

JIS

JAPANESE INDUSTRIAL STANDARD

**Testing methods of switches for
use in electronic equipment**

JIS C 5441—1994

Translated and Published

by

Japanese Standards Association

Printed in Japan

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

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JAPANESE INDUSTRIAL STANDARD

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Testing methods of switches for use in
electronic equipment

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1. Scope This Japanese Industrial Standard specifies test methods of switches which are mainly used for electronic equipment and which have mechanical contacts with the rated voltage of 250 V or under (a.c. of frequency of 50 Hz or 60 Hz, or d.c.) and the rated current of 25 A or under.

Remarks: The cited standards and corresponding International standards are listed in Attached Table 1.

2. Definition For the purpose of this Standard, in addition to the definitions specified in JIS C 0010, the following principal definitions apply:

- (1) mounting bushing A component of a switch by which the switch is mounted on an equipment and which also serves as a bearing.
- (2) clearance The shortest path in air between two conducting parts (corresponding to IEC 664).
- (3) creepage The shortest path along the surface of insulating material between two conducting parts (corresponding to IEC 664).
- (4) contact bounce Opening of close contact and closing of open contact which are caused by a switch mechanism intermittently and at random after the contact moves.
- (5) contact bounce time Time required from the instant of first closing of a pair of contacts until all contact bounces cease, or from the instant of first opening of closed contacts until all contact bounces cease.
- (6) contact chattering Such phenomenon that a pair of contacts in the ON or OFF state are opened or closed by external causes (such as shock and vibration, etc.).
- (7) steady load state The state of a switch after completion of the transient state at the time of throwing-in of the switch.
- (8) steady current The current which flows through a switch at steady load state.
- (9) service factor The ratio in percentage of the time during which the current flows through a switch to a certain repetition period.

- (10) rated open and close current The current which is intended by design to flow through a contact when it is opened or closed.
- (11) rated passing current The current which is intended by design to flow through a contact when it is closed.
- (12) rated overload open and close current The current which is intended to flow through a contact when it is opened or closed in excess of rating for overload test.
- (13) rated rush current The current which is intended by design to flow transiently through a switch at the time of throwing-in of the switch.
- (14) rated overload rush current The rush current at the overload state for overload test.
- (15) rated voltage The voltage which is intended by design to be applied to a switch.
- (16) rated open and close voltage The voltage which is intended by design to be applied to a switch when it is opened or closed.
- (17) rated passing voltage The voltage which is intended by design to be applied to a switch in the ON state.
- (18) electric load Elements (resistor, coil, capacitor, etc.) connected to a circuit to pass a certain current through a specimen switch.
- (19) operation test The test to operate a switch with the electric load connected under the simulated state of actual use of the switch.
- (20) Maximum rated current The maximum of working currents which are intended by design to flow through a switch.

3. Test condition

3.1 Standard condition of test site The environmental condition of test and measurement site shall be as specified in Table 1, unless otherwise specified.

If any doubt arises on the decision based on the measured values under this standard condition, or if it is especially requested, 3.2 shall be followed.

Table 1. Standard condition of test site

Temperature °C	Relative humidity %	Atmospheric pressure kPa
15 to 35	25 to 85	86 to 106

Remarks 1. When a specimen is tested, the fluctuation of temperature and humidity shall be kept to a minimum during a series of measurements to be carried out as a part of test.

2. When a specimen is too large, or a test site is difficult to keep the temperature within the range specified in the Table, the temperature range may be extended to 5°C to 40°C, if it is permitted by detail specifications.

3.2 Referee condition The referee condition shall be based on 5.2 of JIS C 0010 as specified in Table 2.

Table 2. Referee condition

Temperature °C	Relative humidity %	Atmospheric pressure kPa
20 ± 2	60 to 70	86 to 106

4. General provisions The common provisions for the test specified in this Standard are as follows.

- (1) Application of test methods specified in this Standard The test methods specified in this Standard are not necessarily applicable to all types of switches. If necessary, additional test methods and/or the detail of test methods shall be specified.
- (2) Provisions for detail specifications Detail specifications shall specify: the tests to be carried out; measurements to be carried out before and after each test or a series of test; and the sequence.

When the sequence is not specified, follow the sequence of provisions.

- (3) Conditions for initial measurement and final measurement The measurement conditions shall be the same.
- (4) Measurement before and after a series of tests When tests are carried out in the specified sequence, the final measurement for a test shall be taken as the initial measurement for the next test.
- (5) Electrical tolerance Unless any measurement is made, the actual measured values of the test voltage, test current and test frequency shall be within 5 % of the nominal rating of a switch.
- (6) Special preparation Unless specified in detail specifications, a switch shall not be cleaned or otherwise treated in a special manner before or during a test.
- (7) Mounting of a specimen switch When the test method specifies how to mount a specimen switch, it shall be fixed securely in an ordinary mounting method, and electrically connected according to the detail specification.

The mounting method, parts and material shall not adversely affect the electrical or mechanical performance of the switch.

5. Appearance, construction, dimensions and marking

5.1 Appearance, construction and finishing The appearance, construction and finishing shall be examined visually on the following items. However, the specimen shall be disassembled to confirm the interior, if so specified.

When use of a magnifier or test of surface treatment is required, the detail specification shall be followed.

- (1) Finished condition and treatment
- (2) Material
- (3) Surface condition
- (4) Inside situation of semi-transparent material
- (5) Position and state of applied lubricant
- (6) Loosening and separation of parts (especially after stressed)

5.2 Dimensions Dimensions shall be tested with the vernier calliper specified in JIS B 7507, the micrometer callipers for external measurement specified in JIS B 7502, gauges, projectors, measuring microscopes, etc. Screw threads shall be tested with the gauges specified in JIS B 0251 or JIS B 0252 on the following items. However, other measuring apparatus may be used unless doubt arises on the decision.

- (1) External dimension
- (2) Clearance and creepage If specified by the detail specifications, 3.(3) of JIS C 8306 shall be followed in addition to the following provisions.
 - (a) As to clearance, measurement shall be made of the shortest path of the part specified by the detail specification.

Clearance shall be measured when the force of 29.4 N outside apparatus or the force of 1.96 N inside apparatus is applied at the position which minimizes the distance between unlike poles. This provision is not applicable when the short circuit between like poles of parts does not present any danger.

- (b) As to creepage, measurement shall be made of the shortest path along the surface of insulating material of the part specified by the detail specification.

In this case, if the surface of insulating material to be measured has a groove of less than 1 mm in width, the depth of the groove shall not be included in creepage distance.

- (3) Detailed dimensions (for example, dimensions of screws, mounting, terminations, etc.)

5.3 Marking

5.3.1 Marking Marking shall be visually examined unless otherwise specified.

5.3.2 Resistance of marking to solvent The resistance of marking to solvent shall be as specified as follows.

- (1) Purpose The purpose is to test resistance of marking to washing liquid when a switch for printed wiring board is washed.

- (2) Test The test shall be carried out according to the following (a) and (b). After the test, marking shall be visually examined.

(a) Test condition As specified in Table 3.

Table 3. Kinds and immersion time of solvent

Kinds of solvent	Temperature of solvent	Immersion time
As specified in the detail specification	23°C to 28°C	5 ± 0.5 min

- (b) Friction condition After the specimen is taken out of solvent, it shall be scrubbed five times over about 10 mm range with 10 N force, using a rubber bar of 11.3 mm in diameter, 5 mm in thickness and 30 to 40 Shore A hardness, covered with cotton cloth.

5.4 Items specified in detail specification The detail specification shall specify the following items.

- (1) Internal structure (if applicable) (refer to 5.1)
- (2) Magnification of a magnifier (if applicable) (refer to 5.1)
- (3) Test items (refer to 5.1 and 5.2)
- (4) Measuring apparatus (if other measuring apparatus is used) (refer to 5.2)
- (5) Resistance of marking to solvent (if applicable) (refer to 5.3.2)

6. Function operation

6.1 Purpose The purpose is to assess whether the opening and closing functions are appropriate.

6.2 Equipment The equipment used for this test shall, unless otherwise specified, be a contact resistance meter specified in 7.1 or at least equivalent.

6.3 Preparation A specimen switch shall be connected securely with the measuring apparatus, using an appropriate connection fixture.

6.4 Test The test shall follow the detail specification. Each circuit of the specimen switch shall be tested to confirm the electrical opening and closing operation.

Confirm that the mechanical detent, latching, interlock, and automatic resetting mechanism functions correctly or not with operating them.

6.5 Items specified in detail specification The detail specification shall specify the following items.

- (1) Measuring apparatus (if it is different from 6.2)
- (2) Test items and sequence (refer to 6.4)

7. Electrical performance

7.1 Contact resistance

7.1.1 Equipment The equipment for this test shall have an accuracy of 10 % or better and consist of the measuring circuit shown in Figs. 1 to 4, or at least equivalent.

Fig. 1. Specified current method (by d.c.)

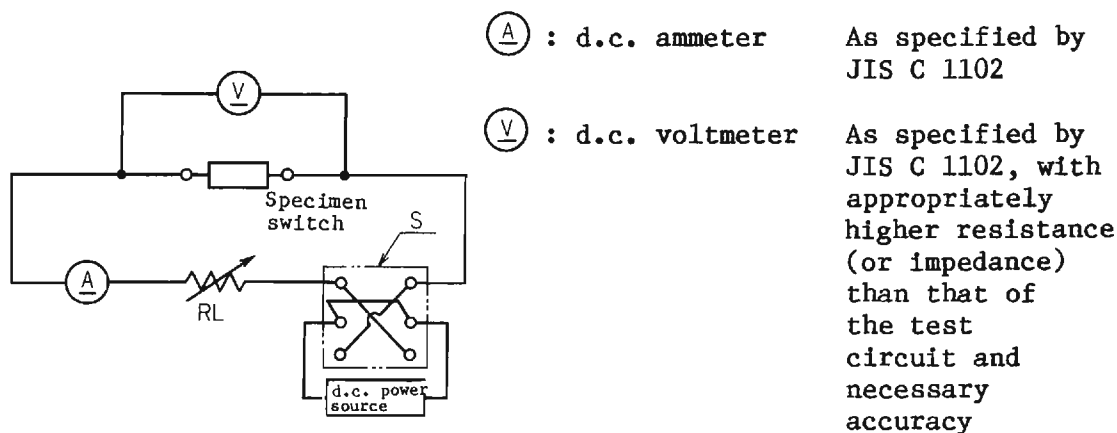


Fig. 2. Specified current method (by a.c.)

