

# 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

R20		Item	Rating
Rated power	70°C		1/4W, 0.25W
	Power rating curve		<p>Power must be derated according to the power rating curve in the accompanying figure when ambient temperature exceeds 70°C.</p>
Rated voltage			Rated voltage is equal to the lesser of the value obtained by the formula: Rated voltage $\times$ nominal resistance $\leq$ maximum operating voltage.
Resistance	Maximum operating voltage		250V
	Resistance tolerance		$\pm 5\%$
Resistance temperature coefficient		Normal resistance	Resistance temperature coefficient
		Less than 10 $\Omega$ 10 $\Omega$ to 20 $\Omega$ 20 $\Omega$ to 220 $\times 10^3 \Omega$ 240 $\times 10^3 \Omega$ to 470 $\times 10^3 \Omega$ 510 $\times 10^3 \Omega$ to 1.0M $\Omega$ 1.1M $\Omega$ to 2.2M $\Omega$	0 $\pm$ 300ppm/ $^{\circ}$ C 0 $\pm$ 250ppm/ $^{\circ}$ C 0 $\pm$ 500ppm/ $^{\circ}$ C 0 $\pm$ 700ppm/ $^{\circ}$ C 0 $\pm$ 1000ppm/ $^{\circ}$ C 0 $\pm$ 1500ppm/ $^{\circ}$ C
Resistance range			0.47 $\Omega$ to 2.2M $\Omega$
Nominal resistance			E24 series
Maximum overload voltage			500V
Maximum intermittent overload voltage			500V
Operating temperature			55°C to 155°C
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

