## ■ Glossary

**CONTACTS**

**Contact Form**

The contact mechanism of the Relay.

**Number of Contact Poles**

The number of contact circuits.

**Rated Load**

The rated load of the contact of the Relay, which determines the characteristic performance of the contact of the Relay, is expressed by the switching voltage and switching current.

**Maximum Switching Voltage**

The switching voltage of the Relay determines the characteristic performance of the contact of the Relay. Do not apply voltage that exceeds the maximum switching voltage of the Relay.

**Carry Current**

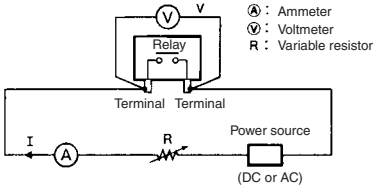
The value of the current which can be continuously applied to the Relay contacts without opening or closing them, which also allows the Relay to stay within the permissible temperature rise limit.

**Maximum Switching (Contact) Current**

A current which serves as a reference in determining the performance of the Relay contacts. This value will never exceed the carry current. When using a Relay, plan not to exceed this value.

**Contact Resistance**

The total resistance of the conductor, which includes specific resistivities, such as of the armature and terminal, and the resistance of the contacts. This value is determined by measuring the voltage drop across the contacts by the allowed test current shown in the table below.

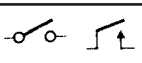
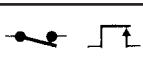
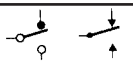
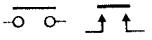
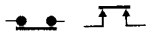
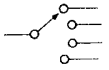
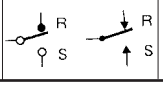



**Test Current**

| Rated current or switched current (A) | Test current (mA) |
|---|---|
| 0.01 or higher but less than 0.1 | 10 |
| 0.1 or higher but less than 1 | 100 |
| 1 or higher | 1,000 |

To measure the contact resistance, a milliohmmeter can also be used, although the accuracy drops slightly.

**Contact Symbols**

| NO contact | NC contact | SPDT contact |
|---|---|---|
|  |  |  |
| **Double-break NO contact** | **Double-break NO contact** | **Make-before-contact contact** |
|  |  |  |
| **Wiper contact** | **Latching Relay contact** | **Ratchet relay contact** |
|  |  |  |

**Make-before-break Contact**

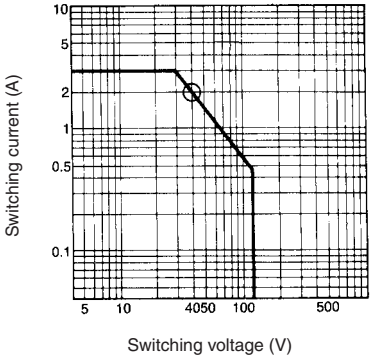
A contact arrangement in which part of the switching section is shared between both an NO and an NC contact. When the Relay operates or releases, the contact that closes the circuit operates before the contact that opens the circuit releases. Thus both the contacts are closed momentarily at the same time.

**Maximum Switching Power**

The maximum capacity value of the load which can be switched without causing problems of material break-down and/or electrical overload. When using a Relay, be careful not to exceed this value. For example, when switching voltage $V_1$ is known, max. switching current $I_1$ can be obtained at the point of intersection on the characteristic curve "Maximum switching power" below. Conversely, max. switching voltage $V_1$ can be operated if $I_1$ is known.

$$\text{Max. switching current } (I_1) = \frac{\text{Maximum switching power [W(VA)]}}{\text{Switching voltage } (V_1)}$$

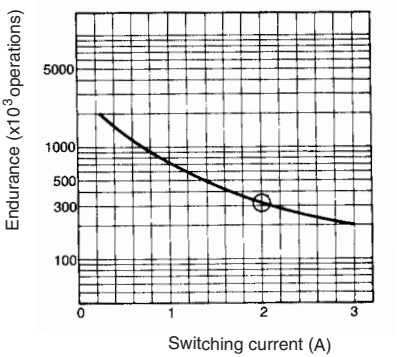
For instance, if the switching voltage = 40 V, the max. switching current = 2 A (see circled point on graph).



