

JIS

JAPANESE INDUSTRIAL STANDARD

**Test methods of low power
electromagnetic relays
for industrial control circuits**

JIS C 5442—1996

Translated and Published

by

Japanese Standards Association

**In the event of any doubt arising,
the original Standard in Japanese is to be final authority**

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association.

Errata will be provided upon request, please contact:
Business Department,
Japanese Standards Association
4-1-24, Akasaka, Minato-ku,
Tokyo, JAPAN 107
TEL. 03-3583-8002
FAX. 03-3583-0462

Errata are also provided to subscribers of JIS (English edition) in *Monthly Information*.

Contents

	Page
1. Scope	1
2. Definitions	1
3. Basic test conditions	4
3.1 Conditions for testing	4
3.2 Standard test power supply	4
4. Electrical performance test	4
4.1 Insulation resistance test	4
4.1.1 Purpose	4
4.1.2 Equipment	5
4.1.3 Preconditioning	5
4.1.4 Test procedure	5
4.1.5 Conditions to be specified in detail specification	5
4.2 Dielectric test (Power frequency withstand voltage)	5
4.2.1 Purpose	5
4.2.2 Equipment	5
4.2.3 Preconditioning	5
4.2.4 Test procedure	6
4.2.5 Conditions to be specified in detail specification	6
4.3 Dielectric test (Impulse withstand voltage)	6
4.3.1 Purpose	6
4.3.2 Waveform of voltage applied and equipment	6
4.3.3 Preconditioning	8
4.3.4 Test procedure	8
4.3.5 Conditions to be specified in detail specification	8
4.4 Characteristics of relay coils	9
4.4.1 D.C. resistance of coil	9
4.4.2 Power consumption of coil (for a.c. relay only)	9
4.5 Contact resistance test	10
4.5.1 Purpose	10
4.5.2 Equipment	10
4.5.3 Preparation	11
4.5.4 Test procedure	11
4.5.5 Conditions to be specified in detail specification	12
4.6 Operate voltage or current and release voltage or current	13
4.6.1 Purpose	13
4.6.2 Equipment	13

C 5442-1996 Contents

	Page
4.6.3 Preparation	14
4.6.4 Test procedure	14
4.6.5 Conditions to be specified in detail specification	15
4.7 Operate time and release time	15
4.7.1 Purpose	15
4.7.2 Equipment	15
4.7.3 Preparation	16
4.7.4 Test procedure	16
4.7.5 Conditions to be specified in detail specification	18
4.8 Contact bounce	18
4.8.1 Purpose	18
4.8.2 Equipment	18
4.8.3 Preparation	18
4.8.4 Test procedure	18
4.8.5 Conditions to be specified in detail specification	19
4.9 Contact chattering	19
4.9.1 Purpose	19
4.9.2 Equipment	19
4.9.3 Test procedure	19
4.9.4 Conditions to be specified in detail specification	19
4.10 Temperature rise	19
4.10.1 Purpose	19
4.10.2 Equipment	19
4.10.3 Preparation	19
4.10.4 Test procedure	20
4.10.5 Conditions to be specified in detail specification	21
5. Mechanical performance tests	21
5.1 Vibration test (see JIS C 0040)	21
5.1.1 Purpose	21
5.1.2 Equipment (see JIS C 0041)	22
5.1.3 Preparation	22
5.1.4 Test procedure	22
5.1.5 Conditions to be specified in detail specification	23
5.2 Shock (see JIS C 0041)	24
5.2.1 Purpose	24
5.2.2 Equipment	25
5.2.3 Preparation	25
5.2.4 Test Procedure	25
5.2.5 Measurement	27

	Page
5.2.6 Conditions to be specified in detail specification	28
5.3 Robustness of termination (see JIS C 0051)	28
5.3.1 Purpose	28
5.3.2 Equipment	28
5.3.3 Test procedure	28
5.3.4 Conditions to be specified in detail specification	33
5.4 Solderability (see 4. of JIS C 0050)	34
5.4.1 Purpose	34
5.4.2 Equipment	34
5.4.3 Materials	34
5.4.4 Preparation	34
5.4.5 Test procedure	34
5.4.6 Conditions to be specified in detail specification	34
5.5 Resistance to soldering heat (see 5. of JIS C 0050)	35
5.5.1 Purpose	35
5.5.2 Equipment	35
5.5.3 Materials	35
5.5.4 Test procedure	35
5.5.5 Conditions to be specified in detail specification	35
6. Climatic tests	36
6.1 Cold (cold storage, cold operation) (see JIS C 0020)	36
6.1.1 Purpose	36
6.1.2 Equipment	36
6.1.3 Preparation and test procedure	36
6.1.4 Conditions to be specified in detail specification	36
6.2 Dry heat (hot storage, hot operation) (see JIS C 0021)	37
6.2.1 Purpose	37
6.2.2 Equipment	37
6.2.3 Preparation and test procedure	37
6.2.4 Conditions to be specified in detail specification	38
6.3 Rapid change of temperature (see 2. of JIS C 0025)	38
6.3.1 Purpose	38
6.3.2 Equipment	38
6.3.3 Preparation	38
6.3.4 Test	38
6.3.5 Conditions to be specified in detail specification	39
6.4 Damp, heat (steady state) (see JIS C 0022)	39
6.4.1 Purpose	39
6.4.2 Equipment	40

