1 Scope:

1.1 This specification is applicable to lead and halogen free RAT series thick film chip resistors for automotive grade.

1.2 Lead free products mean lead free termination meets RoHS requirement. Pb contained in glass material of resistor element are exempted by RoHS directive.

1.3 Comply with AEC-Q200 standard.

2 Explanation Of Part Numbers:

(EX)

RAT **02** - **100** **J** **TH**

Type	Size (Refer to 3.General Specifications)	Nominal Resistance		Resistance Tolerance	Packaging (Refer to IE-SP-055)
Thick Film Chip Resistors for automotive grade	02(0402)	3-Digit	EX. 10Ω=100 4.7Ω=4R7 JUMPER=000	B =± 0.1% D=± 0.5% F=± 1% G=± 2% J=± 5%	TH：2 mm Pitch Carrier Tape 10000 pcs . . . . . BA：Bulk Case
		4-Digit	EX. 10.2Ω=10R2 10KΩ=1002		

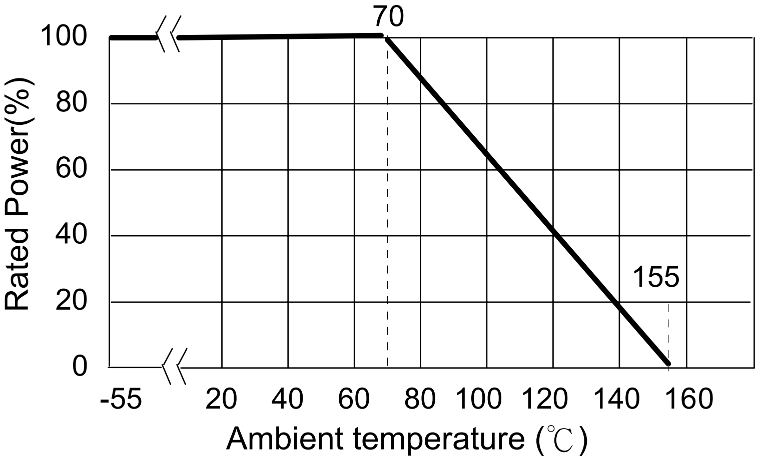
3 General Specifications:

Type	Rated Power at 70℃	Max. Working Voltage	Max. Overload Voltage	T.C.R (ppm/℃)	Resistance Range				JUMPER (0Ω) Rated Power	JUMPER (0Ω) Resistance Value
					B(±0.1%) E-24、E-96	D(±0.5%) E-24、E-96	F(±1%) E-24、E-96	G(±2%)、J(±5%) E-24	J (±5%)	J (±5%)
RAT02 (0402)	$\frac{1}{16}$W	50V	100V	±100	100Ω≦R≦1MΩ	10Ω≦R≦1MΩ	10Ω≦R≦22MΩ	10Ω≦R≦22MΩ	1A	50mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
RAT03 (0603)	$\frac{1}{10}$W	75V	150V	±100	100Ω≦R≦1MΩ	10Ω≦R≦1MΩ	10Ω≦R≦22MΩ	10Ω≦R≦22MΩ	1A	50mΩ MAX.
				±200	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
RAT05 (0805)	$\frac{1}{8}$W	150V	300V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦27MΩ	10Ω≦R≦27MΩ	2A	50mΩ MAX.
				±200	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
RAT06 (1206)	$\frac{1}{4}$W	200V	400V	±100	10Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦27MΩ	10Ω≦R≦27MΩ	2A	50mΩ MAX.
				±200	3Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
RAT12 (1210)	$\frac{1}{2}$W	200V	400V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦27MΩ	10Ω≦R≦27MΩ	2A	50mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
RAT20 (2010)	$\frac{3}{4}$W	200V	400V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦20MΩ	10Ω≦R≦20MΩ	2A	50mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
RAT25 (2512)	1W	200V	400V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦20MΩ	10Ω≦R≦20MΩ	2A	50mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω		
Operating Temperature Range				**-55℃ ~ +155℃**						

3.1 Power Derating Curve:

Operating Temperature Range： - 55～155 ℃

For resistors operated in ambient temperatures above 70℃, power rating shall be derated in accordance with figure below。