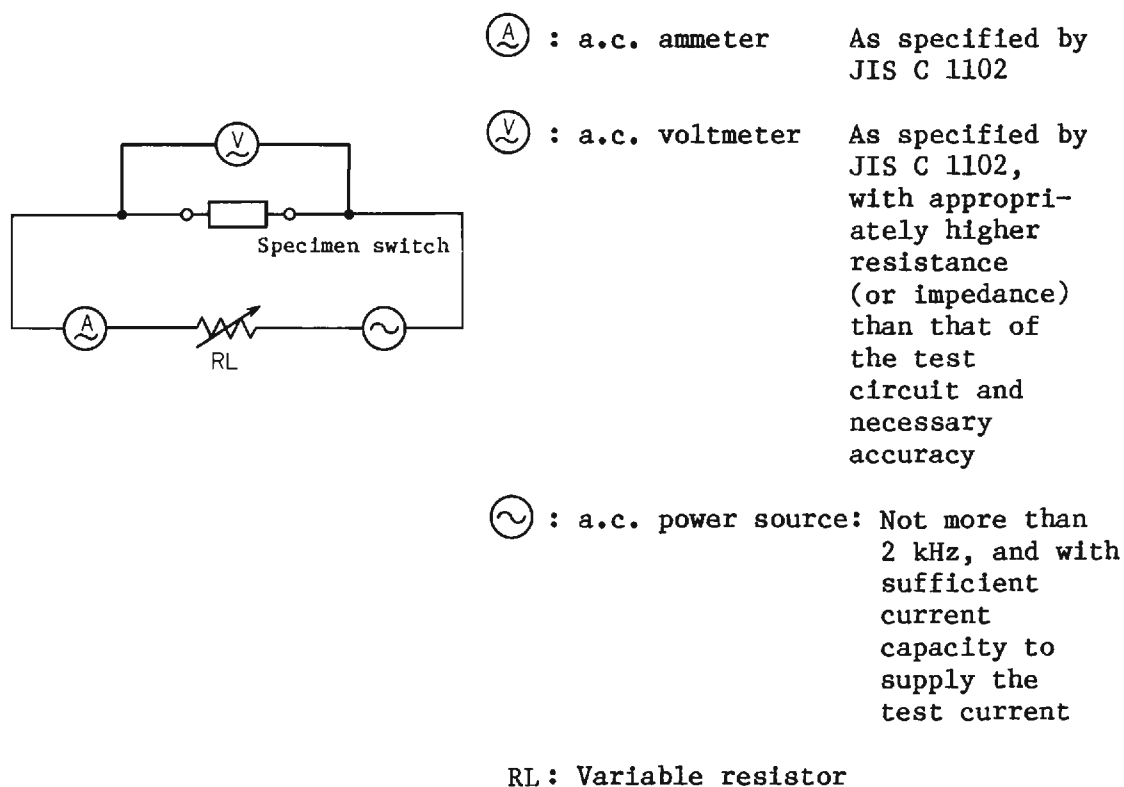
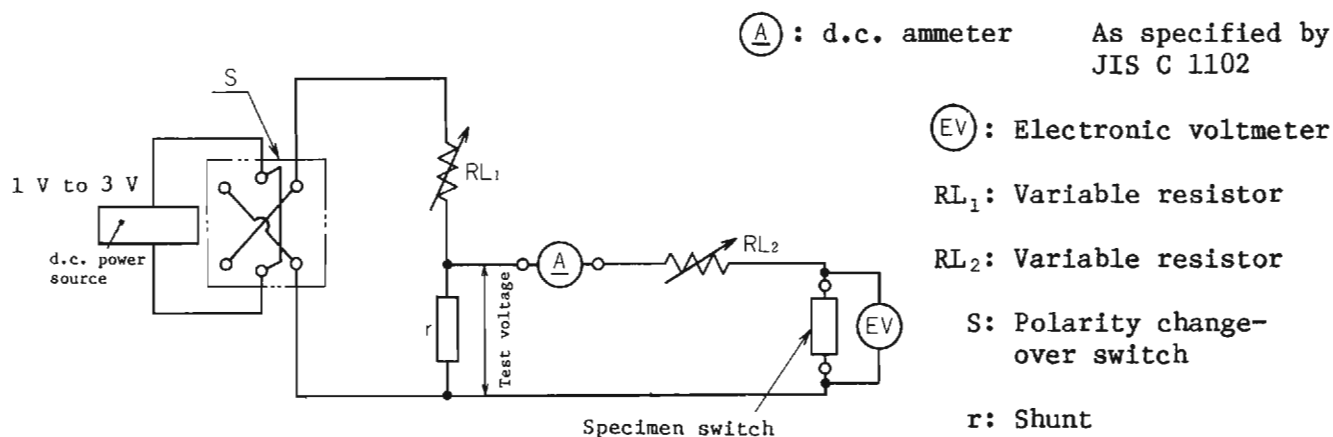


Fig. 3. Low voltage and current method (by d.c.)



Remarks: If the high internal resistance of (A) disturbs measurement, the part of (A) shall be replaced by the circuit shown below.

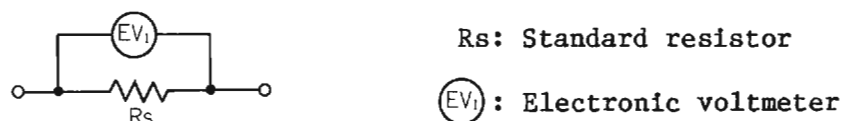
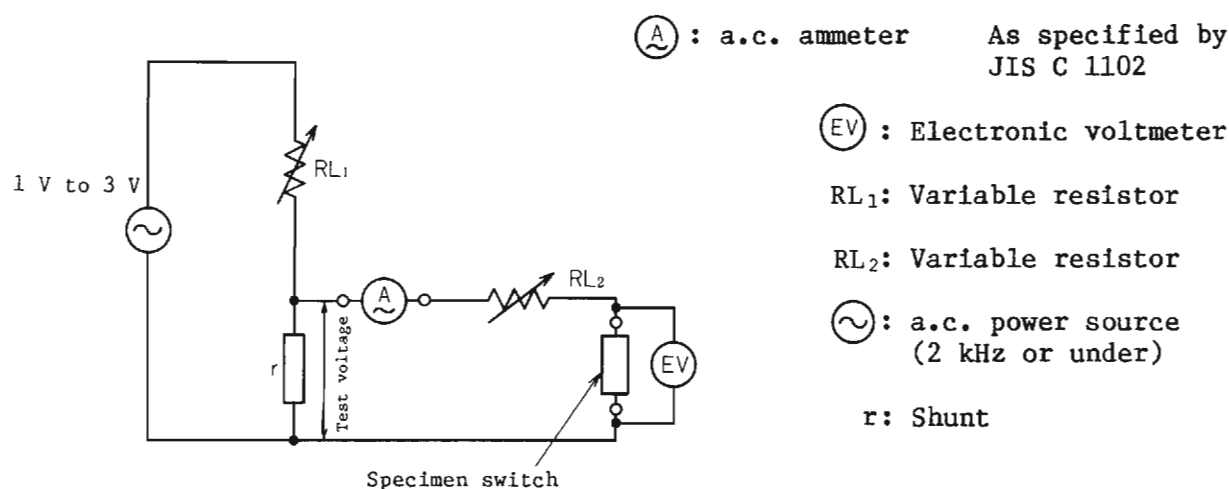


Fig. 4. Low voltage and current method (by a.c.)



Remarks: If the high internal resistance of (A) disturbs measurement, the part of (A) shall be replaced by the circuit shown below.



7.1.2 Preparation A specimen switch shall be connected securely with the measuring apparatus, using an appropriate connection fixture, and avoiding errors in the measurement.

Cleaning of contacts, other special preparation and mounting before the test, if any, shall follow the detail specification.

7.1.3 Test The measuring positions shall be the positions to which external wires are connected. According to one of detail specifications of (1) to (4), the voltage drop shall be measured. The contact resistance r_s shall be calculated by the following equation.

$$r_s = \frac{\Delta V}{I}$$

where, r_s : contact resistance of specimen (Ω)

I : test current (A)

ΔV : voltage drop across the pair of contacts of specimen (V)

If several measurements are necessary on the same measuring positions, such requirement shall be specified in detail specification.

(1) Method A Specified current method (by d.c.)

(1.1) Purpose The purpose is to examine the total electric resistance of the switching circuit, including the switch terminals, at the voltage not less than the melting voltage of contact material.

(1.2) Measurement condition The test current shall be specified by the detail specification. The power source voltage for the test shall be 1 V to 6 V.

(1.3) Measurement circuit The measurement circuit shall be as specified in Fig. 1.

(1.4) Measurement sequence The measurement shall be made in the following sequence of (a) to (d).

- (a) Close the contacts under test.
- (b) Pass the test current through the contacts under test, and measure the voltage drop across the pair of contacts.
- (c) Reverse the direction of test current and measure the voltage drop in the same way.
- (d) Calculate the contact resistance from the average of measured values in the above (b) and (c).

(2) Method B Specified current method (by a.c.)

- (2.1) Purpose The purpose is to examine the total electric resistance of the switching circuit, including the switch terminals, at the voltage not less than the melting voltage of contact material.
- (2.2) Measurement condition The test frequency shall be 2 kHz or under. The test current shall be specified by the detail specification. The power source voltage for the test shall be 1 V to 6 V.
- (2.3) Measurement circuit The measurement circuit shall be as specified in Fig. 2.
- (2.4) Measurement sequence The measurement shall be made in the following sequence of (a) to (c).
- (a) Close the contacts under test.
 - (b) Pass the test current through the contacts under test, and measure the voltage drop across the pair of contacts.
 - (c) Calculate the contact resistance.

(3) Method C Low voltage and current method (by d.c.)