C 5442-1996 Contents

	Page
6.4.3 Test	40
6.4.4 Conditions to be specified in detail specification	40
6.5 Damp heat cyclic test	41
6.5.1 Method 1 (see JIS C 0028)	41
6.5.2 Method 2 (see method 2 of JIS C 0027)	47
6.6 Salt mist test (see JIS C 0024)	52
6.6.1 Purpose	52
6.6.2 Test apparatus	52
6.6.3 Salt solution	53
6.6.4 Severities	53
6.6.5 Initial measurement	53
6.6.6 Preconditioning	53
6.6.7 Test	53
6.6.8 Recovery (after final cycle)	54
6.6.9 Final measurements	54
6.6.10 Conditions to be specified in detail specification	54
6.7 Sealing test (see JIS C 0026)	54
6.7.1 Purpose	54
6.7.2 Heating method	54
6.7.3 Reduced pressure method	55
6.7.4 Method by tracer gas	55
6.7.5 Conditions to be specified in detail specification	56
7. Continuous (opening and closing) operation test	56
7.1 Endurance test	56
7.1.1 Purpose	56
7.1.2 Classification of endurance test	56
7.1.3 Loading	56
7.1.4 Test procedure	58
7.1.5 Conditions to be specified in detail specification	59
7.2 Failure rate test	60
7.2.1 Purpose	60
7.2.2 Test circuit and load	60
7.2.3 Test procedure	61
7.2.4 Failure criterion	62
7.2.5 Calculation of failure rate	62
7.2.6 Failure rate level	62
7.2.7 Conditions to be specified in detail specification	63

	Page
8. Overload test	63
8.1 Purpose	63
8.2 Classification of loading (overloading)	63
8.3 Method for connecting load (overload)	64
8.4 Test	64
8.4.1 Conditions for testing	64
8.4.2 Measurement and assessment criterion	65
8.4.3 Conditions to be specified in detail specification	65
Attached Table 1	66

JAPANESE INDUSTRIAL STANDARD

J I S

Test methods of low power electromagnetic
relays for industrial control circuits

C 5442-1996

1. Scope This Japanese Industrial Standard specifies test methods of low power electromagnetic relays ⁽¹⁾ for industrial control circuits which are mainly used for signal transmission in electronic apparatus and industrial control circuits (hereafter referred to as "relays").

Note ⁽¹⁾ The low power electromagnetic relays mean electromagnetic relays of hinge type and read type intended for use in electric circuits of a.c. at a frequency 50 Hz or 60 Hz or d.c. for a voltage not exceeding 250 V and a current not exceeding 30 A.

Remarks 1. Relays are also called electromagnetic relays.

2. The standards cited in this Standard are given in Attached Table 1.

3. The International Standard corresponding to this Standard is given below.

IEC 255-7 (1991) Electrical relays. Part 7 : Test and measurement procedures for electromechanical all-or-nothing relays

2. Definitions For the purpose of this Standard, in addition to the definitions given in JIS C 0010 and JIS Z 8115, the following principal definitions shall apply :

(1) Terms relating to kinds and performances of relays

- (a) monostable relay A relay which operates when the exciting input is applied to the coil and releases when the exciting input is removed.
- (b) bistable relay A relay which operates or releases when the exciting input is applied to the coil and maintains the situation even when the exciting input is removed. There are single-winding type and double-winding type.
- (c) polarized relay A relay in which the exciting input of coil has polarity.
- (d) non-polarized relay A relay in which the exciting input of coil does not have polarity.
- (e) operation This means transfer of a relay from its release condition to operate condition. This term is applicable to both of monostable relays and bistable relays.
- (f) release This means transfer of a relay from its operate condition to release condition. This term is applicable to both of monostable relays and bistable relays.
- (g) operate condition Such a mechanically stable condition, that all break contacts are opened and all make contacts are closed.
- (h) hold condition Such a condition that any contact does not release in allowable fluctuation band of coil voltage or current, in a relay which has been operated.
- (i) release condition Such a mechanically stable condition, that all make contacts are opened and (or) all break contacts are closed.

- (j) transient condition The condition of a relay that start from the instant when the contacts begin to separate, through completion of bounce, to the instant when the relay reaches its operation condition or release condition.
- (k) initial condition Such a condition that a relay is initially under no-excitation or a released relay becomes under no-excitation.

(2) Terms relating to components of relay

- (a) contact The electrical contact which has functions to connect or switch electric circuits.
- (b) coil A part of relay which supplies electromagnetic force to maintain the relay at operate condition or hold condition.

This is mainly composed of windings.

- (c) armature A movable magnetic piece which drives the contact due to the exciting input into the coil.
- (d) coil transient suppression device A device connected to the relay coil for transient suppression.

Surge suppression diode is an example of coil transient suppression device.

- (e) number of poles The number of contact circuits which can be changed-over by one operation.
- (f) single throw A contact assembly which closes the circuit (s) in only one contact position.
- (g) double throw A contact assembly which has two contact positions and closes respective circuit(s) in each of the positions.
- (h) normally open contact A contact member which is open in release condition and closed in operate condition and hold condition. It is also called a make contact or "a" contact.
- (i) normally closed contact A contact member which is closed in release condition and open in operate condition and hold condition. It is also called a break contact or "b" contact.
- (j) change-over contact A contact member of such construction that both of make contact and break contact are provided and the conductive part of movable contacts are in common. The change-over contact which opens before closing is called "transfer contact" or "c contact" and the change-over contact which closes before opening is called "continuous contact" (make-before-break contact).

(3) Terms relating to characteristics of relays

- (a) operate (pickup) voltage The minimum energizing voltage to operate a relay.
- (b) operate (pickup) current The minimum energizing current to operate a relay.
- (c) release (drop out) voltage The maximum energizing voltage at which all the contacts reset when the voltage is lowered rapidly or decreased gradually.
- (d) release (drop out) current The maximum energizing current at which all the contacts reset when the current is lowered rapidly or decreased gradually.
- (e) operate time The time interval between the instant when the rated exciting input is applied to the coil of a relay and the instant when the contact operates.

If plural contacts are provided in the relay, it means the interval until the instant when the latest contact operates, unless otherwise specified.