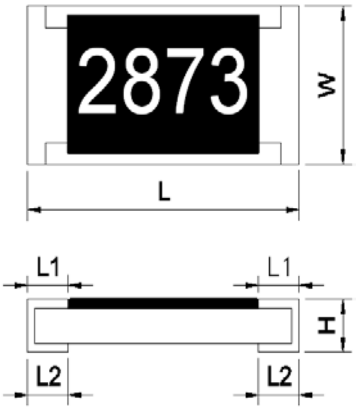
3.2 Voltage Rating:

Rated Voltage: The resistor shall have a DC continuous working voltage or a rms. AC continuous working voltage at commercial-line frequency and wave form corresponding to the power rating, as determined from the following:

$$E = \sqrt{R \times P}$$

E= Rated voltage (v)
P= Power rating (w)
R= Nominal resistance(Ω)

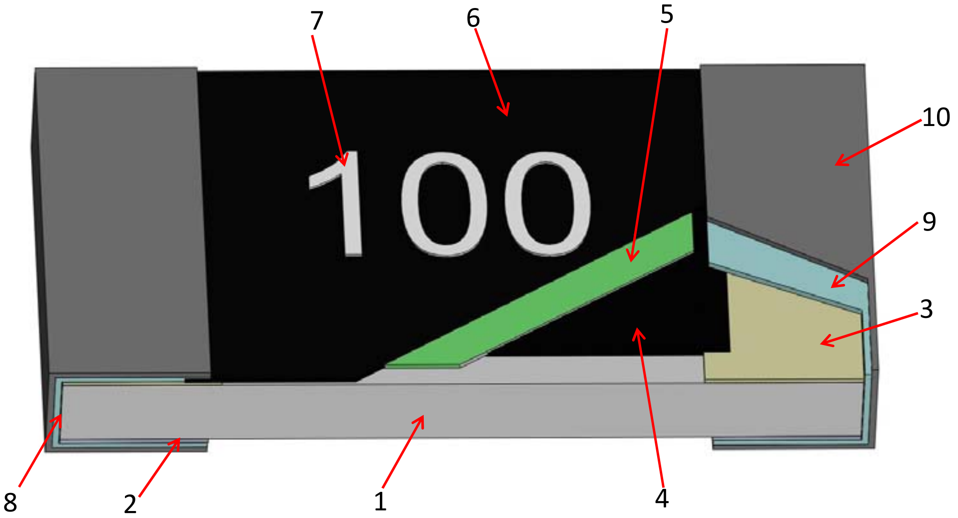
4 Dimensions:



Unit:mm

Type	Dimensions Size Code	L	W	H	L1	L2
RAT02	**0402**	1.00±0.10	0.50±0.05	0.30±0.05	0.20±0.10	0.25±0.10
RAT03	**0603**	1.60±0.10	0.80±0.10	0.45±0.10	0.30±0.15	0.30±0.15
RAT05	**0805**	2.00±0.10	1.25±0.10	0.50±0.10	0.35±0.20	0.35±0.15
RAT06	**1206**	3.05±0.10	1.55±0.10	0.50±0.10	0.45±0.20	0.35±0.15
RAT12	**1210**	3.05±0.10	2.55±0.10	0.55±0.10	0.50±0.20	0.50±0.20
RAT20	**2010**	5.00±0.20	2.50±0.20	0.55±0.10	0.60±0.20	0.60±0.20
RAT25	**2512**	6.30±0.20	3.20±0.20	0.55±0.10	0.60±0.20	0.60±0.20

5 Structure Graph:



1	Ceramic substrate	6	2nd Protective coating
2	Bottom inner electrode	7	Marking
3	Top inner electrode	8	Terminal inner electrode
4	Resistive layer	9	Ni plating
5	1st Protective coating	10	Sn plating

