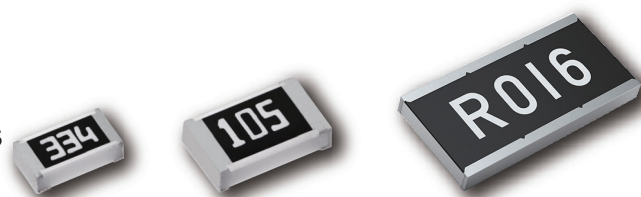


Pamphlet

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
- NEW** ■ High voltage & High accuracy



IN Your
Innovation



Guidelines and precautions regarding the technical information and use of our products described in this online catalog.

- If you want to use our products described in this online catalog for applications requiring special qualities or reliability, or for applications where the failure or malfunction of the products may directly jeopardize human life or potentially cause personal injury (e.g. aircraft and aerospace equipment, traffic and transportation equipment, combustion equipment, medical equipment, accident prevention, anti-crime equipment, and/or safety equipment), it is necessary to verify whether the specifications of our products fit to such applications.
Please ensure that you will ask and check with our inquiry desk as to whether the specifications of our products fit to such applications use before you use our products.
- The quality and performance of our products as described in this online catalog only apply to our products when used in isolation.
Therefore, please ensure you evaluate and verify our products under the specific circumstances in which our products are assembled in your own products and in which our products will actually be used.
- If you use our products in equipment that requires a high degree of reliability, regardless of the application, it is recommended that you set up protection circuits and redundancy circuits in order to ensure safety of your equipment.
- The products and product specifications described in this online catalog are subject to change for improvement without prior notice.
Therefore, please be sure to request and confirm the latest product specifications which explain the specifications of our products in detail, before you finalize the design of your applications, purchase, or use our products.
- The technical information in this online catalog provides examples of our products' typical operations and application circuits.
We do not guarantee the non-infringement of third party's intellectual property rights and we do not grant any license, right, or interest in our intellectual property.
- If any of our products, product specifications and/or technical information in this online catalog is to be exported or provided to non-residents, the laws and regulations of the exporting country, especially with regard to security and export control, shall be observed.

<Regarding the Certificate of Compliance the EU RoHS Directive/REACH Regulations> with

- The switchover date for compliance with the RoHS Directive/REACH Regulations varies depending on the part number or series of our products.
- If you are not sure whether it applies to RoHS/REACH directive or not when using stock items, please do not hesitate to contact our sales representative.

- **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.

We do not take any responsibility for the use of our products outside the scope of the specifications, descriptions, guidelines and precautions described in this online catalog.

85 years history of Panasonic resistors

Panasonic has produced resistors for more than 85 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).



1966

Established
Fukui Matsushita
Electric Company

1933

Started
manufacturing
resistors

2003

Reached total
1 trillion pieces
production

1974

Completed
Morita factory

2018

85th Anniversary
of production

2013

Reached total
2 trillion pieces
production

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[Description of the icon]

- | | | |
|--|--|--|
| Down sizing : Reducing size what same power rating | Anti solder joint crack : Reducing anti solder joint crack in heat cycle environment | Anti-Sulfurated : Reducing variation of resistance value under sulfur environment |
| Anti-Surge : Improving durability for overloading | High power : Reaching higher power rating with same size | High temperature : Reducing variation of resistance value under high temperature environment |
| High precision : Significantly reducing total resistance tolerance | Low TCR : Reducing variation of resistance value under temperature variation | AEC-Q200 : Conforming AEC-Q200
<small>*ERJPA2 Grade 1</small> |



Panasonic chip resistors, product line-up

High precision

ERA*A series

ERJPB series

NEW

High voltage

ERA*P series

ERJPM series

Environment resistant

ERJU/ERJS series

EXBU series

ERJH series

ERA*V/K series

ERJU*R series

ERJUP series

ERJC series

ERJ*BW series

ERJB series

ERJD series

ERJMS4 series

ERJMB1 series

ERJP series

ERJPA series

Current sensing

Small & High power

Thick film type

Thin film type

Metal plate type

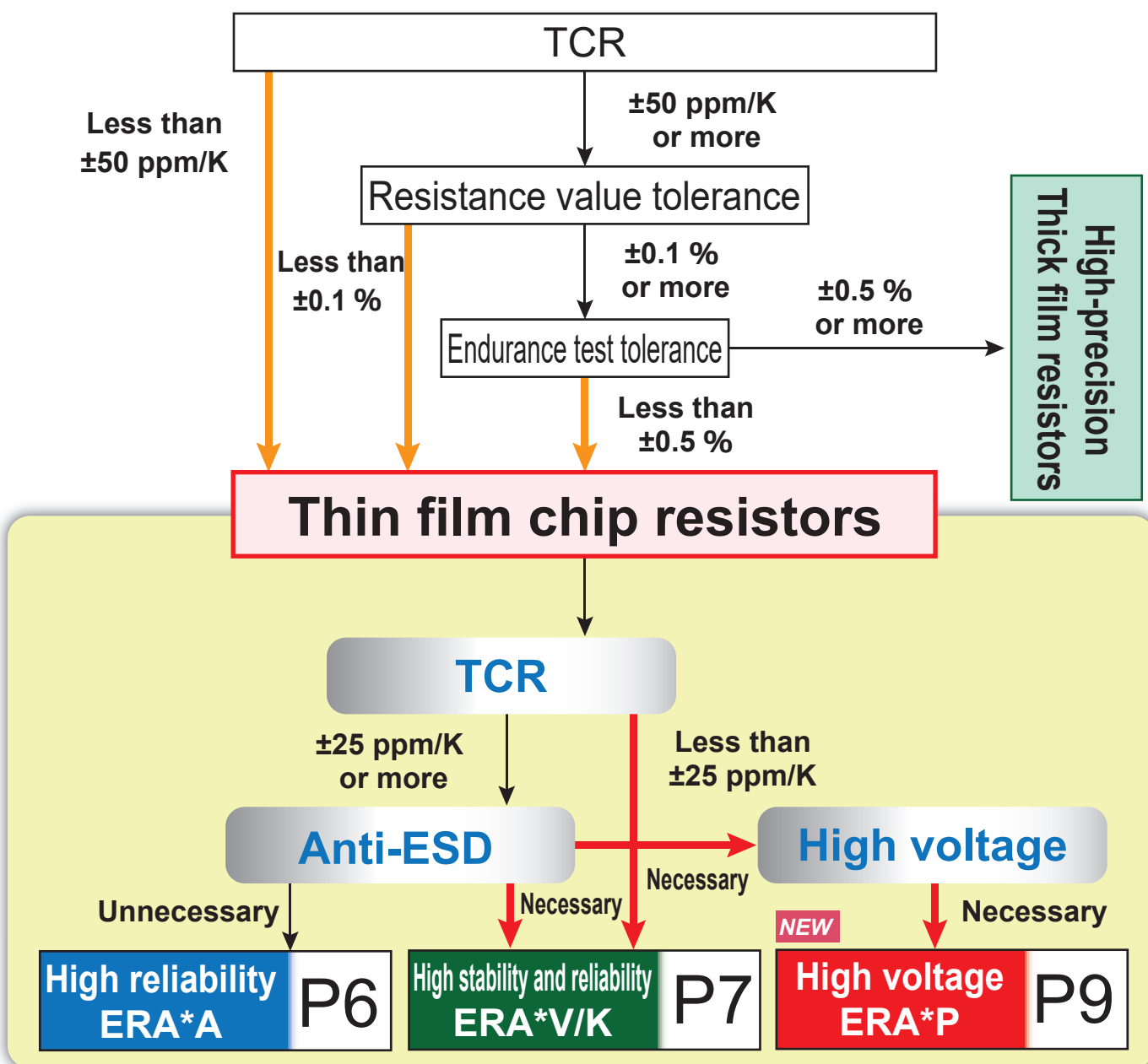
Proper Usage: Thick film & Thin film chip resistors

