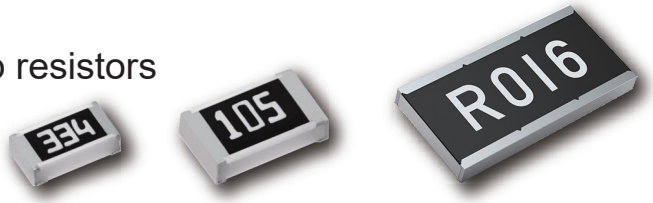
Panasonic
INDUSTRY

Your Committed Enabler

Pamphlet

High performance chip resistor

- High precision chip resistors
- High temperature chip resistors
- Anti-sulfurated chip resistors
- Current sensing chip resistors
- Small & High power chip resistors
- High voltage & High accuracy chip resistors



IN Your Innovation

2024.7

Safety and Legal Matters to Be Observed

Product specifications and applications

- Please be advised that this product and product specifications are subject to change without notice for improvement purposes. Therefore, please request and confirm the latest delivery specifications that explain the specifications in detail before the final design, or purchase or use of the product, regardless of the application. In addition, do not use this product in any way that deviates from the contents of the company's delivery specifications.
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- Please ensure safety through protection circuits, redundant circuits, etc., in the customer's system design so that a defect in our company's product will not endanger human life or cause other serious damage.
- This catalog shows the quality and performance of individual parts. The durability of parts varies depending on the usage environment and conditions. Therefore, please ensure to evaluate and confirm the state of each part after it has been mounted in your product in the actual operating environment before use. If you have any doubts about the safety of this product, then please notify us immediately, and be sure to conduct a technical review including the above protection circuits and redundant circuits at your company.

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AEC-Q200 compliant

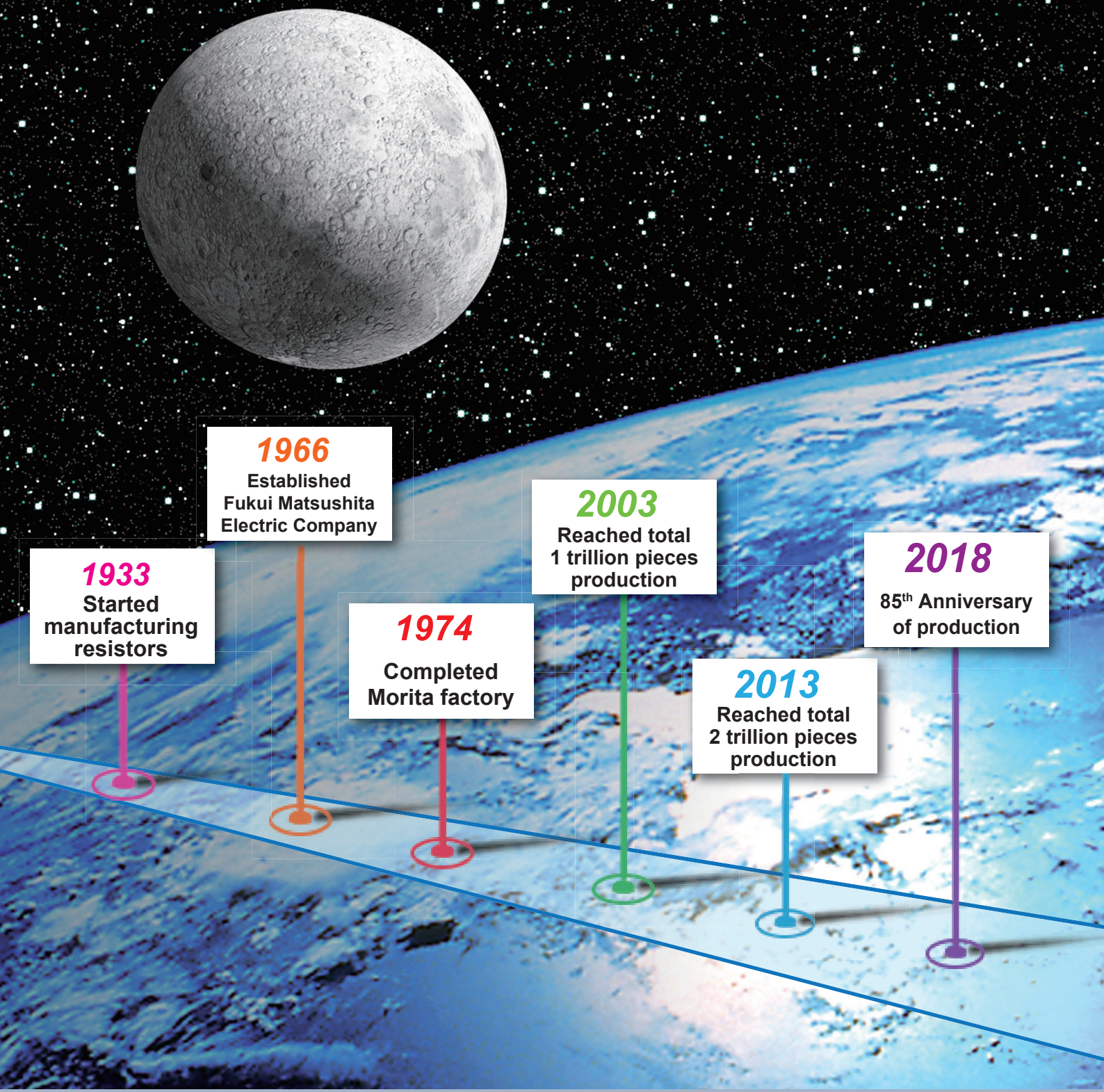
The products are tested based on all or part of the test conditions and methods defined in AEC-Q200.

Please consult with Panasonic for the details of the product specification and specific evaluation test results, etc., and please review and approve Panasonic's product specification before ordering.

Panasonic Industry will assume no liability whatsoever if the use of our company's products deviates from the contents of this catalog or does not comply with the precautions. Please be advised of these restrictions.

91 years history of our company resistors

Our company has produced resistors for more than 91 years.
Based on the concept, "Good products begin with Good components." by our founder Konosuke Matsushita, Panasonic started manufacturing fixed carbon film resistors for radio receivers in 1933 and reached the milestone of accumulative 2 trillion pieces production by 2013.
By lining up with this number of resistors, standard 1608 mm size, we can make a round trip to the moon (244,198 miles).



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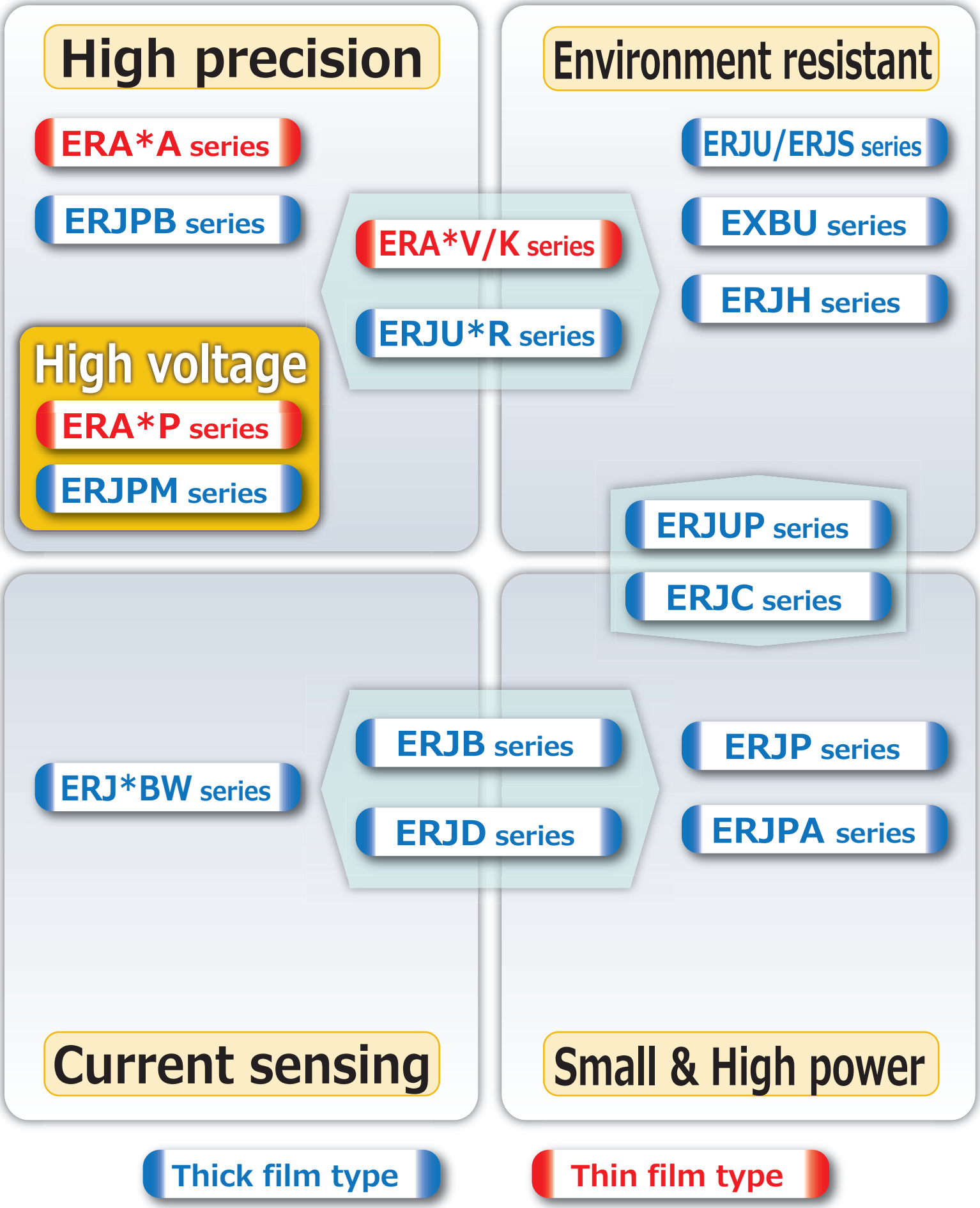
[Description of the icon]