**Electrical Endurance**

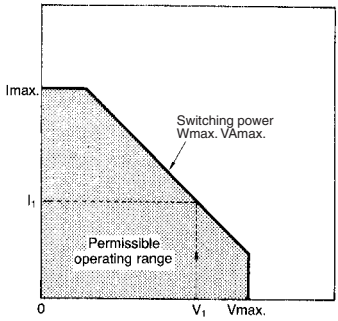
The electrical endurance of the Relay can be determined from the "Electrical life" curve shown below, based on the rated switching current ($I_1$) obtained above.

For instance, the electrical endurance for the max. switching current of 2 A is slightly over 300,000 operations (see circled point on graph below).




However, with a DC load, it may become difficult to break a circuit of 48 V or more, due to arcing. Determine suitability of the Relay in actual usage testing. Correlation between the contact ratings is as shown below.

**Maximum Switching Power**



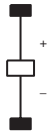
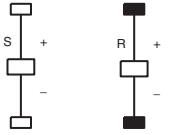
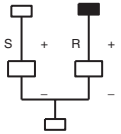
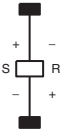

**Failure Rate**

The failure rate indicates the lower limit of the switching power of a Relay. Such minute load levels are found in microelectronic circuits. This value may vary, depending on operating frequency, operating conditions, expected reliability level of the Relay, etc. It is always recommended to double-check Relay suitability under actual load conditions.

In this catalog, the failure rate of each Relay is indicated as a reference value. It indicates error level at a reliability level of 60% ($\lambda_{60}$).

$\lambda_{60}$ = 0.1 x $10^{-6}$/operation means that one error is presumed to occur per 10,000,000 operations at the reliability level of 60%.

**Coil**

| Single-stable | | Double-winding | | Single-winding latching |
|---|---|---|---|---|
| With pole | Without pole | 4 terminals | 3 terminals | |
|  |  |  |  |  |

**Coil Current (Applicable to AC-switching Type Only)**

A current which flows through the coil when the rated voltage is applied to the coil at a temperature of 23°C. The tolerance is +15%, –20% unless otherwise specified.

**Coil Voltage**

A reference voltage applied to the coil when the Relay is used under the normal operation conditions. The following table lists the 100/110 VAC voltages

| Applicable power source | Inscription on Relay | Denomination in catalog |
|---|---|---|
| 100 V 50 Hz | 100 VAC 60 Hz | 100 VAC 60 Hz |
| 100 VAC 50 Hz<br>100 VAC 60 Hz | 100 VAC | 100 VAC |
| 100 VAC 50 Hz<br>100 VAC 60 Hz<br>100 VAC 60 Hz | 100/110 VAC 60 Hz<br>100 VAC 50 Hz | 100/(110) VAC |
| 100 VAC 50 Hz<br>100 VAC 60 Hz<br>110 VAC 50 Hz<br>110 VAC 60 Hz | 100/110 VAC | 100/110 VAC |

**Power Consumption**

The power (=rated voltage x rated current) consumed by the coil when the rated voltage is applied to it. A frequency of 60 Hz is assumed if the Relay is intended for AC operation.

The current flows through the coil when the rated voltage is applied to the coil at a temperature of 23°C and with a tolerance of +15% and –20% unless otherwise specified.

**Coil Resistance (Applicable to DC-switching Type Only)**

The resistance of the coil measured at a temperature of 23°C with a tolerance of ±10% unless otherwise specified. (The coil resistance of an AC-switching Relay may be given for reference when the coil inductance is specified.)

**Must-release (Must-reset) Voltage**

The threshold value of a voltage at which a Relay releases when the rated input voltage applied to the Relay coil in the operating state is decreased gradually.

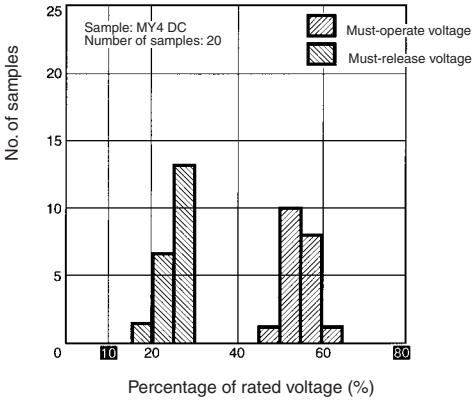
**Must-operate (Must-set) Voltage**

The threshold value of a voltage at which a Relay operates when the input voltage applied to the Relay coil in the reset state is increased gradually.

**Example: MY4 DC Models**

The distributions of the must-operate voltage and the must-release voltage are shown in the following graph.

