

JIS

JAPANESE INDUSTRIAL STANDARD

**Test methods of fixed resistors
for electronic equipment**

JIS C 5202—1990

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In the event of any doubt arising,
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Test methods of fixed resistors for electronic equipment C 5202-1990

1. Scope

This Japanese Industrial Standard specifies the test methods of fixed resistors principally for use in electronic equipment, hereinafter referred to as "resistors". If there is discrepancy between the provision of this specification and that of the relevant detail specification, the provision of the detail specification shall be followed.

- Remarks 1. The Standards given in Attached Table 1 are cited in this Standard.
2. The international standard corresponding to this Standard is shown in Attached Table 1.
3. The units and numerical values in { } in this Standard are based on traditional metric system and are appended for informative reference.

2. Definitions

For the purpose of this Standard the definitions specified in JIS C 0010, JIS C 5201 and JIS C 5602 shall apply.

3. Conditions for test

3.1 Standard conditions Unless otherwise specified, the tests and measurements shall be carried out at a temperature of 15 to 35°C, relative humidity of 45 to 75 % (may be ignored if there is no influence on the tests and measured results), and an air pressure of 86 to 106 kPa (860 to 1060 mbar). However, if doubt arises on the decision based on the measured values under the standard condition, or required especially, the test shall be carried out under the condition specified in 3.3. If conversion is required, the condition specified in 3.2 shall be based.

If it is difficult to carry out a test and measurement under the standard condition, the test and measurement may be carried out under the condition other than the standard condition, unless doubt arises on the decision.

3.2 Reference conditions The reference conditions shall be the reference conditions [temperature of 20°C, air pressure of 101.3 kPa (1013 mbar)] specified in 5.1 of JIS C 0010. However, the reference condition may be represented by the temperature only.

Remarks: No requirement is specified for relative humidity because correction by calculation is generally difficult.

3.3 Referee conditions The referee conditions shall be selected from among those given in Table 1. However, it shall be the condition denoted by symbol A and grade 2 in Table 1, unless otherwise specified.

Table 1. Referee Conditions

Symbol	Temperature °C			Relative humidity		Air pressure kPa (mbar)
	Nominal value	Grade 1	Grade 2	Grade 1	Grade 2	
A	20	± 1	± 2	63 to 67	60 to 70	86 to 106 (860 to 1060)
B	23			48 to 52	45 to 55	
C	25					
D	27			63 to 67	60 to 70	

3.4 Drying

3.4.1 Drying conditions When it is required to dry the resistor to be tested (hereafter referred to as specimen), before the test and measurement, the drying shall, unless otherwise specified, be made under the condition of either A or B given below.

- (1) **Condition A** At a temperature of $55 \pm 2^\circ\text{C}$ and relative humidity not exceeding 20 % for 24 ± 4 h.
- (2) **Condition B** At a temperature of $100 \pm 5^\circ\text{C}$ for 96 ± 4 h.

3.4.2 Dry storage The dried specimen shall be stored as described below only when such storage is specified in this Standard or the relevant detail specification.

The specimen is allowed to cool in a desiccator using a suitable desiccant such as activated alumina or silica gel, kept therein, and taken out at the beginning of the specified test or measurement.

3.4.3 Items to be specified in detail specification In detail specification, the following items shall be specified:

- (1) Drying condition (refer to 3.4.1)
- (2) Application of dry storage (if necessary) (refer to 3.4.2)

3.5 Standard recovery conditions As specified in 5.4.1 (standard recovery conditions) to 5.4.4 (special recovery conditions) of JIS C 0010.

4. Appearance, marking and dimension tests

4.1 Appearance The appearance test shall be carried out visually.

4.2 Marking The marking test shall be carried out visually, and if necessary, the resistance to solvent shall be examined in accordance with 6.9.

4.3 Dimension The dimensional test shall be carried out by means of the vernier callipers specified in JIS B 7507 or the micrometer callipers for external measurement specified in JIS B 7502. However, other measuring apparatus may be used if no doubt arises on the decision.

5. Electrical performance tests

5.1 Resistance

5.1.1 Equipment The equipment for use in this test shall be a measuring apparatus which is reliable for the specified tolerances on resistance or the specified allowable variation of resistance of the specimen.

The limit of error of the measuring apparatus shall not exceed 10 % of the said tolerance or allowable variation.

5.1.2 Preparation The specimen shall be allowed to stand at the temperature of measurement for a sufficient period so that no doubt arises on the decision, before carrying out measurements.

The duration of exposure shall, unless otherwise specified, be not less than 30 min.

Adequate means shall be provided to avoid such factors which influence measurements of specimens as excessive draft and direct heat radiation by sunlight or other heat sources, throughout and before and after the measurement.

5.1.3 Measurement The measurement shall be made by applying a d.c. voltage to the specimen for a short time as possible, in accordance with the following requirements of (1) to (3).

- (1) The duration of voltage application to the specimen shall be within 5 s.
- (2) The applied voltage shall be as given in A of Table 2.
If doubt will arise on the decision, the appropriate voltage in C or E of Table 2 shall be used. However, C of Table 2 is applicable for solid body resistors only.
- (3) At the test for the same item on the same specimen, the measurement shall be made by employing the same measuring apparatus and applied voltage. However, if no doubt arises, the above requirement is not fulfilled.

Table 2. Classification of applied voltage

Unit: V

Nominal resistance range	Classification of applied voltage		
	A (Maximum value)	C	E $\begin{smallmatrix} 0 \\ -10\% \end{smallmatrix}$
Less than 10 Ω	0.1	0.5 to 1	0.1
10 Ω and over up to but excluding 100 Ω	0.3		0.3
100 Ω and over up to but excluding 1 k Ω	1	2.5 to 3	1
1 k Ω and over up to but excluding 10 k Ω	3	8 to 10	3
10 k Ω and over up to but excluding 100 k Ω	10	24 to 30	10
100 k Ω and over up to but excluding 1 M Ω	25	80 to 100	25
1 M Ω and over	50		50

5.1.4 Items to be specified in detail specification In detail specification, the following items shall be specified:

- (1) Accuracy of measuring apparatus (if necessary) (refer to 5.1.1)
- (2) Class of applied voltage (refer to Table 2)

5.2 Temperature characteristic of resistance and deviation in resistance value (not applicable for resistors of nominal resistance less than 5 Ω).

5.2.1 Equipment Care shall be taken so that the test chamber for use in this test will not condensate the moisture on the surface of the specimen.

The whole equipment including the test chamber shall be so prepared that the error in measurement caused by the resistances of connecting wires, contact resistances and electromotive forces of the joints, etc. is minimized.

5.2.2 Preparation If specified in the detail specification, the specimens shall be dried under condition A or B of subclause 3.4.1 and then stored as specified in subclause 3.4.2 prior to the test.

