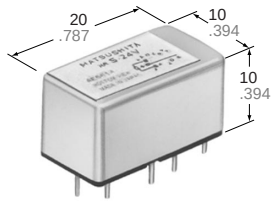
Discontinued

R

# NAiS HALF SIZE Amber RELAY R-RELAYS

## UL File No.: E43149 CSA File No.: LR26550




mm inch

- **Amber sealed construction for automatic wave soldering and cleaning**
- **Latching types available**
- **High sensitivity — TTL direct drive possible**
- **High speed — Up to 500 cycle/sec. operations**
- **Wide switching range and high welding resistance**
  **Gold cobalt (AuCo) contact permits**
  - **Wider switching range from low level up to high current: 10 μA to 1 A**
  - **Higher sticking resistance to inrush current**
  - **Stable contact resistance from initial stage throughout life**

## SPECIFICATIONS

### Contact

| | | | |
|---|---|---|---|
| Arrangement | | | 1 Form C |
| Initial contact resistance, max. (By voltage drop 6 V DC 1 A) | | | 60 mΩ |
| Initial contact pressure | | | Approx. 5 g .18 oz |
| Contact material | | | Gold cobalt |
| Electrostatic capacitance | Contact-Contact | Sealed type | 3 pF |
| | | Magnetically sealed type | 4 pF |
| | N.O. contact-coil | Sealed type | 4 pF |
| | | Magnetically sealed type | 5 pF |
| | N.C. contact-coil | Sealed type | 5 pF |
| | | Magnetically sealed type | 6 pF |
| | Nominal switching capacity | | 1A 20 VDC, 0.3A 110 VAC |
| Rating (resistive) | Max. switching power | | 33 VA, 20 W |
| | Max. switching voltage | | 110 V AC, 30 V DC |
| | Max. switching current | | AC 0.3 A, DC 1 A |
| | Min. switching power | | Approx. 100 mV 10μA |
| UL/CSA rating | | | 0.3 A 125 V AC, 1 A 30 V DC |
| Expected life (min. operations) | Mechanical (at 500 cps.) | | $10^9$ |
| | Electrical (resistive) | 1 A 20 V DC/0.3 A 110 V AC | $10^6$ (at 1 cps.) |
| | | 0.5 A 30 V DC/0.1 A 110 V AC | $3\times10^6$ (at 2 cps.) |
| | | 0.25 A 30 V DC/0.25 A 30 V AC | $5\times10^6$ (at 5 cps.) |
| | | 0.2 A 24 V DC/0.2 A 24 V AC | $10^7$ (at 25 cps.) |
| | | 0.1 A 12 V DC/0.1 A 12 V AC | $5\times10^7$ (at 50 cps.) |
| | | 0.1 A 9 V DC/0.1 A 9 V AC | $10^8$ (at 100 cps.) |

**Remarks**

*1 Measurement at same location as "Initial breakdown voltage" section
*2 Min. 500MΩ at 100 VDC between coils of 2 coil latching type
*3 Detection current: 10mA, Except for between coils of 2 coil latching type
*4 Excluding contact bounce time
*5 Half-wave pulse of sine wave: 6ms; detection time: 10μs
*6 Half-wave pulse of sine wave: 6ms
*7 Detection time: 10μs
*8 Although R relays are rated at 10 G/55 cps. vibration resistance, they will withstand up to 60 G/2,000 cps., provided they receive additional support such as anchoring to the PC board with epoxy resin.
*9 Refer to 5. Conditions for operation, transport and storage mentioned in AMBIENT ENVIRONMENT (Page 49)

### Coil (polarized) (at 25°C 77°F)

| | | |
|---|---|---|
| Minimum operting power | Single side stable | 72 to 133 mW |
| | 1 coil latching | 41 to 45 mW |
| | 2 coil latching | 72 to 107 mW |
| Nominal operating power | Single side stable | 147 to 300 mW |
| | 1 coil latching | 74 to 153 mW |
| | 2 coil latching | 147 to 331 mW |

### Characteristics (at 25°C 77°F)

| | | |
|---|---|---|
| Max. operating speed | | 500 cps. (mechanical) |
| Initial insulation resistance*1 | | Min. 1000 MΩ at 500 V DC*2 |
| Initial breakdown voltage*3 | Between live parts and ground | 1,000 Vrms |
| | Between open contact | 350 Vrms (500 V DC) |
| | Between contact and coil | 1,000 Vrms |
| Operate time*4 (at nominal voltage) | | Max. 3 ms (Approx. 1 ms) |
| Release time(without diode)*4 (at nominal voltage) | | Max. 2 ms (Approx. 0.5 ms) |
| Contact bounce time | Single side stable | Approx. 0.5 ms |
| | 1-coil /2-coil latching | Approx. 0.3 ms |
| Temperature rise | | Max. 35°C at 0.5 W operating power<br>Max. 65°C at 1 W operating power |
| Shock resistance | Functional*5 | Min. 980 m/s² {100 G} |
| | Destructive*6 | Min. 980 m/s² {100 G} |
| Vibration resistance | Functional*7 | 98 m/s² {10 G}, 10 to 55 Hz at double amplitude of 1.6 mm*8 |
| | Destructive | 117.6 m/s² {12 G}, 10 to 55 Hz at double amplitude of 2 mm |
| Conditions for operation, transport and storage*9 (Not freezing and condensing at low temperature) | Ambient temp. | –55°C to +65°C*10<br>–67°F to +149°F |
| | Humidity | 5 to 85% R.H. |
| Unit weight | | Approx. 7 g .25 oz |

*10 Total temperature (ambient temperature plus temperature rise in coil) should not exceed 90°C 194°F for single side stable, and 105°C 221°F for latching relays. See Reference Data for determination of coil voltage versus temperature.