- (3.1) Purpose The purpose is to examine the total electric resistance of the switching circuit, including the switch terminals, at the voltage which does not affect contact material electrically.
- (3.2) Measurement condition The test voltage shall be max. 20 mV or under at the open state of circuit. The test current shall be 100 mA or under.
- (3.3) Measurement circuit The measurement circuit shall be as specified in Fig. 3.
- (3.4) Measurement sequence The measurement shall be made in the following sequence of (a) to (d).
- (a) Close the contacts under test.
 - (b) Pass the test current through the contacts under test, and measure the voltage drop across the pair of contacts.
 - (c) Reverse the direction of test current and measure the voltage drop in the same way.
 - (d) Calculate the contact resistance from the average of measured values in the above (b) and (c).

(4) Method D Low voltage and current method (by a.c.)

- (4.1) Purpose The purpose is to examine the total electric resistance of the switching circuit, including the switch terminals, at the voltage which does not affect contact material electrically.
- (4.2) Measurement condition The test voltage shall be max. 20 mV or under at open circuit. The test frequency shall be 2 kHz or under. The test current shall be 100 mA or under.

- (4.3) Measurement circuit The measurement circuit shall be as specified in Fig. 4.
- (4.4) Measurement sequence The measurement shall be made in the following sequence of (a) to (c).
- (a) Close the contacts under test.
 - (b) Pass the test current through the contacts under test, and measure the voltage drop across the pair of contacts.
 - (c) Calculate the contact resistance.

7.1.4 Items specified by detail specification The detail specification shall specify the following items.

- (1) Accuracy of measuring equipment (if specified) (refer to 7.1.1)
- (2) Test method (refer to 7.1.3)
- (3) Test current (refer to 7.1.3)
- (4) Test voltage (refer to 7.1.3)
- (5) Measurement position (if different from 7.1.3) (refer to 7.1.3)
- (6) Number of times of measurement (if different from 7.1.3) (refer to 7.1.3)
- (7) Power source voltage for test (if different from 7.1.3) [refer to 7.1.3 (1) and (2)]
- (8) Test frequency (if specified) [refer to 7.1.3 (2) and (4)]
- (9) Maximum test voltage at open circuit (if different from 7.1.3) [refer to 7.1.3 (3) and (4)]

7.2 Insulation resistance

7.2.1 Equipment The equipment for this test shall be an insulation resistance tester (as specified by JIS C 1302 and JIS C 1303) or a high-resistance bridge or other measuring apparatus which has at least equivalent accuracy thereto.

7.2.2 Preparation The part whose insulation resistance is measured as specified in detail specification shall be connected securely with the measuring apparatus, using an appropriate connection fixture, and avoiding errors in the measurement.

Special preparation and mounting before the test, if any, shall follow the detail specification.

7.2.3 Test Unless otherwise specified, the test shall be carried out in such a way that the test voltage complying with the requirement of the detail specification selected from among the voltages given in Table 4, is applied to any of the following measuring positions A, B, C and D which is (are) specified in the detail specification for $1 \text{ min} \pm 5 \text{ s}$. Then, the insulation resistance shall be measured with the said voltage being applied. However, if the reading of measuring apparatus stabilizes or tends to increase further above the specified insulation resistance even within the specified period, the decision may be made by such behavior.

When two or more measurements on the same position are specified, measurements shall be made in the same polarity. If any doubts arise at the test of terminals connected together, each terminal shall be tested separately. If a switch has 6 or more, or 7 or more operating positions, the number of measuring positions may be reduced by the detail specification.

Table 4. Test voltage for insulation resistance
Unit: V

Test condition	Test voltage (d.c.)
A	100 ± 10
B	250 ± 25
C	500 ± 50
D	1000 ± 100
E	10 ± 1
F	50 ± 5

- (1) Measuring position A
 - (a) Between live metal parts of different polarity and circuit
 - (b) Between terminations of the same polarity under open-circuit state
 - (c) Between live metal part and dead metal part accessible by a man, and between live metal part and insulated operating part
- (2) Measuring position B Between each termination and other terminations connected with enclosure and/or mounting plate (to be connected together)
- (3) Measuring position C The terminations are grouped into two groups i.e. group 1 and group 2 by connecting the adjacent and insulated terminations alternately.
 - (a) Between group 1 and group 2 connected with enclosure and/or mounting plate
 - (b) Between group 2 and group 1 connected with enclosure and/or mounting plate

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- (4) Measuring position D Between two terminations with minimum insulation distance

7.2.4 Items specified in detail specification The following items shall be specified in detail specifications:

- (1) Special preparation, mounting, etc. (if specified) (refer to 7.2.2)
- (2) Positions to be measured (refer to 7.2.3)
- (3) Test voltage (refer to 7.2.3)
- (4) Number of times of measurement (if measured twice or more) (refer to 7.2.3)

7.3 Dielectric withstand voltage

7.3.1 Purpose The purpose of this test is to determine whether a switch can withstand when the test voltage is applied under the specified condition.

7.3.2 Equipment The power source for this test shall be capable of raising the test voltage gradually from 0 V to the specified test voltage (r.m.s. value at power frequency or d.c. voltage), and lowering vice versa, and shall not cause remarkable waveform distortion, voltage fluctuation, etc. under the loading conditions for this test.

When the test voltage is 1000 V or over at the power frequency, the power source capacity shall be 500 VA or over.

The voltmeter of grade 0.5, grade 1.0 or grade 1.5 specified in JIS C 1102 shall be used. When it is required to investigate the dielectric breakdown caused inside the specimen and if it is difficult to visually observe such failure, an adequate indicator to indicate occurrence of destructive discharge and the leakage current shall be provided.

7.3.3 Preparation Adequate connectors shall connect the test equipment securely with the part on which dielectric withstand voltage is measured.

The detail specifications shall specify special preparation, mounting, etc. needed before the test.

7.3.4 Test Unless otherwise specified, the test shall be carried out in such a way that the test voltage complying with the requirement of the detail specification selected from among the voltages given in Table 5, is applied to any of the following measuring positions A, B, C and D which is (are) specified in the detail specification. Check for flashover, burn, dielectric breakdown and other abnormalities.

The maximum leakage current shall be specified in the detail specification.

The voltage shall, unless otherwise specified, be applied from almost 0 V to the specified value uniformly (to permit reading on a voltmeter) within 15 s. But, it shall not exceed 500 V/s. After the specified test voltage (X-column in Table 5) has been reached, unless otherwise specified, wait for 60 s. Then, decrease the voltage quickly to almost 0 V. Unless any doubt arises concerning the decision, the voltage of Y-column in Table 5 may be applied for 1 s from the beginning.

For a lot test, the voltage of X-column in Table 5 may be applied for 5 s, or the voltage of Y-column in Table 5 may be applied for 1 s from the beginning.

- (1) Measuring position A Test positions of measuring position A are as follows.
 - (a) Between live metal parts of different polarity and circuit
 - (b) Between terminations of the same polarity under open-circuit state
 - (c) Between live metal part and/or dead metal part accessible by a man, and between live metal part and insulated operating part
- (2) Measuring position B Between each termination and other terminations connected with enclosure and/or mounting plate (to be connected together)
- (3) Measuring position C The terminations are grouped into two groups i.e. group 1 and group 2 by connecting the adjacent and insulated terminations alternately.
 - (a) Between group 1 and group 2 connected with enclosure and/or mounting plate
 - (b) Between group 2 and group 1 connected with enclosure and/or mounting plate
- (4) Measuring position D Between two terminations with minimum insulation distance

Table 5. Dielectric withstand test voltage

Unit: V

Test condition	Test voltage		Test condition	Test voltage	
	X column	Y column		X column	Y column
A	100^{+5}_0	120^{+6}_0	F	$1\,500^{+75}_0$	$1\,800^{+90}_0$
B	$150^{+7.5}_0$	180^{+9}_0	G	$2\,000^{+100}_0$	$2\,400^{+120}_0$
C	$250^{+12.5}_0$	300^{+15}_0	H	$3\,000^{+150}_0$	—
D	500^{+25}_0	600^{+30}_0	I	$4\,000^{+200}_0$	—
E	$1\,000^{+50}_0$	$1\,200^{+60}_0$	J	$50^{+2.5}_0$	60^{+3}_0

7.3.5 Items specified in detail specification The following items shall be specified in detail specifications:

- (1) Special preparation, mounting, etc. (if specified) (refer to 7.3.3)
- (2) Positions to be measured (refer to 7.3.4)
- (3) Test voltage (a.c. or d.c.) (refer to 7.3.4)
- (4) Maximum leakage currents (refer to 7.3.4)

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7.4 Reduction of atmospheric pressure

7.4.1 Purpose The purpose of this test is to evaluate whether a switch can withstand an insulation breakdown when it was exposed to a voltage stress under the simulated altitude condition.

7.4.2 Equipment The test chamber shall be capable of keeping the pressure specified in 7.4.4, and have walls through which electric wires are installed.

7.4.3 Preparation Specimen switches shall be wired to the positions measured as specified in the detail specification.

7.4.4 Test The test shall be carried out under the condition and sequence as follows.

- (1) Keep the inside of test chamber at the standard condition (15°C to 35°C).
- (2) Place a specimen switch of the normal state in the chamber.
- (3) Decrease the atmospheric pressure in the chamber down to $8 \text{ kPa} \pm 5 \%$ (atmospheric pressure equivalent to the altitude of about 17600 m), and wait for 4 h. The rate of change of pressure shall be 10 kPa/min or under, unless otherwise specified.
- (4) When the detail specification specifies the electric load, a specimen switch shall be put under the electric load.

The performance specified in the detail specification shall be confirmed.

When the detail specification specifies the intermediate measurement, it shall be performed.

- (5) The test voltage specified in detail specification shall be applied to a specimen switch in the chamber for the specified period of time. Unless otherwise specified, the test voltage for the rated voltage of 42 V or over shall be $400 V_{ac}$.
- (6) The operation test shall be done with a specimen switch placed in the chamber, if so specified by the detail specification. The operation speed and the number of operations shall be as specified by the detail specification.
- (7) Return the pressure in the chamber to the normal atmospheric pressure. The rate of change of pressure shall be 10 kPa/min or under, unless otherwise specified.
- (8) Take a specimen switch out of the chamber, and leave it in the standard condition for 1 h to 2 h.
- (9) Carry out the withstand voltage test as specified in the detail specification.