5.2.3 Test The test shall be carried out as described below.

(1) Measurement

- (a) The specimen shall be maintained at each of the temperatures specified in either one of the conditions A and B of Table 3, in the given order, the resistance shall be measured in accordance with 5.1 after thermal equilibrium is attained at each temperature and recorded together with the temperature at that time and the temperature coefficient of resistance shall be obtained from (2) (a). The test of each step shall be made successively.

As the simplified measuring method, the measurement may be made at two points i.e. room temperature and a temperature approximately 100°C higher than the room temperature.

Remarks: The room temperature means the temperature in the standard conditions.

- (b) Unless otherwise specified, the temperatures and resistance values shall be measured at steps 1, 3 and 4 on the low temperature side, and at steps 4, 7 and 8 on the high temperature side, and the relative change of resistance due to temperature shall be obtained from (2) (b).
- (c) The resistance values in steps 1 and 8 are measured and the resistance drift shall be obtained from (2) (c).

Table 3. Temperature conditions

Unit: °C

Step	Condition		Remarks
	A	B	
1	20 $\begin{smallmatrix} +5 \\ -1 \end{smallmatrix}$		
2	-15 $\pm$ 2	—	Applicable only when temperature characteristic of resistance is clearly non-linear.
3	Low category temperature $\pm$ 3		
4	20 $\begin{smallmatrix} +5 \\ -1 \end{smallmatrix}$		
5	60 $\pm$ 2	—	Applicable only when temperature characteristic of resistance is clearly non-linear.
6	100 $\pm$ 2	—	
7	Upper category temperature $\pm$ 3		
8	20 $\begin{smallmatrix} +5 \\ -1 \end{smallmatrix}$		

- Remarks 1. Thermal equilibrium means such a state that the resistances measured at intervals of 5 min or more exhibit the change not exceeding the accuracy of the measuring instrument.
2. The error in temperature measurement shall be 1°C or less.
3. The condition B shall be applied for the temperature coefficient of resistance if there is no provision.

- (2) Calculation Based on the relevant temperatures and resistances obtained in (1), the temperature coefficient TCR shall be calculated from the formula of (a), the relative change of resistance RC from the formula of (b), and the resistance drift RD from the formula (c).

(a)
$$TCR \text{ (ppm/°C)} = \frac{\Delta R}{R \times \Delta t} \times 10^6$$

where, R : In the case of lower category temperature; assuming that resistances measured in steps 1 and 4 of Table 3 as R_1 and R_4 respectively

$$R = \frac{1}{2} (R_1 + R_4)$$

In the case of upper category temperature; assuming that resistances measured in steps 4 and 8 of Table 3 as R_4 and R_8 respectively

$$R = \frac{1}{2} (R_4 + R_8)$$

ΔR : In the case of lower category temperature; assuming resistance measured in step 3 of Table 3 as R_3

$$\Delta R = R_3 - R$$

In the case upper category temperature; assuming that resistance measured in step 7 of Table 3 as R_7

$$\Delta R = R_7 - R$$

Δt : assuming actually measured temperatures in steps 1, 3, 4, 7 and 8 as t_1 , t_3 , t_4 , t_7 and t_8

In the case of lower category temperature

$$\Delta t = t_3 - \frac{(t_1 + t_4)}{2}$$

In the case of upper category temperature

$$\Delta t = t_7 - \frac{(t_4 + t_8)}{2}$$

Remarks: When steps 2, 5 and 6 are calculation similar to the above should be employed.

$$(b) \quad RC (\%) = A \times \frac{\Delta R}{R} \times 100$$

$$\text{where, } A : A = \frac{T_n}{T_m}$$

where, T_n : difference between specified nominal temperatures (°C)

T_m : difference between actually measured temperatures (°C)

Example: When the nominal temperature in step 1 is 20°C and that in step 3 is -55°C, the difference between specified nominal temperatures is 75°C. When the measurements are made at 19°C in step 1 and at -52°C in step 3, A becomes as follows:

$$A = \frac{75}{71} \\ = 1.1$$

R : refer to (a)

ΔR : refer to (a)

$$(c) \quad RD (\%) = \frac{R - R_0}{R_0} \times 100$$

where, R : actually measured resistance in step 8 (Ω)

R_0 : actually measured resistance in step 1 (Ω)

5.2.4 Items to be specified in detail specification In detail specifications, the following items shall be specified:

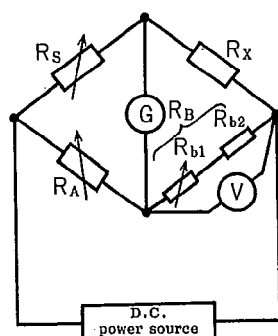
- (1) Preparation (if necessary) (refer to 5.2.2)
- (2) Condition (refer to Table 3)
- (3) Steps to be applied or excluded corresponding to the specified conditions (refer to Table 3)
- (4) How to express temperature characteristic of resistance [refer to 5.2.3 (2)]

5.3 Voltage coefficient

5.3.1 Measuring procedure I (applicable for solid body resistor)

- (1) Equipment It is preferable that the equipment is based on the circuit system illustrated in Fig. 1, and the same precaution as that described in 5.1.2 is required.

Fig. 1. Measuring procedure I



- R_A, R_B : ratio arm resistor
- R_{b1} : variable resistor (percent scale)
- R_{b2} : fixed resistor
- R_s : variable resistor
- R_x : specimen
- ⓖ : galvanometer
- Ⓥ : d.c. voltmeter

Informative reference: The value of R_x can be obtained by adjusting the R_A and R_s to minimize the deflection of galvanometer ⓖ while the R_{b1} is set to 0 % of its percent scale.

The voltage applied to the R_x can be read directly from the voltmeter Ⓥ, because the voltage applied to the R_x is equal to the voltage across both terminals of the R_s . When the value of R_x is obtained at a voltage (E_2) equal to 1/10 of d.c. voltage corresponding to the rated dissipation, and then the output voltage of d.c. power source is changed to a voltage (E_1) corresponding to the rated dissipation and the R_{b1} is adjusted to minimize the deflection of the galvanometer, the rate of change in R_x can be read directly in percentage because the said rate is substituted by the rate of change in R_{b1} as you find it in the above procedure.

- (2) **Preparation** If specified in the detail specification, the specimens shall be dried under condition A or B of subclause 3.4.1 and then stored as specified in subclause 3.4.2 prior to the test.
- (3) **Test** The test shall be made as follows:
 - (a) **Measurement** The resistance value shall be measured by applying a voltage equal to 1/10 of the rated voltage to the specimen, and then by applying the rated voltage. In this procedure, the duration of voltage application shall be minimized as possible, and shall not exceed 3 s.
As a rule, the voltage shall not be applied more than twice within 10 s.

- (b) **Calculation** The voltage coefficient V_c shall be calculated from the following formula based on resistance values and voltage values obtained in (a).