- (f) release time The time interval between the instant when the rated exciting input is removed from the coil of a relay and the instant when the contact resets. If plural contacts are provided in the relay, it means the interval until the instant when the latest contact resets, unless otherwise specified.
- (g) transit time For a break-before-make change over contact, the time interval during which both contact circuits are open.
- (h) bridging time For a make-before-break change over contact, the time interval between the instant one contact circuit is closed and the instant the other opens.
- (i) bounce The abnormal intermittent switching phenomenon of contact resulted from the shock, vibration, etc. caused by collision of the movable part (armature) of a relay with the associated core or its backstop, or by collision of contact tips each other.
- (j) chattering The abnormal intermittent switching phenomenon of contact tips resulted from the shock, vibration, etc. externally applied to a relay.
- (k) cycling (open and close phenomenon) The phenomenon that a contact circuit repeats its open state and closed state alternately. The open state means such state that the ratio of the contact circuit resistance to the contact resistance not including the boundary resistance reaches 10^6 or more, and the closed state means such state that the ratio is within the said ratio.
- (l) hum The noise produced depending on the mating condition of pole pieces (armature and core) during operate condition and hold condition of an a.c. relay.
- (m) static contact resistance The electrical resistance of contacting part under such a state that the contacts are closed stably.
- (n) dynamic contact resistance The electrical resistance of contacting part under such a state that the contacts are opened and closed continuously.
- (o) closed circuit period The period from the instant of initiation of contact to the instant when the contacts separate in a contact assembly which is carrying out switching continuously.
- (p) rated voltage (energize) The reference voltage to be applied to the coil in normal use of a relay.
- (q) rated current (energize) The reference current to be passed through the coil in normal use of a relay.
- (r) rated contact voltage The reference load voltage which can be opened and closed by the contact member in normal use of a relay.
- (s) rated contact current The reference load current which can be opened and closed by the contact member in normal use of a relay.
- (t) rated thermal current The current which can be passed continuously through the switching part without exceeding the temperature rise limit while the contacts are not opened or closed.
- (u) rated insulation voltage The voltage which is employed as the reference

of insulation design.

- (v) service factor The ratio of the total on-current time during one hour to one hour. This is expressed in percent (%).

Informative reference : The terms are based on IEC-255-7 as far as practical.

3. Basic test conditions

3.1 Conditions for testing Conditions for testing shall be as follows :

- (1) Standard conditions (for testing) Unless otherwise specified, the tests and measurements shall be carried out under the standard conditions for testing given in 5.3 of JIS C 0010 (temperature 15°C to 35°C, relative humidity 25 % to 75 %, air pressure 86 kPa to 106 kPa). If doubt arises on the decision based on the measured values under this standard conditions, or if especially required, the conditions given in (3) shall be employed.

Further, if it is difficult to carry out the measurements under the standard conditions, the tests and measurements may be carried out under other conditions than the standard conditions, unless doubt arises on the decision.

- (2) Reference conditions The reference conditions shall be those given in 5.1 of JIS C 0010 (temperature 20°C, air pressure 101.3 kPa). However, only the temperature may be employed as the reference conditions.
- (3) Referee conditions The referee conditions shall be temperature $20 \pm 1^\circ\text{C}$, relative humidity 63 % to 67 %, air pressure 86 kPa to 106 kPa, or temperature $23 \pm 1^\circ\text{C}$, relative humidity $(50 \pm 2)\%$, stated in 5.2 of JIS C 0010.

3.2 Standard test power supply Unless otherwise specified, the power supply for characteristic measurement of relays shall be as stated in Table 1.

Table 1. Standard test power supply

Item	D.C. power supply	A.C. power supply
(1) Voltage fluctuation	Within $\pm 2\%$	
(2) Current fluctuation	Within $\pm 2\%$	
(3) Frequency fluctuation	—	Within $\pm 2\%$
(4) Ripple percentage ⁽²⁾	3 % max.	—
(5) Waveform factor	—	0.95 to 1.25

Note ⁽²⁾
$$r = \frac{U_{\max} - U_{\text{dc}}}{U_{\text{dc}}}$$

Where, r : ripple percentage

$U_{\max}$: maximum ripple voltage

U_{dc} : d.c. voltage (average value)

4. Electrical performance test

4.1 Insulation resistance test

- 4.1.1 Purpose This test is intended to detect the leakage current which flows

along the surface and through the volume of the insulation when a d.c. voltage is applied to a relay in open position, and to measure the resistance value.

4.1.2 Equipment The equipment shall be the insulation resistance tester specified in JIS C 1302 or JIS C 1303, or an equipment at least equivalent.

The test voltage shall be as given in Table 2.

Table 2. Test voltage

Unit : V	
Rated insulation voltage of relay	Test voltage
Up to and including 30	100
Over 30 up to and including 60	250
Over 60 up to and including 250	500

4.1.3 Preconditioning Before the test, the relay to be tested (specimen) shall be allowed to stand for 30 min or more, under 3.1 (1) Standard conditions.

4.1.4 Test procedure In this test the appropriate test voltage is applied to the positions given below, and then the resistance shall be measured when it stabilizes or after elapse of at least 5 s from the voltage application. However, the measurement may be made immediately after the voltage application, if no doubt arises on the decision.

When it is specified to measure the resistance twice or more on the same position, the polarity of voltage shall be the same.

- (1) Between terminals and exposed dead metal parts of relay
- (2) Between terminals of relay each other

4.1.5 Conditions to be specified in detail specification The following items shall be specified in detail specification :

- (1) Number of measurements of insulation resistance (see 4.1.4)

4.2 Dielectric test (Power frequency withstand voltage)

4.2.1 Purpose This test is intended to examine whether the insulating materials for a relay and the spacing between components are adequate, the relay withstands the temporary overvoltage and can be used without trouble after application of the voltage or not.