As shown in the graph, the Relay operates at voltages less than 80% of the rated voltage and releases at voltages greater than 10% of the rated voltage. Therefore, in this catalog, the must-operate and must-release voltages are taken to be 80% max. and 10% min. respectively of the rated voltage.




**Hot Start**

The ratings set forth in the catalog or data sheet are measured at a coil temperature of 23°C unless otherwise specified. However, some catalogs have the description "Hot start 85% (at Ta = 40°C)". This means that the must-operate voltage when the Relay is operated after the rated current is consecutively applied to the coil at an ambient temperature of 40°C satisfies a maximum of 85% of the rated must-operate voltage.

**Maximum Switching Voltage**

The maximum value (or peak value, not continuous value) of permissible voltage fluctuations in the operating power supply of the Relay coil.

**Minimum Pulse Width**

The minimum width of the pulsating voltage required to set and reset a Latching Relay at a temperature of 23°C.

**Coil Inductance**

With DC Relays, the coil inductance is obtained by adding the square waveform to a time constant. With AC Relays, it is the value at the rated frequency. In both cases, the values will be different depending on whether the Relay is in the set or the reset condition.

**ELECTRICAL CHARACTERISTICS**

**Mechanical Life Expectancy**

The life of a Relay when it is switched at the rated operating frequency, but without the rated load.

**Electrical Endurance**

The life of a Relay when it is switched at the rated operating frequency, with the rated load applied to its constants.

**Bounce**

Bouncing is the intermittent opening and closing between contacts caused by vibration or shock resulting from collision between the Relay's moving parts (poles and terminals) and the iron core and backstop, and collision between contacts.

**Operate Bounce Time**

The bounce time of the normally open (NO) contact of a Relay when the rated coil voltage is applied to the Relay coil, at an ambient temperature of 23°C.

**Operate Time**

The time that elapses after power is applied to a Relay coil until the NO contacts have closed, at an ambient temperature of 23°C.

Bounce time is not included. For the Relays having an operate time of less than 10 ms, the mean (reference) value of its operate time is specified as follows:

| | |
|---|---|
| **Operate time** | 5 ms max. (mean value: approx. 2.3 ms) |

**Release Bounce Time**

The bounce time of the normally closed (NC) contact of a Relay when the coil is deenergized at an ambient temperature of 23°C.

**Release Time**

The time that elapses between the moment a Relay coil is deenergized until the NC contacts have closed, at an ambient temperature of 23°C. (With a Relay having SPST-NO or DPST-NO contacts, this is the time that elapses until the NO contacts have operated under the same condition.) Bounce time is not included. For Relays having a release time of less than 10 ms, the mean (reference) value of its release time is specified as follows:

| | |
|---|---|
| **Release time** | 5 ms max. (mean value: approx. 2.3 ms) |

**Reset Time (Applicable to Latching Relays Only)**

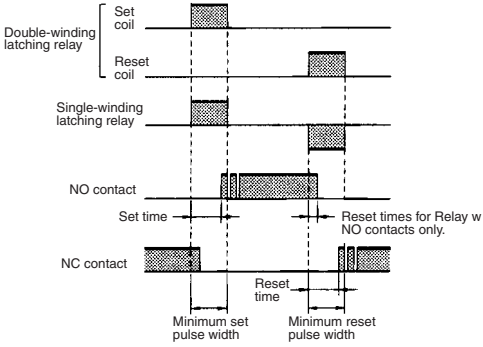
The time that elapses from the moment a Relay coil is deenergized until the NC contacts have closed, at an ambient temperature of 23°C. (With a Relay having SPST-NO or DPST-NO contacts, this is the time that elapses until the NO contacts have operated under the same condition.) Bounce time is not included. For Relays having an operate time of less than 10 ms, the mean (reference) value of its operate time is specified as follows:

| | |
|---|---|
| **Reset time** | 5 ms max. (mean value: approx. 2.3 ms) |

**Set Time (Applicable to Latching Relays Only)**

The time that elapses after power is applied to a Relay coil until the NO contacts have closed, at an ambient temperature or 23°C. Bounce time is not included. For the Relays having an operate time of less than 10 ms, the mean (reference) value of its operate time is specified as follows:

| | |
|---|---|
| **Set time** | 5 ms max. (mean value: approx. 2.3 ms) |




**Dielectric Strength**

The critical value which a dielectric can withstand without rupturing, when a high-tension voltage is applied for 1 minute between the following points:

Between coil and contact

Between contacts of different polarity

Between contacts of same polarity

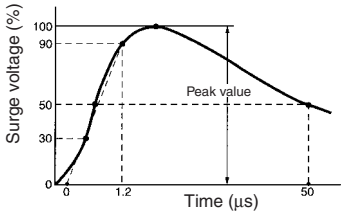
Between set coil and reset coil

Between current-carrying metal parts and ground terminal

Note that normally a leakage current of 3 mA is detected; however, a leakage current of 1 mA or 10 mA may be detected on occasion.