Tolerance · TCR Matrix

TCR(ppm/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

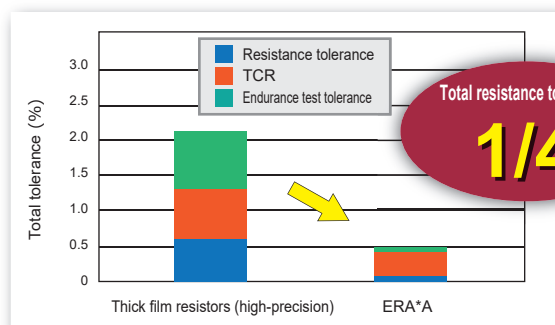
AEC-Q200

ERA*A series



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

- ✓ Resistance tolerance $\pm 0.1\%$
- ✓ TCR ± 25 ppm/K
- ✓ Endurance test tolerance $\pm 0.1\%$

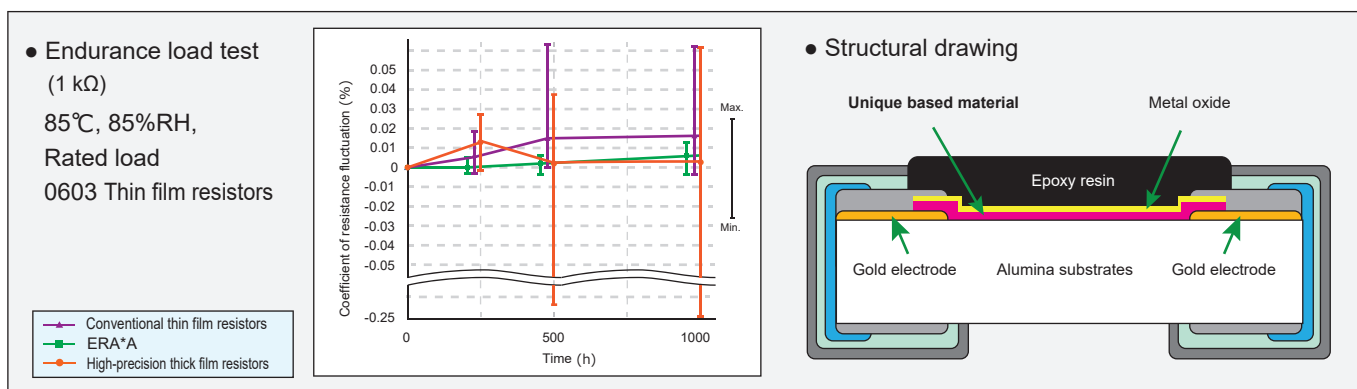


Quarter total tolerance from high-precision thick film resistors

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



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



Specifications

Part No.	Size (inch)	Power rating (W)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR (ppm/ K)	Category temp. range (°C)
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	

Please visit our website for details !



High precision

Thin film, High stability and reliability type

High precision

Low TCR

Anti solder joint crack

Anti-Sulfurated

Anti-Surge

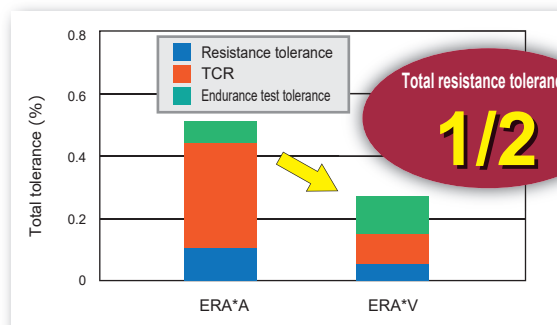
AEC-Q200

ERA*V/K series



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

- ✓ Resistance tolerance $\pm 0.05\%$
- ✓ TCR ± 10 ppm/K
- ✓ Endurance test tolerance $\pm 0.1\%$



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

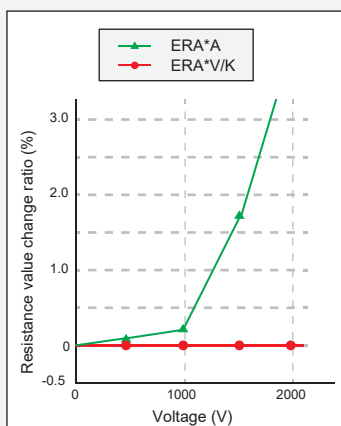
1. High-precision, design margin securing and improve performance
2. Improve reliability in severe conditions

Point

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

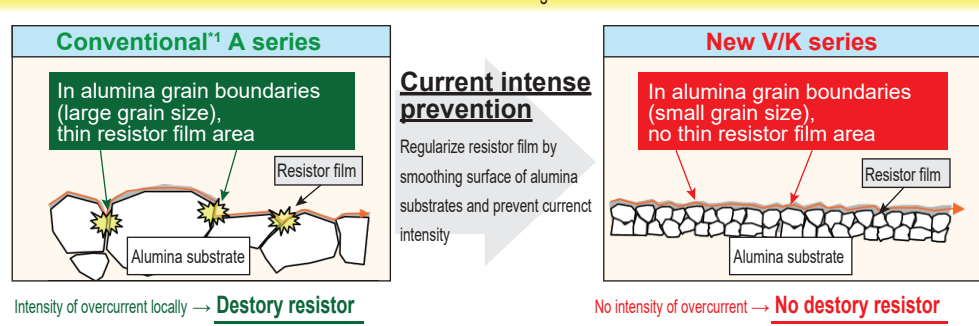
Anti-ESD

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

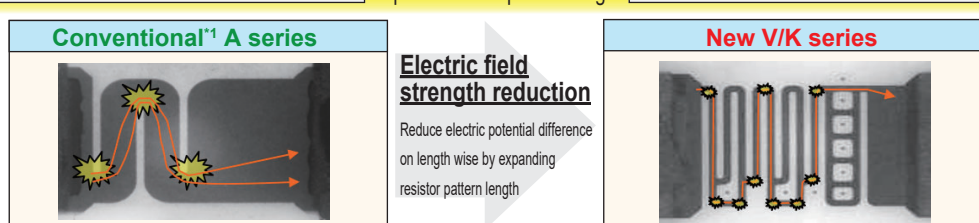


- Anti-ESD improved design

Resistor film thickness regularization



Expand resistor pattern length



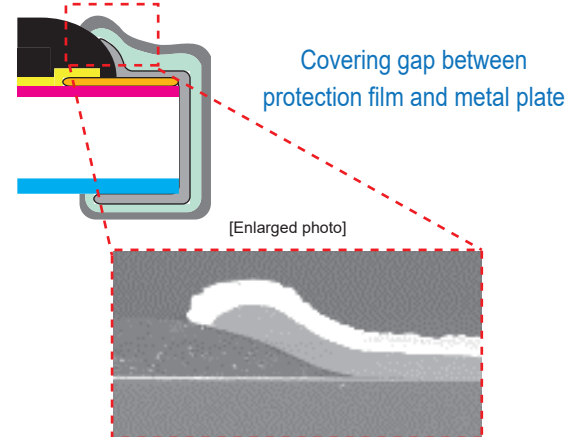
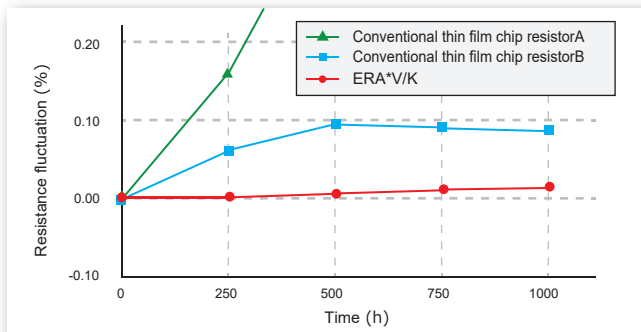
*1: ERA*A