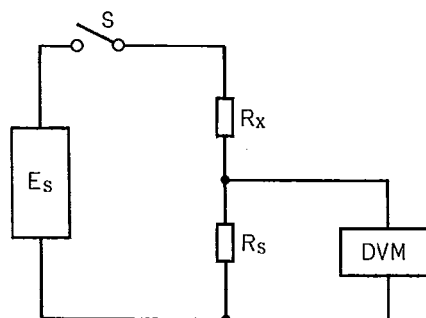
$$V_c (\%/V) = \frac{R_1 - R_2}{R_2} \times \frac{1}{E_1 - E_2} \times 100$$

where, R_1 : measured value of resistance at E_1 (Ω)
 R_2 : measured value of resistance at E_2 (Ω)
 E_1 : rated voltage (V)
 E_2 : 1/10 of rated voltage (V)

5.3.2 Measuring procedure II (excluding wirewound resistors)

- (1) **Equipment** It is preferable that the equipment is based on the circuit system illustrated in Fig. 2. The same precaution as that described in 5.1.2 is necessary.

Fig. 2. Measuring procedure 2



E_s : standard d.c. voltage generator
 R_s : standard resistor
 R_x : specimen
 S : switch
DVM : digital voltmeter

The value of R_s shall, as a rule, be so selected that it does not exceed 1/100 of the value of R_x .

- (2) **Preparation** If specified in the detail specification, the specimens shall be dried under condition A or B of subclause 3.4.1 and then stored as specified in subclause 3.4.2 prior to the test.
- (3) **Test** The test shall be made as follows:
- (a) **Measurement** The voltage of E_s shall be so chosen that the rated voltage and 1/10 of the rated voltage can be applied across the terminations of R_x . The voltage across both ends of R_s when E_s is 1/10 of the rated voltage shall be measured, and then the voltage across both ends of R_s when E_s is the rated voltage shall be measured. The duration of voltage application shall be minimized, and shall not exceed 0.5 s during 5 s in the case of rated voltage.

In the case of 1/10 of rated voltage the duration shall not exceed 4.5 s, and care shall be taken to avoid practical temperature rise of the specimen.

- (b) Calculation The voltage coefficient V_c shall be calculated from the following formula based on voltage values obtained in (a).

$$V_c (\%/V) = \frac{(V_2 \times 10) - V_1}{V_1} \times \frac{1}{E_1 - E_2} \times 100$$

where, V_1 : voltage across both ends of R_s at E_1 (V)

V_2 : voltage across both ends of R_s at E_2 (V)

E_1 : rated voltage (V)

E_2 : $\frac{1}{10}$ of rated voltage (V)

5.3.3 Items to be specified in detail specification In detail specifications, the following items shall be specified:

- (1) Preparation (if necessary) [refer to 5.3.1 (2) and 5.3.2 (2)]
- (2) Applicable range of resistance value (if necessary)
- (3) Applicable measuring procedure (refer to 5.3.1 and 5.3.2)

5.4 Temperature rise

5.4.1 Preparation Unless otherwise specified, the specimen shall be held horizontal, and excess ventilation, influence of heat from outside, etc. shall be avoided.

5.4.2 Test The resistance value of specimen shall be measured in accordance with 5.1, and the highest surface temperature of specimen shall be measured with a thermocouple thermometer or non-contacting thermometer after thermal stabilization is achieved.

The voltage is removed, the specimen is allowed to stand without load for 2 h or more, and then the resistance value is measured again in accordance with 5.1. The variation in the measured values before and after this test shall be calculated. If doubt arises on the decision, each measured resistance value is converted to the value at 20°C and then the decision is made.

Finally the specimen subjected to this test shall be examined whether remarkable abnormality exists or not on its appearance.

Remarks: The reduction of application voltage due to construction of the resistor to be tested and ambient temperature shall be specified in detail specifications.

5.4.3 Item to be specified in detail specification In detail specification, the following item shall be specified.

Detail of mounting (refer to 5.4.1)

5.5 Short-time overload

5.5.1 Preparation The specimen shall be held horizontal, and excess ventilation, influence of heat from outside, etc. shall be avoided.

5.5.2 Test The test shall be made in such a way that the resistance value of specimen is measured in accordance with 5.1, a d.c. or an a.c. r.m.s test voltage (as close as sinusoidal wave of power frequency) is applied to the specimen in accordance with one of the conditions given in Table 4, and the specimen is examined for arcing and other abnormality. If the calculated test voltage exceeds the maximum overload voltage specified in the relevant detail specification, the said maximum overload voltage is employed as the test voltage.

The specimen is allowed to stand without load for 30 min or more after removal of voltage, then the resistance is measured again in accordance with 5.1, and the variation in the resistance values taken before and after this test is calculated.

Finally the specimen subjected to this test is examined for remarkable abnormality on the appearance and legibility of the marking.

Table 4. Test condition for short-time overload

Condition	Test voltage	Duration of test voltage application
A	Voltage equal to 2.5 times rated voltage	5 s
B	Voltage corresponding to 10 times rated dissipation.	
C	Voltage corresponding to 2 times rated dissipation	10 min
D	Voltage equal to 2.5 times rated voltage	15 s
E		30 s

5.5.3 Items to be specified in detail specification In detail specifications, the following items shall be specified:

- (1) Test condition (refer to Table 4)
- (2) Maximum overload voltage (refer to 5.5.2)

5.6 Insulation resistance

5.6.1 Equipment As the equipment for this test, an insulation resistance tester shall generally be used, but a high resistance bridge or other measuring apparatus may be used as needed.

5.6.2 Preparation The terminations of specimen shall be connected together and employed as one of the electrodes for this test, and the electrode given in one of the mounting conditions A to F in Table 5 shall be employed as another electrode.

For surface mounting resistors (hereafter referred to as chip resistors or SMD) mounting condition G or H in Table 5 shall be employed.

In any case, the conductor between an electrode and the measuring apparatus shall be sufficiently spaced from the opposite electrode to avoid doubt arising on the measurement results.

Table 5. Mounting conditions for insulation resistance test

Condition	Electrode and mounting
A	Metal V-block, resistor is placed on root of V-block ⁽¹⁾
B	Metal sheet, both end faces of resistor are clamped by metal sheets.
C	Attached mounting metal fitting
D	Metal sheet, as illustrated in Fig. 3.
E	Small metal balls, as illustrated in Fig. 4.
F	Metal foil, metal foil is wrapped around the body of resistor with a space of approximately 2 mm being left from each termination.
G	Metal block, as illustrated in Fig. 5 (applicable to chip resistors)
H	Metal block, as illustrated in Fig. 6 (applicable to chip resistors)

Note (1) In this case the resistor body of specimen is so placed that it does not extend beyond both ends of V-block.