## TYPICAL APPLICATIONS

Telecommunications equipment, alarm devices, machine tools, NC machines, automatic warehouse control, conveyors, air-conditioners, pressing machines, textile machinery, elevators, control panels, pin-board programmers, parking meters, industrial robots, detectors, annunciators, optical instruments, business machines, time recorders, cash registers, copiers, vending machines, medical equipment.

## ORDERING INFORMATION

EX. R- H L2 12V

| Types of case | Operating function | Coil voltage (DC) |
|---|---|---|
| H: Sealed<br>S: Magnetically sealed | Nil: Single side stable<br>L: 1 coil latching<br>L2: 2 coil latching | 5, 6, 12, 24, 42 V |

(Notes) 1. Power types and 1 Form A types are available on request.
2. For UL/CSA recognized types, delete "N" at head portion of part No. and add suffix UL/CSA, when ordering. Ex. RSD-12V UL/CSA
3. Standard packing Carton: 50 pcs., Case: 500 pcs.

## TYPES AND COIL DATA at 25°C 77°F

Single side stable (R-SD)

| Nominal coil voltage, V DC | Pick-up voltage, V DC (max.) | Drop-out voltage V DC (min.) | Maximum allowable voltage, V DC (40°C) | Coil resistance, Ω (±10%) | Nominal operating power, mW | Inductance, Henrys |
|---|---|---|---|---|---|---|
| 5 | 3.5 | 0.5 | 13 | 170 | 147 | 0.050 |
| 6 | 4.7 | 0.6 | 14 | 220 | 164 | 0.075 |
| 12 | 9.3 | 1.2 | 28 | 890 | 162 | 0.3 |
| 24 | 16 | 2.4 | 42 | 2,000 | 288 | 0.66 |
| 42 | 28 | 4.2 | 85 | 8,000 | 221 | 2.7 |

1 coil latching (R-SLD)

| Nominal coil voltage, V DC | Pick-up voltage, V DC (max.) | Maximum allowable voltage, V DC (40°C) | Coil resistance, Ω (±10%) | Nominal operating power, mW | Inductance, Henrys |
|---|---|---|---|---|---|
| 5 | 3.5 | 18 | 340 | 74 | 0.12 |
| 6 | 4.3 | 20 | 450 | 80 | 0.16 |
| 12 | 8.0 | 30 | 1,500 | 96 | 0.66 |
| 24 | 17 | 75 | 6,000 | 96 | 2.4 |
| 42 | 23 | 110 | 12,000 | 147 | 3.9 |

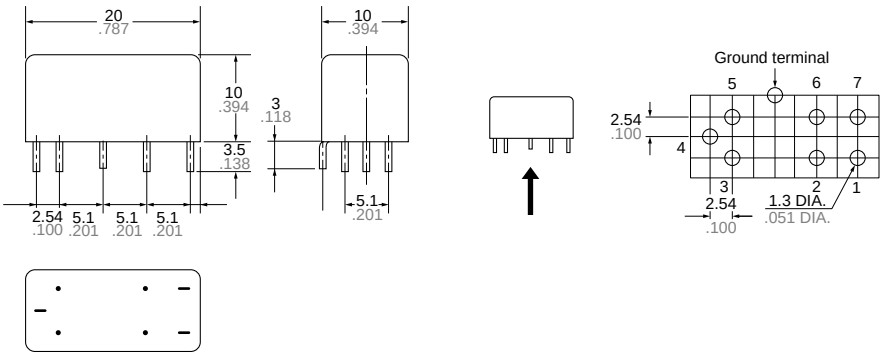
2 coil latching (R-SL2D)

| Nominal coil voltage, V DC | Pick-up voltage, V DC (max.) | Maximum allowable voltage, V DC (40°C) | Coil resistance, Ω (±10%) | | Nominal operating power, mW | Inductance, Henrys |
|---|---|---|---|---|---|---|
| | | | Set coil | Reset coil | | |
| 5 | 3.5 | 13.0 | 170 | 170 | 147 | 0.024 |
| 6 | 4.3 | 14.0 | 225 | 225 | 160 | 0.04 |
| 12 | 8.0 | 26.0 | 650 | 650 | 230 | 0.14 |
| 24 | 17.0 | 50.0 | 2,700 | 2,700 | 213 | 0.35 |
| 42 | 23.0 | 75.0 | 5,500 | 5,500 | 321 | 0.8 |

(Notes) 1. Maximum allowable operating power: 1000 mW at 25°C 77°F.
2. Change rate of pick-up voltage vs. temperature is described in Data on page 157.

## DIMENSIONS

mm inch




Terminal dimensions (Except soldering)

| Terminal No. | Thickness | Width |
|---|---|---|
| 1, 7 | 0.5<br>.020 | 0.6<br>.024 |
| 4 | 0.3<br>.012 | 0.7<br>.028 |
| 2, 3, 5, 6, ground terminal | 0.5 DIA.<br>.020 DIA. | |

Soldering: 0.3 .012 max.

General tolerance: ±0.5 ±.020

Tolerance: ±0.2 ±.008

# SCHEMATIC

1. Single side stable (2, 6: free terminals)

Same operation as the conventional magnetic relays.

(a) During deenergization, terminals **No. 4 (COM)** and **No. 1 (N.C.)** are on “make”.