6 Reliability Test:

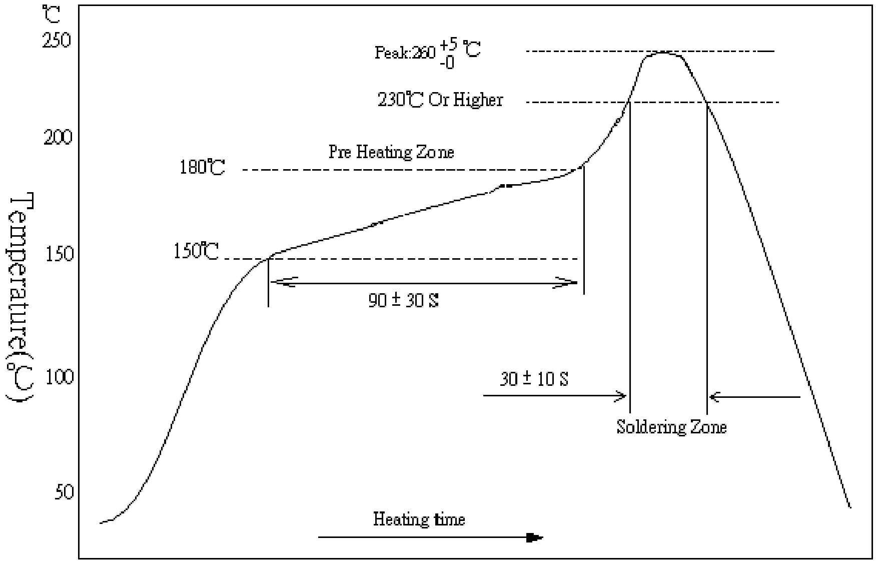
Item	Conditions	Specifications	
		Resistors	Jumper
High Temperature Exposure (Storage	Put the specimens in the chamber with temperature of 125±3℃ for 1000 hours. Then take them out to stabilize in room temperature for 24±2hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	1、0.1%、0.5%、1%： △R=±(1.0%+0.05Ω) 2、2%、5%： △R=±(2.0%+0.10Ω)	Refer to item 3. general specifications
		No mechanical damage.	
Temperature Cycling	Put the specimens in the High & low temperature test chamber with temperature varies from -55℃ to 155℃ for 5 minutes and total 1000 cycles. Then take them out to stabilize in room temperature for 24±2hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	1、0.1%、0.5%、1%： △R=±(1.0%+0.05Ω) 2、2%、5%： △R=±(2.0%+0.05Ω)	Refer to item 3. general specifications
		No mechanical damage.	
Moisture Resistance	reference to the temperature、humidity and duration specified in test method 7a, the specimens are put into the constant temperature humidity chamber to test for total 10 cycles (240hr) without load. Then take them out to stabilize in room temperature for 24±2hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	1、0.1%、0.5%、1%： △R=±(0.5%+0.05Ω) 2、2%、5%： △R=± (2.0%+0.05Ω)	Refer to item 3. general specifications
		No mechanical damage.	
Biased Humidity	Solder the specimens on the test PCB and put them into the constant temperature humidity chamber with 85±2℃ and 85±5%RH. Then apply the test voltage that calculates based on the 10% of rated power for 1000hrs. Then take them out to stabilize in room temperature for 24±2hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	1、0.1%、0.5%、1%： △ R=±(0.5%+0.05Ω) 2、2%、5%： △R=±(2.0%+0.10Ω)	Refer to item 3. general specifications
		No mechanical damage, short or burning-out phenomenon.	
Operational Life	Solder the specimens on the test PCB and Put them in the chamber with temperature of 125±3℃ and load the rated voltage for 1000 hours. Then take them out to stabilize in room temperature for 24±2hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	1、0.1%、0.5%、1%：: △R=±(0.5%+0.05Ω) 2、2%、5%： △R=±(2.0%+0.10Ω)	Refer to item 3. general specifications
		No mechanical damage, short or burning-out phenomenon.	
Physical Dimension	Measure of chip size (L、W、H) by size measuring tool. Measure of conductor size with the high-power microscope Experiment evidence: AEC-Q200	Refer to Datasheet item 4 Dimension	
Resistance to Solvents	Take the specimens to be immersed into the isopropyl alcohol of 25±5℃ for 3+0.5/-0 minutes, then rinse with water and stabilize for 48 hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	△R=±(0.5%+0.05Ω)	Refer to item 3. general specifications
		No mechanical damage, peel-off of G2 overcoat & marking or Leaching problem.	
Resistance to Soldering Heat	The specimens are fully immersed into the Pb-free solder pot, then take them out to stabilize for 1 hour or more and measure of its resistance variance rate. Temp of solder pot：260±5℃ Soldering duration：10±1sec. Experiment evidence AEC-Q200	△R%=±(1.0%+0.05Ω）	Refer to item 3. general specifications
		No cosmetic defect on terminal or peel-off of side end.	