Fig. 3. Mounting by condition D

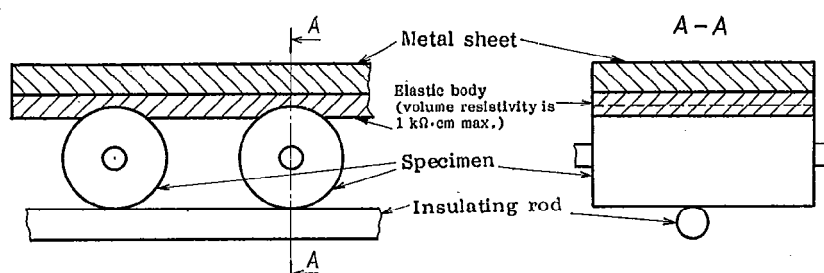


Fig. 4. Small metal balls for condition E

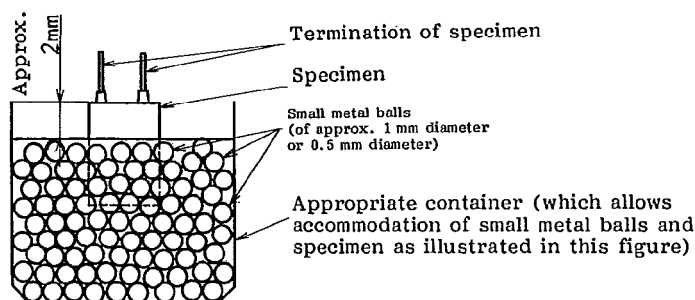


Fig. 5. Metallic block for condition G

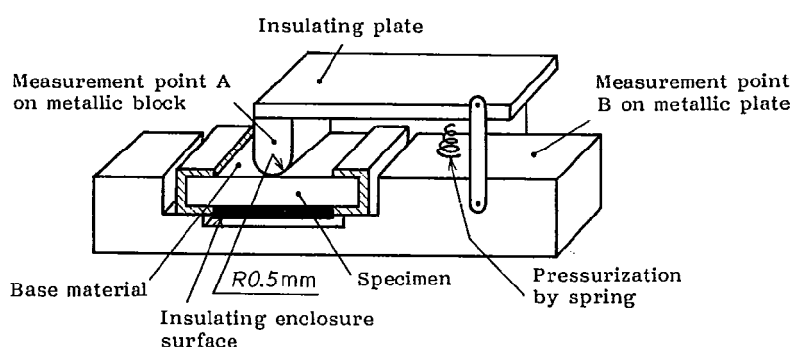
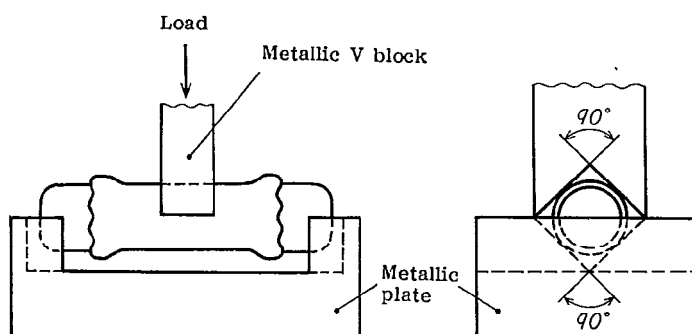


Fig. 6. Metallic block for condition H



5.6.3 Measurement The d.c. voltage specified in the relevant detail specification shall be applied across both electrodes specified in 5.6.2 and maintained for 1 min, and then the insulation resistance shall be measured with the said voltage being applied. If the reading of the measuring apparatus stabilizes at or further rises from a point exceeding the specified insulation resistance, however, the decision may be made by such phenomena even within the specified period.

5.6.4 Items to be specified in detail specification In detail specifications, the following items shall be specified:

- (1) Mounting condition (refer to Table 5)
- (2) Test voltage (refer to 5.6.3)

- (3) Insulation resistance measuring apparatus (if necessary)
(refer to 5.6.1)

5.7 Dielectric withstand voltage (voltage-proof)

5.7.1 Equipment The a.c. power source of the equipment for use in this test shall be capable of raising the voltage up to and lowering from the specified test voltage (r.m.s at power frequency) gradually, without causing remarkable wave distortion and/or voltage fluctuation under the loading condition of this test.

5.7.2 Preparation The terminations of specimen shall be connected together and employed as one of the electrodes for this test, and the electrode given in one of the mounting conditions A, B, C, D, E or F shall be employed as another electrode. For SMD, mounting condition G or H shall be employed.

5.7.3 Test (normal pressure) The test at normal pressure shall be carried out in such a way that the test voltage specified in the relevant detail specification is applied between both electrodes specified in 5.7.2, and the specimen is examined for such abnormality as flash-over, burning and dielectric breakdown.

Unless otherwise specified, the voltage is gradually increased at a rate of about 100 V/s from almost 0 V to the specified voltage and maintained as it is for $1 \text{ min} + \frac{10}{0} \text{ s}$, then gradually decreased to almost 0 V.

The test may be carried out by applying a voltage equal to 120 % of the specified voltage from the beginning for 1 s, unless doubt arises on the decision.

Remarks: The normal pressure means the air pressure in the standard conditions.

5.7.4 Test (reduced pressure) In the test of reduced pressure, the test of 5.7.3 shall be carried out under the air pressure specified in Table 6. Provided that, the test voltage is reduced in accordance with the provision of the relevant detail specification.

Table 6. Conditions of air pressure for voltage-proof

Condition	Air pressure
A	11.3 kPa (113 mbar) $\pm 5 \%$
B	8.5 kPa (85 mbar) $\pm 5 \%$
C	4.4 kPa (44 mbar) $\pm 5 \%$
D	1.0 kPa (10 mbar) $\pm 10 \%$

5.7.5 Items to be specified in detail specification In detail specifications, the following items shall be specified.

- (1) Mounting condition (refer to Table 5)
- (2) Test voltage (refer to 5.7.3)

(3) Duration of voltage application (if not 1 min) (refer to 5.7.3)

(4) Application of test (reduced pressure) (if necessary)
(refer to 5.7.4) and air pressure (refer to Table 6)

5.8 Intermittent overload

5.8.1 Preparation The specimen shall be dried under the condition A of 3.4.

The specimen shall be mounted horizontally and excess ventilation and influence of heat from outside shall be avoided. Unless otherwise specified, the specimens shall be arranged so that the space between them is 50 mm or more, and mounting fittings which allow application of voltage to the specimen shall be prepared.

5.8.2 Test The dried specimen shall be allowed to stand at room temperature without load for 30 min, and then the resistance shall be measured in accordance with 5.1.

The specimen shall be mounted to the mounting fittings prepared in 5.8.1, subjected to voltage application cycles specified in Table 8 each cycle consisting of application of the test voltage (in r.m.s value of sinusoidal voltage at power frequency) specified in Table 7 for 1 s and rest for 25 s. The specimen is allowed to stand at room temperature for 30 min without load, then the resistance shall be measured again in accordance with 5.1 and the variation in the resistance values taken before and after the test shall be calculated. However, if the test voltage in Table 7 exceeds the maximum intermittent overload voltage specified in the detail specification, the maximum intermittent overload voltage shall be employed as the test voltage.

