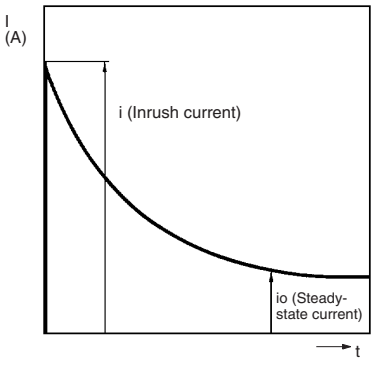
Load

The switching capacity of the Switch significantly differs depending on whether the Switch is used to break an alternating current or a direct current. Be sure to check both the AC and DC ratings of the Switch by referring to its datasheet. The control capacity will drop drastically if it is a DC load. This is because a DC load, unlike an AC load, has no current zero cross point. Therefore, if an arc is generated, it may continue for a comparatively long time. Furthermore, the current direction is always the same, which results in contact relocation phenomena, and the contacts hold each other with ease and will not separate if the surfaces of the contacts are uneven.

Some types of load have a large difference between usual current and inrush current. Make sure that the inrush current is within the permissible value. The higher the inrush current in the closed circuit is, the more the contact abrasion or shift will be. Consequently, contact weld, contact separation failures, or insulation failures may result. Furthermore, the Switch may break or become damaged.

If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy is, which will increase the abrasion of the contacts and contact relocation phenomena. Make sure to use the Switch within the rated conditions.

Inrush Current

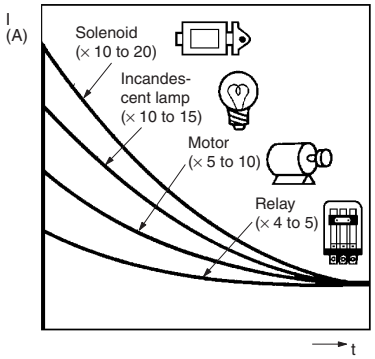


The switching capacity of each Switch appearing on a datasheet is the rated capacity. When applying the Switch to a circuit with a special load with unusual inrush and switching current and voltage waveforms, be sure to test the Switch under the actual conditions before use.

If the load is a micro voltage or current load, use a dedicated Switch for micro loads. The reliability of silver-plated contacts, which are used by standard Switch models, is insufficient in such a case.

If the Switch is used for switching both micro and high-capacity loads, be sure to connect relays suitable to the loads.

Types of Load vs. Inrush Current



The rated loads of the Switch are as follows:

Inductive Load: A load having a minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC).

Lamp Load: A load having an inrush current ten times the steady-state current.

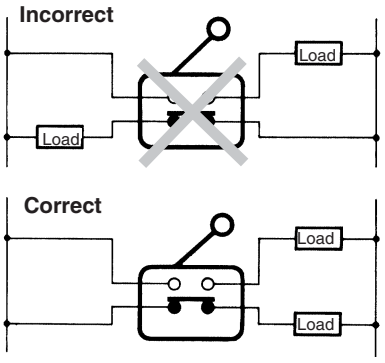
Motor Load: A load having an inrush current six times the steady-state current.

Note: It is important to know the time constant (L/R) of an inductive load in a DC circuit.

Load Connections

Example of Power Source Connection (Different Polarity)

The power source may short-circuit in failure mode if the loads are connected in the same way as the “incorrect” circuit below.

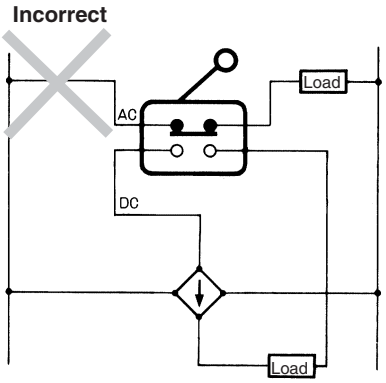


Connect the same polarities to the load.

