

Carbon film resistors

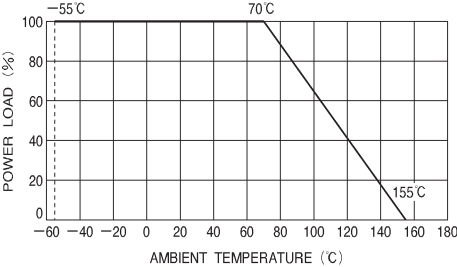
R20 ($3.2 \times 1.9 \phi$ size: 1 / 4W)

ROHM resistors are produced using an integrated production system for parts and materials, and state of the art technology to ensure high precision productivity, and quality. ROHM resistors are ISO-9001 approved. The design and specifications are subject to change without prior notice. Before ordering or use, please check the technical specification sheets.

●Features

- 1) All ceramic rods are made from the same material to yield consistent quality.
- 2) Unique production methods provide outstanding mechanical strength characteristics.
- 3) Superb accuracy of axial taping means excellent high-speed automatic insertion.
- 4) Though miniaturized, the R20 retains the high pulse resistance of its predecessor chips.
- 5) Soft copper wire with solder plating offers superior solderability.
- 6) Both insulator coating and its color codes are highly resistant to solvents, and steam cleaning is no problem.
- 7) Highly nonflammable insulation coating (UL94V-0).

●Ratings

Item		R20	
Rated power (70℃)		1 / 4W (0.25W)	
Power derating curve		 Power must be derated according to the power derating curve in the accompanying figure when ambient temperature exceeds 70 °C.	
Rated voltage		Rated voltage is equal to the lesser of the value obtained by the formula $\sqrt{\text{rated voltage} \times \text{nominal resistance}}$ or maximum operating voltage.	
Maximum operating voltage		250V	
Resistance	Resistance tolerance	J (±5℃)	
	Resistance temperature coefficient	Nominal resistance	Resistance temperature coefficient
		Less than 10 Ω	0 to +300ppm / °C
		10 Ω to 33kΩ	0 to −350ppm / °C
		36kΩ to 220kΩ	0 to −500ppm / °C
		240kΩ to 470kΩ	0 to −700ppm / °C
		510kΩ to 1.0MΩ	0 to −1000ppm / °C
		1.1MΩ to 2.2MΩ	0 to −1500ppm / °C
	Resistance range	0.47 Ω to 2.2MΩ	
	Nominal resistance	E24 series	
	Maximum overload voltage	500V	
Maximum intermittent overload voltage		600V	
Operating temperature		−55℃ to 155℃	
Weight		130mg	

Note: This product meets the specifications given in this specification sheet, but it is influenced by the applied voltage and ambient conditions. For this reason, if the product is to be used in equipment that must be extremely reliable, pay careful consideration to the load rate on the component when designing the equipment.
In cases such as this, we recommend that you design the circuit so that the voltage on the component is no more than half of its rated value. In particular, when the component is used in AC circuits, take steps to ensure that the peak voltage applied to the component is less than the maximum operating voltage.