- Down sizing : Reducing size what same power rating
- Anti-Surge : Improving durability for overloading
- High precision : Significantly reducing total resistance tolerance
- Anti solder joint crack : Reducing anti solder joint crack in heat cycle environment
- High power : Reaching higher power rating with same size
- Low TCR : Reducing variation of resistance value under temperature variation
- Anti-Sulfurated : Reducing variation of resistance value under sulfur environment
- High temperature : Reducing variation of resistance value under high temperature environment
- AEC-Q200 : Conforming AEC-Q200

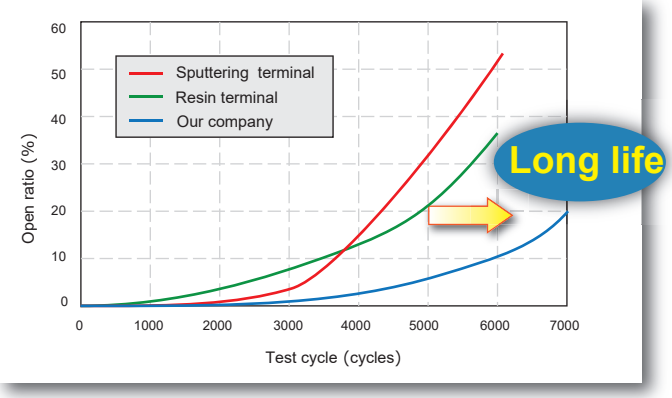
[Applications]

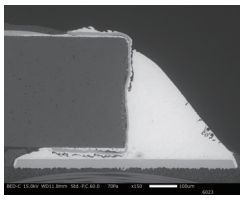
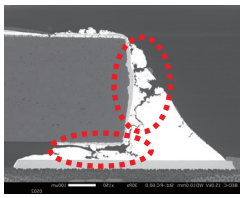
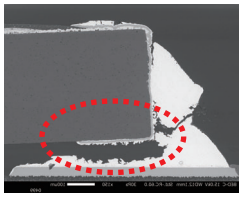
Our company chip resistors, product line-up



Anti solder joint crack

Reduces solder joint crack progression by originally developed soft terminal



	Our company	Other company	
	Resin terminal (Soft terminal)	Resin terminal	Sputtering terminal
3000 cycle			
	No solder crack	Solder crack	

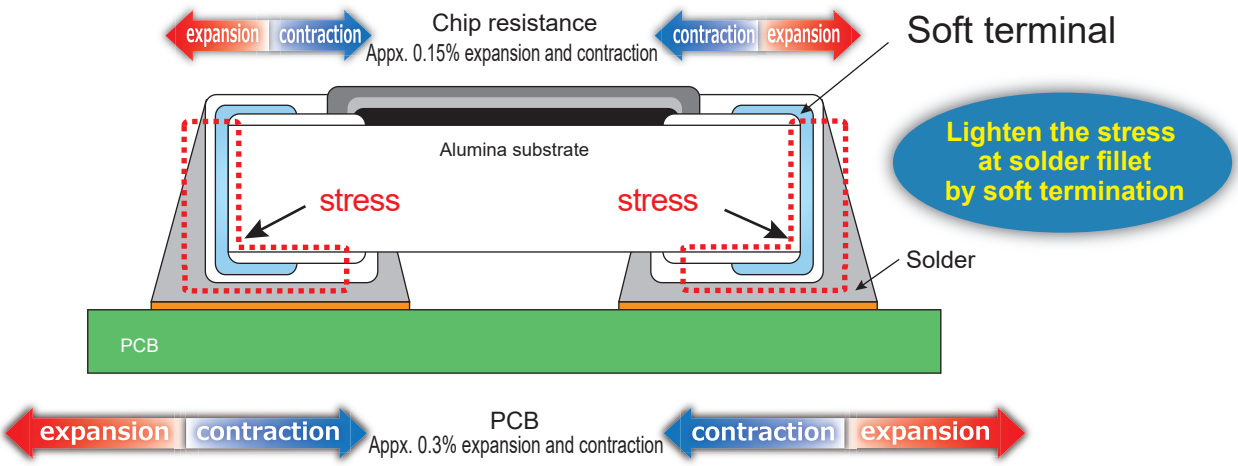
Reduce solder joint crack

1. Long life for the set of device
2. Improvement of reliability

Point

Soft termination technology adopted

◆ Cooling and heating cycle lightens the stress ◆



[Maintain exellent solder connection reliability even in harsh temperature environment such as for automotive.]

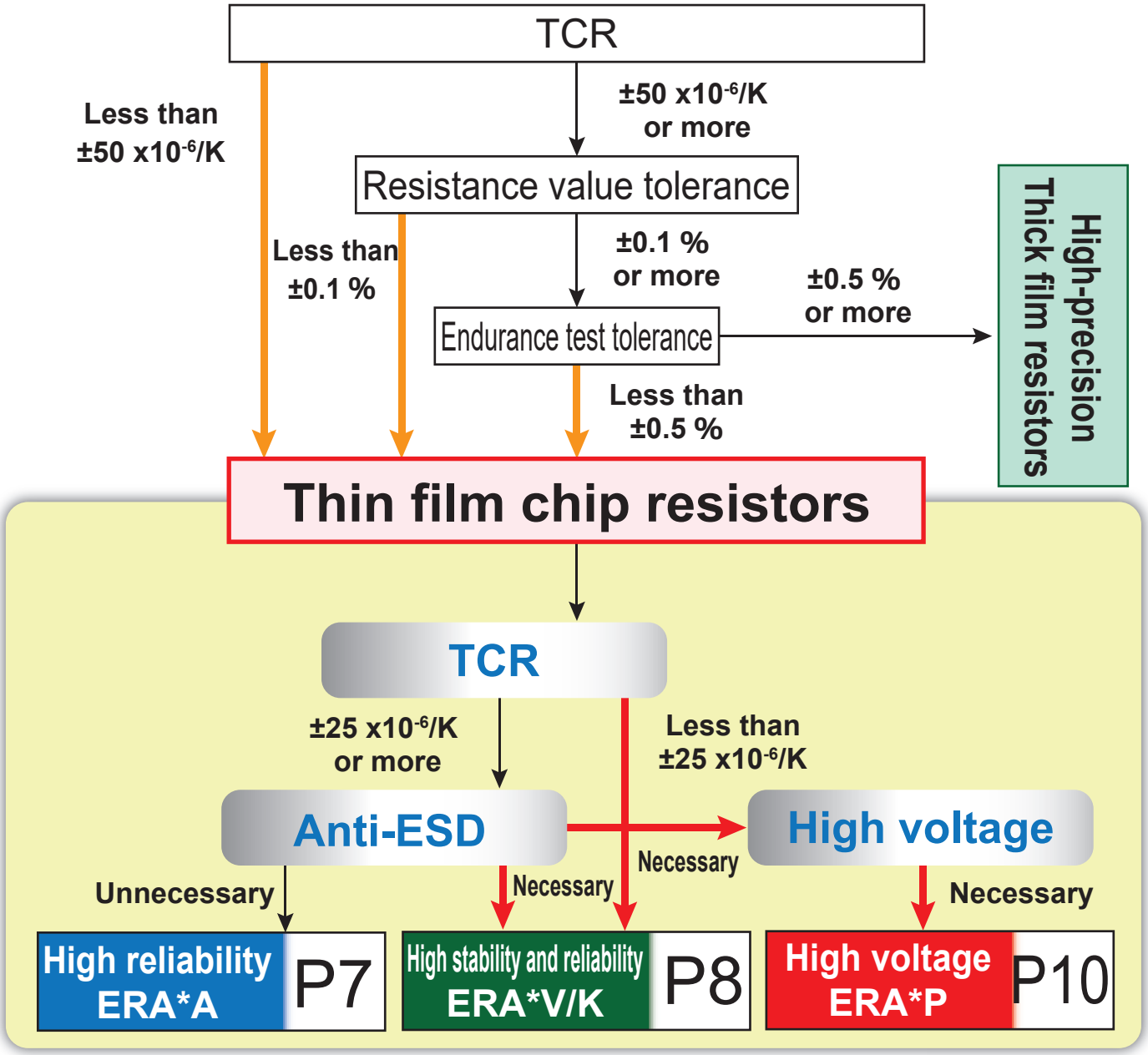
Proper Usage:
Thick film & Thin film chip resistors

Tolerance・TCR Matrix

TCR (x10⁻⁶/K) / Tolerance (%)	10	15	25	50	100	100 <
0.05				Thick film chip area		
0.1	ERA*V/K	ERA*P	ERA*A			
0.5						
1	Thin film chip area					
5						

*Our recommended combinations for Tolerance & TCR

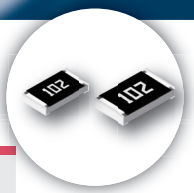
Chip resistors selection guide



High precision
Thin film, High reliability type

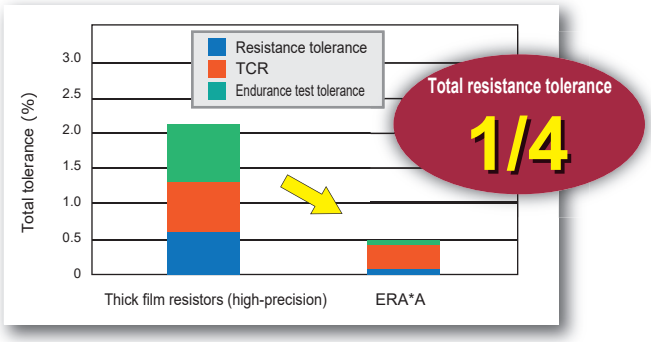
High precision | Low TCR | Anti solder joint crack | AEC-Q200