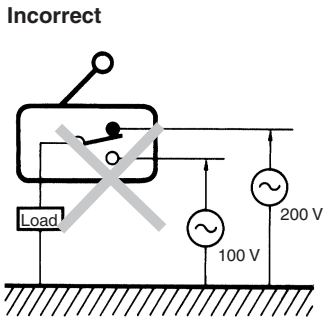
Even in a “correct” circuit, note that the insulation performance of the switch may deteriorate and the switch life may be shortened because one load is connected to one contact.

Example of Incorrect Connection of Power Source (Different Current Type)

The DC and AC power may be mixed.



Do not configure a circuit that may place a voltage between the contacts of the Switch; otherwise metal deposition will occur between the contacts.



Contact Protective Circuit

Apply a contact protective circuit to extend contact life, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protective circuit properly, otherwise an adverse effect may result. The use of the contact protective circuit may delay the response time of the load.

Life Expectancy

The life of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range. If a deteriorated Switch is used continuously, insulation failures, contact weld, contact failures, Switch damage, or Switch burnout may result.

Mounting

Before mounting, dismounting, wiring, or inspecting the Switch, be sure to turn OFF the power supply to the Switch, otherwise an electric shock may be received or the Switch may burn.

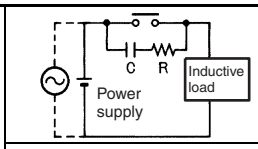
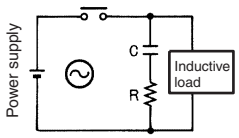
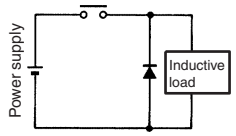
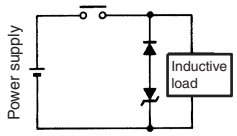
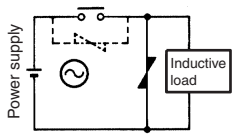
Wiring

When mounting the Switch to the mounting panel, keep a sufficient insulation distance between the mounting panel and the Switch. If the insulation distance is insufficient, add an appropriate insulation guard or separator. This is especially important if the Switch is mounted to a metal object.

The Basic Switch does not incorporate a ground terminal. Do not mount the Basic Switch while power is being supplied.

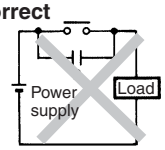
The following provides typical examples of contact protective circuits. If the Switch is used in an excessively humid place for switching a load that generates arcs with ease, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 (nitric acid) if it reacts with moisture. Consequently, the internal metal part may be corroded and result in an operating failure of the Switch. Be sure to select the best contact preventive circuit from the following in order to prevent this.

Typical Examples of Contact Protective Circuit

Circuit example		Applicable current		Feature	Element selection
		AC	DC		
CR circuit		See note.	Yes	**Note:** When AC is switched, the load impedance must be lower than the CR impedance.	C: 0.5 to 1 μF per switching current (1 A) R: 0.5 to 1 Ω per switching voltage (1 V) The values may change according to the characteristics of the load. The capacitor suppresses the spark discharge of current when the contacts are open. The resistor limits the inrush current when the contacts are closed again. Consider these roles of the capacitor and resistor and determine the ideal capacitance and resistance values from experimentation. Use a capacitor with a dielectric strength between 200 and 300 V. When AC is switched, make sure that the capacitor has no polarity.
		Yes	Yes	The operating time will increase if the load is a relay or solenoid. It is effective to connect the CR circuit in parallel to the load when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode method		No	Yes	Energy stored in the coil is changed into current by the diode connected in parallel to the load. Then the current flowing to the coil is consumed and Joule heat is generated by the resistance of the inductive load. The reset time delay in this method is longer than that of the CR method.	The diode must withstand a peak inverse voltage 10 times higher than the circuit voltage and a forward current as high as or higher than the load current.
Diode and Zener diode method		No	Yes	This method will be effective if the reset time delay caused by the diode method is too long.	Zener voltage for a Zener diode must be about 1.2 times higher than the power source since the load may not work under some circumstances.
Varistor method		Yes	Yes	This method makes use of constant-voltage characteristic of the varistor so that no high-voltage is imposed on the contacts. This method causes a reset time delay more or less. It is effective to connect varistor in parallel to the load when the supply voltage is 24 to 48 V and in parallel to the contacts when the supply voltage is 100 to 200 V.	---

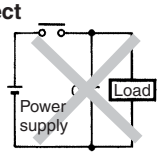
Do not apply contact protective circuits as shown below.