4.2.2 Equipment The equipment shall be a dielectric testing equipment generally prepared for such purpose which can generate test voltages, at 50 Hz or 60 Hz, of sinusoidal or substantially sinusoidal waveform, which has a capacity not less than 500 VA, and which will not cause remarkable distortion of waveform and/or voltage variation depending upon the loading conditions.

4.2.3 Preconditioning Before the test, the specimen shall be allowed to stand for 30 min or more under 3.1 (1) Standard conditions.

When this test is carried out in combination with the insulation resistance test, the latter is carried out at first and this preconditioning may be omitted.

4.2.4 Test procedure The appropriate test voltage given in Table 3 shall be applied to the positions given below, and whether such abnormalities as flash over, burning, dielectric breakdown take place on the specimen or not shall be examined.

A voltage not more than $\frac{1}{3}$ of the test voltage shall be applied, the voltage shall be gradually raised up to the prescribed test voltage while reading the indication of voltmeter, and then maintained at that voltage for 1 min. If no doubt arises on the decision, the test may be carried out by applying a voltage equal to 110 % of the test voltage for 1 s.

- (1) Between terminals and exposed dead metal parts of relay
- (2) Between terminals of relay each other

Table 3. Test voltage

Test voltage (r.m.s. value)								Unit : V
250	500	1 000	1 500	2 000	2 500	3 000	4 000	5 000

4.2.5 Conditions to be specified in detail specification The following items shall be specified in the detail specification :

- (1) Test voltage (see 4.2.4)
- (2) Duration of voltage application (if other than 1 min) (see 4.2.4)
- (3) Leakage current

4.3 Dielectric test (Impulse withstand voltage)

4.3.1 Purpose The test is intended to examine whether the insulating materials of relays and the spacing between components are adequate, and the relay withstands the temporary impulse overvoltage and can be used without trouble after application of the voltage.

4.3.2 Waveform of voltage applied and equipment The equipment for this test shall be the one which generates the impulses specified in Fig. 1 and Table 4, and an example of the circuit is shown in Fig. 2.

The peak value U_p shall be as given in Table 5.

In actual test, slightly distorted waveform as shown in Fig.1 (2) may sometimes appear. In such a case, the time interval between the point at which the voltage reaches 30 % of the peak value (point A) and the point at which the voltage reaches 90 % (point B) (time interval corresponding to straight line AB in the figure) divided by 0.6 shall be employed as t_r , and the point of intersection of straight line AB and time axis (point O) shall be employed as the impulse start point.

Also there are some cases that an oscillating voltage is superposed near the peak value as illustrated in Fig. 1(3), in these cases a curve which passes the center of the amplitude of the oscillation is drawn as shown by dotted line in the figure and

the peak value (point P) shall be obtained. The t_f and t_r shall be obtained in the same way as the case of Fig. 1(2).

Table 4. Parameter for shape of voltage waveform

Kind of waveform	t_f	t_r
A	$1.2 \mu\text{s} \pm 30\%$	$50 \mu\text{s} \pm 20\%$
B	$10 \mu\text{s} \pm 30\%$	$160 \mu\text{s} \pm 20\%$
C	$10 \mu\text{s} \pm 30\%$	$700 \mu\text{s} \pm 20\%$
D	$100 \mu\text{s} \pm 30\%$	$700 \mu\text{s} \pm 20\%$

Table 5. Peak voltage value (Standard value)