The maximum leakage current shall be as specified by the detail specification.

7.4.5 Items specified in detail specification The following items shall be specified in detail specifications:

- (1) Measurement positions (refer to 7.4.4)
- (2) Test voltage and voltage application duration in the chamber (refer to 7.4.4)
- (3) Test voltage and voltage application duration for the withstand voltage test to be carried out after taking a specimen switch out of the chamber. (refer to 7.4.4)
- (4) Operation test conditions (speed, number of operations, etc.) to be carried out during the test (if applicable) (refer to 7.4.4)
- (5) Intermediate measurement during test (if applicable) (refer to 7.4.4)
- (6) Maximum leakage current (refer to 7.4.4)

7.5 Capacitance

7.5.1 Equipment The equipment for this test shall be a measuring apparatus having an accuracy which is within 10 % of the tolerance on capacitance.

7.5.2 Preparation Attention shall be paid on the connection between the measuring apparatus and the specimen to minimize the error in the measurement.

If special preparation, mounting, etc. are needed before the test, such work shall follow the detail specification.

7.5.3 Test The capacitance between measuring points, specified in the detail specification, given below shall be measured by using an a.c. voltage at $1 \text{ kHz} \pm 200 \text{ Hz}$ or at $1 \text{ MHz} \pm 200 \text{ kHz}$. The said a.c. voltage shall be as low as practically possible not to cause trouble on the measurement.

- (1) Between one termination and other termination(s) Metal parts and mounting plates shall be connected and grounded together.
- (2) Between two adjacent terminations In this case, other terminations, Metal parts and mounting plates shall be connected and grounded together.

7.5.4 Items specified in detail specification The following items shall be specified in the detail specification.

- (1) Special preparation, mounting, etc. (if specified) (refer to 7.5.2)
- (2) Test frequency (if specified) (refer to 7.5.3)
- (3) Measuring position (refer to 7.5.3)

7.6 Temperature rise of termination

7.6.1 Purpose The purpose of this test is to evaluate the temperature rise of termination caused by flowing of the rated current.

7.6.2 Equipment The thermocouple used for this test shall be, as specified in JIS C 1602, made of component material T, be of grade 0.75, and have the element wire of 0.32 mm in outer diameter. The reference point shall be of ice point type, thermostad type or compensation type. The moving coil voltmeter of grade 0.5 specified in JIS C 1102 or at least equivalent shall also be used.

7.6.3 Preparation The specimen is mounted on a flat, horizontal, non-conducting surface in still air to avoid the influence of external heat. Unless otherwise specified, the thermocouple is fixed by soldering or other methods to a point on termination which is nearest to the switch body. The wire used for connecting the specimen shall be as specified below. However, in case of no doubt, the wire may be 300 mm or longer, and the conductor diameter may be as specified in the detail specification.

(1) Kind and dimension of wire or cord shall be as specified in Table 6.

Table 6. Kind and dimension of wire or cord

Rated current of switch A		7 or under	Over 7 up to and incl. 10	Over 10 up to and incl. 15	Over 15 up to and incl. 20	Over 20 up to and incl. 30
Dimension of connection wire or cord	Nominal diameter mm	1.0	1.26	1.6	2	2.6
	Nominal cross sectional area mm ²	0.75	1.25	2	3.5	5.5
Length of connection wire or cord m			1 or over (per one wire or cord)			
Kind of connection wire or cord			JIS C 3307 JIS C 3301 JIS C 3306			

Remarks 1. When the wire or cord connected to a switch is specified, such wire or cord shall be used.

2. If the specimen is a switch with attached wire, the specimen shall be directly connected without applying Table 6.

(2) The tip of core of connection wire (stranded wire) and cord shall be processed to prevent loosening when connected to the termination. However, if the tip is so designed not to loosen, any special processing is not required.

The termination at the tip of core shall be a bare crimp terminal specified in JIS C 2805, and it shall adapt to the dimension of the terminal screw and connection wire of specimen.

(3) The lead wire of switch with attached wire shall be soldered to the test connection wire, or bolted using the bare crimp terminal mentioned in (2).

- (4) When the wire or cord is connected with the terminal fixtures of switch, the fastening torque of terminal screw shall be as specified in Table 7, depending upon the nominal diameter of terminal screw.

Table 7. Fastening torque of terminal screw

Nominal diameter of terminal screw mm	3	3.5	4	4.5	5	6	8	10
Fastening torque N·cm	32.3	57.7	77.6	97	129.4	161.7	355.7	485.1

Remarks: If the nominal diameter of terminal screw exceeds 10 mm, the provisions of detail specification shall be followed.

7.6.4 Test Either of (1) or (2) in detail specification mentioned below shall be followed.

- (1) Method A Pass the rated current through the specimen and measure the temperature rise (the difference between measured temperature and ambient temperature) every about 10 min, three times consecutively. Continue this procedure until each of the differences in the temperature rise becomes less than 1°C. Then, that value shall be recorded. Measure the ambient temperature at a point 300 mm apart from the specimen under test in the shortest, horizontal distance.
- (2) Method B Pass the maximum rated current for 1 h through the specimen after the endurance (load) test. Measure the temperature rise every 5 min with the current passing. Continue this procedure until each of the differences in the temperature rise becomes less than 1°C. Then, that value shall be recorded. Measure the ambient temperature in the same manner as Method A.

7.6.5 Items specified in detail specification The following items shall be specified in detail specification.

- (1) Conductor diameter of wire (if it is different from 7.6.3)
- (2) Test method (refer to 7.6.4)
- (3) Test current (refer to 7.6.4)

7.7 Contact bounce [Informative reference: This corresponds to 4.3.7 of IEC 1020]

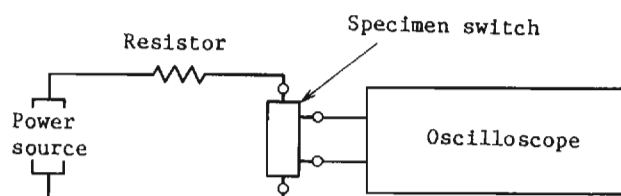
7.7.1 Purpose The purpose of this test is to measure the time required for opening of close contact and closing of open contact which are caused by a switch mechanism intermittently and at random after the contact moves.

In case of logic circuit, the contact bounce may result in errors of data.

7.7.2 Equipment The main equipment used for this test, unless otherwise specified, shall be as follows.

- (1) **Oscilloscope** The bandwidth shall be 1 MHz or over, and the time axis accuracy shall be within 5 %. Display of contacts before moving shall be possible.
- (2) **Measuring circuit** The circuit shall be as shown in Fig. 5, or at least equivalent. The current in the circuit shall be 100 mA or under, and the voltage shall be 6 V_{dc} or under.

Fig. 5. Measuring circuit for contact bounce



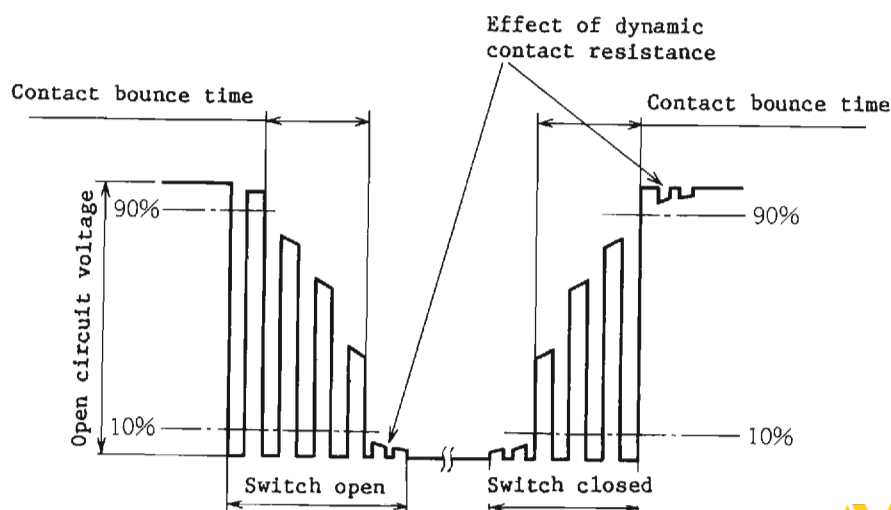
7.7.3 Preparation A specimen switch shall be mounted securely in the normal manner. It shall be connected with the measuring apparatus, using an appropriate connection fixture, and avoiding errors in the measurement.

7.7.4 Test A specimen switch shall be operated with the speed specified in the detail specification. Measure the time required for opening of close contact and closing of open contact which are intermittent and at random while the contact is moving. For measurement, operate the switch five times consecutively. The maximum time shall be recorded as the contact bounce time. The contact bounce time shall be as specified in Fig. 6.

The opening and closing operations shall be defined as follows.

- (1) **The state of opening operation** When the voltage drop across the contacts is 90 % or over of the open circuit voltage, the state shall be defined as open.
- (2) **The state of closing operation** When the voltage drop across the contacts is 10 % or under of the open circuit voltage, the state shall be defined as closed.

Fig. 6. Contact bounce time



7.7.5 Items specified in detail specification The following items shall be specified in detail specification.

- (1) Operating speed of switch (refer to 7.7.4)
- (2) Operating force of switch (if specified) (refer to 7.7.4)

7.8 Contact chattering

7.8.1 Purpose The purpose of this test is to detect such phenomenon that the close contact opens (instant OFF of contact) or the open contact is closed (instant ON of contact) during the dynamic test for resistance to vibration (8.10) and shock (8.11).

7.8.2 Equipment The equipment for this test shall have the following performance.

- (1) The equipment can supply to a specimen switch the d.c. current of 10 V, 150 mA at maximum.
- (2) If the voltage drop and the voltage rise exceed 50 % of open circuit voltage, they can be defined as interruption and connection, respectively.
- (3) The interruption time of Table 8 can be detected.

7.8.3 Preparation A specimen switch shall be mounted in the normal way. The part whose contact chattering is measured shall be connected securely with the measuring apparatus, using an appropriate connection fixture.