Table 7. Intermittent overload test voltage

Condition	Test voltage
A	4 times rated voltage
B	3 times rated voltage

Table 8. Number of intermittent overload test cycles

Condition	Test cycles (cycle)
A	10000^{+400}_0
B	1000^{+100}_0

5.8.3 Items to be specified in detail specification In detail specifications, the following items shall be specified:

- (1) Test conditions (refer to Tables 7 and 8)
- (2) Maximum intermittent overload voltage (refer to 5.8.2)
- (3) Number of intermittent overload test cycles

5.9 Noise

5.9.1 Equipment The equipment for use in this test shall satisfy the requirements specified in 2. Measurement system of Annex 1 (method of measurement of current noise generated in resistors).

5.9.2 Measurement The measurement shall be carried out in accordance with 2.3 of Annex 1, the indication (dB) of the a.c. indicator M_1 in output side of measuring apparatus when the specimen is not loaded, the indication T (dB) of the said M_1 when the specimen is loaded, and the indication D (dB) of the d.c. indicator M_2 in input side of measuring apparatus in this case (loaded) shall be obtained, and then the current-noise voltage V_n per 1 V of applied voltage which passes the band width of one frequency decade shall be calculated from the following formula:

$$V_n \text{ (dB)} = T - f(T - S) - D$$

where, $f(T - S)$ is the correction factor for instrument noise, and given in Annex 1 Table 2.

When dB/V is converted to $\mu\text{V/V}$, Annex 1 Fig. 3 shall be followed.

5.10 High-frequency characteristic

5.10.1 Test The d.c. resistance value of specimen shall be measured in accordance with 5.1, and then the high frequency effective resistance value shall be measured by means of an adequate measuring apparatus or that specified in detail specification, at one of 0.5 MHz, 1 MHz, 5 MHz, 10 MHz, 20 MHz, 50 MHz, 100 MHz, 250 MHz, 500 MHz and 1000 MHz as specified in the detail specification or in the specified frequency range, unless otherwise specified.

The ratio (R_1/R_0) of the high-frequency effective resistance value (R_1) to the d.c. resistance value (R_0), both obtained in the above measurements, shall be calculated.

5.10.2 Items to be specified in detail specification In detail specifications, the following items shall be specified:

- (1) Measuring apparatus (if necessary) (refer to 5.10.1)
- (2) Measuring frequency (refer to 5.10.1)

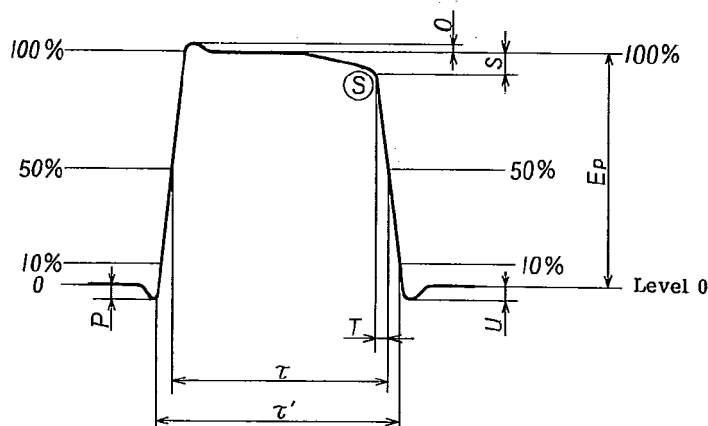
5.11 Withstand to pulse (pulse-proof)

5.11.1 Equipment

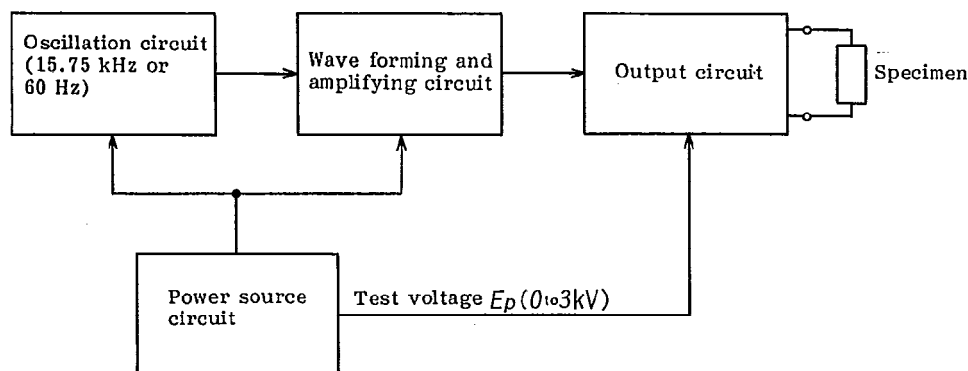
5.11.1.1 Pulse test equipment The pulse generator for use in this test shall generate the voltage waveform illustrated in Fig. 7, and the limits of error shall satisfy the requirements prescribed below.

Fig. 7. Pulse test equipment

(1) Pulse voltage waveform

 E_p : rated pulse voltage P : preshoot O : overshoot S : sag U : undershoot T : fall time (time from $\textcircled{S}$ to 50 % point)

(2) Block diagram of pulse voltage generator



- (1) Distortion of pulse waveform Referring to Fig. 7, $\frac{\tau'}{\tau}$ shall be not more than 1.3, $\frac{T}{\tau}$ shall be not more than 0.1, and each of P , O , S , and U shall be within 10 % of the rated pulse voltage.
- (2) Duration of pulse and tolerance on frequency The duration of pulse shall fall within ± 5 % from the reference pulse duration (τ), and the tolerance on frequency shall be within ± 5 % of the reference test frequency (f).
- (3) Tolerance on rated pulse voltage The tolerances on pulse voltage (E_p) shall be within ± 5 %.

5.11.1.2 Test chamber The test chamber for use in this test shall be capable of maintaining the temperature at the rated category temperature specified in the relevant detail specification $\pm 3^{\circ}\text{C}$, and shall be so constructed that the specimen does not receive direct heat radiation from the heat source throughout the intended locations of specimens (refer to 7.10.1).

5.11.2 Preparation The preparation shall be made as follows:

- (1) **Drying of specimen** Unless otherwise specified in the relevant detail specification, the specimen is dried under the condition A of 3.4.
- (2) **Mounting** The specimen is mounted by using the mounting jig specified in the relevant detail specification. Unless otherwise specified, both terminations of specimen are attached to light-weight terminals provided on the mounting jig, by means of lead wires of the specimen itself (the length is made to 20 to 25 mm) or suitable conductors. The specimens are so arranged that their temperatures will not unreasonably influence each other.