Incorrect



This circuit effectively suppresses arcs when the contacts are OFF. The capacitance will be charged, however, when the contacts are OFF. Consequently, when the contacts are ON again, short-circuited current from the capacitance may cause contact weld.

Incorrect



This circuit effectively suppresses arcs when the contacts are OFF. When the contacts are ON again, however, charge current flows to the capacitor, which may result in contact weld.

Terminal Connections

Be sure to connect appropriate wires to the Switch by considering the voltage and current applied to the Switch.

Solder Terminals

When soldering lead wires to the Switch, make sure that the capacity of the soldering iron is 60 W maximum and that the temperature of the iron tip is 300°C maximum unless otherwise specified in the datasheet of the Switch. Improper soldering may cause abnormal heat radiation from the Switch and the Switch may burn.

The characteristics of the Switch will deteriorate if a soldering iron with a capacity of more than 60 W is applied to any part of the Switch for 6 s or more. For Switches with special soldering specifications, however (provided in *Terminal Connections* under *Cautions* where appropriate), be sure to perform soldering according to the specifications.

Be sure to apply only the minimum required amount of flux. The Switch may have contact failures if flux intrudes into the interior of the Switch.

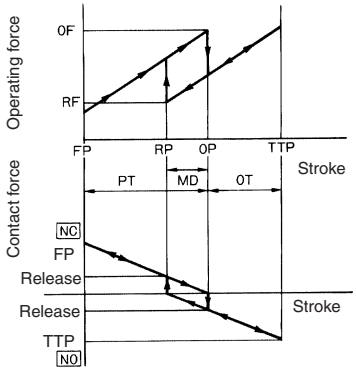
Quick-connect Terminals

Wire the quick-connect terminals with the specified receptacles and insert the terminals straight into the receptacles. Do not impose excessive external force on the terminals in the horizontal or vertical directions, otherwise the terminals may deform or the housing may become damaged.

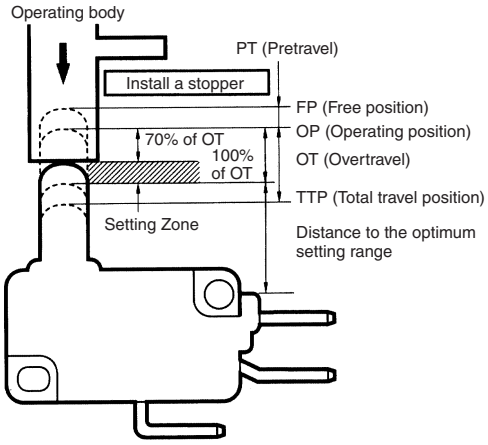
Mechanical Conditions

Operating Stroke Setting

The setting of the stroke is very important for the Switch to operate with high reliability.
The chart below shows the relationship among operating force, stroke, and contact reliability. To obtain high reliability from the Switch, the Switch actuator must be manipulated within an appropriate range of operating force.
Be sure to pay the utmost attention when mounting the Switch.

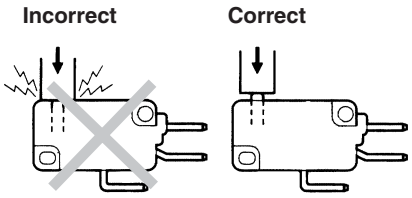


Make sure that the operating body returns the actuator to the free position when the operating body has moved if the Switch is used to form a normally closed (NC) circuit. If the Switch is used to form a normally open (NO) circuit, the operating body must move the Switch actuator to a distance of 70% to 100% of the rated overtravel (OT) of the Switch, ensuring that the operating body pushes the actuator a sufficient distance without touching the Switch itself. For details, refer to *Precautions* for the relevant product.