ERA*A series



Reduce total resistance value by 1/4 from high-precision thick film resistors

- Resistance tolerance ± 0.1 %
- TCR ± 25 x10^{-6}/K
- Endurance test tolerance ± 0.1 %



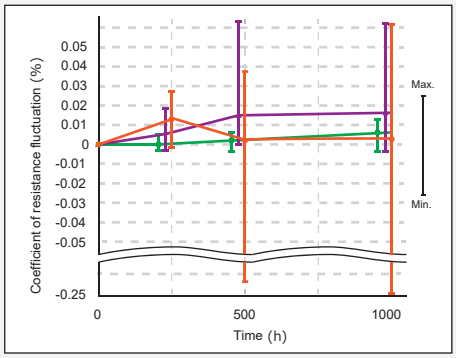
Quarter total tolerance from high-precision thick film resistors

1. Suppress deterioration of set's performance and reliability in long-term use and temperature change
2. Save design cost by design margin securing

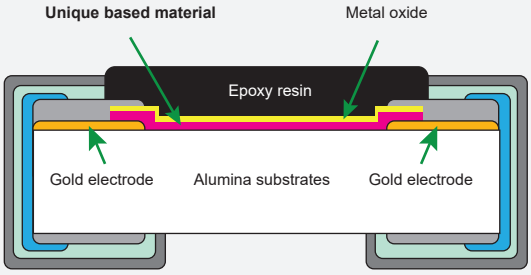
Point

Achieving high-stability (Endurance test tolerance less than 0.1%) with the unique based material

● Endurance load test
(1 kΩ)
85℃, 85%RH,
Rated load
0603 Thin film resistors



● Structural drawing



■ Specifications

Part No.	Size (inch)	Power rating (W)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR (x10^{-6}/ K)	Category temp. range (℃)
ERA1AEB	0201	0.05	25	± 0.1	100 to 10 k	± 25	-55 to +155
ERA2AEB	0402	0.063	50	± 0.1	47 to 100 k	± 25	
ERA3AEB	0603	0.1	75	± 0.1	47 to 330 k	± 25	
ERA6AEB	0805	0.125	100	± 0.1	47 to 1 M	± 25	
ERA8AEB	1206	0.25	150	± 0.1	47 to 1 M	± 25	

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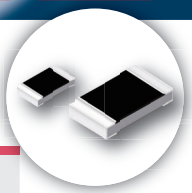
Click

High precision
Thin film, High stability and reliability type

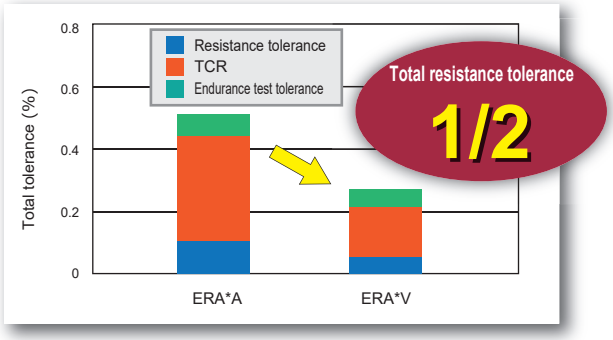
High precision | Low TCR | Anti solder joint crack
Anti-Sulfurated | Anti-Surge | AEC-Q200

ERA*V/K series



Achieving higher-precision and longer-life than conventional*1 series

- Resistance tolerance ± 0.05 %
- TCR ± 10 x10^{-6}/K
- Endurance test tolerance ± 0.1 %



Half total tolerance from thin film chip resistors (Conventional series)

1. High-precision, design margin securing and improve performance
2. Improve reliability in severe conditions

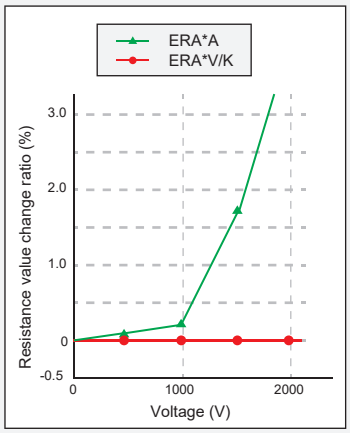
Point

Highest level of ESD resistance by preventing current concentration and reducing electric field strength

Anti-ESD

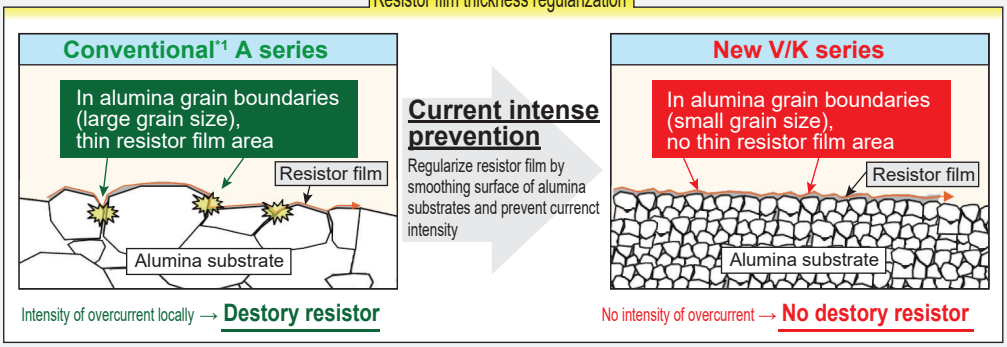
*1:ERA*A

- ESD test (1 kΩ)
  HBM : 150 pF,2 kV,±5 times
  0603 Thin film chip resistors

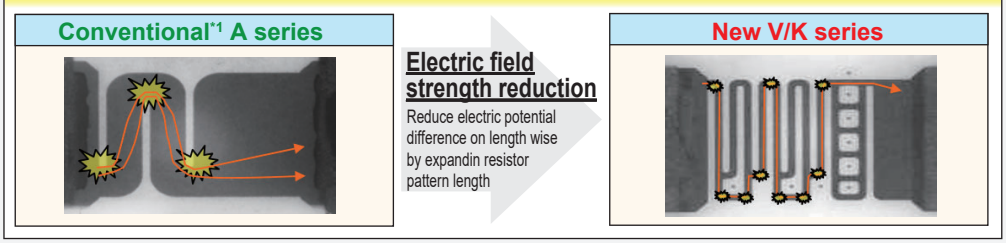


- Anti-ESD improved design

Resistor film thickness regularization



Expand resistor pattern length

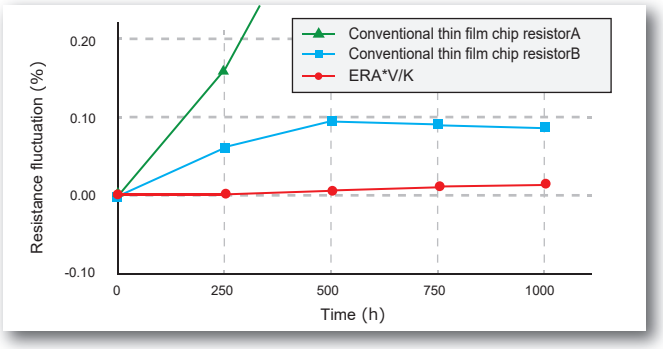


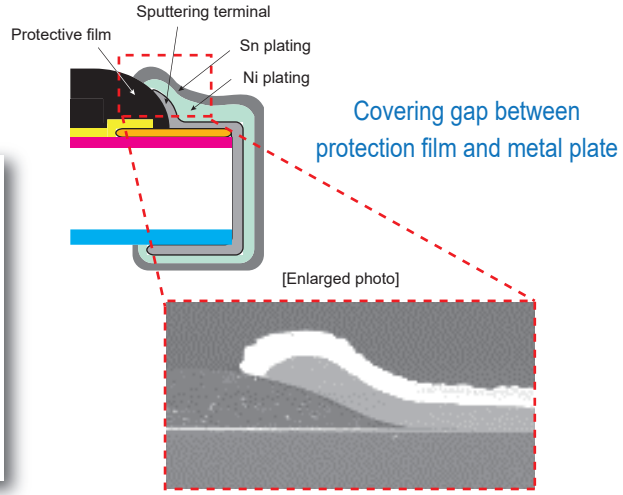
Point

Improve anti-sulfurated by the introduction of edge sputtering electrode covering gap between protection film and electrode

Anti-sulfurated

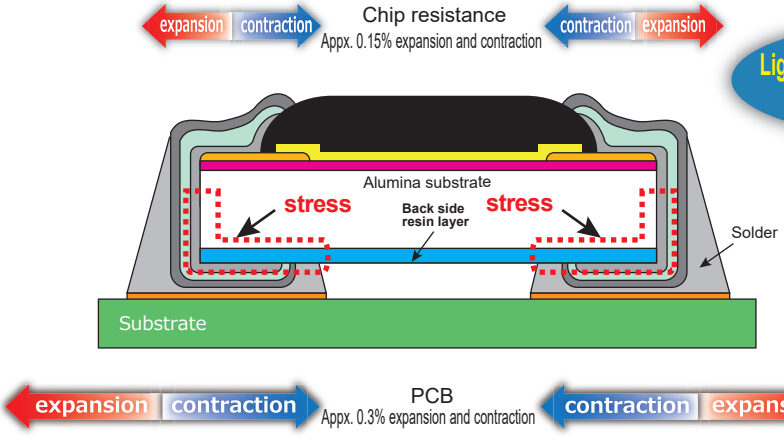
● Sulfurization gas test
ASTM B809 : 105 ℃ 0603 Thin film chip resistors