●Characteristics

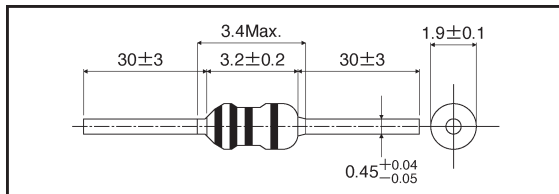
Characteristics	Specifications	Test method																
DC resistance	DC resistance is within maximum variation from nominal DC resistance.	JIS C 5202 5.1 DC resistance value is measured at the test voltage levels specified below: <table><tr><th>Nominal resistance</th><th>DC test voltage</th></tr><tr><td>Less than 10 Ω</td><td>0.1V</td></tr><tr><td>10 Ω to 99 Ω</td><td>0.3V</td></tr><tr><td>100 Ω to 999 Ω</td><td>1.0V</td></tr><tr><td>1 k Ω to 9.999 k Ω</td><td>3.0V</td></tr><tr><td>10 k Ω to 99.999 k Ω</td><td>10.0V</td></tr><tr><td>100 k Ω to 999.999 k Ω</td><td>25.0V</td></tr><tr><td>1 M Ω and over</td><td>50.0V</td></tr></table>	Nominal resistance	DC test voltage	Less than 10 Ω	0.1V	10 Ω to 99 Ω	0.3V	100 Ω to 999 Ω	1.0V	1 k Ω to 9.999 k Ω	3.0V	10 k Ω to 99.999 k Ω	10.0V	100 k Ω to 999.999 k Ω	25.0V	1 M Ω and over	50.0V
Nominal resistance	DC test voltage																	
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10 k Ω to 99.999 k Ω	10.0V																	
100 k Ω to 999.999 k Ω	25.0V																	
1 M Ω and over	50.0V																	
Resistance temperature characteristics	Resistance temperature characteristics fall within the range of resistance temperature c- oefficients specified in the following table. <table><tr><th>Nominal resistance</th><th>(ppm / °C)</th></tr><tr><td>Less than 10 Ω</td><td>0 to +300</td></tr><tr><td>10 Ω to 33k Ω</td><td>0 to −350</td></tr><tr><td>36k Ω to 220k Ω</td><td>0 to −500</td></tr><tr><td>240k Ω to 470k Ω</td><td>0 to −700</td></tr><tr><td>510k Ω to 1.0M Ω</td><td>0 to −1,000</td></tr><tr><td>1.1M Ω to 2.2M Ω</td><td>0 to −1,500</td></tr></table>	Nominal resistance	(ppm / °C)	Less than 10 Ω	0 to +300	10 Ω to 33k Ω	0 to −350	36k Ω to 220k Ω	0 to −500	240k Ω to 470k Ω	0 to −700	510k Ω to 1.0M Ω	0 to −1,000	1.1M Ω to 2.2M Ω	0 to −1,500	JIS C 5202 5.2 Resistance temperature coefficients are calculated according to the following formula, and are based on the resistance temperature coefficient at test temperature, and on resistance at room temperature. $\frac{R_2-R_1}{R_1(t_2-t_1)} \times 10^6 \text{ (ppm / } ^\circ\text{C)}$ R ₁ : Resistance at room temperature (t ₁) R ₂ : Resistance at room temperature + 100°C (t ₂) Test temperature sequence: Room temperature (25°C) Room temperature+100°C		
Nominal resistance	(ppm / °C)																	
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510k Ω to 1.0M Ω	0 to −1,000																	
1.1M Ω to 2.2M Ω	0 to −1,500																	
Voltage coefficient	25ppm / V Max.	JIS C 5202 5.3 The change in resistance, as measured at rated voltage, is calculated according to the following formula, and is based on the measurement for resistance obtained at a voltage equal to 1 / 10 of rated voltage. $\frac{R_1-R_2}{R_2} \times \frac{10^6}{0.9 \times (\text{rated voltage})} \text{ (ppm / V)}$ R ₁ : Resistance, as measured at rated voltage. R ₂ : Measurement for resistance obtained at a voltage equal to 1 / 10 of rated voltage																
Short time overload	Resistance change rate must be within ±(1%+0.05Ω), and there must be no mechanical damage.	JIS C 5202 5.5 DC voltage or AC voltage (at effective commercial frequency) 2.5 times greater than rated voltage is applied for five seconds. Maximum overload voltage is 500V.																
Insulation resistance	10 ⁴ MΩ Min.	JIS C 5202 5.6 Place the resistor in a metal 90-degree V block such that neither end projects beyond the edges of the block, then apply a test voltage of 100V (at effective commercial frequency) for 60 seconds between the V block and the lead.																
Withstand voltage	Resistance change rate must be within ±(0.5%+0.05Ω), and there must be no line loss, overheating, or damage to the insulation.	JIS C 5202 5.7 Place the resistor in a metal 90-degree V block such that neither end projects beyond the edges of the block, then apply a test voltage of 300V (at effective commercial frequency) for 60 to 70 seconds between the V block and the lead.																
Intermittent overload (10Ω or greater)	Resistance change rate must be within ±(0.75%+0.05Ω), and there must be no mechanical damage.	JIS C 5202 5.8 AC voltage (at effective commercial frequency) 4 times greater than rated voltage (3 times greater in the case of 1 / 4W resistors) is applied 1,000 times at 25-seconds intervals, with each application lasting 1 second. Maximum intermittent overload voltage is 600V.																