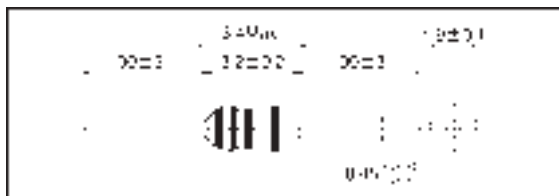
Characteristics	Specifications	Test method																
DC resistance	DC resistance is within maximum variation from nominal DC resistance	JIS C 5202-1 DC resistance value is measured at the test voltage levels specified below. <table><tr><th>Nominal resistance</th><th>DC test voltage</th></tr><tr><td>Less than 10Ω</td><td>0.1V</td></tr><tr><td>10Ω to 99Ω</td><td>0.3V</td></tr><tr><td>100Ω to 999Ω</td><td>1.0V</td></tr><tr><td>1 kΩ to 9.99 kΩ</td><td>3.0V</td></tr><tr><td>10 kΩ to 99.99 kΩ</td><td>10.0V</td></tr><tr><td>100 kΩ to 999.99 kΩ</td><td>25.0V</td></tr><tr><td>1 MΩ and over</td><td>50.0V</td></tr></table>	Nominal resistance	DC test voltage	Less than 10Ω	0.1V	10Ω to 99Ω	0.3V	100Ω to 999Ω	1.0V	1 kΩ to 9.99 kΩ	3.0V	10 kΩ to 99.99 kΩ	10.0V	100 kΩ to 999.99 kΩ	25.0V	1 MΩ and over	50.0V
Nominal resistance	DC test voltage																	
Less than 10Ω	0.1V																	
10Ω to 99Ω	0.3V																	
100Ω to 999Ω	1.0V																	
1 kΩ to 9.99 kΩ	3.0V																	
10 kΩ to 99.99 kΩ	10.0V																	
100 kΩ to 999.99 kΩ	25.0V																	
1 MΩ and over	50.0V																	
Resistance temperature coefficient	Resistance temperature characteristics fall within the range of resistance temperature coefficients specified in the following table. <table><tr><th>Nominal resistance</th><th>ppm/°C</th></tr><tr><td>Less than 10Ω</td><td>0 to +100</td></tr><tr><td>10Ω to 99Ω</td><td>0 to +50</td></tr><tr><td>100Ω to 999Ω</td><td>0 to +50</td></tr><tr><td>1 kΩ to 9.99 kΩ</td><td>0 to +50</td></tr><tr><td>10 kΩ to 99.99 kΩ</td><td>0 to +100</td></tr><tr><td>100 kΩ to 999.99 kΩ</td><td>0 to +100</td></tr></table>	Nominal resistance	ppm/°C	Less than 10Ω	0 to +100	10Ω to 99Ω	0 to +50	100Ω to 999Ω	0 to +50	1 kΩ to 9.99 kΩ	0 to +50	10 kΩ to 99.99 kΩ	0 to +100	100 kΩ to 999.99 kΩ	0 to +100	JIS C 5202-2 Resistance temperature coefficient α is calculated as follows by the following formula and measured on the resistance temperature coefficient at test temperature and on resistance at room temperature. $\alpha = \frac{R_2 - R_1}{R_1 \times (T_2 - T_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ <p>H Resistance at room temperature = 20.0 ± 0.5 H Resistance at test temperature = 100 ± 0.5 Test temperature sequence Room temperature (25.0) Room temperature (20.0) Room temperature (20.0)</p>		
Nominal resistance	ppm/°C																	
Less than 10Ω	0 to +100																	
10Ω to 99Ω	0 to +50																	
100Ω to 999Ω	0 to +50																	
1 kΩ to 9.99 kΩ	0 to +50																	
10 kΩ to 99.99 kΩ	0 to +100																	
100 kΩ to 999.99 kΩ	0 to +100																	
Voltage coefficient	See page 164	JIS C 5202-3 The change in resistance, as measured at rated voltage, is calculated according to the following formula and is based on the measured resistance values at a voltage equal to 1.110 of rated voltage. $\alpha = \frac{R_1 - R_2}{R_2 \times (V_1 - V_2)} \times 10^6 \text{ (ppm/V)}$ <p>H Resistance as measured at rated voltage H Measurement of resistance obtained at a voltage equal to 1.110 of rated voltage</p>																
Short time overload	Resistance change rate must be within 1.0% (0.05Ω) and there must be no mechanical damage	JIS C 5202-4 DC voltage or AC voltage of the test frequency (50 Hz) is greater than rated voltage is applied for five seconds. Maximum overload voltage is 500V.																
Insulation resistance	1000 MΩ	JIS C 5202-5 Place the resistor in a moist 50-degree C tank such that neither end projects beyond the edges of the block. Then apply a test voltage of 1,000 V at 50 Hz (minimum 1 V per mm for 50 mm) between the V block and the lead.																
Withstand voltage	Resistance change rate must be within 1.0% (0.05Ω) and there must be no fire, loss, discoloring, or damage to the insulation	JIS C 5202-6 Place the resistor in a moist 50-degree C tank such that neither end projects beyond the edges of the block. Then apply a test voltage of 300 V at 50 Hz (minimum 1 V per mm for 300 mm) between the V block and the lead.																
Intermittent overload 10.0 m sec	Resistance change rate must be within 1.0% (0.05Ω) and there must be no mechanical damage	JIS C 5202-7 AC voltage at effective (RMS) value of 4 times greater than rated voltage (3 times greater than specified 1.414V) is applied 1.0/0.5 times at 25 seconds intervals with each application lasting 1 second. Maximum intermittent overload voltage is 500V.																

