1 Scope:

1.1 This specification is applicable to lead free and halogen free of ROHS directive for RAT series thick film chip resistors.

1.2 This product is for automotive electronic application.

1.3 RAT01005/RAT0201 AEC-Q200 qualified, grade 1.
Other Types AEC-Q200 qualified, grade 0.

2 Explanation Of Part Numbers:

(EX)

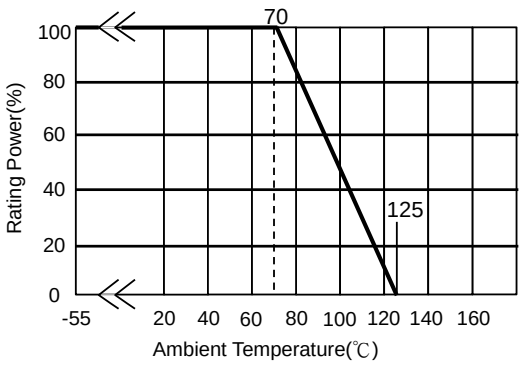
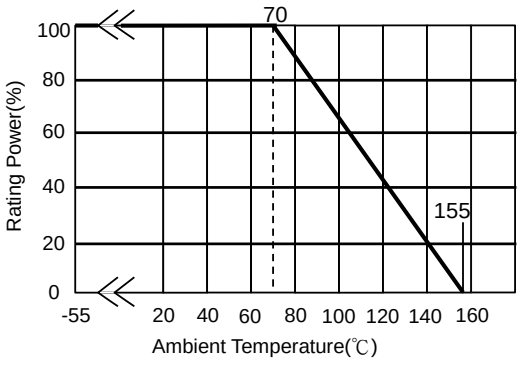
RAT **0402** **T** **100** **J**

Type	Size	Packaging	Nominal Resistance		Resistance Tolerance
Thick Film Chip Resistors for automotive grade	01005 0201 0402 0603 0805 1206 1210 2010 2512	T: Taping Type	3-Digit	EX.10Ω=100 4.7Ω=4R7 JUMPER=000	B =± 0.1% D=± 0.5% F=± 1% G=± 2% J=± 5%
			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%)	F (±1%)	J (±5%)	F (±1%)
RAT (01005)	1/32W	15V	30V	-200 +600	------	------	1Ω≦R<10Ω		0.5A	0.5A	100mΩ MAX	100mΩ MAX
				±250	------	------	10Ω≦R≦10MΩ					
RAT (0201)	1/20W	25V	50V	-200 +400	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω	0.5A	---	50mΩ MAX.	---
				±200	47Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦10MΩ	10Ω≦R≦10MΩ				
RAT (0402)	1/16W	50V	100V	±100	100Ω≦R≦1MΩ	10Ω≦R≦1MΩ	10Ω≦R≦22MΩ	10Ω≦R≦22MΩ	1A	1.33A	50mΩ MAX.	35mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
RAT (0603)	1/10W	75V	150V	±100	100Ω≦R≦1MΩ	10Ω≦R≦1MΩ	10Ω≦R≦22MΩ	10Ω≦R≦22MΩ	1A	2A	50mΩ MAX.	25mΩ MAX.
				±200	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
RAT (0805)	1/8W	150V	300V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦27MΩ	10Ω≦R≦27MΩ	2A	2.5A	50mΩ MAX.	20mΩ MAX.
				±200	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
RAT (1206)	1/4W	200V	400V	±100	10Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦27MΩ	10Ω≦R≦27MΩ	2A	3.5A	50mΩ MAX.	20mΩ MAX.
				±200	3Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
RAT (1210)	1/2 W	200V	400V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦27MΩ	10Ω≦R≦27MΩ	2A	4A	50mΩ MAX.	20mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
RAT (2010)	3/4 W	200V	400V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦20MΩ	10Ω≦R≦20MΩ	2A	5A	50mΩ MAX.	20mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
RAT (2512)	1W	200V	400V	±100	100Ω≦R≦1MΩ	10Ω≦R≦10MΩ	10Ω≦R≦20MΩ	10Ω≦R≦20MΩ	2A	7A	50mΩ MAX.	20mΩ MAX.
				±200	------	------	1Ω≦R＜10Ω	1Ω≦R＜10Ω				
Operating Temperature Range				**-55℃ ~ +155℃ (01005/0201:-55℃ ~ +125℃)**								