Characteristics	Specifications	Test method															
Terminal strength	Resistance change rate must be within $\pm(0.5\%+0.05\Omega)$, and there must be no mechanical damage, such as broken or loose leads.	JIS C 5202 6.1 Bending strength: holding the resistor steady, suspend a weight of 5N from the lead so that it hangs perpendicularly from the resistor. Rotate the resistor 90 degrees in one direction and return it to its original position, then rotate it again 90 degrees in the opposite direction. Torsional strength: Bend the lead 90 degrees approximately 6 mm from the resistor. After fixing the position of the bent lead, rotate it upon its original axis back and forth 360 degrees three times at a speed of approximately 5 seconds per revolution.															
Resistance to vibration (low frequency)	Resistance change rate must be within $\pm(0.5\%+0.05\Omega)$, and there must be no mechanical damage.	JIS C 5202 6.3 Resistor is subjected to a single vibration having an amplitude of 0.8 mm (double amplitude of 1.6 mm) for tow hours each in three mutually perpendicular directions for a total of six hours. Vibration frequency should be varied back and forth regularly from 10 Hz to 55 Hz and back again once every minute.															
Resistance to soldering heat	Resistance change rate must be within $\pm(1\%+0.05\Omega)$, and there must be no mechanical damage.	JIS C 5202 6.4 Dip leads up to 4.0±0.8 mm from the resistor body in a solder bath in the manner described in A or B below, leave them undisturbed for three hours, then measure resistance. <table><tr><th>Conditions</th><th>Temperature</th><th>Soldering time</th></tr><tr><td>A</td><td>350±10℃</td><td>3.5±0.5s.</td></tr><tr><td>B</td><td>260±5℃</td><td>10.0±1.0s.</td></tr></table>	Conditions	Temperature	Soldering time	A	350±10℃	3.5±0.5s.	B	260±5℃	10.0±1.0s.						
Conditions	Temperature	Soldering time															
A	350±10℃	3.5±0.5s.															
B	260±5℃	10.0±1.0s.															
Solderability	At least 95% of the area exposed to the solder bath must be covered with soft, new solder.	JIS C 5202 6.5 Carry out the test in the manner prescribed in JIS C 5202 6.5. Soldering temperature: 235±5℃ Soldering time: 5±0.5s.															
Resistance to cold	Resistance change rate must match the description in the following table, and there must be no mechanical damage. <table><tr><th>Nominal resistance</th><th>Resistance change rate</th></tr><tr><td>Less than 100 kΩ</td><td>± (2%+0.05Ω)</td></tr><tr><td>100 kΩ or greater</td><td>±3%</td></tr></table>	Nominal resistance	Resistance change rate	Less than 100 kΩ	± (2%+0.05Ω)	100 kΩ or greater	±3%	JIS C 5202 7.1 The resistor is placed without load for 1000 to 1048 continuous hours in a chamber kept at a constant −55±3℃.									
Nominal resistance	Resistance change rate																
Less than 100 kΩ	± (2%+0.05Ω)																
100 kΩ or greater	±3%																
Resistance to dry heat	Resistance change rate must match the description in the following table, and there must be no mechanical damage. <table><tr><th>Nominal resistance</th><th>Resistance change rate</th></tr><tr><td>Less than 100 kΩ</td><td>± (2%+0.05Ω)</td></tr><tr><td>100 kΩ or greater</td><td>±3%</td></tr></table>	Nominal resistance	Resistance change rate	Less than 100 kΩ	± (2%+0.05Ω)	100 kΩ or greater	±3%	JIS C 5202 7.2 The resistor is placed without load for 1000 to 1048 continuous hours in a chamber kept at a constant 125±2℃.									
Nominal resistance	Resistance change rate																
Less than 100 kΩ	± (2%+0.05Ω)																
100 kΩ or greater	±3%																
Temperature cycling	Resistance change rate must be within $\pm(1\%+0.05\Omega)$, and there must be no mechanical damage.	JIS C 5202 7.4 The resistor is put through five temperature cycles, each cycle being as described in the following table. <table><tr><th>Step</th><th>Temperature</th><th>Holding time</th></tr><tr><td>1</td><td>−55±3℃</td><td>30min</td></tr><tr><td>2</td><td>Room temperature</td><td>2 to 3min</td></tr><tr><td>3</td><td>155±2℃</td><td>30min</td></tr><tr><td>4</td><td>Room temperature</td><td>2 to 3min</td></tr></table>	Step	Temperature	Holding time	1	−55±3℃	30min	2	Room temperature	2 to 3min	3	155±2℃	30min	4	Room temperature	2 to 3min
Step	Temperature	Holding time															
1	−55±3℃	30min															
2	Room temperature	2 to 3min															
3	155±2℃	30min															
4	Room temperature	2 to 3min															