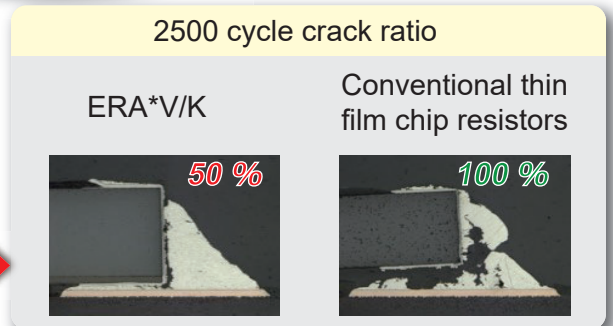
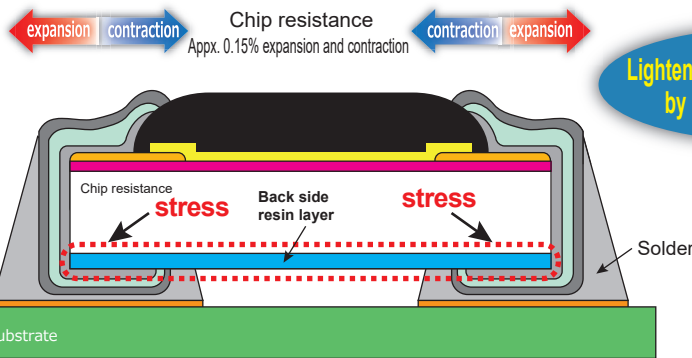
Improve anti-sulfurated by the introduction of edge sputtering electrode covering gap between protection film and electrode

Anti-sulfurated

- Sulfurization gas test
ASTM B809 : 105 °C 0603 Thin film chip resistors



Achieve excellent anti solder joint crack by back side resin layer



Specifications

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

*1: Expansion of resistance range

Please visit our website for details !



1206 size **NEW**

High voltage · High accuracy type

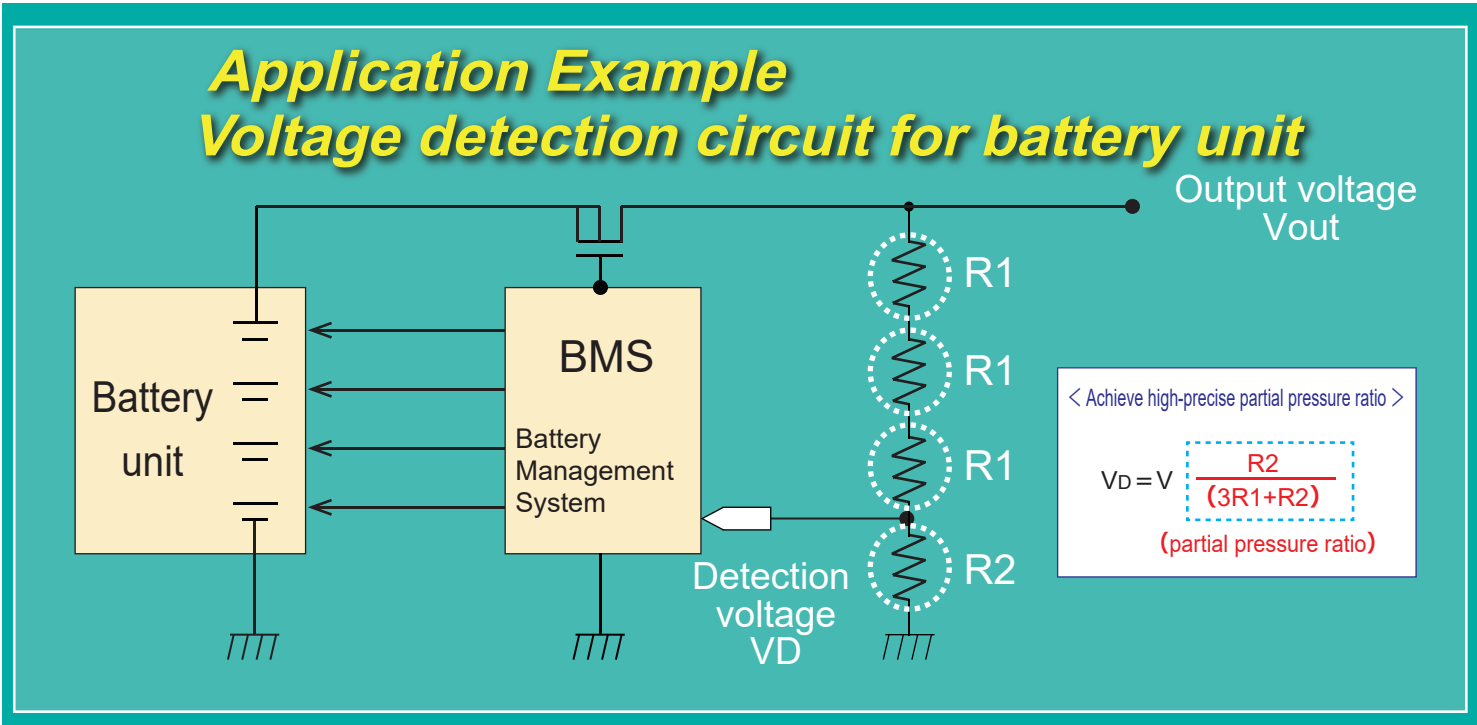
- High precision
- Low TCR
- Anti solder joint crack
- Anti-Surge
- AEC-Q200



ERA*P (Thin film) series ERJPM* (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 ppm/K
- ✓ Anti-solder crack design



■ Specifications

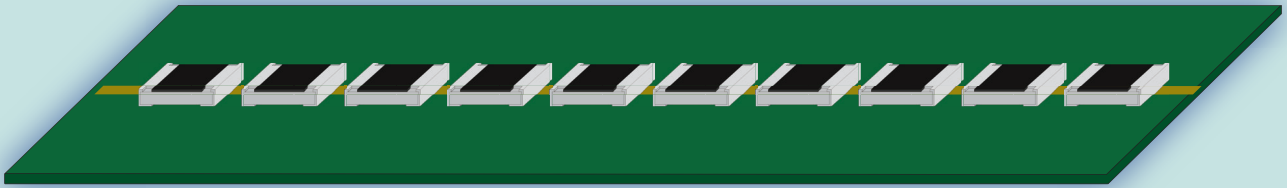
Part No.	Size (inch)	Power rating (W)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR (ppm/K)	Category temp. range (°C)
ERA8PPB	1206	0.25 (@85 °C)	500	± 0.1	160 k to 1 M (E24, E96)	± 15	-55 to +155
ERA8PEB						± 25	
ERJPM8F		0.66 (@70 °C)		± 1	1.02 M to 10 M (E24, E96)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

Please visit our website for details !



Proposal for the voltage sensing applications.