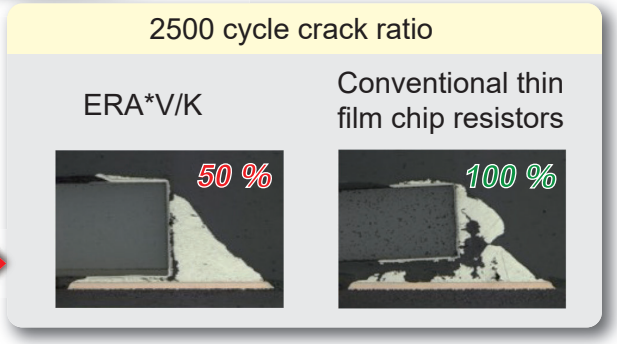
Point

Achieve excellent anti solder joint crack by back side resin layer



Lighten the stress at solder fillet by back side resin layer

2500 cycle crack ratio



■ Specifications

Part No.	Size (inch)	Power rating (W)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR (x10^{-6}/ K)	ESD withstand voltage (kV)	Category temp. range (℃)
ERA2V	0402	0.100	75	± 0.1 ±0.05	1 k ≦ R ≦ 47 k*1	±10(R) ±15(P)	1.0	-55 to +155
					47 ≦ R ≦ 100 k*1	±25(E)		
ERA3V ERA3K (100 kΩ over)	0603	0.125	100	± 0.1 ±0.05	1 k ≦ R ≦ 100 k	±10(R) ±15(P)	1.5	
					47 ≦ R ≦ 240 k	±25(E)		
ERA6V ERA6K (100 kΩ over)	0805	0.250	150	± 0.1 ±0.05	1 k ≦ R ≦ 100 k	±10(R) ±15(P)	2.0	
					47 ≦ R ≦ 750 k	±25(E)		
ERA8V ERA8K (100 kΩ over)	1206	0.250	200	± 0.1 ±0.05	1 k to 160 k	±10(R)	2.0	
					1 k to 1 M	±15(P)		
					47 to 1 M	±25(E)		

*1: Expansion of resistance range

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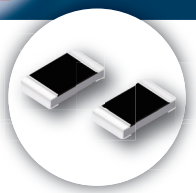
1206 size
High voltage・High accuracy type

High precision | Low TCR | Anti solder joint crack | Anti-Surge | AEC-Q200

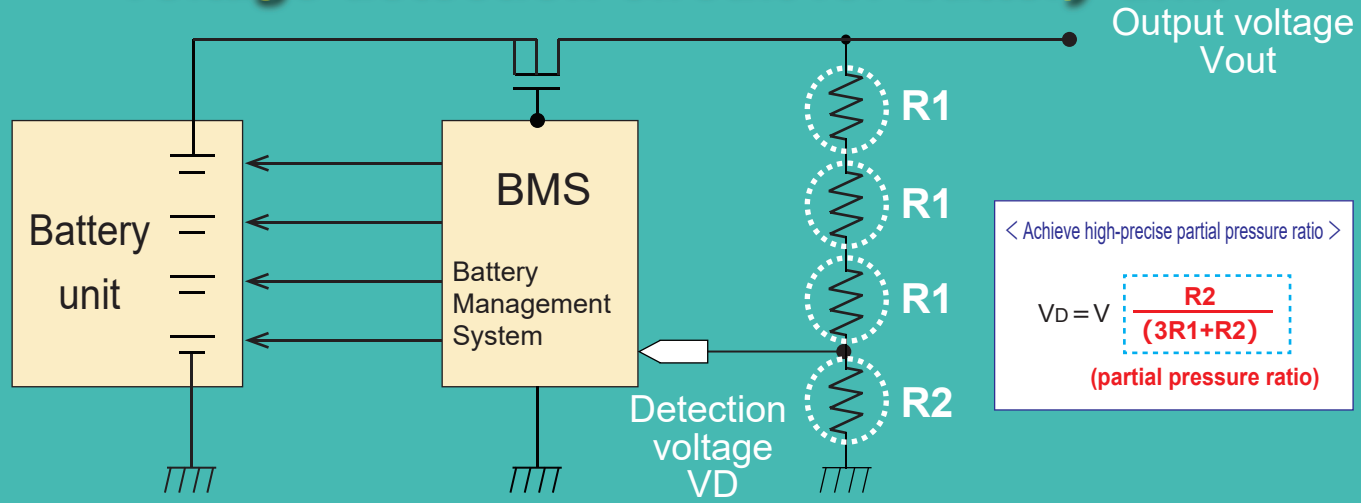


ERA8P (Thin film) series
ERJPM8 (Thick film) series

Reconciling the high limiting element voltage and the high precision.

- Limiting element voltage 500 V
- Resistance value accuracy Max. ± 0.1 %, ±15 x10^{-6}/K
- Anti-solder crack design

Application Example
Voltage detection circuit for battery unit



■ Specifications

Part No.	Size (inch)	Power rating (W)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR (x10^{-6}/K)	Category temp. range (℃)
ERA8PPB	1206	0.25 (@85 ℃)	500	± 0.1	160 k to 1 M (E24, E96)	± 15	-55 to +155
ERA8PEB						± 25	
ERJPM8F		0.66 (@70 ℃)		± 1	1.02 M to 10 M (E24, E96)	± 100	

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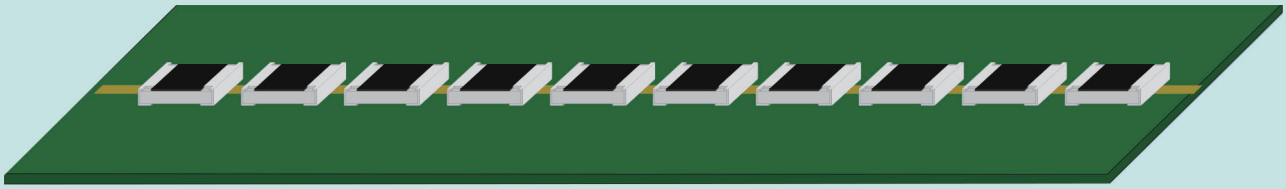
Proposal for the voltage sensing applications.

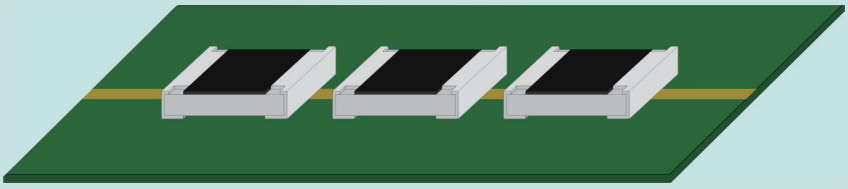
Current Other companies' products
0805 size
300 kΩ × 10 in-line



PCB sizing: 40.25 mm²

PCB down sizing
About 48%
Reduction

Suggestion A・B Our product
1206 size
1 MΩ × 3 in-line



PCB sizing: 21.15 mm²

	Resistance value x usage	Resistance tolerance (%)	TCR ($x10^{-6}$/K)	Working voltage (V)	PCB sizing* (mm^2)
Current : Other company 2012 Thin film resistance	300 kΩ x 10 in-line	± 0.1	± 25	150 x 10 p = 1500	40.25
Suggestion A : **ERA8PEB** 1206 Thin film high resistance	1 MΩ x 3 in-line			500 x 3 p = 1500	**21.15** **(About 48% Reduction)**
Suggestion B : **ERJPM8F** 1206 High resistance and high withstand voltage		**± 1**	**± 100**		

Our company unique computation.

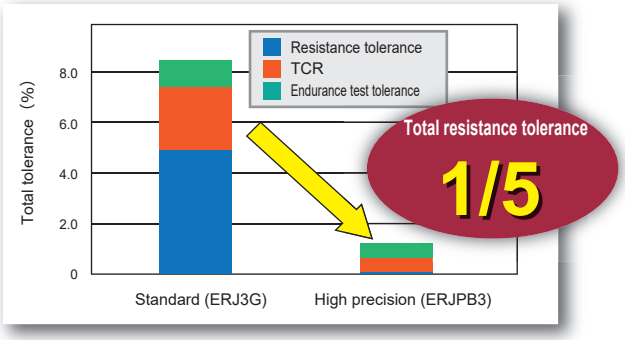
High precision
High precision thick film type

High precision | Low TCR | Anti solder joint crack | AEC-Q200

ERJPB series

Same tolerance level as thin film

- Resistance tolerance ± 0.1 %
- TCR ± 50 x10^{-6}/K
- Endurance test tolerance ± 0.5 %

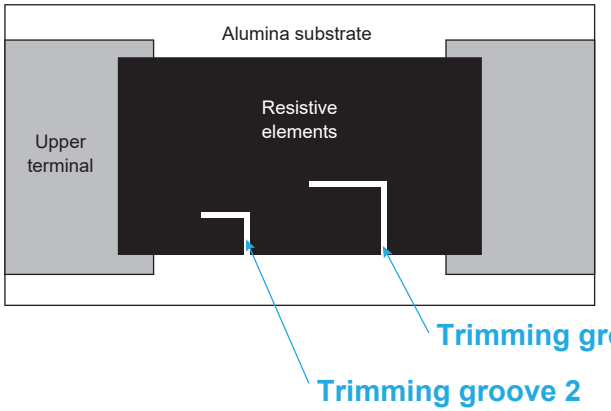


Cut the total tolerance to 1/5

1. Design margin securing
2. Improvement of reliability
3. Cost saving for IC by reducing correction circuit

Point

Achieved high precision resistance tolerance : ±0.1% by unique resistive material and trimming