**Impulse Withstand Voltage**

The critical value which the Relay can withstand when the voltage surges momentarily due to lightning, switching an inductive load, etc. The surge waveform which has a pulse width of +1.2 x 50 ms is shown below:




**Insulation Resistance**

The resistance between an electric circuit (such as the contacts and coil), and grounded, non-conductive metal parts (such as the core), or the resistance between the contacts. The measured values are as follows

| Rated insulation voltage | Measured value |
|---|---|
| 60 V max. | 250 V |
| 61 V min. | 500 V |

**Switching Frequency**

The frequency or intervals at which the Relay continuously operates and releases, satisfying the rated mechanical and electrical service lives.

**Shock Resistance**

The shock resistance of a Relay is divided into two categories:

Destruction, which quantifies the characteristic change of, or damage to, the Relay due to considerably large shocks which may develop during the transportation or mounting of the Relay, and malfunction durability, which quantifies the malfunction of the Relay while it is in operation.

**Stray Capacitance**

The capacitance measured between terminals at an ambient temperature of 23°C and a frequency of 1 kHz.

**Vibration Resistance**

The vibration resistance of a Relay is divided into two categories:

Destruction, which quantifies the characteristic changes of, or damage to, the Relay due to considerably large vibrations which may develop during the transportation or mounting of the Relay, and Malfunction durability, which quantifies the malfunction of the Relay due to vibrations while it is in operation.

$\alpha = 0.002f^2A$

$\alpha$: Acceleration of vibration

f: Frequency

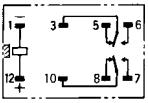
A: Double amplitude

**OPERATING**

**Single Stable Relays (Standard Type)**

These are Relays in which the contacts switch in response to the energization and deenergization of the coil and do not have any special functions.

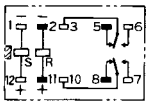
**Terminal Arrangement/Internal Connections (Bottom view)**




**Double-winding Latching Relays**

These are Relays that have a set coil and a reset coil, and have a latching mechanism enabling the set or reset condition to be locked.

**Terminal Arrangement/Internal Connections (Bottom view)**

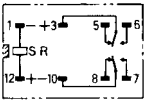



S: set coil
R: reset coil

**Single-winding Latching Relays**

These are Relays that have one coil, and switch between the set and reset condition according to the polarity of the applied voltage, and have a latching mechanism enabling this status to be locked.

**Terminal Arrangement/Internal Connections (Bottom view)**




S: set coil
R: reset coil

**Stepping Relays**

These are Relays in which the contacts shift ON or OFF sequentially with each coil input pulse.

**Ratchet Relays**

These are Relays in which the contacts alternately turn ON and OFF, or sequentially operate, when a pulse signal is input.

# Precautions

**General handling**

- To maintain initial performance, be careful not to drop the Relay or subject it to shock.
- The case is so constructed that it will not come off with normal handling. To maintain initial performance, do not allow the case to come off.
- Use the Relay in a dry atmosphere containing little dust, $SO_2$, $H_2S$, and organic gases.
- Ensure that the voltage applied to the coil is not applied continuously in excess of the maximum permissible voltage.
- With DC-operated Relays that have a built-in diode or a built-in operation indication lamp, do not reverse the polarity connections when the polarity of the coil is specified.
- Do not use the Relay at a voltage or current greater than the specified values.
- Ensure that the ambient operating temperature does not exceed the specified value.
- With General-purpose Relays, leaving or using the Relay for a long time in an atmosphere of hydrogen sulfide gas or high temperature and high humidity will lead to the formation of a sulfide film or an oxidation film on the surface of the contact. In Miniature Relays, the contact force is weak and so the film cannot be destroyed mechanically. Also, with the very small loads, destruction of the film is not possible by arcing and so there will be contact instability and the occurrence of problems in performance and function. For these reasons, Fully Sealed Relays or Hermetically Sealed Relays should be used in atmospheres of harmful gases (such as $H_2S$, $SO_2$, $NH_3$, and $Cl_2$), humidity, and dust.
- The contact ratings of Relays approved by standards and the general ratings of the Relays could be different.