5.11.3 Test The test shall be made as described below. The resistance value of the specimen is measured in accordance with 5.1, the specimen mounted as specified in 5.11.2 (2) and placed in the test chamber at the rated category temperature $\pm 3^{\circ}\text{C}$ is repeatedly subjected to the rated pulse voltage having either waveform given in Table 9 and either duration given in Table 10. No excessive ventilation is made during the test.

The specimen is taken out of the test chamber, allowed to stand at room temperature for approximately 1 h without loaded unless otherwise specified, the resistance value is measured again in accordance with 5.1, and the variation in resistance values taken before and after this test is calculated.

The resistance value is measured in the intermediate period (refer to Table 11) during this test if specified so in the relevant detail specification. In this case, the measurement is carried out on the specimen which has been taken out of the test chamber and allowed to stand at room temperature for 1 h or more without loaded. For convenience of the test, the measurement may be made in the test chamber, however, in such case the resistance values before and after this test are also measured in the test chamber, and the measurement is made approximately 1 h after the pulse loading has been rested to avoid the influence of pulse voltage application.

Finally the specimen subjected to this test is examined for remarkable abnormality on appearance and legibility of the marking.

Table 9. Pulse waveform

Waveform	A	B
Duration of reference pulse μs	7.05	167
Reference test frequency	15.75 kHz	60 Hz

Table 10. Duration of test

Duration of test	Unit: h			
	240 (approx. 10 days)	500 (approx. 21 days)	1000 (approx. 42 days)	2000 (approx. 84 days)
Tolerance on duration	± 8	+24 0	+48 0	+72 0

Table 11. Time of intermediate measurement

Time of intermediate measurement	Unit: h			
	96 (approx. 4 days)	240 (approx. 10 days)	500 (approx. 21 days)	1000 (approx. 42 days)
Tolerance on time	± 4	± 8	+24 0	+48 0

5.11.4 Rated pulse voltage The rated pulse voltage to be applied to the specimen shall be calculated from the following formula:

$$E_p = \sqrt{P \times R \times \frac{1}{\tau f}}$$

where, E_p : rated pulse voltage (V)
 P : rated dissipation at d.c. (W)
 R : nominal resistance value (Ω)
 τ : reference pulse duration (s)
 f : reference test frequency (Hz)

If the calculated rated pulse voltage exceeds the appropriate value in Table 12, the maximum applicable pulse voltage in the said Table shall be understood as the maximum value of the rated pulse voltage. If maximum applicable pulse voltage is not specified in the relevant detail specification, 2.5 times the rated voltage or the maximum overload voltage shall be understood as the maximum applicable pulse voltage.

Informative reference: The rated pulse voltages calculated from the above formula are shown in Informative Reference Table 1.

Table 12. Maximum Applicable Pulse Voltage

Unit: V

Classification	Rated dissipation (W)							
	0.125	0.25	0.5	1	2	3	4	5
Carbon film resistor (RD)	300	500	700	1000	1500	—	—	—
Metal film resistor (RN)					—	—	—	—
Solid body resistor (RC)	200	400	400	600	1000	—	—	—
Metal oxide film resistor (RS)	—	—			800		1000	

5.11.5 Items to be specified in detail specification In detail specifications, the following items shall be specified:

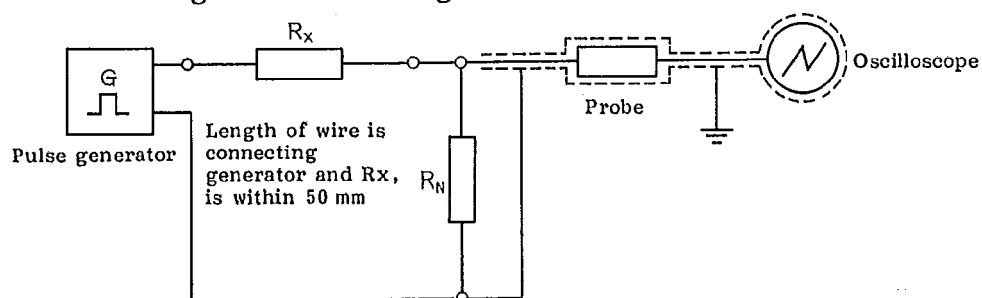
- (1) Selection of waveform (A or B) (refer to Table 9)
- (2) Test duration (refer to Table 10)
- (3) Intermediate measurement (if necessary) (refer to Table 11)
- (4) Mounting and jig (if necessary) [refer to 5.11.2 (2)]
- (5) Maximum applicable pulse voltage (if necessary) (refer to 5.11.4)

5.12 Reactance (This test is applicable only to resistors for which an especially low reactance is specified in the detail specification, and such resistors having a time constant (L/R) of 20 ns or more and a nominal resistance of 100 Ω to 1 M Ω fall in the applicable range.)

5.12.1 Method 1

- (1) Equipment The equipment for use in this test shall have a circuit configuration illustrated in Fig. 8.

Fig. 8. Measuring circuit for method 1



R_x : specimen

R_N : non-inductive resistor, the resistance of which is approximately 0.1 times the resistance of R_x

(1.1) Pulse generator

- (a) Pulse width: sufficient to cover 3 times the time constant ($\frac{L}{R}$).
- (b) Rise time on load (10 % to 90 %): less than 3 ns
- (c) Repetition rate: greater than 10 kHz, or that required to obtain good oscilloscope readability

(1.2) Oscilloscope

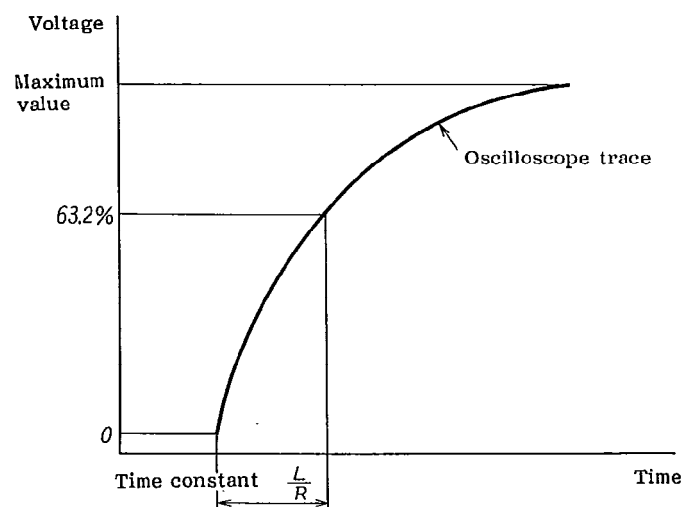
- (a) Rise time (10 % to 90 %): less than 12 ns (frequency response, 30 MHz or better)
- (b) Time space: 2 ns/mm or faster
- (c) Input capacitance at R_L : 25 pF or less
- (d) Amplification: sufficient to obtain good reading for the pulse voltage used

(2) Test

- (a) The time constant ($\frac{L}{R}$) shall be determined by measuring the time between the instant when the pulse starts and the instant when the voltage attains 63.2 % of the maximum (refer to Fig. 9).
- (b) If there is noise or distortion at the start of rise, the zero point is determined by extension of the pulse curve.
- (c) If there is no overshoot or oscillation and the time constant $\frac{L}{R}$ is 20 ns or more, then the effective inductance L_R can be calculated from the following formula:

$$L_R \text{ (H)} = \frac{L}{R} \times R$$

Fig. 9. Voltage waveform on oscilloscope



5.12.2 Method 2

- (1) Equipment The equipment for use in this test shall be an adequate one or the one specified in the relevant detail specification.