By unique “Double L-shaped trimming” process, we can make slight adjustments of resistance value.
(2nd small L-shaped trimming has low adjustment rate)

■ Specifications

Part No.	Size (inch)	Power rating (W)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR (x10^{-6}/K)	Category temp. range (℃)
ERJPB3B	0603	0.20	150	± 0.1, ± 0.5	200 to 100 k	± 50	-55 to +155
ERJPB6B	0805	0.25	150	± 0.1, ± 0.5	200 to 1M	± 50	

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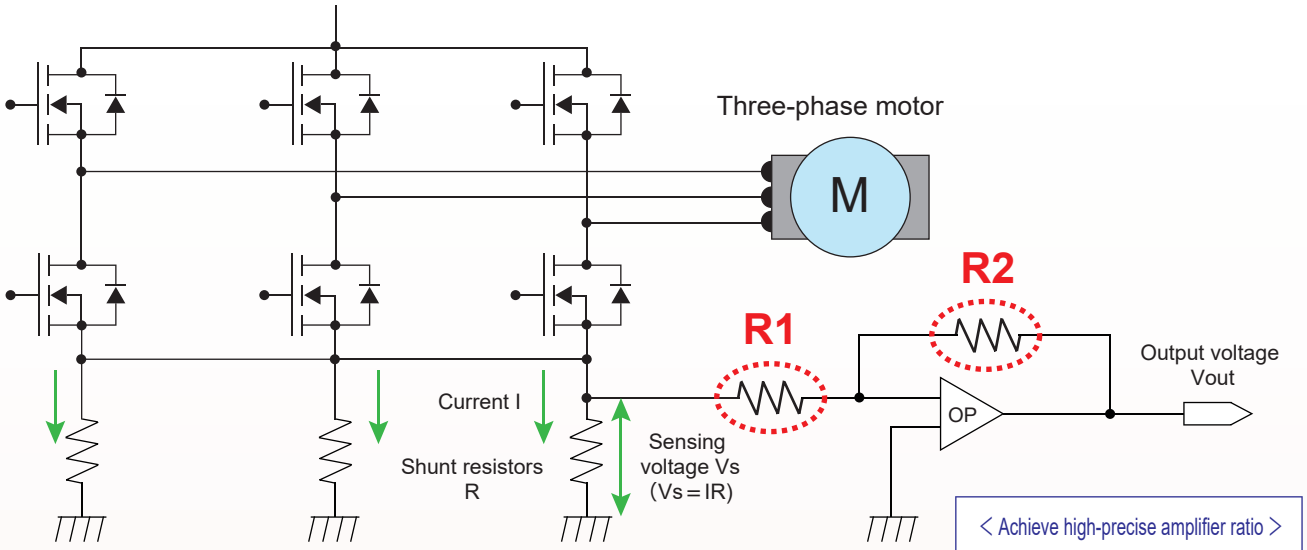
Application

Application Example

Current detection amplifier circuit for motor drive control unit



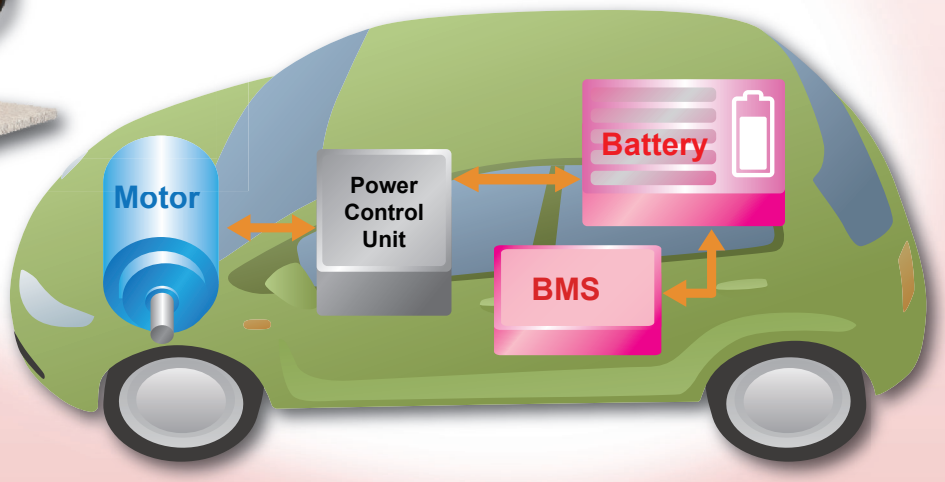
< Achieve high-precise amplifier ratio >

$$Vout = Vs \times \frac{R2}{R1}$$

(amplification rate)

Industrial robot

Automotive



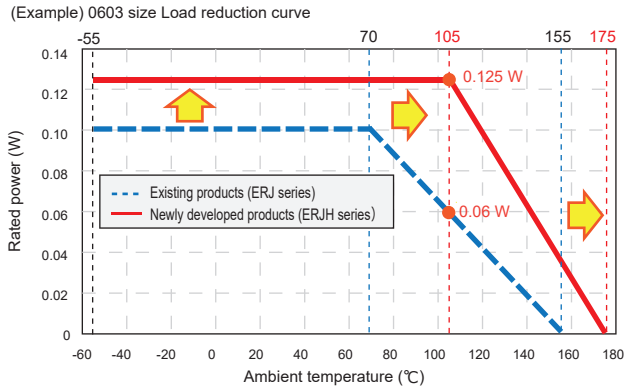
Environment resistant
High temperature chip resistor

Down sizing | High power | High temperature | Anti solder joint crack | AEC-Q200

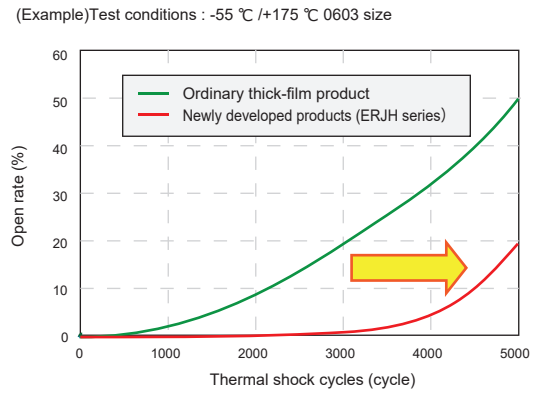
ERJH series

Achieves high heat resistance by new materials developing

Expansion of maximum operating temperature and rated operating temperature



Extended solder life by suppressing crack progress crack developing rate in thermal shock test



Guarantees that the resistor endures 1000 cycles of thermal shock testing(-55℃/+175℃)

1. Expand of max operating temperature 155 ℃ ⇒ 175 ℃
2. Expand of rated operating temperature 70 ℃ ⇒ 105 ℃
3. Improvement of solder crack resistance

Point

Excellent high heat resistance due to both material flexibility and heat resistance

Overcome the trade-offs of conventional materials by reviewing the design of raw materials

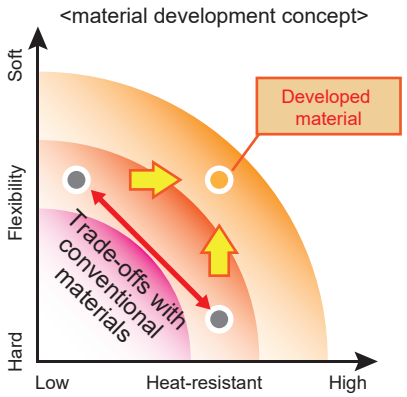
✓ Improvement of operating temperature

Max operating temp. : 175 ℃

Rated operating temp. : 105 ℃

✓ Suppression of solder cracks

<material development concept>



■ Specifications

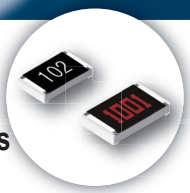
Part No.	Size (inch)	Power rating (W)	Resistance tolerance (%)	Resistance range (Ω)	Category temp. range (℃)
ERJH2	0402	0.10	± 0.5, ± 1, ±5	1 to 300 k	-55 to +175
ERJH3G/E	0603	0.125			
ERJH3Q		0.25		1 to 10	
ERJHP6	0805	0.50		1 to 300 k	

Please visit our website for details !

Click

Environment resistant
Anti-Sulfurated series

Anti-Sulfurated | Anti solder joint crack | AEC-Q200

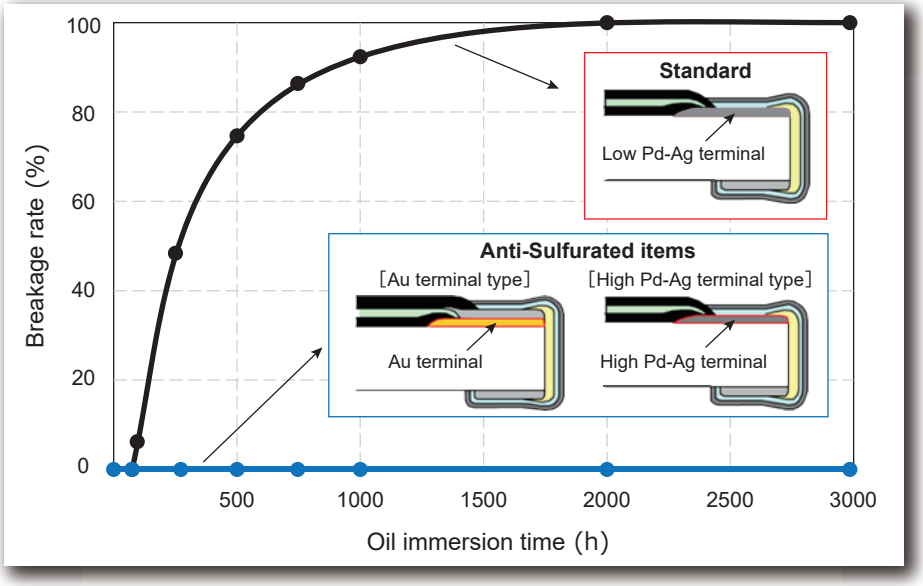


Standard : ERJS/U series
Array *1 : EXBU series
High precision : ERJU*R series
Low resistance : ERJU*S/Q series
Small size & High power : ERJC/ERJUP series
Wide terminal : ERJC series