Characteristic	Specification	Test method															
Tensile strength	Resistance change rate must be within $\pm 1\% + 0.010\%$ and there must be no mechanical damage, such as broken or loose ends.	JIS C 5202 6.1 The tensile strength, holding the resistor directly, is exerted by pulling 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. Tensile strength tests at the east 90 degrees approximately 6 times, then the resistor, after turning the position of the tensile test multiple times, is rotated east and west and both 90 degrees three times at a speed of approximately 5 seconds per revolution.															
Resistance change rate at frequency	Resistance change rate must be within $\pm 0.1\% + 0.010\%$ and there must be no mechanical damage.	JIS C 5202 6.2 Resistor is subjected to a single vibration having an amplitude of 0.5 mm double amplitude at 10 mm/sec sine wave, which is three mutually perpendicular directions for a total of six hours. Vibration frequency is set to 500 Hz and 1 kHz equally with 10 Hz to 55 Hz and noise spectrum is 400 Hz to 1 kHz.															
Temperature change during heat	Resistance change rate must be within $\pm 1\% + 0.010\%$ and there must be no mechanical damage.	JIS C 5202 6.4 Op. leads up to 4.0 mm from the resistor body are soldered in the manner described in 2 and 3 below. Resistor is subjected for three hours, then measure resistance. <table><tr><th>Conditions</th><th>Temperature</th><th>Soldering time</th></tr><tr><td>A</td><td>250 <math>\pm</math> 10°C</td><td>2.5 <math>\pm</math> 0.5 s</td></tr><tr><td>B</td><td>250 <math>\pm</math> 5°C</td><td>10.0 <math>\pm</math> 1.0 s</td></tr></table>	Conditions	Temperature	Soldering time	A	250 $\pm$ 10°C	2.5 $\pm$ 0.5 s	B	250 $\pm$ 5°C	10.0 $\pm$ 1.0 s						
Conditions	Temperature	Soldering time															
A	250 $\pm$ 10°C	2.5 $\pm$ 0.5 s															
B	250 $\pm$ 5°C	10.0 $\pm$ 1.0 s															
Solderability	At least 95% of the area exposed to the solder bath must be soldered with satisfactory solder.	JIS C 5202 6.5 Carried out in the bath in the manner prescribed in JIS C 5202 6.4. Soldering temperature: 150 $\pm$ 5°C Soldering time: 5 $\pm$ 0.3 s															
Resistance to shock	Resistance change rate must match the description in the following table, and there must be no mechanical damage. <table><tr><th>Normal resistance</th><th>Resistance change rate</th></tr><tr><td>Less than 100 <math>\pm</math> 0</td><td><math>\pm 2\% + 0.050\%</math></td></tr><tr><td>100 <math>\pm</math> 0 or greater</td><td><math>\pm 0.5\%</math></td></tr></table>	Normal resistance	Resistance change rate	Less than 100 $\pm$ 0	$\pm 2\% + 0.050\%$	100 $\pm$ 0 or greater	$\pm 0.5\%$	JIS C 5202 7.1 The resistor is placed without heat for 1000 to 10000 continuous hours in an atmosphere of air at constant $25 \pm 3^\circ\text{C}$ .									
Normal resistance	Resistance change rate																
Less than 100 $\pm$ 0	$\pm 2\% + 0.050\%$																
100 $\pm$ 0 or greater	$\pm 0.5\%$																
Resistance to vibration	Resistance change rate must match the description in the following table, and there must be no mechanical damage. <table><tr><th>Normal resistance</th><th>Resistance change rate</th></tr><tr><td>Less than 100 <math>\pm</math> 0</td><td><math>\pm 2\% + 0.050\%</math></td></tr><tr><td>100 <math>\pm</math> 0 or greater</td><td><math>\pm 0.5\%</math></td></tr></table>	Normal resistance	Resistance change rate	Less than 100 $\pm$ 0	$\pm 2\% + 0.050\%$	100 $\pm$ 0 or greater	$\pm 0.5\%$	JIS C 5202 7.2 The resistor is stored without heat for 1000 to 10000 continuous hours in an atmosphere of air at constant $25 \pm 2^\circ\text{C}$ .									
Normal resistance	Resistance change rate																
Less than 100 $\pm$ 0	$\pm 2\% + 0.050\%$																
100 $\pm$ 0 or greater	$\pm 0.5\%$																
Temperature cycling	Resistance change rate must be within $\pm 1\% + 0.050\%$ , and there must be no mechanical damage.	JIS C 5202 7.4 The resistor is put through 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><math>-55 \pm 3^\circ\text{C}</math></td><td>30 min</td></tr><tr><td>2</td><td>Op. in ramp rate</td><td>2 to 3 min</td></tr><tr><td>3</td><td><math>+55 \pm 2^\circ\text{C}</math></td><td>30 min</td></tr><tr><td>4</td><td>Op. in ramp rate</td><td>2 to 3 min</td></tr></table>	Step	Temperature	Holding time	1	$-55 \pm 3^\circ\text{C}$	30 min	2	Op. in ramp rate	2 to 3 min	3	$+55 \pm 2^\circ\text{C}$	30 min	4	Op. in ramp rate	2 to 3 min
Step	Temperature	Holding time															
1	$-55 \pm 3^\circ\text{C}$	30 min															
2	Op. in ramp rate	2 to 3 min															
3	$+55 \pm 2^\circ\text{C}$	30 min															
4	Op. in ramp rate	2 to 3 min															