(b) During energization with the indicated polarity, terminals **No. 4** and **No. 7 (N.O.)** are on “make”.

**Note:**
Energization with an opposite polarity does not switch the contact. Apply proper polarity to switch the contact.

2. Latching type

Once energizaed, the **COM** contact is kept under the same condition without further energizing continuously.

To switch over the contact, energy with an opposite polarity should be applied to the coil.

**1 coil latching (2, 6: free terminals)**

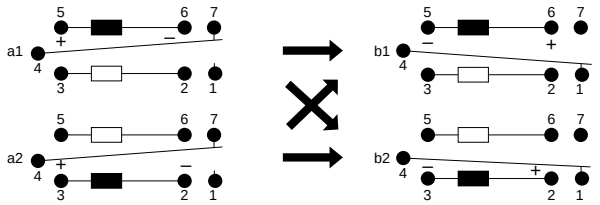
(a) When terminals **No. 5 (–)** and **No. 3 (+)** are energized, terminals **No. 4** and **No. 7** are switched to “make”. (or stay on “make”). when the coil current is switched off, terminals **No. 4** and **No. 7** are held on “make.”

(b) When energized with reverse polarity terminals **No. 4** and **No. 1** are switched to “make” and held on “make” until energized again with an opposite polarity.


**2 coil latching**

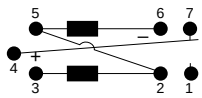
(a) When terminals **No. 5 (+)** and **No. 6 (–)** or terminals **No. 3 (+)** and **No. 2 (–)** are energized terminals **No. 4** and **No. 7** are switched to “make”. (or remain on “make”). When the coil current is switched off, these terminals are held on “make”.

(b) When terminals **No. 5 (–)** and **No. 6 (+)** or terminals **No. 3 (–)** and **No. 2(+)** are enaergized in the reverse of condition (a), terminals **No. 4** and **No. 1** are switched to “make” and held on “make” until energized in an opposite polarity once again.




**Special use of 2 coil latching**

2 coil latching can be used in the same manner as 1 coil latching by shorting **No. 5** and **No. 2** or **No. 3** and **No. 6**

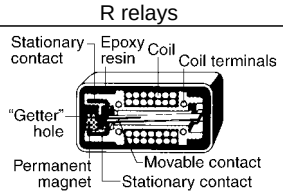
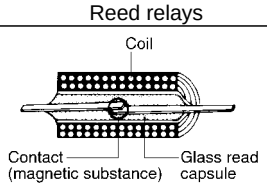



1. The latching type of R relay can be used as the memory element to be operated by a pulse supplied from one or two different sources.

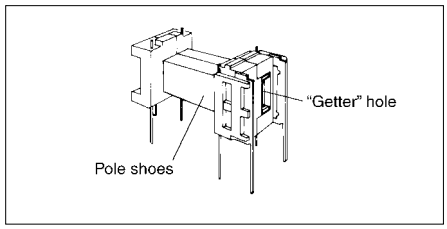
2. With the 2 coil latching type, when simultaneously applying one polarity to one coil and the opposite polarity to the other, the previously energized coil will take priority of operation and will maintain the contact condition.

3. In practical use, switching either from $\mathbf{a}_1$ to $\mathbf{b}_2$ or from $\mathbf{a}_2$ to $\mathbf{b}_1$ is recommendable.

# DIFFERENCES BETWEEN R RELAYS AND REED RELAYS

| | R relays | Reed relays |
|---|---|---|
| Structure |   |   |
| Contact arrangement | 1 Form C | 1 Form A or 1 Form B |
| Contact capacity | 20 W (high contact pressure) | 5 to 15 W |
| Operating function | Single side stable<br>Latching | Single side stable |
| “Getter” hole | Yes | No |

“Getter” holes are formed on both pole shoes to obtain uniform contact resistance throughout life. Film-forming phenomena on contacts is thus fully prevented.

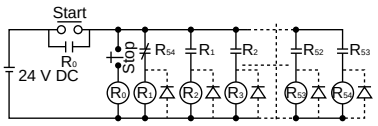


# REFERENCE DATA

1.-(1) Contact reliability

Test sample: R-SD-24V 54 pcs.

Circuits: (A) Following figure with diode
(B) Following figure without diode




Item to be checked: Detect with the circuit stopped

Circuits:

(A) Diode provided: The circuit does not stop throughout 100 million times.

(B) Diode not provided: $\lambda_{60} = 2.5 \times 10^{-8}$ times

1.-(2) Contact reliability

TEST CONDITION

Sample: R-SD-24V, 10 pcs.

Contact voltage: 100 mV

Contact current: 10μA

Cycle rate: 50 cps.

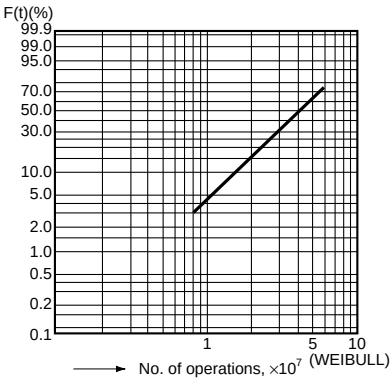
Detection level: 100 Ω

Testing operation: $3\times10^7$

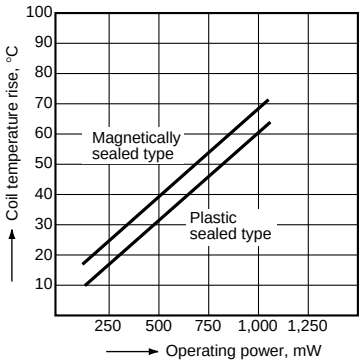
m = 1.9 $\sigma = 2.5\times10^7$

$\mu = 4.7\times10^7$ 95% reliability limit: $1.15\times10^7$

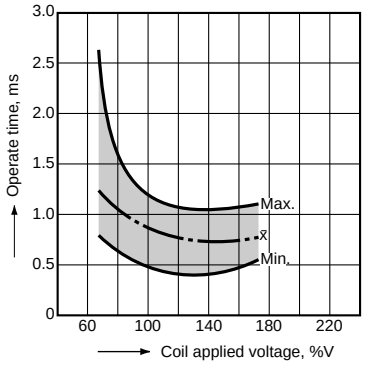
(Mean time between failure)