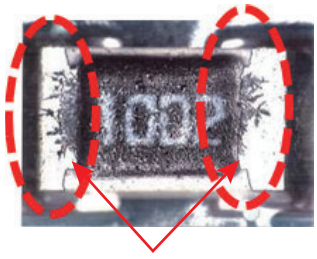
*1 : AEC-Q200 Grade 1

Anti-Sulfurated terminal reduces variation in the resistance value under harsh environment(sulfur)

- Sulfurized oil immersion test of chip resistors

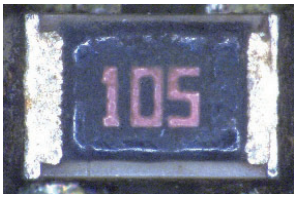


[Breakage in conventional items]

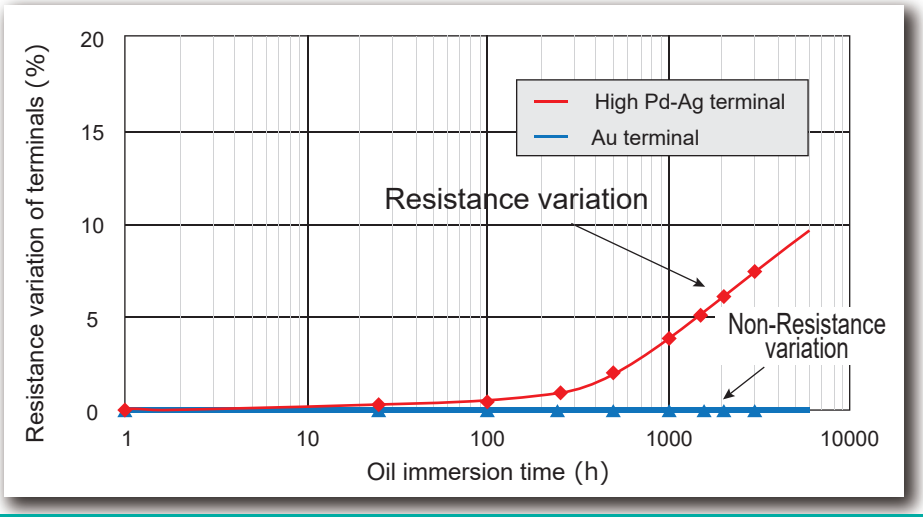


Sulfurated Ag needle crystal

[Non-Breakage in anti-sulfuraed items]



- Sulfurized oil immersion test of Au terminal and high Pd-Ag terminal



The sulfurization is inhibited with using Gold or Silver with high concentration Palladium as the inner electrode material. Each design have the high anti-sulfuration characteristics, but Gold type is much better.

With Anti-Sulfurated characteristics,

1. High reliability by reducing sulfurated breakage
2. Improve reliability of device at harsh environment
3. Cost reduction by unnecessary of sealing substrate

< Wide lineup of Anti-Sulfurated chip resistors with anti-sulfurated electrode >

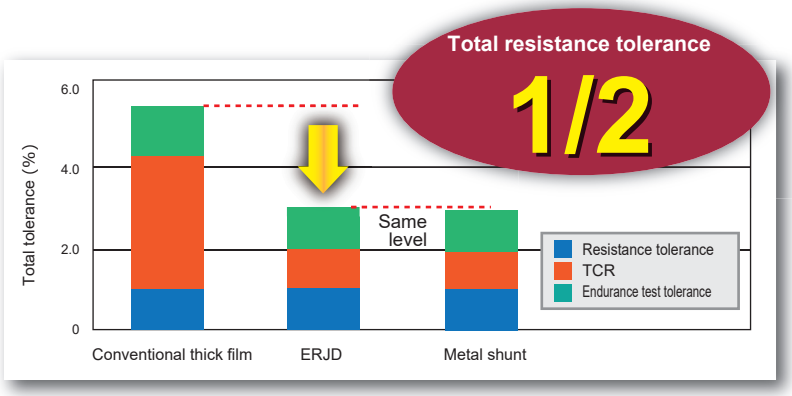
Type \ Size (inch)		01005	0201	0402	0603	0805	1206	1210	2010 1020 (Wide terminal)	2512	Web catalog
Standard				ERJS02	ERJS03	ERJS06	ERJS08	ERJS14	ERJS1D	ERJS1T	Click
		ERJU0X	ERJU01	ERJU02	ERJU03	ERJU06	ERJU08	ERJU14	ERJU1D	ERJU1T	
Precision				ERJU2R	ERJU3R	ERJU6R					Click
Small & High power					ERJUP3	ERJUP6	ERJUP8				Click
Low resistance (0.1 Ω to 1 Ω)						ERJU6S					Click
						ERJU6Q					
Wide terminal	Low resistance (10 mΩ to 1 Ω)								ERJC1B		Click
									ERJC1C		
Array	2 resistors		EXBU14	EXBU24	EXBU34						Click
	4 resistors		EXBU18	EXBU28	EXBU38						
	8 resistors			EXBU2H							

Current sensing
Low TCR high power / wide terminal type

Low TCR | Down sizing | High power | Anti solder joint crack | AEC-Q200

ERJD series

Achieved low-resistance / low-TCR
~ VA proposal for metal shunt resistors ~



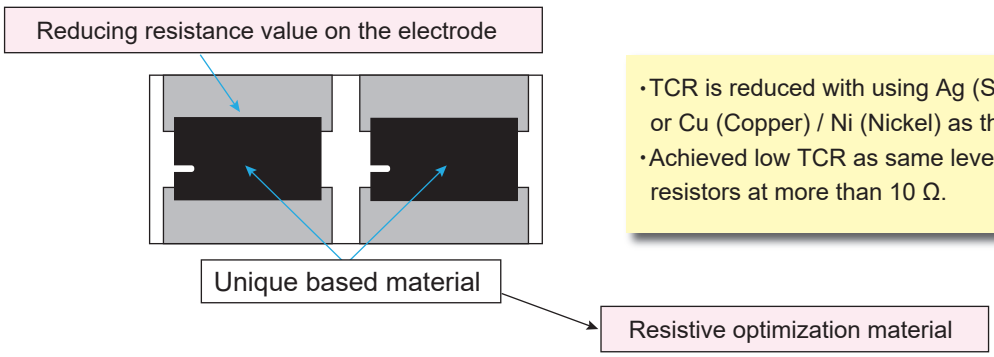
[Reduces TCR of 10 mΩ from 350 x10^{-6}/K to 100 x10^{-6}/K]

Achieved same level performance as metal shunt resistor

1. Design margin securing
2. Improvement of reliability
3. Cost saving

Point

Achieved low resistance TCR by unique resistive material



- TCR is reduced with using Ag (Silver) / Pd (palladium) or Cu (Copper) / Ni (Nickel) as the resistive material.
- Achieved low TCR as same level as metal shunt resistors at more than 10 Ω.

■ Specifications

Part No.	Size (inch)	Power rating (W)	Resistance tolerance (%)	Resistance range (Ω)	TCR (ppm/K)	Category temp. range (℃)
ERJD1	1020	2.0	± 1, ± 5	10 m to 200 m	± 100	-55 to 155
ERJD2	0612	1.0	± 1, ± 5	10 m to 200 m	± 100	

Please visit our website for details !

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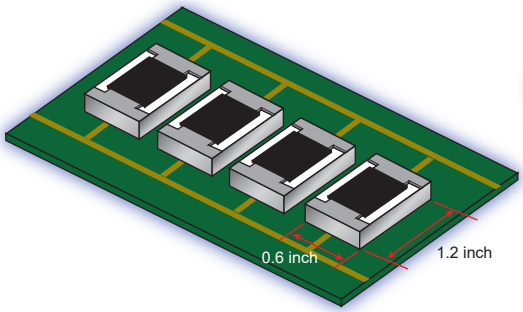
Current sensing
Double-sided resistive elements structure type

High power | Down sizing | Anti solder joint crack | AEC-Q200

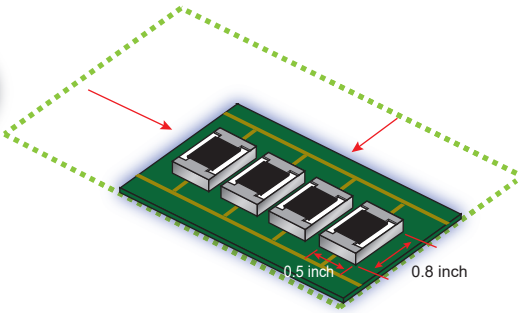
ERJ*BW series

Small case size, low resistance, and high power by double-sided resistive elements structure



1206 size

PCB down sizing **45%**



0805 size

[Achieved smaller case size(1206 → 0805) than conventional type for 10 mΩ]

PCB area reduction

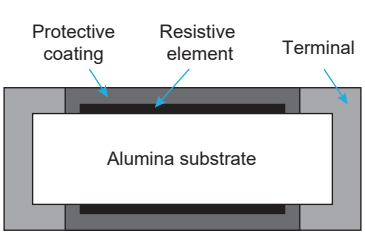
1. Down sizing 2. Weight saving 3. Cost saving

Point

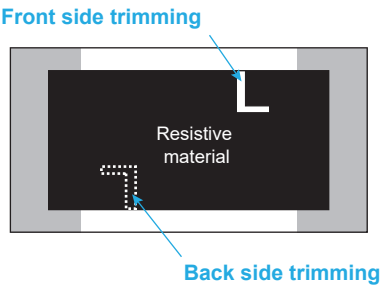
Realized small current sensing resistors by double-sided resistive elements structure

Double-sided resistive elements structure

[Side view]



[Top view]



- Load concentration is reduced by two symmetrical L-shaped trimming,
- Achieved small size & high power and overload characteristics.