Current Other companies' products
0805 size × 10 pcs (300 kΩ)

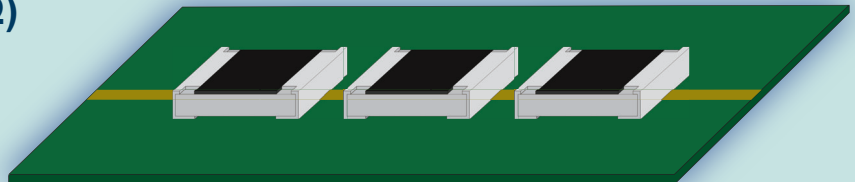


PCB sizing: 40.25 mm²



PCB down sizing
About 48%
Reduction

Suggestion A · B Our product
1206 size × 3 pcs. (1 MΩ)



PCB sizing: 21.15 mm²

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

Panasonic unique computation.

High precision High precision thick film type

High precision

Low TCR

Anti solder joint crack

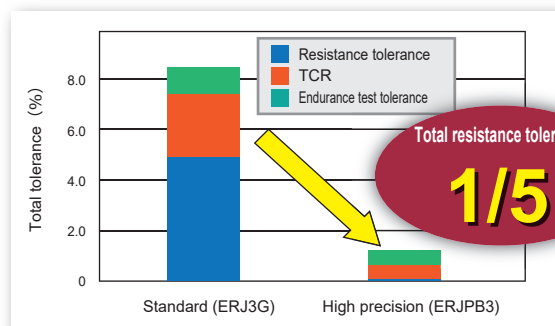
AEC-Q200

ERJPB series



Same tolerance level as thin film

- ✓ Resistance tolerance $\pm 0.1\%$
- ✓ TCR ± 50 ppm/K
- ✓ Endurance test tolerance $\pm 0.5\%$

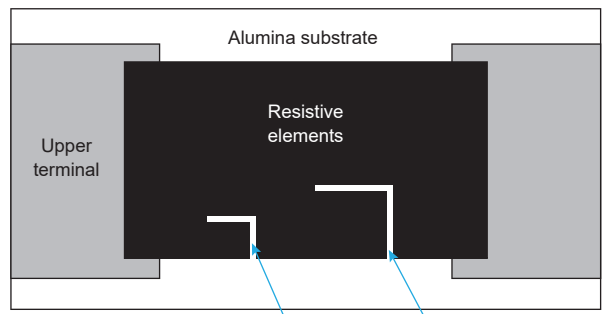


Cut the total tolerance to 1/5

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



Point Achieved high precision resistance tolerance : $\pm 0.1\%$ 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 (ppm/K)	Category temp. range ($^{\circ}\text{C}$)
ERJPB3B	0603	0.20	150	$\pm 0.1, \pm 0.5$	200 to 100 k	± 50	-55 to 155
ERJPB6B	0805	0.25	150	$\pm 0.1, \pm 0.5$	200 to 1M	± 50	

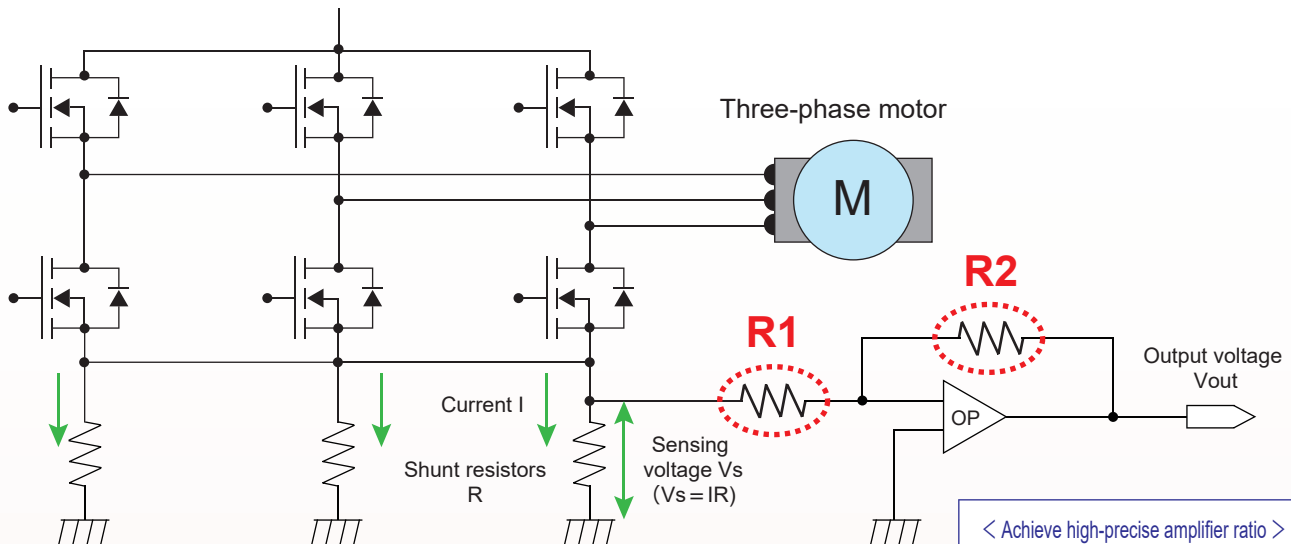
Please visit our website for details !



Application

Application Example

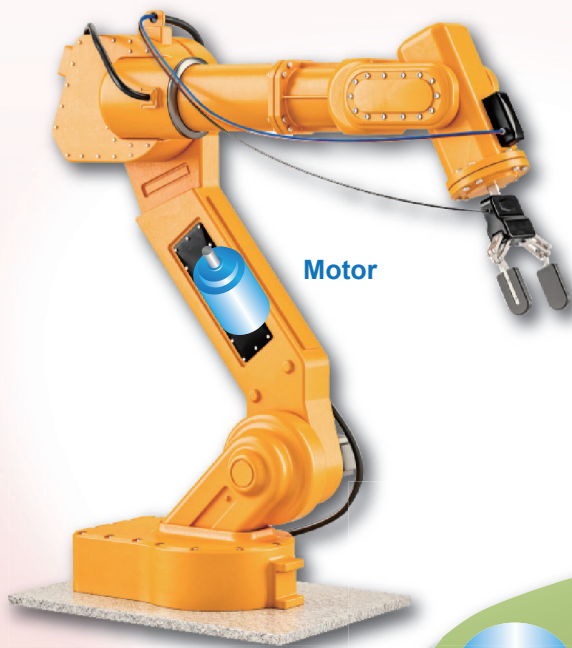
Current detection amplifier circuit for motor drive control unit



< Achieve high-precise amplifier ratio >

$$V_{out} = V_s \frac{R2}{R1}$$

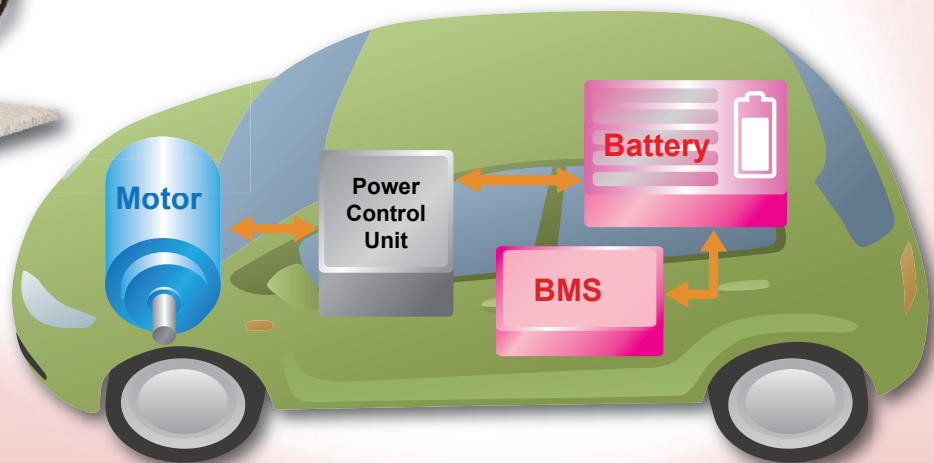
(amplification rate)