Informative reference: In general, a high frequency impedance analyzer is used.

- (2) Test

- (a) Preparation for measurement The calibration of the reference points shall be carried out in the measuring frequency range.

Informative reference: In the high frequency impedance analyzer, calibration is carried out at the three kinds of reference point [0 Ω , OS (open, short-circuit) and 50 Ω]

- (b) Measurement The specimen is connected to the measuring terminals, and the series inductance or parallel capacitance at the frequency specified in the relevant detail specification shall be measured.
 - (c) Measuring frequency The frequency shall be specified by the detail specification from among the frequencies given below.

1 MHz, 3 MHz, 5 MHz, 10 MHz, 30 MHz, 100 MHz, 300 MHz, 500 MHz and 1000 MHz

5.12.3 Items to be specified in detail specification In detail specifications, the following items shall be specified:

- (1) Applicable resistor (refer to 5.12)
- (2) Measuring method (refer to 5.12.1 and 5.12.2)
- (3) Measuring instrument (if necessary) [refer to 5.12.2 (1)]
- (4) Measuring frequency [refer to 5.12.2 (2)]

6. Mechanical performance tests6.1 Robustness of termination (refer to JIS C 0051)

6.1.1 Equipment The equipment for use in this test shall not give the specimen during the test, scratch, strain etc. which will affect the test results.

6.1.2 Test method 1 (applicable for resistors other than SMD) The tests prescribed in items (1) to (5) below shall be carried out in accordance with the provisions of relevant detail specification. The terminations shall be examined for break and loosening in each case as the test results. Further the electrical performances shall be measured, if such measurements are specified in the relevant detail specification.

- (1) Tensile strength of termination [refer to 2. (test Ual) of JIS C 0051] Unless otherwise specified, the body of specimen is fixed, the tensile force shall be applied gradually up to the specified value given in Table 13 in the lead-out direction of termination, and maintained as it is for 10 ± 1 s. Fig. 10 shall be referred for the direction of loading.

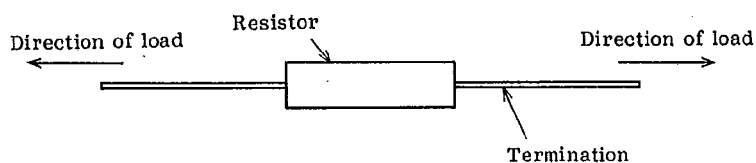
Table 13. Tensile force

Kind of termination	Nominal sectional area mm ²	Nominal wire diameter mm (for circular cross section)	Tensile force N {kgf}
Lead wire termination	Up to and including 0.05	Up to and including 0.25	1 {0.102}
	Over 0.05 up to and including 0.07	Over 0.25 up to and including 0.3	2.5 {0.255}
	Over 0.07 up to and including 0.2	Over 0.3 up to and including 0.5	5 {0.51}
	Over 0.2 up to and including 0.5	Over 0.5 up to and including 0.8	10 {1.02}
	Over 0.5 up to and including 1.2	Over 0.8 up to and including 1.25	20 {2.04}
	Over 1.2	Over 1.25	40 {4.08}
Other termination	—	—	20 {2.04}

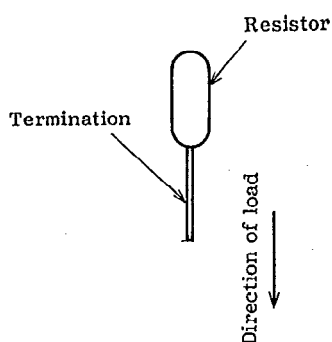
Remarks: Lead frame is included in lead wire termination.

Fig. 10. Direction of tensile load

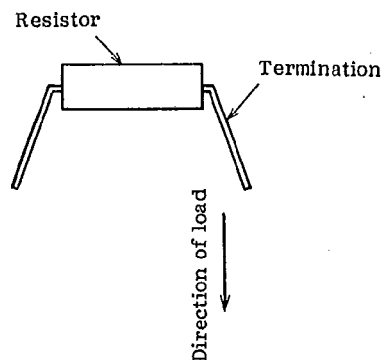
(1) Lead wire type



(2) SIP type



(3) DIP type



- (2) Torsional strength of lead-wire termination (Applicable for resistors with opposite lead-wire termination type) [refer to 5.1 (test U_c) of JIS C 0051] The lead-wire termination of the specimen shall be bent through an angle of 90 degrees with a radius of curvature of approximately 0.75 mm, at a point 6.0 to 6.5 mm from its root.

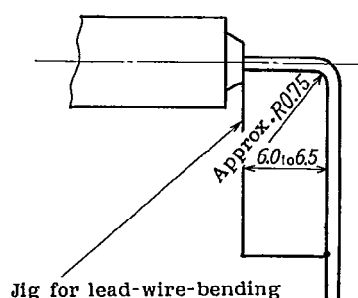
The lead-wire shall be clamped at a point 1.2 ± 0.4 mm apart from the said bend towards its end, rotated through an angle of 360 degrees with the normal lead-out axis as the axis of rotation along a plane perpendicular to the said axis, and such operation is counted as once. Next it shall be rotated in opposite direction through an angle of 360 degrees to return to the original position, and such operation is counted as twice. Unless otherwise specified, such operation shall be made five times (refer to Fig. 11).

The time required for one operation shall be approximately 5 s. Unless otherwise specified in the relevant detail specification, either the resistor-body holder or the lead-wire fixture may be rotated for carrying out this test.