Characteristics	Specifications	Test method									
Resistance to humidity (steady state)	Resistance change rate must match the description in the following table, and there must be no mechanical damage.	JIS C 5202 7.5 The resistor is placed without load for 240 continuous hours in a chamber kept at a constant $40\pm 2^{\circ}\text{C}$ and 90% to 95% relative humidity.									
	Nominal resistance										
	Resistance change rate										
Endurance (under load in damp environment)	Less than 100 k Ω	JIS C 5202 7.9 The resistor is placed for 1000 to 1048 continuous hours in a chamber kept at a constant $40\pm 2^{\circ}\text{C}$ and 90% to 95% relative humidity, where rated DC voltage is alternately applied (for 1.5 hours) and turned off (for 0.5 hours) in a continuous cycle.									
	100 k Ω or greater										
	Resistance change rate										
Endurance (rated load)	Less than 100 k Ω	JIS C 5202 7.10 The resistor is placed for 1000 to 1048 continuous hours in a chamber kept at a constant $70\pm 2^{\circ}\text{C}$, where rated voltage is alternately applied (for 1.5 hours) and turned off (for 0.5 hours) in a continuous cycle.									
	100 k Ω or greater										
	Resistance change rate										
Resistance to solvents	Printed markings and surface of the insulation must not be noticeably damaged.	JIS C 5202 6.9 Resistor is immersed five times in solvent as specified in the following table and rubbed dry each time with absorbent cotton.									
		<table> <tr> <th>Solvent</th><th>Temperature of solvent</th><th>Duration</th></tr> <tr> <td>Isopropyl alcohol</td><td>20 to 25</td><td>60$\pm$10s.</td></tr> <tr> <td>Water</td><td>55$\pm$5</td><td>5$\pm$0.5Min.</td></tr> </table>	Solvent	Temperature of solvent	Duration	Isopropyl alcohol	20 to 25	60 $\pm$ 10s.	Water	55 $\pm$ 5	5 $\pm$ 0.5Min.
Solvent	Temperature of solvent	Duration									
Isopropyl alcohol	20 to 25	60 $\pm$ 10s.									
Water	55 $\pm$ 5	5 $\pm$ 0.5Min.									

* The design and specifications are subject to change without prior notice. Before ordering or using, check the latest technical specification.

●External dimensions (Units: mm)



●Structure and materials

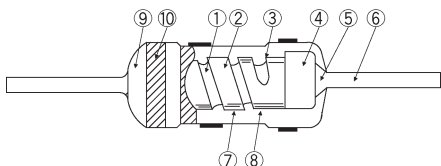


Fig.1

(1) Substrate: Alumina magnetic rod

Alumina is superior to regular mullite or forsterite with respect to mechanical strength, thermal conductivity, and thermal stability.