Unit : kV				
Peak value (U_p) -10%				
1	1.5	2	5	10

Fig. 1. Waveform of voltage to be applied

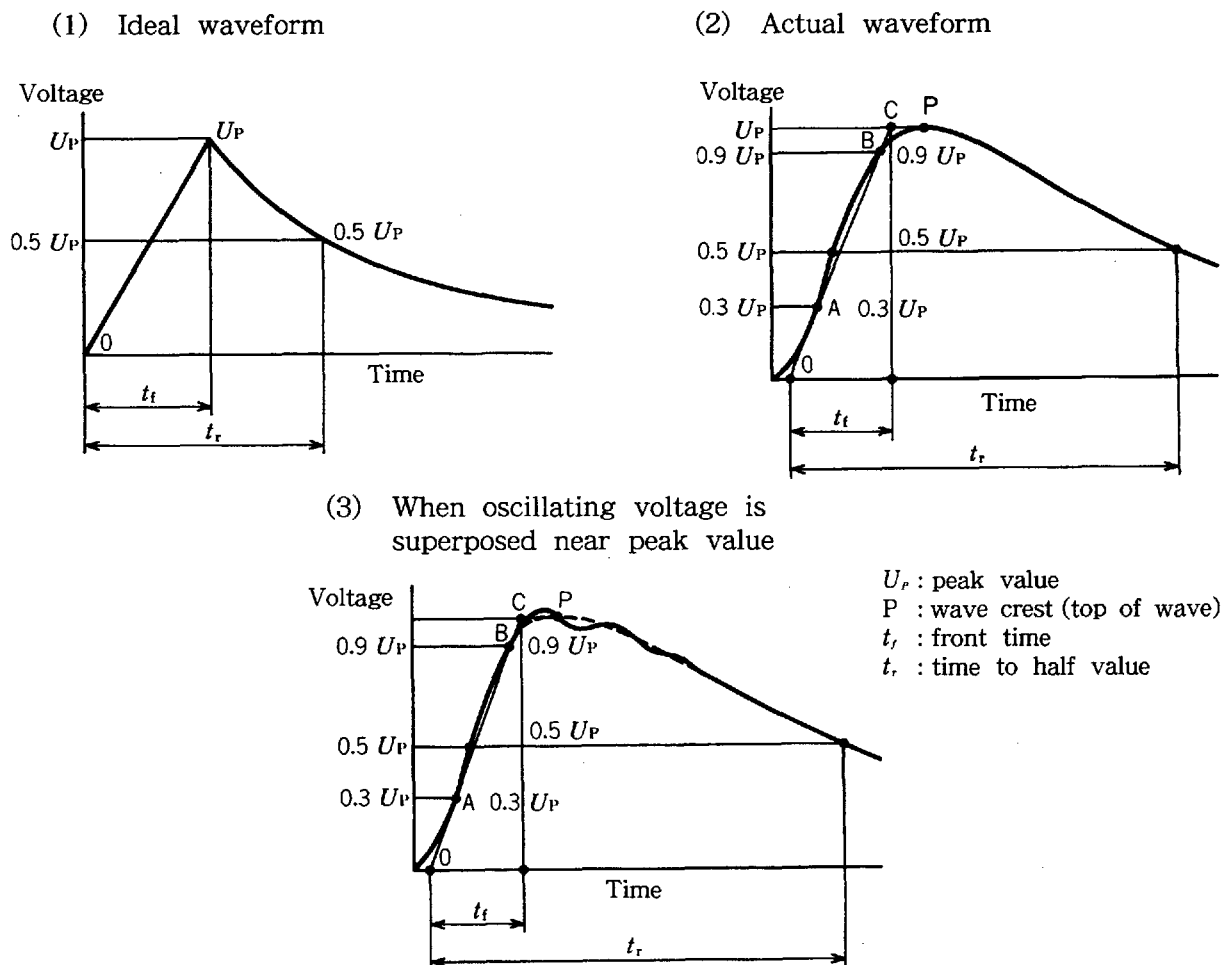
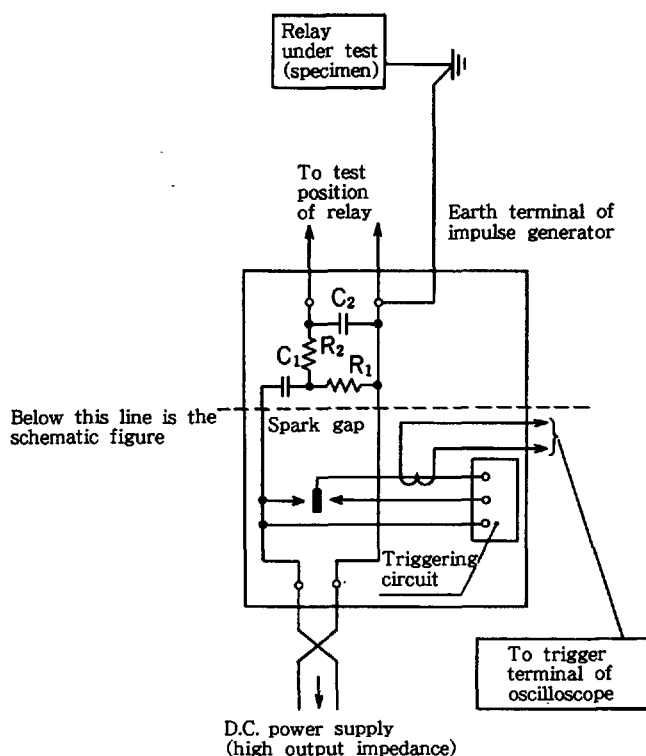


Fig. 2. An example of test circuit



R_1 , R_2 , C_1 and C_2 : Resistors and capacitors to determine time constant of waveform

4.3.3 Preconditioning The preconditioning shall follow 4.2.3.

4.3.4 Test procedure The test voltage specified in Tables 4 and 5 shall be applied to the positions given below and whether such abnormalities as flash over, burning, dielectric breakdown take place on the specimen or not shall be examined (if temporary flash over occurs, it is not considered as abnormality).

The test voltage shall be applied three times in positive polarity and three times in negative polarity with an interval of 5 s or more.

The standard values for the peak value of test voltage are given in Table 5, however, the test may be made using a voltage other than the said standard voltage. In such a case the detail specification shall specify the peak value.

- (1) Between terminals and exposed dead metal parts of relay
- (2) Between terminals of relay each other

4.3.5 Conditions to be specified in detail specification The following items shall be specified in the detail specification :

- (1) Test voltage (peak value of impulse) (see Table 5)
- (2) Test waveform (see Fig. 1 and Table 4)
- (3) Items to be checked in relay operation after test (if necessary)

4.4 Characteristics of relay coils

4.4.1 D.C. resistance of coil

4.4.1.1 Purpose This test is intended to measure d.c. resistances of coils of relays.

4.4.1.2 Equipment The equipment shall be a resistance bridge or another equipment which has sufficient accuracy compared with the specified tolerance on the coil resistance.

The accuracy of equipment shall not exceed 10 % of the specified tolerance on the coil resistance.

4.4.1.3 Preconditioning Before the test, the specimen shall be allowed to stand for 30 min or more under 3.1 (1) Standard conditions (provided that the relative humidity is not exceeding 75 %).

During the test, such factors which affect the measurements as excessive ventilation, sunlight and direct heat radiation from any heat sources shall be avoided.

4.4.1.4 Test procedure The test shall be carried out within such an extent that the temperature rise of coil due to the d.c. voltage and current applied to the specimen for measurement is negligible, and as stated below.

- (1) Unless otherwise specified in the detail specification, the reference temperature shall be 20°C. When the temperature at measurement differs from the reference temperature, the conversion shall be made by the formula stated below (to be used within a range of 10°C to 100°C).

$$R_t = R_{t_0} [1 + \alpha (t - t_0)]$$

Where, R_t : resistance value at $t(^{\circ}\text{C})$

R_{t_0} : resistance value at $t_0(^{\circ}\text{C})$

α : constant mass temperature coefficient of resistance
(0.003 93 for annealed copper wire)

- (2) The duration of voltage application to specimen shall be within 5 s.
- (3) In the test on the same specimen for same test item, the same measuring apparatus and applied voltage (or power supply voltage to the bridge) shall be employed for the measurements. If there is no dispute, this is not necessarily required.