Industrial robot

Motor

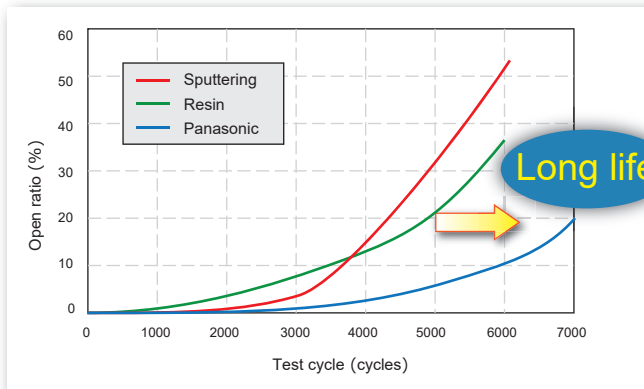
Automotive



Characteristics of panasonic thick film chip resistors

Anti solder joint crack

Reduces solder joint crack progression by originally developed soft terminal



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

Reduce solder joint crack

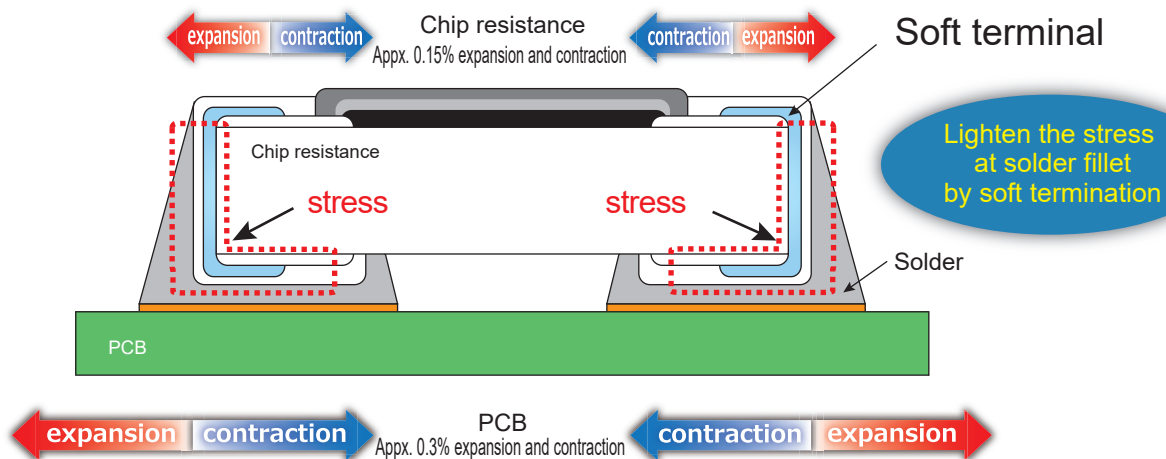
1. Long life for the set of device
2. Improvement of reliability



Point

Soft termination technology adopted

◆ Cooling and heating cycle lightens the stress ◆



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

Environment resistant High temperature chip resistor

Down sizing

High power

High temperature

Anti solder joint crack

AEC-Q200

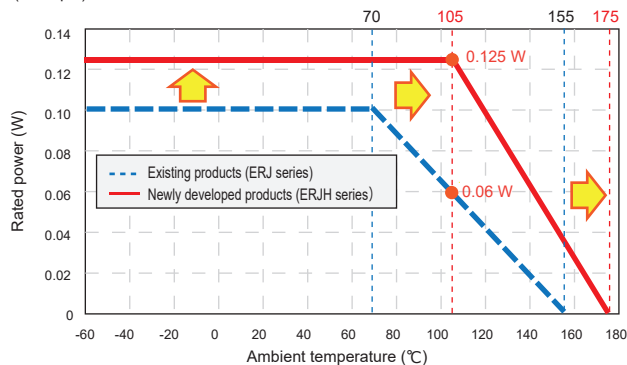
ERJH series



Achieves high heat resistance by new materials developing

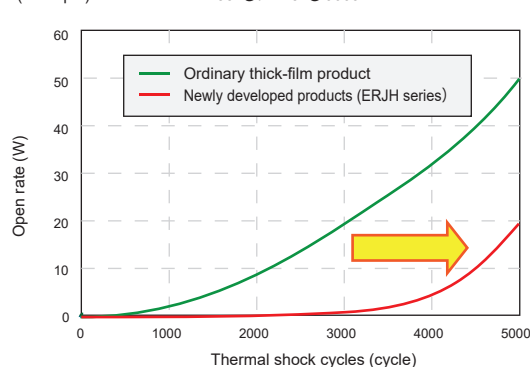
Expansion of maximum operating temperature and rated operating temperature

(Example) 0603 size Load reduction curve



Extended solder life by suppressing crack progress

(Example) Test conditions : -55 °C / +175 °C 0603 size



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

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



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

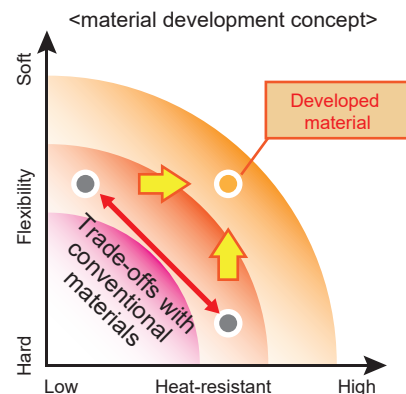
Overcome the trade-offs of conventional materials by reviewing the design of raw materials

✓ Improvement of operating temperature

✓ Suppression of solder cracks

Max operating temp. : 175 °C

Rated operating temp. : 105 °C



■ Specifications

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

Please visit our website for details !



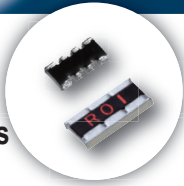
Environment resistant Anti-Sulfurated series

Anti-Sulfurated

Anti solder joint crack

AEC-Q200

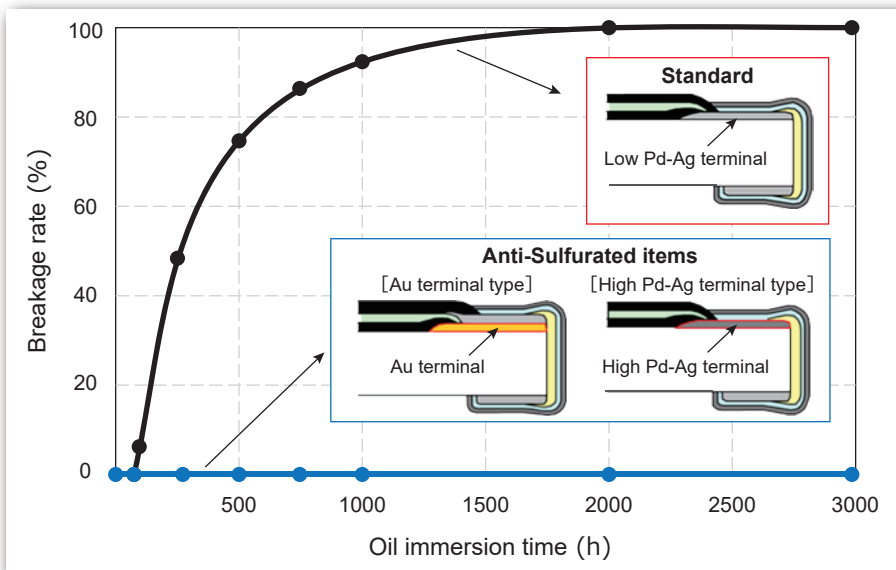
Standard : ERJS/U series Low resistance : ERJU*S/Q series
 Array ^{*1} : EXBU series Small size & High power : ERJC/ERJUP series
 High precision : ERJU*R series Wide terminal : ERJC series