If the stroke is set in the vicinity of the operating position (OP) or at the releasing position (RP), switching operation may become unstable. As a result, the Switch cannot ensure high reliability. Furthermore, the Switch may malfunction due to vibration or shock.

If the stroke is at the total travel position (TTP), the momentary inertia of the operating body may damage the actuator or the Switch itself. Furthermore, the life of the Switch may be shortened.



Switching Speed and Frequency

The switching frequency and speed of a Switch have a great influence on the performance of the Switch. Pay attention to the following.

- If the actuator is operated too slowly, the switching operation may become unstable, causing faulty contact or contact weld.
- If the actuator is operated too quickly, the Switch may be damaged by shock.
- If the switching frequency is too high, the switching of the contacts cannot catch up with the operating speed of the actuator.
- If the operating frequency is extremely low (i.e., once a month or less frequent), a film may be generated on the surface of the contacts, which may cause contact failures.

The permissible switching speed and switching frequency of a Switch indicates the operational reliability of the Switch. The life expectancy of the Switch is based on operation under specific conditions regarding the switching speed and switching frequency. The life of the Switch, however, may vary even if the Switch is operated within the permissible switching speed and frequency ranges. Test a Switch sample under the actual conditions to ascertain its life expectancy.

Operating Condition

Do not leave the Switch actuated for a long time, otherwise the parts of the Switch may soon deteriorate and changes in its characteristic performance may result.

■ Correct Use

Electrical Conditions

Application of Switch to Electronic Circuits

The Basic Switch in switching operation may cause contact bouncing or chattering, thus generating noise or pulse signals that may interfere the operation of electronic circuits or audio equipment. To prevent this, take the following countermeasures.

- Design the circuits so that they include appropriate CR circuits to absorb noise or pulse signals.
- Use Switches incorporating gold-plated contacts for micro loads, which are more resistive to environmental conditions than standard Switches. (Ensure, however, that the load capacity is sufficient.)

Switches for Micro Loads

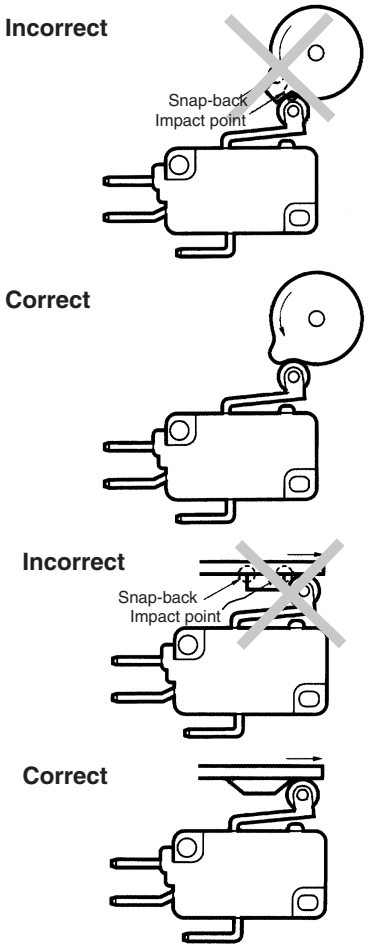
Use a dedicated Switch for micro loads, otherwise contact failures may result. Be sure to connect the Switch to a load within the permissible range. Even if the load is within the permissible range, the inrush current of the load may deteriorate the contacts, thus shortening the life of the Switch. Therefore, if necessary, insert the proper contact protective circuit.