4.4.1.5 Conditions to be specified in detail specification The following items shall be specified in the detail specification :

- (1) Accuracy of equipment (if necessary) (see 4.4.1.2)
- (2) Reference temperature (if differs from 20°C)

4.4.2 Power consumption of coil (for a.c. relay only)

4.4.2.1 Purpose This test is intended to measure the power consumption of an a.c. relay coil.

4.4.2.2 Test procedure The test shall be carried out as follows :

- (1) The measurement shall be carried out at the rated excitation state on the specimen free from external magnetic influences.
- (2) The current when the rated voltage is applied shall be measured and the rated power consumption shall be calculated as the product of the applied voltage and the measured current.

4.4.2.3 Conditions to be specified in detail specification The following items shall be specified in the detail specification :

- (1) Voltage to be applied (if other than rated voltage)
- (2) Frequency of a.c. power supply (see 4.4.2.2)

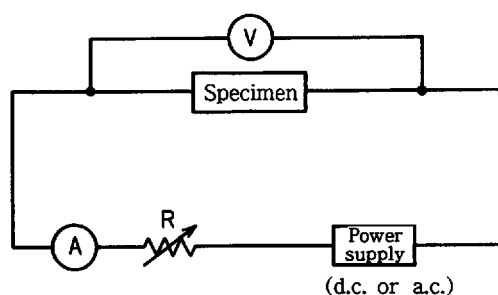
4.5 Contact resistance test

4.5.1 Purpose This test is intended to measure the contact resistance of a relay (static contact resistance and dynamic contact resistance).

4.5.2 Equipment The equipment shall consist of the circuits given below or at least equivalent, and have an accuracy of measurement not exceeding $\pm 10 \%$.

- (1) Voltage drop method The method shall be as shown in Fig. 3. When an a.c. power supply is used, its frequency shall be from power frequency up to 2 kHz.

Fig. 3. Voltage drop method

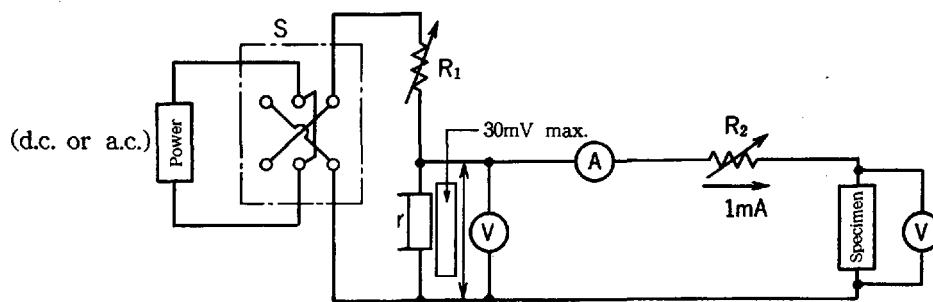


Ⓐ : ammeter Ⓥ : voltmeter R : variable resistor

- (2) Method by low voltage and low current The method shall be as shown in Fig. 4. The frequency of a.c. power supply, if used, shall be as stated in (1).

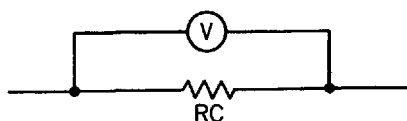
When d.c. power supply is used, the measurement shall be made in both directions i.e. the polarity of electrode is changed-over by throwing switch S into opposite side. If there is no dispute, the voltage may be applied in only one direction.

Fig. 4. Method by low voltage and low current



Ⓐ : ammeter R_1, R_2 : variable resistors
 r : shunt (non-inductive type resistance shall be used for a.c.)
 Ⓥ : electronic voltmeter S : switch

Remarks : If there is some trouble on the measurement due to high internal resistance of Ⓐ, the part of Ⓐ should be replaced by the circuit given below.



RC : standard resistor
 Ⓥ : electronic voltmeter

4.5.3 Preparation If cleaning of contact, other special preparation, mounting of specimen, etc. are necessary in advance of the test, such treatment shall be made in accordance with the detail specification.

4.5.4 Test procedure The test shall be carried out according to one of (1) to (4) stated below.

- (1) Voltage drop method for static contact resistance In the test, the contact resistance shall be calculated from the measuring voltage and the measuring current applied to the contact to be tested (specimen) under normally closed state by means of the equipment specified in 4.5.2 (1). Although either d.c. or a.c. power supply may be used for the measurement, the measured values by d.c. shall be adopted if there are some disputes.

In the case of measurement with d.c. power supply, the measurement shall be carried out with the polarity changed, if such polarity change is specified in the detail specification.

Four-terminal system which provides voltage terminals and current terminals separately for the specimen shall be employed. In this case, the voltage terminals shall be located close to the specimen.

The measuring voltage to be applied to the specimen shall be 25 % of the rated contact voltage or 6 V whichever is the lower. The measuring current shall, as a rule, be the current specified in Table 6.

Table 6. Test current

Rated contact current or make-break current(I) A	Test current mA
$I < 0.01$	1
$0.01 \leq I < 0.1$	10
$0.1 \leq I < 1$	100
$1 \leq I$	1 000

- (2) Voltage drop method for dynamic contact resistance The test shall be carried out by the method specified in (1). However, rectangular wave of the rated voltage shall be applied to the coil.

The frequency of on-off of coil, measuring period, and measuring voltage and current of the contact shall have the respective values specified in the detail specification. The measurement shall be carried out at the point of time after the contact reaches normally closed state or elapse of at least 30 % of the closed circuit period whichever is the later.