3.1 Power Derating Curve:

Type	RAT(01005) / RAT (0201)	Other
Operating Temperature Range	−55℃ ~ +125℃	−55℃ ~ +155℃
Explain	For resistors operated in ambient temperatures above 70℃, power rating shall be derated in accordance with figure below.	For resistors operated in ambient temperatures above 70℃, power rating shall be derated in accordance with figure below.
Figure		

3.2 Voltage Rating:

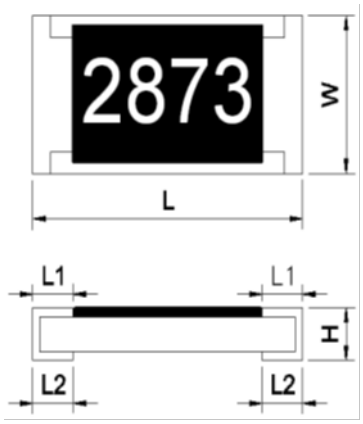
Rated Voltage: The resistor shall have a DC continuous working voltage or a rms. AC continuous working voltage at commercial-line frequency and wave form corresponding to the power rating, as determined from the following:

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

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

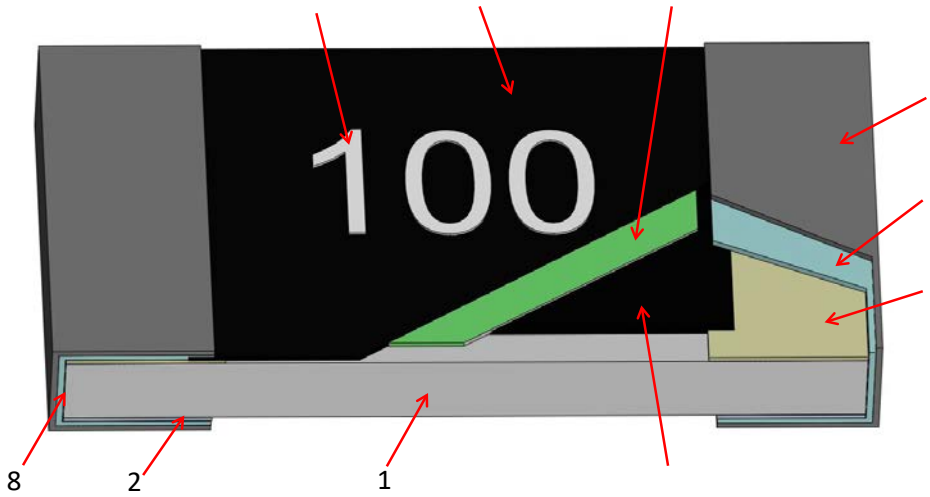
4 Dimensions:

Unit:mm



Type \ Dimension	Size Code	L	W	H	L1	L2
RAT	**01005**	0.40±0.02	0.20±0.02	0.13±0.02	0.10±0.03	0.10±0.03
RAT	**0201**	0.60±0.03	0.30±0.03	0.23±0.03	0.10±0.05	0.15±0.05
RAT	**0402**	1.00±0.10	0.50±0.05	0.30±0.05	0.20±0.10	0.25±0.10
RAT	**0603**	1.60±0.10	0.80±0.10	0.45±0.10	0.30±0.15	0.30±0.15
RAT	**0805**	2.00±0.10	1.25±0.10	0.50±0.10	0.35±0.20	0.35±0.15
RAT	**1206**	3.05±0.10	1.55±0.10	0.50±0.10	0.45±0.20	0.35±0.15
RAT	**1210**	3.05±0.10	2.55±0.10	0.55±0.10	0.50±0.20	0.50±0.20
RAT	**2010**	5.00±0.20	2.50±0.20	0.55±0.10	0.60±0.20	0.60±0.20
RAT	**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