7.8.4 Test The equipment specified in 7.8.2 can detect interruption and connection times of Table 8 specified in detail specification. This equipment shall be connected with a specimen switch mounted to the dynamic test equipment for vibration and shock. Examine whether the current interruption or connection exceeds continuously the specified value, during the test of resistance to vibration and the test of shock. When individual contacts are measured or plural contacts are measured simultaneously, connect the close contact in series, and connect the open contact in parallel.

Table 8. Interruption time or connection time

1 μ s	10 μ s	100 μ s	1 ms	10 ms
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7.8.5 Items specified in details specification The following items shall be specified in detail specification.

- (1) Magnitude of current and voltage to apply to a specimen (refer to 7.8.2)
- (2) Magnitude of interruption time and/or connection time of current (refer to 7.8.2 and 7.8.4)
- (3) Connection method of contact (if different from 7.8.4)

7.9 Stability of contact resistance

7.9.1 Purpose The purpose of this test is to evaluate the secular change of contact resistance of switch contacts, which may be caused by a long interval of switch operation. A specimen switch is exposed to the high end within the working temperature range.

This test shall be applied to a switch whose working circuit voltage is not more than the millivolt (mV) level, and whose operation interval is long.

7.9.2 Equipment The equipment used for this test shall be as follows.

- (1) Contact resistance tester Refer to 7.1.1.
- (2) Mechanical endurance tester Refer to 9.1.2.
- (3) High temperature tester Refer to 11.3.2.

7.9.3 Preparation A switch shall be mounted in the normal way.

7.9.4 Test The test shall be done in the following sequence.

- (1) Carry out the test under 9.1 Mechanical endurance - Standard atmospheric condition. The number of tests shall be 10 % of that specified in detail specification, Mechanical endurance - Standard atmospheric condition.
- (2) Carry out 11.3 High temperature test. The test temperature shall be the upper limit of working temperature range specified in detail specification.

The test period shall be 100 h, 200 h, 500 h, 1000 h or 2000 h, as specified in detail specification. If necessary, the detail specification shall specify that the test is applied to both the open and close contacts.

Never apply the shock and vibration to the close contact during the test.

- (3) Contact resistance shall be measured by 7.1.3, Method D, Low voltage and current method (by a.c.).

Measure all the close contacts, then, measure all the contacts which opened during the test, by making close.

7.9.5 Items specified in detail specification The detail specification shall specify the following items.

- (1) Number of tests and operation speed of mechanical endurance - standard atmospheric condition (refer to 7.9.4)
- (2) Temperature and test period of high temperature test (refer to 7.9.4)

7.10 Resistance from operating part to mounting bushing (surface)

7.10.1 Purpose The purpose of this test is to evaluate the total electric resistance between the conducting part of operating part of switch and the mounting bushing.

7.10.2 Equipment The equipment for this test shall be able to measure the electric resistance between the conducting part of operating part of switch and the mounting bushing.

7.10.3 Test The test is to measure the electric resistance between the conducting part of operating part of switch and the appropriate position of mounting bushing, according to the method specified in detail specification.

7.10.4 Items specified in detail specification The detail specification shall specify the following specifications.

- (1) Measurement method (refer to 7.10.3)
- (2) Measurement condition (refer to 7.10.3)

8. Mechanical performance

8.1 Robustness of termination (including screw mounting robustness) (refer to JIS C 0051)

8.1.1 Equipment The equipment for this test shall not give the specimen such scratch, strain, etc. that will influence the test results.

8.1.2 Preparation Place the termination in the normal position, and fix the specimen with the mounting jig.

8.1.3 Initial measurements The initial measurements shall be the following (1) to (6), as specified in detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

8.1.4 Test Test the item (1) and any of the items (2) to (4) given below as specified in detail specification. Check for broken or loosened terminations. Measure as specified in the detail specification.

- (1) Tensile strength Comply with 2 of JIS C 0051 and the following. Place the switch termination in the normal position. Apply gradually (without giving a shock) the tension of Table 9 as specified in detail specification along the pulling axis of termination. Maintain for 10 s. All terminations shall be tested. The tension of lug terminations (lead wiring termination and tab termination) and screw terminations shall not be tested by Table 9, but by the detail specification.

Table 9. Tension

Nominal cross sectional area S ⁽¹⁾ mm ²	Nominal diameter of circular cross section d mm	Tension N	Informative reference: Mass of a weight corresponding to tension kg
$S \leq 0.05$	$d \leq 0.25$	1	0.102
$0.05 < S \leq 0.07$	$0.25 < d \leq 0.3$	2.5	0.255
$0.07 < S \leq 0.2$	$0.3 < d \leq 0.5$	5	0.510
$0.2 < S \leq 0.5$	$0.5 < d \leq 0.8$	10	1.020
$0.5 < S \leq 1.2$	$0.8 < d \leq 1.25$	20	2.041
$1.2 < S$	$1.25 < d$	40	4.081

Note ⁽¹⁾ For lead wire termination with circular cross section, plate termination, or pin termination: The nominal cross sectional area shall be calculated from nominal dimensions as specified in detail specification.

Remarks: When the diameter of lead wire terminations is too large, the detail specification shall specify the appropriate tension.

- (2) Compressive strength (not applicable to flexible termination) Comply with 3. of JIS C 0051 and the following. Place the switch termination in the normal position. Apply compressive force in Table 10 as specified in detail specification to a point on terminations which is nearest to the switch body. Maintain the gap of 2 mm between the switch body and the nearest point of compression test equipment.

All terminations shall be tested. If specified by the detail specification, a switch with four or more terminations may be tested on any four of those terminations. In this case, all terminations shall be tested almost in the same probability. If necessary, the direction of compressive force shall be shown in a drawing.

The compressive force of lug terminations (lead wiring termination and tab termination) and screw terminations shall not be tested by Table 10, but by the detail specification.

Table 10. Compressive force

Nominal cross sectional area S ⁽¹⁾ mm ²	Nominal diameter of circular cross section d mm	Compressive force N
$S \leq 0.05$	$d \leq 0.25$	0.25
$0.05 < S \leq 0.07$	$0.25 < d \leq 0.3$	0.5
$0.07 < S \leq 0.2$	$0.3 < d \leq 0.5$	1
$0.2 < S \leq 0.5$	$0.5 < d \leq 0.8$	2
$0.5 < S \leq 1.2$	$0.8 < d \leq 1.25$	4
$1.2 < S$	$1.25 < d$	8

- (3) Bending strength (applicable only to terminations easily bent) Comply with 4 of JIS C 0051 and the following.

The bending force shall be as specified in Table 11, according to the section modulus. All terminations shall be tested. If specified by the detail specification, a switch with four or more terminations may be tested on any four of those terminations. In this case, all terminations shall be tested almost in the same probability.

This limitation of number of terminations to be tested shall not be applied to (c) Simultaneous bending strength. The simultaneous bending strength shall be applied to a switch having several terminations on one or more sides.

- (a) Lead wire termination or plate termination (printed wiring board termination) Fix the main body with termination oriented vertically in normal position. Suspend a weight at the tip of termination. Bend the switch main body within the vertical plane for 2 s to 3 s by about 90°. Restore it to the original position with the same speed. This procedure is called one bending. The detail specification shall specify either Method 1 or 2 as follows.

Method 1: After one bending, bend to an opposite direction. This is the second bending. Then, bend to the opposite direction (the same direction as the first). This is the third bending. Bend twice or more.

Method 2: After one bending, bend to the same direction. This is the second bending. Then, bend to the same direction. This is the third bending. Bend twice or more.

- (b) Lug terminations (lead wire termination and tab termination) Lug terminations (lead wire termination and tab termination) which can be bent with a finger shall be bent with a finger by 45°. Restore to the original position. This procedure is called one bending. The detail specification shall specify either Method 1 or 2 as follows.

Method 1: Bend to an opposite direction in the same way as the first. This is the second bending. Bend twice.

Method 2: Bend to the same direction in the same way as the first. This is the second bending. Bend twice.

- (c) Simultaneous bending strength Use a fixture and capture all the terminations at one side of a switch. The point of capture shall be 3 mm apart from the terminations sealed to the switch body. Attach a weight to the fixture to orient the terminations downward. Bend the switch body for 2 s to 3 s by 45°. Restore to the original position with the same speed. Next, bend to the opposite direction, and restore to the original position again.

The mass of this weight shall include the mass of fixture, and it shall be calculated by multiplying the bending force of Table 11 by the number of terminations captured by the fixture.

Remarks: For short terminations, the upper surface of fixture shall not touch the switch body for the bending test (if it touches, the tension may occur on terminations).

Table 11. Bending force

Section modulus Z_x mm^3	Nominal wire diameter of circular cross section d mm	Bending force N	Informative reference: Mass of a weight corresponding to the bending force kg
$Z_x \leq 1.5 \times 10^{-3}$	$d \leq 0.25$	0.5	0.051
$1.5 \times 10^{-3} < Z_x \leq 2.6 \times 10^{-3}$	$0.25 < d \leq 0.3$	1.25	0.127
$2.6 \times 10^{-3} < Z_x \leq 1.2 \times 10^{-2}$	$0.3 < d \leq 0.5$	2.5	0.255
$1.2 \times 10^{-2} < Z_x \leq 0.5 \times 10^{-1}$	$0.5 < d \leq 0.8$	5	0.51
$0.5 \times 10^{-1} < Z_x \leq 1.9 \times 10^{-1}$	$0.8 < d \leq 1.25$	10	1.02
$1.9 \times 10^{-1} < Z_x$	$1.25 < d$	20	2.04

Remarks: The section modulus Z_x of round wire shall be calculated by the following equation.

$$Z_x (\text{mm}^3) = \frac{\pi d^3}{32}$$

where, d : lead wire diameter (mm)

The section modulus Z_x of plate termination shall be calculated by the following equation.

$$Z_x (\text{mm}^3) = \frac{ba^2}{6}$$

where, a : thickness of plate perpendicular to the bending axis (mm)

b : dimension of another side of rectangular cross section (mm)

- (4) Torsional strength (Applicable to screw termination) Comply with 6. of JIS C 0051 and the following.