- (3) Low voltage and low current method for static contact resistance In the test, the contact resistance shall be calculated from the measuring voltage and the measuring current applied to the specimen under normally closed state by means of the equipment specified in 4.5.2 (2). Although either d.c. or a.c. power supply may be used for the measurement, the measured values by d.c. shall be adopted if there are some disputes.

In the case of measurement with d.c. power supply, the measurement shall be carried out with the polarity changed, if such polarity change is specified in the detail specification.

Four-terminal system which provides voltage terminals and current terminals separately for the specimen shall be employed. In this case, the voltage terminals shall be located close to the specimen.

The measuring voltage to be applied to the specimen shall be so adjusted that the open circuit voltage under open state of the specimen is 30 mV or less. The measuring current shall be 1 mA.

Before the test no voltage exceeding 30 mV shall be applied to the specimen.

- (4) Low voltage and low current method for dynamic contact resistance The test shall be carried out by the method specified in (3). However the coil shall be driven by rectangular wave of the rated voltage. The frequency of on-off of coil, measuring period shall be as specified in the detail specification.

The measurement shall be carried out at the point of time after the contact reaches normally closed state or elapse of at least 30% of the closed circuit period whichever is the later.

4.5.5 Conditions to be specified in detail specification The following items shall be specified in the detail specification :

- (1) Preparation (see 4.5.3)
- (2) Measuring circuit (see 4.5.2)

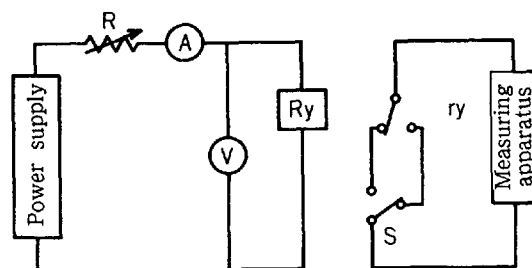
- (3) Number of times of measurements (see 4.5.4)
- (4) Test voltage and current (see 4.5.4)
- (5) Frequency of on-off and measuring period for dynamic contact resistance (see 4.5.4)

4.6 Operate voltage or current and release voltage or current

4.6.1 Purpose This test is intended to measure the voltage or the current at which a relay operates or releases by increasing or decreasing its energizing quantity of the relay.

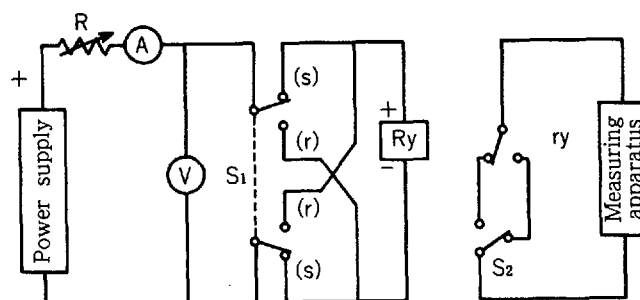
4.6.2 Equipment The equipment consists of a power supply which can change its output voltage (or current), a switch which can change over this power supply (for Figs. 6 and 7) and a measuring apparatus for detecting the operation and release of specimen, as illustrated in Figs. 5 to 7. The accuracy of the instruments for measuring voltage (or current) shall be within $\pm 0.5\%$. The measuring apparatus shown in Figs. 5 to 7 is the one to detect the operation and release, and a voltmeter, an ammeter or an adequate apparatus may be employed.

Fig. 5 Device A



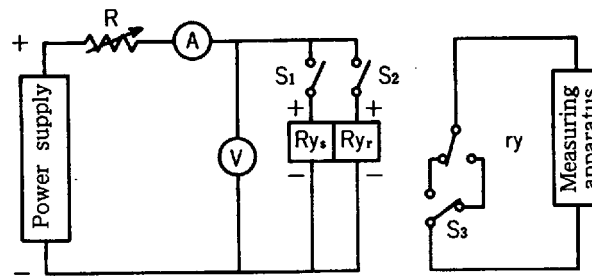
S : switch Ry : coil of specimen ry : contact of specimen
R : variable resistor A : ammeter V : voltmeter

Fig. 6 Device B



S₁, S₂ : switch Ry : coil of specimen ry : contact of specimen
(s) : operation side of switch S₁ (r) : release side of switch S₁
R : variable resistor A : ammeter V : voltmeter

Fig. 7 Device C



S_1, S_2, S_3 : switch Ry_s : operation coil of specimen
 Ry_r : release coil of specimen ry : contact of specimen
 R : variable resistor $\textcircled{A}$: ammeter $\textcircled{V}$: voltmeter

4.6.3 Preparation The preparation shall be as follows :

- (1) Mounting of specimen Unless the mounting method is specified, the specimen shall be so mounted that the armature moves in three directions i.e. horizontal, vertically upwards and downwards. If there is no dispute, the specimen may be mounted in one direction specified in the detail specification.
- (2) Preconditioning before test The condition of the relay to be subjected to the test shall be one of the conditions given in Table 7. The preconditioning is considered as completed when the temperature at each part stabilizes. In the case of conditions 1, the specimen shall be allowed to stand at the ambient temperature for at least 30 min.

Table 7. Requirement for preconditioning

Required condition	Coil	Ambient temperature °C	Contact
1	—	20 ± 2	—
2	Application of rated voltage	20 ± 2	—
3	Application of rated voltage	40 ± 2	—
4	Application of rated voltage	40 ± 2	Passing of rated current

4.6.4 Test procedure The test shall be carried out by any one of the methods stated below, at the ambient temperature shown in Table 7 and specified in the detail specification. If there is no dispute, the measurement may be made under the standard conditions and the measured values may be converted to the values under the ambient temperature specified in Table 7.

The test shall be carried out immediately after the preconditioning.

- (1) Test method A This method is applicable to monostable relays, and the measurements shall be carried out as stated below, by means of device A in Fig. 5.
 - (a) Operate voltage or current The voltage or current shall be rapidly or gradually increased and the voltage or current at the instant when the relay

becomes operate condition shall be measured.