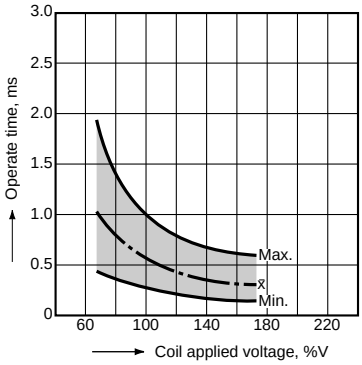

2. Coil temperature rise (under saturated condition)



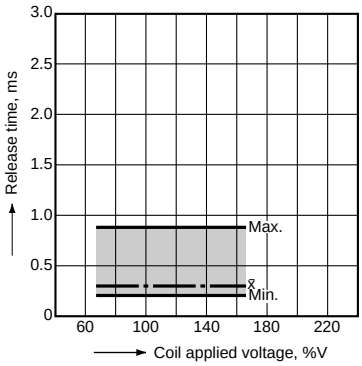

3.-(1) Operate time including bounce time (Single side stable)




3.-(2) Operate time including bounce time (2 coil latching)



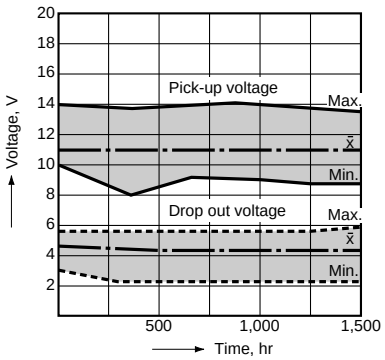

4. Release time including bounce time (Single side stable)




5.-(1) Leaving at high temperature (Change of pick-up and drop-out voltages)

Tested sample: R-SD-24V, 30 pcs.

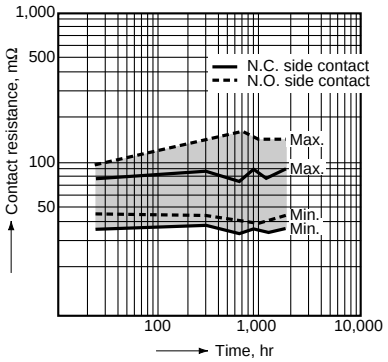
Condition: Deenergized leaving at 90°C 194°F (constant temperature)




5.-(2) Leaving at high temperature (Change of contact resistance)

Tested sample: R-SD-24V, 30 pcs.

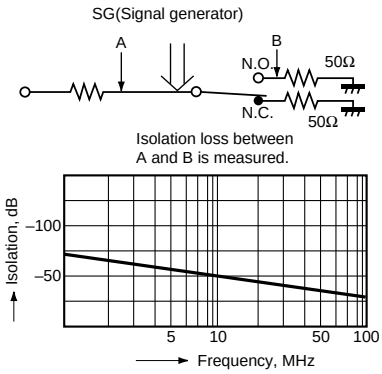
Condition: Deenergized leaving at 90°C 194°F (constant temperature)




6. High frequency characteristics

Tested sample: R-SD-24V

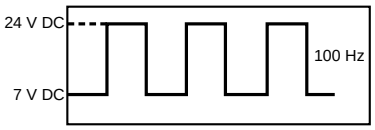
Tested condition:



## 7. Contact sticking resistance

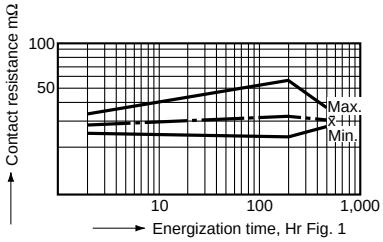
TEST CONDITION

The purpose of this test was to confirm contact sticking resistance and contact stability against coil ripples.
Tested Sample: R-SD-24V, 10 pcs.
Test method: Following coil ripples were applied.
Test period: 500 hours




TEST RESULT

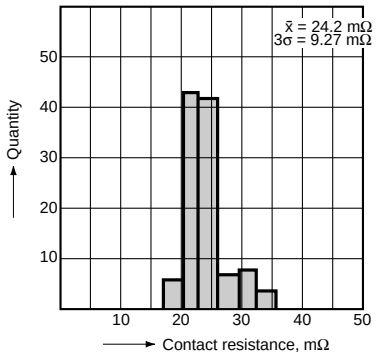
No occurance of sticking was observed.
Contact resistance: Fig. 1
R-SD-24V: 29 mΩ to 30.4 mΩ



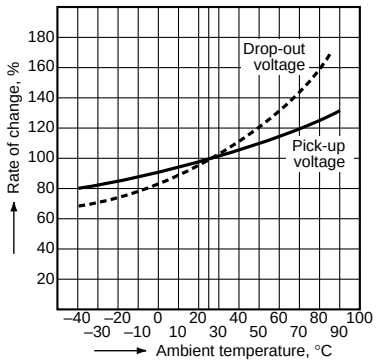

In actual application, above coil ripples should be avoided and use of a capacitor in the circuit is recommended to keep the ripple factor below 5%.