When combining Relays with various types of Sockets, check the contact ratings of the Relays before use.

**OPERATING COILS**

**AC-operated Relays**

The power supply used to operate AC-operated Relays is almost always at the commercial frequency (50 or 60 Hz). Standard voltages are 6, 12, 24, 48, 100, and 200 VAC. Because of this, when the voltage is other than a standard voltage, the Relay will be a special-order item and so inconvenience may arise with respect to price, delivery period, and stability of performance. Consequently, a Standard-voltage Relay should be selected if at all possible.

In AC-operated Relays, there is a resistance loss of the shading coil, an overcurrent loss of the magnetic circuit, a hysteresis loss, as well as other losses. The coil input also increases and so in general it is normal for the temperature rise to be higher than in a DC-operated Relay. Also, at voltages less than the must-operate voltage (i.e., the minimum operation voltage), a vibration is produced which necessitates that attention be paid to the fluctuation of the power supply voltage.

For example, when the power supply voltage drops at the time of motor stating, the Relay will be reset while vibrating and the contacts will burn, fuse, or the self holding will go out of place. In AC-operated Relays, there is an inrush current. (When the armature is in a separated condition, the impedance is low and a current flows that is larger than the rated current; when the armature is in the closed condition, the impedance increases and a current flows which is of the rated value.) When a large number of Relays are used connected in series, this factor must be taken into account together with the power consumption.

**DC-operated Relays**

The power supply used to operate DC-operated Relays may have voltage as a standard or it may have current as a standard. When voltage is the standard, the rated coil voltages include 5, 6, 12, 24, 48, and 100 VDC. When current is the standard, the rated current in mA is listed in the catalog.

In DC-operated Relays, when the Relay is used in an application where it is operated at some limit value, either voltage or current, the current applied to the coil will gradually increase or decrease. It is important to note that this may delay the movement of the contacts resulting in failure to meet the specified control capacity. The coil resistance value of a DC-operated Relay may change by approximately 0.4% per °C due to changes in the ambient temperature and the heat radiated by the Relay itself. Therefore, it is important to note that increases in temperature will be accompanied by higher must-operate and must-release voltages.

**Power Supply Capacity**

The fluctuation of the power supply voltage over a long period will of course affect Relay operation, but momentary fluctuations will also be the cause of incorrect Relay operation.

For example, when a large solenoid, Relay, motor, heater, or other device is operated from the same power supply as the one that operates the Relay, or when a large number of Relays are used, if the power supply does not have sufficient capacity when these devices are operated simultaneously, the voltage drop may prevent the Relay from operating. On the other hand, when the voltage drop is estimated and the voltage increased accordingly, if the voltage is applied to the Relay when there is no voltage drop, this will cause heating of the coil.

Provide leeway in the capacity of the power supply and keep the voltage within the switching voltage range of the Relay.

**Lower Limit Value of the Must-operate Voltage**

Use of Relays at high temperatures or rise of coil temperature due to a continuous flow of current through the coil will result in an increase in coil resistance which means the must-operate voltage will also increase. This matter requires attention be paid to determining a lower limit value of the operation power supply voltage. The following example and explanation should be referred to when designing the power supply.

**Note:** Even though the rating is a voltage rating (as is the rating for all Standard Relays), the Relay should be thought of as being current operated.

**Catalog values for model MY**

Rated voltage: 24 VDC, coil resistance: 650 Ω, must-operate voltage: 80% or less of rated voltage, at a coil temperature of 23°C.

A rated current of 36.9 mA (24 VDC/650 W = 36.9 mA) flows through this Relay, which operates at 80% or less of this value i.e., at 29.5 mA or less (36.9 mA x 0.8 = 29.5 mA). When the present coil temperature rises by 10°C, the coil resistance will be 676 W (650 Ω x 1.04 = 676 W). To have the must-operate current of 29.5 mA flow in this condition, it will be necessary to apply a voltage of 19.94 V (29.5 mA x 676 Ω =19.94 v). This voltage (which is the must-operate voltage when the coil temperature is 33°C (23°C +10°C), is 83.1% (19.94/24 = 83.1%) of the rated voltage which represents an increase compared to when the coil temperature was 23°C.