Mechanical Conditions

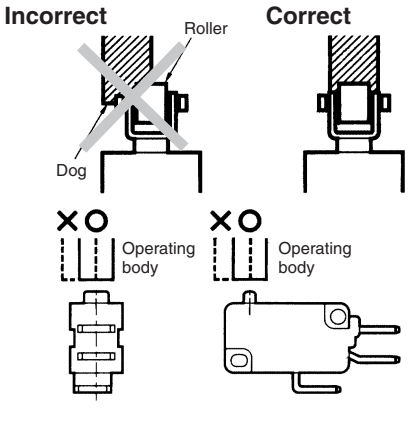
Switching Method

The switching method has a great influence on the performance of the Switch. Consider the following before operating the Switch.

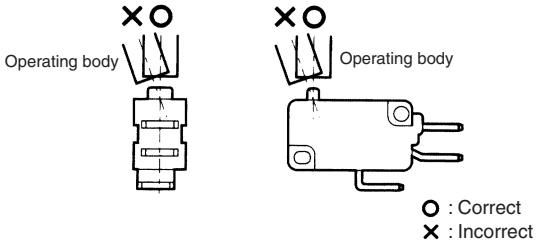
- Design the operating body (i.e., the cam or dog) so that it will operate the actuator smoothly. If the actuator snaps backwards quickly or receives damage due to the shape of the operating body, its life expectancy may be shortened.



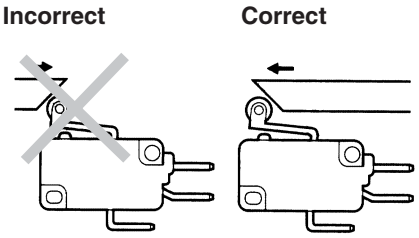
- Make sure that no improper load is imposed on the actuator, otherwise the actuator may incur local abrasion. As a result, the actuator may become damaged or its life expectancy shortened.



- Make sure that the operating body moves in a direction where the actuator moves. If the actuator is a pin plunger type, make sure that the operating body presses the pin plunger vertically.



Operate the actuator of a hinge roller lever or simulated hinge lever type in the direction shown below. Operating the actuator in the opposite direction may result in deformation of the lever.



- Do not modify the actuator to change the operating position (OP).
- If an external actuator is used as an operating object, check the material and thickness of the lever and make sure that the force imposed on the lever is within the permissible range.

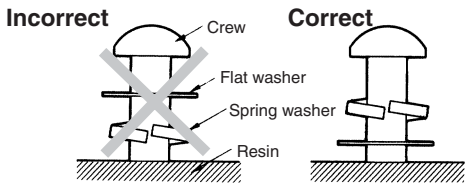
Mounting

When mounting the Switch, pay attention to the following.

Securing

When securing the Switch, be sure to use the specified mounting screws and tighten the screws with flat washers or spring washers securely.

If the Switch housing is made of thermoplastic, the Switch housing may incur crack damage if it comes into contact with the spring washers directly. In that case make sure that the flat washers come into contact with the Switch housing as shown below.



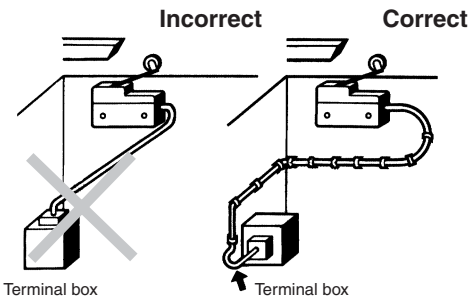
- Do not modify the Switch in any way, for example, by widening the mounting holes.
- Do not subject the Switch to excessive shock or high-frequency vibrations when mounting as this may have an adverse effect on Switch performance.

Locking Agent

If glue or locking agent is applied, make sure that it does not stick to the movable parts or intrude into the interior of the Switch, otherwise the Switch may work improperly or cause contact failure. Some types of glue or locking agent may generate gas that has a bad influence on the Switch. Pay the utmost attention when selecting the glue or locking agent. Particular care is required with unsealed Switches. Glue or locking agent may intrude into the interior of the switch via the pushbutton or the terminals and cause faulty operation. Select the glue or locking agent carefully and be sure to apply it in appropriate places.