(2) Resistive elements

0Ω: Copper film

Less than 10Ω: Nickel film. In addition to their high stability, these resistors are designed to cut off safely in the event of a voltage spike.

10Ω and above: Carbon film. This type of film offers superior uniformity and stability.

(3) Cutting groove

The groove is cut to a uniform depth and width across the whole element, and there are no chips or cracks in the finished product.

(4) Terminals: Tin-plated copper, steel cap

This material provides a solid physical and electrical connection.

(5) Connections: Spot-welded

Spot welding ensures a solid, durable connection between the terminal and the terminal wire.

(6) Terminal wires: Solder-plated copper wire

Can be soldered effectively even after a long time.

(7) Protective film

For resistors of 10Ω or more, a special inorganic material guarantees the long-term stability of the dielectric film.

(8) Under coating: Phenolic resin

The dielectric film is protected by a coat of high-purity phenolic resin.

(9) Outer coating: Epoxy resin (color: light brown)

This coating offers superior resistance to heat, the elements, and solvents, and is a good insulator. It is also very safe, meeting the UL94V-0 standard for nonflammability.

(10) Markings: Color coding using thermo-hardened paint

Markings offer outstanding resistance to solvents and chemicals, and do not fade.

●Reference standards

ROHM's pioneering products meet the following domestic and international standards.

- JIS C 5202: Regulations on test methods for fixed resistors
- JIS C 5003: Regulations on test methods for malfunction rates
- JIS C 6402: Resistors, fixed, carbon film
- MIL-R-11: Resistors, fixed, composition (insulated)
- MIL-R-10509: Resistors, fixed, film (high stability)
- MIL-R-22684: Resistors, fixed, film, insulated
- EIA-RS-196: Fixed film resistors--precision and semi-precision
- DIN-44052: Resistors, fixed, lacquered, cracked carbonfilm, high stability, with axial leads

●Pulse voltage limits

The pulse voltage rating (1) is determined by the following formula. However, if the value obtained from the formula exceeds the maximum pulse voltage (2) or the resistance-limited voltage peak value (3), the lowest value must be taken as the pulse voltage rating.

(1) Pulse voltage rating

$$V_p = \sqrt{\frac{P \times R}{f \times t}}$$

P: Rated power(W) f: repetition frequency (Hz)

R: nominal resistance (Ω) t: pulse width (s)

(2) Maximum pulse voltage R20 × 600V

R25X × 750V

(3) Resistance-limited voltage peak

Less than 10Ω

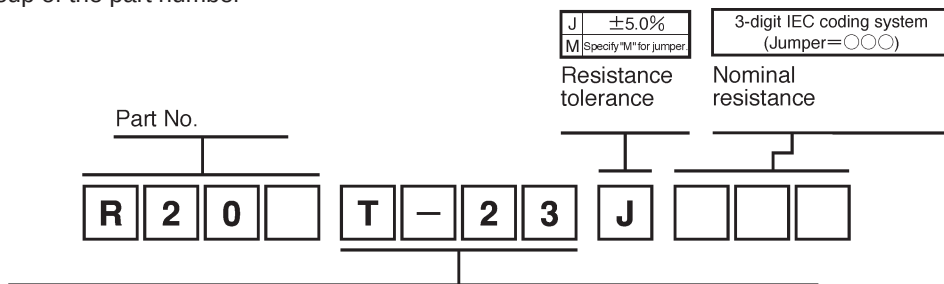
Up to four times the rated DC voltage

10Ω or more

Up to seven times the rated DC voltage

It is assumed that the pulse width is less than 10ms.