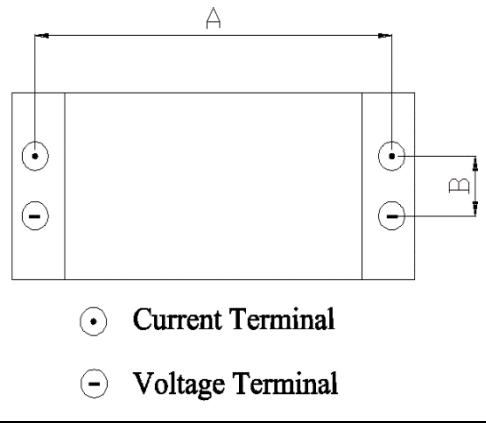
6 Reliability Test:

Item	Conditions	Specifications	
		Resistors	Jumper
High Temperature Exposure (Storage)	Put the specimens in the chamber with temperature of 155±3℃ for 1000 hours. Then take them out to stabilize in room temperature for 24±4hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	01005: △R=±2.0% Others: 0.1%、0.5%、1%：△R=±1.0% 2%、5%：△R=±2.0%	Refer to item 3. general specifications
Temperature Cycling	Put the specimens in the High & low temperature test chamber with temperature varies from -55℃ to 125℃ for 15 minutes and total 1000 cycles. Then take them out to stabilize in room temperature for 24±4hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	△R=±2.0%	Refer to item 3. general specification
Short Time Overload	Applied 2.5 times rated voltage for 5 seconds and release the load for about 30 minutes, then measure its resistance variance ate. (Rated voltage refer to item 3. general specifications) Refer to JIS-C5201-1 4.13	01005: △R=±2.0% Others: 0.1%、0.5%、1%：△R=±1.0% 2%、5%：△R=±2.0%	Refer to item 3. general specification
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±4hr or more, and measure of its resistance variance rate. Experiment evidence: AEC-Q200	01005: △R=±5.0% Others: 0.1%、0.5%、1%：△R=±2.0% 2%、5%：△R=±3.0%	Refer to item 3. general specification
Operational Life	Solder the specimens on the test PCB and Put them in the chamber with temperature of 125±3℃ and load the voltage for 1000 hours. Then take them out to stabilize in room temperature for 24±4hr or more, and measure of its resistance variance rate. Note: The input voltage shall refer to the power de-rating curve (referring to page 2,No.3.1) Experiment evidence: AEC-Q200	01005: △R=±5.0% Others: 0.1%、0.5%、1%：△R=±2.0% 2%、5%：△R=±3.0%	Refer to item 3. general specification
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	01005: △R=±2.0% Others:△R=±1.0%	Refer to item 3. general specification.

Item	Conditions	Specifications	
		Resistors	Jumper
ESD	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	△R=±3.0%	Refer to item 3. general specification
Solderability	**Test method:** **Test item 1 (solder pot test):** Method B Precondition: The specimens are subjected to 155℃ dry bake for 4hrs±15min. 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 30+0/-0.5 sec. Then rinse with water and observe the soldering coverage under the microscope. Experiment evidence AEC-Q200	1.Soldering coverage over 95% 2.At the edge of terminal, the object underneath (e.g. white ceramic) shall not expose.	
Electrical Characterization	$TCR\ (ppm/℃) = \frac{(R2-R1)}{R1(T2-T1)} \times 10^6$ 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	Refer to item 3. general specifications	NA
Board Flex (Bending Test)	Solder the specimens on the test PCB and put the PCBA onto the Bending Tester. Add force at the central part of PCB, and the duration of the applied forces shall be 60 (+ 5) Sec. Measure of its resistance variance rate in load. Bending depth (D)： 0402,06303 0805=5mm 01005,0201,12061210=3mm 2010 2512=2mm Experiment evidence: AEC-Q200	△R=±1.0%	Refer to item 3. general specification
		No mechanical damage, peel-off of side end or chip crack.	