## 8. Distribution of contact resistance

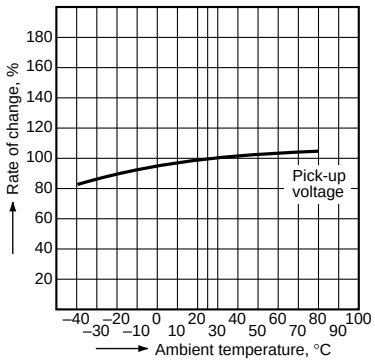
Tested sample: R-SD-24V (WG type) 105 pcs.




## 9.-(1) Rate of change in pick-up and drop-out voltage (Single side stable)

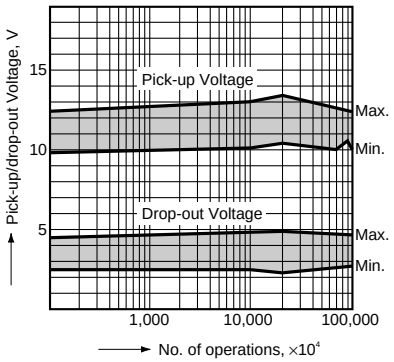



## 9.-(2) Rate of change in pick-up voltage (2 coil latching)



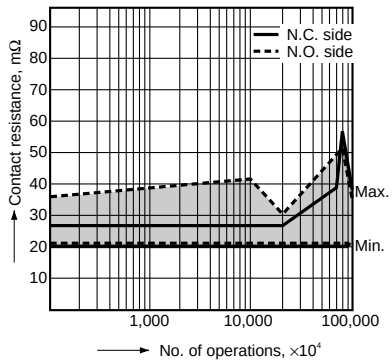

## 10.-(1) Mechanical life

(Change of pick-up and drop-out V)
Tested Sample: R-SD-24V, 10 pcs.
Operation frequency: 500 cps



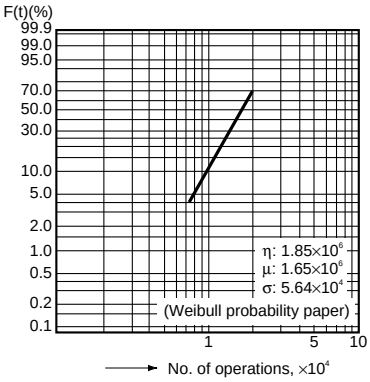

## 10.-(2) Mechanical life

(Change of contact resistance)
Tested Sample: R-SD-24V, 10 pcs.
Operation frequency: 500 cps



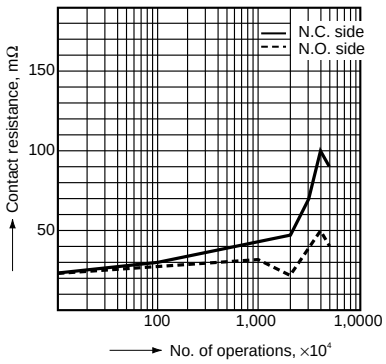

## 11.-(1) Electrical life

(1 A 20 V DC resistive load)
Tested sample: R-SD-24V, 10 pcs.



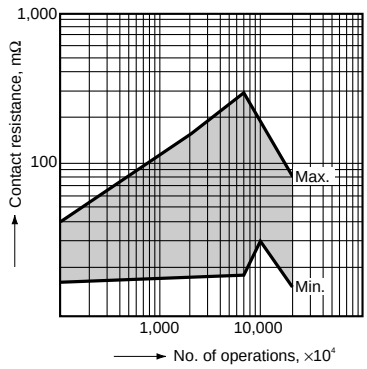

## 11.-(2) Electrical life

Tested Sample: R-SD-24V, 10 pcs.
Load: 60 mA 24 V DC resistive load
Frequency: 50 cps



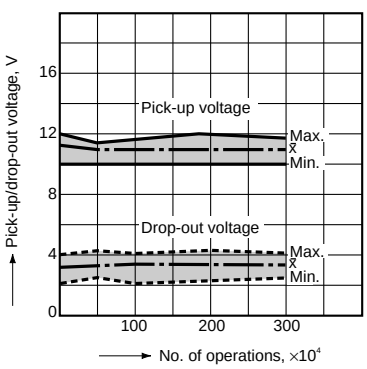

## 11.-(3) Electrical life

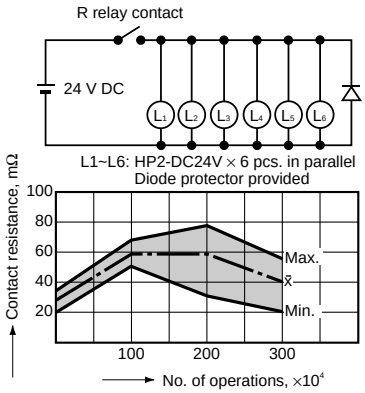
Tested Sample: R-SD-12V, 10 pcs.
Load: 54 mA 12 V DC inductive load
with diode protection
(4 relay coils in parallel of NR-SD-12V)
Frequency: 50 cps