●Makeup of the part number



Packaging specifications (carbon film resistors)

Part No.	Code	Package style	Tape inner width	Case	Standard ordering unit(pcs)	Shipped to
R20	T-24	Axial taping	26mm	Ammo box	2000	JPN, ASIA (except KOREA)
	T-23	Axial taping	26mm	Ammo box	5000	JPN, ASIA, BRAZIL
	T-29	Axial taping	52mm	Ammo box	2000	JPN, KOREA
	T-04	Axial taping	52mm	Ammo box	5000	EUROPE, ASIA, BRAZIL

●Electrical characteristics

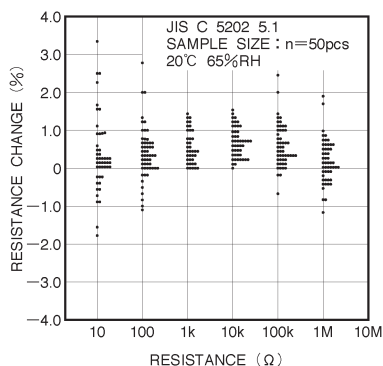


Fig.2 DC resistance

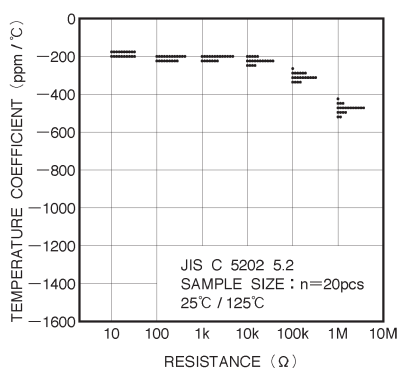


Fig.3 Resistance temperature characteristics

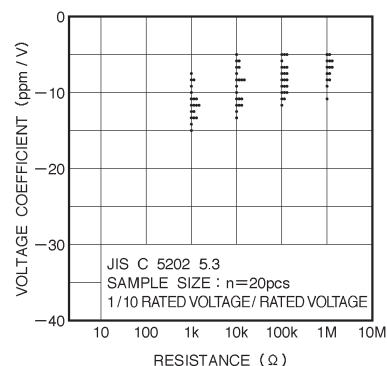


Fig.4 Voltage coefficient

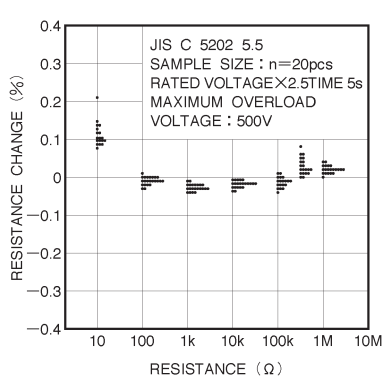


Fig.5 Short time overload

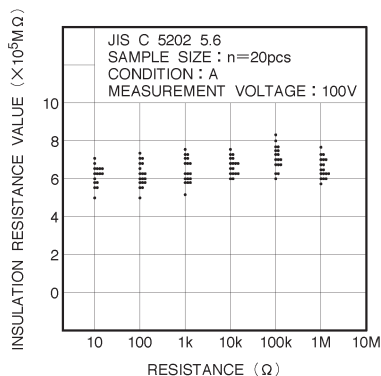


Fig.6 Insulation resistance

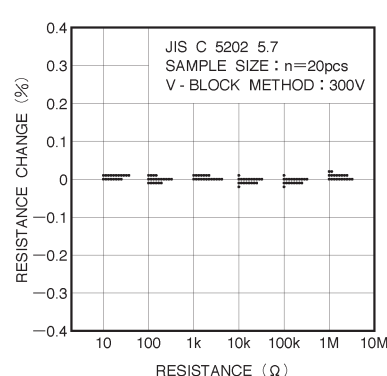


Fig.7 Withstand voltage

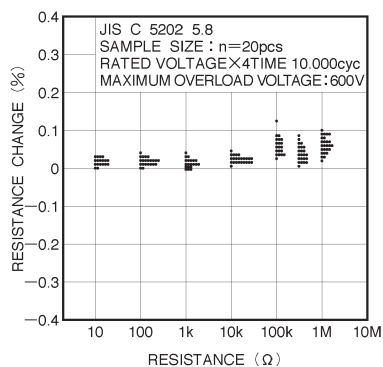


Fig.8 Intermittent overload

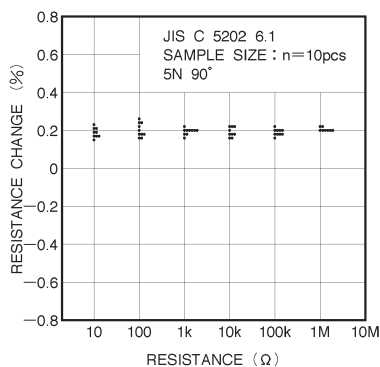


Fig.9 Terminal strength (bending)