All terminations shall be tested. If specified by the detail specification, a switch with four or more terminations may be tested on any four terminations. In this case, all terminations shall be tested almost in the same probability. A switch shall be fixed by an ordinary fixture. Each nut of screw and each termination shall be subjected to the torque of Table 12 for 10 s to 15 s. The severity shall be by detail specification. Never apply a shock. During this test, place a washer or metallic plate between the screw head and the fastening plate. The washer or metallic plate shall have a hole slightly larger than a screw. The thickness of washer or metallic plate shall be about 6 times the nominal pitch of screw. The nut thickness shall be about 0.8 times the nominal diameter of screw. These shall be free of stain and be dry.

Table 12. Torque

Nominal diameter of screw mm		2.6	3.0	3.5	4.0	5.0	6.0
Torque Nm	Severity 1	0.4	0.5	0.8	1.2	2.0	2.5
	Severity 2	0.2	0.25	0.4	0.6	1.0	1.25

Remarks 1. If the nominal diameter of screw is larger than 6 mm, the torque shall be as specified by the detail specification.

2. Nuts or screws may be loosened later.

8.1.5 Final measurement The items for final measurement shall be the following (1) to (6), as specified by detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

8.1.6 Items specified in detail specification The detail specification shall specify the following items.

- (1) Items for initial measurement (refer to 8.1.3)
- (2) Test method (refer to 8.1.4)
- (3) Number of terminations to be tested when terminations are four or more (refer to 8.1.4)
- (4) Tension and compressive force of lug termination (lead wire termination and tab termination) and screw termination (refer to 8.1.4)
- (5) Test method of bending strength of lead wire termination, plate termination (printed wiring board termination), and lug termination [refer to 8.1.4 (3)]
- (6) Severity of torque of screw termination [refer to 8.1.4 (4)]
- (7) Severity of torque of screw termination whose diameter is larger than 6 mm [refer to 8.1.4 (4)]

- (8) Bending force (refer to 8.1.4)
- (9) Items of final measurement (refer to 8.1.5)

8.2 Robustness of operating part

8.2.1 Purpose The purpose of this test is to evaluate the mechanical robustness of operating part of switch, using the static load.

8.2.2 Equipment The equipment for this test shall be a pressure gauge or torquemeter with appropriate accuracy to the values specified in the detail specification, or a measuring apparatus at least equivalent thereto.

8.2.3 Initial measurements The initial measurements shall be the following (1) to (6), as specified in detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

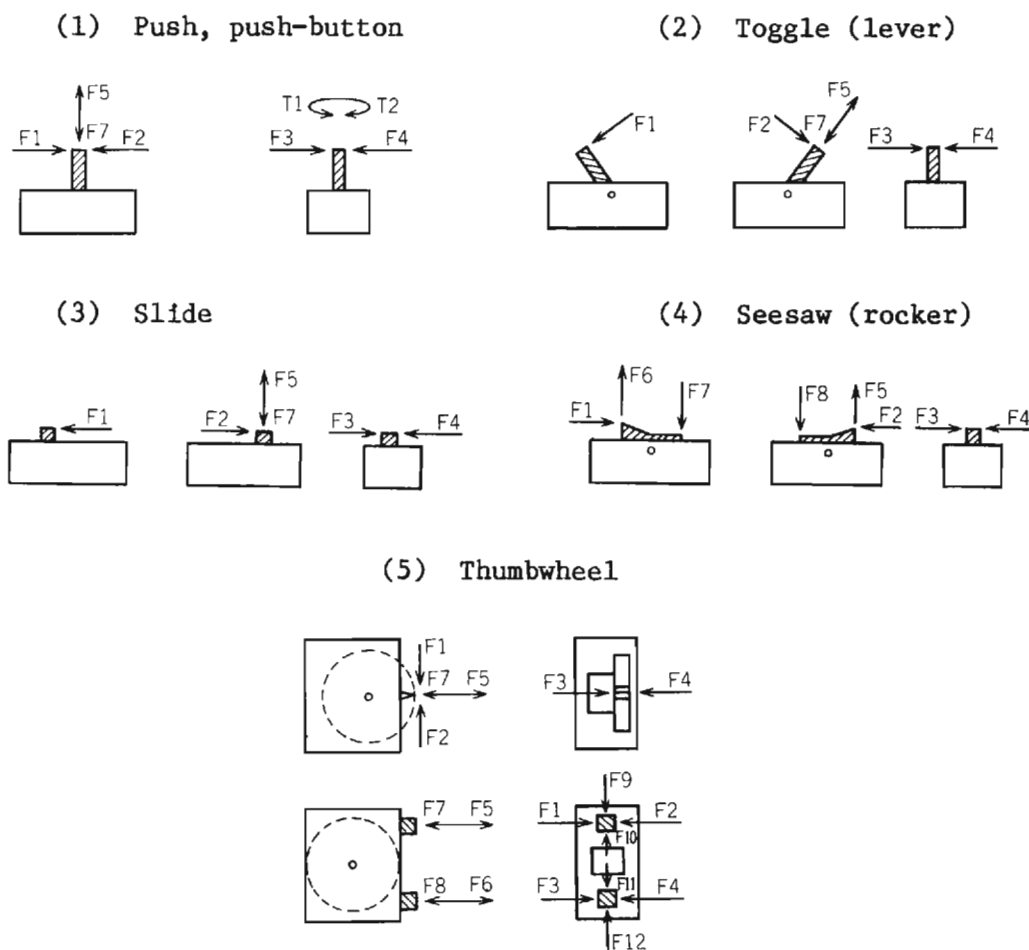
8.2.4 Test Mount the specimen according to the normal mounting method. Hold the operating part according to the specified method. Apply the external force specified in the detail specification to the operating part and maintain it for either of the periods given in Table 13 as specified in detail specification. Then, examine whether it has caused any damage detrimental to service, such as deformation of operating part.

- (1) Push and/or pull Apply a pushing force (one of F1 to F3, F6 to F12) or pulling force (one of F5, F6, F7) specified in Fig. 7 gradually to the operating part. After the force has reached the specified value, maintain it for the specified period.
- (2) Torque (twist) Apply a torque gradually to the operating part in the direction specified in Fig. 7 (1) T1, T2. After the torque has reached the specified value, maintain it for the specified period.

Table 13. Maintaining period

Unit: s		
Maintaining period		
10,	15,	60

Fig. 7. Direction and position of applying the external force (or load) to the operating part



8.2.5 Final measurement The items for final measurement shall be the following (1) to (6), as specified by detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)

(4) Insulation resistance (refer to 7.2)

(5) Withstand voltage (refer to 7.3)

(6) Operating force (refer to 8.4)

8.2.6 Items specified in detail specification The detail specification shall specify the following items.

(1) Items for initial measurement (refer to 8.2.3)

(2) Classification of test [refer to 8.2.4 (1) to (2)]

(3) Holding method of operating part (if specified) (refer to 8.2.4)

(4) Magnitude of push, pull or torque [refer to 8.2.4 (1) and (2)]

(5) Position and direction of applying push, pull or torque [refer to 8.2.4 (1) and (2)]

(6) Holding period of push, pull or torque (refer to 8.2.4 and Table 10)

(7) Items of final measurement (refer to 8.2.5)

8.3 Robustness of mounting part

8.3.1 Equipment The equipment for this test shall be a torquemeter with appropriate accuracy to the value specified for this test, or a measuring apparatus at least equivalent thereto.

8.3.2 Initial measurements The initial measurements shall be the following (1) to (6), as specified in detail specification.

(1) Appearance, construction and finishing (refer to 5.1)

(2) Function operation (refer to 6)

(3) Contact resistance (refer to 7.1)

(4) Insulation resistance (refer to 7.2)

(5) Withstand voltage (refer to 7.3)

(6) Operating force (refer to 8.4)

8.3.3 Test

(1) **Robustness of mounting bushing** The robustness of mounting bushing shall be tested as follows.

(1.1) **Purpose** The purpose of this test is to evaluate whether the switch having a screw mounting bushing can withstand the force applied at the time of normal mounting.

- (1.2) Method Mount the switch in the normal mounting method, or by using the specified fixture if so specified, to a metal plate with a proper hole.

Clamp the mounting nut with 125 % torque of specified torque in detail specification, and hold it for 5 min.

Fasten the nut and loosen it. Repeat this procedure 5 times.

- (2) Robustness of screw mounting The robustness of screw mounting shall be tested as follows.

- (2.1) Purpose The purpose of this test is to evaluate whether the switch having a screw mounting bushing can withstand the force applied at the time of normal mounting.

- (2.2) Method Mount the switch in the normal mounting method.

The following matters shall apply.

- (a) Use the specified switch if so specified. If not specified, use the screw of the maximum nominal diameter which can mount a switch.
- (b) The test torque shall be as specified in Table 14. Unless otherwise specified, apply the torque for 10 s to 15 s.

Table 14. Nominal diameter and torque value of screw

Torque value Nm	Nominal diameter of screw mm	
	Over	Up to and incl.
0.2		1.7
0.3	1.7	2.2
0.4	2.2	2.8
0.5	2.8	3.0
0.6	3.0	3.2
0.8	3.2	3.6
1.2	3.6	4.1
1.8	4.1	4.7
2.0	4.7	5.3
2.5	5.3	6.0
3.5	6.0	8.0

8.3.4 Final measurement The items for final measurement shall be the following (1) to (6), as specified by detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

8.3.5 Items specified in detail specification The detail specification shall specify the following items.

- (1) Classification of test [refer to 8.3.3 (1) and 8.3.3 (2)]
- (2) Fastening torque value (refer to Table 14)
- (3) Nominal diameter of mounting screw (refer to Table 14)
- (4) Mounting plate of switch (if specified) [refer to 8.3.3 (1.2)]

8.4 Operating force

8.4.1 Purpose The purpose of this test is to measure the force or torque required to operate a switch.

8.4.2 Equipment The equipment for this test shall be a pressure gauge or torquemeter with appropriate accuracy pertaining to the specified value or tolerance, or a measuring apparatus at least equivalent thereto.

8.4.3 Preparation Mount a specimen switch to a metallic plate in the normal mounting method. The mounting force shall be enough to withstand the force or torque of measurement. The size (length and width) of the mounting plate shall be at least the size of specimen.