7 Measurement Point:

Bottom electrode



Unit : mm

TYPE \ DIM	A	B
RAT0201	0.44±0.05	0.22±0.05
RAT0402	0.80±0.05	0.24±0.05
RAT0603	1.35±0.05	0.35±0.05
RAT0805	1.80±0.05	0.35±0.05
RAT1206	2.90±0.05	0.35±0.05
RAT1210	2.90±0.05	0.35±0.05
RAT2010	4.50±0.05	1.15±0.05
RAT2512	5.90±0.05	1.60±0.05

8 Plating Thickness:

8.1 Ni: $\geqq 2\ \mu m$

8.2 Sn(Tin): $\geqq 3\ \mu m$

8.3 Sn(Tin):Matte Sn

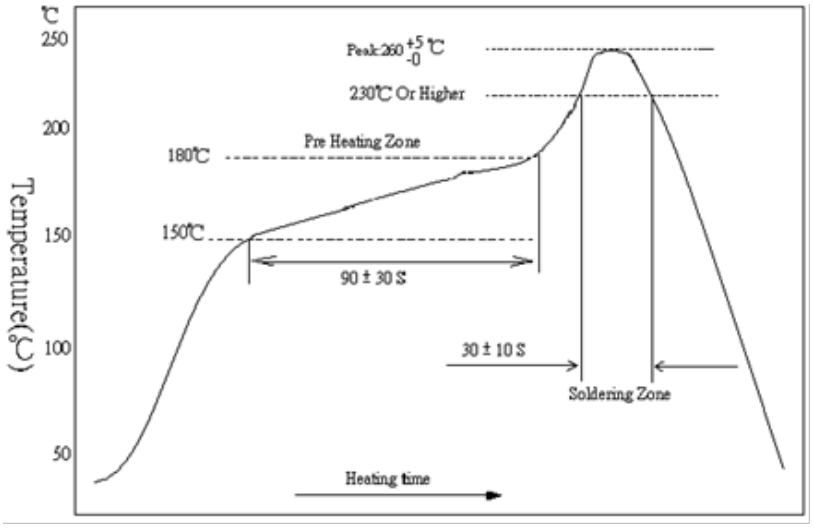
9 Rule of package empty quantity:

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

10 Technical application notes: (This is for recommendation, please customer perform adjustment according to actual application)

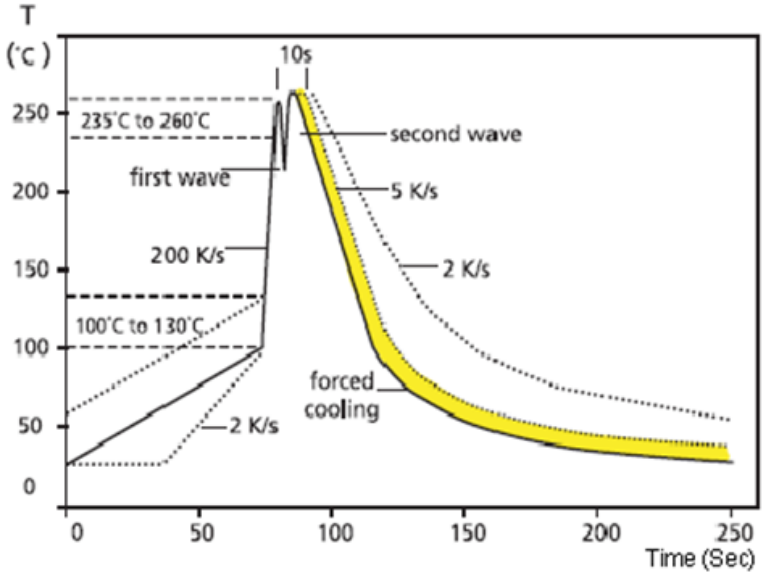
10.1 Recommend Soldering Method:

10.1.1 Lead Free IR Reflow Soldering Profile (MEET J-STD-020D)



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

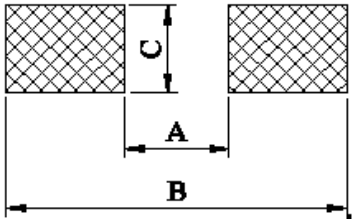
10.1.2 Lead Free Double-Wave Soldering Profile.(This applies to 0603 size inclusive above products)



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

10.2 Recommend Land Pattern Design (For Reflow Soldering)：

When a component is soldered, the resistance after soldering changes slightly depending on the size of the soldering area and the amount of soldering. When designing a circuit, it is necessary to consider the effect of a decrease or increase in its resistance.



Unit:mm

DIM / TYPE	A	B	C
RAT01005	0.2	0.5	0.2
RAT0201	0.3	1.0	0.4
RAT0402	0.5	1.5	0.6
RAT0603	0.8	2.1	0.9
RAT0805	1.2	3.0	1.3
RAT1206	2.2	4.2	1.6
RAT1210	2.2	4.2	2.8
RAT2010	3.5	6.1	2.8
RAT2512	3.8	8.0	3.5

10.3 Automobile Electronic Application:

This specification is for automobile electronic use. RALEC will take no responsibility if any damage, cost or loss occurs when the product has been used in any special circumstances.

(a) Information、entertainment、navigation、audio control units.

(b) Comfortable door, window, seat control unit.

(c) Internal lighting control unit.

10.4 Environment Precautions:

If consumer intends to use our company product in special environment or condition (including but not limited to those mentioned below), then will need to make individual recognition of product features and reliability accordingly.

(a) Used in high temperature and humidity environment

(b) Exposed to sea breeze or other corrosive gas, such as Cl2、H2S、NH3、SO2 and NO2.

(c) Used in non-verified liquids including water, oil, chemical and organic solvents.

(d) Using non-verified resin or other coating material to seal or coat our Company product.

(e) After soldering, it is necessary to use water-soluble detergents to clean residual solder fluxes, even though no-clean fluxes are recommended.

10.5 Momentary Overload Precautions:

The product might be out of function when momentary overloaded. Please make sure to avoid momentary overloading while using and preserving.

10.6 Operation and Processing Precautions:

(a) Avoid damage to the edge of resistor and protective layer caused by mechanical stress.

(b) Handle with care when printing circuit board (PCB) is divided or fixed on support body, because bending of printing circuit board (PCB) mounting will make mechanical stress for resistors.

(c) Make sure the power rating is under the limit when using the resistor. When power rating is over the limit, the resister will be overloaded. There might be machinery damage due to the climbing temperature

(d) If the resister will be exposed under massive impact load (shock wave) in a short period of time, the working environment must be set up well before use.

(e) Please make evaluation and confirmation when the product is well used in your company and have a through consideration of its fail-safe design to ensure the system safety.

11 Stock period:

11.1 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.

11.2 Please avoid the mentioned harsh environment below when storing to ensure product performance and its' weldability. Places exposed to sea breeze or other corrosive gas, such as Cl_2、H_2S、NH_3、SO_2 and NO_2.

11.3 When the product is moved and stored, please ensure the correct orientation of the box. Do not drop or squeeze the box. Otherwise, the electrode or the body of the product may be damaged.

12 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

13 Attachments:

13.1 Document Revise Record(QA-QR-027)

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