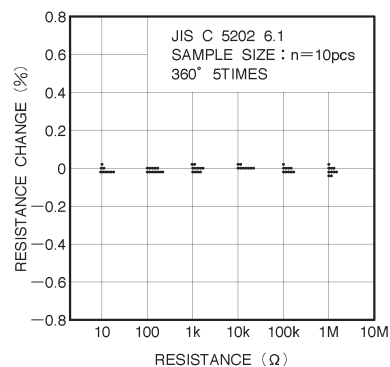


Fig.10 Terminal strength (torsional)

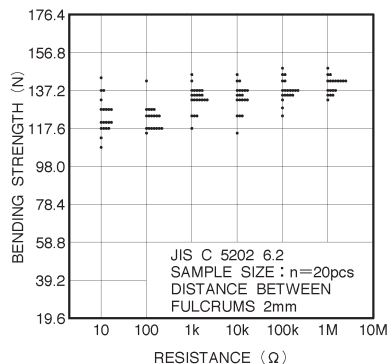


Fig.11 Bending strength

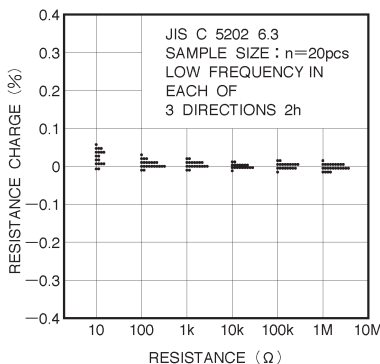


Fig.12 Resistance to vibration

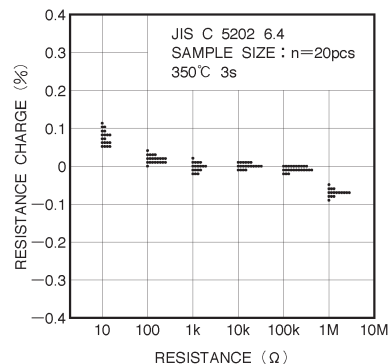


Fig.13 Resistance to soldering heat

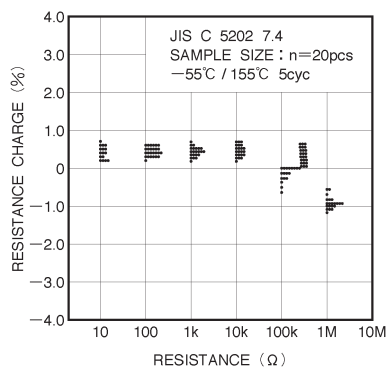


Fig.14 Temperature cycling

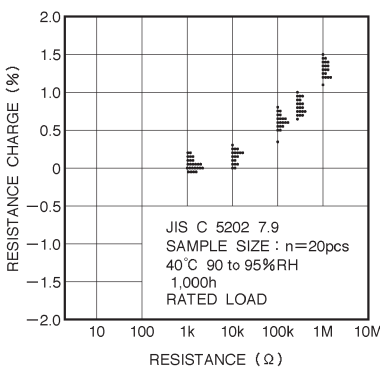
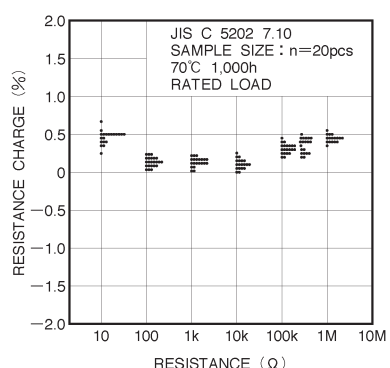
Fig.15 Endurance
(under load
and damp)

Fig.16 Endurance (rated load)