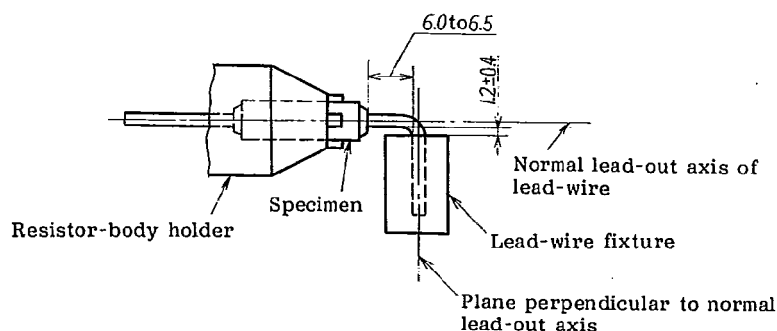
Fig. 11. Example of torsional strength test method of lead-wire termination

Unit: mm

Example of lead-wire bending



Example of clamping for torsional strength of lead-wire termination



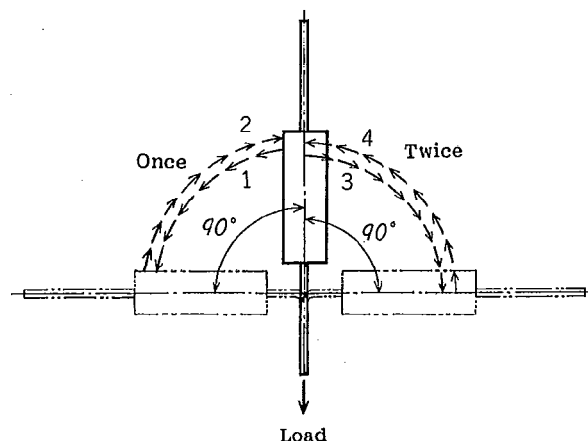
- (3) Torsional strength of cap termination One cap termination of the specimen is fixed, and a torsional moment of 100 N·cm {10.2 kgf·cm} shall be applied to the other cap termination clockwise and counterclockwise. Provided that, this test is applicable for tubular resistors with cap terminations of 20 mm or more in outside diameter.
- (4) Bending strength of lead-wire termination [refer to 4.5.2.1 in 4. (test Ub) of JIS C 0051] The specimen is held so that the normal lead-out axis of the lead-wire termination is vertical, a weight corresponding to the bending force specified in Table 14 is suspended unless otherwise specified, the resistor body is turned in the vertical plane through an angle of 90 degrees in 2 to 3 s and then returned to the original position at the same speed. This operation is counted as once. Next the resistor body is turned in opposite direction through an angle of 90 degrees and then returned to the original, this operation is counted as twice. Unless otherwise specified, the test shall be carried out twice (refer to Fig. 12).

Further, care shall be taken not to twist the lead wire during this test.

Table 14. Bending force

Nominal sectional area mm ²	Nominal wire diameter mm (for circular cross section)	Bending force N {kgf}	Informative reference Mass of weight corresponding to bending force kg
Up to and including 0.05	Up to and including 0.25	0.5 {0.051}	0.051
Over 0.05 up to and including 0.07	Over 0.25 up to and including 0.3	1.25 {0.127}	0.127
Over 0.07 up to and including 0.2	Over 0.3 up to and including 0.5	2.5 {0.255}	0.255
Over 0.2 up to and including 0.5	Over 0.5 up to and including 0.8	5 {0.51}	0.51
Over 0.5 up to and including 1	Over 0.8 up to and including 1.2	10 {1.02}	1.02
Over 1	Over 1.2	20 {2.04}	2.04

Fig. 12. Schematic drawing of bending strength test method



- (5) Torque strength of threaded stud and screw termination [refer to 6. (test Ud) of JIS C 0051] The body of specimen is fixed, unless otherwise specified the torque specified in condition 1 or condition 2 of Table 15 shall be applied without shock to the nut mated with the screw termination for 10 to 15 s.

In this test a washer or a metallic plate with adequate clearance to the screw shall be placed between the head of screw and the surface which is tightened. The thickness of the washer or metallic plate shall be approximately 6 times the nominal pitch of the screw and the thickness of the nut shall be approximately 0.8 times the nominal major diameter of the screw. These components shall be dry and free from dirt.

Table 15. Torque

		Unit: N·m {kgf·m}		
Nominal diameter of screw (mm)		2.6	3.0	3.5
Torque	Condition 1	0.4 {0.041}	0.5 {0.051}	0.8 {0.082}
	Condition 2	0.2 {0.020}	0.25 {0.025}	0.4 {0.041}
Nominal diameter of screw (mm)		4.0	5.0	6.0
Torque	Condition 1	1.2 {0.12}	2.0 {0.20}	2.5 {0.25}
	Condition 2	0.6 {0.061}	1.0 {0.10}	1.25 {0.125}

6.1.3 Items to be specified in detail specification In detail specifications, the following items shall be specified:

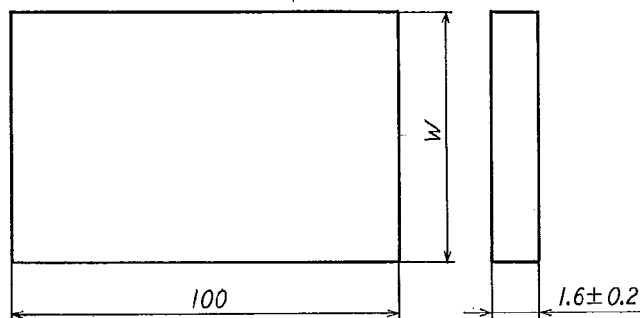
- (1) Tensile strength of termination
 - (a) Tensile force (refer to Table 13)
 - (b) Direction of load (refer to Fig. 10)
 - (c) Measurement of electrical performance (if necessary) (refer to 6.1.2)
- (2) Torsional strength of lead wire termination
Number of rotations (if necessary) [refer to 6.1.2 (2)]
- (3) Torsional strength of cap termination
Applicable resistor [refer to 6.1.2 (3)]
- (4) Bending strength of lead-wire termination
 - (a) Bending force (if necessary) (refer to Table 14)
 - (b) Number of bends (if necessary) [refer to 6.1.2 (4)]
- (5) Torque strength of threaded stud and screw termination
Torque (if necessary) (refer to Table 15)

6.1.4 Test method 2 (applicable for SMD)

- (1) Resistance to base material bending The test for strength of terminations and electrodes when mounted to a printed circuit board shall be as follows:
 - (a) Mounting of SMD to be tested The SMD to be tested (hereafter referred to as specimen) shall be mounted on the testing printed circuit board specified in the relevant detail specification in accordance with the provision of Annex 2. the testing printed circuit board shall be as shown in Fig. 13 if not specified in the specification. The lands and dimension W shall be specified in the detail specification.

Fig. 13. Testing printed circuit board

Unit: mm



Material GE4 given in JIS C 6484

Thickness of copper foil $0.035 \begin{matrix} +0.010 \\ -0.005 \end{matrix}$ mm

- (b) Preconditioning The specimen SMD which requires preconditioning shall be preconditioned as specified in the relevant detail specification.
- (c) Initial measurement The appearance of specimen SMD shall be visually examined by using a magnifying lens of magnification 10. The electrical and/or mechanical performances shall be examined if the relevant detail specification calls for.
- (d) Arrangement The specimen SMD mounted on the testing printed circuit board shall be placed on the supports all illustrated in Fig. 14. The supports shall be placed on a robust flat testing board so that the testing procedure is not affected at the time of pressurization. The supports and testing board may be those given in Fig. 15.

Fig. 14. Arrangement

Unit: mm