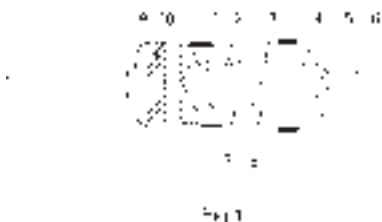
Characteristics	Specifications	Test method									
Resistance to humidity (steady state)	Resistance change rate must match the description in the following table, and there must be no mechanical damage. <table><tr><th>Nominal resistance</th><th>Resistance change rate</th></tr><tr><td>Less than 100 kΩ</td><td><math>\pm 2\%</math> +0.05%</td></tr><tr><td>100 kΩ or greater</td><td><math>\pm 0.1\%</math></td></tr></table>	Nominal resistance	Resistance change rate	Less than 100 kΩ	$\pm 2\%$ +0.05%	100 kΩ or greater	$\pm 0.1\%$	JIS C 5202 7-5 The resistor is placed without load for 240 continuous hours in a chamber kept at a constant 40±2 °C and 90% to 95% relative humidity.			
Nominal resistance	Resistance change rate										
Less than 100 kΩ	$\pm 2\%$ +0.05%										
100 kΩ or greater	$\pm 0.1\%$										
Endurance under load in damp environment	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><math>\pm 2\%</math> +0.05%</td></tr><tr><td>100 kΩ or greater</td><td><math>\pm 0.1\%</math></td></tr></table>	Nominal resistance	Resistance change rate	Less than 100 kΩ	$\pm 2\%$ +0.05%	100 kΩ or greater	$\pm 0.1\%$	JIS C 5202 7-9 The resistor is placed for 1000 to 1048 continuous hours in a chamber kept at a constant 40±2 °C and 90% to 95% relative humidity where rated DC voltage is alternately applied for 1.5 hours and turned off for 1.5 hours in a continuous cycle.			
Nominal resistance	Resistance change rate										
Less than 100 kΩ	$\pm 2\%$ +0.05%										
100 kΩ or greater	$\pm 0.1\%$										
Endurance (load load)	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><math>\pm 2\%</math> +0.05%</td></tr><tr><td>100 kΩ or greater</td><td><math>\pm 0.1\%</math></td></tr></table>	Nominal resistance	Resistance change rate	Less than 100 kΩ	$\pm 2\%$ +0.05%	100 kΩ or greater	$\pm 0.1\%$	JIS C 5202 7-10 The resistor is placed for 1000 to 1048 continuous hours in a chamber kept at a constant 70±2 °C where rated voltage is alternately applied for 1.5 hours and turned off for 0.5 hours in a continuous cycle.			
Nominal resistance	Resistance change rate										
Less than 100 kΩ	$\pm 2\%$ +0.05%										
100 kΩ or greater	$\pm 0.1\%$										
Resistance to solvents	Finger 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 pulled dry 300° time with attention to 107°.									
		<table><tr><th>Solvent</th><th>Temperature of solvent</th><th>Duration</th></tr><tr><td>90PPH n-C6H14</td><td>20 to 25</td><td>90±10s</td></tr><tr><td>Wash</td><td>25±5</td><td>30±5Min</td></tr></table>	Solvent	Temperature of solvent	Duration	90PPH n-C6H14	20 to 25	90±10s	Wash	25±5	30±5Min
Solvent	Temperature of solvent	Duration									
90PPH n-C6H14	20 to 25	90±10s									
Wash	25±5	30±5Min									

\* For change rate of resistance, data are shown in the following table, and the test is performed at 1000 to 1048 hours of operation.