- (b) Release voltage or current The rated voltage or rated current shall be applied to the coil, the voltage or current shall be rapidly or gradually decreased, and the voltage or current at the instant when the relay becomes release condition shall be measured.
- (2) Test method B This method is applicable to bistable relays of single winding, and the measurements shall be carried out as stated below by means of device B in Fig. 6.
 - (a) Operate voltage or current Switch S_1 is closed to release side, the relay is brought to release condition by applying the rated voltage or current to the coil, then the voltage or current shall be made zero. Then switch S_1 is closed to operate side, the voltage or current is raised rapidly or gradually and the voltage or current at the instant when the relay becomes operate condition shall be measured.
 - (b) Release voltage or current Switch S_1 is closed to operate side, the relay is brought to operate condition by applying the rated voltage or current to the coil, then the voltage or current shall be made zero. Then switch S_1 is closed to release side, the voltage or current is raised rapidly or gradually and the voltage or current at the instant when the relay becomes release condition shall be measured.
- (3) Test method C This method is applicable to bistable relays of double windings, and the measurements shall be carried out as stated below by means of device C in Fig.7.
 - (a) Operate voltage or current Switch S_2 is closed, the relay is brought to release condition by applying the rated voltage or current to the coil then the voltage or current is made zero and switch S_2 is opened. Then switch S_1 is closed, the voltage or current is raised rapidly or gradually and the voltage or current at the instant when the relay becomes operate condition, shall be measured.
 - (b) Release voltage or current Switch S_1 is closed, the relay is brought to operate condition by applying the rated voltage or current to the coil, then the voltage or current is made zero and switch S_1 is opened. Then switch S_2 is closed, the voltage or current is raised rapidly or gradually and the voltage of current at the instant when the relay becomes release condition, shall be measured.

4.6.5 Conditions to be specified in detail specification The following items shall be specified in the detail specification :

- (1) Designation of test method A, B or C (see 4.6.4)
- (2) Requirement for preconditioning [see 4.6.3 (2)]
- (3) Direction of mounting relay (if the direction is one) [see 4.6.3 (1)]

4.7 Operate time and release time

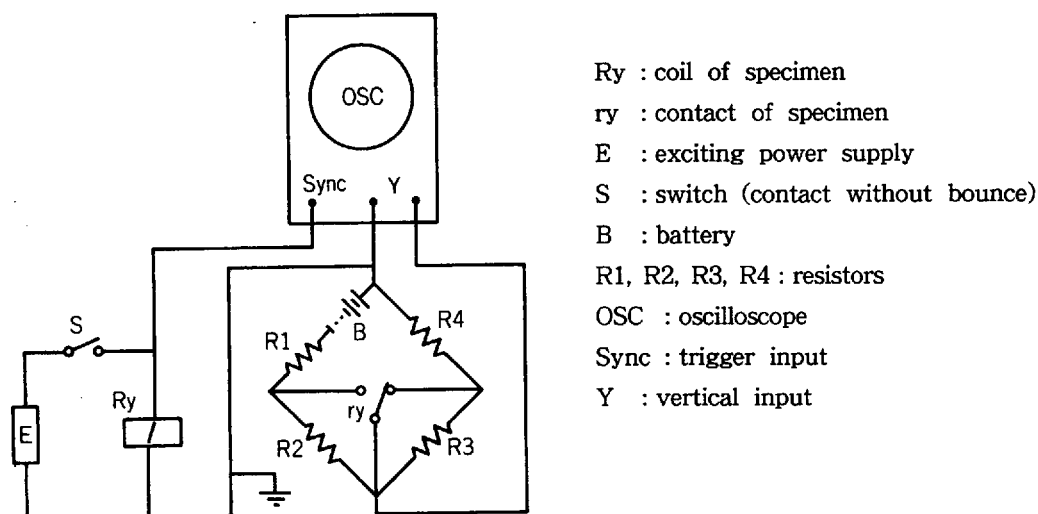
4.7.1 Purpose This test is intended to measure operate time and release time of a relay.

4.7.2 Equipment The equipment for this test consists of an oscilloscope or a digital

timer, the resolution of which is not exceeding 5 % of the operate time or the release time. An example of circuit configuration of this equipment is shown in Fig. 8.

For excitation of the coil of specimen, the standard power supply shall be used.

Fig. 8. An example of measuring circuit for operate time and release time



Remarks : It is desirable to employ the values stated below for resistors to identify the bridge time and the change-over time.

$$R1 : R2 : R3 : R4 = 1 : 2 : \frac{1}{3} : 1$$

4.7.3 Preparation Unless the mounting method is specified, the specimen shall be so mounted that the armature moves in three directions i.e. horizontal, vertically upwards and downwards. If there is no dispute, the specimen may be mounted in one direction.

4.7.4 Test procedure The contact and coil of specimen shall be connected to the respective power supplies whose voltage and current are specified in the detail specification, and the time in question shall be obtained by observing the waveform (see Fig. 9) on the oscilloscope or measuring with the timer when the coil voltage or current is applied and removed intermittently. The bounce time of contact shall not be included in the operate time and the release time given below.

- (1) **Operate time** The operate time shall be measured as stated below. All the make contacts are connected in series, the coil is excited at the rated value by using the power supply of 4.7.2, and the time interval between the excitation and the closing of contacts is measured. All the break contacts are connected in parallel, the coil is excited rapidly at the rated value, and the time interval between the excitation and the separation of the contacts is measured. In both measurements, a d.c. operated relay is tested five times, an a.c. operated relay 20 times (five times, if phase control is employed) and the maximum value is obtained.

If the contact which operates latest is obvious from the structure of the relay, the measurement may be carried out on the said contact only.