8.4.4 Test Apply the force at a certain rate in the direction of operation of the operating part. Measure the maximum force or the maximum torque required to operate the switch according to the kind of the operating system (refer to Fig. 8).

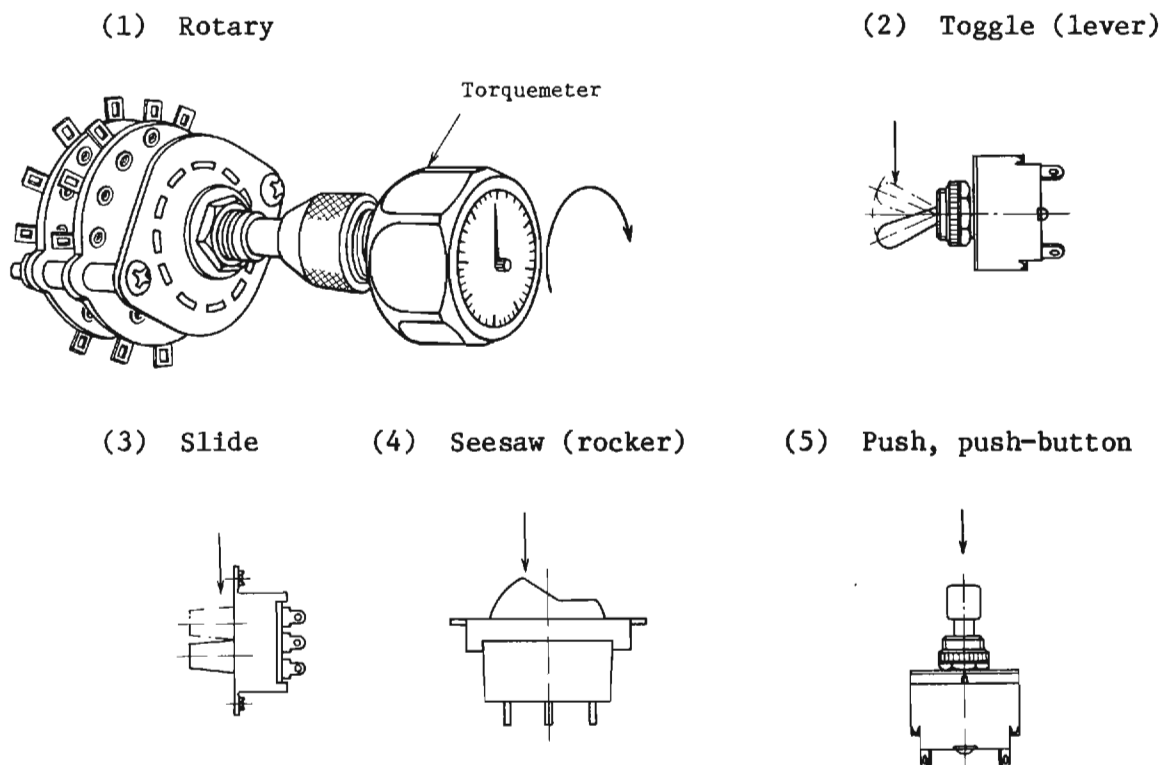
If specified by the detail specification, the test shall be done in both ways (go and return).

8.4.5 Items specified in detail specification The following items shall be specified in detail specification.

- (1) Classification of operation (rotating torque, operating force) (refer to 8.4.4)
- (2) Direction and position for application of operating force (refer to 8.4.4)

- (3) Number of times of measurement (refer to 8.4.4)
 (4) Test condition (unilateral or bilateral) (refer to 8.4.4)

Fig. 8. Measuring direction of operating force



8.5 Recovery force

8.5.1 Purpose The purpose of this test is to examine the recovery force by which the operating part of automatic recovery switch returns to the initial stop position.

8.5.2 Equipment The equipment for this test shall be a measuring apparatus with appropriate accuracy pertaining to the specified value or tolerance.

8.5.3 Preparation The preparation shall be as follows.

A specimen switch shall be mounted on a metallic mounting plate in the normal mounting way.

In this case, unless otherwise specified, a push-button operation switch shall be mounted on the mounting plate in horizontal position.

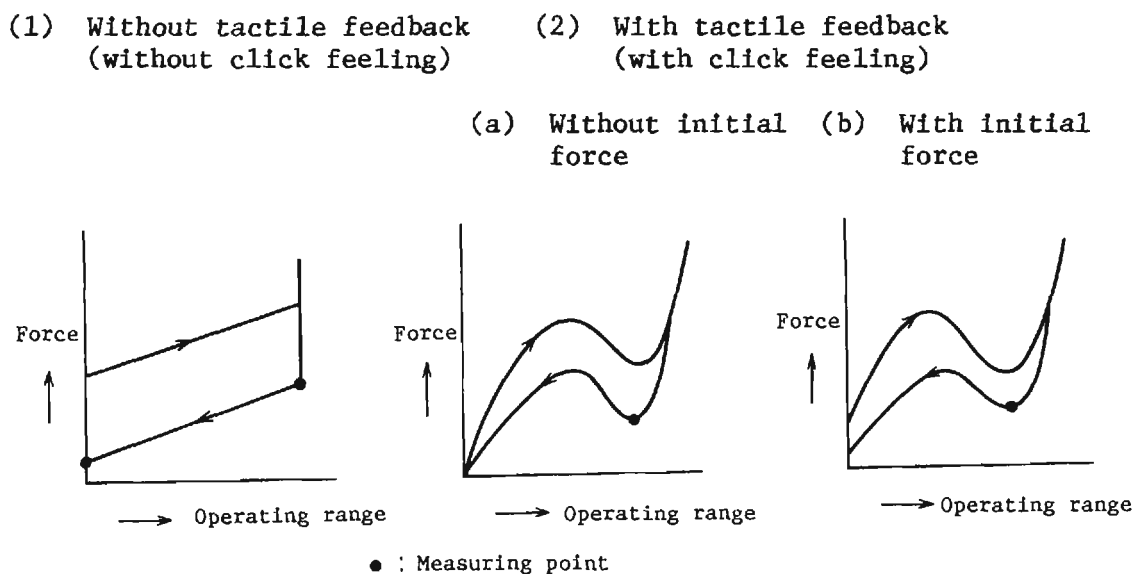
Switches other than push-button operation shall be mounted on the mounting plate in vertical position.

Carrying out the test, mounting with or without push-button or the like shall be in compliance with provisions in the detail specification.

8.5.4 Test The test shall be as follows.

- (1) Unless otherwise specified, apply the operating force to the normal operating position, and operate the specimen switch up to the operating limit position.
- (2) Remove the operating force gradually. Restore the specimen switch to the initial stop position. In this process, examine the following (2.1) and/or (2.2) (refer to Fig. 9).
 - (2.1) The operating part returns from the operating limit position to the initial stop position. Measure the recovery force at the measuring points specified in detail specification.
 - (2.2) Examine whether the operating part has returned to the initial stop position correctly.

Fig. 9. Examples of measuring points specified by detail specification



8.5.5 Items specified in detail specification The detail specification shall specify the following items.

- (1) Orientation of mounting (if specified) (refer to 8.5.3)
- (2) Mounting of push-button, etc. (refer to 8.5.3)
- (3) Position and direction of applying force (if specified) (refer to 8.5.4)
- (4) Measuring point of recovery force (refer to 8.5.4)

8.6 Operating range

8.6.1 Equipment The equipment for this test shall have appropriate accuracy pertaining to the value or tolerance specified for this test.

8.6.2 Test Mount the specimen switch by its normal means of attachment. Measure the operating range of the operating part according to (1) or (2) given below.

- (1) For switches whose operating range is expressed in angle Move the operating part gradually, and measure the angle between the specified stop positions.
- (2) For switches whose operating range is expressed in distance Move the operating part gradually, and measure the distance between the specified stop positions.

8.6.3 Items specified in detail specification The detail specifications shall specify the following items.

- (1) Test method [refer to 8.6.2 (1) and (2)]
- (2) Kind of operating range of operating part [refer to 8.6.2 (1) and (2)]
- (3) Measuring position (if specified) [refer to 8.6.2 (1) and (2)]
- (4) Number of times of measurement (if specified) (refer to 8.6.2)

8.7 Resistance to soldering heat (refer to JIS C 0050)

8.7.1 Purpose The purpose of this test is to examine whether the specimen can withstand the thermal stress of soldering.

8.7.2 Summary of test The test shall be in the following three methods, as specified in detail specification.

Method 1A: Solder tank at 260°C

Method 1B: Solder tank at 350°C

Method 2: Solder iron at 350°C

8.7.3 Initial measurements The initial measurements shall be the following (1) to (6), as specified in detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

8.7.4 Method 1A: Solder tank method at 260°C

- (1) Solder tank The solder tank shall be 40 mm or over deep, and have a capacity of 300 ml or over.

Fill the tank with the specified solder which is kept at $260 \pm 5^\circ\text{C}$ before the test.

- (2) Flux The flux shall be as specified below.
- (a) Rosin (colophonium) of 25 % by mass ratio and 2-propanol or ethanol solution of 75 % specified in JIS K 8839 or JIS K 8101 shall be used. To this, diethylammonium chloride (analytical reagent class) shall be added up to 0.5 % chlorine content [ratio of free chlorine to rosin (colophonium) content].
 - (b) If the test is carried out as a part of a series of tests, prior to the moisture resistance test, inactive flux shall be used. The inactive flux is composed of rosin (colophonium) of 25 % by mass ratio and 2-propanol or ethanol solution of 75 % specified in JIS K 8839 or JIS K 8101.
- (3) Solder The composition of solder shall be as follows, or as specified in JIS Z 3282, H60A, H60S, H63A, or JIS C 0050 Annex B.

Tin	59 wt% to 61 wt%	Arsenic	0.05 wt% or under
Antimony	0.5 wt% or under	Iron	0.02 wt% or under
Copper	0.1 wt% or under	Lead	residue

- (4) Procedure Before every test, scrape the surface of molten solder with a squeegee made of adequate material to keep it clean and glittering.

Immerse the specimen termination in room temperature in the flux specified in (2). Then, immerse it in the longitudinal axial direction in the solder tank. Immerse the termination 10 mm or more apart from the wall of tank.