### ●External dimensions (Units: mm)



### ●Structure and materials



#### (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

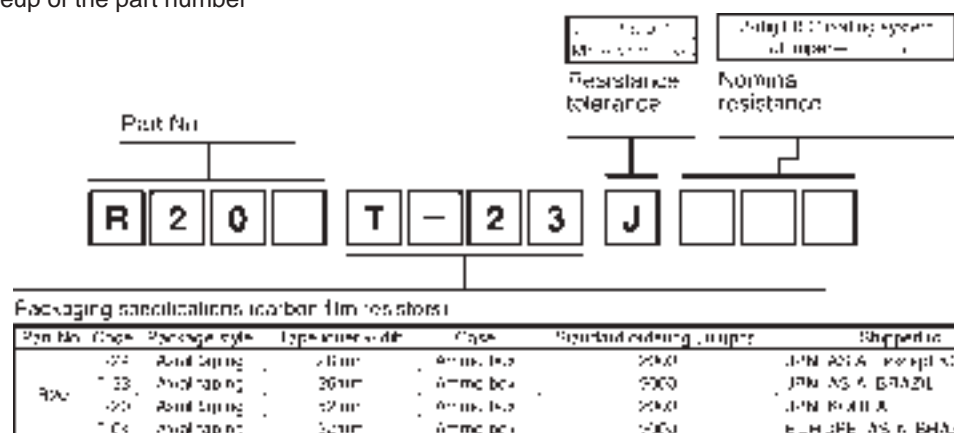
Up to four times the rated DC voltage

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



●Electrical characteristics

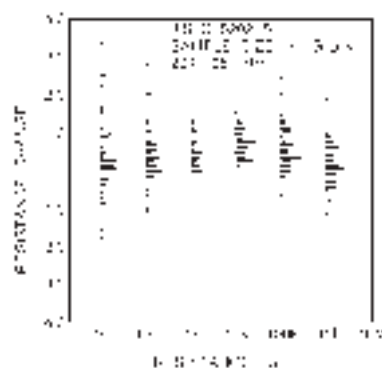


Fig. 2 DC resistance

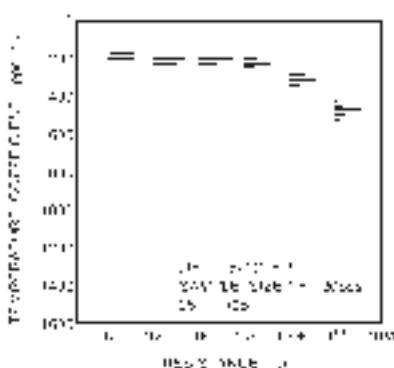


Fig. 3 Resistance temperature characteristics

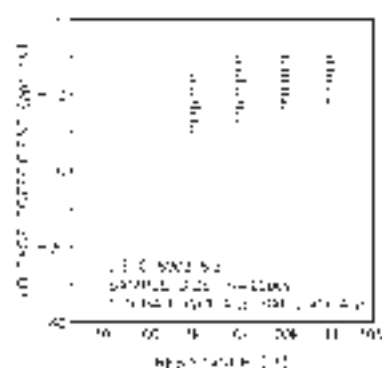


Fig. 4 Voltage coefficient

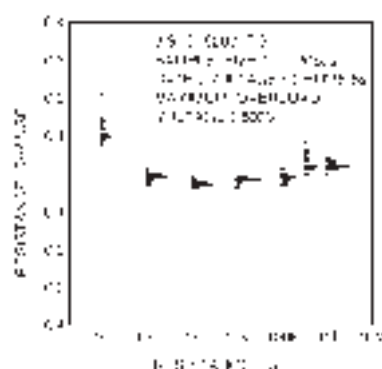


Fig. 5 Short time overload

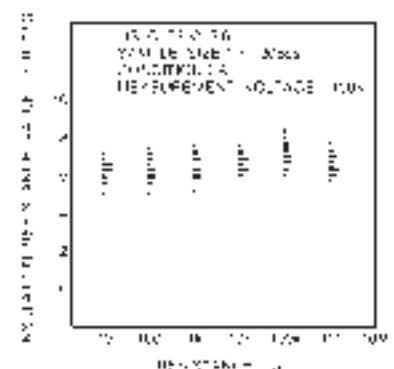


Fig. 6 Insulation resistance

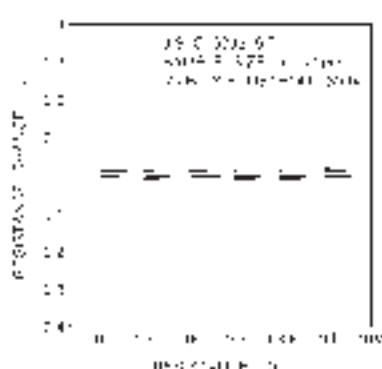


Fig. 7 Withstand voltage

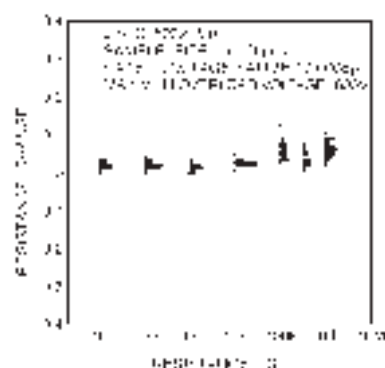


Fig. 8 Intermittent overload

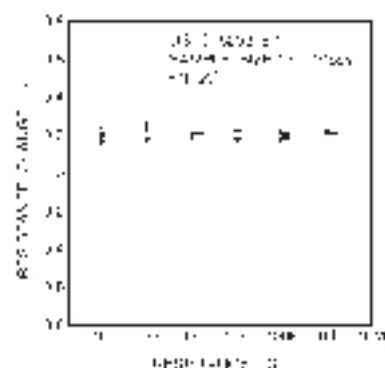


Fig. 9 Terminal strength (bonding)