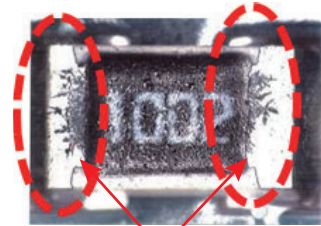
*1 : AEC-Q200 Grade 1

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

● Sulfurized oil immersion test of chip resistors

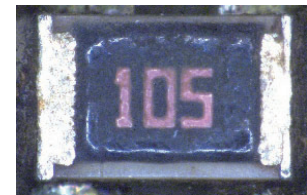


[Breakage in conventional items]

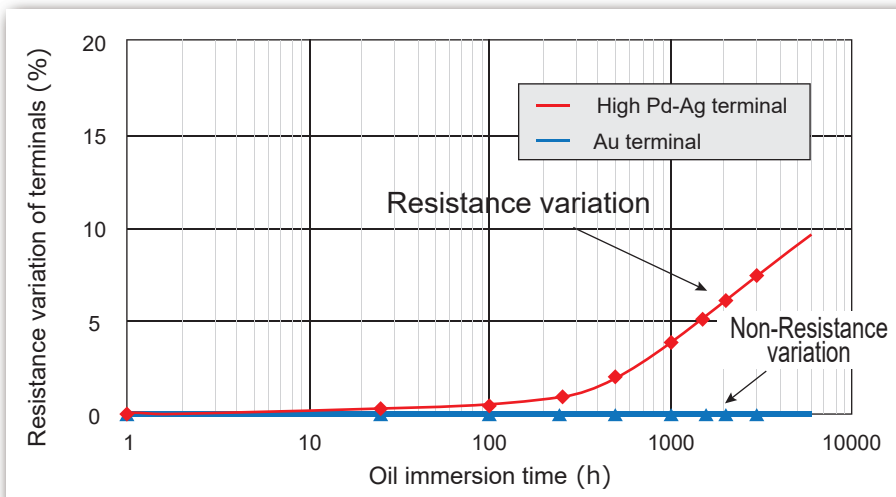


Sulfurated Ag needle crystal

[Non-Breakage in anti-sulfurated 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

Anti-Sulfurated series Line-up

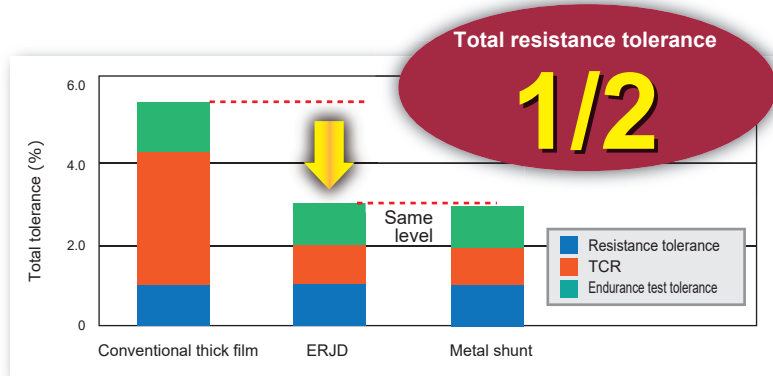
< Wide lineup of Anti-Sulfurated chip resistors with anti-sulfurated electrode >

Size (inch) Type		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 (0.1Ω to 10Ω)						ERJU6S					Click
						ERJU6Q					
Wide terminal	Low resistance (10mΩ to 1Ω)									ERJC1B	Click
										ERJC1C	
Array	2 resistors		EXBU14	EXBU24	EXBU34						Click
	4 resistors		EXBU18	EXBU28	EXBU38						
	8 resistors			EXBU2H							

ERJD series



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



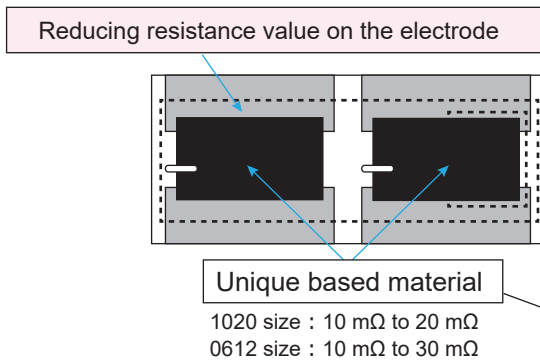
[Achieved TCR 350 → 100 ppm/K in 10 mΩ]

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 (°C)
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 !



Current sensing

Double-sided resistive elements structure type

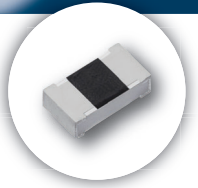
High power

Down sizing

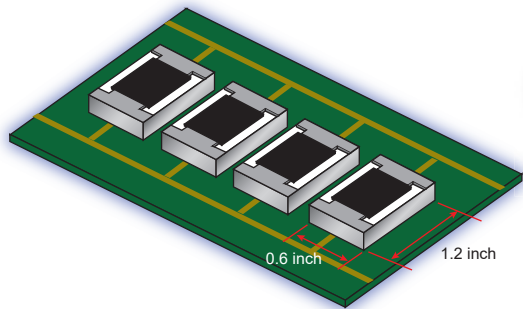
Anti solder joint crack

AEC-Q200

ERJ*BW series

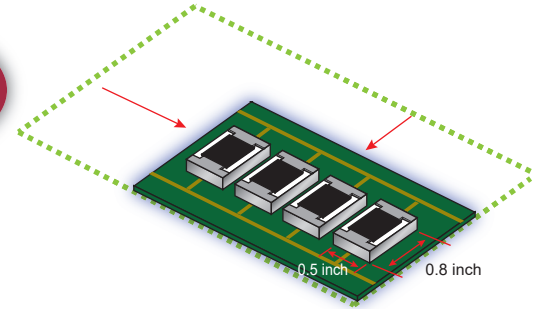
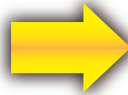


Small case size, low resistance, and high power by double-sided resistive elements structure



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

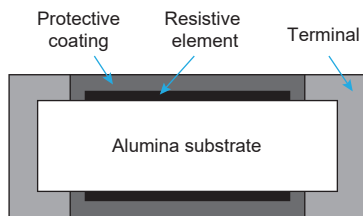
Point



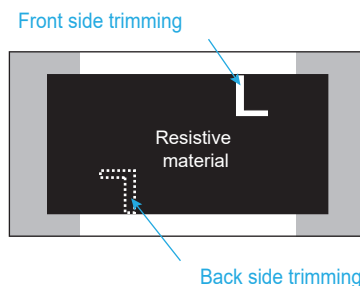
Realized small current sensing resistors by double-sided resistive elements structure

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 (ppm/K)	Category temp. range (°C)
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 200 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 !