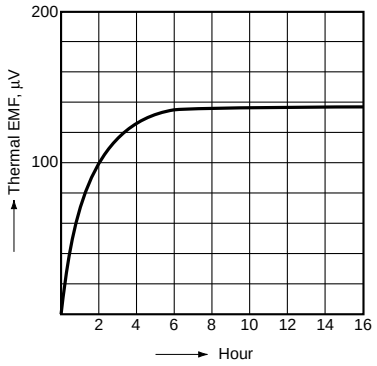

## 11.-(4)Electrical life

(327 mA 24 V DC relay coil load)
Tested sample: R-SD-24V, 5 pcs.
Condition: HP2-DC24×6 pcs. in parallel,
diode protector provided

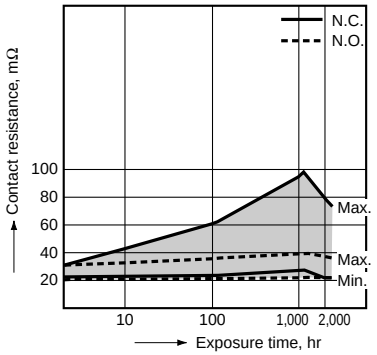


12. Thermal electro motive force
Tested Sample: R-SD-12V, 5 pcs.
Coil applied V: 12 V DC
Ambient atmosphere: 25°C, 60% RH



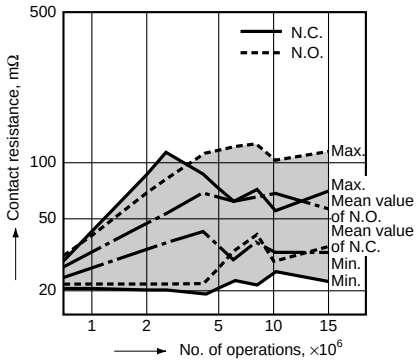

13. High temperature test
TEST CONDITION
Tested Sample: R-SD-24V, 30 pcs.
Ambient temperature: 80°C
Humidity: less than 50% R.H.
Exposure time: 2,000 hours with relays deenergized.
TEST RESULT
Contact resistance: Fig. 1
All samples were measured less than 100 mΩ in contact resistance throughout this test.




14. Influence of adjacent mounting

| Type \ Distance (mm) (inch) | 0 (0) | 5 (.197) | 10 (.394) | 15 (.591) |
|---|---|---|---|---|
| Magnetically shielded type | ±5% | ±1% | 0 | 0 |
| Sealed type | — | ±10% | ±6% | ±2% |

15. Resistive load test
TEST CONDITION
Tested Sample: R-SD-24V, 10 pcs.
Load: 1 A 20 V DC Resistive
Cycle rate: 1.4 cps.
Contact resistance in life test

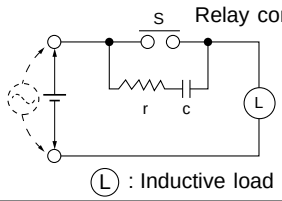
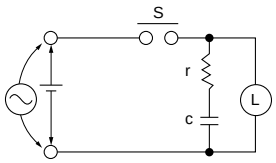
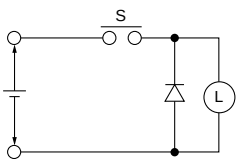



# APPLICATION HINTS

**Contact protection circuit**

When using R relays in inductive load circuits, a contact protection circuit is recommended.

**Examples:**

| CR | CR | Diode |
|---|---|---|
|   Ⓛ : Inductive load |   |   |
| 1. r = more than 20 to 30 ohms<br>2. In an AC circuit impedance of L is to be somewhat smaller than impedance of r and c. | Can be used for both AC and DC circuits. Use 500 to 1000 ohms for r and 0.1 µF to 0.2 µF 200 V for c in a general 12 to 24 V load circuit. | For DC circuits only. |

The following is life data under our HP2 relay load.

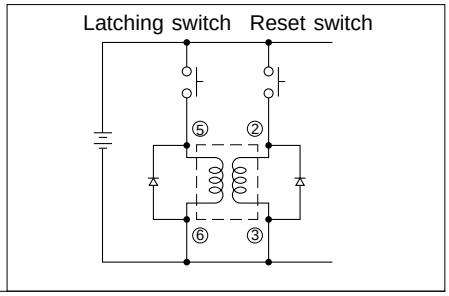
| Contact voltage | Contact current | Contact protection circuit | Operating speed | Expected life, min. op. |
|---|---|---|---|---|
| 6 V DC | 232 mA | 0.2 µF + 1kΩ or diode | 2 op./s | $3\times10^7$ |
| 12 V DC | 106 mA | 0.2 µF + 1kΩ or diode | 2 op./s | $3\times10^7$ |
| 24 V DC | 54 mA | 0.1 µF + 1kΩ or diode | 2 op./s | $3\times10^7$ |
| 100 V DC | 15 mA | 0.1 µF + 1kΩ or diode | 2 op./s | $2\times10^7$ |
| 24 V DC | 80 mA | 0.2 µF + 1kΩ | 2 op./s | $3\times10^7$ |
| 100 V DC | 20 mA | 0.1 µF + 1kΩ or varistor | 2 op./s | $2\times10^7$ |
| 200 V DC | 10 mA | 0.1 µF + 1kΩ | 2 op./s | $2\times10^7$ |

(Notes)
1. When inrush current occurs in the capacitor load circuit or incandescent lamp load circuit, reduce it to less than 5 A. Electrical life of “AuCo” contact types is 10,000 operations in a 5 A inrush current circuit.
2. When 5 A to 10 A inrush current occurs in the capacitor load circuit or incandescent lamp load circuit, the use of power types is recommended.