Unless otherwise specified in detail specification, immerse the termination within 1 s up to the point which is 2.0 mm to 2.5 mm from the part body or the mounting surface. Keep the termination immersed for the following duration, according to the detail specification.

- (a) 5 ± 1 s
- (b) 10 ± 1 s

- Remarks 1. The shorter duration of 5 s is mainly intended for the switch for printed wiring board, which is susceptible to heat.
2. If the test is carried out as a part of a series of tests, prior to the moisture resistance test, the specimen switch shall be selected from among those which have passed the 8.8 Solderability test within 72 h prior to this test.

Unless otherwise specified in detail specification, a thermal shield plate shall be placed between the switch body and the molten solder. The plate shall be 1.5 ± 0.5 mm thick, and made of heat insulating material, and have a hole corresponding to the dimensions of termination. If the detail specification specifies the use of a radiator, the details of construction and dimensions shall be specified in correlation with the soldering method used for production process.

8.7.5 Method 1B: Solder tank method at 350°C

- (1) Solder tank The solder tank shall be as specified in 8.7.4 (1), and filled with the solder which is kept at $350 \pm 10^\circ\text{C}$.
- (2) Procedure The same procedure as 8.7.4 (3) shall be followed. However, the immersion duration shall be 3.5 ± 0.5 s.

The whole procedure of immersion, stop and lift up shall be finished within 3.5 s to 5 s.

8.7.6 Method 2: Soldering iron method at 350°C

- (1) Soldering iron The soldering iron shall be as specified below.

(a) Iron tip A

The temperature of iron tip $350 \pm 10^\circ\text{C}$ (at the start of test)

The diameter of iron tip 8 mm

The length of exposed part 32 mm, wedged into the length of 10 mm.

(b) Iron tip B

The temperature of iron tip $350 \pm 10^\circ\text{C}$ (at the start of test)

The diameter of iron tip 3 mm

The length of exposed part 12 mm, wedged into the length of 5 mm.

Which iron tip is to be used, either A or B, shall be specified by detail specification.

- (2) Solder and flux The solder shall be the threadlike rosin-core solder. One or more cores shall contain rosin (colophonium) up to 2.5 % to 3.5 %.

The composition of solder shall be as follows, or as specified in JIS Z 3282, H60A, H60S, H63A, or JIS C 0050 Annex B.

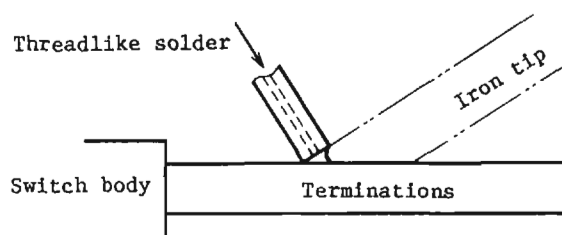
Tin	59 wt% to 61 wt%	Arsenic	0.05 wt% or under
Antimony	0.5 wt% or under	Iron	0.02 wt% or under
Copper	0.1 wt% or under	Lead	residue

- (3) Procedure Which iron tip is to be used, either A or B, shall be specified by detail specification, depending upon the kind of switch. The nominal diameter of threadlike solder shall be 1.2 mm for iron tip A, and 0.8 mm for iron tip B.

Orient the terminations so that the tip is applied to the test surface in the horizontal position, as shown in Fig. 10.

During this test, if the termination requires any mechanical fixture, it shall be heat insulation material.

Fig. 10. Application of iron tip



When a switch is susceptible to heat, the distance between the switch body and the test point, and use of a radiator shall be specified by detail specification.

If the outer dimensions of terminations do not permit the above-mentioned procedure, other conditions may be specified by detail specification.

The residual solder after the previous test shall be wiped out.

Duration for applying the iron tip to the termination of specimen switch shall be either (a) or (b) below, as specified by the detail specification.

(a) 5 ± 1 s

(b) 10 ± 1 s

The residue of flux of specimen switch shall be removed with 2-propanol or ethanol specified in JIS K 8839 or JIS K 8101.

Remarks: If a specimen switch is susceptible to heat, thermal stress for a long period of time may cause irreparable defects. Usually, the practical soldering duration is 1 s to 2 s. Determination of test duration must consider this fact and thermal susceptibility of switch. So, special preventive measures (e.g. automatic shield of thermal source) may be required.

8.7.7 Posttreatment Leave a specimen switch in the normal condition. Unless otherwise specified, the period shall be 30 min, or the time required for temperature to stabilize.

8.7.8 Final measurement The items for final measurement shall be the following (1) to (6), as specified by detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

8.7.9 Items specified in detail specification The detail specification shall specify the following items.

- (1) Initial measurement (refer to 8.7.3)
- (2) Applicable test method (refer to 8.7.4, 8.7.5 or 8.7.6)
- (3) Immersion depth (if the point is not 2.0 mm to 2.5 mm from the part body) [refer to 8.7.4 (4)]
- (4) Immersion duration [refer to 8.7.4 (4), 8.7.5 (2) or 8.7.6 (3)]
- (5) Details of radiator, if used [refer to 8.7.4 (4)]
- (6) Soldering iron tip (A or B) [refer to 8.7.6 (3)]
- (7) Distance from switched body to test part [refer to 8.7.6 (3)]
- (8) Items of final measurement (refer to 8.7.8)

8.8 Solderability (refer to JIS C 0050)

8.8.1 Purpose The purpose of this test is to examine solderability and solder repellency of lead wire, lug termination, and irregular-shape termination (for printed wiring board).

8.8.2 Outline of test The test methods are the following two methods, as specified by detail specification.

- (1) **Method 1: Solder tank method at 235°** The soldering temperature and time are adjusted, also to examine solder repellency. The solder tank method is one of practical methods to examine solderability. However, it is not suitable to express results numerically.
- (2) **Method 2: Solder iron method at 350°C** The detail specification apply to solderability of terminations which cannot be examined by Method 1. If so specified in detail specification, the accelerated aging of 8.8.5 shall be carried out prior to the test.

8.8.3 Preparation of specimen switch The surface to be tested shall be kept as clean as when the switch was delivered. After delivery, the surface shall not be touched with fingers or other contaminants.

Prior to solderability test, the specimen shall not be washed. If so specified in detail specification, the specimen may be immersed in neutral organic solvent to remove the grease.

8.8.4 Initial measurements The initial measurements shall be the following (1) to (6), as specified in detail specification.

- (1) Appearance, construction and finishing (refer to 5.1)
- (2) Function operation (refer to 6)
- (3) Contact resistance (refer to 7.1)
- (4) Insulation resistance (refer to 7.2)
- (5) Withstand voltage (refer to 7.3)
- (6) Operating force (refer to 8.4)

8.8.5 Accelerated aging If the detail specification specifies the accelerated aging, the aging by the following method shall be made for 1 h.

Remarks: If the aging temperature is higher than the highest ambient temperature or the storage temperature, the terminations may be separated for the test.

If the switch deteriorates by steam of 100°C, and this is not likely to occur in the natural aging, but it may affect solderability, the terminations shall be separated for the test.

- (1) **Aging 1, aging 1a** (by steam, 1 h) Pour boiled, distilled water in a vessel of appropriate size made of borosilicate glass or stainless steel (for example, 22 beaker). Hold the specimen switch so that the test part may be 25 mm to 35 mm above the surface of water with the terminations kept vertical.

The terminations shall be 10 mm or over apart from the wall of vessel.

The vessel shall be almost closed with a cover made of the same material. The cover shall cover about $\frac{7}{8}$ area of opening.

To suspend the specimen switch, a hole or groove may be made on this cover. The specimen switch shall be supported with a non-metallic fixture.

To continue boiling, or to keep the water level, pour hot distilled water little by little, or use a condenser.

- (2) **Disposal after aging** After aging, place the specimen switch for 2 h to 24 h at the test site in the standard condition specified in 3.1.

8.8.6 Method 1: Solder tank method at 235°C This method evaluates solderability of lead wires, lug terminations and irregular-shape terminations.

- (1) **Solder tank** The solder tank shall be 40 mm or over deep, and have a capacity of 300 ml or over. Fill the tank with the specified solder which is kept at $235 \pm 5^\circ\text{C}$.
- (2) **Flux** The flux shall be as specified below. Rosin (colophonium) of 25 % by mass ratio and 2-propanol or ethanol of 75 % specified in JIS K 8839 or JIS K 8101 shall be used. For activation, diethylammonium chloride (analytical reagent class) may be added up to 0.5 % chlorine content [ratio of free chlorine to rosin (colophonium) content], according to the detail specification.
- (3) **Solder** The composition of solder shall be as follows, or as specified in JIS Z 3282, H60A, H60S, H63A, or JIS C 0050 Annex B.

Tin	59 wt% to 61 wt%	Arsenic	0.05 wt% or under
Antimony	0.5 wt% or under	Iron	0.02 wt% or under
Copper	0.1 wt% or under	Lead	residue

- (4) **Procedure** Before every test, scrape the surface of molten solder with a squeegee made of adequate material to keep it clean and glittering.

Immerse the specimen termination in room temperature in the flux specified in (2). Remove the excess flux by free fall for a proper period of time, or by the similar way. If any doubt arises, the above-mentioned time shall be 60 ± 5 s.

Then, immerse it immediately in the longitudinal axial direction in the solder tank. Immerse the termination 10 mm or more apart from the wall of tank.

The immersion speed shall be 25 ± 2.5 mm/s. The specimen shall be immersed for 2 ± 0.5 s at the depth specified by the detail specification. Then, pull out the terminations at the speed of 25 ± 2.5 mm/s.

As for the switch of large heat capacity, the immersion time may be specified as 5 ± 0.5 s by the detail specification. The termination shall be immersed up to 2.0 mm to 2.5 mm from the body or the mounting surface.

If specified in detail specification, a thermal shield plate may be placed between the part body and the molten solder. The plate shall be 1.5 ± 0.5 mm thick, made of heat insulating material, and have a hole corresponding to the dimensions of termination.

The residue of flux of specimen switch shall be removed with 2-propanol or ethanol specified in JIS K 8839 or JIS K 8101.

8.8.7 Soldering iron method at 350°C If Method 1 (solder tank method at 235°C) is impossible to apply, this method is used to assess solderability of terminations.