Small size & High power Anti-Surge type

Down sizing

High power

Anti-Surge

Low TCR

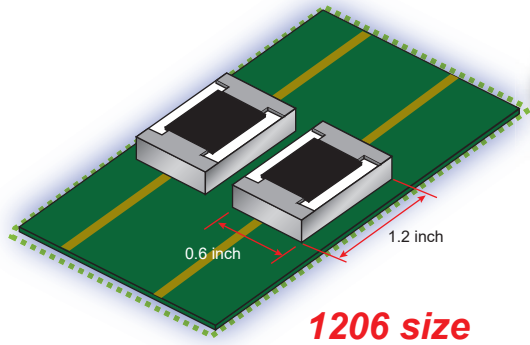
Anti solder joint crack

AEC-Q200

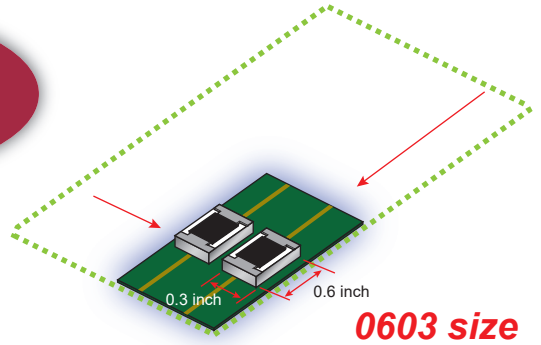
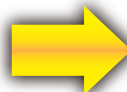
ERJPA/P0 series



Improvement of High power & Anti-Surge rating



PCB down sizing
69%

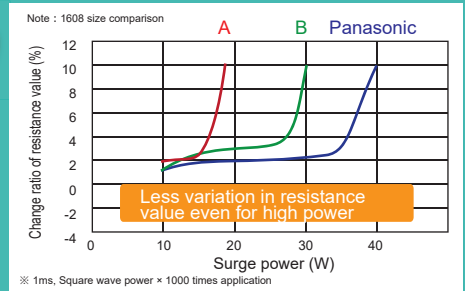


PCB area reduction

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

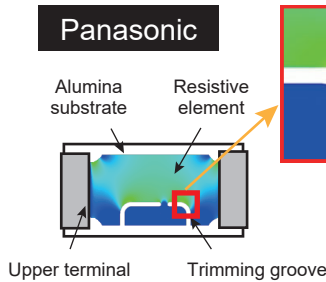
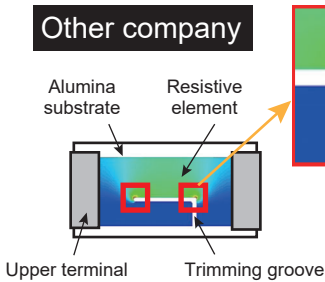
High Anti-Surge performance

1. Failure reduction
2. Design margin securing



Point

Surge distribution by unique resistive material / trimming



- Unique "Double-C shaped trimming" for surge distribution.
- Achieved small size & high power and overload characteristics.

Specifications

Part No.	Size (inch)	Power rating*1 (W)	Rated terminal part temperature (°C)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR*2 (ppm/K)	Category temp. range (°C)
ERJPA2	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.

Please visit our website for details !



Small size & High power Wide terminal type

Down sizing

High power

Anti-Surge

Low TCR

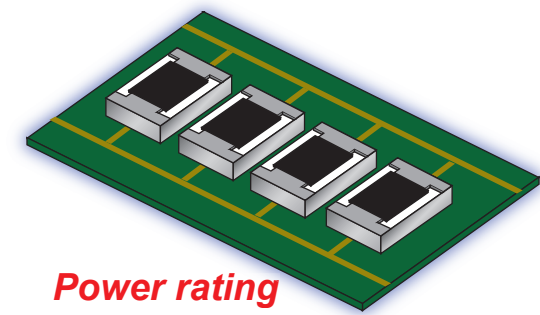
Anti solder joint crack

AEC-Q200

ERJB series

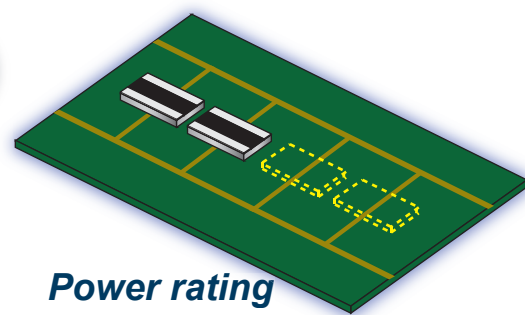


Improvement of High power & Anti-Surge rating



Power rating
1 W products x 4p

Number of pieces
50%



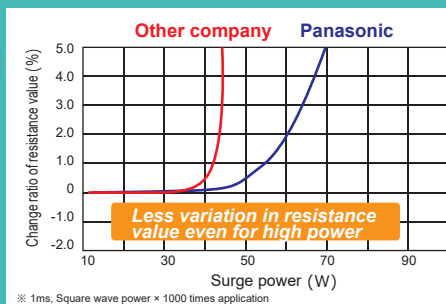
Power rating
2 W products x 2p

Number of pieces reduction

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

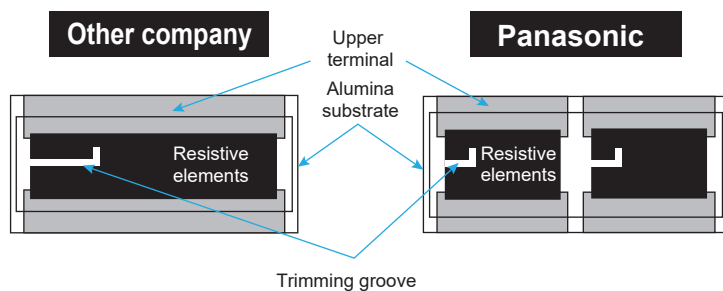
High Anti-Surge performance

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.
- Achieved small size & high power and overload characteristics.

Specifications

Part No.	Size (inch)	Power rating ^{*1} (W)	Rated terminal part temperature (°C)	Limiting element voltage (V)	Resistance tolerance (%)	Resistance range (Ω)	TCR ^{*2} (ppm/K)	Category temp. range (°C)
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	-55 to 155
		1.0 (10<R)	95			11 to 10 k (E24)	47mΩ≤R<100mΩ : 0 to +150 100mΩ≤R≤10kΩ : ± 100	
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	-55 to 155
		0.75 (1 K<R)	90			1.1 k to 1 M (E24)	100mΩ≤R<220mΩ : 0 to +100 220mΩ≤R≤10MΩ : ± 100	
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	-55 to 155

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


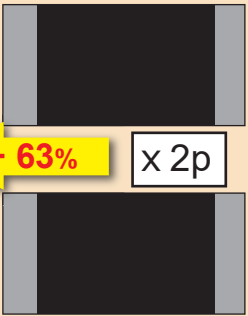






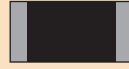


*2 : TCR is applied for the ± 1% product.

Please visit our website for details !



Down sizing proposal

By the replacement with high power resistors from standard resistors,
” Panasonic contributes to make PCB smaller.”