**2 coil latching types**

A) The circuit at right is recommended when using one coil for latching and the other coil for reset.
R relays are sensitive enough to be operated by the discharge of energy accumulated in the inner-coil capacitance. The use of a diode of over 200 V breakdown will prevent misoperation from this source.

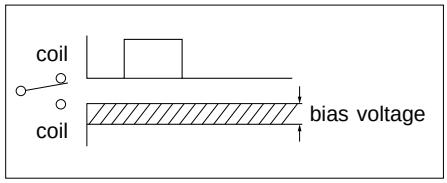
In order to maintain the insulation between the two coils, connection of the terminal No. 3 and No. 6 or the terminal No. 2 and No. 5 is recommended, as shown in the right figure.
Rectifiers should be inserted in this circuit when the nominal coil voltage of the R relay is more than 24 V DC.



B) No damage will occur to the coil of either the one or two coil bistable types even if the operating voltage is as much as 2 or 3 times the nominal coil voltage.

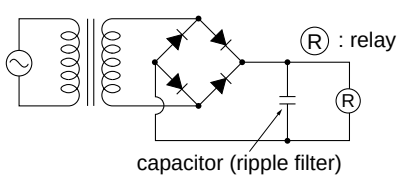
C) If separate pulses are applied to each coil of the 2 coil bistable types, the first pulse will operate when the pulses are of equal voltage. When voltages differ the higher voltage will cause operation provided the voltage difference is greater than the measured pick-up voltage. Voltage difference on the coils will reduce contact pressure proportionately.

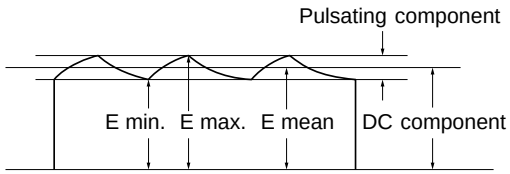
Continuous bias voltage after an operating pulse lowers contact pressure and vibration resistance.




**Ripple factor**

Coils should be operated on pure DC. Rectified AC may cause changes in the pick-up/drop-out characteristics because of the ripple factor. Use of a capacitor in the circuit is recommended to keep the ripple factor below 5%.




To calculate the ripple factor

$$\text{Ripple factor (\%)} = \frac{\text{E max.} - \text{E min.}}{\text{E mean}} \times 100\%$$

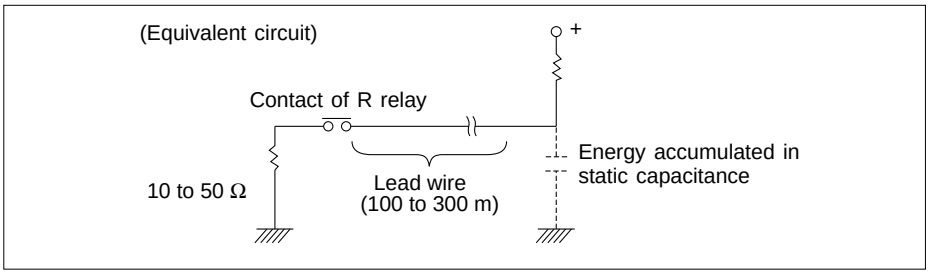
E max. = max. value of pulsating component
E min. = min. value of pulsating component
E mean - average value DC component

**When designing R relay circuits**

Care should be taken when designing relay circuits since the response of the relay is so fast that bouncing or chattering from conventional relays in the circuit may cause false operation.

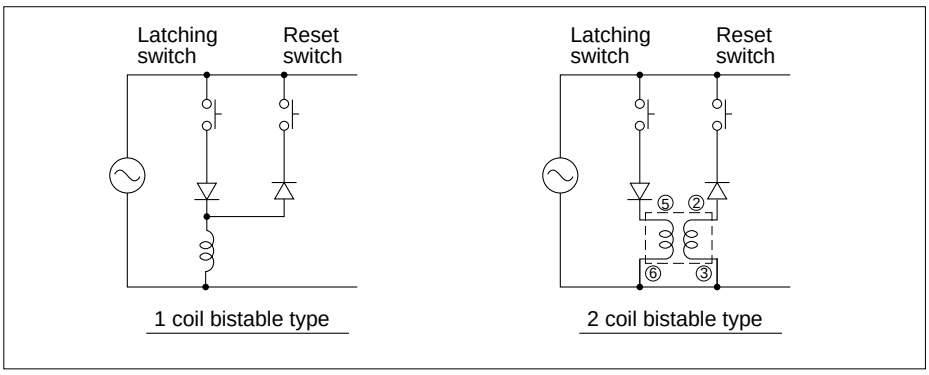
**When using long lead wires**

When long wires (as long as 100 m or more) are to be used, the use of resistance (10 to 50 Ω) in series with the contact is required in order to eliminate the effect of the possible inrush current due to the stray capacitance existing between the two wires or between the wire and ground.



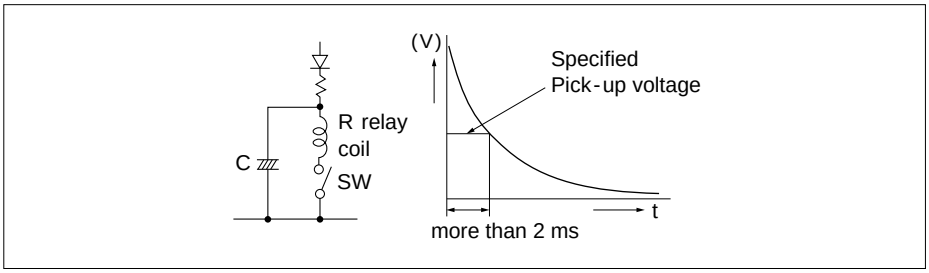

**AC operation of latching relays**

When using circuits such as those at the right, avoid continued or extended latching or resetting power input.