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Conditions</th><th colspan="2">Specifications</th></tr>
<tr><th>Resistors</th><th>Jumper</th></tr>
<tr><td>Thermal Shock</td><td>Solder the specimens on the test PCB and put them into the Thermal Shock Test Chamber with the temperature of -55℃ for 15min and +125℃ for 15min, which is specified as 1 cycle and total 300 cycles needed. Then take out the specimens to stabilize for 24±2hr or more and measured of its resistance variance rate.<table><tr><th></th><th>Test condition</th></tr><tr><td>The lowest Temp</td><td>-55±5℃</td></tr><tr><td>The highest Temp</td><td>125±5℃</td></tr><tr><td>Dwell time</td><td>15min</td></tr></table>Experiment evidence AEC-Q200</td><td>1、0.1%、0.5%、1%：
△R=±(0.5%+0.05Ω)
2、2%、5%：
△ R=± (1.0%+0.05Ω)</td><td>Refer to item 3. general specifications</td></tr>
<tr><td rowspan="2">ESD</td><td rowspan="2">Put the specimens on the test fixture and two (2)discharges (2KVDC) shall be applied to each PUT, one (1) with a positive polarity and one (1) with a negative polarity. Afterwards, the specimens stabilize for 30min or more and measure of its resistance variance rate. The test is performed with direct contact and regular discharge mode. The resistor and capacitor used on the spearhead is 2000Ω and 150pF respectively.
Experiment evidence AEC-Q200</td><td>1、0.1%、0.5%、1%：
△R=±(2.0%+0.05Ω)
2、2%、5%：
△R=±(3.0%+0.10Ω)</td><td>Refer to item 3. general specifications</td></tr>
<tr><td colspan="2">No mechanical damage, short or burning-out phenomenon.</td></tr>
<tr><td>Solderability</td><td>Put the specimens in the apparatus of PCT, at a temperature of 105℃, humidity of 100% RH, and air pressure of 1.22× 105 Pa for a duration of 8 hours. Then leave the specimens in room temperature for 2 hours.
Test method:
Test item 1 (solder pot test): Method A
The specimens are immersed into the flux first, then fully immersed into the solder pot, at a temperature of 235± 5 ℃ for 5+0/-0.5 sec. Then rinse with water and observe the soldering coverage under the microscope.
Test item 2 (Leaching test): Method D
The specimens are immersed into the flux first, then fully immersed into the solder pot, at a temperature of 260±5 ℃ for 120±5sec. Then rinse with water and observe the soldering coverage under the microscope.
Experiment evidence AEC-Q200</td><td colspan="2">1.Soldering coverage over 95%
2.At the edge of terminal, the object underneath (e.g. white ceramic) shall not expose.</td></tr>
<tr><td>Electrical Characterization</td><td>TCR（ppm / ℃）$= \frac{(R2-R1)}{R1(T2-T1)} \times 10^6$
R1: Resistance at room temperature (Ω)
R2: Resistance at -55℃ or +125℃(Ω)
T1: Room temperature (℃)
T2: Temperature -55℃ or +125℃
Experiment evidence: AEC-Q200</td><td>Refer to item 3. general specifications</td><td>NA</td></tr>
<tr><td rowspan="2">Board Flex (Bending Test)</td><td rowspan="2">Solder the specimens on the test PCB and put the PCBA onto the Bending Tester. Add force at the central part of PCB, and measure of its resistance variance rate in load.
Bending depth
(D)=5mm
Experiment evidence: AEC-Q200</td><td>△ R=±(1.0%+0.05Ω)</td><td>Refer to item 3. general specifications</td></tr>
<tr><td colspan="2">No mechanical damage, peel-off of side end or chip crack.</td></tr>
</table>

Item	Conditions	Specifications	
		Resistors	Jumper
Terminal Strength (SMD)	Solder the specimens on the test PCB and put them on the fixture. Then 1.8Kgf pushing force is applied with the test probe (diameter as R0.5) on the board and hold for 60sec, and measure of resistance variance rate in load. Experiment evidence: AEC-Q200	△ R=±(1.0%+0.05Ω)	Refer to item 3. general specifications
		No mechanical damage or peel-off of side end.	
Sulfuration Test	Put the tested resistor in saturated vapor, at a temperature of 60±2℃, humidity of 91~93% RH for 1000hrs. Refer to ASTM-B-809-95	△ R=±(1.0%+0.05Ω)	Refer to item 3. general specifications