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

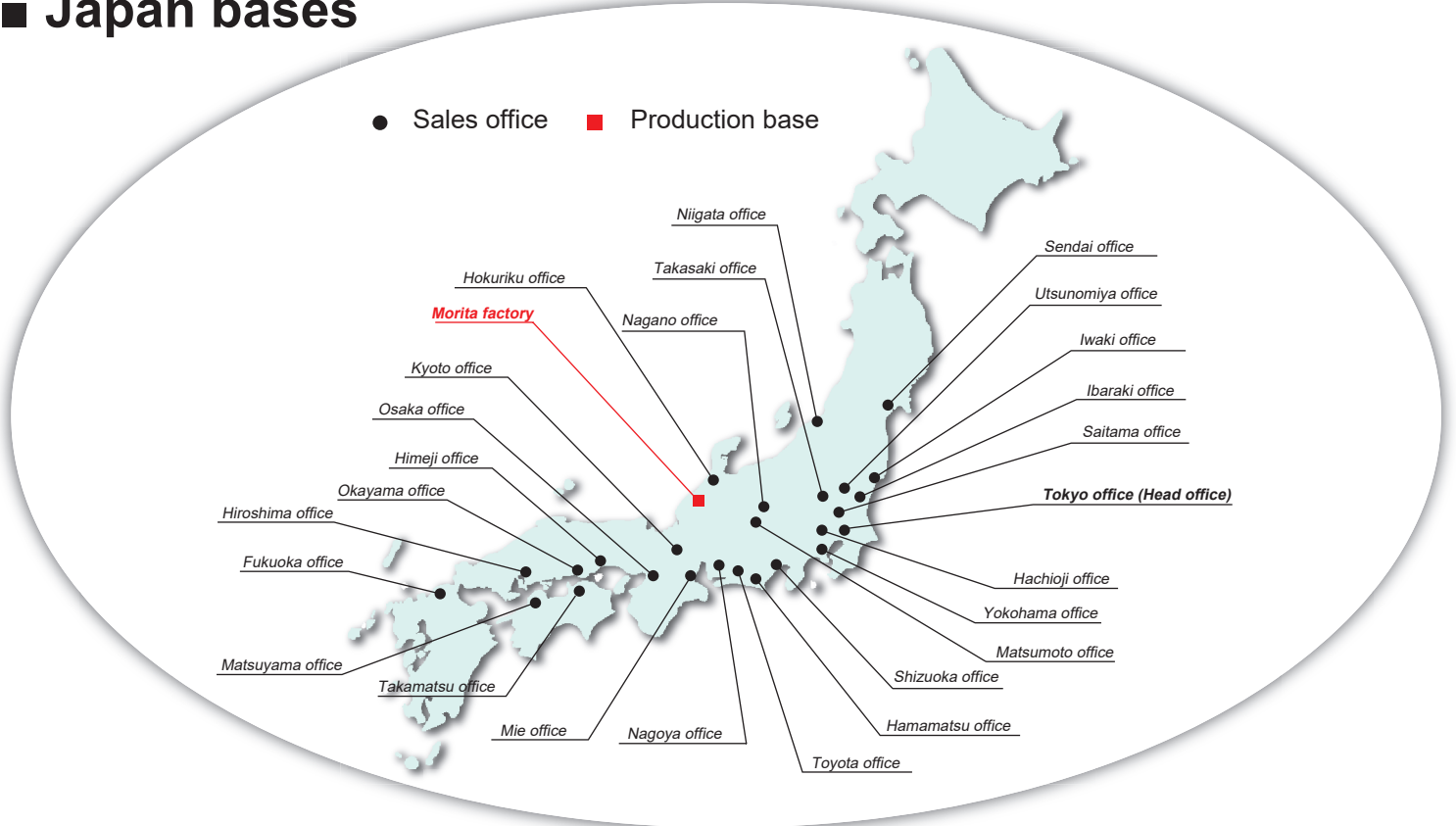
* “  ” means down sizing rate (%) of PCB.

Panasonic

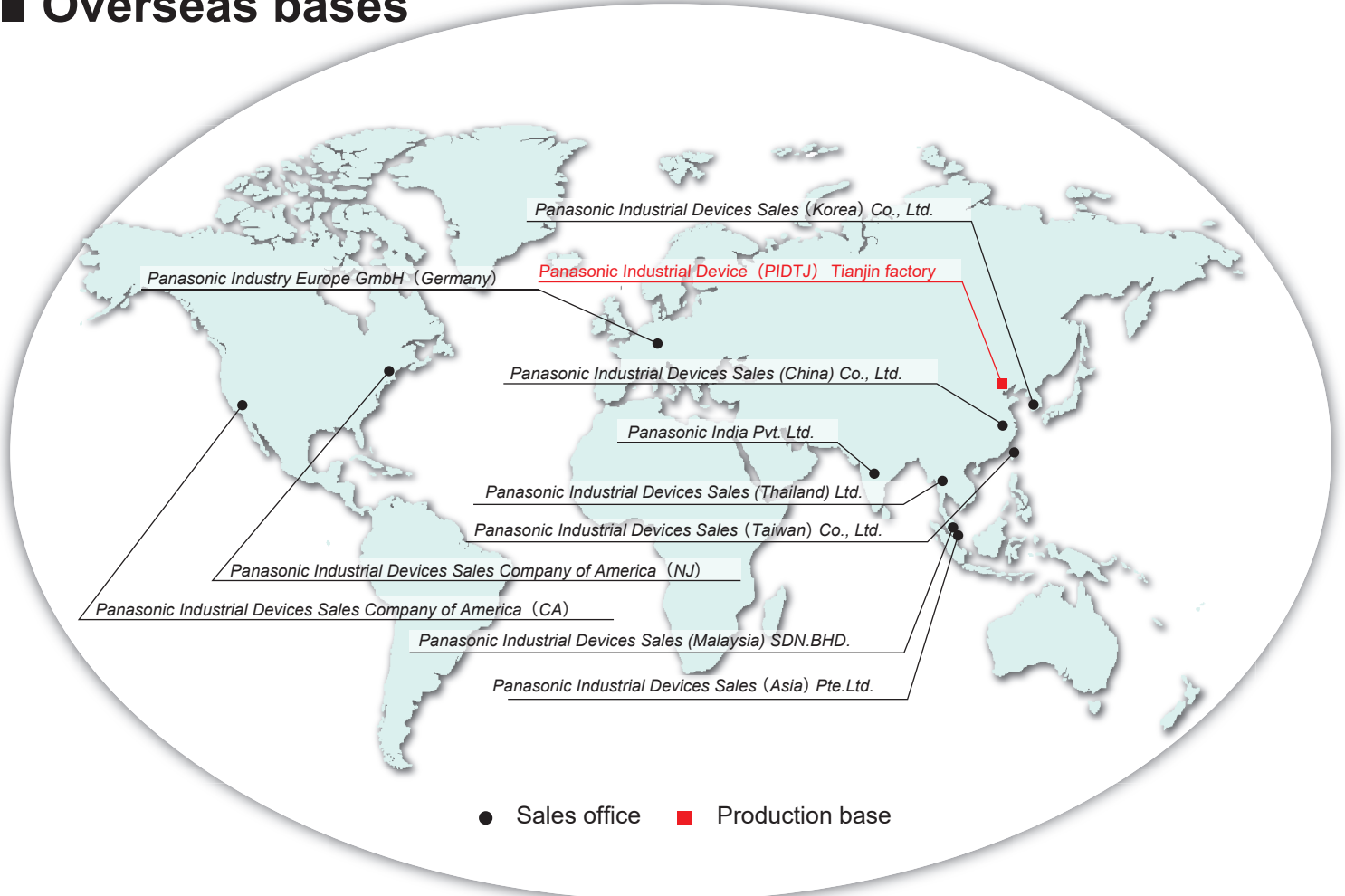
Standard

Main locations

Japan bases



Overseas bases



Safety 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

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