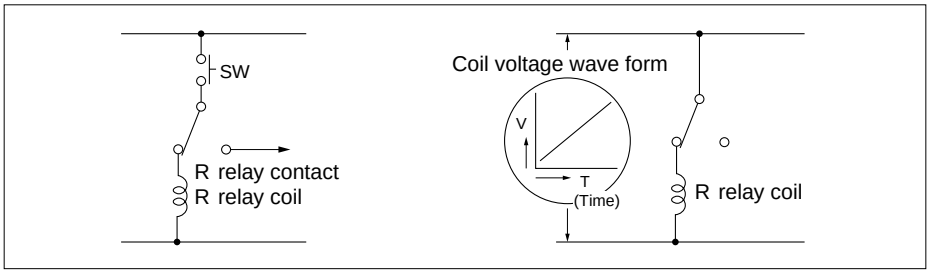

**Capacitor discharge operation of latching types**

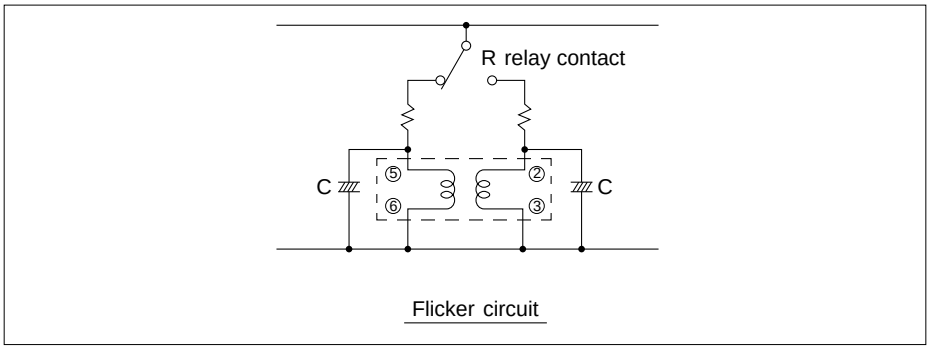
When operating bistable (latching) types by discharge of a capacitor, more reliable operation can be expected if the time to reach pick-up voltage is greater than 2 ms at 5 to 10 μF: (24 V type).



**Automatic coil circuit interruption**

Misoperation may occur in self-operated cutoff circuits such as shown at right. This can be avoided by adding a resistor and capacitor and increasing the pick-up voltage to above that specified.
In a timer circuit, step-pulse voltage from PUT (Programmable Unijunction Transistor) or SBS (Silicon Bilateral Switch) is recommended.




Flicker circuit

**Residual voltage**

When single side stable types or latching types are driven by transistor or UJT, residual voltage is sometimes applied to the coils and decreases contact pressure at N.O. side even if the transistor or UJT are in OFF condition. As a result, characteristics of relays may be harmed. Design your circuits in principle to make such residual voltage zero.

**Short circuit prevention between N.C. and N.O.**

The separation of loads or insertion of a resistor for circuit protection are recommended for the circuits where large current flows due to arcing. (See Fig. 1).

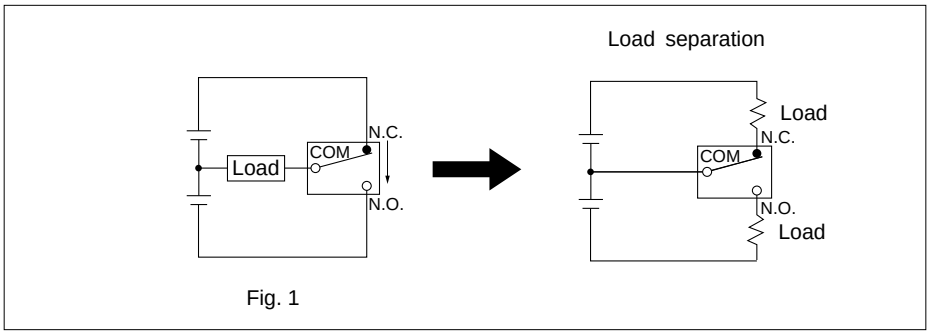


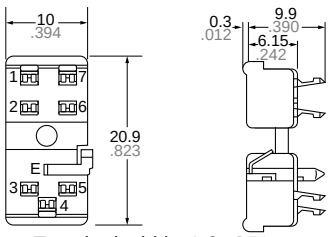

Fig. 1

# ACCESSORIES

mm inch

**PC board terminal sockets (with hold-down clip)**

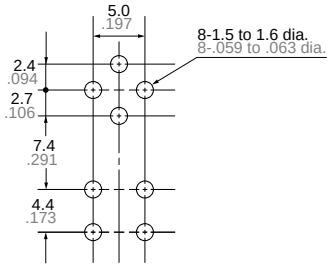
**R-PS**



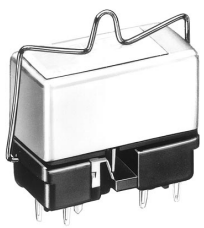

Terminal width: 1.3 .051
Terminal thickness: 1.2 .047

General tolerance: ±0.5 ±.020

PC board pattern (Copper-side view)




Tolerance: ±0.2 ±.008



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