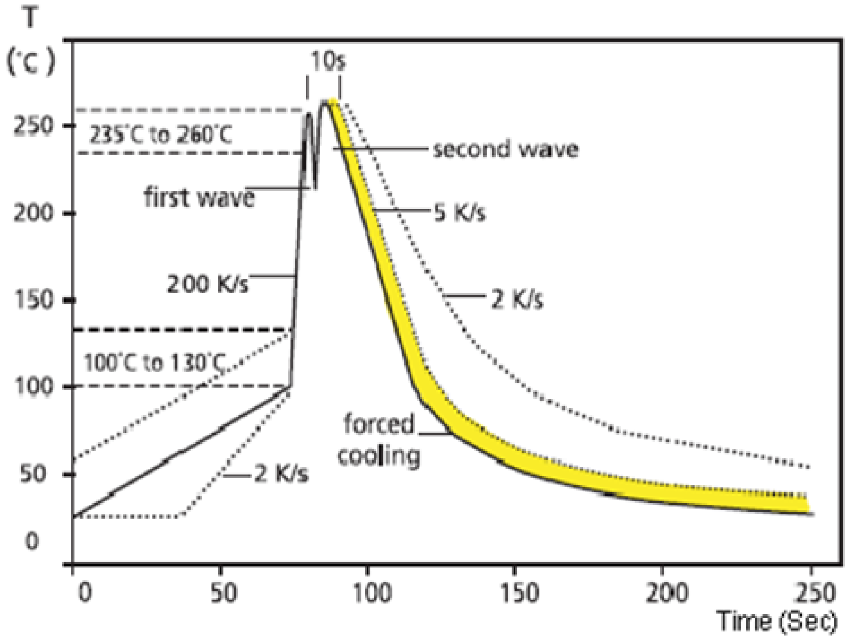
7 Recommend Soldering Method:

7.1 Lead Free Reflow Soldering Profile



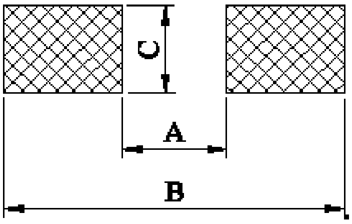
Remark: The peak temperature of soldering heat is 260 +5/-0 ℃ for 10 seconds.

7.2 Lead Free Double-Wave Soldering Profile.(This applies to 0603 size inclusive above products)



7.3 Soldering Iron: temperature 350℃±10℃, dwell time shall be less than 3 sec.

8 Recommend Land Pattern Design (For Reflow Soldering)



Unit:mm

DIM / TYPE	A	B	C
RAT02	0.5	1.5	0.6
RAT03	0.8	2.1	0.9
RAT05	1.2	3.0	1.3
RAT06	2.2	4.2	1.6
RAT12	2.2	4.2	2.8
RAT20	3.5	6.1	2.8
RAT25	3.8	8.0	3.5

9 Plating Thickness:

9.1 Ni:≧2μm

9.2 Sn(Tin):≧3μm

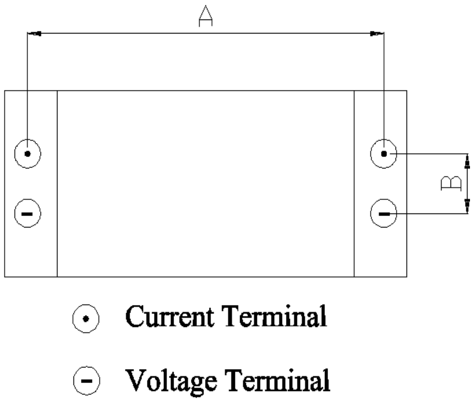
9.3 Sn(Tin):Matte Sn

10 Rule of package empty quantity:

10.1 Each reel that empty quantities don’t exceed 0.1% of whole quantities and continuous 2pcs (included) are allowed.

11 Measurement Point:

Bottom electrode



Unit : mm

DIM / TYPE	A	B
RAT02	**0.80±0.05**	**0.24±0.05**
RAT03	**1.35±0.05**	**0.35±0.05**
RAT05	**1.80±0.05**	**0.35±0.05**
RAT06	**2.90±0.05**	**0.35±0.05**
RAT12	**2.90±0.05**	**0.35±0.05**
RAT20	**4.50±0.05**	**1.15±0.05**
RAT25	**5.90±0.05**	**1.60±0.05**

12 Stock period:

12.1 The temperature condition must be controlled at 25±5℃, the R.H. must be controlled at 60±15%. The stock can maintain quality level in two years.

13 The carton packaged for electronic-information products is made by the symbol as follows: (For china)

	
Marking for control of pollution cause by electronic-information products	Marking for package recovery

14 Attachments:

14.1 Document Revise Record (QA-QR-027)