■ Specifications

Part No.	Size (inch)	Power rating (W)	Resistance tolerance (%)	Resistance range (Ω)	TCR (x10^{-6}/K)	Category temp. range (℃)
ERJ2BW	0402	0.25	± 1, ± 2, ± 5	47 m to 100 m	0 to +300	-55 to +155
ERJ3BW	0603	0.33	± 1, ± 2, ± 5	20 m to 100 m	20mΩ≦R<39mΩ : 0 to +250 39mΩ≦R≦100mΩ : 0 to +150	
ERJ6BW	0805	0.5	± 1, ± 2, ± 5	10 m to 100 m	10mΩ≦R<15mΩ : 0 to +300 15mΩ≦R≦100mΩ : 0 to +200	
ERJ8BW	1206	1.0	± 1, ± 2, ± 5	10 m to 100 m	10mΩ≦R<20mΩ : 0 to +200 20mΩ≦R<47mΩ : 0 to +150 47mΩ≦R≦100mΩ : 0 to +100	

Please visit our website for details !

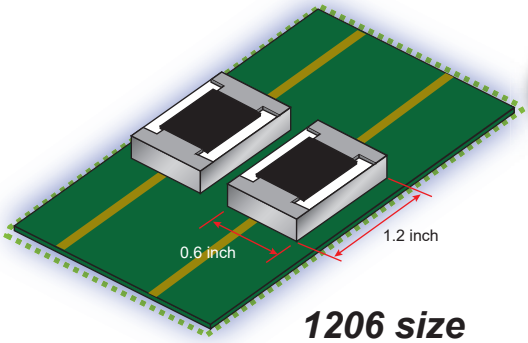
Click

Small size & High power
Anti-Surge type

Down sizing | High power | Anti-Surge | Low TCR | Anti solder joint crack | AEC-Q200

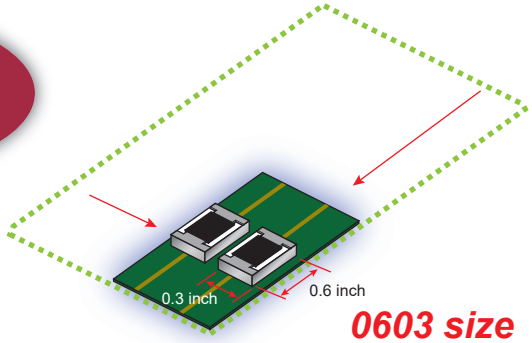
ERJPA/P0 series

Improvement of High power & Anti-Surge rating



1206 size

PCB down sizing **69%**



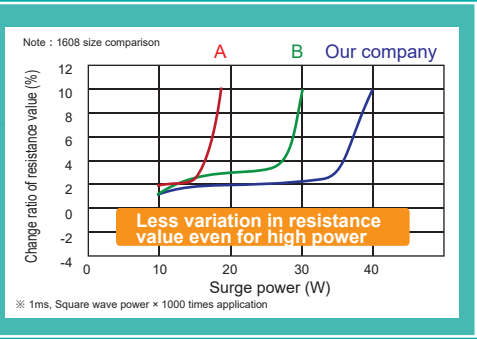
0603 size

PCB area reduction

1. Down sizing
2. Weight saving
3. Cost saving

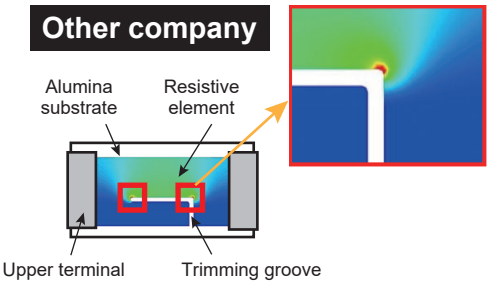
High Anti-Surge performance

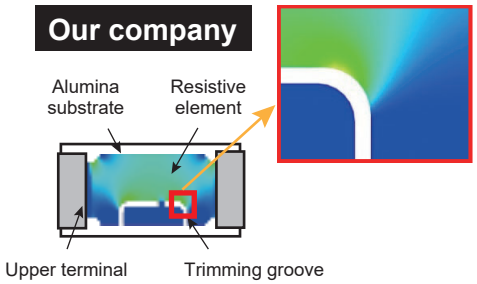
1. Failure reduction
2. Design margin securing



Point

Surge distribution by unique resistive material / trimming





- Unique “Double-C shaped trimming” for surge distribution.
- Achived small size & high power and overload characteristics.

■ Specifications

Part No.	Size (inch)	Power rating*1 (W)	Rated terminal part temperature (℃)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR*2 (x10-6/K)	Category temp. range (℃)
ERJPA2*3	0402	0.25	100	50	± 0.5, ± 1	10 to 1 M (E24, E96)	± 100	-55 to +155
					± 5	10 to 1 M (E24)	± 200	
ERJPA3	0603	0.33	130	150	± 0.5, ± 1	10 to 1 M (E24, E96)	± 100	
					± 5	1 to 1.5 M (E24)	± 200	
ERJP06	0805	0.50	115	400	± 0.5, ± 1	10 to 1 M (E24, E96)	R<33Ω : ± 300 33Ω≦R : ± 100	
					± 5	1 to 3.3 M (E24)	R<10Ω : - 100 to +600 10Ω≦R<33Ω : ± 300 33Ω≦R : ± 200	

*1 :The rated power is guaranteed with the terminal part temperature prescript.

*2 :TCR is applied for the ± 1% product.

*3 :AEC-Q200 Grade1

Please visit our website for details !

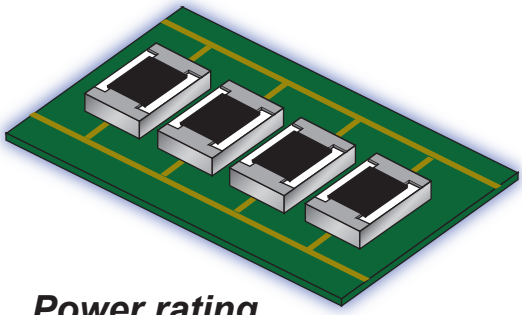
Click

Small size & High power
Wide terminal type

Down sizing | High power | Anti-Surge | Low TCR | Anti solder joint crack | AEC-Q200

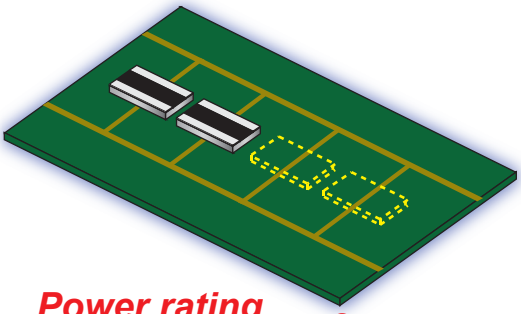
ERJB series

Improvement of High power & Anti-Surge rating



Power rating 1 W products x 4p

Number of pieces 50%



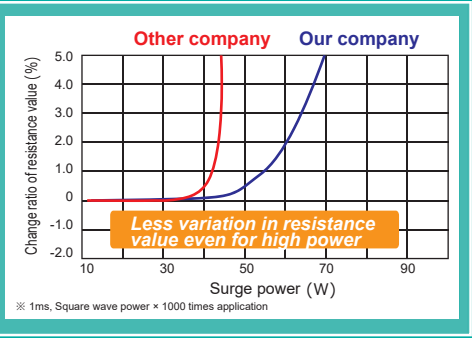
Power rating 2 W products x 2p

Number of pieces reduction

1. Down sizing
2. Weight saving
3. Cost saving

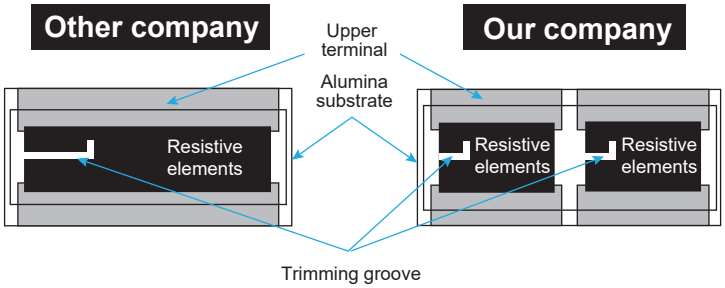
High Anti-Surge performance

1. Failure reduction
2. Design margin securing



Point

Higher power rating by wide termination structure with separated resistive elements



- Separated resistive elements for surge distribution.
- Achived small size & high power and overload characteristics.

■ Specifications

Part No.	Size (inch)	Power rating*1 (W)	Rated terminal part temperature (℃)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR*2 (x10⁻⁶/K)	Category temp. range (℃)
ERJB1	1020	2.0 (R≦10)	125	200	± 1, ±2, ±5	10 m to 10 (E24)	10mΩ≦R<22mΩ : 0 to +350 22mΩ≦R<47mΩ : 0 to +200 47mΩ≦R<100mΩ : 0 to +150 100mΩ≦R≦10kΩ : ± 100	-55 to +155
		1.0 (10<R)	95			11 to 10 k (E24)		
ERJB2	0612	1.5 (R≦1 K)	125	200	± 1, ±2, ±5	10 m to 1 k (E24)	10mΩ≦R<22mΩ : 0 to + 350 22mΩ≦R<47mΩ : 0 to + 200 47mΩ≦R<100mΩ : 0 to + 150 100mΩ≦R<220mΩ : 0 to + 100 220mΩ≦R≦10MΩ : ± 100	
		0.75 (1 K<R)	90			1.1 k to 1 M (E24)		
ERJB3	0508	1.0	105	150	± 1, ±2, ±5	20 m to 10 (E24)	22mΩ≦R<47mΩ : 0 to + 300 47mΩ≦R<1Ω : 0 to + 200 1Ω≦R≦10Ω : ± 200	

*1 :The rated power is guaranteed with the terminal part temperature prescript.