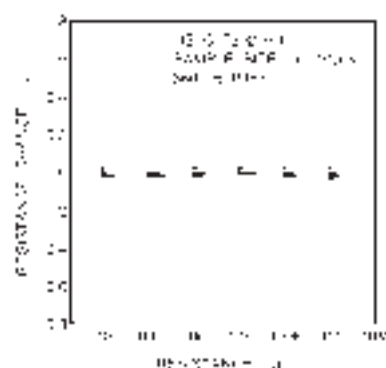


Fig. 10 Terminal strength (soldering)

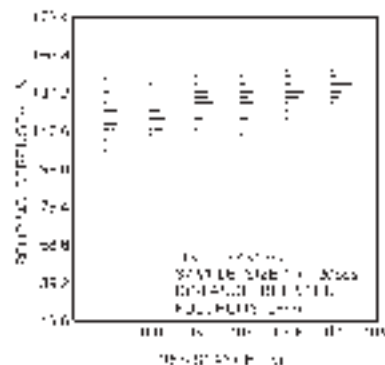


Fig. 11 Bending strength

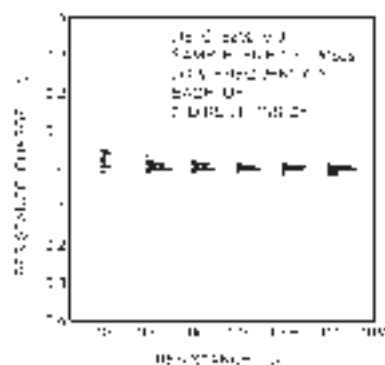


Fig. 12 Resistance in vibration

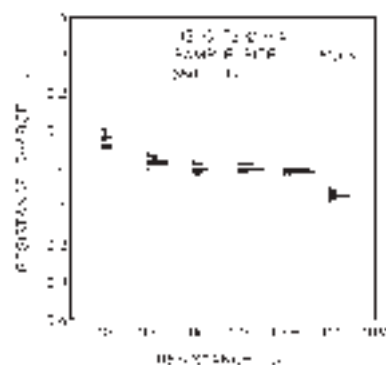


Fig. 13 Resistance to soldering heat

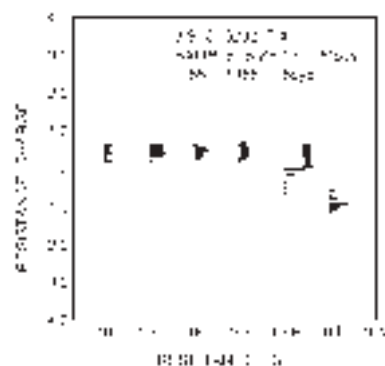


Fig. 14 Temperature cycling

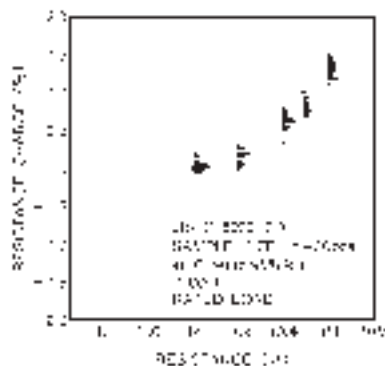
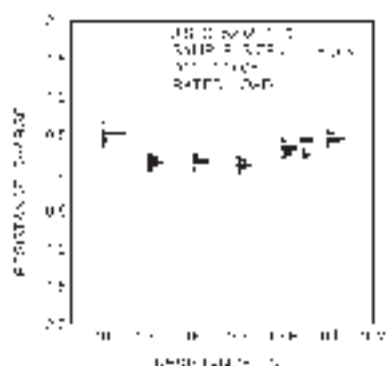
Fig. 15 Endurance  
(under load  
and damp)

Fig. 16 Endurance (rated load)