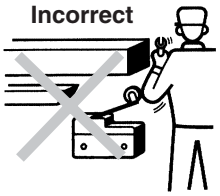
Wiring

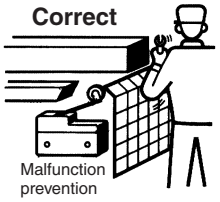
Make sure that the lead wires are connected with no inappropriate pulling force and that the wires are supported securely.



Mounting Location

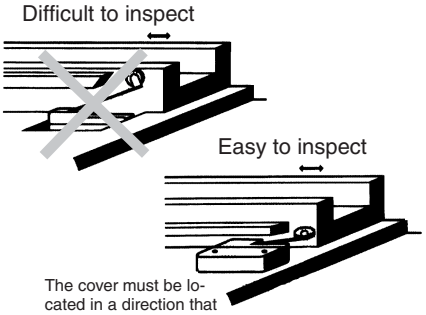
Be sure not to mount the Switch in locations where the Switch may be actuated by mistake.





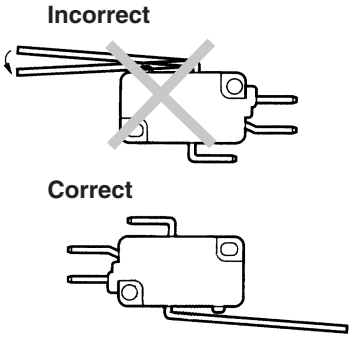
Maintenance and Inspection

Make sure that the Switch is mounted in locations that allow easy inspection or replacement of the Switch.



Mounting Direction

When using a Switch of low operating force attached with a long lever, make sure that the lever is in the downward direction as shown below, otherwise the Switch may not reset properly.

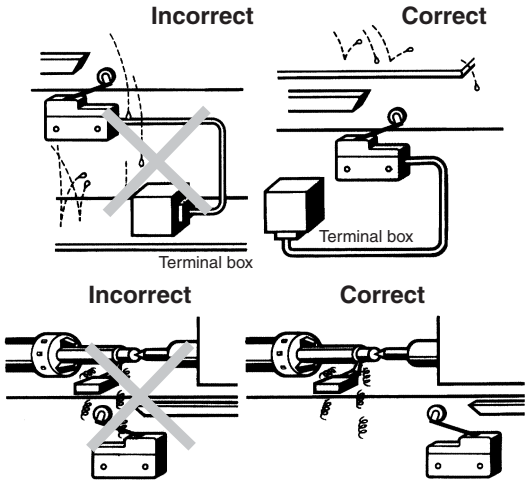


Operation and Storage Environment

Oil and Water Resistance

The standard Switch is not water-resistant. Protect the Switch with appropriately when using the Switch in places with water or oil spray.

If the Switch is exposed to water drops, use a sealed Switch.



Handling

Do not drop the Switch, otherwise the Switch may break or deform.

Do not apply oil, grease, or other lubricants to the sliding parts of the Switch, otherwise the actuator may not operate smoothly. The intrusion of oil, grease, or other lubricants into the internal part may cause faulty operation or contact failure.

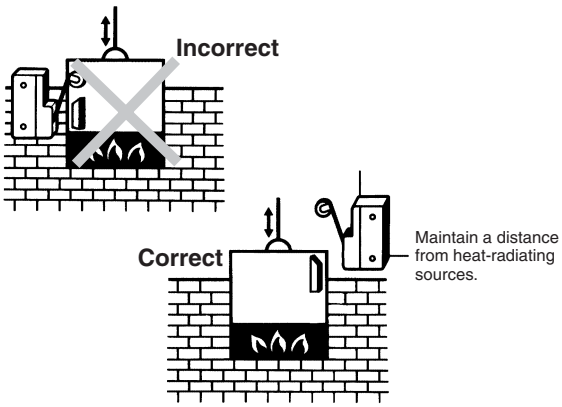
Operating Environment

Do not install the Switch in any location or direction where the Switch resonates or continuous vibration or shock is imposed on the Switch. If continuous vibration or shock is imposed on the Switch, a contact failure, malfunction, or a decrease in life expectancy may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.

Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or in locations with high temperature and humidity. Otherwise, contact failure or corrosion damage may result.

If the Switch is used in places with silicone gas, arc energy may attract silicon dioxide (SiO_2) to the contacts and a contact failure may result. If there is silicone oil, silicone sealant, a wire covered with silicone, or any other silicone-based product near the Switch, attach a contact protective circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Be sure to use the Switch at temperature within the specified range. If the Switch is exposed to radical temperature changes or intense heat, the performance characteristics of the Switch may change.



Storage Environment

When storing the Switch, consider countermeasures (e.g., storing in a plastic bag) to prevent discoloration resulting from sulfidization of the terminals (silver-plated). Make sure that the location is free of corrosive gas or dust with no high temperature or humidity. It is recommended that the Switch be inspected before use if it is stored for three months or more.

■ Switch Trouble and Remedial Action

Type	Location of failure	Failure	Possible cause	Remedy
Failures related to electrical characteristics	Contacts	Faulty contact	Dust and dirt collect on the contacts.	Clean the environment, place the Switch in a box, or use a sealed Switch.
			Oil or water has penetrated into the Switch.	
			Chemical substances have been generated on the contact surfaces because the atmosphere contains chemical gas.	Use a Switch having contacts with high environmental resistivity (such as gold or alloy contacts).
			Chemical substances have been generated on the contact surface when the Switch breaks a very low load.	
			Solder flux has penetrated into the Switch.	Review the soldering method or use a flux-tight Switch.
		Malfunction	The contacts are separated from each other by vibration or shock.	Use a Switch having a high contact force (generally a heavy OF).
		Contact weld	The load connected to the Switch is too high.	Use a Switch having higher switching capacity or insert a relay to switch high-capacity loads.
		Insulation degradation (burning)	Contacts have been melted and scattered by arc.	Insert a contact protection circuit.
			Water has penetrated into the Switch because the Switch is placed in extremely humid environment.	Remove the cause of the failure or use a sealed Switch.
			Liquid has penetrated into the Switch and been carbonized by arc heat.	

Type	Location of failure	Failure	Possible cause	Remedy
Failures related to mechanical characteristics	Actuator	Misoperation	The sliding part of the actuator has been damaged because an excessive force was applied on the actuator.	Make sure that no excessive force is applied to the actuator, or use an auxiliary actuator mechanically strong.
			Dust and dirt or oil have penetrated into the actuator.	Remove the cause of the failure or use a sealed Switch.
			The actuator does not release because the operating body is too heavy.	Use a Switch having a heavier OF.
			The Switch is loosely installed and thus does not operate even when the actuator is at the rated OP.	Secure the Switch.
		Service life is too short	The shape of the dog or cam is improper.	Change the design of the dog or cam.
			The operating method is improper.	Review the OT and operating speed.
		Damage	A shock has been applied to the actuator.	Change the environment or use a Switch mechanically strong.
			The clamping part has not been tightened enough or the Switch has been loosely mounted.	Replace the Switch with a new one.
			Deformation or drop-out	Relocate the Switch so that improper force will not be imposed on the actuator or in the wrong direction. Review the operating method.
	Mounting section	Damage	Screws have not been inserted straight.	Check and correct screw insertion methods.
			The mounting screws were tightened with too much torque.	Tighten the screws to an appropriate torque.
			The mounting pitch is wrong.	Correct the pitch.
			The Switch is not installed on a flat surface.	Install the Switch on a flat surface.
	Terminal	Damage	An excessive force was applied to the terminal while being wired.	Do not apply an excessive force.
			The plastic part has been deformed by solder heat.	Use a soldering iron rated with a proper wattage or solder for a proper time. (Refer to the information given under *Precautions* for that model.)

ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.
To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.

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