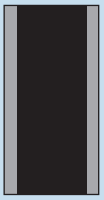
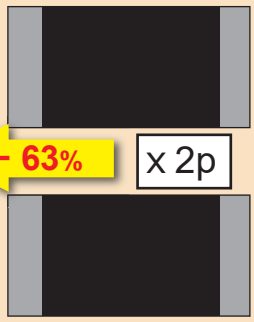
*2 :TCR is applied for the ± 1% product.

Please visit our website for details !

Click

Down sizing proposal

Contributes to "PCB miniaturization" by replacing standard products with small & high-power products of the same or higher power rating.

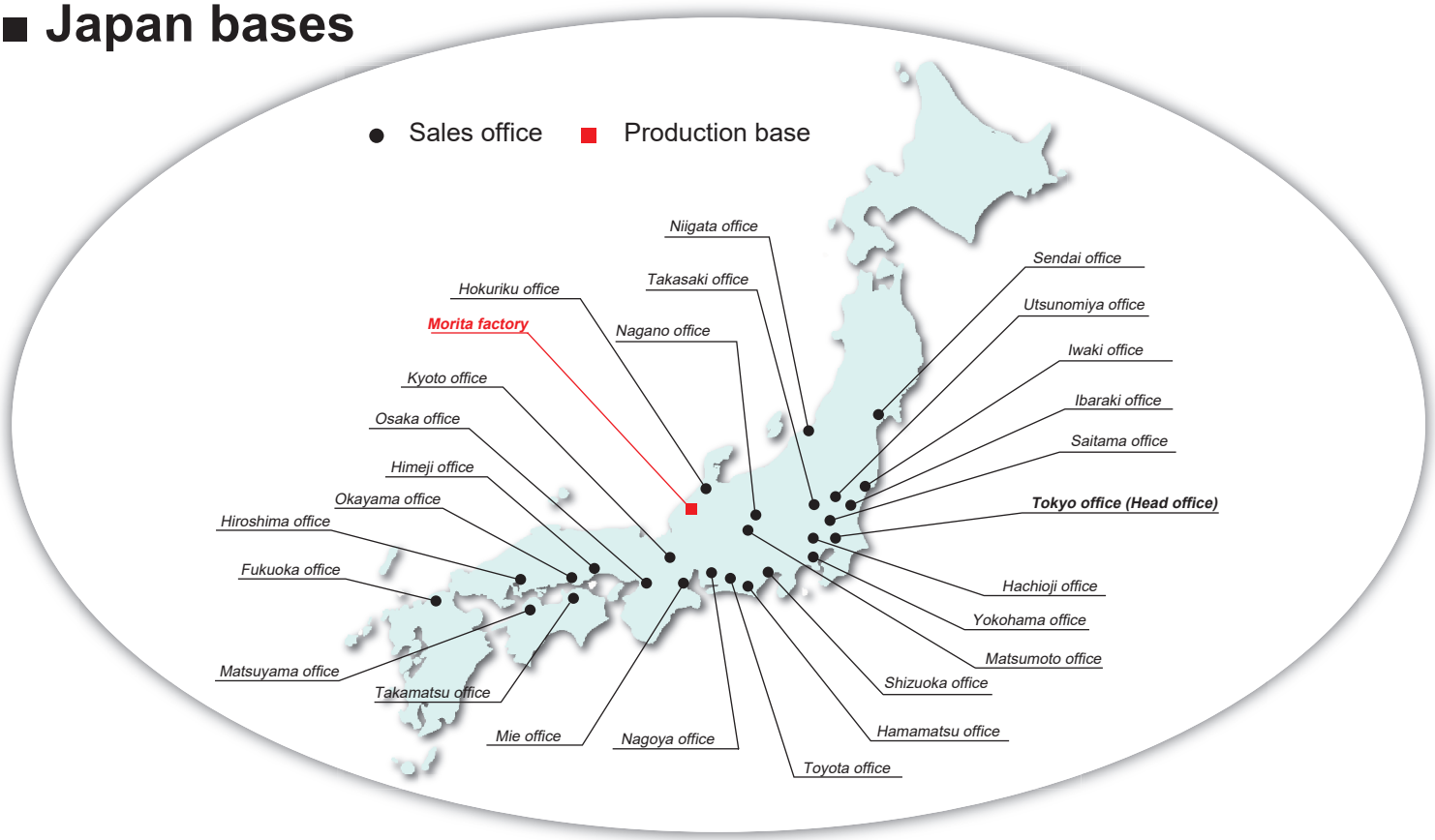
Size (inch) / Power (W)	0402	0603	0805	1206 0612 (Wide terminal)	3225	2010 1020 (Wide terminal)	2512
2.0						ERJB1   − 63% x 2p	
1.0				ERJB2 	− 65%		
0.75					− 45%		
0.5			ERJP06 	− 65%			
0.25		ERJPA3 	− 69%				
0.2	ERJPA2 						
0.125		− 78%					

* " ← " means down sizing rate (%) of PCB.

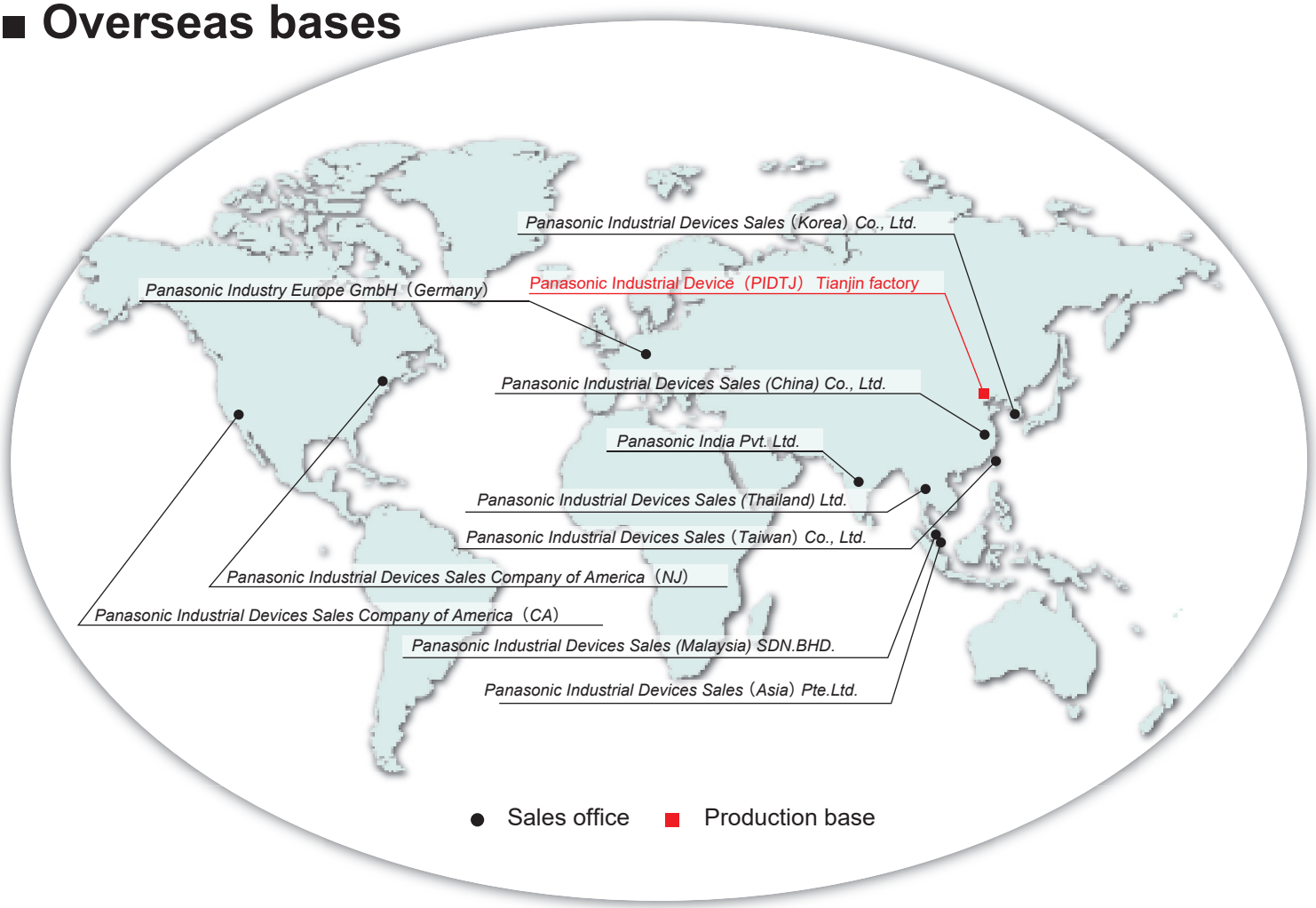
Our comapny | Standard

Main locations

■ Japan bases



■ Overseas bases



Safty Precautions

When using our products, no matter what sort of equipment they might be used for,
be sure to confirm the applications and environmental conditions with our specifications in advance.

Panasonic
INDUSTRY

Thin / Thick film chip resistor

First edition : January 1, 2021
Revision : October 20, 2021
Revision : July 22, 2022
Revision : November 15, 2022
Revision : xxxxx, 2024

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